1 INTRODUCTION

Shell Canada Limited (Shell) is applying to the Alberta Energy and Utilities Board (EUB) and Alberta Environment (AENV) for the expansion of an integrated oil sands mining and bitumen extraction operation near Fort McKay, Alberta. The proposed project, named the Jackpine Mine Expansion & Pierre River Mine Project ("the Project"), will include an amendment to the Shell Jackpine Mine – Phase 1 approval for an expansion on the east side of the Athabasca River and a new approval for development of the Pierre River Mine, located on the west side of the Athabasca River.

For the purposes of this report, the Jackpine Mine Expansion is referred to as the Jackpine Expansion Mining Area (JEMA) and the Pierre River Mine is referred to as the Pierre River Mining Area (PRMA).

The JEMA will increase bitumen production at Jackpine Mine – Phase 1 by 100,000 barrels per day to a nominal bitumen production capacity of 300,000 barrels per day. This expansion will include additional mining areas and associated processing facilities, utilities and infrastructure.

The PRMA will produce up to 200,000 barrels per day of bitumen and will include additional mining areas and associated processing facilities, utilities and infrastructure.

Environmental Setting Reports (ESRs) have been prepared in support of the Environmental Impact Assessment (EIA) for the Project to provide information on existing environmental and cultural conditions in the assessment study areas. The environmental setting field studies for the Project have focused on portions of Leases 88, 89, 15, 631 and 632 for the JEMA and Leases 9, 17, 309, 310, 351 and 352 for the PRMA. Neighbouring leases and swap areas were also included in the field studies.

The Terrestrial ESR consists of six sections:

- Section 1 – Introduction.
- Section 2 – Soils and Terrain ESR.
- Section 3 – Terrestrial Vegetation, Wetlands and Forest Resources ESR.
- Section 4 – Forestry ESR.
- Section 5 – Wildlife and Wildlife Habitat ESR.
- Section 6 – Biodiversity ESR.

The associated appendices for each section are provided in entirety at the end of the report.

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SOIL AND TERRAIN ENVIRONMENTAL SETTING FOR THE JACKPINE MINE EXPANSION & PIERRE RIVER MINE PROJECT

Prepared For:
Shell Canada Limited

Prepared By:
Golder Associates Ltd.

December 2007 **05-1344-027**

50 BEST EMPLOYERS IN CANADA 2007

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TABLE OF CONTENTS

SECTION **PAGE**

2 SOILS AND TERRAIN 1
2.1 INTRODUCTION 1
2.1.1 Study Objectives 1
2.1.2 Study Areas 2
2.2 METHODS 7
2.2.1 Review of Existing Information 7
2.2.2 Soil Mapping and Soil Interpretation Program for the Regional Study Area 8
2.2.3 Soil Mapping and Soil Interpretation Program for the Local Study Area 9
2.3 REGIONAL RESULTS 19
2.3.1 Natural Region and Natural Subregions 19
2.3.2 Geology 21
2.3.3 Terrain Classification 23
2.3.4 Soil Classification 25
2.3.5 Land Capability for Forest Ecosystems 26
2.3.6 Soil Sensitivity to Acidification 29
2.4 JACKPINE EXPANSION MINING AREA RESULTS 30
2.4.1 Terrain Types 30
2.4.2 Soil Classification 38
2.4.3 Soil Map Unit Interpretations 44
2.5 PIERRE RIVER MINING AREA RESULTS 50
2.5.1 Terrain Types 50
2.5.2 Soil Classification 54
2.5.3 Soil Map Unit Interpretations 62
2.6 SUMMARY 67

LIST OF TABLES

Table 2.2-1 Correlation of Soil and Terrain Units in the Regional Study Area 8
Table 2.2-2 Parent Material Groupings 15
Table 2.3-1 Bedrock Groups and Formations of the Regional Study Area and Local Study Areas 21
Table 2.3-2 Terrain Units in the Regional Study Area 23
Table 2.3-3 Soil Series in the Regional Study Area 25
Table 2.3-4 Geographic Extent of Land Capability for Forest Ecosystems Classes in the Regional Study Area 26
Table 2.3-5 Series-Specific Mid Case and Fixed Case 50-Year Critical Loads 29
Table 2.4-1 Description of Terrain Types in the Jackpine Expansion Mining Area Local Study Area 30
Table 2.4-2 Geographic Extent of Terrain Units in the Jackpine Expansion Mining Project Local Study Area 32
Table 2.4-3 Geographic Extent of Slope Classes and Surface Expression in the Jackpine Expansion Mining Area Local Study Area 32
Table 2.4-4 Soil Map Unit Legend for the Jackpine Expansion Mining Area Local Study Area 40
Table 2.4-5 Geographic Extent of Soil Series in the Jackpine Expansion Mining Area Local Study Area 44

Table 2.4-6 Capability for Forest Ecosystems in the Jackpine Expansion Mining Area Local Study Area by Soil Map Unit 45
Table 2.4-7 Wind Erosion Risk Ratings in the Jackpine Expansion Mining Area Local Study Area by Soil Map Unit 47
Table 2.4-8 Water Erosion Risk Ratings in the Jackpine Expansion Mining Area Local Study Area by Soil Map Unit 47
Table 2.5-1 Description of Terrain Types in the Pierre River Mine Area Local Study Area 51
Table 2.5-2 Geographic Extent of Terrain Units in the Pierre River Mining Area Local Study Area 52
Table 2.5-3 Geographic Extent of Slope Classes and Surface Expression in the Pierre River Mining Area Local Study Area 54
Table 2.5-4 Soil Map Unit Legend for the Pierre River Mining Area Local Study Area 57
Table 2.5-5 Geographic Extent of Soil Series in the Pierre River Mining Area Local Study Area 61
Table 2.5-6 Land Capability for Forest Ecosystems in the Pierre River Mining Area Local Study Area 62
Table 2.5-7 Wind Erosion Risk Ratings in the Pierre River Mining Area Local Study Area 64
Table 2.5-8 Water Erosion Risk Ratings in the Pierre River Mining Area Local Study Area 64

LIST OF FIGURES

Figure 2.1-1 Terrestrial Resources Regional Study Area 3
Figure 2.1-2 Jackpine Expansion Mining Area Terrestrial Resources Local Study Area 5
Figure 2.1-3 Pierre River Mining Area Terrestrial Resources Local Study Area 6
Figure 2.2-1 Soil Inspection Locations Jackpine Expansion Mining Area Local Study Area 10
Figure 2.2-2 Soil Inspection Locations Pierre River Mining Area Local Study Area 12
Figure 2.3-1 Natural Subregions in the Regional and Local Study Areas 20
Figure 2.3-2 Bedrock Geology of the Regional Study Area and Local Study Areas 22
Figure 2.3-3 Dominant Terrain Map Units in the Regional Study Area 24
Figure 2.3-4 Dominant Soil Series in the Regional Study Area 27
Figure 2.3-5 Land Capability for Forest Ecosystems in the Regional Study Area 28
Figure 2.4-1 Dominant Terrain Units in the Jackpine Expansion Mining Area Local Study Area 36
Figure 2.4-2 Slope Classes and Surface Expression in the Jackpine Expansion Mining Area Local Study Area 37
Figure 2.4-3 Dominant Soil Series in the Jackpine Expansion Mining Area Local Study Area 39
Figure 2.4-4 Land Capability for Forest Ecosystems in the Jackpine Expansion Mining Area Local Study Area 46
Figure 2.4-5 Wind Erosion Risk for Exposed Mineral Soils in the Jackpine Expansion Mining Area Local Study Area 48
Figure 2.4-6 Water Erosion Risk for Exposed Mineral Soils in the Jackpine Expansion Mining Area Local Study Area 49
Figure 2.5-1 Dominant Terrain Map Units in the Pierre River Mining Area Local Study Area 53
Figure 2.5-2 Slope Classes and Surface Expression in the Pierre River Mining Area Local Study Area 55
Figure 2.5-3 Dominant Soil Series in the Pierre River Mining Area Local Study Area 56

Figure 2.5-4 Land Capability for Forest Ecosystems in the Pierre River Mining Area Local Study Area....63
Figure 2.5-5 Wind Erosion Risk for Exposed Mineral Soils in the Pierre River Mining Area Local Study Area....65
Figure 2.5-6 Water Erosion Risk for Exposed Mineral Soils in the Pierre River Mining Area Local Study Area....66

LIST OF APPENDICES

Appendix A Key to Abbreviations Used in Soil Map Units and Inspection List
Appendix B Soil Series Descriptions
Appendix C Soil Inspection Site List
Appendix D Soil Map Unit Descriptions
Appendix E Composition Of Soil Map Units
Appendix F Soil Chemistry
Appendix G Land Capability Worksheets

2 SOILS AND TERRAIN

2.1 INTRODUCTION

This Soil and Terrain Environmental Setting Report (ESR) complements and extends information collected for Muskeg River Mine (1999), Jackpine Mine – Phase 1 (2002) and Muskeg River Mine Expansion (2006). New data collected for the Shell Canada Limited (Shell) Jackpine Mine Expansion & Pierre River Mine Project (the Project), combined with the existing information on Shell project areas, other regional information and the project design provide the environmental setting data required to prepare the Environmental Impact Assessment (EIA) for the Project. Environmental setting information on soils and terrain, including soil data analysis and interpretation for land capability and soil suitability for reclamation is required for the impact assessment, closure, conservation and reclamation planning Closure, Conservation and Reclamation Plan (CC&R Plan), mitigation and monitoring program planning.

2.1.1 Study Objectives

The goal of this ESR is to describe the existing soil and terrain of the Regional Study Area (RSA) and both Local Study Areas (LSAs) to facilitate impact analysis associated with the Project and to serve as the basis for reclamation planning. The specific objectives of the ESR are the following:

- map and describe the soil series and map units in the RSA and the LSAs;
- map and describe the terrain units and topography in the RSA and the LSAs;
- map and describe the surficial geology in the LSAs;
- assess the land capability for forestry of soil series in the LSAs;
- assess the reclamation suitability of each soil series in the LSAs to aid in reclamation planning;
- list the soil series specific acidification critical loads in the RSA;
- assess the sensitivity of soils in the LSAs to erosion;
- assess the reclamation suitability of topsoil and subsoil in the LSAs and determine the approximate volume of suitable soil materials available for reclamation;
- assess the preliminary reclamation suitability of overburden; and

- collect baseline soil chemistry for the LSAs to support soil reclamation suitability and land capability for forestry ratings.

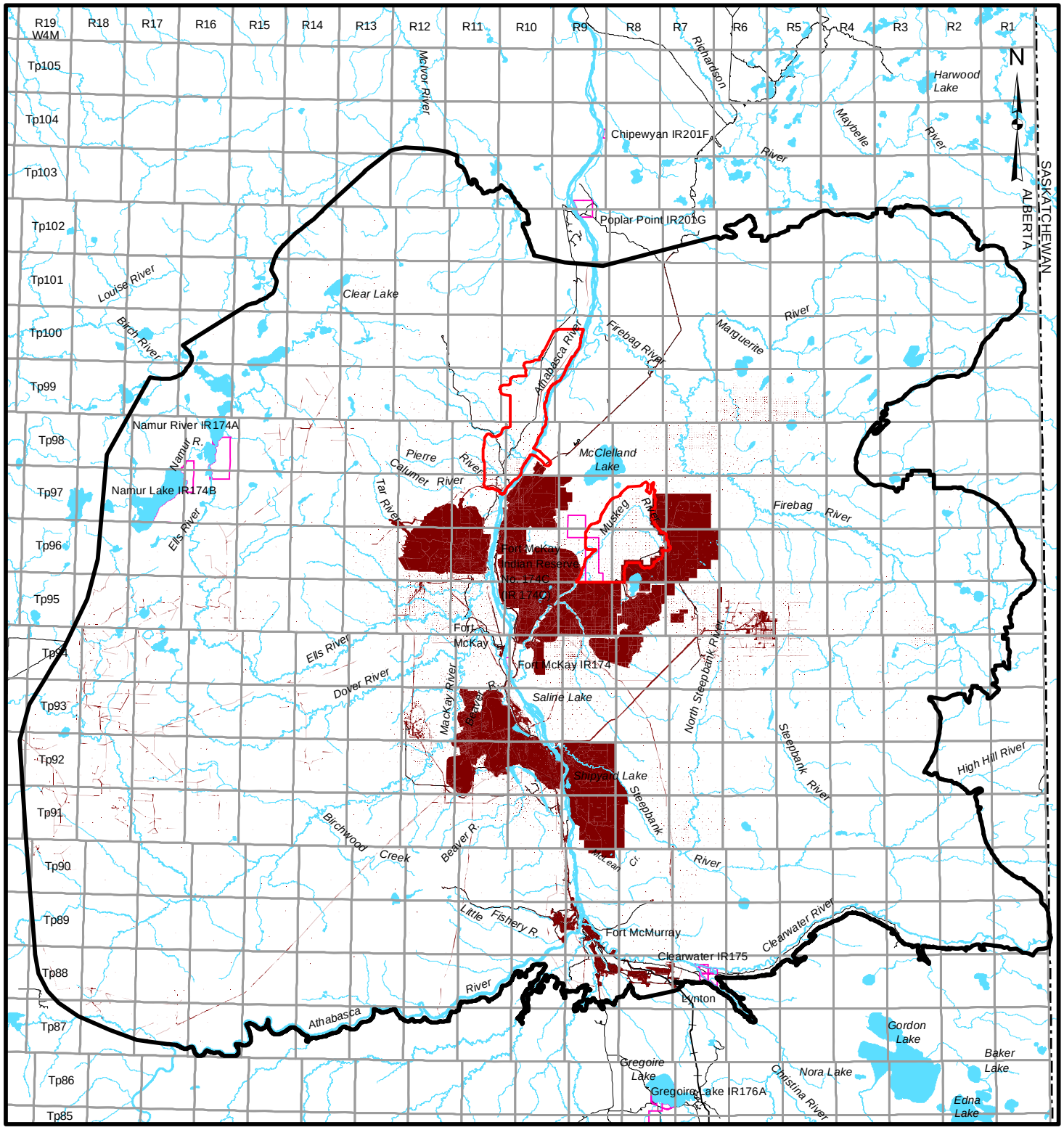
2.1.2 Study Areas

The Terrestrial LSAs and RSA were developed with consideration of all terrestrial components (soil and terrain, terrestrial vegetation, wetlands and forest resources, wildlife and wildlife habitat and biodiversity). Therefore, the LSAs and RSA used for this report are used for all Terrestrial Resources components.

The RSA was established to assess the the importance of the Project within a broad regional area (Figure 2.1-1). The RSA is in the Central Mixedwood and the Athabasca Plain natural subregions (NRC 2006) of the Boreal Natural Region. The RSA encompasses an area of 2,277,376 ha and covers Townships 87 to 103, Ranges 1 to 19, W4M (Figure 2.1-1). The RSA boundary was defined with consideration of the following terrestrial resources:

- ecodistrict boundaries;
- geographic or topographic boundaries such as the eastern shoulder of the Birch Mountains;
- defined woodland caribou habitat areas (e.g., Audet, Firebag and Steepbank caribou areas);
- average distance of two moose home ranges from oil sands developments (about 26 km);
- allowances for the major river systems (e.g., Athabasca and Clearwater rivers) that act as natural study boundaries; and
- inclusion of the community of Fort McMurray and other areas likely to expand in the future.

Terrain, landforms, topography and soils in the RSA have been described previously (Golder 1998, 2002, 2003c; CNRL 2002, Shell 2005).



LEGEND

- TERRESTRIAL RESOURCES REGIONAL STUDY AREA
- LOCAL STUDY AREAS
- INDIAN RESERVE
- OPEN WATER
- PUBLIC ROADWAY
- RAILROAD

DISTURBED

- EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE
- EXISTING AND APPROVED URBAN AND INDUSTRIAL LINEAR DISTURBANCE

REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2004), Pearson Timberline Ltd. (April 2004), AOSERP (1982), EUB, AGS, LANDSAT 7 ETM Imagery (July 2006), and Alberta SRD, used under license. Saskatchewan digital data obtained from Information Services Corp. (September 2004), used under license.
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 12.

30 0 30
SCALE 1:1,000,000 KILOMETRES

PROJECT
JACKPINE MINE EXPANSION & PIERRE RIVER MINE PROJECT

TITLE
TERRESTRIAL RESOURCES REGIONAL STUDY AREA

Shell Canada Limited

PROJECT No. 05-1344-027.7400			SCALE AS SHOWN	REV. 0
DESIGN	VR	22 Jan. 2007	FIGURE: 2.1-1	
GIS	JH	17 Nov. 2007		
CHECK	DD	17 Nov. 2007		
REVIEW	WES/TC	19 Nov. 2007		

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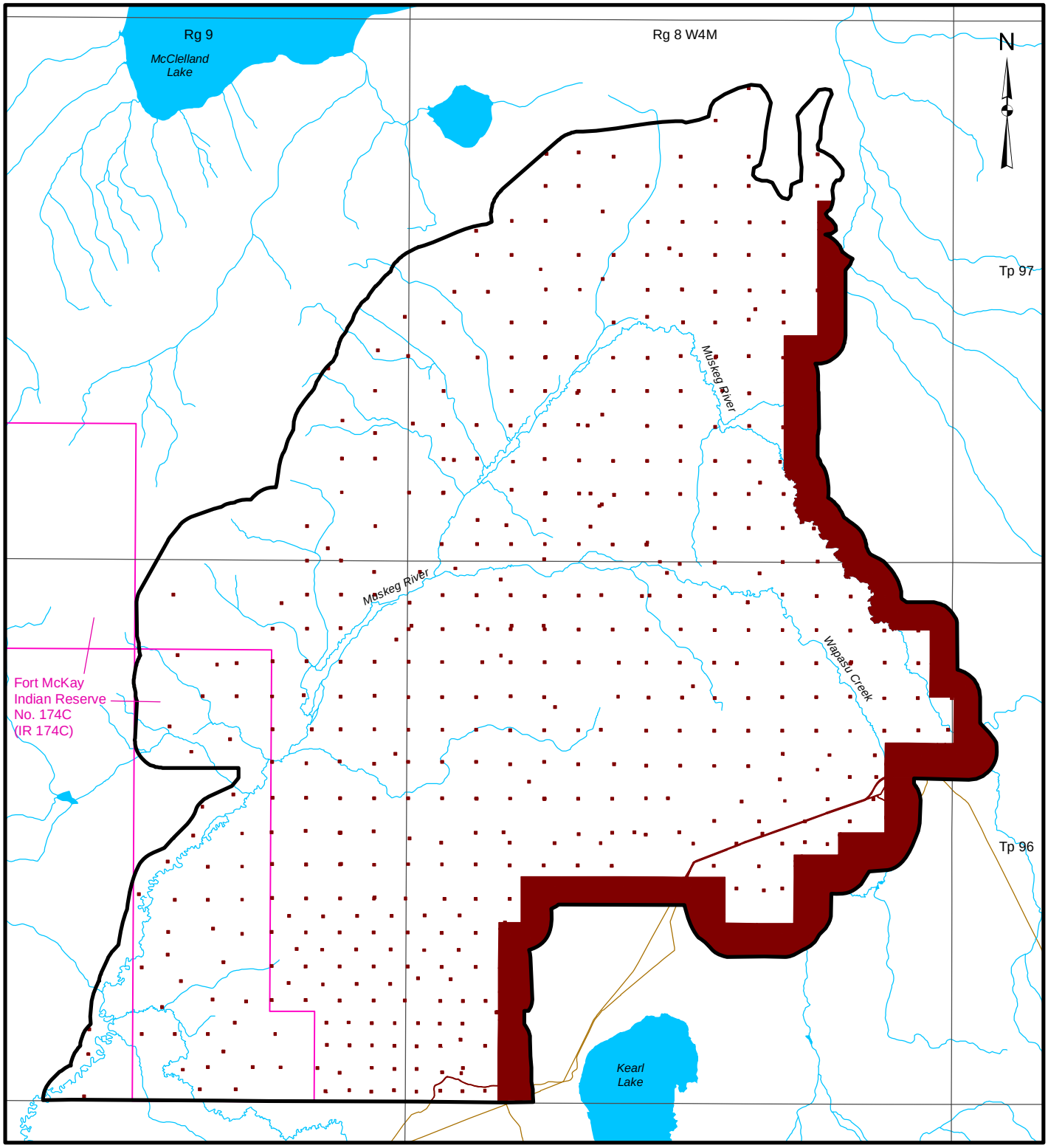
There are two LSAs for the Project (Figures 2.1-2 and 2.1-3). The Jackpine Expansion Mining Area (JEMA) LSA is along the Muskeg River north and east of the approved Jackpine Mine – Phase 1 and covers an area of 18,348 ha. The Pierre River Mining Area (PRMA) LSA is located on the west side of the Athabasca River, north of the approved Canadian Natural Resources Limited (Canadian Natural) Horizon Project and covers an area of 21,136 ha.

The JEMA and PRMA LSAs are established to assess the effects of the Project at the local scale. They fall within the Central Mixedwood and Athabasca Plains Natural Subregions (NRC 2006) and the following townships:

- Township 96, Ranges 8 and 9, W4M;
- Township 97, Ranges 8 and 11, W4M;
- Township 98, Ranges 10 and 11, W4M;
- Township 99, Range 9; and
- Township 100, Ranges 9 and 10, W4M.

The extent of the Project LSAs was defined on the basis of the project development area plus a buffer zone to account for indirect effects of the project. This buffer zone is based on a 500 m offset from the project development area but varies in width depending on the configuration of the project footprint, as well as land uses and natural features in the surrounding area. The JEMA LSA is bounded on the east by the Imperial Oil Resources Ventures Limited (Imperial Oil) Kearl Oil Sands Project (Kearl Project). To the south, the JEMA LSA abuts the approved Shell Jackpine Mine – Phase 1 development area. The PRMA LSA is bound by the Athabasca River to the east.

All environmental setting surveys were centred on the Project LSAs. However, environmental setting surveys were conducted before the Project footprint was finalized, resulting in some survey locations occurring outside of the boundaries of the LSAs. Data collected from these survey locations were included in the analyses.



LEGEND

- JACKPINE EXPANSION MINING AREA LOCAL STUDY AREA
- INDIAN RESERVE
- OPEN WATER
- PUBLIC ROADWAY

DISTURBED

- EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE
- EXISTING AND APPROVED URBAN AND INDUSTRIAL LINEAR DISTURBANCE

3 0 3

SCALE 1:100,000 KILOMETRES

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PROJECT

JACKPINE MINE EXPANSION & PIERRE RIVER MINE PROJECT

TITLE

JACKPINE EXPANSION MINING AREA
TERRESTRIAL RESOURCES LOCAL STUDY AREA

Shell Canada Limited

PROJECT No. 05-1344-027.9000			SCALE AS SHOWN	REV. 0
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REVIEW	WES/TC	19 Nov. 2007		

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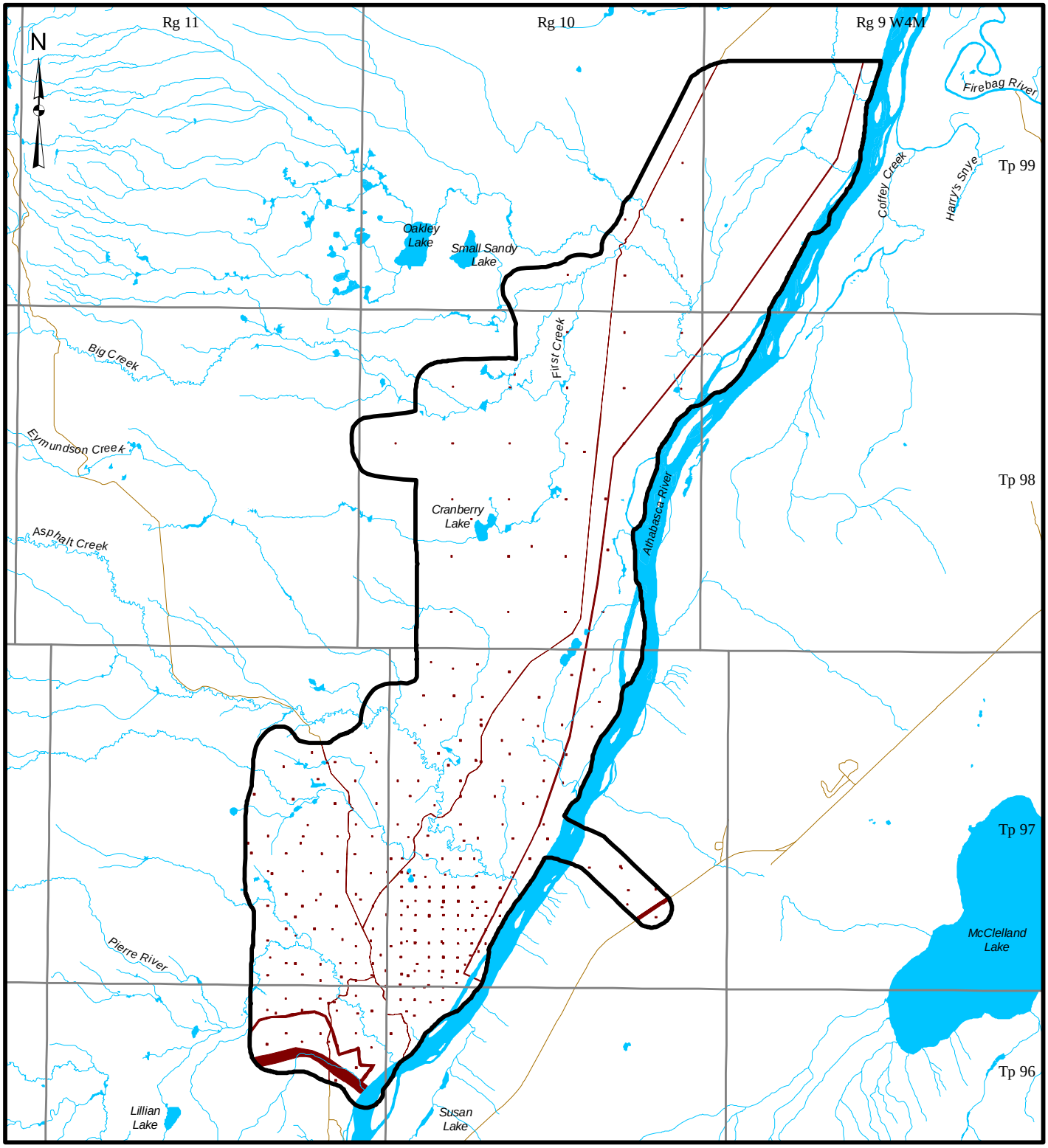

LEGEND

- PIERRE RIVER MINING AREA LOCAL STUDY AREA
- OPEN WATER
- ROAD

4 0 4

SCALE 1:160,000 KILOMETRES

DISTURBED

- EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE
- EXISTING AND APPROVED URBAN AND INDUSTRIAL LINEAR DISTURBANCE

REFERENCE

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PROJECT

JACKPINE MINE EXPANSION & PIERRE RIVER MINE PROJECT

TITLE

PIERRE RIVER MINING AREA
TERRESTRIAL RESOURCES LOCAL STUDY AREA

Shell Canada Limited

PROJECT No. 05-1344-027.7400			SCALE AS SHOWN	REV. 0
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CHECK	DD	17 Nov. 2007		
REVIEW	WES/TC	19 Nov. 2007		

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2.2 METHODS

2.2.1 Review of Existing Information

Existing soil survey information for the LSAs and RSA was reviewed for the pre-planning and interpretation stages. Pertinent information sources included:

- ecoregions and ecodistricts of Alberta (Strong 1992; Strong and Leggat 1992a,b);
- surficial geology maps and reports (Bayrock 1971; Bayrock and Reimchen 1974);
- Alberta Oil Sands Environmental Research Program (AOSERP) (Turchenek and Lindsay 1982);
- Alberta Vegetation Inventory (AVI) maps (Alberta-Pacific Forest Industries 2000; AEP 1997);
- the latest edition of the Alberta Soil Names File (AG30SNF) distributed as part of Agricultural Region of Alberta Soil Inventory Database (AGRASID) (ASIC 2006, website);
- Integrated Oil Sands Projects: A Checklist for Submissions (AENV 2002); and
- soil surveys for regional EIAs including:
  - Suncor Energy Inc. (Suncor) Voyageur Upgrader and North Steepbank Mine (Suncor 2005);
  - Shell Jackpine Mine – Phase 1 (Shell 2002);
  - Albian Sands Energy Inc. (Albian Sands) Muskeg River Mine Project and Muskeg River Mine Expansion (Shell 1997, 2005; AXYS 2004);
  - Deer Creek Energy Joslyn Project (Deer Creek Energy 2005);
  - Suncor Voyaguer South Project EIA (Suncor 2007); and
  - Imperial Oil Kearl Project EIA (Imperial Oil 2005).

.

2.2.2 Soil Mapping and Soil Interpretation Program for the Regional Study Area

2.2.2.1 Soil Mapping in the Regional Study Area

Soil and terrain map units for the RSA were derived from the existing AOSERP mapping in the Oil Sands Region (Turchenek and Lindsay 1982), which was recently revised for the Cumulative Environmental Management Association (CEMA) NO_x/SO_x Management Working Group (Golder 2001).

Regional Study Area soil map unit data and characteristics were used to determine forest capability, terrain types and soil series in the RSA as follows:

- Forest land capability ratings - forest capability was assessed by determining the forest capability for individual soil series using the *Revised Land Capability Classification for Forest Ecosystems in the Oil Sands* (CEMA 2006). Soil physical characteristics and analytical characteristics for individual series were determined from modal characteristics outlined in published reports and EIAs.
- Terrain types – terrain types were determined based on the correlation between soil units and terrain type as outlined in Table 2.2-1.
- Potential for acidification - Soil series-specific critical loads as developed for the NO_x/SO_x Management Working Group of CEMA (CEMA 2004).

Table 2.2-1 Correlation of Soil and Terrain Units in the Regional Study Area

Soil Unit – Name/Map Units	Terrain Unit – Name/Map Units
Algar Lake, Dover, Joslyn, Kearl, Steepbank	glaciolacustrine (Lg)
Buckton, Horse River, Kinosis, Legend	morainal - fine textured (M1)
Bitumount, Firebag, Fort, Mildred, Ruth Lake	glaciofluvial (Fg)
Gipsy, Surmont	morainal - coarse textured (M2)
Muskeg, Conklin, McLelland, Bayard	fen (N)
Mariana, Wabasca, Hartley	shallow fen (Ns)
Gregoire, Mikkwa	bog (B)
McMurray, Namur	fluvial (F)
Marguerite	eolian (E)
Livock	glaciofluvial or glaciolacustrine over moraine (LFg/M)

2.2.3 Soil Mapping and Soil Interpretation Program for the Local Study Area

Soil mapping was conducted following the guidelines outlined in:

- A Soil Mapping System for Canada: Revised (Agriculture Canada 1981);
- Soil Quality Criteria Relative to Disturbance and Reclamation (Alberta Agriculture 1987); and
- Canadian System of Soil Classification (Agriculture Canada 1998).

The key to the symbols used in soil map unit designation are outlined in Appendix A. Soil series descriptions are outlined in Appendix B, the list of field inspection sites is in Appendix C and detailed soil map unit descriptions are provided in Appendix D.

Field Soil Survey Program in the Local Study Areas

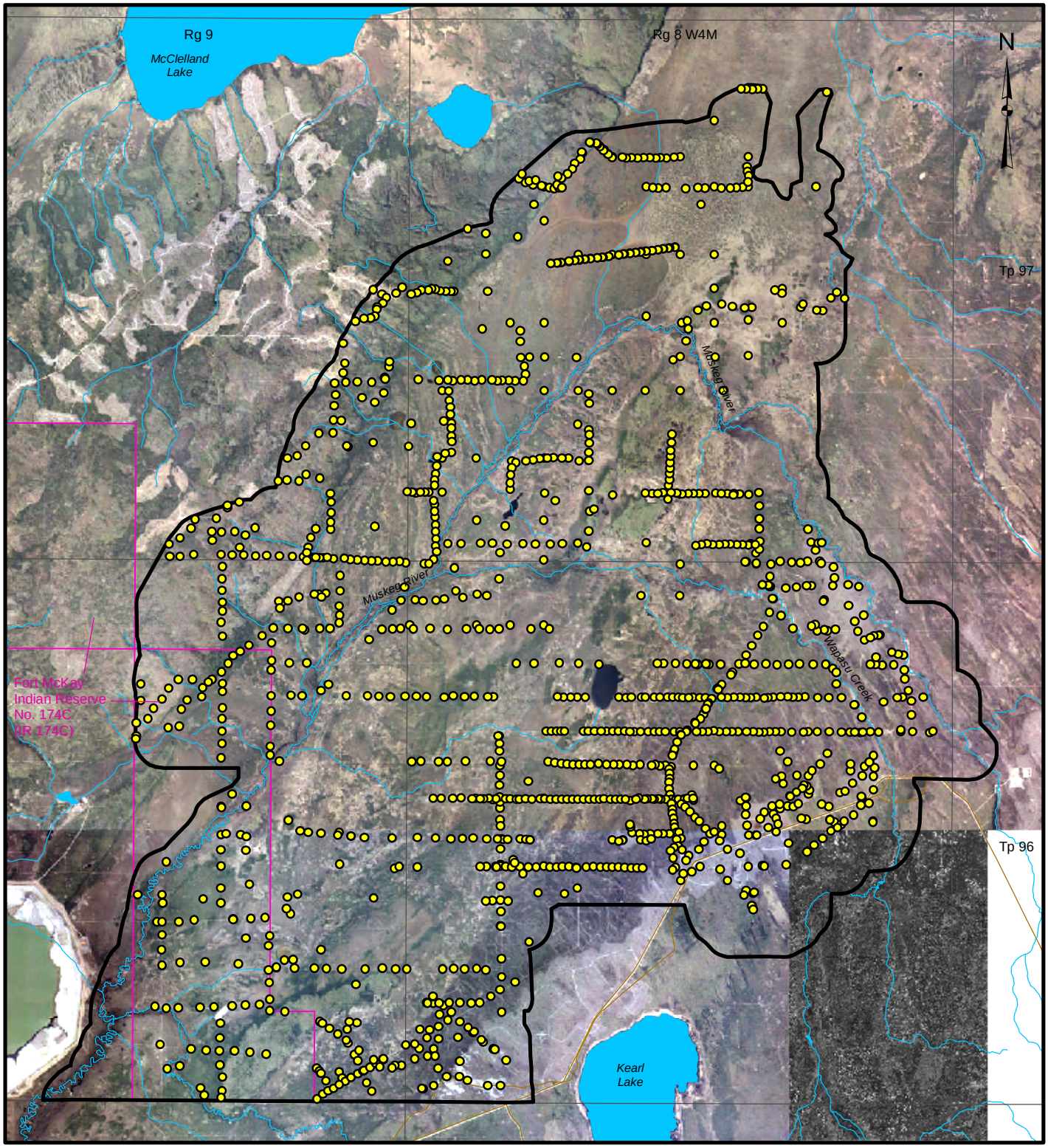
A pedologic approach to soil mapping (i.e., air photo interpretation and relating soils to geomorphology, topography and vegetation patterns) was used. Soil mapping included:

- review of existing soils information and pertinent published soil mapping;
- pre-typing of soil polygons on an aerial photograph base;
- field investigations to confirm soils and polygon boundaries; and
- preparation of the final maps at suitable scale (1:20,000).

Field Inspections

In the JEMA LSA of 18,348 ha, 1,269 soil observations were recorded, resulting in an average sampling intensity of one inspection site per 14 ha (Figure 2.2-1). In the JEMA development area of 14,350 ha, there were 1,111 soil observations, resulting in an average sampling intensity of one inspection site per 13 ha. The field inspection density in the JEMA development area is considered adequate for a Level 1 soil survey as:

- the soil field work and mapping by experienced soil surveyors was based on accepted pedology soil survey principals; and
- a large proportion of the area consists of a few, uniform soils which do not require closely spaced observations. Mildred soils on glaciofluvial deposits comprise 2,002 ha (11%) of the LSA and deep organic soils (Albian, McLelland and Muskeg) comprise 8,590 ha (47%).



LEGEND

- JACKPINE EXPANSION MINING AREA LOCAL STUDY AREA
- INDIAN RESERVE
- OPEN WATER
- PUBLIC ROADWAY

SOIL INSPECTION LOCATIONS

- SOIL INSPECTION SITE

3 0 3

SCALE 1:100,000 KILOMETRES

REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2004), Alberta SRD, and SOIL-INFO Ltd. (2007), used under license. Imagery (Orthophoto) obtained from Shell Canada (August 2005).
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 12.

PROJECT

JACKPINE MINE EXPANSION & PIERRE RIVER MINE PROJECT

TITLE

SOIL INSPECTION LOCATIONS JACKPINE EXPANSION MINING AREA LOCAL STUDY AREA

Shell Canada Limited

PROJECT No. 05-1344-027.9000			SCALE AS SHOWN	REV. 0
DESIGN	VR	06 Jun. 2007	FIGURE: 2.2-1	
GIS	JH	17 Nov. 2007		
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REVIEW	WES/TC	19 Nov. 2007		

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In the PRMA LSA of 21,136 ha, 898 soil observations were recorded, resulting in an average sampling intensity of one inspection site per 23 ha (Figure 2.2-2) (Appendix C). In the PRMA development area of 10,403 ha, there were 599 soil observations, resulting in an average sampling intensity of one inspection site per 17 ha. The field inspection density in the PRMA development area is considered adequate for a Level 1 soil survey as:

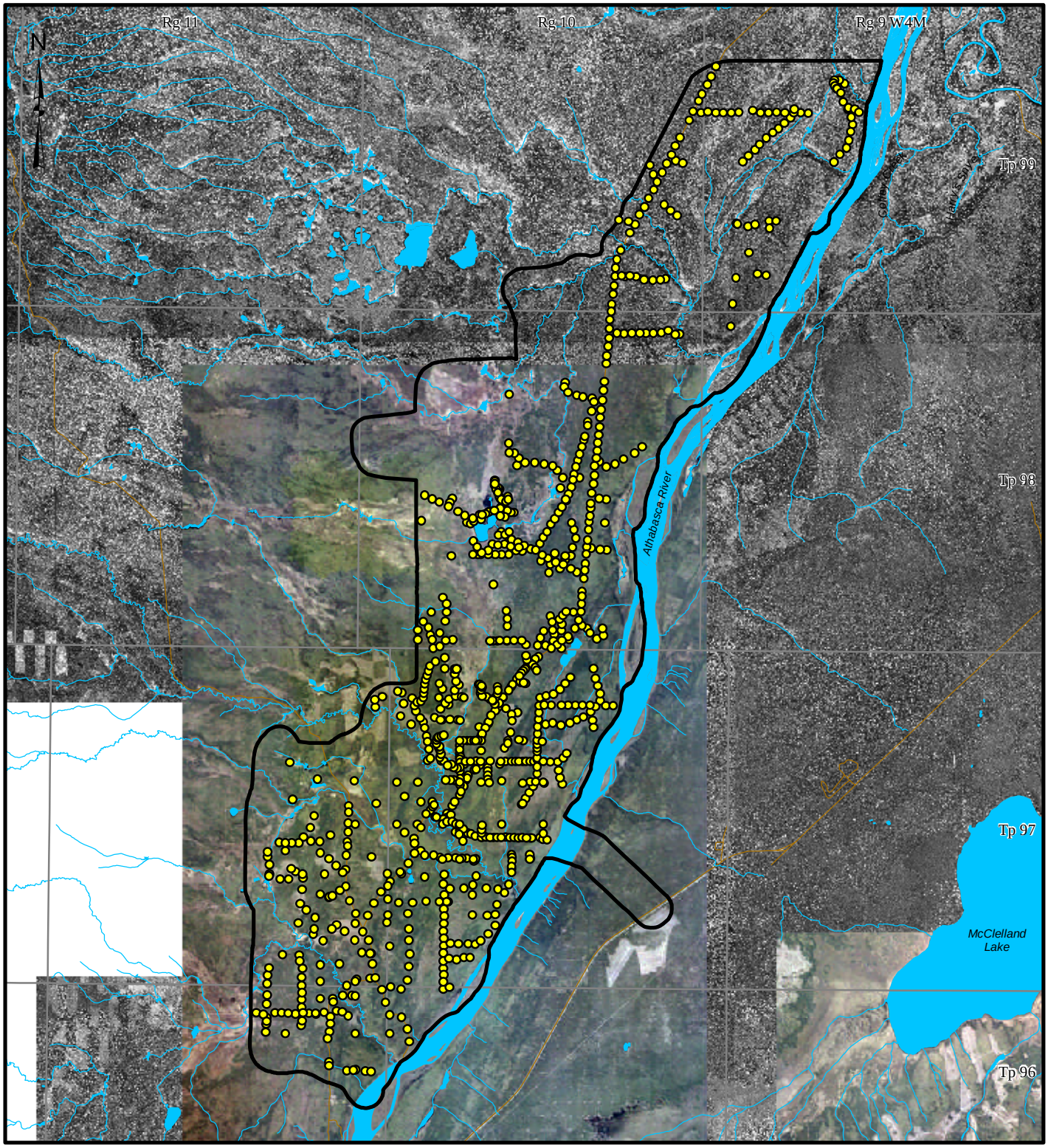
- the soil field work and mapping by experienced soil surveyors was based on accepted pedology soil survey principals;
- a large proportion of the area consists of a few, uniform soils which do not require closely spaced observations. Fort and Mildred soils on glaciofluvial deposits comprise 11,125 ha (53%) of the LSA and deep organic soils (Albian, McLelland and Muskeg) comprise 1,623 ha (8%); and
- field observations were not possible in a designated "no work zone" of about 1,500 ha (due to ongoing discussion with the local trap line owner). When the "no work zone" is excluded the development area inspection density is one site per 14 ha.

JPME R1
AENV SIR 406

Field inspections were conducted from October 2005 to July 2007. Access was by provided by 4x4 truck, Argo, four wheel All Terrain Vehicle (ATV) and helicopter.

Sampling locations were not uniform throughout the study area, but rather focused towards those soil polygons with the most variability and towards transitional soil polygon boundaries (for example within those boundaries of peaty Gleysols and Organic soils). Observation points were exclusively selected in undisturbed soils off the access cutlines or other disturbed areas. For accessibility reasons, transects were located primarily along cutlines and trails.

Mineral soils were examined using a shovel and/or a dutch hand auger to a depth of between 0.5 and 1 m. Organic soils were inspected to the depth of peat plus 20 cm into the underlying mineral material, or to a maximum depth of 2.3 m. All observation points were located using Global Positioning System (GPS) co-ordinates. Information was collected using hand-held personal data assistants (field computers) with an internal GPS system with an accuracy of plus or minus 3 to 5 m. Photographs were taken at locations representing typical soil series.



LEGEND

- PIERRE RIVER MINING AREA
- LOCAL STUDY AREA
- OPEN WATER
- ROAD

SOIL INSPECTION LOCATIONS

- SOIL INSPECTION SITE

4 0 4

SCALE 1:160,000 KILOMETRES

REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2004), Alberta SRD, and SOIL-INFO Ltd. (2007), used under license. Imagery (orthophoto) obtained from Shell Canada (August 2005).
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 12.

PROJECT

JACKPINE MINE EXPANSION &
PIERRE RIVER MINE PROJECT

TITLE

SOIL INSPECTION LOCATIONS
PIERRE RIVER MINING AREA
LOCAL STUDY AREA

Shell Canada Limited

PROJECT No. 05-1344-027.7400			SCALE AS SHOWN	REV. 0
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GIS	JH	19 Nov. 2007		
CHECK	DD	17 Nov. 2007		
REVIEW	WES/TC	19 Nov. 2007		

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Terrain and soil profile characteristics were recorded using the criteria outlined in the CanSIS manual (Agriculture Canada Expert Committee on Soil Survey 1983) and included the following:

- date of sampling;
- location (eastings and northings);
- parent material;
- subgroup and soils series;
- horizon designation;
- horizon colour (not for all horizons);
- texture;
- structure;
- drainage class;
- moisture regime;
- nutrient regime;
- stoniness class;
- presence of carbonates and/or salts;
- topographic class;
- vegetation community (ecosite phase or wetlands);
- moisture and nutrient regime (edatope);
- depth of peat;
- surface expression;
- slope class, position and aspect; and
- depth to groundwater.

2.2.3.1 Soil Mapping Procedures

For soils mapping at the LSA level, the soil resources were classified according to guidelines established by the Canadian System of Soil Classification (Agriculture Canada 1998). This hierarchical system has five taxonomic levels: order, great group, sub-group, family and series. Classes at the order level have the broadest range of characteristics, whereas classes at the series level have the narrowest range of characteristics (that is a more defined range of characteristics). The purpose of a soil classification system is to organize soil characteristics, which are a product of soil forming processes, into a logical arrangement. This conceptual framework provides a means for communicating, testing and applying pedological information of similar natural entities. Soil taxonomy is the hierarchical ordered arrangement of classified soils.

The LSA maps display and describe the distribution of soil units. Soils described to the series level are the building blocks for these soil units.

Soil Series Designation

Soil classification to the series level involves three major steps:

- taxonomy to the soil subgroup level based on morphological features (e.g., types of A and B horizons, degree of gleying based on morphological evidence, etc.);
- classification, or grouping, of soil parent materials according to mode of deposition plus textural and chemical characteristics; and
- merging the two classifications to define soils series.

The latest edition of the Alberta Soil Names File is an integral part of AGRASID, and lists all established soil series in the province. A foundation of this soil series list is the modernized classification of soil parent materials – a grouping that places greater emphasis on textural characteristics, less on colour and mode of deposition. Table 2.2-2 lists the parent material groupings, identified by the codes in the middle column.

Table 2.2-2 Parent Material Groupings

Group	Code	Description
Coarse textured materials		
Undifferentiated	C0	Undifferentiated coarse textured (S, LS, SL) material
Gravels	C1	Gravels or gravelly (cobbly/stony) coarse textured material
Very coarse	C2	Very coarse (S, LS) sediments deposited by wind or water
Moderately coarse	C3	Moderately coarse (SL, FSL) sediments deposited by wind or water
Tills	C4	Very coarse textured till (Till name)
	C5	Moderately coarse textured tills (Till name)
Bedrock	C6	Coarse textured (S, LS, SL) softrock
	C7	Coarse grained bedrock
Medium textured materials		
Undifferentiated	M0	Undifferentiated medium textured (VFSL, L, SiL, SiCL, CL, SCL) materials
Gravelly	M1	Gravelly, medium textured, water-laid sediments (also cobbly and stony variations)
Medium	M2	Medium textured (L, SiL, VFSL) sediments deposited by wind and water
Moderately fine	M3	Moderately fine textured (CL, SCL, SiCL) sediments deposited by water
Till	M4	Medium textured (L to CL) till (Till name)
Bedrock	M5	Medium textured (L to CL) softrock
Gravelly till	M6	Gravelly, cobbly or stony, medium textured till
Fine textured materials		
Undifferentiated	F0	Undifferentiated fine textured (C, SiC, HC) materials
Fine	F1	Fine textured (C, SiC) water-laid sediments
Very fine	F2	Very fine textured (HC) water-laid sediments
Till-like	F3	Fine textured (C) water-laid sediments with till-like features
Till	F4	Fine textured (C) till (Till name)
Bedrock	F5	Fine textured (C, SiC) softrock
Layered materials (parent material change occurs between 30 and 100 cm)		
Gravelly CO to ME/till	L1	Gravel or gravelly (or cobbly/stony) coarse over medium or fine textured till
	L2	Coarse textured (S, LS, SL) over medium or fine textured till
	L3	Medium textured (VFSL, L, sic, CL) over medium or fine textured till
CO to ME/gravel	L4	Coarse textured over gravel or gravelly coarse (includes cobbly and stony variations)
	L5	Medium textured over gravel or gravelly coarse (includes cobbly and stony variations)
Various dep./softrock	L6	Till (Till name) over softrock
	L7	Coarse (not till) over softrock
	L8	Medium (not till) over softrock
CO to ME/Fine	L9	Coarse (not till) textured over fine or very fine (not till)
	L10	Medium (not till) textured over fine or very fine (not till)
Peat/various materials	L11	Peat (any) over coarse textured
	L12	Peat (any) over medium textured
	L13	Peat (any) over fine textured
Fine/till	L14	Fine textured (not till) over medium to moderately fine textured till
	L15	Very fine textured (not till) over medium to moderately fine textured till
Fine/rock	L16	Fine to very fine textured (not till) over softrock
Gr ME/till	L17	Gravelly (or cobbly/stony) medium textured material over medium or fine textured till
ME/CO	L18	Medium textured material over coarse textured material
Gr ME/rock	L19	Gravelly medium textured material over softrock
CO/ME	L20	Coarse textured over medium or moderately fine (not till)
Gr CO/ME	L21	Gravelly coarse textured over medium or moderately fine (not till)
FI/ME	L22	Fine (not till) over medium (not till)
Peat Materials		
Undifferentiated	P0	Undifferentiated peat
Bog	P1	Bog (Sphagnum) peat
Fen	P2	Fen peat
Forest	P3	Forest peat

Note: Adapted from CAESA Soil Inventory Working Group (1997).

Soil Map Unit Designation

Soil polygons have been mapped using both the results of the field investigations, interpretation of aerial photographs and previous data. Information from soil inspections was extrapolated to other map units using the principles of pedology (geomorphology, surficial geology and vegetation patterns).

The soil map unit polygons define the natural distribution of soils in the study area. Soil map units include a breakdown of the soil series expected in each polygon and the expected proportion of each soil series. Most map units consist of two or more associated soil series which are interspersed over short distances within the map unit, and cannot be separated for mapping purposes. Map units are comprised as follows:

- dominant soils occupy more than 60%;
- co-dominant soils occupy between 30 to 60%;
- significant soils occupy between 15 to 30%; and
- minor soils occupy less than 15% of a soil map unit.

Detailed soil series compositions for each map unit are outlined in Appendix E.

2.2.3.2 Soil Sampling

At the end of the general field investigations, samples were collected of the major soil series that were encountered in the two LSAs. Detailed descriptions and samples of the soil horizons are described in Appendix D. The detailed pedons were described in accordance with guidelines established in the Canadian System of Soil Classification (Agriculture Canada 1998).

Soil Physical Properties and Chemistry Analysis

Soil analyses were conducted to:

- provide a baseline overview of soil chemical characteristics in the LSAs;
- determine characteristics of individual soil series in conjunction with soil physical (i.e., coarse fragment content) and edaphic characteristics (i.e., drainage); and
- determine soil nutrient characteristics needed to assess forest capability.

Soil samples from representative soil profiles of the major soil series were collected during the field programs. Sample analyses included:

- particle size analysis on selected mineral horizons;
- pH on selected mineral horizons;
- Electrical Conductivity (EC) on selected mineral horizons;
- Sodium Adsorption Ratio (SAR) on selected mineral horizons;
- saturation percentage on selected mineral horizons;
- Cation Exchange Capacity (CEC) on selected mineral horizons;
- exchangeable calcium, magnesium, potassium and sodium (Ca, Mg, K and Na);
- plant available nitrogen, phosphorus, potassium and sulphur (N, P, K and S);
- calcium carbonate equivalent ($CaCO_3$) on selected mineral horizons;
- saturated paste aluminum (Al) in selected mineral horizons;
- percent organic matter (%OM) on selected upper mineral and organic horizons soil horizons;
- Total Kjeldahl Nitrogen (TKN) on selected upper mineral and organic horizons;
- trace metals (arsenic, barium, beryllium, cadmium, cobalt, chromium, copper, mercury, manganese, molybdenum, nickel, lead, selenium, strontium, thallium, vanadium and zinc) on selected horizons; and
- hydrocarbon analyses (benzene, toluene, ethylbenzene, xylenes and total hydrocarbon) on selected horizons.

Baseline soil analysis results are presented in Appendix F. Soil physical properties and chemistry for individual soil series are presented in Appendix B. The reported soil analyses do not provide a statistical evaluation of the natural soil variation, but rather confirms whether parameters fall within an accepted range for a defined soil series.

2.2.3.3 Soil Map Unit Interpretations for the Local Study Areas

Soil map units in the LSAs were interpreted to determine forest capability, terrain types, wind erosion risk, water erosion risk, reclamation material volumes (peat, topsoil and suitable subsoil) as follows:

JPME R1
AENV SIR 407

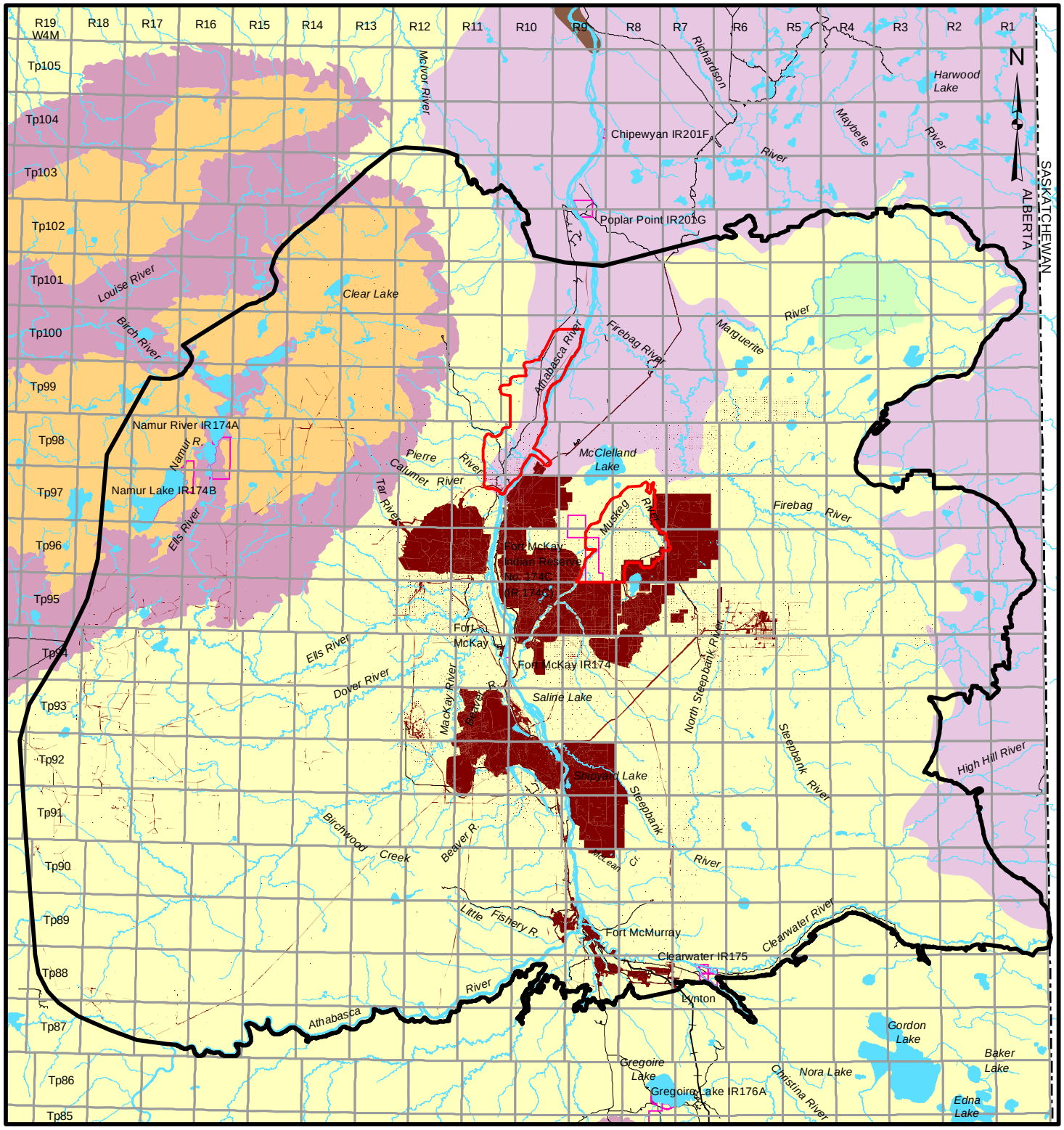
- Forest land capability ratings – forest capability for the LSAs were determined using a three-step process. The first step was assigning forest capability ratings for individual soil series and soil variants using the *Revised Land Capability Classification for Forest Ecosystems in the Oil Sands* (CEMA 2006). Soil physical characteristics and analytical data were used to determine the forest capability for modal profiles (Appendices F and G). If analytical data for a soil series was not available, analytical data from previous soil ESRs were used for that soil series. The second step involved determining the proportion of individual soil series and variants and their associated forest capability rating that comprised each soil map unit. The third step involved modifying the forest capability for individual soil unit polygons based on aspect, slope position, soil aeration and water table depths (CEMA 2006). The forest capability ratings were then determined based on the proportion of individual series in each map unit. In some cases, ratings were modified based on map unit slope position, aspect, soil aeration or groundwater levels.
- Terrain types – terrain types for the LSAs were determined based on the relationship between soils and terrain.
- Wind erosion risk ratings – wind erosion risk ratings for exposed soils in the LSAs were adapted from Coote and Pettapiece (1989) and were determined for individual soils based on their modal characteristics.
- Water erosion risk ratings – water erosion risk ratings for exposed soils in the LSAs were adapted from Tejak and Coote (1993) and Pedocan (1993), and were determined for individual soil map/landscape model units based on the proportion of individual series in that unit and average slope angles.
- Peat volumes – peat volumes for the LSAs were based on the average depth of peat for organic soils for individual soil map units multiplied by the map unit area in hectares (ha).

- Reclamation suitability classes and volumes – reclamation suitability ratings for the LSAs were determined from criteria outlined by Alberta Agriculture (1987). Reclamation suitability was determined for individual soil series based on their modal physical and chemical characteristics. Reclamation suitability classes and volumes of each class were determined for the topsoil layer based on modal characteristics and average depths of LFH, Ae, Ahe and Ah horizons. Reclamation suitability and volumes for the upper subsoil layer was determined for modal characteristics and average depths of B and AB horizons. Reclamation suitability and volumes for the lower subsoil layer was determined for modal characteristics and average depths of BC and C horizons to a depth of 1 m.
- Representative soil profiles of selected series sampled and analyzed for typical diagnostic chemical and physical parameters (Golder 2003c).

2.3 REGIONAL RESULTS

2.3.1 Natural Region and Natural Subregions

Natural regions are the largest ecological units mapped in Alberta. The six natural regions in Alberta are defined on the basis of landscape patterns, vegetation, soils and physiographic features. Two of these regions are found in the RSA: the Boreal Forest and a small area of the Canadian Shield. Natural subregions are subdivisions of the natural regions and were modified for Alberta in 2006 (NRC 2006). These natural subregions are characterized by vegetation, climate, elevation and latitudinal or physiographic differences. There are five ecosubregions in the RSA: the Central Mixedwood, the Lower Boreal Highlands, the Upper Boreal Highlands, the Athabasca Plains and the Canadian Shield/Kazan Uplands (NRC 2006) (Figure 2.3-1). The Project is located in the Central Mixedwood and the Athabasca Plains Natural Subregions (NRC 2006).



LEGEND

- TERRESTRIAL RESOURCES REGIONAL STUDY AREA
- LOCAL STUDY AREAS
- INDIAN RESERVE
- OPEN WATER
- PUBLIC ROADWAY
- RAILROAD

ECOSUBREGIONS

- ATHABASCA PLAIN
- CENTRAL MIXEDWOOD
- KAZAN UPLANDS
- LOWER BOREAL HIGHLANDS
- PEACE-ATHABASCA DELTA
- UPPER BOREAL HIGHLANDS

DISTURBED

- EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE
- EXISTING AND APPROVED URBAN AND INDUSTRIAL LINEAR DISTURBANCE

30 0 30

SCALE 1:1,000,000 KILOMETRES

REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2004), Pearson Timberline Ltd. (April 2004), AOSERP (1982), EUB, AGS, LANDSAT 7 ETM Imagery (July 2006), and Alberta SRD, used under license. Saskatchewan digital data obtained from Information Services Corp. (September 2004), used under license.
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 12.

PROJECT

JACKPINE MINE EXPANSION & PIERRE RIVER MINE PROJECT

TITLE

NATURAL SUBREGIONS IN THE REGIONAL STUDY AREA AND LOCAL STUDY AREAS

Shell Canada Limited

PROJECT No. 05-1344-027.7400			SCALE AS SHOWN	REV. 0
DESIGN	VR	22 Jan. 2007	FIGURE: 2.3-1	
GIS	VR	16 Nov. 2007		
CHECK	DD	17 Nov. 2007		
REVIEW	WES/TC	19 Nov. 2007		

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2.3.2 Geology

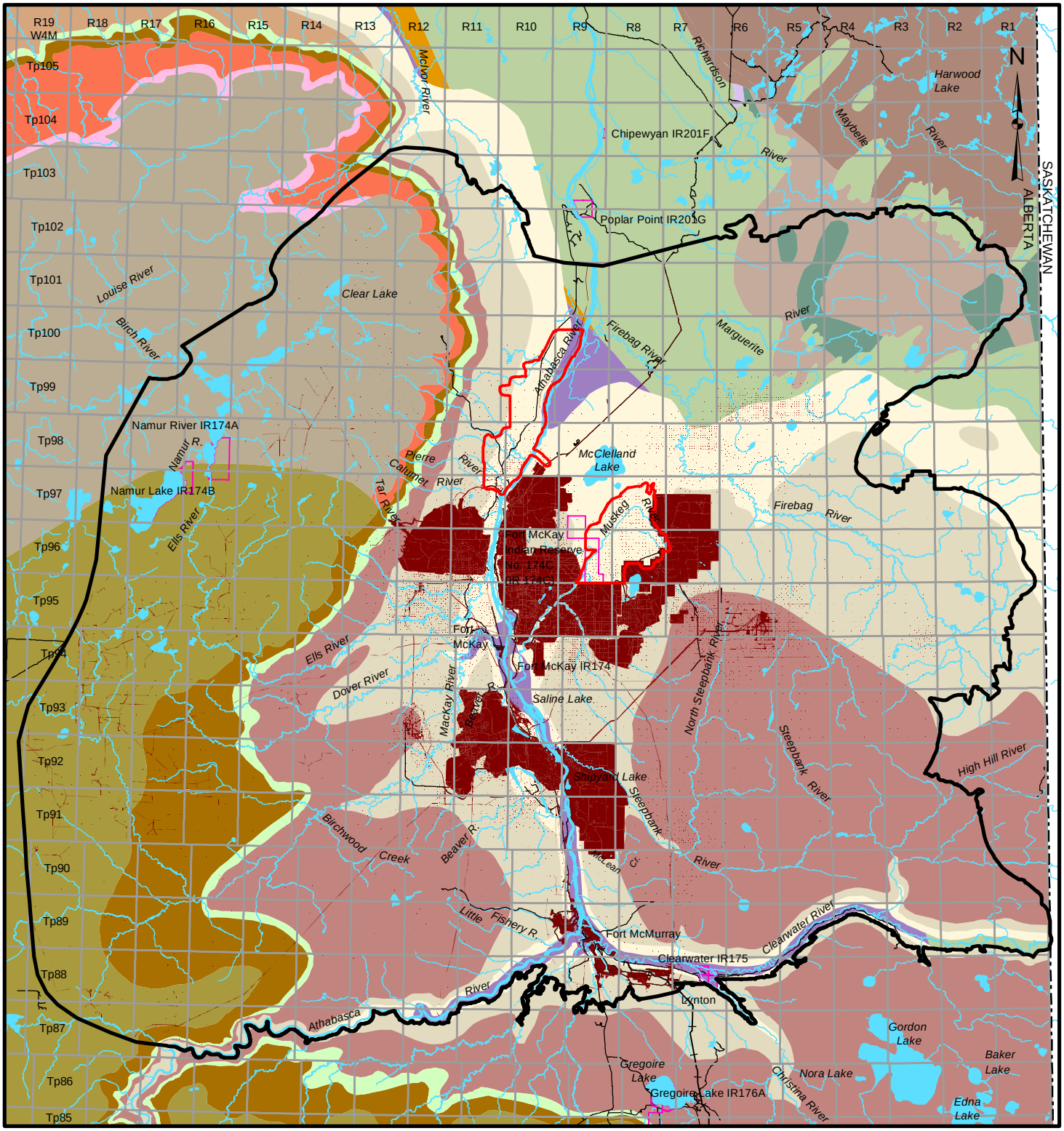
2.3.2.1 Bedrock Geology

The bedrock geology of the region has been described by Hamilton et al. (1999). Table 2.3-1 outlines the major bedrock formations in the RSA and LSAs. The spatial distribution of bedrock geology is illustrated in Figure 2.3-2. Within the LSAs the underlying bedrock is primarily comprised of the McMurray Formation and with a small portion of the PRMA on the west side underlain by the Clearwater Formation.

The bedrock geology of the RSA and the LSAs is described in detail in the Hydrogeology ESR (Komex 2007).

Table 2.3-1 Bedrock Groups and Formations of the Regional Study Area and Local Study Areas

Bedrock Type	Description	Symbol
Cretaceous		
Upper Cretaceous	Smoky Group: shale and silty clay with ironstone; marine	Ks
Upper and Lower Cretaceous	Labiche Formation: shale and silty shale; iron concretions; silty fish scale-bearing bed	Kl
Lower Cretaceous	Pelican Formation: sandstone; marine	Kpl
	Grand Rapids Formation: sandstone, siltstone and silty shale with thin coal beds; shoreline complex	Kg
	Joli Fou Formation: shale; marine	Kj
	Clearwater Formation: silty shale, siltstone, and sandstone; marine	Kc
	McMurray Formation: sandstone and siltstone with silty shale interbeds; oil impregnated; nonmarine to deltaic	Km
Devonian		
Upper Devonian	Waterways Formation: shale and limestone; marine	Dw
Middle Devonian	Slave Point Formation: limestone and dolomitic limestone with minor shale and gypsum; marine	Ds
	Middle Devonian: various sandstone, shale, dolomite, and dolomitic limestone formations with minor gypsum and anhydrite; marine to evaporitic	DM
Archaen		
	recrystallized mylonitic rocks: fine grained, massive rock; felsic varieties; well foliated with streaky patches of quartz and feldspar	Ax
	akali feldspar-rich granitoids: medium to coarse grained; well foliated	Ag



LEGEND

- TERRESTRIAL RESOURCES REGIONAL STUDY AREA
- LOCAL STUDY AREAS
- INDIAN RESERVE
- OPEN WATER
- PUBLIC ROADWAY
- RAILROAD

DISTURBED

- EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE
- EXISTING AND APPROVED URBAN AND INDUSTRIAL LINEAR DISTURBANCE

BEDROCK GEOLOGY FORMATIONS

- ALKALI FELDSPAR-RICH GRANITOID
- CLEARWATER FORMATION
- DUNVEGAN FORMATION
- GRAND RAPIDS FORMATION
- GREY FOLIATED GRANITOID
- JOLI FOU FORMATION
- LABICHE FORMATION
- LOON RIVER FORMATION
- MANITOU FALLS FORMATION
- MCMURRAY FORMATION
- MIDDLE DEVONIAN
- PELICAN FORMATION
- RECRYSTALLIZED MYLONITIC ROCKS
- SHAFTESBURY FORMATION
- SLAVE POINT FORMATION
- SMOKY GROUP
- WATERWAYS FORMATION

REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2004), Pearson Timberline Ltd. (April 2004), AOSERP (1982), EUB, AGS, LANDSAT 7 ETM Imagery (July 2006), and Alberta SRD, used under license. Saskatchewan digital data obtained from Information Services Corp. (September 2004), used under license. Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 12.

30 0 30

SCALE 1:1,000,000 KILOMETRES

PROJECT

JACKPINE MINE EXPANSION & PIERRE RIVER MINE PROJECT

TITLE

BEDROCK GEOLOGY OF THE REGIONAL STUDY AREA AND LOCAL STUDY AREAS

Shell Canada Limited

PROJECT No. 05-1344-027.7400			SCALE AS SHOWN	REV. 0
DESIGN	VR	22 Jan. 2007	FIGURE: 2.3-2	
GIS	JH	19 Nov. 2007		
CHECK	DD	17 Nov. 2007		
REVIEW	WES/TC	19 Nov. 2007		

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2.3.3 Terrain Classification

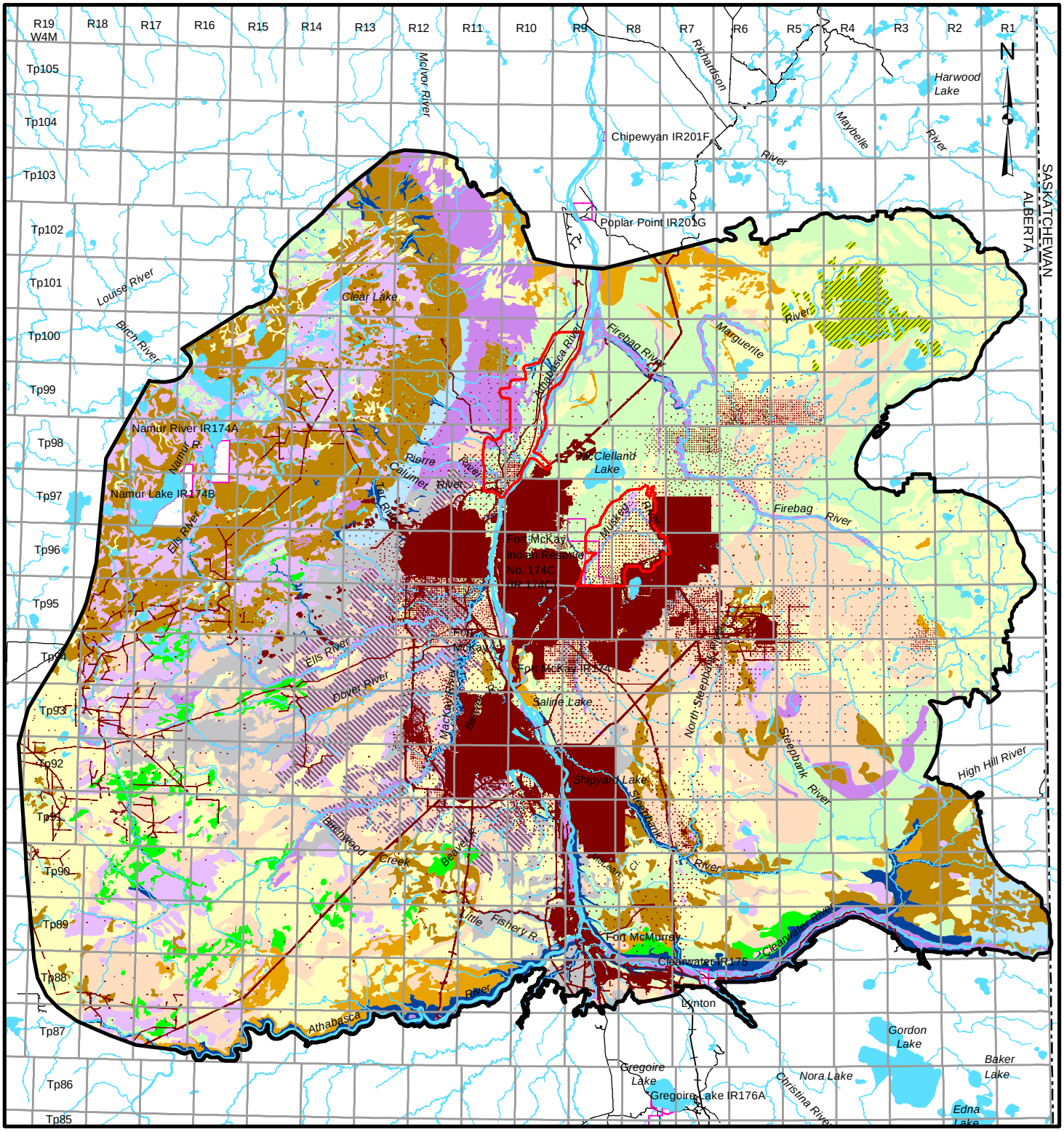
The dominant terrain map units within the RSA are organic (fen-N and shallow fen-Ns), which together comprise 779,014 ha (35%) of the RSA. Morainal/till materials, generally fine textured, comprise 360,841 ha (16%) of the RSA. Glaciofluvial, generally coarse textured, occur in 286,604 ha (13%) of the RSA. Terrain units and their respective areas in the RSA are listed in Table 2.3-2 and are shown in Figure 2.3-3.

Table 2.3-2 Terrain Units in the Regional Study Area

Terrain Unit	Area [ha]	Percent of RSA [%]
fen (N)	444,830	20
morainal/till, fine (M1)	360,841	16
shallow fen (Ns)	334,184	15
glaciofluvial (Fg)	286,604	13
bog (B)	145,453	6
fluvial (F)	115,355	5
glaciolacustrine (Lg)	99,738	4
eolian (E)	70,122	3
glaciollacustrine or morainal/till fine (Lg or M1)	68,295	3
glaciofluvial or glaciolacustrine over moraine (LFg/M)	37,671	2
morainal/till, coarse (M2)	17,861	<1
subtotal terrain units	*1,980,954*	*87*
disturbed, rocks, rough broken, open water	290,289	13
Indian Reserves[(a)]	6,133	<1
subtotal miscellaneous	*296,422*	*13*
Total	**2,277,376**	**100**

(a) No soil survey data are available for Indian Reserves.

Note: Some numbers are rounded for presentation purposes. Therefore, it may appear that the totals do not equal the sum of the individual values.



LEGEND

- TERRESTRIAL RESOURCES REGIONAL STUDY AREA
- LOCAL STUDY AREAS
- INDIAN RESERVE
- OPEN WATER
- PUBLIC ROADWAY
- RAILROAD

TERRAIN MAP UNIT

- BOG (B)
- EOLIAN (E)
- FLUVIAL (F)
- GLACIOFLUVIAL (Fg)
- GLACIOLACUSTRINE (Lg)
- GLACIOLACUSTRINE OR GLACIOFLUVIAL OVER MORAINE (LFg/M)
- GLACIOLACUSTRINE OR MORAINE / TILL, FINE (Lg/ M1)
- MORAINE / TILL, FINE (M1)
- MORAINE / TILL, COARSE (M2)
- FEN (N)
- SHALLOW FEN (Ns)
- ROUGH BROKEN (RB)
- ROCK

DISTURBED

- EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE
- EXISTING AND APPROVED URBAN AND INDUSTRIAL LINEAR DISTURBANCE

30 0 30

SCALE 1:1,000,000 KILOMETRES

REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2004), Pearson Timberline Ltd. (April 2004), AOSERP (1982), EUB, AGS, LANDSAT 7 ETM Imagery (July 2006), and Alberta SRD, used under license. Saskatchewan digital data obtained from Information Services Corp. (September 2004), used under license.
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 12.

PROJECT

JACKPINE MINE EXPANSION & PIERRE RIVER MINE PROJECT

TITLE

DOMINANT TERRAIN MAP UNITS IN THE REGIONAL STUDY AREA

Shell Canada Limited

PROJECT No. 05-1344-027.7400			SCALE AS SHOWN	REV. 0
DESIGN	VR	22 Jan. 2007	FIGURE: 2.3-3	
GIS	JH	17 Nov. 2007		
CHECK	DD	17 Nov. 2007		
REVIEW	WES/TC	19 Nov. 2007		

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2.3.4 Soil Classification

Soil map units in the RSA were previously described (Shell 2005). The area of each soil series is presented in Table 2.3-3.

Table 2.3-3 Soil Series in the Regional Study Area

Dominant Soil Series of Soil Units	Area [ha]	Percent of RSA [%]
Mineral Soils		
Algar Lake	43,416	2
Bitumount	39,022	2
Buckton	31,674	1
Dover	52,427	2
Firebag	62,845	3
Fort	1,297	<1
Gipsy	6,292	<1
Horse River	23,703	1
Joslyn	68,295	3
Kearl	3,895	<1
Kinosis	50,283	2
Legend	125,972	6
Livock	37,671	2
Marguerite	70,122	3
McMurray	54,099	2
Mildred	171,567	8
Namur	61,256	3
Ruth Lake	11,873	1
Steepbank	129,207	6
Surmont	11,569	1
subtotal mineral soil	*1,056,485*	*46*
Organic Soil		
Bayard	14,649	1
Conklin	63,273	3
Gregoire	19,642	1
Hartley	157,642	7
Mariana	144,117	6
McLelland	136,362	6
Mikkwa	125,811	6
Muskeg	230,547	10
Wabasca	32,425	1
subtotal organic soil	*924,468*	*41*
Other		
disturbed lands	156,161	7
rough broken	61,329	3
open water	52,956	2
rock	19,844	1
Indian Reserves[(a)]	6,133	<1
subtotal other (non-soil)	*296,423*	*13*
Total	**2,277,376**	**100**

(a) No soil survey data are available for Indian Reserves.

Note: Some numbers are rounded for presentation purposes. Therefore, it may appear that the totals do not equal the sum of the individual values.

Mineral soils are the most common in the RSA and comprise 1,056,488 ha (46%) of the area and organic soils comprise 924,468 ha (41%). Areas classed as Other constitute 296,423 ha (13%); these areas include existing industrial, linear and other disturbances. The most extensive mineral soils are the Mildred, Legend and Steepbank soil units which collectively comprise 20% of the RSA. The most extensive organic soil units are Muskeg, Hartley, Mariana, McLelland and Mikkwa, which collectively comprise 35% of the RSA. The distribution of the remaining soils is much lower relative to these dominant soils (Table 2.3-3). The relatively large proportion of disturbed areas (156,161 ha or 7% of RSA) includes a variety of disturbances, such as cut lines, drill pads and roadways. Although vegetation is disturbed in these areas, soil disturbance varies from severe to minimal. The spatial distribution of the soil units is shown in Figure 2.3-4.

2.3.5 Land Capability for Forest Ecosystems

The area of each capability class in the RSA is summarized in Table 2.3-4. A large portion of the RSA (1,005,640 ha, 44% of the RSA) is classified as non-productive (Class 5) for forestry due to excess water. Areas classed as moderate to high capability (Class 1 and 2) comprise 311,114 ha (13% of the RSA) of the total area. The spatial distribution of land capability classes is shown in Figure 2.3-5.

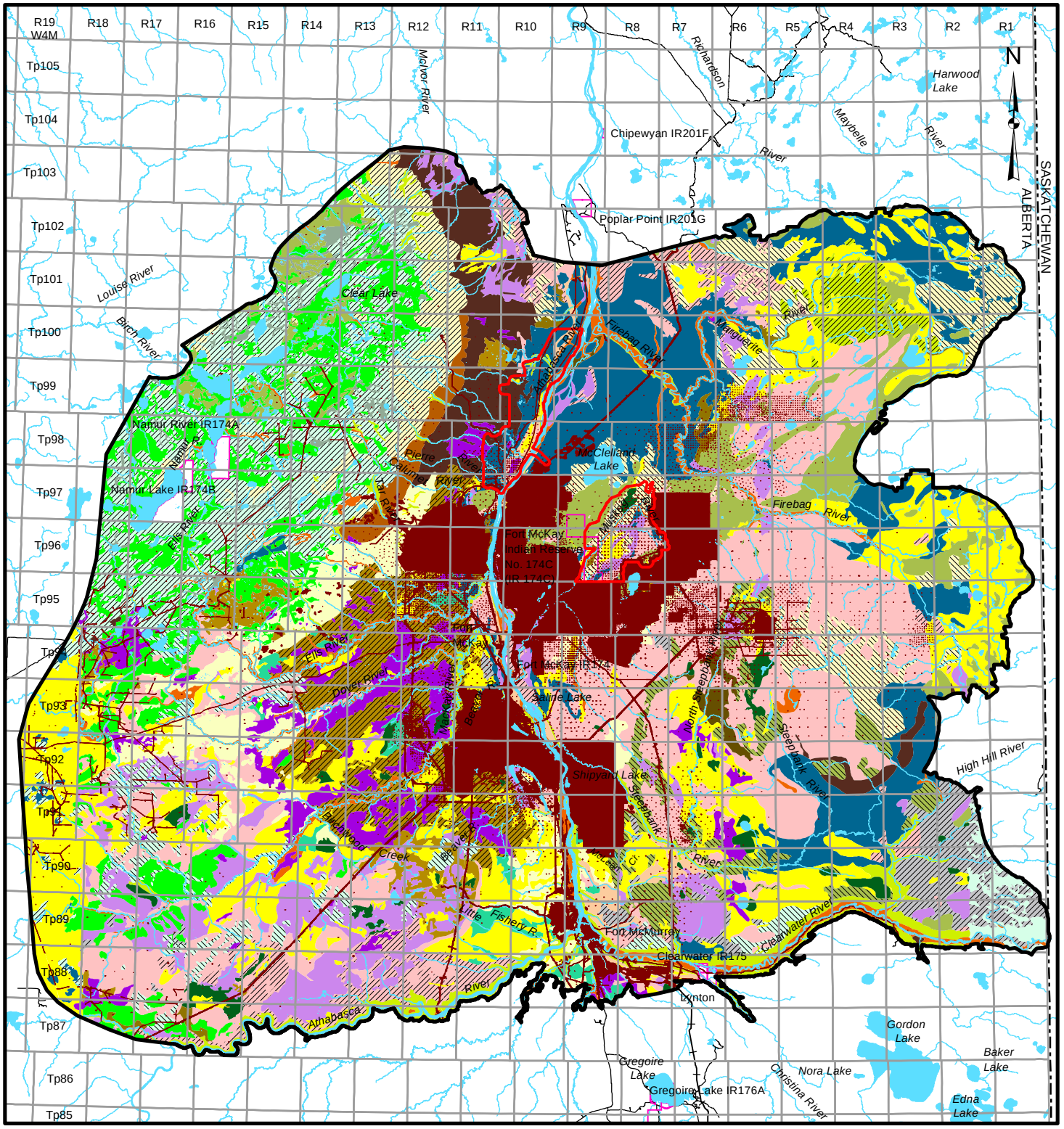
Table 2.3-4 Geographic Extent of Land Capability for Forest Ecosystems Classes in the Regional Study Area

Land Capability Class	Area [ha]	Percent of RSA [%]
Class 1 (high)	54,099	2
Class 2 (moderate)	257,015	11
Class 3 (low)	154,607	7
Class 4 (conditionally productive)	590,767	26
Class 5 (non-productive)[(a)]	1,005,640	44
Disturbed, open water	209,115	9
Indian Reserves [(b)]	6,133	<1
Total	**2,277,376**	**100**

(a) Rock and rough broken were assumed to be non-productive for forestry (included in Class 5).

(b) No soil survey data are available for Indian Reserves.

Note: Some numbers are rounded for presentation purposes. Therefore, it may appear that the totals do not equal the sum of the individual values.



LEGEND

- TERRESTRIAL RESOURCES REGIONAL STUDY AREA
- LOCAL STUDY AREAS
- INDIAN RESERVE
- OPEN WATER
- PUBLIC ROADWAY
- RAILROAD

SOIL CLASSIFICATION

- ALGAR
- BUCKTON
- BITUMOUNT
- BAYARD
- CONKLIN
- DOVER
- FIREBAG
- FORT
- GREGOIRE
- GIPSY
- HARTLEY
- HORSE RIVER
- JOSLYN
- KEARL
- KINOSIS
- LEGEND
- LIVOCK
- MARGUERITE
- MILDRED
- MIKKWA
- McLELLAND
- McMURRAY
- MARIANA
- MUSKEG
- NAMUR
- ROUGH BROKEN
- ROCK
- RUTH LAKE
- SURMONT
- STEEPBANK
- WABASCA

DISTURBED

- EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE
- EXISTING AND APPROVED URBAN AND INDUSTRIAL LINEAR DISTURBANCE

REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2004), Pearson Timberline Ltd. (April 2004), AOSERP (1982), EUB, AGS, LANDSAT 7 ETM Imagery (July 2006), and Alberta SRD, used under license. Saskatchewan digital data obtained from Information Services Corp. (September 2004), used under license.
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 12.

30 0 30

SCALE 1:1,000,000 KILOMETRES

PROJECT

JACKPINE MINE EXPANSION & PIERRE RIVER MINE PROJECT

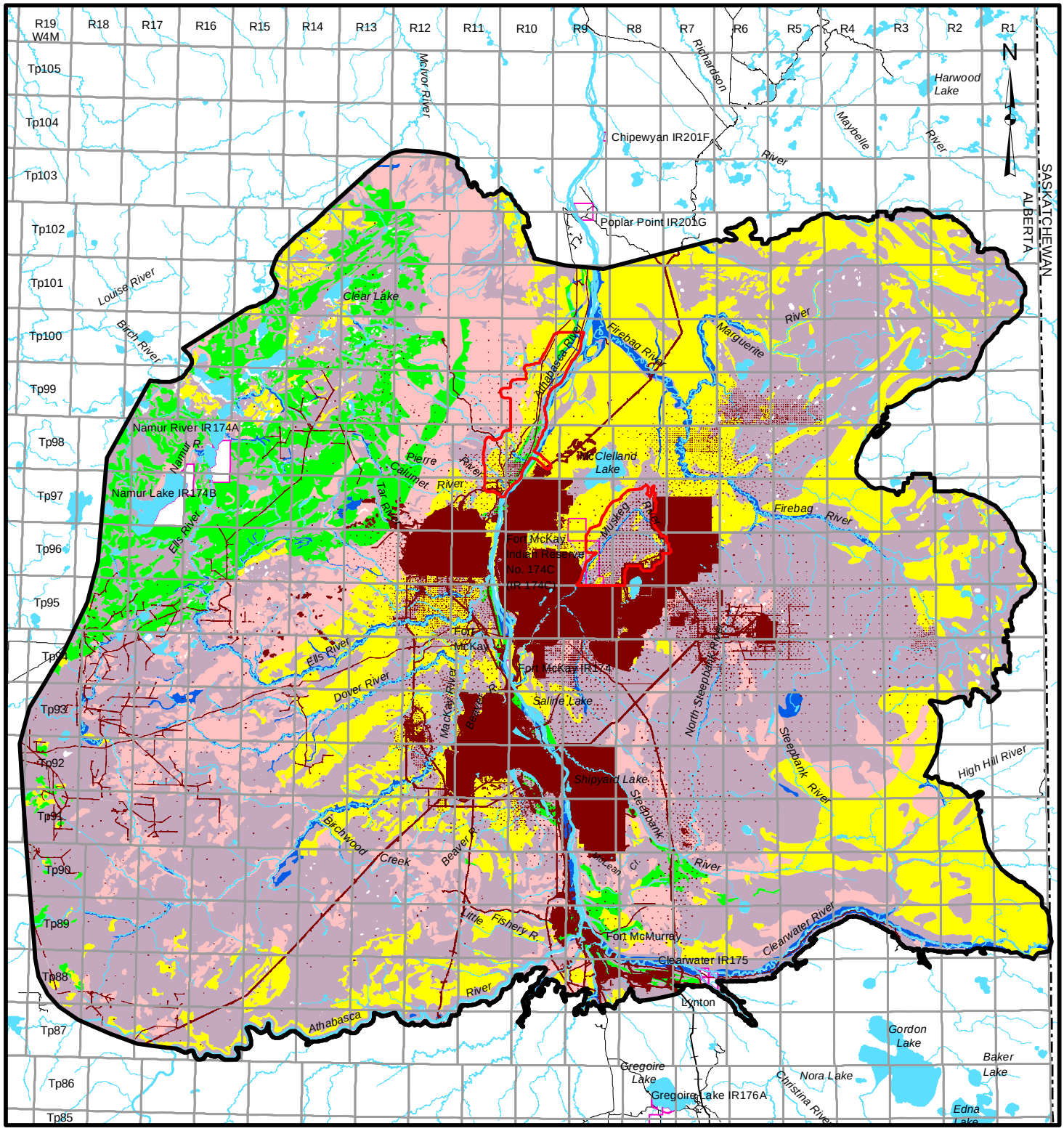
TITLE

DOMINANT SOIL SERIES IN THE REGIONAL STUDY AREA

Shell Canada Limited

PROJECT No. 05-1344-027.7400			SCALE AS SHOWN	REV. 0
DESIGN	VR	22 Jan. 2007	FIGURE: 2.3-4	
GIS	JH	17 Nov. 2007		
CHECK	DD	17 Nov. 2007		
REVIEW	WESTC	19 Nov. 2007		

I:\CLIENTS\SHELL\05-1344-027\mapping\mxd\soils\DRAFT\rsa_dom_soil_new.mxd



LEGEND

- TERRESTRIAL RESOURCES REGIONAL STUDY AREA
- LOCAL STUDY AREAS
- INDIAN RESERVE
- OPEN WATER
- PUBLIC ROADWAY
- RAILROAD

LAND CAPABILITY

- HIGH CAPABILITY (1)
- MODERATE CAPABILITY (2)
- LOW CAPABILITY (3)
- CONDITIONALLY PRODUCTIVE (4)
- NON-PRODUCTIVE (5)

DISTURBED

- EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE
- EXISTING AND APPROVED URBAN AND INDUSTRIAL LINEAR DISTURBANCE

REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2004), Pearson Timberline Ltd. (April 2004), AOSERP (1982), EUB, AGS, LANDSAT 7 ETM Imagery (July 2006), and Alberta SRD, used under license. Saskatchewan digital data obtained from Information Services Corp. (September 2004), used under license.
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 12.

30 0 30
SCALE 1:1,000,000 KILOMETRES

PROJECT
JACKPINE MINE EXPANSION & PIERRE RIVER MINE PROJECT

TITLE
LAND CAPABILITY FOR FOREST ECOSYSTEMS IN THE REGIONAL STUDY AREA

Shell Canada Limited

PROJECT No. 05-1344-027.7400			SCALE AS SHOWN	REV. 0
DESIGN	VR	22 Jan. 2007	FIGURE: 2.3-5	
GIS	JH	17 Nov. 2007		
CHECK	DD	17 Nov. 2007		
REVIEW	WES/TC	19 Nov. 2007		

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2.3.6 Soil Sensitivity to Acidification

Series-specific critical loads have been developed to provide more detail into the sensitivity of soils to acidification. Golder (2003a,b, 2004) developed soil series critical loads for the NOx-SOx Management Working Group of the CEMA, based on changes in base cation to aluminum (BC/Al) ratios in mineral soils, and base cation to hydrogen (BC/H) ratios for organic soils.

The critical load chosen to be most representative of soil acidification effects in the Oil Sands Region is the 50-year fixed-case critical load (Golder 2003a,b, 2004). The 50-year fixed-case critical load is the Potential Acid Input (PAI) load that is predicted to exceed the BC/Al or BC/H critical chemical levels after 50 years of exposure. The mid-case soil critical loads (Table 2.3-5) represent the mid-point in change between the original oil sands soil chemistry and the levels where effects to soils may occur (Golder 2003a,b, 2004).

Table 2.3-5 Series-Specific Mid Case and Fixed Case 50-Year Critical Loads

Soil Series	Series Symbol	50-Year Mid Case Critical Load [keq/ha/yr H^+]	50-Year Fixed Case Critical Load [keq/ha/yr H^+]
Algar	ALG	0.4	1.1
Bayard	BYD	0.7	0.7
Bitumount	BMT	0.5	1.1
Buckton	BKN	1.1	1.1
Chipewyan	CPN	1.1	1.1
Conklin	CNK	1.1	1.1
Dalkin	DKN	1.1	1.1
Dover	DOV	1.1	1.1
Firebag	FIR	0.55	1.0
Fort	FRT	0.9	1.1
Gipsy	GPY	1.1	1.1
Gregoire	GGR	0.5	0.5
Hartley	HLY	1.1	1.1
Horse River	HRR	1.1	1.1
Joslyn	JSN	1.1	1.1
Kearl	KEL	0.8	1.1
Kinosis	KNS	1	1.1
Legend	LGD	1.1	1.1
Livock	LVK	1.1	1.1
Mamawi	MMW	1.1	1.1
Marguerite	MAR	0.4	0.8
Mariana	MRN	0.8	1.1
McLelland	MLD	1.1	1.1
McMurray	MMY	1.1	1.1
Mikkwa	MKW	0.8	1.1
Mildred	MIL	0.4	1.0
Muskeg	MUS	0.6	1.0
Namur	NAM	1.1	1.1
Ruth Lake	RUT	1.1	1.1
Steepbank	STP	0.4	1.1
Surmont	SRT	1.1	1.1
Wabasca	WBC	1.1	1.1

Soils with low (i.e., less than 1 in Table 2.3-5) 50-year fixed-case critical load values such as Algar, Bayard, Bitumount, Gregoire, Firebag, Marguerite, Mildred, Muskeg and Steepbank, are most sensitive to potential acidification, whereas soils with greater values are less sensitive. Coarse-textured soils, such as Mildred and Firebag and are generally most sensitive to acidification. Both the fixed and mid-case critical load values for soils in the RSA are listed in Table 2.3-5. The geographical extent of the dominant soils series in the RSA is shown in Figure 2.3-4.

2.4 JACKPINE EXPANSION MINING AREA RESULTS

2.4.1 Terrain Types

Terrain types are derived from the genetic composition of landform classification in the Canada Soil Information System (CanSIS) (Agriculture Canada 1982). For the purpose of this report, the CanSIS terrain types were further subdivided to delineate organic fens, shallow organic fens, organic bogs, shallow organic bogs and glaciofluvial veneers over moraine. Terrain types found in the JEMA LSA are described in Table 2.4-1.

Table 2.4-1 Description of Terrain Types in the Jackpine Expansion Mining Area Local Study Area

Terrain Type	Terrain Symbol	Description
Moraine (Tills)[a]		
Horse River Till	M	Tills that are characterized as: generally of medium-textured material and have few coarse fragments.
Kinosis Till	M	Tills that are characterized as: acid to neutral pH, fine sandy loam to clay texture material and approximately contains 10 to 20% coarse fragment content.
Glaciofluvial	Fg	Material is deposited by glacial meltwater stream either directly in front of or in contact with glacier ice. Glaciofluvial deposits consist of coarse textured, well-rounded, sorted and often stratified material.
Glaciofluvial Veneer over Moraine	Fg/M	The overlying material consists of glaciofluvial material while the underlying material consists of morainal material. The glaciofluvial veneer is less than 100 cm in thickness.
Organic[b]		
Organic - Bog	B	Peat deposits that are formed from *Sphagnum* mosses under a closed drainage system.
Organic - Fen	N	Peat deposits that are formed from sedges and mosses in areas with nutrient-rich high water tables.
Organic Veneer	Bs	Shallow peat deposits that are formed from *Sphagnum* mosses over a mineral substrate.
	Ns	Shallow peat deposits that are formed from sedges and mosses in areas with nutrient-rich high water tables over a mineral substrate.

(a) Materials are deposited by glaciers without modification by other agents of transportation. Material consists of a heterogeneous mixture of boulders, sand, silt and clay; angular to rounded; non-sorted and non-stratified material.

(b) Materials composed of largely organic materials resulting from the accumulation of vegetative matter. They contain at least 30% organic matter by weight.

Moraine (M)

Morainal material was deposited directly by glaciers without further modification. Material often consists of a heterogeneous mixture of boulders, sand, silt and clay; angular to rounded; non-sorted and non-stratified material.

Morainal material in the LSA is generally designated as Horse River till. This till type is characterized as medium to moderately fine textured, having low coarse fragment content, is non-saline and slightly calcareous.

Glaciofluvial (Fg)

Glaciofluvial materials were deposited by glacial meltwater streams, either directly in front of or in contact with glacier ice during the last glacial retreat. Glaciofluvial materials in the LSA consist of coarse textured, well-rounded, sorted and often stratified material. These materials are generally very coarse textured (i.e., loamy sand to sand), although there are some areas of moderately coarse-textured (sandy loam) materials. There are also some areas of gravelly coarse-textured materials. Upland areas of glaciofluvial deposits are well to rapidly drained, with areas that are poorly to very poorly drained. In some cases these are overlain with a veneer or blanket of fen or bog peat.

Glaciofluvial Veneer Over Moraine or Glaciolacustrine (Fg/M or Fg/Lg)

Glaciofluvial veneer deposits over till can be well, moderately well, imperfectly or poorly drained, depending on slope position, depth to groundwater and thickness of the coarse-textured veneer.

Organic (N or B)

There are two types of organic deposits in the LSA, Bog Peat (B) and Fen Peat (N). Bog peats are commonly formed from *Sphagnum* mosses under closed drainage where there is very little or no water movement. Bog peats are usually strongly acidic, poorly decomposed and nutrient poor. Fen peats are formed from sedges and mosses in areas with nutrient-rich high water tables. Sedge peats are usually more basic, nutrient rich and further decomposed than bog peats. Organic Veneers (Ns or Bs).

Organic Veneers (Ns or Bs)

Organic veneers are generally designated where there is less than a one-metre accumulation of peat over mineral material. Shallow bog peat deposits are designated by the abbreviation Bs. Shallow fen peat deposits are designated by the abbreviation Ns.

2.4.1.1 Geographic Extent

The spatial distribution of dominant terrain map units in the JEMA LSA is shown in Figure 2.4-1, while the geographic extent is summarized in Table 2.4-2. The fen terrain (organic) type is by far the most extensive (10,889 ha; 59% of the LSA). The other two more common terrain types are glaciofluvial (2,255 ha; 12% of the LSA) and moraine (1,687 ha; 9% of the LSA).

Table 2.4-2 Geographic Extent of Terrain Units in the Jackpine Expansion Mining Project Local Study Area

Terrain Unit	Map Code	Area [ha]	Percent of JEMA LSA [%]
fen	N	10,889	59
glaciofluvial	Fg	2,255	12
moraine	M	1,687	9
shallow fen	Ns	843	5
shallow bog	Bs	525	3
glaciofluvial/moraine	Fg/M	313	2
bog	Bs	77	<1
disturbed	disturbed	1,702	9
water	water	57	<1
Total		**18,348**	**100**

Note: Some numbers are rounded for presentation purposes. Therefore, it may appear that the totals do not equal the sum of the individual values.

2.4.1.2 Slope Classes and Surface Expression

The spatial distribution of slope classes in the JEMA LSA is shown in Figure 2.4-2, and their geographic extent is summarized in Table 2.4-3. Level to nearly level slopes are the most common type in the JEMA LSA (13,815 ha; 75%). Very gently undulating and gentle slopes occupy approximately 2,758 ha (15%) of the JEMA LSA.

Table 2.4-3 Geographic Extent of Slope Classes and Surface Expression in the Jackpine Expansion Mining Area Local Study Area

Slope Class	Percent Slope [%]	Slope Classes	Surface Expression	Area [ha]	Percent of JEMA LSA [%]
1	0 to 0.5	level	level	6,022	33
2	0.5 to 2	nearly level	undulating	7,793	42
3	2 to 5	very gently undulating	undulating	2,251	12
4	5 to 9	gentle slopes	Inclined	507	3
5	9 to 15	moderate slopes	inclined	17	<1
n/a	disturbances	n/a	n/a	1,702	9
n/a	water	n/a	n/a	57	<1
Total				**18,348**	**100**

Note: Some numbers are rounded for presentation purposes. Therefore, it may appear that the totals do not equal the sum of the individual values.

n/a = Not applicable.

2.4.1.3 Special Terrain Feature – Permafrost

Several permafrost features were found within the JEMA LSA during vegetation surveys (Figure 2.4-1). There are areas of discontinuous permafrost in the JEMA LSA, and mounds associated with cryosol soils (e.g., Mikkwaa series, Table 2.4-5). Permafrost mounds are generally isolated dome-shaped hills that are formed as a result of permafrost upheaval. They are primarily found within the Arctic region of Alaska, Canada, Greenland and Siberia where permafrost is continuous. However, many have been identified in the sub-arctic boreal forest region of North America, in the zone of discontinuous permafrost (Embleton and King 1968).

At least six permafrost mounds were identified within relatively close proximity to one another (as indicated by white arrows in Photo 1). Two mounds of this group were assessed for vegetative composition with a detailed vegetation plot and a rare plant meander (vegetation plot 3BV023). The convex portion of the mounds displays the characteristics of the ground cover of an open, blueberry jack pine-aspen (b1) ecosite phase (Photo 2). The dome of the mounds have a sparse cover of young jack pine, aspen and white spruce saplings that are established (Photo 3). The basal fringe is composed generally of a ring of tall black spruce and tamarack trees, typical of the surrounding wetlands habitats of shrubby swamps (SONS) and wooded fens (FTNN).

A small mound was also located at another vegetation plot (vegetation plot 3CV038) within the JEMA LSA, rising about 1.5 m above the surrounding terrain (wooded fen). Its frozen core was covered with a 43-cm moss base, with Labrador tea and reindeer lichen being the most prominent of vegetation species.

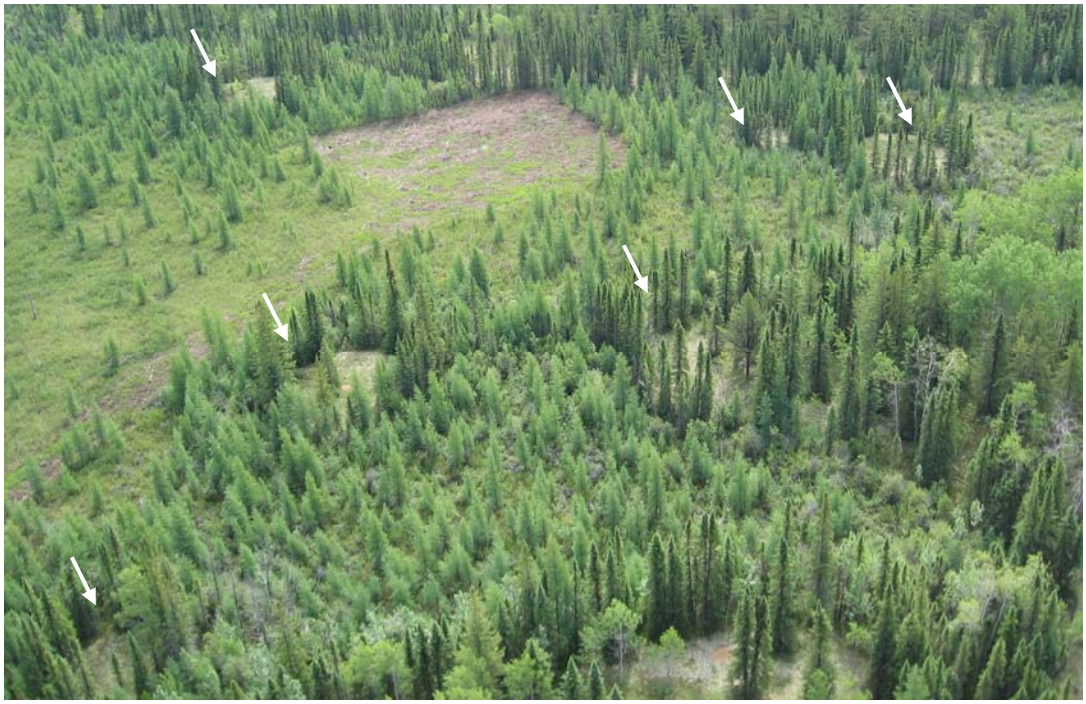
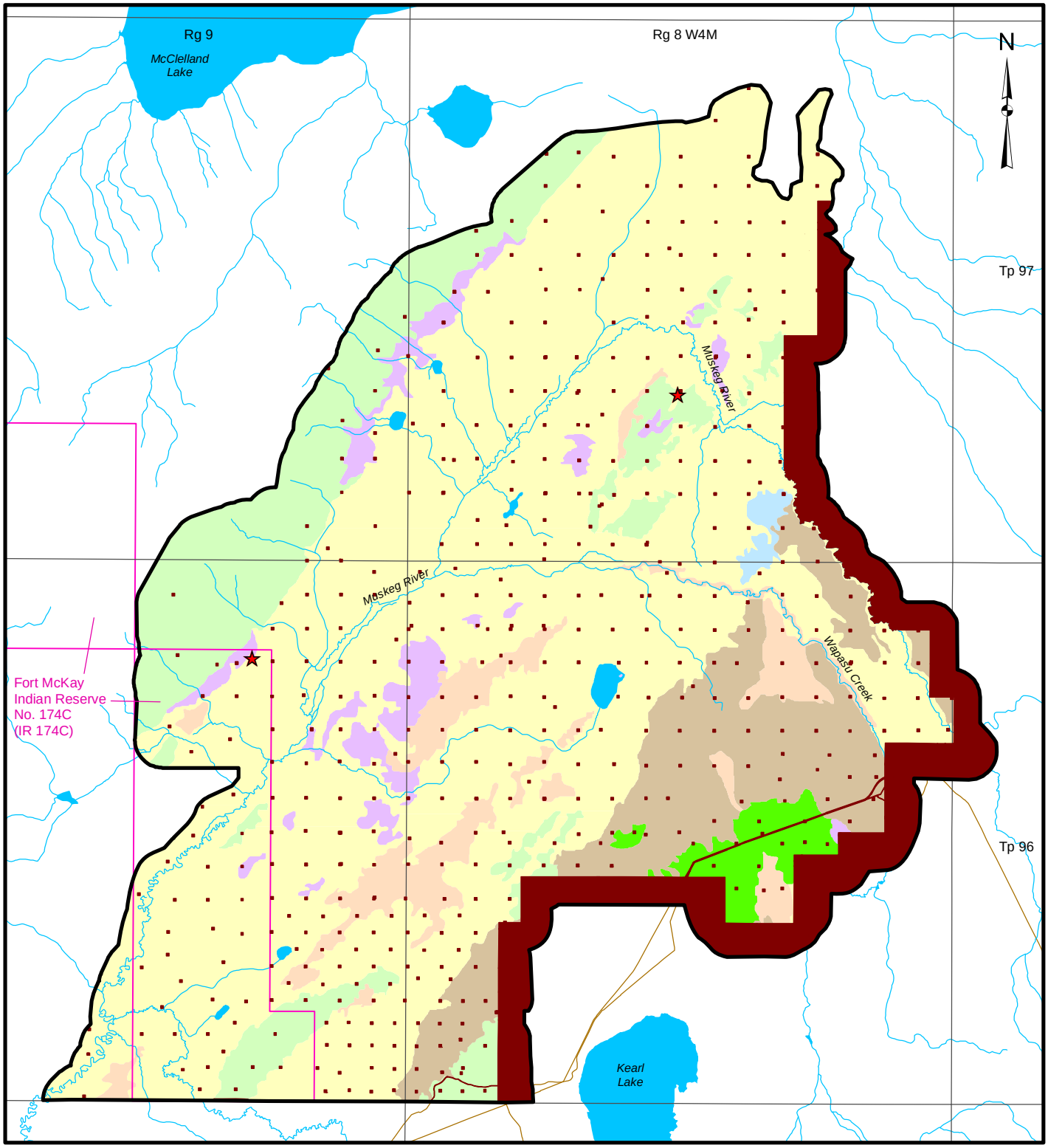


Photo 1 Aerial View of Permafrost Features

Photo 2 An Individual Mound Observed From the Air

Photo 3 Vegetative Composition of the Permafrost Feature as Observed From the Fringe



LEGEND

- JACKPINE EXPANSION MINING AREA LOCAL STUDY AREA
- INDIAN RESERVE
- OPEN WATER
- PUBLIC ROADWAY
- PERMAFROST MOUND

DOMINANT TERRAIN UNITS

- BOG (B)
- SHALLOW BOG (Bs)
- GLACIOFLUVAL (GF)
- GLACIOFLUVAL OVER MORAINE (GF/M)
- MORAINE (M)
- FEN (N)
- SHALLOW FEN (Ns)

DISTURBED

- EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE
- EXISTING AND APPROVED URBAN AND INDUSTRIAL LINEAR DISTURBANCE

3 0 3

SCALE 1:100,000 KILOMETRES

REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2004), Alberta SRD, and SOIL-INFO Ltd. (2007), used under license.
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 12.

PROJECT

JACKPINE MINE EXPANSION & PIERRE RIVER MINE PROJECT

TITLE

DOMINANT TERRAIN UNITS IN THE JACKPINE EXPANSION MINING AREA LOCAL STUDY AREA

Shell Canada Limited

PROJECT No. 05-1344-027.9000			SCALE AS SHOWN	REV. 0
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GIS	JH	17 Nov. 2007		
CHECK	DD	17 Nov. 2007		
REVIEW	WESTC	19 Nov. 2007		

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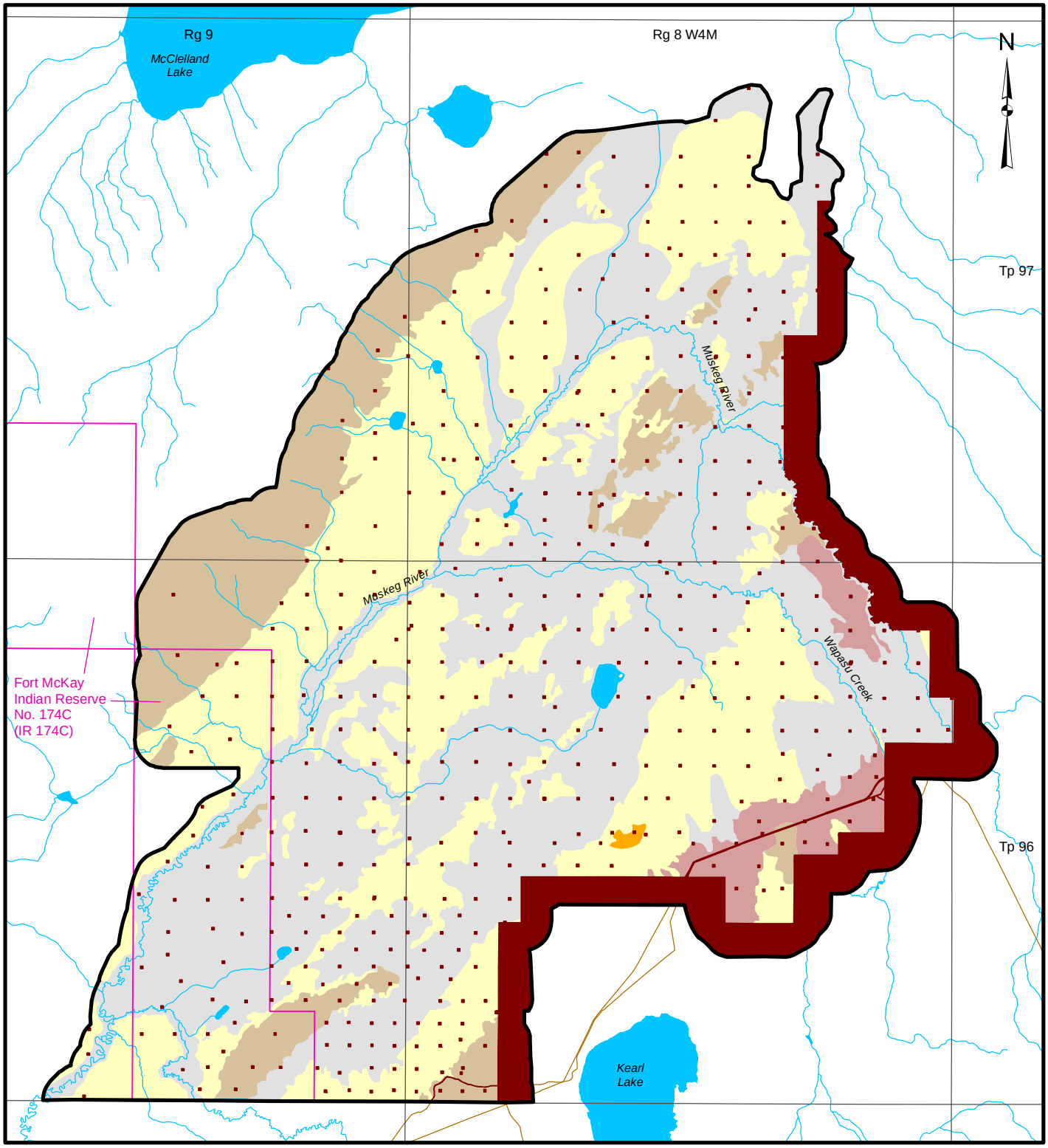


LEGEND

- JACKPINE EXPANSION MINING AREA LOCAL STUDY AREA
- INDIAN RESERVE
- OPEN WATER
- PUBLIC ROADWAY

SLOPE CLASS	PERCENT SLOPE
1	0 to 0.5
2	0.5 to 2
3	2 to 5
4	5 to 9
5	9 to 15

DISTURBED

- EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE
- EXISTING AND APPROVED URBAN AND INDUSTRIAL LINEAR DISTURBANCE

3 0 3

SCALE 1:100,000 KILOMETRES

REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2004), Alberta SRD, and SOIL-INFO Ltd. (2007), used under license.
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 12.

PROJECT

JACKPINE MINE EXPANSION & PIERRE RIVER MINE PROJECT

TITLE

SLOPE CLASSES AND SURFACE EXPRESSION IN THE JACKPINE EXPANSION MINING AREA LOCAL STUDY AREA

Shell Canada Limited

PROJECT No. 05-1344-027.9000			SCALE AS SHOWN	REV. 0
DESIGN	VR	06 Jun. 2007	FIGURE: 2.4-2	
GIS	JH	17 Nov. 2007		
CHECK	DD	17 Nov. 2007		
REVIEW	WES/TC	19 Nov. 2007		

Project: I:\CLIENTS\SHELL\05-1344-027\mapping\mxd\soils\DRAFT\jackpine\bl_lsa_slope_jp_esr.mxd - Plot: I:\CLIENTS\SHELL\05-1344-027\mapping\pdf\soils\DRAFT\jackpine\Fig2.4-2_bl_lsa_slope_jp_esr.pdf

2.4.2 Soil Classification

2.4.2.1 Soil Map Legend

A total of 36 soil map units were defined for the JEMA LSA. Detailed descriptions of map unit composition characteristics are outlined in Table 2.4-4, and in Appendix D.

Soil map unit areas and the component series within each map unit were used to calculate the geographic extent of individual soil series (Table 2.4-5).

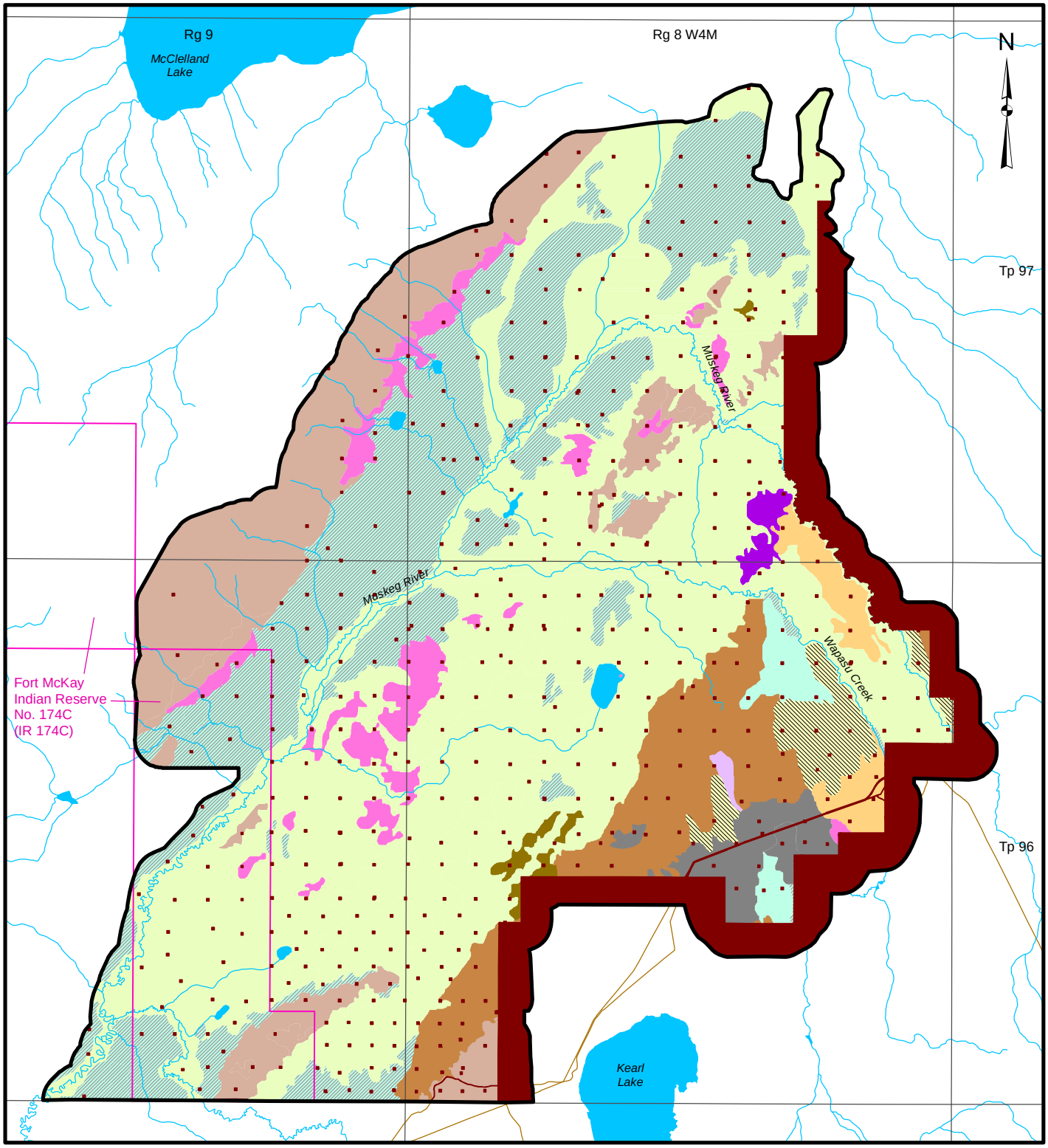
Soil series in the JEMA LSA were derived from Alberta Soil Names Generation 3 User Handbook (ASIC 2006, website) and from previous soil ESRs in the Oil Sands Region (CNRL 2002; Golder 2002, 2003c; Shell 2005). A new soil series, Albian, was added for this Project. Albian is a Typic Fibrisol with generally greater than 160 cm of fibric peat. In the Jackpine Mine – Phase 1 area the deep organic soils were mapped as McLelland (fen) or Muskeg (bog). The Albian soils include both fen and bog, but differ from McLelland and Muskeg, both of which are Mesisols, in that the Albian peat material is less decomposed (fibric) than the peat (mesic) in McLelland or Muskeg.

The JEMA LSA includes 4,063 ha (22% of the LSA) of mineral soils, 12,526 ha (68% of the LSA) of organic soils 57 ha (less than 1% of the LSA) water and 1,702 ha (9% of the LSA) disturbances (Table 2.4-5)

The most abundant mineral soil series is Mildred (2,002 ha; 11% of the JEMA LSA). Other common mineral soils are Ells River (pt) (630 ha; 3% of the JEMA LSA) and Horse River (545 ha; 3% of the JEMA LSA).

The most abundant organic soil series is McLelland (7,025 ha; 39% of the JEMA LSA). Other common organic soils are Albian (2,341ha; 13% of the JEMA LSA), Hartley (1,049 ha; 6% of the JEMA LSA) and Muskeg (xs-shallow) (1,109 ha; 6% of the JEMA LSA).

The geographic extent and classification of each soil series is summarized in Table 2.4-5. The spatial distribution of dominant soil series is presented in Figure 2.4-3.



LEGEND

- JACKPINE EXPANSION MINING AREA LOCAL STUDY AREA
- INDIAN RESERVE
- OPEN WATER
- PUBLIC ROADWAY

SOIL SERIES

- ALBIAN
- BITUMOUNT (PEATY)
- ELLS RIVER (PEATY)-HORSE RIVER
- ELLS RIVER (PEATY)-MARIANA
- HARTLEY-MUSKEG (SHALLOW)
- HARTLEY-McLELLAND (SHALLOW)
- HORSE RIVER
- LIVOCK
- MARIANA
- MILDRED
- MUSKEG
- McLELLAND

DISTURBED

- EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE
- EXISTING AND APPROVED URBAN AND INDUSTRIAL LINEAR DISTURBANCE

3 0 3
SCALE 1:100,000 KILOMETRES

REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2004), Alberta SRD, and SOIL-INFO Ltd. (2007), used under license.
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 12.

PROJECT
JACKPINE MINE EXPANSION & PIERRE RIVER MINE PROJECT

TITLE
DOMINANT SOIL SERIES IN THE JACKPINE EXPANSION MINING AREA LOCAL STUDY AREA

Shell Canada Limited

PROJECT No. 05-1344-027.9000			SCALE AS SHOWN	REV. 0
DESIGN	VR	06 Jun. 2007	FIGURE: 2.4-3	
GIS	JH	19 Nov. 2007		
CHECK	DD	17 Nov. 2007		
REVIEW	WESTC	19 Nov. 2007		

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Table 2.4-4 Soil Map Unit Legend for the Jackpine Expansion Mining Area Local Study Area

Map Unit Symbol	Map Unit Name	Surface Expression and Parent Material	Soil Patterns	Comments
ABN1/O1	Albian	level, flat, horizontal or plateau fen and bog peatlands (P1 and P2)	Dominant: TY.F (ABN) Significant: TY.M (MLD) Minor: TY.M (MUS) and FI.OC (MKWaa)	Other soils may appear including T.F (HLY) and T.M (MUSxc or MLDxc). Occasional domed bogs present. These areas associated with Cryosols and cryic phases of organic soils. Fibric material dominates the upper tier.
ABN2/O2	Albian	level, basin (bowl) fen and bog peatlands (P1, P2, L12)	Dominant: TY.F (ABN) Significant: T.M and T.F (MLDxc, MUSxc and HLY) Minor: ptR.G (BMTpt)	Wet upland depressions featuring a variety of organic veneers and blankets overlying a variety of glaciolacustrine and glaciofluvial materials. Peaty and gleyed phases occur on boundaries of units.
ABN3/O3	Albian	level, channeled, ribbed, or net fen and bog peatlands (P1 and P2)	Dominant: TY.F (ABN) Significant: TY.M (MLD) Minor: T.M (MUSxs), T.F (HLY), FI.OC (MKWaa)	Other soils may include T.F (HLY) and T.M (MUSxc or MLDxc). Minor inclusions of domed bogs and cryic soil phases or Cryosols. Fibric material dominates the upper tier.
ABN4/O6	Albian	domed fen and bog peatlands (P1 and P2)	Dominant: TY.F (ABN) Significant: TY.M (MLD) and FI.OC (MKWaa) Minor: TY.M (MUS)	Elevated 1 to 2 metres above surrounding fen and bog peatlands. Fibric material dominates the upper tier.
BMTpt1/U1l	Bitumount	nearly level to level, coarse textured (C2, C3), layered (L2, L3, L9, L20) and fine (F1) deposits	Dominant: ptO.G (BMTpt) Significant: T.M (MLDxs), GL.R (NAMgl) or R.G (NOR) Minor: O.LG (ALG), GLE.DYB (MILgl and SUTgl)	Low lying areas dominated by coarse textured and layered Gleysols and thin Organic soils. Peaty phases are common.
ELptMR1/O5	peaty Ells River – Mariana	level organic with hummocky mineral soils. organic veneer to blankets overlying fluted moderately fine to moderately coarse textured till or till like (M4, F4, L12 and F1) deposits	Co-Dominant: ptR.G (ELSpt) and T.M (MRN) Minor: T.F (HLY), E.DYB (SUT), O.GL (HRR and HVNaa)	Transition between dominantly well drained upland soils and fen and bog peatlands (P1, P2) parent materials. A variety of soils appear in unit. Areas of upland soils common. F1 parent material may occur.

PAGE CORRECTED FOR ERRATA

JPME R1 ERRATA

Table 2.4-4 Soil Map Unit Legend for the Jackpine Expansion Mining Area Local Study Area (continued)

Map Unit Symbol	Map Unit Name	Surface Expression and Parent Material	Soil Patterns	Comments
ELptHR1/U1l	peaty Ells River – Horse River	organic veneers overlying undulating low relief, fluted, moderately fine to moderately coarse textured till or till like (M4, F4, L2, L3 and L12) deposits	Co-Dominant: ptR.G (ELSpt) and O.GL (HRR) Minor: E.DYB (SUT) O.GL (LVK), O.LG (STP), T.M (MLDxt), T.F (HLY)	Minor amounts of moderately to coarse textured veneers and blankets occur within polygons.
HLMLxt1/O1	Hartley – xt McLelland	level, flat, horizontal or plateau fen and bog peatlands (L12)	Co-Dominant: T.F (HLY) and T.M (MLDxt) Minor: ptR.G (ELSpt) and GL.GL (LVKgl)	N/A
HLMUxc1/O1	Hartley - xcMuskeg	level, flat, horizontal or plateau fen and bog peatlands (L12)	Co-Dominant: T.F (HLY) and T.M (MUSxc) Minor: ptR.G (ELSpt)	N/A
HRR2/U1h	Horse River	undulating high relief moderately fine textured (M4) till; medium to moderately coarse textured fluvial veneers (L2 and L3) may occur	Dominant: O.GL (HRR) Significant: Gleysols including peaty variants Minor: O.GL (LVK), E.DYB (SUT), BR.GL (HRRzz) and thin organic soils	N/A
HRR1/H1l	Horse River	hummocky low relief moderately fine textured (M4) till; medium to moderately coarse textured fluvial veneers (L2 and L3) may occur	Dominant: O.GL (HRR) Minor: O.GL (LVK), E.DYB (SUT), and BR.GL (HRRzz)	N/A
HRLV1/H1l	Horse River – Livock	hummocky low relief moderately fine textured (M4) till and moderately coarse to coarse textured fluvial veneers (L2 and L3) occur	Co-Dominant: O.GL (HRR) and (LVK) Minor: E.DYB (SUT), E.DYB (MIL) and BR.GL (HRRzz) developed on veneers/till or till	Transition between till dominated areas to sandy areas to the west.
HRLV1/H1m	Horse River – Livock	hummocky moderate relief, moderately fine textured (M4) till and moderately coarse to coarse textured fluvial veneers (L2 and L3) occur	Co-Dominant: O.GL (HRR) and (LVK) Minor: E.DYB (SUT), E.DYB (MIL) and BR.GL (HRRzz) developed on veneers/till or till	N/A

PAGE CORRECTED FOR ERRATA

JPME R1 ERRATA

Table 2.4-4 Soil Map Unit Legend for the Jackpine Expansion Mining Area Local Study Area (continued)

Map Unit Symbol	Map Unit Name	Surface Expression and Parent Material	Soil Patterns	Comments
HRLV1/U1h	Horse River – Livock	undulating high relief, moderately fine textured (M4) till and moderately coarse to coarse textured fluvial veneers (L2 and L3) occur	Co-Dominant: O.GL (HRR) and (LVK) Minor: E.DYB (SUT), E.DYB (MIL) and BR.GL (HRRzz) developed on veneers/till or till	N/A
MIL1/U1h	Mildred	undulating high relief, coarse textured (C2) glaciofluvial; C1 and L18 deposits may occur	Dominant: E.DYB (MIL) Minor: O.DYB (MILzz), O.GL (LVK), O.GL (FRT), E.DYB (FIR)	Some polygons may be dominated by O.DYB.
MIL2/U1h	Mildred	undulating high relief, coarse textured (C2) glaciofluvial. C1, L11, P2, P3 and L18 deposits may occur	Dominant: E.DYB (MIL) Significant: Gleysols and thin organics Minor: O.DYB (MILzz), O.GL (LVK), O.GL (FRT), E.DYB (FIR)	N/A
MLD1/FP1	McLelland	meander floodplain – nearly level, soils developed on organic veneers to blankets (P2, L11, L13) over fluvial, fluviolacustrine or lacustrine deposits	Dominant: TY.M (MLD) Significant: TY.F (ABN) Minor: T.M (MLDxt, MLDxs and MUSxc)	Floodplain of Muskeg River. Other soils that may occur include peaty Rego Gleysols developed on fluvial or fluviolacustrine sediments (uncommon).
MLD1/FP3	McLelland	confined floodplain possibly terraced, soils developed on organic veneers to blankets (P2, L11, L13) over fluvial, fluviolacustrine or lacustrine deposits	Dominant: TY.M (MLD) Significant: T.M (MLDxt, MLDxs and MUSxc)	Other soils that may occur include ptR.G, O.R, CU.R and gleyed variants.
MLD1/O1	McLelland	level, flat, horizontal or plateau fen and bog peatlands (P1 and P2)	Dominant: TY.M (MLD) Significant: T.M and T.F (HLYxs, MLDxs and MUSxc)	N/A
MRN1/O1	Mariana	organic veneers overlying fluted moderately fine to moderately coarse textured till (M4) sediments	Dominant: T.M (MRN) Significant: ptR.G (ELSpt)	N/A

PAGE CORRECTED FOR ERRATA

JPME R1 ERRATA

Table 2.4-4 Soil Map Unit Legend for the Jackpine Expansion Mining Area Local Study Area (continued)

Map Unit Symbol	Map Unit Name	Surface Expression and Parent Material	Soil Patterns	Comments
MUSxc1/O5	Muskeg	level organic with hummocky mineral soils. Soils developed on organic veneers to blankets (P2, L11, L13) over coarse textured fluvial, fluvio-lacustrine or lacustrine deposits	Dominant: T.M (MUSxc) Significant: TY.M (MLD) and E.DYB (MIL)	N/A
ZWA1/W3	Water	a single water basin which may be filled or partly filled with water	N/A	N/A
Note: N/A = Not applicable.				

PAGE CORRECTED FOR ERRATA

JPME R1 ERRATA

Table 2.4-5 Geographic Extent of Soil Series in the Jackpine Expansion Mining Area Local Study Area

Series Name	Series Abbreviation	Soil Classification	Area [ha]	Percent of JEMA LSA [%]
Albian	ABN	Typic Fibrisol	2,324	13
Algar Lake	ALG	Orthic Luvic Gleysol	3	<1
Bitumount	BMT	Orthic Gleysol	277	2
Ells River	ELS	Rego Gleysol	615	3
Firebag	FIR	Eluviated Dystric Brunisol	8	<1
Fort	FRT	Orthic Gray Luvisol	87	<1
Halverson	HVN	Orthic Gray Luvisol	21	<1
Hartley	HLY	Terric Fibrisol	1,044	6
Horse River	HRR	Orthic Gray Luvisol	539	3
Livock	LVK	Orthic Gray Luvisol	254	1
Mariana	MRN	Terric Mesisol	458	2
McLelland	MLD	Typic Mesisol	7,086	39
Mildred	MIL	Eluviated Dystric Brunisol	1,982	11
Mikkwa	MKW	Fibric Organic Cryosol	291	2
Muskeg	MUS	Typic Mesisol	1,299	7
Norberta	NOR	Rego Gleysol	3	<1
Namur	NAM	Gleyed Regosol	3	<1
Sutherland	SUT	Eluviated Dystric Brunisol	145	1
Steepbank	STP	Orthic Gleysol	7	<1
Gleysols	N/A	N/A	91	<1
Water	N/A	N/A	102	1
Disturbed	N/A	N/A	1,708	9
		Total	**18,348**	**100**

Note:
N/A = Not Applicable

Soil units which occur to a minor extent (less than 2%) may not be shown in Figure 2.4-3 as the map scale is too small. Detailed descriptions of the soil series are in Appendix B.

2.4.3 Soil Map Unit Interpretations

2.4.3.1 Land Capability for Forestry

Forest Capability Classes were calculated using procedures outlined in the *Land Capability Classification System for Forest Ecosystems in the Oilsands* (CEMA 2006). Five classes are recognized in the system. Forest Capability Classes 1, 2 and 3 are capable of supporting commercially productive forests while Forest Capability Classes 4 and 5 are considered non-productive.

PAGE CORRECTED FOR ERRATA

Forestry capability ratings of each soil map unit and soil series are presented in Appendix G. Forest Capability Classes 1, 2 and 3 occupy about 754 ha (4%) of the JEMA LSA (Table 2.4-6). Forest Capability Classes 4 and 5 occupy about 15,835 ha (86%) of the JEMA LSA. Open water and disturbed areas comprise about 1,759 ha (10%) of the JEMA LSA.

The geographic extent of areas occupied by the five capability classes is summarized in Table 2.4-6. The spatial distribution of Forest Capability Classes is presented in Figure 2.4-4.

Table 2.4-6 Capability for Forest Ecosystems in the Jackpine Expansion Mining Area Local Study Area by Soil Map Unit

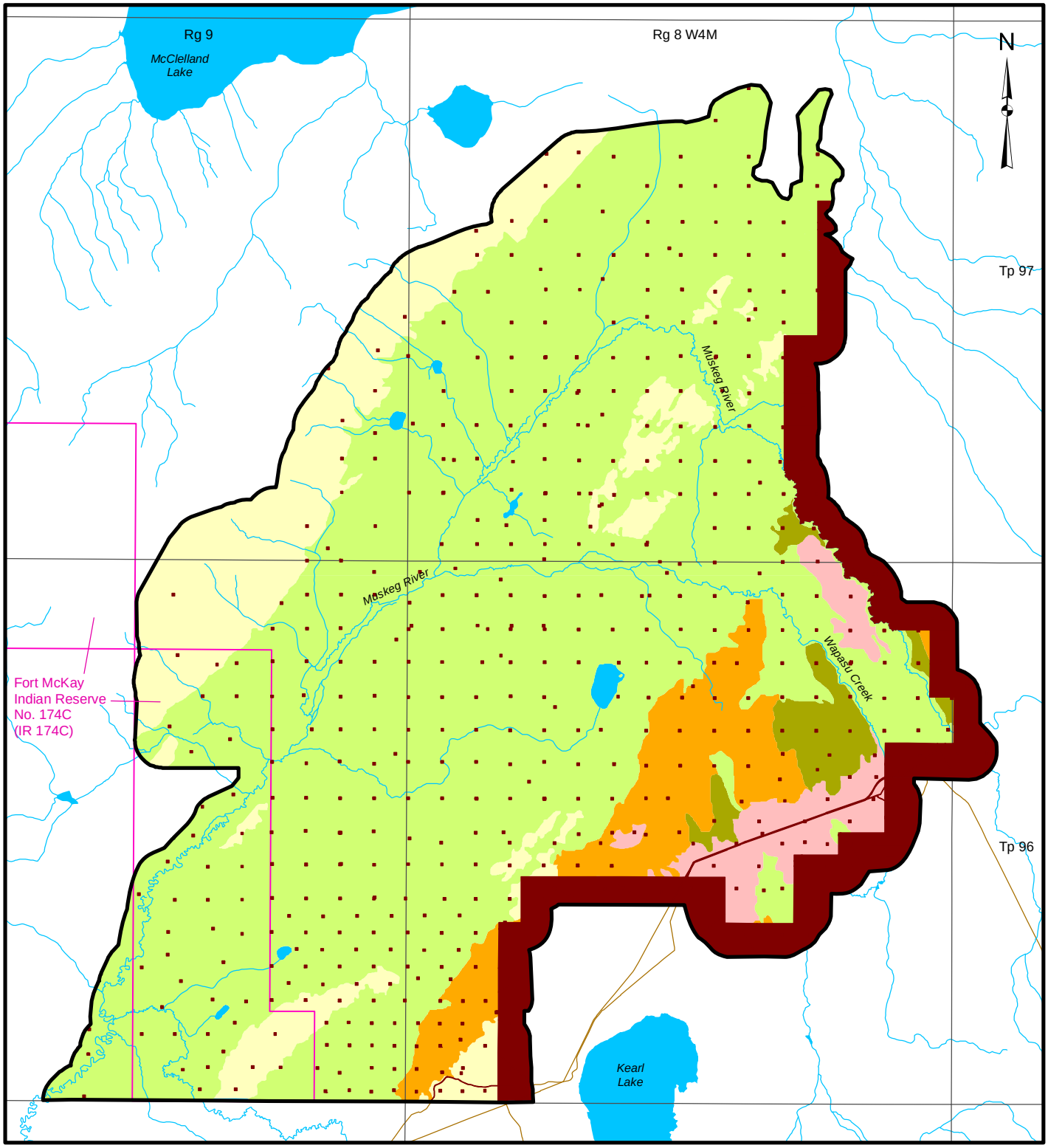
Forest Capability Class	Area [ha]	Percent of JEMA LSA [%]
Class 1 (high)	0	0
Class 2 (moderate)	720	4
Class 3 (low)	34	<1
Class 4 (conditionally productive)	2,862	16
Class 5 (non-productive)	12,973	71
open water	57	<1
disturbed	1,702	9
Total	**18,348**	**100**

Note: Some numbers are rounded for presentation purposes. Therefore, it may appear that the totals do not equal the sum of the individual values.

2.4.3.2 Wind and Water Erosion Risk

Wind erosion risk ratings of exposed soils for each soil map unit are presented in Appendix D. The wind erosion risk ratings were adapted from the Alberta publication *Wind Erosion Risk* (Coote and Pettapiece 1989). Erosion risk primarily applies to disturbed soils since vegetated soils are generally not at risk to erosion.

In general, very sandy soils are at the highest risk of wind erosion when disturbed. In the JEMA LSA, this includes the coarse-textured soils in Mildred soil map units. The remainder of the JEMA LSA is rated as having a low risk to wind erosion.



LEGEND

- JACKPINE EXPANSION MINING AREA LOCAL STUDY AREA
- INDIAN RESERVE
- OPEN WATER
- PUBLIC ROADWAY

LAND CAPABILITY

- MODERATE CAPABILITY (2)
- MODERATE/CONDITIONALLY PRODUCTIVE (2-4)
- CONDITIONALLY PRODUCTIVE (4)
- CONDITIONALLY PRODUCTIVE/NON-PRODUCTIVE (4-5)
- NON-PRODUCTIVE (5)

DISTURBED

- EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE
- EXISTING AND APPROVED URBAN AND INDUSTRIAL LINEAR DISTURBANCE

3 0 3

SCALE 1:100,000 KILOMETRES

REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2004), Alberta SRD, and SOIL-INFO Ltd. (2007), used under license.
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 12.

PROJECT

JACKPINE MINE EXPANSION & PIERRE RIVER MINE PROJECT

TITLE

LAND CAPABILITY FOR FOREST ECOSYSTEMS IN THE JACKPINE EXPANSION MINING AREA LOCAL STUDY AREA

Shell Canada Limited

PROJECT No. 05-1344-027.9000			SCALE AS SHOWN	REV. 0
DESIGN	VR	06 Jun. 2007	FIGURE: 2.4-4	
GIS	JH	17 Nov. 2007		
CHECK	DD	17 Nov. 2007		
REVIEW	WES/TC	19 Nov. 2007		

Project: I:\CLIENTS\SHELL\05-1344-027\mapping\mxd\soils\DRAFT\jackpine\bl_lsa_lcap_jp_esr.mxd - Plot: I:\CLIENTS\SHELL\05-1344-027\mapping\pdf\soils\DRAFT\jFig2.4-4_jackpine\bl_lsa_lcap_jp_esr.pdf

The spatial distribution of dominant wind erosion risk classes in the JEMA LSA is shown in Figure 2.4-5 and the geographic extent is summarized in Table 2.4-7. High wind erosion risk areas occupy about 2,180 ha (12%) of the JEMA LSA while low wind erosion risk areas comprise about 14,409 ha (79% of the JEMA LSA).

Table 2.4-7 Wind Erosion Risk Ratings in the Jackpine Expansion Mining Area Local Study Area by Soil Map Unit

Wind Erosion Risk	Area [ha]	Percent of JEMA LSA [%]
low	14,409	79
moderate	0	0
high	2,180	12
open water	57	<1
disturbance	1,702	9
Total	**18,348**	**100**

Note: Some numbers are rounded for presentation purposes. Therefore, it may appear that the totals do not equal the sum of the individual values.

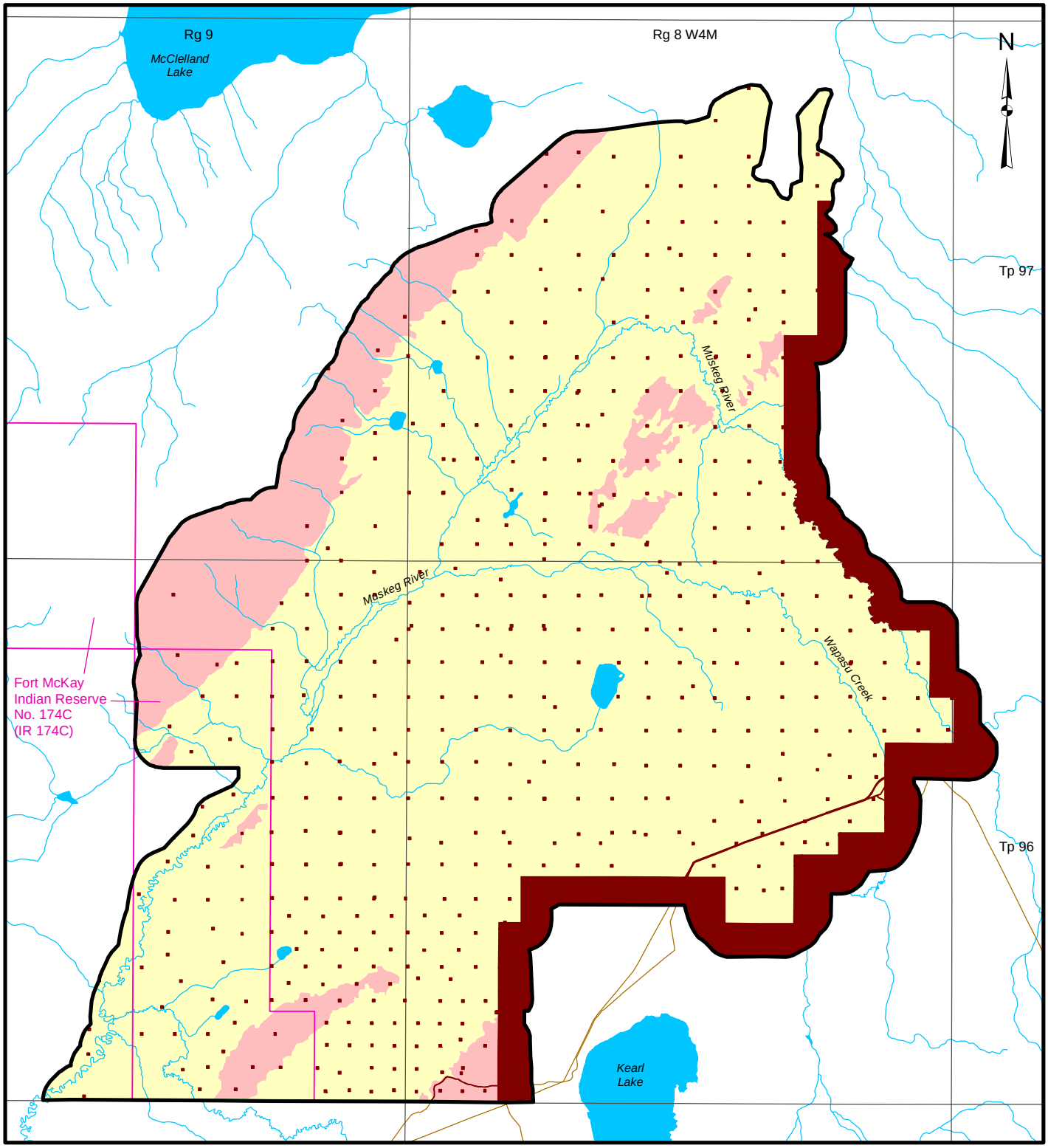
Water erosion risk ratings were adapted from the Alberta publication *Water Erosion Risk* (Tejak and Coote 1993; Pedocan 1993). Erosion risk primarily applies to disturbed soils because vegetated soils are not generally at risk to water erosion. Water erosion risk is affected by the soil characteristics such as texture and slope. Therefore, water erosion risk for exposed soil was calculated for each mapped soil map/landscape model map unit. Generally, water erosion risk was high to very high for soil map units that had slopes greater than 9% (Table 2.4-8).

Table 2.4-8 Water Erosion Risk Ratings in the Jackpine Expansion Mining Area Local Study Area by Soil Map Unit

Water Erosion Risk	Area [ha]	Percent of JEMA LSA [%]
low	14,514	79
moderate	792	4
high	1,283	7
disturbance	1,702	9
water	57	<1
Total	**18,348**	**100**

Note: Some numbers are rounded for presentation purposes. Therefore, it may appear that the totals do not equal the sum of the individual values.

Low water erosion risk categories occupy about 14,514 ha (79 %) of the JEMA LSA. High water erosion risk categories occupy approximately 1,283 ha (7%) of the JEMA LSA. Water erosion risk ratings of exposed soil for each soil map unit in the JEMA LSA are illustrated in Figure 2.4-6 and presented in Appendix D.



LEGEND

- JACKPINE EXPANSION MINING AREA LOCAL STUDY AREA
- INDIAN RESERVE
- OPEN WATER
- PUBLIC ROADWAY

WIND EROSION RISK

- HIGH
- LOW

DISTURBED

- EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE
- EXISTING AND APPROVED URBAN AND INDUSTRIAL LINEAR DISTURBANCE

3 0 3

SCALE 1:100,000 KILOMETRES

REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2004), Alberta SRD, and SOIL-INFO Ltd. (2007), used under license.
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 12.

PROJECT

JACKPINE MINE EXPANSION & PIERRE RIVER MINE PROJECT

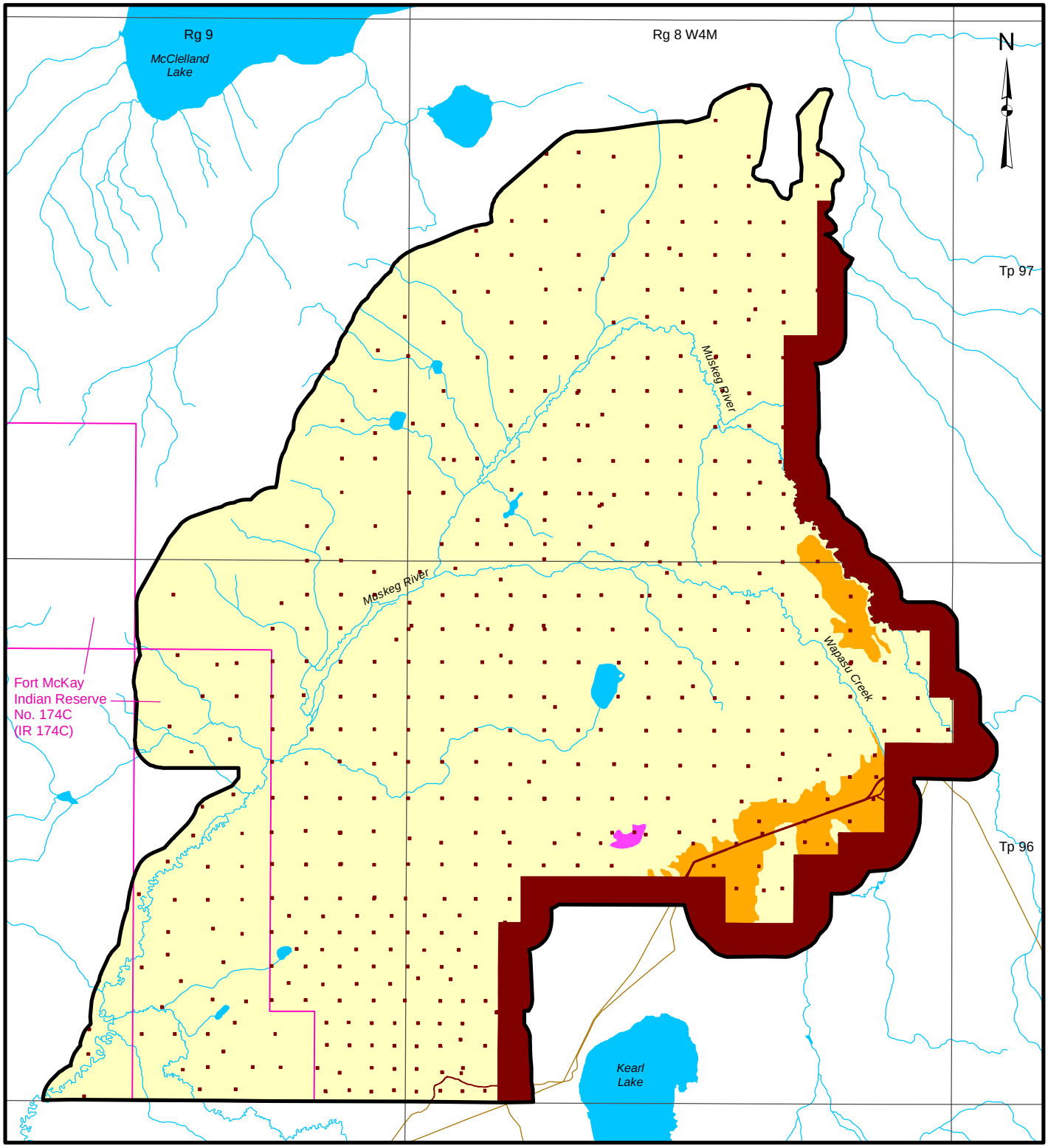
TITLE

WIND EROSION RISK FOR EXPOSED MINERAL SOILS IN THE JACKPINE EXPANSION MINING AREA LOCAL STUDY AREA

Shell Canada Limited

PROJECT No. 05-1344-027.9000			SCALE AS SHOWN	REV. 0
DESIGN	VR	06 Jun. 2007		
GIS	JH	19 Nov. 2007		
CHECK	DD	17 Nov. 2007	FIGURE: 2.4-5	
REVIEW	WESTC	19 Nov. 2007		

Project: I:\CLIENTS\SHELL\05-1344-027\mapping\mxd\soils\DRAFT\jackpine\bl_lsa_wind_eros_jp_esr.mxd - Plot: I:\CLIENTS\SHELL\05-1344-027\mapping\pdf\soils\DRAFT\jackpine\Fig2.4-5_bl_lsa_wind_eros_jp_esr.pdf



LEGEND

- JACKPINE EXPANSION MINING AREA LOCAL STUDY AREA
- INDIAN RESERVE
- OPEN WATER
- PUBLIC ROADWAY

WATER EROSION RISK

- HIGH
- MODERATE
- LOW

DISTURBED

- EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE
- EXISTING AND APPROVED URBAN AND INDUSTRIAL LINEAR DISTURBANCE

3 0 3

SCALE 1:100,000 KILOMETRES

REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2004), Alberta SRD, and SOIL-INFO Ltd. (2007), used under license.
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 12.

PROJECT

JACKPINE MINE EXPANSION & PIERRE RIVER MINE PROJECT

TITLE

WATER EROSION RISK FOR EXPOSED MINERAL SOILS IN THE JACKPINE EXPANSION MINING AREA LOCAL STUDY AREA

Shell Canada Limited

PROJECT No. 05-1344-027.9000			SCALE AS SHOWN	REV. 0
DESIGN	VR	06 Jun. 2007	FIGURE: 2.4-6	
GIS	JH	19 Nov. 2007		
CHECK	DD	17 Nov. 2007		
REVIEW	WESTC	19 Nov. 2007		

Project I:\CLIENTS\SHELL\05-1344-027\mapping\mxd\soils\DRAFT\jackpine\bl_lsa_water_jp_esr.mxd - Plot: I:\CLIENTS\SHELL\05-1344-027\mapping\pdf\soils\DRAFT\jackpine\Fig2.4-6_bl_lsa_water_jp_esr.pdf

2.4.3.3 Topsoil and Subsoil Reclamation Suitability in the Jackpine Expansion Mining Area Project Local Study Area

Topsoil reclamation suitability ratings and the average depth of topsoil, upper subsoil and lower subsoil for each soil map unit and each soil series are presented in Appendix B and E. Soil reclamation suitability for topsoil and subsoil was developed from the Alberta Soil Advisory Committee (1987) guidelines and is based on soil physical and chemical properties.

All mineral topsoil is suitable for reclamation; about 1% of the mineral soil areas is rated as good; about 20% is rated as fair, and about 80% is rated as poor. Generally, factors limiting topsoil suitability were texture (course or fine) and pH.

Mineral upper subsoil is suitable for reclamation; about 30% of the mineral soil areas is rated as fair, and about 60% is rated as poor. Mineral lower subsoil is suitable for reclamation; about 10% of the mineral soil areas is rated as fair, and about 90% is rated as poor. Factors limiting subsoil suitability were texture (course or fine) and moist consistency. "Lean Oil Sands" was not a limiting factor as subsoil depths were considered to a 1 m depth. Soils with some hydrocarbon within the surface meter were observed to a very limited extent and could not be mapped at the scale of the soil survey.

Organic soils (peat) were not rated for reclamation suitability as generally all peat is considered suitable.

The actual volumes of mineral topsoil, upper and lower subsoil as well as organic soil (peat), which will be salvaged and used for reclamation will depend on the actual development areas and soil replacement requirements as outlined in the CC&R Plan provided with the EIA for the project.

2.5 PIERRE RIVER MINING AREA RESULTS

2.5.1 Terrain Types

Terrain types are derived from the genetic composition of landform classification in the Canada Soil Information System (CanSIS) (Agriculture Canada 1982). For this report, the CanSIS terrain types were further subdivided to delineate organic fens, shallow organic fens, organic bogs, shallow organic bogs and glaciofluvial veneers over moraine. Terrain types found in the PRMA LSA are described in Table 2.5-1.

Table 2.5-1 Description of Terrain Types in the Pierre River Mine Area Local Study Area

Terrain Type	Map Symbol	Description
Moraine (Tills)[a]		
Glaciolacustrine	Lg	Materials deposited in or along the margins of glacial lakes and include sediments that were released by the melting of floating ice. Material is fine and often varved with occasional ice-rafted pebbles. Material also consists of sand and gravelly beach deposits.
Glaciofluvial	Fg	Material is deposited by glacial meltwater stream either directly in front of or in contact with glacier ice. Glaciofluvial deposits consist of coarse textured, well-rounded, sorted and often stratified material.
Glaciofluvial Veneer over Moraine	Fg/M	The overlying material consists of glaciofluvial material while the underlying material consists of morainal material. The glaciofluvial veneer is less than 100 cm in thickness.
Fluvial	F	Material that has been transported and deposited by streams and rivers.
Organic[b]		
Organic - Bog	B	Peat deposits that are formed from *Sphagnum* mosses under a closed drainage system.
Organic - Fen	N	Peat deposits that are formed from sedges and mosses in areas with nutrient-rich high water tables.
Organic Veneers	Bs	Shallow peat deposits that are formed from *Sphagnum* mosses over a mineral substrate.
	Ns	Shallow peat deposits that are formed from sedges and mosses in areas with nutrient-rich high water tables over a mineral substrate.

(a) Materials are deposited by glaciers without modification by other agents of transportation. Material consists of a heterogeneous mixture of boulders, sand, silt and clay; angular to rounded; non-sorted and non-stratified material.

(b) Materials composed of largely organic materials resulting from the accumulation of vegetative matter. They contain at least 30% organic matter by weight.

Glaciolacustrine (Lg)

See Comments under JEMA Glaciolacustrine materials were deposited by running water into standing water (e.g., glacial lake deposits). Glaciolacustrine material in the LSA is generally fine textured.

Glaciofluvial (Fg)

Glaciofluvial materials were deposited by glacial meltwater streams, either directly in front of or in contact with glacier ice during the last glacial retreat. Glaciofluvial materials in the LSA consist of coarse textured, well-rounded, sorted and often stratified material. These materials are generally very coarse textured (i.e., loamy sand to sand), although there are some areas of moderately coarse-textured (sandy loam) materials. There are also some areas of gravelly coarse-textured materials. Upland areas of glaciofluvial deposits are well to rapidly drained, with areas that are poorly to very poorly drained. In some cases these are overlain with a veneer or blanket of fen or bog peat.

Glaciofluvial Veneer over Moraine or Glaciolacustrine (Fg/M or Fg/Lg)

Glaciofluvial veneer deposits over till can be well, moderately well, imperfectly or poorly drained, depending on slope position, depth to groundwater and thickness of the coarse-textured veneer. Glaciofluvial veneer deposits over till are designated by the abbreviation Fg/M. Glaciofluvial veneer deposits over glaciolacustrine are designated by the abbreviation Fg/Lg.

Fluvial (F)

Fluvial material has been transported and deposited by streams and rivers. Fluvial deposits are associated with watercourses throughout the LSA. Fluvial materials in the LSA are generally coarse to medium textured, although some fine-textured materials were also found. The texture of fluvial material reflects the specific watercourse environment in which it was deposited.

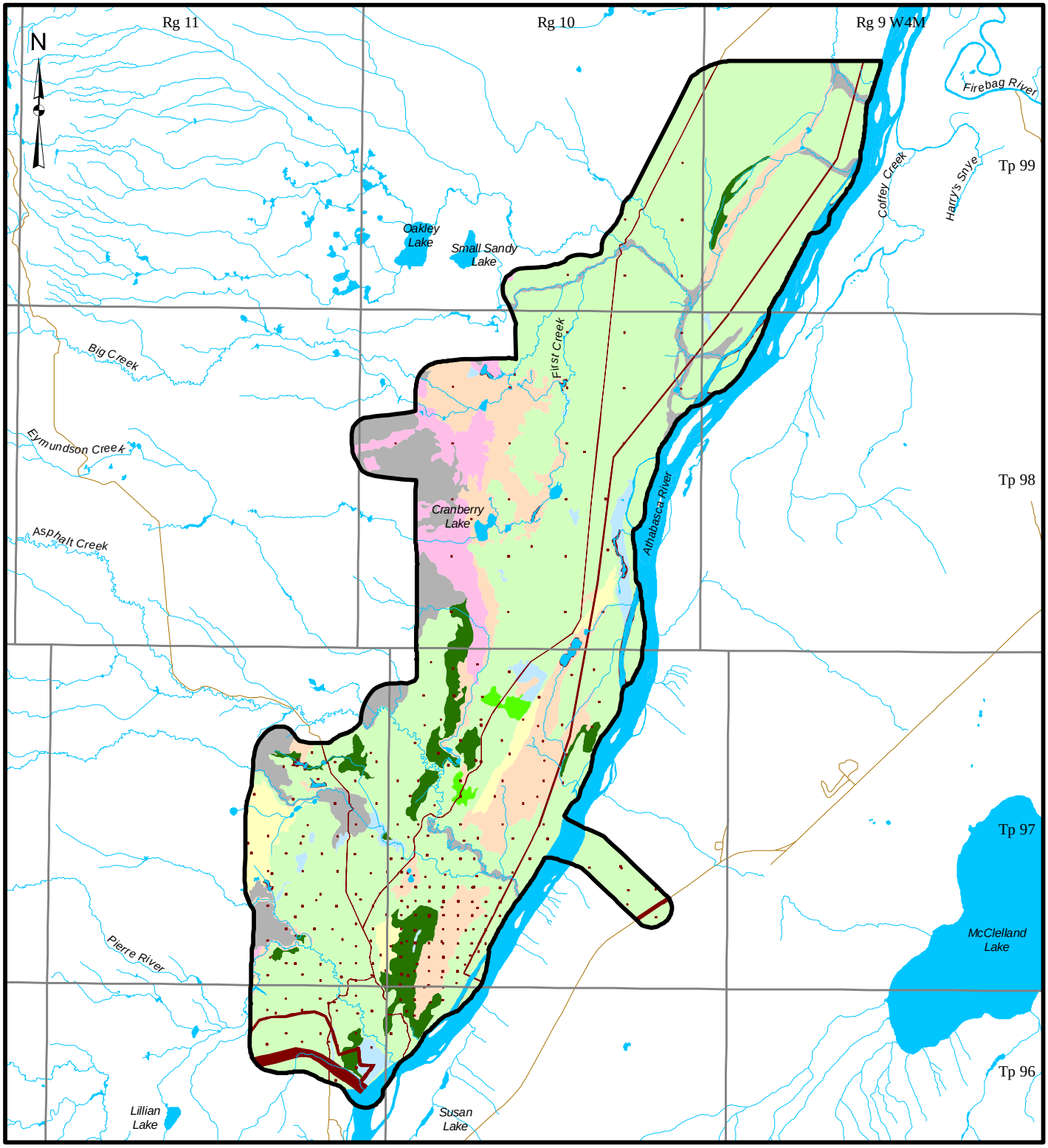
2.5.1.1 Geographic Extent

The dominant terrain map units within the PRMA LSA are glaciofluvial (Fg; 11,964 ha or 57% of the PRMA LSA), shallow fens (Ns; 2,837 ha or 13% of the PRMA LSA), glaciofluvial over moraine (Fg/M; 1,876 ha or 9% of the PRMA LSA) and glaciolacustrine (Lg; 1,573 ha or 7% of the PRMA LSA) (Table 2.5-2). Other terrain map units make up less than 10% of the PRMA LSA. Terrain units in the PRMA LSA are shown in Figure 2.5-1. Terrain units which occur to a minor extent may not be shown in Figure 2.5-2 as the map scale is too small.

Table 2.5-2 Geographic Extent of Terrain Units in the Pierre River Mining Area Local Study Area

Terrain Unit	Map Symbol	Area [ha]	Percent of PRMA LSA [%]
glaciofluvial	Fg	11,964	57
shallow fen	Ns	2,837	13
glaciofluvial/moraine	Fg/M	1,876	9
glaciolacustrine	Lg	1,573	7
shallow bog/glaciofluvial	Bs/Fg	891	4
fluvial	F	558	3
shallow bog	Bs	363	2
shallow fen/glaciolacustrine	Ns/Lg	261	1
fen	N	84	<1
water	water	394	2
disturbed	disturbed	335	2
Total		**21,136**	**100**

Note: Some numbers are rounded for presentation purposes. Therefore, it may appear that the totals do not equal the sum of the individual values.



LEGEND

- PIERRE RIVER MINING AREA LOCAL STUDY AREA
- OPEN WATER
- ROAD

DOMINANT TERRAIN UNITS

- SHALLOW BOG (Bs)
- SHALLOW BOG/GLACIOFLUVIAL (Bs/Fg)
- GLACIOFLUVIAL (GF)
- GLACIOFLUVIAL/MORAINAL (GF/M)
- GLACIOLACUSTRINE (Lg)
- FEN (N)
- SHALLOW FEN (Ns)
- SHALLOW FEN/GLACIOLACUSTRINE (Ns/Lg)

DISTURBED

- EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE
- EXISTING AND APPROVED URBAN AND INDUSTRIAL LINEAR DISTURBANCE

REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2004), Alberta SRD, and SOIL-INFO Ltd. (2007), used under license.
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 12.

4 0 4
SCALE 1:160,000 KILOMETRES

PROJECT
JACKPINE MINE EXPANSION &
PIERRE RIVER MINE PROJECT

TITLE
DOMINANT TERRAIN MAP UNITS IN THE
PIERRE RIVER MINING AREA LOCAL STUDY AREA

Shell Canada Limited

PROJECT No. 05-1344-027.7400			SCALE AS SHOWN	REV. 0
DESIGN	VR	10 Aug. 2007	FIGURE: 2.5-1	
GIS	JH	17 Nov. 2007		
CHECK	DD	17 Nov. 2007		
REVIEW	WES/TC	19 Nov. 2007		

Project: I:\CLIENTS\SHELL\05-1344-027\mapping\mxd\soils\DRAFT\pierreriverlbl_lsa_terrain_units_pr.mxd

2.5.1.2 Slope Classes and Surface Expression

The spatial distribution of slope classes in the PRMA LSA is shown in Figure 2.5-2 and their geographic extent is summarized in Table 2.5-3. Very gentle to gentle slopes are the most common type in the PRMA LSA (11,613 ha; 55%). Level and nearly level occupy approximately 7,767 ha (37%) of the PRMA LSA.

Table 2.5-3 Geographic Extent of Slope Classes and Surface Expression in the Pierre River Mining Area Local Study Area

Slope Class	Percent Slope [%]	Slope Classes	Surface Expression	Area [ha]	Percent of PRMA LSA [%]
1	0 to 0.5	level	level	4,012	19
2	0.5 to 2	nearly level	undulating	3,755	18
3	2 to 5	very gently undulating	undulating	8,960	42
4	5 to 9	gentle slopes	Inclined	2,653	13
5	9 to 15	moderate slopes	inclined	1,027	5
n/a	disturbances	n/a	n/a	335	2
n/a	water	n/a	n/a	394	2
Total				**21,136**	**100**

Note: Some numbers are rounded for presentation purposes. Therefore, it may appear that the totals do not equal the sum of the individual values.

n/a = Not applicable.

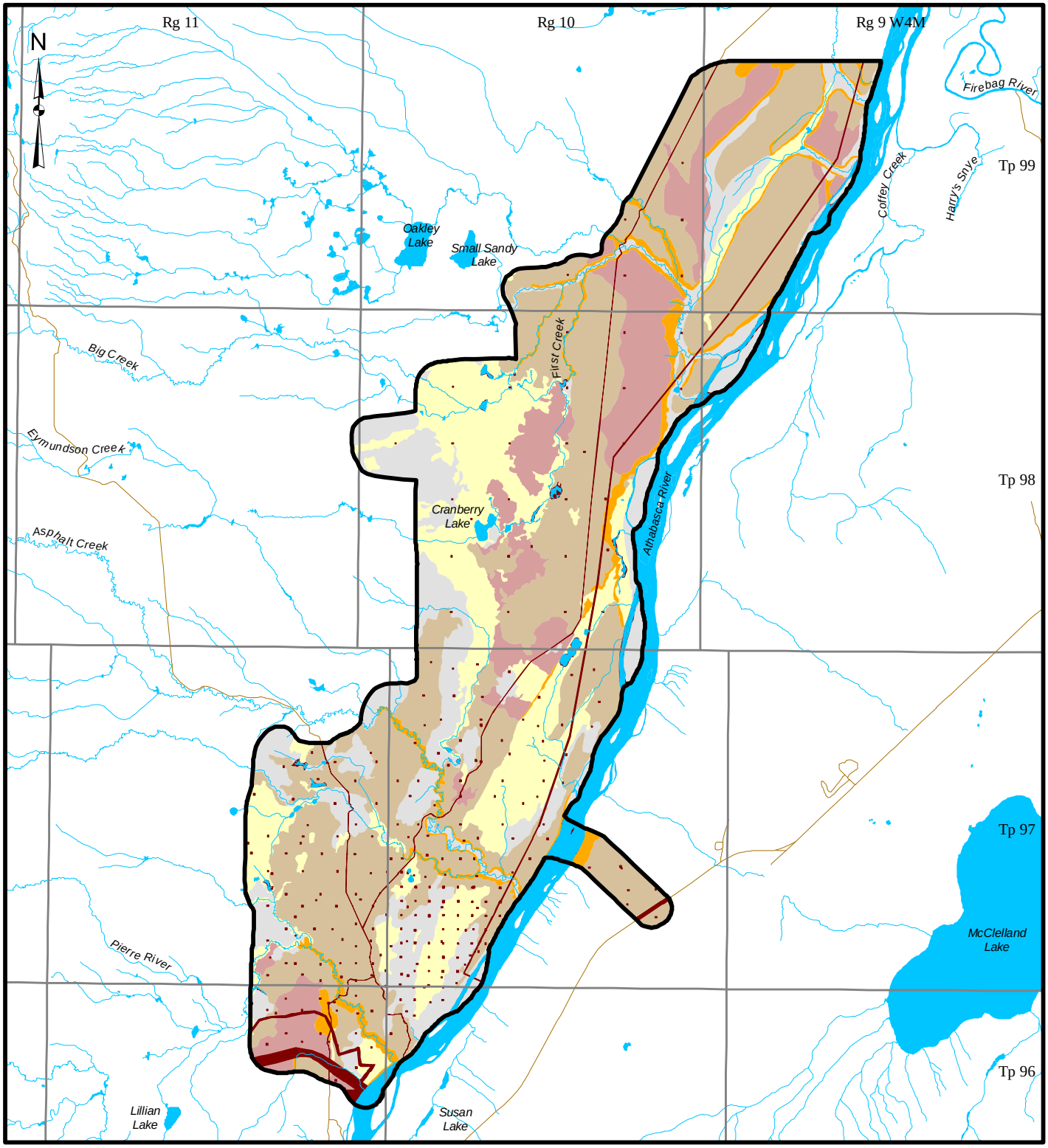
2.5.2 Soil Classification

2.5.2.1 Soil Map Legend

A total of 36 soil map units were defined for the PRMA LSA. Detailed descriptions of map unit composition and characteristics are outlined in Table 2.5-4 and in Appendix D.

Soil map unit areas and the component series within each map unit were used to calculate the geographic extent of individual soil series. The geographic extent of each soil series is summarized in Table 2.5-5. The spatial distribution of dominant soil series in the PRMA LSA is presented in Figure 2.5-3.

Soil series in the PRMA LSA were derived from Alberta Soil Names Generation 3 User Handbook (ASIC 2006, website) and from previous soil ESRs in the Oil Sands Region (CNRL 2002; Golder 2002, 2003c; AXYS 2004). The Albian soil series, a Typic Fibrisol, was added to the soil legend for this Project.



LEGEND

- PIERRE RIVER MINING AREA LOCAL STUDY AREA
- OPEN WATER
- ROAD

SLOPE CLASS	PERCENT SLOPE
1	0 to 0.5
2	0.5 to 2
3	2 to 5
4	5 to 9
5	9 to 15

DISTURBED

- EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE
- EXISTING AND APPROVED URBAN AND INDUSTRIAL LINEAR DISTURBANCE

REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2004), Alberta SRD, and SOIL-INFO Ltd. (2007), used under license.
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 12.

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SCALE 1:160,000 KILOMETRES

PROJECT
JACKPINE MINE EXPANSION & PIERRE RIVER MINE PROJECT

TITLE
SLOPE CLASSES AND SURFACE EXPRESSION IN THE PIERRE RIVER MINING AREA LOCAL STUDY AREA

Shell Canada Limited

PROJECT No. 05-1344-027.7400			SCALE AS SHOWN	REV. 0
DESIGN	VR	10 Aug. 2007	FIGURE: 2.5-2	
GIS	JH	17 Nov. 2007		
CHECK	DD	17 Nov. 2007		
REVIEW	WES/TC	19 Nov. 2007		

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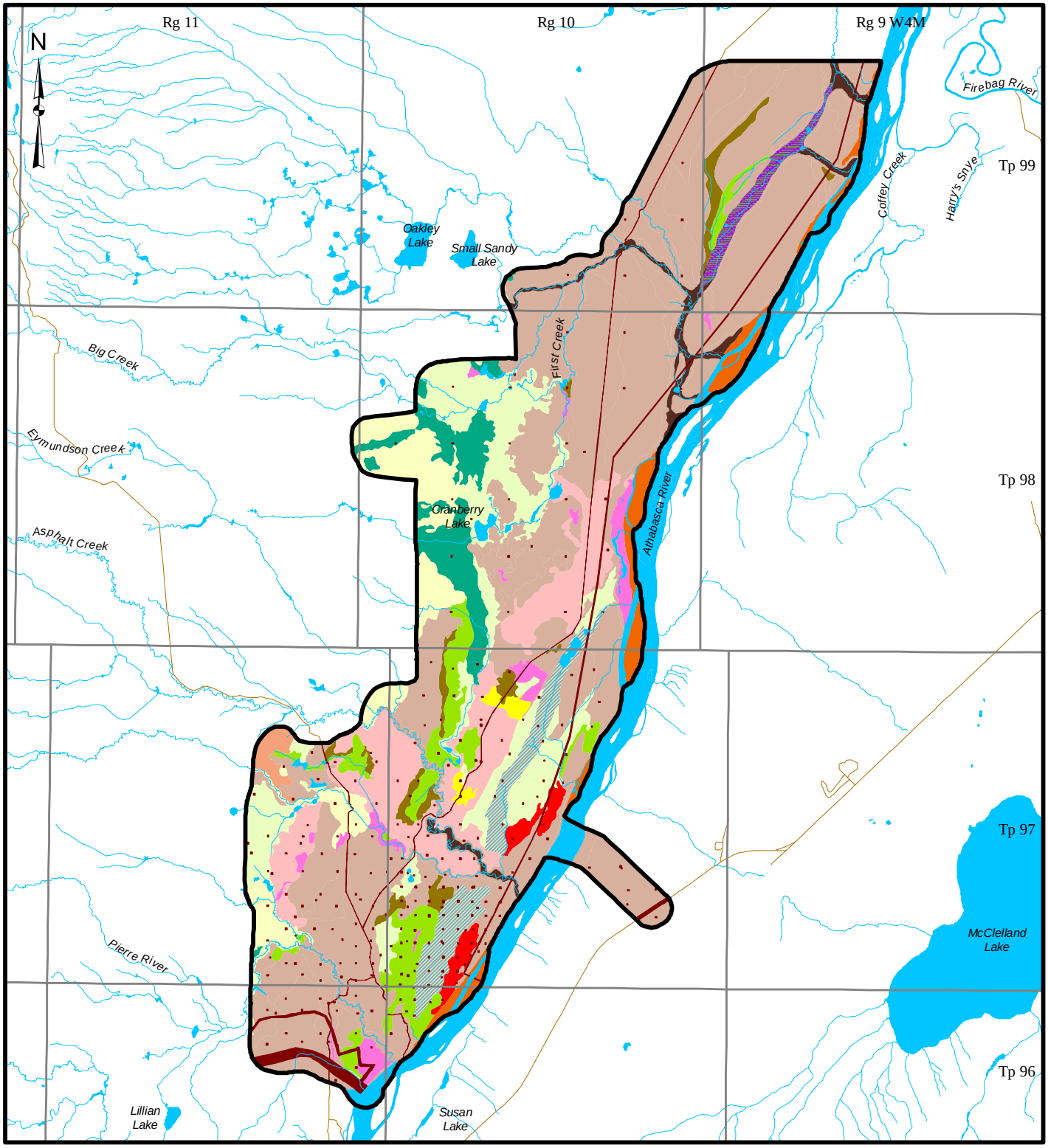

LEGEND

- PIERRE RIVER MINING AREA LOCAL STUDY AREA
- OPEN WATER
- ROAD

SOIL SERIES

- ALBIAN
- BITUMOUNT (PEATY)
- DOVER
- DOVER-CHATEH
- FIREBAG
- FORT
- FORT-LIVOCK
- MILDRED
- MUSKEG (SHALLOW)
- MUSKEG-BITUMOUNT (PEATY)
- McLELLAND
- McLELLAND-CHATEH
- McLELLAND-MIKKWA
- McMURRAY
- NAMUR

DISTURBED

- EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE
- EXISTING AND APPROVED URBAN AND INDUSTRIAL LINEAR DISTURBANCE

4 0 4
SCALE 1:160,000 KILOMETRES

REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2004), Alberta SRD, and SOIL-INFO Ltd. (2007), used under license.
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 12.

PROJECT
JACKPINE MINE EXPANSION & PIERRE RIVER MINE PROJECT

TITLE
DOMINANT SOIL SERIES IN THE PIERRE RIVER MINING AREA LOCAL STUDY AREA

Shell Canada Limited

PROJECT No. 05-1344-027.7400			SCALE AS SHOWN	REV. 0
DESIGN	VR	10 Aug. 2007	FIGURE: 2.5-3	
GIS	JH	17 Nov. 2007		
CHECK	DD	17 Nov. 2007		
REVIEW	WES/TC	19 Nov. 2007		

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Table 2.5-4 Soil Map Unit Legend for the Pierre River Mining Area Local Study Area

Map Unit Symbol	Map Unit Name	Surface Expression and Parent Material	Soil Patterns	Comments
ABN1/O1	Albian	level, flat, horizontal or plateau fen and bog peatlands (P1 and P2)	Dominant: TY.F (ABN) Significant: TY.M (MLD) Minor: TY.M (MUS) and FI.OC (MKWaa)	Other soils may appear including T.F (HLY) and T.M (MUSxc or MLDxc). Occasional domed bogs present. These areas associated with Cryosols and cryic phases of organic soils. Fibric material usually dominates upper tier.
BMTpt1/U1l	Bitumount	nearly level to level, coarse textured (C2, C3), layered (L2, L3, L9, L20) and fine (F1) deposits	Dominant: ptO.G (BMTpt) Significant: T.M (MLDxs), GL.R (NAMgl) or R.G (NOR) Minor: O.LG (ALG), GLE.DYB (MILgl and SUTgl)	Low lying areas dominated by coarse textured and layered Gleysols and thin organic soils. Peaty phases common.
DOVcogl1/U1l	Dover	nearly level to level, moderately fine textured (M3) deposits	Dominant: GL.GL (DOVcogl) Significant: O.LG (ALG) Minor: O.GL (DOV)	Moderately fine textured glaciolacustrine deposits.
DOglCHptzr1/U1l	Dover-Chateh	nearly level to level fine-textured (F1) deposits.	Dominant: GL.GL (DOVgl), R.G (CHTptzr) Significant: O.LG (ALG), O.HG (DAR) Minor: T.M (MLDxc)	N/A
DOV2/FP3	Dover	confined floodplain, fine-textured (F1) deposits	Dominant: O.GL (DOV) Significant: O.LG (ALG), R.G (CHTzr), O.HG (DAR Minor: T.M (MLDxc)	Some moderately fine and medium textured soils may occur.
DOV1/U1l	Dover	nearly level to level, fine and moderately fine-textured (F1 and M3) deposits	Dominant: O.GL (DOV) Significant: nono Minor: O.LG (ALG), R.G (CHTzr)	N/A
DOV2/U1l	Dover	nearly level to level, fine and moderately fine-textured (F1 and M3) deposits	Dominant: O.GL (DOV) Significant: O.LG (ALG), R.G (CHTzr) Minor: T.M (MLDxc)	N/A
FIR1/U1l	Firebag	nearly level to level, stony very coarse-textured (C1) glaciofluvial ice-contact deposits	Dominant: E.DYB (FIR) Significant: E.DYB (MIL) Minor: O.GL (FRT)	N/A
FIRgl1/U1l	Firebag	nearly level to level, stony very coarse-textured (C1) glaciofluvial ice-contact deposits	Dominant: GLE.DYB (FIRgl) Significant: E.DYB (MIL); ptR.G (BMTpt) Minor: O.GL (FRT)	N/A
FRLV1/H1l	Fort – Livock	hummocky low relief, medium-textured glaciofluvial (M3) deposits	Co-Dominant: O.GL (FRT) and O.GL (LVK) Minor: O.LG (STP), O.GL (PEA)	Presence of McMurray formation derived alluvial material often present in profile.
FRT1/U1h	Fort	undulating high relief, medium-textured glaciofluvial (M3)	Dominant: O.GL (FRT) Significant: O.GL (PEA) Minor:	Presence of McMurray formation derived alluvial material often present in profile.
FRLV1/U1h	Fort – Livock	undulating high relief, medium-textured glaciofluvial (M3)	Co-Dominant: O.GL (FRT) and O.GL (LVK) Minor: O.LG (STP)	Presence of McMurray formation derived alluvial material often present in profile.

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JPME R1 ERRATA

Table 2.5-4 Soil Map Unit Legend for the Pierre River Mining Area Local Study Area (continued)

Map Unit Symbol	Map Unit Name	Surface Expression and Parent Material	Soil Patterns	Comments
MIL1/H1l	Mildred	hummocky low relief, coarse-textured (C2) glaciofluvial	Dominant: E.DYB (MIL) Minor: O.DYB (MILzz), O.GL (LVK), O.GL (FRT), E.DYB (SUT)	Undulating slopes (U1h) occur in some polygons. Soil profiles may be stratified in some polygons. MAR (E.DYB) may occur within units. Some polygons may be dominated by O.DYB.
MIL1/H1m	Mildred	hummocky moderate relief, coarse-textured (C2) glaciofluvial	Dominant: E.DYB (MIL) Minor: O.DYB (MILzz), O.GL (LVK), O.GL (FRT), E.DYB (SUT)	Sometimes stratified. H1l and H1h slopes can occur within polygons. MAR (E.DYB) may occur within units.
MIL1/U1l	Mildred	undulating low relief, coarse-textured (C2) glaciofluvial. C1 and L18 deposits may occur	Dominant: E.DYB (MIL) Minor: O.DYB (MILzz), O.GL (LVK), O.GL (FRT), E.DYB (FIR)	Some polygons may be dominated by O.DYB.
MIL1/U1h	Mildred	undulating high relief, coarse-textured (C2) glaciofluvial. C1 and L18 deposits may occur.	Dominant: E.DYB (MIL) Minor: O.DYB (MILzz), O.GL (LVK), O.GL (FRT), E.DYB (FIR)	Some polygons may be dominated by O.DYB.
MIL2/U1l	Mildred	undulating high relief, coarse-textured (C2) glaciofluvial. C1 and L18 deposits may occur.	Dominant: E.DYB (MIL) Significant: gleysols Minor: O.DYB (MILzz), O.GL (LVK), O.GL (FRT), E.DYB (FIR)	N/A
MIL2/U1h	Mildred	undulating high relief, coarse-textured (C2) glaciofluvial. C1 and L18 deposits may occur.	Dominant: E.DYB (MIL) Significant: gleysols Minor: O.DYB (MILzz), O.GL (LVK), O.GL (FRT), E.DYB (FIR)	N/A
MIFR1/U1h	Mildred-Fort	undulating high relief, coarse-textured (C2) glaciofluvial. C1, L11, P2, P3 and L18 deposits may occur	Co-Dominant: E.DYB (MIL); O.GL (FRT) Minor: O.GL (LVK) and O.GL (PEA)	N/A
MIFR1/U1l	Mildred-Fort	undulating low relief, coarse-textured (C2) glaciofluvial. C1, L11, P2, P3 and L18 deposits may occur	Co-Dominant: E.DYB (MIL); O.GL (FRT) Minor: O.GL (LVK), O.GL (PEA), gleyed variants and gleysols	N/A
MIFR2/U1h	Mildred-Fort	undulating high relief, coarse-textured (C2) glaciofluvial; C1, L11, P2, P3 and L18 deposits may occur	Co-Dominant: E.DYB (MIL); O.GL (FRT) Significant: Gleyed variants, Gleysols and thin organics Minor: O.GL (LVK) and O.GL (PEA)	N/A
MIFR2/U1l	Mildred-Fort	undulating low relief, coarse-textured (C2) glaciofluvial; C1, L11, P2, P3 and L18 deposits may occur	Co-Dominant: E.DYB (MIL); O.GL (FRT) Significant: Gleyed variants, Gleysols and thin organics Minor: O.GL (LVK) and O.GL (PEA)	N/A
MIFR1/H1l	Mildred-Fort	hummocky low relief, coarse textured (C2) glaciofluvial; C1, L11, P2, P3 and L18 deposits may occur	Co-Dominant: E.DYB (MIL); O.GL (FRT) Minor: O.GL (LVK), O.GL (PEA), gleyed variants and gleysols	N/A
MIFR 1/l3h	Mildred-Fort	inclined to steep single slope landforms, medium to coarse textured (L18 and C2) glaciofluvial deposits	Co-Dominant: E.DYB (MIL); O.GL (FRT) Minor: O.GL (LVK), O.GL (PEA), CU.R (NAM)	Soils may develop on colluvial deposits. Bedrock generally within 5 m of the surface.

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Table 2.5-4 Soil Map Unit Legend for the Pierre River Mining Area Local Study Area (continued)

Map Unit Symbol	Map Unit Name	Surface Expression and Parent Material	Soil Patterns	Comments
MIFR 1/SC1h	Mildred-Fort	valley with confined floodplain, medium to coarse textured (L18 and C2) glaciofluvial deposits; C1, F1 M2, L11 and L18 deposits may occur	Co-Dominant: E.DYB (MIL); O.GL (FRT) Significant: CU.R (NAMgl), R.G (MMW) and other gleyed variants and gleysols Minor: O.GL (PEA), CU.R (NAM), T.M (MLDxs)	Gleyed variants, gleysols, and thin organics confined to floodplain and may be less than 30% of unit.
MIFR 1/SC3	Mildred-Fort	V-shaped valley with no floodplain or terraces, medium to coarse textured (L18 and C2) glaciofluvial deposits. C1, F1 M2, L11, and L18 deposits may occur	Co-Dominant: E.DYB (MIL); O.GL (FRT) Minor: O.GL (PEA), CU.R (NAM), R.G (MMW), CU.R (NAMgl)	Gleyed variants and gleysols confined to valley bottom. Colluvial deposits common.
MLxcCHptzr/O 1	McLelland – Chateh	level, flat, horizontal or plateau fen and bog peatlands (P1 and P2)	Co-Dominant T.M (MLDxc): ptR.G (CHT) Minor: TY.M (MLD), O.LG (ALGpt)	N/A
MLD1/O1	McLelland	level, flat, horizontal or plateau fen and bog peatlands (P1 and P2)	Dominant: TY.M (MLD) Significant: TY.F (ABN), TY. M (MUS)	N/A
MLDxs1/O1	McLelland	level, flat, horizontal or plateau fen and bog peatlands (P1 and P2)	Dominant: T.M (MLDxs) Significant: T.M and T.F (HLYxs, MLDxs and MUSxc) Minor: ptO.LG (WHMaapt)	Peat overlies sand.
MLDxc1/O1	McLelland	level, flat, horizontal or plateau fen and bog peatlands (P1 and P2)	Dominant: T.M (MLDxc) Significant: T.M and T.F (HLYxs, MLDxs and MUSxc)	Peat overlies moderately fine textured materials.
MLxsMKaaxs1 /O1	McLelland-aaMikkwa	level, flat, horizontal or plateau fen and bog peatlands (P1 and P2, L11, L12,); soils developed on organic veneers to blankets (P1, P2, L11 and L12) over coarse textured fluvial, fluvio-lacustrine or lacustrine deposits, M2 deposits may occur	Dominant: T.M (MLDxs), FI.OC (aaMikkwaxs) Significant: T.M (MUSxs), R.G (MMWpt),and cyric phases Minor: O.LG (WHMaa)	One large polygon located in meltwater channel in the north of the LSA. Underlying materials a mix of medium and coarse textured fluvial and glaciofluvial material.
MMY 1/U1l	McMurray	undulating low relief. medium textured (M2) fluvial, C2 and L18 deposits may occur	Dominant: CU.R (MMY) Significant: gleyed variants and gleysols	Confined to areas adjacent to the Athabasca River.
MUxsBMpt1/O 5	Muskeg – peaty Bitumount	level, flat, horizontal or plateau fen and bog peatlands (P1 and P2); soils developed on organic veneers to blankets (P2, L11, L12) over coarse-textured fluvial, fluvio-lacustrine or lacustrine deposits; M2 deposits may occur	Dominant: T.M (MLDxs) and ptR.G (BMTpt) Significant: TY.M (MLD) and TY.F (ABN), GLE.DYB (MILgl); R.G (MMW)	Some polygons in transition zone between dominantly well drained upland soils and fen and bog peatlands (P1, P2) parent materials. Minor amounts of gleyed or peaty phase upland soils.

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Table 2.5-4 Soil Map Unit Legend for the Pierre River Mining Area Local Study Area (continued)

Map Unit Symbol	Map Unit Name	Surface Expression and Parent Material	Soil Patterns	Comments
MUSxs1/O1	Muskeg	level, flat, horizontal or plateau fen and bog peatlands (P1 and P2, L11); soils developed on organic veneers to blankets (P1, P2, L11) over coarse textured fluvial, fluvio-lacustrine or lacustrine deposits, M2 deposits may occur	Dominant: T.M (MUSxs) Significant: T.M (MLD), E.DYB (MIL)	Islands of imperfectly and moderately well drained soils.
MUSxs1/O2	Muskeg	basin (bowl) with raised edges. Fen and bog peatlands (P1, P2, L12, L13). soils developed on organic veneers to blankets (L12 and L13) over medium to coarse-textured fluvial, fluvio-lacustrine or lacustrine deposits	Dominant: T.M (MUSxs) Significant: T.M (MLD) Minor: ptR.G (MMW), ptO.G (BMT)	Underlying materials have variable textures.
MUSxs1/O4	Muskeg	inclined organic with hummocky mineral soils; soils developed on organic veneers to blankets (P2, L11, L13) over fine textured fluvial, fluvio-lacustrine or lacustrine deposits	Dominant: T.M (MUSxs) Significant: TY.M (MLD); ptO.LG (WHMaapt) and E.DYB (MIL)	Islands of imperfectly and moderately well drained soils.
MUSxc1/O5	Muskeg	level organic with hummocky mineral soils; soils developed on organic veneers to blankets (P2, L11, L13) over fine textured fluvial, fluvio-lacustrine or lacustrine deposits	Dominant: T.M (MUSxc) Significant: TY.M (MLD) and E.DYB (MIL)	N/A
MUSxs1/O5	Muskeg	level organic with hummocky mineral soils; soils developed on organic veneers to blankets (P2, L11, L13) over coarse-textured fluvial, fluvio-lacustrine or lacustrine deposits	Dominant: T.M (MUSxs) Significant: TY.M (MLD); ptO.LG (WHMaapt) and E.DYB (MIL)	N/A
NAMcu2/FP3	Namur	confined floodplain possibly terraced. medium to coarse-textured fluvial and colluvial materials (F1, M2, M0, P2 P3, L11, L12)	Dominant: CU.R (NAM) Significant: GL.R (NAMgl), R.G (MMW), O.GL (PEA), O.GL (FRT), GL.GL (FRTgl), T.M (MLDxs) and various other gleyed variants, Gleysols and thin organics	Soils are variable and range from well to poorly drained. Often terraced. Imperfectly and poorly drained soils generally located adjacent to and on the floodplain. Gleyed and peaty phase upland soils may occur.
ZWA1/W3	Water	a single water basin which may be filled or partly filled with water	N/A	N/A

Note:
N/A = Not applicable.

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Table 2.5-5 Geographic Extent of Soil Series in the Pierre River Mining Area Local Study Area

Series Name	Series Abbreviation	Subgroup	Area [ha]	Percent of PRMA LSA [%]
Albian	ABN	Typic Fibrisol	588	3
Algar Lake	ALG	Orthic Luvic Gleysol	181	1
Bitumount	BMTpt	peaty Orthic Gleysol	573	3
Chateh	CHT	Orthic Gleysol	492	2
Dover	DOV	Orthic Gray Luvisol	458	2
Dover coarse gleyed	DOVcogl	Gleyed Gray Luvisol	145	1
Firebag	FIR	Eluviated Dystric Brunisol	275	1
Fort	FRT	Orthic Gray Luvisol	3,676	17
Hartley	HLYxs	Terric Fibrosol	156	1
Livock	LVK	Orthic Gray Luvisol	499	2
Mamawi	MMW	Rego Gleysol	513	2
McLelland	MLD	Typic Mesisol	926	4
McLelland shallow	MLD xs/xc	Terric Mesisol	2,076	10
Mildred	MIL	Eluviated Dystric Brunisol	7,733	37
McMurray	MMY	Rego Gleysol	391	2
Mikkwa	MKWaa	Mesic Organic Cryosol	90	<1
Muskeg	MUS	Typic Mesisol	108	1
Muskeg shallow	MUS xs/xc	Terric Mesisol	441	2
Namur	NAM	Gleyed Regosol	357	2
Peavine	PEA	Orthic Gray Luvisol	616	3
Sutherland	SUT	Eluviated Dystric Brunisol	87	<1
Steepbank	STP	Orthic Gleysol	6	<1
WHMaa	WHMaa	Orthic Luvic Gleysol	20	<1
water	water	water	394	2
disturbed	disturbed	disturbed	335	2
Total			**21,136**	**100**

The PRMA LSA includes 16,022 ha (76% of LSA) of mineral soils, 4,385 ha (21% of LSA) of organic soils 384 ha (2% of LSA) water and 335 ha (2% of LSA) disturbances (Table 2.5-5).

The most abundant mineral soil series are Mildred (7,733 ha; 37% of the LSA) and Fort (3,676 ha; 17% of the LSA). The most abundant organic soil series is McLelland (xs/xc shallow) (2,076 ha; 10% of the LSA). The other most common organic soils are and McLelland (926 ha; 4% of the LSA) and Albian (588 ha; 3% of the LSA).

The geographic extent and classification of each soil series is summarized in Table 2.5-5. The spatial distribution of dominant soil series is presented in Figure 2.5-3.

Soil units which occur to a minor extent (less than 2%) may not be shown in Figure 2.5-3 as the map scale is too small. Detailed descriptions of the soil series are in Appendix B.

2.5.3 Soil Map Unit Interpretations

2.5.3.1 Land Capability for Forestry

Forest Capability Classes were calculated using the procedure outlined in the *Land Capability Classification System for Forest Ecosystems in the Oilsands* (CEMA 2006). Five classes are recognized in the system. Forest Capability Classes 1, 2 and 3 are capable of supporting commercially productive forests while Forest Capability Classes 4 and 5 are considered non-commercial.

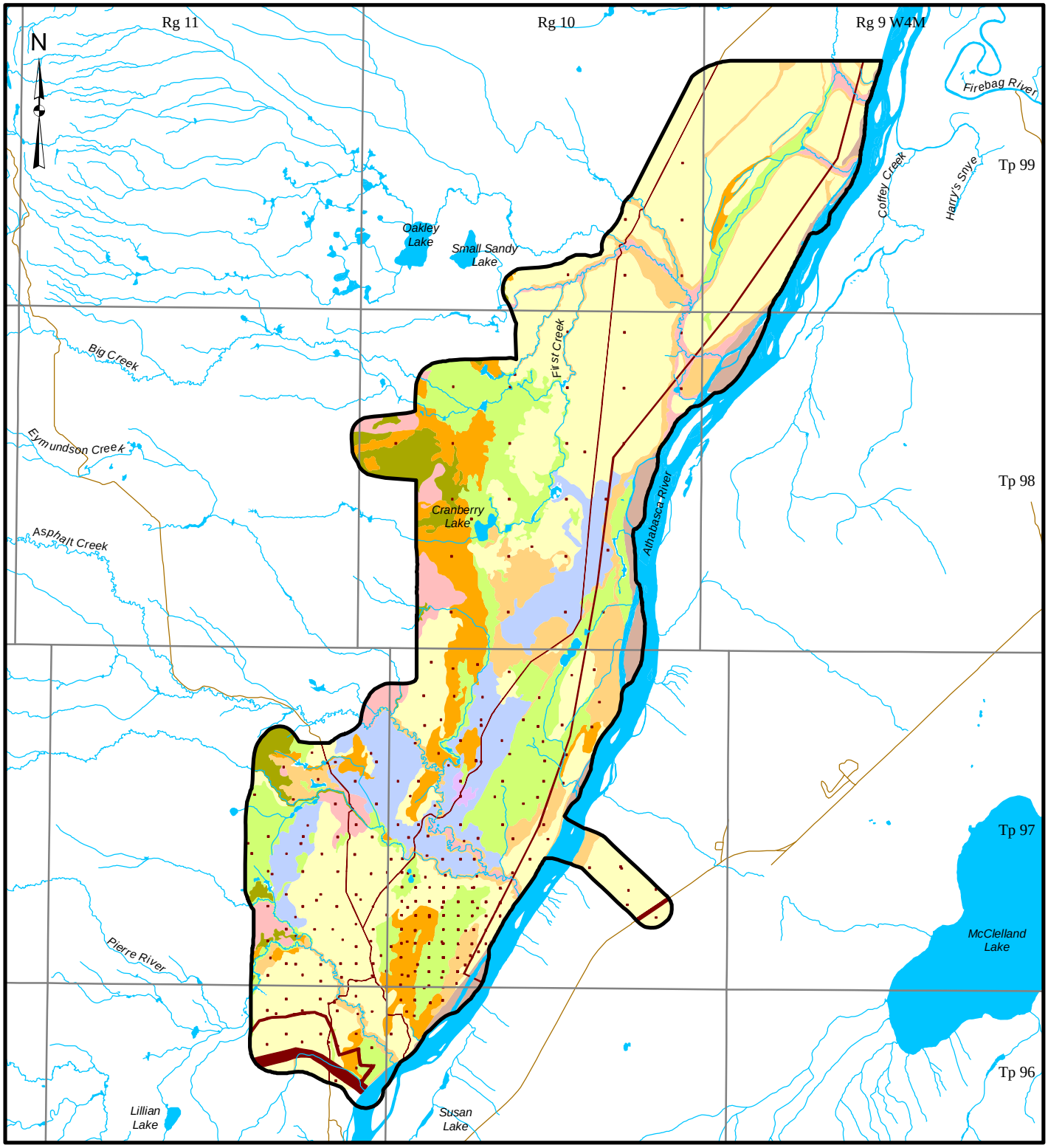
Forest capability ratings for each soil series are presented in Appendix B, and the ratings for each soil map unit are presented in Appendix D. Forest Capability Classes 1, 2 and 3 occupy about 5,877 ha (28%) of the PRMA LSA. Forest Capability Classes 4 and 5 occupy about 14,530 ha (69%) of the PRMA LSA. Open water and disturbed areas comprise about 729 ha (4%) of the PRMA LSA.

The geographic extent of areas occupied by the five capability classes is summarized in Table 2.5-6. The spatial distribution of forest capability classes is presented in Figure 2.5-4.

Table 2.5-6 Land Capability for Forest Ecosystems in the Pierre River Mining Area Local Study Area

Forest Capability Class	Area [ha]	Percent of PRMA LSA [%]
Class 1 (high)	391	2
Class 2 (moderate)	1,746	8
Class 3 (low)	3,740	18
Class 4 (conditionally productive)	10,364	49
Class 5 (non-productive)	4,166	20
disturbed	394	2
open water	335	2
Total	**21,136**	**100**

Note: Some numbers are rounded for presentation purposes. Therefore, it may appear that the totals do not equal the sum of the individual values.



LEGEND

- PIERRE RIVER MINING AREA LOCAL STUDY AREA
- OPEN WATER
- ROAD

LAND CAPABILITY

- HIGH/CONDITIONALLY PRODUCTIVE (1-4)
- MODERATE CAPABILITY (2)
- MODERATE/LOW CAPABILITY (2-3)
- MODERATE/CONDITIONALLY PRODUCTIVE (2-4)
- LOW CAPABILITY (3)
- LOW/CONDITIONALLY PRODUCTIVE (3-4)
- CONDITIONALLY PRODUCTIVE (4)
- CONDITIONALLY PRODUCTIVE/NON-PRODUCTIVE (4-5)
- NON-PRODUCTIVE (5)

DISTURBED

- EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE
- EXISTING AND APPROVED URBAN AND INDUSTRIAL LINEAR DISTURBANCE

4 0 4
SCALE 1:160,000 KILOMETRES

REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2004), Alberta SRD, and SOIL-INFO Ltd. (2007), used under license.
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 12.

PROJECT
JACKPINE MINE EXPANSION &
PIERRE RIVER MINE PROJECT

TITLE
LAND CAPABILITY FOR FOREST ECOSYSTEMS
IN THE PIERRE RIVER MINING AREA LOCAL STUDY AREA

Shell Canada Limited

PROJECT No. 05-1344-027.7400			SCALE AS SHOWN	REV. 0
DESIGN	VR	10 Aug. 2007	FIGURE: 2.5-4	
GIS	JH	17 Nov. 2007		
CHECK	DD	17 Nov. 2007		
REVIEW	WES/TC	19 Nov. 2007		

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2.5.3.2 Wind and Water Erosion Risk

Wind and water erosion risk ratings of exposed soils are summarized in Tables 2.5-7 and 2.5-8, respectively. The wind erosion risk ratings were adopted from the Alberta publication *Wind Erosion Risk* (Coote and Pettapiece 1989), while the water erosion risk ratings were adopted from the Alberta publication *Water Erosion Risk* (Tejak and Coote 1993; Pedocan 1993). Erosion risk primarily applies to disturbed soils because vegetated soils are not generally at risk to erosion. The wind and water erosion risk ratings are illustrated in Figures 2.5-5 and 2.5-6 and presented in Appendix D.

Table 2.5-7 Wind Erosion Risk Ratings in the Pierre River Mining Area Local Study Area

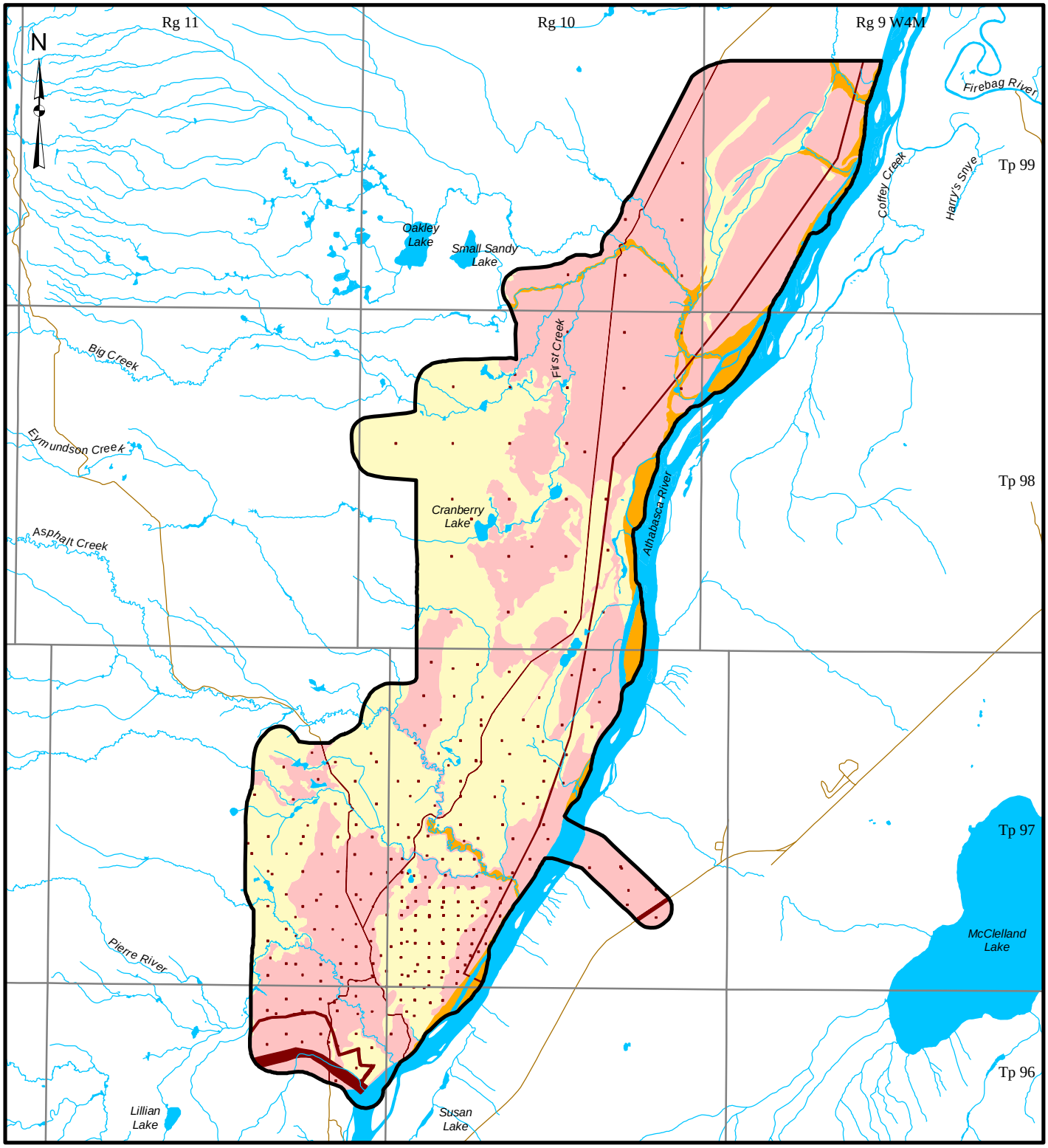
Wind Erosion Risk	Area [ha]	Percent of PRMA LSA [%]
low	8,472	40
moderate	929	4
high	11,006	52
disturbance	335	2
water	394	2
Total	**21,136**	**100**

Note: Some numbers are rounded for presentation purposes. Therefore, it may appear that the totals do not equal the sum of the individual values.

Table 2.5-8 Water Erosion Risk Ratings in the Pierre River Mining Area Local Study Area

Water Erosion Risk	Area [ha]	Percent of PRMA LSA [%]
low	12,986	61
moderate	6,655	32
high	766	4
disturbance	335	2
water	394	2
Total	**21,136**	**100**

Note: Some numbers are rounded for presentation purposes. Therefore, it may appear that the totals do not equal the sum of the individual values.



LEGEND

- PIERRE RIVER MINING AREA LOCAL STUDY AREA
- OPEN WATER
- ROAD

WIND EROSION RISK

- HIGH
- MODERATE
- LOW

DISTURBED

- EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE
- EXISTING AND APPROVED URBAN AND INDUSTRIAL LINEAR DISTURBANCE

4 0 4

SCALE 1:160,000 KILOMETRES

REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2004), Alberta SRD, and SOIL-INFO Ltd. (2007), used under license.
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 12.

PROJECT

JACKPINE MINE EXPANSION & PIERRE RIVER MINE PROJECT

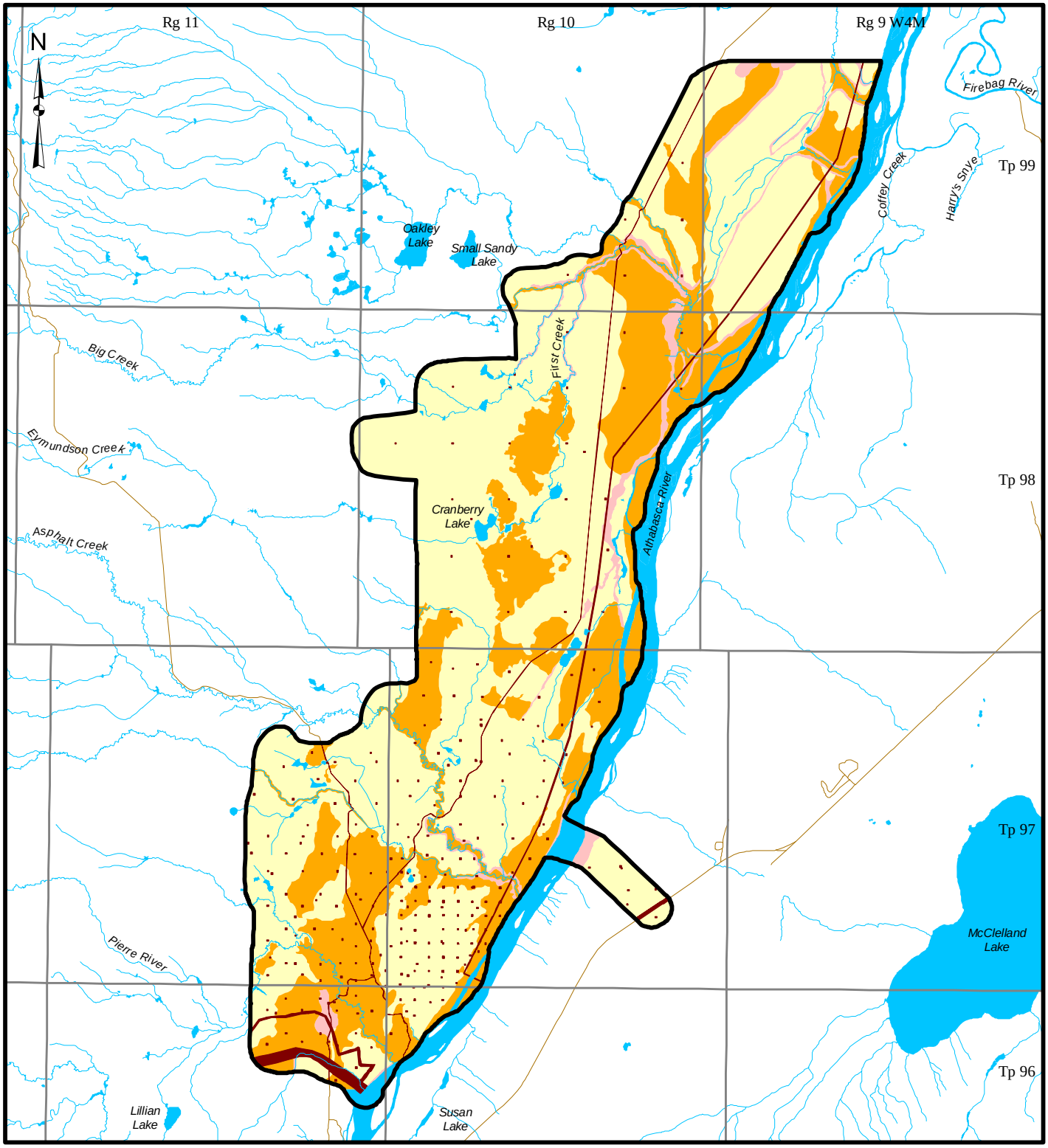
TITLE

WIND EROSION RISK FOR EXPOSED MINERAL SOILS IN THE PIERRE RIVER MINING AREA LOCAL STUDY AREA

Shell Canada Limited

PROJECT No. 05-1344-027.7400			SCALE AS SHOWN	REV. 0
DESIGN	VR	10 Aug. 2007	FIGURE: 2.5-5	
GIS	JH	17 Nov. 2007		
CHECK	DD	17 Nov. 2007		
REVIEW	WES/TC	19 Nov. 2007		

Project: I:\CLIENTS\SHELL\05-1344-027\mapping\mxd\soils\DRAFT\pierreriverlsa_wind_eros_pr.mxd



LEGEND

- PIERRE RIVER MINING AREA LOCAL STUDY AREA
- OPEN WATER
- ROAD

WATER EROSION RISK

- HIGH
- MODERATE
- LOW

DISTURBED

- EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE
- EXISTING AND APPROVED URBAN AND INDUSTRIAL LINEAR DISTURBANCE

4 0 4

SCALE 1:160,000 KILOMETRES

REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2004), Alberta SRD, and SOIL-INFO Ltd. (2007), used under license.
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 12.

PROJECT

JACKPINE MINE EXPANSION & PIERRE RIVER MINE PROJECT

TITLE

WATER EROSION RISK FOR EXPOSED MINERAL SOILS IN THE PIERRE RIVER MINING AREA LOCAL STUDY AREA

Shell Canada Limited

PROJECT No. 05-1344-027.7400			SCALE AS SHOWN	REV. 0
DESIGN	VR	10 Aug. 2007	FIGURE: 2.5-6	
GIS	JH	17 Nov. 2007		
CHECK	DD	17 Nov. 2007		
REVIEW	WES/TC	19 Nov. 2007		

Project: I:\CLIENTS\SHELL\05-1344-027\mapping\mxd\soils\DRAFT\pierreriverlbl_lsa_water_eros_pr.mxd

2.5.3.3 Topsoil and Subsoil Reclamation Suitability in the Pierre River Mining Area Local Study Area

Topsoil reclamation suitability ratings and the average depth of topsoil, upper subsoil and lower subsoil for each soil map unit and each soil series are presented in Appendices B and E. Soil reclamation suitability for topsoil and subsoil was developed from the Alberta Soils Advisory Committee (1987) guidelines which rates soils based on soil physical and chemical properties.

All mineral topsoil is suitable for reclamation; about 5% of the mineral soil areas is rated as good; about 40% is rated as fair, and more than 50% is rated as poor. Generally, the factors limiting topsoil suitability are texture (course) and pH.

Most mineral upper subsoil is suitable for reclamation; about 2% of the mineral soil areas is rated as good; about 35% is rated as fair, and more than 60% is rated as poor and 2% is unsuitable. Most mineral lower subsoil is suitable for reclamation; about 2% of the mineral soil areas is rated as good; about 5% is rated as fair, and more than 90% is rated as poor and 2% is unsuitable. Factors limiting subsoil suitability were texture (course or fine) and moist consistence.

Organic soils (peat) were not rated for reclamation suitability as generally all peat is considered suitable.

The actual volumes of mineral topsoil, upper and lower subsoil as well as organic soil (peat), which will be salvaged and used for reclamation will depend on the actual development areas and soil replacement requirements as outlined in the CC&R Plan provided with the EIA for the project.

2.6 SUMMARY

Regional Study Area

A Terrestrial Resources RSA of 2,277,376 ha was mapped for soil and terrain in preparation for consideration of the cumulative effects assessment of disturbance and acidification emissions. The RSA selected was the same as several recent oil sands mining project EIAs (Shell 2002, 2005; CNRL 2002). Mineral soils occupy approximately 1,056,488 ha (46%) of the RSA, while organic soils occupy approximately 924,467 ha (41%) of the RSA, and other non-soils occupy approximately 296,421 ha (13%) of the RSA.

Common mineral soil series mapped in the RSA included: Mildred, Steepbank, Legend, Firebag, Marguerite, Joslyn, Namur, McMurray, Dover, Kinosis, Algar

Lake and Bitumount. Common soil parent materials for mineral soils include glaciofluvial, morainal and glaciolacustrine. Common organic soils include Muskeg, Hartley, Mariana, McLelland, Mikkwa, Conklin and Wabasca Series. Organic soils are found on fen, shallow fen, bog and shallow bog peat deposits.

Organic soils were rated as non-productive for forestry (Forest Capability Class 5). Gleysolic mineral soils were generally rated as productive or conditionally productive for forestry (Forest Capability Class 4 or 5). Well-drained and moderately well and well-drained mineral soils were generally rated as high, moderate or low forest capability (Forest Capability Classes 1, 2 or 3). Some well-drained coarse-textured mineral soils were rated as conditionally productive for forestry (Forest Capability Class 4). Approximately 465,721 ha (20%) of the RSA were rated in Forest Capability Classes 1, 2 or 3. Approximately 1,596,407 (70%) of the RSA was rated as Forest Capability Classes 4 or 5.

The mineral soils most sensitive to acidification are generally sandy soils developed on fluvial or glaciofluvial parent materials (Algar, Bitumount, Gregoire, Firebag, Marguerite, Mildred and Steepbank soil series).

Local Study Areas

Two terrestrial resource Local Study Areas (LSAs) were defined for the Project; the PRMA LSA (21,136 ha) and the JEMA LSA (18,348 ha).

The JEMA LSA includes 4,063 ha (22% of LSA) of mineral soils and 12,526 ha (68% of LSA) of organic soils 57 ha (less than 1% of the LSA). The most abundant mineral soil series is Mildred (2,002 ha; 11% of the LSA). Other common mineral soils are Ells River (pt) (630 ha; 3% of the LSA) and Horse River (545 ha; 3% of the LSA). The most abundant organic soil series is McLelland (7,025 ha; 39% of the LSA). Other common organic soils are Albian (2,341 ha; 13% of the LSA), Hartley (1,049 ha; 6% of the LSA) and Muskeg (xs-shallow) (1,109 ha; 6% of the LSA).

The PRMA LSA includes 16,022 ha (76% of the LSA) of mineral soils and 4,385 ha (21% of LSA) of organic soils. The most abundant mineral soil series are Mildred (7,733 ha; 37% of the LSA) and Fort (3676 ha, 14% of the LSA). The most abundant organic soil series is McLelland shallow (Terric) (2,076 ha, 10% of the LSA). Other common organic soil series include McLelland (Typic) (926 ha, 4% of the LSA), Albian (588 ha, 3% of the LSA) and Muskeg (441 ha, 2% of the LSA).

In the JEMA LSA, land capability for Forestry Classes 1, 2 and 3, with high, moderate and low capability, respectively, occupy about 754 ha (5%) of the LSA. Class 4, conditionally productive, occurs in 2,862 ha (16%) and Class 5, non-productive, occurs in 12,973 ha (71%) of the LSA. Open water and disturbed areas comprise about 1,759 ha (10%) of the JEMA LSA.

For the PRMA LSA, land capability for Forestry Classes 1, 2 and 3, with high, moderate and low capability, respectively, occupy about 5,877 ha (28%) of the LSA. Class 4, conditionally productive, occurs in 10,364 ha (49%), and Class 5, non-productive, occurs in 4,166 ha (20%) of the LSA. Open water and disturbed areas comprise about 729 ha (4%) of the PRMA LSA.

Wind and water erosion risk was also rated. Erosion risk assumes a disturbed soil surface without vegetation. In the JEMA LSA: water erosion risk was rated low to moderate for 15,306 ha (79%) and high for 1,283 ha (7%); wind erosion risk. was rated low to moderate for 14,409 ha (79%) and high for 766 ha (4%).

In the PRMA LSA water erosion risk was rated low to moderate for 19,641 ha (93%) and high for 766 ha (4%); wind erosion risk was rated low to moderate for 9,401 ha (44%) and high for 11,006 ha (52%).

Reclamation suitability of mineral soils was rated for topsoil (A horizon and surface litter/organic), upper subsoil (B horizon) and lower subsoil (BC and C horizon). Organic soils were not rated, as generally all peat is considered suitable.

In the JEMA LSA, all mineral topsoil is suitable for reclamation; about 20% is rated as fair and about 80% is rated as poor. Mineral upper subsoil is suitable for reclamation; about 30% of the mineral soil areas is rated as fair, and about 60% is rated as poor. Mineral lower subsoil is suitable for reclamation; about 10% of the mineral soil areas is rated as fair, and about 90% is rated as poor.

In the PRMA LSA all mineral topsoil is suitable for reclamation; about 5% of the mineral soil areas is rated as good; about 40% is rated as fair, and more than 50% is rated as poor. Most mineral upper subsoil is suitable for reclamation, about 35% is rated as fair and more than 60% is rated as poor. Most mineral lower subsoil is suitable for reclamation, about 5% is rated as fair and more than 90% is rated as poor.

The actual volumes of mineral topsoil, upper and lower subsoil as well as organic soil (peat), which will be salvaged and used for reclamation will depend on the actual development areas and soil replacement requirements as outlined in the CC&R Plan provided with the EIA for the Project.

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APPENDIX A

KEY TO ABBREVIATIONS USED IN SOIL MAP UNITS AND INSPECTION LIST

Submitted to:
Shell Canada Limited

Prepared by:
Golder Associates Ltd.

December 2007 **05-1344-027**

LIST OF TABLES

Table A-1 Soil Series....1
Table A-2 Soil Phases....1
Table A-3 Soil Subgroup Classification....2
Table A-4 Parent Materials....3
Table A-5 Slope Position....3
Table A-6 Slope Class....4
Table A-7 Surface Landform Expression....4
Table A-8 Drainage Classes....4
Table A-9 Soil Horizon Designations....5
Table A-10 Soil Textural Classes....6
Table A-11 Soil Structure Classes....6
Table A-12 Edatope (Composite of Moisture and Nutrient Regimes)....6
Table A-13 Land Capability for Forest Ecosystems....7
Table A-14 Ecosite Phases/Wetlands Types....7
Table A-15 Terrain Units....7

Table A-1 Soil Series

Soil Series	Abbreviations
Albian	ABN
Algar Lake	ALG
Bitumont	BMTpt
PEATY Bitumont	BMTPT
Chateh	CHT
Dover	DOV
Dover coarse gleyed	DOVCOGL
Peaty Ells River	ELSPT
Firebag	FIR
Fort	FRT
Halverson	HVNaa
Hartley	HLY
Horse River	HRR
Livock	LVK
Mamawi	MMW
Mariana	MRN
McLelland	MLD
McLelland Shallow	MLDXS/XC
McMurray	MMY
Mildred	MIL
Mikkwa	MKWaa
Muskeg	MUS
Muskeg Shallow	MUSXS/XC
Gleyed Namur	NAMGL
Norberta	NOR
Peavine	PEA
Steepbank	STP
Sutherland	SUT
WHMaa	WHMaa

Table A-2 Soil Phases

Suffix Applied as Unit Modifier	Meaning/Explanation
aa	not modal SCA
co	coarse
cr	carbonated
fi	finer textured on sandy loam material
gl	gleyed
pt	peaty phase
st	stony

Table A-2 Soil Phases (continued)

Suffix Applied as Unit Modifier	Meaning/Explanation
xc	clay within 100 cm
xg	gravel contact within 100 cm
xl	sandstone or oil sands within 100 cm
xm	medium textured material within 100 cm
xs	sand within 100 cm
xt	till contact within 100 cm
zb	Brunisolic
zh	Humic
zo	Orthic
zl	Luvisolic
zr	Rego
example: MILgl = gleyed Mildred	
MLDxc = clay within 100 cm McLelland	

Table A-3 Soil Subgroup Classification

Soil Classification	Description
Brunisolic Order	
E.DYB	Eluviated Dystric Brunisol
GL.DYB	Gleyed Dystric Brunisol
GLE.DYB	Gleyed Eluviated Dystric Brunisol
O.DYB	Orthic Dystric Brunisol
O.SB	Orthic Sombric Brunisol
Gleysolic Order	
HU.LG	Humic Luvic Gleysol
O.G	Orthic Gleysol
O.HG	Orthic Humic Gleysol
O.LG	Orhtic Luvic Gleysol
R.G	Rego Gleysol
Luvisolic Order	
BR.GL	Brunisolic Gray Luvisol
D.GL	Dark Gray Luvisol
GL.GL	Gleyed Gray Luvisol
GLBR.GL	Gleyed Brunisolic Gray Luvisol
GLD.GL	Gleyed Dark Gray Luvisol
O.GL	Orthic Gray Luvisol
Organic Order	
T.F	Terric Fibrisol
THU.F	Terric Humic Fibrisol
TME.F	Terric Mesic Fibrisol
ME.F	Mesic Fibrisol
TY.F	Typic Fibrisol
FI.H	Fibric Humisol
ME.H	Mesic Humisol
TFI.H	Terric Fibric Humisol
TME.H	Terric Mesic Humisol
T.H	Terric Humisol
HU.M	Humic Mesisol

Table A-3 Soil Subgroup Classification (continued)

Soil Classification	Description
HY.M	Hydric Mesisol
TFI.M	Terric Fibric Mesisol
THU.M	Terric Humic Mesisol
T.M	Terric Mesisol
FI.M	Fibric Mesisol
TY.M	Typic Mesisol
Regosolic Order	
CU.R	Cumulic Regosol
GL.R	Gleyed Regosol
GLCU.R	Gleyed Cumulic Humic Regosol
GL.HR	Gleyed Humic Regosol
O.HR	Orthic Humic Regosol
O.R	Orthic Regosol

Table A-4 Parent Materials

Parent Materials Symbol	Description
GF	glaciofluvial
GL	glaciolacustrine
M	moraine/till
F	fluvial
E	eolian
O	organic
N	fen
Ns	shallow fen
B	bog
Bs	shallow bog

Table A-5 Slope Position

Slope Symbol	Description
C	crest
U	upper slope
M	mid slope
L	lower slope
T	toe
D	depression
Level	level

Table A-6 Slope Class

Slope Class	Slope [%]	Description
1	0 to 0.5	level
2	0.5 to 2	nearly level
3	2 to 5	very gentle slopes
4	5 to 10	gentle slopes
5	10 to 15	moderate slopes
6	15 to 30	strong slopes
7	30 to 45	very strong slopes
8	45 to 70	extreme slopes

Table A-7 Surface Landform Expression

Surface Landform Symbol	Description
l	level
u	undulating
h	hummocky
l	inclined
r	ridged
o	other

Table A-8 Drainage Classes

Drainage Class Symbol	Description
R	rapidly
W	well
MW	moderately well
I	imperfectly
P	poorly
VP	very poorly

Table A-9 Soil Horizon Designations

Horizon	Description
Of	organic horizon consisting of fibric (e.g., poorly decomposed material)
Om	organic horizon consisting of mesic material (e.g., at a state of decomposition intermediate between fibric and humic)
Oh	organic material at an advanced state of decomposition (e.g., humic)
LFH	organic materials of varying degrees of decomposition found at the surface of mineral soil profiles
Ae	surface mineral horizon characterized by the loss (eluviation) of clay, Fe, Al or organic matter alone or in combination, which generally results in a lighter colour than the underlying horizons
Ah	surface mineral horizon enriched with organic matter
Bm	subsurface mineral horizon slightly altered by soil forming processes, usually accumulation, which result in development of colour and/or structure
Bt	subsurface mineral horizon that accumulates illuvial clay, which can alter texture and structure and generally forms below an eluvial Ae horizon
Bf	subsurface mineral horizon enriched with Fe and Al combined with organic matter, generally having a reddish colour
BC	transitional horizon exhibiting characteristics of both the overlying B and underlying C horizons
C	subsurface mineral horizon comparatively unaffected by soil forming processes at work in the A and B horizons, frequently called the parent material
Cg	subsurface mineral horizon distinguished by dull colours indicating reduction due to saturation for all or part of the year in C or B horizons
Ck	subsurface mineral horizon which contains carbonates as indicated by visible effervescence with dilute HCL
IC, IIC	C horizons with distinct parent materials, generally differentiated by texture
b	a buried soil horizon (e.g., Ahb)
ca	a horizon with secondary enrichment of accumulated carbonates, in which the concentration exceeds the unenriched parent material (e.g., Cca)
j	a modifier indicative of an expression of, but not meeting the specified limits of the suffix it modifies and therefore juvenile (e.g., Btj)
n	a horizon with the following morphological characteristics: prismatic or columnar structure, dark coatings on ped surfaces, a hard to very hard consistence when dry and a ratio of exchangeable Ca to exchangeable Na of 10 or less (e.g., Btnj)
s	a horizon containing salts, including gypsum, which may be detected as a surface crust of salt crystals, as crystals or veins in the horizon, by depressed crop growth or by the presence of salt tolerant plants (e.g., Csk)
z	suffix indicative of a frozen horizon (e.g., Ohz)

Table A-10 Soil Textural Classes

Texture Symbol	Description
HC	heavy clay
C	clay
CL	clay loam
SC	sandy clay
SCL	sandy clay loam
SiC	silty clay
SiCL	silty clay loam
SiL	silt loam
Si	silt
L	loam
SL	sandy loam
LS	loamy sand
S	sand

Table A-11 Soil Structure Classes

Structure Symbol	Description
GR	granular
SG	single grain
ABK	angular blocky
SBK	subangular blocky
PL	platy
PR	prismatic
MA	massive
C	columnar
w	prefix denoting weak (e.g., wSBK)

Table A-12 Edatope (Composite of Moisture and Nutrient Regimes)

Moisture Regime	
2	xeric
3	subxeric
4	submesic
5	mesic
6	subhygric
7	hygric
8	subhydric
9	hydric
Nutrient Regime	
P	poor
M	medium
R	rich

Table A-13 Land Capability for Forest Ecosystems

Capability Class	Description
Class 1	high capability
Class 2	moderate capability
Class 3	low capability
Class 4	conditionally productive
Class 5	non-productive

Table A-14 Ecosite Phases/Wetlands Types

Ecosite	Description
a1	lichen jack pine
b1	blueberry jack pine-aspen
b2	blueberry aspen (white birch)
b3	blueberry aspen-white spruce
b4	blueberry white spruce-jack pine
c1	Labrador tea–mesic jack pine-black spruce
d1	low-bush cranberry aspen
d2	low-bush cranberry aspen-white spruce
g1	Labrador tea–subhygric black spruce-jack pine
h1	Labrador tea/horsetail white spruce-black spruce
BTNN	treed bog
FONG	graminoid fen
FONS	shrubby fen
FTNN	treed fen
SONS	shrubby swamp
STNN	treed swamp
WONN	open water

Table A-15 Terrain Units

Terrain Units	Description
Fg	glaciofluvial
Lg	glaciolacustrine
L	lacustrine
M	moraine/till
F	fluvial
F (s)	fluvial (steep)
C	colluvial
E	eolian
O	organic
N	fen
Ns	shallow fen
B	bog
Bs	shallow bog

Map Unit Designation

The soil resources were classified according to guidelines established by the Canadian System of Soil Classification (Soil Classification Working Group 1998). This hierarchical system has five taxonomic levels:

- order;
- great group;
- sub-group;
- family; and
- series.

Classes at the order level have the broadest range of characteristics, whereas classes at the series level have the narrowest range of characteristics (i.e., a more defined range of characteristics). The purpose of a soil classification system is to organize soil characteristics, which are a product of soil forming processes, into a logical arrangement. This conceptual framework provides a mean for communicating, testing and applying pedologic information of similar natural entities. Soil taxonomy is the hierarchical ordered arrangement of classified soils.

Soils were mapped using both the results of the field investigations, interpretation of aerial photographs and previous data. Information from soil inspections was extrapolated to other map units using the principles of pedology (geomorphology, surficial geology and vegetation patterns).

Soils described to the series level are the building blocks for soil map unit polygons. Soil series were determined based on taxonomy to the soil subgroup and classification, or grouping, of soil parent materials

The soil map unit polygons define the natural distribution of soils in the study area. Soil map units include a breakdown of the soil series expected in each polygon and the expected proportion of each soil series. Most map units consist of two or more associated soil series which are interspersed over short distances within the map unit, and cannot be separated for mapping purposes. Map units are comprised as follows: dominant soils occupy more than 60%; co-dominant soils occupy between 30 to 60%; and significant soils occupy between 15 to 30% and minor soils occupy less than 15% of a soil map unit

Organic soil map units were identified somewhat differently than those dominated by mineral soils. To simplify the complexity of peat-dominated areas,

the naming of soil series was restricted to Albian (ABN) (TY.F), McLelland (MLD) (TY.M) or Muskeg (MUS) (TY.M). MLD was used with fen, marsh and swamp ecosite types; MUS with bog vegetation.

Where a lower case symbol is used with organic soils it indicates the dominant texture of the mineral substratum underlying the organic (peat) soils:

- xc = mineral substratum below peat is predominantly clayey;
- xs = mineral substratum below peat is predominantly sandy; and
- xt = mineral substratum below peat is predominantly till (generally medium textured).

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APPENDIX B

SOIL SERIES DESCRIPTIONS

Submitted to:
Shell Canada Limited

Prepared by:
Golder Associates Ltd.

December 2007 **05-1344-027**

50 BEST EMPLOYERS IN CANADA 2007

CANADA'S 50 BEST MANAGED PRIVATE COMPANIES

TABLE OF CONTENTS

SECTION **PAGE**

1 FOREST LAND CAPABILITY CLASSES 1

2 RECLAMATION SUITABILITY CLASSES 2

3 RECLAMATION SUITABILITY CRITERIA 3

4 CALCAREOUS CLASSES 4

5 SOIL SERIES DESCRIPTIONS FOR PIERRE RIVER MINE AREA 5
5.1 SOIL SERIES DESCRIPTIONS 6
5.1.1 Albian (ABN) 6
5.1.2 Algar Lake (ALG) 7
5.1.3 peaty Algar Lake (ALGpt) 8
5.1.4 peaty Bitumont (BMTpt) 9
5.1.5 Chateh (CHT) 10
5.1.6 rego Chateh (CHTzr) 11
5.1.7 peaty rego Chateh (CHTzrpt) 12
5.1.8 Darough (DAR) 13
5.1.9 Dover (DOV) 14
5.1.10 gleyed Dover (DOVgl) 15
5.1.11 Coarse Gleyed Dover (DOVcogl) 16
5.1.12 Firebag (FIR) 17
5.1.13 gleyed Firebag (FIRgl) 18
5.1.14 Fort (FRT) 19
5.1.15 xsHartley (HLYxs) 20
5.1.16 Livock (LVK) 21
5.1.17 Mamawi (MMW) 22
5.1.18 peaty Mamawi (MMWpt) 23
5.1.19 McLelland (MLD) 24
5.1.20 xsMcLelland (MLDxs) 25
5.1.21 McMurray (MMY) 26
5.1.22 Mildred (MIL) 27
5.1.23 Mikkwa (MKWaa) 28
5.1.24 Muskeg (MUS) 29
5.1.25 Muskeg shallow (MUSxc) 30
5.1.26 Norberta (NOR) 31
5.1.27 Namur (NAM) 32
5.1.28 Namur Gleyed (NAMgl) 33
5.1.29 Peavine Soil Series (PEA) 34
5.1.30 Sutherland (SUT) 35
5.1.31 Steepbank (STP) 36
5.1.32 peaty Wanham (WHMpt) 37

6 SOIL SERIES DESCRIPTIONS FOR JACKPINE EXPANSION MINING AREA 38
6.1 SOIL SERIES DESCRIPTIONS 38
6.1.1 Albian (ABN) 38
6.1.2 Algar Lake (ALG) 40

6.1.3 peaty Bitumont (BMTpt) 41
6.1.4 Ells River (peaty) (ELSpt) 42
6.1.5 Firebag (FIR) 43
6.1.6 Fort (FRT) 44
6.1.7 Halverson (HVNaa) 45
6.1.8 Hartley (HLY) 46
6.1.9 Horse River (HRR) 47
6.1.10 Livock (LVK) 48
6.1.11 Mariana (MRN) 49
6.1.12 McLelland (MLD) 50
6.1.13 McLelland shallow (MLDxt) 51
6.1.14 Mildred (MIL) 52
6.1.15 Mikkwa (MKWaa) 53
6.1.16 Muskeg (MUS) 54
6.1.17 Muskeg shallow (MUSxc) 55
6.1.18 Norberta (NOR) 56
6.1.19 Namur gleyed (NAMgl) 57
6.1.20 Sutherland (SUT) 58
6.1.21 Steepbank (STP) 59

LIST OF TABLES

Table B-1 Forest Land Capability Subclasses 1
Table B-2 Criteria for Evaluating the Suitability of Surface Material (Topsoil) for Revegetation in the Northern Forest Region 3
Table B-3 Criteria for Evaluating the Suitability of Subsurface Material (Upper Subsoil) for Revegetation in the Northern Forest Region 3
Table B-4 Calcareous Classes 4
Table B-5 Soil Series and Variants in Pierre River Mining Area 5
Table B-6 Soil Series and Variants in Jackpine Expansion Mining Area 38

1 FOREST LAND CAPABILITY CLASSES

The forest land capability classification has been adopted from Cumulative Effects Management Association (CEMA) (2006). The classification includes:

- **Class 1 High Capability (Final land rating 81 to 100):** Land having no significant limitations to supporting productive forestry, or only minor limitations that can be overcome with normal management practices.
- **Class 2 Moderate Capability (Final land rating 61 to 80):** Land having limitations which, combined, are moderately limiting for forest production. The limitations will result in reduced productivity or benefits, or require increased inputs to the extent that the overall advantage to be gained from the use will still be attractive, but appreciably inferior to that expected on Class 1 land.
- **Class 3 Low Capability (Final land rating 41 to 60):** Land having limitations which, combined, are moderately severe for forest production. The limitations will result in reduced productivity or benefits, or require increased inputs to the extent that the overall advantage to be gained from the use will be low.
- **Class 4 Conditionally Productive (Final land rating 21 to 40):** Land having severe limitations, some of which may be surmountable through management, but which cannot be feasibly corrected with existing practice.
- **Class 5 Non-Productive (Final land rating 0 to 20):** Land having limitations that appear so severe as to preclude any possibility of successful forest production.

Table B-1 Forest Land Capability Subclasses

Subclasses	Limiting Factors
W	soil moisture regime – hygric to hydric
X	soil moisture regime – very xeric to subxeric
O	organic modifier
P	stoniness
Z	impermeable layer
F	soil nutrient regime
D	structure/consistence
V	reaction (pH)
N	salinity (EC)
Y	sodicity (SAR)

2 RECLAMATION SUITABILITY CLASSES

The material is rated based on criteria set by Alberta Agriculture (1987). Ratings are divided into three categories of suitability and one category indicating that the material is unsuitable as a rooting medium. The four categories are described as follows:

1. Good (G): No or slight limitations that affect use as a plant growth medium.

2. Fair (F): Moderate limitations that affect use but can be overcome by proper planning and good management.

3. Poor (P): Severe limitations that make use questionable. This does not mean the material cannot be used, but rather careful planning and very good management is required.

4. Unsuitable (U): Chemical or physical properties are so severe reclamation would not be economically feasible or in some cases impossible (i.e., special reclamation strategies must be implemented and land use may be severely restricted).

3 RECLAMATION SUITABILITY CRITERIA

Table B-2 Criteria for Evaluating the Suitability of Surface Material (Topsoil) for Revegetation in the Northern Forest Region

Rating/Property	Good (G)	Fair (F)	Poor (P)	Unsuitable (U)
reaction (pH)	5.0 to 6.5	4.0 to 5.0 and 6.5 to 7.5	3.5 to 4.0 and 7.5 to 9.0	<3.5 and >9.0
salinity (E.C.) [dS/m]	<2	2 to 4	4 to 8	>8
sodicity (SAR)	<4	4 to 8	8 to 12	>12
saturation [%]	30 to 60	20 to 30, 60 to 80	15 to 20, 80 to 120	<15 and >120
stonines/rockiness (% area)	<30/<20	30 to 50/20 to 40	50 to 80/40 to 70	>80/>70
texture	SL, FSL, VFSL, L, SiL	CL, SCL, SiCL	S, LS, SiC, C, HC	
moist consistence	very friable, friable	loose, firm	very firm	extremely firm
CaCO3 equivalent [%]	<2	2 to 20	20 to 70	>70

Table B-3 Criteria for Evaluating the Suitability of Subsurface Material (Upper Subsoil) for Revegetation in the Northern Forest Region

Rating/Property	Good (G)	Fair (F)	Poor (P)	Unsuitable (U)
reaction (pH)	5.0 to 7.0	4.0 to 5.0 and 7.0 to 8.0	3.5 to 4.0 and 8.0 to 9.0	<3.5 and >9.0
salinity (E.C.) [dS/m]	<3	3 to 5	5 to 8	>8
sodicity (SAR)	<4	4 to 8	8 to 12	>12
saturation [%]	30 to 60	20 to 30, 60 to 80	15 to 20, 80 to 100	<15 and >100
coarse fragments (%/Vol)	<30/<15	30 to 50/15 to 30	50 to 70/30 to 50	>70/>50
texture	FS, SL, VFSL, L, SiL	CL, SiC, SiCL	S, LS, SiC, C, HC	bedrock
moist consistence	very friable, friable, firm	loose, very firm	extremely firm	hard rock
CaCO3 equivalent [%]	<5	5 to 20	20 to 70	>70

4 CALCAREOUS CLASSES

Calcareous classes are estimated in the field on the amount of carbonates present expressed as $CaCO_3$ equivalent An approximation of the class can be made by noting the effervescence obtained with 10% HC1. These approximations should be confirmed by measurements in the laboratory.

Table B-4 Calcareous Classes

Class	$CaCO_3$ Equivalent [%]
weakly calcareous	<5
moderately calcareous	5 to 15
strongly calcareous	15 to 25
very strongly calcareous	25 to 40
extremely calcareous	>40

5 SOIL SERIES DESCRIPTIONS FOR PIERRE RIVER MINE AREA

Table B-5 Soil Series and Variants in Pierre River Mining Area

Series Name	Series Abbreviation	Subgroup	Parent Material
Albian	ABN	Typic Fibrisol	P1 and P2 -fen and bog peat
Algar Lake	ALG	Orthic Luvic Gleysol	F1 - fine glaciolacustrine
	ALGpt	peaty Luvic Gleysol	F1 - fine glaciolacustrine
Bitumont	BMTpt	peaty Orthic Gleysol	Organic veneer overlying coarse textured overlying moderately fine to fine textured (L2, L3, L9, L20 and F1) glaciofluvial
Chateh	CHT	Orthic Gleysol	F1 - fine glaciolacustrine
	CHTzr	Rego Gleysol	F1 - fine glaciolacustrine
	CHTptzr	peaty Rego Gleysol	F1 - fine glaciolacustrine
Darough	DAR	Orthic Humic Gleysol	F1 - fine glaciolacustrine
Dover	DOV	Orthic Gray Luvisol	F1 - fine glaciolacustrine
	DOVgl	Gleyed Gray Luvisol	F1 - fine glaciolacustrine
	DOVcogl	Gleyed Gray Luvisol	M3 - moderately fine textured sediments deposited by water
Firebag	FIR	Eluviated Dystric Brunisol	C1 -coarse glaciofluvial
	FIRgl	Gleyed Eluviated Dystric Brunisol	C1 -coarse glaciofluvial
Fort	FRT	Orthic Gray Luvisol	L18 -medium textured overlying moderately fine textured glaciofluvial
Hartley	HLYxs	Terric Fibrosol	L11 - organic (sphagnum peat) over coarse textured glaciofluvial
Livock	LVK	Orthic Gray Luvisol	L3 - medium textured glaciofluvial overlying moderately fine textured till
Mamawi	MMW	Rego Gleysol	M2 - medium textured sediments deposited by water
	MMWpt	peaty Rego Gleysol	M2 - medium textured sediments deposited by water
McLelland	MLD	Typic Mesisol	P2 - fen peat
	MLDxc	Terric Mesisol	L13 - organic (fen peat) overlying fine textured glaciolacustrine
	MLDxs	Terric Mesisol	L11 - organic (fen peat) over coarse textured glaciofluvial
McMurray	MMY	Cumulic Regosol	M2 - medium textured sediments deposited by water
Mildred	MIL	Eluviated Dystric Brunisol	C2 - very coarse glaciofluvial
	MILgl	Gleyed Eluviated Dystric Brunisol	C2 - very coarse glaciofluvial
	MILzz	Orthic Dystric Brunisol	C2 - very coarse glaciofluvial
Mikkwa	MKWaa	Mesic Organic Cryosol	P1 - sphagnum peat
	MKWaaxs	Terric Mesic Organic Cryosol	P1 - sphagnum peat
Muskeg	MUS	Typic Mesisol	P1 - sphagnum peat
	MUSxc	Terric Mesisol	L13 - organic (sphagnum peat) overlying fine textured glaciolacustrine
	MUSxs	Terric Mesisol	L11 - organic (sphagnum peat) over coarse textured glaciofluvial
Norberta	NOR	Rego Gleysol	C2 - very coarse glaciofluvial
Namur	NAM	Orthic Regosol	F1- fine textured glaciolacustrine
	NAMgl	Gleyed Regosol	F1- fine textured glaciolacustrine
Peavine	PEA	Orthic Gray Luvisol	M2 - medium textured sediments deposited by water
Sutherland	SUT	Eluviated Dystric Brunisol	L2 - very coarse glaciofluvial overlying moderately fine till
	SUTgl	Gleyed Eluviated Dystric Brunisol	
Steepbank	STP	Orthic Gleysol	M4 - moderately fine textured till
Wanham	WHMaapt	peaty Orthic Luvic Gleysol	M2 - medium textured sediments deposited by water

5.1 SOIL SERIES DESCRIPTIONS

5.1.1 Albian (ABN)

Soil Classification	Typic Fibrisol
Parent Material	fen peat (P2)
Texture (topsoil/subsoil)	fen peat/(not determined)
Surface Stoniness	non-stony
Drainage Class	very poorly
Organic depth/Relationship to topography	>220 cm/no relationship to topography
Forest Land Capability Class	5W
Reclamation Suitability	organic - topsoil, upper subsoil and lower subsoil
Colour Transition (good/poor) **Topsoil/subsoil**	poor very dark grayish brown/(not determined)

EXAMPLE PROFILE

Horizon	Depth [cm]	Colour	Texture	Structure	Consistencey
Of	0 to 220	very dark grayish brown	organic	–	–

– = Not available.

Note: Thickness of organic material >220 cm and may be up to 600 cm thick.
Soils are wet all year.

Representative Chemical and Physical Properties[(a)]

Horizon	Depth [cm]	Sat [%]	pH [H_2O]	CEC	EC [ds/M]	SAR	TKN	Organic Carbon [%]	C/N Ratio	Texture
Of	0 to 220	–	–	–	–	–	–	–	–	O

[(a)] CAESA Soil Inventory Project Working Group (1997).

– = Not available.

JPME R1
AENV SIR
412

5.1.2 Algar Lake (ALG)

Soil Classification	Orthic Luvic Gleysol
Parent Material	glaciolacustrine
Texture (topsoil/subsoil)	organic/clay
Surface Stoniness	non-stony
Drainage Class	very poorly to poorly
Organic depth/Relationship to topography	40 cm/no relationship to topography
Forest Land Capability Class	4VW
Reclamation Suitability	topsoil - organic; upper subsoil - poor; lower subsoil - poor
Colour Transition (good/poor) **Topsoil/subsoil**	good black/dark grayish brown

EXAMPLE PROFILE

Horizon	Depth [cm]	Colour	Texture	Structure	Consistence
Om	40 to 0	black	organic	–	–
Aeg	0 to 5	light brownish gray	sandy loam	weak fine platy	friable
Btg	5 to 35	very dark grayish brown	clay	moderate fine angular blocky	firm to very firm
Cg	35 to 80	dark grayish brown	clay	massive	firm to very firm

– = Not available.

Note: Thickness of organic material is 20 to 40 cm.
Soils are wet year round.

Representative Chemical and Physical Properties[(a)]

Horizon	Depth [cm]	Sat [%]	pH [H_2O]	CEC	EC [ds/M]	SAR	TKN	Organic Carbon [%]	C/N Ratio	Texture
Om	40 to 0	60	5.4	97	0	–	–	40	–	O
Aeg	0 to 5	53	5.2	6	0	–	–	1	–	SL
Btg	5 to 35	73	4.9	27	0	–	–	0.5	–	C
Cg	35 to 80	99	7.4	19	0	–	–	0	–	C

[(a)] CAESA Soil Inventory Project Working Group (1997).

– = Not available.

JPME R1
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412

5.1.3 peaty Algar Lake (ALGpt)

Soil Classification	peaty Orthic Luvic Gleysol
Parent Material	glaciolacustrine
Texture (topsoil/subsoil)	organic/clay
Surface Stoniness	non-stony
Drainage Class	very poorly to poorly
Organic depth/Relationship to topography	40 cm/no relationship to topography
Forest Land Capability Class	4VW
Reclamation Suitability	topsoil - organic; upper subsoil - poor; lower subsoil - poor
Colour Transition (good/poor) **Topsoil/subsoil**	good black/dark grayish brown

EXAMPLE PROFILE

Horizon	Depth [cm]	Colour	Texture	Structure	Consistence
Om	25 to 0	black	organic	–	–
Aeg	0 to 5	light brownish gray	sandy loam	weak fine platy	friable
Btg	5 to 35	very dark grayish brown	clay	moderate fine angular blocky	firm to very firm
Cg	35 to 80	dark grayish brown	clay	massive	firm to very firm

– = Not available.

Note: Thickness of organic material is 15 to 40 cm.
Soils are wet year round.

Representative Chemical and Physical Properties[(a)]

Horizon	Depth [cm]	Sat [%]	pH [H_2O]	CEC	EC [ds/M]	SAR	TKN	Organic Carbon [%]	C/N Ratio	Texture
Om	25 to 0	60	5.4	97	0	–	–	40	–	O
Aeg	0 to 5	53	5.2	6	0	–	–	1	–	SL
Btg	5 to 35	73	4.9	27	0	–	–	0.5	–	C
Cg	35 to 80	99	7.4	19	0	–	–	0	–	C

[(a)] CAESA Soil Inventory Project Working Group (1997).

5.1.4 peaty Bitumont (BMTpt)

Soil Classification	peaty Orthic Gleysol
Parent Material	organic/glaciofluvial
Texture (topsoil/subsoil)	organic/loamy sand to sand
Surface Stoniness	non-stony
Drainage Class	very poorly to poorly
Organic depth/Relationship to topography	40 cm/no relationship to topography
Forest Land Capability Class	4W
Reclamation Suitability	topsoil - organic; upper subsoil - poor; lower subsoil - poor
Colour Transition (good/poor) **Topsoil/subsoil**	poor very dark grayish brown/grayish brown

EXAMPLE PROFILE

Horizon	Depth [cm]	Colour	Texture	Structure	Consistence
Om	40 to 0	very dark grayish brown	organic	–	–
Cg	0 to 80	grayish brown	loamy sand to sand	massive	friable

– = Not available.

Note: Thickness of organic material is 20 to 40 cm.
Soils are wet year round.
Layered parent materials are common with textures ranging from sand to clay.

Representative Chemical and Physical Properties[(a)]

Horizon	Depth [cm]	Sat [%]	pH [H_2O]	CEC	EC [ds/M]	SAR	TKN	Organic Carbon [%]	C/N Ratio	Texture
Om	40 to 0	51	4.5	114	0	–	ND	46	–	O
Cg	0 to 80	74	6.5	3	0	–	–	0.2	–	LS

[(a)] CAESA Soil Inventory Project Working Group (1997).

– = Not available.

5.1.5 Chateh (CHT)

Soil Classification	Orthic Gleysol
Parent Material	glaciolacustrine
Texture (topsoil/subsoil)	clay loam/clay
Surface Stoniness	non-stony
Drainage Class	poorly
Organic depth/Relationship to topography	20 cm/no relationship to topography
Forest Land Capability Class	4W
Reclamation Suitability	topsoil - organic; upper subsoil - poor; lower subsoil - poor
Colour Transition (good/poor) **Topsoil/subsoil**	poor brown/grayish brown

EXAMPLE PROFILE

Horizon	Depth [cm]	Colour	Texture	Structure	Consistence
Om	20 to 0	very dark grayish brown	organic	–	–
Bg	0 to 30	brown	clay loam	massive	firm
Cg	30 to 80	grayish brown	clay	massive	firm

– = Not available.

Note: Thickness of organic material is 10 to 20 cm.
Soils are wet year round.

Representative Chemical and Physical Properties[(a)]

Horizon	Depth [cm]	Sat [%]	pH [H_2O]	CEC	EC [ds/M]	SAR	TKN	Organic Carbon [%]	C/N Ratio	Texture
Om	20 to 0	51	4.5	114	0	–	ND	46	–	O
Ahg	0 to 30	–	–	–	–	–	–	–	–	–
Bg	30 to 80	74	6.5	3	0	–	–	0.2	–	LS
BCg1	–	–	–	–	–	–	–	–	–	–

[(a)] CAESA Soil Inventory Project Working Group (1997).

– = Not available.

5.1.6 rego Chateh (CHTzr)

Soil Classification	Rego Gleysol
Parent Material	glaciolacustrine
Texture (topsoil/subsoil)	clay loam/clay
Surface Stoniness	non-stony
Drainage Class	poorly
Organic depth/Relationship to topography	10 cm/no relationship to topography
Forest Land Capability Class	4WD
Reclamation Suitability	topsoil - organic; upper subsoil - poor; lower subsoil - poor
Colour Transition (good/poor) **Topsoil/subsoil**	poor dark grayish brown

EXAMPLE PROFILE

Horizon	Depth [cm]	Colour	Texture	Structure	Consistence
Om	10 to 0	black	organic	–	–
Cg	0 to 100	dark grayish brown	clay	massive	firm

– = Not available.

Note: Thickness of organic material is 10 to 20 cm.
Soils are wet year round.

Representative Chemical and Physical Properties[(a)]

Horizon	Depth [cm]	Sat [%]	pH [H_2O]	CEC	EC [ds/M]	SAR	TKN	Organic Carbon [%]	C/N Ratio	Texture
Om	10 to 0	51	4.5	114	0	–	ND	46	–	O
Cg	0 to100	–	–	–	–	–	–	–	–	–

(a) CAESA Soil Inventory Project Working Group (1997).

5.1.7 peaty rego Chateh (CHTzrpt)

Soil Classification	Peaty Rego Gleysol
Parent Material	glaciolacustrine
Texture (topsoil/subsoil)	organic/clay
Surface Stoniness	non-stony
Drainage Class	Poorly to very poorly
Organic depth/Relationship to topography	25 cm/no relationship to topography
Forest Land Capability Class	4WD
Reclamation Suitability	topsoil - organic; upper subsoil - poor; lower subsoil - poor
Colour Transition (good/poor) **Topsoil/subsoil**	poor dark grayish brown

EXAMPLE PROFILE

Horizon	Depth [cm]	Colour	Texture	Structure	Consistence
Om	25 to 0	black	organic	–	–
Cg	0 to 100	dark grayish brown	clay	massive	firm

– = Not available.

Note: Thickness of organic material is 10 to 20 cm.
Soils are wet year round.

Representative Chemical and Physical Properties[(a)]

Horizon	Depth [cm]	Sat [%]	pH [H_2O]	CEC	EC [ds/M]	SAR	TKN	Organic Carbon [%]	C/N Ratio	Texture
Om	25 to 0	51	4.5	114	0	–	ND	46	–	O
Cg	0 to 100	–	–	–	–	–	–	–	–	–

(a) CAESA Soil Inventory Project Working Group (1997).

5.1.8 Darough (DAR)

Soil Classification	Orthic Humic Gleysol
Parent Material	glaciolacustrine
Texture (topsoil/subsoil)	clay/clay
Surface Stoniness	non-stony
Drainage Class	Poorly
Organic depth/Relationship to topography	10 cm/no relationship to topography
Forest Land Capability Class	4W
Reclamation Suitability	topsoil - organic; upper subsoil - poor; lower subsoil - poor
Colour Transition (good/poor) **Topsoil/subsoil**	poor black/dark brown

EXAMPLE PROFILE

Horizon	Depth [cm]	Colour	Texture	Structure	Consistence
Om	10 to 0	black	organic	–	–
Ah	0 to 10	black	clay	fine granular	friable
Bg	10 to 30	dark brown	clay	massive	firm
Cg	30 to 100	dark grayish brown	clay	massive	firm

– = Not available.

Note: Thickness of organic material is 10 to 20 cm.
Soils are wet year round.

Representative Chemical and Physical Properties[(a)]

Horizon	Depth [cm]	Sat [%]	pH [H_2O]	CEC	EC [ds/M]	SAR	TKN	Organic Carbon [%]	C/N Ratio	Texture
Om	10 to 0	51	4.5	114	0	–	ND	46	–	O
Ah	0 to10	–	–	–	–	–	–	–	–	–
Bg	10 to 30									
Cg	30 to 100									

[(a)] CAESA Soil Inventory Project Working Group (1997).

– = Not available.

5.1.9 Dover (DOV)

Soil Classification	Orthic Gray Luvisol
Parent Material	glaciolacustrine
Texture (topsoil/subsoil)	clay/clay
Surface Stoniness	non-stony
Drainage Class	Moderately well
Organic depth/Relationship to topography	5 cm/no relationship to topography
Forest Land Capability Class	2D
Reclamation Suitability	topsoil -fair; upper subsoil - fair; lower subsoil - poor
Colour Transition (good/poor) **Topsoil/subsoil**	poor grayish brown/dark brown

EXAMPLE PROFILE

Horizon	Depth [cm]	Colour	Texture	Structure	Consistence
LFH	5 to 0	Black	organic	–	–
Ae	0 to 15	grayish brown	loam to clay loam	weak medium platy	friable
Bt	15 to 35	dark brown	clay	weak subangular blocky	firm
C	30 to 100	dark grayish brown	clay	massive	very firm

– = Not available.

Representative Chemical and Physical Properties[(a)]

Horizon	Depth [cm]	Sat [%]	pH [H_2O]	CEC	EC [ds/M]	SAR	TKN	Organic Carbon [%]	C/N Ratio	Texture
LFH	5 to 0	51	4.5	114	0	–	ND	46	–	O
Ae	0 to15	–	6	–	–	–	–	–	–	–
Bt	15 to 35		4.7							
C	35 to 100		4.7							

[(a)] Pedocan (1993).

– = Not available.

5.1.10 gleyed Dover (DOVgl)

Soil Classification	Gleyed Gray Luvisol
Parent Material	glaciolacustrine
Texture (topsoil/subsoil)	clay/clay
Surface Stoniness	non-stony
Drainage Class	imperfectly
Organic depth/Relationship to topography	10 cm/no relationship to topography
Forest Land Capability Class	2D
Reclamation Suitability	topsoil -fair; upper subsoil - fair; lower subsoil - poor
Colour Transition (good/poor) **Topsoil/subsoil**	poor grayish brown/dark brown

EXAMPLE PROFILE

Horizon	Depth [cm]	Colour	Texture	Structure	Consistence
LFH	10 to 0	Black	organic	–	–
Aegj	0 to 15	grayish brown	loam to clay loam	weak medium platy	friable
Btgj	15 to 30	dark brown	clay	weak subangular blocky	firm
BCgj	30 to 55	dark grayish brown	clay	massive	firm
Cgj	55 to 100	dark grayish brown	clay	massive	very firm

– = Not available.

Representative Chemical and Physical Properties[(a)]

Horizon	Depth [cm]	Sat [%]	pH [H_2O]	CEC	EC [ds/M]	SAR	TKN	Organic Carbon [%]	C/N Ratio	Texture
LFH	10 to 0	51	4.5	114	0	–	ND	46	–	O
Ae	0 to15	–	6	–	–	–	–	–	–	–
Bt	15 to 30		4.7							
BCgj	30 to 55		4.7							
Cgj	55 to 100		4.7							

(a) Pedocan (1993).

– = Not available.

5.1.11 Coarse Gleyed Dover (DOVcogl)

Soil Classification	Gleyed Gray Luvisol
Parent Material	fluviolacustrine
Texture (topsoil/subsoil)	loam-silt loam/silt loam to clay loam
Surface Stoniness	non-stony
Drainage Class	imperfectly
Organic depth/Relationship to topography	10 cm/no relationship to topography
Forest Land Capability Class	2D
Reclamation Suitability	topsoil -fair; upper subsoil - fair; lower subsoil - poor
Colour Transition (good/poor) **Topsoil/subsoil**	poor grayish brown/dark brown

EXAMPLE PROFILE

Horizon	Depth [cm]	Colour	Texture	Structure	Consistence
LFH	10 to 0	black	organic	–	–
Aegj	0 to 12	grayish brown	loam to silt loam	weak medium platy	friable
Btgj	12 to 35	dark grayish brown	silty clay loam	weak subangular blocky	firm
Cgj	35 to 100	dark brown	silt loam to silty clay loam	massive	firm

– = Not available.

Representative Chemical and Physical Properties[(a)]

Horizon	Depth [cm]	Sat [%]	pH [H_2O]	CEC	EC [ds/M]	SAR	TKN	Organic Carbon [%]	C/N Ratio	Texture
LFH	12 to 0	51	4.5	114	0	–	ND	46	–	O
Aegj	0 to12	–	6	–	–	–	–	–	–	–
Btgj	12 to 35		4.7							
Cgj	35 to 100		4.7							

(a) Pedocan (1993).

– = Not available.

5.1.12 Firebag (FIR)

Soil Classification	Eluviated Dystric Brunisol
Parent Material	glaciofluvial
Texture (topsoil/subsoil)	sand/sand
Surface Stoniness	moderately to exceedingly
Drainage Class	well to rapidly
Topsoil depth/Relationship to topography	5 - 10 cm/no relationship to topography
Forest Land Capability Class	4X
Reclamation Suitability	topsoil - poor; upper subsoil - poor; lower subsoil - poor
Colour Transition (good/poor) **Topsoil/subsoil**	good light brownish gray/brown to pale brown

EXAMPLE PROFILE

Horizon	Depth [cm]	Colour	Texture	Structure	Consistence
LF	5 to 0	–	–	–	–
Ae	0 to 8	light brownish gray	sand	very weak fine platy	soft
Bm	8 to 35	yellowish brown	sand	single grained	soft
BC	35 to 80	brown to dark brown	sand	single grained	soft
C	80 to 120	brown to pale brown	sand	single grained	soft

– = Not available.

Representative Chemical and Physical Properties[(a)]

Horizon	Depth [cm]	Sat [%]	pH [H_2O]	CEC	EC [ds/M]	SAR	TKN	Organic Carbon [%]	C/N Ratio	Texture
LF	5 to 0	90	6.3	93	–	–	–	38	–	–
Ae	0 to 8	99	5.3	1	0	0	–	0.3	–	S
Bm	8 to 35	99	5.7	1	0	0	–	1	–	S
BC	35 to 80	88	6.0	4	0	0	–	–	–	SL
C	80 to 120	99	6.2	2	0	0	–	–	–	LS

[(a)] CAESA Soil Inventory Project Working Group (1997).

– = Not available.

5.1.13 gleyed Firebag (FIRgl)

Soil Classification	Gleyed Eluviated Dystric Brunisol
Parent Material	glaciofluvial
Texture (topsoil/subsoil)	sand/sand
Surface Stoniness	moderately to exceedingly
Drainage Class	imperfectly
Topsoil depth/Relationship to topography	5 - 10 cm/no relationship to topography
Forest Land Capability Class	4X
Reclamation Suitability	topsoil - poor; upper subsoil - poor; lower subsoil - poor
Colour Transition (good/poor) **Topsoil/subsoil**	good light brownish gray/brown to pale brown

EXAMPLE PROFILE

Horizon	Depth [cm]	Colour	Texture	Structure	Consistence
LF	5 to 0	–	–	–	–
Ae	0 to 8	light brownish gray	sand	very weak fine platy	soft
Bmgj	8 to 35	yellowish brown	sand	single grained	soft
BCgj	35 to 80	brown to dark brown	sand	single grained	soft
Cgj	80 to 120	brown to pale brown	sand	single grained	soft

– = Not available.

Representative Chemical and Physical Properties[(a)]

Horizon	Depth [cm]	Sat [%]	pH [H_2O]	CEC	EC [ds/M]	SAR	TKN	Organic Carbon [%]	C/N Ratio	Texture
LF	5 to 0	90	6.3	93	–	–	–	38	–	–
Ae	0 to 8	99	5.3	1	0	0	–	0.3	–	S
Bmgj	8 to 35	99	5.7	1	0	0	–	1	–	S
BCgj	35 to 80	88	6.0	4	0	0	–	–	–	SL
Cgj	80 to 120	99	6.2	2	0	0	–	–	–	LS

[(a)] CAESA Soil Inventory Project Working Group (1997).

– = Not available.

5.1.14 Fort (FRT)

Soil Classification	Orthic Gray Luvisol
Parent Material	glaciofluvial
Texture (topsoil/subsoil)	sandy loam/sand
Surface Stoniness	non-stony
Drainage Class	well
Topsoil depth/Relationship to topography	5 - 10 cm/no relationship to topography
Forest Land Capability Class	3
Reclamation Suitability	topsoil - fair; upper subsoil - fair; lower subsoil - poor
Colour Transition (good/poor) **Topsoil/subsoil**	good light brownish gray/pale brown

EXAMPLE PROFILE

Horizon	Depth [cm]	Colour	Texture	Structure	Consistence
LF	4 to 0	–	–	–	–
Ae	0 to 9	light brownish gray	sandy loam	weak fine platy	soft
Bt	9 to 39	dark yellowish brown	sandy loam	moderate fine subangular blocky	soft
BC	39 to 100	brown	sand	single grained	soft

– = Not available.

Representative Chemical and Physical Properties[(a)]

Horizon	Depth [cm]	Sat [%]	pH [H_2O]	CEC	EC [ds/M]	SAR	TKN	Organic Carbon [%]	C/N Ratio	Texture
LF	4 to 0	–	–	–	–	–	–	–	–	–
Ae	0 to 9	26	5.5	1.8	0.2	0.9	0.04	0.3	7.5/1	SL
Bt	9 to 39	25	4.6	23.1	0.1	1.3	–	–	–	SL
BC	39 to 100	27	5.3	1.3	<0.1	1.2	–	–	–	S

(a) Sample GA-3.

– = Not available.

5.1.15 xsHartley (HLYxs)

Soil Classification	Terric Fibrisol
Parent Material	Organic (fen peat)
Texture (topsoil/subsoil)	organic/not determined
Surface Stoniness	non-stony
Drainage Class	very poorly
Organic depth/Relationship to topography	50 - 160 cm/no relationship to topography
Forest Land Capability Class	5W
Reclamation Suitability	topsoil - organic; upper subsoil - organic; lower subsoil - organic
Colour Transition (good/poor) Topsoil/subsoil	poor very dark grayish brown/(not determined)

EXAMPLE PROFILE

Horizon	Depth [cm]	Colour	Texture	Structure	Consistence
Of	0 to 120	very dark grayish brown	organic	–	–
Cg	120 +	very dark grayish brown	clay loam	massive	firm

– = Not available.

Note: Thickness of organic material 50 to 160 cm.
Soils are wet all year.
HLYxs soils have sandy subsoils.

Representative Chemical and Physical Properties[(a)]

Horizon	Depth [cm]	Sat [%]	pH [H_2O]	CEC	EC [ds/M]	SAR	TKN	Organic Carbon [%]	C/N Ratio	Texture
Of	0 to 120	90	6.5	172	0	–		45	–	O
Cg	120 +	83	6.2	24	0	–	–	0.7	–	CL

[(a)] CAESA Soil Inventory Project Working Group (1997).

– = Not available.

5.1.16 Livock (LVK)

Soil Classification	Orthic Gray Luvisol
Parent Material	glaciofluvial/till
Texture (topsoil/subsoil)	silt loam/clay loam
Surface Stoniness	non-stony
Drainage Class	well
Topsoil depth/Relationship to topography	5 - 15 cm/no relationship to topography
Forest Land Capability Class	3
Reclamation Suitability	topsoil - fair; upper subsoil - fair; lower subsoil - poor
Colour Transition (good/poor) **Topsoil/subsoil**	good light brownish gray/pale brown

EXAMPLE PROFILE

Horizon	Depth [cm]	Colour	Texture	Structure	Consistence
LF	5 to 0	–	–	–	–
Ae	0 to 14	light brownish gray	silt loam	weak fine platy	soft
Bt	14 to 45	dark yellowish brown	clay loam to silty clay loam	moderate fine subangular blocky	soft
BC	45 to 75	brown	loam	massive	friable
IICk	75 to 120	pale brown	clay loam	massive	firm

– = Not available.

Note: LVKgl soils are classified as Gleyed Gray Luvisols. These soils are imperfectly drained and have a Aegj, Btgj, BCgj, Cgj horizon sequence. These soils are found in lower, toe and depressional landscape positions. Textures in these soils are the same as the well drained LVK soils.

Representative Chemical and Physical Properties[(a)]

Horizon	Depth [cm]	Sat [%]	pH [H_2O]	CEC	EC [ds/M]	SAR	TKN	Organic Carbon [%]	C/N Ratio	Texture
LF	5 to 0	36	4.8	65	0	–	–	25	–	O
Ae	0 to 15	24	4.8	11	0	–	–	1.2	–	SiL
Bt	15 to 50	33	4.9	19	0	–	–	0.5	–	CL-SiCL
BC	50 to 80	58	6.6	19	0	–	–	–	–	L
IICk	80 to 120	99	7.6	11	0	–	–	–	–	CL

[(a)] CAESA Soil Inventory Project Working Group (1997).

– = Not available.

5.1.17 Mamawi (MMW)

Soil Classification	Rego Gleysol
Parent Material	fluvial
Texture (topsoil/subsoil)	sandy loam to loam/sandy loam to loam
Surface Stoniness	non-stony
Drainage Class	Imperfectly to poorly
Topsoil depth/Relationship to topography	5 - 15 cm/no relationship to topography
Forest Land Capability Class	4W
Reclamation Suitability	topsoil - organic; upper subsoil - poor; lower subsoil - poor
Colour Transition (good/poor) **Topsoil/subsoil**	good light brownish gray/pale brown

EXAMPLE PROFILE

Horizon	Depth [cm]	Colour	Texture	Structure	Consistence
Om	10 to 0	–	organic	–	–
Cg	0 to 100	light brownish gray	sandy loam to loam	massive	firm

– = Not available.

Representative Chemical and Physical Properties[(a)]

Horizon	Depth [cm]	Sat [%]	pH [H_2O]	CEC	EC [ds/M]	SAR	TKN	Organic Carbon [%]	C/N Ratio	Texture
Om	10 to 0	–	–	–	–	–	–	–	–	O
Cg	0 to 100	–	–	–	–	–	–	–	–	–

(a) CAESA Soil Inventory Project Working Group (1997).

– = Not available.

5.1.18 peaty Mamawi (MMWpt)

Soil Classification	Peaty Rego Gleysol
Parent Material	fluvial
Texture (topsoil/subsoil)	Sandy loam to loam/sandy loam to loam
Surface Stoniness	non-stony
Drainage Class	Imperfectly to poorly
Topsoil depth/Relationship to topography	15 – 40 cm/no relationship to topography
Forest Land Capability Class	4W
Reclamation Suitability	topsoil - organic; upper subsoil - poor; lower subsoil - poor
Colour Transition (good/poor) **Topsoil/subsoil**	good light brownish gray/pale brown

EXAMPLE PROFILE

Horizon	Depth [cm]	Colour	Texture	Structure	Consistence
Om	25 to 0	–	organic	–	–
Cg	0 to 100	light brownish gray	sandy loam to loam	massive	firm

– = Not available.

Representative Chemical and Physical Properties[(a)]

Horizon	Depth [cm]	Sat [%]	pH [H_2O]	CEC	EC [ds/M]	SAR	TKN	Organic Carbon [%]	C/N Ratio	Texture
Om	25 to 0	–	–	–	–	–	–	–	–	O
Cg	0 to 100	–	–	–	–	–	–	–	–	–

[(a)] CAESA Soil Inventory Project Working Group (1997).

– = Not available.

5.1.19 McLelland (MLD)

Soil Classification	Typic Mesisol
Parent Material	organic (fen peat)
Texture (topsoil/subsoil)	organic/(not determined)
Surface Stoniness	non-stony
Drainage Class	very poorly
Organic depth/Relationship to topography	>160 cm/no relationship to topography
Forest Land Capability Class	5W
Reclamation Suitability	topsoil - organic; upper subsoil - organic; lower subsoil - organic
Colour Transition (good/poor) **Topsoil/subsoil**	poor very dark grayish brown/(not determined)

EXAMPLE PROFILE

Horizon	Depth [cm]	Colour	Texture	Structure	Consistence
Om	0 to 220	very dark grayish brown	organic	–	–

– = Not available.

Note: Thickness of organic material is >160 cm.
Soils are wet all year.
Sedge (fen) peat.

Representative Chemical and Physical Properties[(a)]

Horizon	Depth [cm]	Sat [%]	pH [H_2O]	CEC	EC [ds/M]	SAR	TKN	Organic Carbon [%]	C/N Ratio	Texture
Om	0 to 220	90	6.5	172	0	–	–	40	–	O

[(a)] CAESA Soil Inventory Project Working Group (1997).

– = Not available.

5.1.20 xsMcLelland (MLDxs)

Soil Classification	Terric Mesisol
Parent Material	organic (fen peat)/fluvial
Texture (topsoil/subsoil)	organic/loamy sand to sand
Surface Stoniness	non-stony
Drainage Class	very poorly
Organic depth/Relationship to topography	40 - 160 cm/no relationship to topography
Forest Land Capability Class	5W
Reclamation Suitability	topsoil - organic; upper subsoil - organic; lower subsoil - organic
Colour Transition (good/poor) **Topsoil/subsoil**	poor very dark grayish brown/very dark grayish brown

EXAMPLE PROFILE

Horizon	Depth [cm]	Colour	Texture	Structure	Consistence
Of	0 to 25		organic	–	–
Om	25 to 140		organic	–	–
Cg	140 +	very dark grayish brown	Loamy sand to sand	massive	fraible

– = Not available.

Note: Thickness of organic material is 40 to 160 cm.
Soils are wet all year.
Sedge (fen) pea
MLDxc soils have clay textured C horizons found between 40 to 160 cm.

Representative Chemical and Physical Properties[(a)]

Horizon	Depth [cm]	Sat [%]	pH [H_2O]	CEC	EC [ds/M]	SAR	TKN	Organic Carbon [%]	C/N Ratio	Texture
Of	0 to 25	–	–	–	–	–	–	–	–	–
Om	25 to 140	–	–	–	–	–	–	–	–	–
Cg	140 +	–	–	–	–	–	–	–	–	–

[(a)] CAESA Soil Inventory Project Working Group (1997).

– = Not available.

5.1.21 McMurray (MMY)

Soil Classification	Cumulic Regosol
Parent Material	fluvial
Texture (topsoil/subsoil)	Sandy loam to loam/sandy loam to loam (textures variable)
Surface Stoniness	non-stony to slightly stony
Drainage Class	moderately well
Topsoil depth/Relationship to topography	0 - 15 cm/no relationship to topography
Forest Land Capability Class	1V
Reclamation Suitability	topsoil - fair to good; upper subsoil - fair to good; lower subsoil - fair
Colour Transition (good/poor) **Topsoil/subsoil**	poor pale brown

EXAMPLE PROFILE

Horizon	Depth [cm]	Colour	Texture	Structure	Consistence
LF	2 to 0		–	–	–
C1	0 to 3		loamy sand	–	–
Hb	3 to 4		–	–	–
C2	4 to 10	2.5YR 4/3	sand to loamy sand	–	–
BC	10 to 16		–	–	–
C3	16 to 85		–	–	–
Cg	85 to 125		sand to sandy loam	–	–

– = Not available.

Note: Found on modern floodplains-textures variable but primarily loamy.

Representative Chemical and Physical Properties[(a)]

Horizon	Depth [cm]	Sat [%]	pH [H_2O]	CEC	EC [ds/M]	SAR	TKN	Organic Carbon [%]	C/N Ratio	Texture
LF	8 to 0	–	5.1	121	<1	–	–	35.6	–	–
Ahegj1	0 to 8	–	6.0	26	<1	–	–	5.0	–	silt loam
Ahgjb1	8 to 15	–	6.1	20	<1	–	–	4.3		silt loam
Cgj1	15 to 24	–	6.6	91	<1	–	–	2.1		sandy loam
Ahgjb2	24 to 33	–	6.8	19	<1	–	–	2.3		loam
Cgj2	33 to 34	–	7.0	14	<1	–	–	0		sandy
Ahgjb3	34 to 42	–	7.0	13	<1	–	–	3.2		loam
Cgj3	42 to 59	–	7.3	9	<1	–	–	2.1		loam
C+Hgj4	59 to 100	–	7.2	17	<1	–	–	3.5		sandy loam

[(a)] Source: AGRASID (ASIC 2006, website).

– = Not available.

5.1.22 Mildred (MIL)

Soil Classification	Eluviated Dystric Brunisol
Parent Material	glaciofluvial
Texture (topsoil/subsoil)	sand/sand
Surface Stoniness	non-stony
Drainage Class	well to rapidly
Topsoil depth/Relationship to topography	5 - 10 cm/no relationship to topography
Forest Land Capability Class	4X
Reclamation Suitability	topsoil - poor; upper subsoil - poor; lower subsoil - poor
Colour Transition (good/poor) **Topsoil/subsoil**	good light brownish gray/brown to pale brown

EXAMPLE PROFILE

Horizon	Depth [cm]	Colour	Texture	Structure	Consistence
LF	2 to 0	–	–	–	–
Ae	0 to 10	light brownish gray	sand	very weak fine platy	soft
Bm	10 to 43	yellowish brown	sand	single grained	soft
BC	43 to 100	brown to dark brown	sand	single grained	soft
C	100 to 120	brown to pale brown	sand	single grained	soft

– = Not available.

Note: MILzz soils do not have an Ae horizon and are classified as O.DYB.

MILgl soils are classified as Gleyed Eluviated Dystric Brunisols. These soils are imperfectly drained and have an Aegj, Bmgj, BCgj, Cgj horizon sequence.

Representative Chemical and Physical Properties[(a)]

Horizon	Depth [cm]	Sat [%]	pH [H_2O]	CEC	EC [ds/M]	SAR	TKN	Organic Carbon [%]	C/N Ratio	Texture
LF	2 to 0	ND	ND	ND	ND	ND	ND	ND	ND	O
Ae	0 to 10	31	5.5	1.2	0.2	0.5	<0.02	0.2	>100	S
Bm	10 to 43	31	6.4	0.7	0.6	0.2	–	–	–	S
BC	43 to 100	30	6.5	0.4	0.2	0.5	–	–	–	S
C	100 to 120	ND	ND	ND	ND	ND	ND	ND	ND	S

(a) Sample GA-2.

– = Not available.

5.1.23 Mikkwa (MKWaa)

Soil Classification	Fibric Organic Cryosol
Parent Material	organic (bog peat)
Texture (topsoil/subsoil)	organic/(not determined)
Surface Stoniness	non-stony
Drainage Class	very poorly
Organic depth/Relationship to topography	50 - 160 cm/no relationship to topography
Forest Land Capability Class	5W
Reclamation Suitability	topsoil - organic; upper subsoil - organic; lower subsoil - organic
Colour Transition (good/poor) **Topsoil/subsoil**	poor very dark grayish brown/not determined

EXAMPLE PROFILE

Horizon	Depth [cm]	Colour	Texture	Structure	Consistence
Of	0 to 40	very dark grayish brown	organic	–	–
Ofz	40 to100	very dark grayish brown	organic	–	frozen

– = Not available.

Note: Thickness of organic material 50 to 160 cm.
Soils are wet and frozen all year.

Representative Chemical and Physical Properties[(a)]

Horizon	Depth [cm]	Sat [%]	pH [H_2O]	CEC	EC [ds/M]	SAR	TKN	Organic Carbon [%]	C/N Ratio	Texture
Of	0 to 40	883	5.9	134	0.2	0.2	2.36	46.5	19.7/1	O
Ofz	40 to 100	979	6.0	133	0.2	0.2	1.84	45.3	24.6/1	O

[(a)] Sample GA-28.

– = Not available.

5.1.24 Muskeg (MUS)

Soil Classification	Typic Mesisol
Parent Material	organic (bog peat)
Texture (topsoil/subsoil)	organic/not determined
Surface Stoniness	non-stony
Drainage Class	very poorly
Organic depth/Relationship to topography	>160 cm/no relationship to topography
Forest Land Capability Class	5W
Reclamation Suitability	topsoil - organic; upper subsoil - organic; lower subsoil - organic
Colour Transition (good/poor) Topsoil/subsoil	poor very dark grayish brown/not determined

EXAMPLE PROFILE

Horizon	Depth [cm]	Colour	Texture	Structure	Consistence
Of	0 to 30	very dark grayish brown	organic	–	–
Om	30 to 220	very dark grayish brown	organic	–	–

– = Not available.

Note: Thickness of organic material is >160 cm.

Soils are wet all year.

Sphagnum (bog) peat.

Representative Chemical and Physical Properties[(a)]

Horizon	Depth [cm]	Sat [%]	pH [H_2O]	CEC	EC [ds/M]	SAR	TKN	Organic Carbon [%]	C/N Ratio	Texture
Of	0 to 30	10	3.6	106	0	–	–	45	–	O
Om	30 to 220	40	4.6	172	0	–	–	40	–	O

[(a)] CAESA Soil Inventory Project Working Group (1997).

– = Not available.

5.1.25 Muskeg shallow (MUSxc)

Soil Classification	Terric Mesisol
Parent Material	organic (bog peat)
Texture (topsoil/subsoil)	organic/clay
Surface Stoniness	non-stony
Drainage Class	very poorly
Organic depth/Relationship to topography	40 - 160 cm/no relationship to topography
Forest Land Capability Class	5W
Reclamation Suitability	topsoil - organic; upper subsoil - organic; lower subsoil - organic
Colour Transition (good/poor) **Topsoil/subsoil**	poor very dark grayish brown/very dark grayish brown

EXAMPLE PROFILE

Horizon	Depth [cm]	Colour	Texture	Structure	Consistence
Om	0 to 120	very dark grayish brown	organic	–	–
IICg	120 +	very dark grayish brown	clay	massive	sticky

– = Not available.

Note: Thickness of organic material is 40 to 160 cm.
Soils are wet all year.
Sphagnum (bog) peat.
MUSxs soils have sandy textured subsoil.

Representative Chemical and Physical Properties[(a)]

Horizon	Depth [cm]	Sat [%]	pH [H_2O]	CEC	EC [ds/M]	SAR	TKN	Organic Carbon [%]	C/N Ratio	Texture
Om	0 to 120	517	3.4	99	0.4	0.2	0.94	45.4	48.3/1	O
IICg	120 +	–	–	–	–	–	–	–	–	CL

(a) Sample GA-26.

– = Not available.

5.1.26 Norberta (NOR)

Soil Classification	Rego Gleysol
Parent Material	glaciofluvial
Texture (topsoil/subsoil)	organic/sand
Surface Stoniness	non-stony
Drainage Class	poorly
Organic depth/Relationship to topography	20 -40 cm/no relationship to topography
Forest Land Capability Class	4W
Reclamation Suitability	topsoil - organic; upper subsoil - organic; lower subsoil - poor
Colour Transition (good/poor) **Topsoil/subsoil**	poor very dark grayish brown/grayish brown

EXAMPLE PROFILE

Horizon	Depth [cm]	Colour	Texture	Structure	Consistence
Of	38 to 16	very dark grayish brown	organic	–	–
Om	16 to 0	very dark grayish brown	organic	–	–
Cg	0 to 82	grayish brown	sand	massive	firm

– = Not available.

Note: Thickness of organic material is 20 to 40 cm.
Soils are wet year round.

Representative Chemical and Physical Properties[(a)]

Horizon	Depth [cm]	Sat [%]	pH [H_2O]	CEC	EC [ds/M]	SAR	TKN	Organic Carbon [%]	C/N Ratio	Texture
Of	38 to 16	693	4.1	102	0.2	0.7	1.35	42.4	35.1/1	O
Om	16 to 0	693	4.1	102	0.2	0.7	1.35	42.4	35.1/1	O
Cg	0 to 82	26	5.8	2.4	0.2	0.6	–	–	–	S

[(a)] Sample GA-8.

– = Not available.

5.1.27 Namur (NAM)

Soil Classification	Orthic Regosol
Parent Material	fluvial
Texture (topsoil/subsoil)	no topsoil/silt loam to loam to sandy loam to silty clay
Surface Stoniness	non-stony
Drainage Class	Moderately to imperfectly
Topsoil depth/Relationship to topography	0 cm/no relationship to topography
Forest Land Capability Class	2
Reclamation Suitability	topsoil - poor; upper subsoil - fair; lower subsoil - fair
Colour Transition (good/poor) **Topsoil/subsoil**	good no topsoil

EXAMPLE PROFILE

Horizon	Depth [cm]	Colour	Texture	Structure	Consistence
LF	5 to 0	–	–	–	–
Cg	0 to 100	brown	variable (see above)	massive	friable

– = Not available.

Note: There is no topsoil.

Soils are seasonally wet.

Developed on loamy to clayey textured materials associated with fluvial fan and apron landforms. May also include coarser textured variants.

Representative Chemical and Physical Properties[(a)]

Horizon	Depth [cm]	Sat [%]	pH [H_2O]	CEC	EC [ds/M]	SAR	TKN	Organic Carbon [%]	C/N Ratio	Texture
LF	5 to 0	–	–	–	–	–	–	–	–	–
Cg	0 to 100	–	–	–	–	–	–	–	–	–

[(a)] CAESA Soil Inventory Project Working Group (1997).

5.1.28 Namur Gleyed (NAMgl)

Soil Classification	Gleyed Regosol
Parent Material	fluvial
Texture (topsoil/subsoil)	no topsoil/silt loam to loam to sandy loam to silty clay
Surface Stoniness	non-stony
Drainage Class	imperfectly
Topsoil depth/Relationship to topography	0 cm/no relationship to topography
Forest Land Capability Class	2
Reclamation Suitability	topsoil - poor; upper subsoil - fair; lower subsoil - fair
Colour Transition (good/poor) **Topsoil/subsoil**	good no topsoil

EXAMPLE PROFILE

Horizon	Depth [cm]	Colour	Texture	Structure	Consistence
LF	5 to 0	–	–	–	–
Cgj	0 to 100	brown	variable (see above)	massive	friable

– = Not available.

Note: There is no topsoil.

Soils are seasonally wet.

Developed on loamy to clayey textured materials associated with fluvial fan and apron landforms. May also include coarser textured variants.

Representative Chemical and Physical Properties[(a)]

Horizon	Depth [cm]	Sat [%]	pH [H_2O]	CEC	EC [ds/M]	SAR	TKN	Organic Carbon [%]	C/N Ratio	Texture
LF	5 to 0	82	6.0	98	0	0	–	38.3	–	O
Cgj	0 to 100	78	4.9	33	0	0	–	1.8	–	SiC

[(a)] CAESA Soil Inventory Project Working Group (1997).

– = Not available.

5.1.29 Peavine Soil Series (PEA)

Soil Classification	Orthic Gray Luvisol
Parent Material	glaciofluvial
Texture (topsoil/subsoil)	silt loam/silty clay loam
Surface Stoniness	non-stony
Drainage Class	well to moderately well
Organic depth/Relationship to topography	10 cm/no relationship to topography
Forest Land Capability Class	2
Reclamation Suitability	topsoil - fair; upper subsoil - fair to poor; lower subsoil - fair to poor
Colour Transition (good/poor) **Topsoil/subsoil**	poor very dark grayish brown/grayish brown

EXAMPLE PROFILE

Horizon	Depth [cm]	Colour	Texture	Structure	Consistence
LFH	9 to 0	–	–	–	–
Ae	0 to 13	10YR 5/2	silt loam	platy	friable
Bt	10 to 41	10YR 5/4	silt loam to silty clay loam	–	–
BC	41 to 53	10YR 4.5/3	silt loam	–	firm
Ck1	53 to 61	–	silt loam	massive	firm
Ck2	61-100	–	silt loam	massive	firm

– = Not available.

Representative Chemical and Physical Properties

Horizon	Depth [cm]	Sat [%]	pH [H_2O]	CEC	EC [ds/M]	SAR	TKN	Organic Carbon [%]	C/N Ratio	Texture
LFH	9 to 0	80	5.4	70	0	–	–	–	–	–
Ae	0 to 13	76	4.8	8	0	–	–	–	–	silt loam
Bt	10 to 41	95	5.0	15	0	–	–	–	–	silt loam to silty clay loam
BC	41 to 53	–	6.1	13	0	–	–	–	–	silt loam
Ck1	53 to 61	54	7.4	7	1	–	–	–	–	silt loam
Ck2	61-100		7.8	8	2	–	–	–	–	silt loam

[a)]CAESA Soil Inventory Project Working Group (1997).

– = Not available.

5.1.30 Sutherland (SUT)

Soil Classification	Eluviated Dystric Brunisol
Parent Material	glaciofluvial/till
Texture (topsoil/subsoil)	sand/sandy clay loam
Surface Stoniness	non-stony
Drainage Class	well to rapidly
Topsoil depth/Relationship to topography	5 - 10 cm/no relationship to topography
Forest Land Capability Class	3
Reclamation Suitability	topsoil - poor; upper subsoil - poor; lower subsoil - poor
Colour Transition (good/poor) **Topsoil/subsoil**	good light brownish gray/brown to pale brown

EXAMPLE PROFILE

Horizon	Depth [cm]	Colour	Texture	Structure	Consistence
LF	7 to 0	–	–	–	–
Ae	0 to 40	light brownish gray	sand	very weak fine platy	soft
Bm	40 to 75	yellowish brown	sand	single grained	soft
IIC	75 to 120	brown to pale brown	sandy clay loam	massive	firm

– = Not available.

Note: SUTgl soils are imperfectly drained and have an Aegj, Bmgj, BCgj, IICkgj horizon sequence.

Representative Chemical and Physical Properties[(a)]

Horizon	Depth [cm]	Sat [%]	pH [H_2O]	CEC	EC [ds/M]	SAR	TKN	Organic Carbon [%]	C/N Ratio	Texture
LF	7 to 0	–	–	–	–	–	–	–	–	O
Ae	0 to 40	25	5.0	0.8	0.2	0.7	0.04	0.2	5.5/1	S
Bm	40 to 75	24	5.7	1.4	0.1	0.6	–	–	–	S
IIC	75 to 120	35	5.5	9.1	0.8	0.7	–	–	–	SCL

[(a)] Sample GA-1.

– = Not available.

5.1.31 Steepbank (STP)

Soil Classification	Orthic Gleysol
Parent Material	till
Texture (topsoil/subsoil)	organic/clay loam
Surface Stoniness	non-stony
Drainage Class	poorly
Organic depth/Relationship to topography	<40 cm/no relationship to topography
Forest Land Capability Class	4W
Reclamation Suitability	topsoil - organic; upper subsoil - poor; lower subsoil - poor
Colour Transition (good/poor) **Topsoil/subsoil**	poor very dark grayish brown/grayish brown

EXAMPLE PROFILE

Horizon	Depth [cm]	Colour	Texture	Structure	Consistence
Om	20 to 0	very dark grayish brown	organic	–	–
Bg	0 to 30	grayish brown	clay loam	massive	firm
Cg	30 to 90	grayish brown	clay loam	massive	firm

– = Not available.

Note: Thickness of organic material is 20 to 40 cm.
Soils are wet year round.

Representative Chemical and Physical Properties[(a)]

Horizon	Depth [cm]	Sat [%]	pH [H_2O]	CEC	EC [ds/M]	SAR	TKN	Organic Carbon [%]	C/N Ratio	Texture
Om	20 to 0	40	4.5	127	0	–	–	45.4	–	O
Bg	0 to 30	90	6.8	8	0	–	–	0.7	–	L
Cg	30 to 90	99	7.5	12	0	–	–	–	–	CL

[(a)] CAESA Soil Inventory Project Working Group (1997).

– = Not available.

5.1.32 peaty Wanham (WHMpt)

Soil Classification	Peaty Orthic Luvic Gleysol
Parent Material	fluvial
Texture (topsoil/subsoil)	Sandy loam to loam/sandy loam to loam
Surface Stoniness	non-stony
Drainage Class	Imperfectly to poorly
Topsoil depth/Relationship to topography	15 – 40 cm/no relationship to topography
Forest Land Capability Class	4VW
Reclamation Suitability	topsoil - organic; upper subsoil - poor; lower subsoil - poor
Colour Transition (good/poor) **Topsoil/subsoil**	good light brownish gray/pale brown

EXAMPLE PROFILE

Horizon	Depth [cm]	Colour	Texture	Structure	Consistence
Om	25 to 0	–	organic	–	–
Cg	0 to 100	light brownish gray	silt loam to loam	massive	firm

– = Not available.

Representative Chemical and Physical Properties[(a)]

Horizon	Depth [cm]	Sat [%]	pH [H_2O]	CEC	EC [ds/M]	SAR	TKN	Organic Carbon [%]	C/N Ratio	Texture
Om	25 to 0	60	5.4	97	0	–	–	40	–	O
Aeg	0 to 5	53	5.2	6	0	–	–	1	–	SL
Btg	5 to 35	73	4.9	27	0	–	–	0.5	–	C
Cg	35 to 80	99	7.4	19	0	–	–	0	–	C

[(a)] CAESA Soil Inventory Project Working Group (1997).

– = Not available.

JPME R1
AENV SIR
411

6 SOIL SERIES DESCRIPTIONS FOR JACKPINE EXPANSION MINING AREA

Table B-6 Soil Series and Variants in Jackpine Expansion Mining Area

Series Name	Series Abbreviation	Subgroup	Parent Material
Albian	ABN	Typic Fibrisol	P1 and P2 -fen and bog peat
Algar Lake	ALG	Orthic Luvic Gleysol	F1 - fine glaciolacustrine
Bitumont	BMTpt	peaty Orthic Gleysol	Organic veneer overlying coarse textured overlying moderately fine to fine textured (L2, L3, L9, L20 and F1) glaciofluvial
Ells River	ELSpt	peaty Rego Gleysol	Organic veneer overlying moderately fine to fine till (M4, F4)
Firebag	FIR	Eluviated Dystric Brunisol	C1 -coarse glaciofluvial
Fort	FRT	Orthic Gray Luvisol	L18 -medium textured overlying moderately fine textured glaciofluvial
Halverson	HVNaa	Orthic Gray Luvisol	L2 - coarse glaciofluvial veneer overlying moderately fine till
Hartley	HLY	Terric Fibrisol	L12 - organic (fen peat) over moderately fine till
	HLYxs	Terric Fibrisol	L11 - organic (fen peat) over coarse textured glaciofluvial
Horse River	HRR	Orthic Gray Luvisol	M4 - moderately fine textured till
	HRRzz	Brunisolic Gray Luvisol	M4 - moderately fine textured till
Livock	LVK	Orthic Gray Luvisol	L3 - medium textured glaciofluvial overlying moderately fine textured till
	LVKgl	Gleyed Gray Luvisol	L3 - medium textured glaciofluvial overlying moderately fine textured till
Mariana	MRN	Terric Mesisol	L12 - organic (bog) over moderately fine till
McLelland	MLD	Typic Mesisol	P2 - fen peat
	MLDxc	Terric Mesisol	L13 - organic (fen peat) overlying fine textured glaciolacustrine
	MLDxs	Terric Mesisol	L11 - organic (fen peat) over coarse textured glaciofluvial
	MLDxt	Terric Mesisol	L12 - organic (fen peat) over moderately fine till
Mildred	MIL	Eluviated Dystric Brunisol	C2 - very coarse glaciofluvial
	MILzz	Orthic Dystric Brunisol	C2 - very coarse glaciofluvial
Mikkwa	MKWaa	Fibric Organic Cryosol	P1 - organic (fen and sphagnum) peat
Muskeg	MUS	Typic Mesisol	P1 - sphagnum peat
	MUSxc	Terric Mesisol	L13 - organic (sphagnum peat) overlying fine textured glaciolacustrine
	MUSxs	Terric Mesisol	L11 - organic (sphagnum peat) over coarse textured glaciofluvial
Norberta	NOR	Rego Gleysol	C2 - very coarse glaciofluvial
Namur	NAMgl	Gleyed Regosol	F1- fine textured glaciolacustrine
Sutherland	SUT	Eluviated Dystric Brunisol	L2 - very coarse glaciofluvial overlying moderately fine till
	SUTgl	Gleyed Eluviated Dystric Brunisol	L2 - very coarse glaciofluvial overlying moderately fine till
Steepbank	STP	Orthic Gleysol	M4 - moderately fine textured till

6.1 SOIL SERIES DESCRIPTIONS

6.1.1 Albian (ABN)

Soil Classification	Typic Fibrisol
Parent Material	fen peat (P2)
Texture (topsoil/subsoil)	fen peat/(not determined)
Surface Stoniness	non-stony

Drainage Class	very poorly
Organic depth/Relationship to topography	>220 cm/no relationship to topography
Forest Land Capability Class	5W
Reclamation Suitability	organic - topsoil; upper subsoil and lower subsoil
Colour Transition (good/poor) **Topsoil/subsoil**	poor very dark grayish brown/not determined

EXAMPLE PROFILE

Horizon	Depth [cm]	Colour	Texture	Structure	Consistence
Of	0 to 220	very dark grayish brown	organic	–	–

– = Not available.

Note: Thickness of organic material >220 cm and may be up to 600 cm thick.
Soils are wet all year.

Representative Chemical and Physical Properties[(a)]

Horizon	Depth [cm]	Sat [%]	pH [H_2O]	CEC	EC [ds/M]	SAR	TKN	Organic Carbon [%]	C/N Ratio	Texture
Of	0 to 220	–	–	–	–	–	–	–	–	O

(a) Soil Layer File data.

– = Not available.

JPME R1
AENV SIR
412

6.1.2 Algar Lake (ALG)

Soil Classification	Orthic Luvic Gleysol
Parent Material	glaciolacustrine
Texture (topsoil/subsoil)	organic/clay
Surface Stoniness	non-stony
Drainage Class	very poorly to poorly
Organic depth/Relationship to topography	40 cm/no relationship to topography
Forest Land Capability Class	4VW
Reclamation Suitability	topsoil - organic; upper subsoil - poor; lower subsoil - poor
Colour Transition (good/poor) **Topsoil/subsoil**	good black/dark grayish brown

EXAMPLE PROFILE

Horizon	Depth [cm]	Colour	Texture	Structure	Consistence
Om	40 to 0	black	organic	–	–
Aeg	0 to 5	light brownish gray	sandy loam	weak fine platy	friable
Btg	5 to 35	very dark grayish brown	clay	moderate fine angular blocky	firm to very firm
Cg	35 to 80	dark grayish brown	clay	massive	firm to very firm

Note: Thickness of organic material is 20 to 40 cm.
Soils are wet year round.

Representative Chemical and Physical Properties[(a)]

Horizon	Depth [cm]	Sat [%]	pH [H_2O]	CEC	EC [ds/M]	SAR	TKN	Organic Carbon [%]	C/N Ratio	Texture
Om	40 to 0	60	5.4	97	0	–	–	40	–	O
Aeg	0 to 5	53	5.2	6	0	–	–	1	–	SL
Btg	5 to 35	73	4.9	27	0	–	–	0.5	–	C
Cg	35 to 80	99	7.4	19	0	–	–	0	–	C

[(a)] Soil Layer File data.
– = Not available.

6.1.3 peaty Bitumont (BMTpt)

Soil Classification	peaty Orthic Gleysol
Parent Material	organic/glaciofluvial
Texture (topsoil/subsoil)	organic/loamy sand to sand
Surface Stoniness	non-stony
Drainage Class	very poorly to poorly
Organic depth/Relationship to topography	40 cm/no relationship to topography
Forest Land Capability Class	4W
Reclamation Suitability	topsoil - organic; upper subsoil - poor; lower subsoil - poor
Colour Transition (good/poor) **Topsoil/subsoil**	poor very dark grayish brown/grayish brown

EXAMPLE PROFILE

Horizon	Depth [cm]	Colour	Texture	Structure	Consistence
Om	40 to 0	very dark grayish brown	organic	–	–
Cg	0 to 80	grayish brown	loamy sand to sand	massive	friable

– = Not available.

Note: Thickness of organic material is 20 to 40 cm.
Soils are wet year round.
Layered parent materials are common with textures ranging from sand to clay.

Representative Chemical and Physical Properties[(a)]

Horizon	Depth [cm]	Sat [%]	pH [H_2O]	CEC	EC [ds/M]	SAR	TKN	Organic Carbon [%]	C/N Ratio	Texture
Om	40 to 0	51	4.5	114	0	–	ND	46	–	O
Cg	0 to 80	74	6.5	3	0	–	–	0.2	–	LS

[(a)] Soil Layer File data.

– = Not available.

6.1.4 Ells River (peaty) (ELSpt)

Soil Classification	peaty Rego Gleysol
Parent Material	organic/till
Texture (topsoil/subsoil)	organic/clay loam
Surface Stoniness	non-stony
Drainage Class	very poorly to poorly
Organic depth/Relationship to topography	40 cm/no relationship to topography
Forest Land Capability Class	4W
Reclamation Suitability	topsoil - organic; upper subsoil - poor; lower subsoil - poor
Colour Transition (good/poor) Topsoil/subsoil	poor very dark grayish brown/brown to dark brown

EXAMPLE PROFILE

Horizon	Depth [cm]	Colour	Texture	Structure	Consistence
Om	40 to 0	very dark grayish brown	organic	–	–
Ckg	0 to 80	brown to dark brown	clay loam	massive	firm

– = Not available.

Note: Thickness of organic material is 20 to 40 cm.
Soils are wet year round.
Stones will be found in the parent material.

Representative Chemical and Physical Properties[(a)]

Horizon	Depth [cm]	Sat [%]	pH [H_2O]	CEC	EC [ds/M]	SAR	TKN	Organic Carbon [%]	C/N Ratio	Texture
Om	40 to 0	40	4.2	115	0	–	ND	45	–	O
Ckg	0 to 80	99	7.8	11	0	–	–	0	–	CL

(a) Soil Layer File data.

– = Not available.

6.1.5 Firebag (FIR)

Soil Classification	Eluviated Dystric Brunisol
Parent Material	glaciofluvial
Texture (topsoil/subsoil)	sand/sand
Surface Stoniness	moderately to exceedingly
Drainage Class	well to rapidly
Topsoil depth/Relationship to topography	5 - 10 cm/no relationship to topography
Forest Land Capability Class	4X
Reclamation Suitability	topsoil - poor; upper subsoil - poor; lower subsoil - poor
Colour Transition (good/poor) **Topsoil/subsoil**	good light brownish gray/brown to pale brown

EXAMPLE PROFILE

Horizon	Depth [cm]	Colour	Texture	Structure	Consistence
LF	5 to 0	–	–	–	–
Ae	0 to 8	light brownish gray	sand	very weak fine platy	soft
Bm	8 to 35	yellowish brown	sand	single grained	soft
BC	35 to 80	brown to dark brown	sand	single grained	soft
C	80 to 120	brown to pale brown	sand	single grained	soft

– = Not available.

Representative Chemical and Physical Properties[(a)]

Horizon	Depth [cm]	Sat [%]	pH [H_2O]	CEC	EC [ds/M]	SAR	TKN	Organic Carbon [%]	C/N Ratio	Texture
LF	5 to 0	90	6.3	93	–	–	–	38	–	–
Ae	0 to 8	99	5.3	1	0	0	–	0.3	–	S
Bm	8 to 35	99	5.7	1	0	0	–	1	–	S
BC	35 to 80	88	6.0	4	0	0	–	–	–	SL
C	80 to 120	99	6.2	2	0	0	–	–	–	LS

[(a)] Soil Layer File data.

– = Not available.

6.1.6 Fort (FRT)

Soil Classification	Orthic Gray Luvisol
Parent Material	glaciofluvial
Texture (topsoil/subsoil)	sandy loam/sand
Surface Stoniness	non-stony
Drainage Class	well
Topsoil depth/Relationship to topography	5 - 10 cm/no relationship to topography
Forest Land Capability Class	3
Reclamation Suitability	topsoil - fair; upper subsoil - fair; lower subsoil - poor
Colour Transition (good/poor) **Topsoil/subsoil**	good light brownish gray/pale brown

EXAMPLE PROFILE

Horizon	Depth [cm]	Colour	Texture	Structure	Consistence
LF	4 to 0	–	–	–	–
Ae	0 to 9	light brownish gray	sandy loam	weak fine platy	soft
Bt	9 to 39	dark yellowish brown	sandy loam	moderate fine subangular blocky	soft
BC	39 to 100	brown	sand	single grained	soft

– = Not available.

Representative Chemical and Physical Properties[(a)]

Horizon	Depth [cm]	Sat [%]	pH [H_2O]	CEC	EC [ds/M]	SAR	TKN	Organic Carbon [%]	C/N Ratio	Texture
LF	4 to 0	–	–	–	–	–	–	–	–	–
Ae	0 to 9	26	5.5	1.8	0.2	0.9	0.04	0.3	7.5/1	SL
Bt	9 to 39	25	4.6	23.1	0.1	1.3	–	–	–	SL
BC	39 to 100	27	5.3	1.3	<0.1	1.2	–	–	–	S

(a) Sample GA-3.

– = Not available.

6.1.7 Halverson (HVNaa)

Soil Classification	Orthic Gray Luvisol
Parent Material	glaciofluvial/till
Texture (topsoil/subsoil)	sandy loam/clay loam
Surface Stoniness	non-stony
Drainage Class	well
Topsoil depth/Relationship to topography	15 cm/no relationship to topography
Forest Land Capability Class	3
Reclamation Suitability	topsoil - good; upper subsoil - poor; lower subsoil - poor
Colour Transition (good/poor) Topsoil/subsoil	good light brownish gray/brown

EXAMPLE PROFILE

Horizon	Depth [cm]	Colour	Texture	Structure	Consistence
LF	5 to 0	–	–	–	–
Ae	0 to 15	light brownish gray	sandy loam	weak fine platy	soft
Bt	15 to 50	dark yellowish brown	sandy loam	moderate fine subangular blocky	soft
IIBC	50 to 80	brown	clay loam	massive	soft
IICk	80 to 120	brown	clay loam	massive	soft

– = Not available.

Representative Chemical and Physical Properties[(a)]

Horizon	Depth [cm]	Sat [%]	pH [H_2O]	CEC	EC [ds/M]	SAR	TKN	Organic Carbon [%]	C/N Ratio	Texture
LF	5 to 0	90	6.5	90	0	–	–	40	–	–
Ae	0 to 15	58	5.5	7	0	–	–	0.8	–	SL
Bt	15 to 50	88	5.6	12	0	–	–	0.6	–	SL
IIBC	50 to 80	89	5.2	22	0	–	–	0	–	CL
IIC	80 to 120	99	7.4	20	0	–	–	0	–	CL

[(a)] Soil Layer File data.

– = Not available.

6.1.8 Hartley (HLY)

Soil Classification	Terric Fibrisol
Parent Material	organic
Texture (topsoil/subsoil)	organic/(not determined)
Surface Stoniness	non-stony
Drainage Class	very poorly
Organic depth/Relationship to topography	50 - 160 cm/no relationship to topography
Forest Land Capability Class	5W
Reclamation Suitability	topsoil - organic; upper subsoil - organic; lower subsoil - organic
Colour Transition (good/poor) Topsoil/subsoil	poor very dark grayish brown/(not determined)

EXAMPLE PROFILE

Horizon	Depth [cm]	Colour	Texture	Structure	Consistence
Of	0 to 120	very dark grayish brown	organic	–	–
Cg	120 +	very dark grayish brown	clay loam	massive	firm

– = Not available.

Note: Thickness of organic material 50 to 160 cm.
Soils are wet all year.
HLYxs soils have sandy subsoils.

Representative Chemical and Physical Properties[(a)]

Horizon	Depth [cm]	Sat [%]	pH [H_2O]	CEC	EC [ds/M]	SAR	TKN	Organic Carbon [%]	C/N Ratio	Texture
Of	0 to 120	90	6.5	172	0	–	–	45	–	O
Cg	120 +	83	6.2	24	0	–	–	0.7	–	CL

(a) Soil Layer File data.

– = Not available.

6.1.9 Horse River (HRR)

Soil Classification	Orthic Gray Luvisol
Parent Material	till
Texture (topsoil/subsoil)	silt loam/clay loam
Surface Stoniness	slightly stony
Drainage Class	moderately well
Topsoil depth/Relationship to topography	15 cm/no relationship to topography
Forest Land Capability Class	2
Reclamation Suitability	topsoil - fair to poor; upper subsoil - fair; lower subsoil - fair to poor
Colour Transition (good/poor) Topsoil/subsoil	good light brownish gray/brown

EXAMPLE PROFILE

Horizon	Depth [cm]	Colour	Texture	Structure	Consistence
LF	5 to 0	–	–	–	–
Ae	0 to 15	light brownish gray	silt loam	weak fine platy	friable
Bt	15 to 50	dark yellowish brown	clay loam	moderate fine subangular blocky	firm
BC	50 to 80	brown	clay loam	massive	firm
C	80 to 120	brown	clay loam	massive	firm

– = Not available.

Note: HRRzz profiles are classified as Brunisolic Gray Luvisols. These soils have a sandy loam Bm horizon overlying the clay loam textured Bt.

Representative Chemical and Physical Properties[(a)]

Horizon	Depth [cm]	Sat [%]	pH [H_2O]	CEC	EC [ds/M]	SAR	TKN	Organic Carbon [%]	C/N Ratio	Texture
LF	5 to 0	20	4.2	65	0	–	–	25	–	–
Ae	0 to 15	13	4.5	8	0	–	–	0.7	–	SiL
Bt	15 to 50	33	4.9	29	0	–	–	0.5	–	CL
BC	50 to 80	41	5.2	25	0	–	–	0.5	–	CL
Ck	80 to 120	99	7.6	12	0	–	–	–	–	CL

[(a)] Soil Layer File data.

– = Not available.

6.1.10 Livock (LVK)

Soil Classification	Orthic Gray Luvisol
Parent Material	glaciofluvial/till
Texture (topsoil/subsoil)	silt loam/clay loam
Surface Stoniness	non-stony
Drainage Class	well
Topsoil depth/Relationship to topography	5 - 15 cm/no relationship to topography
Forest Land Capability Class	3
Reclamation Suitability	topsoil - fair; upper subsoil - fair; lower subsoil - poor
Colour Transition (good/poor) **Topsoil/subsoil**	good light brownish gray/pale brown

EXAMPLE PROFILE

Horizon	Depth [cm]	Colour	Texture	Structure	Consistence
LF	5 to 0	–	–	–	–
Ae	0 to 14	light brownish gray	silt loam	weak fine platy	soft
Bt	14 to 45	dark yellowish brown	clay loam to silty clay loam	moderate fine subangular blocky	soft
BC	45 to 75	brown	loam	massive	friable
IICk	75 to 120	pale brown	clay loam	massive	firm

– = Not available.

Note: LVKgl soils are classified as Gleyed Gray Luvisols. These soils are imperfectly drained and have a Aegj, Btgj, BCgj, Cgj horizon sequence. These soils are found in lower, toe and depressional landscape positions. Textures in these soils are the same as the well drained LVK soils.

Representative Chemical and Physical Properties[(a)]

Horizon	Depth [cm]	Sat [%]	pH [H_2O]	CEC	EC [ds/M]	SAR	TKN	Organic Carbon [%]	C/N Ratio	Texture
LF	5 to 0	36	4.8	65	0	–	–	25	–	O
Ae	0 to 15	24	4.8	11	0	–	–	1.2	–	SiL
Bt	15 to 50	33	4.9	19	0	–	–	0.5	–	CL–SiCL
BC	50 to 80	58	6.6	19	0	–	–	–	–	L
IICk	80 to 120	99	7.6	11	0	–	–	–	–	CL

[(a)] Soil Layer File data.

– = Not available.

6.1.11 Mariana (MRN)

Soil Classification	Terric Mesisol
Parent Material	organic
Texture (topsoil/subsoil)	organic/clay loam
Surface Stoniness	non-stony
Drainage Class	very poorly
Organic depth/Relationship to topography	50 - 160 cm/no relationship to topography
Forest Land Capability Class	5W
Reclamation Suitability	topsoil - organic; upper subsoil - organic; lower subsoil - organic
Colour Transition (good/poor) **Topsoil/subsoil**	poor very dark grayish brown/grayish brown

EXAMPLE PROFILE

Horizon	Depth [cm]	Colour	Texture	Structure	Consistence
Of	0 to 25	very dark grayish brown	organic	–	–
Om	25 to 120	very dark grayish brown	organic	–	–
Cg	120 +	grayish brown	clay loam	massive	firm

– = Not available.

Note: Thickness of organic material is 50 to 160 cm.
Soils are wet all year.

Representative Chemical and Physical Properties[(a)]

Horizon	Depth [cm]	Sat [%]	pH [H_2O]	CEC	EC [ds/M]	SAR	TKN	Organic Carbon [%]	C/N Ratio	Texture
Of	0 to 25	10	3.6	106	0	–	–	45	–	O
Om	25 to 120	40	4.6	172	0	–	–	40	–	O
Cg	120 +	99	7.5	20	0	–	–	0.3	–	CL

[(a)] Soil Layer File data.

– = Not available.

6.1.12 McLelland (MLD)

Soil Classification	Typic Mesisol
Parent Material	organic
Texture (topsoil/subsoil)	organic/(not determined)
Surface Stoniness	non-stony
Drainage Class	very poorly
Organic depth/Relationship to topography	>160 cm/no relationship to topography
Forest Land Capability Class	5W
Reclamation Suitability	topsoil - organic; upper subsoil - organic; lower subsoil - organic
Colour Transition (good/poor) **Topsoil/subsoil**	poor very dark grayish brown/not determined

EXAMPLE PROFILE

Horizon	Depth [cm]	Colour	Texture	Structure	Consistence
Om	0 to 220	very dark grayish brown	organic	–	–

– = Not available.

Note: Thickness of organic material is >160 cm.
Soils are wet all year.
Sedge (fen) peat.

Representative Chemical and Physical Properties[(a)]

Horizon	Depth [cm]	Sat [%]	pH [H_2O]	CEC	EC [ds/M]	SAR	TKN	Organic Carbon [%]	C/N Ratio	Texture
Om	0 to 220	90	6.5	172	0	–	–	40	–	O

[(a)] Soil Layer File data.

– = Not available.

6.1.13 McLelland shallow (MLDxt)

Soil Classification	Terric Mesisol
Parent Material	organic/till
Texture (topsoil/subsoil)	organic/clay loam
Surface Stoniness	non-stony
Drainage Class	very poorly
Organic depth/Relationship to topography	40 - 160 cm/no relationship to topography
Forest Land Capability Class	5W
Reclamation Suitability	topsoil - organic; upper subsoil - organic; lower subsoil - organic
Colour Transition (good/poor) **Topsoil/subsoil**	poor very dark grayish brown/very dark grayish brown

EXAMPLE PROFILE

Horizon	Depth [cm]	Colour	Texture	Structure	Consistence
Of	0 to 25	very dark grayish brown	organic	–	–
Om	25 to 140	very dark grayish brown	organic	–	–
Cg	140 +	very dark grayish brown	clay loam	massive	sticky

– = Not available.

Note: Thickness of organic material is 40 to 160 cm.
Soils are wet all year.
Sedge (fen) peat.
MLDxs soils have sandy textured C horizons found between 40 to 160 cm.
MLDxc soils have clay textured C horizons found between 40 to 160 cm.

Representative Chemical and Physical Properties[(a)]

Horizon	Depth [cm]	Sat [%]	pH [H_2O]	CEC	EC [ds/M]	SAR	TKN	Organic Carbon [%]	C/N Ratio	Texture
Of	0 to 25	70	5.5	106	0	–	–	45	–	O
Om	25 to 140	90	6.5	172	0	–	–	40	–	O
Cg	140 +	83	6.2	24	0	–	–	0.7	–	CL

[(a)] Soil Layer File data.

– = Not available.

6.1.14 Mildred (MIL)

Soil Classification	Eluviated Dystric Brunisol
Parent Material	glaciofluvial
Texture (topsoil/subsoil)	sand/sand
Surface Stoniness	non-stony
Drainage Class	well to rapidly
Topsoil depth/Relationship to topography	5 - 10 cm/no relationship to topography
Forest Land Capability Class	4X
Reclamation Suitability	topsoil - poor; upper subsoil - poor; lower subsoil - poor
Colour Transition (good/poor) **Topsoil/subsoil**	good light brownish gray/brown to pale brown

EXAMPLE PROFILE

Horizon	Depth [cm]	Colour	Texture	Structure	Consistence
LF	2 to 0	–	–	–	–
Ae	0 to 10	light brownish gray	sand	very weak fine platy	soft
Bm	10 to 43	yellowish brown	sand	single grained	soft
BC	43 to 100	brown to dark brown	sand	single grained	soft
C	100 to 120	brown to pale brown	sand	single grained	soft

– = Not available.

Note: MILzz soils do not have an Ae horizon and are classified as O.DYB.

MILgl soils are classified as Gleyed Eluviated Dystric Brunisols. These soils are imperfectly drained and have an Aegj, Bmgj, BCgj, Cgj horizon sequence.

Representative Chemical and Physical Properties[(a)]

Horizon	Depth [cm]	Sat [%]	pH [H_2O]	CEC	EC [ds/M]	SAR	TKN	Organic Carbon [%]	C/N Ratio	Texture
LF	2 to 0	ND	ND	ND	ND	ND	ND	ND	ND	O
Ae	0 to 10	31	5.5	1.2	0.2	0.5	<0.02	0.2	>100	S
Bm	10 to 43	31	6.4	0.7	0.6	0.2	–	–	–	S
BC	43 to 100	30	6.5	0.4	0.2	0.5	–	–	–	S
C	100 to 120	ND	ND	ND	ND	ND	ND	ND	ND	S

[(a)] Sample GA-2.

– = Not available.

ND = No data.

6.1.15 Mikkwa (MKWaa)

Soil Classification	Fibric Organic Cryosol
Parent Material	organic
Texture (topsoil/subsoil)	organic/(not determined)
Surface Stoniness	non-stony
Drainage Class	very poorly
Organic depth/Relationship to topography	50 - 160 cm/no relationship to topography
Forest Land Capability Class	5W
Reclamation Suitability	topsoil - organic; upper subsoil - organic; lower subsoil - organic
Colour Transition (good/poor) **Topsoil/subsoil**	poor very dark grayish brown/(not determined)

EXAMPLE PROFILE

Horizon	Depth [cm]	Colour	Texture	Structure	Consistence
Of	0 to 40	very dark grayish brown	organic	–	–
Ofz	40 to100	very dark grayish brown	organic	–	frozen

– = Not available.

Note: Thickness of organic material 50 to 160 cm.
Soils are wet and frozen all year.

Representative Chemical and Physical Properties[(a)]

Horizon	Depth [cm]	Sat [%]	pH [H_2O]	CEC	EC [ds/M]	SAR	TKN	Organic Carbon [%]	C/N Ratio	Texture
Of	0 to 40	883	5.9	134	0.2	0.2	2.36	46.5	19.7/1	O
Ofz	40 to 100	979	6.0	133	0.2	0.2	1.84	45.3	24.6/1	O

[(a)] Sample GA-28.

– = Not available.

6.1.16 Muskeg (MUS)

Soil Classification	Typic Mesisol
Parent Material	organic
Texture (topsoil/subsoil)	organic/(not determined)
Surface Stoniness	non-stony
Drainage Class	very poorly
Organic depth/Relationship to topography	>160 cm/no relationship to topography
Forest Land Capability Class	5W
Reclamation Suitability	topsoil - organic; upper subsoil - organic; lower subsoil - organic
Colour Transition (good/poor) Topsoil/subsoil	poor very dark grayish brown/(not determined)

EXAMPLE PROFILE

Horizon	Depth [cm]	Colour	Texture	Structure	Consistence
Of	0 to 30	very dark grayish brown	organic	–	–
Om	30 to 220	very dark grayish brown	organic	–	–

– = Not available.

Note: Thickness of organic material is >160 cm.
Soils are wet all year.
Sphagnum (bog) peat.

Representative Chemical and Physical Properties[(a)]

Horizon	Depth [cm]	Sat [%]	pH [H_2O]	CEC	EC [ds/M]	SAR	TKN	Organic Carbon [%]	C/N Ratio	Texture
Of	0 to 30	10	3.6	106	0	–	–	45	–	O
Om	30 to 220	40	4.6	172	0	–	–	40	–	O

[(a)] Soil Layer File data.

– = Not available.

6.1.17 Muskeg shallow (MUSxc)

Soil Classification	Terric Mesisol
Parent Material	organic
Texture (topsoil/subsoil)	organic/clay
Surface Stoniness	non-stony
Drainage Class	very poorly
Organic depth/Relationship to topography	40 - 160 cm/no relationship to topography
Forest Land Capability Class	5W
Reclamation Suitability	topsoil - organic; upper subsoil - organic; lower subsoil - organic
Colour Transition (good/poor) **Topsoil/subsoil**	poor very dark grayish brown/very dark grayish brown

EXAMPLE PROFILE

Horizon	Depth [cm]	Colour	Texture	Structure	Consistence
Om	0 to 120	very dark grayish brown	organic	–	–
IICg	120 +	very dark grayish brown	clay	massive	sticky

– = Not available.

Note: Thickness of organic material is 40 to 160 cm.
Soils are wet all year.
Sphagnum (bog) peat.
MUSxs soils have sandy textured subsoil.

Representative Chemical and Physical Properties[(a)]

Horizon	Depth [cm]	Sat [%]	pH [H_2O]	CEC	EC [ds/M]	SAR	TKN	Organic Carbon [%]	C/N Ratio	Texture
Om	0 to 120	517	3.4	99	0.4	0.2	0.94	45.4	48.3/1	O
IICg	120 +	–	–	–	–	–	–	–	–	CL

[(a)] Sample GA-26.

– = Not available.

6.1.18 Norberta (NOR)

Soil Classification	Rego Gleysol
Parent Material	glaciofluvial
Texture (topsoil/subsoil)	organic/sand
Surface Stoniness	non-stony
Drainage Class	poorly
Organic depth/Relationship to topography	20-40 cm/no relationship to topography
Forest Land Capability Class	4W
Reclamation Suitability	topsoil - organic; upper subsoil - organic; lower subsoil - poor
Colour Transition (good/poor) **Topsoil/subsoil**	poor very dark grayish brown/grayish brown

EXAMPLE PROFILE

Horizon	Depth [cm]	Colour	Texture	Structure	Consistence
Of	38 to 16	very dark grayish brown	organic	–	–
Om	16 to 0	very dark grayish brown	organic	–	–
Cg	0 to 82	grayish brown	sand	massive	firm

– = Not available.

Note: Thickness of organic material is 20 to 40 cm.
Soils are wet year round.

Representative Chemical and Physical Properties[(a)]

Horizon	Depth [cm]	Sat [%]	pH [H_2O]	CEC	EC [ds/M]	SAR	TKN	Organic Carbon [%]	C/N Ratio	Texture
Of	38 to 16	693	4.1	102	0.2	0.7	1.35	42.4	35.1/1	O
Om	16 to 0	693	4.1	102	0.2	0.7	1.35	42.4	35.1/1	O
Cg	0 to 82	26	5.8	2.4	0.2	0.6	–	–	–	S

[(a)] Sample GA-8.

– = Not available.

6.1.19 Namur gleyed (NAMgl)

Soil Classification	Gleyed Regosol
Parent Material	fluvial
Texture (topsoil/subsoil)	no topsoil/silt loam to loam to sandy loam to silty clay
Surface Stoniness	non-stony
Drainage Class	imperfectly
Topsoil depth/Relationship to topography	0 cm/no relationship to topography
Forest Land Capability Class	2
Reclamation Suitability	topsoil - poor; upper subsoil - fair; lower subsoil - fair
Colour Transition (good/poor) **Topsoil/subsoil**	good no topsoil

EXAMPLE PROFILE

Horizon	Depth [cm]	Colour	Texture	Structure	Consistence
LF	5 to 0	–	–	–	–
Cgj	0 to 100	brown	variable (see above)	massive	friable

– = Not available.

Note: There is no topsoil.

Soils are seasonally wet.

Developed on loamy to clayey textured materials associated with fluvial fan and apron landforms. May also include coarser textured variants.

Representative Chemical and Physical Properties[(a)]

Horizon	Depth [cm]	Sat [%]	pH [H_2O]	CEC	EC [ds/M]	SAR	TKN	Organic Carbon [%]	C/N Ratio	Texture
LF	5 to 0	82	6.0	98	0	0	–	38.3	–	O
Cgj	0 to 100	78	4.9	33	0	0	–	1.8	–	SiC

(a) Soil Layer File data.

– = Not available.

6.1.20 Sutherland (SUT)

Soil Classification	Eluviated Dystric Brunisol
Parent Material	glaciofluvial/till
Texture (topsoil/subsoil)	sand/sandy clay loam
Surface Stoniness	non-stony
Drainage Class	well to rapidly
Topsoil depth/Relationship to topography	5 - 10 cm/no relationship to topography
Forest Land Capability Class	3
Reclamation Suitability	topsoil - poor; upper subsoil - poor; lower subsoil - poor
Colour Transition (good/poor) **Topsoil/subsoil**	good light brownish gray/brown to pale brown

EXAMPLE PROFILE

Horizon	Depth [cm]	Colour	Texture	Structure	Consistence
LF	7 to 0	–	–	–	–
Ae	0 to 40	light brownish gray	sand	very weak fine platy	soft
Bm	40 to 75	yellowish brown	sand	single grained	soft
IIC	75 to 120	brown to pale brown	sandy clay loam	massive	firm

– = Not available.

Note: SUTgl soils are imperfectly drained and have an Aegj, Bmgj, BCgj, IICkgj horizon sequence.

Representative Chemical and Physical Properties[(a)]

Horizon	Depth [cm]	Sat [%]	pH [H_2O]	CEC	EC [ds/M]	SAR	TKN	Organic Carbon [%]	C/N Ratio	Texture
LF	7 to 0	–	–	–	–	–	–	–	–	O
Ae	0 to 40	25	5.0	0.8	0.2	0.7	0.04	0.2	5.5/1	S
Bm	40 to 75	24	5.7	1.4	0.1	0.6	–	–	–	S
IIC	75 to 120	35	5.5	9.1	0.8	0.7	–	–	–	SCL

[(a)] Sample GA-1.

– = Not available.

6.1.21 Steepbank (STP)

Soil Classification	Orthic Gleysol
Parent Material	till
Texture (topsoil/subsoil)	organic/clay loam
Surface Stoniness	non-stony
Drainage Class	poorly
Organic depth/Relationship to topography	<40 cm/no relationship to topography
Forest Land Capability Class	4W
Reclamation Suitability	topsoil - organic; upper subsoil - poor; lower subsoil - poor
Colour Transition (good/poor) **Topsoil/subsoil**	poor very dark grayish brown/grayish brown

EXAMPLE PROFILE

Horizon	Depth [cm]	Colour	Texture	Structure	Consistence
Om	20 to 0	very dark grayish brown	organic	–	–
Bg	0 to 30	grayish brown	clay loam	massive	firm
Cg	30 to 90	grayish brown	clay loam	massive	firm

– = Not available.

Note: Thickness of organic material is 20 to 40 cm.
Soils are wet year round.

Representative Chemical and Physical Properties[(a)]

Horizon	Depth [cm]	Sat [%]	pH [H_2O]	CEC	EC [ds/M]	SAR	TKN	Organic Carbon [%]	C/N Ratio	Texture
Om	20 to 0	40	4.5	127	0	–	–	45.4	–	O
Bg	0 to 30	90	6.8	8	0	–	–	0.7	–	L
Cg	30 to 90	99	7.5	12	0	–	–	–	–	CL

[(a)] Soil Layer File data.

– = Not available.

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APPENDIX C

SOIL INSPECTION SITE LIST

Submitted to:
Shell Canada Limited

Prepared by:
Golder Associates Ltd.

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50 BEST EMPLOYERS IN CANADA 2007

CANADA'S 50 BEST MANAGED PRIVATE COMPANIES

LIST OF TABLES

Table C-1 List of Soil Inspection Sites in the Jackpine Expansion Mining Area Local Study Area 1
Table C-2 List of Soil Inspection Sites in the Pierre River Mining Area Local Study Area 28

Table C-1 List of Soil Inspection Sites in the Jackpine Expansion Mining Area Local Study Area

Field Site #	Soil Series	Soil Subgroup	Parent Material	Drainage	Landform	Surface Expression	Slope Class	Slope Position	Ecosite
cc065	MMWptgr	R.G	FG	poor	—	level	1	lower	—
ccc002	ABN	TY.F	O	very poor	fen	level	1	level	FTNN
ccc003	BMTzr	R.G	FG	imperfect	bog	level	2	lower	BTNN
ccc004	MIL	E.DYB	FG	well	upland	undulating	2	mid	c1
ccc005	MLDxs	T.M	Ob/FG	very poor	fen	level	1	level	FTNN
ccc006	MILzz	O.EB	FG	well	upland	undulating	2	level	d1
ccc007	MLDxs	T.M	Ob/FG	very poor	fen	level	1	level	FONS
ccc008	ABNxs	T.F	O	very poor	fen	level	1	level	FONS
ccc009	MUSxs	T.M	Ov/FG	very poor	bog	level	2	level	BTNN
ccc010	HLYxc	T.F	Ov/FG	very poor	bog	level	2	level	BTNN
ccc011	ABN	TY.F	O	very poor	fen	level	1	level	FONS
ccc012	ABN	TY.F	O	very poor	fen	level	1	level	FONG
ccc013	ABN	TY.F	O	poor	fen	level	2	level	FTNN
ccc014	ABN	TY.F	O	very poor	fen	level	1	level	FONG
ccc015	ABN	TY.F	O	very poor	fen	level	1	level	FONG
ccc016	MLDxc	T.M	Ob/LG	very poor	fen	level	1	level	FTNN
ccc017	ABN	TY.F	Ob/LG	very poor	fen	level	1	level	FONS
ccc018	ABN	TY.F	O	very poor	fen	level	1	level	FONS
ccc019	ABN	TY.F	O	very poor	fen	level	1	level	FONS
ccc020	HRR	O.GL	Till	moderately well	bog	undulating	2	upper	BTNN
ccc021	ABN	TY.F	O	poor	bog	level	2	level	BONS
ccc022	ABN	TY.F	O	moderately well	bog	level	1	level	d1
ccc023	HRR	O.GL	Till	moderately well	upland	hummocky	3	upper	g1
ccc024	MUSxc	T.M	Ov/Till	poor	bog	level	2	level	BTNN
ccc025	ABN	TY.F	O	very poor	fen	level	1	level	FTNN
ccc026	ABN	TY.F	O	very poor	fen	level	1	level	FTNN
ccc027	HRR	O.GL	Till	moderately well	upland	hummocky	4	upper	g1
ccc028	ABN	TY.F	O	very poor	fen	level	1	level	FTNN
ccc029	MMW	R.G	FG	poorly	upland	ridged	3	lower	g1
ccc030	ABN	TY.F	Ob/LG	very poor	fen	level	1	level	FONS
ccc031	ABN	TY.F	O	very poor	fen	level	2	level	FTNN
ccc032	NAMgl	GL.R	FG	imperfect	upland	level	2	level	BTNN
ccc033	ABN	TY.F	O	very poor	fen	level	1	level	FONS
ccc034	HLYxc	T.F	Ob/LG	very poor	fen	level	1	level	FTNN
ccc035	HLYxc	T.F	Ov/FG	poor	upland	incl.	2	level	g1
ccc036	MILzz	O.EB	Fe	well	upland	undulating	3	upper	b1
ccc037	ABN	TY.F	Ob/FG	very poor	fen	level	1	level	FTNN
ccc038	ABN	TY.F	O	very poor	fen	level	1	level	FONS
ccc039	ABN	TY.F	O	very poor	fen	level	1	level	FONS
ccc040	ABN	TY.F	Ov/FG	very poor	fen	level	1	level	FTNN
ccc041	ABN	TY.F	O	very poor	fen	level	1	level	FTNN
ccc042	MLDxs	T.M	Ob/FG	poor	fen	level	1	level	FONS
ccc043	MLD	TY.M	O	poor	fen	level	1	level	FONS
ccc044	MLD	TY.M	O	poor	fen	level	1	level	FONS
ccc045	ABN	TY.F	O	very poor	fen	level	1	level	FTNN
ccc046	NAM	O.R	FG	moderately well	bog	undulating	2	level	BTNN
ccc047	MUSxt	T.M	Till	poor	bog	level	1	level	BTNN
ccc048	NAMpt	ptO.R	Till	moderately well	upland	level	2	level	BTNN

Table C-1 List of Soil Inspection Sites in the Jackpine Expansion Mining Area Local Study Area (continued)

Field Site #	Soil Series	Soil Subgroup	Parent Material	Drainage	Landform	Surface Expression	Slope Class	Slope Position	Ecosite
ccc049	MLDxs	T.M	Ov/FG	poor	swamp	level	1	level	FONS
ccc050	MMWpt	ptR.G	Till	poor	bog	level	2	level	BTNN
ccc051	MILzz	O.EB	FG	rapid	upland	level	2	level	d1
ccc052	MILzz	E.EB	FG	well	upland	undulating	2	level	d1
ccc053	MILzz	O.EB	FG	rapid	upland	undulating	2	level	d1
ccc054	MILzz	O.EB	FG	rapid	upland	undulating	2	level	d1
ccc055	MILzz	E.EB	FG	well	upland	undulating	2	level	b1
ccc056	ABN	TY.F	O	poor	bog	level	1	level	BTNN
ccc057	HLYxs	T.F	Ov/FG	poor	bog	level	1	level	BTNN
ccc058	MLDxc	T.M	Ov/LG	very poor	fen	level	1	level	FTNN
ccc059	MLDxc	T.M	Ob/LG	poor	fen	level	1	level	FTNN
ccc060	MLD	TY.M	Ob/F	very poor	fen	level	1	level	FONS
ccc061	MLD	TY.M	O/F	very poor	swamp	level	1	level	FONS
ccc062	HRR	O.GL	Till	moderately well	upland	hummocky	3	crest	FTNN
ccc063	HRR	O.GL	TILL	moderately well	—	undulating	3	mid	—
ccc066	NAMpt	ptO.R	FG	moderately well	—	level	2	mid	BTNN
ccc067	MILzz	O.DYB	FG	rapid	—	—	0	mid	d1
ccc068	NAMpt	O.R	FG	moderately well	—	level	2	mid	MONG
ccc069	MLDxs	T.M	O	very poor	—	level	1	level	FONS
ccc070	HRRgl	GL.GL	TILL	imperfect	—	—	0	lower	disturbed
ccc071	ABN	TY.F	O	very poor	—	level	1	level	BTNN
ccc072	ABN	TY.F	O	very poor	—	level	1	level	FONS
ccc074	ABN	TY.F	O	very poor	—	level	1	level	FONS
CCS001	ABN	TY.F	O	very poor	fen	level	1	level	k1
CCS002	ABN	TY.F	O	very poor	fen	level	1	level	k2
CCS003	ABN	TY.F	O	very poor	fen	level	1	level	k2
CCS004	ABN	TY.F	O	very poor	fen	level	2	level	k1
CCS005	ABN	TY.F	O	very poor	fen	level	1	level	k2
CCS006	ABN	TY.F	O	very poor	fen	level	1	level	k2
CCS007	ABN	TY.F	O	very poor	fen	level	1	level	k2
CCS008	ABN	TY.F	O	very poor	fen	level	1	level	k2
CCS009	ABN	TY.F	O	very poor	fen	level	1	level	k1
CCS010	ABN	TY.F	O	very poor	bog	level	1	level	i2
CCS011	ABN	TY.F	O	very poor	fen	level	1	level	k1
CCS012	ABN	TY.F	O	very poor	fen	level	1	level	k1
CCS013	ABN	TY.F	O	very poor	fen	level	1	level	k1
CCS014	ABN	TY.F	O	very poor	fen	level	1	level	k1
CCS015	ABN	TY.F	O	poor	bog	level	1	level	i2
CCS016	ABN	TY.F	O	poor	bog	level	1	level	i2
CCS017	ABN	TY.F	O	poor	bog	level	2	level	i2
CCS018	ABN	TY.F	O	poor	bog	level	2	level	i2
CCS019	ABN	TY.F	O	poor	bog	level	2	level	i2
CCS020	ABN	TY.F	O	poor	bog	level	1	level	i1
CCS057	MIL	E.DYB	FG	rapid	upland	inclined	3	mid	d2
CCS058	MIL	E.DYB	FG	well	upland	inclined	3	mid	b3
CCS059	MUSxs	T.M	Ov/FG	poor	bog	level	4	level	i1
CCS060	MUSxs	T.M	Ov/FG	poor	bog	level	1	level	i1
CCS061	MILzz	O.EB	FG	rapid	upland	ridged	8	crest	b3
CCS062	MIL	E.DYB	FG	rapid	upland	ridged	8	crest	b2
CCS063	MIL	E.DYB	FG	rapid	upland	hummocky	7	crest	b3

Table C-1 List of Soil Inspection Sites in the Jackpine Expansion Mining Area Local Study Area (continued)

Field Site #	Soil Series	Soil Subgroup	Parent Material	Drainage	Landform	Surface Expression	Slope Class	Slope Position	Ecosite
CCS064	FRT	O.GL	FG	rapid	upland	hummocky	5	upper	b1
CCS065	MIL	E.DYB	FG	rapid	upland	hummocky	5	lower	b4
CCS066	MIL	E.DYB	FG	well	upland	undulating	6	upper	b2
CCS067	MIL	E.DYB	FG	rapid	upland	undulating	6	upper	b2
CCS068	MIL	E.DYB	FG	well	upland	undulating	3	mid	b3
CCS069	FRTzz	BR.GL	FG	moderately well	upland	undulating	8	toe	b3
CCS070	MILzz	O.DYB	FG	rapid	upland	hummocky	3	level	a1
CCS071	FRTzz	BR.GL	FG	rapid	upland	hummocky	6	crest	a1
CCS072	MIL	E.DYB	FG	rapid	upland	hummocky	3	level	a1
CCS076	MIL	E.DYB	FG	well	upland	ridged	5	mid	d2
CCS077	NAM	O.R	FG	well	upland	ridged	7	crest	d2
CCS078	MIL	E.DYB	FG	well	upland	inclined	4	mid	d2
CCS079	MIL	E.DYB	FG	rapid	upland	hummocky	5	upper	b3
CCS091	STPpt	ptR.G	FGv/Till	poor	upland	undulating	2	level	f3
CCS092	MIL	E.DYB	FG	rapid	upland	undulating	2	level	d3
CCS093	MIL	E.DYB	FG	well	upland	ridged	6	upper	b2
CCS094	MILgl	GL.DYB	FG	imperfect	upland	level	3	level	d2
CCS095	MIL	E.DYB	FG	rapid	upland	undulating	4	mid	d2
CCS096	MKWaa	ME.OC	O	poor	bog	level	1	level	BTNN
ga-1	MIL	E.DYB	FG/Till	well	upland	undulating	3	mid	—
GA-10	MIL	E.DYB	FG	well	upland	hummocky	4	upper	b2
GA-16	MIL	E.DYB	FG	well	upland	hummocky	5	mid	b4
ga-2	MIL	E.DYB	FG	rapid	upland	hummocky	4	mid	—
ga3	—	—	—	—	—	—	0	—	—
ga4	HRR	O.GL	Till	well	upland	undulating	3	mid	—
GA-6	MLDxs	T.M	Ov/FG	very poor	fen	level	1	level	k1
GA-8	BMTzrpt	ptR.G	Ov/FG	poor	bog	level	1	level	h1
H&S545	ABN	TY.F	O	very poor	fen	level	1	level	STNN
H&S546	ABN	TY.F	O	very poor	fen	level	1	level	STNN
H&S547	ABN	TY.F	O	very poor	fen	level	1	level	STNN
H&S548	ABN	TY.F	O	very poor	fen	level	1	level	STNN
H&S549	ABN	TY.F	O	very poor	fen	level	1	level	STNN
H&S550	ABN	TY.F	O	very poor	fen	level	1	level	STNN
H&S551	ABN	TY.F	O	very poor	fen	level	1	level	STNN
H&S552	ABN	TY.F	O	very poor	fen	level	1	level	STNN
H&S553	ABN	TY.F	O	very poor	fen	level	1	level	STNN
H&S554	ABN	TY.F	O	very poor	fen	level	1	level	STNN
H&S555	ABN	TY.F	O	very poor	fen	level	1	level	STNN
H&S556	ABN	TY.F	O	very poor	fen	level	1	level	MONG
H&S557	ABN	TY.F	O	very poor	fen	level	1	level	STNN
H&S558	ABN	TY.F	O	very poor	fen	level	1	level	STNN
H&S559	ABN	TY.F	O	very poor	fen	level	1	level	STNN
H&S560	ABN	TY.F	O	very poor	fen	level	1	level	STNN
H&S561	ABN	TY.F	O	very poor	fen	level	1	level	STNN
H&S562	ABN	TY.F	O	very poor	fen	level	1	level	STNN
H&S563	ABN	TY.F	O	very poor	fen	level	1	level	STNN
H&S564	ABN	TY.F	O	very poor	fen	level	1	level	STNN
H&S565	ABN	TY.F	O	very poor	fen	level	1	level	STNN
H&S566	ABN	TY.F	O	very poor	fen	level	1	level	STNN
H&S567	ABN	TY.F	O	very poor	fen	level	1	level	STNN
H&S568	ABN	TY.F	O	very poor	fen	level	1	level	STNN
H&S569	ABN	TY.F	O	very poor	fen	level	1	level	STNN

Table C-1 List of Soil Inspection Sites in the Jackpine Expansion Mining Area Local Study Area (continued)

Field Site #	Soil Series	Soil Subgroup	Parent Material	Drainage	Landform	Surface Expression	Slope Class	Slope Position	Ecosite
H&S570	FRT	O.GL	FG	moderately well	upland	undulating	3	lower	—
H&S571	FRT	O.GL	FG	well	upland	incl.	4	mid	d2
H&S572	FRT	O.GL	FG	well	upland	hummocky	4	upper	—
HBS001	HLYxc	T.F	Ob/Till	poor	bog	level	1	level	—
HBS002	MLDxs	T.M	Ov/Till	poor	fen	level	1	level	FTNN
HBS003	MMWpt	ptR.G	Till	poor	bog	level	1	level	disturbed by fire
HBS004	MMWpt	ptR.G	Till	poor	bog	level	1	level	BTNN
HBS005	MLDxc	T.M	Ov/Till	poor	fen	level	1	level	FTNN
HBS006	HLY	T.F	Ov/Till	poor	fen	level	1	level	FTNN
HBS007	HLY	T.F	Ob/Till	poor	fen	level	1	level	FTNN
HBS008	HLY	M.F	Ob/Till	poor	fen	level	1	level	FTNN
HBS009	HLY	T.F	Ov/Till	poor	fen	level	1	level	FTNN
HBS010	HLY	T.F	Ov/Till	poor	fen	level	1	lower	FTNN
HBS011	MLDxc	T.M	Ov/Till	poor	fen	level	1	lower	FTNN
HBS012	ABN	TY.F	O	poor	fen	level	1	lower	FTNN
HBS013	ABN	TY.F	O	poor	fen	level	1	level	FTNN
HBS014	ABN	TY.F	O	poor	fen	level	1	level	FTNN
HBS015	ABN	TY.F	O	poor	fen	level	1	level	FTNN
HBS016	ABN	TY.F	O	poor	fen	level	1	lower	FTNN
HBS017	ABN	TY.F	O	poor	fen	level	1	lower	FTNN
HBS018	ABN	TY.F	O	poor	fen	level	1	level	FTNN
HBS019	ABN	TY.F	O	poor	fen	level	1	level	FTNN
HBS020	ABN	TY.F	O	poor	fen	level	1	level	FTNN
HBS021	ABN	TY.F	O	poor	fen	level	1	level	FTNN
HBS022	ABN	TY.F	O	poor	fen	level	1	level	FTNN
HBS023	ABN	TY.F	O	poor	fen	level	1	level	FTNN
HBS024	ABN	TY.F	O	poor	fen	level	1	level	FTNN
HBS025	ABN	TY.F	O	poor	fen	level	1	level	FTNN
HBS026	ABN	TY.F	O	poor	fen	level	1	level	FTNN
HBS027	ABN	TY.F	O	poor	fen	level	1	level	FTNN
HBS028	ABN	TY.F	O	poor	fen	level	1	level	FTNN
HBS029	ABN	TY.F	O	poor	fen	level	1	level	FTNN
HCS009	FRT	O.GL	FG	moderately well	other	undulating	3	upper	disturbed
HCS010	MUSxs	T.M	Ov/FG	very poor	bog	level	1	level	k1
HCS011	MMWpt	ptR.G	FG	poor	wetlands	inclined	2	mid	disturbed
HCS012	MLD	TY.M	Ob/LG	very poor	wetlands	level	1	level	k1
HCS013	NAMgl	GL.R	FG	imperfect	wetlands	level	1	level	disturbed
HCS014	MLDxs	T.M	O	very poor	wetlands	level	1	level	k1
HCS015	BMTpt	O.G	Ov/FG	imperfect	wetlands	level	1	level	disturbed
HCS016	MIL	E.DYB	FG	well	upland	ridged	3	mid	disturbed
HCS017	MIL	E.DYB	FG	rapid	upland	inclined	6	mid	disturbed
HCS018	MIL	E.DYB	FG	rapid	upland	inclined	6	mid	disturbed
HCS019	MIL	E.DYB	FG	rapid	upland	level	1	level	a1
HCS021	MLDxs	T.M	Ob/FG	poor	wetlands	level	1	level	disturbed
HCS022	MLDxs	T.M	Ov/FG	poor	wetlands	level	1	level	disturbed
HCS069	MIL	E.DYB	FG	rapid	upland	hummocky	6	mid	b1
HCS070	MIL	E.DYB	FG	rapid	upland	hummocky	5	upper	b1
HCS071	MIL	E.DYB	FG	well	upland	level	3	level	b1
HCS072	MIL	E.DYB	FG	rapid	upland	hummocky	5	upper	b1
HCS073	MIL	E.DYB	FG	rapid	upland	hummocky	3	mid	b1

Table C-1 List of Soil Inspection Sites in the Jackpine Expansion Mining Area Local Study Area (continued)

Field Site #	Soil Series	Soil Subgroup	Parent Material	Drainage	Landform	Surface Expression	Slope Class	Slope Position	Ecosite
HCS074	MIL	E.DYB	FG	well	upland	hummocky	5	mid	d2
HCS075	MUS	TY.M	O	very poor	bog	level	2	level	BTNN
HCS076	MLDxs	T.M	Ob/FG	poor	bog	undulating	2	mid	BTNN
HCS077	MIL	E.DYB	FG	well	upland	undulating	4	lower	b1
HCS078	MIL	E.DYB	FG	rapid	upland	hummocky	5	upper	b1
HCS079	MIL	E.DYB	FG	rapid	upland	hummocky	6	upper	b1
HCS080	MIL	E.DYB	FG	well	upland	hummocky	4	lower	b2
HCS081	MIL	E.DYB	FG	well	upland	undulating	3	mid	d2
HCS102	MIL	E.DYB	FG	well	upland	undulating	2	mid	b1
HCS103	MIL	E.DYB	FG	well	upland	hummocky	3	mid	b1
HCS104	MIL	E.DYB	FG	rapid	upland	hummocky	6	upper	b1
HCS105	MIL	E.DYB	FG	well	upland	hummocky	3	mid	b1
HCS121	MIL	E.DYB	FG	well	upland	level	1	level	b1
HCS122	MILzz	O.DYB	FG	well	upland	undulating	2	mid	b3
HCS123	MILzz	O.DYB	FG	well	upland	undulating	3	lower	disturbed
HCS124	MIL	E.DYB	FG	well	upland	undulating	3	upper	disturbed
HCS125	MIL	E.DYB	FG	well	upland	undulating	3	lower	disturbed
HCS126	MIL	E.DYB	FG	well	upland	undulating	3	lower	b1
HCS127	MIL	E.DYB	FG	rapid	upland	hummocky	7	mid	e1
HCS128	MIL	E.DYB	FG	rapid	upland	undulating	3	upper	b2
HCS129	MIL	E.DYB	FG	well	upland	inclined	4	mid	b2
HCS130	HRR	O.GL	Till	well	upland	inclined	4	toe	disturbed
HCS131	HRR	O.GL	Till	well	upland	level	2	level	disturbed
HCS132	MLD	TY.M	O	very poor	fen	level	1	level	FTNN
HCS133	MIL	E.DYB	FG	moderately well	upland	undulating	4	mid	g1
HCS134	SUT	E.DYB	Fv/Till	well	upland	undulating	3	toe	disturbed
HCS135	LVK	O.GL	FG	well	upland	undulating	3	mid	e2
HCS136	MIL	E.DYB	FG	rapid	upland	hummocky	5	mid	b2
HCS137	MIL	E.DYB	FG	well	upland	hummocky	5	toe	b2
HCS138	MUSxs	T.M	Ob/Till	poor	bog	level	2	level	k1
HCS139	MILzz	O.DYB	FG	rapid	upland	hummocky	6	crest	b2
HCS140	MILzz	O.DYB	FG	well	upland	hummocky	3	mid	e2
HCS141	MILzz	O.DYB	FG	rapid	upland	hummocky	3	upper	b3
HCS142	MILzz	O.DYB	FG	rapid	upland	undulating	3	lower	b1
HCS143	MIL	E.DYB	FG	rapid	upland	hummocky	4	mid	b3
HCS144	MIL	E.DYB	FG	well	upland	level	2	level	b1
HCS145	MILzz	O.DYB	FG	rapid	upland	hummocky	6	upper	b1
HCS146	MILzz	O.DYB	FG	well	upland	hummocky	6	toe	b1
HCS147	MILzz	O.DYB	FG	rapid	upland	hummocky	4	upper	b1
HCS500	MMWpt	ptR.G	Ov/LG	poor	fen	level	1	level	j1
HCS501	BMTzrpt	ptR.G	Ov/L	poor	bog	level	2	level	disturbed
HCS503	MUSxc	T.M	Ov/Till	poor	bog	level	1	level	disturbed
HCS504	BMTzrpt	ptR.G	FG	moderately well	bog	level	1	level	disturbed
HCS507	MMWpt	ptR.G	Ov/L	poor	bog	undulating	1	lower	disturbed
HCS508	MUSxs	T.M	Ov/FG	poor	bog	level	1	level	disturbed
HCS509	MMWpt	ptR.G	Ov/L	poor	bog	undulating	1	level	disturbed
HCS510	MIL	E.DYB	FG	rapid	upland	hummocky	4	crest	disturbed
HCS516	MIL	E.DYB	FG	rapid	upland	hummocky	6	upper	disturbed
HCS573	MLD	TY.M	O	poor	fen	level	1	level	STNN
HCS577	MIL	E.DYB	FG	well	upland	undulating	4	mid	disturbed
HCS579	MILzz	O.DYB	FG	rapid	upland	hummocky	5	upper	disturbed

Table C-1 List of Soil Inspection Sites in the Jackpine Expansion Mining Area Local Study Area (continued)

Field Site #	Soil Series	Soil Subgroup	Parent Material	Drainage	Landform	Surface Expression	Slope Class	Slope Position	Ecosite
HCS580	MILzz	O.DYB	FG	rapid	upland	hummocky	5	mid	b1
HCS581	MIL	E.DYB	FG	well	upland	hummocky	5	mid	disturbed
HCS582	MILzz	O.DYB	FG	rapid	upland	undulating	3	mid	b1
HCS583	MILzz	O.DYB	FG	moderately well	upland	undulating	4	mid	disturbed
HCS584	MILzz	O.DYB	FG	moderately well	upland	hummocky	4	mid	disturbed
HCS585	MIL	E.DYB	FG	rapid	upland	inclined	6	mid	d2
HCS-594	ABN	TY.F	O	poor	bog	level	1	level	FTNN
HCS-595	MKWaa	FI.OC	O	poor	fen	level	1	level	FTNN
HCS-596	MKWaa	FI.OC	O	poor	bog	level	2	level	i1
HCS-597	MKWaa	FI.OC	O	poor	bog	level	2	level	i3
HCS-598	MLD	TY.M	O	very poor	treed fen	level	1	level	FTNN
HCS-599	ABN	TY.F	O	very poor	treed fen	level	1	level	FTNN
HCS-600	ABN	TY.F	O	very poor	treed fen	level	1	level	FTNN
HCS-601	ABN	TY.F	O	very poor	treed fen	level	1	level	FTNN
HCS-602	ABN	TY.F	O	very poor	treed fen	level	1	level	FTNN
HCS-603	ABN	TY.F	O	very poor	bog	level	1	level	FTNN
HCS-604	MLD	TY.M	O	very poor	other	level	1	level	i1
HCS-605	ABN	TY.F	O	very poor	treed fen	level	1	level	FTNN
HCS-606	MLD	TY.M	O	very poor	treed fen	level	1	level	FTNN
HCS-607	MLD	TY.M	—	very poor	treed fen	level	1	level	FTNN
HCS-608	MLD	TY.M	O	very poor	fen	level	1	level	—
HCS-609	MUSxs	T.M	O	very poor	bog	level	1	level	FTNN
HCS-610	ABN	TY.F	O	very poor	treed fen	level	1	level	k1
HCS-611	ABN	TY.F	O	very poor	fen	level	1	level	k1
HCS-612	ABN	TY.F	O	very poor	treed fen	level	1	level	k1
HELI01	MLD	TY.M	O	very poor	—	level	1	level	—
HELI02	MLD	TY.M	O	very poor	—	level	1	level	—
HELI03	MLD	TY.M	O	very poor	—	level	1	level	—
HELI04	MLD	TY.M	O	very poor	—	level	1	level	—
HELI05	MLD	TY.M	O	very poor	—	level	1	level	—
HELI06	MLD	TY.M	O	very poor	—	level	1	level	—
HELI08	MLD	TY.M	O	very poor	—	level	1	level	—
HELI09	MLD	TY.M	O	very poor	—	level	1	level	—
HELI10	MLD	TY.M	O	very poor	—	level	1	level	—
HELI11	MLD	TY.M	O	very poor	—	level	1	level	—
HELI12	MLD	TY.M	O	very poor	—	level	1	level	—
HELI13	MLD	TY.M	O	very poor	—	level	1	level	—
HELI14	MLD	TY.M	O	very poor	—	level	1	level	—
HELI15	MLD	TY.M	O	very poor	—	level	1	level	—
HELI16	MLD	TY.M	O	very poor	—	level	1	level	—
HELI17	MLD	TY.M	O	very poor	—	level	1	level	—
HELI18	MLD	TY.M	O	very poor	—	level	1	level	—
HELI19	MLD	TY.M	O	very poor	—	level	1	level	—
HELI20	MLD	TY.M	O	very poor	—	level	1	level	—
HELI21	MLD	TY.M	O	very poor	—	level	1	level	—
HELI22	MLD	TY.M	O	very poor	—	level	1	level	—
HELI23	MLD	TY.M	O	very poor	—	level	1	level	—
HELI24	MLD	TY.M	O	very poor	—	level	1	level	—
HELI25	MLD	TY.M	O	very poor	—	level	1	level	—
HELI26	MLD	TY.M	O	very poor	—	level	1	level	—
HELI27	MLD	TY.M	O	very poor	—	level	1	level	—

Table C-1 List of Soil Inspection Sites in the Jackpine Expansion Mining Area Local Study Area (continued)

Field Site #	Soil Series	Soil Subgroup	Parent Material	Drainage	Landform	Surface Expression	Slope Class	Slope Position	Ecosite
HELI28	MLD	TY.M	O	very poor	—	level	1	level	—
HELI29	MLD	TY.M	O	very poor	—	level	1	level	—
HELI30	MLD	TY.M	O	very poor	—	level	1	level	—
HELI31	MLD	TY.M	O	very poor	—	level	1	level	—
HELI32	MLD	TY.M	O	very poor	—	level	1	level	—
HELI33	MLD	TY.M	O	very poor	—	level	1	level	—
HELI34	MLD	TY.M	O	very poor	—	level	1	level	—
HELI35	MLD	TY.M	O	very poor	—	level	1	level	—
HELI36	MLD	TY.M	O	very poor	—	level	1	level	—
HELI37	MLD	TY.M	O	very poor	—	level	1	level	—
HELI38	MLD	TY.M	O	very poor	—	level	1	level	—
HELI39	MLD	TY.M	O	very poor	—	level	1	level	—
HELI40	MLD	TY.M	O	very poor	—	level	1	level	—
HELI41	MLD	TY.M	O	very poor	—	level	1	level	—
HELI42	MLD	TY.M	O	very poor	—	level	1	level	—
HELI43	MLD	TY.M	O	very poor	—	level	1	level	—
HELI44	MLD	TY.M	O	very poor	—	level	1	level	—
HELI45	MLD	TY.M	O	very poor	—	level	1	level	—
HELI46	MLD	TY.M	O	very poor	—	level	1	level	—
HELI47	MLD	TY.M	O	very poor	—	level	1	level	—
HELI48	MLD	TY.M	O	very poor	—	level	1	level	—
HELI49	MLD	TY.M	O	very poor	—	level	1	level	—
HELI50	MLD	TY.M	O	very poor	—	level	1	level	—
HHS004	MIL	E.DYB	FG	well	upland	undulating	3	lower	b3
HHS005	FRT	O.GL	Till	moderately well	upland	undulating	3	upper	b3
HHS006	FRTzz	BR.GL	FG	well	upland	level	1	mid	upsh
HHS007	FRT	O.GL	Till	well	upland	undulating	5	mid	upsh
HHS008	MMWpt	ptR.G	Till	poor	bog	level	1	level	BTNN
HHS009	MMWpt	ptR.G	Till	poor	bog	undulating	2	mid	BTNN
HHS009	MMWpt	ptR.G	Till	poor	bog	undulating	2	mid	BTNN
HHS009	MMWpt	ptR.G	Till	poor	bog	undulating	2	mid	BTNN
HHS009	MMWpt	ptR.G	Till	poor	bog	undulating	2	mid	BTNN
HHS010	HRRgl	GL.GL	Till	imperfect	upland	undulating	3	toe	disturbed by fire
HHS011	HRR	O.GL	Till	well	upland	undulating	4	upper	disturbed by fire
HHS013	HRR	O.GL	FG	well	upland	undulating	4	mid	disturbed
HHS014	HRR	O.GL	Till	well	upland	undulating	3	mid	disturbed
HHS015	MIL	E.DYB	FG	well	upland	undulating	2	upper	a1
HHS016	BMTzrpt	ptR.G	FG	poor	fen	level	1	upper	FONS
HHS017	MUSxs	T.M	FG	poor	bog	level	2	toe	BTNN
HHS018	MUSxs	T.M	FG	poor	bog	level	2	lower	BTNN
HHS019	HRR	O.GL	Till	moderately well	upland	undulating	3	mid	disturbed
HHS020	HRRzz	BR.GL	Till	moderately well	upland	undulating	3	upper	disturbed
HHS021	FRTglzz	GL.GL	Till/FG	imperfect	upland	undulating	3	mid	disturbed
HHS022	FRTglzz	GL.GL	Till/FG	imperfect	upland	undulating	3	mid	—
HHS023	HLY	T.F	O/FG	very poor	fen	level	1	level	FTNN
HHS024	HLY	T.F	O/FG	very poor	fen	level	1	level	FTNN
HHS025	BMTzrpt	ptR.G	FG	very poor	fen	level	1	upper	disturbed
HHS026	MMWpt	ptR.G	Ov/Till	very poor	fen	level	1	upper	—
HHS027	BMTzrpt	ptR.G	FG	poor	upland	undulating	2	upper	disturbed

Table C-1 List of Soil Inspection Sites in the Jackpine Expansion Mining Area Local Study Area (continued)

Field Site #	Soil Series	Soil Subgroup	Parent Material	Drainage	Landform	Surface Expression	Slope Class	Slope Position	Ecosite
HHS028	MMWpt	ptR.G	Till	poor	fen	level	1	lower	disturbed
HHS029	NAM	O.R	FG	well	upland	undulating	4	mid	disturbed
HHS030	MLDxs	T.M	FG	poor	fen	level	1	mid	disturbed
HHS031	MLDxs	T.M	Ov/FG	poor	fen	level	1	level	—
HHS031a	MIL	E.DYB	FG	rapid	upland	level	3	mid	—
HHS032	MUSxc	T.M	Till	poor	bog	level	2	mid	disturbed
HHS033	MIL	E.DYB	FG	rapid	upland	undulating	3	upper	h1
HHS034	MLD	TY.M	FG	very poor	fen	level	1	level	FTNN
HHS035	BMTzrpt	ptR.G	Till	poor	bog	level	1	level	BTNN
HHS036	MLD	FI.M	O	poor	fen	level	1	level	FTNN
HHS037	MKWaa	FI.OC	O	poor	bog	hummocky	3	upper	BTNN
HHS038	MLDzz	FI.M	O	very poor	bog	level	1	level	BTNN
HHS039	MLDzz	FI.M	O	very poor	fen	level	1	level	FONG
HHS041	MLDzz	FI.M	O	very poor	fen	level	1	level	FTNN
HHS042	ABN	TY.F	Ob/L	very poor	fen	level	1	level	FTNN
HHS042a	ABN	TY.F	Ob/L	very poor	fen	level	1	level	FTNN
HHS043	ABN	TY.F	Ob/L	very poor	fen	level	1	level	FTNN
HHS044	ABN	TY.F	Ob/L	very poor	fen	level	1	level	FTNN
HHS044a	ABN	TY.F	Ob/L	very poor	fen	level	1	level	—
HHS045	ABN	TY.F	Ob/L	very poor	fen	level	1	level	FONS
HHS046	ABN	TY.F	O	very poor	fen	level	1	level	FTNN
HHS047	ABN	TY.F	O	very poor	fen	level	1	level	FTNN
HHS048	ABN	TY.F	O	very poor	fen	level	1	level	—
HHS049	BMTzrpt	ptR.G	FG	very poor	bog	undulating	1	level	BTNN
HHS050	ABN	TY.F	O	very poor	fen	level	1	level	FONG
HHS051	ABN	TY.F	O	very poor	fen	level	1	level	FTNN
HHS052	ABN	TY.F	O	very poor	fen	level	1	level	FTNN
HHS054	HRR	O.GL	Till	moderately well	upland	undulating	1	lower	disturbed
HHS055	HRR	O.GL	Till	well	upland	undulating	2	upper	disturbed
HHS056	FRT	O.GL	Till	well	upland	undulating	4	upper	disturbed
HHS057	FRT	O.GL	Tillv/FG	well	upland	undulating	4	mid	d2
HHS058	MIL	E.DYB	FG	rapid	upland	undulating	4	mid	d1
HHS059	HRRfi	O.GL	Till	moderately well	upland	undulating	1	upper	b3
HHS060	HRR	O.GL	Mv/FG	moderately well	upland	undulating	4	upper	disturbed
HHS060	HRR	O.GL	Mv/FG	moderately well	upland	undulating	4	upper	d2
HHS060	HRR	O.GL	Mv/FG	moderately well	upland	undulating	4	upper	disturbed
HHS060	HRR	O.GL	Mv/FG	moderately well	upland	undulating	4	upper	d2
HHS061	HRR	O.GL	Till	well	upland	undulating	3	upper	b3/d2
HHS062	STPzrpt	ptR.G	Till	very poor	wetlands	undulating	2	crest	disturbed
HHS063	MLDxc	T.M	Till	very poor	fen	level	1	level	disturbed
HHS064	FRTzz	BR.GL	FG/Till	moderately well	upland	undulating	2	lower	disturbed
HHS065	FRTzz	BR.GL	FG/till	moderately well	upland	undulating	2	lower	—
HHS066	HRR	O.GL	Till	moderately well	upland	undulating	2	lower	—
HHS067	STP	ptR.G	Till	poor	other wetlands	level	2	lower	disturbed

Table C-1 List of Soil Inspection Sites in the Jackpine Expansion Mining Area Local Study Area (continued)

Field Site #	Soil Series	Soil Subgroup	Parent Material	Drainage	Landform	Surface Expression	Slope Class	Slope Position	Ecosite
HHS068	MIL	E.DYB	oil sands	moderately well	upland	ridged	3	upper	disturbed
HHS068a	HLY	T.F	Ov/Till	very poor	fen	level	1	lower	—
HHS069	FRT	O.GL	FG	moderately well	upland	level	1	level	disturbed
HHS070	HRR	O.GL	Till	moderately well	upland	level	2	level	disturbed
HHS071	HLY	T.F	Till	very poor	fen	level	1	level	FTNN
HHS072	HLY	T.F	Till	poor	bog	level	1	level	BTNN
HHS073	HRR	O.GL	Till	moderately well	upland	level	3	mid	disturbed
HHS074	STPzrpt	ptR.G	Till	poor	bog	level	2	level	disturbed
HHS075	STPzrpt	ptR.G	Till	poor	bog	level	2	lower	disturbed
HHS076	HRR	O.GL	Till	well	upland	undulating	4	crest	disturbed
HHS077	STPzrpt	ptR.G	Till	poor	bog	level	2	level	disturbed by fire
HHS078	STPzr	R.G	Till	poor	bog	undulating	2	lower	disturbed
HHS079	HRR	O.GL	Till	well	upland	undulating	4	lower	disturbed by fire
HHS080	HRR	O.GL	Till	well	upland	undulating	3	mid	disturbed
HHS081	STPzrpt	ptR.G	Till	poor	bog	undulating	2	level	disturbed
HHS082	STPzrpt	ptR.G	Till	poor	bog	level	2	level	disturbed
HHS083	STPzr	R.G	Till	poor	upland	level	1	level	disturbed
HHS084	HRR	O.GL	Till	well	upland	level	1	level	disturbed
HHS085	STPzrpt	ptR.G	Till	poor	wetlands	level	1	level	k1
HHS086	HRR	O.GL	Till	well	upland	undulating	4	crest	disturbed
HHS087	HRR	O.GL	Till	moderately well	upland	level	1	level	disturbed
HHS088	HRR	O.GL	Till	moderately well	upland	level	1	crest	disturbed
HHS089	STPzrpt	ptR.G	Till	very poor	bog	level	1	level	disturbed
HHS090	HRR	O.GL	Till	moderately well	upland	undulating	3	upper	disturbed
HHS091	HRR	O.GL	Till	moderately well	upland	level	2	level	disturbed
HHS092	HRR	O.GL	Till	moderately well	upland	undulating	3	upper	disturbed
HHS093	STPzr	R.G	Till	poor	upland	undulating	2	level	disturbed
HHS094	STPzr	R.G	Till	poor	upland	undulating	2	level	disturbed
HHS095	STPzr	ptR.G	Till	poor	bog	level	1	level	j1
HHS096	MIL	E.DYB	FG	well	upland	undulating	3	mid	disturbed
HHS097	HRR	O.GL	Till	well	upland	undulating	3	upper	disturbed
HHS098	HRR	O.GL	Till	well	upland	undulating	3	upper	disturbed
HHS099	HRR	O.GL	Till	well	upland	undulating	2	mid	disturbed
HHS100	STPzr	ptR.G	Till	poor	upland	undulating	2	mid	disturbed
HHS101	ABN	TY.F	O	very poor	fen	level	1	level	k1
HHS102	HLY	T.F	Ob/Till	very poor	fen	level	1	level	k1
HHS103	STPzr	ptR.G	Till	poor	upland	undulating	3	mid	disturbed
HHS104	NAM	O.R	F	moderately well	upland	ridged	1	upper	disturbed
HHS105	HRRzz	BR.GL	Till	well	upland	undulating	2	upper	disturbed
HHS106	STPzrpt	ptR.G	Till	poor	bog	level	3	mid	disturbed
HHS107	STPzrpt	ptR.G	Till	poor	bog	level	1	level	j1
HHS108	HRR	O.GL	Till	well	upland	undulating	3	lower	disturbed
HHS109	HRR	O.GL	Till	moderately well	upland	inclined	3	crest	disturbed

Table C-1 List of Soil Inspection Sites in the Jackpine Expansion Mining Area Local Study Area (continued)

Field Site #	Soil Series	Soil Subgroup	Parent Material	Drainage	Landform	Surface Expression	Slope Class	Slope Position	Ecosite
HHS110	FRTgl	GL.GL	Till	imperfect	upland	undulating	3	lower	disturbed
HHS111	HRR	O.GL	Till	well	upland	undulating	3	crest	disturbed
HHS112	HRR	O.GL	TILL	well	upland	undulating	4	crest	disturbed
HHS112a	HRR	O.GL	Till	well	upland	undulating	3	toe	b1
HHS113	MUSxc	T.M	Ov/Till	very poor	bog	level	1	level	BTNN
HHS113a	MIL	E.DYB	FG	moderately well	upland	undulating	3	toe	b1
HHS114	HRRgl	GL.GL	Till	imperfect	upland	inclined	6	toe	b1
HHS115	ABN	TY.F	O	very poor	fen	level	1	level	FTNN
HHS115a	HRR	O.GL	Till	moderately well	upland	undulating	3	toe	disturbed
HHS116	MIL	E.DYB	FG	well	upland	undulating	2	mid	disturbed
HHS117	HRRzz	BR.GL	Till	moderately well	upland	undulating	2	mid	disturbed
HHS118	FRT	O.GL	Till	well	upland	ridged	3	upper	disturbed
HHS119	HRRgl	GL.GL	Till	imperfect	upland	ridged	3	toe	disturbed
HHS120	STPzrpt	ptR.G	Ov/Till	poor	wetlands	level	1	level	FTNN
HHS121	MLDxs	T.M	Ov/Till	poor	wetlands	level	1	level	FTNN
HHS122	MLDxs	T.M	Ob/Till	poor	wetlands	level	1	level	FTNN
HHS123	MLDxc	T.M	Ov/Till	poor	wetlands	level	2	level	disturbed
HHS123a	MLDxc	T.F	Till	poor	fen	level	2	mid	disturbed
HHS124	BMTzrpt	ptR.G	Till	poor	wetlands	level	1	level	disturbed
HHS124a	HLY	T.F	Ob/Till	poor	bog	undulating	1	level	disturbed
HHS125	MLDxs	T.M	Ov/Till	poor	wetlands	level	1	level	disturbed
HHS126	FRT	O.GL	Till	moderately well	upland	ridge	3	upper	—
HHS126a	MLD	TY.M	O	very poor	fen	level	1	level	FTNN
HHS127	MLDxc	T.M	Ov/Till	poor	wetlands	level	1	level	disturbed
HHS128	MLDxc	T.M	Ov/Till	poor	bog	undulating	1	level	j1,disturbed
HHS128a	MLDxc	T.M	Ob/Till	very poor	wetlands	level	1	level	disturbed
HHS129	MLDxc	T.M	Ov/Till	poor	wetlands	level	2	level	disturbed
HHS130	STPzrpt	ptR.G	Till	poor	wetlands	level	1	level	disturbed
HHS132	MLDxs	T.H	Ob/Till	very poor	bog	level	1	level	disturbed
HHS133	MLDxs	T.H	Ov/Till	poor	bog	level	1	level	disturbed by fire
HHS134	MLDxc	T.M	Ov/Till	poor	wetlands	level	2	level	disturbed
HHS135	MLDxc	T.M	Ob/Till	poor	other wetlands	level	2	level	—
HHS137	ALGpt	ptO.LG	Till	poor	wetlands	level	1	level	disturbed
HHS138	HRRgl	GL.GL	Till	imperfect	upland	inclined	3	mid	disturbed
HHS139	MLDxc	T.M	Till	poor	wetlands	inclined	3	level	disturbed
HHS140	MLDxc	T.M	Till	very poor	wetlands	level	1	level	disturbed
HHS142	MLD	HY.M	Till	very poor	fen	level	1	level	FTNN
HHS146	STPzrpt	ptR.G	Till	poor	bog	level	2	upper	disturbed
HHS147	MLDxs	T.M	Till	very poor	fen	level	1	level	FTNN
HHS148	MLDxc	T.M	Till	poor	bog	undulating	2	level	BTNN/J1
HHS148a	MLDxc	T.M	Till	poor	bog	undulating	2	level	BTNN/J1
HHS150	MLDxc	T.M	Ov/Till	poor	wetlands	level	1	level	disturbed
HHS151	MLDxc	T.M	Ov/Till	poor	other wetlands	level	1	level	—
HHS152	MLDxc	T.M	Ov/Till	poor	other wetlands	level	1	level	—
HHS153	MLDxc	T.M	Ov/Till	very poor	wetlands	level	1	level	disturbed
HHS154	MLDxp	T.M	Ov/Till	very poor	wetlands	level	1	level	—
HHS155	MUSxc	T.M	Ob/Till	very poor	bog	level	2	level	disturbed

Table C-1 List of Soil Inspection Sites in the Jackpine Expansion Mining Area Local Study Area (continued)

Field Site #	Soil Series	Soil Subgroup	Parent Material	Drainage	Landform	Surface Expression	Slope Class	Slope Position	Ecosite
HHS156	MUSxc	T.M	Ov/Till	poor	bog	level	2	level	disturbed
HHS157	MUSxc	T.M	Ov/Till	poor	bog	level	2	level	disturbed
HHS158	HLY	T.F	Ob/Till	poor	bog	level	2	level	disturbed
HHS159	HLY	T.F	Ov/Till	poor	bog	level	2	lower	disturbed
HHS160	MUSxc	T.M	Ov/Till	poor	bog	level	2	lower	disturbed
HHS161	HLY	T.F	Ov/Till	poor	bog	level	1	level	disturbed
HHS162	MUSxc	T.H	Till	poor	bog	level	2	level	BTNN
HHS163	MUSxc	T.M	Ov/Till	poor	bog	level	1	level	BTNN
HHS164	MUSxc	T.H	Ov/Till	poor	bog	level	2	lower	disturbed
HHS165	MUSxc	T.H	Ov/Till	poor	bog	undulating	2	lower	—
HHS166	MUSxc	T.M	Ov/Till	poor	bog	undulating	2	lower	—
HHS167	MUSxc	T.M	Ov/Till	poor	bog	level	2	lower	—
HHS168	MUSxc	T.H	Ov/Till	poor	bog	level	2	lower	—
HHS169	MUSxc	T.H	Ov/Till	poor	bog	undulating	2	level	—
HHS170	STPpt	ptR.G	Till	imperfect	bog	ridged	3	lower	disturbed
HHS171	MILgl	GLE.DYB	FG	imperfect	upland	inclined	3	upper	disturbed
HHS171a	MUSxt	T.M	Ov/Till	poor	bog	level	2	lower	disturbed
HHS173	MILzz	O.DYB	Till	well	upland	ridged	5	lower	disturbed
HHS174	STPzr	ptR.G	Ov/Till	imperfect	wetlands	level	1	level	—
HHS175	MLDxs	T.M	Ov/Till	very poor	wetlands	level	1	level	—
HHS176	MLDxc	T.M	Ov/Till	poor	wetlands	level	1	level	—
HHS177	MLDxs	T.M	Ov/Till	poor	wetlands	level	1	level	—
HHS178	MLDxs	T.M	Ov/Till	poor	wetlands	level	1	level	—
HHS179	MLDxs	T.M	Ov/Till	poor	wetlands	level	1	level	—
HHS180	STPzrpt	ptR.G	Till	poor	bog	level	2	level	disturbed
HHS181	STPzrpt	ptR.G	Till	poor	bog	undulating	1	level	disturbed
HHS182	HRRzz	BR.GL	Till	moderately well	bog	level	1	level	disturbed
HHS183	STPzrpt	ptR.G	Till	poor	bog	undulating	1	level	disturbed
HHS184	STPzrpt	ptR.G	Till	poor	bog	level	1	level	—
HHS185	STPzrpt	ptR.G	Till	poor	bog	level	1	level	—
HHS186	HLY	T.F	Till	poor	bog	undulating	2	lower	disturbed
HHS187	STPzrpt	ptR.G	Till	poor	bog	undulating	2	lower	disturbed
HHS188	HRRgl	GL.GL	Till	very poor	bog	level	1	level	disturbed
HHS189	MIL	E.DYB	FG	well	upland	level	3	mid	disturbed
HHS190	FRTgl	GL.GL	FG	moderately well	upland	undulating	3	lower	disturbed
HHS191	HRR	O.GL	Till	well	upland	undulating	2	lower	disturbed
HHS192	LVK	O.GL	Till/FG	well	upland	undulating	2	mid	disturbed
HHS193	MIL	E.DYB	FG	well	upland	undulating	3	upper	disturbed
HHS194	MIL	E.DYB	FG	well	upland	hummocky	5	upper	—
HHS195	MIL	E.DYB	FG	well	upland	undulating	3	upper	—
HHS196	STPzrpt	ptR.G	Till	poor	bog	level	1	level	k1
HHS197	STPzrpt	ptR.G	Till	poor	bog	undulating	1	level	—
HHS198	MUSxt	T.M	Till	poor	bog	undulating	1	level	—
HHS200	MUSxt	T.M	Till	poor	bog	level	1	level	FTNN
HHS201	MLD	TY.M	O	very poor	fen	level	1	level	FTNN
HHS202	MLDxt	T.M	Ob/Till	very poor	fen	level	1	level	FTNN
HHS203	MLD	TY.M	O	very poor	fen	level	1	level	FTNN
HHS204	MLDxt	T.M	Ob/Till	very poor	fen	level	1	level	FTNN
HHS205	MLD	TY.M	O	very poor	fen	level	1	level	FTNN
HHS206	MLD	TY.M	O	very poor	fen	level	1	level	FONS
HHS207	MLD	TY.M	O	very poor	fen	level	1	level	FTNN

Table C-1 List of Soil Inspection Sites in the Jackpine Expansion Mining Area Local Study Area (continued)

Field Site #	Soil Series	Soil Subgroup	Parent Material	Drainage	Landform	Surface Expression	Slope Class	Slope Position	Ecosite
HHS208	MLD	TY.M	O	very poor	fen	level	1	level	FONS
HHS209	MLD	TY.M	O	very poor	fen	level	1	level	—
HHS210	ABN	TY.F	O	very poor	fen	level	1	level	—
HHS211	MLD	TY.M	O	very poor	fen	level	1	level	—
HHS212	MLDxt	T.M	Ob/Till	poor	bog	undulating	2	level	BTNN
HHS214	ABN	TY.F	O	very poor	fen	level	1	level	FONS
HHS216	ABN	TY.F	O	very poor	fen	level	1	level	FONS
HHS217	ABN	TY.F	O	very poor	bog	undulating	2	level	FTNN
HHS218	ABN	TY.F	O	very poor	fen	level	1	level	FTNN
HHS219	ABN	TY.F	O	very poor	fen	level	1	level	FONS
HHS220	HLY	T.F	Ov/Till	poor	bog	undulating	2	level	disturbed
HHS221	MIL	E.DYB	FG	rapid	upland	ridged	4	upper	disturbed
HHS222	MIL	E.DYB	FG	rapid	upland	undulating	3	toe	—
HHS225	MIL	E.DYB	FG	rapid	upland	undulating	3	lower	disturbed
HHS227	MLD	TY.M	O	very poor	fen	level	1	level	FTNN
HHS228	HLY	T.F	Ov/Till	poor	bog	undulating	2	mid	disturbed
HHS229	ABN	TY.F	O	very poor	fen	level	1	level	disturbed
HHS230	MLDxt	T.M	Ov/Till	poor	fen	level	1	level	disturbed
HHS231	MIL	E.DYB	FG	well	upland	ridged	3	upper	disturbed
HHS232	HLY	T.F	Ov/Till	poor	bog	level	2	lower	disturbed
HHS233	BMTzrpt	ptR.G	FG	imperfect	bog	undulating	2	toe	disturbed
HHS234	BMTzrpt	ptR.G	FG	imperfect	bog	level	2	lower	disturbed
HHS235	STPzrpt	ptR.G	Till	poor	bog	undulating	2	mid	disturbed
HHS236	BMTpt	ptO.G	FG	imperfect	upland	undulating	3	lower	disturbed by fire
HHS237	MIL	E.DYB	FG	moderately well	upland	undulating	3	upper	disturbed by fire
HHS238	HLY	T.F	Ob/Till	poor	bog	level	2	mid	disturbed
HHS239	HLY	T.F	Ob/Till	poor	bog	level	2	level	—
HHS240	HLY	T.F	Ob/Till	poor	bog	level	2	level	disturbed
HHS241	HLY	T.F	Ob/Till	poor	bog	level	2	lower	disturbed
HHS242	MLD	TY.M	O	very poor	fen	level	1	level	FTNN
HHS243	MLDxt	T.M	Ov/Till	very poor	fen	level	1	level	FTNN
HHS244	MLDxt	T.M	Ov/Till	very poor	fen	level	1	level	FTNN
HHS245	MUSxt	T.M	Ov/Till	poor	bog	level	2	mid	disturbed
HHS246	BMTpt	ptO.G	FG	poor	bog	level	2	lower	disturbed
HHS247	BMTpt	ptO.G	FG	poor	bog	level	2	level	disturbed
HHS248	MLD	TY.M	O	very poor	fen	level	1	level	disturbed
HHS249	STPzrpt	ptR.G	Till	poor	bog	undulating	3	level	disturbed by fire
HHS250	MIL	E.DYB	FG	well	upland	ridged	3	crest	disturbed by fire
HHS251	MLDxt	T.M	Ob/Till	very poor	fen	level	1	level	FONS
HHS252	MLDxt	T.M	Ov/Till	very poor	fen	level	1	level	disturbed
HHS253	MLD	TY.M	O	very poor	fen	level	1	level	FTNN
HHS254	MLD	TY.M	O	very poor	fen	level	1	level	FTNN
HHS255	MLD	TY.M	O	very poor	fen	level	1	level	FTNN
HHS256	MLD	TY.M	O	very poor	fen	level	1	level	FTNN
HHS257	MLDxs	T.M	Ov/FG	very poor	fen	level	1	level	disturbed
HHS258	HRR	O.GL	Till	well	upland	undulating	2	mid	d1
HHS259	MIL	E.DYB	FG	well	upland	ridged	5	mid	disturbed \burn
HHS260	MIL	E.DYB	FG	well	upland	ridged	5	mid	disturbed by fire

Table C-1 List of Soil Inspection Sites in the Jackpine Expansion Mining Area Local Study Area (continued)

Field Site #	Soil Series	Soil Subgroup	Parent Material	Drainage	Landform	Surface Expression	Slope Class	Slope Position	Ecosite
HHS261	MILgl	GLE.DYB	FG	moderately well	upland	ridged	4	lower	disturbed /burn
HHS262	MUSxt	T.M	Ov/Till	poor	bog	level	1	level	disturbed by fire
HNS001	BMTzrpt	ptR.G	FG	very poor	bog	level	1	level	disturbed
HNS002	MIL	E.DYB	FG	rapid	upland	ridged	5	toe	disturbed
HNS003	MUSxs	T.M	Ov/FG	poor	bog	level	1	level	disturbed
HNS004	MUSxs	T.M	Ov/FG	very poor	bog	level	1	level	disturbed
HNS005	FRT	O.GL	Till	moderately well	upland	undulating	4	toe	disturbed
HNS006	MIL	E.DYB	FG	rapid	upland	ridged	3	upper	disturbed
HNS007	MIL	E.DYB	FG	imperfect	upland	level	1	level	disturbed
HNS008	MILgl	GLE.DYB	FG	poor	wetlands	undulating	3	mid	disturbed
HNS009	MLD	TY.M	O	very poor	swamp	level	1	level	STNN
HNS010	MLD	TY.M	O	very poor	fen	level	1	level	FTNN
HNS011	MIL	E.DYB	FG	rapid	upland	undulating	3	lower	disturbed
HNS012	MIL	E.DYB	FG	rapid	upland	ridged	6	toe	disturbed
HNS013	MIL	E.DYB	FG	rapid	upland	undulating	3	mid	disturbed
HNS014	MLDxs	T.M	Ov/FG	very poor	fen	level	1	level	FTNN
HNS064	MIL	E.DYB	FG	rapid	upland	hummocky ridged	8	crest	b2
HNS065	MIL	E.DYB	FG	well	upland	hummocky	6	upper	disturbed
HNS066	MIL	E.DYB	FG	well	upland	hummocky	6	upper	—
HNS079	MIL	E.DYB	FG	rapid	upland	hummocky	7	toe	b2
HNS080	MIL	E.DYB	FG	well	upland	hummocky	5	mid	b3
HNS081	MIL	E.DYB	FG	rapid	upland	hummocky	6	mid	a1
HNS094	MIL	E.DYB	FG	well	upland	hummocky	6	upper	disturbed
HNS095	MIL	E.DYB	FG	well	upland	hummocky	5	upper	disturbed
HNS096	MIL	E.DYB	FG	rapid	upland	level	1	level	disturbed
HNS107	MIL	E.DYB	FG	rapid	upland	hummocky	4	mid	b2
HNS108	MIL	E.DYB	FG	well	upland	hummocky	4	toe	disturbed
HNS109	MIL	E.DYB	FG	rapid	upland	hummocky	4	lower	b2
HNS110	MILzz	O.DYB	FG	rapid	upland	hummocky	6	crest	a1
HNS111	MIL	E.DYB	FG	rapid	upland	hummocky	7	mid	b2
HNS112	MIL	E.DYB	FG	rapid	upland	hummocky	6	mid	b2
HNS113	MIL	E.DYB	FG	rapid	upland	hummocky ridged	5	toe	b1
HNS114	MIL	E.DYB	FG	moderately well	upland	hummocky	7	toe	disturbed
HNS115	MLD	TY.M	O	very poor	fen	level	1	level	FONS
HNS116	MUS	TY.M	O	very poor	bog	level	1	level	BTNN
HNS117	MMWpt	ptR.G	Ov/LG	poor	bog	level	1	level	BTNN
HNS118	MILgl	GLE.DYB	FG	poor	upland	inclined	4	lower	h1
HNS119	MILgl	GLE.DYB	FG	imperfect	upland	undulating	4	upper	b4
HNS120	MIL	E.DYB	FG	well	upland	hummocky	5	toe	b3
HNS121	MILzz	O.DYB	FG	well	upland	level	3	level	b3
HNS123	MIL	E.DYB	FG	well	upland	hummocky	4	upper	disturbed
HNS124	MILzz	O.DYB	FG	well	upland	hummocky	6	toe	disturbed
HNS500	MLDxc	T.M	O/LG	very poor	fen	level	1	level	k1
HNS501	MLD	TY.M	Ob/FG	very poor	fen	level	1	level	k1
HNS502	MLD	TY.M	Ob/Till	very poor	fen	level	1	level	k1
HNS503	MLD	TY.M	O	very poor	fen	level	1	level	—
HNS504	MLD	TY.M	O	very poor	fen	level	1	level	k1

Table C-1 List of Soil Inspection Sites in the Jackpine Expansion Mining Area Local Study Area (continued)

Field Site #	Soil Series	Soil Subgroup	Parent Material	Drainage	Landform	Surface Expression	Slope Class	Slope Position	Ecosite
HNS505	MIL	E.DYB	FG	moderately well	upland	undulating	2	level	—
HNS506	MLDxs	T.M	Ov/FG	very poor	fen	level	1	level	FTNN
HNS507	MLD	TY.M	O	very poor	fen	level	1	level	k2
HNS508	MLDxs	T.M	Ov/FG	very poor	fen	level	1	level	k2
HNS509	MIL	E.DYB	FG	well	upland	undulating	3	mid	b1
HNS510	MIL	E.DYB	FG	rapid	upland	undulating	3	mid	d2
HNS511	MLDxs	T.M	Ov/FG	very poor	fen	level	1	level	k2
HNS512	MLDxs	T.M	Ov/FG	poor	wetlands	level	1	level	i1
HNS513	MLDxs	T.M	Ob/FG	very poor	fen	level	1	level	k2
HNS514	MLDxs	T.M	Ov/FG	very poor	fen	level	1	level	k1
HNS515	MMWpt	ptR.G	LG	very poor	other	level	1	level	j1
HNS516	MLDxc	T.M	Ob/LG	very poor	fen	level	1	level	k2
HNS517	ABN	TY.F	O	very poor	fen	level	1	level	k2
HNS518	ABN	TY.F	O	very poor	fen	level	1	level	k2
HNS519	ABN	TY.F	O	very poor	fen	level	1	level	i2
HNS520	HLY	T.F	O	very poor	fen	level	1	level	k2
HNS538	ABN	TY.F	O	very poor	fen	level	1	level	k2
HNS539	ABN	TY.F	O	very poor	fen	level	1	level	k2
HNS540	ABN	TY.F	O	very poor	fen	level	1	level	k2
HNS541	ABN	TY.F	O	very poor	fen	level	1	level	k2
HNS542	ABN	TY.F	O	very poor	fen	level	1	level	k2
HNS545	ABN	TY.F	O	very poor	other	level	1	level	j1
HNS546	ABN	TY.F	O	very poor	fen	level	1	level	j1
HNS547	ABN	TY.F	O	poor	fen	level	1	level	j1
HNS548	ABN	TY.F	O	very poor	fen	level	1	level	j1
HNS549	ABN	TY.F	LG	very poor	fen	level	1	level	j1
HNS550	ABN	TY.F	O	very poor	fen	level	1	level	j1
HNS551	ABN	TY.F	O	very poor	fen	level	1	level	j1
HNS552	ABN	TY.F	O	very poor	fen	level	1	level	j1
HNS553	ABN	TY.F	O	very poor	fen	level	1	level	j1
HNS554	ABN	TY.F	O	very poor	fen	level	1	level	j1
HNS555	ABN	TY.F	O	very poor	fen	level	1	level	j1
HNS556	ABN	TY.F	O	very poor	fen	level	1	level	l1
HNS557	ABN	TY.F	O	very poor	fen	level	1	level	j1
HNS558	ABN	TY.F	O	very poor	fen	level	1	level	j1
HNS559	MLD	TY.M	O	very poor	fen	level	1	level	j1
HNS560	ABN	TY.F	O	very poor	fen	level	1	level	j1
HNS561	ABN	TY.F	O	very poor	fen	level	1	level	j1
HNS562	ABN	TY.F	O	very poor	fen	level	1	level	j1
HNS563	ABN	TY.F	O	very poor	fen	level	1	level	j1
HNS564	ABN	TY.F	O	very poor	fen	level	1	level	j1
HNS565	ABN	TY.F	O	very poor	fen	level	1	level	j1
HNS566	ABN	TY.F	O	very poor	fen	level	1	level	j1
HNS567	ABN	TY.F	O	very poor	fen	level	1	level	—
HNS568	ABN	TY.F	O	very poor	fen	level	1	level	—
HNS569	ABN	TY.F	O	very poor	fen	level	1	level	—
HNS570	PEA	O.GL	FG	moderately well	upland	undulating	3	mid	d2
HNS571	PEA	O.GL	FG	well	upland	incl.	4	mid	d2
HNS572	FRT	O.GL	FG	well	upland	hummocky	4	mid	d2
HNS573	FRT	O.GL	FG	well	upland	hummocky	4	crest	d2
HNS574	MIL	E.DYB	FG	well	upland	hummocky	6	crest	d2

Table C-1 List of Soil Inspection Sites in the Jackpine Expansion Mining Area Local Study Area (continued)

Field Site #	Soil Series	Soil Subgroup	Parent Material	Drainage	Landform	Surface Expression	Slope Class	Slope Position	Ecosite
HNS575	FRT	O.GL	FG	well	upland	hummocky	5	mid	d2
HNS576	PEA	O.GL	FG	well	upland	hummocky	4	upper	d2
HNS577	PEA	O.GL	FG	well	upland	undulating	2	mid	d2
HNS578	MIL	E.DYB	FG	well	upland	hummocky	3	mid	d2
HNS579	FRT	O.GL	FG	well	upland	hummocky	4	upper	d2
HNS580	ABN	TY.F	O	very poor	fen	level	1	level	FTNN
HSS002	DOVzz	BR.GL	FG	moderately well	upland	undulating	2	level	upland shrub
HSS004	FRT	O.GL	Till/FG	moderately well	upland	rolling	2	upper	upland shrub
HSS005	MIL	E.DYB	FG	well	upland	undulating	2	mid	upland shrub
HSS006	HRR	O.GL	Till	imperfect	upland	undulating	2	upper	upland shrub
HSS007	HRR	O.GL	Till	moderately well	upland	undulating	3	mid	upland shrub
HSS008	HRR	O.GL	Till	imperfect	upland	undulating	2	level	b3
HSS008a	MLD	TY.M	O	very poor	fen	level	1	level	k1
HSS009	HRR	O.GL	Till	moderately well	upland	level	2	upper	d1
HSS010	HRR	O.GL	Till	moderately well	upland	undulating	2	upper	upland shrub
HSS011	DOVgl	GL.GL	LG	imperfect	upland	level	1	level	disturbed
HSS012	HRR	O.GL	Till	moderately well	upland	undulating	2	toe	disturbed
HSS013	MLDxc	T.M	LG	very poor	swamp	level	1	level	disturbed
HSS014	MLDxc	FI.M	Ob/L	very poor	upland	level	1	level	disturbed
HSS015	HRR	O.GL	Till	imperfect	upland	inclined	2	mid	disturbed
HSS016	FRTzz	BR.GL	Till	imperfect	upland	undulating	1	level	disturbed
HSS017	FRT	O.GL	Till	well	upland	undulating	3	lower	b3
HSS018	HRR	O.GL	Till	moderately well	upland	undulating	2	toe	d1
HSS019	MIL	E.DYB	FG	rapid	upland	inclined	4	mid	b1
HSS020	HRR	O.GL	Till	well	upland	undulating	2	mid	d1
HSS021	HRR	O.GL	Till	moderately well	upland	inclined	2	lower	d1
HSS022	HRR	O.GL	Till	well	upland	undulating	2	mid	d1
HSS023	HRR	O.GL	Till	well	wetlands	level	1	level	d1
HSS024	HRR	O.GL	Till	moderately well	upland	undulating	2	mid	disturbed
HSS025	HRR	O.GL	Till	well	upland	undulating	2	upper	d1
HSS026	FRTzz	BR.GL	FGv/Till	moderately well	upland	inclined	4	upper	disturbed
HSS027	HRR	O.GL	Till	well	upland	level	1	level	d1
HSS028	HRRzz	BR.GL	Till	moderately well	upland	hummocky	6	lower	disturbed
HSS029	HRR	O.GL	FG	well	upland	level	1	level	disturbed
HSS030	FRTzz	BR.GL	FG	well	upland	level	1	level	d1
HSS031	HRR	O.GL	FG/Till	moderately well	upland	level	2	level	disturbed
HSS032	HRR	O.GL	Till	moderately well	upland	level	1	level	d1
HSS033	HRR	O.GL	Till	moderately well	upland	level	1	level	d1
HSS034	MUSxc	THU.M	Ob/LG	poor	upland	level	1	level	e1
HSS035	HRR	O.GL	Till	moderately well	upland	level	3	mid	d2

Table C-1 List of Soil Inspection Sites in the Jackpine Expansion Mining Area Local Study Area (continued)

Field Site #	Soil Series	Soil Subgroup	Parent Material	Drainage	Landform	Surface Expression	Slope Class	Slope Position	Ecosite
HSS036	MIL	E.DYB	FG	well	upland	rolling	2	level	disturbed
HSS037	HRRgl	GL.GL	Till	poor	upland	ridged	1	level	disturbed
HSS038	MLDxc	T.M	Ov/LG	very poor	wetlands	level	1	level	FONG
HSS039	FRTzz	BR.GL	FG	moderately well	other	level	1	level	d1
HSS040	MLDxs	T.M	Ov/FG	poor	wetlands	level	1	level	disturbed
HSS041	MLDxc	T.M	Ob/FG	poor	wetlands	level	1	level	FTNN
HSS043	—	N/A	O/FG	poor	wetlands	level	1	level	j1
HSS045	MMWpt	ptR.G	Ov/FG	poor	wetlands	level	1	level	j1
HSS046	MUSxt	T.M	Ov/Till	poor	wetlands	level	1	level	disturbed
HSS047	HRR	O.GL	Till	imperfect	upland	level	1	level	disturbed
HSS048	MMWpt	ptR.G	L	poor	wetlands	level	1	level	k2
HSS049	HRR	O.GL	Till	moderately well	wetlands	ridged	3	upper	disturbed
HSS050	STPpt	ptO.G	FG/Till	poor	wetlands	level	2	level	disturbed
HSS051	MLDxc	T.M	Ov/LG	poor	wetlands	level	1	level	disturbed
HSS052	MLDxc	T.M	Ov/FG	poor	wetlands	level	1	level	k1
HSS053	MLDxc	T.M	Ov/Till	poor	wetlands	level	1	level	i1
HSS054	MLDxc	T.M	Ov/Till	poor	wetlands	level	1	level	j1
HSS055	MLDxc	T.M	Ov/Till	poor	wetlands	level	1	level	disturbed
HSS056	MLDxc	T.M	Ov/Till	poor	wetlands	undulating	1	level	—
HSS057	MLDxs	T.M	Ob/FG	poor	fen	level	1	level	k1
HSS058	MUSxs	T.M	Ov/FG	poor	bog	undulating	2	level	disturbed
HSS059	HRR	O.GL	Till	moderately well	upland	level	1	level	disturbed
HSS059	HRR	O.GL	Till	moderately well	upland	level	1	level	—
HSS059	HRR	O.GL	Till	moderately well	upland	level	1	level	disturbed
HSS059	HRR	O.GL	Till	moderately well	upland	level	1	level	—
HSS061	MLD	TY.M	O	poor	fen	level	1	level	K1
HSS062	MLD	ME.H	O	very poor	fen	level	1	level	k1
HSS063	MLD	ME.H	O	poor	fen	level	1	level	k1
HSS064	MLD	ME.H	O	very poor	fen	level	1	level	k1
HSS065	—	—	Till	well	upland	ridged	0	level	disturbed
HSS066	HLY	T.F	Till	poor	bog	undulating	1	level	disturbed
HSS067	HRRgl	GL.GL	Till	imperfect	upland	ridged	1	mid	disturbed
HSS069	MLDxc	T.M	Ob/Till	poor	wetlands	level	1	level	j1
HSS070	MLDxc	T.M	Ov/FG	poor	wetlands	level	1	level	j1
HSS071	MLDxc	T.M	Ov/FG	poor	wetlands	level	1	level	j1
HSS072	MLDxc	T.M	O/FG	poor	wetlands	level	1	level	disturbed
HSS073	MLDxc	T.M	Ov/FG	very poor	wetlands	undulating	1	level	—
HSS074	MLDxc	T.M	Ov/FG	very poor	wetlands	level	1	level	disturbed
HSS075	MMWpt	ptR.G	Ov/FG	poor	wetlands	level	1	level	disturbed
HSS076	WHMaapt	ptO.LG	Till	poor	wetlands	level	1	level	disturbed
HSS077	MLDxc	T.M	O	poor	wetlands	level	1	level	j1
HSS078	JSNglzs	GLG.SO	LG	poor	wetlands	ridged	3	upper	disturbed
HSS079	MUS	TY.M	O	very poor	bog	level	1	level	j1
HSS080	MKWaa	TY.M	O	very poor	bog	level	1	level	k1
HSS081	MLD	TY.M	O	very poor	fen	level	1	level	FONS
HSS082	BMTzrpt	ptR.G	Till	poor	wetlands	inclined	2	lower	disturbed
HSS083	MLDxc	T.M	Ob/Till	poor	wetlands	level	2	lower	j1
HSS084	MKWaa	TY.M	Ob/Till	very poor	bog	level	1	level	disturbed

Table C-1 List of Soil Inspection Sites in the Jackpine Expansion Mining Area Local Study Area (continued)

Field Site #	Soil Series	Soil Subgroup	Parent Material	Drainage	Landform	Surface Expression	Slope Class	Slope Position	Ecosite
HSS085	MILxp	E.DYB	LG	moderately well	upland	ridged	3	mid	disturbed
HSS086	MLDxc	T.M	Ov/L	very poor	wetlands	level	1	level	—
HSS087	MILxp	E.DYB	FG	rapid	upland	undulating	1	level	—
HSS088	MLDxs	T.M	Ob/L	poor	wetlands	undulating	1	level	—
HSS089	BMTzrpt	ptR.G	Ob/L	poor	wetlands	undulating	1	level	—
HSS090	WHMaa	O.LG	Till	poor	upland	ridged	2	mid	disturbed
HSS090a	BMTzrpt	ptR.G	Till	poor	upland	ridged	2	mid	disturbed
HSS092	MLD	TY.M	O	very poor	fen	level	1	lower	k1
HSS093	MLD	TY.M	O	poor	wetlands	undulating	1	level	—
HSS094	MLDxs	T.M	Ob/L	poor	wetlands	undulating	1	level	—
HSS095	MUSxc	T.M	Till	very poor	bog	undulating	2	level	disturbed
HSS096	MUSxc	T.M	Ov/Till	poor	bog	undulating	1	level	disturbed
HSS097	BMTzrpt	ptR.G	Till	very poor	bog	level	1	level	disturbed
HSS098	SUT	E.DYB	FG/Till	moderately well	upland	ridged	3	toe	disturbed
HSS099	MUSxc	T.M	Ov/Till	poor	bog	undulating	1	lower	—
HSS100	HRR	O.GL	Till	moderately well	upland	ridged	4	toe	disturbed
HSS101	HRRzz	BR.GL	Till	moderately well	upland	ridged	1	level	disturbed
HSS102	MLDxt	T.M	Ov/Till	poor	wetlands	undulating	1	level	disturbed
HSS103	HRRzz	BR.GL	Till	moderately well	upland	undulating	3	mid	—
HSS104	HRRzz	BR.GL	Till	moderately well	upland	ridged	3	toe	disturbed
HSS105	HRRzz	BR.GL	Till	moderately well	upland	undulating	3	mid	—
HSS106	STPzrpt	ptR.G	Ov/Till	poor	wetlands	undulating	2	level	—
HSS107	HRRzz	BR.GL	Till	moderately well	upland	undulating	3	mid	—
HSS108	STPzrpt	ptR.G	Ov/Till	poor	wetlands	undulating	2	level	—
HSS109	MLDxc	T.M	Ov/Till	poor	wetlands	undulating	1	level	—
HSS110	MLDxc	T.M	Ov/Till	poor	wetlands	undulating	1	level	—
HSS111	HRRgl	GL.GL	Till	imperfect	upland	level	1	level	disturbed
HSS112	MUSxc	T.M	Ob/Till	very poor	bog	level	1	level	disturbed
HSS113	WHMaa	O.LG	Till	imperfect	wetlands	undulating	1	lower	—
HSS114	HRRgl	GL.GL	Till	imperfect	upland	level	1	lower	disturbed
HSS115	WHMaa	O.LG	Till	imperfect	wetlands	undulating	1	lower	—
HSS116	WHMaa	O.LG	Till	imperfect	wetlands	undulating	1	lower	—
HSS117	MLDxc	T.M	Till	very poor	wetlands	undulating	1	level	disturbed
HSS118	STPzrpt	ptR.G	Till	poor	wetlands	undulating	1	level	disturbed
HSS119	STPpt	ptO.G	Till	poor	bog	level	1	level	—
HSS120	MUSxc	T.M	Ov/Till	poor	bog	level	1	level	disturbed
HSS121	MLDxc	T.M	Ov/Till	poor	wetlands	undulating	1	level	—
HSS122	MLDxc	T.M	Ov/Till	poor	wetlands	undulating	1	level	—
HSS123	STPzrpt	ptR.G	Till	poor	wetlands	undulating	1	level	disturbed
HSS124	MUSxt	T.M	Ob/Till	very poor	bog	level	1	level	j1
HSS125	MUSxs	T.H	Ob/FG	very poor	bog	level	1	level	j1
HSS126	MUSxc	T.M	Ob/Till	very poor	bog	level	1	level	J2
HSS127	ALGpt	ptO.LG	Till	poor	bog	level	1	level	j1
HSS129	ALGpt	ptO.LG	Till	poor	wetlands	undulating	1	level	—
HSS130	FRT	O.GL	Till	well	upland	ridged	3	mid	disturbed
HSS131	FRT	O.GL	Till	moderately well	upland	level	1	level	disturbed

Table C-1 List of Soil Inspection Sites in the Jackpine Expansion Mining Area Local Study Area (continued)

Field Site #	Soil Series	Soil Subgroup	Parent Material	Drainage	Landform	Surface Expression	Slope Class	Slope Position	Ecosite
HSS132	WHMaa	O.LG	Till	moderately well	upland	undulating	3	upper	disturbed
HSS133	MILzz	O.DYB	FG	moderately well	upland	undulating	2	mid	disturbed
HSS134	STPzrpt	ptR.G	Ov/Till	poor	bog	inclined	2	mid	l1
HSS135	FRT	O.GL	Till	moderately well	upland	inclined	2	upper	l1
HSS136	MUSxs	T.M	Ov/Till	poor	bog	level	3	mid	k1
HSS137	MUSxs	T.M	Ov/Till	poor	bog	level	1	level	—
HSS138	MUSxt	T.M	Ov/Till	poor	bog	undulating	1	level	—
HSS139	STPzrpt	ptR.G	Ov/Till	poor	bog	undulating	2	mid	k1
HSS140	MILgl	GLE.DYB	FG	imperfect	upland	undulating	3	mid	i1
HSS141	MUSxt	T.M	Ov/Till	poor	bog	undulating	1	level	k1
HSS142	MLD	TY.M	O	very poor	fen	level	1	level	FTNN
HSS143	MUSxs	T.M	Ov/Till	very poor	bog	level	1	level	k1
HSS144	BMTzrpt	ptR.G	Ov/Till	poor	bog	level	1	level	i1
HSS145	MUS	TY.M	Ob/Till	very poor	bog	level	1	level	k1
HSS146	MIL	E.DYB	FG	moderately well	upland	ridged	1	crest	k1
HSS147	MUSxt	T.M	Ov/Till	very poor	bog	undulating	2	lower	k1
HSS148	MUSxt	T.M	Ov/Till	poor	bog	undulating	2	mid	disturbed
HSS149	WHMaa	O.LG	Till	imperfect	upland	undulating	2	mid	disturbed
HSS150	FRTzz	BR.GL	Till	moderately well	upland	undulating	3	mid	disturbed
HSS151	LVKzz	BR.GL	Till	well	upland	undulating	3	mid	disturbed
HSS152	FRTzz	BR.GL	Till	well	upland	undulating	2	mid	disturbed
HSS153	—	—	—	—	—	—	0	—	—
HSS154	MLDxt	T.M	Ov/Till	very poor	wetlands	level	1	level	disturbed
HSS155	HRR	O.GL	Till	moderately well	upland	undulating	1	level	disturbed
HSS156	STPzrpt	R.G	Till	very poor	bog	level	1	level	disturbed
HSS157	HRRzz	BR.GL	Till	moderately well	upland	undulating	2	mid	disturbed
HSS158	STPpt	ptO.G	Till	poor	bog	undulating	2	mid	disturbed
HSS159	LVKzz	BR.GL	FGv/Till	moderately well	upland	level	2	mid	—
HSS160	STPzrpt	ptR.G	Till	very poor	swamp	swamp	1	level	disturbed
HSS161	FRT	O.GL	FG	well	upland	undulating	3	mid	disturbed by fire
HSS161a	HRR	O.GL	Till	well	upland	undulating	2	upper	—
HSS162	HRR	O.GL	Till	moderately well	upland	undulating	3	toe	disturbed
HSS164	HRRzz	BR.GL	Till	well	upland	undulating	1	mid	disturbed
HSS165	STPzrpt	ptR.G	Till	poor	wetlands	undulating	2	lower	disturbed by fire
HSS166	—	—	Till	well	upland	undulating	2	mid	disturbed
HSS167	FRTzz	BR.GL	Till	moderately well	upland	undulating	2	mid	disturbed by fire
HSS168	HRR	O.GL	Till	well	upland	undulating	2	upper	disturbed
HSS169	ALGpt	ptO.LG	Till	poor	wetlands	level	2	level	disturbed by fire
HSS170	MUSxt	T.M	Ob/Till	very poor	bog	level	1	level	k1
HSS171	FRT	O.GL	Till	moderately well	upland	ridged	1	lower	disturbed by fire
HSS172	HRR	O.GL	Till	well	upland	level	2	level	d1

Table C-1 List of Soil Inspection Sites in the Jackpine Expansion Mining Area Local Study Area (continued)

Field Site #	Soil Series	Soil Subgroup	Parent Material	Drainage	Landform	Surface Expression	Slope Class	Slope Position	Ecosite
HSS173	ALG	O.LG	Till	poor	upland	inclined	3	toe	disturbed by fire
HSS174	HRR	O.GL	Till	well	upland	ridged	2	upper	disturbed
HSS175	ABN	TY.F	O	very poor	bog	level	1	level	disturbed
HSS176	HRR	O.GL	Till	well	upland	undulating	2	upper	disturbed
HSS177	ABN	TY.F	Ob/Till	very poor	bog	level	1	level	disturbed by fire
HSS178	HRR	O.GL	Till	well	upland	ridged	1	crest	disturbed
HSS179	MUSxt	T.M	Ov/Till	poor	bog	level	1	level	k1
HSS180	SUT	E.DYB	FG/Till	well	upland	level	2	level	disturbed
HSS181	MIL	E.DYB	FG/Till	well	upland	undulating	3	upper	disturbed
HSS182	FRT	O.GL	Till/FG	moderately well	other	level	1	level	disturbed
HSS183	HRR	O.GL	Till	well	upland	undulating	1	upper	d1
HSS184	—	—	Till	—	upland	inclined	2	mid	d1
HSS185	HRR	O.GL	Till	moderately well	upland	level	1	level	disturbed
HSS186	MUSxt	T.M	Ov/Till	poor	bog	level	1	level	disturbed
HSS187	MUSxt	T.M	Ov/Till	very poor	bog	level	1	level	k1
HSS188	MUSxt	T.M	Ov/Till	poor	bog	level	1	level	disturbed
HSS189	HRR	O.GL	Till	moderately well	upland	undulating	2	mid	disturbed
HSS190	HRRzz	BR.GL	Till	well	upland	undulating	2	mid	disturbed
HSS191	HRR	O.GL	Till	well	upland	undulating	2	mid	disturbed
HSS192	MUSxt	T.M	Ov/Till	poor	bog	level	2	level	disturbed
HSS193	HRR	O.GL	Till	moderately well	upland	undulating	2	mid	disturbed
HSS194	SUT	E.DYB	FG/Till	well	upland	undulating	2	upper	disturbed
HSS195	HRRgl	GL.GL	Till	imperfect	upland	level	1	level	disturbed
HSS196	HRR	O.GL	Till	moderately well	upland	level	1	level	disturbed
HSS197	MUSxt	T.M	Ov/Till	poor	bog	level	1	level	disturbed
HSS198	MUSxt	T.M	Ov/Till	poor	bog	level	1	level	j1
HSS199	STPzrpt	ptR.G	Ov/Till	poor	bog	level	1	level	disturbed
HSS200	MUSxt	T.M	Ob/Till	very poor	bog	level	1	level	j1
HSS201	MUSxt	T.M	Ov/Till	very poor	bog	level	1	level	j1
HSS202	MUSxt	T.H	Ov/Till	very poor	bog	level	1	level	disturbed
HSS203	BMTzrpt	ptR.G	FG	poor	bog	level	1	level	disturbed
HSS204	FRT	O.GL	FG	moderately well	upland	level	2	mid	disturbed
HSS205	HRR	O.GL	Till	moderately well	upland	level	2	upper	disturbed
HSS206	STPzrpt	ptR.G	Till	poor	upland	level	2	level	disturbed
HSS207	MUSxt	T.M	OvTill	poor	bog	level	1	level	disturbed
HSS208	STPzrpt	ptR.G	Till	poor	upland	level	1	lower	—
HSS209	HRR	O.GL	Till	well	upland	level	1	level	disturbed
HSS210	MLDxs	T.M	Ob/Till	very poor	fen	level	1	level	disturbed
HSS211	BMTzrpt	ptR.G	FG	poor	bog	undulating	2	upper	disturbed
HSS222	BMTzrpt	ptR.G	FG	poor	bog	level	1	level	disturbed
HSS224	MUS	ME.F	O	poor	bog	undulating	3	lower	BTNN
HSS225	ABN	TY.F	O	very poor	fen	level	1	level	FTNN
HSS226	MUSxt	T.M	Ov/Till	poor	bog	undulating	3	mid	disturbed
HSS227	WHMaa	O.LG	Till	poor	upland	undulating	2	lower	disturbed
HSS228	HLY	T.F	Till	poor	upland	undulating	2	mid	disturbed
HSS229	WHMaa	O.LG	Till	poor	upland	undulating	2	mid	disturbed

Table C-1 List of Soil Inspection Sites in the Jackpine Expansion Mining Area Local Study Area (continued)

Field Site #	Soil Series	Soil Subgroup	Parent Material	Drainage	Landform	Surface Expression	Slope Class	Slope Position	Ecosite
HSS230	WHMaapt	ptO.LG	Till	poor	upland	undulating	2	mid	disturbed
HSS231	WHMaapt	ptO.LG	Till	poor	upland	level	1	mid	disturbed
HSS232	BMTpt	ptO.G	FG	poor	upland	undulating	2	mid	disturbed
HSS233	STP	O.G	Till	poor	upland	undulating	2	mid	disturbed
HSS234	HLY	T.F	Ov/L	very poor	bog	undulating	3	toe	disturbed
HSS235	MUSxs	T.M	Ov/Till	poor	bog	level	1	level	disturbed
HSS236	ABN	TY.F	O	very poor	fen	level	1	level	disturbed
HSS237	ABN	TY.F	O	very poor	fen	level	1	level	FTNN
HSS238	MUSxs	T.M	Ob/Till	very poor	bog	level	1	level	disturbed
HSS239	MLD	TY.M	O	very poor	fen	level	1	level	FTNN
HSS240	ABN	TY.F	O	very poor	fen	level	1	level	FTNN
HSS241	MLD	TY.M	O	very poor	fen	level	1	level	FTNN
HSS243	MUSxt	T.M	Ov/Till	poor	bog	level	1	level	disturbed
HSS244	HRR	O.GL	Till	moderately well	upland	ridged	3	upper	disturbed
HSS245	MIL	O.DYB	FG	well	upland	undulating	1	level	d2
HSS246	MIL	E.DYB	FG	well	upland	undulating	1	level	d2
HSS247	ABN	TY.F	O	very poor	bog	undulating	1	level	FTNN
HSS248	ABN	TY.F	O	very poor	bog	level	1	level	FTNN
HSS249	ABN	TY.F	O	very poor	bog	undulating	1	level	FTNN
HSS250	ABN	TY.F	O	very poor	bog	undulating	1	level	FTNN
HSS251	ABN	TY.F	O	poor	bog	level	1	level	FTNN
HSS252	ABN	TY.F	O	very poor	bog	level	1	level	FTNN
HSS253	MUS	FI.M	O	poor	bog	level	1	level	FTNN
jc002	ABN	TY.F	O	very poor	fen	level	0	—	FTNN
jc003	ABN	TY.F	O	very poor	fen	level	0	—	FONS
jc004	ABN	TY.F	O	very poor	fen	level	0	—	FONS
jc006	—	—	—	—	upland	hummocky	0	—	—
jc007	ABN	TY.F	O	very poor	fen	level	0	—	FTNN
jc008	—	—	—	—	upland	level	0	—	FTNN
jc009	ABN	TY.F	O	very poor	fen	level	0	—	FONS
jc010	—	—	—	—	—	—	0	—	FONS
jc012	ABN	TY.F	O	very poor	fen	level	0	—	FONS
jc013	—	—	—	—	upland	ridge	0	—	—
jc014	ABN	TY.F	O	very poor	fen	level	0	—	FTNN
jc015a	ABN	TY.F	O	very poor	fen	level	0	—	FTNN
jc015b	—	—	—	—	upland	—	0	—	—
JC016	—	—	—	—	upland	—	0	—	—
jc026	ABN	TY.F	O	very poor	fen	level	0	—	FTNN
jc027	ABN	TY.F	O	very poor	fen	level	0	—	FONS
jc028	ABN	TY.F	O	very poor	fen	level	0	—	—
jc029		—	—	—	upland	ridge	0	—	—
jc030	—	—	—	—	upland	—	0	—	—
jc031	ABN	TY.F	O	very poor	fen	level	0	—	—
jc033	—	—	—	—	upland	—	0	—	—
jc034	ABN	TY.F	O	very poor	fen	level	0	—	FTNN
jc035	ABN	TY.F	O	very poor	fen	level	0	—	—
jc036	—	—	—	—	—	—	0	—	—
jc038	ABN	TY.F	O	very poor	fen	—	0	—	—
jc039	ABN	TY.F	O	very poor	fen	—	0	—	—
jc041	ABN	TY.F	O	very poor	fen	—	0	—	FTNN
jc042	—	—	—	—	upland	—	0	—	—
jc043	—	—	—	—	upland	—	0	—	—

Table C-1 List of Soil Inspection Sites in the Jackpine Expansion Mining Area Local Study Area (continued)

Field Site #	Soil Series	Soil Subgroup	Parent Material	Drainage	Landform	Surface Expression	Slope Class	Slope Position	Ecosite
jc044	—	—	—	—	upland	—	0	—	—
jc045	—	—	—	—	upland	—	0	—	—
jc046	—	—	—	—	upland	—	0	—	—
jc047	—	—	—	—	upland	—	0	—	—
jc048	—	—	—	—	upland	—	0	—	—
jc049	—	—	—	—	upland	—	0	—	—
RD001	MLD	TY.M	Ob/LG	poor	fen	01	2	level	j1
RD002	MLDxs	T.M	Ob/LG	poor	fen	level	1	level	j1
RD003	MLD	TY.M	O	poor	fen	level	1	level	k2
RD004	MLD	ME.F	O	poor	fen	level	1	level	k2
RD005	MLD	FI.M	O	poor	fen	level	1	level	k2
RD006	ABN	TY.F	Ob/L	poor	fen	level	1	level	k2
RD007	ABN	TY.F	O	rapid	fen	level	1	level	k2
RD008	ABN	TY.F	Ob/LG	poor	fen	level	1	level	k1
RD009	BMTzrpt	ptR.G	Ov/F	poor	fen	level	1	level	FTNN
RD010	MLD	TY.M	O	poor	fen	level	1	level	k2
RD011	BMTzrpt	ptR.G	Ov/F	poor	fen	level	2	level	k2
RD012	MLDxs	T.M	Ov/F	rapid	fen	level	1	level	k2
RD013	BMTzrpt	ptR.G	Ov/F	poor	fen	level	2	level	k2
RD014	MLDxs	T.M	Ob/F	poor	fen	level	1	level	k2
RD015	MLDxs	T.M	Ob/F	poor	fen	level	1	level	k2
RD016	MMWpt	ptR.G	Ov/LG	poor	fen	level	1	level	j1
RD017	MLDxc	T.M	Ob/LG	poor	fen	level	1	level	j2
RD018	MLDxc	T.M	Ob/LG	poor	fen	level	1	level	k2
RD019	MMWpt	ptR.G	Ov/LG	poor	fen	level	1	level	k2
RD020	MLD	TY.M	O	poor	fen	level	1	level	k2
RD021	MLD	FI.M	O	poor	fen	level	1	level	k2
SCS0032	ABN	TY.F	O	poor	bog	level	1	level	BTNN
SCS0033	ABN	TY.F	O	poor	bog	level	1	level	BONS
SCS0034	ABN	TY.F	O	poor	fen	level	1	level	FONS
SCS0035	HLY	T.F	O	poor	—	level	1	level	SONS
SCS0036	ABN	TY.F	O	poor	—	level	1	level	BTNN
SCS0037	ABN	TY.F	O	poor	—	level	1	level	k2
SCS0038	ABN	TY.F	O	poor	—	level	1	level	BTNN
SCS0039	ABN	TY.F	O	poor	—	level	1	level	FTNN
SCS0040	ABN	TY.F	O	poor	—	level	1	level	FTNN
SCS0041	MILgl	GL.DYB	FG	imperfect	upland	u1l	2	lower	—
SCS0042	SUT	E.DYB	FG/Till	imperfect	—	undulating	2	level	d2
SCS0043	HLY	T.F	Ob/FG	poor	—	level	1	level	FTNN
SCS0044	ABN	TY.F	O	very poor	—	level	1	level	FONS
SCS0045	ABN	TY.F	O	very poor	—	level	1	level	FONS
SCS0046	MKWaa	FI.OC	O	poor	—	level	1	level	BTNN
SCS0047	MLD	TY.M	O	very poor	—	level	1	level	b4
SCS0048	MKWaa	FI.OC	O	poor	—	level	1	level	BTNN
SCS0049	ABN	TY.F	O	very poor	—	level	1	level	FTNN
SCS0050	ABN	TY.F	O	very poor	—	level	1	level	FTNN
SCS0052	ABN	TY.F	O	very poor	—	level	1	level	FTNN
SCS0054	ABN	TY.F	O	very poor	—	level	1	level	FTNN
SCS0055	ABN	TY.F	O	very poor	—	level	1	level	FTNN
SCS0056	ABN	TY.F	O	very poor	—	level	1	level	FTNN
SCS0057	ABN	TY.F	O	very poor	—	level	1	level	k2
SCS0058	ABN	TY.F	O	very poor	—	level	1	level	FTNN
SCS0059	ABN	TY.F	O	very poor	—	level	1	level	FONS

Table C-1 List of Soil Inspection Sites in the Jackpine Expansion Mining Area Local Study Area (continued)

Field Site #	Soil Series	Soil Subgroup	Parent Material	Drainage	Landform	Surface Expression	Slope Class	Slope Position	Ecosite
SCS0060	MLD	TY.M	O	very poor	—	level	1	level	FTNN
SCS0061	MLDxc	T.M	Olb/L	poor	—	level	1	level	FTNN
SCS0062	ABN	TY.F	O	very poor	—	level	1	level	FONS
SCS0063	MMW	R.G	FG	poor	—	level	1	level	FTNN
SCS0064	MLDxt	T.M	Ob/till	poor	—	level	1	level	FTNN
SCS0065	ABN	TY.F	O	very poor	—	level	1	level	FTNN
SCS0066	HLY	T.F	Ob/till	very poor	—	level	1	level	FTNN
SCS0067	MLD	TY.M	O	very poor	—	level	1	level	FONS
SCS0068	BMTzrpt	R.G	LG	poor	—	level	1	level	FTNN
SCS0069	STPpt	O.G	Till	poor	—	level	1	level	BTNN
SCS0071	BMTzrpt	R.G	FG	poor	—	level	1	level	FTNN
SCS0072	ABN	TY.F	Ob/till	very poor	—	level	1	level	FTNN
SCS0073	ABN	TY.F	O	very poor	—	level	1	level	FTNN
SCS0074	ABN	TY.F	Ob/till	very poor	—	level	1	level	FTNN
SCS0075	ABN	TY.F	O	very poor	—	level	1	level	FTNN
SCS0076	ABN	TY.F	O	very poor	—	level	1	level	FONS
SCS0077	ABN	TY.F	O	very poor	—	level	1	level	—
SCS0078	ABN	TY.F	O	very poor	—	level	1	level	FTNN
SCS0079	STPzrpt	R.G	Till	poor	—	level	1	level	FTNN
SCS0080	ABN	TY.F	O	very poor	—	level	1	level	FTNN
SCS0081	BMTzrpt	ptR.G	Till	poor	—	level	1	level	—
SCS0082	BMTzr	R.G	FG	poor	—	level	1	level	BTNN
SCS0083	BMTzrpt	ptR.G	Till	poor	—	level	1	level	BTNN
SCS022	ABN	TY.F	O	very poor	fen	level	1	level	FONS
SCS023	ABN	TY.F	O	very poor	fen	level	1	level	FONS
SCS024	MIL	E.DYB	FG	rapid	—	—	0	mid	d2
SCS025	HLY	T.F	Ob/FG	very poor	fen	level	1	level	FONS
SCS026	MIL	E.DYB	FG	rapid	—	—	0	mid	a1
SCS027	ABN	TY.F	O	very poor	fen	level	1	level	FONS
SCS028	MIL	E.DYB	FG	rapid	—	—	0	mid	b3
SCS029	MILzz	O.DYB	FG	moderately well	—	—	0	mid	b2
SCS030	MILzz	O.DYB	FG	moderately well	—	—	0	mid	b2
SCS031	MKWaa	FI.OC	O	poor	bog	level	1	level	BTNN
SCS051	ABN	TY.F	O	very poor	—	level	1	level	FTNN
SCS053	ABN	TY.F	O	very poor	fen	level	1	level	FTNN
SCS070	WHMaapt	ptO.LG	Till	imperfect	—	level	0	lower	BTNN
SCS084	ABN	TY.F	O	very poor	—	level	1	level	BTNN
SCS085	ABN	TY.F	O	very poor	—	level	1	level	BTNN
SCS086	ABN	TY.F	O	very poor	—	level	1	level	BTNN
SCS087	ABN	TY.F	O	very poor	—	level	1	level	FTNN
SCS088	ABN	TY.F	O	very poor	—	level	1	level	FTNN
SCS089	MKWaa	FI.OC	O	poor	—	level	1	level	BTNN
SCS090	MKWaa	FI.OC	O	poor	—	level	1	level	BTNN
SCS091	ABN	TY.F	O	very poor	—	level	1	level	BTNN
SCS092	ABN	TY.F	O	very poor	—	level	1	level	BTNN
SCS093	ABN	TY.F	O	very poor	—	level	1	level	FTNN
SCS094	ABN	TY.F	O	very poor	—	level	1	level	FTNN
SCS095	ABN	TY.F	O	very poor	—	level	1	level	FTNN
SCS096	ABN	TY.F	O	very poor	—	level	1	level	FTNN
SCS097	ABN	TY.F	O	very poor	—	level	1	level	FTNN
SCS098	ABN	TY.F	O	very poor	—	level	1	level	FTNN

Table C-1 List of Soil Inspection Sites in the Jackpine Expansion Mining Area Local Study Area (continued)

Field Site #	Soil Series	Soil Subgroup	Parent Material	Drainage	Landform	Surface Expression	Slope Class	Slope Position	Ecosite
SCS099	ABN	TY.F	O	very poor	—	level	1	level	FTNN
SCS100	ABN	TY.F	O	very poor	—	level	1	level	BTNN
SCS101	ABN	TY.F	O	very poor	—	level	1	level	FTNN
SCS102	ABN	TY.F	O	very poor	—	level	1	level	FTNN
SCS103	ABN	TY.F	O	very poor	—	level	1	level	FTNN
SCS104	MLD	TY.M	O	very poor	—	level	1	level	FONS
SCS105	MLD	TY.M	O	very poor	—	level	1	level	FONS
SCS106	MLD	TY.M	O	very poor	—	level	1	level	BTNN
SCS107	ABN	TY.F	O	very poor	—	level	1	level	FONS
SCS108	ABN	TY.F	O	very poor	—	level	1	level	FONS
SCS109	ABN	TY.F	O	very poor	—	level	1	level	BTNN
SCS110	ABN	TY.F	O	very poor	—	level	1	level	FONS
SCS111	ABN	TY.F	O	very poor	—	level	1	level	BTNN
SCS112	MKWaa	FI.OC	O	poor	—	level	1	level	BTNN
SCS113	ABN	TY.F	O	very poor	—	level	1	level	FTNN
SRS001	MILzz	O.DYB	FG	well	upland	u1h	3	level	b3
SRS007	ABN	TY.F	O	poor	fen	level	1	level	FTNN
SRS032	HLY	T.F	O	very poor	—	level	1	level	—
SRS033	ABN	TY.F	O	very poor	—	level	1	level	—
SRS034	ABN	TY.F	O	very poor	—	level	1	level	—
SRS035	SUTgl	GLE.DYB	FG/TILL	imperfect	—	undulating	3	lower	d2
SRS036	ABN	TY.F	O	very poor	—	level	1	level	—
SRS037	MILzz	O.DYB	FG	well	—	—	0	mid	—
SRS038	ABN	TY.F	O	very poor	—	level	1	level	—
SRS039	MILzz	O.DYB	FG	well	—	—	0	mid	d2
SRS040	MILzz	O.DYB	FG	well	—	—	0	mid	d2
SRS041	MILgl	GL.DYB	FG	imperfect	—	—	0	lower	d2
SRS042	MUS	TY.M	O	very poor	domed bog	level	1	level	BTNN
SRS043	MUS	TY.M	O	very poor	bog	level	2	level	FTNN
SRS044	MLD	TY.M	O	very poor	fen	level	1	level	FTNN
SRS045	ABN	TY.F	O	very poor	fen	level	2	level	FTNN
SRS046	ABN	TY.F	O	very poor	fen	level	2	level	FTNN
SRS047	ABN	TY.F	O	poor	fen	level	1	level	FTNN
SRS047	ABN	TY.F	O	poor	fen	level	1	level	FTNN
SRS047	ABN	TY.F	O	poor	fen	level	1	level	FTNN
SRS047	ABN	TY.F	O	poor	fen	level	1	level	FTNN
SRS048	MUS	TY.M	O	poor	bog	level	3	level	FTNN
SRS049	ABN	TY.F	O	very poor	fen	level	1	level	FTNN
SRS050	SUT	O.DYB	FG/TILL	well	upland	level	2	mid	d2
SRS051	BMTzrpt	ptR.G	FG	poor	wetlands	level	1	level	SONS
srs052	STPzrpt	ptR.G	Till	poor	upland	undulating	3	level	h1
SRS053	MLDxt	TY.M	Ob/Till	poor	fen	level	1	level	FONS
SRS054	MLD	TY.M	O	very poor	fen	level	2	level	FTNN
srs055	MKWaa	FI.OC	O	poor	bog	level	2	level	BTNN
SRS056	ABN	TY.F	O	poor	fen	level	2	level	FTNN
SRS057	ABN	TY.F	O	very poor	fen	level	1	level	FTNN
SRS058	MLD	TY.M	O	very poor	fen	level	1	level	FTNN
SRS069	ABN	TY.F	O	very poor	fen	level	1	level	FTNN
SRS070	ABN	TY.F	O	very poor	fen	level	1	level	FTNN
SRS071	ABN	TY.F	O	very poor	fen	level	1	level	FTNN
SRS100	MLDxc	T.M	O/LG	very poor	fen	level	1	level	FTNN
SRS101	MKWaa	ME.OC	O	poor	bog	level	2	level	STNN

Table C-1 List of Soil Inspection Sites in the Jackpine Expansion Mining Area Local Study Area (continued)

Field Site #	Soil Series	Soil Subgroup	Parent Material	Drainage	Landform	Surface Expression	Slope Class	Slope Position	Ecosite
SRS102	MUSxt	T.M	Ov/Till	very poor	bog	level	2	level	STNN
SRS103	MUSxt	T.M	Ov/Till	very poor	bog	level	2	level	STNN
SRS104	MMWpt	ptR.G	O/LG	very poor	bog	level	2	level	STNN
SRS105	STPzrpt	ptR.G	O/TILL	very poor	bog	level	2	level	STNN
SRS106	ABN	TY.F	O	very poor	bog	level	2	level	STNN
SRS107	MKWaa	FI.OC	O	very poor	bog	level	2	level	STNN
SRS108	MKWaa	FI.OC	O	very poor	bog	level	2	level	STNN
SRS109	MKWaa	FI.OC	O	very poor	bog	level	2	level	FTNN
SRS110	ABN	TY.F	O	very poor	bog	level	2	level	STNN
SRS111	ABN	TY.F	O	very poor	bog	level	2	level	STNN
SRS112	ABN	TY.F	O	very poor	fen	level	1	level	STNN
SRS113	MLD	TY.M	O	very poor	fen	level	1	level	FTNN
SRS114	MLD	TY.M	Ob/Till	very poor	fen	level	1	level	FTNN
SRS115	MLDxt	T.M	Ob/Till	very poor	fen	level	1	level	FTNN
SRS116	STPpt	ptO.G	Ov/Till	very poor	upland	level	4	level	STNN
SRS117	MILgl	GLE.DYB	GF	very poor	upland	undulating	3	level	STNN
SRS118	MUSxt	T.M	Ov/TILL	poor	upland	undulating	3	level	STNN
SRS200	MKWaa	FI.OC	O	very poor	bog	level	2	level	STNN
SRS201	MKWaa	TY.F.CRY	O	very poor	bog	level	2	level	STNN
SRS202	ABN	TY.F	O	very poor	bog	level	2	level	STNN
SRS203	ABN	TY.F	O	very poor	bog	level	2	level	STNN
SRS204	ABN	TY.F	O	very poor	bog	level	2	level	STNN
SRS205	ABN	TY.F	O	very poor	bog	level	2	level	STNN
SRS206	ABN	TY.F	O	very poor	bog	level	2	level	STNN
SRS207	ABN	TY.F	O	very poor	bog	level	2	level	STNN
SRS208	ABN	TY.F	O	very poor	fen	level	2	level	STNN
SRS209	ABN	TY.F	O	very poor	fen	level	2	level	FTNN
SRS210	MKWaa	ME.OC	O	very poor	fen	level	2	level	FTNN
SRS211	MKWaa	FI.OC	O	very poor	bog	undulating	3	level	STNN
SRS212	MKWaa	FI.OC	O	very poor	fen	level	2	level	STNN
SRS213	ABN	TY.F	O	very poor	bog	level	2	level	STNN
SRS214	MKWaa	FI.OC	O	very poor	bog	level	2	level	STNN
SRS215	MKWaa	FI.OC	O	very poor	bog	undulating	2	level	FTNN
SRS216	MKWaa	FI.OC	O	very poor	domed bog	undulating	2	level	STNN
SRS217	ABN	TY.F	O	very poor	fen	level	1	level	FTNN
SRS218	ABN	TY.F	O	very poor	fen	level	1	level	FONS
SRS219	MKWaa	FI.OC	O	very poor	bog	undulating	3	level	STNN
SRS220	ABN	TY.F	O	very poor	fen	level	1	level	MONG
SRS221	MKWaa	FI.OC	O	very poor	domed bog	undulating	2	level	STNN
SRS222	ABN	TY.F	O	very poor	fen	level	1	level	FTNN
SRS223	ABN	TY.F	O	very poor	bog	undulating	2	level	STNN
SRS224	ABN	TY.F	O	very poor	fen	level	1	level	STNN
SRS225	MKWaa	FI.OC	O	very poor	domed bog	undulating	3	level	STNN
SRS226	MKWaa	FI.OC	O	very poor	bog	undulating	2	level	STNN
SRS227	MKWaa	ME.OC	O	very poor	fen	level	1	level	BTNN
SRS228	ABN	TY.F	O	very poor	fen	level	1	level	BTNN
SRS229	ABN	TY.F	O	very poor	fen	level	1	level	BTNN
SRS230	MKWaa	ME.OC	O	very poor	domed bog	undulating	3	level	STNN
SRS231	MKWaa	FI.OC	O	very poor	bog	level	2	level	STNN
SRS232	MKWaa	FI.OC	O	very poor	bog	level	2	level	STNN

Table C-1 List of Soil Inspection Sites in the Jackpine Expansion Mining Area Local Study Area (continued)

Field Site #	Soil Series	Soil Subgroup	Parent Material	Drainage	Landform	Surface Expression	Slope Class	Slope Position	Ecosite
SRS233	MKWaa	FI.OC	O	very poor	bog	level	2	level	STNN
SRS234	ABN	TY.F	O	very poor	bog	undulating	1	level	STNN
SRS235	ABN	TY.F	O	very poor	bog	level	1	level	FTNN
SRS236	ABN	TY.F	O	very poor	bog	level	2	level	FTNN
SRS237	ABN	TY.F	O	very poor	fen	level	1	level	FONS
SRS238	ABN	TY.F	O	very poor	bog	level	1	level	FTNN
SRS239	MKWaa	FI.OC	O	very poor	domed bog	level	2	level	STNN
SRS240	ABN	TY.F	O	very poor	fen	level	1	level	FONS
SRS241	ABN	TY.F	O	very poor	bog	level	2	level	FTNN
SRS242	MKWaa	TI.OC	O	very poor	fen	level	2	level	FTNN
SRS300	MKWaa	FI.OC	O	very poor	bog	level	2	level	STNN
SRS301	MKWaa	FI.OC	O/LG	very poor	bog	level	2	level	STNN
SRS302	ABN	TY.F	O	very poor	bog	level	2	level	FTNN
SRS303	ABN	TY.F	O	very poor	fen	level	1	level	MONG
SRS304	ABN	TY.F	O	very poor	domed bog	level	2	level	STNN
SRS305	ABN	TY.F	O	very poor	bog	level	2	level	STNN
SRS306	ABN	TY.F	O	very poor	bog	level	2	level	FTNN
SRS307	MUSxc	T.M	O/LG	very poor	bog	level	2	level	STNN
SRS308	ALGpt	ptO.LG	O/LG	very poor	bog	level	2	level	STNN
SRS309	SUTglpt	ptGLE.DYB	O/FG	poor	bog	level	2	level	STNN
SRS310	MUSxs	T.M	O/FG	poor	bog	level	2	level	STNN
SRS311	MUSxs	T.M	O/FG	poor	bog	level	2	level	STNN
SRS312	WHMaapt	ptO.LG	O/LG	poor	bog	level	2	level	STNN
SRS313	FRTgl	GL.GL	FG	imperfect	upland	u1h	3	lower	d2
SRS314	WHMaapt	ptO.LG	O/FG	imperfect	upland	u1h	3	lower	d2
SRS315	MILgl	GLE.DYB	FG	imperfect	upland	u1h	3	lower	d2
SRS316	ABN	TY.F	O/GL	very poor	bog	level	1	level	STNN
SRS317	HLY	T.F	O/FG	very poor	fen	level	1	level	FTNN
SRS318	MIL	E.DYB	FG	rapid	upland	inclined	4	mid	b4
SRS319	ABN	TY.F	O	very poor	fen	level	1	level	FTNN
SRS320	MKWaa	FI.OC	O	very poor	fen	level	2	level	STNN
SRS321	ABN	TY.F	O	very poor	bog	level	2	level	FTNN
SRS322	—	—	—	—	—	—	0	—	—
SRS323	MLD	TY.M	O	very poor	fen	level	1	level	k2
TER002	ABN	TY.F	O	very poor	fen	level	1	level	—
TER003	BMTzrpt	ptR.G	FG	rapid	upland	level	1	mid	—
TER004	ABN	TY.F	O	very poor	fen	level	1	level	—
TER005	ABN	TY.F	O	very poor	fen	level	1	level	—
TER006	ABN	TY.F	O	very poor	fen	level	1	level	—
TER007	ABN	TY.F	O	very poor	fen	level	1	level	—
TER008	ABN	TY.F	O	very poor	fen	level	1	level	—
TER010	ABN	TY.F	O	very poor	fen	level	1	level	—
TER011	ABN	TY.F	O	very poor	fen	level	1	level	—
TER012	ABN	TY.F	O	very poor	fen	level	1	level	—
TER013	HLY	T.F	Ob/FG	poor	bog	level	1	level	—
TER014	ABN	TY.F	O	very poor	fen	level	1	level	—
TER015	HLY	T.F	Ov/FG	poor	bog	level	1	level	—
TER016	ABN	TY.F	O	very poor	fen	level	1	level	—
TER017	HLY	T.F	Ov/FG	poor	bog	level	1	level	—
TER018	ABN	TY.F	O	very poor	fen	level	1	level	—

Table C-1 List of Soil Inspection Sites in the Jackpine Expansion Mining Area Local Study Area (continued)

Field Site #	Soil Series	Soil Subgroup	Parent Material	Drainage	Landform	Surface Expression	Slope Class	Slope Position	Ecosite
TER019	ABN	TY.F	O	very poor	fen	level	1	level	—
TER020	ABN	TY.F	O	very poor	fen	level	1	level	—
TER021	ABN	TY.F	O	very poor	fen	level	1	level	—
TER022	ABN	TY.F	O	very poor	fen	level	1	level	—
TER023	HLY	T.F	Ob/LG	poor	bog	level	1	level	—
TER024	ABN	TY.F	O	very poor	fen	level	1	level	—
TER025	WHMaapt	ptO.LG	F	imperfect	upland	level	2	lower	—
TER026	ABN	TY.F	O	very poor	fen	level	1	level	—
TER027	ABN	TY.F	O	very poor	fen	level	1	level	—
TER028	ABN	TY.F	O	very poor	fen	level	1	level	—
TER029	ABN	TY.F	O	very poor	fen	level	1	level	—
TER030	ABN	TY.F	O	very poor	fen	level	1	level	—
TER031	ABN	TY.F	O	very poor	fen	level	1	level	—
TER032	MIL	E.DYB	FG	rapid	upland	undulating	3	mid	—
TER033	ABN	TY.F	O	very poor	fen	level	1	level	—
TER034	ABN	TY.F	O	very poor	fen	level	1	level	—
TER035	ABN	TY.F	O	very poor	fen	level	1	level	—
TER036	ABN	TY.F	O	very poor	fen	level	1	level	—
TER037	ABN	TY.F	O	very poor	fen	level	1	level	—
TER038	ABN	TY.F	O	very poor	fen	level	1	level	—
TER039	ABN	TY.F	O	very poor	fen	level	1	level	—
TER040	MIL	E.DYB	FG	rapid	upland	undulating	3	mid	—
TER041	ABN	TY.F	O	very poor	fen	level	1	level	—
TER042	ABN	TY.F	O	very poor	fen	level	1	level	—
TER045	ABN	TY.F	O	very poor	fen	level	1	level	—
TER046	ABN	TY.F	O	very poor	fen	level	1	level	—
TER047	ABN	TY.F	O	very poor	fen	level	1	level	—
TER048	MIL	E.DYB	FG	rapid	upland	undulating	3	mid	—
TER049	ABN	TY.F	O	very poor	fen	level	1	level	—
TER050	ABN	TY.F	O	very poor	fen	level	1	level	—
TER051	MIL	E.DYB	FG	rapid	upland	undulating	3	mid	—
TER052	ABN	TY.F	O	very poor	fen	level	1	level	—
TER053	ABN	TY.F	O	very poor	fen	level	1	level	—
TER054	ABN	TY.F	O	very poor	fen	level	1	level	—
TER055	HLY	T.F	Ob/FG	poor	bog	level	1	level	—
TER056	HLY	T.F	Ob/FG	poor	bog	level	1	level	—
TER057	MIL	E.DYB	FG	rapid	fen	undulating	3	mid	—
TER058	ABN	TY.F	O	very poor	fen	level	1	level	—
TER059	ABN	TY.F	O	very poor	fen	level	1	level	—
TER060	ABN	TY.F	O	very poor	fen	level	1	level	—
TER061	BMTzrpt	ptR.G	FG	rapid	upland	level	1	mid	—
TER062	HLY	T.F	Ob/FG	poor	bog	level	1	level	—
TER063	HLY	T.F	Ob/FG	poor	bog	level	1	level	—
TER064	ABN	TY.F	O	very poor	fen	level	1	level	—
TER065	BMTptzr	ptR.G	FG	rapid	upland	level	1	mid	—
TER066	ABN	TY.F	O	very poor	fen	level	1	level	—
TER067	MIL	E.DYB	FG	rapid	upland	undulating	3	mid	—
TER068	ABN	TY.F	O	very poor	fen	level	1	level	—
TER069	ABN	TY.F	O	very poor	fen	level	1	level	—
TER070	ABN	TY.F	O	very poor	fen	level	1	level	—
TER071	ABN	TY.F	O	very poor	fen	level	1	level	—
TER072	ABN	TY.F	O	very poor	fen	level	1	level	—
TER073	ABN	TY.F	O	very poor	fen	level	1	level	—

Table C-1 List of Soil Inspection Sites in the Jackpine Expansion Mining Area Local Study Area (continued)

Field Site #	Soil Series	Soil Subgroup	Parent Material	Drainage	Landform	Surface Expression	Slope Class	Slope Position	Ecosite
TER074	ABN	TY.F	O	very poor	fen	level	1	level	—
TER075	ABN	TY.F	O	very poor	fen	level	1	level	—
TER076	ABN	TY.F	O	very poor	fen	level	1	level	—
TER077	ABN	TY.F	O	very poor	fen	level	1	level	—
TER079	ABN	TY.F	O	very poor	fen	level	1	level	—
TER080	MIL	E.DYB	FG	rapid	upland	undulating	3	mid	—
TER081	ABN	TY.F	O	very poor	fen	level	1	level	—
TER082	ABN	TY.F	O	very poor	fen	level	1	level	—
TER083	ABN	TY.F	O	very poor	fen	level	1	level	—
TER084	ABN	TY.F	O	very poor	fen	level	1	level	—
TER089	ABN	TY.F	O	very poor	fen	level	1	level	—

— = No data.

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409

Table C-2 List of Soil Inspection Sites in the Pierre River Mining Area Local Study Area

Field Site #	Series	Subgroup	Parent Material	Drainage	Landform	Surface Expression	Peat Depth [cm]	Slope Class	Slope Position	Ecosite
2216	MIL	E.DYB	F	W	upland	hummocky	3	4	L	—
2217	MIL	E.DYB	F	W	upland	hummocky	3	4	U	—
2218	MIL	E.DYB	F	W	upland	hummocky	3	5	U	—
2219	NAMgl	GL.R	Colluvial	I	upland	hummocky	20	3	M	—
7151	MUSxs	T.M	Ov/F	VP	bog	level	155	1	level	—
7152	MUSxc	T.M	Ov/L	VP	bog	level	80	1	level	—
7153	MUSxc	T.M	Ov/F	VP	bog	level	60	1	level	—
7154	MILzz	O.DYB	FG	R	upland	ridge	3	5	U	—
7155	MILzz	O.DYB	F	W	upland	hummocky	4	4	U	—
7156	FRT	O.GL	F	W	upland	hummocky	4	4	M	—
7157	MUSxc	T.M	Ov/L	VP	bog	level	130	1	level	—
7158	MIL	E.DYB	F	W	upland	undulating	3	3	U	—
7159	FRTzz	BR.GL	F	W	upland	hummocky	4	4	M	—
7160	MIL	E.DYB	F	W	upland	hummocky	2	4	M	—
7161	MLDxc	T.M	Ov/L	VP	fen	level	70	1	level	—
7162	MLDxc	T.M	Ov/L	VP	fen	level	60	1	level	—
7163	ALGpt	ptR.G	L	VP	fen	level	35	1	level	—
7164	MIL	E.DYB	F	W	upland	hummocky	3	3	U	—
7165	MIL	E.DYB	F	W	upland	hummocky	2	4	M	—
7166	MIL	E.DYB	F	W	upland	hummocky	3	4	L	—
7167	MUS	TY.M	O	VP	bog	level	160	1	level	—
7168	MIL	E.DYB	F	W	upland	undulating	3	3	M	—
7169	MIL	E.DYB	F	W	upland	hummocky	3	4	M	—
7170	MIL	E.DYB	F	W	upland	hummocky	—	4	M	—
7171	MIL	E.DYB	F	W	upland	undulating	3	3	M	—
7172	MIL	E.DYB	F	W	upland	undulating	3	3	M	—
7173	MIL	E.DYB	F	MW	upland	hummocky	5	4	U	—
7174	MLDxc	T.M	Ov/L	VP	fen	level	130	1	level	—
7176	MIL	E.DYB	F	—	upland	hummocky	3	4	M	—
7177	MIL	E.DYB	F	W	upland	hummocky	3	4	M	—
7178	MIL	E.DYB	F	W	upland	hummocky	3	4	U	—
7179	MUSxc	T.M	Ov/L	VP	bog	level	145	1	level	—
7182	CHTzr	R.G	L	I	upland	level	10	1	level	—
7183	CHTzr	R.G	L	P, I	upland	level	9	1	level	—
7184	CHTzr	ptR.G	L	P	other wetlands	level	15	1	level	—
7185	NAMgl	GL.R	L	I	upland	level	10	1	level	—
7186	DOVgl	GL.GL	L	I	—	undulating	6	1	M	—
7187	DOVgl	GL.GL	L	I	upland	level	7	1	level	—
7188	DOV	O.GL	L	MW	upland	undulating	4	3	M	—
7189	MLDxc	T.M	Ov/L	VP	swamp	level	130	1	level	—
7190	MLDxc	T.M	Ov/L	VP	swamp	level	70	1	level	—
7191	MLDxc	T.M	Ov/L	VP	swamp	level	70	1	level	—
7192	MLDxs	T.M	Ov/F	VP	swamp	level	60	1	level	—

Table C-2 List of Soil Inspection Sites in the Pierre River Mining Area Local Study Area (continued)

Field Site #	Series	Subgroup	Parent Material	Drainage	Landform	Surface Expression	Peat Depth [cm]	Slope Class	Slope Position	Ecosite
7193	MILzz	O.DYB	F	W	upland	hummocky	4	4	M	—
7194	MIL	E.DYB	F	W	upland	hummocky	3	4	M, level	—
7195	MIL	E.DYB	F	W	upland	undulating	6	3	M	—
7196	FRTzz	BR.GL	F	MW	upland	undulating	6	3	M	—
7197	FRT	O.GL	F	MW	upland	undulating	5	2	M	—
7198	FRT	O.GL	F	W	upland	undulating	4	3	M	—
7199	FRT	O.GL	COLLOvIUM	R	upland	inclined	4	8	M	—
7200	MUSxs	T.M	Ov/F	P	bog	level	70	1	LE	—
7201	MKWaa	R.SC	Ov/F	VF	fen	level	60	1	level	—
7202	BMTptzr	ptR.G	Ov/F	P	bog	level	50	1	level	—
7203	FRT	O.GL	F	MW	upland	undulating	5	2	L	—
7204	FRTyg	O.GL	COLLUvIAL	—	upland	inclined	28	1	—	—
7205	FRT	O.GL	F	W	upland	undulating	5	3	M	—
7206	FRT	O.GL	F	W	upland	undulating	5	2	M	—
7207	MIL	E.DYB	F	W	upland	undulating	5	2	M	—
7208	MIL	E.DYB	F	W	upland	undulating	5	3	M	—
7209	MIL	E.DYB	F	W	upland	undulating	5	3	M	—
7213	MILyg	E.DYB	—	—	upland	undulating	4	1	—	—
7214	MIL	E.DYB	F	W	upland	undulating	3	3	M	—
7215	MIL	E.DYB	F	W	upland	undulating	3	3	M	—
7220	NAMgl	GL.R	F	—	wetlands	undulating	15	1	—	—
7221	MIL	E.DYB	F	W	upland	hummocky	3	4	U	—
7222	MIL	E.DYB	F	W	—	hummocky	3	4	M	—
7223	MIL	E.DYB	F	W	upland	hummocky	4	4	U	—
7224	FRT	O.GL	F	W	upland	undulating	4	3	M	—
7226	MIL	E.DYB	F	W	upland	hummocky	3	4	L	—
7227	MIL	E.DYB	F	W	upland	hummocky	3	4	M	—
7228	MIL	E.DYB	F	W	upland	hummocky	3	4	M	—
7229	MIL	E.DYB	F	W	upland	hummocky	4	4	M	—
7230	MIL	E.DYB	F	W	upland	hummocky	3	4	U	—
7231	MIL	E.DYB	F	W	upland	undulating	3	3	U	—
7232	BMTptzr	ptR.G	F	P	bog	level	38	1	L	—
7234	MILyg	E.DYB	F	MW	upland	undulating	5	3	L	—
7235	FRT	O.GL	F	W	—	hummocky	4	1	M	—
7236	FRT	O.GL	F	W	upland	hummocky	4	5	U	—
7237	MIL	E.DYB	F	W	upland	hummocky	4	4	M	—
7238	MIL	E.DYB	F	W	upland	undulating	3	3	M	—
7239	MIL	E.DYB	F	W	upland	undulating	5	3	M	—
7240	MIL	E.DYB	F	W	—	hummocky	3	4	L	—
7241	MIL	E.DYB	F	W	upland	hummocky	4	4	M	—
7333	FRTgl	GL.GL	—	—	upland	undulating	10	1	—	—
—	—	O.GL	Till	—	upland	u/h	—	3	—	—
AC_ 01	—	—	—	—	—	—	—	1	—	—

Table C-2 List of Soil Inspection Sites in the Pierre River Mining Area Local Study Area (continued)

Field Site #	Series	Subgroup	Parent Material	Drainage	Landform	Surface Expression	Peat Depth [cm]	Slope Class	Slope Position	Ecosite
AC_07_100	MILzz	O.EB	—	W	upland	level	—	1	level	—
AC_07_101	MILzz	O.EB	F	W	upland	undulating	—	2	M	—
AC_07_102	FRT	BR.GL	F	W	upland	undulating	—	2	U	—
AC_07_103	FRTzz	BR.GL	F	W	upland	undulating	—	2	M	—
AC_07_104	FRT	O.GL	F	W	upland	level	—	1	level	—
AC_07_105	FRTzz	BR.GL	F	W	upland	undulating	—	2	M	—
AC_07_106	MILzz	O.EB	F	MW	upland	undulating	—	2	M	—
AC_07_107	FRT	O.GL	—	—	—	undulating	—	1	—	—
AC_07_108	FRTzz	O.EB	F	MW	upland	undulating	—	2	U	—
AC_07_109	FRTzz	BR.GL	F	MW	upland	undulating	—	2	L	—
AC_07_110	FRTzz	O.EB	F	MW	upland	—	—	2	U	—
AC_07_111	FRTzz	BR.GL	—	—	—	—	—	1	—	—
AC_07_112	FRTzz	O.EB	F	MW	upland	undulating	—	2	L	—
AC_07_113	FRTzz	BR.GL	F	W	upland	—	—	3	U	—
AC_07_114	MUSxs	T.M	—	—	bog	—	—	1	—	—
AC_07_115	MLDxc	T.M	—	VP	fen	—	—	1	level	—
AC_07_116	BMTptzr	ptR.G	F	P	bog	—	—	1	level	—
AC_07_117	MLDxc	T.M	F	VP	fen	fen	—	1	level	—
AC_07_118	CHTzr	R.G	L	P	upland	level	—	1	level	—
AC_07_119	MLDxc	T.M	F	VP	fen	—	—	1	level	—
AC_07_120	FRTgl	GL.GL	F	MW	upland	level	—	2	U	—
AC_07_121	MUSxc	T.M	F	P	bog	bog	—	1	level	—
AC_07_122	STPzr	ptR.G	F	VP	bog	bog	—	1	level	—
AC_07_123	MUSxc	T.M	Ov/L	P	bog	bog	—	1	level	—
AC_07_124	BMTptzr	ptR.G	L	P	bog	bog	—	1	level	—
AC_07_125	MLDxs	T.M	Ov/L	VP	fen	fen	—	1	level	—
AC_07_126	MUSxc	T.M	Ov/L	P	bog	bog	—	1	level	—
AC_07_127	MLDxs	T.M	Ov/F	VP	fen	—	—	1	level	—
AC_07_128	MUSxs	T.M	—	—	—	—	—	1	—	—
AC_07_129	MUSxs	T.M	F	P	bog	bog	—	1	level	—
AC_07_130	MLDxs	T.M	Ov/F	VP	fen	fen	—	1	level	—
AC_07_180	MLDxc	T.M	Ov/L	VP	fen	fen	—	1	level	—
AC_07_180	MLDxc	T.M	Ov/L	P	wetlands	level	—	1	level	—
AC_07_88	LVK	O.GL	Fv/till	W	upland	hummocky	—	3	M	—
AC_07_89	LVK	O.GL	Fv/L	W	upland	hummocky	—	3	M	—
AC_07_90	LVK	O.GL	Fv/L	W	upland	hummocky	—	3	L	—
AC_07_91	LVK	O.GL	F	W	upland	hummocky	—	2	M	—
AC_07_92	MUSxs	T.M	—	—	—	—	—	1	—	—
AC_07_93	LVK	O.GL	F	MW	upland	undulating	—	2	L	—
AC_07_94	—	—	—	W	upland	undulating	—	2	M	—
AC_07_94	—	—	—	—	—	—	—	1	—	—
AC_07_95	FRTgl	GL.GL	F	I	upland	undulating	—	2	L	—
AC_07_96	FRT	O.GL	F	MW	upland	—	—	2	M	—

Table C-2 List of Soil Inspection Sites in the Pierre River Mining Area Local Study Area (continued)

Field Site #	Series	Subgroup	Parent Material	Drainage	Landform	Surface Expression	Peat Depth [cm]	Slope Class	Slope Position	Ecosite
AC_07_97	MLDxs	T.M	O/F	VP	fen	—	—	1	level	—
AC_07_98	FRT	O.GL	F	W	upland	undulating	—	2	L	—
AC_07_99	MILzz	O.EB	F	W	upland	—	—	2	M	—
AC7001	MLDxs	T.M	Ov/F	P	—	fp3	—	1	L	—
AC7002	MLDxs	T.M	—	—	—	inclined	—	—	—	—
AC7003	MLDxs	T.M	Ov/F	P	fen	inclined	—	1	—	—
AC7004	MLDxs	T.M	Ov/F	P	fen	fen	—	1	level	—
AC7005	BMTzr	R.G	F	I	—	undulating	—	2	L	—
AC7006	MIL	E.DYB	F	W	upland	—	—	4	M	—
AC7007	MIL	E.DYB	F	—	—	—	—	4	—	—
AC7009	MIL	E.DYB	—	—	—	undulating	—	—	—	—
AC7009	MIL	E.DYB	F	MW	upland	—	—	2	M	—
AC7011	MIL	E.DYB	F	W	upland	undulating	—	3	L	—
AC7012	MIL	E.DYB	F	W	upland	—	—	4	U	—
AC7013	MIL	E.DYB	—	—	—	—	—	—	—	—
AC7014	MIL	E.DYB	F	—	upland	—	—	3	s	—
AC7015	MIL	E.DYB	F	MW	upland	—	—	2	L	—
AC7016	MIL	E.DYB	F	W	upland	undulating	—	3	U	—
AC7017	MIL	E.DYB	F	W	upland	—	—	3	L	—
AC7018	MIL	E.DYB	—	—	—	—	—	—	—	—
AC7019	MIL	E.DYB	F	W	upland	—	—	4	M	—
AC7020	MIL	E.DYB	FG	R	upland	hummocky	—	4	L	—
AC7021	MILyg	O.EB	F	W	upland	undulating	—	3	M	—
AC7022	MLDxc	T.M	Ov/f	—	—	fen	—	—	—	—
AC7023	MLD	TY.M	O	VP	fen	—	—	1	level	—
AG70026	FRT	O.GL	L	MW	upland	undulating	—	3	M	—
AG7024	MLD	TY.FM	O	VP	fen	fen	—	1	level	—
AG7025	MLD	TY.FM	—	—	—	—	—	—	—	—
AG7027	FRTzz	O.EB	Fv/tar sand	W	upland	undulating	—	3	M	—
AG7028	MLD	TY.M	O	—	fen	—	—	—	—	—
AG7029	CHTzrpt	ptR.G	L	P	fen	—	—	2	M	—
AG7030	MUSxc	T.M	Ov/L	P	bog	—	—	2	L	—
AG7031	CHTzrpt	ptR.G	F	—	—	bog	—	—	—	—
AG7032	—	—	Fv/till	MW	upland	—	—	3	U	—
AG7032	—	—	—	—	—	—	—	—	—	—
AG7033	MLDxs	T.M	Ov/L	VP	fen	fen	—	1	level	—
AG7034	MLDxs	T.M	Ov/L	VP	fen	fen	—	1	L	—
AG7035	FRTzz	BR.GL	Fv/till	MW	upland	—	—	3	U	—
AG7036	BMTptzr	ptR.G	F	P	bog	bog	—	1	level	—
AG7037	MLDxs	T.M	Ov/F	VP	fen	fen	—	1	level	—
AG7038	MILgl	GLE.DYB	F	I	upland	undulating	—	2	M	—
AG7039	FRTzz	BR.GL	F	MW	upland	undulating	—	2	U	—
AG7040	BMTptzr	ptR.G	F	P	upland	undulating	—	2	M	—

Table C-2 List of Soil Inspection Sites in the Pierre River Mining Area Local Study Area (continued)

Field Site #	Series	Subgroup	Parent Material	Drainage	Landform	Surface Expression	Peat Depth [cm]	Slope Class	Slope Position	Ecosite
AG7041	LVKgl	GL.GL	Fv/till	I	upland	undulating	—	3	L	—
AG7042	LVK	O.GL	Fv/TILL	W	upland	undulating	—	3	U	—
AG7043	LVKzz	BR.GL	Fv/till	W	upland	undulating	—	3	U	—
AG7044	SUTzz	O.EB	Fv/till	W	upland	undulating	—	3	U	—
AG7045	MLDxc	T.M	Ov/L	P	fen	fen	—	2	level	—
AG7046	BMTptzr	ptR.G	L	P	fen	fen	—	1	level	—
AG7047	LVKzz	BR.GL	Fv/till	W	upland	undulating	—	3	M	—
AG7048	LVKzz	O.EB	Fv/till	MW	upland	undulating	—	3	U	—
AG7049	FRTzz	O.EB	F	W	upland	undulating	—	3	M	—
AG7050	FRTzz	O.EB	F	MW	upland	undulating	—	3	U	—
AG7051	FRTgl	GL.GL	F	I	upland	undulating	—	3	L	—
AG7052	MILgl	GLE.DYB	F	I	upland	undulating	—	3	L	—
AG7053	SUTzz	O.EB	Fv/till	W	upland	undulating	—	3	M	—
AG7054	MLDxc	T.M	Ov/L	VP	fen	fen	—	1	level	—
AG7055	MILgl	GLE.DYB	F	I	upland	undulating	—	2	M	—
AG7055	MILgl	GLE.DYB	—	—	—	—	—	—	—	—
AG7056	FRT	O.GL	F	W	upland	undulating	—	3	M	—
AG7057	MIL	O.DYB	F	MW	upland	undulating	—	3	M	—
AG7058	FRTzz	O.EB	F	MW	upland	undulating	—	3	L	—
AG7059	FRT	O.GL	F	MW	upland	undulating	—	2	L	—
AG7060	—	—	—	—	—	undulating	—	—	—	—
AG7061	BMTptzr	ptR.G	F	P	upland	undulating	—	2	L	—
AG7062	—	—	—	—	—	—	—	—	—	—
AG7063	MLDxc	T.M	Ov/F	VP	fen	fen	—	1	level	—
AG7064	MLDxc	T.M	Ov/F	P	fen	—	—	1	level	—
AG7065	MLDxc	T.M	—	—	—	—	—	—	—	—
AG7066	FRTzz	O.EB	F	W	upland	undulating	—	2	M	—
AG7067	BMTptzr	ptR.G	F	P	upland	hummocky	—	1	level	—
AG7068	MUSxc	T.M	Ov/F	P	bog	bog	—	1	level	—
AG7069	MUSxt	T.M	Ov/till	P	bog	bog	—	1	M	—
AG7070	MUSxc	T.M	Ov/L	VP	fen	fen	—	1	level	—
AG7071	STPzr	ptR.G	Till	P	upland	inclined	—	2	L	—
AG7072A	MLDxc	T.M	Ov/L	VP	fen	fen	—	1	level	—
AG7073	FRT	O.GL	F	W	upland	undulating	—	3	U	—
AG7074	FRT	O.GL	F	W	upland	undulating	—	2	M	—
AG7075	HRR	O.GL	Till	W	upland	undulating	—	3	M	—
AG7076	FRTzz	O.EB	F	W	upland	undulating	—	3	M	—
AG7077	FRT	O.GL	F	MW	upland	undulating	—	3	M	—
AG7078	BMTptzr	ptR.G	F	P	upland	fp1	—	1	M	—
AG7079	MLDxs	T.M	O	VP	fen	fen	—	1	level	—
AG7080	MLDxs	T.M	O	VP	fen	fen	—	1	level	—
AG7081	MLDxs	T.M	O	VP	fen	fen	—	1	level	—
AG7082	FRTgl	GL.GL	F	I	upland	undulating	—	2	M	—

Table C-2 List of Soil Inspection Sites in the Pierre River Mining Area Local Study Area (continued)

Field Site #	Series	Subgroup	Parent Material	Drainage	Landform	Surface Expression	Peat Depth [cm]	Slope Class	Slope Position	Ecosite
AG7083	HRRgl	GL.GL	Till	I	upland	undulating	—	2	M	—
AG7084	FRT	O.GL	F	MW	upland	undulating	—	3	M	—
AG7085	FRT	O.GL	L	MW	upland	undulating	—	2	L	—
AG7086	BMTptzr	ptR.G	L	I	upland	undulating	—	2	M	—
AG7087	MLDxs	T.M	O	P	fen	fen	—	1	level	—
c50021	MIL	E.DYB	FG	W	upland	undulating	1	5	L	disturbed
c50022	MILzz	BR.GL	FG	W	upland	undulating	3	3	L	b4
c50023	MILzz	O.DYB	FG	W	upland	undulating	—	4	U	distturbed B4
c50024	FRT	BR.GL	FG	W	upland	undulating	—	4	U	disturbed
c50025	PEA	O.GL	L	MW	upland	undulating	—	3	M	disturbed
c50026	MLDxc	T.M	O	VP	fen	level	95	1	level	FTNN
c50027	FRTzz	BR.GL	F	W	upland	hummocky	—	5	M	disturbed
c50028	FRT	O.DYB	Fv/Tarsand	W	upland	hummocky	—	4	U	disturbed
c50029	FRTzz	BR.GL	FG	W	upland	hummocky	—	4	M	disturbed
c50030	MILzz	O.DYB	FG	W	upland	hummocky	—	4	M	disturbed
c50031	MILzz	BR.GL	FG	W	upland	hummocky	—	5	M	disturbed
c50032	MLD	TY.M	O	VP	fen	level	175	1	level	FTNN
c50033	FRTzz	BR.GL	FG	MW	upland	undulating	3	3	M	BTNN
c50034	FRTzz	BR.GL	FG	MW	upland	undulating	7	3	M	D2
c50035	MLDxc	T.F	Ov/L	VP	fen	level	55	1	level	MONG
c50036	MLDxc	T.F	Ov/LG	VP	fen	level	60	1	level	MONG
c50037	MILzz	O.DYB	FG	W	upland	hummocky	2	4	U	C1
c50038	MIL	E.DYB	FG	W	upland	undulating	8	3	M	B4
c50039	MIL	E.DYB	FG	W	upland	hummocky	8	4	L	C1
c50040	MIL	E.DYB	FG	W	upland	hummocky	3	4	L	B4
c50041	MIL	E.DYB	FG	W	upland	hummocky	—	5	M	D1
c50042	MLDxs	T.F	Ov/FG	VP	fen	level	70	1	level	MONG
c50043	MLDxs	T.F	Ov/FG	VP	fen	level	70	1	level	MONG
c50044	MIL	E.DYB	FG	W	upland	hummocky	5	4	U	H1
c50045	MILzz	O.DYB	FG	W	upland	hummocky	5	4	M	D2
c50046	MIL	E.DYB	FG	W	upland	hummocky	5	4	M	B1
c50047	MIL	E.DYB	FG	W	upland	undulating	4	3	L	B1
c50048	MIL	E.DYB	FG	W	upland	hummocky	—	4	U	DL
c50049	MLDxs	T.M	O	VP	fen	level	155	1	level	FONS
c50050	MILzz	O.DYB	FG	W	upland	hummocky	4	4	M	B1
c50051	MILyg	E.DYB	—	—	upland	—	—	—	—	B3
c50052	MILzz	O.EB	FG	W	upland	hummocky	6	3	M	B1
c50053	MILzzyg	O.EB	FG	W	upland	undulating	5	3	M	D2
c50054	MIL	E.DYB	FG	W	upland	hummocky	dist	4	M	disturbed
c50055	MIL	E.DYB	FG	W	upland	hummocky	dist	4	M	disturbed
c50056	MIL	E.DYB	FG	W	upland	hummocky	dist	4	M	disturbed
c50057	MIL	E.DYB	FG	W	upland	undulating	dist	3	L	distturbed. b1

Table C-2 List of Soil Inspection Sites in the Pierre River Mining Area Local Study Area (continued)

Field Site #	Series	Subgroup	Parent Material	Drainage	Landform	Surface Expression	Peat Depth [cm]	Slope Class	Slope Position	Ecosite
c50058	MILzz	O.DYB	FG	W	upland	undulating	dist	3	U	disturbed
c50059	MIL	E.DYB	FG	W	upland	undulating	4	3	L	—
c50060	MIL	E.DYB	FG	W	upland	hummocky	4	4	L	a1
c50061	MIL	E.DYB	FG	W	upland	undulating	4	3	M	b1
c50062	MILzz	O.DYB	FG	W	upland	undulating	3	4	M	a1
c50063	MIL	E.DYB	FG	W	upland	—	4	4	M	b1
c50064	MIL	E.DYB	FG	W	upland	hummocky	3	4	M	b1
c50065	MIL	E.DYB	FG	W	upland	hummocky	3	4	M	b1
c50066	MILzz	O.DYB	FG	W	upland	undulating	3	3	M	a1
c50067	MIL	E.DYB	FG	W	upland	hummocky	3	4	M	b1
c50068	MIL	O.DYB	FG	R	upland	hummocky	3	3	M	b3
c50069	MILzz	O.DYB	FG	R	upland	inclined	3	5	M	b3
c50070	MIL	E.DYB	FG	W	upland	undulating	4	3	M	b4
c50071	MIL	E.DYB	FG	R	upland	hummocky	2	5	U	—
c50072	MILzz	O.DYB	FG	W	upland	undulating	3	4	L	a1
c50073	MIL	E.DYB	FG	W	upland	undulating	3	3	M	a1
c50074	MIL	E.DYB	FG	R	upland	hummocky	3	5	U	—
C50075	MIL	E.DYB	FG	R	upland	hummocky	3	5	M	a1
c50076	MIL	E.DYB	FG	R	upland	hummocky	3	5	M	a1
c50077	MIL	E.DYB	FG	W	upland	undulating	3	3	U	a1
c50078	MIL	E.DYB	FG	W	upland	undulating	3	3	U	a1
c50079	MIL	E.DYB	FG	R	upland	undulating	2	3	M	a1
c50086	MIL	E.DYB	FG	W	upland	undulating	3	3	M	b1
c50095	MILzz	O.DYB	FG	W	upland	undulating	4	3	M	b3
c50096	BMTptzr	ptR.G	Ov/FG	VP	fen	level	40	1	level	MONG
c50097	MILzz	O.DYB	FG	W	upland	undulating	5	3	M	a1
c50098	MILzz	O.DYB	FG	W	upland	undulating	5	3	M	—
c50099	MILzz	O.DYB	FG	W	upland	hummocky	5	4	M	b1
c50100	LVKzz	BR.GL	Till	W	upland	hummocky	—	4	U	disturbed
HCS1701	FRT	BR.GL	FG	MW	upland	undulating	5	3	upper	BTNN
HCS1702	MMWpt	ptR.G	FG	P	bog	level	50	1	level	BTNN
HCS1703	FRTzz	BR.GL	FG	W	upland	undulating	8	4	top	d2
HCS1704	MIL	E.DYB	FG	W	upland	undulating	5	3	upper	b1
HCS1705	MILzz	O.DYB	FG	W	upland	undulating	4	2	mid	b1
HCS1706	MILzz	O.DYB	FG	W	upland	undulating	5	1	mid	b1
HCS1707	MIL	E.DYB	FG	W	upland	undulating	4	3	mid	b1
HCS1708	MIL	E.DYB	FG	W	upland	undulating	6	3	upper	b1
HCS1709	MIL	E.DYB	FG	W	upland	undulating	8	2	upper	b3/d2
HCS1710	MIL	E.DYB	FG	W	upland	undulating	7	3	upper	b1
HCS1711	MIL	E.DYB	FG	W	upland	undulating	6	2	upper	b4
HCS1712	MILzz	BR.GL	FG	W	upland	undulating	7	2	upper	b1
HCS1713	MILzz	BR.GL	FG	W	upland	undulating	6	3	mid	b1
HCS1714	MIL	E.DYB	FG	W	upland	undulating	6	3	upper	b1

Table C-2 List of Soil Inspection Sites in the Pierre River Mining Area Local Study Area (continued)

Field Site #	Series	Subgroup	Parent Material	Drainage	Landform	Surface Expression	Peat Depth [cm]	Slope Class	Slope Position	Ecosite
HCS1715	MIL	E.DYB	FG	W	upland	undulating	10	4	mid	b4
HCS1716	MILzz	O.DYB	FG	W	upland	undulating	8	3	mid	b1
HCS1717	MILzz	O.DYB	FG	W	upland	level	10	1	level	d2
HCS1718	MILzz	O.DYB	FG	W	upland	undulating	11	1	mid	d2
HCS1719	MILzz	O.DYB	FG	W	upland	undulating	8	2	mid	b1
HCS1720	MIL	E.DYB	FG	W	upland	undulating	6	4	upper	b1
HCS1721	MIL	E.DYB	FG	W	upland	undulating	8	3	upper	b4/d2
HCS1722	MIL	E.DYB	FG	W	upland	undulating	9	4	crest	b4
HCS1723	MILzz	O.DYB	FG	W	upland	ridged	8	6	crest	b4
HCS1724	MIL	E.DYB	FG	W	upland	undulating	9	4	mid	d2
HCS1725	MILzz	O.DYB	FG	W	upland	undulating	8	5	mid	d2/b3
HCS1726	MIL	E.DYB	FG	W	upland	undulating	8	4	mid	d2
HCS1727	MILzz	O.DYB	FG	W	upland	undulating	8	4	mid	d2
HCS1728	MIL	E.DYB	FG	W	upland	undulating	4	4	mid	b1
HCS1729	MILzz	O.DYB	FG	W	upland	ridged	8	5	crest	b4
HCS1730	MMW	R.G	L	VP	other	inclined	10	2	top	SONS
HCS9001	MIL	E.DYB	FG	W	upland	undulating	9	2	mid	g1
HCS9002	MIL	E.DYB	FG	W	upland	undulating	7	3	mid	b1
HCS9003	MIL	E.DYB	FG	W	upland	undulating	10	4	crest	b1
HCS9004	MIL	E.DYB	FG	W	upland	undulating	10	3	mid	b1
HCS9005	MIL	E.DYB	FG	W	upland	undulating	9	4	mid	b1
HCS9006	MIL	E.DYB	FG	W	upland	undulating	12	2	mid	b1
HCS9007	MIL	E.DYB	FG	W	upland	undulating	11	4	upper	b1
HCS9008	MIL	E.DYB	FG	W	upland	ridged	6	5	upper	b1
HCS9009	MIL	E.DYB	FG	W	upland	undulating	14	3	lower	a1
HCS9010	MIL	E.DYB	FG	W	upland	undulating	11	4	mid	g1
HCS9011	MIL	E.DYB	FG	W	upland	undulating	8	2	top	b1
HCS9012	MIL	E.DYB	FG	W	upland	level	14	1	level	b1/g1
HCS9013	MIL	E.DYB	FG	R	upland	undulating	8	6	upper	b1
HCS9014	MIL	O.DYB	FG	W	upland	undulating	10	5	crest	b1
HCS9015	MIL	E.DYB	FG	W	upland	undulating	7	4	upper	b1
HCS9016	MILzz	O.DYB	FG	R	upland	hummocky	4	6	mid	b1
HCS9017	MIL	E.DYB	FG	W	upland	undulating	9	5	upper	b1
HCS9018	MIL	E.DYB	FG	W	upland	level	8	2	level	b1
HCS9019	MIL	E.DYB	FG	R	upland	hummocky	4	5	upper	b1
HCS9020	MIL	E.DYB	FG	R	upland	undulating	4	4	upper	b1
HCS9021	MILzz	E.DYB	FG	W	upland	undulating	5	4	lower	b1
HCS9022	MIL	E.DYB	FG	R	upland	undulating	5	2	mid	b1
HCS9023	MIL	E.DYB	FG	W	upland	undulating	10	2	mid	d2
HCS9024	MILzz	O.DYB	FG	W	upland	undulating	3	5	upper	disturbed
HCS9025	MILzz	O.DYB	FG	W	upland	undulating	4	2	top	disturbed
HCS9026	PEAgl	GL.GL	LG	I	upland	level	30	1	level	h1
HCS9027	PEA	GL.GL	LG	I	upland	level	28	1	level	h1

Table C-2 List of Soil Inspection Sites in the Pierre River Mining Area Local Study Area (continued)

Field Site #	Series	Subgroup	Parent Material	Drainage	Landform	Surface Expression	Peat Depth [cm]	Slope Class	Slope Position	Ecosite
HCS9028	FRTzz	BR.GL	L/FG	MW	upland	level	12	1	level	d2
HCS9029	MILzz	O.DYB	FG	R	upland	hummocky	3	4	crest	d3
HCS9030	MMYpt	ptR.G	L	P	upland	level	40	1	level	d3
HCS9031	FRT	BR.GL	LGv/Till	I	upland	level	5	1	level	b4
HCS9032	FRT	BR.GL	LG	W	upland	inclined	11	4	upper	d2
HCS9033	STPzz	ptR.G	Ov/LG	P	bog	inclined	20	5	mid	BTNN
HCS9034	MKW	ME.OC	O	P	bog	level	80	1	level	BTNN
HCS9035	MLD	TY.M	O	VP	fen	level	240	1	level	FTNN
HCS9036	MMWpt	ptR.G	L	P	bog	undulating	25	1	top	BTNN
HCS9037	LVKzz	BR.GL	FGv/Till	MW	upland	inclined	7	4	upper	d3
HCS9038	HRS	O.R	F	I	upland	terraced	15	9	mid	d3
HCS9039	SUTzz	O.EB	Till	W	upland	inclined	8	5	mid	d2
HCS9040	DARzrpt	ptR.G	LG	P	upland	level	30	1	level	BTNN
HCS9041	MUSxc	T.F	Ov/LG	VP	bog	level	80	1	level	FTNN
HCS9042	FRTzz	BR.GL	FG	W	wetlands	level	8	1	level	d2
HCS9043	FRTzz	BR.GL	Till	W	upland	terraced	15	7	upper	d2
HCS9044	MLDxc	T.M	Ob/FG	P	bog	level	110	1	level	BTNN
HCS9045	HRR	O.GL	Till	W	upland	level	9	3	top	d2
HCS9046	MMWpt	ptR.G	LG	P	bog	undulating	40	3	lower	BTNN
HCS9047	MIL	E.DYB	FG	R	upland	undulating	10	—	mid	d3
HCS9048	MIL	E.DYB	FG	R	upland	undulating	6	3	mid	d3
HCS9049	MIL	E.DYB	FG	R	upland	undulating	9	4	upper	d2
HCS9050	MILzz	O.DYB	FG	R	upland	undulating	4	3	mid	b3
HCS9051	MIL	E.DYB	FG	R	upland	undulating	4	3	mid	b3
HCS9052	MIL	E.DYB	FG	R	upland	undulating	4	3	upper	b2
HCS9053	FRTzz	E.DYB	FG	R	upland	undulating	4	3	upper	b3
HCS9054	FRT	O.GL	FG	W	upland	inclined	15	5	mid	d2
HCS9055	LVK	BR.GL	FG	W	upland	undulating	8	3	top	f3
HCS9056	MMWpt	ptR.G	FG	P	bog	level	30	1	level	k1
HCS9057	BMTptzr	ptR.G	FG	P	bog	level	20	1	level	k1
HCS9058	MLDxs	T.M	Ov/FG	VP	fen	level	85	1	level	k1
HCS9059	LVK	O.GL	FG	W	upland	undulating	5	3	upper	d2
HCS9060	FRTzz	BR.GL	FG	W	upland	undulating	4	4	upper	d2
HCS9061	DOV	O.GL	LG	W	upland	undulating	8	3	mid	d2
HCS9062	MUSxc	T.M	Ov/LG	VP	bog	level	75	1	level	k1
HCS9063	MUSxc	T.M	Ov/LG	P	bog	level	80	1	level	k1
HCS9064	BMTptzr	ptR.G	FG	P	bog	level	45	1	level	k1
HCS9065	MUSxc	T.M	Ov/LG	P	bog	level	65	1	level	k1
HCS9066	BMTzr	R.G	FG	P	wetlands	level	10	1	level	k1
HCS9067	MMWpt	ptR.G	FG	P	bog	level	35	1	level	k1
HCS9068	MUSxc	T.M	Ov/LG	P	bog	level	70	1	level	k1
HCS9069	LVKzz	BR.GL	Fv/Till	W	upland	undulating	5	3	mid	b3
HCS9070	MUSxc	T.M	Ov/FG	VP	fen	level	80	1	level	FTNN

Table C-2 List of Soil Inspection Sites in the Pierre River Mining Area Local Study Area (continued)

Field Site #	Series	Subgroup	Parent Material	Drainage	Landform	Surface Expression	Peat Depth [cm]	Slope Class	Slope Position	Ecosite
HCS9071	MMW	R.G	LG	MW	upland	undulating	10	2	mid	h1
HCS9072	FRT	BR.GL	FG	W	upland	undulating	5	3	upper	b2
HCS9073	NAM	O.R	F	MW	upland	terraced	5	4	mid	f3
HCS9074	MUSxs	T.M	Ob/FG	P	bog	level	110	1	level	BTNN
HCS9075	LVKzz	BR.GL	FG	W	upland	ridged	8	6	crest	d2
HCS9076	SUT	E.DYB	FG	W	upland	undulating	5	1	level	d2
HCS9077	FRTzz	BR.GL	FG	W	upland	hummocky	8	3	mid	d2
HCS9078	BMTptzr	ptR.G	Ov/FG	P	bog	level	55	1	level	BTNN
HCS9079	FRTzz	BR.GL	FG	W	upland	undulating	7	2	upper	d2
HCS9080	FRTzz	BR.GL	FG	R	upland	ridged	4	6	crest	d2
HCS9081	FRT	O.GL	FG	R	upland	ridged	7	4	upper	d2
HCS9082	FRTzz	BR.GL	FG	W	upland	undulating	7	3	mid	d2
HCS9083	MIL	E.DYB	FG	W	upland	undulating	12	1	mid	b4
HCS9084	MILzz	O.DYB	FG	W	upland	undulating	9	2	mid	d2
HCS9085	MILzz	O.DYB	FG	W	upland	undulating	14	2	mid	d2
HCS9086	NAM	O.R	FG	MW	upland	undulating	4	2	mid	disturbed
HCS9087	LVKzz	BR.GL	FG	W	upland	level	4	1	level	disturbed
HCS9088	MILzz	O.DYB	FG	W	upland	undulating	3	3	mid	disturbed
HCS9089	MILzz	BR.GL	FG	W	upland	undulating	3	2	mid	disturbed
HCS9090	MILzz	BR.GL	FG	W	upland	undulating	10	3	mid	d2
HCS9091	MMW	ptR.G	LG	P	upland	undulating	25	6	top	disturbed
HCS9092	MILzz	BR.GL	FG	W	upland	undulating	8	3	upper	d2
HCS9093	MILzz	BR.GL	FG	W	upland	undulating	8	2	mid	d2
HCS9094	MILzz	BR.GL	FG	W	upland	undulating	8	3	upper	d2
HCS9095	FRTzz	BR.GL	FG	W	upland	undulating	8	2	mid	d2
HCS9096	MILzz	O.DYB	FG	W	upland	undulating	8	2	mid	d2
HCS9097	SUT	O.DYB	FG	W	upland	undulating	4	5	upper	disturbed
HCS9098	LVK	BR.GL	FG	W	upland	undulating	5	3	upper	disturbed
HCS9099	MMW	R.G	FG	MW	upland	undulating	4	3	top	disturbed
HCS9100	FRTzz	BR.GL	FG	W	upland	ridged	4	7	crest	disturbed
HCS9101	NAMgl	GL.R	LG	VP	bog	undulating	15	1	top	BTNN
HCS9101	NAMgl	GL.R	LG	I	upland	undulating	10	2	mid	BTNN
HNS09001	MIL	E.DYB	FG	R	upland	undulating	8	3	mid	a1
HNS09002	MIL	E.DYB	FG	W	upland	level	11	1	level	b3
HNS09003	HRR	O.GL	Till	W	upland	hummocky	—	6	crest	disturbed
HNS09004	MIL	E.DYB	FG	W	upland	level	6	1	level	f1
HNS09005	HRR	O.GL	Till	MW	upland	undulating	15	3	upper	d2
HNS09006	HRR	O.GL	Till	MW	upland	level	20	1	level	d2
HNS09007	MLDxs	T.M	Ov/FG	VP	fen	level	75	1	level	FTNN
HNS09008	HRR	O.GL	FG	MW	upland	level	8	1	level	f1
HNS09009	MIL	E.DYB	FG	MW	upland	level	12	1	level	f3
HNS09010	HRR	O.GL	FG	MW	upland	level	25	1	level	b3
HNS09011	MLDxc	T.M	Ob/LG	VP	fen	level	100	1	level	FONG

Table C-2 List of Soil Inspection Sites in the Pierre River Mining Area Local Study Area (continued)

Field Site #	Series	Subgroup	Parent Material	Drainage	Landform	Surface Expression	Peat Depth [cm]	Slope Class	Slope Position	Ecosite
HNS09012	FRT	O.GL	FG	R	upland	undulating	11	1	level	disturbed
HNS09013	FRT	O.GL	FG	W	upland	undulating	—	4	upper	d2
HNS09014	LVK	O.GL	FG	MW	upland	level	14	3	level	disturbed
HNS09015	LVK	O.GL	FG	R	upland	level	25	1	level	b3
HNS09016	LVK	O.GL	FGv/Till	MW	upland	level	8	1	level	d2
HNS09017	MIL	E.DYB	FG	R	upland	level	—	1	level	d2
HNS09018	MIL	E.DYB	FG	R	upland	level	8	1	level	d2
HNS09019	MIL	E.DYB	FG	R	upland	level	11	1	level	d2
HNS09020	MIL	E.DYB	FG	R	upland	level	11	1	level	b1
HNS09041	MIL	E.DYB	FG	R	upland	hummocky	3	6	crest	disturbed
HNS09042	MIL	E.DYB	FG	R	upland	hummocky	6	5	upper	disturbed
HNS09043	MIL	E.DYB	FG	R	upland	hummocky	8	4	crest	disturbed
HNS09044	FRTzz	BR.GL	FG	W	upland	undulating	5	3	mid	disturbed
HNS09045	FRTzz	BR.GL	FG	W	upland	undulating	8	3	mid	disturbed
HNS09046	FRTzz	BR.GL	FG	R	upland	undulating	5	4	top	d2
HNS09047	MIL	E.DYB	FG	R	upland	level	6	1	level	b3
HNS09048	MIL	E.DYB	FG	R	upland	level	8	2	level	d1
HNS09049	LVKzz	BR.GL	FG	W	upland	hummocky	12	1	upper	b2
HNS09050	FRTzz	BR.GL	FG	MW	upland	undulating	9	4	mid	b3
HNS09051	FRTzz	BR.GL	FG	R	upland	level	11	1	level	d2
HNS09052	MILzz	BR.GL	FG	R	upland	level	10	1	level	d2
HNS09053	MILzz	BR.GL	FG	MW	upland	level	9	2	level	d2
HNS09054	MILzz	O.GL	FG	MW	upland	level	5	2	level	d2
HNS09055	HRRzz	O.GL	FG	MW	upland	level	190	3	level	b3
HNS09056	MIL	E.DYB	FG	W	upland	inclined	10	5	mid	b3
HNS09057	FRT	O.GL	FG	R	upland	level	12	3	level	b1
HNS09058	NAM	O.R	F	MW	upland	hummocky	10	4	crest	f1
HNS09059	FRT	O.GL	FG	MW	upland	level	11	3	crest	d2
HNS09060	FRT	O.GL	FG	R	upland	level	7	3	level	disturbed
HNS17001	MLDxs	T.M	Ob/FG	VP	fen	level	110	1	level	FONS
HNS17002	MUSxs	T.M	Ob/FG	P	bog	level	100	1	level	BTNN
HNS17003	FRT	O.GL	FG/Till	W	upland	level	7	3	level	d2
HNS17004	FRT	O.GL	FG/Till	W	upland	level	7	1	level	b3
HNS17005	FRT	O.GL	FG/Till	W	upland	level	12	2	level	d3
HNS17006	FRT	O.GL	FG/Till	W	upland	level	6	2	level	b3
HNS17007	FRT	O.GL	FG/Till	W	upland	level	12	2	level	d2
HNS17008	LVK	O.GL	FGv/M	MW	upland	undulating	15	4	crest	d2
HNS17009	FRT	O.GL	FG/Till	W	upland	level	12	3	level	d2
HNS17010	FRT	O.GL	FG/Till	W	upland	level	9	3	level	d2
HNS17011	FRT	O.GL	FG/Till	W	upland	undulating	11	3	upper	d2
HNS17012	FRT	O.GL	FG/Till	W	upland	hummocky	8	6	top	d2
HNS17013	FRT	O.GL	FG/Till	W	upland	level	10	3	level	d2
HNS17014	MLDxc	T.M	Ob/FG	VP	fen	level	110	1	level	FONS

Table C-2 List of Soil Inspection Sites in the Pierre River Mining Area Local Study Area (continued)

Field Site #	Series	Subgroup	Parent Material	Drainage	Landform	Surface Expression	Peat Depth [cm]	Slope Class	Slope Position	Ecosite
HNS17015	MLDxc	T.M	Ov/FG	P	bog	level	50	1	level	BTNN
HNS17016	FRT	O.GL	FG	W	upland	inclined	7	4	top	b3
HNS17017	FRT	O.GL	FG	W	upland	level	9	1	level	b3
HNS17018	MIL	E.DYB	FG	R	upland	level	10	1	level	d2
HNS17019	MIL	E.DYB	FG	R	upland	hummocky	—	5	top	b3
HNS17020	LVKyg	O.GL	FG/Till	W	upland	level	8	2	level	b3
HNS17021	LVKyg	O.GL	FG/Till	W	upland	level	8	2	level	d2
HNS17022	LVKyg	O.GL	FG/Till	W	upland	level	11	1	level	b2
HNS17023	LVKyg	O.GL	FG/Till	W	upland	level	11	1	level	b2
HNS17024	MIL	E.DYB	FG	W	upland	level	11	1	level	b2
HNS17025	LVKyg	O.GL	FG/Till	MW	upland	level	11	1	level	b2
HNS17026	LVKyg	O.GL	FG/Till	MW	upland	level	11	1	level	b1
HNS17027	LVKyg	O.GL	FG/Till	MW	upland	level	11	1	level	b1
HNS17028	LVKyg	O.GL	FG/Till	MW	upland	level	0	1	level	b2
HNS17029	FRTzz	BR.GL	FG/Till	W	upland	level	—	1	level	b2
HNS17030	FRTzz	O.GL	FG/Till	W	upland	level	7	1	level	b1
HNS17031	MIL	E.DYB	FG	R	upland	level	—	1	level	b1
HNS17032	BMTptzr	ptR.G	L	VP	fen	level	20	1	level	FONG
HNS17033	MIL	E.DYB	FG	R	upland	hummocky	10	5	top	b1
HNS17034	MIL	E.DYB	FG	R	upland	level	10	2	level	b1
HNS17035	MIL	E.DYB	FG	R	upland	hummocky	10	5	crest	b3
HNS17036	MILzz	O.DYB	FG	R	upland	hummocky	10	1	level	b3
HNS17037	MILzz	O.DYB	FG	W	upland	hummocky	12	5	level	b1
HNS17038	MIL	E.DYB	FG	R	upland	level	6	1	level	a1
HNS17039	MILzz	O.DYB	FG	R	upland	level	6	3	level	d2
HNS17040	MIL	E.DYB	FG	R	upland	level	4	2	level	a1
HNS17041	MIL	E.DYB	FG	R	upland	hummocky	4	5	upper	b1
HNS17042	MIL	E.DYB	FG	R	upland	level	6	1	level	b3
HNS17043	MIL	E.DYB	FG	R	upland	level	7	2	level	b3
HNS17044	MIL	E.DYB	FG	R	upland	level	5	2	level	b1
HNS17045	MIL	E.DYB	FG	R	upland	level	6	3	level	b1
HNS17046	MIL	E.DYB	FG	R	upland	level	8	2	level	a1
HNS17047	MIL	E.DYB	FG	R	upland	level	8	1	level	a1
HNS17048	MLD	TY.M	O	VP	fen	level	240	1	level	FONS
HNS17049	MILzz	O.DYB	FG	R	upland	undulating	12	2	level	d2
HNS17050	MLDxs	T.M	Ob/FG	VP	fen	level	150	1	level	FTNN
HNS17051	BMTptzr	ptR.G	FG	VP	fen	level	30	1	level	FONS
HNS17052	MIL	E.DYB	FG	W	upland	undulating	9	3	level	a1
HNS17053	FRT	O.GL	FG	W	upland	undulating	9	2	level	b1
HNS17054	MIL	E.DYB	FG	R	upland	hummocky	7	1	level	b3
HNS17055	MIL	E.DYB	FG	W	upland	hummocky	11	3	level	b4
HNS17056	MIL	E.DYB	FG	W	upland	hummocky	11	3	level	a1
HNS17057	MIL	E.DYB	FG	W	upland	level	11	1	level	b2

Table C-2 List of Soil Inspection Sites in the Pierre River Mining Area Local Study Area (continued)

Field Site #	Series	Subgroup	Parent Material	Drainage	Landform	Surface Expression	Peat Depth [cm]	Slope Class	Slope Position	Ecosite
HNS9027	NAM	O.R	F	W	upland	undulating	10	2	top	e1
HNS9028	MIL	E.DYB	FG/Till	W	upland	level	10	1	level	a1
HNS9029	MIL	E.DYB	FG/Till	W	upland	undulating	10	5	crest	a1
HNS9030	MIL	E.DYB	FG/Till	W	upland	hummocky	5	4	mid	a1
HNS9031	FRT	O.GL	Till	W	upland	level	10	2	upper	b4
HNS9032	LVK	O.GL	Till	W	upland	level	10	1	level	d2
HNS9033	HRR	O.GL	Till	R	upland	level	10	1	level	e1
HNS9034	FRT	E.DYB	FG	W	upland	level	8	2	upper	BTNN
HNS9035	FRT	O.GL	Till	W	upland	undulating	10	2	mid	b3
HNS9036	SUTgl	GLE.DYB	FG/Till	W	upland	undulating	20	2	top	b3
HNS9037	MILzz	O.DYB	FG	W	upland	undulating	5	2	level	disturbed
HNS9037a	MMW	R.G	F	W	upland	level	10	1	level	disturbed
HNS9038	MUSxs	T.M	Ov/FG	P	bog	level	60	1	level	FTNN
HNS9039	MIL	E.DYB	FG	R	upland	hummocky	6	6	mid	disturbed
HNS9040	MILzz	O.DYB	FG	W	upland	undulating	5	2	yop	disturbed
HNS9040	MILzz	O.DYB	FG	R	upland	hummocky	4	4	level	a1
HNS9041	HRR	O.GL	Till	W	upland	undulating	8	4	mid	b3
IN838	MIL	EDYB	FG	R	upland	undulating	—	3	M	—
LN_007_004	—	O.GL	Till	—	upland	—	—	3	—	—
LN_007_005	—	O.GL	Till	—	upland	undulating	—	3	U	—
LN_007_006	—	O.GL	—	—	other	—	—	8	T	—
LN_007_007	—	—	—	—	—	—	—	1	—	—
LN_007_008	BMTptzr	ptR.G	Till	—	other	u/h	—	3	—	—
LN_007_009	HRR	O.GL	Till	—	upland	—	—	4	—	—
LN_007_010	—	—	Till	MW	upland	—	—	3	—	—
LN_007_011	HRR	O.GL	Till	—	upland	undulating	—	3	—	—
LN_007_012	HRR	O.GL	Till	—	upland	undulating	—	3	—	—
LN_007_013	HRR	O.GL	Till	MW	upland	u/h	—	3	—	—
LN_007_014	HRR	O.GL	Till	—	upland	h/l	—	6	—	—
LN_007_015	HRR	O.GL	Till	—	upland	undulating	—	3	—	—
LN_007_016	HRR	O.GL	Till	—	upland	undulating	—	3	—	—
LN_007_017	MLDxt	T.M	—	VP	other	o1	—	—	—	—
LN_007_018	MLD	TY.M	O	—	wetlands	o1	—	—	—	—
LN_007_019	MLD	T.M	O	VP	wetlands	—	—	—	level	—
LN_007_020	MLD	TY.M	O	VP	wetlands	—	—	—	level	—
LN_007_021	MLD	T.M	O	VP	wetlands	o1	—	1	level	—
LN_007_022	MLD	TY.M	O	VP	wetlands	o1	—	1	level	—
LN_007_023	MLD	TY.M	O	VP	wetlands	o1	—	1	level	—
LN_007_024	MLD	TY.M	O	VP	wetlands	o1	—	1	level	—
LN_007_025	MLD	TY.M	O	VP	wetlands	o1	—	—	level	—
LN_007_026	MLDxc	T.M	O	VP	wetlands	o1	—	1	level	—
LN_007_027	MLDxc	T.M	O	P	wetlands	o1	—	1	level	—
LN_007_028	BMTptzr	ptR.G	O	P	wetlands	o1	—	—	level	—

Table C-2 List of Soil Inspection Sites in the Pierre River Mining Area Local Study Area (continued)

Field Site #	Series	Subgroup	Parent Material	Drainage	Landform	Surface Expression	Peat Depth [cm]	Slope Class	Slope Position	Ecosite
LN_007_029	BMTptzr	ptR.G	O	P	wetlands	o1	—	—	level	—
LN_007_030	MLDxs	T.M	O	P	wetlands	o1	—	1	level	—
LN_007_031	MMWpt	ptR.G	O	P	wetlands	o1	—	—	level	—
LN_007_032	MLDxs	T.M	O	P	wetlands	o1	—	—	level	—
LN_007_033	MLD	TY.M	O	VP	wetlands	o1	—	1	level	—
LN_007_034	MMWpt	ptR.G	O	P	wetlands	o1	—	1	level	—
LN_007_035	HRR	O.GL	Till	MW	upland	—	—	2	—	—
LN_007_036	FRTzz	BR.GL	Till	—	upland	—	—	1	—	—
LN_007_037	FRTzz	BR.GL	FG	—	upland	—	—	1	—	—
LN_007_038	FRT	BR.GL	FG	—	upland	—	—	—	—	—
LN_007_039	MIL	E.DYB	FG	—	upland	—	—	1	—	—
LN_007_040	BMTzr	R.G	—	—	wetlands	—	—	1	—	—
LN_007_041	BMTptzr	ptR.G	FG	—	wetlands	—	—	1	—	—
LN_007_042	FRTzz	BR.GL	FG	—	upland	u/l	—	—	—	—
LN_007_043	MIL	E.DYB	FG	—	upland	—	—	—	—	—
LN_007_044	MILzz	O.DYB	FG	—	upland	u/l	—	1	—	—
LN_007_045	MLDxs	T.M	—	P	wetlands	—	—	—	—	—
LN_007_046	FRT	O.GL	FG	—	upland	u/l	—	1	—	—
LN_007_047	FRT	O.GL	FG	—	upland	u/l	—	—	—	—
LN_007_048	FRT	O.GL	FG	—	upland	—	—	1	—	—
LN_007_049	FRT	O.GL	FG	—	upland	—	—	1	—	—
LN_007_050	FRTzz	BR.GL	FG	—	upland	—	—	1	—	—
LN_007_051	FRTzz	BR.GL	FG	—	upland	—	—	1	—	—
LN_007_052	FRTzz	BR.GL	FG	—	upland	—	—	1	—	—
LN_007_053	FRTzz	BR.GL	FG	MW	upland	—	—	1	—	—
LN_007_054	FRTzz	BR.GL	FG	—	upland	—	—	1	—	—
LN_007_055	FRTzz	BR.GL	FG	—	upland	—	—	—	—	—
LN_007_056	FRTzz	BR.GL	FG	—	upland	—	—	1	—	—
LN_007_057	FRT	O.GL	FG	—	upland	—	—	1	—	—
LN_007_058	FRT	O.GL	FG	—	upland	—	—	1	—	—
LN_007_059	MLDxc	T.M	Ov/LG	—	lowland	01	—	1	—	—
LN_007_060	MLDxc	T.M	O	P	wetlands	—	—	1	—	—
LN_007_061	MLDxc	T.M	b/FG	—	wetlands	—	—	—	—	—
LN_007_062	MLDxc	T.M	O	P	wetlands	—	—	1	—	—
LN_007_063	MLDxc	T.M	O	VP	wetlands	—	—	1	—	—
LN_007_064	FRTgl	GL.GL	FG	—	wetlands	—	—	—	—	—
LN_007_065	MIL	E.DYB	FG	—	upland	—	—	1	—	—
LN_007_066	MIL	E.DYB	FG	—	upland	—	—	1	—	—
LN_007_067	MIL	E.DYB	FG	—	upland	—	—	1	—	—
LN_007_068	MLDxs	T.M	O/FG	—	wetlands	—	—	1	—	—
LN_007_069	MILgl	GLE.DYB	FG	—	upland	—	—	1	—	—
LN_007_070	MIL	E.DYB	FG	—	upland	—	—	—	—	—
LN_007_071	MIL	E.DYB	FG	—	upland	undulating	—	—	—	—

Table C-2 List of Soil Inspection Sites in the Pierre River Mining Area Local Study Area (continued)

Field Site #	Series	Subgroup	Parent Material	Drainage	Landform	Surface Expression	Peat Depth [cm]	Slope Class	Slope Position	Ecosite
LN_007_072	DOV	O.GL	LG	—	upland	—	—	1	—	—
LN_007_073	MIL	O.DYB	FG	—	upland	u/h	—	1	—	—
LN_007_074	MILzz	O.DYB	FG	—	upland	u/h	—	1	—	—
LN_007_075	—	—	—	—	—	—	—	1	—	—
LN_007_090	MIL	E.DYB	FG	W	upland	undulating	—	3	M	—
LN_007_091	MIL	E.DYB	FG	W	upland	—	—	3	M	—
LN_007_092	MIL	E.DYB	FG	—	upland	—	—	1	—	—
LN_007_093	MIL	E.DYB	FG	W	upland	undulating	—	3	M	—
LN_007_094	MIL	E.DYB	FG	W	upland	undulating	—	3	M	—
LN_007_095	MILzz	O.DYB	FG	W	upland	—	—	3	M	—
LN_007_096	MUSxc	T.M	O/LG	VP	bog	—	—	1	D	—
LN_007_097	MUSxc	T.M	O/LG	P	bog	—	—	1	D	—
LN_007_098	STPpt	ptR.G	Og/LG	P	bog	o1	—	1	D	—
LN_007_099	FRT	O.GL	FG	W	upland	undulating	—	—	U	—
LN_007_100	FRT	O.GL	FG	MW	upland	—	—	3	M	—
LN_2007002	FRT	O.GL	Till	—	upland	u/h	—	3	—	—
LN07081	FRT	O.GL	Till	W	upland	undulating	9	3	U	—
LN07082	FRT	O.GL	Till	W	upland	u1l	8	2	level	—
LN700	BMTptzr	R.Gpt	Ov/FG	P	bog	level	40	1	D	BTNN
LN701	MLDxs	T.M	Ov/FG	P	fen	level	140	1	level	FTNN
LN704	LVK	O.GL	FGv/Till	MW	upland	undulating	10	3	M	—
LN705	FRT	O.GL	FG	MW	upland	inclined	10	3	M	—
LN706	MLDxc	T.M	Ov/FG	P	bog	level	50	1	L	BTNN
LN707	FRT	O.GL	FG	MW	upland	undulating	8	3	M	—
LN708	FRT	O.GL	FG	W	upland	undulating	7	2	level	—
LN709	FRT	O.GL	FG/Till	W	upland	undulating	8	2	level	—
LN710	FRT	O.GL	FG	W	upland	undulating	9	3	U	—
LN711	FRT	O.GL	FG	W	upland	undulating	8	1	level	—
LN712	MLDxs	T.M	O/FG	P	bog	hummocky	90	1	L	BTNN
LN713	FRT	O.GL	FG	W	upland	undulating	6	2	level	—
LN7131	MLD	T.M	Ov/F	VP	fen	level	110	1	level	FTNN
LN7132	MIL	E.DYB	FG	MW	upland	level	7	2	level	—
LN7133	FRTgl	GL.GL	F	I	upland	undulating	8	2	L	—
LN7134	FRTgl	GL.GL	F	I	upland	undulating	7	2	M	—
LN7135	MLD	T.M	Ov/L	VP	fen	level	6	1	level	FTNN
LN7136	FRT	O.GL	F	W	upland	undulating	7	2	M	—
LN7137	DOVxs	GL.GL	Lv/F	MW	upland	undulating	6	2	M	d2
LN7138	DOVxs	O.GL	L/F	W	upland	undulating	—	2	M	—
LN7139	DOVxs	O.GL	L	MW	upland	undulating	—	2	M	—
LN714	FRTgl	GL.GL	FG	I	upland	undulating	10	2	L	—
LN7140	DOV	O.GL	—	—	upland	undulating	—	1	—	—
LN7142	DOV	O.GL	L	MW	upland	undulating	8	2	M	—
LN7143	MLD	T.M	Ov/F	VP	bog	level	110	1	level	—

Table C-2 List of Soil Inspection Sites in the Pierre River Mining Area Local Study Area (continued)

Field Site #	Series	Subgroup	Parent Material	Drainage	Landform	Surface Expression	Peat Depth [cm]	Slope Class	Slope Position	Ecosite
LN7144	FRT	O.GL	F	MW	upland	hummocky	7	4	L	—
LN7146	FRT	BR.GL	F	MW	upland	undulating	5	3	M	—
LN7147	FRT	BR.GL	F	MW	upland	undulating	5	3	M	—
LN7148	FRT	BR.GL	F	MW	upland	undulating	6	3	M	—
LN7149	FRT	O.GL	F	W	upland	hummocky	5	4	M	—
LN715	FRT	O.GL	FG	MW	upland	undulating	8	3	U	—
LN7150	LVK	O.GL	Fv/Till	MW	upland	undulating	6	3	M	—
LN716	FRT	O.GL	FG	MW	upland	undulating	5	2	M	—
LN717	FRT	O.GL	FG	MW	upland	undulating	5	2	M	—
LN718	BMTpt	R.Gpt	FG	VP	fen	hummocky	40	1	level	FTNN
LN719	ALG	O.LG	FG	P	other wetlands	level	40	1	level	—
LN720	FRT	O.GL	FG	W	upland	undulating	6	2	level	—
LN721	MIL	E.DYB	FG	MW	upland	undulating	7	2	level	—
LN722	FRT	O.GL	FG	MW	upland	undulating	5	1	level	—
LN723	FRT	O.GL	FG	MW	upland	undulating	5	3	U	—
LN724	MLDxs	T.M	Ov/FG	P	bog	level	50	1	level	BTNN
LN725	MLDxs	T.M	Ov/FG	P	bog	level	50	1	level	BTNN
LN726	ALG	O.LG	FG	P	bog	level	20	2	level	BTNN
LN727	FRT	GL.GL	FG	I	upland	undulating	6	2	U	—
LN729	FRT	O.GL	FG	W	upland	undulating	12	3	U	—
LN731	ABN	TY.M	O	VP	bog	level	220	1	L	BTNN
LN732	ABN	TY.F	Ob	P	bog	level	220	1	level	BTNN
LN733	MUS	TY.M	Ob	P	bog	level	220	1	level	BTNN
LN734	MLDxs	T.M	Ob	P	bog	level	100	1	level	BTNN
LN735	MLDxt	T.M	Ob/FG	P	bog	level	100	1	level	—
LN736	MLDxs	T.M	Ov/FG	P	bog	level	100	1	level	BTNN
LN737	BMTptzr	ptR.G	Ov/FG	P	bog	level	35	1	level	BTNN
LN738	MLD	TY.M	Ob/FG	VP	fen	level	180	1	level	FTNN
LN739	MLD	TY.M	Ob	P	fen	level	220	1	level	—
LN740	MLD	TY.M	O	P	bog	level	220	1	level	BTNN
LN741	ABN	TY.F	O	VP	fen	level	220	1	level	FTNN
LN742	MLD	TY.M	Ob	P	bog	level	220	1	level	BTNN
LN743	MLD	TY.M	Ob	P	bog	level	220	1	level	BTNN
LN744	ABN	TY.F	Ob	VP	bog	level	220	1	level	—
LN745	ABN	TY.F	Ob	P	bog	level	220	1	level	BTNN
LN746	MLD	TY.M	Ob	P	fen	level	220	1	level	FTNN
LN747	MLDxc	T.M	Ob/FG	P	fen	level	100	1	level	FTNN
LN748	MLD	TY.M	Ob	P	bog	level	220	1	level	BTNN
LN749	MLD	TY.M	Ob	P	bog	level	220	1	level	BTNN
LN750	FIR	O.GL	FG	W	upland	undulating	7	3	M	—
Ln751	FRT	BR.GL	—	MW	upland	undulating	8	2	M	—
LN752	FRTgl	GL.GL	—	MW	upland	level	11	2	M	—
LN753	ABN	TY.F	Ob	P	fen	level	220	1	level	FTNN

Table C-2 List of Soil Inspection Sites in the Pierre River Mining Area Local Study Area (continued)

Field Site #	Series	Subgroup	Parent Material	Drainage	Landform	Surface Expression	Peat Depth [cm]	Slope Class	Slope Position	Ecosite
LN754	MLDxs	T.M	—	P	bog	level	60	1	level	BTNN
LN755	MLDxs	T.M	FG	I	upland	undulating	9	2	M	—
LN755	MLDxs	T.M	—	P	bog	level	60	1	level	—
LN756	MLD	TY.M	—	VP	fen	level	—	1	level	—
LN757	BMTptzr	ptR.G	Ov/FG	P	fen	level	—	1	level	—
LN758	BMTptzr	ptR.G	Ov/FG	P	bog	level	35	1	level	—
LN759	MUSxs	T.M	Ov/FG	P	bog	level	50	1	level	—
LN760	BMTptzr	ptR.G	bTNN	P	bog	level	—	1	level	—
LN761	BMTptzr	ptR.G	—	P	bog	level	30	1	level	—
LN762	MUSxs	T.M	Ov/FG	P	bog	level	90	2	T	—
LN763	FBG	BR.GL	FG	MW	—	undulating	20	3	U	—
LN764	MLDxs	T.M	Ob/FG	VP	fen	level	100	1	level	—
LN765	MIL	E.DYB	—	—	upland	undulating	6	1	—	—
LN766	BMTptzr	ptR.G	—	I/P	—	level	50	2	level	—
LN767	BMTptzr	ptR.G	Ov/FG	P	bog	level	30	1	level	—
LN768	MLDxs	T.M	Ob/FG	P/VP	fen	level	120	1	level	—
LN769	MIL	E.DYB	FG	MW	upland	undulating	20	3	U	—
LN770	SUT	E.DYB	FG/M	W	upland	undulating	6	1	M	—
LN771	BMTpt	ptR.G	Ov/FG	P	bog	level	30	1	level	BTNN
LN772	MLD	TY.M	Ob	P	fen	level	220	1	level	FTNN
LN773	MLD	TY.M	Ob	VP	fen	level	220	1	level	FTNN
LN774	MUSxs	T.M	Ob/FG	P	bog	level	90	1	level	BTNN
LN775	MUSxs	T.M	Ob/FG	P	bog	level	55	1	level	BTNN
LN776	MUSxs	T.M	O	P	bog	level	140	1	level	—
LN777	MLDxs	T.M	Ob/FG	P	fen	level	130	1	level	FTNN
LN778	MLD	TY.M	Ob/FG	VP	fen	level	220	1	level	—
LN779	MLDxs	TY.M	Ob/FG	P	fen	level	180	1	level	FTNN
LN780	MLDxs	T.M	Ob/FG	P	fen	level	120	1	level	FTNN
LN781	FRTzz	BR.GL	—	W	upland	undulating	25	2	M	—
LN782	MLDxs	T.M	Ob/FG	VP	fen	level	110	1	level	—
LN783	MLDxs	T.M	Ob/FG	P	fen	level	90	1	level	FTNN
LN784	MLDxs	T.M	Ob/FG	P	fen	level	130	1	level	FTNN
LN785	MLDxc	T.M	Ob/FG	P	fen	level	115	1	level	FTNN
LN786	MLDxs	T.M	Ob/FG	P	fen	level	70	1	level	FTNN
LN787	MLDxs	T.M	Ob/FG	P	fen	level	100	1	level	FTNN
LN788	MLDxs	T.M	Ov/FG	P	fen	level	40	1	level	FTNN
LN789	MLD	TY.M	Ob/FG	P	fen	level	160	1	level	FTNN
LN790	MLDxs	T.M	Ov/FG	P	bog	level	50	1	level	BTNN
LN791	MUSxs	T.M	—	P	bog	level	40	1	level	BTNN
LN792	MLD	TY.M	Ob/FG	P	fen	level	210	1	level	—
LN793	MLDxs	T.M	Ob/FG	P	fen	level	130	1	level	FTNN
LN800	MIL	E.DYB	—	W	upland	undulating	6	1	U	—
LN801	MIL	E.DYB	—	W	upland	undulating	5	2	M	—

Table C-2 List of Soil Inspection Sites in the Pierre River Mining Area Local Study Area (continued)

Field Site #	Series	Subgroup	Parent Material	Drainage	Landform	Surface Expression	Peat Depth [cm]	Slope Class	Slope Position	Ecosite
LN802	MIL	E.DYB	—	—	upland	undulating	8	1	—	—
LN803	MIL	E.DYB	FG	R/W	upland	undulating	—	1	level	—
LN804	MIL	E.DYB	FG	W	upland	undulating	—	2	level	—
LN805	MIL	E.DYB	FG	W	upland	undulating	8	3	U	—
LN806	MIL	E.DYB	—	—	upland	undulating	—	1	—	—
LN807	MIL	E.DYB	—	—	upland	undulating	6	1	—	—
LN808	MIL	E.DYB	FG	W	upland	undulating	—	3	U	—
LN809	MIL	E.DYB	FG	W	—	—	—	3	U	—
LN811	WGNaa	TY.F	Ob	VP	fen	level	220	1	level	—
LN812	MKWaa	ME.OC	—	P	bog	level	>100	1	level	—
LN813	MIL	E.DYB	—	—	upland	undulating	6	1	—	—
LN814	MIL	E.DYB	FG	W	upland	undulating	5	3	M	—
LN816	MIL	E.DYB	FG	MW	upland	undulating	—	3	level	—
LN817	MIL	E.DYB	FG	W	upland	undulating	—	3	level	—
LN818	MIL	E.DYB	FG	R	upland	undulating	—	3	level	—
LN819	MIL	E.DYB	FG	R	upland	hummocky	5	4	U	—
LN820	MIL	E.DYB	FG	R	upland	hummocky	6	4	M	—
LN821	MIL	E.DYB	FG	R	upland	hummocky	5	4	U	—
LN822	MIL	E.DYB	FG	R	upland	hummocky	4	4	U	—
LN823	MIL	E.DYB	FG	R	upland	undulating	4	3	M	—
LN824	MIL	E.DYB	FG	R	upland	hummocky	—	4	L	—
LN825	MIL	E.DYB	FG	R	upland	undulating	3	3	M	—
LN826	MIL	E.DYB	FG	R	upland	hummocky	3	4	C	—
LN827	MIL	E.DYB	FG	R	upland	hummocky	3	4	L	—
LN828	MIL	E.DYB	FG	R	upland	undulating	—	3	M	—
LN829	MIL	E.DYB	FG	R	upland	hummocky	6	3	L	—
LN831	FIR	E.DYB	FG	R	upland	undulating	—	3	M	—
LN832	MIL	E.DYB	FG	R	upland	undulating	—	3	M	—
LN833	MIL	E.DYB	FG	R	upland	hummocky	—	3	M	—
LN834	MIL	E.DYB	FG	R	upland	undulating	6	3	M	—
LN835	MIL	E.DYB	FG	R	upland	undulating	6	3	M	—
LN836	MIL	E.DYB	FG	R	upland	undulating	—	3	M	—
LN837	MIL	E.DYB	FG	R	upland	undulating	6	3	U	—
n50015	FRT	O.GL	FG	W	upland	hummocky	5	4	U	—
n5016	FRT	O.GL	FG	W	—	hummocky	2	4	U	—
n5017	MILzz	O.EB	FG	W	upland	hlm	2	5	U	disturbed
n5018	MIL	E.DYB	FG	R	upland	hummocky	4	5	U	—
n5019	FRTzz	BR.GL	FG	R	upland	hummocky	—	4	U	—
n5020	FRTzz	BR.GL	FG	R	upland	hummocky	—	4	U	—
n5021	FRTzz	BR.GL	FG	R	upland	hummocky	5	4	U	disturbed
n5022	DOVzz	D.GL	LG	I	upland	undulating	7	3	M	—
n5023	DOV	O.GL	FG	W	upland	hummocky	10	4	U	—
n5024	BMTptzr	ptR.G	Ov/FG	P	bog	level	40	1	level	—

Table C-2 List of Soil Inspection Sites in the Pierre River Mining Area Local Study Area (continued)

Field Site #	Series	Subgroup	Parent Material	Drainage	Landform	Surface Expression	Peat Depth [cm]	Slope Class	Slope Position	Ecosite
n5025	HRR	O.GL	Till	MW	upland	hummocky	7	4	U	—
n5026	FRTzz	BR.GL	FG	W	upland	hummocky	5	4	U	disturbed
n5027	FRTzz	BR.GL	FG	W	upland	hummocky	5	4	U	—
n5028	FRTzz	BR.GL	FG	W	upland	hummocky	4	4	M	disturbed
n5029	FRTzz	BR.GL	FG	W	upland	u1l	6	3	M	disturbed
n5030	FRTzz	BR.GL	FG	W	upland	undulating	6	3	M	—
n5031	FRTzz	BR.GL	FG	W	upland	undulating	7	3	M	—
n5032	FRTzz	BR.GL	FG	W	upland	hummocky	5	5	C	—
n5033	MUS	TY.M	O	VP	bog	level	>220	1	level	FTNN
n5034	FRTzzgl	GLBR.GL	FG	I	—	level	15	2	level	—
n5035	MILyg	E.DYB	FG	MW	upland	level	10	2	L	—
n5036	MIL	E.DYB	FG	W	upland	undulating	5	2	L	—
n5037	MIL	E.DYB	FG	R	upland	hummocky	—	5	U	—
n5038	BMTptzr	ptR.G	Ov/FGL	VP	wetlands	level	35	1	level	FONS
n5039	MILzz	O.DYB	FG	R	upland	undulating	3	3	M	disturbed
n5040	MIL	E.DYB	FG	R	upland	hummocky	2	5	U	—
n5041	MIL	E.DYB	FG	R	upland	hummocky	3	6	U	—
n5042	MIL	O.DYB	FG	—	upland	hummocky	4	6	—	—
n5044	FRTzz	BR.GL	FG	R	upland	hummocky	5	4	M	—
n5046	MIL	E.DYB	FG	R	upland	hummocky	5	6	U	—
n5047	FIRzz	BR.GL	FG	R	upland	hummocky	3	5	M	—
n5048	MIL	E.DYB	FG	R	upland	j	10	5	M	—
n5049	MIL	E.DYB	FG	R	upland	hummocky	7	4	M	—
n5050	MIL	E.DYB	FG	R	upland	hummocky	4	4	M	—
n5051	MIL	E.DYB	FG	R	upland	undulating	7	3	M	—
n5052	MIL	E.DYB	FG	—	upland	undulating	—	3	—	—
n5053	MUSxs	T.M	Ov/FG	P	bog	level	50	1	level	—
n5054	MIL	E.DYB	FG	R	upland	hummocky	4	4	M	—
n5055	MIL	E.DYB	FG	R	upland	j	—	4	M	—
n5056	MIL	E.DYB	FG	—	upland	undulating	—	3	—	—
n5057	MIL	E.DYB	FG	R	—	hummocky	—	3	M	—
n5058	MIL	E.DYB	FG	—	upland	undulating	5	3	—	b1
n5059	MIL	E.DYB	—	R	upland	undulating	—	2	M	—
n5060	MIL	E.DYB	FG	R	—	undulating	10	3	level	—
n5061	MIL	E.DYB	—	R	upland	undulating	10	3	L	—
n5062	MIL	E.DYB	FG	—	upland	undulating	—	1	M	—
n5063	MIL	E.DYB	—	R	—	—	—	3	M	—
n5064	MIL	E.DYB	FG	R	upland	undulating	—	3	M	—
n5065	MIL	E.DYB	—	—	—	—	7	3	—	—
n5066	MIL	E.DYB	FG	R	upland	—	5	3	M	—
n5067	MIL	E.DYB	FG	R	upland	hummocky	7	4	M	—
n5068	MUSxs	T.M	—	P	bog	level	140	1	level	—
n5069	MIL	E.DYB	FG	R	upland	undulating	7	3	M	—

Table C-2 List of Soil Inspection Sites in the Pierre River Mining Area Local Study Area (continued)

Field Site #	Series	Subgroup	Parent Material	Drainage	Landform	Surface Expression	Peat Depth [cm]	Slope Class	Slope Position	Ecosite
n5070	MIL	O.DYB	FG	VR	—	hummocky	3	6	C	—
n5071	MIL	E.DYB	FG	R	upland	undulating	4	3	L	—
n5072	MILzz	O.DYB	FG	R	upland	undulating	—	3	M	a1
n5073	MILzz	O.DYB	—	—	—	u1h—h1l	—	3	—	a1
n5074	MILzz	O.DYB	—	R	upland	undulating	4	3	—	a1
n5076	MIL	E.DYB	FG	R	upland	undulating	4	3	M	a1
n5077	MILzz	O.DYB	FG	R	upland	undulating	—	3	M	a1
n5078	MILzz	O.DYB	FG	R	upland	undulating	—	4	M	a1
n5085	MIL	E.DYB	—	R	upland	undulating	5	3	M	b1
n5092	MILzz	O.DYB	FG	R	upland	undulating	5	3	M	—
n5093	MIL	E.DYB	—	—	upland	undulating	4	1	—	—
n5094	MIL	E.DYB	FG	R	upland	hummocky	—	4	M	—
n5095	MIL	E.DYB	FG	R	upland	hummocky	8	3	M	—
n5096	MIL	E.DYB	FG	R	upland	undulating	4	3	M	—
n5097	MIL	E.DYB	FG	R	upland	hummocky	10	4	U	b1
NL728	MLDxc	T.M	Ov/FG	P	bog	level	55	1	level	BTNN
NL730	MLD	TY.M	O	VP	bog	level	220	1	L	—
PR_07	FRT	O.GL	F	W	upland	undulating	—	3	M	—
PR-04	LVK	O.GL	—	—	—	undulating	—	—	—	—
PR-05	MIL	E.DYB	F	W	upland	undulating	—	3	M	—
PR-06	PEAgl	GL.GL	L	I	upland	undulating	—	2	M	—
PR-08	MLD	TY.M	O	VP	fen	fen	—	1	level	—
PR-09	LVK	O.GL	Fv/TILL	W	upland	undulating	—	3	M	—
PR-10	BMTptzr	ptR.G	F	P	bog	—	—	2	L	—
PR-11	DOVco	O.GL	Fv/L	W	upland	undulating	—	3	M	—
PR-12	FRTzz	BR.GL	F	MW	upland	undulating	—	4	L	—
PR-13	BMTptzr	ptR.G	F	VP	wetlands	undulating	—	3	L	—
PR-14	MLDxc	T.M	O	P	wetlands	undulating	—	1	level	—
PR-15	FRT	O.GL	F	W	upland	undulating	—	3	M	—
pr-3	FRTgl	GL.GL	F	I	upland	level	—	2	level	—
TER001	MILzz	O.DYB	FG	R	upland	—	0	1	—	—
TER095	MIL	E.DYB	FG	R	upland	—	0	—	—	—
TER096	MIL	E.DYB	FG	R	upland	—	15	1	—	—
TER097	FRTzz	BR.GL	Till	I	upland	—	0	1	—	—
TER098	MIL	E.DYB	FG	R	upland	—	0	1	—	—
TER099	MIL	E.DYB	FG	R	upland	—	0	1	—	—
TER100	MILzz	O.DYB	FG	R	upland	—	0	1	—	—
TER101	MIL	E.DYB	FG	R	upland	—	0	1	—	—
TER102	MIL	E.DYB	FG	R	upland	—	0	1	—	—
TER103	MIL	E.DYB	FG	R	upland	—	45	1	—	—
TER104	MIL	E.DYB	FG	R	upland	—	0	1	—	—
TER105	MIL	E.DYB	FG	R	upland	—	0	1	—	—
TER106	MUSxc	T.F	Ov/Till	P	bog	—	60	1	—	—

Table C-2 List of Soil Inspection Sites in the Pierre River Mining Area Local Study Area (continued)

Field Site #	Series	Subgroup	Parent Material	Drainage	Landform	Surface Expression	Peat Depth [cm]	Slope Class	Slope Position	Ecosite
TER107	MIL	E.DYB	FG	R	upland	—	0	1	—	—
TER108	MIL	E.DYB	FG	R	upland	—	0	1	—	—
TER109	MIL	E.DYB	FG	R	upland	—	0	1	—	—
TER110	MIL	E.DYB	FG	R	upland	—	0	1	—	—
TER111	MIL	E.DYB	FG	R	upland	—	30	1	—	—
TER112	MIL	E.DYB	FG	R	upland	—	0	1	—	—
TER113	HRR	O.GL	Till	I	upland	—	0	1	—	—
TER114	MIL	E.DYB	FG	R	upland	—	0	1	—	—
TER115	HRRgl	GL.GL	Till	I	upland	—	0	1	—	—
TER116	MIL	E.DYB	FG	R	upland	—	0	1	—	—
TER117	MIL	E.DYB	FG	R	upland	—	0	1	—	—
TER118	HRR	O.GL	Till	I	upland	—	0	1	—	—
TER119	HRR	O.GL	Till	I	upland	—	0	1	—	—
TER120	MLD	TY.F	O	VP	fen	—	182	1	—	—
TER121	MUSxc	T.F	Ov/FG	P	bog	—	60	1	—	—
TER122	HRR	O.GL	Till	I	upland	—	0	1	—	—
TER123	MIL	E.DYB	FG	R	upland	—	0	1	—	—
TER124	MIL	E.DYB	FG	R	upland	—	0	1	—	—
TER125	MUSxS	T.F	Ob/FG	P	bog	—	122	1	—	—
TER126	MIL	E.DYB	FG	R	upland	—	0	1	—	—
TER127	MIL	E.DYB	FG	R	upland	—	0	1	—	—
TER128	MIL	E.DYB	FG	R	upland	—	0	1	—	—
TER129	BMTpt	ptR.G	Till	I	upland	—	30	1	—	—
TER130	MLDxc	T.F	Ov/Till	P	bog	—	91	1	—	—
TER131	MLD	TY.F	O	VP	fen	—	304	1	—	—
TER132	MUSxc	T.F	Ov/FG	P	bog	—	76	1	—	—
TER133	HRRgl	GL.GL	Till	I	upland	—	0	1	—	—
TER134	MIL	E.DYB	FG	R	upland	—	0	1	—	—
TER135	MIL	E.DYB	FG	R	upland	—	0	1	—	—
TER136	MIL	E.DYB	FG	R	upland	—	0	1	—	—
TER137	MUSxs	T.F	Ob/FG	P	bog	—	121	1	—	—
TER138	MIL	E.DYB	FG	R	upland	—	0	1	—	—
TER139	MUSXs	T.F	Ob/FG	P	bog	—	152	1	—	—
TER140	MIL	E.DYB	FG	R	upland	—	0	1	—	—
TER141	MIL	E.DYB	FG	R	upland	—	0	1	—	—
TER142	MIL	E.DYB	FG	R	upland	—	0	1	—	—
TER143	MUSxs	T.F	Ob/FG	P	bog	—	152	1	—	—
TER144	HRRgl	GL.GL	Till	I	upland	—	0	1	—	—

— = No data.

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APPENDIX D

SOIL MAP UNIT DESCRIPTIONS

Submitted to:
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Prepared by:
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TABLE OF CONTENTS

SECTION **PAGE**

1 DESCRIPTION AND CHARACTERISTICS OF SOIL MAP UNITS 1
1.1 PIERRE RIVER MINING AREA SOIL MAP UNIT DESCRIPTIONS 2
1.1.1 ABN1/O1 3
1.1.2 BMTpt1/U1l 4
1.1.3 DOVcogl 1/U1l 5
1.1.4 DOVglCHptzr 1/U1l 6
1.1.5 DOV2/FP3 7
1.1.6 DOV1/U1l 8
1.1.7 DOV2/U1l 9
1.1.8 FIR1/U1l 10
1.1.9 FIRgl1/U1l 11
1.1.10 FRLV1/H1l 12
1.1.11 FRLV1/U1h 13
1.1.12 FRT1/U1h 14
1.1.13 MIL1/H1l 15
1.1.14 MIL1/H1m 16
1.1.15 MIL1/U1h 17
1.1.16 MIL1/U1l 18
1.1.17 MIFR1/U1h 19
1.1.18 MIFR1/U1l 20
1.1.19 MIFR2/U1h 21
1.1.20 MIFR2/U1l 22
1.1.21 MIFR1/H1l 23
1.1.22 MIFR1/I3h 24
1.1.23 MIFR1/SC1h 25
1.1.24 MIFR1/SC3 26
1.1.25 MLxcCHptzr1/O1 27
1.1.26 MLD1/O1 28
1.1.27 MLDxc1/O1 29
1.1.28 MLDxs1/O1 30
1.1.29 MLxsMKaaxs1/O1 31
1.1.30 MMY1/U1l 32
1.1.31 MUxsBMpt1/O5 33
1.1.32 MUSxs1/O2 34
1.1.33 MUSxs1/O4 35
1.1.34 MUSxc1/O5 36
1.1.35 MUSxs1/O5 37
1.1.36 NAMcu2/FP3 38
1.1.37 ZWA1/W3 38
1.2 JACKPINE EXPANSION MINING AREA SOIL MAP UNIT DESCRIPTIONS 39
1.2.1 ABN1/O1 40
1.2.2 ABN2/O2 41
1.2.3 ABN3/O3 42
1.2.4 ABN4/O6 43
1.2.5 BMTpt1/U1l 44
1.2.6 ELptMR1/O5 45
1.2.7 ELptHR1/U1l 46
1.2.8 HLMLxt1/O1 47
1.2.9 HLMUxc1/O1 48

1.2.10 HRR1/H1l 49
1.2.11 HRR2/U1h 50
1.2.12 HRLV1 51
1.2.13 MIL1 53
1.2.14 MIL2 60
1.2.15 MLD1 61
1.2.16 MLxsBMpt1/O5 63
1.2.17 MRN1/O1 64
1.2.18 MUSxc1/O5 64
1.2.19 ZWA1/W3 65

LIST OF TABLES

Table D-1 Soil Variants 1
Table D-2 Summary of Interpretations for Pierre River (Soil Landscape Units) 2
Table D-3 ABN1/O1 Soil Description 3
Table D-4 BMTpt1/U1l Soil Description 4
Table D-5 DOVcogl/U1l Soil Description 5
Table D-6 DOVglCHptzr/U1l Soil Description 6
Table D-7 DOV 2/FP3 Soil Description 7
Table D-8 DOV 1/U1l Soil Description 8
Table D-9 DOV 2/U1l Soil Description 9
Table D-10 FIR1/U1l Soil Description 10
Table D-11 FIR1/U1l Soil Description 11
Table D-12 FRLV/H1l Soil Description 12
Table D-13 FRLV/U1h Soil Description 13
Table D-14 FRT1/U1h Soil Description 14
Table D-15 MIL1/H1l Soil Description 15
Table D-16 MIL1/H1m Soil Description 16
Table D-17 MIL1/U1h Soil Description 17
Table D-18 MIL1/U1l Soil Description 18
Table D-19 MIFR1/U1h Soil Description 19
Table D-20 MIFR1/U1l Soil Description 20
Table D-21 MIFR2/U1h Soil Description 21
Table D-22 MIFR2/U1l Soil Description 22
Table D-23 MIFR1/H1l Soil Description 23
Table D-24 MIFR1/I3h Soil Description 24
Table D-25 MIFR1/SC1h Soil Description 25
Table D-26 MIFR1/SC3 Soil Description 26
Table D-27 MLxcCHptzr1/O1 Soil Description 27
Table D-28 MLD1/O1 Soil Description 28
Table D-29 MLDxc1/O1 Soil Description 29
Table D-30 MLDxs1/O1 Soil Description 30
Table D-31 MLxsMKaaxs1/O1 Soil Description 31
Table D-32 MMY1/U1l Soil Description 32
Table D-33 MUxsBMpt1/O5 Soil Description 33
Table D-34 MUSxs1/O2 Soil Description 34
Table D-35 MUSxs1/O4 Soil Description 35
Table D-36 MUSxc1/O5 Soil Description 36
Table D-37 MUSxs1/O5 Soil Description 37
Table D-38 NAMcu2/FP3 Soil Description 38
Table D-39 Summary of Interpretations for Jackpine (Soil Landscape Units) 39

Table D-40 ABN1/O1 Soil Description....40
Table D-41 ABN2/O2 Soil Description....41
Table D-42 ABN3/O3 Soil Description....42
Table D-43 ABN4/O6 Soil Description....43
Table D-44 BMTpt1/U1l Soil Description....44
Table D-45 ELptMR1/O5 Soil Description....45
Table D-46 ELptHR1/U1l Soil Description....46
Table D-47 HLMLxt1/O1 Soil Description....47
Table D-48 HLMUxc1/O1 Soil Description....48
Table D-49 HRR1/H1l Soil Description....49
Table D-50 HRR2/U1h Soil Description....50
Table D-51 HRLV1/U1h Soil Description....51
Table D-52 HRLV1/H1l Soil Description....52
Table D-53 HRLV1/H1m Soil Description....52
Table D-54 MIL1/U1h Soil Description....54
Table D-55 MIL1/U1l Soil Description....54
Table D-56 MIL1/H1l Soil Description....55
Table D-57 MIL1/H1m Soil Description....55
Table D-58 MIL1/H1h Soil Description....56
Table D-59 MIL1/HR2m Soil Description....56
Table D-60 MIL1/HR2h Soil Description....57
Table D-61 MIL1/I3l Soil Description....57
Table D-62 MIL1/I3m Soil Description....58
Table D-63 MIL1/I3h Soil Description....58
Table D-64 MIL1/SC1h Soil Description....59
Table D-65 MIL1/SC3 Soil Description....59
Table D-66 MIL2/U1h Soil Description....60
Table D-67 MIL2/U1l Soil Description....61
Table D-68 MLD1/FP1 Soil Description....62
Table D-69 MLD1/FP3 Soil Description....62
Table D-70 MLD1/O1 Soil Description....63
Table D-71 MLxsNOpt1/O1 Soil Description....63
Table D-72 MRN1/O1 Soil Description....64
Table D-73 MUSxc1/O5 Soil Description....65

1 DESCRIPTION AND CHARACTERISTICS OF SOIL MAP UNITS

Table D-1 Soil Variants

Code	Description
AA	not modal SCA
CA	calcareous
CB	cobbly
CO	coarse
CR	carbonated
DL	disturbed
ER	eroded
FI	fine
GL	gleyed
GR	gravelly (entire profiled)
OB	overblown
OW	overwashed
NP	non-peaty
PT	peaty
ST	stony
TK	thick A I material thicker than modal
XC	clay at 30 to 99 cm
XG	gravel at 30 to 99 cm
XL	lithic at 30 to 99 cm
XM	medium material at 30 to 99 cm
XS	sand at 30 to 99 cm
XT	till at 30 to 99 cm
XU	undifferentiated material at 30 to 99 cm
XZ	permafrost at 30 to 99 cm
YC	clay at 100 to 200 cm
YG	gravel at 100 to 200 cm
YL	lithic at 100 to 200 cm
YM	medium material at 100 to 200 cm
YP	paralithic at 100 to 200 cm
YS	sand at 100 to 200 cm
YT	till at 100 to 200 cm
YZ	permafrost at 100 to 200 cm
ZB	Brunisolic
ZF	Fibric
ZG	Gleyed Regosol
ZH	Humic
ZL	Luvisolic
ZO	Orthic
ZR	Regosol
ZS	Solodic
ZT	Solonetzic
ZZ	atypical subgroup

Note: Adapted from CAESA-SIWG (2006, website).

1.1 PIERRE RIVER MINING AREA SOIL MAP UNIT DESCRIPTIONS

JPME R1 ERRATA AND

JPME R1 AENV SIR 408

Table D-2 Summary of Interpretations for Pierre River (Soil Landscape Units)

Map Unit Name	Map Unit Symbol	Forest Land Capability Class	Erosion	
			Wind	Water
Albian	ABN1/O1	5W[10]	low	low
Bitumount	BMTpt1/U1l	4W[9] 4[1]	low	low
Dover	DOV1/U1l	3-2	low	low
	DOV2/U1l	3-2	low	low
	DOV2/FP3	3-2	low	low
	DOVcogl1/U1l	3-4	low	low
gleyed Dover – peaty rego Chateh	DOglCHptzr1/U1l	4V	low	low
Firebag	FIR1/U1l	4X-3F	low	low
	FIRgl1/U1l	4X-3F	low	low
Fort	FRT1/U1h	3V	low	low
Fort - Livock	FRLV1/U1h	3V-3D	low	low
	FRLV1/H1l	3V-3D	low	moderate
Mildred	MIL1/U1h	4X[10]	high	low
	MIL1/U1l	4X[10]	high	low
	MIL1/H1l	4X[10]	high	moderate
	MIL1/H1m	4X[10]	high	high
	MIL2/U1l	4X 4W	high	low
	MIL2/U1h	4X 4W	high	low
Mildred - Fort	MIFR1/U1h	4X[10]	high	moderate
	MIFR1/U1l	4X[10]	high	moderate
	MIFR1/H1l	4X[10]	high	low
	MIFR1/I3h	4X[10]	high	moderate
	MIFR1/SC1h	4X[10]	high	low
	MIFR1/SC3	4X[10]	high	low
	MIFR2/U1h	4X[10]	high	low
	MIFR2/U1l	4X[10]	high	low
McLelland	MLDxs1/O1	5W[10]	low	low
	MLDxc1/O1	5W[10]	low	low
	MLD1/O1	5W[10]	low	low
McLelland – Chateh	MLxcCHptzr1/O1	5W[5] 4W[5]	low	low
McLelland - Mikkwa	MLxsMKaaxs1/O1	5W[10]	low	low
McMurray	MMY1/U1l	4W	low	moderate
Muskeg – peaty Bitumount	MUxsBMpt1/O5	5W 4W	low	low
xcMuskeg	MUSxc1/O5	5W[10]	low	low
xsMuskeg	MUSxs1/O1	5W[10]	low	Low
	MUSxs1/O2	5W[10]	low	low
	MUSxs1/O4	5W[10]	low	low
	MUSxs1/O5	5W[10]	low	low
cuNamur	NAMcu2/FP3	2V		
Water	ZWA1/W3	N/A	N/A	N/A

Note:
N/A = Not Applicable

PAGE CORRECTED FOR ERRATA

1.1.1 ABN1/O1

The ABN1 unit consists of dominantly poorly drained Typic Fibrisols (ABN) developed on thick (>2.2 m), level, flat, horizontal or plateau (slopes <0.5%) fen and bog peatlands. Fibric material usually dominates upper tier. Typic Mesisols (MLD) are found in significant amounts. Typic Mesisols (MUS) and Fibric Organic Cryosols (MKWaa) are found in minor amounts. Other soils that may occur in the unit include Terric Fibrisols (HLY) and Terric Mesisols (MUSxc and MLDxc). Areas of domed organics may be present. There are minor areas of O6 (domed) landforms present in the unit. Fibric Organic Cryosols dominate these areas.

Table D-3 ABN1/O1 Soil Description

Soil Map Unit Name	ABN1/O1
Dominant Soils	Typic Fibrisols (ABN)
Significant Soils	Typic Mesisols (MLD)
Minor Soils	Typic Mesisols (MUS); Fibric Organic Cryosols (MKWaa); Terric Fibrisols (HYL); Terric Mesisols (MUSxc and MLDxc)
Landscape Model	O1 - level organic
Parent Materials	Sphagnum and fen peat
Forest Capability	$5W^{10}$
Water Erosion Risk	low
Wind Erosion Risk	low
Reclamation Suitability of Topsoil	organic
Typical Topsoil Depth	n/a
Reclamation Suitability of Upper Subsoil	organic
Typical Upper Subsoil Depth	n/a
Reclamation Suitability of Lower Subsoil	organic
Typical Lower Subsoil Depth	n/a

n/a = Not applicable.

1.1.2 BMTpt1/U1l

The BMTpt1 unit consists of dominantly poorly drained peaty Orthic Gleysols (BMTpt) developed on low relief undulating (slopes 0.5 to 2%), fine to coarse textured (sand to clay) glaciofluvial deposits. Low lying areas dominated by coarse textured and layered Gleysols and thin organic soils. Typic Mesisols (MLDxs) and Gleyed Regosols (NORgl and NAMgl) and are found in significant amounts. Orthic Luvic Gleysols (ALG) and Gleyed Eluviated Dystric Brunisols (MILgl and SUTgl) are found in minor amounts along the margins of the unit. The parent material textures are not predictable.

Table D-4 BMTpt1/U1l Soil Description

Soil Map Unit Name	BMTpt1/U1l
Dominant Soils	peaty Orthic Gleysols (BMTpt)
Significant Soils	Terric Mesisols (MLDxs), Gleyed Regosols (NAMgl), Rego Gleysols (NORgl)
Minor Soils	Orthic Luvic Gleysols (ALG), Gleyed Eluviated Dystric Brunisols (MILgl and SUTgl)
Landscape Model	U1l – low relief undulating
Parent Materials	Variable textured glaciofluvial deposits overlying moderately fine to fine textured till and glaciolacustrine
Forest Capability	$4W^{9}$ 4^{1}
Water Erosion Risk	low
Wind Erosion Risk	low
Reclamation Suitability of Topsoil	organic
Typical Topsoil Depth	<40 cm (organic)
Reclamation Suitability of Upper Subsoil	poor
Typical Upper Subsoil Depth	0
Reclamation Suitability of Lower Subsoil	poor
Typical Lower Subsoil Depth	not determined

Note: Low lying areas dominated by variable textured and layered Gleysols and thin Organic soils. Peaty phases are common.

1.1.3 DOVcogl 1/U1l

The DOVcogl unit consists of dominantly imperfectly drained Gleyed Gray Luvisols (DOVcogl) developed on low relief undulating (slopes 0.5 to 2%), moderately fine textured (clay loam) glaciolacustrine and glaciofluvial deposits. Textures are typically coarser than modal DOV profiles. Orthic Gray Luvisols (modal DOV) and Gleyed Regosols (NAMgl) are found in significant amounts. Orthic Luvic Gleysols (ALGco) and Rego Gleysols (CHTptzr)) are found in minor amounts in depressional areas and along the margins of the unit. Parent material textures are variable and unpredictable. Unit often associated with floodplains of incised streams

Table D-5 DOVcogl/U1l Soil Description

Soil Map Unit Name	DOVcogl/U1l
Dominant Soils	Gleyed Gray Luvisols (DOVcogl)
Significant Soils	Orthic Gray Luvisols (DOV), Gleyed Regosols (NAMgl)
Minor Soils	Orthic Luvic Gleysols (ALGco), Rego Gleysols (CHTptzr)
Landscape Model	U1l – low relief undulating
Parent Materials	Variable textured glaciofluvial and glaciolacustrine deposits
Forest Capability	3-4
Water Erosion Risk	low
Wind Erosion Risk	low
Reclamation Suitability of Topsoil	Poor
Typical Topsoil Depth	15 cm (mineral)
Reclamation Suitability of Upper Subsoil	Poor
Typical Upper Subsoil Depth	30 cm
Reclamation Suitability of Lower Subsoil	poor
Typical Lower Subsoil Depth	55 cm

1.1.4 DOVglCHptzr 1/U1l

The DOVglCHptzr unit consists of dominantly imperfectly drained Gleyed Gray Luvisols (DOVgl) and imperfectly to poorly drained peaty Rego Gleysols (CHTptzr) developed on low relief undulating (slopes 0.5 to 2%), fine textured (clay and silty clay) glaciolacustrine deposits. Orthic Luvic Gleysols (ALG), and Orthic Humic Gleysols (DAR) are found in significant amounts. Terric Mesisols (MLDxc) may be found in depressional areas within the map unit.

Table D-6 DOVglCHptzr/U1l Soil Description

Soil Map Unit Name	DOVglCHptzr/U1l
Dominant Soils	Gleyed Gray Luvisols (DOVgl) and peaty Rego Gleysols (CHTptzr)
Significant Soils	Orthic Luvic Gleysols (ALG), Orthic Humic Gleysols (DAR)
Minor Soils	Terric Mesisols (MLDxc)
Landscape Model	U1l – low relief undulating
Parent Materials	Fine textured glaciolacustrine deposits
Forest Capability	3-2
Water Erosion Risk	Low
Wind Erosion Risk	low
Reclamation Suitability of Topsoil	Good
Typical Topsoil Depth	20 cm (GL.GL) and 0 (R.G)
Reclamation Suitability of Upper Subsoil	Poor/fair
Typical Upper Subsoil Depth	30 cm (GL.GL) and 0 (R.G)
Reclamation Suitability of Lower Subsoil	poor
Typical Lower Subsoil Depth	50 cm

1.1.5 DOV2/FP3

The DOV 2/FP3 unit consists of dominantly moderately well drained Orthic Gray Luvisols (DOV) developed on confined floodplains (slopes 0.5 to 2%), fine textured (clay and silty clay) lacustrine and fluvial deposits. Orthic Luvic Gleysols (ALG), Rego Gleysols (CHTzr), and Orthic Humic Gleysols (DAR) are found in significant amounts. Terric Mesisols (MLDxc) may be found in depressional areas within the map unit.

Table D-7 DOV 2/FP3 Soil Description

Soil Map Unit Name	DOV2/FP3
Dominant Soils	Orthic Gray Luvisols (DOV)
Significant Soils	Orthic Luvic Gleysols (ALG), Orthic Humic Gleysols (DAR), Rego Gleysols (CHTzr)
Minor Soils	Terric Mesisols (MLDxc)
Landscape Model	FP3 confined floodplain possibly terraced
Parent Materials	Fine textured lacustrine and fluvial deposits
Forest Capability	3-4
Water Erosion Risk	Low
Wind Erosion Risk	low
Reclamation Suitability of Topsoil	good to organic
Typical Topsoil Depth	25 cm
Reclamation Suitability of Upper Subsoil	fair/poor
Typical Upper Subsoil Depth	25 cm
Reclamation Suitability of Lower Subsoil	poor
Typical Lower Subsoil Depth	50 cm

1.1.6 DOV1/U1l

The DOV1/U1l unit consists of moderately well drained Orthic Gray Luvisols (DOV) developed on low relief undulating (slopes 0.5 to 2%), fine textured (clay and silty clay) glaciolacustrine deposits. Orthic Luvic Gleysols (ALG), and Rego Gleysols (CHTzr), are found in minor amounts

Table D-8 DOV 1/U1l Soil Description

Soil Map Unit Name	DOV1/U1l
Dominant Soils	Orthic Gray Luvisols (DOV)
Significant Soils	
Minor Soils	Orthic Luvic Gleysols (ALG) and Rego Gleysols (CHzr)
Landscape Model	U1l – low relief undulating
Parent Materials	Fine textured glaciolacustrine deposits
Forest Capability	3
Water Erosion Risk	Low
Wind Erosion Risk	low
Reclamation Suitability of Topsoil	good
Typical Topsoil Depth	25 cm
Reclamation Suitability of Upper Subsoil	fair/poor
Typical Upper Subsoil Depth	25 cm
Reclamation Suitability of Lower Subsoil	poor
Typical Lower Subsoil Depth	50 cm

1.1.7 DOV2/U1l

The DOV2/U1l unit consists of moderately well drained Orthic Gray Luvisols (DOV) developed on low relief undulating (slopes 0.5 to 2%), fine textured (clay and silty clay) glaciolacustrine deposits. Orthic Luvic Gleysols (ALG), and Rego Gleysols (CHTzr), are found in significant amounts. Terric Mesisols (MLDxc) occurs in minor amounts.

Table D-9 DOV 2/U1l Soil Description

Soil Map Unit Name	DOV2/U1l
Dominant Soils	Orthic Gray Luvisols (DOV)
Significant Soils	Orthic Luvic Gleysols (ALG), and Rego Gleysols (CHTzr)
Minor Soils	Terric Mesisols (MLDxc)
Landscape Model	U1l – low relief undulating
Parent Materials	Fine textured glaciolacustrine deposits
Forest Capability	3
Water Erosion Risk	Low
Wind Erosion Risk	low
Reclamation Suitability of Topsoil	good
Typical Topsoil Depth	25 cm
Reclamation Suitability of Upper Subsoil	fair/poor
Typical Upper Subsoil Depth	25 cm
Reclamation Suitability of Lower Subsoil	poor
Typical Lower Subsoil Depth	50 cm

1.1.8 FIR1/U1l

The FIR 1/U1l unit consists of moderately well drained Eluviated Dystric Brunisols (FIR) developed on low relief undulating (slopes 0.5 to 2%), stony, coarse textured (gravelly sand and sand) ice contact glaciofluvial deposits. Eluviated Dystric Brunisols (MIL) is found in significant amounts. Orthic Gray Luvisols (FRT) may occur in minor amounts.

Table D-10 FIR1/U1l Soil Description

Soil Map Unit Name	FIR/U1l
Dominant Soils	Eluviated Dystric Brunisols (FIR)
Significant Soils	Eluviated Dystric Brunisols (MIL)
Minor Soils	Orthic Gray Luvisols (FRT)
Landscape Model	U1l – low relief undulating
Parent Materials	Stony Coarse textured ice-contact glaciofluvial deposits
Forest Capability	4X-3F
Water Erosion Risk	low
Wind Erosion Risk	low
Reclamation Suitability of Topsoil	Fair
Typical Topsoil Depth	20 cm
Reclamation Suitability of Upper Subsoil	Poor
Typical Upper Subsoil Depth	15 cm
Reclamation Suitability of Lower Subsoil	poor
Typical Lower Subsoil Depth	65 cm

1.1.9 FIRgl1/U1l

The FIRgl 1/U1l unit consists of imperfect drained Gleyed Eluviated Dystric Brunisols (FIRgl) developed on low relief undulating (slopes 0.5 to 2%), stony, coarse textured (gravelly sand and sand) ice-contact glaciofluvial deposits. Eluviated Dystric Brunisols (MIL) and peaty Rego Gleysols (BMTpt) are found in significant amounts. Orthic Gray Luvisols (FRT) may occur in minor amounts.

Table D-11 FIR1/U1l Soil Description

Soil Map Unit Name	FIRgl/U1l
Dominant Soils	Gleyed Eluviated Dystric Brunisols (FIRgl)
Significant Soils	Eluviated Dystric Brunisols (MIL) and Rego Gleysols (BMTpt)
Minor Soils	Orthic Gray Luvisols (FRT)
Landscape Model	U1l – low relief undulating
Parent Materials	Stony Coarse textured ice-contact glaciofluvial deposits
Forest Capability	4X-3F
Water Erosion Risk	low
Wind Erosion Risk	low
Reclamation Suitability of Topsoil	Fair
Typical Topsoil Depth	20 cm
Reclamation Suitability of Upper Subsoil	Poor
Typical Upper Subsoil Depth	15 cm
Reclamation Suitability of Lower Subsoil	poor
Typical Lower Subsoil Depth	65 cm

1.1.10 FRLV1/H1l

The FRLV 1/H1l unit consists of well drained Orthic Gray Luvisols (FRT, LVK) developed on hummocky low relief (slopes 5 to 9%), medium to moderately coarse textured (sandy loam and loam) glaciofluvial deposits overlying medium to moderately fine textured till. Orthic Gray Luvisols (FRT and LVK) are co-dominant. Orthic Luvic Gleysols (STP) and Orthic Gray Luvisol (PEA) occur in minor amounts. Presence of McMurray Formation derived alluvial material often present in profile.

Table D-12 FRLV/H1l Soil Description

Soil Map Unit Name	FRLV1/H1l
Dominant Soils	Orthic Gray Luvisols (FRT and LVK)
Significant Soils	
Minor Soils	Orthic Gray Luvisols (PEA) and Orthic Luvic Gleysol (STP)
Landscape Model	H1l – low relief hummocky
Parent Materials	Medium to moderately coarse textured glaciofluvial deposits overlying medium to moderately fine textured till
Forest Capability	3V-3D
Water Erosion Risk	low
Wind Erosion Risk	low
Reclamation Suitability of Topsoil	Fair
Typical Topsoil Depth	25 cm
Reclamation Suitability of Upper Subsoil	Fair
Typical Upper Subsoil Depth	20 cm
Reclamation Suitability of Lower Subsoil	Poor-fair
Typical Lower Subsoil Depth	55 cm

1.1.11 FRLV1/U1h

The FRLV 1/U1h unit consists of well drained Orthic Gray Luvisols (FRT, LVK) developed on undulating high relief (slopes 2 to 5%), medium to moderately coarse textured (sandy loam and loam) glaciofluvial deposits overlying medium to moderately fine textured till. Orthic Gray Luvisols (FRT and LVK) are co-dominant. Orthic Luvic Gleysols (STP) occurs in minor amounts. Presence of McMurray Formation derived alluvial material often present in profile.

Table D-13 FRLV/U1h Soil Description

Soil Map Unit Name	FRLV1/U1h
Dominant Soils	Orthic Gray Luvisols (FRT and LVK)
Significant Soils	
Minor Soils	Orthic Luvic Gleysol (STP)
Landscape Model	U1l-undulating high relief
Parent Materials	Medium to moderately coarse textured glaciofluvial deposits overlying medium to moderately fine textured till
Forest Capability	3V-3D
Water Erosion Risk	Moderate
Wind Erosion Risk	low
Reclamation Suitability of Topsoil	Fair
Typical Topsoil Depth	25 cm
Reclamation Suitability of Upper Subsoil	Fair
Typical Upper Subsoil Depth	25 cm
Reclamation Suitability of Lower Subsoil	Poor-fair
Typical Lower Subsoil Depth	50 cm

1.1.12 FRT1/U1h

The FRT 1/U1h unit consists of moderately well to well drained Orthic Gray Luvisols (FRT) developed on high relief undulating (slopes 2 to 5%), medium to moderately coarse textured (sandy loam and loam) glaciofluvial deposits. Orthic Gray Luvisols (PEA) occurs in significant amounts. Presence of McMurray Formation derived alluvial material often present in profile.

Table D-14 FRT1/U1h Soil Description

Soil Map Unit Name	FRT1/U1h
Dominant Soils	Orthic Gray Luvisols (FRT)
Significant Soils	Orthic Gray Luvisols (PEA)
Minor Soils	
Landscape Model	U1h-high relief undulating
Parent Materials	medium to moderately coarse textured glaciofluvial deposits
Forest Capability	3V
Water Erosion Risk	Moderate
Wind Erosion Risk	low
Reclamation Suitability of Topsoil	Fair
Typical Topsoil Depth	25 cm
Reclamation Suitability of Upper Subsoil	Fair
Typical Upper Subsoil Depth	20 cm
Reclamation Suitability of Lower Subsoil	poor
Typical Lower Subsoil Depth	55 cm

1.1.13 MIL1/H1l

The MIL1/H1l unit consists of well drained Eluviated Dystric Brunisols (MIL) developed on hummocky low relief (slopes 5 to 9%), coarse textured (loamy sand and sand) glaciofluvial deposits. Orthic Dystric Brunisols (MILzz), Orthic Gray Luvisols (LVK and FRT), and Eluviated Dystric Brunisols (SUT) occur in minor amounts. Soil profiles may be stratified in some polygons. Eluviated Dystric Brunisols (MAR) may occur in some units. Some polygons may be dominated by Orthic Dystric Brunisols (MILzz).

Table D-15 MIL1/H1l Soil Description

Soil Map Unit Name	MIL1/H1l
Dominant Soils	Eluviated Dystric Brunisols (MIL)
Significant Soils	
Minor Soils	Orthic Dystric Brunisols (MILzz), , Orthic Gray Luvisols (FRT and LVK) and Eluviated Dystric Brunisols (SUT)
Landscape Model	H1l – low relief hummocky
Parent Materials	Coarse textured glaciofluvial
Forest Capability	4X
Water Erosion Risk	moderate
Wind Erosion Risk	high
Reclamation Suitability of Topsoil	poor
Typical Topsoil Depth	15
Reclamation Suitability of Upper Subsoil	poor
Typical Upper Subsoil Depth	40
Reclamation Suitability of Lower Subsoil	poor
Typical Lower Subsoil Depth	45

1.1.14 MIL1/H1m

The MIL1/H1m unit consists of well drained Eluviated Dystric Brunisols (MIL) developed on hummocky moderate relief (slopes 9 to 15%), coarse textured (loamy sand and sand) glaciofluvial deposits. Orthic Dystric Brunisols (MILzz), Orthic Gray Luvisols (FRT and LVK), and Eluviated Dystric Brunisols (SUT) occur in minor amounts. Soil profiles sometimes stratified. Low and high relief hummocky slopes can occur within units.

Table D-16 MIL1/H1m Soil Description

Soil Map Unit Name	MIL1/H1m
Dominant Soils	Eluviated Dystric Brunisols (MIL)
Significant Soils	
Minor Soils	Orthic Dystric Brunisols (MILzz), , Orthic Gray Luvisols (FRT and LVK) and Eluviated Dystric Brunisols (SUT)
Landscape Model	H1m – moderate relief hummocky
Parent Materials	Coarse textured glaciofluvial
Forest Capability	4X
Water Erosion Risk	high
Wind Erosion Risk	high
Reclamation Suitability of Topsoil	poor
Typical Topsoil Depth	15
Reclamation Suitability of Upper Subsoil	poor
Typical Upper Subsoil Depth	40
Reclamation Suitability of Lower Subsoil	poor
Typical Lower Subsoil Depth	45

1.1.15 MIL1/U1h

The MIL1/U1h unit consists of well drained Eluviated Dystric Brunisols (MIL) developed on high relief undulating (slopes 2 to 5%), coarse textured (loamy sand and sand) glaciofluvial deposits. Orthic Dystric Brunisols (MILzz), Orthic Gray Luvisols (FRT and LVK), and Eluviated Dystric Brunisols (FIR) occur in minor amounts. Soil profiles sometimes stratified. Some polygons dominated by Orthic Dystric Brunisols (MILzz)

Table D-17 MIL1/U1h Soil Description

Soil Map Unit Name	MIL1/U1h
Dominant Soils	Eluviated Dystric Brunisols (MIL)
Significant Soils	n/a
Minor Soils	Orthic Dystric Brunisols (MILzz), Eluviated Dystric Brunisols (FIR), Orthic Gray Luvisols (FRT and LVK)
Landscape Model	U1h – high relief undulating
Parent Materials	Coarse textured glaciofluvial
Forest Capability	4X
Water Erosion Risk	low
Wind Erosion Risk	high
Reclamation Suitability of Topsoil	poor
Typical Topsoil Depth	15
Reclamation Suitability of Upper Subsoil	poor
Typical Upper Subsoil Depth	40
Reclamation Suitability of Lower Subsoil	poor
Typical Lower Subsoil Depth	45

1.1.16 MIL1/U1l

The MIL1/U1l unit consists of well drained Eluviated Dystric Brunisols (MIL) developed on high relief undulating (slopes 0.5 to 2%), coarse textured (loamy sand and sand) glaciofluvial deposits. Orthic Dystric Brunisols (MILzz), Orthic Gray Luvisols (FRT and LVK), and Eluviated Dystric Brunisols (FIR) occur in minor amounts. Soil profiles sometimes stratified. Some polygons dominated by Orthic Dystric Brunisols (MILzz)

Table D-18 MIL1/U1l Soil Description

Soil Map Unit Name	MIL1/U1h
Dominant Soils	Eluviated Dystric Brunisols (MIL)
Significant Soils	n/a
Minor Soils	Orthic Dystric Brunisols (MILzz), Eluviated Dystric Brunisols (FIR), Orthic Gray Luvisols (FRT and LVK)
Landscape Model	U1l – low relief undulating
Parent Materials	Coarse textured glaciofluvial
Forest Capability	4X
Water Erosion Risk	low
Wind Erosion Risk	high
Reclamation Suitability of Topsoil	poor
Typical Topsoil Depth	15
Reclamation Suitability of Upper Subsoil	poor
Typical Upper Subsoil Depth	40
Reclamation Suitability of Lower Subsoil	poor
Typical Lower Subsoil Depth	45

1.1.17 MIFR1/U1h

The MIFR1/U1h unit consists of well drained Eluviated Dystric Brunisols (MIL) and well drained Orthic Gray Luvisols (FRT) developed on high relief undulating (slopes 0.5 to 2%), coarse textured (loamy sand and sand) glaciofluvial deposits. Orthic Gray Luvisols (LVK and PEA), occur in minor amounts.

Table D-19 MIFR1/U1h Soil Description

Soil Map Unit Name	MIFR1/U1h
Dominant Soils	Eluviated Dystric Brunisols (MIL) and Orthic Gray Luvisols (FRT)
Significant Soils	n/a
Minor Soils	Orthic Gray Luvisols (LVK and PEA)
Landscape Model	U1h – high relief undulating
Parent Materials	Coarse textured glaciofluvial
Forest Capability	4X-3
Water Erosion Risk	moderate
Wind Erosion Risk	low
Reclamation Suitability of Topsoil	Poor-fair
Typical Topsoil Depth	20 cm
Reclamation Suitability of Upper Subsoil	Poor-fair
Typical Upper Subsoil Depth	40 (0 on regosols, organics, and gleysols)
Reclamation Suitability of Lower Subsoil	Poor
Typical Lower Subsoil Depth	40

1.1.18 MIFR1/U1l

The MIFR1/U1h unit consists of well drained Eluviated Dystric Brunisols (MIL) and well drained Orthic Gray Luvisols (FRT) developed on low relief undulating (slopes 0.5 to 2%), coarse textured (loamy sand and sand) glaciofluvial deposits. Orthic Gray Luvisols (LVK and PEA), occur in minor amounts.

Table D-20 MIFR1/U1l Soil Description

Soil Map Unit Name	MIFR 1/U1l
Dominant Soils	Eluviated Dystric Brunisols (MIL) and Orthic Gray Luvisols (FRT)
Significant Soils	n/a
Minor Soils	Orthic Gray Luvisols (LVK and PEA) and gleyed variants and gleysols
Landscape Model	U1l – low relief undulating
Parent Materials	Coarse textured glaciofluvial
Forest Capability	4X-3
Water Erosion Risk	low
Wind Erosion Risk	low
Reclamation Suitability of Topsoil	Poor-fair
Typical Topsoil Depth	20 cm
Reclamation Suitability of Upper Subsoil	Poor-fair
Typical Upper Subsoil Depth	40 (0 on regosols, organics, and gleysols)
Reclamation Suitability of Lower Subsoil	Poor
Typical Lower Subsoil Depth	40

1.1.19 MIFR2/U1h

The MIFR2/U1h unit consists of well drained Eluviated Dystric Brunisols (MIL) and well drained Orthic Gray Luvisols (FRT) developed on high relief undulating (slopes 2 to 5%), coarse textured (loamy sand and sand) glaciofluvial deposits. Gleyed variants, gleysols, and thin organics occur in significant amounts. Orthic Gray Luvisols (LVK and PEA), occur in minor amounts.

Table D-21 MIFR2/U1h Soil Description

Soil Map Unit Name	MIFR 2/U1h
Dominant Soils	Eluviated Dystric Brunisols (MIL) and Orthic Gray Luvisols (FRT)
Significant Soils	Gleyed variants, gleysols and thin organics
Minor Soils	Orthic Gray Luvisols (LVK and PEA)
Landscape Model	U1h – high relief undulating
Parent Materials	Coarse textured glaciofluvial
Forest Capability	4X-3
Water Erosion Risk	moderate
Wind Erosion Risk	low
Reclamation Suitability of Topsoil	Poor-fair
Typical Topsoil Depth	20 cm
Reclamation Suitability of Upper Subsoil	Poor-fair
Typical Upper Subsoil Depth	40 (0 on regosols, organics, and gleysols)
Reclamation Suitability of Lower Subsoil	Poor
Typical Lower Subsoil Depth	40

1.1.20 MIFR2/U1l

The MIFR2/U1l unit consists of well drained Eluviated Dystric Brunisols (MIL) and well drained Orthic Gray Luvisols (FRT) developed on high relief undulating (slopes 0.5 to 2%), coarse textured (loamy sand and sand) glaciofluvial deposits. Gleyed variants, gleysols, and thin organics occur in significant amounts. Orthic Gray Luvisols (LVK and PEA), occur in minor amounts.

Table D-22 MIFR2/U1l Soil Description

Soil Map Unit Name	MIFR 2/U1l
Dominant Soils	Eluviated Dystric Brunisols (MIL) and Orthic Gray Luvisols (FRT)
Significant Soils	Gleyed variants, gleysols and thin organics
Minor Soils	Orthic Gray Luvisols (LVK and PEA)
Landscape Model	U1l – low relief undulating
Parent Materials	Coarse textured glaciofluvial
Forest Capability	4X-3
Water Erosion Risk	low
Wind Erosion Risk	low
Reclamation Suitability of Topsoil	Poor-fair
Typical Topsoil Depth	20 cm
Reclamation Suitability of Upper Subsoil	Poor-fair
Typical Upper Subsoil Depth	40 (0 on regosols, organics, and gleysols)
Reclamation Suitability of Lower Subsoil	Poor
Typical Lower Subsoil Depth	40

1.1.21 MIFR1/H1l

The MIFR1/H1l unit consists of well drained Eluviated Dystric Brunisols (MIL) and well drained Orthic Gray Luvisols (FRT) developed on low relief hummocky (slopes 5 to 9%), coarse textured (loamy sand and sand) glaciofluvial deposits. Orthic Gray Luvisols (LVK and PEA) and gleyed variants and gleysols occur in minor amounts.

Table D-23 MIFR1/H1l Soil Description

Soil Map Unit Name	MIFR1/H1l
Dominant Soils	Eluviated Dystric Brunisols (MIL) and Orthic Gray Luvisols (FRT)
Significant Soils	n/a
Minor Soils	Orthic Gray Luvisols (LVK and PEA) and gleyed variants and gleysols
Landscape Model	H1l – low relief humocky
Parent Materials	Coarse textured glaciofluvial
Forest Capability	4X-3
Water Erosion Risk	low
Wind Erosion Risk	low
Reclamation Suitability of Topsoil	Poor-fair
Typical Topsoil Depth	20 cm
Reclamation Suitability of Upper Subsoil	Poor-fair
Typical Upper Subsoil Depth	40 (0 on regosols, organics, and gleysols)
Reclamation Suitability of Lower Subsoil	Poor
Typical Lower Subsoil Depth	40

1.1.22 MIFR1/I3h

The MIFR1/I3h unit consists of well drained Eluviated Dystric Brunisols (MIL) and well drained Orthic Gray Luvisols (FRT) developed on steep single slope landforms (slopes 15 to 30%+), coarse textured (loamy sand and sand) glaciofluvial deposits. Orthic Gray Luvisols (LVK and PEA) and Cumulic Regosols (NAM) occur in minor amounts. Soils may develop on colluvial deposits. Bedrock generally occurs within 5 metres

Table D-24 MIFR1/I3h Soil Description

Soil Map Unit Name	MIFR1/I3h
Dominant Soils	Eluviated Dystric Brunisols (MIL) and Orthic Gray Luvisols (FRT)
Significant Soils	n/a
Minor Soils	Orthic Gray Luvisols (LVK and PEA) and gleyed variants and gleysols
Landscape Model	I3h-steep single slope landform
Parent Materials	Coarse textured glaciofluvial
Forest Capability	3-4X
Water Erosion Risk	moderate
Wind Erosion Risk	low
Reclamation Suitability of Topsoil	Poor-fair
Typical Topsoil Depth	20 cm
Reclamation Suitability of Upper Subsoil	Poor-fair
Typical Upper Subsoil Depth	40 (0 on regosols, organics, and gleysols)
Reclamation Suitability of Lower Subsoil	Poor
Typical Lower Subsoil Depth	40

1.1.23 MIFR1/SC1h

The MIFR1/SC1h unit consists of well drained Eluviated Dystric Brunisols (MIL) and well drained Orthic Gray Luvisols (FRT) developed on a steep sided valley with a confined floodplain (slopes > 9%), coarse textured (loamy sand and sand) glaciofluvial deposits. Gleyed Cumulic Regosols (NAMgl), Rego Gleysol (MMW) and other gleyed variants and gleysols occur in significant amounts. Orthic Gray Luvisols (PEA), Cumulic Regosols (NAM), and Terric Mesisols (MLDxs) occur in minor amounts. Gleyed variants, gleysols, and thin organics confined to floodplain and may be less than 30% of the unit.

Table D-25 MIFR1/SC1h Soil Description

Soil Map Unit Name	MIFR1/SC1h
Dominant Soils	Eluviated Dystric Brunisols (MIL) and Orthic Gray Luvisols (FRT)
Significant Soils	Gleyed Cumulic Regosols (NAMgl), Rego Gleysols (MMW), and other gleyed variants and gleysols
Minor Soils	Orthic Gray Luvisols (PEA), Cumulic Regosols (NAM) and Terric Mesisols (MLDxs)
Landscape Model	SC1h- high relief valley with confined floodplain
Parent Materials	Coarse textured glaciofluvial
Forest Capability	3-4X
Water Erosion Risk	moderate
Wind Erosion Risk	low
Reclamation Suitability of Topsoil	Poor-fair
Typical Topsoil Depth	20 cm
Reclamation Suitability of Upper Subsoil	Poor-fair
Typical Upper Subsoil Depth	40 (0 on regosols, organics, and gleysols)
Reclamation Suitability of Lower Subsoil	Poor
Typical Lower Subsoil Depth	40

1.1.24 MIFR1/SC3

The MIFR1/SC3 unit consists of well drained Eluviated Dystric Brunisols (MIL) and well drained Orthic Gray Luvisols (FRT) developed on V shaped valleys with no floodplain or terraces, coarse textured (loamy sand and sand) glaciofluvial deposits. Orthic Gray Luvisols (PEA), Cumulic Regosol (NAM), gleyed Cumulic Regosols (NAMgl) and Rego Gleysols (MMW) occur in minor amounts.

Table D-26 MIFR1/SC3 Soil Description

Soil Map Unit Name	MIFR1/SC3
Dominant Soils	Eluviated Dystric Brunisols (MIL) and Orthic Gray Luvisols (FRT)
Significant Soils	n/a
Minor Soils	Orthic Gray Luvisols (PEA), Cumulic Regosols (NAM) gleyed Cumulic Regosols (NAMgl) and Rego Gleysols (MMW)
Landscape Model	SC3- V shaped valley with no floodplain or terraces
Parent Materials	Coarse textured glaciofluvial
Forest Capability	4X-3
Water Erosion Risk	moderate
Wind Erosion Risk	low
Reclamation Suitability of Topsoil	Poor-fair
Typical Topsoil Depth	20 cm
Reclamation Suitability of Upper Subsoil	Poor-fair
Typical Upper Subsoil Depth	40 (0 on regosols, organics, and gleysols)
Reclamation Suitability of Lower Subsoil	Poor
Typical Lower Subsoil Depth	40

1.1.25 MLxcCHptzr1/O1

The MLxcCHptzr1/O1 unit consists of poorly to very poorly drained Terric Mesisols (MLxc) and poorly to very poorly drained peaty Rego Gleysols (CHTptzr) developed on level, flat, horizontal or plateau fen and bog peatlands. Underlying material is fine to very fine textured lacustrine or glaciolacustrine sediments. Mineral contact generally occurs between 15 and 160 cm.

Table D-27 MLxcCHptzr1/O1 Soil Description

Soil Map Unit Name	MLxcCHptzr1/01
Dominant Soils	Terric Mesisols (MLDxc), and peaty Rego Gleysols (CHTptzr)
Significant Soils	n/a
Minor Soils	Typic Mesisols (MLD) and Orthic Luvic Gleysols (O.LG)
Landscape Model	O1- level, flat, horizontal, or plateau fen and bog peatlands
Parent Materials	Organic veneers overlying fine textured lacustrine or glaciolacustrine sediments
Forest Capability	5W
Water Erosion Risk	Low
Wind Erosion Risk	Low
Reclamation Suitability of Topsoil	Organic
Typical Topsoil Depth	n/a
Reclamation Suitability of Upper Subsoil	Organic
Typical Upper Subsoil Depth	n/a
Reclamation Suitability of Lower Subsoil	Organic
Typical Lower Subsoil Depth	

1.1.26 MLD1/O1

The MLD1/O1 unit consists of dominantly poorly to very poorly drained Typic Mesisols (MLD) developed on thick (>2.2 m), level, flat, horizontal, or plateau fen peatlands. Typic Fibrisols (ABN) and Typic Mesisols (MUS) are found in significant amounts.

Table D-28 MLD1/O1 Soil Description

Soil Map Unit Name	MLD1/O1
Dominant Soils	Typic Mesisols (MLD)
Significant Soils	Terric Mesisols (MUSxc, MLDxs), Terric Fibrisols (HLYxs)
Minor Soils	n/a
Landscape Model	O1 – level organic
Parent Materials	Fen peat
Forest Capability	5W[10]
Water Erosion Risk	low
Wind Erosion Risk	low
Reclamation Suitability of Topsoil	organic
Typical Topsoil Depth	n/a
Reclamation Suitability of Upper Subsoil	organic
Typical Upper Subsoil Depth	n/a
Reclamation Suitability of Lower Subsoil	organic
Typical Lower Subsoil Depth	n/a

1.1.27 MLDxc1/O1

The MLDxc1/O1unit consists of dominantly poorly to very poorly drained Typic Mesisols (MLDxc) developed on thin (>40 and <160 cm), level, flat, horizontal, or plateau fen peatlands overlying moderately fine to fine textured lacustrine or glaciolacustrine sediments. Terric Mesisols (MUSxc) and Typic Fibrisols (HLYxc) occurs in significant amounts. . Rego Gleysols (CHTptzr) and other imperfectly or poorly drained soils may occur at the margins of the unit in minor amounts.

Table D-29 MLDxc1/O1 Soil Description

Soil Map Unit Name	MLDxc1/O1
Dominant Soils	Terric Mesisols (MLDxc)
Significant Soils	Terric Mesisols (MUSxc) and Terric Fibrisols (HLYxc)
Minor Soils	Rego Gleysols (CHTptzr) and gleyed variants and gleysols
Landscape Model	O1 – level organic
Parent Materials	Fen peat
Forest Capability	5W[10]
Water Erosion Risk	low
Wind Erosion Risk	low
Reclamation Suitability of Topsoil	organic
Typical Topsoil Depth	n/a
Reclamation Suitability of Upper Subsoil	organic
Typical Upper Subsoil Depth	n/a
Reclamation Suitability of Lower Subsoil	organic
Typical Lower Subsoil Depth	n/a

1.1.28 MLDxs1/O1

The MLDxs1/O1unit consists of dominantly poorly to very poorly drained Terric Mesisols (MLDxc) developed on thin (>40 and <160 cm), level, flat, horizontal, or plateau fen peatlands overlying moderately coarse to coarse textured fluvial or glaciofluvial sediments. Terric Mesisols (MUSxs) and Typic Fibrisols (HLYxs) occurs in significant amounts. Orthic Luvic Gleysols (WHAptaa) and other imperfectly or poorly drained soils may occur at the margins of the unit in minor amounts.

Table D-30 MLDxs1/O1 Soil Description

Soil Map Unit Name	MLDxs1/O1
Dominant Soils	Terric Mesisols (MLDxs)
Significant Soils	Terric Mesisols (MUSxs) and Terric Fibrisols (HLYxs)
Minor Soils	Orthic Luvic Gleysols (WHAaapt) and other gleyed variants and gleysols
Landscape Model	O1 – level organic
Parent Materials	Fen peat
Forest Capability	5W[10]
Water Erosion Risk	low
Wind Erosion Risk	low
Reclamation Suitability of Topsoil	organic
Typical Topsoil Depth	n/a
Reclamation Suitability of Upper Subsoil	organic
Typical Upper Subsoil Depth	n/a
Reclamation Suitability of Lower Subsoil	organic
Typical Lower Subsoil Depth	n/a

1.1.29 MLxsMKaaxs1/O1

The MLxsMKaaxs1/O1unit consists of dominantly poorly to very poorly drained Terric Mesisols (MLDxc) and Fibric Organic Cryosols (MKWaa) developed on thin (>40 and <160 cm), level, flat, horizontal, or plateau fen peatlands overlying moderately coarse to coarse textured fluvial or glaciofluvial sediments. Terric Mesisols (MUSxs), peaty Rego Gleysols (MMWpt) and cryic phases occur in significant amounts. Orthic Luvic Gleysols (WHAaa) and other imperfectly or poorly drained soils may occur at the margins of the unit in minor amounts.

Table D-31 MLxsMKaaxs1/O1 Soil Description

Soil Map Unit Name	MLxsMKaaxs1/O1
Dominant Soils	Terric Mesisols (MLDxs) and Fine Orgainc Cryosols (MKWaa)
Significant Soils	Terric Mesisols (MUSxs), Rego Gleysols (MMWpt) and cryic phases
Minor Soils	Orthic Luvic Gleysols (WHAaa) and other gleyed variants and gleysols
Landscape Model	O1 – level organic
Parent Materials	Fen peat
Forest Capability	$5W^{10}$
Water Erosion Risk	low
Wind Erosion Risk	low
Reclamation Suitability of Topsoil	organic
Typical Topsoil Depth	n/a
Reclamation Suitability of Upper Subsoil	organic
Typical Upper Subsoil Depth	n/a
Reclamation Suitability of Lower Subsoil	organic
Typical Lower Subsoil Depth	n/a

1.1.30 MMY1/U1l

The MMY1/U1l unit consists of dominantly moderately well drained Cumulic Regosols (MMY) developed on undulating low relief (slopes 0.5 to 2%), medium to coarse textured fluvial deposits. Gleyed variants and gleysols occur in significant amounts. Unit confined to areas adjacent to the Athabasca River.

Table D-32 MMY1/U1l Soil Description

Soil Map Unit Name	MMY 1/U1l
Dominant Soils	Cumulic Regosols (MMY)
Significant Soils	Gleyed variants and gleysols
Minor Soils	
Landscape Model	U1l-undualting low relief
Parent Materials	Fluvial
Forest Capability	4W[10]
Water Erosion Risk	low
Wind Erosion Risk	low
Reclamation Suitability of Topsoil	fair
Typical Topsoil Depth	10 cm
Reclamation Suitability of Upper Subsoil	faiir
Typical Upper Subsoil Depth	20 cm
Reclamation Suitability of Lower Subsoil	Fair
Typical Lower Subsoil Depth	70 cm

1.1.31 MUxsBMpt1/O5

The MUxsBMpt1/O5 unit consists of dominantly poorly drained Terric Mesisols (MUSxs) and peaty Orthic Gleysols (BMTpt) developed on thin (40 to 160 cm), level, flat, horizontal, or plateau fen and bog peatlands and moderately coarse to coarse textured undulating low relief glaciofluvial deposits. Typic Mesisols (MUS), Typic Fibrisols (ABN), Gleyed Eluviated Dystric Brunisols (MILgl) and Rego Gleysols (MMW) occur in significant amounts. Some polygons in transition zone between dominantly well drained upland soils and fen and bog peatlands.

Table D-33 MUxsBMpt1/O5 Soil Description

Soil Map Unit Name	MUxsBMpt1/O5
Dominant Soils	Terric Mesisols (MUSxs) and Orthic Gleysol (BMTpt)
Significant Soils	Typic Mesisols (MUS), Typic Fibrisols (ABN), Gleyed Eluviated Dystric Brunisols (MILgl) and Rego Gleysols (MMW)
Minor Soils	
Landscape Model	O5 – level organic with hummocky mineral soils
Parent Materials	Sphagnum peat and coarse glaciofluvial
Forest Capability	5W[10]
Water Erosion Risk	low
Wind Erosion Risk	low
Reclamation Suitability of Topsoil	organic
Typical Topsoil Depth	n/a
Reclamation Suitability of Upper Subsoil	organic
Typical Upper Subsoil Depth	n/a
Reclamation Suitability of Lower Subsoil	organic
Typical Lower Subsoil Depth	n/a

n/a = Not applicable.

1.1.32 MUSxs1/O2

The MUSxs1/O2 unit consists of dominantly poorly drained Terric Mesisols (MUSxs) developed on thin (40 to 160 cm), basin (bowl) with raised edges fen and bog peatlands overlying medium to coarse textured fluvial, fluviolacustrine or lacustrine deposits. Terric Mesisols (MLDxs) occurs in significant amounts. Rego Gleysols (MMWpt) and Orthic Gleysols (BMTpt) occur in minor amounts.

Table D-34 MUSxs1/O2 Soil Description

Soil Map Unit Name	MUSxs1/O2
Dominant Soils	Terric Mesisols (MUSxs)
Significant Soils	Terric Mesisols (MLDxs)
Minor Soils	Rego Gleysols (MMWpt) and Orthic Gleysols (BMTpt)
Landscape Model	O2 – basin (bowl) with raised edges
Parent Materials	Sphagnum peat
Forest Capability	5W[10]
Water Erosion Risk	low
Wind Erosion Risk	low
Reclamation Suitability of Topsoil	organic
Typical Topsoil Depth	n/a
Reclamation Suitability of Upper Subsoil	organic
Typical Upper Subsoil Depth	n/a
Reclamation Suitability of Lower Subsoil	organic
Typical Lower Subsoil Depth	n/a

n/a = Not applicable.

1.1.33 MUSxs1/O4

The MUSxs1/O4 unit consists of dominantly poorly drained Terric Mesisols (MUSxs) developed on thin (40 to 160 cm), inclined fen and bog peatlands and hummocky mineral soils developed on moderately coarse to coarse textured glaciofluvial deposits. Typic Mesisols (MLD), peaty Orthic Luvic Gleysols (WHMaapt) and Eluviated Dystric Brunisols (MIL) occur in significant amounts.

Table D-35 MUSxs1/O4 Soil Description

Soil Map Unit Name	MUSxs1/O4
Dominant Soils	Terric Mesisols (MUSxs)
Significant Soils	Typic Mesisols (MUS), Orthic Luvic Gleysols (WHMaapt), and Eluviated Dystric Brunisols (MIL)
Minor Soils	
Landscape Model	O4 – inclined organic
Parent Materials	Sphagnum peat
Forest Capability	5W[10]
Water Erosion Risk	low
Wind Erosion Risk	low
Reclamation Suitability of Topsoil	organic
Typical Topsoil Depth	n/a
Reclamation Suitability of Upper Subsoil	organic
Typical Upper Subsoil Depth	n/a
Reclamation Suitability of Lower Subsoil	organic
Typical Lower Subsoil Depth	n/a

n/a = Not applicable.

1.1.34 MUSxc1/O5

The MUSxc1/O5 unit consists of dominantly poorly drained Terric Mesisols (MUSxc) and developed on thin (40 to 160 cm), level, flat, horizontal, or plateau fen and bog peatlands interspersed with undulating to hummocky moderately fine to fine textured glaciolacustrine and lacustrine deposits.

Table D-36 MUSxc1/O5 Soil Description

Soil Map Unit Name	MUSxc1/O5
Dominant Soils	Terric Mesisols (MUSxc)
Significant Soils	Terric Mesisols (MLDxc), and Rego Gleysols (CHTptzr), Orthic Luvic Gleysols (ALG)
Minor Soils	Typic Mesisols (MUS and MLD)
Landscape Model	O5 – level organic with hummocky mineral soils
Parent Materials	Sphagnum peat/moderately fine to fine glaciolacustrine
Forest Capability	$5W^{10}$
Water Erosion Risk	low
Wind Erosion Risk	low
Reclamation Suitability of Topsoil	organic
Typical Topsoil Depth	n/a
Reclamation Suitability of Upper Subsoil	organic
Typical Upper Subsoil Depth	n/a
Reclamation Suitability of Lower Subsoil	organic
Typical Lower Subsoil Depth	n/a

n/a = Not applicable.

1.1.35 MUSxs1/O5

The MUSxs1/O5 unit consists of dominantly poorly drained Terric Mesisols (MUSxc) developed on thin (40 to 160 cm), level, flat, horizontal, or plateau fen and bog peatlands overlying medium to coarse textured glaciofluvial and fluvial deposits and mineral soils developed on low relief hummocky and high relief undulating medium to coarse textured glaciofluvial deposits.

Table D-37 MUSxs1/O5 Soil Description

Soil Map Unit Name	MUSxs1/O5
Dominant Soils	Terric Mesisols (MUSxs)
Significant Soils	Terric Mesisols (MLDxs), Eluviated Dystric Brunisols (MIL)
Minor Soils	Typic Mesisols (MUS and MLD)
Landscape Model	O5 – level organic with hummocky mineral soils
Parent Materials	Sphagnum peat/medium to moderately coarse textured fluvial or glaciofluvial
Forest Capability	5W[10]
Water Erosion Risk	low
Wind Erosion Risk	low
Reclamation Suitability of Topsoil	organic
Typical Topsoil Depth	n/a
Reclamation Suitability of Upper Subsoil	organic
Typical Upper Subsoil Depth	n/a
Reclamation Suitability of Lower Subsoil	organic
Typical Lower Subsoil Depth	n/a

n/a = Not applicable.

1.1.36 NAMcu2/FP3

The NAMcu/FP3 unit consists of dominantly moderately well drained Cumulic Regosols (NAMcu) developed on medium to moderately coarse textured fluvial, colluvial and fluviolacustrine materials on confined floodplains. Gleyed Regosols (NAMgl), Rego Gleysols (MMW), Orthic Gray Luvisols (PEA), Orthic Gray Luvisols (FRT), Gleyed Gray Luvisols (FRTgl and PEAgl), and Terric Mesisols (MLDxs) occur in significant amounts. Soils are variable and unpredictable. Imperfectly and poorly drained soils occur adjacent to and on the floodplain. Landform often terraced.

Table D-38 NAMcu2/FP3 Soil Description

Soil Map Unit Name	NAMcu2/FP3
Dominant Soils	Cumulic Regosols (NAMgl)
Significant Soils	Gleyed Regosols (NAMgl, Rego Gleysols (MMW), Orthic Gray Luvisols (FRT), Gleyed Gray Luvisols (FRTgl and PEAgl), and Terric Mesisols (MLDxs)
Minor Soils	n/a
Landscape Model	FP3-confined floodplain, possibly terraced
Parent Materials	Sphagnum peat/medium to moderately coarse textured fluvial or glaciofluvial
Forest Capability	2V
Water Erosion Risk	Low
Wind Erosion Risk	Low
Reclamation Suitability of Topsoil	Fair
Typical Topsoil Depth	10 cm
Reclamation Suitability of Upper Subsoil	unsuitable
Typical Upper Subsoil Depth	na
Reclamation Suitability of Lower Subsoil	Unsuitable
Typical Lower Subsoil Depth	na

unsutable

n/a = Not applicable.

1.1.37 ZWA1/W3

The ZWA1/W3 unit consists of open waterbodies.

1.2 JACKPINE EXPANSION MINING AREA SOIL MAP UNIT DESCRIPTIONS

JPME R1 ERRATA

Table D-39 Summary of Interpretations for Jackpine (Soil Landscape Units)

Map Unit Name	Map Unit Symbol	Forest Land Capability Class	Erosion	
			Wind	Water
Albian	ABN1/O1	$5W^{10}$	low	low
	ABN2/O2	$5W^{10}$	low	low
	ABN3/O3	$5W^{10}$	low	low
	ABN4/O6	$5W^{10}$	low	low
Bitumount	BMTpt1/U1l	$4W^{9}\ 4^{1}$	low	low
peaty Ells River - Mariana	ElptMR1/O5	$4W^{4}\ 5W^{4}5X^{2}$	low	low
peaty Ells River – Horse River	ELptHR1/U1l	$4W^{5}\ 2^{4}\ 3^{1}$	low	low
Hartley - xtMcLelland	HLMLxt/O1	$5W^{10}$	low	low
Hartley - xcMuskeg	HLMUxc/O1	$5W^{10}$	low	low
Horse River	HRR1/H1l	2^{10}	low	moderate
	HRR2/U1h	$2^{7}\ 4W^{3}$	low	low
Horse River - Livock	HRLV1/U1h	2^{10}	low	low
	HRLV1/H1l	2^{10}	low	moderate
	HRLV1/H1m	2^{10}	low	high
Mildred	MIL1/U1h	4X	high	low
	MIL2/U1h	$4X^{8}\ 4W^{2}$	high	low
McLelland	MLD1/FP1	$5W^{10}$	low	low
	MLD1/FP3	$5W^{10}$	low	low
	MLD1/O1	$5W^{10}$	low	low
Mariana	MRN1/O1	$5W^{10}$	low	low
xcMuskeg	MUSxc1/O5	$5W^{10}$	low	low
Water	ZWA1/W3	N/A	N/A	N/A
Note: N/A = Not Applicable				

PAGE CORRECTED FOR ERRATA

1.2.1 ABN1/O1

The ABN1 unit consists of dominantly poorly drained Typic Fibrisols (ABN) developed on thick (more than 2.2 m), level, flat, horizontal or plateau (slopes less than 0.5%) fen and bog peatlands. Typic Mesisols (MLD) are found in significant amounts. Typic Mesisols (MUS) and Fibric Organic Cryosols (MKWaa) are found in minor amounts. Other soils that may occur in the unit include Terric Fibrisols (HLY) and Terric Mesisols (MUSxc and MLDxc). Areas of domed organics may be present. There are minor areas of O6 (domed) landforms present in the unit. Fibric Organic Cryosols dominate these areas.

Table D-40 ABN1/O1 Soil Description

Soil Map Unit Name	ABN1/O1
Dominant Soils	Typic Fibrisols (ABN)
Significant Soils	Typic Mesisols (MLD)
Minor Soils	Typic Mesisols (MUS); Fibric Organic Cryosols (MKWaa); Terric Fibrisols (HYL); Terric Mesisols (MUSxc and MLDxc)
Landscape Model	O1 - level organic
Parent Materials	Sphagnum and fen peat
Forest Capability	5W[10]
Water Erosion Risk	low
Wind Erosion Risk	low
Reclamation Suitability of Topsoil	organic
Typical Topsoil Depth	n/a
Reclamation Suitability of Upper Subsoil	organic
Typical Upper Subsoil Depth	n/a
Reclamation Suitability of Lower Subsoil	organic
Typical Lower Subsoil Depth	n/a

n/a = Not applicable.

1.2.2 ABN2/O2

The ABN2 unit consists of dominantly poorly drained Typic Fibrisols (ABN) developed on thick (more than 2.2 m), basin (bowl) (slopes less than 0.5%) fen and bog peatlands. Terric Mesisols (MLDxc) and Terric Fibrisols (MUSxc) are found in significant amounts. The unit features a variety of organic veneers and blankets overlying a variety of glaciofluvial and glaciolacustrine deposits. The peaty and gleyed phases occur along the boundaries of the units.

Table D-41 ABN2/O2 Soil Description

Soil Map Unit Name	ABN2/O2
Dominant Soils	Typic Fibrisols (ABN)
Significant Soils	Terric Mesisols (MLDxc, MUSxc); Terric Fibrisols (HYL)
Minor Soils	peaty Rego Gleysols
Landscape Model	O2 – organic basin/bowl
Parent Materials	Sphagnum and fen peat blanket overlying medium textured mineral soil
Forest Capability	5W[10]
Water Erosion Risk	low
Wind Erosion Risk	low
Reclamation Suitability of Topsoil	organic
Typical Topsoil Depth	n/a
Reclamation Suitability of Upper Subsoil	organic
Typical Upper Subsoil Depth	n/a
Reclamation Suitability of Lower Subsoil	organic
Typical Lower Subsoil Depth	n/a

n/a = Not applicable.

1.2.3 ABN3/O3

The ABN3 unit consists of dominantly poorly drained Typic Fibrisols (ABN) developed on thick (more than 2.2 m), patterned (slopes less than 0.5%) fen and bog peatlands. Typic Mesisols (MLD) and are found in significant amounts. Terric Mesisols (MUSxs, MUSxc, MLDxc), Terric Fibrisols (HLY) and Fibric Organic Cryosols (MKWaa) are found in minor amounts. The unit features a variety of organic veneers and blankets overlying a variety of glaciofluvial and glaciolacustrine deposits.

Table D-42 ABN3/O3 Soil Description

Soil Map Unit Name	ABN3/O3
Dominant Soils	Typic Fibrisols (ABN)
Significant Soils	Typic Mesisols (MLD)
Minor Soils	Terric Mesisols (MUSxs, MUSxc, MLDxc), Terric Fibrisols (HYL), Fibric Organic Cryosols (MKWaa)
Landscape Model	O3 – organic patterned (channeled, ribbed or net)
Parent Materials	Sphagnum and fen peat
Forest Capability	5W[10]
Water Erosion Risk	low
Wind Erosion Risk	low
Reclamation Suitability of Topsoil	organic
Typical Topsoil Depth	n/a
Reclamation Suitability of Upper Subsoil	organic
Typical Upper Subsoil Depth	n/a
Reclamation Suitability of Lower Subsoil	organic
Typical Lower Subsoil Depth	n/a

n/a = Not applicable.

1.2.4 ABN4/O6

The ABN4 unit consists of dominantly poorly drained Typic Fibrisols (ABN) developed on thick (more than 2.2 m), domed (slopes 0 to 10%) fen and bog peatlands. Typic Mesisols (MLD) and Fibric Organic Cryosols are found in significant amounts. Typic Mesisols (MUS) are found in minor amounts. The unit features hummocky (domed) organic landforms that are frozen year round. The domes are 1 to 2 meters higher than the surrounding level landscape.

Table D-43 ABN4/O6 Soil Description

Soil Map Unit Name	ABN4/O6
Dominant Soils	Typic Fibrisols (ABN)
Significant Soils	Typic Mesisols (MLD), Fibric Organic Cryosols (MKWaa)
Minor Soils	Typic Mesisols (MUS)
Landscape Model	O6 – organic domed
Parent Materials	Sphagnum and fen peat
Forest Capability	5W[10]
Water Erosion Risk	low
Wind Erosion Risk	low
Reclamation Suitability of Topsoil	organic
Typical Topsoil Depth	n/a
Reclamation Suitability of Upper Subsoil	organic
Typical Upper Subsoil Depth	n/a
Reclamation Suitability of Lower Subsoil	organic
Typical Lower Subsoil Depth	n/a

n/a = Not applicable.

1.2.5 BMTpt1/U1l

The BMTpt1 unit consists of dominantly poorly drained peaty Orthic Gleysols (BMTpt) developed on low relief undulating (slopes 0.5 to 2%), fine to coarse textured (sand to clay) glaciofluvial deposits. Typic Mesisols (MLDxs) and Gleyed Regosols (NORgl and NAMgl) and are found in significant amounts. Orthic Luvic Gleysols and Gleyed Eluviated Dystric Brunisols (MILgl and SUTgl) are found in minor amounts along the margins of the unit. The parent material textures are not predictable.

Table D-44 BMTpt1/U1l Soil Description

Soil Map Unit Name	BMTpt1/U1l
Dominant Soils	peaty Orthic Gleysols (BMTpt)
Significant Soils	Terric Mesisols (MLDxs), Gleyed Regosols (NAMgl), Rego Gleysols (NOR)
Minor Soils	Orthic Luvic Gleysols (ALG), Gleyed Eluviated Dystric Brunisols (MILgl and SUTgl)
Landscape Model	U1l – low relief undulating
Parent Materials	Variable textured glaciofluvial deposits overlying moderately fine to fine textured till and glaciolacustrine
Forest Capability	$4W^{9}$ 4^{1}
Water Erosion Risk	low
Wind Erosion Risk	low
Reclamation Suitability of Topsoil	organic
Typical Topsoil Depth	less than 40 cm (organic)
Reclamation Suitability of Upper Subsoil	poor
Typical Upper Subsoil Depth	0
Reclamation Suitability of Lower Subsoil	poor
Typical Lower Subsoil Depth	not determined

Note: Low lying areas dominated by variable textured and layered Gleysols and thin Organic soils. Peaty phases are common.

1.2.6 ELptMR1/O5

The ELptMR1 unit consists of co-dominant amounts of poorly drained peaty Rego Gleysols (ELSpt) and Terric Mesisols (MRN) developed on level, organic deposits (slopes less than 0.5%). Islands of mineral soils are present in minor amounts (less than 15%) in the unit. These islands are mostly Eluviated Dystric Brunisols developed on coarse (sand) glaciofluvial deposits overlying till (SUT) and Orthic Gray Luvisols developed on medium to coarse textured till and glaciofluvial deposits (HRR and HVNaa). Typic Fibrisols (HYL) are also found in minor amounts in the unit. This unit is a transition between the dominantly well drained upland areas and the fen and bog peatlands.

Table D-45 ELptMR1/O5 Soil Description

Soil Map Unit Name	ELptMR1/O5
Co-Dominant Soils	peaty Rego Gleysols (ELSpt), Terric Mesisols (MRN)
Significant Soils	n/a
Minor Soils	Terric Fibrisols (HLY), Eluviated Dystric Brunisols (SUT), Orthic Gray Luvisols (HRR and HVNaa)
Landscape Model	O5 – level organic with islands of hummocky mineral soils
Parent Materials	Sphagnum and fen peat overlying moderately fine textured till or fine textured glaciolacustrine
Forest Capability	$4W^4\ 5W^4\ 5X^2$
Water Erosion Risk	low
Wind Erosion Risk	low
Reclamation Suitability of Topsoil	organic
Typical Topsoil Depth	less than 40 cm (organic)
Reclamation Suitability of Upper Subsoil	poor to organic
Typical Upper Subsoil Depth	0
Reclamation Suitability of Lower Subsoil	poor to organic
Typical Lower Subsoil Depth	not determined

n/a = Not applicable.

1.2.7 ELptHR1/U1l

The ELptHR1 unit consists of co-dominant amounts of poorly drained peaty Rego Gleysols (ELSpt) and Orthic Gray Luvisols (HRR) developed on fluted, low relief undulating (slopes 0.5 to 3%) fine to moderately coarse textured (clay loam) till. Minor amounts of moderately to coarse textured veneers and blankets occur within the polygons. Soils found in minor amounts include Terric Mesisols (MLDxt), Terric Fibrisols (HLY), Orthic Luvic Gleysols (STP), Orthic Gray Luvisols (LVK) and Eluviated Dystric Brunisols (SUT).

Table D-46 ELptHR1/U1l Soil Description

Soil Map Unit Name	ELptHR1/U1l
Co-Dominant Soils	peaty Rego Gleysols (ELSpt), Orthic Gray Luvisols (HRR)
Significant Soils	n/a
Minor Soils	Terric Fibrisols (HLY), Terric Mesisols (MLDxt) Eluviated Dystric Brunisols (SUT), Orthic Gray Luvisols (LVK), Orthic Luvic Gleysols (STP)
Landscape Model	U1l – low relief undulating
Parent Materials	Sphagnum and fen peat overlying moderately coarse to moderately fine textured till or fine textured glaciolacustrine
Forest Capability	$4W^5\ 2^4\ 3^1$
Water Erosion Risk	low
Wind Erosion Risk	low
Reclamation Suitability of Topsoil	organic to poor
Typical Topsoil Depth	less than 40 cm (ELSpt); 15 cm (HRR)
Reclamation Suitability of Upper Subsoil	poor to fair
Typical Upper Subsoil Depth	0 (ELSpt); 15 (HRR)
Reclamation Suitability of Lower Subsoil	poor to fair
Typical Lower Subsoil Depth	not determined (ELSpt); 50 cm (HRR)

n/a = Not applicable.

1.2.8 HLMLxt1/O1

The HLMLxt1 unit consists of co-dominant amounts of poorly drained Terric Fibrisols (HLY) and Terric Mesisols (MLDxt) developed on level (slopes less than 0.5%) organic deposits overlying medium to moderately fine textured (loam to clay loam) till. The mineral contact is found 50 to 100 cm below the surface. Soils found in minor amounts include peaty Rego Gleysols (ELSpt) and Gleyed Gray Luvisols (LVKgl).

Table D-47 HLMLxt1/O1 Soil Description

Soil Map Unit Name	HLMLxt1/O1
Co-Dominant Soils	Terric Fibrisols (HLY), Terric Mesisols (MLDxt)
Significant Soils	n/a
Minor Soils	peaty Rego Gleysols (ELSpt), Gleyed Gray Luvisols (LVKgl)
Landscape Model	O1 – level organic
Parent Materials	Sphagnum and fen peat overlying undifferentiated medium to moderately fine textured till
Forest Capability	5W[10]
Water Erosion Risk	low
Wind Erosion Risk	low
Reclamation Suitability of Topsoil	organic
Typical Topsoil Depth	n/a
Reclamation Suitability of Upper Subsoil	organic
Typical Upper Subsoil Depth	n/a
Reclamation Suitability of Lower Subsoil	organic
Typical Lower Subsoil Depth	n/a

n/a = Not applicable.

1.2.9 HLMUxc1/O1

The HLMLxc1 unit consists of co-dominant amounts of poorly drained Terric Fibrisols (HLY) and Terric Mesisols (MUSxc) developed on level (slopes less than 0.5%) organic deposits overlying medium to moderately fine textured (loam to clay loam) undifferentiated deposits. The mineral contact is found 50 to 100 cm below the surface. Peaty Rego Gleysols (ELSpt) are found in minor amounts in the unit.

Table D-48 HLMUxc1/O1 Soil Description

Soil Map Unit Name	HLMUxc1/O1
Co-Dominant Soils	Terric Fibrisols (HLY), Terric Mesisols (MUSxc)
Significant Soils	n/a
Minor Soils	peaty Rego Gleysols (ELSpt)
Landscape Model	O1 – level organic
Parent Materials	Sphagnum and fen peat overlying undifferentiated medium to moderately fine textured till
Forest Capability	$5W^{10}$
Water Erosion Risk	low
Wind Erosion Risk	low
Reclamation Suitability of Topsoil	organic
Typical Topsoil Depth	n/a
Reclamation Suitability of Upper Subsoil	organic
Typical Upper Subsoil Depth	n/a
Reclamation Suitability of Lower Subsoil	organic
Typical Lower Subsoil Depth	n/a

n/a = Not applicable.

1.2.10 HRR1/H1l

The HRR1 unit consists of dominantly moderately well drained Orthic Gray Luvisols (HRR) developed low relief hummocky (slopes 5 to 9%), moderately fine textured (clay loam) till. The unit contains minor amounts of soils developed on moderately coarse textured veneers overlying till. These soils include Orthic Gray Luvisols (LVK), Eluviated Dystric Brunisols (SUT) and Brunisolic Gray Luvisols (HRRzz).

Table D-49 HRR1/H1l Soil Description

Soil Map Unit Name	HRR1/H1l
Dominant Soils	Orthic Gray Luvisols (HRR)
Significant Soils	n/a
Minor Soils	Orthic Gray Luvisols (LVK), Eluviated Dystric Brunisols (SUT), Brunisolic Gray Luvisols (HRRzz)
Landscape Model	H1l – low relief hummocky
Parent Materials	Moderately fine textured till
Forest Capability	2
Water Erosion Risk	moderate
Wind Erosion Risk	low
Reclamation Suitability of Topsoil	fair to poor
Typical Topsoil Depth	15
Reclamation Suitability of Upper Subsoil	fair
Typical Upper Subsoil Depth	15
Reclamation Suitability of Lower Subsoil	fair to poor
Typical Lower Subsoil Depth	50

n/a = Not applicable.

1.2.11 HRR2/U1h

The HRR2 unit consists of dominantly moderately well drained Orthic Gray Luvisols (HRR) developed high relief undulating (slopes 2 to 5%), moderately fine textured (clay loam) till. The unit contains significant amounts of imperfectly and poorly drained soils. These soils are peaty Rego and peaty Orthic Gleysols. Soils found in minor amounts include Orthic Gray Luvisols (LVK), Eluviated Dystric Brunisols (SUT) and Brunisolic Gray Luvisols (HRRzz).

Table D-50 HRR2/U1h Soil Description

Soil Map Unit Name	HRR2/U1h
Dominant Soils	Orthic Gray Luvisols (HRR)
Significant Soils	Undifferentiated Gleysols
Minor Soils	Orthic Gray Luvisols (LVK), Eluviated Dystric Brunisols (SUT), Brunisolic Gray Luvisols (HRRzz), Thin organic soils
Landscape Model	U1h – high relief undulating
Parent Materials	Moderately fine textured till
Forest Capability	2^7 $4W^3$
Water Erosion Risk	low
Wind Erosion Risk	low
Reclamation Suitability of Topsoil	fair to poor
Typical Topsoil Depth	15
Reclamation Suitability of Upper Subsoil	fair
Typical Upper Subsoil Depth	15
Reclamation Suitability of Lower Subsoil	fair to poor
Typical Lower Subsoil Depth	50

1.2.12 HRLV1

The HRLV1 unit consists of co-dominant amounts of moderately well drained Orthic Gray Luvisols developed on moderately fine textured (clay loam) till (HRR) and well drained Orthic Gray Luvisols developed on coarse textured (loamy sand to sand) glaciofluvial deposits (LVK). Soils found in minor amounts are developed on sandy blankets and sandy veneers overlying till. These soils include Orthic Gray Luvisols (LVK), Eluviated Dystric Brunisols (SUT and MIL) and Brunisolic Gray Luvisols (HRRzz).

Three HRLV1 soil and landscape units were mapped:

- **HRLV1/U1h** is found on high relief undulating landscapes (slopes 2 to 5%).
- **HRLV1/H1l** is found on low relief hummocky landscapes (slopes 5 to 9%).
- **HRLV1/H1m** is found on moderate relief hummocky landscapes (slopes 10 to 15%).

Table D-51 HRLV1/U1h Soil Description

Soil Map Unit Name	HRLV1/U1h
Co-Dominant Soils	Orthic Gray Luvisols (HRR and LVK)
Significant Soils	n/a
Minor Soils	Eluviated Dystric Brunisols (SUT and MIL), Brunisolic Gray Luvisols (HRRzz)
Landscape Model	U1h – high relief undulating
Parent Materials	Moderately fine textured till with areas of moderately coarse textured glaciofluvial overlying till
Forest Capability	2^{10}
Water Erosion Risk	low
Wind Erosion Risk	low
Reclamation Suitability of Topsoil	fair
Typical Topsoil Depth	15
Reclamation Suitability of Upper Subsoil	fair
Typical Upper Subsoil Depth	15
Reclamation Suitability of Lower Subsoil	fair
Typical Lower Subsoil Depth	50

n/a = Not applicable.

Table D-52 HRLV1/H1l Soil Description

Soil Map Unit Name	HRLV1/H1l
Co-Dominant Soils	Orthic Gray Luvisols (HRR and LVK)
Significant Soils	n/a
Minor Soils	Eluviated Dystric Brunisols (SUT and MIL), Brunisolic Gray Luvisols (HRRzz)
Landscape Model	H1l – low relief hummocky
Parent Materials	Moderately fine textured till with areas of moderately coarse textured glaciofluvial overlying till
Forest Capability	2^{10}
Water Erosion Risk	moderate
Wind Erosion Risk	low
Reclamation Suitability of Topsoil	fair
Typical Topsoil Depth	15
Reclamation Suitability of Upper Subsoil	fair
Typical Upper Subsoil Depth	15
Reclamation Suitability of Lower Subsoil	fair
Typical Lower Subsoil Depth	50

n/a = Not applicable.

Table D-53 HRLV1/H1m Soil Description

Soil Map Unit Name	HRLV1/H1m
Co-Dominant Soils	Orthic Gray Luvisols (HRR and LVK)
Significant Soils	n/a
Minor Soils	Eluviated Dystric Brunisols (SUT and MIL), Brunisolic Gray Luvisols (HRRzz)
Landscape Model	H1m – moderate relief hummocky
Parent Materials	Moderately fine textured till with areas of moderately coarse textured glaciofluvial overlying till
Forest Capability	2^{10}
Water Erosion Risk	high
Wind Erosion Risk	low
Reclamation Suitability of Topsoil	fair
Typical Topsoil Depth	15
Reclamation Suitability of Upper Subsoil	fair
Typical Upper Subsoil Depth	15
Reclamation Suitability of Lower Subsoil	fair
Typical Lower Subsoil Depth	50

n/a = Not applicable.

1.2.13 MIL1

The MIL1 unit is dominantly well to rapidly drained Eluviated Dystric Brunisols developed on coarse textured (loamy sand to sand) glaciofluvial deposits. Soils found in minor amounts are developed on sandy glaciofluvial deposits. These soils include Orthic Dystric Brunisols (MILzz), Eluviated Dystric Brunisols (FIR), Orthic Gray Luvisols (FRT and LVK).

The MIL1 soil unit was mapped on twelve landscapes:

- **MIL1/U1h** is found on high relief undulating landscapes (slopes 2 to 5%).
- **MIL1/U1l** is found on low relief undulating landscapes (slopes 2 to 3%).
- **MIL1/H1l** is found on low relief hummocky landscapes (slopes 5 to 9%).
- **MIL1/H1m** is found on moderate relief hummocky landscapes (slopes 10 to 15%).
- **MIL1/H1h** is found on high relief hummocky landscapes (slopes 15 to 30%).
- **MIL1/HR2m** is found on moderate relief hummocky and ridged landscapes (slopes 10 to 15%).
- **MIL1/HR2h** is found on high relief hummocky and ridged landscapes (slopes 10 to 15%).
- **MIL1/I3l** is found on low relief inclined landscapes (slopes 2 to 5%).
- **MIL1/I3m** is found on moderate relief inclined landscapes (slopes 5 to 9%).
- **MIL1/I3h** is found on high relief inclined landscapes (slopes 10 to 30%).
- **MIL1/SC1h** is found on steep valleys with confined floodplains (slopes more than 9%).
- **MIL1/SC3** is found on v-shaped valleys with no terraces or floodplain (slopes more than 9%).

Table D-54 MIL1/U1h Soil Description

Soil Map Unit Name	MIL1/U1h
Dominant Soils	Eluviated Dystric Brunisols (MIL)
Significant Soils	n/a
Minor Soils	Orthic Dystric Brunisols (MILzz), Eluviated Dystric Brunisols (FIR), Orthic Gray Luvisols (FRT and LVK)
Landscape Model	U1h – high relief undulating
Parent Materials	Coarse textured glaciofluvial
Forest Capability	4X
Water Erosion Risk	low
Wind Erosion Risk	high
Reclamation Suitability of Topsoil	poor
Typical Topsoil Depth	10
Reclamation Suitability of Upper Subsoil	poor
Typical Upper Subsoil Depth	10
Reclamation Suitability of Lower Subsoil	poor
Typical Lower Subsoil Depth	45

n/a = Not applicable.

Table D-55 MIL1/U1l Soil Description

Soil Map Unit Name	MIL1/U1l
Dominant Soils	Eluviated Dystric Brunisols (MIL)
Significant Soils	n/a
Minor Soils	Orthic Dystric Brunisols (MILzz), Eluviated Dystric Brunisols (FIR), Orthic Gray Luvisols (FRT and LVK)
Landscape Model	U1l – low relief undulating
Parent Materials	Coarse textured glaciofluvial
Forest Capability	4X
Water Erosion Risk	low
Wind Erosion Risk	high
Reclamation Suitability of Topsoil	poor
Typical Topsoil Depth	10
Reclamation Suitability of Upper Subsoil	poor
Typical Upper Subsoil Depth	10
Reclamation Suitability of Lower Subsoil	poor
Typical Lower Subsoil Depth	45

n/a = Not applicable.

Table D-56 MIL1/H1l Soil Description

Soil Map Unit Name	MIL1/H1l
Dominant Soils	Eluviated Dystric Brunisols (MIL)
Significant Soils	n/a
Minor Soils	Orthic Dystric Brunisols (MILzz), Eluviated Dystric Brunisols (FIR), Orthic Gray Luvisols (FRT and LVK)
Landscape Model	H1l – low relief hummocky
Parent Materials	Coarse textured glaciofluvial
Forest Capability	4X
Water Erosion Risk	moderate
Wind Erosion Risk	high
Reclamation Suitability of Topsoil	poor
Typical Topsoil Depth	10
Reclamation Suitability of Upper Subsoil	poor
Typical Upper Subsoil Depth	10
Reclamation Suitability of Lower Subsoil	poor
Typical Lower Subsoil Depth	45

n/a = Not applicable.

Table D-57 MIL1/H1m Soil Description

Soil Map Unit Name	MIL1/H1m
Dominant Soils	Eluviated Dystric Brunisols (MIL)
Significant Soils	n/a
Minor Soils	Orthic Dystric Brunisols (MILzz), Eluviated Dystric Brunisols (FIR), Orthic Gray Luvisols (FRT and LVK)
Landscape Model	H1m – moderate relief hummocky
Parent Materials	Coarse textured glaciofluvial
Forest Capability	4X
Water Erosion Risk	high
Wind Erosion Risk	high
Reclamation Suitability of Topsoil	poor
Typical Topsoil Depth	10
Reclamation Suitability of Upper Subsoil	poor
Typical Upper Subsoil Depth	10
Reclamation Suitability of Lower Subsoil	poor
Typical Lower Subsoil Depth	45

n/a = Not applicable.

Table D-58 MIL1/H1h Soil Description

Soil Map Unit Name	MIL1/H1h
Dominant Soils	Eluviated Dystric Brunisols (MIL)
Significant Soils	n/a
Minor Soils	Orthic Dystric Brunisols (MILzz), Eluviated Dystric Brunisols (FIR), Orthic Gray Luvisols (FRT)
Landscape Model	H1h – high relief hummocky
Parent Materials	Coarse textured glaciofluvial
Forest Capability	4X
Water Erosion Risk	high
Wind Erosion Risk	high
Reclamation Suitability of Topsoil	poor
Typical Topsoil Depth	10
Reclamation Suitability of Upper Subsoil	poor
Typical Upper Subsoil Depth	10
Reclamation Suitability of Lower Subsoil	poor
Typical Lower Subsoil Depth	45

n/a = Not applicable.

Table D-59 MIL1/HR2m Soil Description

Soil Map Unit Name	MIL1/HR2m
Dominant Soils	Eluviated Dystric Brunisols (MIL)
Significant Soils	n/a
Minor Soils	Orthic Dystric Brunisols (MILzz), Eluviated Dystric Brunisols (FIR), Orthic Gray Luvisols (FRT)
Landscape Model	HR2m – moderate relief hummocky and ridged
Parent Materials	Coarse textured glaciofluvial
Forest Capability	4X
Water Erosion Risk	high
Wind Erosion Risk	high
Reclamation Suitability of Topsoil	poor
Typical Topsoil Depth	10
Reclamation Suitability of Upper Subsoil	poor
Typical Upper Subsoil Depth	10
Reclamation Suitability of Lower Subsoil	poor
Typical Lower Subsoil Depth	45

n/a = Not applicable.

Table D-60 MIL1/HR2h Soil Description

Soil Map Unit Name	MIL1/HR2h
Dominant Soils	Eluviated Dystric Brunisols (MIL)
Significant Soils	n/a
Minor Soils	Orthic Dystric Brunisols (MILzz), Eluviated Dystric Brunisols (FIR), Orthic Gray Luvisols (FRT)
Landscape Model	HR2h – moderate relief hummocky and ridged
Parent Materials	Coarse textured glaciofluvial
Forest Capability	4X
Water Erosion Risk	high
Wind Erosion Risk	high
Reclamation Suitability of Topsoil	poor
Typical Topsoil Depth	10
Reclamation Suitability of Upper Subsoil	poor
Typical Upper Subsoil Depth	10
Reclamation Suitability of Lower Subsoil	poor
Typical Lower Subsoil Depth	45

n/a = Not applicable.

Table D-61 MIL1/I3l Soil Description

Soil Map Unit Name	MIL1/I3l
Dominant Soils	Eluviated Dystric Brunisols (MIL)
Significant Soils	n/a
Minor Soils	Orthic Dystric Brunisols (MILzz), Eluviated Dystric Brunisols (FIR), Orthic Gray Luvisols (FRT and LVK)
Landscape Model	I3l – low relief inclined
Parent Materials	Coarse textured glaciofluvial
Forest Capability	4X
Water Erosion Risk	low
Wind Erosion Risk	high
Reclamation Suitability of Topsoil	poor
Typical Topsoil Depth	10
Reclamation Suitability of Upper Subsoil	poor
Typical Upper Subsoil Depth	10
Reclamation Suitability of Lower Subsoil	poor
Typical Lower Subsoil Depth	45

n/a = Not applicable.

Note: Stratified profiles may occur in the unit.

Table D-62 MIL1/I3m Soil Description

Soil Map Unit Name	MIL1/I3m
Dominant Soils	Eluviated Dystric Brunisols (MIL)
Significant Soils	n/a
Minor Soils	Orthic Dystric Brunisols (MILzz), Eluviated Dystric Brunisols (FIR), Orthic Gray Luvisols (FRT and LVK)
Landscape Model	I3m – moderate relief inclined
Parent Materials	Coarse textured glaciofluvial
Forest Capability	4X
Water Erosion Risk	moderate
Wind Erosion Risk	high
Reclamation Suitability of Topsoil	poor
Typical Topsoil Depth	10
Reclamation Suitability of Upper Subsoil	poor
Typical Upper Subsoil Depth	10
Reclamation Suitability of Lower Subsoil	poor
Typical Lower Subsoil Depth	45

n/a = Not applicable.

Note: Stratified profiles may occur in the unit.

Table D-63 MIL1/I3h Soil Description

Soil Map Unit Name	MIL1/I3h
Dominant Soils	Eluviated Dystric Brunisols (MIL)
Significant Soils	n/a
Minor Soils	Orthic Dystric Brunisols (MILzz), Eluviated Dystric Brunisols (FIR), Orthic Gray Luvisols (FRT and LVK)
Landscape Model	I3h – high relief inclined
Parent Materials	Coarse textured glaciofluvial
Forest Capability	4X
Water Erosion Risk	high
Wind Erosion Risk	high
Reclamation Suitability of Topsoil	poor
Typical Topsoil Depth	10
Reclamation Suitability of Upper Subsoil	poor
Typical Upper Subsoil Depth	10
Reclamation Suitability of Lower Subsoil	poor
Typical Lower Subsoil Depth	45

n/a = Not applicable.

Note: Stratified profiles may occur in the unit.

Table D-64 MIL1/SC1h Soil Description

Soil Map Unit Name	MIL1/SC1h
Dominant Soils	Eluviated Dystric Brunisols (MIL)
Significant Soils	n/a
Minor Soils	Orthic Dystric Brunisols (MILzz), Eluviated Dystric Brunisols (FIR), Orthic Gray Luvisols (FRT and LVK)
Landscape Model	SC1h – steep valleys with confined floodplain
Parent Materials	Coarse textured glaciofluvial
Forest Capability	4X
Water Erosion Risk	high
Wind Erosion Risk	high
Reclamation Suitability of Topsoil	poor
Typical Topsoil Depth	10
Reclamation Suitability of Upper Subsoil	poor
Typical Upper Subsoil Depth	10
Reclamation Suitability of Lower Subsoil	poor
Typical Lower Subsoil Depth	45

n/a = Not applicable.

Notes: Stratified profiles may occur in the unit.
Gleyed, peaty variants and Gleysols occur in lower and toe slope positions.

Table D-65 MIL1/SC3 Soil Description

Soil Map Unit Name	MIL1/SC3
Dominant Soils	Eluviated Dystric Brunisols (MIL)
Significant Soils	n/a
Minor Soils	Orthic Dystric Brunisols (MILzz), Eluviated Dystric Brunisols (FIR), Orthic Gray Luvisols (FRT and LVK)
Landscape Model	SC1h – steep valleys with confined floodplain
Parent Materials	Coarse textured glaciofluvial
Forest Capability	4X
Water Erosion Risk	high
Wind Erosion Risk	high
Reclamation Suitability of Topsoil	poor
Typical Topsoil Depth	10
Reclamation Suitability of Upper Subsoil	poor
Typical Upper Subsoil Depth	10
Reclamation Suitability of Lower Subsoil	poor
Typical Lower Subsoil Depth	45

n/a = Not applicable.

Notes: Stratified profiles may occur in the unit.
Gleyed, peaty variants and Gleysols occur in lower and toe slope positions.

1.2.14 MIL2

The MIL2 unit is dominantly well to rapidly drained Eluviated Dystric Brunisols developed on coarse textured (loamy sand to sand) glaciofluvial deposits. Undifferentiated Gleysols and thin organic soils are found in significant amounts. Soils found in minor amounts are developed on sandy glaciofluvial deposits. These soils include Orthic Dystric Brunisols (MILzz), Eluviated Dystric Brunisols (FIR), Orthic Gray Luvisols (FRT and LVK).

The MIL2 soil unit was mapped on two landscapes:

- **MIL2/U1h** is found on high relief undulating landscapes (slopes 2 to 5%).
- **MIL2/U1l** is found on low relief undulating landscapes (slopes 2 to 3%).

Table D-66 MIL2/U1h Soil Description

Soil Map Unit Name	MIL2/U1h
Dominant Soils	Eluviated Dystric Brunisols (MIL)
Significant Soils	Undifferentiated Gleysols and thin organic soils
Minor Soils	Orthic Dystric Brunisols (MILzz), Eluviated Dystric Brunisols (FIR), Orthic Gray Luvisols (FRT and LVK)
Landscape Model	U1h – high relief undulating
Parent Materials	Coarse textured glaciofluvial
Forest Capability	$4X^8$ $4W^2$
Water Erosion Risk	low
Wind Erosion Risk	high
Reclamation Suitability of Topsoil	poor
Typical Topsoil Depth	10
Reclamation Suitability of Upper Subsoil	poor
Typical Upper Subsoil Depth	10
Reclamation Suitability of Lower Subsoil	poor
Typical Lower Subsoil Depth	45

Table D-67 MIL2/U1l Soil Description

Soil Map Unit Name	MIL2/U1l
Dominant Soils	Eluviated Dystric Brunisols (MIL)
Significant Soils	Undifferentiated Gleysols and thin organic soils
Minor Soils	Orthic Dystric Brunisols (MILzz), Eluviated Dystric Brunisols (FIR), Orthic Gray Luvisols (FRT and LVK)
Landscape Model	U1h – high relief undulating
Parent Materials	Coarse textured glaciofluvial
Forest Capability	$4X^8$ $4W^2$
Water Erosion Risk	low
Wind Erosion Risk	high
Reclamation Suitability of Topsoil	poor
Typical Topsoil Depth	10
Reclamation Suitability of Upper Subsoil	poor
Typical Upper Subsoil Depth	10
Reclamation Suitability of Lower Subsoil	poor
Typical Lower Subsoil Depth	45

1.2.15 MLD1

The MLD1 unit consists of dominantly poorly drained Typic Mesisols (MLD) developed on thick (more than 2.2 m), level, fen peatlands. Typic Fibrisols (ABN) are found in significant amounts. Terric Mesisols (MLDxt, MLDxc and MUSxc) are found in minor amounts.

The MLD1 soil unit was mapped on three landscapes:

- **MLD1/FP1** is found on meander floodplain landscapes (slopes less than 2%).
- **MLD1/FP3** is found on confined floodplain landscapes (slopes less than 2%).
- **MLD1/O1** is found on level organic landscapes (slopes less than 2%).

Table D-68 MLD1/FP1 Soil Description

Soil Map Unit Name	MLD1/FP1
Dominant Soils	Typic Mesisols (MLD)
Significant Soils	Typic Fibrisols (ABN)
Minor Soils	Terric Mesisols (MUSxc, MLDxs, MLDxt)
Landscape Model	FP1 – meander floodplain
Parent Materials	Fen peat
Forest Capability	5W[10]
Water Erosion Risk	low
Wind Erosion Risk	low
Reclamation Suitability of Topsoil	organic
Typical Topsoil Depth	n/a
Reclamation Suitability of Upper Subsoil	organic
Typical Upper Subsoil Depth	n/a
Reclamation Suitability of Lower Subsoil	organic
Typical Lower Subsoil Depth	n/a

n/a = Not applicable.

Notes: Floodplain of the Muskeg River.
Other soil that may be present include peaty Rego Gleysols developed on fluvial or fluviolacustrine sediments.

Table D-69 MLD1/FP3 Soil Description

Soil Map Unit Name	MLD1/FP3
Dominant Soils	Typic Mesisols (MLD)
Significant Soils	Terric Mesisols (MUSxc, MLDxs, MLDxt)
Landscape Model	FP3 – confined floodplain
Parent Materials	Fen peat
Forest Capability	5W[10]
Water Erosion Risk	low
Wind Erosion Risk	low
Reclamation Suitability of Topsoil	organic
Typical Topsoil Depth	n/a
Reclamation Suitability of Upper Subsoil	organic
Typical Upper Subsoil Depth	n/a
Reclamation Suitability of Lower Subsoil	organic
Typical Lower Subsoil Depth	n/a

n/a = Not applicable.

Note: Other soil that may be present include peaty Rego Gleysols, Orthic Regosols, Cumulic Regosols and gleyed variants.

Table D-70 MLD1/O1 Soil Description

Soil Map Unit Name	MLD1/O1
Dominant Soils	Typic Mesisols (MLD)
Significant Soils	Terric Mesisols (MUSxc, MLDxs), Terric Fibrisols (HLYxs)
Minor Soils	n/a
Landscape Model	O1 – level organic
Parent Materials	Fen peat
Forest Capability	5W[10]
Water Erosion Risk	low
Wind Erosion Risk	low
Reclamation Suitability of Topsoil	organic
Typical Topsoil Depth	n/a
Reclamation Suitability of Upper Subsoil	organic
Typical Upper Subsoil Depth	n/a
Reclamation Suitability of Lower Subsoil	organic
Typical Lower Subsoil Depth	n/a

n/a = Not applicable.

1.2.16 MLxsBMpt1/O5

The MLxsBMpt1/O1 unit consists of co-dominantly poorly drained Terric Mesisols (MLDxt) developed on thin (40 to 160 cm), level, fen peatlands and peaty Rego Gleysols (ELSpt) developed on very thin (less than 40 cm), level, fen peatlands overlying moderately fine textured till. Typic Fibrisols (ABN), Typic Mesisols (MLD) and Gleyed Eluviated Dystric Brunisols (MILgl) are found in significant amounts.

Table D-71 MLxsNOpt1/O1 Soil Description

Soil Map Unit Name	MLxsNOpt1/O1
Co-Dominant Soils	Typic Mesisols (MLDxs), peaty Rego Gleysols (BMTpt)
Significant Soils	Typic Mesisols (MLD), Typic Fibrisols (ABN), Gleyed Eluviated Dystric Brunisols (MILgl)
Minor Soils	n/a
Landscape Model	O5 – level organic with hummocky mineral soils
Parent Materials	Fen peat
Forest Capability	5W[5] 4W[5]
Water Erosion Risk	low
Wind Erosion Risk	low
Reclamation Suitability of Topsoil	organic
Typical Topsoil Depth	n/a
Reclamation Suitability of Upper Subsoil	organic to poor
Typical Upper Subsoil Depth	n/a
Reclamation Suitability of Lower Subsoil	organic to poor
Typical Lower Subsoil Depth	n/a

n/a = Not applicable.

1.2.17 MRN1/O1

The MRN1/O1 unit consists of dominantly poorly drained Terric Mesisols (MRN) developed on thin (40 to 160 cm), level, bog peatlands. Peaty Rego Gleysols (ELSpt) developed on moderately fine textured till are found in significant amounts.

Table D-72 MRN1/O1 Soil Description

Soil Map Unit Name	MRN1/O1
Dominant Soils	Terric Mesisols (MRN)
Significant Soils	peaty Rego Gleysols (ELSpt)
Minor Soils	n/a
Landscape Model	O1 – level organic
Parent Materials	Sphagnum peat
Forest Capability	5W[10]
Water Erosion Risk	low
Wind Erosion Risk	low
Reclamation Suitability of Topsoil	organic
Typical Topsoil Depth	n/a
Reclamation Suitability of Upper Subsoil	organic
Typical Upper Subsoil Depth	n/a
Reclamation Suitability of Lower Subsoil	organic
Typical Lower Subsoil Depth	n/a

n/a = Not applicable.

1.2.18 MUSxc1/O5

The MUSxc1/O5 unit consists of dominantly poorly drained Terric Mesisols (MUSxc) developed on thin (40 to 160 cm), level, fen bog peatlands. Typic Mesisols (MLD) and Eluviated Dystric Brunisols (MIL) developed on coarse textured glaciofluvial deposits are found in significant amounts.

Table D-73 MUSxc1/O5 Soil Description

Soil Map Unit Name	MUSxc1/O5
Dominant Soils	Terric Mesisols (MUSxc)
Significant Soils	Typic Mesisols (MLD), Eluviated Dystric Brunisols (MIL)
Minor Soils	n/a
Landscape Model	O5 – level organic with hummocky mineral soils
Parent Materials	Sphagnum peat and coarse glaciofluvial
Forest Capability	5W[10]
Water Erosion Risk	low
Wind Erosion Risk	low
Reclamation Suitability of Topsoil	organic
Typical Topsoil Depth	n/a
Reclamation Suitability of Upper Subsoil	organic
Typical Upper Subsoil Depth	n/a
Reclamation Suitability of Lower Subsoil	organic
Typical Lower Subsoil Depth	n/a

1.2.19 ZWA1/W3

The ZWA1/O5 unit consists of open waterbodies.

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APPENDIX E

COMPOSITION OF SOIL MAP UNITS

Submitted to:
Shell Canada Limited

Prepared by:
Golder Associates Ltd.

December 2007 **05-1344-027**

50 BEST EMPLOYERS IN CANADA 2007

CANADA'S 50 BEST MANAGED PRIVATE COMPANIES

OFFICES ACROSS NORTH AMERICA, SOUTH AMERICA, EUROPE, ASIA AND AUSTRALIA

LIST OF TABLES

Table E-1 Composition of Map Units Used for Area Calculations in the Jackpine Expansion Mining Area Local Study Area 1
Table E-2 Composition of Map Units Used for Area Calculations in the Pierre River Mining Area Local Study Area 2

JPME R1 ERRATA AND

JPME R1 AENV SIR 408

Table E-1 Composition of Map Units Used for Area Calculations in the Jackpine Expansion Mining Area Local Study Area

Map Unit	Dominant		Co-dominant		Co-dominant		Significant		Significant		Significant		Minor		Minor		Minor		Minor		Minor	
	Soil	(%)	Soil	(%)	Soil	(%)	Soil	(%)	Soil	(%)	Soil	(%)	Soil	(%)	Soil	(%)	Soil	(%)	Soil	(%)	Soil	(%)
ABN1/O1	ABN	65	-	-	-	-	MLD	20	-	-	-	-	MUS	3	MKWaa	3	HLY	3	MUSxc	3	MLDxc	3
ABN2/O2	ABN	60	-	-	-	-	MLDxc	15	HLY	15	-	-	gleysols	10	-	-	-	-	-	-	-	-
ABN3/O3	ABN	65	-	-	-	-	MLD	20	-	-	-	-	MUSxc	5	MKW	5	HLY	5	-	-	-	-
ABN4/O6	ABN	60	-	-	-	-	MLD	15	MKWaa	15	-	-	MUS	5	MLDxs	5	-		-	-	-	-
BMTpt1/U1l	BMTpt	70	-	-	-	-	-	-	MAMgl	10	NOR	5	ALG	5	MILgl	5	SUTgl	5	-	-		
ELptHR1/U1l	-	-	ELSpt	43	HRR	43	-	-	-	-	-	-	HLY	3	MLDxt	3	SUT	3	LVK	3	STP	2
ElptMR1/O5	-	-	ELSpt	43	MRN	43	-	-	-	-	-	-	HLY	4	SUT	4	HRR	4	HVNaa	2	-	-
HLMLxt/O1	-	-	HLY	45	MLDxt	45	-	-	-	-	-	-	ELSpt	5	LVKgl	5	-	-	-	-	-	-
HLMUxc/O1	-	-	HLY	45	MLDxt	45	-	-	-	-	-	-	ELSpt	5	LVKgl	5	-	-	-	-	-	-
HRLV1/H1l	-	-	HRR	43	LVK	43	-	-	-	-	-	-	SUT	5	MIL	5	HRRzz	4	-	-	-	-
HRLV1/H1m	-	-	HRR	43	LVK	43	-	-	-	-	-	-	SUT	5	MIL	5	HRRzz	4	-	-	-	-
HRLV1/U1h	-	-	HRR	43	LVK	43	-	-	-	-	-	-	SUT	5	MIL	5	HRRzz	4	-	-	-	-
HRR1/H1l	HRR	65	-	-	-	-	gleysols	20	-	-	-	-	LVK	5	SUT	5	HRRzz	5	-	-	-	-
HRR2/U1h	HRR	85	-	-	-	-	-	-	-	-	-	-	LVK	5	SUT	5	HRRzz	5	-	-	-	-
MIL1/U1h	MIL	85	-	-	-	-	-	-	-	-	-	-	MILzz	4	FIR	4	FRFT	4	LVK	3	-	-
MIL2/U1h	MIL	65	-	-	-	-	gleysols	20	-	-	-	-	MILzz	4	FIR	4	FRFT	4	LVK	3	-	-
MLD1/FP1	MLD	70	-	-	-	-	MUSxs	10	MLDxs	10	HLYxs	10	-	-	-	-	-	-	-	-	-	-
MLD1/FP3	MLD	70	-	-	-	-	MUSxs	10	MLDxs	10	HLYxs	10	-	-	-	-	-	-	-	-	-	-
MLD1/O1	MLD	70	-	-	-	-	MUSxs	10	MLDxs	10	HLYxs	10	-	-	-	-	-	-	-	-	-	-
MRN1/O1	MRN	80	-	-	-	-	Elspt	20	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MUSxc1/O5	MUSxc	70	-	-	-	-	MLD	15	MIL	15	-	-	-	-	-	-	-	-	-	-	-	-
ZWA1/W3	Water	100	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Note: - =Not Applicable.

PAGE CORRECTED FOR ERRATA

JPME R1 ERRATA, JPME R1 AENV SIR 408 AND JPME R1 AENV SIR 409

Table E-2 Composition of Map Units Used for Area Calculations in the Pierre River Mining Area Local Study Area

Map Unit	Dominant		Co-Dominant		Co-Dominant		Significant		Significant		Significant		Minor		Minor		Minor		Minor		Minor	
	Soil	(%)	Soil	(%)	Soil	(%)	Soil	(%)	Soil	(%)	Soil	(%)	Soil	(%)	Soil	(%)	Soil	(%)	Soil	(%)	Soil	(%)
ABN1/O1	ABN	65	-	-	-	-	MLD	20	-	-	-	-	MUS	3	MKWaa	3	HLY	3	MUSxc	3	MLDxc	3
BMTpt1/U1l	BMTpt	70	-	-	-	-	MLDxs	10	-	-	-	-	NAMgl	4	SUTgl	4	ALG	4	MILgl	4	NOR	4
DOglCHptzr 1/U1l	-	-	DOVgl	45	CHTptzr	45	MLDxc	10		-	-	-	-	-	-	-	-	-	-	-	-	-
DOV1/U1l	DOV	90	-	-	-	-	-	-	-	-	-	-	ALG	5	CHTzr	5	-	-	-	-	-	-
DOV2/FP3	DOV	60	-	-	-	-	ALG	10	CHTzr	10	DAR	10	MLDxc	10	-	-	-	-	-	-	-	-
DOV2/U1l	DOV	60	-	-	-	-	ALG	15	CHTzr	15	MLDxc	10	-	-	-	-	-	-	-	-	-	-
DOVcogl1/U1l	DOVcogl	75	-	-	-	-	ALG	10	DAR	10	-	-	DOV	5	-	-	-	-	-	-	-	-
FIR1/U1l	FIR	70	-	-	-	-	MIL	20	FRT	10	-	-	-	-	-	-	-	-	-	-	-	-
FIRgl1/U1l	FIRgl	70	-	-	-	-	FIR	20	FRT	10	-	-	-	-	-	-	-	-	-	-	-	-
FRLV1/H1l	-	-	FRT	45	LVK	45	-	-	-	-	-	-	STP	5	PEA	5	-	-	-	-	-	-
FRLV1/U1h	-	-	FRT	45	LVK	45	STP	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-
FRT1/U1h	FRT	90	-	-	-	-	PEA	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MIFR1/13h	FRT	80	-	-	-	-	PEA	20	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MIFR1/SC1h	-	-	MIL	43	FRT	43	-	-	-	-	-	-	LVK	5	PEA	5	NAM	4	-	-	-	-
MIFR1/SC3	-	-	MIL	33	FRT	33	NAMgl	10	MMW	10	-	-	PEA	5	NAM	5	MLDxs	4	-	-	-	-
MIFR1/U1h	-	-	MIL	43	FRT	43	-	-	-	-	-	-	PEA	4	NAM	4	MMW	4	NAMgl	2	-	-
MIFR1/U1l	-	-	MIL	43	FRT	43	-	-	-	-	-	-	PEA	4	NAM	4	MMW	4	NAMgl	2	-	-
MIFR2/U1h	-	-	MIL	45	FRT	45	-	-	-	-	-	-	LVK	5	PEA	5	-	-	-	-	-	-
MIFR2/U1l	-	-	MIL	35	FRT	35	MLDxs	10	MMW	10	-	-	LVK	5	PEA	5	-	-	-	-	-	-
MIFR1/H1l	-	-	MIL	35	FRT	35	MLDxs	10	MMW	10	-	-	LVK	5	PEA	5	-	-	-	-	-	-
MIL1/H1m	-	-	MIL	45	FRT	45	-	-	-	-	-	-	LVK	5	PEA	5	-	-	-	-	-	-
MIL1/U1h	MIL	85	-	-	-	-	-	-	-	-	-	-	MILzz	4	LVK	4	FRT	4	SUT	3	-	-
MIL1/U1l	MIL	85	-	-	-	-	-	-	-	-	-	-	MILzz	4	LVK	4	FRT	4	FIR	3	-	-
MIL1/H1l	MIL	85	-	-	-	-	-	-	-	-	-	-	MILzz	4	LVK	4	FRT	4	FIR	3	-	-
MIL2/U1l	MIL	65	-	-	-	-	gleysols	20	-	-	-	-	MILzz	4	FIR	4	FRT	4	LVK	3	-	-
MIL2/U1h	MIL	65	-	-	-	-	gleysols	20	-	-	-	-	MILzz	4	FIR	4	FRT	4	LVK	3	-	-
MLD1/O1	-	-	MLDxs	35	BMTpt	35	MLD	10	ABN	10	MILgl	10	-	-	-	-	-	-	-	-	-	-
MUSxc1/O5	MUS	70	-	-	-	-	MLD	15	MKWaa	15	-	-	-	-	-	-	-	-	-	-	-	-
MUSxs1/O5	MUSxs	70	-	-	-	-	MLD	15	MIL	15	-	-	-	-	-	-	-	-	-	-	-	-
MLDxc1/O1	MLD	70	-	-	-	-	ABN	15	MUS	15	-	-	-	-	-	-	-	-	-	-	-	-
MLDxs1/O1	MLDxc	70	-	-	-	-	HLYxs	10	MLDxs	10	MUSxc	10	-	-	-	-	-	-	-	-	-	-
MLxcCHptzr/O1	-	-	MLDxc	45	CHT	45	-	-	-	-	-	-	MLD	5	ALGpt	5	-	-	-	-	-	-
MLxsMKaaxs1/O1	-	-	MLDxs	30	MKWaa	30	MUSxs	15	MMWpt	15	WHMaapt	10	-	-	-	-	-	-	-	-	-	-
MMY1/U1l	MMY	70	-	-	-	-	MMW	30	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MUSxs1/O1	MUSxc	70	-	-	-	-	MLD	15	MIL	15	-	-	-	-	-	-	-	-	-	-	-	-
MUSxs1/O2	MUSxc	70	-	-	-	-	MLD	20	-	-	-	-	MMW	5	BMTpt	5	-	-	-	-	-	-
MUSxs1/O4	MUSxc	70	-	-	-	-	MLD	10	WHMaapt	10	MIL	10	-	-	-	-	-	-	-	-	-	-
MUxsBMpt1/O5	-	-	MLDxs	35	BMTpt	35	MLD	10	ABN	10	MMW	10	-	-	-	-	-	-	-	-	-	-
NAMcu2/FP3	NAM	64	-	-	-	-	-	-	-	-	NAMgl	7	MMW	7	PEA	7	FRT	5	FRTgl	5	MLDxs	5
ZWA1/W3	Water	100	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Note: - = Not Applicable.

PAGE CORRECTED FOR ERRATA

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APPENDIX F

SOIL CHEMISTRY

Submitted to:
Shell Canada Limited

Prepared by:
Golder Associates Ltd.

December 2007 **05-1344-027**

50 BEST EMPLOYERS IN CANADA 2007

CANADA'S 50 BEST MANAGED PRIVATE COMPANIES

OFFICES ACROSS NORTH AMERICA, SOUTH AMERICA, EUROPE, ASIA AND AUSTRALIA

LIST OF TABLES

Table F-1 Soil Chemistry for the Pierre River Mining Area Local Study Area 1
Table F-2 Soil Chemistry for the Jackpine Expansion Mining Area Local Study Area 3

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Table F-1 Soil Chemistry for the Pierre River Mining Area Local Study Area

Sample	Series	Horizon	Sand [%]	Silt [%]	Clay [%]	Texture	Sodium (Na) [mg/L]	Magnesium (Mg) [mg/L]	Potassium (K) [mg/L]	Calcium (Ca) [mg/L]	Cation Exchange Capacity (CEC)	Sodium Adsorption Ratio (SAR)	Conductivity (EC) [dS/m]	pH in Saturated Paste	Organic Carbon [%]	Total Kjeldahl Nitrogen [%]	Saturation [%]
ABN 0-50	ABN	Of 0-50	—	—	—	—	—	—	—	—	—	—	—	5.4	36.1	1.72	2,380
ABN 50-100		Of 50-100	—	—	—	—	—	—	—	—	—	—	—	5.9	—	—	2,720
ABN 100-200		Of 100-200	—	—	—	—	—	—	—	—	—	—	—	5.9	—	—	2,560
PR-1L	FIR	LFH	—	—	—	—	—	—	—	—	46.3	—	—	—	26.3	0.85	—
PR-1A		Ae	82	15	3	loamy sand	—	—	—	—	1.7	—	0.7	5.7	0.36	0.04	84
PR-1B		Bm	88	7	6	loamy sand	15	2	2	7	—	1.3	0.2	5.1	—	—	84
PR-1C		C	92	5	3	sand	—	—	—	—	—	—	—	5.1	—	—	56
PR-2A		—	—	—	—	—	—	—	—	—	84.8	—	—	4	29.3	0.82	914
PR-2B		—	—	—	—	—	—	—	—	—	—	—	—	6.9	—	—	1,202
PR-2C		—	71	17	12	sandy loam	—	—	—	—	—	—	0.2	6	—	—	99
PR-3A	FRTgl	LFH 5-0	—	—	—	—	—	—	—	—	81.9	—	—	—	41	0.79	—
PR-3B		Aegj 0-5	41	53	6	silt loam	—	—	—	—	4.1	—	0.3	4.1	0.5	0.05	90
PR-3C		Bmgj 5-46	77	12	11	sandy loam	17	14	3	33	—	0.6	0.3	5.5	—	—	81
PR-3D		Bt 46-54	78	12	10	sandy loam	27	11	2	27	—	1.1	0.3	6	—	—	84
PR-3E		C 54-100	85	7	8	loamy sand	—	—	—	—	—	—	0.5	6.6	—	—	96
PR-4A	LVK	LFH 7-0	—	—	—	—	—	—	—	—	75.6	—	—	—	23.1	1.36	—
PR-4B		Ae 0-19	75	18	7	sandy loam	—	—	—	—	7	—	0.3	5.3	1.01	0.11	144
PR-4C		Bt 19-55	64	31	5	sandy loam	14	31	3	81	—	0.3	0.6	6.1	—	—	105
PR-4D		Ck 55-100	36	29	35	clay loam	—	—	—	—	—	—	0.7	7.6	—	—	153
PR-5A	MIL	LFH 3-0	—	—	—	—	—	—	—	—	19.3	—	—	—	9.63	0.24	—
PR-5B		Ahe 0-2	90	6	4	sand	—	—	—	—	8	—	0.2	5	2.15	0.1	183
PR-5C		Bm 2-65	88	7	5	sand	7	0.5	0.5	1.4	—	—	0.05	5.4	—	—	81
PR-5D		C 65-100	94	4	2	sand	—	—	—	—	—	—	0.05	5.6	—	—	81
PR-6A	PEAgl	LFH 7-0	—	—	—	—	—	—	—	—	61.1	—	—	—	18	0.99	—
PR-6B		Aegj 0-46	16	65	20	silt loam	—	—	—	—	57	—	0.2	3.6	2.43	0.19	156
PR-6C		Bt 46-67	7	66	27	silty clay loam	47	74	7	383	—	0.6	2.4	3.2	—	—	195
PR-6D		C 67-100	10	65	25	silt loam	—	—	—	—	—	—	3.2	3.2	—	—	183
PR-7A	FRT	LFH 5-0	—	—	—	—	—	—	—	—	18.8	—	—	—	9.36	0.55	—
PR-7B		Ae 0-11	62	31	7	sandy loam	—	—	—	—	3.2	—	0.3	4.4	0.43	0.04	78
PR-7C		Bt 11-43	53	37	10	sandy loam	10	1	2	6	—	1	0.1	4.8	—	—	90
PR-7D		C 43-100	91	4	5	sand	—	—	—	—	—	—	0.2	5	—	—	69
PR-8A	MLD	Of 0-25	—	—	—	—	—	—	—	—	85.7	—	—	4.2	39.2	0.95	3,660
PR-8B		Om 25-220+	—	—	—	—	—	—	—	—	—	—	—	5.5	—	—	1,624
PR-9A	LVK	LFH 7-0	—	—	—	—	—	—	—	—	63	—	—	—	20.7	1.26	—
PR-9B		Ae 0-38	41	49	10	loam	—	—	—	—	4.6	—	0.1	5.6	0.26	0.05	87
PR-9C		Bt 38-62	34	50	16	silt loam	16	3	2	13	—	1	0.2	5.1	—	—	96
PR-9D		C 62-100	64	22	14	sandy loam	—	—	—	—	—	—	0.7	4.6	—	—	96
PR-10A	BMTptzr	Of 20-10	—	—	—	—	—	—	—	—	37	—	—	4.4	9.82	0.21	1,364
PR-10B		Om 10-0	—	—	—	—	—	—	—	—	—	—	—	6	—	—	1,020
PR-10C		Cg 0-55	46	40	14	loam	—	—	—	—	—	—	0.5	6.9	—	—	90
PR-10D		Cg2 55-100	80	13	7	loamy sand	—	—	—	—	—	—	0.4	7.1	—	—	75
PR-11A	DOVco	LFH 5-0	—	—	—	—	—	—	—	—	72.1	—	—	—	25.1	0.94	—
PR-11B		Ae 0-12	57	36	7	sandy loam	—	—	—	—	3.8	—	0.2	5.2	0.35	0.05	99
PR-11C		Bt 12-48	87	4	9	loamy sand	12	2	2	8	—	1	0.1	6	—	—	87
PR-11D		C 48-85	12	31	57	clay	—	—	—	—	—	—	0.5	7.2	—	—	156
PR-11E		Ck 85-100	18	33	49	clay	—	—	—	—	—	—	0.7	7.6	—	—	180

JPME R1
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412

Table F-1 Soil Chemistry for the Pierre River Mining Area Local Study Area (continued)

Sample	Series	Horizon	Sand [%]	Silt [%]	Clay [%]	Texture	Sodium (Na) [mg/L]	Magnesium (Mg) [mg/L]	Potassium (K) [mg/L]	Calcium (Ca) [mg/L]	Cation Exchange Capacity (CEC)	Sodium Adsorption Ratio (SAR)	Conductivity (EC) [dS/m]	pH in Saturated Paste	Organic Carbon [%]	Total Kjeldahl Nitrogen [%]	Saturation [%]
PR-12A	FRTzz	LFH 7-0	—	—	—	—	—	—	—	—	56.7	—	—	—	24.7	0.72	—
PR-12B		Bme 0-7	41	49	10	loam	—	—	—	—	6.8	—	0.3	6.2	0.71	0.06	105
PR-12C		Ae 7-42	32	61	7	silt loam	—	—	—	—	4.1	—	0.2	6.3	0.41	—	96
PR-12D		Bt 43-52	32	51	17	silt loam	14	10	2	45	—	0.5	0.4	6.3	—	—	99
PR-12E		C 52-75	40	53	7	silt loam	—	—	—	—	—	—	0.6	6.9	—	—	117
PR-12F		Ck 75-105	82	10	7	loamy sand	—	—	—	—	—	—	1.3	7.3	—	—	66
PR-12G		IICk 105-125	44	49	7	loam	—	—	—	—	—	—	0.5	7.6	—	—	117
PR-13A	BMTptzr	Of 35-15	—	—	—	—	—	—	—	—	35.4	—	—	6.3	25.4	0.61	1,386
PR-13B		Om 15-0	—	—	—	—	—	—	—	—	—	—	—	7.1	—	—	904
PR-13C		Ckg 0-18	33	53	14	silt loam	—	—	—	—	—	—	0.7	7.5	—	—	75
PR-13D		C 18-38	29	53	17	silt loam	—	—	—	—	—	—	0.6	7.5	—	—	105
PR-13E		C2 38-80	74	17	9	sandy loam	—	—	—	—	—	—	0.6	7.7	—	—	72
PR-14A	MLDxc	Of 0-12	—	—	—	—	—	—	—	—	99.9	—	—	5.3	42.6	1.22	2,040
PR-14B		Om 12-50	—	—	—	—	—	—	—	—	—	—	—	6.8	—	—	936
PR-14C		Cg 50-85	66	22	12	sandy loam	—	—	—	—	—	—	0.6	6.9	—	—	69
PR-14D		Cg2 85-100	64	24	12	sandy loam	—	—	—	—	—	—	0.2	6.8	—	—	81
PR-15A	FRT	LFH 5-0	—	—	—	—	—	—	—	—	66.4	—	—	—	20.9	1.05	—
PR-15B		Ae 0-12	41	50	9	silt loam	—	—	—	—	5.3	—	0.3	4.8	0.46	0.04	105
PR-15C		Ae2 12-35	42	44	14	loam	—	—	—	—	5.4	—	0.2	5.7	—	—	96
PR-15D		Bt 35-43	34	39	27	loam/clay loam	15	4	1	16	—	0.9	0.2	5.2	—	—	111
PR-15E		C 43-57	88	5	7	loamy sand	—	—	—	—	—	—	0.4	7.5	—	—	96
PR-15F		Ck 57-100	90	5	5	sand	—	—	—	—	—	—	1.6	7.3	—	—	75

— = No data.

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412

Table F-2 Soil Chemistry for the Jackpine Expansion Mining Area Local Study Area

Sample	Series	Horizon	Sand [%]	Silt [%]	Clay [%]	Texture	Sodium (Na) [mg/L]	Magnesium (Mg) [mg/L]	Potassium (K) [mg/L]	Calcium (Ca) [mg/L]	Cation Exchange Capacity (CEC)	Sodium Absorption Ratio (SAR)	Electrical Conductivity (EC) [dS/m]	pH in Saturated Paste	Organic Carbon [%]	Total Kjeldahl Nitrogen [%]	Saturation [%]
CCC-006-A	MILzz	Ae (0-2)	90	5	5	—	13.2	10.5	4.2	69.2	3.3	0.4	0.4	6.3	1	0.06	25
CCC-006-B		Bm (2-55)	91	6	4	—	13.2	5.4	8.2	32.3	1.5	0.6	0.3	5.6	—	—	22
GA-10-A	MIL	Ae (0-11)	90	7	3	—	14.2	6.4	7.2	19.6	1	0.7	0.2	5.2	0.2	0.02	27
GA-10-B		Bm (11-70)	—	—	—	—	8.2	3.4	6.2	13.5	0.6	0.5	0.2	5.5	—	—	29
GA-10-C		C (70-100)	—	—	—	—	24.2	3.4	5.2	10	1.8	1.8	0.2	5.6	—	—	24
GA-11-A	MIL	Ahe (0-2)	89	5	5	—	9.2	1.4	11.2	6.9	2.2	0.9	0.2	5.5	0.5	0.04	32
GA-11-B		Bm (2-68)	—	—	—	—	8.2	2.4	2.2	6.3	0.9	0.7	0.1	6.2	—	—	26
GA-11-C		BC (68-100)	—	—	—	—	10.2	1.4	3.2	4.3	0.7	1.2	0.1	6.1	—	—	26
GA-12-A	BMTzrpt	Of (0-34)	—	—	—	—	5.5	12.9	3.5	74.9	106	0.3	0.1	5.4	37.7	1.23	950
GA-12-B		Om (34-51)	82	12	5	—	10.8	5.6	2.2	21.6	4.1	0.5	0.2	6.2	—	—	47
GA-12-BB		Cg (51-100)	96	1	3	—	5.2	1.4	1.2	2.2	0.3	—	0.1	6	—	—	29
GA-13-B	SUT	Bm (11-52)	85	9	5	—	11.2	5.4	3.2	17.6	1.4	0.6	0.2	5.4	—	—	27
GA-13-C		BC (52-75)	50	43	7	—	26.6	36.7	4.2	120.1	5	0.5	1	4.3	—	—	32
GA-13-D		IICca (75-95)	42	32	26	—	30.3	53.2	1.2	211.4	7.3	0.5	1.3	7	—	—	41
GA-13-E		IIC (95-115)	62	30	9	—	13.8	36.6	4.2	128.1	4.4	0.3	1	4.4	—	—	49
GA-14-A	MIL	Ae (0-12)	—	—	—	—	12.2	2.4	6.2	10.3	0.6	0.9	0.2	4.4	0.1	0.02	33
GA-14-B		Bm (12-66)	—	—	—	—	7.2	2.4	7.2	11.4	1.8	0.5	0.2	4.7	—	—	31
GA-14-C		BC (66-100)	—	—	—	—	13.2	2.4	2.2	9.9	2.1	1	0.2	5.2	—	—	28
GA-15-A	MIL	Ahe (0-2)	—	—	—	—	9.2	2.4	12.2	9.8	5.1	0.7	0.3	5.1	—	0.1	43
GA-15-B		Ae (2-10)	—	—	—	—	9.2	2.4	7.2	12.9	2.1	0.7	0.2	5.2	—	0.03	33
GA-15-C		Bm (10-65)	—	—	—	—	11.2	3.4	4.2	17.1	2	0.7	0.2	6.1	—	—	27
GA-15-D		BC (65-100)	—	—	—	—	7.2	1.4	4.2	7.7	1	0.7	0.1	6.3	—	—	30
GA-16-A	MIL	Ahe (0-3)	88	9	3	—	9.2	1.4	6.2	3.2	1.4	1.2	0.1	4	0.2	0.02	32
GA-16-B		Ae (3-11)	87	9	4	—	10.6	2.4	14.2	11.7	4.3	0.7	0.3	4.4	1.1	0.09	42
GA-16-C		Bm (11-55)	91	5	4	—	5.8	1.4	1.2	7.5	2.7	0.5	0.1	5.8	—	—	33
GA-16-D		BC (55-100)	96	3	2	—	7.2	1.4	2.2	4.5	1.3	0.8	0.1	6.1	—	—	28
GA-17-A	MIL	Ae (0-12)	—	—	—	—	8.2	4.4	7.2	15.7	1.8	0.5	0.2	4.4	0.8	0.06	36
GA-17-B		Bm (12-53)	—	—	—	—	13.2	4.4	3.2	20.9	1.7	0.7	0.2	4.9	—	—	28
GA-17-C		BC (53-100)	—	—	—	—	12.2	5.4	1.2	17	1.7	0.7	0.2	5.2	—	—	30
GA-18-A	MIL	Ahe (0-7)	86	9	4	—	32.2	8.5	19.2	26	6.1	1.5	0.4	4.4	1.3	0.08	47
GA-18-B		Bm (7-38)	89	8	3	—	12.2	6.4	7.2	16.6	1.6	0.6	0.2	5.1	—	—	27
GA-18-C		BC (38-100)	30	56	14	—	22.3	11.6	4.2	20.7	10.7	1.1	0.3	4.4	—	—	40
GA-19-A	MIL	Ae (0-2)	—	—	—	—	6.2	2.4	4.2	6.2	0.8	0.6	0.1	5.1	0.5	0.03	28
GA-19-B		Bm (2-46)	—	—	—	—	9.2	4.4	7.2	14.5	0.8	0.6	0.2	5.4	—	—	28
GA-19-C		C (46-100)	—	—	—	—	4.2	1.4	1.2	2.2	0.2	0.7	0.1	6.2	—	—	27
GA-1-A	SUT	Ae (0-40)	90	7	3	—	12.2	4.4	6.2	15.4	0.8	0.7	0.2	5	0.2	0.04	25
GA-1-B		Bm (40-75)	90	2	7	—	8.2	2.4	2.2	10.9	1.4	0.6	0.1	5.7	—	—	24
GA-1-C		IIC (75-100)	56	17	27	—	28.2	39.1	3.2	84.8	9.1	0.7	0.8	5.5	—	—	35
GA-20-A	MUS	Om (17-195)	—	—	—	—	10.2	26.9	1.2	150	63.1	0.3	0.2	6	35.8	1.55	405
GA-21-A	MILgl	Bm (0-15)	86	9	5	—	11.4	4.4	2.2	34.9	2.4	0.5	0.3	6.5	—	—	36
GA-21-B		BCgj (15-42)	89	8	4	—	6.5	3.4	1.2	43.8	2.4	0.3	0.3	7.2	—	—	46
GA-21-C		Cgj (42-60)	69	25	7	—	16.2	7.5	2.2	32.7	3.2	0.7	0.3	7.1	—	—	33
GA-22-A	FRT	Ae (0-6)	74	17	9	—	9.3	19.4	21.2	48.3	5	0.3	0.6	3.6	2.2	0.05	37
GA-22-B		Bt (6-31)	68	27	5	—	8.5	3.4	8.2	7.2	5.1	0.7	0.2	3.9	—	—	38
GA-22-C		BC1 (31-81)	74	21	4	—	10.6	2.4	6.2	5.2	4.9	1	0.1	4.1	—	—	33
GA-22-D		BC2 (81-100)	65	30	5	—	10.2	2.4	7.2	6.2	5.3	0.9	0.1	4.2	—	—	33

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413

Table F-2 Soil Chemistry for the Jackpine Expansion Mining Area Local Study Area (continued)

Sample	Series	Horizon	Sand [%]	Silt [%]	Clay [%]	Texture	Sodium (Na) [mg/L]	Magnesium (Mg) [mg/L]	Potassium (K) [mg/L]	Calcium (Ca) [mg/L]	Cation Exchange Capacity (CEC)	Sodium Absorption Ratio (SAR)	Electrical Conductivity (EC) [dS/m]	pH in Saturated Paste	Organic Carbon [%]	Total Kjeldahl Nitrogen [%]	Saturation [%]
GA-23-A	STPzrpt	Om (11-37)	—	—	—	—	11.3	50.4	12.6	224	145	0.3	0.6	6.8	37.7	1.35	320
GA-23-B		Cg (37-100)	62	28	10	—	7.2	12.6	3.2	46.6	11.4	0.3	0.3	6.6	—	—	43
GA-24-A	MUS	Of (0-14)	—	—	—	—	5.9	28.4	2.2	233	178	0.2	0.3	6.5	41.8	1.17	625
GA-25-A	HRRzz	Ae (0-6)	52	44	4	—	1.2	3.4	3.2	17.3	1.7	0.1	0.3	5.2	0.3	0.04	30
GA-25-B		Bm (6-27)	70	22	9	—	44.2	10.5	2.2	49.1	2.4	1.5	0.4	5.7	—	—	17
GA-25-C		Bt (27-67)	43	24	33	—	19.2	37.3	3.2	113.2	13.3	0.4	0.9	4.6	—	—	42
GA-25-D		Ck (67-100)	28	30	42	—	17.3	62.7	1.2	209.3	14.5	0.3	1.3	6.9	—	—	60
GA-26-A			—	—	—	—	3.2	6.1	39.5	31.2	99.3	0.2	0.4	3.4	45.4	0.94	517
GA-27-A			—	—	—	—	20.2	8	3.2	31.9	10.1	1	0.2	5.2	2.7	0.08	44
GA-28-A			—	—	—	—	6.8	23.9	5.2	153	134	0.2	0.2	5.9	46.5	2.36	883
GA-28-B			—	—	—	—	4.3	29.5	4.2	163	133	0.2	0.2	6	45.3	1.84	979
GA-2-A	MIL	Ae (0-10)	91	3	7	—	10.2	7.5	6.2	25.8	1.2	0.5	0.2	5.5	0.2	0.02	31
GA-2-B		Bm (10-43)	98	1	2	—	8.4	19.4	1.2	97.8	0.7	0.2	0.6	6.4	—	—	31
GA-2-C		BC (43-100)	97	1	2	—	9.2	5.4	2.2	19.3	0.4	0.5	0.2	6.5	—	—	30
GA-3-A	FRT	Ae (0-9)	64	32	5	—	12.2	4.4	7.2	9.4	1.8	0.9	0.2	4.2	—	0.04	26
GA-3-B		Bt (9-39)	56	34	10	—	12.2	1.4	7.2	5.3	23.1	1.3	0.1	4.6	—	—	25
GA-3-C		BC (39-100)	96	2	2	—	7.2	1.4	4.2	2.3	1.3	1.2	0.1	5.3	—	—	27
GA-4-A	HRR	Ae (0-30)	37	53	10	—	12.2	5.7	2.2	19	5	0.6	0.2	4.7	0.7	0.06	35
GA-4-B		Bt (30-65)	28	35	37	—	17.2	8.2	1.2	21.5	14.2	1	0.2	4.8	—	—	38
GA-4-C		Ck (65-100)	61	24	15	—	14.2	28.7	1.2	78.7	5.7	0.4	0.5	7	—	—	30
GA-5-A	MILzz	Ae (0-1)	94	4	2	—	1.2	1.4	2.2	2.9	1.3	0.1	0.2	6.1	—	—	20
GA-5-B		Bm (1-75)	94	2	5	—	19.6	2.4	5.2	18.1	1.3	1.1	0.2	6	—	—	23
GA-6-A	MLD	Of (0-15)	—	—	—	—	14.4	50.5	5.3	279	125	0.2	1	6.8	35.8	1.09	303
GA-6-B		Om (15-140)	—	—	—	—	10.2	31.4	3.2	170.3	40.1	0.2	0.7	7.2	12	0.42	75
GA-7-A	MIL	Ae (0-7)	91	5	—	—	8.2	4.4	10.2	23.1	3.4	0.4	0.2	5	1	0.06	36
GA-7-B		Bm (7-68)	93	3	5	—	10.2	1.4	2.2	7.3	1.5	0.9	0.1	5.5	—	—	26
GA-7-C		BC (68-100)	95	3	2	—	9.2	1.4	3.2	5.5	1.1	1	0.1	5.9	—	—	25
GA-8-A	BMTzrpt	Om (22-38)	—	—	—	—	9.4	5	9.7	22	102	0.7	0.2	4.1	42.4	1.35	693
GA-8-B		Cg (38-100)	93	4	2	—	11.2	6.4	1.2	17.2	2.4	0.6	0.2	5.8	—	—	26
GA-9-A	MILzz	Bm (1-38)	90	5	5	—	7.8	1.4	1.2	4.2	1.1	0.8	0.1	5.8	—	—	34
GA-9-B		BC (38-55)	94	2	3	—	10.8	4.4	1.2	17.2	0.9	0.5	0.2	6.3	—	—	31
GA-9-C		C (55-100)	94	2	4	—	4.5	1.4	1.2	6.2	0.7	0.4	0.1	6.4	—	—	34

— = No data.

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APPENDIX G

LAND CAPABILITY WORKSHEETS

Submitted to:
Shell Canada Limited

Prepared by:
Golder Associates Ltd.

December 2007 **05-1344-027**

LAND CAPABILITY WORKSHEET

SOIL MOISTURE REGIME INDEX AND SUBCLASS DETERMINATION

Water table ≤100 cm[1]

Moisture Regime	SMR Index and Subclass	Description	Surface organic thickness [cm]	Water table depth [cm]
Subhygric (6)[2]	80	Water removed slowly enough to keep the soil wet for a significant part of the growing season; some temporary seepage and possible mottling below 20 cm.	10 to 40	May be <100
Hygric (7a)[2]	66	Hygric aerated: Water removed slowly enough to keep the soil wet for most of the growing season; mottling present within 50 cm.	16 to 40	30-100
Hygric (7r)[2]	24W	Hygric reduced: Water removed slowly enough to keep the soil wet for most of the growing season; >50% gley within 50 cm	16 to 40	30-100
Subhydric (8)	0W	Water removed slowly enough to keep the water table at or near surface for most of the year; organic and gleyed mineral soils; permanent seepage <30 cm below soil surface.	>40	0-30
Hydric (9)	0W	Water removed so slowly that the water table is at or above the soil surface all year; organic and gleyed mineral soils.	>40	0+

[1] Circle the appropriate SMR index and subclass based on soil and landscape description, surface organic thickness, and water table depth.

[2] Subhygric and hygric moisture regimes are not to be applied to reclaimed soils at this time.

Note: additional indicators can be found in Table 9.

Available Water Holding Capacity (AWHC) Calculation (Water Table >100cm; No Gleying)

Horizon Designation	Texture	Horizon Thickness [cm]	Multiplier	AWHC [mm]	% coarse fragments adjustment		AWHC [mm]
					[vol.]	[mm]	
					_____	_____	
					_____	_____	
					_____	_____	
					_____	_____	
						Profile AWHC = ∑	(i)

Layering modifiers

Check box if soil profile information above meets the criteria for one of the layering modifiers for a 15 mm upgrade.

Impermeable layer	❑	_____
Coarse over fine material stratification	❑	_____
Fine over coarse material stratification	❑	_____
Layering effect =		(ii)

Subclass 'O' where ≥15 cm O horizon beginning at 0 cm (reclaimed soils).
Subclass 'P' where % coarse fragments adjustment is ≥30 mm.
Subclass 'Z' where R, KC, IMP, or i horizon occupies ≥30 cm of the profile.

Landscape Modifiers (≥10% slopes)

Aspect (degree range)	Crest	Upper	Mid	Lower
	1	2	3	4
NW-NE (316-45)	-15	0	+15	+15
NE-SE (46-135)	-15	-15	0	0
SE-SW (136-225)	-15	-30	-30	-30
SW-NW (226-315)	-15	-15	0	0

(iii)

Circle applicable slope and aspect combination; toe, depression and level = 0.

Adjusted AWHC

Adjusted AWHC = (i) + (ii) + (iii) = _____ (i) + _____ (ii) + _____ (iii) = _____

Moisture regime	SMR Index and Subclass	Adjusted AWHC [mm 100 cm^{-1}]
Very zeric (1)	10X	<56
Xeric (2)	24X	56 to 85
Subxeric (3)	38X	86 to 115
Submesic (4)	52	116 to 145
Mesic (5)	66	146 to 175

SMR, SMR index and Subclass

Soil moisture Regime _____

SMR Index _____

Subclass _____

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414

SOIL NUTRIENT REGIME INDEX AND SUBCLASS DETERMINATION

Total C, N and C:N

Horizon Designation	Depth [cm]	Horizon Thickness [cm]	Bulk Density [Mg m^{-3}]	TOC [%]	TOC [Mg ha^{-1}]	Total Nitrogen [%]	Total Nitrogen [Mg ha^{-1}]
				∑		∑	
				C:N =			

Nutrient retention rating

Horizon Designation	Depth [cm]	Horizon Thickness [cm]	Texture	Assigned Rating	Weighted Average Calculation

Cumulative Rating

Parameter		Value		Rating
Organic Carbon	(Mg ha^{-1})			
Total Nitrogen	(Mg ha^{-1})			
C/N ratio				
Nutrient Retention[1]		TS	US	

[1] Weighted average calculation may be required.

Cumulative Rating	∑	
Soil Nutrient Regime Index and Subclass	SNR	

Base Rating

Base Rating = SMR Index + SNR Index = SMR Index + SNR Index = _____ (a)

Subclass(es) =

LIMITING FACTOR DEDUCTIONS

Topsoil Adjustment (0 to 20 cm)

Factor		Value	Deduction	Subclass
Structure/Consistence				D
Reaction	pH			V
Salinity	EC (dS m^{-1})			N
Sodicity	SAR			Y
TS deduction (b)	**(b)** = (most limiting of D, V, N, Y%)(a)			
	(b) = (_)(a) = **(b)**			
Interim soil rating (c)	**(c)** = (a) – (b)			
	(c) = (_) – (_) = **(c)**			

Upper Subsoil Adjustment (20 to 50 cm)

Factor		Value	Deduction	Subclass
Structure/Consistence				D
Reaction	pH			V
Salinity	EC (dS m^{-1})			N
Sodicity	SAR			Y
US deduction (d)	**(d)** = (most limiting of D, V, N, Y%)(c) (0.67)			
	(d) = (_)(_)(0.67) = **(d)**			

Lower Subsoil Adjustment (50 to 100 cm)

Factor		Value	Deduction	Subclass
Structure/Consistence				D
Reaction	pH			V
Salinity	EC (dS m^{-1})			N
Sodicity	SAR			Y
LS deduction (e)	**(e)** = most limiting of D, V, N, Y%)(c) (0.33)			
	(e) = (_)(_)(0.33) = **(e)**			

Final Land rating = (a) – (b) – (d) – (e)

Final Land Rating = (_) – (_) – (_) - (_) = _

Land Capability Rating Ranges	Land Capability Class
81 to 100	Class 1
61 to 80	Class 2
41 to 60	Class 3
21 to 40	Class 4
0 to 20	Class 5

Land capability rating
Land capability class
Subclass(es)

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TERRESTRIAL VEGETATION, WETLANDS AND FOREST RESOURCES ENVIRONMENTAL SETTING FOR THE JACKPINE MINE EXPANSION & PIERRE RIVER MINE PROJECT

Submitted to:
Shell Canada Limited

Prepared by:
Golder Associates Ltd.

December 2007 **05-1344-027**

50 BEST EMPLOYERS IN CANADA 2007

CANADA'S 50 BEST MANAGED PRIVATE COMPANIES

TABLE OF CONTENTS

SECTION **PAGE**

3 TERRESTRIAL VEGETATION, WETLANDS AND FOREST RESOURCES....1
3.1 INTRODUCTION AND OBJECTIVES....1
3.2 STUDY AREAS....2
3.3 METHODS....9
3.3.1 Data Collection....9
3.3.2 Terrestrial Vegetation and Wetlands Vegetation Classification and Mapping....17
3.3.3 Correlation Between the Regional and Local Study Area Ecological Land Classification Systems....27
3.3.4 Terrestrial Vegetation and Wetlands Reporting....28
3.3.5 Landscape-Level Assessment....34
3.3.6 Key Indicator Resources....37
3.3.7 Sustainable Ecosystem Working Group Vegetation Indicators....51
3.3.8 Quality Assurance / Quality Control....52
3.4 REGIONAL RESULTS....52
3.4.1 Terrestrial Vegetation and Wetlands....52
3.4.2 Landscape-Level Analyses....58
3.4.3 Key Indicator Resources....66
3.5 JACKPINE EXPANSION MINING AREA RESULTS....75
3.5.1 Jackpine Expansion Mining Area Terrestrial Vegetation and Wetlands....75
3.5.2 Landscape-Level Analyses....111
3.5.3 Key Indicator Resources....124
3.6 PIERRE RIVER MINING AREA RESULTS....137
3.6.1 Pierre River Mining Area Terrestrial Vegetation and Wetlands....137
3.6.2 Landscape-Level Analyses....174
3.6.3 Key Indicator Resources....187
3.7 SUMMARY....201

LIST OF TABLES

Table 3.3-1 Regional Land Cover Classes....19
Table 3.3-2 Correlation Between Regional Land Cover Classes and Local Study Area Vegetation Classes....27
Table 3.3-3 Alberta Natural Heritage Information Centre Rare Plant Ranking System....31
Table 3.3-4 Provincial Ecological Community Conservation Ranks....32
Table 3.3-5 Landscape-Level Metrics Assessed....36
Table 3.3-6 Terrestrial Resources Key Indicator Resources....38
Table 3.3-7 Stand Age Classes According to Dominant Tree Species....42
Table 3.3-8 Rare Plant Potential Rankings for the Regional Study Area....46
Table 3.3-9 Rare Plant Potential Rankings for the Local Study Areas....46
Table 3.3-10 Traditional Plant Species Abundance Scoring....48
Table 3.3-11 Traditional Plant Potential Rankings for the Regional Study Area....49
Table 3.3-12 Traditional Plant Potential Rankings for the Local Study Areas....50
Table 3.4-1 Total Area and Percent Cover of Land Cover Classes Within the Regional Study Area....54
Table 3.4-2 Landscape Heterogeneity of Terrestrial Regional Land Cover Classes....60

Table 3.4-3 Landscape Heterogeneity of Wetlands Regional Land Cover Classes....60
Table 3.4-4 Landscape Heterogeneity of Disturbed Regional Land Cover Classes....61
Table 3.4-5 Fragmentation of Natural Areas by Human Disturbed Areas Within the Regional Study Area....63
Table 3.4-6 Fragmentation of Forested and Non-Forested Areas Within the Regional Study Area....65
Table 3.4-7 Spatial Analysis of Riparian Areas Within the Regional Study Area....66
Table 3.4-8 Area and Percent Cover of Riparian Communities Within 100 m of Waterbodies and Watercourses Within the Regional Study Area....67
Table 3.4-9 Area and Percent Cover of Peatlands and Non-Peatlands Within the Regional Study Area....68
Table 3.4-10 Estimated Old Growth in the Regional Study Area....69
Table 3.4-11 Productive and Unproductive Forests Within the Regional Study Area....71
Table 3.4-12 Area and Percent Cover of Rare Plant Potential Within the Regional Study Area....73
Table 3.4-13 Area and Percent Cover of Traditional Plant Potential Within the Regional Study Area....73
Table 3.5-1 Total Area and Percent Cover of Ecosite Phases and Wetlands Types Within the Jackpine Expansion Mining Area Local Study Area....77
Table 3.5-2 Percent Distribution of Overstorey Density Class, Tree Species Composition and Stand Structure Class Within the Jackpine Expansion Mining Area Local Study Area....81
Table 3.5-3 Percent Distribution of Height, Age and Timber Productivity Rating Classes Within the Jackpine Expansion Mining Area Local Study Area....85
Table 3.5-4 Rare Vascular Plant Species Observed Within the Jackpine Expansion Mining Area Local Study Area....89
Table 3.5-5 Rare and Unranked Bryophyte Species Observed Within the Jackpine Expansion Mining Area Local Study Area....92
Table 3.5-6 Rare and Unranked Lichen Species Observed Within the Jackpine Expansion Mining Area Local Study Area....95
Table 3.5-7 Rare Plants Found Historically in the Jackpine Expansion Mining Area Local Study Area....98
Table 3.5-8 Special Plant Communities Within the Jackpine Expansion Mining Area Local Study Area....100
Table 3.5-9 Diversity Measures of Vascular Plant Species Within the Jackpine Expansion Mining Area Local Study Area....103
Table 3.5-10 Species Richness Within the Jackpine Expansion Mining Area Local Study Area....105
Table 3.5-11 Non-Native and Invasive Species Within the Jackpine Expansion Mining Area Local Study Area....109
Table 3.5-12 Areas Potentially Affected by Dust in the Jackpine Expansion Mining Area Local Study Area....111
Table 3.5-13 Landscape Heterogeneity of Ecosite Phases Within the Jackpine Expansion Mining Area Local Study Area....114
Table 3.5-14 Landscape Heterogeneity of Wetlands Types Within the Jackpine Expansion Mining Area Local Study Area....114
Table 3.5-15 Landscape Heterogeneity of Disturbed Areas Within the Jackpine Expansion Mining Area Local Study Area....115
Table 3.5-16 Fragmentation of Natural Areas by Human Disturbed Areas Within the Jackpine Expansion Mining Area Local Study Area....116
Table 3.5-17 Fragmentation of Forested and Non-Forested Areas Within the Jackpine Expansion Local Study Area....118
Table 3.5-18 Spatial Analysis of Riparian Areas Within the Jackpine Expansion Local Study Area....120

Table 3.5-19 Spatial Analyses of Old Growth Areas Within the Jackpine Expansion Local Study Area....122
Table 3.5-20 Area and Percent Cover of Riparian Communities Within the Jackpine Expansion Mining Area Local Study Area....124
Table 3.5-21 Total Area and Percent Distribution of Timber Productive and Non-Timber Productive Forest Cover Types by Age Class Within the Jackpine Expansion Mining Area Local Study Area....127
Table 3.5-22 Total Area and Percent Occurrence of Old Growth Within the Jackpine Expansion Mining Area Local Study Area....128
Table 3.5-23 Area and Percent Cover of Peatlands Within the Jackpine Expansion Mining Area Local Study Area....130
Table 3.5-24 Area and Percent Cover of Timber Productive and Non-Productive Sites Within the Jackpine Expansion Mining Area Local Study Area....132
Table 3.5-25 Area and Percent Cover of Rare Plant Potential Within the Jackpine Expansion Mining Area Local Study Area....134
Table 3.5-26 Area and Percent Cover of Traditional Plant Potential Within the Jackpine Expansion Mining Area Local Study Area....134
Table 3.6-1 Total Area and Percent Cover of Ecosite Phases and Wetlands Types Within the Pierre River Mining Area Local Study Area....139
Table 3.6-2 Percent Distribution of Overstorey Density Class, Tree Species Composition and Stand Structure Class Within the Pierre River Mining Area Local Study Area....144
Table 3.6-3 Percent Distribution of Height, Age and Timber Productivity Rating Classes Within the Pierre River Mining Area Local Study Area....147
Table 3.6-4 Rare Vascular Plant Species Observed Within the Pierre River Mining Area Local Study Area....152
Table 3.6-5 Rare and Unranked Bryophyte Species Observed Within the Pierre River Mining Area Local Study Area....153
Table 3.6-6 Rare and Unranked Lichen Species Observed Within the Pierre River Mining Area Local Study Area....155
Table 3.6-7 Special Plant Communities Within the Pierre River Mining Area Local Study Area....159
Table 3.6-8 Diversity Measures of Vascular Plant Species Within the Pierre River Mining Area Local Study Area....163
Table 3.6-9 Species Richness Within the Pierre River Mining Area Local Study Area....166
Table 3.6-10 Non-Native and Invasive Species Within the Pierre River Mining Area Local Study Area....171
Table 3.6-11 Areas Potentially Affected by Dust in the Pierre River Mining Area Local Study Area....173
Table 3.6-12 Correlation of Ecosite Phases Within the Central Mixedwood and Athabasca Plain Natural Subregions....176
Table 3.6-13 Landscape Heterogeneity of Ecosite Phases Within the Pierre River Mining Area Local Study Area....177
Table 3.6-14 Landscape Heterogeneity of Wetlands Types Within the Pierre River Mining Area Local Study Area....178
Table 3.6-15 Landscape Heterogeneity of Disturbed Areas Within the Pierre River Mining Area Local Study Area....179
Table 3.6-16 Fragmentation of Natural Areas by Human Disturbed Areas Within the Pierre River Mining Area Local Study Area....181
Table 3.6-17 Fragmentation of Forested and Non-Forested Areas Within the Pierre River Mining Area Local Study Area....183
Table 3.6-18 Spatial Analysis of Riparian Areas Within the Pierre River Mining Area Local Study Area....185

Table 3.6-19 Spatial Analyses of Old Growth Areas Within the Pierre River Mining Area Local Study Area....187
Table 3.6-20 Area and Percent Cover of Riparian Communities Within the Pierre River Mining Area Local Study Area....188
Table 3.6-21 Total Area and Percent Distribution of Timber Productive and Non-Timber Productive Forest Cover Types by Age Class Within the Pierre River Mining Area Local Study Area....191
Table 3.6-22 Total Area and Percent Occurrence of Old Growth Within the Pierre River Mining Area Local Study Area....192
Table 3.6-23 Area and Percent Cover of Peatlands Within the Pierre River Mining Area Local Study Area....194
Table 3.6-24 Area and Percent Cover of Timber Productive and Non-Productive Sites Within the Pierre River Mining Area Local Study Area....196
Table 3.6-25 Area and Percent Cover of Rare Plant Potential Within the Pierre River Mining Area Local Study Area....196
Table 3.6-26 Area and Percent Cover of Traditional Plant Potential Within the Pierre River Mining Area Local Study Area....198

LIST OF FIGURES

Figure 3.2-1 Terrestrial Resources Regional Study Area....3
Figure 3.2-2 Natural Subregions of the Regional Study Area....4
Figure 3.2-3 Jackpine Expansion Mining Area Terrestrial Local Study Area....7
Figure 3.2-4 Pierre River Mining Area Terrestrial Local Study Area....8
Figure 3.3-1 Ecosite Classification Hierarchy....22
Figure 3.3-2 Wetlands Classes and Their Relationship to Chemical and Biotic Gradients....23
Figure 3.3-3 Wetlands Classification....24
Figure 3.3-4 Ecological Land Cover Classification....25
Figure 3.4-1 Ecological Land Cover Classes Within the Regional Study Area....53
Figure 3.4-2 Natural and Human Disturbed Areas Within the Regional Study Area....62
Figure 3.4-3 Forested, Non-Forested and Human Disturbed Areas Within the Regional Study Area....64
Figure 3.4-4 Productive and Unproductive Forests Within the Regional Study Area....70
Figure 3.4-5 Rare Plant Potential Within the Regional Study Area....72
Figure 3.4-6 Traditional Plant Potential Within the Regional Study Area....74
Figure 3.5-1 Ecosite Phases and Wetlands Types Within the Jackpine Expansion Mining Area Local Study Area....76
Figure 3.5-2 Vegetation Plots and Rare Plant Survey Sites Within the Jackpine Expansion Mining Area Local Study Area....80
Figure 3.5-3 Percent Occurrence of Primary and Secondary Tree Species Among Terrestrial and Wetlands Forest Vegetation in the Jackpine Expansion Mining Area Local Study Area....83
Figure 3.5-4 Percent Variability in Canopy Height and Stand Age Between Terrestrial and Wetlands Forest Vegetation in the Jackpine Expansion Mining Area Local Study Area....87
Figure 3.5-5 Rare Vascular Plant Species and Special Plant Communities Identified Within the Jackpine Expansion Mining Area Local Study Area....88
Figure 3.5-6 Rare Non-Vascular Plants Identified Within the Jackpine Expansion Mining Area Local Study Area....91
Figure 3.5-7 Vascular Plant Species Richness by Vegetation Type Within the Jackpine Expansion Mining Area Local Study Area....106

Figure 3.5-8 Bryophyte Species Richness by Vegetation Type Within the Jackpine Expansion Mining Area Local Study Area 107
Figure 3.5-9 Lichen Species Richness by Vegetation Type Within the Jackpine Expansion Mining Area Local Study Area 108
Figure 3.5-10 Non-Native and Invasive Plant Species Identified Within the Jackpine Expansion Mining Area Local Study Area 110
Figure 3.5-11 Natural and Human Disturbed Areas Within the Jackpine Expansion Mining Area Local Study Area 117
Figure 3.5-12 Forested, Non-Forested and Human Disturbed Areas Within the Jackpine Expansion Mining Area Local Study Area 119
Figure 3.5-13 Riparian Zones Within the Jackpine Expansion Mining Area Local Study Area 121
Figure 3.5-14 Old Growth Forests Within the Jackpine Expansion Mining Area Local Study Area 123
Figure 3.5-15 Age Class Distribution Within the Jackpine Expansion Mining Area Local Study Area 126
Figure 3.5-16 Peatlands Within the Jackpine Expansion Mining Area Local Study Area....129
Figure 3.5-17 Patterned Fens Within the Jackpine Expansion Mining Area Local Study Area 131
Figure 3.5-18 Forest Productivity Within the Jackpine Expansion Mining Area Local Study Area 133
Figure 3.5-19 Rare Plant Potential Within the Jackpine Expansion Mining Area Local Study Area 135
Figure 3.5-20 Traditional Plant Potential Within the Jackpine Expansion Mining Area Local Study Area....136
Figure 3.6-1 Ecosite Phases and Wetlands Types Within the Pierre River Mining Area Local Study Area....138
Figure 3.6-2 Vegetation Plots and Rare Plant Survey Sites Within the Pierre River Mining Area Local Study Area 142
Figure 3.6-3 Percent Occurrence of Primary and Secondary Tree Species Among Terrestrial and Wetlands Forest Vegetation in the Pierre River Mining Area Local Study Area....146
Figure 3.6-4 Percent Variability in Canopy Height and Stand Age Between Terrestrial and Wetlands Forest Vegetation in the Pierre River Mining Area Local Study Area 150
Figure 3.6-5 Rare Vascular Plant Species and Special Plant Communities Identified Within the Pierre River Mining Area Local Study Area....151
Figure 3.6-6 Rare Non-Vascular Plants Identified Within the Pierre River Mining Area Local Study Area....154
Figure 3.6-7 Vascular Plant Species Richness by Vegetation Type Within the Pierre River Mining Area Local Study Area....168
Figure 3.6-8 Bryophyte Species Richness by Vegetation Type Within the Pierre River Mining Area Local Study Area 169
Figure 3.6-9 Lichen Species Richness by Vegetation Type Within the Pierre River Mining Area Local Study Area 170
Figure 3.6-10 Non-Native and Invasive Plant Species Identified Within the Pierre River Mining Area Local Study Area 172
Figure 3.6-11 Natural and Human Disturbed Areas Within the Pierre River Mining Area Local Study Area....180
Figure 3.6-12 Forested and Unforested Areas Within the Pierre River Mining Area Local Study Area 182
Figure 3.6-13 Riparian Areas Within the Pierre River Mining Area Local Study Area....184
Figure 3.6-14 Old Growth Forests Within the Pierre River Mining Area Local Study Area....186

Figure 3.6-15 Age Class Distribution Within the Pierre River Mining Area Local Study Area 190
Figure 3.6-16 Peatlands Within the Pierre River Mining Area Local Study Area.....193
Figure 3.6-17 Patterned Fens Within the Pierre River Mining Area Local Study Area 195
Figure 3.6-18 Forest Productivity Within the Pierre River Mining Area Local Study Area.....197
Figure 3.6-19 Rare Plant Potential Within the Pierre River Mining Area Local Study Area.....199
Figure 3.6-20 Traditional Plant Potential Within the Pierre River Mining Area Local Study Area 200

LIST OF APPENDICIES

Appendix H Potential Rare Plants in the Oil Sands Region
Appendix I Rare Plant Communities at the Boreal Forest Natural Region
Appendix J Methods for Landscape-Level Analysis
Appendix K Ranking Information on Traditional Plants Within the Oil Sands Region
Appendix L Vegetation Types and Distributions in the Jackpine Expansion Mining Area
Appendix M Site Summary Data
Appendix N Vegetation Types and Distributions in the Pierre River Mining Area

3 TERRESTRIAL VEGETATION, WETLANDS AND FOREST RESOURCES

3.1 INTRODUCTION AND OBJECTIVES

This Terrestrial Vegetation, Wetlands and Forest Resources Environmental Setting Report (ESR) complements and extends information collected for Muskeg River Mine (1999), Jackpine Mine – Phase 1 (2002) and Muskeg River Mine Expansion (2006). New data collected for the Shell Jackpine Mine Expansion & Pierre River Mine Project (the Project) combined with the existing information on Shell project areas, other regional information and the project design provide the data required to prepare the Environmental Impact Assessment (EIA) for the Project.

This ESR provides information required to complete the EIA for the Project. Methods used for completing the ESR are detailed in Section 3.3. Environmental setting information on terrestrial vegetation, wetlands and forest resources includes mapping of the Regional Study Area (RSA) and Project Local Study Areas (LSAs), details on rare plants and rare plant communities, landscape-level analysis and details on Key Indicator Resources (KIRs) as required for the impact assessment and mitigation and monitoring program planning. Characterization of the terrestrial vegetation, wetlands and forest resources in the Project LSAs also includes descriptions of the forest characteristics, details on vegetation type species richness, documented non-native and invasive species in the LSAs and areas potentially affected by dust.

A complete list of rare plants potentially found in the Oil Sands Region, and descriptions of rare plants observed on the Project LSAs are listed in Appendix H. Rarity is determined by the Alberta Natural Heritage Information Centre (ANHIC 2006d) and the Committee on the Status of Endangered Wildlife in Canada (COSEWIC 2007). Rare plant communities found in the Oil Sands Region are listed in Appendix I. The complete methods for landscape-level analysis are detailed in Appendix J. Appendix K details the ranking methods used for traditional plant analysis in the Oil Sands Region. Appendix L lists and describes the vegetation types and distributions found in the Jackpine Expansion Mining Area. Appendix M is site summary data from all vegetation surveys conducted for the Project. Appendix N lists and describes the vegetation types and distributions found in the Pierre River Mining Area.

The objectives of this study are to describe the existing terrestrial vegetation and wetlands resources within the terrestrial study areas. The following components form the basis of the vegetation descriptions:

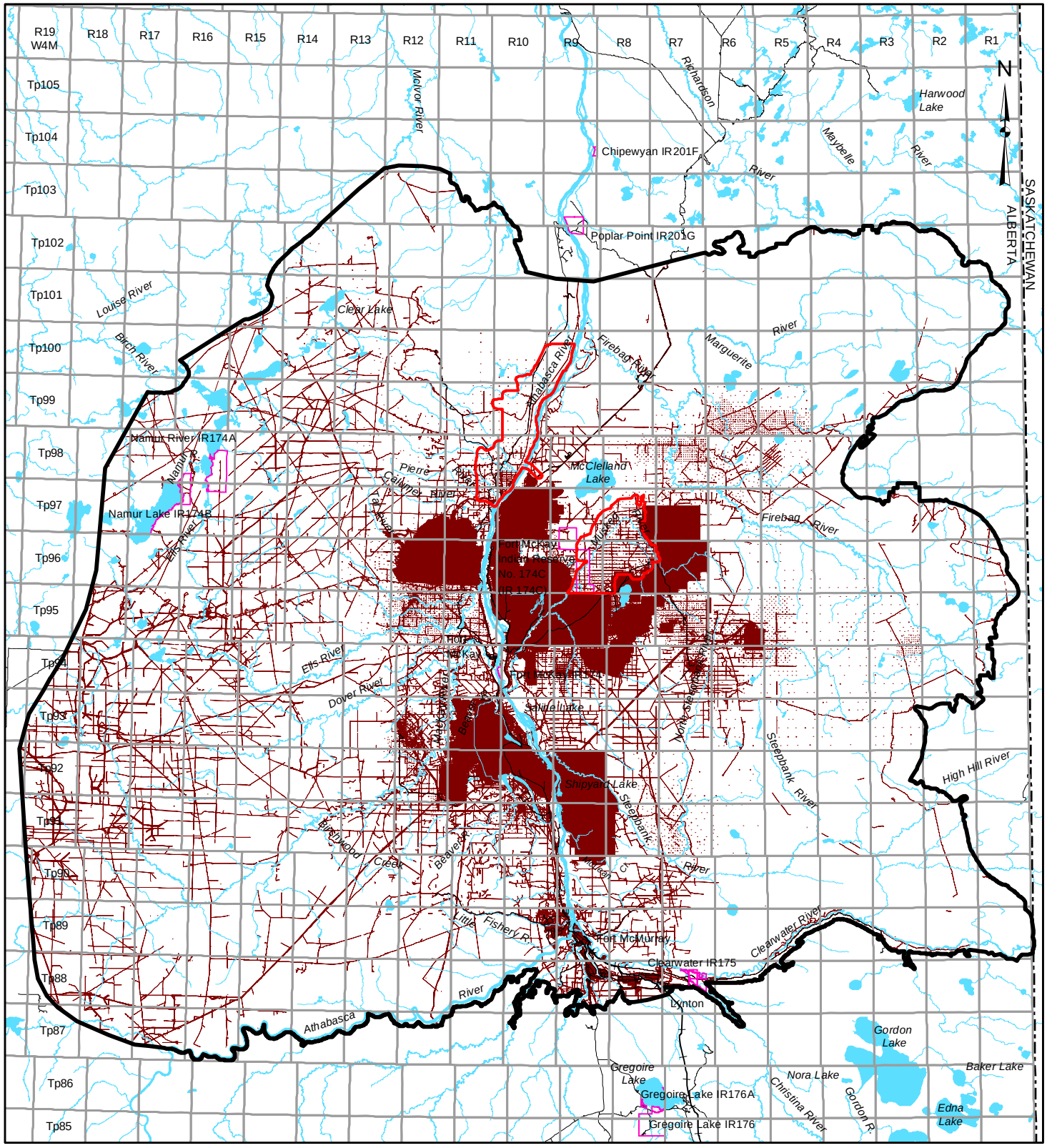
- plant communities;
- rare plants and rare plant communities;
- species diversity;
- forest productivity;
- landscape-level analysis;
- Key Indicator Resources (KIRs), including:
  - lichen jack pine communities;
  - riparian communities;
  - old growth forests;
  - peatlands;
  - patterned fens;
  - rare and special plant communities;
  - productive forests;
  - rare plant potential; and
  - traditional plant potential.
- Sustainable Ecosystem Working Group (SEWG) indicators including area, pattern and age of vegetation types.

Describing these components in terms of their vegetation characteristics, abundance and spatial extent across the study areas provides a basis for assessing potential impacts of the Project on terrestrial vegetation and wetlands resources.

3.2 STUDY AREAS

The Terrestrial LSAs and Regional Study Area (RSA) were developed with consideration of all terrestrial components (soil and terrain, terrestrial vegetation, wetlands and forest resources, wildlife and wildlife habitat and biodiversity). Therefore, the LSAs and RSA used for this report are also used for all Terrestrial Resources components. The use of the terms LSA and RSA in this report refer to the Terrestrial Resources LSAs or RSA.

The RSA was established to assess the the importance of the Project within a broad regional area (Figure 3.2-1). The RSA is in the Central Mixedwood and the Athabasca Plain Natural Subregions (Natural Regions Committee 2006) (Figure 3.2-2). These subregions are in the Boreal Natural Region. The RSA covers an area of 2,277,376 ha.



LEGEND

- TERRESTRIAL RESOURCES REGIONAL STUDY AREA
- LOCAL STUDY AREAS
- INDIAN RESERVE
- OPEN WATER
- PUBLIC ROADWAY
- RAILROAD

DISTURBED

- EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE
- EXISTING AND APPROVED URBAN AND INDUSTRIAL LINEAR DISTURBANCE

25 0 25

SCALE 1:1,000,000 KILOMETRES

REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2004), Pearson Timberline Ltd. (April 2004), LANDSAT 7 ETM Imagery (July 2006), and Alberta SRD, used under license.
Saskatchewan digital data obtained from Information Services Corp. (September 2004), used under license.
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 12.

PROJECT

JACKPINE MINE EXPANSION & PIERRE RIVER MINE PROJECT

TITLE

TERRESTRIAL RESOURCES REGIONAL STUDY AREA

Shell Canada Limited

PROJECT No. 05-1344-027.7600			SCALE AS SHOWN	REV. 0
DESIGN	VR	22 Jan. 2007	FIGURE: 3.2-1	
GIS	JH	14 Nov. 2007		
CHECK	AA	20 Nov. 2007		
REVIEW	TC	27 Nov. 2007		

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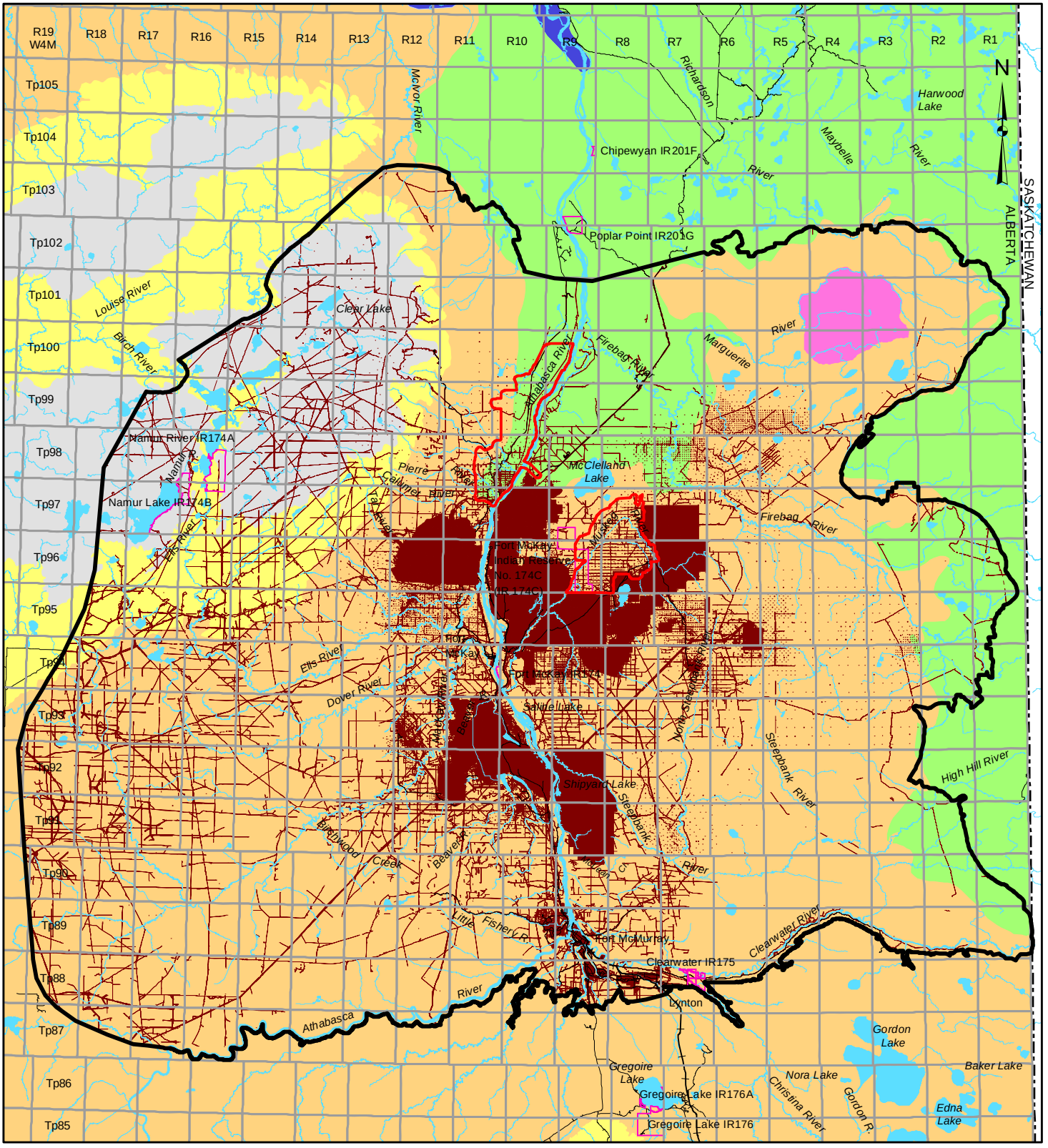

LEGEND

- TERRESTRIAL RESOURCES REGIONAL STUDY AREA
- LOCAL STUDY AREAS
- INDIAN RESERVE
- OPEN WATER
- PUBLIC ROADWAY
- RAILROAD

NATURAL SUBREGIONS

- ATHABASCA PLAIN
- CENTRAL MIXEDWOOD
- KAZAN UPLANDS
- LOWER BOREAL HIGHLANDS
- PEACE-ATHABASCA DELTA
- UPPER BOREAL HIGHLANDS

DISTURBED

- EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE
- EXISTING AND APPROVED URBAN AND INDUSTRIAL LINEAR DISTURBANCE

25 0 25

SCALE 1:1,000,000 KILOMETRES

REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2004), Pearson Timberline Ltd. (April 2004), LANDSAT 7 ETM Imagery (July 2006), and Alberta SRD, used under license.
Saskatchewan digital data obtained from Information Services Corp. (September 2004), used under license.
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 12.

PROJECT

JACKPINE MINE EXPANSION & PIERRE RIVER MINE PROJECT

TITLE

NATURAL SUBREGIONS OF THE REGIONAL STUDY AREA

Shell Canada Limited

PROJECT No. 05-1344-027.7600		SCALE AS SHOWN	REV. 0
DESIGN	VR	22 Jan. 2007	FIGURE: 3.2-2
GIS	JH	14 Nov. 2007	
CHECK	AA	20 Nov. 2007	
REVIEW	TC	27 Nov. 2007	

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The RSA boundary was defined with consideration of the following terrestrial resources:

- ecodistrict boundaries;
- geographic or topographic boundaries such as the eastern shoulder of the Birch Mountains;
- defined woodland caribou habitat areas (e.g., Audet, Firebag and Steepbank caribou areas);
- average distance of two moose home ranges from oil sands developments (about 26 km);
- allowances for the major river systems (e.g., Athabasca and Clearwater rivers) that act as natural study boundaries; and
- inclusion of the community of Fort McMurray and other areas likely to expand in the future.

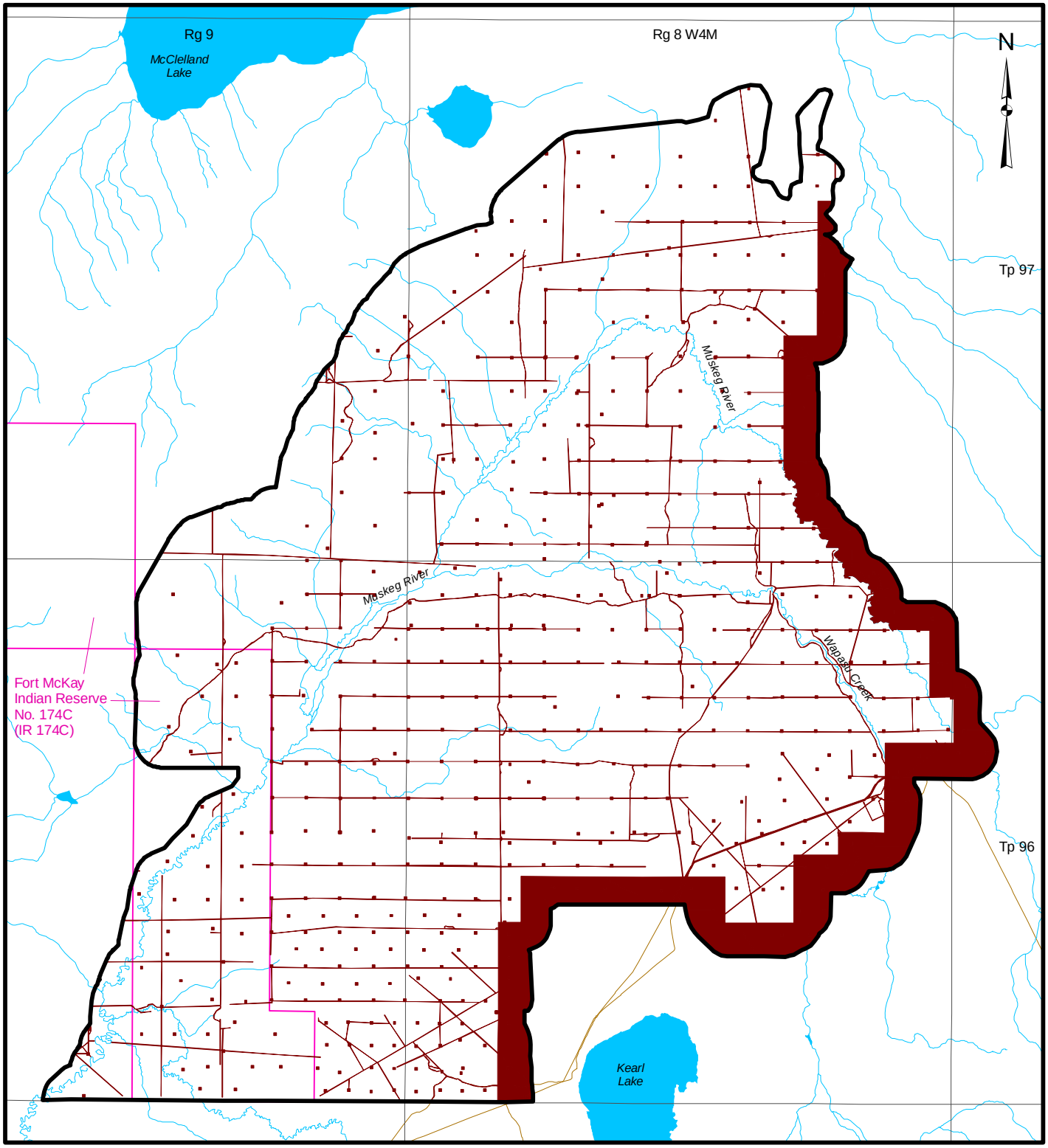
There are two LSAs for the Project (Figure 3.2-3 and 3.2-4). The Jackpine Expansion Mining Area (JEMA) LSA is along the Muskeg River north and east of the approved Jackpine Mine – Phase 1 and covers an area of 18,348 ha. The Pierre River Mining Area (PRMA) LSA is located on the west side of the Athabasca River, north of the approved Canadian Natural Horizon Project and covers an area of 21,136 ha.

The JEMA and PRMA LSAs are established to assess the effects of the Project at the local scale. They fall within the Central Mixedwood and Athabasca Plains Natural Subregions (Natural Regions Committee 2006) (Figure 3.2-2) and the following townships:

- Township 96, Ranges 8 and 9, W4M;
- Township 97, Ranges 8 and 11, W4M;
- Township 98, Ranges 10 and 11, W4M;
- Township 99, Range 9, W4M; and
- Township 100, Ranges 9 and 10, W4M.

The extent of the Project LSAs was defined on the basis of the project development area plus a buffer zone to account for indirect effects of the project. This buffer zone is based on a 500 m offset from the Project Development Area but varies in width depending on the configuration of the project footprint, as well as land uses and natural features in the surrounding area.To the east, the JEMA LSA is bounded by Imperial Oil Resources Ventures

Limited (Imperial Oil) Kearl Lake Project. To the south, the JEMA LSA abuts the approved Shell Jackpine Mine – Phase 1 footprint. The PRMA LSA is bound by the Athabasca River to the east.



LEGEND

- JACKPINE EXPANSION MINING AREA LOCAL STUDY AREA
- INDIAN RESERVE
- OPEN WATER
- PUBLIC ROADWAY

DISTURBED

- EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE
- EXISTING AND APPROVED URBAN AND INDUSTRIAL LINEAR DISTURBANCE

3 0 3

SCALE 1:100,000 KILOMETRES

REFERENCE

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PROJECT

JACKPINE MINE EXPANSION & PIERRE RIVER MINE PROJECT

TITLE

JACKPINE MINE EXPANSION MINING AREA TERRESTRIAL LOCAL STUDY AREA

Shell Canada Limited

PROJECT No. 05-1344-027.7600			SCALE AS SHOWN	REV. 0
DESIGN	VR	06 Jun. 2007	FIGURE: 3.2-3	
GIS	JH	14 Nov. 2007		
CHECK	AA	20 Nov. 2007		
REVIEW	TC	27 Nov. 2007		

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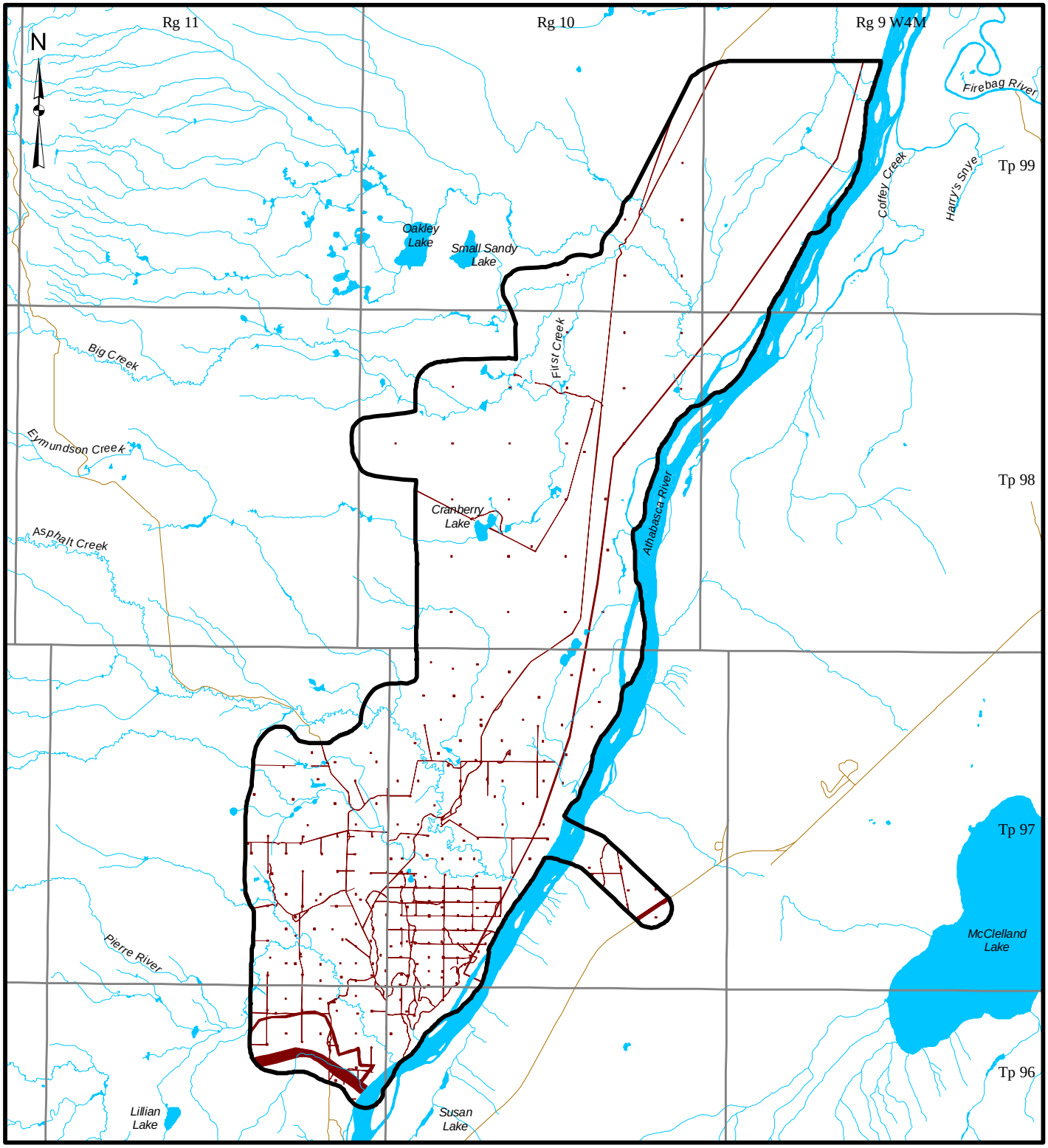

LEGEND

- PIERRE RIVER MINING AREA
- LOCAL STUDY AREA
- OPEN WATER
- ROAD

DISTURBED

- EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE
- EXISTING AND APPROVED URBAN AND INDUSTRIAL LINEAR DISTURBANCE

4 0 4

SCALE 1:160,000 KILOMETRES

REFERENCE

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PROJECT

JACKPINE MINE EXPANSION &
PIERRE RIVER MINE PROJECT

TITLE

PIERRE RIVER MINING AREA
TERRESTRIAL LOCAL STUDY AREA

Shell Canada Limited

PROJECT No. 05-1344-027.7600			SCALE AS SHOWN	REV. 0
DESIGN	VR	10 Aug. 2007		
GIS	JH	14 Nov. 2007		
CHECK	AA	20 Nov. 2007		
REVIEW	TC	27 Nov. 2007		

FIGURE: 3.2-4

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3.3 METHODS

The methods used in preparing this report fall under the following four main categories:

- vegetation data collection used for mapping purposes and to characterize the vegetation resources within the LSAs;
- vegetation mapping at the regional and local scales;
- vegetation analyses used in further characterizing the vegetation resources within the LSAs; and
- Quality Assurance and Quality Control (QA/QC).

3.3.1 Data Collection

Detailed Vegetation Inventory, Rare Plant and Vegetation Mapping Aerial surveys were completed within the Jackpine Expansion and Pierre River Mining Areas LSAs in June and July of 2006 and 2007. Spring surveys implemented to capture plant species in early flowering periods were conducted June 3 to 12, 2006 and June 2 to June 11, 2007. Summer surveys implemented to capture plant species in late flowering periods were conducted July 18 to July 27, 2006 and July 17 to 25, 2007. Ground survey sites were accessed from existing linear disturbances using all-terrain vehicles, or by helicopter where ground access was limited. Three field crews conducted the surveys during each period, with each crew led by an experienced vegetation ecologist.

In addition, vegetation mapping aerial surveys were conducted on September 16 to 18, 2005 and September 17 to 18, 2006. The aerial surveys were conducted by helicopter with one crew consisting of two experienced vegetation ecologists.

Field survey methods followed those as outlined in Golder's *Technical Procedure Manuals* (Golder 2006a,b,c,d,e). Field procedures for establishing detailed vegetation inventory plots are based on the methodology described in the *Ecological Land Survey Site Description Manual* (AEP 1994). For rare plant surveys, field protocols were based on guidelines developed by the Alberta Native Plant Council (ANPC 2000a) and integrated with Golder Rare Plant Survey Technical Proceedures (Golder 2006f). Scientific names and common names presented in this report follow those used by the Alberta Natural Heritage Information Centre (ANHIC) (ANHIC 2006a,b,c).

Vascular plants collected in the field were brought back to the office or sent to the University of Calgary herbarium and/or botanical specialists for verification

purposes. Bryophytes collected in the field were sent to Dale Vitt for identification. Collected lichens were identified by Trevor Goward (macro-lichens) and Curtis Bjork (micro-lichens). Lorna Allen of the ANHIC provided feedback on rare and special plant communities.

3.3.1.1 Detailed Vegetation Inventory Surveys

Purpose

Detailed vegetation inventory plots were established across the LSAs to obtain site-specific, descriptive information on the nature and characteristics of plant communities within this study area. The main purposes of the detailed vegetation inventory were to:

- classify and describe ecosite phases, wetlands types and other vegetation types within the LSAs;
- sample for rare plants, traditional use plants and weeds;
- aid in the process of ecosite phase and wetlands mapping; and
- collect the necessary data to determine community-level biodiversity measures.

While existing field guides and reports on vegetation within the Boreal Forest Natural Region of Alberta (NRC 2006) provide a basis for vegetation classification and mapping at a local scale and provide lists of species and plant communities that are present within the region (Beckingham and Archibald 1996; Halsey et al. 2003), site-specific information was required to describe the vegetation resources within the LSAs in more detail.

Field Planning

Before initiating field surveys, the LSAs were stratified according to a draft ecosite phase and wetlands type maps. The sampling strategy for the detailed vegetation plots was designed to select a cross-section of vegetation types within the LSAs, factoring in the following variables: size and distribution of each vegetation type, access constraints and other sampling objectives (e.g., rare plant survey).

Plots were interspersed throughout the LSAs and among stands with different canopy compositions and in different landscape positions to capture the natural range of variability in species and vegetation types across the study area. Targets for the number of detailed plots to be established within each ecosite phase and wetlands type were set at the outset of the field program. Efforts were made to

establish as least one plot in as many vegetation types as possible that covered less than one percent of the LSAs. Above one percent in each of the LSAs, plot targets were then stratified according to their percent composition of that LSA. Plot targets were then adjusted to capture slightly more of high rare plant potential areas and vegetation types undersampled in the Boreal Forest Natural Region. To accomplish this, plot targets for vegetation types that are well sampled and understood in the Boreal Forest Natural Region were reduced.

Field Protocol

Each detailed vegetation plot was established in a representative location within the vegetation polygon. A Global Positioning System (GPS) co-ordinate was recorded at the centre of each plot. Plot sizes were based on methods described in the *Ecological Site Description Survey Manual* (ASRD 2003). Two protocols were used when establishing a vegetation plot. The primary plot boundary was defined by a 10×10 m dimension. Within this plot, species composition and cover of the understorey vegetation layers (i.e., tall shrub, low shrub, forb, grass, bryophyte, terrestrial lichen and epiphyte layer) were assessed. Site characteristics were described for the plot location. In certain circumstances, such as in a narrow vegetation band along a waterbody, the plot shape was adjusted to accommodate homogenous plant community conditions.

After defining and assessing the primary plot, a second 20×20 m tree canopy plot was established to assess species composition and canopy cover for tree layers (i.e., main and secondary canopies). The shape of this plot was adjusted to accommodate vegetation and topography where necessary. For example, a 10×40 m tree canopy plot size may have been more appropriate for a linear-shaped plant community following a stream.

In addition to recording species within the plot boundaries, a separate search for plants (including rare plants) was done beyond the plot boundary (to a distance of about 25 m from plot centre) to provide a list of additional plant species occurring within the same vegetation type. These data were recorded in a separate place on the data form so they could be used for generating species lists, but could be excluded when calculating indices based on a standard plot dimension.

Key administrative information recorded on the detailed vegetation inventory form for each plot included project name and number, plot number, waypoint identifier, Universal Transverse Mercator (UTM) co-ordinates, date, surveyor initials and photo numbers.

Information collected on site characteristics included the following variables:

- ecosite phase or wetlands type;
- slope;
- aspect;
- successional status;
- surface expression;
- riparian subclass;
- flood hazard;
- disturbance subclass;
- surface shape;
- slope position;
- moisture regime;
- nutrient regime;
- surface substrate type and percent cover;
- landscape profile diagram; and
- comments.

Vegetation data included the following variables:

- vegetation strata height and percent cover;
- species composition;
- species percent cover;
- other species found outside of plot boundary; and
- comments.

3.3.1.2 Spring and Summer Rare Plant Surveys

Purpose

Rare plant surveys were undertaken in conjunction with the detailed vegetation inventory surveys to determine the presence and location of rare plant species so that reliable information on their status (e.g., population size and management concerns) could be compiled (ANPC 2000a). A rare plant survey can confirm the presence of rare species on a site, but if not found, the existence of a rare plant on a site cannot be ruled out (ANPC 2000a). Rare plants are also one of the species-level KIRs identified for the Project.

Field Planning

Before conducting rare plant surveys, a list of rare species that could potentially occur within the Oil Sands Region was compiled. This list was updated after correspondence with ANHIC (Appendix H) to reflect any new rare plant occurrences in the region and any changes in rare plant species status. While this list may not include all species that could potentially occur within the LSAs, or may include some species that are near the fringe of their natural range, it does provide a good starting point for the purposes of initiating rare plant surveys. Additional information on the data sources for the rare plant list is provided in Section 3.3.1.7.

A literature review was conducted to document habitat types associated with each of the rare plants on the list. Surveyors reviewed key habitat types of species before the field program, aerial photographs and a draft field map of the vegetation types in the LSAs, and then identified areas that could support the highest potential for rare species. A focused search effort was planned for as many microhabitats, unusual plant associations and landscape features, as possible. A portion of the total survey effort was also spent in vegetation types considered to have a low to moderate rare plant potential, as rare plants can occur in these areas as well.

Field Protocol

A meander search was conducted on sites of interest identified at the field planning stage, with a focus within a particular habitat and across the range of microhabitat variation found within a plant community. The length of each meander varied according to the complexity and number of microhabitats present at each location.

As rare plant surveys were done in conjunction with detailed vegetation inventory surveys, rare plant survey information was typically recorded on detailed vegetation inventory forms (Section 3.3.1.1). Where rare plants were found incidentally or circumstances did not dictate a detailed vegetation inventory survey, a rare plant survey form was used.

Key information recorded on rare plant survey forms included the following variables: project name and number, plot number, waypoint identifier, UTM co-ordinates, date, surveyor initials, photo numbers, ecosite phase or wetlands type, moisture regime, nutrient regime, dominant and indicator species, landscape profile diagram and comments. Collection samples were only taken in cases where the population would remain secure (i.e., when there were at least 20 individuals present).

3.3.1.3 Rare and Special Plant Community Surveys

Purpose

Rare plant communities are one of the community-level KIRs identified for the Project. Special plant communities are communities that are suspected to be rare or unique but are differentiated from rare plant communities in that there is less information available. Rare and special plant community surveys were undertaken to determine the presence and location of rare communities so that reliable information on their status (e.g., population size and management concerns) can be compiled.

Field Planning

Surveys aimed at sampling for rare and special plant communities were incorporated into the overall field planning process. The rare plant community list (Appendix I) provided a basis from which surveyors referred to when searching for appropriate sites to sample. The objectives of the rare plant community survey were aligned well with the objectives of the rare plant survey program, namely, focusing on areas that might offer unique habitat, landscape features or unusual plant associations (e.g., shrubby riparian zones or steep, southerly exposed slopes). Aerial photographs were examined to aid in identifying areas with the potential to support unique habitats.

Field Protocol

A detailed vegetation inventory plot would typically be established on sites of interest identified at the field planning stage as a means to gather information about the rare or special plant community.

3.3.1.4 Traditional Plant Surveys

No field surveys were completed specifically to locate and document the abundance and distribution of traditional plant species within the LSAs. However, when present, these species were recorded on detailed vegetation inventory plot forms. More information on how traditional use plants were mapped and described within the study areas is provided in Section 3.4.3.2.

3.3.1.5 Non-Native and Native Invasive Species Surveys

No field surveys were completed to specifically locate and document the abundance and distribution of non-native and native invasive plants (“weeds”) within the LSAs. However, whenever present, weeds were recorded on detailed vegetation inventory or rare plant survey forms.

3.3.1.6 Vegetation Mapping Aerial Survey

Purpose

The primary purpose of establishing vegetation mapping aerial survey plots within the Project LSAs was to groundtruth the ecosite phase and wetlands types mapping. As draft maps were developed before initiating the field program, site-level data was collected to improve upon the accuracy of the vegetation map. Vegetation mapping aerial surveys contributed to this validation and improvement process along with all other vegetation field data collected.

These surveys were also used to assist in field planning (e.g., documenting access and vegetation communities of interest) for subsequent use in on-the-ground field surveys.

Field Protocol

To conduct the vegetation mapping aerial surveys, north-south transects were flown by helicopter within both of the Project LSA boundaries. As a linear transect was flown, ecosites phases and wetlands types were chosen to be surveyed based on criteria such as:

- uniqueness of the habitat of interest within the adjacent habitat;
- geographic distribution of survey plots from one another; and
- overall representation of habitat types.

When an ecosite phase/wetlands type was selected, field crews recorded data while hovering in a helicopter above the habitat. Data gathered included a UTM co-ordinate, the four dominant species (to confirm the ecosite phase/wetlands type), a site reference photograph and notes.

3.3.1.7 Other Data Sources

Rare Plants

As indicated in Section 3.3.1.2, information on rare plant species occurrences within the RSA and greater Oil Sands Region of northeastern Alberta was obtained before the field program and later updated to reflect any additional occurrences and changes in rare plant species status (Appendix H). This updated list was generated from a rare element query completed by ANHIC. The query zone covered an area that extended north to Lake Claire, marginally south of Cold Lake, east to the Alberta/Saskatchewan border and west of the Birch Mountains. Most of the search area occurs within the Central Mixedwood

Natural Subregion but portions cover the Dry Mixedwood, Lower Boreal Highlands, Upper Boreal Highlands, Athabasca Plain and Kazan Uplands natural subregions (Figure 3.2-2).

Historical Vegetation and Rare Plants Plot Data

Vegetation inventory and rare plant survey data documented for other development projects in the areas surrounding the Project areas was reviewed and incorporated into this report. The primary source of historical rare plant data was the ANHIC rare plant species Element Occurrence Record (EOR) data within the LSAs and RSA (ANHIC 2006d, 2007). Other data reviewed includes the Jackpine Mine – Phase 1 Environmental Setting Report (ESR) (Golder 2002) and Imperial Kearl (Imperial Oil 2005) Environmental Impact Assessment (EIA). Data from the Kearl EIA includes survey and historical data.

Alberta Vegetation Inventory

The Alberta Vegetation Inventory (AVI) data used for the Project is based upon interpretation of 1:20,000 scale photographs covering all townships that occur fully or partially within the LSAs. The AVI mapping process involves delineating a polygon boundary for each vegetation type on aerial photographs based on a variety of characteristics, and transferring this information onto a 1:20,000 scale orthophoto base map. Polygon boundaries are then digitized, with associated forestry attributes entered into a database. Forestry attributes assigned to each AVI polygon include:

- ecological moisture regime;
- crown closure (density);
- height;
- overstorey and understorey species composition (up to five species per layer);
- timber productivity rating;
- stand structure;
- non-forested, anthropogenic (man-made) or naturally non-vegetated land; and
- stand origin (used in generating stand age).

The AVI data within the LSAs were based on aerial photographs taken in 1999 and approved by Alberta Sustainable Resource Development (ASRD) (Parry 2003, pers. comm.), as required under the AVI auditing process (AEP 1991).

The minimum polygon size for AVI interpretation is 2 ha (AEP 1991). However, overlaying the environmental setting disturbance layer onto the AVI reduced the minimum polygon size to less than 2 ha.

Other Data Sources

During the preparation study of the lease areas for the Project, Shell acquired aerial photographs in 2005. These images are of high quality and were used to ensure that mapping was current and accurate. The images show recent clearing and burned areas in the Project areas.

Alberta Sustainable Resource Development maintains a geographical database of provincial wildfire data (ASRD 2006, website). The 2002 Kearl Lake wildfire affected most of the southeast portion of the JEMA. The ASRD polygon data was used to delineate this wildfire in the mapping of this area.

3.3.2 Terrestrial Vegetation and Wetlands Vegetation Classification and Mapping

Mapping vegetation provides a foundation for describing and quantifying terrestrial vegetation and wetlands types within both the RSA and the LSAs. The classification systems used for the vegetation maps are also used to model different types of vegetation resources of economic, ecological and/or social importance. Methods used in developing the vegetation maps at the RSA and LSA scales are provided below.

3.3.2.1 Regional Study Area

A regional land cover classification map was developed using satellite imagery and a GIS to provide information on the relative abundance of vegetation types within the RSA. Image classification is a method of automatically categorizing all pixels in an image. The image classification for the RSA satellite imagery is at a coarser scale than completed for the LSAs (which uses finer scale AVI data) resulting in a more broadly defined vegetation classification. However, classification of satellite imagery at the RSA level is an accepted standard practice for regional vegetation resource mapping.

The RSA vegetation classification used for previous environmental setting and impact assessment reports in the Oil Sands Region (CNRL 2002; Petro-Canada 2001; Shell 2002, 2005; Suncor 2003, 2005) was updated with new satellite

imagery and new classification methods for this report. Specifications of this new imagery are as follows:

- LANDSAT 5 satellite spectral imagery with a 30 × 30 m pixel size;
- cloud-free coverage; and
- images captured over a four-day period between August 25 and 28, 2005.

The resolution of the imagery (i.e., pixel size) was appropriate for a regional-level vegetation classification as it strikes a balance between computer processing time and resolution. The imagery was also cloud-free and captured within a narrow time-frame resulting in a high-quality image. Quality control measures were implemented to ensure the imagery was correctly georeferenced within the RSA. The imagery was loaded into remote sensing software (eCognition) for the classification process.

Land cover classes easily identifiable from the satellite imagery and AVI data (AEP 1991) from the region were used in selecting classification "training sites". These training sites were selected to capture the range of variation in the reflectance values or "spectral signature" of the vegetation classes. Based on the signatures, the remote sensing software would assign the best-fit classification to all pixels in the image. The process of selecting training sites and image classification was an iterative process balancing the objectives of having as many meaningful vegetation classes as possible with a reasonable level of accuracy. Once the classification was complete, AVI polygons other than those used as training sites were compared against the classification for validation purposes.

The classification resulted in a total of 13 land cover classes within the RSA. These classes fell within one of the following four broad groups:

- terrestrial vegetation;
- wetlands;
- miscellaneous cover types; and
- disturbances.

Terrestrial vegetation is generally defined as land where the soils are not saturated for extended periods of the year. All terrestrial land cover classes were forested.

The National Wetlands Working Group (NWWG 1988) defines wetlands as, "…land that is saturated with water long enough to promote wetlands or aquatic processes as indicated by poorly drained soils, hydrophytic vegetation and various kinds of biological activity which are adapted to a wet environment". Wetlands in the RSA consist of marshes, fens, bogs and swamps. Miscellaneous land cover types include recently burned areas and water. Disturbances were categorized as cutblocks or "other"; such as linear disturbances, urban areas and industrial land. Table 3.3-1 provides a complete list of the regional land cover classes.

Table 3.3-1 Regional Land Cover Classes

General Land Category	Regional Land Cover Class
terrestrial	coniferous jack pine
terrestrial	coniferous jack pine-black spruce
terrestrial	coniferous white spruce
terrestrial	deciduous aspen-balsam poplar
terrestrial	mixedwood aspen-jack pine
terrestrial	mixedwood aspen-white spruce
wetlands	non-treed wetlands
wetlands	treed poor fen/bog
wetlands	treed fen
miscellaneous cover type	burn
miscellaneous cover type	water
disturbance	cutblock
disturbance	urban/industrial/other

3.3.2.2 Local Study Areas

Ecological Land Cover Classification

Like the ecological land cover classification at the RSA level, vegetation classification at the LSA level is represented by five broad land cover groups including:

- terrestrial vegetation;
- wetlands;
- miscellaneous vegetation types;
- non-vegetation types; and
- disturbances.

Terrestrial vegetation is classified to ecosite phase as defined in the Field Guide to Ecosites of Northern Alberta (Beckingham and Archibald 1996) and used as a basis to map and describe the terrestrial resources within the LSAs. This classification is based on the principles of Ecological Land Classification (ELC). The system uses a mixture of biotic and abiotic variables to create a hierarchical, or nested ecological classification structure.

At the highest level in the ecological classification hierarchy, ecological areas and natural subregions are defined on the basis of broad eco-climatic factors. For the JEMA LSA, the Boreal Mixedwood ecological area (Beckingham and Archibald 1996) represents the broad climatic region at the LSA level. The PRMA LSA includes the Boreal Mixedwood and Canadian Shield ecological areas.

At the site level, ecosites are ecological units that develop under similar environmental influences, broadly defined on the basis of climate, soil nutrients and soil moisture regime (Beckingham and Archibald 1996). There are eight distinct ecosites within the Boreal Mixedwood ecological area, which corresponds with the Central Mixedwood Natural Subregion (NRC 2006). The Canadian Shield ecological area corresponds with the Athabasca Plain Natural Subregion, and contains five distinct ecosites.

Ecosites are subdivided into ecosite phases according to the dominant species in the tree canopy (Figure 3.3-1). Ecosite phases within the same ecosite share the same range in moisture and nutrient regime conditions but vary in canopy composition. The terrestrial component of the LSAs is mapped to the ecosite phase level of this classification system. Plant community types are a subdivision of the ecosite phase based on understorey species composition and abundance. While plant community type can be derived from vegetation plot data, it is not interpretable at the scale of mapping used for the LSAs.

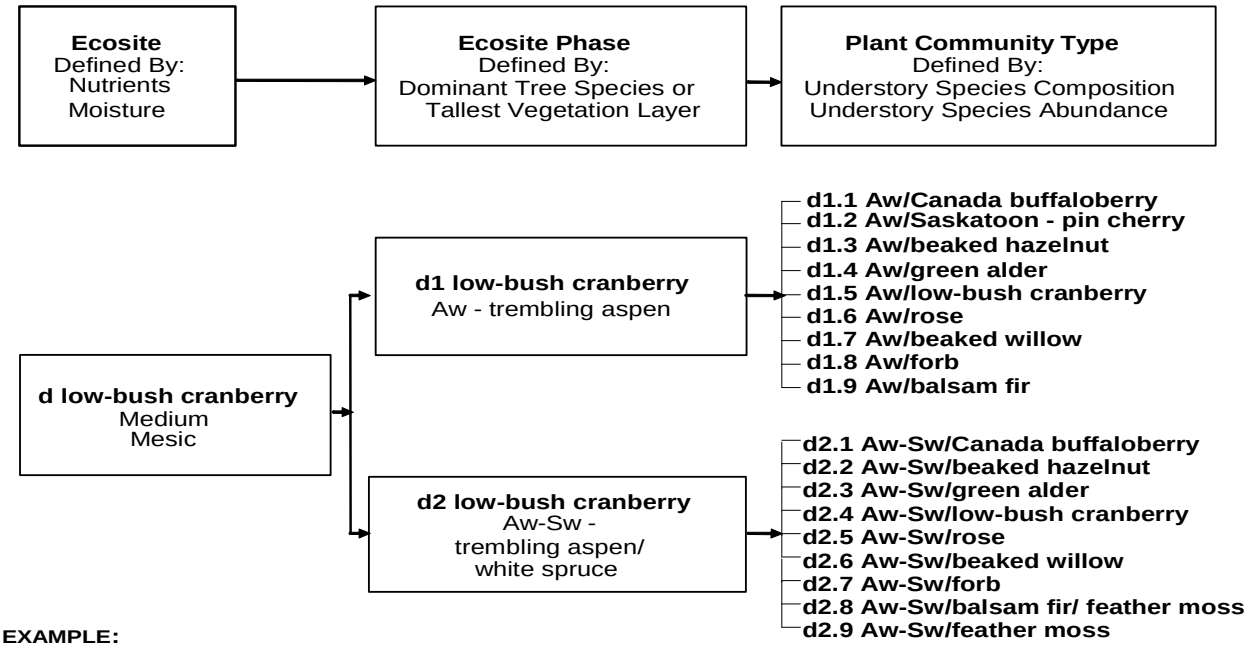
Wetlands within the LSAs were described and mapped using Alberta Wetlands Inventory (AWI) Standards (Halsey et al. 2003). In the AWI system, there are five primary wetlands types:

- bog;
- fen;
- marsh;
- swamp; and
- shallow open-water.

These wetlands types are defined in terms of inter-relationships among the hydrologic, chemical and biotic processes that control wetlands structure and function (Figure 3.3-2). Vegetation and landform modifiers are used to subdivide the primary wetlands types (Figure 3.3-3). The modifiers have been defined in such a way that the subdivided wetlands classes can readily be discriminated on airphotos.

The terrestrial and wetlands classification systems, as described above, were combined into one integrated ecological land cover classification for the LSAs as shown in Figure 3.3-4.

The other classification units (i.e., miscellaneous vegetation types, non-vegetated types and disturbances) were included in the integrated system so that all areas within the LSAs would be mapped to an appropriate class. Ecosite phases, wetlands types and miscellaneous vegetation types are often collectively referred to as “vegetation types” within this report.



EXAMPLE:

d low-bush cranberry + d1 Aw - trembling aspen + d1.6 Aw/rose = d1.6 low-bush cranberry/ trembling aspen/ rose

REFERENCE

OBTAINED FROM BECKINGHAM AND ARCHIBALD (1996)

PROJECT

JACKPINE MINE EXPANSION &
PIERRE RIVER MINE PROJECT

TITLE

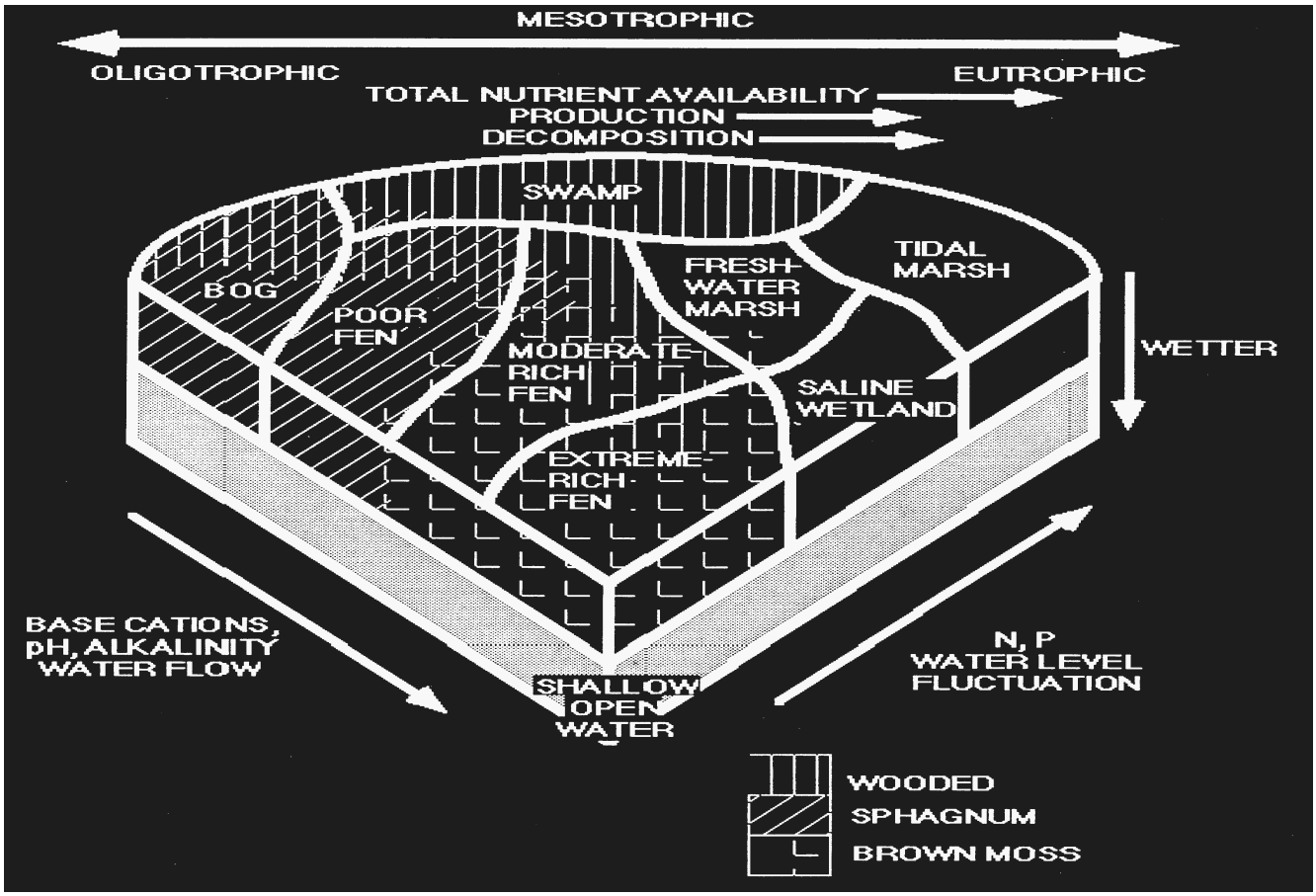
ECOSITE CLASSIFICATION HIERARCHY

Shell Canada Limited

PROJECT 05-1344-027.7640			FILE No. Ecosite Classification	
DESIGN	AA	21/08/07	SCALE AS SHOWN	REV. 0
CADD	YW	21/08/07	FIGURE: 3.3-1	
CHECK	AA	27/11/07		
REVIEW	WES/TC	27/11/07		

L:\2005\1344-OIL SANDS\05-1344-027-Shell Omnibus\7600\7640\Vegetation ESR\Fig 3.3-1 Ecosite Classification Hierarchy.dwg Nov 28, 2007 - 2:48pm

L:\2005\1344-OIL SANDS\05-1344-027-Shell Omnibus\7600\7640\Vegetation ESR\Fig 3.3-2 Wetlands Classes and Their Relationship to Chemical and Biotic Gradients.dwg Nov 28, 2007 - 3:06pm



Source: Halsey et al. 2003.

PROJECT

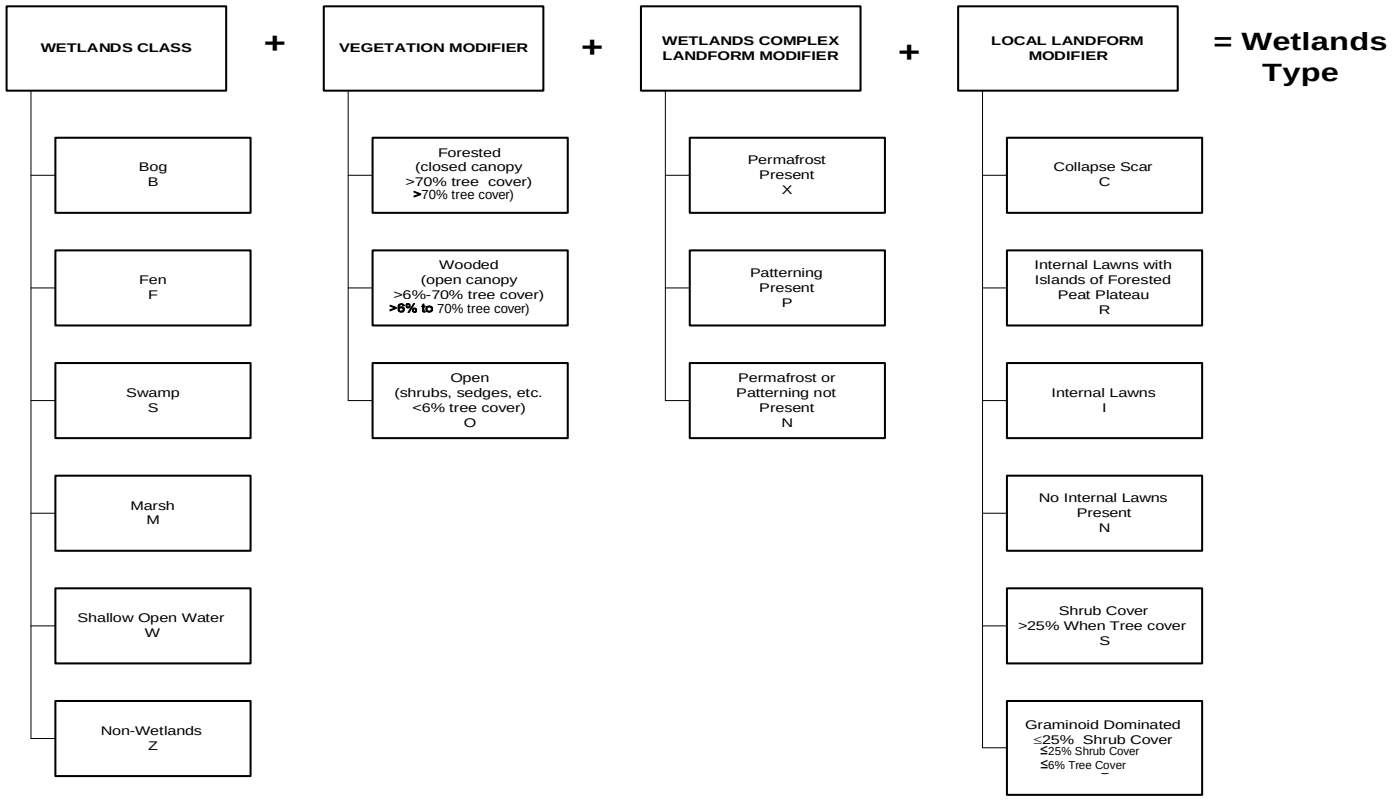
JACKPINE MINE EXPANSION &
PIERRE RIVER MINE PROJECT

TITLE

WETLANDS CLASSES AND THEIR RELATIONSHIP TO CHEMICAL AND BIOTIC GRADIENTS

Shell Canada Limited

PROJECT 05-1344-027.7640			FILE No.	Wetlands Classes
DESIGN	AA	21/08/07	SCALE AS SHOWN	REV. 0
CADD	YW	21/08/07	**FIGURE: 3.3-2**	
CHECK	AA	27/11/07		
REVIEW	WES/TC	27/11/07		



EXAMPLE:
Bog (B) + Wooded (T) + Permafrost not Present (N) + Internal Lawns (I) = Wooded Bog with Internal Lawns (BTNI)

Source: Nesby 1997.

PROJECT

JACKPINE MINE EXPANSION & PIERRE RIVER MINE PROJECT

TITLE

WETLANDS CLASSIFICATION

Shell Canada Limited

PROJECT 05-1344-027.7640			FILE No.	Wetlands Class	
DESIGN	AA	21/08/07	SCALE	AS SHOWN	REV. 0
CADD	YW	21/08/07	FIGURE: 3.3-3		
CHECK	AA	27/11/07			
REVIEW	WES/TC	27/11/07			

ECOLOGICAL LAND COVER CLASSIFICATION

Uplands

Central Mixedwood Natural Subregion

- a1 lichen jack pine
- b1 blueberry jack pine-aspen
- b2 blueberry aspen (white birch)
- b3 blueberry aspen-white spruce
- b4 blueberry white spruce-jack pine
- c1 Labrador tea−mesic jack pine-black spruce
- d1 low-bush cranberry aspen
- d2 low-bush cranberry aspen-white spruce
- d3 low-bush cranberry white spruce
- e1 dogwood balsam poplar-aspen
- e2 dogwood balsam poplar-white spruce
- e3 dogwood white spruce
- f1 horsetail balsam poplar
- f2 horsetail balsam poplar-white spruce
- f3 horsetail white spruce
- g1 Labrador tea−subhygric black spruce-jack pine
- h1 Labrador tea/horsetail white spruce-black spruce
- PJ-Lt Comp jack pine-tamarack complex

Athabasca Plain Natural Subregion

- a1 bearberry jack pine
- b1 Canada buffalo-berry-green alder jack pine-aspen-white birch
- b2 Canada buffalo-berry-green alder aspen
- b3 Canada buffalo-berry-green alder aspen-white spruce-black spruce
- b4 Canada buffalo-berry-green alder white spruce-black spruce-jack pine
- c1 Labrador tea-mesic jack pine-black spruce
- d1 Labrador tea-subhygric black spruce-jack pine
- e1 willow/horsetail aspen-white birch-balsam poplar
- e2 willow/horsetail aspen-white spruce-black spruce
- e3 willow/horsetail white spruce-black spruce
- PJ-Lt Comp jack pine-tamarack complex

Non-forested

- BUu burn uplands
- Me meadow
- Sh shrubland

Wetlands

Non-forested

Peatlands

- BONN open bog
- BONS shrubby bog
- BUw burn wetlands
- FONG graminoid fen
- FONS shrubby fen
- FOPN patterned fen

Non-Peatlands

- MONG marsh
- SONS shrubby swamp
- WONN shallow open water

Forested and Wooded

Peatlands

- BFNN forested bog
- BTNI wooded bog with internal lawns
- BTNN wooded bog
- BTNR wooded bog with internal lawns and islands of forested peat plateau
- BTXC wooded permafrost bog with collapse scar
- FFNN forested fen
- FTNI wooded fen with internal lawns
- FTNN wooded fen
- FTPN wooded patterned fen

Non-Peatlands

- STNN wooded swamp

Human Disturbances

Disturbances

- CC cutblock
- DIS disturbance

Natural Non-Vegetated

Water and Mineral

- lake
- river
- sand

PROJECT

JACKPINE MINE EXPANSION &
PIERRE RIVER MINE PROJECT

TITLE

ECOLOGICAL LAND COVER CLASSIFICATION

Shell Canada Limited

PROJECT 05−1344−027.7640			FILE No.	Ecological
DESIGN	AA	21/08/07	SCALE AS SHOWN	REV. 0
CADD	YW	05/09/07	**FIGURE: 3.3-4**	
CHECK	AA	27/11/07		
REVIEW	WES/TC	27/11/07		

L:\2005\1344−OIL SANDS\05−1344−027−Shell Omnibus\7600\7640\Vegetation ESR\Fig 3.3−4 Ecological Land Cover Classification.dwg Nov 28, 2007 − 3:34pm

Local Study Area Mapping

Draft Ecosite Phase and Wetlands Map

Draft vegetation maps were developed before the initial field surveys. The AVI data for the LSAs was classified on the basis of a regional ecosite phase and wetlands model developed by Golder. This model is based on relationships between AVI attributes (primarily tree canopy composition) and terrestrial vegetation and wetlands types classification units. The draft vegetation map provided a basis to stratify the LSAs for sampling purposes.

Final Ecosite Phase and Wetlands Map

All vegetation plot data were checked for accuracy before being used in finalization and verification of the vegetation map. Sites that were not representative of the vegetation polygon they occurred in (based on field observations) were excluded from further use in the mapping process. The remaining plots were evaluated against the existing vegetation map to determine if the regional model needed to be adjusted for local conditions. The model was recalibrated as necessary.

After re-running the AVI data through the revised model, the entire vegetation map was inspected for accuracy. Individual polygons were re-classified as necessary. New polygons were also digitized in cases of obvious variation in vegetation classification within a mapped polygon. For example, shallow open water (WONN) and marshes (MONG) often occurred within the same AVI polygon. In these cases, polygons were split.

Recently burned areas were digitized into the vegetation coverage based on historical wildfire maps/polygon data obtained from ASRD (ASRD 2006 website) and adjusted through visual interpretation of burn areas from the orthophoto.

Recently harvested area polygons were digitized into the vegetation coverage based on aerial orthophotos obtained by Shell in 2005 and adjusted through visual interpretation of the orthophoto.

A disturbances layer was created for the LSAs which included borrow pits, well sites, borehole pads, clearings, roads, rights-of-ways, trails and seismic lines. These disturbances were overlaid onto the vegetation map. Sources of disturbance data included AltaLIS, IHS Energy Ltd., AVI and visual interpretation of the orthophoto of the LSAs. A maximum linear disturbance width of 8 m was applied to all seismic lines in the LSAs.

3.3.3 Correlation Between the Regional and Local Study Area Ecological Land Classification Systems

Table 3.3-2 provides a correlation between the regional land cover classes used in the RSA map and the vegetation types and disturbances mapped within the LSAs. The correlation shows the dominant relationships between the two classification systems. Due to the size of the RSA and resolution of the imagery (i.e., 30 m pixel size), the regional classes likely include portions of other ecosites phases and wetlands types other than those listed.

Table 3.3-2 Correlation Between Regional Land Cover Classes and Local Study Area Vegetation Classes

Regional Land Cover Class	Local Study Area Ecosite Phase / Wetlands Type		
	Natural Subregion	Map Code	Description
Terrestrial Vegetation			
coniferous jack pine	Central Mixedwood	a1	lichen jack pine
	Athabasca Plain	a1	bearberry jack pine
coniferous jack pine−black spruce	Central Mixedwood	b4	blueberry white spruce-jack pine
		c1	Labrador tea−mesic jack pine-black spruce
		g1	Labrador tea−subhygric black spruce-jack pine
	Athabasca Plain	b4	Canada buffalo-berry–green alder white spruce-black spruce-jack pine
		c1	Labrador tea-mesic jack pine-black spruce
		d1	Labrador tea-subhygric black spruce-jack pine
coniferous white spruce	Central Mixedwood	d3	low-bush cranberry white spruce
		e3	dogwood white spruce
		f3	horsetail white spruce
		h1	Labrador tea/horsetail white spruce-black spruce
	Athabasca Plain	e3	willow/horsetail white spruce-black spruce
deciduous aspen−balsam poplar	Central Mixedwood	b2	blueberry aspen (white birch)
		d1	low-bush cranberry aspen
		e1	dogwood balsam poplar-aspen
		f1	horsetail balsam poplar-aspen
	Athabasca Plain	b2	Canada buffalo-berry–green alder aspen
		e1	willow/horsetail aspen-white birch-balsam poplar
mixedwood aspen−jack pine	Central Mixedwood	b1	blueberry jack pine-aspen
	Athabasca Plain	b1	Canada buffalo-berry–green alder jack pine-aspen-white birch
mixedwood aspen−white spruce	Central Mixedwood	b3	blueberry aspen-white spruce
		d2	low-bush cranberry aspen-white spruce
		e2	dogwood balsam poplar-white spruce
		f2	horsetail balsam poplar-white spruce
	Athabasca Plain	b3	Canada buffalo-berry–green alder aspen-white spruce-black spruce
		e2	willow/horsetail aspen-white spruce-black spruce

Table 3.3-2 Correlation Between Regional Land Cover Classes and Local Study Area Vegetation Classes (continued)

Regional Land Cover Class	Local Study Area Ecosite Phase / Wetlands Type		
	Natural Subregion	Map Code	Description
Wetlands			
non-treed wetlands	Central Mixedwood/Athabasca Plain	BONN	open bog
		BONS	shrubby bog
		FONG	graminoid fen
		FONS	shrubby fen
		FOPN	patterned fen
		Me	meadow
		MONG	marsh
		Sh	shrubland
		SONS	shrubby swamp
		WONN	shallow open water
treed poor fen / bog		BFNN	forested bog
		BTNI	wooded bog with internal lawns
		BTNN	wooded bog
		BTNR	wooded bog with forested permafrost bog and internal lawns
		BTXC	wooded permafrost bog with collapse scars
		FFNN	forested fen
		FTNI	wooded fen with internal lawns
		FTNN	wooded fen
treed fen		FFNN	forested fen
		FTNI	wooded fen with internal lawns
		FTNN	wooded fen
		STNN	wooded swamp
Other			
burn	Central Mixedwood/Athabasca Plain	BUu	burn uplands
		BUw	burn wetlands
water		channel	channel
		lake	lake
		river	river
		sand	sand
Disturbances			
cutblock	Central Mixedwood/Athabasca Plain	CC	cutblock
urban/industrial/other		DIS	disturbance

3.3.4 Terrestrial Vegetation and Wetlands Reporting

3.3.4.1 Terrestrial Vegetation and Wetlands

The RSA regional land cover classification (Section 3.3.3) is quantified and mapped. Each land cover class is also described in terms of dominant vegetation and distribution within the RSA.

The LSAs are classified as per the methods described in Section 3.3.4. The LSAs composition of this classification is quantified and mapped. The ecosite phases and wetlands types and other vegetation types within the LSAs are described in terms of general landscape influencing factors and resulting dominant vegetation. The general distribution with the LSAs is also described.

3.3.4.2 Forest Resources – Stand Attributes

For the RSA, regional land cover classes and disturbed areas were divided into forested and non-forested categories to quantify forest fragmentation and show the spatial attributes of forested and non-forested classes in the landscape. Details on the methods used for this analysis are presented in Section 3.3.5.2.

At the LSA level, in addition to forested/non-forested diversity metrics (Section 3.3.5.2), forest areas attributes are described. Relative comparisons of forest stand attributes were made among ecosite phases and wetlands types within the LSAs using the following AVI variables:

- overstorey canopy density;
- stand height;
- overstorey tree species composition;
- canopy structure;
- timber productivity; and
- stand age.

3.3.4.3 Rare Plants

A rare plant species is any native vascular or non-vascular plant (including lichens and fungi) that because of its biological characteristics, or for some other reason, exists in low numbers or in very restricted areas (ANPC 2000a). Plant rarity is determined by three factors: geographic range, habitat specificity and local population size (Drury 1974; Rabinowitz 1981). For example, many orchids have a widely dispersed distribution but are usually only found in small numbers. Other rare plant species require specific habitat conditions that are uncommon. Thus, the range of some rare species is restricted to so few localities that they are considered rare even though they occur in large numbers at each locality.

Rare plants in Alberta are represented by those species listed on the ANHIC tracking and watch lists (Gould 2000, 2006). The tracking lists include species of high priority because they are rare or there is a conservation concern

(Gould 2006). Species on the watch lists are typically taxa that have restricted distributions within Alberta but are common within their range. Information on watch list species is gathered by ANHIC to ascertain trends in populations (Gould 2006).

The ANHIC tracking and watch list denotes nine ranks of rarity for rare plants where the species are evaluated and ranked on their status both globally and provincially (Table 3.3-3). Ranking is generally based on the number of known population occurrences in the province.

At the national level, rare plant species are designated by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) (i.e., *Species at Risk Act* [SARA]-listed species) and denoted by four rarity definitions or classes (COSEWIC 2007):

- **At Risk:** Any species known to be "At Risk" after formal detailed status assessment and legal designation as "Endangered" or "Threatened" in Alberta.
- **May Be At Risk**: Any species that "May Be At Risk" of extinction or extirpation, and is therefore a candidate for detailed risk assessment.
- **Sensitive**: Any species that is not at risk of extinction or extirpation but may require special attention or protection to prevent it from becoming at risk.
- **Extirpated/Extinct:** Any species no longer thought to be present in Alberta ("Extirpated") or no longer believed to be present anywhere in the world ("Extinct").

Table 3.3-3 Alberta Natural Heritage Information Centre Rare Plant Ranking System

Code[(a)]	Description
Rank	
G1 S1	less than five occurrences or only a few remaining individuals
G2 S2	6 to 20 occurrences or with many individuals in fewer occurrences
G3 S3	21 to 100 occurrences; may be rare and local throughout its range, or in a restricted range (may be abundant in some locations or may be vulnerable to extirpation because of some factor of its biology)
G4 S4	apparently secure under present conditions, typically greater than 100 occurrences but may be fewer with many large populations; may be rare in parts of its range, especially peripherally
G5 S5	demonstrably secure under present conditions, greater than 100 occurrences; may be rare in parts of its range, especially peripherally
GU SU	status uncertain often because of low search effort or cryptic nature of the element; possibly in peril, unrankable, more information needed
GH SH	historically known, may be relocated in the future
GNR SNR	unranked or under review
GNA SNA	conservation status not applicable (includes exotic species)
Other Codes	
E	exotic species established, may be native to nearby regions
HYB	hybrid taxon that is recurrent in the landscape
P	potentially exists; may have occurred historically (but having not been persuasively documented)
Q	taxonomic questions or problems
R	reported but lacking sufficient documentation to accept or reject
RD	report dubious
RF	reported falsely
T_	rank for a subspecific taxon
X	believed to be extirpated
G? or S?	not yet ranked
_?	rank questionable

[(a)] G = global; S = Alberta.

Source: Gould (2000, 2006).

3.3.4.4 Rare and Special Plant Communities

As with rare plants, ANHIC also develops tracking lists of plant community elements that are considered high priority because they are rare or special in some way. The tracking lists serve as a focus for data gathering to increase our collective knowledge and understanding of these elements of Alberta's biodiversity (Allen 2006). Rare plant communities are described by ANHIC as follows:

> "Vegetation types that have been described as 'unusual', 'uncommon', 'of limited extent' or 'encountered infrequently' by vegetation experts were considered for inclusion on the Ecological Community Tracking List. Vegetation types that have been described as 'in decline' or 'threatened' by vegetation experts were

also considered for inclusion. Only natural communities were considered (Allen 2006)."

The ranking system used for rare plant communities is outlined in Table 3.3-4. The rarest of communities in Alberta are ranked as "S1" while communities that are demonstrably secure in Alberta are ranked as "S5".

Table 3.3-4 Provincial Ecological Community Conservation Ranks

Rank[(a)]	Rank Definition
S1	Five or fewer occurrences or very few remaining hectares.
S2	6 to 20 occurrences or few remaining hectares.
S3	21 to 80 occurrences. May be rare and local throughout its range or found locally, even abundantly, in a restricted range (e.g., a single western province or a physiographic region in the east).
S4	Apparently secure globally (state / province wide), though it may be quite rare in parts of its range, especially at the periphery.
S5	Demonstrably secure globally (state / province wide), though it may be quite rare in parts of its range, especially at the periphery.
SNR	Element is not yet ranked.
SU	Unrankable: currently unrankable due to lack of information or due to substantially conflicting information about status or trends.
SNA	Not Applicable: a conservation status rank is not applicable because the community is not a suitable target for conservation activities.
S#S#	Range rank[(a)]: a numeric range rank (e.g., S2S3) is used to indicate any range of uncertainty about the status of the species or community. Ranges cannot skip more than one rank (e.g., SU is used rather than S1S4).
Modifiers	
Q	Can be added to any global rank to denote questionable taxonomy (e.g., G2Q = 6 to 20 known occurrences, but questions exist concerning the classification of this type). Cannot be used with provincial ranks.
?	Can be added to any rank to denote an inexact numeric rank (e.g., S1? = believed to be five or less occurrences, but some doubt exists concerning status).

[(a)] Ranks can be combined to indicate a range (e.g., S2S3 = may be between 6 and 80 occurrences throughout Alberta, but the exact status is uncertain). Combined ranks indicate a larger margin of error than ranks assigned a "?" qualifier.

Source: Allen (2006).

Special plant communities are communities that are suspected as being rare or unique but are differentiated from rare plant communities in that there is less information known about them, and currently, are not included on the ecological community tracking list (Allen 2006). Because some aspects of Alberta's vegetation are poorly known, documenting those cases which appear to be unique in some way contributes to the body of knowledge on these communities.

The ecological community tracking list documenting all known rare communities for the Boreal Forest Natural Region is provided in Appendix I. Potentially rare communities observed within the study area were compared against this list to determine if there were any occurrences found within the LSAs. Descriptions of potentially rare or special plant communities documented within the LSAs were forwarded to Lorna Allen of ANHIC for review and expert opinion on the validity of these occurrences.

3.3.4.5 Species Diversity and Richness

Based on all vegetation data collected within the LSAs, several species diversity measures were calculated by vegetation type. Diversity measures, which incorporate all available data without standardizing by plot size or sampling intensity, included:

- total number of vascular species;
- total number of rare vascular species; and
- total number of vascular species unique to ecosite phase or wetlands type.

Taking sampling intensity into consideration when assessing diversity, all detailed vegetation inventory plots were pooled to calculate the following species richness measures:

- vascular species richness;
- bryophyte species richness; and
- lichen species richness.

Minimum and maximum species richness values were also calculated along with the standard deviation of the mean.

3.3.4.6 Non-Native and Invasive Species

Non-native and invasive species are commonly referred to as "weeds". A commonly accepted definition for what constitutes a weed is "a plant out of place". Therefore, assessing whether a plant is a weed is a matter of context (ANPC 2000b). Certain plants may be desirable natives in a native ecosystem but may be considered weeds in an agricultural field. Alternatively, crops or forage plants may be unwanted in a natural habitat. For this report, the definition of a weed is limited to those plants listed in the *Alberta Weed Control Act* (Province of Alberta 2002) and those that are native or alien to Alberta and with invasive properties (ANHIC 2006c; ANPC 2000b).

According to Alberta Agriculture and Food (2006, website), weeds listed in the *Alberta Weed Control Act* are invasive, aggressive and difficult to manage. They may displace or significantly alter native plant communities and may also cause economic damage to private and public lands. According to the Alberta Native Plant Council (ANPC 2000b), alien invaders are species that originate from outside of Alberta that, once introduced into native ecosystems, are able to survive, reproduce and have the capacity to displace native plants and reduce

biodiversity. They are able to do this through aggressive competition for moisture, nutrients and light, and possibly due to the lack of predators and pathogens. All native and non-native invasive species identified within the LSAs from the various vegetation surveys have been listed and described in this report.

3.3.4.7 Dust

The deleterious effects of dust on vegetation are generally confined to the immediate area adjacent to roadways (e.g., 50 m) (Walker and Everett 1987; Everett 1980). Meininger and Spatt (1988) found that the effects of dust were confined to within 300 m of roads, with an order of magnitude decrease in deposition between 5 and 50 m and a further order of magnitude decrease between 50 and 500 m.

Based on this information, a 50-m buffer was placed around all disturbance types that could be sources of dust within the LSAs. All vegetation within this buffer is assumed to be potentially affected by dust. Dust is assumed to be equal to vehicular activity on the LSAs. Sources are primarily roads, but can include other areas accessible by vehicle.

3.3.5 Landscape-Level Assessment

Landscape features such as patch size and shape, heterogeneity and connectivity have major implications on species composition, distribution and viability (Noss and Harris 1986). In most instances, biodiversity at the landscape-level refers to the pattern of vegetation and wildlife species communities distributed across the landscape (Noss and Cooperrider 1994). The purpose of these analyses is to measure the arrangement of patches in the landscape within the local and regional study areas before development for comparison to the post-development scenario. Section 6 of this report discusses the landscape-level assessments in context of biodiversity.

3.3.5.1 Heterogeneity

Heterogeneity analyses were completed to examine the abundance, distribution and diversity of different patch types on the landscape. Regional land cover classes were used as patch types in the RSA analysis and ecological land cover classes (ecosite phases, wetlands types and disturbed areas) were used as patch types in the LSA level analysis. Refer to Section 3.2 for a definition of the study areas and Sections 3.4.1, 3.5.1 and 3.6.1 for detailed descriptions of each patch type.

3.3.5.2 Fragmentation

Fragmentation is the breaking-up of natural areas by disturbances into smaller and more isolated patches (Morrison et al. 1998). Fragmentation analyses were completed to examine how the landscape is partitioned relative to the following categories:

- natural areas and human disturbed areas;
- forested and non-forested areas;
- riparian areas; and
- old growth areas.

Natural Areas and Human Disturbed Areas

The purpose of this analysis was to examine how the natural landscape is divided by human disturbance within the RSA and LSAs. The "natural" category includes all regional land cover classes for the RSA, and all ecological land cover classes for the JEMA LSA and PRMA LSA. The "human disturbed" category used in this assessment includes all cutblocks, agricultural areas, and urban (e.g., municipalities and roads) and industrial (e.g., mines, seismic lines, wellpads and pipelines) developments.

Forested and Non-Forested Areas

The purpose of this analysis was to evaluate the connectedness, available habitat and core area habitat for forest-dwelling and open-habitat species within the RSA and LSAs by examining the distribution and abundance of forested and non-forested areas at current human disturbance levels. Core area habitat is defined as the proportion of a patch type that is greater than 100 m from the edge of a different patch type. Some species require that a minimum amount of available habitat be core area due to a high sensitivity to human disturbance. The "forested" category includes all habitats with treed vegetation. Refer to Section 4.2.2 for a description of how forested areas were defined in the RSA and LSAs. The "non-forested" category includes all naturally occurring non-treed habitats, including water and burns.

Riparian Areas

JPME R1 ERRATA

SEE CORRECTION IN JPME R1 SEC 7, ERRORS & OMISSIONS

The purpose of this analysis was to evaluate the abundance and distribution of riparian communities within the RSA and LSAs. Riparian communities support a diverse array of plants and wildlife and are critical features of the landscape (Goforth et al. 2002). The "riparian" category includes all potential riparian habitat within 100 m of a watercourse with a patch area greater than 0.2 ha and

0.1 ha for the RSA and LSAs, respectively. Refer to Section 3.3.6.1 for a description of potential riparian habitats in the RSA and LSAs. Fragmentation analysis of riparian habitat at the RSA level was restricted due to computational limitations at that scale.

Old Growth Areas

The purpose of this analysis was to examine the abundance and distribution of old growth forest within the LSAs. Old growth forests are unique and dynamic ecosystems that provide some of the highest quality habitat available for plants and animals alike (Timoney 1998). The "old growth" category was based on stand age of the leading tree species in a given patch using area summaries from AVI coverage. Refer to Section 3.3.6.1 for a detailed description of old growth forest classification. The classification system contains no age data for tree stands at the RSA level; therefore, all fragmentation analyses for old growth forests are done at the LSA level only.

3.3.5.3 Analyses and Values

The landscape-level analyses were completed using FRAGSTATS Version 3 software (McGarigal and Marks 1995). Table 3.3-5 summarizes the metrics assessed for the heterogeneity and fragmentation analyses. Each analysis used the same basic set of metrics (e.g., class area, number of patches, patch size mean and so forth), with additional metrics (e.g., mean patch fractal dimension, interspersion/juxtaposition index) determined as appropriate. For complete descriptions of the landscape measurements, refer to Appendix J.

Table 3.3-5 Landscape-Level Metrics Assessed

Landscape Measurement	Description/ Definition	Type of Analysis	Study Area	Units
class area (CA)	area of each patch type	fragmentation/ heterogeneity	RSA/LSA	hectares [ha]
class area proportion (CA proportion)	percentage of the RSA/LSA that is comprised of each patch type	fragmentation/ heterogeneity	RSA/LSA	percent [%]
number of patches (NP)	number of patches in a landscape	fragmentation/ heterogeneity	RSA/LSA	n/a
patch size mean (AREA_MN)	average area of each patch type in a landscape	fragmentation/ heterogeneity	RSA/LSA	hectares [ha]
patch size median (AREA_MD)	midpoint of the rank order distribution of size for patches of the corresponding patch type	fragmentation/ heterogeneity	RSA/LSA	hectares [ha]
patch size standard deviation (AREA_SD)	variability of patch size	fragmentation/ heterogeneity	RSA/LSA	hectares [ha]
patch size coefficient of variation (AREA_CV)	standardized index of the variability of patch size relative to the mean patch size	fragmentation/ heterogeneity	RSA/LSA	percent [%]
total edge (TE)	total length of all patch edges	fragmentation/ heterogeneity	RSA/LSA	kilometres [km]

Table 3.3-5 Landscape-Level Metrics Assessed (continued)

Landscape Measurement	Description/ Definition	Type of Analysis	Study Area	Units
mean patch fractal dimension (FRAC_MN)	complexity of patch shape (value ranges between 1 and 2)	fragmentation/ heterogeneity	RSA/LSA	n/a
mean nearest neighbour (ENN_MN)	mean of the shortest distance between each patch and each adjacent patch of the same type	fragmentation/ heterogeneity	LSA	metres [m]
nearest neighbour standard deviation (ENN_SD)	relative variability of interpatch distances between two patches of one vegetation type	fragmentation/ heterogeneity	LSA	metres [m]
nearest neighbour coefficient of variation (ENN_CV)	standardized index of the variability of distances between two patches of same vegetation type	fragmentation/ heterogeneity	LSA	percent [%]
interspersion/ juxtaposition index (IJI)	distribution of patches on the landscape	fragmentation/ heterogeneity	RSA/LSA	percent [%]
total core area (TCA)[(a)]	sum of core area for all patches of a corresponding patch type	fragmentation	LSA	hectares [ha]
total core area proportion (TCA proportion)[(a)]	percentage of the LSA that is comprised of core area for a patch type	fragmentation	LSA	percent [%]
core area index -area weighted mean (CAI_AM)[(a)]	percentage of a patch that is comprised of core areas relative to the total landscape	fragmentation	LSA	percent [%]
patch richness (PR)	number of different patch types	heterogeneity	RSA/LSA	n/a
Shannon's evenness index (SHEI)	distribution of area among or within patch types	heterogeneity	RSA/LSA	n/a

[(a)] These measurements are calculated in the analysis of core areas using a 100 m buffer inside natural patches only.

Note: Modified from McGarigal and Marks (1995) and Franklin and Dickson (1999). Refer to Appendix J for detailed descriptions of the landscape measurements.

FRAGSTATS Version 3 uses raster (cells in a grid) rather than vector (polygon) GIS data, so the values (e.g., areas) provided in this section may differ slightly from those for most terrestrial analyses, including vegetation, where vector data were used. The raster cell size was set to 4 m at the LSA scale and 20 m at the RSA scale. As some of the linear disturbances (e.g., seismic lines) were less than 20 m wide, it was necessary to map them at 20 m widths so they could be detected and included in the RSA analyses. Although the analysis overestimates the area of human disturbance, the results more accurately reflect the spatial configuration and fragmentation of the landscape. Use of the raster format also slightly overestimates edge values because it follows the stair-step perimeter of a patch rather than a smooth edge.

3.3.6 Key Indicator Resources

Selection Process

Vegetation KIRs represent groups of communities, individual communities and species that have been identified as being rare, unique, diverse, sensitive,

ecologically important or regionally significant. The vegetation KIR list has been refined over several oil sands EIAs. A review was completed in 1998 on all regional KIRs for the Mobil Kearl Oil Sands Project (Golder 1999). The KIRs identified from this process were re-evaluated for this report and updated accordingly.

The KIRs were selected based on ecological importance and vulnerability, resource use value, monitoring value and social importance. The KIRs have been categorized into two main classes: community-level and species-level (Table 3.3-6).

Table 3.3-6 Terrestrial Resources Key Indicator Resources

KIR Selected	Study Area	Rationale
Community Level		
lichen jack pine communities	RSA/LSA	sensitive land class important for wildlife habitat, forestry and traditional use
riparian communities	RSA/LSA	highly productive areas with high rare plant potential; form important wildlife habitat and corridor areas
old growth forests	RSA/LSA	uncommon mature forest within the boreal forest with restricted distribution because of the fire regime
peatlands (bogs and fens)	RSA/LSA	important boreal forest ecosystems that cannot be reclaimed because of the complex interrelated hydrological, chemical and biotic conditions
patterned fens	LSA	rare wetlands type with high rare plant potential; susceptible to physical disturbance
rare and special plant communities	LSA	plant communities with restricted spatial distributions
productive forests	RSA/LSA	important to the forest industry
Species Level		
rare plants	RSA/LSA	plants with restricted spatial, ecological and temporal distributions
traditional use plants	RSA/LSA	plants traditionally used by Aboriginal peoples for food, medicine or spiritual purposes

3.3.6.1 Community-Level Key Indicator Resources

Lichen Jack Pine Communities

Lichen jack pine communities were selected as a community-level KIR because of their importance for caribou habitat and due to their restricted spatial distribution in the region.

At the RSA level, lichen jack pine communities are defined by the coniferous jack pine regional land cover class. At the LSA level, the Central Mixedwood lichen jack pine (a1) ecosite phase and the Athabasca Plain bearberry jack pine (a1) ecosite phase are considered lichen jack pine communities.

Riparian Communities

Defining Riparian Communities

Riparian communities represent vegetation assemblages adjacent to streams and waterbodies and whose structure and function are influenced by, or dependent upon this aquatic association. Riparian communities are viewed as supporting important biodiversity functions as they provide unique habitat for vegetation and wildlife.

Development of a riparian layer for analysis was done in two steps. In the first step, all waterbodies (i.e., rivers, streams, lakes and ponds) available from AltaLIS at a 1:20,000 scale were first buffered 100 m from the edge of open water. While the width of a riparian zone varies according to topography and hydrologic regime, the 100 m buffer zone criteria was assumed to represent a maximum riparian zone width within the region. The buffer zone was overlaid onto the regional land cover classification map for the RSA-level assessment, and ecosite phase and wetlands types maps for the LSA-level assessments. If vegetation classes and types within the buffer zone were classed as having riparian potential, then the area was classed as riparian habitat.

In the second step, all riparian habitat polygons less than 0.1 ha were removed. These polygons were not considered to represent effective riparian habitat. Other polygons that may have been fragmented by roads or seismic lines, for example, but did occur within a riparian zone were kept as riparian habitat, albeit fragmented.

Vegetation classes with the potential to support riparian communities within the RSA are as follows:

- coniferous white spruce;
- deciduous aspen-balsam poplar;
- mixedwood aspen-white spruce;
- non-treed wetlands; and
- treed fen.

Vegetation types with the potential to support riparian communities within the LSAs are as follows:

Central Mixedwood Natural Subregion Ecosite Phases:

- dogwood balsam poplar-aspen (e1);
- dogwood balsam poplar-white spruce (e2);
- dogwood white spruce (e3);
- horsetail balsam poplar-aspen (f1);
- horsetail balsam poplar-white spruce (f2);
- horsetail white spruce (f3);
- Labrador tea/horsetail white spruce-black spruce (h1);

Athabasca Plain Natural Subregion Ecosite Phases:

- willow/horsetail aspen-white birch-balsam poplar (e1);
- willow/horsetail aspen-white spruce-black spruce (e2);
- willow/horsetail white spruce-black spruce (e3);

Vegetation Types Bound in Both Natural Subregions:

- meadow (Me);
- shrubland (Sh);
- forested fen (FFNN);
- graminoid fen (FONG);
- shrubby fen (FONS);
- patterned fen (FOPN);
- wooded fen with internal lawns (FTNI);
- wooded fen (FTNN);
- marsh (MONG);
- shrubby swamp (SONS);
- wooded swamp (STNN); and
- sand.

Old Growth Forests

Background

Within the boreal forest, old growth forest stands have unique structural attributes and ecological processes. Tree mortality leads to gaps in the forest canopy allowing direct sunlight that allows for growth of herbaceous plants and "release" of immature trees in the understorey. The accumulation of snags and

downed woody debris adds to the high level of structural diversity (Schneider 2002). Old growth forests are also hotspots for biodiversity from genetic and species levels to ecosystem levels. Because of their high structural and functional diversity, old growth forests provide some of the highest habitat value available for plants and animals alike (Timoney 1998).

Old growth may be defined as forests where annual growth equals annual losses, or where mean annual increment of timber volume equals zero. They can also be defined as stands that are self-regenerating (i.e., having a specific structure that is maintained) and where the structure includes juvenile, mature, dying and decaying trees of the same species. Old growth forests develop at different rates dependent upon tree species and factors such as site quality, climate, decay rates, stand history and disturbance type magnitude and frequency. Structural characteristics, dominant processes, successional development stages, habitat quality and human values are also important factors in defining old growth (Hayward 1991). To summarize, old growth is often defined by a combination of the following variables:

- tree height and diameter;
- stem and snag density;
- cavity characteristics;
- mortality rates;
- nutrient cycling;
- energy flow characteristics; and
- structural heterogeneity.

Timoney (1998) states that old growth forests can simply be characterized by age but characteristics vary depending on forest type and geographic location.

Old Growth Classification and Analysis

Because of the limitations inherent in mapping old growth based on the variety of factors listed above, old growth forest classification in this analysis follows the work presented by Schneider (2002), which is based on stand age of the leading species. Pure white spruce and balsam fir stands (≥80% coniferous) are considered old growth at 140 years, jack pine stands at 120 years, and mixedwood and deciduous leading stands at 100 years (Table 3.3-7). Area summaries for these forest types are provided for the LSAs based on AVI coverage (see Section 3.3.1.7 for details on AVI data). Classification of old growth at the RSA level is not possible due to the lack of age data at that scale.

Table 3.3-7 Stand Age Classes According to Dominant Tree Species

Dominant Tree Species	Stand Age Class (years of age)			
	Early	Young[(a)]	Mature	Old Growth
Timber Productive Tree Species and Site Types				
trembling aspen	0 to 20	>20 to 59	60 to 99	≥ 100
balsam poplar				
white birch				
mixedwood stands				
jack pine	0 to 20	>20 to 59	60 to 119	≥ 120
white spruce	0 to 20	>20 to 59	60 to 139	≥ 140
balsam fir				
burn	0 to 20	n/a	n/a	n/a
cutblock	0 to 20	>20 to 59	n/a	n/a
Non-Timber Productive Tree Species and Site Types				
black spruce and tamarack	0 to 20	>20 to 59	60 to 139	≥ 140
burn	0 to 20	n/a	n/a	n/a

[(a)] According to ASRD (2003), a "young" stand is generally less than 60 years of age.
n/a = Not applicable.

The age at which black spruce and tamarack dominant stands transition from mature to old growth status was not discussed by Schneider (2002) because the focus of that report was on harvestable stands. In general, black spruce and tamarack stands do not have the same types of structural characteristics (e.g., tall, large-diameter trees and gaps in canopy) as timber productive old growth forests because these species are strongly associated with wetlands or transitional wetlands habitat where tree growth is suppressed, due to elevated water table levels. While there is a general lack of literature on old growth black spruce and tamarack stands, Timoney (1998) suggests that forest types dominated by theses species may offer a unique array of microhabitats for plants and add structure and organic matter from coarse woody debris, but concedes that more study is required. Thus, black spruce and tamarack stands were included as a distinct class of old growth (i.e., non-timber productive), which may have different but important functions within whole ecosystems including contributions to biodiversity.

For analysis purposes, black spruce and tamarack stands are assumed to reach old growth status at 140 years, similar to white spruce. Area summaries for this old growth class are provided at the LSA level based on AVI coverage (Section 3.3.1.7 for details on AVI data).

For the RSA level, only estimates of old growth can be made without detailed data. An estimate of the natural levels of forest age-class variability has been studied for Alberta-Pacific Forest Industries Inc. (Al-Pac). Andison (2003, website) estimates that overmature (old growth) forest types account for 10 to 42% of the forested land base, based on an 80-year fire cycle.

Schneider (2002) also provides an estimate of old growth forests in Alberta of 26.5%, which is close to the mid-point of the range provided by Andison (2003, website). The regional land cover classes (Section 3.3.3) are matched with midpoint values of the Andison (2003, website) overmature (old growth) estimates for broad forest types to estimate the amount of old growth potentially occurring in the RSA.

Peatlands

Peatlands are defined as having more than 40 cm of accumulated organics and include all types of fens and bogs (Halsey et al. 2003). Peatlands are important ecosystems within the boreal forest; they are diverse in type and represent important plant and wildlife habitat. Typically, peatlands in the boreal natural region are characterized by extensive areas of wooded, permafrost bogs in the north and peatland complexes of wooded fens and non-permafrost bogs in the south (Vitt et al. 1994).

In the RSA, the non-treed wetlands, treed poor fen/bog and treed fen vegetation classes are considered to be dominated by peatlands: Portions of each of these classes contain non-peatland components (i.e., swamps and marshes). Due to the limitations inherent in regional mapping, separation of peatlands and non-peatland wetlands is not possible. However, soil surveys in the region show that peatlands dominant the landscape where land is saturated with water long enough to promote wetlands or aquatic processes.

In the LSAs, the following wetlands types are classed as peatlands:

- forested bog (BFNN);
- open bog (BONN);
- shrubby bog (BONS);
- wooded bog with internal lawns (BTNI);
- wooded bog (BTNN);
- wooded bog with forested permafrost bog and internal lawns (BTNR);
- wooded permafrost bog with collapse scars (BTXC);
- burn wetlands (BUw);
- forested fen (FFNN);
- graminoid fen (FONG);
- shrubby fen (FONS);

- patterned fen (FOPN);
- wooded fen with internal lawns (FTNI); and
- wooded fen (FTNN).

The burn wetlands vegetation type likely includes portions of non-peatlands but only as a minor component.

Patterned Fens

Patterned fens are peatlands that display a distinctive pattern related to spatial alteration between open wet (flarks) areas and drier shrubby to wooded areas (strings). Due to the resolution of the RSA land cover classification, identification of patterned fens at that scale is not possible. It is only possible to determine the distribution and abundance of patterned fens within the LSAs based on interpreting air photos and field investigations.

Productive Forests

Productive forests are defined as the portion of the land base capable of producing economically viable timber for forest harvesting operations. Vegetation classes at the RSA level were classified as either "productive" or "unproductive". Productive forests include the following classes:

- coniferous jack pine;
- coniferous jack pine−black spruce;
- coniferous white spruce;
- cutblock;
- deciduous aspen−balsam poplar;
- mixedwood aspen−jack pine; and
- mixedwood aspen−white spruce.

Burn areas at the RSA level were excluded from the productive forest land base even though portions of it may be productive. Because there is a lack of information of what types of vegetation occur within the burn areas, the burn land cover class was assigned an "unknown" productivity class.

Productive forests in the LSAs were determined from the AVI based on the Timber Productivity Rating (TPR), which ranks a stand into one of four productivity levels including "good", "medium", "fair" and "unproductive". The TPR ratings are based on the dominant tree species and stand height-age

relationships. As black spruce and tamarack trees are not economic species, all stands dominated by either of these species were assigned an "unproductive" rank, regardless of their TPR rating.

Additional details on forest resources, including timber volume and Mean Annual Increment (MAI), are provided in the Forestry ESR (Section 4).

3.3.6.2 Plant Species Level

Rare Plant Potential

Rare plant potential relates to the potential of a particular habitat type to support rare plants. A rare plant potential ranking of high, moderate or low was assigned to each ecosite phase and wetlands type within the LSAs based on an evaluation of rare plant data in the Oil Sands Region and available rare plant habitat literature.

Over 3,000 vegetation plots from the Oil Sands Region were used in making a preliminary assessment of rare plant potential by vegetation type. The number of rare plant occurrences was tallied along with the total number of sites visited within each vegetation type. Within this information, rare plant frequency of occurrence was calculated for each vegetation type. These frequency values were sorted to determine if there were any natural breaks in the data that could be used to distinguish between low, moderate and high ranks. Information on rare species habitats within the region was also evaluated. The results were used to adjust the rankings accordingly, especially in cases where there was a limited sample size of a particular vegetation type.

Based on these information sources and subsequent analyses, each vegetation type (e.g., ecosite phase, wetlands type, meadow, shrubland) was assigned a rare plant potential ranking of high, moderate or low.

The vegetation type rare plant potential ranks were translated to the regional land cover classes based on the relationships provided in Table 3.3-2. Table 3.3-8 lists the rare plant potential ranks for the RSA. Table 3.3-9 lists the ranks for the LSAs.

Table 3.3-8 Rare Plant Potential Rankings for the Regional Study Area

Regional Land Cover Class
High Rank – Rare Plant Potential
non-treed wetlands
treed fen
Moderate Rank – Rare Plant Potential
burn
coniferous jack pine
coniferous jack pine−black spruce
cutblock
mixedwood aspen−jack pine
treed poor fen / bog
Low Rank – Rare Plant Potential
coniferous white spruce
deciduous aspen−balsam poplar
disturbances (urban, industrial, agricultural and other)
mixedwood aspen−white spruce
water

Table 3.3-9 Rare Plant Potential Rankings for the Local Study Areas

Ecosite Phase/Wetlands Type	
High Rank – Rare Plant Potential	
BONN	open bog
BONS	shrubby bog
FONG	graminoid fen
FONS	shrubby fen
FOPN	patterned fen
FTNI	wooded fen with internal lawns
FTNN	wooded fen
FTNR	wooded fen with internal lawns and islands of forested peat plateau
FTPN	wooded patterned fen
MONG	marsh
Sh	shrubland (riparian or otherwise)
SONS	shrubby swamp
WONN	shallow open water
Moderate Rank – Rare Plant Potential	
a1 (CM)	lichen jack pine
a1 (AP)	bearberry jack pine
b1 (CM)	blueberry jack pine-aspen
b2 (CM)	blueberry aspen (white birch)
b3 (CM)	blueberry aspen-white spruce
b4 (CM)	blueberry white spruce-jack pine
b1 (AP)	Canada buffalo-berry–green alder jack pine-aspen-white birch
b2 (AP)	Canada buffalo-berry–green alder aspen
b3 (AP)	Canada buffalo-berry–green alder aspen-white spruce-black spruce
b4 (AP)	Canada buffalo-berry–green alder white spruce-black spruce-jack pine
BUu	burn uplands
BUw	burn wetlands
c1 (CM)	Labrador tea-mesic jack pine-black spruce
c1 (AP)	Labrador tea-mesic jack pine-black spruce
e1 (AP)	willow/horsetail aspen-white birch-balsam poplar
CC	cutblock

Table 3.3-9 Rare Plant Potential Rankings for the Local Study Areas (continued)

Ecosite Phase/Wetlands Type	
Me	meadow
Pj-Lt Comp	jack pine-tamarack complex
SFNN	forested swamp
STNN	wooded swamp
Low Rank – Rare Plant Potential	
BFNN	forested bog
BTNI	wooded bog with internal lawns
BTNN	wooded bog
BTNR	wooded bog with internal lawns and islands of forested peat plateau
BTXC	wooded permafrost bog with collapse scar
BTXN	wooded bog with permafrost
channel	channel
cutbank	cutbank
d1 (CM)	low-bush cranberry aspen
d2 (CM)	low-bush cranberry aspen-white spruce
d3 (CM)	low-bush cranberry white spruce
DIS	disturbance
e1 (CM)	dogwood balsam poplar-aspen
d1 (AP)	Labrador tea-subhygric black spruce-jack pine
e2 (CM)	dogwood balsam poplar-white spruce
e3 (CM)	dogwood white spruce
e2 (AP)	willow/horsetail aspen-white spruce-black spruce
e3 (AP)	willow/horsetail white spruce-black spruce
f1 (CM)	horsetail balsam poplar-aspen
f2 (CM)	horsetail balsam poplar-white spruce
f3 (CM)	horsetail white spruce
g1 (CM)	Labrador tea-subhygric black spruce-jack pine
h1 (CM)	Labrador tea/horsetail white spruce-black spruce
lake	lake
river	river
sand	sand

Note: "(CM)" indicates Central Mixedwood Natural Subregion ecosite phase types; "(AP)" indicates Athabasca Plain Natural Subregion ecosite phases. All other types occur in both Natural Subregions.

Traditional Plant Potential

Traditional use plants are those plants used by Aboriginal people of the region as part of their traditional lifestyle. The uses of these traditional plants are varied and include food, ceremonial, medicinal and other purposes. As a result of previous work (Fort McKay and AGRA 1998; Golder 2003a,b, 2005), a list of traditional use plants was compiled (Appendix K). This list forms the foundation of an assessment documenting the abundance and distribution of traditional use plants within the regional and local study areas. Included in this previous work is a documented list of traditional plants found on the Shell Jackpine Mine – Phase 1 Lease and identified by Fort McKay elders as being culturally significant (Golder 2003a).

Traditional plant potential in the RSA and other local study areas has been assessed previously (CNRL 2002; Petro-Canada 2001; Shell 2002, 2005; Suncor 2003, 2005). The methods employed for this environmental setting report were similar, but were updated based on the inclusion of additional regional vegetation data.

Vegetation plot data from the Oil Sands Region, both north and south of Fort McMurray, were compiled to evaluate abundances of traditional use species to rank vegetation types for their potential to support traditional plants.

To quantify species abundance levels, mean cover and percent frequency of occurrence of each species was calculated for each vegetation type. Based on these two parameters a scoring system was developed (Table 3.3-10). Species that commonly occurred within a vegetation type with relatively high percent cover were given a high abundance score while other species that were rarely present and exhibited low cover were given a low abundance score. More specific information on how cover abundance and frequency was categorized is provided in Appendix K.

Table 3.3-10 Traditional Plant Species Abundance Scoring

Measure	Description	Score
abundant	very common with high cover	4
common	very common with low to moderate cover or common with high cover	3
frequent	common with low to moderate cover or occasional with moderate cover	2
infrequent	occasional with low cover or very common with very low cover	1
not present	rarely present or with very low cover and not plentiful	0

After species scores were calculated, they were summed to calculate an overall score for each vegetation type (see Appendix K for details). Based on the overall score, traditional plant potential for each vegetation type was ranked as high, moderate or low.

The ecosite phase and wetlands types traditional plant potential ranks were translated to the regional land cover classes according to the relationship provided in Table 3.3-2. Table 3.3-11 lists the ranks for the RSA. Table 3.3-12 lists the ranks for the LSAs.

Table 3.3-11 Traditional Plant Potential Rankings for the Regional Study Area

Regional Land Cover Class
High Rank – Traditional Plant Potential
coniferous white spruce
deciduous aspen−balsam poplar
mixedwood aspen−jack pine
mixedwood aspen−white spruce
Moderate Rank – Traditional Plant Potential
burn
coniferous jack pine−black spruce
treed poor fen / bog
treed fen
Low Rank – Traditional Plant Potential
coniferous jack pine
cutblock
disturbances (urban, industrial, agricultural and other)
non-treed wetlands
water

Table 3.3-12 Traditional Plant Potential Rankings for the Local Study Areas

Ecosite Phase/Wetlands Type	
High Rank – Traditional Plant Potential	
b1 (CM)	blueberry jack pine-aspen
b2 (CM)	blueberry aspen (white birch)
b3 (CM)	blueberry aspen-white spruce
b4 (CM)	blueberry white spruce-jack pine
b1 (AP)	Canada buffalo-berry–green alder jack pine-aspen-white birch
b2 (AP)	Canada buffalo-berry–green alder aspen
b3 (AP)	Canada buffalo-berry–green alder aspen-white spruce-black spruce
b4 (AP)	Canada buffalo-berry–green alder white spruce-black spruce-jack pine
d1 (CM)	low-bush cranberry aspen
d2 (CM)	low-bush cranberry aspen-white spruce
d3 (CM)	low-bush cranberry white spruce
e1 (CM)	dogwood balsam poplar-aspen
e2 (CM)	dogwood balsam poplar-white spruce
e3 (CM)	dogwood white spruce
f2 (CM)	horsetail balsam poplar-white spruce
e1 (AP)	willow/horsetail aspen-white birch-balsam poplar
e2 (AP)	willow/horsetail aspen-white spruce-black spruce
e3 (AP)	willow/horsetail white spruce-black spruce
Moderate Rank – Traditional Plant Potential	
a1 (CM)	lichen jack pine
BTNI	wooded bog with internal lawns
BTNN	wooded bog
BUu	burn uplands
BUw	burn wetlands
c1 (CM)	Labrador tea-mesic jack pine-black spruce
c1 (AP)	Labrador tea-mesic jack pine-black spruce
CC	cutblock
f1 (CM)	horsetail balsam poplar-aspen
f3 (CM)	horsetail white spruce
FFNN	forested fen
FONS	shrubby fen
FTNI	wooded fen with internal lawns
FTNN	wooded fen
FTNR	wooded fen with internal lawns and islands of forested peat plateau
h1 (CM)	Labrador tea/horsetail white spruce-black spruce
SFNN	forested swamp
Sh	shrubland (riparian or otherwise)

Table 3.3-12 Traditional Plant Potential Rankings for the Local Study Areas (continued)

Ecosite Phase/Wetlands Type	
STNN	wooded swamp
Low Rank – Traditional Plant Potential	
a1 (AP)	bearberry jack pine
BFNN	forested bog
BONN	open bog
BONS	shrubby bog
BTNR	wooded bog with internal lawns and islands of forested peat plateau
BTXC	wooded permafrost bog with collapse scar
channel	channel
cutbank	cutbank
d1 (AP)	Labrador tea-subhygric black spruce-jack pine
DIS	disturbance
FONG	graminoid fen
FOPN	patterned fen
FTPN	wooded patterned fen
g1 (CM)	Labrador tea-subhygric black spruce-jack pine
lake	lake
Me	meadow
MONG	marsh
Pj-Lt Comp	jack pine-tamarack complex
river	river
sand	sand
SONS	shrubby swamp
WONN	shallow open water

Note: "(CM)" indicates Central Mixedwood Natural Subregion ecosite phase types; "(AP)" indicates Athabasca Plain Natural Subregion ecosite phases. All other types occur in both Natural Subregions.

3.3.7 Sustainable Ecosystem Working Group Vegetation Indicators

The Cumulative Environmental Management Association (CEMA) Sustainable Ecosystem Working Group (SEWG) is mandated to develop environmental indicators that can be used to characterize environmental setting and future environmental conditions as part of the EIA process. One of the goals of the indicator list is to "sustain the natural range of vegetation communities, successional patterns and ecological processes". Three indicators have been developed by SEWG to be used in evaluating this goal, which include:

- area of vegetation types;
- pattern of vegetation types; and
- age of vegetation types.

Results on the areas of vegetation types in the RSA and both LSAs are provided in Sections 3.4.1, 3.5.1 and 3.6.1, respectively. Results on the pattern of vegetation types are provided in the Biodiversity ESR (Section 6). Results on the age of vegetation types are provided in Sections 3.5.1.3 and 3.6.1.3.

3.3.8 Quality Assurance / Quality Control

A QA/QC program was implemented to ensure that data collection, data entry and data analysis were conducted with confidence. The QA/QC program used for the Project ensures that the possibility of error is minimized during data collection, data entry and data analysis.

As a means of consistency and quality of data collected, standardized datasheets and methodologies were used. Technical procedure manuals and specific work instructions were written for this purpose (Golder 2006a,b,c,d,e,f). Quality assurance and quality control protocols were used to ensure consistency among surveyors. Datasheet QA/QC was completed in the field and in the evening for all datasheets completed for that day. The QA/QC check included an exchange of datasheets between field crews or team members to ensure legibility and that all fields were properly entered.

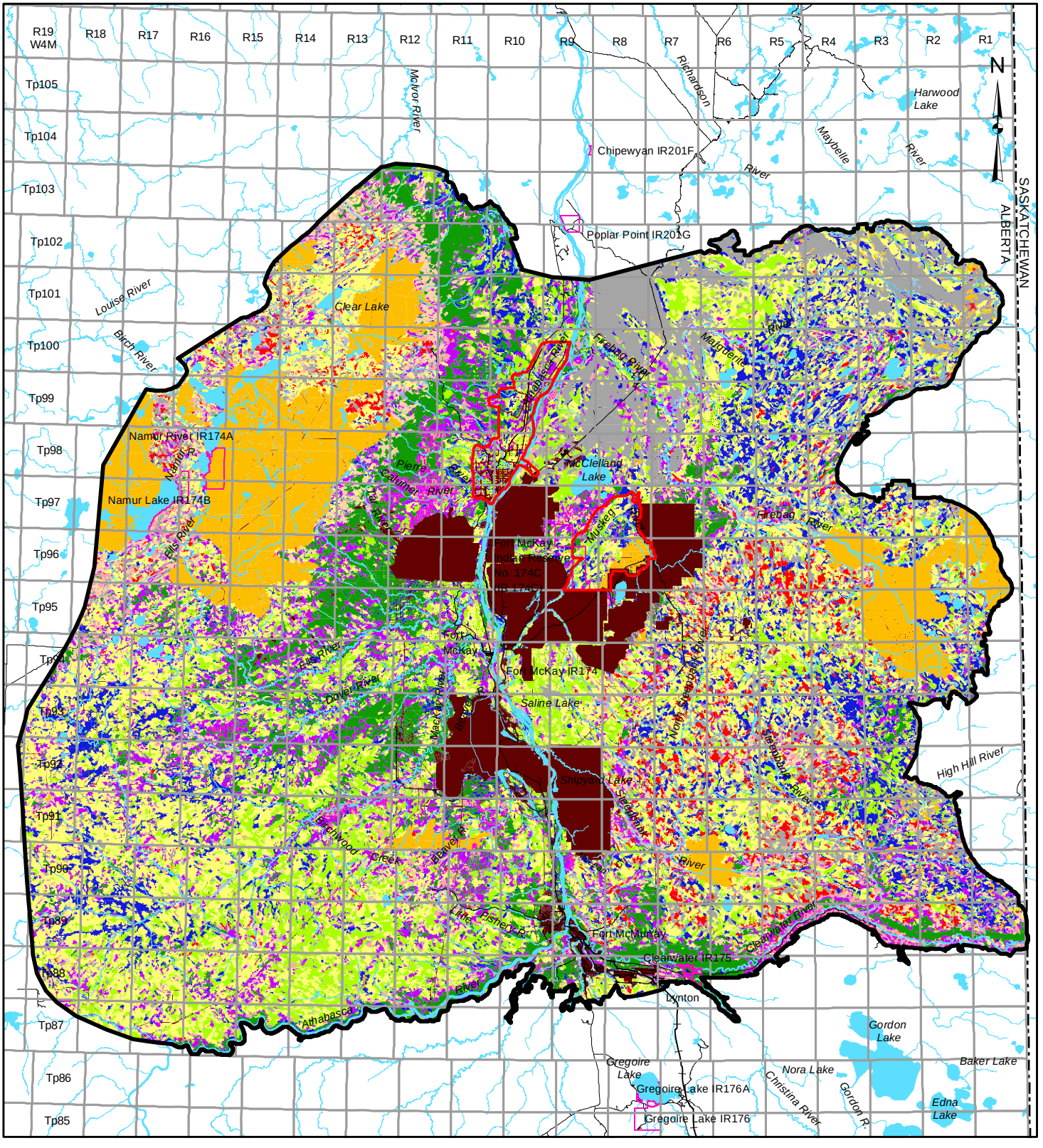
Data entry was evaluated for errors or omissions by reviewing each datasheet to ensure that the electronic database accurately reflected field observations. All calculations conducted as part of the Project were checked to make sure that the correct formulas, procedures or data source was used.

3.4 REGIONAL RESULTS

3.4.1 Terrestrial Vegetation and Wetlands

3.4.1.1 Overview

The regional vegetation classification identifies 13 land cover classes (Table 3.4-1, Figure 3.4-1). This regional coverage includes six terrestrial classes, three wetlands classes, two miscellaneous land cover classes and two disturbance classes.



LEGEND

- TERRESTRIAL RESOURCES REGIONAL STUDY AREA
- LOCAL STUDY AREAS
- INDIAN RESERVE
- OPEN WATER
- PUBLIC ROADWAY
- RAILROAD

DISTURBED

- EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE
- EXISTING AND APPROVED URBAN AND INDUSTRIAL LINEAR DISTURBANCE

LAND COVER CLASSES

- BURN
- CONIFEROUS JACK PINE
- CONIFEROUS JACK PINE-BLACK SPRUCE
- CONIFEROUS WHITE SPRUCE
- CUTBLOCK
- DECIDUOUS ASPEN-BALSAM POPLAR
- MIXEDWOOD ASPEN-JACK PINE
- MIXEDWOOD ASPEN-WHITE SPRUCE
- NON-TREED WETLANDS
- TREED BOG / POOR FEN
- TREED FEN

25 0 25

SCALE 1:1,000,000 KILOMETRES

REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2004), Pearson Timberline Ltd. (April 2004), LANDSAT 7 ETM Imagery (July 2006), and Alberta SRD, used under license.
Saskatchewan digital data obtained from Information Services Corp. (September 2004), used under license.
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 12.

PROJECT

JACKPINE MINE EXPANSION & PIERRE RIVER MINE PROJECT

TITLE

ECOLOGICAL LAND COVER CLASSES WITHIN THE REGIONAL STUDY AREA

Shell Canada Limited

PROJECT No. 05-1344-027.7600			SCALE AS SHOWN	REV. 0
DESIGN	VR	22 Jan. 2007	FIGURE: 3.4-1	
GIS	JH	14 Nov. 2007		
CHECK	AA	20 Nov. 2007		
REVIEW	TC	27 Nov. 2007		

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The Project RSA covers an area of 2,277,376 ha. Terrestrial vegetation covers 800,902 ha (35%) of the RSA while wetlands cover 1,039,328 ha (46%) of the RSA (Table 3.4-1). Existing disturbances (i.e., urban areas, industrial development, roads, seismic lines, well sites and clearings) and cutblocks account for 181,153 ha (8%) of the RSA. The remaining 255,993 ha (11%) of the RSA is burnt or represented by lakes and rivers.

Table 3.4-1 Total Area and Percent Cover of Land Cover Classes Within the Regional Study Area

Regional Land Cover Class	Regional Study Area	
	[ha]	[%]
Terrestrial Vegetation		
deciduous aspen-balsam poplar	203,653	9
coniferous jack pine	215,255	9
coniferous jack pine-black spruce	61,737	3
coniferous white spruce	58,199	3
mixedwood aspen-jack pine	61,535	3
mixedwood aspen-white spruce	200,523	9
terrestrial vegetation subtotal	*800,902*	*35*
Wetlands (Peatlands)		
non-treed wetlands	230,167	10
treed bog / poor fen	525,347	23
treed fen	283,815	12
wetlands (peatlands) subtotal	*1,039,328*	*46*
Other		
burn	207,257	9
water	48,736	2
other subtotal	*255,993*	*11*
Disturbances		
cutblock	10,839	<1
disturbances (urban and industrial)	170,314	7
disturbances subtotal	*181,153*	*8*
Total	**2,277,376**	**100**

Note: Some numbers are rounded for presentation purposes. Therefore, it may appear that the totals do not equal the sum of the individual values.

3.4.1.2 Regional Land Cover Class Descriptions

Regional Lands Cover Classes are described in terms of dominant vegetation and general distribution in the RSA. References to ecosite phases refer to the Central Mixedwood Natural Subregion classification, as it is the dominant subregion in the RSA.

Deciduous Aspen-Balsam Poplar

The deciduous aspen-balsam poplar land cover class is typically found on upland sites with well to moderately well-drained soils developed from morainal parent materials. It has a closed canopy, usually dominated by aspen but balsam poplar may be common as well. White spruce and other conifers may be present but

with very low cover. The understorey typically supports a diverse mix of shrubs and forbs including species such as Canada buffalo-berry, prickly rose, Labrador tea and low-bush cranberry. The low-bush cranberry aspen (d1) ecosite phase is most strongly associated with this land cover class. The dogwood balsam poplar-aspen (e1) and the horsetail balsam poplar-aspen (f1) ecosite phases are also associated with this class. The deciduous aspen-balsam poplar land cover class covers 203,653 ha (9%) of the RSA (Table 3.4-1) and occurs mostly on the west side of the Athabasca River, especially along the escarpment of the Birch Mountains, but also east of Fort McMurray (Figure 3.4-1).

Coniferous Jack Pine

The coniferous jack pine land cover class is associated with rapidly drained aeolian and glaciofluvial deposits and the jack pine lichen (a1) ecosite phase. This land cover class is dominated by a relatively open, even-aged canopy of jack pine and an understorey of blueberry, bog cranberry, common bearberry and reindeer lichen (*Cladina mitis*). The coniferous jack pine land cover class covers 215,255 ha (9%) of the RSA (Table 3.4-1) and occurs mostly in the northern and eastern parts of the study area (Figure 3.4-1).

Coniferous Jack Pine-Black Spruce

The coniferous jack pine-black spruce land cover class is found on well to imperfectly drained soils where submesic to subhygric moisture regimes and poor nutrient regimes exist. It is associated with the Labrador tea–mesic jack pine-black spruce (c1) ecosite phase but may also include a percentage of the Labrador tea–subhygric black spruce-jack pine (g1) ecosite phase. The tree layer of the land cover class typically contains a mix of jack pine and black spruce with jack pine being more common on well-drained sites and black spruce more common on imperfectly drained sites Ground-level vegetation is typically composed of Labrador tea and feather mosses such as Schreber's moss and knight's plume moss. The coniferous jack pine-black spruce land cover class covers 61,737 ha (3%) of the RSA (Table 3.4-1) and occurs mostly in the northwestern and eastern parts of the study area (Figure 3.4-1).

Coniferous White Spruce

The coniferous white spruce land cover class is typically found in areas with well to imperfectly drained soils. White spruce communities typically occur near streams and cool, wet slopes in hilly upland areas where fires have been excluded for several decades. This land cover class is most strongly associated with the low-bush cranberry white spruce (d3) ecosite phase. The dogwood white spruce (e3), the horsetail white spruce (f3) and the Labrador tea/horsetail white spruce–black spruce (h1) ecosite phases are also associated with this class. The tree

layer is usually dominated by white spruce but may also contain a significant black spruce component and few deciduous trees. Compared with other terrestrial land cover classes, this forest type tends to contain older trees and represent a late forest successional stage. The coniferous white spruce land cover class covers 58,199 ha (3%) of the RSA (Table 3.4-1) and is scattered throughout most parts of the study area (Figure 3.4-1).

Mixedwood Aspen-Jack Pine

The mixedwood aspen-jack pine land cover class has rapid to well-drained soils developed from coarse-textured glaciofluvial parent material. It occurs in crest or upper slope positions where soils are generally dry. This land cover class is most strongly associated with the blueberry jack pine-aspen (b1) ecosite phase. Stands are usually dominated by a mix of jack pine and aspen. Understorey vegetation may include species such as green alder, Canada buffalo-berry, common blueberry, bog cranberry and reindeer lichen (*Cladina mitis*). The mixedwood aspen-jack pine land cover class covers 61,535 ha (3%) of the RSA (Table 3.4-1) and occurs throughout most parts of the study area but is most concentrated along the top of the Birch Mountain escarpment (Figure 3.4-1).

Mixedwood Aspen-White Spruce

The mixedwood aspen-white spruce land cover class is typically found on upland terrain with well to imperfectly well-drained soils developed from morainal parent materials. The tree canopy of this class is typically composed of a mixture of aspen and white spruce but may also contain balsam poplar, white birch and black spruce. Shrub and forb cover is usually diverse with species such as Labrador tea, twinflower, prickly rose, low-bush cranberry, bunchberry and wild sarsaparilla. The low-bush cranberry aspen-white spruce (d2) ecosite phase is most strongly associated with this land cover class. The dogwood balsam poplar-white spruce (e2) and horsetail balsam poplar-white spruce (f2) ecosite phases are also associated with this class. The mixedwood aspen-white spruce land cover class covers 200,523 ha (9%) of the RSA (Table 3.4-1) and is scattered throughout the study area, but mostly on the west side of the Athabasca River (Figure 3.4-1).

Non-Treed Wetlands

The non-treed wetlands land cover class represents all wetlands that lack a tree canopy, which includes the graminoid fen, shrubby fen, shrubby swamp and marsh wetlands types. Soils are poorly to very poorly drained typically resulting in the development of organic soils. Vegetation may contain a shrub layer, usually dominated by willow, but may also be represented by dwarf birch or river alder. Sedges are usually abundant in shrubby or graminoid wetlands. Other

common vascular species include bluejoint, swamp horsetail, marsh-marigold, marsh cinquefoil and buck-bean. Common bryophytes include brown moss, tufted moss, golden moss and peat moss. The non-treed wetlands land cover class covers 230,167 ha (10%) of the RSA (Table 3.4-1) and occur throughout most parts of the study area (Figure 3.4-1).

Treed Poor Fen/Bog

The treed poor fen/bog land cover class is found on poorly to very poorly drained, organic soils within low-lying areas. Vegetation may vary in structure, with some sites consisting of a very open tree canopy of black spruce and closed black spruce shrub layer, while other sites support a denser canopy of black spruce. The tree canopy in a portion of the poor fens may contain a component of tamarack. Black spruce bogs are acidic and very nutrient poor. Poor fens have slightly higher pH values. Shrub cover and composition is varied but may include Labrador tea, black spruce and bog cranberry within the bogs and more willow and dwarf birch on poor fens as groundwater pH increases. Other common species include cloudberry, horsetail, three-leaved Solomon's-seal, sedge, peat moss and golden moss. The treed poor fen/bog land cover class is the most common class in the RSA. It covers 525,347 ha (23%) of the RSA (Table 3.4-1) and is common throughout (Figure 3.4-1).

Treed Fen

Treed fens are characterized as poor to moderately rich peatlands. The overstorey is often dominated by tamarack but black spruce may form a significant component of the canopy. Dwarf birch and willow are often found in the understorey along with tamarack and black spruce. The herb layer is characterized by a cover of buck-bean, marsh marigold and marsh cinquefoil. Various sedge species are common in the graminoid layer. The treed fen land cover class covers 283,815 ha (12%) of the RSA (Table 3.4-1) and occurs throughout most parts of the study area (Figure 3.4-1).

Burn

The burn land cover class includes areas that may have been burnt over within the last 20 years. This cover class includes a variety of regenerating vegetation types from dry jack pine stands to shrubby vegetation type composed of a variety of species such as white birch, willow and black spruce. The burn land cover class covers 207,257 ha (9%) of the RSA (Table 3.4-1). It is prominent on top of Birch Mountain, in the east-central part of the study area, and in several other smaller patches throughout the RSA (Figure 3.4-1), including the 2002 Kearl Lake wildfire in the JEMA LSA.

Water

The water class primarily includes rivers and lakes within the RSA. It covers 48,736 ha (2%) of the RSA (Table 3.4-1) and includes water features such as the Athabasca River and McClelland Lake.

Cutblocks

The cutblock land cover class is represented by areas that have been cut over by timber harvest operations and are presently regenerating. Pole- to sapling-sized trees are considered to dominate the cutblock class. More recent cutblocks may be dominated by shrubs such as willow, green alder, prickly rose and low-bush cranberry as well as various forbs and grasses. The cutblock land cover class covers 10,839 ha (less than 1%) of the RSA (Table 3.4-1) and primarily occurs west of the Athabasca River.

Disturbance

Disturbances within the RSA are represented by mines, industrial areas, borrow pits, well sites, borehole pads, clearings, roads, rights-of-ways, trails and seismic lines. Disturbances are concentrated mainly in the central part of the RSA where several mines are in operation or at the construction stage. The disturbance land cover class occupies 107,314 ha (7%) of the RSA (Table 3.4-1).

3.4.2 Landscape-Level Analyses

3.4.2.1 Heterogeneity

Composition and Distribution of Regional Land Cover Classes

The composition and distribution of the 13 regional land cover classes in the RSA are represented in Figure 3.4-1. The results of the heterogeneity analysis for regional land cover classes in the RSA are summarized according to terrestrial (Table 3.4-2), wetlands (Table 3.4-3) and disturbed classes (Table 3.4-4) as follows:

- The 13 regional land cover classes are evenly distributed within the RSA (Shannon's evenness of 0.92 out of 1). Terrestrial classes (6) cover 36%, wetlands classes (4) cover 47% and disturbed classes (3) cover 17% of the RSA (Figure 3.4-1).
- Among terrestrial classes (Table 3.4-2), coniferous jack pine is the largest regional land cover class with 5,981 patches covering 214,229 ha (9%) of the RSA. Mean patch size is 35.8±273.7 ha, but median patch size is only 10.0 ha. This indicates that the distribution of patch sizes is

skewed towards smaller patches; therefore, the median is a more accurate estimate of typical patch size for this class. Coniferous jack pine patches are also highly variable in size (AREA_CV of 764%).

- Deciduous aspen-balsam poplar and mixedwood aspen-white spruce are the next largest terrestrial classes, with 7,154 and 10,436 patches covering 201,331 ha (9%) and 198,429 ha (9%) of the RSA, respectively.
- Overall, the dominant three terrestrial habitats are relatively evenly distributed within the RSA; however, mixedwood aspen-white spruce is more evenly distributed (Interpersion/Juxtaposition Index [IJI] of 89%) than coniferous jack pine (IJI of 84%) and deciduous aspen-balsam poplar (IJI of 82%).
- The remaining three terrestrial classes are essentially equally abundant (3% of the RSA), but the coniferous jack pine-black spruce is not as evenly distributed (IJI of 79%) as mixedwood aspen-jack pine or coniferous white spruce (both with an IJI of 90%).
- Wetlands (Table 3.4-3) comprise both the largest and smallest regional land cover class within the RSA. The largest is treed bog/poor fen with 14,871 patches covering 520,332 ha (23%) of the RSA. It has a mean patch size of 35.0±144.1 ha and a median patch size of 5.7 ha. This indicates that there are disproportionately more small patches than large ones. Treed fen and non-treed wetlands are similarly abundant on the landscape at 10% and 12% of the RSA, respectively. Water covers only 48,686 ha (2%) of the RSA, which is distributed among 1,758 patches of highly variable size (AREA_CV of 653%).
- Water is the most evenly distributed wetlands class (IJI of 90%) and treed fens tend to be more aggregated within the RSA (IJI of 78%).
- Among the disturbed classes (Table 3.4-4), 1,649 burned patches cover 205,345 ha (9%) of the RSA. This class has the largest mean patch size (124.5±1,213.8 ha), although the median patch size is 6.4 ha, which indicates that most burn patches are much smaller. Human disturbed areas cover 199,540 ha (8%) of the RSA and are distributed among 5,508 patches that are highly variable in size (AREA_CV of 7,129%). Disturbed areas have a mean patch size of 36.2±2,582.5 ha and median patch size of 0.2 ha suggesting that most patches are small.
- Human disturbed patches are more evenly distributed (IJI of 87%) than burns (IJI of 76%).

In summary, wetlands classes are the most abundant patch types in the RSA (47%), followed by terrestrial classes (36%) and disturbed classes (17%). Mean patch size ranges from 17.4±32.2 ha (coniferous white spruce) to 124.5±1,213.8 ha (burn). Median patch size ranges from 0.2 ha (human disturbed) to 13.1 ha (coniferous jack pine-black spruce) and IJI ranges from

76% (burn) to 90% (water, coniferous white spruce and mixedwood aspen-jack pine). The mean patch size metrics indicate that patch size for each regional land cover class is variable (AREA_CV more than 100%), and there are disproportionately more small patches than large patches for all classes within the RSA. Classes are generally evenly distributed, but burns, treed fens and coniferous jack pine-black spruce tend to be more aggregated within the RSA.

Table 3.4-2 Landscape Heterogeneity of Terrestrial Regional Land Cover Classes

Landscape Measurement[(a)]	Unit	Coniferous Jack Pine	Coniferous Jack Pine-Black Spruce	Coniferous White Spruce	Deciduous Aspen-Balsam Poplar	Mixedwood Aspen-Jack Pine	Mixedwood Aspen-White Spruce
class area (CA)	ha	214,229	61,400	57,693	201,331	61,077	198,429
CA proportion of RSA	%	9	3	3	9	3	9
number of patches (NP)	n/a	5,981	2,410	3,310	7,154	3,177	10,436
mean patch size (AREA_MN)	ha	35.8	25.5	17.4	28.1	19.2	19.0
median patch size (AREA_MD)	ha	10.0	13.1	9.1	4.5	9.4	7.4
patch size standard deviation (AREA_SD)	ha	273.7	48.3	32.2	271.4	48.6	41.3
patch size coefficient of variance (AREA_CV)	%	764	190	185	964	253	217
distribution (IJI)	%	84	79	90	82	90	89

(a) A description of landscape measurements is provided in Appendix J.

n/a = Not applicable.

Notes: Some numbers are rounded for presentation purposes.

Table 3.4-3 Landscape Heterogeneity of Wetlands Regional Land Cover Classes

Landscape Measurement[(a)]	Unit	Non-Treed Wetlands	Treed bog/ poor fen	Treed fen	Water
class area (CA)	ha	228,010	520,332	281,292	48,686
CA proportion of RSA	%	10	23	12	2
number of patches (NP)	n/a	12,408	14,871	10,650	1,758
mean patch size (AREA_MN)	ha	18.4	35.0	26.4	27.7
median patch size (AREA_MD)	ha	3.7	5.7	7.2	3.5
patch size standard deviation (AREA_SD)	ha	69.5	144.1	132.7	180.8
patch size coefficient of variance (AREA_CV)	%	378	412	502	653
distribution (IJI)	%	84	86	78	90

(a) A description of landscape measurements is provided in Appendix J.

n/a = Not applicable.

Table 3.4-4 Landscape Heterogeneity of Disturbed Regional Land Cover Classes

Landscape Measurement[a]	Unit	Burn[b]	Human Disturbed
class area (CA)	ha	205,345	199,540
CA proportion of RSA	%	9	8
number of patches (NP)	n/a	1,649	5,508
mean patch size (AREA_MN)	ha	124.5	36.2
median patch size (AREA_MD)	ha	6.4	0.2
patch size standard deviation (AREA_SD)	ha	1,213.8	2,582.5
patch size coefficient of variance (AREA_CV)	%	975	7,129
distribution (IJI)	%	76	87

(a) A description of landscape measurements is provided in Appendix J.

(b) The Burned class includes all terrestrial and wetlands areas disturbed by fire.

n/a = Not applicable.

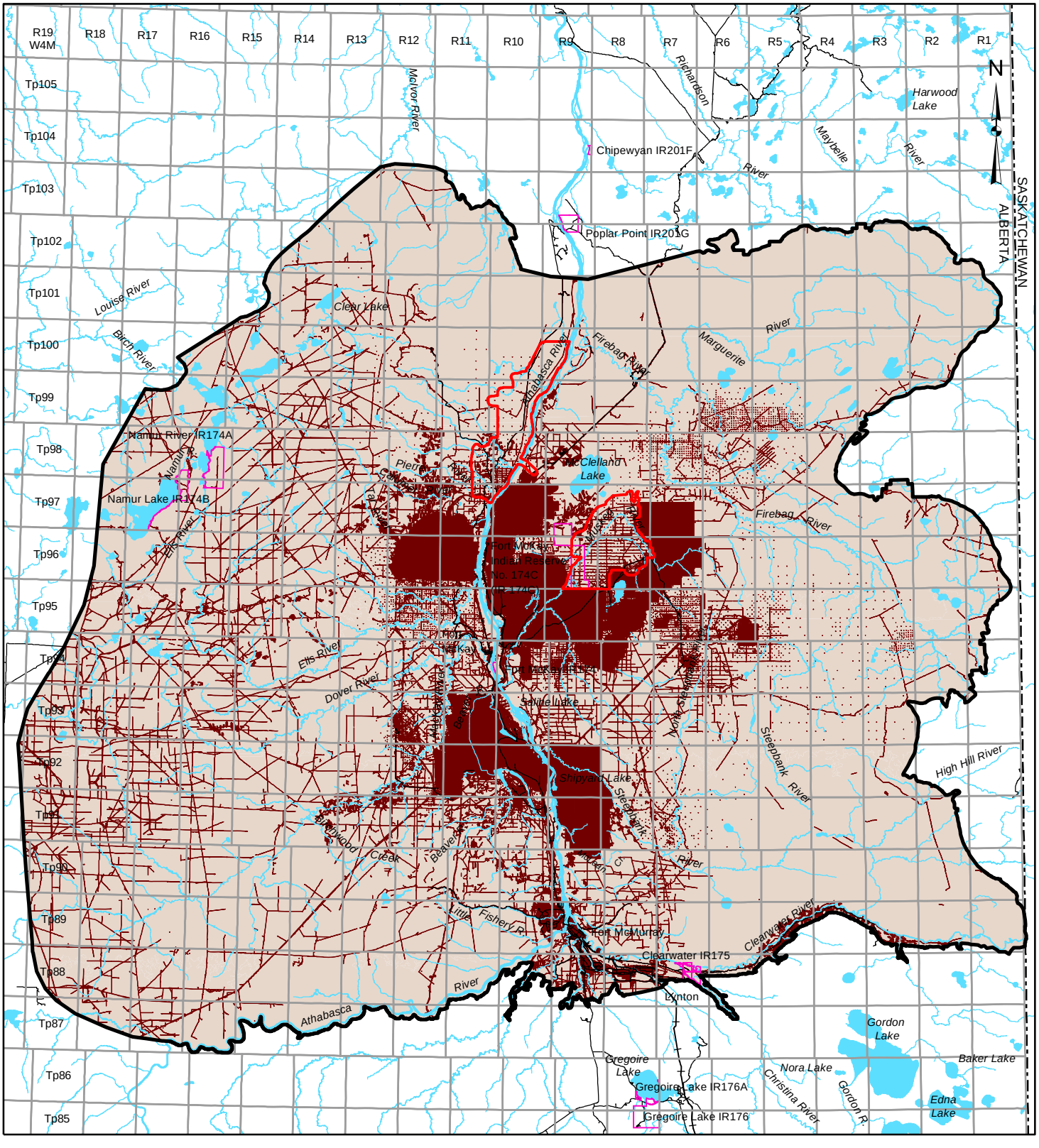
Note: Some numbers are rounded for presentation purposes.

3.4.2.2 Fragmentation

Natural Areas and Human Disturbed Areas

Landscape fragmentation was assessed by examining the distribution of natural areas and human disturbed areas in the RSA (Figure 3.4-2, Table 3.4-5). A summary of fragmentation results are as follows:

- Natural areas occupy 2,077,913 ha (92%) of the RSA, distributed among 8,210 patches. Mean patch size is 253.1±7,517.6 ha and median patch size is much smaller (1.2 ha), thus indicating that there are many small and few large "natural" patches. Human disturbed areas comprise a much smaller proportion of the RSA (5,510 patches occupying 199,461 ha or 8%). Human disturbed patches were smaller on average (AREA_MN of 36.2±2,580.9 ha and AREA_MD of 0.2 ha) and more variable in size (AREA_CV of 7,130%) than natural patches.
- The shape complexity index shows that natural patches are moderately simple in shape (FRAC_MN of 1.06) and primarily composed of core area habitat (87%). Disturbed patches are very simple in shape (i.e., nearly circular or square; FRAC_MN of 1.03). There is no core habitat available in disturbed patches.
- The total edge (or boundary length) between natural and human disturbed patches in the RSA is 35,128 km.



LEGEND

- TERRESTRIAL RESOURCES REGIONAL STUDY AREA
- LOCAL STUDY AREAS
- INDIAN RESERVE
- OPEN WATER
- PUBLIC ROADWAY
- RAILROAD

NATURAL AND HUMAN DISTURBED AREAS

- NATURAL AREAS
- HUMAN DISTURBED AREAS

25 0 25

SCALE 1:1,000,000 KILOMETRES

REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2004), Pearson Timberline Ltd. (April 2004), LANDSAT 7 ETM Imagery (July 2006), and Alberta SRD, used under license.
Saskatchewan digital data obtained from Information Services Corp. (September 2004), used under license.
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 12.

PROJECT

JACKPINE MINE EXPANSION & PIERRE RIVER MINE PROJECT

TITLE

NATURAL AND HUMAN DISTURBED AREAS WITHIN THE REGIONAL STUDY AREA

Shell Canada Limited

PROJECT No. 05-1344-027.7600			SCALE AS SHOWN	REV. 0
DESIGN	VR	22 Jan. 2007	FIGURE: 3.4-2	
GIS	VR	17 Nov. 2007		
CHECK	AA	17 Nov. 2007		
REVIEW	WES/TC	20 Nov. 2007		

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Table 3.4-5 Fragmentation of Natural Areas by Human Disturbed Areas Within the Regional Study Area

Landscape Measurement[a]	Unit	Natural	Human Disturbed[b]
class area (CA)	ha	2,077,913	199,461
CA proportion of RSA	%	92	8
number of patches (NP)	n/a	8,210	5,510
patch size mean (AREA_MN)	ha	253.1	36.2
patch size median (AREA_MD)	ha	1.2	0.2
patch size standard deviation (AREA_SD)	ha	7,517.6	2,580.9
patch size coefficient of variation (AREA_CV)	%	2,970	7,130
shape complexity (FRAC_MN)	n/a	1.06	1.03
core area index area weighted mean (CAI_AM)	%	87	n/a
total edge (TE)	km	35,128	

(a) A description of landscape measurements is provided in Appendix J.

(b) Some values do not equal values presented in Table 3.4-4 due to differences in patch definition between the heterogeneity and fragmentation analyses.

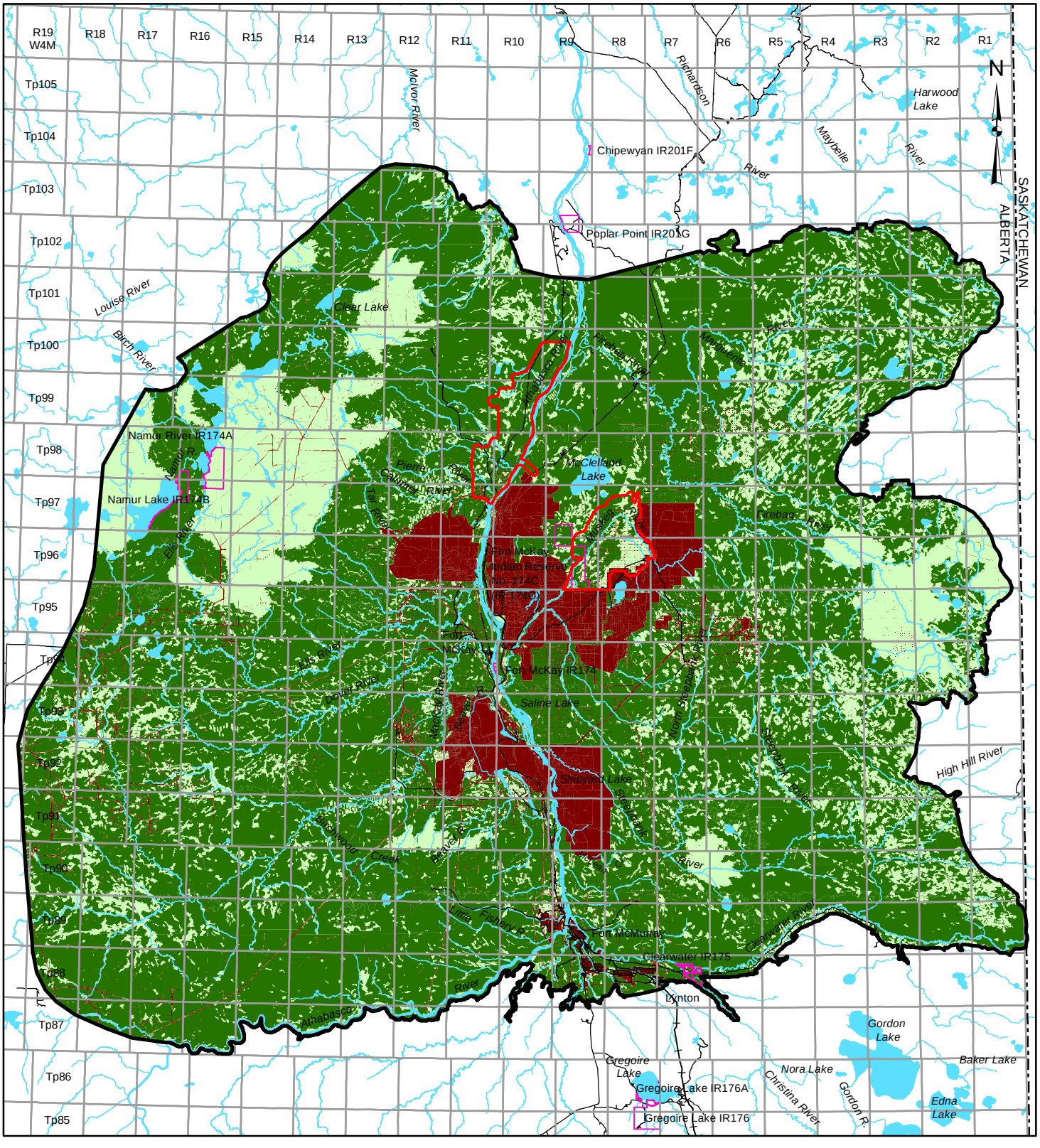
n/a = Not applicable.

Note: Some numbers are rounded for presentation purposes.

Forested and Non-Forested Areas

Landscape fragmentation and core area habitat were assessed by examining the distribution of forested and non-forested areas in the RSA (Figure 3.4-3 and Table 3.4-6). A summary of fragmentation results are as follows:

- Forested areas are much more abundant (1,595,870 ha) than non-forested areas (482,007 ha), but are distributed among fewer patches (10,858 forested patches compared to 13,236 non-forested patches).
- Forested areas have a mean patch size of 147.0±3,378.2 ha, a median patch size of 1.6 ha and a high coefficient of variation (AREA_CV of 2,298%). This indicates that patch size is highly variable and that there are many small patches of forested areas (50% of patches are less than 1.6 ha) and a few large forested areas in the northern portion of the RSA (Figure 3.4-3).



LEGEND

- TERRESTRIAL RESOURCES REGIONAL STUDY AREA
- LOCAL STUDY AREAS
- INDIAN RESERVE
- OPEN WATER
- PUBLIC ROADWAY
- RAILROAD

FORESTED AND NON-FORESTED AREAS

- FORESTED
- NON-FORESTED

DISTURBED

- EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE
- EXISTING AND APPROVED URBAN AND INDUSTRIAL LINEAR DISTURBANCE

25 0 25

SCALE 1:1,000,000 KILOMETRES

REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2004), Pearson Timberline Ltd. (April 2004), LANDSAT 7 ETM Imagery (July 2006), and Alberta SRD, used under license.
Saskatchewan digital data obtained from Information Services Corp. (September 2004), used under license.
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 12.

PROJECT

JACKPINE MINE EXPANSION & PIERRE RIVER MINE PROJECT

TITLE

FORESTED, NON-FORESTED AND HUMAN DISTURBED AREAS WITHIN THE REGIONAL STUDY AREA

Shell Canada Limited

PROJECT No. 05-1344-027.7600			SCALE AS SHOWN	REV. 0
DESIGN	VR	22 Jan. 2007		
GIS	VR	17 Nov. 2007		
CHECK	AA	17 Nov. 2007		
REVIEW	WES/TC	20 Nov. 2007		

FIGURE: 3.4-3

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- Non-forested areas are much smaller (AREA_MN of 36.4±565.7 ha), have a larger median patch size (3.4 ha) and a lower coefficient of variation (AREA_CV of 1,553%) than forested areas. This indicates that the size of non-forested patches is also highly variable and that there are many small patches of non-forested areas (50% of patches are less than 3.4 ha) and a few large patches of non-forested areas (e.g., a large burned area in the northwest portion of the RSA).
- Forested and non-forested patches both have a moderately simple shape (FRAC_MN of 1.07 and 1.09, respectively) compared to the quite regularly shaped human disturbed patches (FRAC_MN of 1.03; Table 3.4-5).
- Within forested patches, 73% is considered core area (51% of the RSA), thus providing effective habitat for interior forest-dwelling species. In contrast, only 54% of non-forested patches is considered core area (11% of the RSA), which is likely a function of the much smaller mean patch size of these patches.
- Forested areas are separated by a mean distance of 46.0±28.7 m, a median distance of 40.0 m and have a relatively low variation of this nearest neighbour parameter (ENN_CV of 62%). Most of the forested areas are separated by human disturbed areas and areas of open water.
- Non-forested areas are separated by a mean distance of 129.0±215.6 m, a median distance of 40.0 m and have a moderately high variation of this nearest neighbour distance (ENN_CV of 167%). Most of the non-forested areas in the RSA are separated by forested areas.

Table 3.4-6 Fragmentation of Forested and Non-Forested Areas Within the Regional Study Area

Landscape Measurement[(a)]	Unit	Forested	Non-Forested
class area (CA)	ha	1,595,870	482,007
CA proportion of RSA	%	71	21
number of patches (NP)	n/a	10,858	13,236
patch size mean (AREA_MN)	ha	147.0	36.4
patch size median (AREA_MD)	ha	1.6	3.4
patch size standard deviation (AREA_SD)	ha	3,378.2	565.7
patch size coefficient of variation (AREA_CV)	%	2,298	1,553
shape complexity (FRAC_MN)	n/a	1.07	1.09
total core area (TCA)	ha	1,163,833	260,824
TCA proportion of RSA	%	51	11
core area index area weighted mean (CAI_AM)	%	73	54
nearest neighbour mean (ENN_MN)	m	46.0	129.0
nearest neighbour median (ENN_MD)	m	40.0	40.0
nearest neighbour standard deviation (ENN_SD)	m	28.7	215.6
nearest neighbour coefficient of variation (ENN_CV)	%	62	167

[(a)] A description of landscape measurements is provided in Appendix J.

n/a = Not applicable.

Note: Some numbers are rounded for presentation purposes.

Riparian Areas

Spatial attributes of riparian patches were assessed for the RSA (Table 3.4-7). A summary of fragmentation results are as follows:

- Riparian patches cover a total of 203,463 ha (9%) of the RSA. This area consists of 12,299 patches with a mean patch size of 16.5±61.8 ha and a median patch size of 3.7 ha.
- Riparian patch size was highly variable (AREA_CV of 374%).
- Riparian communities are moderately well distributed within the RSA, but tend to be more prevalent west of the Athabasca River.

Table 3.4-7 Spatial Analysis of Riparian Areas Within the Regional Study Area

Landscape Measurement[(a)]	Unit	Riparian
class area (CA)	ha	203,463
CA proportion of RSA	%	9
number of patches (NP)	n/a	12,299
patch size mean (AREA_MN)	ha	16.5
patch size median (AREA_MD)	ha	3.7
patch size standard deviation (AREA_SD)	ha	61.8
patch size coefficient of variation (AREA_CV)	%	374

(a) A description of landscape measurements is provided in Appendix J.

n/a = Not applicable.

Note: Some numbers are rounded for presentation purposes.

3.4.3 Key Indicator Resources

3.4.3.1 Community-Level Key Indicator Resource Descriptions in the Regional Study Area

Key Indicator Resources are used to describe and assess economically, culturally and ecologically important plant communities within the RSA. Within the Oil Sands Region, lichen jack pine communities, riparian communities, peatlands and economic (old growth and productive) forests have been selected as community-level vegetation KIRs.

Lichen Jack Pine Communities

Lichen jack pine communities at the RSA scale are associated with the coniferous jack pine land cover class. A total of 215,255 ha (9% of the RSA) were mapped in the RSA.

Riparian Communities

Riparian communities were selected as a community-level KIR primarily for their wildlife resource value, ecological and social importance, and vulnerability to disturbance. Riparian communities account for 203,463 ha (9%) of the RSA (Table 3.4-8). They are composed of both terrestrial vegetation and wetlands types, dominated by non-treed wetlands that comprise 30% of all riparian communities. The deciduous aspen-balsam poplar land cover class is the most common terrestrial riparian community covering 44,033 ha (2%) of the RSA.

Table 3.4-8 Area and Percent Cover of Riparian Communities Within 100 m of Waterbodies and Watercourses Within the Regional Study Area

Regional Land Cover Class	Regional Study Area		
	[ha]	% of Riparian	[%]
Terrestrial Vegetation			
coniferous white spruce	15,819	8	1
deciduous aspen-balsam poplar	44,033	22	2
mixedwood aspen-white spruce	39,303	19	2
terrestrial vegetation subtotal	*99,155*	*49*	*4*
Wetlands			
non-treed wetlands	61,529	30	3
treed fen	42,779	21	2
wetlands subtotal	*104,308*	51	*5*
Total	**203,463**	**100**	**9**

Note: Some numbers are rounded for presentation purposes. Therefore, it may appear that the totals do not equal the sum of the individual values.

Peatlands

Peatlands are a community-level KIR primarily selected for their ecological and social importance, and vulnerability to disturbance. Within the RSA, peatlands are represented by the following land cover classes:

- non-treed wetlands;
- treed fen; and
- treed poor fen/bog.

Peatlands account for 1,039,238 ha (46%) of the RSA (Figure 3.4-1, Table 3.4-9). The treed poor fen/bog land cover class makes up the majority of all peatlands and covers an area of 525,347 ha (23%) of the RSA. Peatlands occur throughout the RSA.

Table 3.4-9 Area and Percent Cover of Peatlands and Non-Peatlands Within the Regional Study Area

Regional Land Cover Class	Regional Study Area	
	[ha]	[%]
Peatlands[(a)]		
non-treed wetlands	230,167	10
treed bog / poor fen	525,347	23
treed fen	283,815	12
peatlands subtotal	*1,039,328*	*46*
Non-Peatlands		
deciduous aspen-balsam poplar	203,653	9
coniferous jack pine	215,255	9
coniferous jack pine-black spruce	61,737	3
coniferous white spruce	58,199	3
mixedwood aspen-jack pine	61,535	3
mixedwood aspen-white spruce	200,523	9
water	48,736	2
cutblock	10,839	<1
disturbances (urban and industrial)	170,314	7
non-peatlands subtotal	*1,030,791*	*45*
Burn		
burn (unknown)	207,257	9
burn subtotal	*207,257*	*9*
Total	**2,277,376**	**100**

(a) The majority component of each peatlands land cover class is dominated by peatlands. Some non-peatlands do occur within the classes (i.e., swamps and marshes).

Note: Some numbers are rounded for presentation purposes. Therefore, it may appear that the totals do not equal the sum of the individual values.

Old Growth Forests

An estimate of the natural levels of forest age-class variability has been studied for Alberta-Pacific Forest Industries Inc. (Al-Pac). Andison (2003, website) estimates that overmature (old growth) forest types account for 10 to 42% of the forested land base, based on an 80-year fire cycle. Schneider (2002) also provides an estimate of old growth forests in Alberta of 26.5%, which is close to the mid-point of the range provided by Andison (2003, website).

Based on Andison's (2003, website) estimates, Table 3.4-10 shows the amount of predicted old growth forest in the RSA based on the mid-point value of the range in the percent occurrence of each particular forest type. In total, 374,433 ha (16%) of the RSA is estimated to be classed as potential old growth forest.

Table 3.4-10 Estimated Old Growth in the Regional Study Area

Regional Land Cover Classes	Forest Type (Old Growth Range)[(a)]	Mid-Point Estimated Occurrence of Old Growth in the RSA[(a)]	Estimated Total Class Area in the RSA	Estimated Old Growth in the RSA	
		[%]	[ha]	[ha]	[%]
Forested Cover Type					
deciduous aspen-balsam poplar	hardwood dominant (14 to 42%)	28	203,653	57,023	3
coniferous jack pine	pine dominant (16 to 36%)	26	215,255	55,966	2
coniferous jack pine-black spruce	pine dominant (16to 36%)	26	61,737	16,052	1
coniferous white spruce	white spruce dominant (10 to 34%)	22	58,199	12,804	1
mixedwood aspen-jack pine	mixedwood dominant (16 to 38%)	27	61,535	16,614	1
mixedwood aspen-white spruce	mixedwood dominant (16 to 38%)	27	200,523	54,141	2
treed bog / poor fen	black spruce dominant (12 to 28%)	20	525,347	105,069	5
treed fen	black spruce dominant (12 to 28%)	20	283,815	56,763	2
forested cover type subtotal		*n/a*	*1,610,064*	*374,433*	*16*
Non-Forested Cover Type					
non-forested cover types	n/a	n/a	667,312	0	0
non-forested cover type subtotal		*n/a*	*667,312*	*0*	*0*
Total			**2,277,376**	**374,433**	**16**

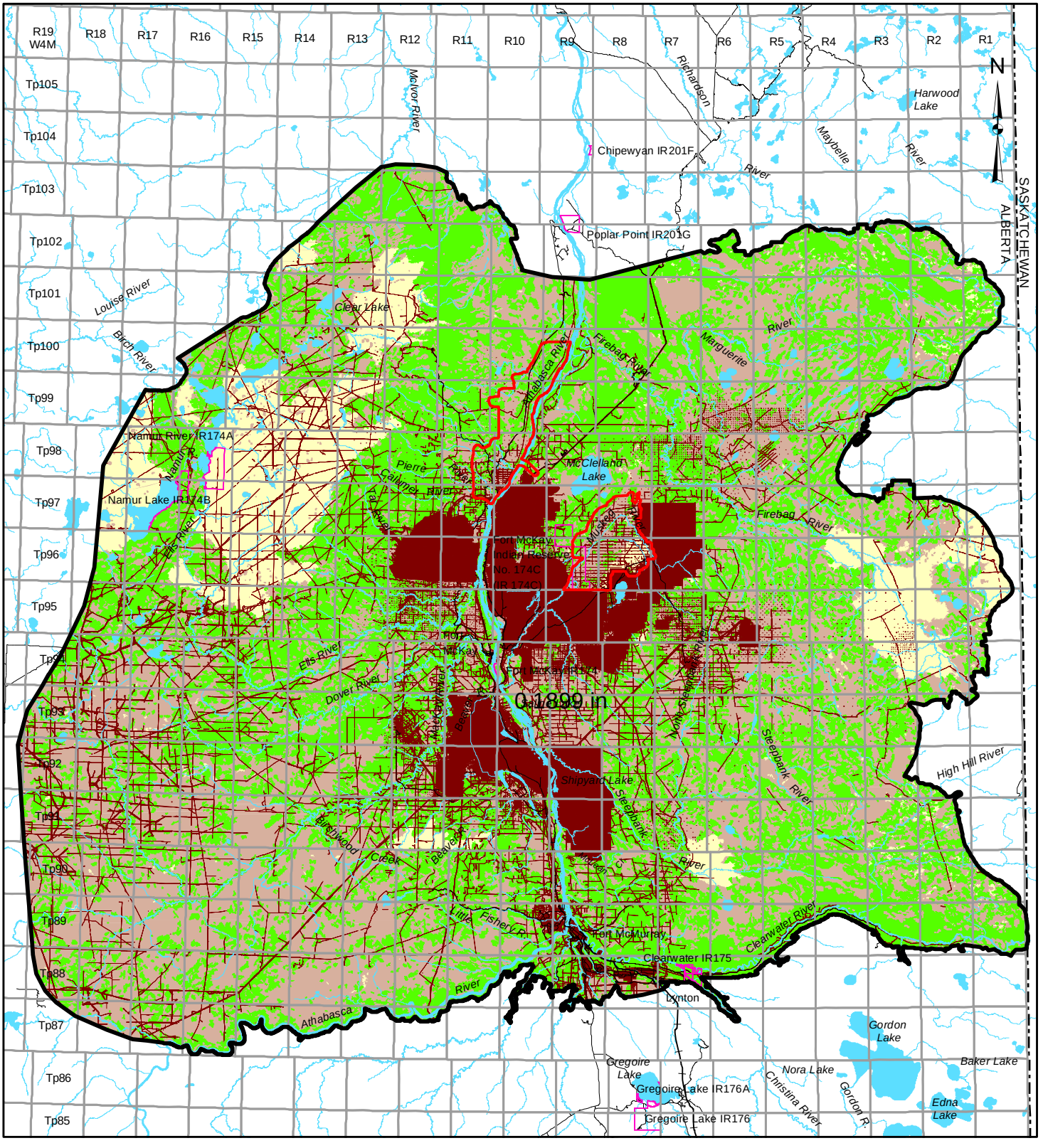
[(a)] Based on overmature age class range values in Andison (2003, website).

n/a = Not applicable.

Note: Some numbers are rounded for presentation purposes. Therefore, it may appear that the totals do not equal the sum of the individual values.

Productive Forests

Productive forests were selected as a community-level KIR because of their economic importance. Within the RSA, there is 800,902 ha (35%) of potentially productive forest land (Figure 3.4-4, Table 3.4-11). This includes all terrestrial forests and cutblocks.



LEGEND

- TERRESTRIAL RESOURCES REGIONAL STUDY AREA
- LOCAL STUDY AREAS
- INDIAN RESERVE
- OPEN WATER
- PUBLIC ROADWAY
- RAILROAD

FOREST PRODUCTIVITY

- PRODUCTIVE
- UNPRODUCTIVE
- RECENT BURN

DISTURBED

- EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE
- EXISTING AND APPROVED URBAN AND INDUSTRIAL LINEAR DISTURBANCE

REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2004), Pearson Timberline Ltd. (April 2004), LANDSAT 7 ETM Imagery (July 2006), and Alberta SRD, used under license.
Saskatchewan digital data obtained from Information Services Corp. (September 2004), used under license.
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 12.

PROJECT

JACKPINE MINE EXPANSION & PIERRE RIVER MINE PROJECT

TITLE

PRODUCTIVE AND UNPRODUCTIVE FORESTS WITHIN THE REGIONAL STUDY AREA

Shell Canada Limited

PROJECT No. 05-1344-027.7600			SCALE AS SHOWN	REV. 0
DESIGN	VR	22 Jan. 2007		
GIS	JH	14 Nov. 2007		
CHECK	AA	20 Nov. 2007		
REVIEW	TC	27 Nov. 2007		

FIGURE: 3.4-4

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Table 3.4-11 Productive and Unproductive Forests Within the Regional Study Area

Regional Land Cover Class	Timber Productivity	Regional Study Area	
		[ha]	[%]
Terrestrial Vegetation			
deciduous aspen-balsam poplar	productive	203,653	9
coniferous jack pine	productive	215,255	9
coniferous jack pine-black spruce	productive	61,737	3
coniferous white spruce	productive	58,199	3
mixedwood aspen-jack pine	productive	61,535	3
mixedwood aspen-white spruce	productive	200,523	9
	productive subtotal	*800,902*	*35*
Wetlands and Other			
non-treed wetlands	unproductive	230,167	10
treed bog / poor fen	unproductive	525,347	23
treed fen	unproductive	283,815	12
water	unproductive	48,736	2
cutblock	unproductive	10,839	<1
disturbances (urban and industrial)	unproductive	170,314	7
	unproductive subtotal	*1,269,217*	*56*
Burn			
burn	unknown	207,257	9
	burn subtotal	*207,257*	*9*
Total		**2,277,376**	**100**

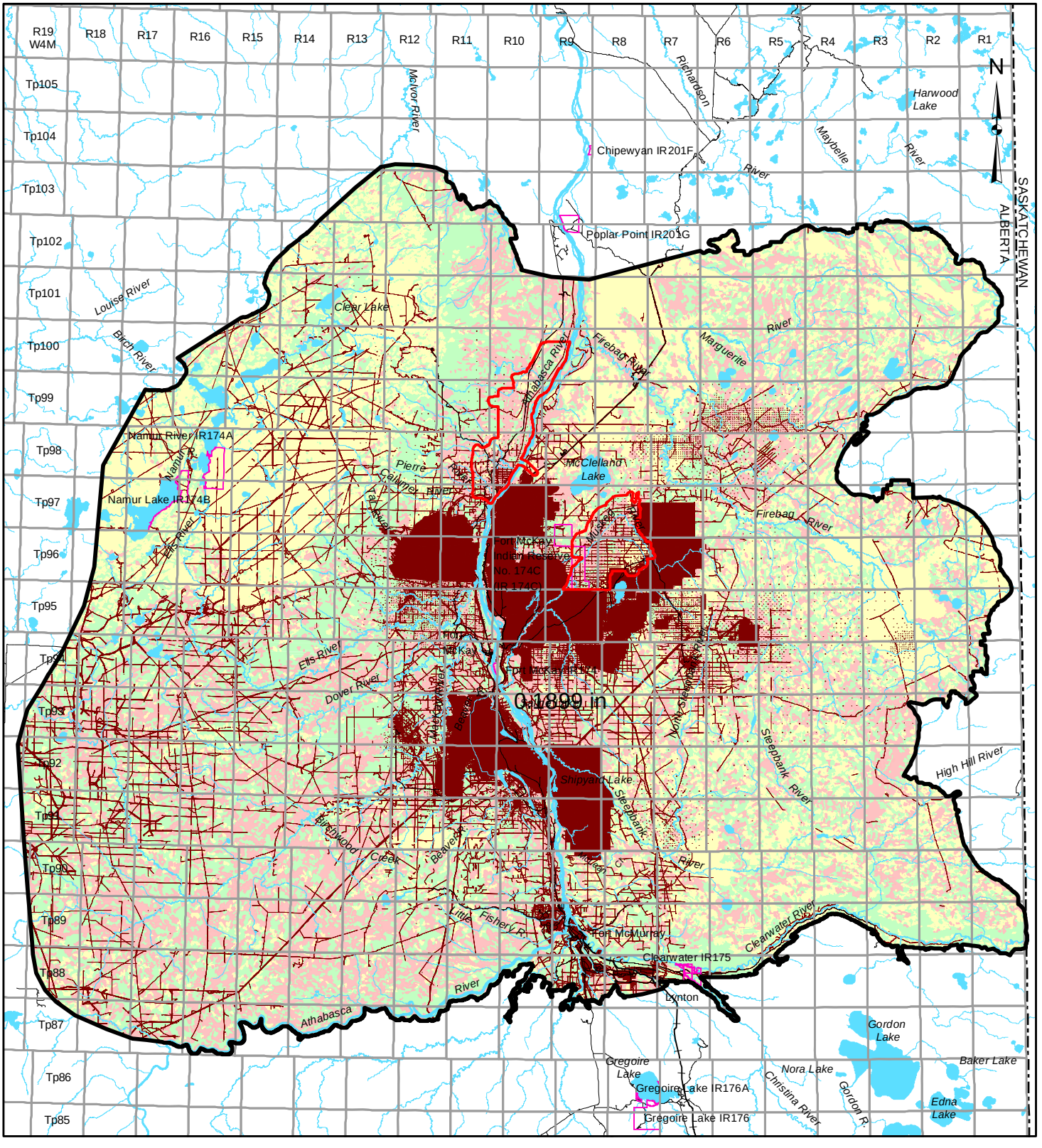
Note: Some numbers are rounded for presentation purposes. Therefore, it may appear that the totals do not equal the sum of the individual values.

3.4.3.2 Species-Level Key Indicator Resource Descriptions in the Regional Study Area

For the Project, rare plants and traditional use plants have been selected as species-level vegetation KIRs within the RSA because of their resource use value, ecological and social importance, and vulnerability to disturbance.

Rare Plant Potential

Rare plant potential within the RSA is provided in Table 3.4-12 and Figure 3.4-5. There is 513,982 ha (23%) of high, 1,081,970 ha (48%) of moderate and 681,425 ha (30%) of low potential rare plant habitat within the RSA.



LEGEND

- TERRESTRIAL RESOURCES REGIONAL STUDY AREA
- LOCAL STUDY AREAS
- INDIAN RESERVE
- OPEN WATER
- PUBLIC ROADWAY
- RAILROAD

RARE PLANT POTENTIAL

- HIGH
- MODERATE
- LOW

DISTURBED

- EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE
- EXISTING AND APPROVED URBAN AND INDUSTRIAL LINEAR DISTURBANCE

25 0 25

SCALE 1:1,000,000 KILOMETRES

REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2004), Pearson Timberline Ltd. (April 2004), LANDSAT 7 ETM Imagery (July 2006), and Alberta SRD, used under license.
Saskatchewan digital data obtained from Information Services Corp. (September 2004), used under license.
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 12.

PROJECT

JACKPINE MINE EXPANSION & PIERRE RIVER MINE PROJECT

TITLE

RARE PLANT POTENTIAL WITHIN THE REGIONAL STUDY AREA

Shell Canada Limited

PROJECT No. 05-1344-027.7600			SCALE AS SHOWN	REV. 0
DESIGN	VR	22 Jan. 2007		
GIS	JH	14 Nov. 2007		
CHECK	AA	20 Nov. 2007		
REVIEW	TC	27 Nov. 2007		

FIGURE: 3.4-5

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Table 3.4-12 Area and Percent Cover of Rare Plant Potential Within the Regional Study Area

Regional Land Cover Class	Regional Study Area	
	[ha]	[%]
High Rank – Rare Plant Potential		
non-treed wetlands	230,167	10
treed fen	283,815	12
high subtotal	*513,982*	*23*
Moderate Rank – Rare Plant Potential		
coniferous jack pine	215,255	9
coniferous jack pine-black spruce	61,737	3
mixedwood aspen-jack pine	61,535	3
treed bog/poor fen	525,347	23
burn	207,257	9
cutblock	10,839	<1
moderate subtotal	*1,081,970*	*48*
Low Rank – Rare Plant Potential		
deciduous aspen-balsam poplar	203,653	9
coniferous white spruce	58,199	3
mixedwood aspen-white spruce	200,523	9
water	48,736	2
disturbances (urban and industrial)	170,314	7
low subtotal	*681,425*	*30*
Total	**2,277,376**	**100**

Note: Some numbers are rounded for presentation purposes. Therefore, it may appear that the totals do not equal the sum of the individual values.

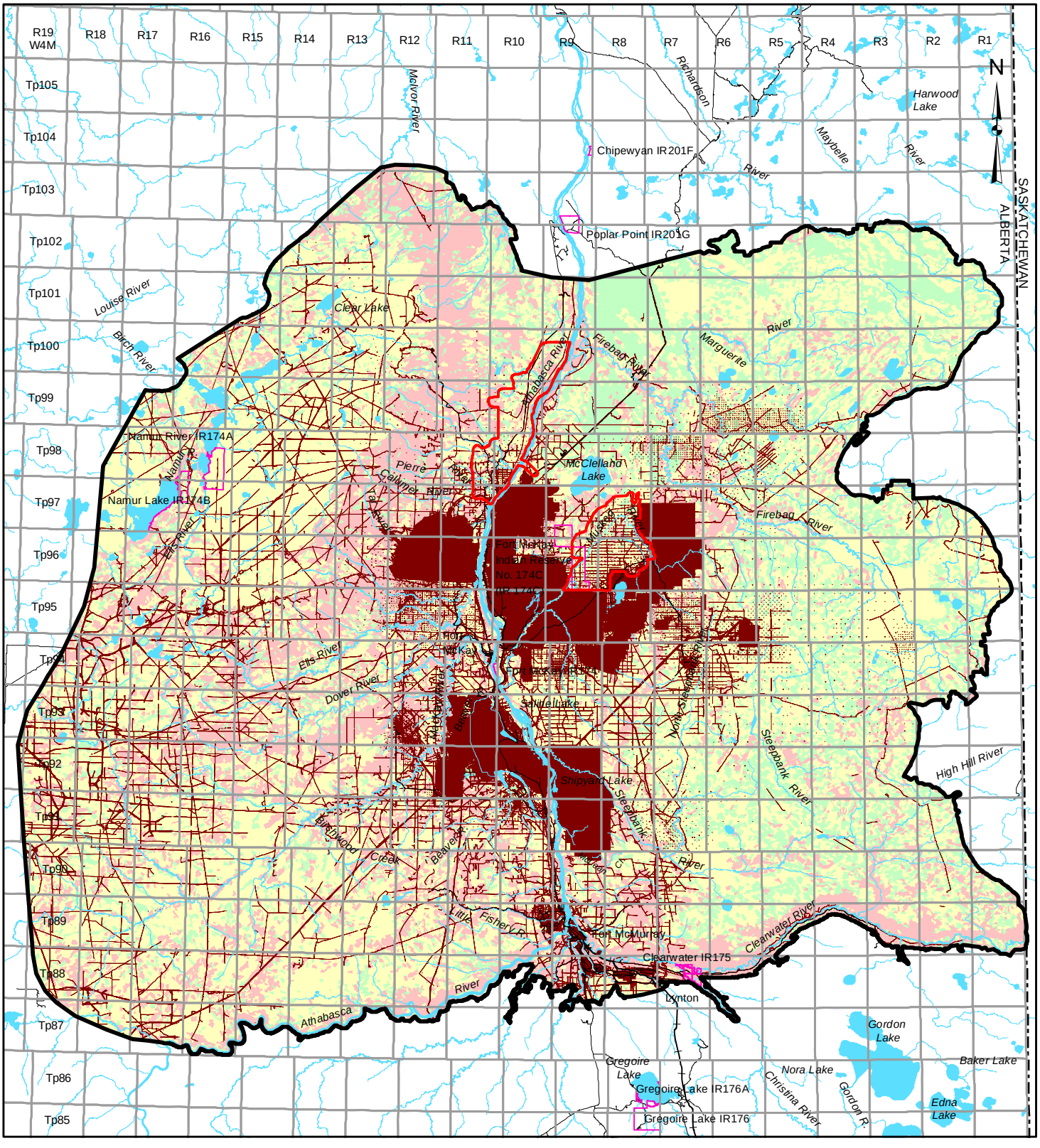
Traditional Plant Potential

Traditional plant potential within the RSA is provided in Table 3.4-13 and Figure 3.4-6. There is 523,910 ha (23%) of high, 1,078,155 ha (47%) of moderate and 675,311 ha (30%) of low potential traditional plant habitat within the RSA.

Table 3.4-13 Area and Percent Cover of Traditional Plant Potential Within the Regional Study Area

Regional Land Cover Class	Regional Study Area	
	ha	%
High Rank – Traditional Plant Potential		
deciduous aspen-balsam poplar	203,653	9
coniferous white spruce	58,199	3
mixedwood aspen-jack pine	61,535	3
mixedwood aspen-white spruce	200,523	9
high subtotal	*523,910*	*23*
Moderate Rank – Traditional Plant Potential		
coniferous jack pine-black spruce	61,737	3
treed bog / poor fen	525,347	23
treed fen	283,815	12
burn	207,257	9
moderate subtotal	*1,078,155*	*47*
Low Rank – Traditional Plant Potential		
coniferous jack pine	215,255	9
non-treed wetlands	230,167	10
water	48,736	2
cutblock	10,839	<1
disturbances (urban and industrial)	170,314	7
low subtotal	*675,311*	*30*
Total	**2,277,376**	**100**

Note: Some numbers are rounded for presentation purposes. Therefore, it may appear that the totals do not equal the sum of the individual values.



LEGEND

- TERRESTRIAL RESOURCES REGIONAL STUDY AREA
- LOCAL STUDY AREAS
- INDIAN RESERVE
- OPEN WATER
- PUBLIC ROADWAY
- RAILROAD

TRADITIONAL PLANT POTENTIAL

- HIGH
- MODERATE
- LOW

DISTURBED

- EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE
- EXISTING AND APPROVED URBAN AND INDUSTRIAL LINEAR DISTURBANCE

REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2004), Pearson Timberline Ltd. (April 2004), LANDSAT 7 ETM Imagery (July 2006), and Alberta SRD, used under license.
Saskatchewan digital data obtained from Information Services Corp. (September 2004), used under license.
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 12.

PROJECT

JACKPINE MINE EXPANSION & PIERRE RIVER MINE PROJECT

TITLE

TRADITIONAL PLANT POTENTIAL WITHIN THE REGIONAL STUDY AREA

Shell Canada Limited

PROJECT No. 05-1344-027.7600			SCALE AS SHOWN	REV. 0
DESIGN	VR	22 Jan. 2007	FIGURE: 3.4-6	
GIS	JH	14 Nov. 2007		
CHECK	AA	20 Nov. 2007		
REVIEW	TC	27 Nov. 2007		

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3.5 JACKPINE EXPANSION MINING AREA RESULTS

3.5.1 Jackpine Expansion Mining Area Terrestrial Vegetation and Wetlands

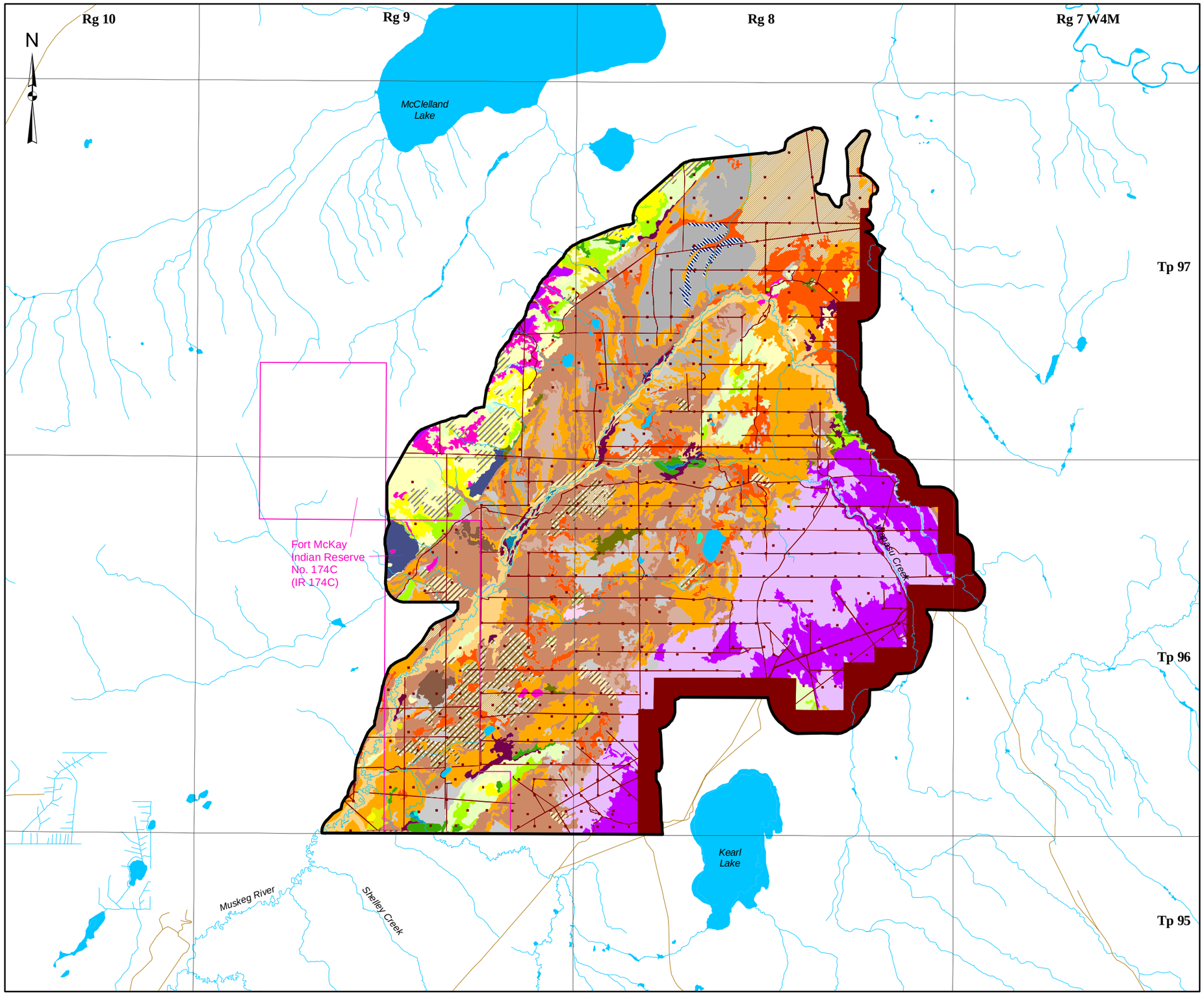
3.5.1.1 Overview

The JEMA LSA covers an area of 18,348 ha. There are a total of 39 cover types that occur within the LSA including:

- 16 terrestrial ecosite phases;
- 16 wetlands types;
- three miscellaneous vegetation types;
- two non-vegetation types; and
- two disturbance types.

The JEMA LSA is primarily composed of a large, intricate wetlands complex that follows the Muskeg River, which is bound by the Fort Hills to the north and uplands near Kearl Lake to the south (Figure 3.5-1). The wetlands complex is primarily fens, but also includes bogs and non-peatland wetlands. The wetlands complex includes a "lenticular" (lens-like) patterned fen in the northeast of the LSA, and also shows evidence of discontinuous permafrost. The 2002 Kearl Lake wildfire has burned much of the southeast corner of the JEMA LSA.

Terrestrial ecosite phases only represent 2,362 ha (13%) of the JEMA LSA (Table 3.5-1, Figure 3.5-1). The most common terrestrial vegetation type is represented by the blueberry jack pine-aspen (b1) ecosite phase occupying 518 ha (3%) of the study area. The next common terrestrial vegetation type is the low-bush cranberry aspen (d1) ecosite phase covering 484 ha (3%) of the JEMA LSA, followed by the low-bush cranberry aspen-white spruce (d2) ecosite phase (239 ha or 1% of the JEMA LSA). The least common terrestrial vegetation types are the dogwood white spruce (e3) and dogwood balsam poplar-white spruce (e2) ecosite phases, covering 4 and 5 ha (less than 1%), respectively, within the JEMA LSA.



LEGEND

- JACKPINE EXPANSION MINING AREA LOCAL STUDY AREA
- INDIAN RESERVE
- OPEN WATER
- PUBLIC ROADWAY

DISTURBED

- EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE
- EXISTING AND APPROVED URBAN AND INDUSTRIAL LINEAR DISTURBANCE

ECOSITE PHASE

- LICHEN JACK PINE (a1)
- BLUEBERRY JACK PINE-ASPEN (b1)
- BLUEBERRY ASPEN (WHITE BIRCH) (b2)
- BLUEBERRY ASPEN-WHITE SPRUCE (b3)
- BLUEBERRY WHITE SPRUCE-JACK PINE (b4)
- LABRADOR TEA-MESIC JACK PINE-BLACK SPRUCE (c1)
- LOW-BUSH CRANBERRY ASPEN (d1)
- LOW-BUSH CRANBERRY ASPEN-WHITE SPRUCE (d2)
- LOW-BUSH CRANBERRY WHITE SPRUCE (d3)
- DOGWOOD BALSAM POPLAR-ASPEN (e1)
- DOGWOOD BALSAM POPLAR-WHITE SPRUCE (e2)
- DOGWOOD WHITE SPRUCE (e3)
- HORSETAIL WHITE SPRUCE (f3)
- LABRADOR TEA-SUBHYGRIC BLACK SPRUCE-JACK PINE (g1)
- LABRADOR TEA/HORSETAIL WHITE SPRUCE-BLACK SPRUCE (h1)
- JACK PINE-TAMARACK COMPLEX (Pj-Lt Complex)

WETLANDS TYPES

- FORESTED BOG (BFNN)
- OPEN BOG (BONN)
- WOODED BOG WITH INTERNAL LAWNS (BTNI)
- WOODED BOG (BTNN)
- WOODED BOG WITH INTERNAL LAWNS AND ISLANDS OF FORESTED PEAT PLATEAU (BTNR)
- WOODED PERMAFROST BOG WITH COLLAPSE SCAR (BTXC)
- FORESTED FEN (FFNN)
- GRAMINOID FEN (FONG)
- SHRUBBY FEN (FONS)
- OPEN PATTERNED FEN (FOPN)
- WOODED FEN WITH INTERNAL LAWNS (FTNI)
- WOODED FEN (FTNN)
- WOODED PATTERNED FEN (FTPN)
- SHRUBBY SWAMP (SONS)
- WOODED SWAMP (STNN)
- SHALLOW OPEN WATER (WONN)

OTHER

- BURN UPLAND (BUu)
- BURN WETLANDS (BUw)
- CUTBLOCK (CC)
- SHRUBLAND (Sh)

REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2004), and Alberta SRD, used under license.
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 12.

2.5 0 2.5
SCALE 1:100,000 KILOMETRES

PROJECT
JACKPINE MINE EXPANSION & PIERRE RIVER MINE PROJECT

TITLE
ECOSITE PHASES AND WETLANDS TYPES WITHIN THE JACKPINE EXPANSION MINING AREA LOCAL STUDY AREA

Shell Canada Limited

PROJECT No. 05-1344-027.7600			SCALE AS SHOWN	REV. 0
DESIGN	AA	10 Aug. 2007		
GIS	JH	14 Nov. 2007		
CHECK	AA	20 Nov. 2007		
REVIEW	TC	27 Nov. 2007		

FIGURE: 3.5-1

Project: I:\CLIENTS\SHELL\05-1344-027\mapping\mxd\veg\DRAFT\jackpine\bl_ecosite_ph_lp_esri.mxd - Plot: 7J\2005\GIS\ArcMapTemplates\templatesw

Wetlands dominate the JEMA LSA (Table 3.5-1), covering 10,884 ha (59%). Peatlands, represented by bogs, fens and burn wetlands (also classed as a miscellaneous vegetation type) account for 11,868 ha (65%) of the JEMA LSA. The most common wetlands type is the wooded fen (FTNN) covering 3,452 ha (19%) of the JEMA LSA followed by the shrubby fen (FONS) representing 2,505 ha (14%) of the JEMA LSA. Non-peatland wetlands, including swamps and shallow open water account for 918 ha (5%) of the JEMA LSA. Shrubby swamps (SONS) cover 752 ha (4%) of the JEMA LSA or 82% of all non-peatland wetlands. The least common wetlands types are the forested bog (BFNN), forested fen (FFNN) and shallow open water (WONN) covering less than 1, 2 and 2 ha (less than 1%), respectively within the JEMA LSA.

Miscellaneous vegetation types account for 3,031 ha (17%) of the JEMA LSA, which include shrublands and areas that have been recently burned by wildfire. Non-vegetation types cover 59 ha (less than 1%) of the JEMA LSA and include watercourses and lakes.

Disturbances cover 2,013 ha (11%) of the JEMA LSA including 120 ha (1%) of cutblocks and 1,893 ha (10%) of other disturbances, which represent borrow pits, well sites, borehole pads, clearings, roads, rights-of-ways, trails and seismic lines.

Table 3.5-1 Total Area and Percent Cover of Ecosite Phases and Wetlands Types Within the Jackpine Expansion Mining Area Local Study Area

Map Code	Description	Area		Number of Survey Sites			
		[ha]	% of LSA	Detailed Inventory and Rare Plant	Vegetation Aerial Survey	Rare Plant[(a)]	Total
Central Mixedwood Terrestrial Ecosite Phases							
a1	lichen jack pine	164	1	2 (4)	2 (22)	1 (0)	**5 (26)**
b1	blueberry jack pine-aspen	518	3	2 (7)	2 (33)	3 (0)	**4 (40)**
b2	blueberry aspen (white birch)	201	1	2 (4)	3 (7)	0 (0)	**5 (11)**
b3	blueberry aspen-white spruce	230	1	1 (4)	0 (16)	0 (0)	**1 (20)**
b4	blueberry white spruce-jack pine	89	<1	2 (0)	2 (14)	1 (0)	**5 (14)**
c1	Labrador tea-mesic jack pine-blackspruce	59	<1	2 (0)	3 (6)	0 (0)	**5 (6)**
d1	low-bush cranberry aspen	484	3	7 (3)	7 (60)	0 (0)	**14 (63)**
d2	low-bush cranberry aspen-white spruce	239	1	4 (2)	3 (46)	0 (0)	**5 (48)**
d3	low-bush cranberry white spruce	93	1	3 (0)	1 (12)	0 (0)	**4 (12)**
e1	dogwood balsam poplar-aspen	7	<1	0 (1)	0 (7)	0 (0)	**0 (8)**
e2	dogwood balsam poplar-white spruce	5	<1	1 (0)	1 (7)	0 (0)	**2 (7)**
e3	dogwood white spruce	4	<1	0 (0)	0 (7)	0 (0)	**0 (7)**
f1	horsetail balsam poplar-aspen	0	0	0 (0)	0 (1)	0 (0)	**0 (1)**
f2	horsetail balsam poplar-white spruce	0	0	0 (0)	0 (1)	0 (0)	**0 (1)**
f3	horsetail white spruce	16	<1	2 (0)	0 (3)	0 (0)	**2 (3)**
g1	Labrador tea-subhygric black spruce-jack pine	72	<1	1 (1)	1 (6)	2 (0)	**4 (7)**
h1	Labrador tea/horsetail white spruce-black spruce	167	1	2 (0)	1 (2)	0 (0)	**3 (2)**
PJ-Lt Comp	jack pine-tamarack complex	14	<1	0 (0)	0 (0)	0 (0)	**0 (0)**
	terrestrial subtotal	*2,362*	*13*	*31 (26)*	*26 (250)*	*7 (0)*	***64 (276)***

Table 3.5-1 Total Area and Percent Cover of Ecosite Phases and Wetlands Types Within the Jackpine Expansion Mining Area Local Study Area (continued)

Map Code	Description	Area		Number of Survey Sites			
		[ha]	% of LSA	Detailed Inventory and Rare Plant	Vegetation Aerial Survey	Rare Plant[a]	Total
Wetlands							
BFNN	forested bog	<1	<1	0 (0)	0 (0)	0 (0)	**0 (0)**
BONN	open bog	61	<1	2 (1)	0 (2)	0 (0)	**2 (3)**
BTNI	wooded bog with internal lawns	714	4	6 (0)	1 (0)	0 (0)	**7 (0)**
BTNN	wooded bog	632	3	5 (0)	8 (18)	2 (0)	**15 (18)**
BTNR	wooded bog with internal lawns and islands of forested peat plateau	17	<1	3 (0)	0 (0)	0 (0)	**3 (0)**
BTXC	wooded permafrost bog with collapse scar	89	<1	1 (1)	0 (0)	0 (0)	**1 (0)**
FFNN	forested fen	2	<1	0 (0)	0 (0)	0 (0)	**0 (0)**
FONG	graminoid fen	878	5	9 (5)	6 (27)	1 (2)	**16 (35)**
FONS	shrubby fen	2,505	14	17 (6)	18 (11)	2 (0)	**37 (17)**
FOPN	open patterned fen	792	4	10 (4)	1 (7)	3 (0)	**14 (11)**
FTNI	wooded fen with internal lawns	409	2	5 (0)	0 (0)	0 (0)	**5 (0)**
FTNN	wooded fen	3,452	19	17 (5)	20 (38)	0 (0)	**37 (43)**
FTPN	wooded patterned fen	415	2	4 (1)	10 (3)	1 (0)	**15 (4)**
SONS	shrubby swamp	752	4	5 (1)	3 (18)	0 (0)	**8 (19)**
STNN	wooded swamp	164	1	0 (0)	0 (0)	0 (0)	**0 (0)**
WONN	shallow open water	2	<1	2 (0)	8 (41)	0 (0)	**10 (41)**
MONG	marsh[b]	0	0	1 (1)	0 (9)	0 (0)	**1 (10)**
	wetlands subtotal	*10,884*	*59*	*87 (25)*	*77 (173)*	*9 (2)*	***173 (100)***
Miscellaneous Vegetation Types							
Me	meadow[b]	0	0	0 (0)	0 (2)	0 (0)	**0 (2)**
Sh	shrubland	5	<1	0 (1)	0 (3)	0 (0)	**0 (4)**
BUu	burn upland	1,124	6	11 (0)	0 (0)	2 (0)	**13 (0)**
BUw	burn wetlands[c]	1,902	10	16 (0)	4 (0)	0 (0)	**20 (0)**
	miscellaneous vegetation types subtotal	*3,031*	*17*	*27 (1)*	*4 (5)*	*2 (0)*	***33 (6)***
Non-vegetation types							
Lake	open water	59	<1	0 (0)	0 (0)	0 (0)	**0 (0)**
River	river	<1	<1	0 (0)	0 (0)	0 (0)	**0 (0)**
	non-vegetation types subtotal	*59*	*<1*	*0 (0)*	*0 (0)*	*0* (0)	***0 (0)***
Disturbances							
CC	cutblock	120	1	0 (0)	0 (2)	0 (0)	**0 (2)**
DIS	disturbance	1,893	10	0 (0)	0 (0)	0 (1)	**0 (1)**
	disturbances subtotal	*2,013*	*11*	*0 (0)*	*0 (2)*	*0 (1)*	***0 (3)***
Total		**18,348**	**100**	**145 (52)**	**81 (430)**	**18 (3)**	**244 (485)**

(a) The number in the brackets indicates the number of plots surveyed during the Project that are not within the Jackpine Expansion Mining Area LSA.

(b) Indicates Wetlands Types and Miscellaneous Vegetation Types too small for mapping to include as their own polygon areas. However, plots were conducted in these types.

(c) The burn wetlands type is also considered to be a peatlands wetlands type.

Note: Some numbers are rounded for presentation purposes. Therefore, it may appear that the totals do not equal the sum of the individual values.

The JEMA LSA falls completely within the Central Mixedwood Natural Subregion (NRC 2006). Descriptions of ecosite phases, wetlands types and other vegetation types mapped within the JEMA LSA are provided in Appendix L. These descriptions are based on established descriptions for ecosites phases and wetlands types in the region (Beckingham and Archibald 1996; Halsey et al. 2003). In cases where needed, the descriptions are supplemented with vegetation

and soils data collected from the JEMA LSA. Appendix L also contains full species lists for all vegetation types sampled.

3.5.1.2 Plot Data Summary

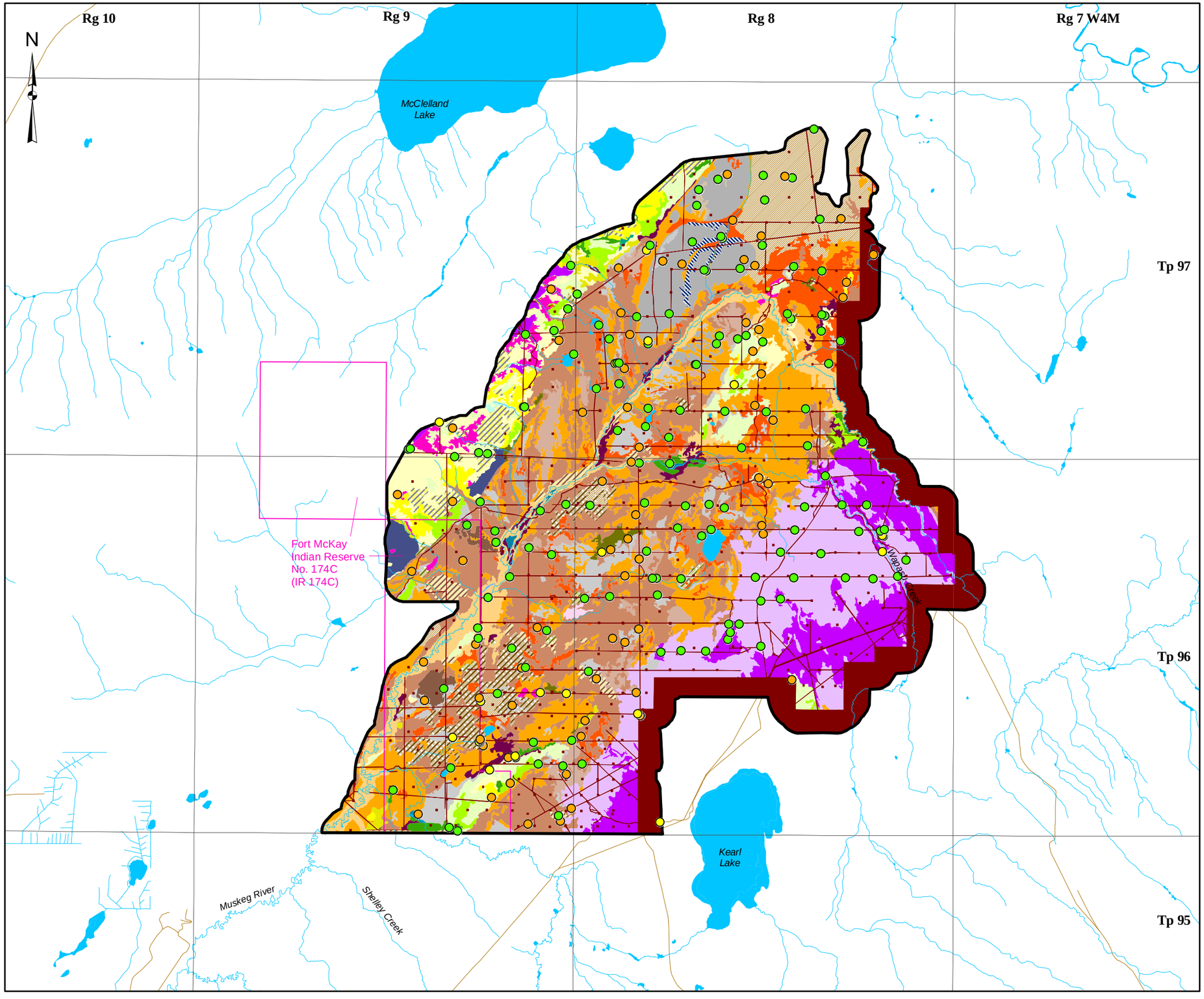
Data were collected from 244 detailed survey sites within the JEMA LSA. This included 145 detailed vegetation plots, 81 vegetation aerial survey plots and 18 rare plant survey sites (Table 3.5-1, Figure 3.5-2). Based on these data, a species list for the JEMA LSA was generated and is provided in Appendix L. Site data for each site is provided in Appendix M.

3.5.1.3 Forest Resources – Stand Attributes

Data are summarized from AVI to provide descriptions for each vegetation type with respect to main tree canopy composition and density as well as stand structure (Table 3.5-2). The main tree canopy is the uppermost structural level of a forest stand that contains the leading tree species. Stand structure provides information on the number of layers or type of layering evident in the stand and may include those with the following structures:

- single layer: tree stand with a single main tree canopy;
- multi-layered: tree stand with a well-defined main canopy and secondary canopy or understorey;
- complex structure: tree stand with a high variation in heights but with no distinct tree layers; usually associated with forest peatlands; and
- horizontal structure: structure of a polygon in cases where two unique stands occur adjacent to each other but are both too small to map separately.

There are no obvious trends in main canopy tree density among vegetation types except to show that canopy density is variable, and this variation may be related to factors including, but not limited to stand age and stand density (Table 3.5-2).



LEGEND

- JACKPINE EXPANSION MINING AREA LOCAL STUDY AREA
- INDIAN RESERVE
- OPEN WATER
- PUBLIC ROADWAY

DISTURBED

- EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE
- EXISTING AND APPROVED URBAN AND INDUSTRIAL LINEAR DISTURBANCE

VEGETATION SURVEY TYPE

- VEGETATION MAPPING AERIAL SURVEY PLOT
- RARE PLANT SURVEY PLOT
- DETAILED VEGETATION INVENTORY PLOT

ECOSITE PHASE

- LICHEN JACK PINE (a1)
- BLUEBERRY JACK PINE-ASPEN (b1)
- BLUEBERRY ASPEN (WHITE BIRCH) (b2)
- BLUEBERRY ASPEN-WHITE SPRUCE (b3)
- BLUEBERRY WHITE SPRUCE-JACK PINE (b4)
- LABRADOR TEA-MESIC JACK PINE-BLACK SPRUCE (c1)
- LOW-BUSH CRANBERRY ASPEN (d1)
- LOW-BUSH CRANBERRY ASPEN-WHITE SPRUCE (d2)
- LOW-BUSH CRANBERRY WHITE SPRUCE (d3)
- DOGWOOD BALSAM POPLAR-ASPEN (e1)
- DOGWOOD BALSAM POPLAR-WHITE SPRUCE (e2)
- DOGWOOD WHITE SPRUCE (e3)
- HORSETAIL WHITE SPRUCE (f3)
- LABRADOR TEA-SUBHYGRIC BLACK SPRUCE-JACK PINE (g1)
- LABRADOR TEA/HORSETAIL WHITE SPRUCE-BLACK SPRUCE (h1)
- JACK PINE-TAMARACK COMPLEX (Pj-Lt Complex)

WETLANDS TYPES

- FORESTED BOG (BFNN)
- OPEN BOG (BONN)
- WOODED BOG WITH INTERNAL LAWNS (BTNI)
- WOODED BOG (BTNN)
- WOODED BOG WITH INTERNAL LAWNS AND ISLANDS OF FORESTED PEAT PLATEAU (BTNR)
- WOODED PERMAFROST BOG WITH COLLAPSE SCAR (BTXC)
- FORESTED FEN (FFNN)
- GRAMINOID FEN (FONG)
- SHRUBBY FEN (FONS)
- OPEN PATTERNED FEN (FOPN)
- WOODED FEN WITH INTERNAL LAWNS (FTNI)
- WOODED FEN (FTNN)
- WOODED PATTERNED FEN (FTPN)
- SHRUBBY SWAMP (SONS)
- WOODED SWAMP (STNN)
- SHALLOW OPEN WATER (WONN)

OTHER

- BURN UPLAND (BUu)
- BURN WETLANDS (BUw)
- CUTBLOCK (CC)
- SHRUBLAND (Sh)

REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2004), and Alberta SRD, used under license.
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 12.

2.5 0 2.5

SCALE 1:100,000 KILOMETRES

PROJECT
JACKPINE MINE EXPANSION &
PIERRE RIVER MINE PROJECT

TITLE
VEGETATION PLOTS AND RARE PLANT SURVEY SITES WITHIN THE JACKPINE EXPANSION MINING AREA LOCAL STUDY AREA

Shell Canada Limited

PROJECT No. 05-1344-027.7600			SCALE AS SHOWN	REV. 0
DESIGN	AA	27 Aug. 2007		
GIS	JH	14 Nov. 2007		
CHECK	AA	20 Nov. 2007		
REVIEW	TC	27 Nov. 2007		

FIGURE: 3.5-2

Project: I:/CLIENTS/SHELL/05-1344-027/mapping/mxd/veg/DRAFT/jackpine/bl_ecosite_veg_survey_sites_ph_jp_est.mxd - Plot: ?J12005\GIS\ArcMapTemplates\templates\v91WyProject.pdf?

Table 3.5-2 Percent Distribution of Overstorey Density Class, Tree Species Composition and Stand Structure Class Within the Jackpine Expansion Mining Area Local Study Area

Map Code	Description	Area [ha]	Percent Distribution by Overstorey Density Class					Percent Distribution by Overstorey Tree Species								Percent Distribution by Structure Class			
			0 to 5	6 to 30	31 to 50	51 to 70	71 to 100	Aw	Bw	Pb	Pj	Sw	Fb	Sb	Lt	S	M	C	H
Central Mixedwood Terrestrial Ecosite Phases																			
a1	lichen jack pine	164	0	11	29	60	0	<1	0	0	93	0	0	5	1	84	11	5	0
b1	blueberry jack pine-aspen	518	0	20	19	58	2	57	3	0	38	2	0	1	0	72	28	0	0
b2	blueberry aspen (white birch)	201	0	16	13	71	0	34	55	0	3	8	0	1	0	74	26	0	0
b3	blueberry aspen-white spruce	230	0	26	20	54	0	47	26	0	6	21	0	<1	0	51	49	0	0
b4	blueberry white spruce-jack pine	89	0	19	13	68	0	6	2	0	47	42	0	3	0	72	28	0	0
c1	Labrador tea-mesic jack pine-blackspruce	59	0	17	38	29	16	5	0	0	81	<1	0	13	<1	75	25	0	0
d1	low-bush cranberry aspen	484	0	1	2	32	66	93	4	1	2	<1	0	0	0	58	42	0	0
d2	low-bush cranberry aspen-white spruce	239	0	1	13	80	6	66	2	0	3	29	<1	0	0	67	32	0	<1
d3	low-bush cranberry white spruce	93	0	17	33	50	0	4	0	0	3	68	0	21	4	65	17	18	0
e1	dogwood balsam poplar-aspen	7	0	0	0	100	0	20	70	10	0	0	0	0	0	100	0	0	0
e2	dogwood balsam poplar-white spruce	5	0	0	69	31	0	0	0	15	0	85	0	0	0	31	69	0	0
e3	dogwood white spruce	4	0	0	100	0	0	10	0	0	0	90	0	0	0	100	0	0	0
f3	horsetail white spruce	16	0	59	41	0	0	0	0	0	0	100	0	0	0	41	59	0	0
g1	Labrador tea-subhygric black spruce-jack pine	72	0	<1	67	33	0	0	0	0	8	1	0	87	3	32	<1	68	0
h1	Labrador tea/horsetail white spruce-black spruce	167	0	15	47	38	0	2	0	0	<1	58	0	40	0	76	15	8	0
PJ-Lt Comp	jack pine-tamarack complex	14	0	100	0	0	0	0	0	0	60	0	0	0	40	0	100	0	0
Forested and Wooded Wetlands																			
BFNN	forested bog	<1	0	0	0	0	100	0	0	0	0	0	0	100	0	100	0	0	0
BTNI	wooded bog with internal lawns	714	0	61	27	11	0	0	0	0	0	0	0	99	1	16	47	37	0
BTNN	wooded bog	632	0	4	38	58	0	0	0	0	0	0	0	97	3	44	6	50	0
BTNR	wooded bog with internal lawns and islands of forested peat plateau	17	0	0	0	100	0	0	0	0	0	0	0	100	0	100	0	0	0
BTXC	wooded permafrost bog with collapse scar	89	0	0	1	99	0	0	0	0	0	0	0	100	0	38	0	62	0
FFNN	forested fen	2	0	0	0	0	100	0	0	0	0	0	0	20	80	100	0	0	0
FTNI	wooded fen with internal lawns	409	0	55	25	20	0	0	0	0	0	0	0	31	69	8	57	35	0
FTNN	wooded fen	3,452	1	35	43	20	0	0	0	0	1	1	0	33	65	28	41	32	0
FTPN	wooded patterned fen	415	0	65	35	0	0	0	0	0	0	0	0	15	85	0	78	22	0
STNN	wooded swamp	164	<1	31	51	17	1	31	0	0	16	7	0	29	17	31	68	1	0
Non-Forested Wetlands																			
BONN	open bog	61	57	43	0	0	0	0	0	0	0	0	0	80	20	57	43	0	0
FONG	graminoid fen	878	97	3	0	<1	0	0	0	0	0	0	0	20	80	83	17	0	0
FONS	shrubby fen	2,505	54	31	15	1	0	0	0	0	0	0	0	23	77	17	69	14	0
FOPN	open patterned fen	792	8	87	5	0	0	0	0	0	0	0	0	48	52	5	89	5	0
SONS	shrubby swamp	752	98	0	0	1	0	17	0	0	9	18	0	27	29	98	2	1	0
WONN	shallow open water	2	100	0	0	0	0	0	0	0	0	0	0	0	0	100	0	0	0
Miscellaneous Vegetation Types																			
Sh	shrubland	5	100	0	0	0	0	-	-	-	-	-	-	-	-	100	0	0	0
BUu	burn upland	1,124	100	0	0	0	0	n/d	n/d	n/d	n/d	n/d	n/d	n/d	n/d	100	0	0	0
BUw	burn wetlands	1,902	100	0	0	0	0	n/d	n/d	n/d	n/d	n/d	n/d	n/d	n/d	100	0	0	0
Non-vegetation types																			
Lake	open water	59	100	0	0	0	0	-	-	-	-	-	-	-	-	100	0	0	0
River	river	<1	100	0	0	0	0	-	-	-	-	-	-	-	-	100	0	0	0
Disturbances																			
CC	cutblock	120	100	0	0	0	0	n/d	n/d	n/d	n/d	n/d	n/d	n/d	n/d	100	0	0	0
DIS	disturbance	1,893	100	0	0	0	0	-	-	-	-	-	-	-	-	100	0	0	0

– = Not applicable.

n/d = No data or only partial data available (e.g., cutblocks).

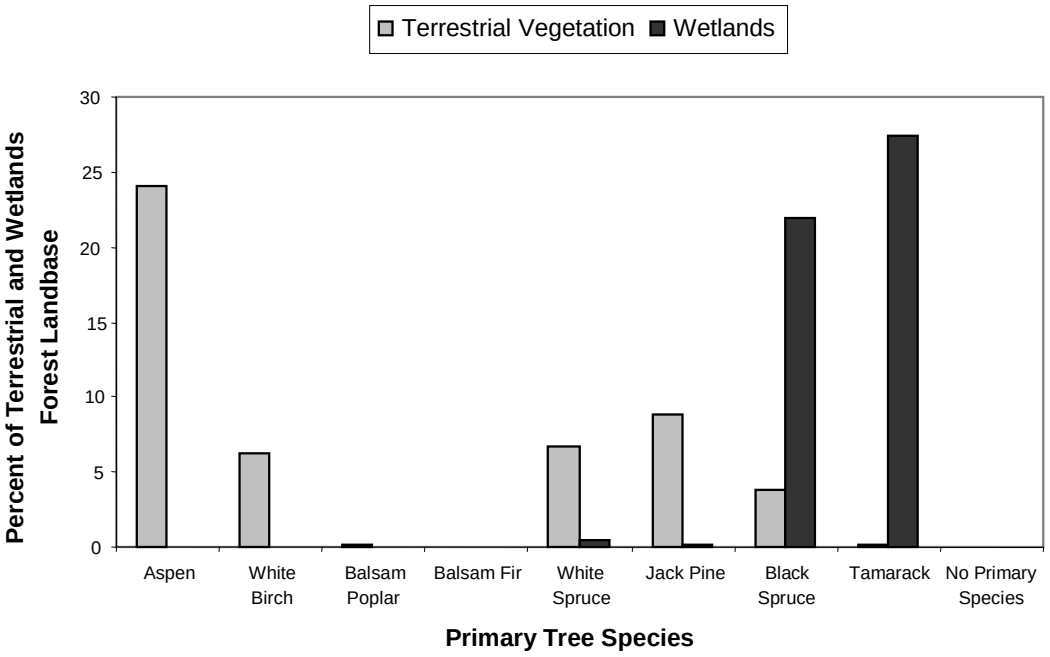
Note: Stand structure classes: S = single storey; M = multi-layered; C = complex; H = horizontal.

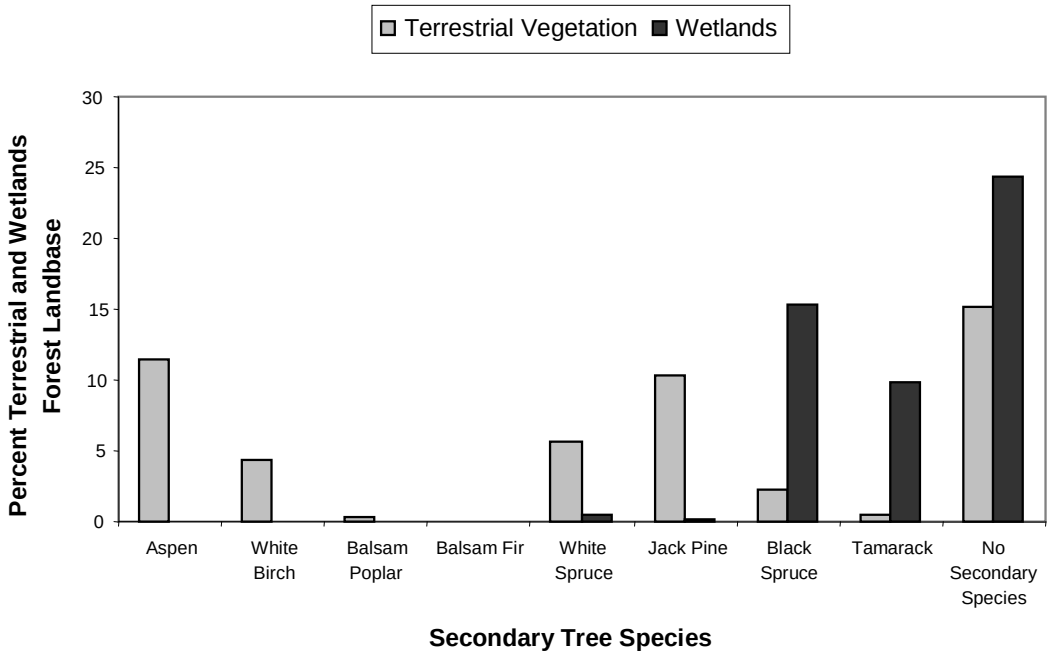
Main canopy tree species composition is strongly associated with vegetation type mainly because tree species are often good indicators of the broad ecological characteristics of a site (Table 3.5-2). For example, species such as jack pine and aspen are not typically found in wetlands, while tamarack is rarely present within uplands. Black spruce on the other hand, while a dominant species in wetlands, can also be dominant in both the Labrador tea–subhygric black spruce-jack pine (g1) and Labrador tea/horsetail white spruce-black spruce (h1) ecosite phases. These ecosite phases are transitional between terrestrial and wetlands ecosystems, and therefore, share certain characteristics with both environments.

From an ecological mapping perspective, classifying black spruce-dominated stands can be difficult when groundtruth data is lacking within specific AVI polygons. Often, two or more of these black spruce-dominated vegetation types occur together in the same area with only subtle differences in topography and elevation required to affect a change in the ecology of the site. Main tree canopy composition as shown in Table 3.5-2 relates well to ecosite phases and wetlands types as described in more detail in Appendix L.

Stand structure among vegetation types is also summarized in Table 3.5-2. Single and multi-storied stands are most commonly associated with terrestrial vegetation types while treed wetlands tend to have a more complex canopy structure.

Figure 3.5-3 shows the percent occurrence of primary and secondary tree canopy species among terrestrial and wetlands forest vegetation. Among terrestrial ecosite phases, aspen is the dominant species covering over 20% of the forested land base. Among wetlands, tamarack is the dominant species, with black spruce making up most of the rest of the dominant tree species. These species cover over 53% of that same total forested land base. Secondary tree canopy species (i.e., the species with the second most coverage in the main canopy) are shown in the bottom graph of Figure 3.5-3. This shows that there is commonly no secondary tree species within both terrestrial and wetlands forests. When there is a secondary species, aspen is most common in terrestrial forests and black spruce in wetlands.





PROJECT

JACKPINE MINE EXPANSION &
PIERRE RIVER MINE PROJECT

TITLE

PERCENT OCCURRENCE OF PRIMARY AND SECONDARY TREE SPECIES AMONG TERRESTRIAL AND WETLANDS FOREST VEGETATION IN THE JACKPINE EXPANSION MINING AREA LOCAL STUDY AREA

Shell Canada Limited

PROJECT 05-1344-027.7640			FILE No.	Tree Species
DESIGN	AA	21/08/07	SCALE AS SHOWN	REV. 0
CADD	YW	05/09/07	**FIGURE: 3.5-3**	
CHECK	AA	27/11/07		
REVIEW	WES/TC	27/11/07		

L:\2005\1344-OIL SANDS\05-1344-027-Shell Omnibus\7600\7640\Vegetation ESR\Fig 3.5-3 Percent occurrence of tree species.dwg Nov 28, 2007 - 3:39pm

Stand Height, Age and Timber Productivity

The AVI data are summarized to provide descriptions for each vegetation type with respect to main tree canopy height, stand age and timber productivity (Table 3.5-3). The tallest mean stand height is attributed to the dogwood white spruce (e3) ecosite phase (28 m). The lowest mean height for a terrestrial vegetation type is attributed to the Labrador tea-subhygric black spruce-jack pine (g1) ecosite phase (8 m). Mean height values for the treed bog and fen wetlands types are less than 12 m. The wooded swamp (STNN) is the tallest wetlands type with a mean height of 14 m.

The oldest forested uplands mean stand age is associated with the dogwood white spruce (e3) ecosite phase (140 years). The youngest mean stand age is associated with the low-bush cranberry aspen (d1) ecosite phase (86 years). Forest succession relationships are illustrated with the mean ages of d1, d2 and d3 ecosite phases. Among these vegetation types, stand age increases as forest succession progresses from an aspen state (d1 ecosite phase of 86 years), to a mixedwood state (d2 ecosite phase of 95 years), and finally towards a coniferous white spruce state (d3 ecosite phase of 107 years).

Wetlands in the JEMA LSA are generally younger than the uplands. Wetlands average ages range from 70 years (wooded bog with internal lawns and islands of forested peat plateau [BTNR]) to 90 years (forested bog [BFNN] and forested fen [FFNN]).

A timber productivity rating of good, medium, fair or unproductive is assigned to all forested stands and cutblocks within the AVI. All stands with leading black spruce or tamarack were assigned an unproductive rating because they are not typically harvested. The highest mean timber productivity is attributed to the dogwood balsam poplar-white spruce (e2) ecosite phase followed closely by the lichen jack pine (a1), low-bush cranberry aspen (d1) and low-bush cranberry aspen-white spruce (d2) ecosite phases. The lowest timber productivity for a terrestrial vegetation type is associated with the Labrador tea–subhygric black spruce-jack pine (g1) ecosite phase. Forest wetlands tended to be unproductive because they are usually dominated by black spruce or tamarack.

Some wooded swamps are classed to Forest Capability Class 3 or 4 (i.e., timber productive), due to well decomposed organic horizons that provide a source of nutrients, as well as having adequate soil aeration for at least part of the growing season (refer to the Soil ESR (Section 2) for additional information).

Table 3.5-3 Percent Distribution of Height, Age and Timber Productivity Rating Classes Within the Jackpine Expansion Mining Area Local Study Area

Map Code	Description	Area [ha]	Mean Height, Age and TPR			Percent Distribution by Height Class					Percent Distribution by Age Class [years]						Percent Distribution by Timber Productivity Rating Class			
			Height [m]	Age [years]	TPR[(a)]	0 to 6 m	7 to 12 m	13 to 18 m	19 to 24 m	25 to 30 m	0 to 59	60 to 79	80 to 99	100 to 119	120 to 139	140 to 159	Good	Medium	Fair	Unproductive
Central Mixedwood Ecosite Phases																				
a1	lichen jack pine	164	17	93	2.4	5	0	58	37	0	0	5	35	60	0	0	64	31	0	5
b1	blueberry jack pine-aspen	518	17	93	1.9	1	4	60	35	0	1	2	35	62	0	0	12	59	30	0
b2	blueberry aspen (white birch)	201	18	95	2.0	0	0	75	25	0	0	1	23	77	0	0	5	84	12	0
b3	blueberry aspen-white spruce	230	18	99	1.8	0	3	46	49	2	0	0	11	87	2	0	2	57	41	0
b4	blueberry white spruce-jack pine	89	19	96	2.3	0	0	66	25	9	0	0	40	60	0	0	33	67	0	0
c1	Labrador tea-mesic jack pine-blackspruce	59	16	92	2.2	7	2	71	20	0	0	18	18	64	0	0	37	54	2	7
d1	low-bush cranberry aspen	484	19	86	2.4	<1	0	43	57	0	<1	22	55	23	0	0	42	56	1	0
d2	low-bush cranberry aspen-white spruce	239	21	95	2.4	0	0	32	40	27	0	2	61	20	6	11	45	55	0	0
d3	low-bush cranberry white spruce	93	19	107	1.8	16	5	16	47	16	0	5	27	12	55	0	33	41	0	25
e1	dogwood balsam poplar-aspen	7	14	80	2.0	0	0	100	0	0	0	0	100	0	0	0	0	100	0	0
e2	dogwood balsam poplar-white spruce	5	22	105	2.5	0	0	0	100	0	0	0	31	0	69	0	31	69	0	0
e3	dogwood white spruce	4	28	140	2.0	0	0	0	0	100	0	0	0	0	0	100	0	100	0	0
f3	horsetail white spruce	16	23	110	2.8	0	0	12	29	58	0	0	12	0	88	0	71	29	0	0
g1	Labrador tea-subhygric black spruce-jack pine	72	8	92	0.0	20	80	0	0	0	1	23	5	72	0	0	0	0	0	100
h1	Labrador tea/horsetail white spruce-black spruce	167	15	100	1.5	0	41	26	33	0	0	0	62	3	28	7	19	30	0	51
PJ-Lt Comp	jack pine-tamarack complex	14	16	100	2.0	0	0	100	0	0	0	0	0	100	0	0	0	100	0	0
Forested and Wooded Wetlands																				
BFNN	forested bog	<1	10	90	0.0	0	100	0	0	0	0	0	100	0	0	0	0	0	0	100
BTNI	wooded bog with internal lawns	714	5	76	0.0	91	9	0	0	0	10	37	50	3	0	0	0	0	0	100
BTNN	wooded bog	632	7	88	0.0	52	45	3	0	0	0	39	31	25	6	0	0	0	0	100
BTNR	wooded bog with internal lawns and islands of forested peat plateau	17	5	70	0.0	100	0	0	0	0	0	100	0	0	0	0	0	0	0	100
BTXC	wooded permafrost bog with collapse scar	89	7	79	0.0	62	38	0	0	0	0	62	38	0	0	0	0	0	0	100
FFNN	forested fen	2	11	90	0.0	0	100	0	0	0	0	0	100	0	0	0	0	0	0	100
FTNI	wooded fen with internal lawns	409	7	87	0.0	36	63	1	0	0	0	14	62	25	0	0	0	0	0	100
FTNN	wooded fen	3,452	8	93	0.0	31	61	9	<1	0	1	12	43	33	11	0	0	1	0	99
FTPN	wooded patterned fen	415	8	89	0.0	21	79	0	0	0	0	2	78	16	4	0	0	0	0	100
STNN	wooded swamp	164	14	84	1.4	14	33	51	2	<1	5	8	43	11	33	0	19	7	0	74
Non-Forested Wetlands																				
BONN	open bog	61	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
FONG	graminoid fen	878	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
FONS	shrubby fen	2,505	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
FOPN	open patterned fen	792	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SONS	shrubby swamp	752	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
WONN	shallow open water	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Miscellaneous Vegetation Types																				
Sh	shrubland	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BUu	burn upland	1,124	n/d	5	2.1	100	0	0	0	0	100	0	0	0	0	0	49	34	1	16
BUw	burn wetlands	1,902	n/d	5	0.0	100	0	0	0	0	100	0	0	0	0	0	0	1	0	99
Non-Vegetation Types																				
Lake	open water	59	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
River	river	<1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Disturbances																				
CC	cutblock	120	1	0	2.0	100	0	0	0	0	100	0	0	0	0	0	0	100	0	0
DIS	disturbance	1,893	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

[(a)] Timber productivity rating (TPR) values: 0 = unproductive (including all black spruce and tamarack leading stands); 1 = fair; 2 = moderate; 3 = good.

– = Not applicable.

n/d = No data or only partial data available (e.g., cutblocks).

The variation in canopy height among all forested terrestrial vegetation and wetlands types is shown in Figure 3.5-4. The most common height class for terrestrial stands occurs between 13 and 18 m. Among treed wetlands, most of the stands occur within either the 0 to 6 m or the 7 to 12 m height classes.

The range of age classes among all forested terrestrial vegetation and wetlands types is also shown in Figure 3.5-4. The greatest proportion of terrestrial vegetation has a stand age that ranges between 100 and 119 years. Stand age among treed wetlands are not as skewed to one age class as terrestrial vegetation; however, the most common age for treed wetlands occurs within the 80 to 89 year age class. More details on the occurrence of old growth forests within the JEMA LSA are provided in Section 3.5.3.1.

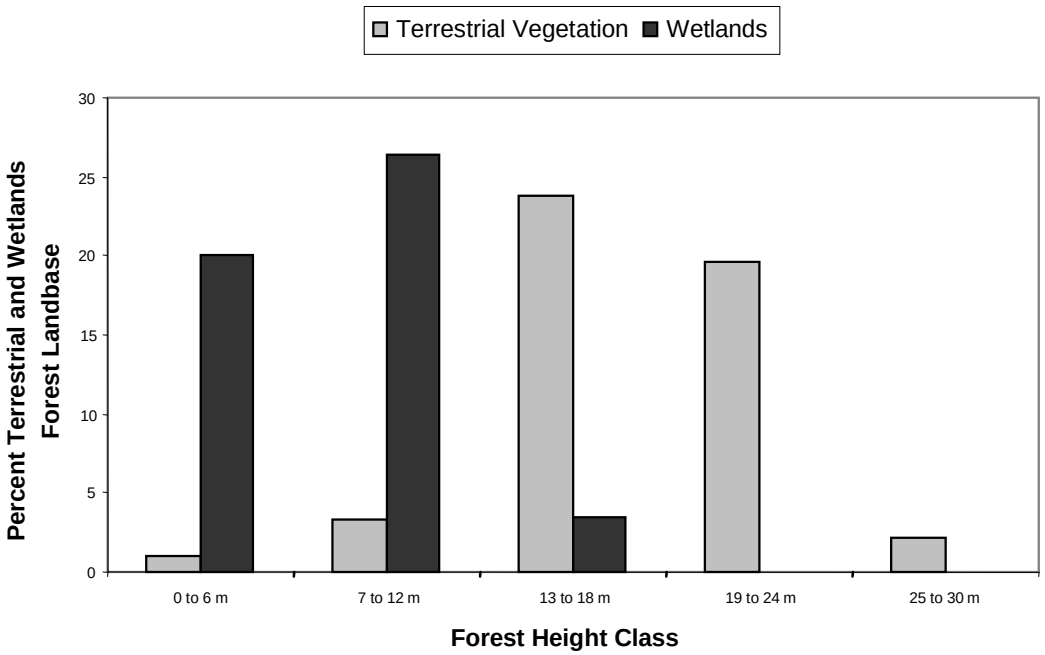
3.5.1.4 Rare Plants

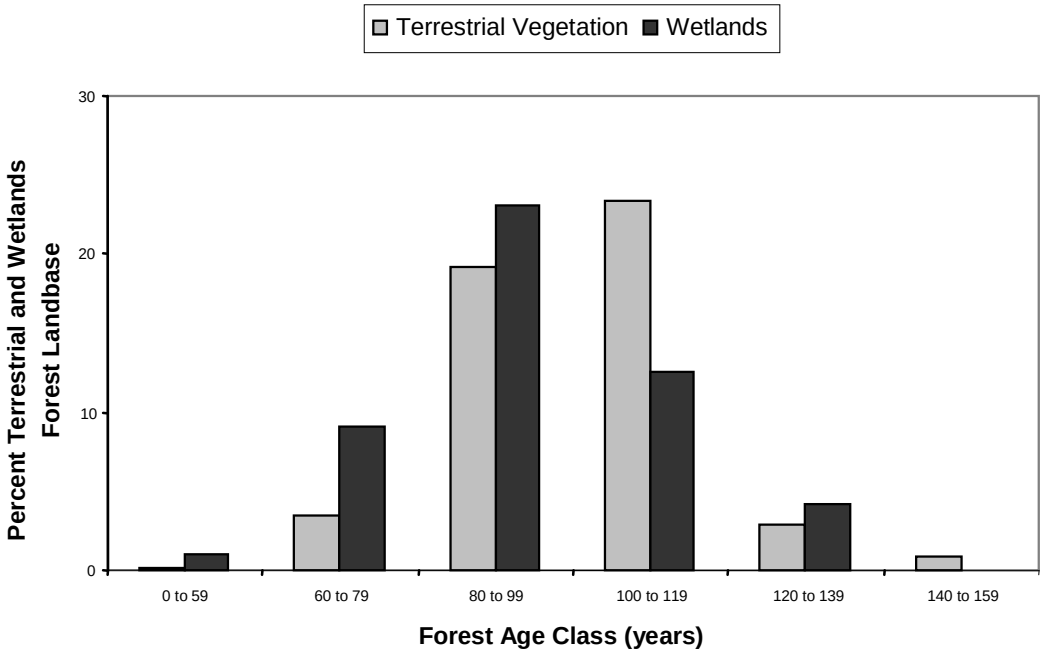
This section documents the occurrences of rare vascular plants, bryophytes and lichen species within the JEMA LSA. Relative to previous development projects in the Oil Sands Region, there are a higher number of rare plants listed here. A change in methodology resulted in an increase in bryophyte and lichen samples collected compared to previous projects and expert bryologists and lichenologists were available to identify the high number of collections. Rare plants found in parts of the JEMA LSA surveyed in previous years were also included in the rare species lists provided. Thus, the record of more rare plant species likely reflects the change in methodology rather than a change in the presence of rare species in the particular study area.

The higher number of rare plants found is also proportional to the quality of the habitat in the LSA. The JEMA LSA contains a high percentage of high rare plant potential area (51%, see Section 3.5.3.2), particularly fens.

Rare Vascular Plant Species

There were eight rare vascular plant species observed within the JEMA LSA at a total of 33 different sites (Figure 3.5-5, Table 3.5-4 and Appendix M). Seven of these species are from the ANHIC Tracking List and one species from the Watch List (Gould 2006). Surveys within the JEMA LSA took place during the 2006 field program.





PROJECT

JACKPINE MINE EXPANSION &
PIERRE RIVER MINE PROJECT

TITLE

PERCENT VARIABILITY IN CANOPY HEIGHT AND STAND AGE BETWEEN TERRESTRIAL AND WETLANDS FOREST VEGETATION IN THE JACKPINE EXPANSION MINING AREA LOCAL STUDY AREA

Shell Canada Limited

PROJECT 05-1344-027.7640			FILE No.	Tree Species
DESIGN	AA	21/08/07	SCALE AS SHOWN	REV. 0
CADD	YW	05/09/07	**FIGURE: 3.5-4**	
CHECK	AA	27/11/07		
REVIEW	WES/TC	27/11/07		

L:\2005\1344-OIL SANDS\05-1344-027-Shell Omnibus\7600\7640\Vegetation ESR\Fig 3.5-4 Canopy Height and Stand Age.dwg Nov 28, 2007 - 3:40pm

Rg 10
Rg 9
Rg 8
Rg 7 W4M
Tp 97
Tp 96
Tp 95
N
McClelland Lake
Kearl Lake
Muskeg River
Shelley Creek
Wapasu Creek
Fort McKay Indian Reserve No. 174C (IR 174C)
3BV008
10417
3CV009
3CV027
RY04
RY06
RY05
3BV009
3AV010
RY02
ANHIC EOR
RY03
3AV009
3CV014
RY27
3AV036
3AV042
3CP023
3CV034
3BV013
3BV033
3BV024
3BV042
3AV024
3AV022
3AV021
3BV045
3AV056
3CV039
3BV020
3BV019
3AV053
3BV061
ANHIC EOR
BW63
BW95
RHS27
AW95
K42
AW40
3BP001
3BP003
AW19
3AP002
3AV002
3AP001
3AV003
AW02
BW30
BW29
BW27
BW26

LEGEND

- JACKPINE EXPANSION MINING AREA LOCAL STUDY AREA
- INDIAN RESERVE
- OPEN WATER
- PUBLIC ROADWAY

DISTURBED

- EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE
- EXISTING AND APPROVED URBAN AND INDUSTRIAL LINEAR DISTURBANCE
- JACKPINE EXPANSION MINING AREA RARE PLANT SURVEY - RARE SPECIES OCCURENCE
- HISTORICAL ANHIC ELEMENT OCCURRENCE RECORD
- HISTORICAL ANHIC ELEMENT OCCURRENCE RECORD AND KEARL EIA RECORD
- HISTORICAL KEARL EIA RECORD
- LENTICULAR FEN SPECIAL PLANT COMMUNITY OCCURENCE

ECOSITE PHASE

- LICHEN JACK PINE (a1)
- BLUEBERRY JACK PINE-ASPEN (b1)
- BLUEBERRY ASPEN (WHITE BIRCH) (b2)
- BLUEBERRY ASPEN-WHITE SPRUCE (b3)
- BLUEBERRY WHITE SPRUCE-JACK PINE (b4)
- LABRADOR TEA-MESIC JACK PINE-BLACK SPRUCE (c1)
- LOW-BUSH CRANBERRY ASPEN (d1)
- LOW-BUSH CRANBERRY ASPEN-WHITE SPRUCE (d2)
- LOW-BUSH CRANBERRY WHITE SPRUCE (d3)
- DOGWOOD BALSAM POPLAR-ASPEN (e1)
- DOGWOOD BALSAM POPLAR-WHITE SPRUCE (e2)
- DOGWOOD WHITE SPRUCE (e3)
- HORSETAIL WHITE SPRUCE (f3)
- LABRADOR TEA-SUBHYGRIC BLACK SPRUCE-JACK PINE (g1)
- LABRADOR TEA/HORSETAIL WHITE SPRUCE-BLACK SPRUCE (h1)
- JACK PINE-TAMARACK COMPLEX (Pj-Lt Complex)

WETLANDS TYPES

- FORESTED BOG (BFNN)
- OPEN BOG (BONN)
- WOODED BOG WITH INTERNAL LAWNS (BTNI)
- WOODED BOG (BTNN)
- WOODED BOG WITH INTERNAL LAWNS AND ISLANDS OF FORESTED PEAT PLATEAU (BTNR)
- WOODED PERMAFROST BOG WITH COLLAPSE SCAR (BTXC)
- FORESTED FEN (FFNN)
- GRAMINOID FEN (FONG)
- SHRUBBY FEN (FONS)
- OPEN PATTERNED FEN (FOPN)
- WOODED FEN WITH INTERNAL LAWNS (FTNI)
- WOODED FEN (FTNN)
- WOODED PATTERNED FEN (FTPN)
- SHRUBBY SWAMP (SONS)
- WOODED SWAMP (STNN)
- SHALLOW OPEN WATER (WONN)

OTHER

- BURN UPLAND (BUu)
- BURN WETLANDS (BUw)
- CUTBLOCK (CC)
- SHRUBLAND (Sh)

REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2004), and Alberta SRD, used under license.
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 12.

2.5 0 2.5
SCALE 1:100,000 KILOMETRES

PROJECT
JACKPINE MINE EXPANSION & PIERRE RIVER MINE PROJECT

TITLE
RARE VASCULAR PLANT SPECIES AND SPECIAL PLANT COMMUNITIES IDENTIFIED WITHIN THE JACKPINE EXPANSION MINING AREA LOCAL STUDY AREA

Shell Canada Limited

PROJECT No. 05-1344-027.7600			SCALE AS SHOWN	REV. 0
DESIGN	AA	27 Aug. 2007		
GIS	JH	14 Nov. 2007		
CHECK	AA	20 Nov. 2007		
REVIEW	TC	27 Nov. 2007		

FIGURE: 3.5-5

Project: I:/CLIENTS/SHELL/05-1344-027/mapping/mxd/veg/DRAFT/jackpine/bl_ecosite_rare_vascular_plants_jp_esr.mxd- Plot: ?J:\2005\GIS\ArcMapTemplates\templates\v91\MyProject.pdf?

Table 3.5-4 Rare Vascular Plant Species Observed Within the Jackpine Expansion Mining Area Local Study Area

Common Name and Scientific Name	ANHIC Rank[a]	COSEWIC (2005) Status	Vegetation Type Within the LSA	Site Number	Number of Populations Recorded in the LSA[b]	Number of Populations Reported in the RSA[c]
Tracking List						
white water-lily *(Nymphaea tetragona)*	S1 G5	May be at Risk	FONS	3BV024	1	3
small butterwort *(Pinguicula villosa)*	S1 G4	Sensitive	FOPN	3AV002	1	0
northern slender ladies'-tresses *(Spiranthes lacera)*	S1 G5	May be at Risk	BUu	3AV053, 3AV056	2	3 (1)
slender-leaved sundew *(Drosera linearis)*	S2 G4	Sensitive	FONG, FOPN	3AP001, 3AV002, 3AV003, 3AV009, 3AV036, 3BV033, 3CV036	7	1 (1)
pitcher-plant *(Sarracenia purpurea)*	S2 G5	Sensitive	FONG, FONS, FOPN, FTPN	3AP001, 3AP002, 3AV002, 3AV003, 3AV009, 3AV010, 3AV036, 3BP003, 3BV008, 3BV009, 3BV033, 3BV045, 3BV061, 3CP023, 3CV009, 3CV014, 3CV036, 3CV039, 3BP001	19	21 (3)
golden saxifrage *(Chrysosplenium iowense)*	S3 G3	Sensitive	BONN	3BV013	1	7 (1)
green saxifrage *(Chrysosplenium tetrandrum)*	S3 G5	Secure	SONS, FTNN	3AV024, 3BV020	2	3
Watch List[d]						
hairy-fruited sedge *(Carex lasiocarpa)*	S4 G5	Secure	FONG, FONS, FOPN, FTNN, FTPN, MONG	3AV009, 3AV021, 3AV022, 3AV036, 3AV042, 3BV019, 3BV033, 3BV042, 3CV009, 3CV014, 3CV027, 3CV034, 3CV036, 3CV039	14	4 (2)

(a) Rare plant status ranks according to the Alberta Heritage Information Centre (Gould 2006); G = global; S = Alberta.

(b) Numbers of rare vascular plant populations within the JEMA LSA, based on data collected for the Project. Historical records within the LSA from previous EIAs and ANHIC (2007) are provided in Table 3.5-7.

(c) Numbers of rare vascular plant populations within the RSA is based on historical data from the Alberta Natural Heritage Information Centre (ANHIC 2006d) and contributing data from the 2006 vegetation and rare plant surveys of the JEMA program that located the listed species outside of the JEMA Local Study Area. The number in brackets indicates occurrences found during the 2006/2007 PRMA vegetation and rare plant surveys, and are in addition to the RSA tally.

(d) The number of occurrences of species on the Watch List at the RSA level has not been presented, as these species are not mapped by ANHIC (Rintoul 2007, pers. comm.).

Note: This table is organized in order of decreasing rarity rank (Gould 2006), then by species scientific name.

Seven of the eight rare species observed within the JEMA LSA have also been observed within the RSA (ANHIC 2006d), and five were also found during PRMA 2006/2007 surveys. Pitcher-plant (*Sarracenia purpurea*) and golden saxifrage (*Chrysosplenium iowense*) were documented most often in the RSA, with 21 and seven populations being reported, respectively. Small butterwort

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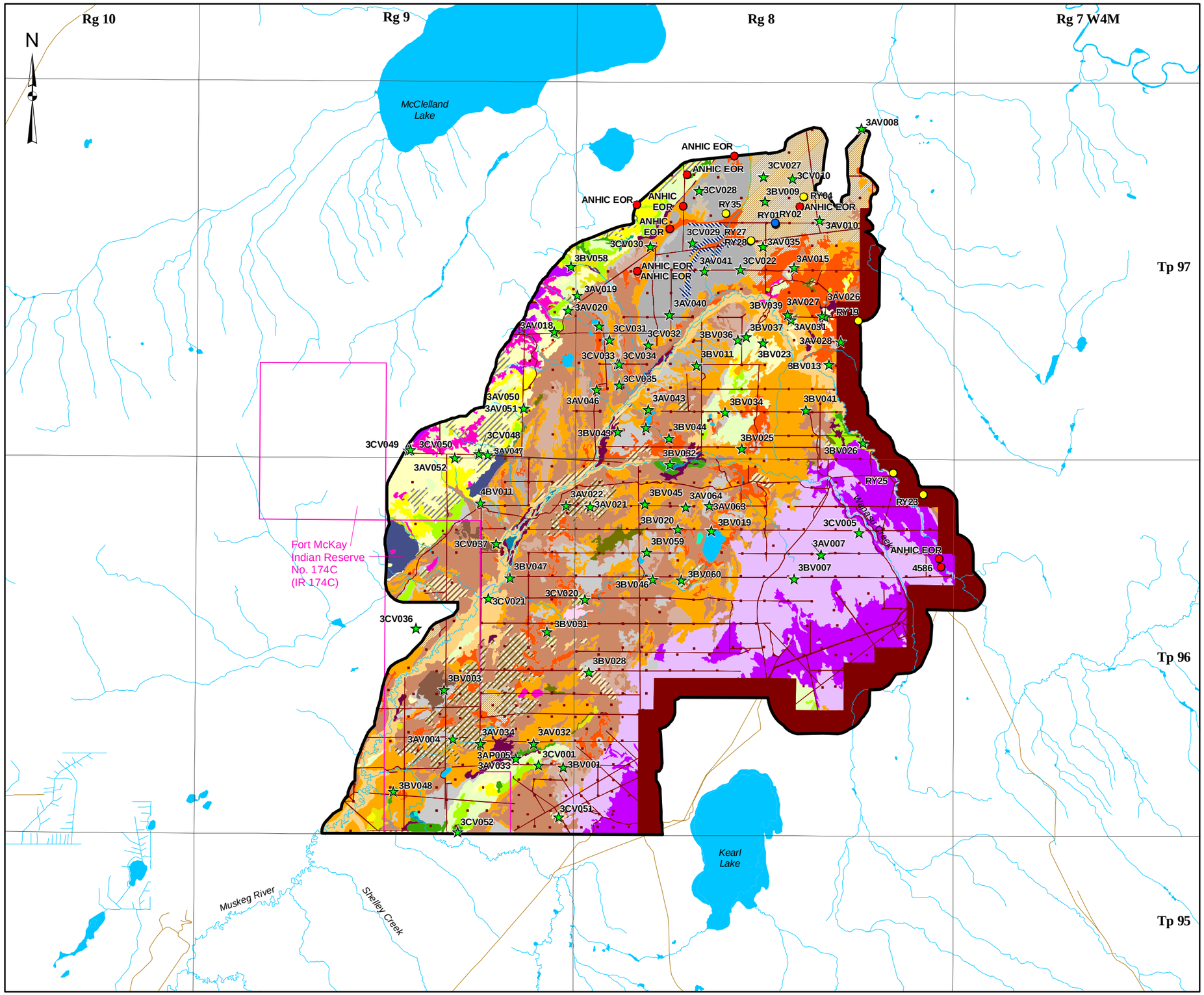
(*Pinguicula villosa*) on the Tracking List and hairy-fruited sedge (*Carex lasiocarpa*) on the Watch List has not been previously reported within the RSA by ANHIC. White water-lily and northern slender ladies' tresses (*Spiranthes lacera*) are listed by COSEWIC (2007) as *May Be At Risk*, while small butterwort, slender-leaved sundew (*Drosera linearis*), pitcher plant (*Sarracenia purpurea*) and golden saxifrage (*Chrysosplenium iowense*) are listed as *Sensitive*, all of which are documented in the LSA.

Table 3.5-4 provides a list of all rare vascular plants species found within the JEMA LSA (Figure 3.5-5). The ANHIC rank indicates the "rarity" of the species, globally and within the province. The COSEWIC ranking describes the rarity of a species as recognized at a Federal level. Refer to Section 3.3.6.2 for more information on rare plant status rankings. The vegetation type(s) associated with a rare plant indicates the characteristic ecosite phase, wetlands type or miscellaneous vegetation type where the species was found. Associated site numbers are also provided so that the species can be located (Figure 3.5-5 and Appendix M). The total number of populations recorded within the LSA is based on results from the 2006 and 2007 surveys for the Project, Shell Jackpine Mine – Phase 1 (Golder 2002) and Imperial Kearl (Imperial Oil 2005) EIAs and historical ANHIC records (AHNIC 2007). The number of populations reported in the RSA is based on historical ANHIC records (ANHIC 2006d).

Appendix H provides descriptions of each species' characteristic vegetation type and distribution ranges.

Rare Bryophyte Species

There were 11 rare bryophyte species observed within the JEMA LSA (Figure 3.5-6, Table 3.5-5 and Appendix M). Nine of these species are from the ANHIC Tracking List and two species from the Watch List (Gould 2006). Additionally, a single occurrence of a bryophyte species (*Plagiochila porelloides*) was found that has not been ranked in Alberta. The status of bryophyte species that are listed as being *Unranked in Alberta* (Table 3.5-5) may be due to insufficient provincial data, unreported occurrences or may not have been previously identified in Alberta. All of these species were observed from 15 different sites surveyed within the JEMA LSA. All of the bryophyte species found within the project area have not been assessed by COSEWIC (2007).



LEGEND

- JACKPINE EXPANSION MINING AREA LOCAL STUDY AREA
- INDIAN RESERVE
- OPEN WATER
- PUBLIC ROADWAY

DISTURBED

- EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE
- EXISTING AND APPROVED URBAN AND INDUSTRIAL LINEAR DISTURBANCE
- JACKPINE EXPANSION MINING AREA RARE PLANT SURVEY - RARE SPECIES OCCURENCE
- HISTORICAL ANHIC ELEMENT OCCURRENCE RECORD
- HISTORICAL ANHIC ELEMENT OCCURRENCE RECORD AND KEARL EIA RECORD
- HISTORICAL KEARL EIA RECORD

ECOSITE PHASE

- LICHEN JACK PINE (a1)
- BLUEBERRY JACK PINE-ASPEN (b1)
- BLUEBERRY ASPEN (WHITE BIRCH) (b2)
- BLUEBERRY ASPEN-WHITE SPRUCE (b3)
- BLUEBERRY WHITE SPRUCE-JACK PINE (b4)
- LABRADOR TEA-MESIC JACK PINE-BLACK SPRUCE (c1)
- LOW-BUSH CRANBERRY ASPEN (d1)
- LOW-BUSH CRANBERRY ASPEN-WHITE SPRUCE (d2)
- LOW-BUSH CRANBERRY WHITE SPRUCE (d3)
- DOGWOOD BALSAM POPLAR-ASPEN (e1)
- DOGWOOD BALSAM POPLAR-WHITE SPRUCE (e2)
- DOGWOOD WHITE SPRUCE (e3)
- HORSETAIL WHITE SPRUCE (f3)
- LABRADOR TEA-SUBHYGRIC BLACK SPRUCE-JACK PINE (g1)
- LABRADOR TEA/HORSETAIL WHITE SPRUCE-BLACK SPRUCE (h1)
- JACK PINE-TAMARACK COMPLEX (Pj-Lt Complex)

WETLANDS TYPES

- FORESTED BOG (BFNN)
- OPEN BOG (BONN)
- WOODED BOG WITH INTERNAL LAWNS (BTNI)
- WOODED BOG (BTNN)
- WOODED BOG WITH INTERNAL LAWNS AND ISLANDS OF FORESTED PEAT PLATEAU (BTNR)
- WOODED PERMAFROST BOG WITH COLLAPSE SCAR (BTXC)
- FORESTED FEN (FFNN)
- GRAMINOID FEN (FONG)
- SHRUBBY FEN (FONS)
- OPEN PATTERNED FEN (FOPN)
- WOODED FEN WITH INTERNAL LAWNS (FTNI)
- WOODED FEN (FTNN)
- WOODED PATTERNED FEN (FTPN)
- SHRUBBY SWAMP (SONS)
- WOODED SWAMP (STNN)
- SHALLOW OPEN WATER (WONN)

OTHER

- BURN UPLAND (BUu)
- BURN WETLANDS (BUw)
- CUTBLOCK (CC)
- SHRUBLAND (Sh)

REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2004), and Alberta SRD, used under license.
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 12.

2.5 0 2.5

SCALE 1:100,000 KILOMETRES

PROJECT

JACKPINE MINE EXPANSION & PIERRE RIVER MINE PROJECT

TITLE

RARE NON-VASCULAR PLANTS IDENTIFIED WITHIN THE JACKPINE EXPANSION MINING AREA LOCAL STUDY AREA

Shell Canada Limited

PROJECT No. 05-1344-027.7600			SCALE AS SHOWN	REV. 0
DESIGN	AA	27 Aug. 2007	FIGURE: 3.5-6	
GIS	JH	14 Nov. 2007		
CHECK	AA	20 Nov. 2007		
REVIEW	TC	27 Nov. 2007		

Project: I:/CLIENTS/SHELL/05-1344-027/mapping/mxd/veg/DRAFT/jackpine/bl_ecosite_rare_NonVascular_plants_jp_esr.mxd- Plot: ?J:\2005\GIS\ArcMapTemplates\templates\v91\MyProject.pdf?

Table 3.5-5 Rare and Unranked Bryophyte Species Observed Within the Jackpine Expansion Mining Area Local Study Area

Common Name and Scientific Name	ANHIC Rank[a]	COSEWIC(2005) Status	Vegetation Type Within the LSA	Site Number	Number of Occurrences Recorded in the LSA[b]	Number of Occurrences Reported in the RSA[c]
Tracking List						
liverwort *(Calypogeia integristipula)*	S1 G4G5	not assessed	BUw	3AV007	1	0
liverwort *(Lophozia rutheana)*	S1 G4?	not assessed	Buw	3CV005	1	0
liverwort *(Anastrophyllum helleranum)*	S2 G5	not assessed	d3	3CV052	1	5
snake liverwort *(Conocephalum conicum)*	S2 G5	not assessed	f3	3BV026	1	2
Pseudobryum cinclidioides (no common name)	S2 G5	not assessed	FTNN	3CV033, 3CV037	2	2
flagon-fruited splachnum (*Splachnum ampullaceum)*	S2 G5	not assessed	g1	3AP005	1	4
globe-fruited splachnum (*Splachnum sphaericum)*	S2 G3G5	not assessed	g1	3AP005	1	5
brown moss *(Warnstorfia tundrae)*	S2 GU	not assessed	FONG	3BV001	1	2
yellow collar moss (*Splachnum luteum)*	G3 S3	not assessed	g1	3AP005	1	4 (1)
Watch List[d]						
campylium moss *(Campylium polygamum)*	G5 S3	not assessed	SONS, MONG	3BV012, 3BV019	2	0[d] (1)
liverwort *(Calypogeia sphagnicola)*	SNR G4	not assessed	BTNI	3CV029	1	0[d]
Unranked in Alberta[e]						
Plagiochila porelloides (no common name)	not ranked	not assessed	FTNN	3BV047, 3CV024	2	0 (2)

[a] Rare plant status ranks according to the Alberta Heritage Information Centre (Gould 2006); G = global; S = Alberta.

[b] Numbers of rare bryophytes populations within the JEMA LSA, based on data collected for the Project. Historical records from previous EIAs and ANHIC (2007) are provided in Table 3.5-7.

[c] Numbers of rare bryophytes within the RSA is based on historical data from the Alberta Natural Heritage Information Centre (ANHIC 2006d) and contributing data from the 2006 vegetation and rare plant surveys of the JEMA program that located the listed species outside of the JEMA Local Study Area. The number in brackets indicates occurrences found during the 2006/2007 PRMA vegetation and rare plant surveys, and are in addition to the RSA tally.

[d] The number of occurrences of species on the Watch List at the RSA level has not been presented as these species are not mapped by ANHIC (Rintoul 2007, pers. comm.).

[e] Species unranked in Alberta and no occurrences reported in Alberta by ANHIC. Many of these species are unranked globally and with incomplete known ranges (NatureServe 2006, website).

Note: This table is organized in order of decreasing rarity rank (Gould 2006), then by species scientific name.

Seven of the 11 species found on the Tracking List have also been reported within the RSA (ANHIC 2006d). Of these species, globe-fruited splachnum *(Splachnum sphaericum)* was documented most often in the RSA with five recorded observations (ANHIC 2006d). Globe-fruited splachnum *(Splachnum sphaericum), Calypogeia sphagnicola* (liverwort) and *Warnstorfia tundrae* (brown moss) have been previously documented in the JEMA LSA (Table 3.5-7). *Calypogeia integristipula* (liverwort), *Lophozia rutheana* (liverwort) and *Campylum polygamum* (moss) have not been previously reported in the RSA.

The absence of these species in other parts of the RSA may be related to the fact that the known ranges of many bryophytes within North America are incomplete (NatureServe 2006, website). In addition, the data collection protocols followed for this project resulted in a greater number of bryophyte samples being collected as compared with many other previous projects completed in the region.

Table 3.5-5 provides a list of all bryophyte species found within the JEMA LSA and the RSA. The ANHIC rank indicates the "rarity" of the species, globally and within the province. The COSEWIC ranking describes the rarity of a species as recognized at a Federal level. Refer to Section 3.3.6.2 for more information on rare plant status rankings. The vegetation type(s) associated with a rare bryophyte indicates the characteristic ecosite phase, wetlands type or miscellaneous vegetation type where the species was found. Associated site numbers are also provided so that the species can be located (Figure 3.5-6 and Appendix M). The total number of populations recorded within the LSA is based on results from the 2006 and 2007 surveys for the Project. Appendix H provides descriptions of each species characteristic vegetation type or microhabitat and distribution ranges.

Rare Lichen Species

There were 13 known rare lichen species documented at a total of 68 sites within the JEMA LSA (Figure 3.5-6, Table 3.5-6 and Appendix M). All 13 of these species are included on the ANHIC Tracking List. Seventeen species are yet unranked by Alberta (Gould 2000; ANHIC 2006b) that were found at 107 sites throughout the JEMA LSA. Only three of the 13 lichens have been reported previously within the RSA (ANHIC 2006d), that includes American starburst lichen (*imshaugia placordia*), old man's beard (*Bryoria simplicior*) and *Arthonia patellulata*, all of which are epiphyte (tree growing) lichens. All of the lichen species found within the Project area have not been assessed by COSEWIC (2007).

The relatively high number of rare lichens documented within the JEMA LSA is due in part to the high number of samples collected for the Project. In addition, the lichen flora of Alberta is poorly known, especially in the north and eastern

portions of the province (Goward 2007, pers. comm). Thus, benchmark information for the region is generally lacking, and there is little information on lichen species presence and abundance to compare with data collected for the Project.

Similar results have been noted in other jurisdictions. For example, the Wisconsin State University has compiled a list of 166 lichens that appear rare; however, the genera have been poorly surveyed and so are thought to be undercollected in the state (Thomson and Will-Wolf 2000, website). The United States National Parks also found many lichen species within their national park system (79 species) that were not listed in the North American Checklist (Esslinger 2006, website; USGS 2007, website). These examples illustrate that lichens as a group are undercollected, at least in certain regions, which has resulted in lack of species presence, abundance and distribution information.

Table 3.5-6 provides a list of all lichen species found within the JEMA LSA. The ANHIC rank indicates the "rarity" of the species, globally and within the province. Refer to Section 3.3.6.2 for more information on rare plant status rankings. The vegetation type(s) associated with a rare lichen indicates the characteristic ecosite phase, wetlands type or miscellaneous vegetation type where the species was found. Associated site numbers are also provided so that the species can be located (Figure 3.5-6). The total number of occurrences recorded within the JEMA LSA is based on results from the 2006 surveys for the Project. The number of occurrences reported in the RSA is based on 2006 and 2007 surveys for the Project and historical ANHIC records (ANHIC 2006d). Appendix H provides descriptions of each species characteristic vegetation type or microhabitat and distribution ranges.

Table 3.5-6 Rare and Unranked Lichen Species Observed Within the Jackpine Expansion Mining Area Local Study Area

Common Name and Scientific Name	ANHIC Rank[a]	COSEWIC (2005) Status	Vegetation Types Within the LSA	Site Number	Number of Occurrences Recorded in the LSA[b]	Other Occurrences Reported in the RSA[c]
Tracking List						
powdery goldspeck lichen (*Candelariella efflorescens)*	S1 G?	not assessed	f3	3AV050	1	0
Lecanora expallens (no common name)	S1 G?	not assessed	d2, FOPN	3AV026, 3CV010	2	0
Lecanora subintricata (no common name)	S1 G?	not assessed	b1, d1, f3, h1, BUw, BTNI, BTNN, FONS, FOPN, FTNN, FTPN	3AV004, 3AV007, 3AV027, 3AV032, 3AV035, 3AV043, 3AV050, 3BV023, 3BV034, 3BV041, 3BV043, 3BV045, 3BV047, 3CV010, 3CV022, 3CV029, 3CV031, 3CV034, 3CV036, 3CV037, 3CV050	21	8 (19)
Lecidella elaeochroma (no common name)	S1 G?	not assessed	b1, c1, d2, BUw, BTNN, BTNR, FOPN, FTNN	3AV007, 3AV020, 3AV026, 3AV051, 3BV034, 3BV047, 3CV001, 3CV010, 3CV020, 3CV028, 3CV036	11	2 (8)
Ochrolechia gowardii (no common name)	S1 G?	not assessed	SONS	3CV021	1	0
rock ramalina *(Ramalina intermedia)*	S1 G?	not assessed	h1	3BV032	1	0
Rinodina metaboliza (no common name)	S2 G?	not assessed	d2	3AV026, 3CV001	2	0 (4)
powder–edged speckled greenshield *(Flavopunctelia soredica)*	S2 G3G5	not assessed	FOPN, FTPN, SONS	3AV021, 3CV021, 3CV036	3	0
American starburst *lichen (Imshaugia placorodia)*	S2 G3G5	not assessed	a1, b3, c1	3AV031, 3AV052, 3CV049	3	8 (39)
punctured ramalina *(Ramalina dilacerata)*	S2 G3G5	not assessed	d1, d2, d3, f3, BONS, STNN	3AV018, 3AV034, 3AV050, 3AV051, 3BV013, 3BV026, 3BV028, 3BV037, 3CV001, 3CV051, 3CV052	11	1 (38)
Melanelia trabeculata (no common name)	S2? G?	not assessed	d1, d2, h1, BTNI, STNN	3AV040, 3BV032, 3BV037, 3CV001, 3CV051	5	1 (7)
old man's beard *(Bryoria simplicior)*	S2S3 G?	not assessed	BUw, FTPN	3AV021, 3BV007	2	4 (3)
Arthonia patellulata (no common name)	S3? G5	not assessed	b3, d1, d2	3AV015, 3AV018, 3AV051, 3AV052, 3BV011	5	2 (24)
Unranked in Alberta[d]						
Candelariella lutella (no common name)	–	not assessed	d1	3BV037	1	0 (2)
Cliostomum pallens (no common name)	–	not assessed	f3, FONS, FOPN, FTNI, FTNN	3AV046, 3AV050, 3BV041, 3BV045, 3BV047, 3BV059, 3CV027, 3CV033, 3CV037, 4BV011	10	0 (5)
Lecanora boligera (no common name)	–	not assessed	FONS, FOPN, FTNI, FTNN	3BV009, 3BV024, 3BV059, 3CV037	4	1 (1)

Table 3.5-6 Rare and Unranked Lichen Species Observed Within the Jackpine Expansion Mining Area Local Study Area (continued)

Common Name and Scientific Name	ANHIC Rank[a]	COSEWIC (2005) Status	Vegetation Types Within the LSA	Site Number	Number of Occurrences Recorded in the LSA[b]	Other Occurrences Reported in the RSA[c]
Lecanora laxa (no common name)	–	not assessed	BTNI, FTNN	3AV043, 3CV030, 3CV035	3	0 (3)
Lecanora persimilis (no common name)	–	not assessed	a1, b1, d2, g1, BTNI, FONS, FOPN, FTNI, FTNN	3AV040, 3AV063, 3BV023, 3BV031, 3BV041, 3BV043, 3BV059, 3CV001, 3CV034, 3CV035, 3CV036, 3CV049	12	0 (6)
Lecidea amaurospoda (no common name)	–	not assessed	FTNN	3CV035	1	0
Lecidea leprarioides (no common name)	–	not assessed	d1, FTNN	3AV015, 3BV047	2	0 (1)
Lecidea nylanderi (no common name)	–	not assessed	b2, b4, d1	3BV058, 3CV048, 3CV050	3	0 (11)
Leptorhaphis epidermidis (no common name)	–	not assessed	b2, FTNN	3AV047, 3CV048, 4BV011	3	1
Micarea denigrata (no common name)	–	not assessed	FONS	3CV031	1	0 (1)
Micarea sylvicola (no common name)	–	not assessed	c1, g1, SONS	3AV063, 3BV025, 3CV020	3	1 (5)
Rinodina disjuncta (no common name)	–	not assessed	FTNN	3CV033	1	0 (5)
Rinodina orculata (no common name)	–	not assessed	d1	3BV037	1	0 (4)
Scoliciosporum perpusillum (no common name)	–	not assessed	a1, b1, b3, b4, d1, d2, d3, f3, g1, h1, BUw, BTNI, BTNN, BTNR, FONG, FONS, FOPN, FTNI, FTNN, SONS, STNN	3AV007, 3AV008, 3AV010, 3AV018, 3AV019, 3AV022, 3AV026, 3AV027, 3AV032, 3AV034, 3AV035, 3AV040, 3AV041, 3AV046, 3AV050, 3AV051, 3AV052, 3AV063, 3AV064, 3BV003, 3BV009, 3BV023, 3BV025, 3BV026, 3BV031, 3BV032, 3BV034, 3BV036, 3BV037, 3BV039, 3BV044, 3BV046, 3BV047, 3BV048, 3BV058, 3BV059, 3BV060, 3CV001, 3CV010, 3CV022, 3CV028, 3CV029, 3CV030, 3CV031, 3CV032, 3CV033, 3CV034, 3CV035, 3CV049, 3CV050, 3CV051, 3CV052	55	21 (49)

Table 3.5-6 Rare and Unranked Lichen Species Observed Within the Jackpine Expansion Mining Area Local Study Area (continued)

Common Name and Scientific Name	ANHIC Rank[a]	COSEWIC (2005) Status	Vegetation Types Within the LSA	Site Number	Number of Occurrences Recorded in the LSA[b]	Other Occurrences Reported in the RSA[c]
Scoliciosporum umbrinum (no common name)	–	not assessed	d1, STNN	3BV028, 3BV037	2	1 (1)
alder stickpin *(Stenocybe pullatula)*	–	not assessed	FTNN	3BV020	1	0 (4)
variable wrinkle–lichen *(Tuckermannopsis orbata (*also *Cetraria orbata)*	–	not assessed	h1, BTNR, FOPN, STNN	3AV008, 3AV027, 3AV028, 3BV028	4	1 (13)

(a) Rare plant status ranks according to the Alberta Heritage Information Centre (Gould 2006); G = global; S = Alberta; – = Not ranked.

(b) Numbers of rare lichen populations within the JEMA LSA, based on data collected for the Project. Historical records from previous EIAs and ANHIC (2007) are provided in Table 3.5-7.

(c) Numbers of rare lichens within the RSA is based on historical data from the Alberta Natural Heritage Information Centre (ANHIC 2006d) and contributing data from the 2006 vegetation and rare plant surveys of the JEMA program that located the listed species outside of the JEMA Local Study Area. The number in brackets indicates occurrences found during the 2006/2007 PRMA vegetation and rare plant surveys, and are in addition to the RSA tally.

(d) Species unranked in Alberta and no occurrences reported in Alberta by ANHIC. Many of these species are unranked globally and with incomplete known ranges (NatureServe 2006, website).

Historical Rare Plant Data in the Jackpine Expansion Mining Area Local Study Area

Documented detailed vegetation inventory and rare plant survey data collected for other development projects in the areas surrounding the JEMA LSA was reviewed and incorporated into this report. The primary source of historical rare plant data was a query of ANHIC rare plant species Element Occurrence Record (EOR) data encompassing the JEMA LSA (ANHIC 2007). Other data reviewed includes the Jackpine Mine – Phase 1 Environmental Setting Report (Golder 2002) and Kearl (Imperial Oil 2005) Environmental Impact Assessment. Data from the Kearl EIA includes presented survey and historical data.

Table 3.5-7 details the historical rare plant occurrences found on the JEMA LSA. Locations can be found by relating site numbers to Figures 3.5-5 and 3.5-6.

Table 3.5-7 Rare Plants Found Historically in the Jackpine Expansion Mining Area Local Study Area

Scientific Name	Common Name	ANHIC Rank[a]	Vegetation Type Within the LSA	Number of Historical Occurrences in the LSA	Site Number	Source[b]
Tracking List						
Cardamine pratensis	meadow bitter cress	S1S2 G5	STNN	1	AW40	Kearl
Carex lacustris	lakeshore sedge	S2 G5	FOPN	1	RY03	Kearl
Cephalozia loitlesbergeri	liverwort	SNRG5	FTPN	2	RY02, RY05	ANHIC, Kearl
Cephaloziella elachista	liverwort	SNRG4	FOPN	1	RY01	ANHIC, Kearl
Chiloscyphus pallescens	liverwort	S1G5	FOPN, FTPN, g1/STNN, not available	4	RY02, RY27, RY19, n/a	ANHIC, Kearl
Chrysosplenium iowense[c]	golden saxifrage	S3G3	not available	1	n/a	ANHIC
Conardia compacta	moss	S2G3G5	not available	1	n/a	ANHIC
Cypripedium acaule	stemless lady's slipper	S3G5	a1 (4), b1 (4)	8	AW02, AW19, BW26, BW27, BW29, BW30, BW63, RHS27	ANHIC, Kearl
Drepanocladus sendtneri	brown moss	S1G5?	not available	1	n/a	ANHIC
Eleocharis compressa var borealis	flattened spike-rush	S1G5T5	not available	1	n/a	ANHIC
Hygroamblystegium noterophilum	moss	SUG4	not available	2	n/a	ANHIC
Hygroamblystegium tenax	no common name	S2G5	FONG	1	RY25	Kearl
Limprichtia cossonii	moss	SUGU	not available	1	n/a	ANHIC
Lophocolea bidentata	liverwort	SNRG5	FTPN (3), FONS	4	RY02, RY05, RY28, n/a	ANHIC, Kearl
Lophozia heterocolpos	liverwort	S2G5	FTPN	2	RY02, RY05	ANHIC, Kearl
Lophozia incisa	liverwort	S2G5	not available	1	n/a	ANHIC
Odontoschisma denudatum	liverwort	S1G5	FTPN	1	RY05	ANHIC, Kearl
Riccardia latifrons	liverwort	S2G4G5	FTNN, FTPN, not available	3	RY02, n/a	ANHIC, Kearl
Riccardia palmata	liverwort	S1G5	FTPN (3), FOPN	4	RY02, RY05, RY04, RY28	ANHIC, Kearl
Sarracenia purpurea[c]	pitcher plant	S2G5	FOPN (5), FTPN (2)	7	RY02, RY03, RY04, RY05, RY06, RY27, 10417	ANHIC, Kearl
Sphagnum fallax	peat moss	S2G5	FONS	1	RY35	Kearl
Spiranthes lacera[c]	northern slender ladies'-tresses	S1G5	b1	2	AW95, BW95	Kearl
Splachnum sphaericum[c]	globe-fruited splachnum	S2G3G5	not available	1	n/a	ANHIC
Warnstorfia tundrae[c]	brown moss	S2GU	not available	1	n/a	ANHIC
Watch List						
Calypogeia sphagnicola[c]	liverwort	G4 SNR	FTPN (3), FOPN (2)	5	RY01, RY02, RY04, RY05, RY28	Kearl
Coptis trifolia	goldthread	S3G5	d3	1	K42	Kearl

[a] Rare plant status ranks according to the Alberta Natural Heritage Information Centre (Gould 2006); G = Global; S = Alberta.

[b] Sources ANHIC Element Occurrence Records for the LSA area (ANHIC 2007) and survey and historical data from the Kearl EIA (Imperial Oil 2005). The Shell Canda Ltd. Jackpine Mine – Phase 1 Project (Golder 2002) was reviewed, but all rare plants fall outside the JEMA LSA.

[c] Species also found during the 2006 surveys of the JEMA LSA.

n/a = Not available.

3.5.1.5 Rare and Special Plant Communities

Rare and special plant communities were selected as community-level vegetation KIRs because of their ecological and social importance, and vulnerability to disturbance.

Rare Plant Communities

No rare plant communities were observed within the JEMA LSA during field surveys. This finding was later verified through a comparison of sites surveyed with those listed in the Preliminary Ecological Community Tracking List (Allen 2006).

Special Plant Communities

A special plant community was observed within the JEMA LSA (Table 3.5-8). Special plant communities are not included on ANHIC's Tracking List because of a lack of information. Therefore, documenting the presence of these plant communities is important to facilitate a status assessment in the future. Based on the data available, confirmation on the special status of the community listed here was provided by Lorna Allen (Allen 2007, pers. comm.). A description of the community is provided below. It's location is provided in Figure 3.5-5.

Lenticular Patterned Fen

The "lenticular" (lens-like) patterned fen special plant community is situated in the northeast corner of the JEMA LSA, about 4 km southeast of McClelland Lake (Figure 3.5-5 and Photo 1). This fen covers an area of approximately 642 ha, the entirety of which lies within the boundaries of the LSA. An associated (and more typical) patterned fen adjoins the lenticular patterned fen to the north and northeast, and occupies an area of about 1,378 ha. This associated fen is not within the JEMA LSA.

The lenticular patterned fen has been previously described in the Imperial Kearl Oil Sands EIA (Imperial Oil 2005), where it has also been recognized as being a Special Plant Community complex. The unique nature of the fen is affected by its landscape position at both an area of groundwater discharge, more typical of bogs (Vitt et al. 1996; Halsey et al. 1997), and a surface water drainage divide (more typical of patterned fens) between the Muskeg and Firebag rivers (Halsey and Devito 2003). "It occupies a drainage divide and is also an area that likely receives regional groundwater discharge from the surficial aquifer. Water quality of the lenticular patterned fen is typical of patterned fens at the base of regional uplands, with relatively high base cation and low nutrient concentrations (Halsey and Devito 2003)."

The unique character of this patterned fen is expressed by the fact that it does not form typical linear strings (woody ridges) and flarks (herbaceous pools), but rather takes on a lenticular, island-like patterning. The strings of this patterned fen are represented by lenticular-shaped wooded, poor fen islands. These islands are surrounded by open, graminoid fen flarks. Internal to some of the poor fen strings are depressed, open graminoid fens, similar to internal lawns without snags (Halsey et. al. 2003). The pH of these internal graminoid fens is near neutral, and characteristic of rich fens (Imperial Oil 2005).

The lenticular patterned fen is similar in plant composition to other patterned fens in the western boreal forest (see species list for patterned fen [FOPN, FTPN] in Appendix L); however, the immediate contrast of the poor fen islands and rich open graminoid fens is unique. Fifty-seven vascular species were found in this community (Table 3.5-8), comprising 23% of all vascular species found in the JEMA LSA. Rare vascular species found include *Drosera linearis*, *Sarracenia purpurea* and *Carex lasiocarpa* (Table 3.5-4, Figure 3.5-5). Rare or unranked lichen species found include *Clistomum pallens*, *Scoliciosporum perpusillum* and *Lecanora subintricata* (Table 3.5-6, Figure 3.5-6).

Table 3.5-8 Special Plant Communities Within the Jackpine Expansion Mining Area Local Study Area

Special Plant Community		Vegetation Type	Site Number
Common Name	**Scientific Name**		
lenticular patterned fen (dwarf birch/hairy-fruited sedge/buck-bean–pitcher-plant)	lenticular patterned fen (*Betula pumila/Carex lasiocarpa/Menyanthes trifoliata – Sarracenia purpurea)*	Open patterned fen (FOPN)	3AV008, 3AV011, 3BV008, 3CV026

Photo 1 Lenticular Patterned Fen Southeast of McClelland Lake

Rare vascular species found in the lenticular patterned fen for the Imperial Kearl EIA (Imperial Oil 2005) included *Carex lacustris* and *Sarracenia purpurea* (Table 3.5-7, Figure 3.5-5). Rare bryophytes (Table 3.5-7, Figure 3.5-6) included: *Calypogeia sphagnicola*, *Cephalozia loitlesbergeri* (a new species to Alberta), *Cephalozia elachista*, *Chiloscyphus pallescens*, *Lophocolea bidentata*, *Lophozia heterocolpos*, *Odontoschisma denudatum*, *Riccardia latifrons* and *Riccardia palmata*.

3.5.1.6 Species Diversity and Richness

Plant species were distributed across 16 ecosite phases, 16 wetlands types, three miscellaneous vegetation types and four non-vegetated or disturbance types within the JEMA LSA. In total, 539 plant species were identified within the JEMA LSA. This includes 65 woody species (trees and shrubs), 168 forbs, 67 graminoids, 104 terrestrial bryophytes, 41 terrestrial lichens and 94 epiphytes (primarily lichens but including bryophytes as well).

Species diversity measures calculated by vegetation type are as follows and detailed below:

- total number of vascular species;
- total number of rare vascular species;
- total number of vascular species unique to ecosite phase or wetlands type; and
- mean number of species (species richness).

Total Number of Vascular Species

The number of vascular plant species among vegetation types was calculated as one measure of species diversity. The greatest numbers of vascular plant species occurred within burned wetlands (BUw) which accounted for 101 species, or 40% of all vascular plants recorded within the JEMA LSA (Table 3.5-9). However, as all burned wetlands were grouped, this count may account for several regenerating wetlands types. This was followed closely by the shrubby fen (FONS) wetlands type (89 species) and the wooded fen (FTNN) (89 species).

The lowest numbers of surveyed vascular plant species were within the Labrador tea−subhygric black spruce-jack pine (g1) ecosite phase and the wooded bog with internal lawns (BTNI) wetlands types, with nine and ten vascular species, respectively.

Total Number of Rare Vascular Species

The highest numbers of rare vascular species were found in the open patterned fen (FOPN) and the wooded patterned fen (FTPN) wetlands types, with four and three rare vascular species respectively (Table 3.5-9). One rare vascular species was found in upland vegetation types (burned uplands [BUu]).

Table 3.5-9 Diversity Measures of Vascular Plant Species Within the Jackpine Expansion Mining Area Local Study Area

Map Code	Description	Number of Sites[(a)]	Number of Vascular Species	Percent of All Vascular Species	Number of Rare Vascular Species	Number of Vascular Species Unique to Vegetation Type
Forested Terrestrial Vegetation						
a1	lichen jack pine	7	36	14	0	2
b1	blueberry jack pine-aspen	12	47	19	0	2
b2	blueberry aspen (white birch)	6	32	13	0	1
b3	blueberry aspen-white spruce	5	45	18	0	1
b4	blueberry white spruce-jack pine	4	22	9	0	0
c1	Labrador tea−mesic jack pine-black spruce	2	14	6	0	0
d1	low-bush cranberry aspen	11	57	6	0	1
d2	low-bush cranberry aspen-white spruce	6	48	23	0	3
d3	low-bush cranberry white spruce	3	42	19	0	1
e1	dogwood balsam poplar-aspen	1	27	11	0	2
e2	dogwood balsam poplar-white spruce	1	18	7	0	0
e3	dogwood white spruce	n/d	0	0	0	0
f1	horsetail balsam poplar-aspen	n/d	0	0	0	0
f2	horsetail balsam poplar-white spruce	n/d	0	0	0	0
f3	horsetail white spruce	2	38	15	0	3
g1	Labrador tea−subhygric black spruce-jack pine	5	9	4	0	0
h1	Labrador tea/horsetail white spruce-black spruce	3	30	12	0	0
Forested and Wooded Wetlands						
BFNN	forested bog	n/d	0	0	0	0
BTNI	wooded bog with internal lawns	12	10	4	0	0
BTNN	wooded bog	12	41	16	0	0
BTNR	wooded bog with internal lawns and islands of forested peat plateau	3	22	9	0	0
BTXC	wooded permafrost bog with collapse scar	2	19	8	0	0
FFNN	forested fen	n/d	0	0	0	0
FTNI	wooded fen with internal lawns	7	41	16	0	0
FTNN	wooded fen	28	89	35	2	4
FTPN	wooded patterned fen	6	44	18	3	2
STNN	wooded swamp	7	42	17	0	3
Non-Forested Wetlands						
BONN	open bog	3	29	12	1	1
FONG	graminoid fen	17	64	25	3	8
FONS	shrubby fen	26	89	35	3	8
FOPN	patterned fen	19	57	23	4	5
MONG	marsh	1	19	8	1	2
SONS	shrubby swamp	8	64	25	1	9
WONN	shallow open water	n/d	0	0	0	0
Miscellaneous Vegetation Types						
Me	meadow	n/d	0	0	0	0
Sh	shrubland	1	24	10	0	3
BUu	burn uplands	13	74	29	1	7
BUw	burn wetlands	18	101	40	0	8
Disturbances						
CC	cutblock	n/d	0	0	0	0
DIS	disturbance	n/d	0	0	0	0

[(a)] Includes all detailed vegetation inventory and rare plant survey sites. Number of rare vascular species is within the JEMA LSA only.

n/d = No data.

Total Number of Unique Species

The shrubby swamp (SONS) has the highest number of unique species at nine, followed closely by the shrubby fen (FONS), graminoid fen (FONG) and burn wetlands (BUw) wetlands types with eight vascular species each (Table 3.5-9).

Mean Species Richness

Species richness for vascular plants, bryophytes and lichens are shown in Table 3.5-10. The low-bush cranberry (d), dogwood (e) and horsetail (f) ecosites tended to have among the highest values for vascular species richness (Table 3.5-10, Figure 3.5-7). In addition, the wooded swamp (STNN) wetlands type as well as the burn uplands (BUu), burn wetlands (BUw) and shrubland (Sh) vegetation types also had relatively high numbers of vascular plant species. Among uplands, the nutrient-poor, pine- and black spruce-dominated vegetation types (e.g., a1, c1, g1), had the lowest values of vascular species richness among all vegetation types. The blueberry white spruce-jack pine (b4) ecosite also reports low diversity numbers. Overall, bogs represent the lowest diversity of wetlands types. The graminoid fen (FONG) wetlands type also displays limited diversity.

The highest values for bryophyte species richness tend to be associated with the horsetail white spruce (f3) and low-bush cranberry aspen-white spruce (d2) ecosite phases, as well as the wooded permafrost bog with collapse scars (BTXC) and wooded fen (FTNN) wetlands types (Table 3.5-10, Figure 3.5-8). Low values for bryophyte species richness include the dogwood (e) ecosites, the Labrador tea/horsetail white spruce-black spruce (h1) ecosite phase and wetlands types that lack a tree canopy (MONG, FONG, FONS, SONS).

The highest values for lichen species richness tended to be associated with upland pine-dominated sites and other coniferous-dominated ecosite phases including Labrador tea-subhygric black spruce-jack pine (g1), lichen jack pine (a1), Labrador tea–mesic jack pine-black spruce (c1), blueberry jack pine-aspen (b1) low-bush cranberry white spruce-aspen (d2) and Labrador tea/horsetail white spruce-black spruce (Table 3.5-10, Figure 3.5-9). High lichen values in wetlands types were observed in wooded swamps (STNN) and wooded bog with internal lawns and islands of forested peat plateau (BTNR). The lowest values of lichen species was observed in the dogwood balsam poplar-white spruce (e2) ecosite phase, but low richness values tended to be associated with burns (uplands and wetlands) and wetlands types that lack a tree canopy (i.e., FONG, MONG).

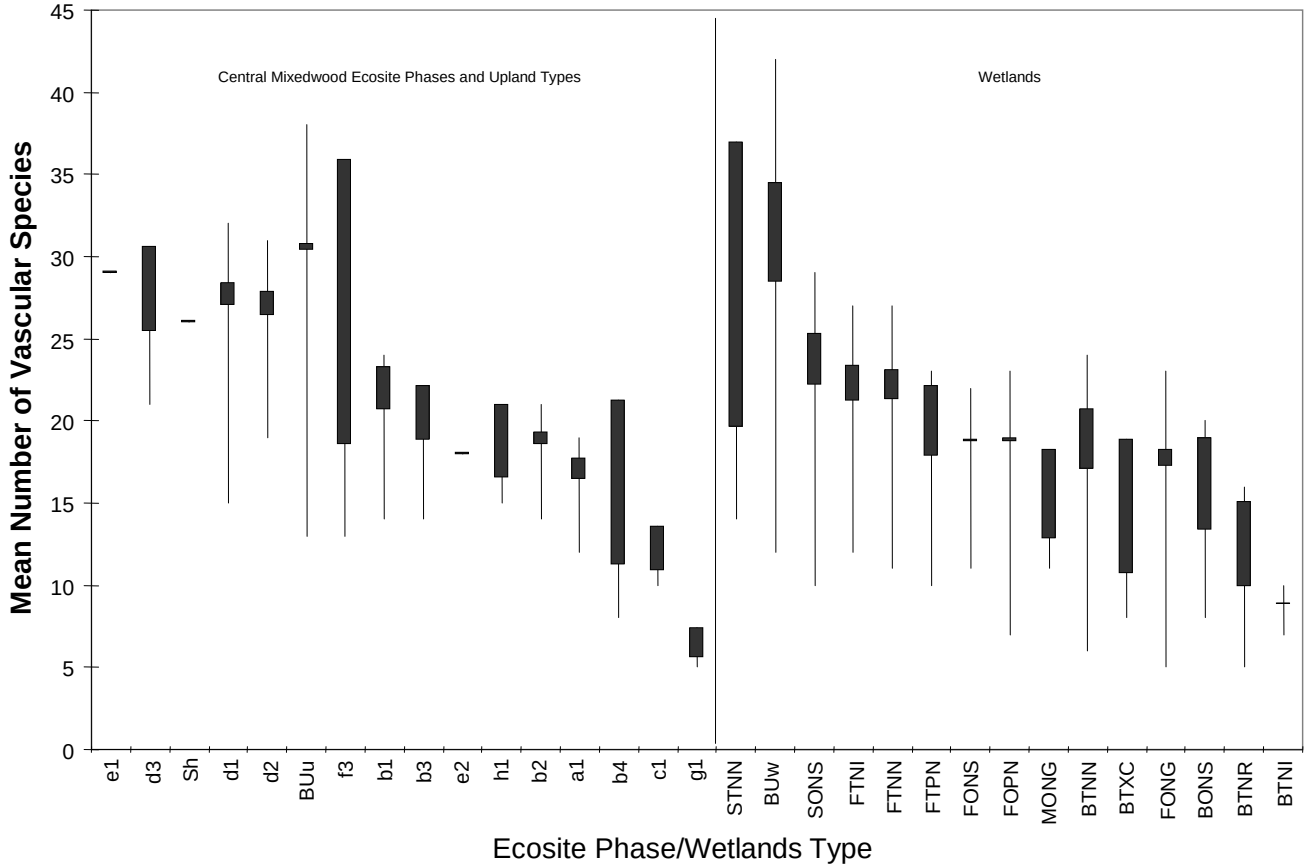
Table 3.5-10 Species Richness Within the Jackpine Expansion Mining Area Local Study Area

Ecosite Phase/Wetlands Type		n[(a)]	Vascular Plant Species Richness				Bryophyte Species Richness				Lichen Species Richness			
Map Code	Description		Mean	St. Dev.[(b)]	Min.	Max.	Mean	St. Dev.[(b)]	Min.	Max.	Mean	St. Dev.[(b)]	Min.	Max.
Central Mixedwood Ecosite Phases														
a1	lichen jack pine	6	15.2	2.6	12	19	3.3	2.1	1	7	17.5	4.6	13	25
b1	blueberry jack pine-aspen	9	20.0	3.3	14	24	3.9	2.2	2	9	17.2	3.2	13	23
b2	blueberry aspen (white birch)	6	16.8	2.5	14	21	6.2	1.7	4	8	14.5	8.1	5	28
b3	blueberry aspen-white spruce	5	19.0	3.2	14	22	6.0	1.0	5	7	15.2	4.2	11	21
b4	blueberry white spruce-jack pine	2	13.5	7.8	8	19	5.5	2.1	4	7	16.0	1.4	15	17
c1	Labrador tea-mesic jack pine-black spruce	2	11.5	2.1	10	13	6.0	0.0	6	6	18.0	2.8	16	20
d1	low-bush cranberry aspen	10(9)	23.4	5.0	15	32	4.9	2.3	2	10	10.7	6.0	1	19
d2	low-bush cranberry aspen-white spruce	6(5)	23.3	4.6	19	31	8.8	4.0	3	13	19.6	3.0	16	24
d3	low-bush cranberry white spruce	3	26.0	4.6	21	30	6.7	5.0	2	12	15.3	3.2	13	19
e1	dogwood balsam poplar-aspen	1	29.0	0.0	29	29	3.0	0.0	3	3	11.0	0.0	11	11
e2	dogwood balsam poplar-white spruce	1	18.0	0.0	18	18	2.0	0.0	2	2	4.0	0.0	4	4
f3	horsetail white spruce	2	22.5	13.4	13	32	9.5	3.5	7	12	16.0	5.7	12	20
g1	Labrador tea-subhygric black spruce-jack pine	2	6.0	1.4	5	7	6.5	2.1	5	8	21.5	7.8	16	27
h1	Labrador tea/horsetail white spruce-black spruce	2	17.5	3.5	15	20	3.0	0.0	3	3	17.5	3.5	15	20
Forested and Wooded Wetlands														
BTNI	wooded bog with internal lawns	6	7.7	1.2	7	10	7.3	3.3	4	13	16.5	8.0	4	24
BTNN	wooded bog	5	13.8	6.9	6	24	5.8	2.6	3	9	16.6	7.9	8	29
BTNR	wooded bog with internal lawns and islands of forested peat plateau	3	9.0	6.1	5	16	8.3	6.8	3	16	18.3	5.7	12	23
BTXC	wooded permafrost bog with collapse scar	2	12.5	6.4	8	17	12.0	8.5	6	18	12.0	8.5	6	18
FTNI	wooded fen with internal lawns	5(4)	17.6	5.8	12	27	6.2	3.7	2	11	14.8	4.1	11	20
FTNN	wooded fen	22	17.4	3.9	11	27	10.4	3.1	5	16	16.1	5.6	4	27
FTPN	wooded patterned fen	5	17.0	5.1	10	23	8.0	5.2	1	13	11.3	6.4	6	19
STNN	wooded swamp	2	23.5	13.4	14	33	8.0	0.0	8	8	23.5	4.9	20	27
Non-Forested Wetlands														
BONN	open bog	3	12.3	6.7	8	20	6.7	3.1	4	10	11.0	8.5	3	20
FONG	graminoid fen	14(6)	12.4	4.8	5	23	3.0	1.8	1	7	7.3	3.0	5	13
FONS	shrubby fen	23(22)	15.6	3.2	11	22	5.5	1.9	3	10	9.5	7.0	1	31
FOPN	open patterned fen	14(10)	14.7	4.3	7	23	6.1	3.7	2	15	13.0	6.3	4	24
MONG[(c)]	open marsh	2(1)	14.0	4.2	11	17	2.0	1.4	1	3	5.0	0.0	5	5
SONS	shrubby swamp	6	18.5	6.8	10	29	5.0	1.7	3	7	8.0	4.7	3	14
Miscellaneous Vegetation Types														
BUu	burn upland	11(7)	23.2	7.6	13	38	3.7	1.3	2	6	1.1	0.4	1	2
BUw	burn wetlands	16(13)	20.9	7.5	12	42	6.1	3.0	1	12	3.9	6.7	1	20
Sh	shrubland	1	26.0	0.0	26	26	7.0	0.0	7	7	23.0	0.0	23	23

(a) n = number of detailed vegetation plots. Where there are two numbers shown, the first relates to the number of plots used in calculating vascular species richness. The number shown in parentheses refers to the number of plots used in calculating species richness for bryophytes and lichens as complete non-vascular species lists were not available for some plots.

(b) St. Dev. = standard deviation of the sample mean.

(c) The open marsh (MONG) wetlands type was too small to map at the scale of the JEMA LSA, but has been included here to compare richness measures with other vegetation types.



PROJECT

JACKPINE MINE EXPANSION &
PIERRE RIVER MINE PROJECT

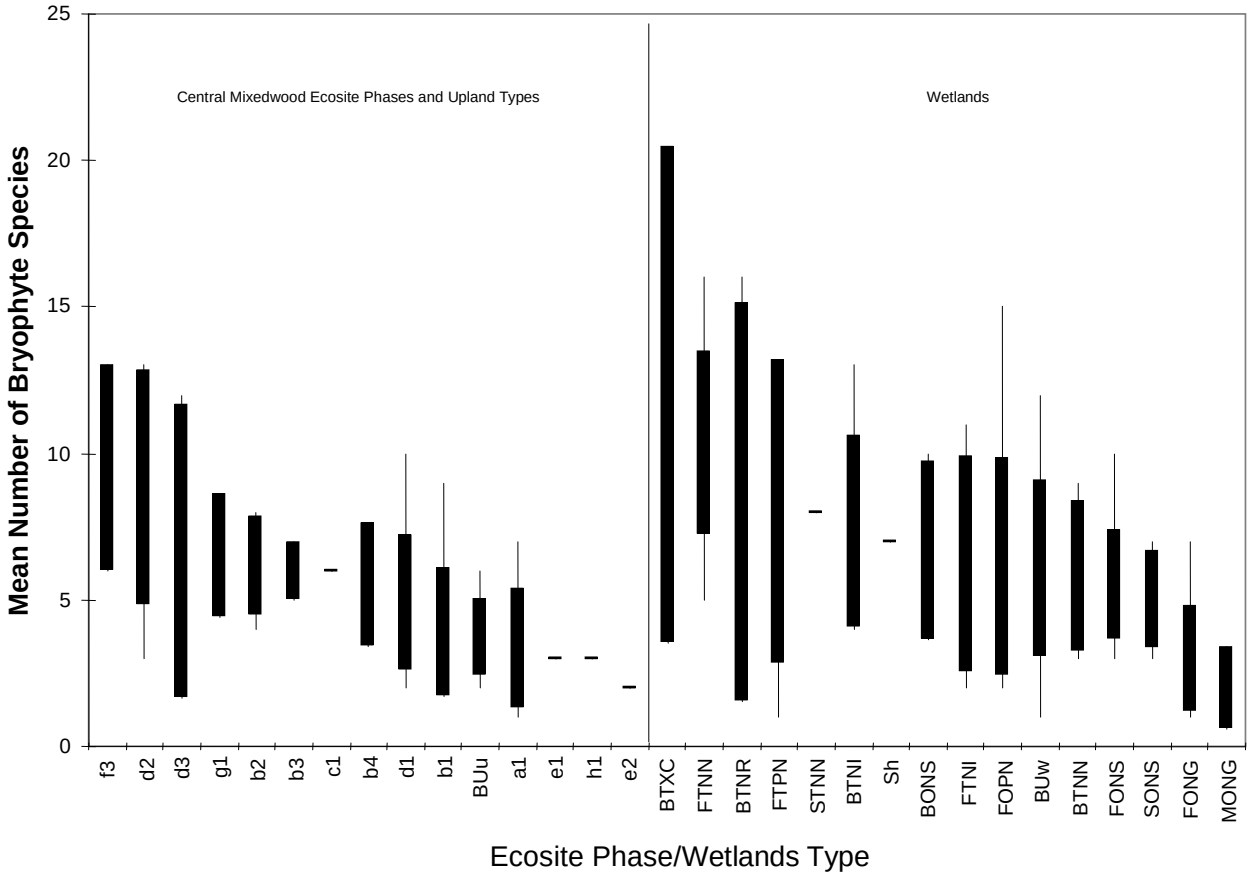
TITLE

VASCULAR PLANT SPECIES RICHNESS BY VEGETATION TYPE WITHIN THE JACKPINE EXPANSION MINING AREA LOCAL STUDY AREA

Shell Canada Limited

PROJECT 05-1344-027.7640			FILE No.	Vascular Plant
DESIGN	AA	21/08/07	SCALE AS SHOWN	REV. 0
CADD	YW	30/08/07	**FIGURE: 3.5-7**	
CHECK	AA	27/11/07		
REVIEW	WES/TC	27/11/07		

L:\2005\1344-OIL SANDS\05-1344-027-Shell Omnibus\7600\7640\Vegetation ESR\Fig 3.5-7 Vascular Plant Species Richness by Vegetation Type.dwg Nov 28, 2007 - 3:43pm



PROJECT

JACKPINE MINE EXPANSION &
PIERRE RIVER MINE PROJECT

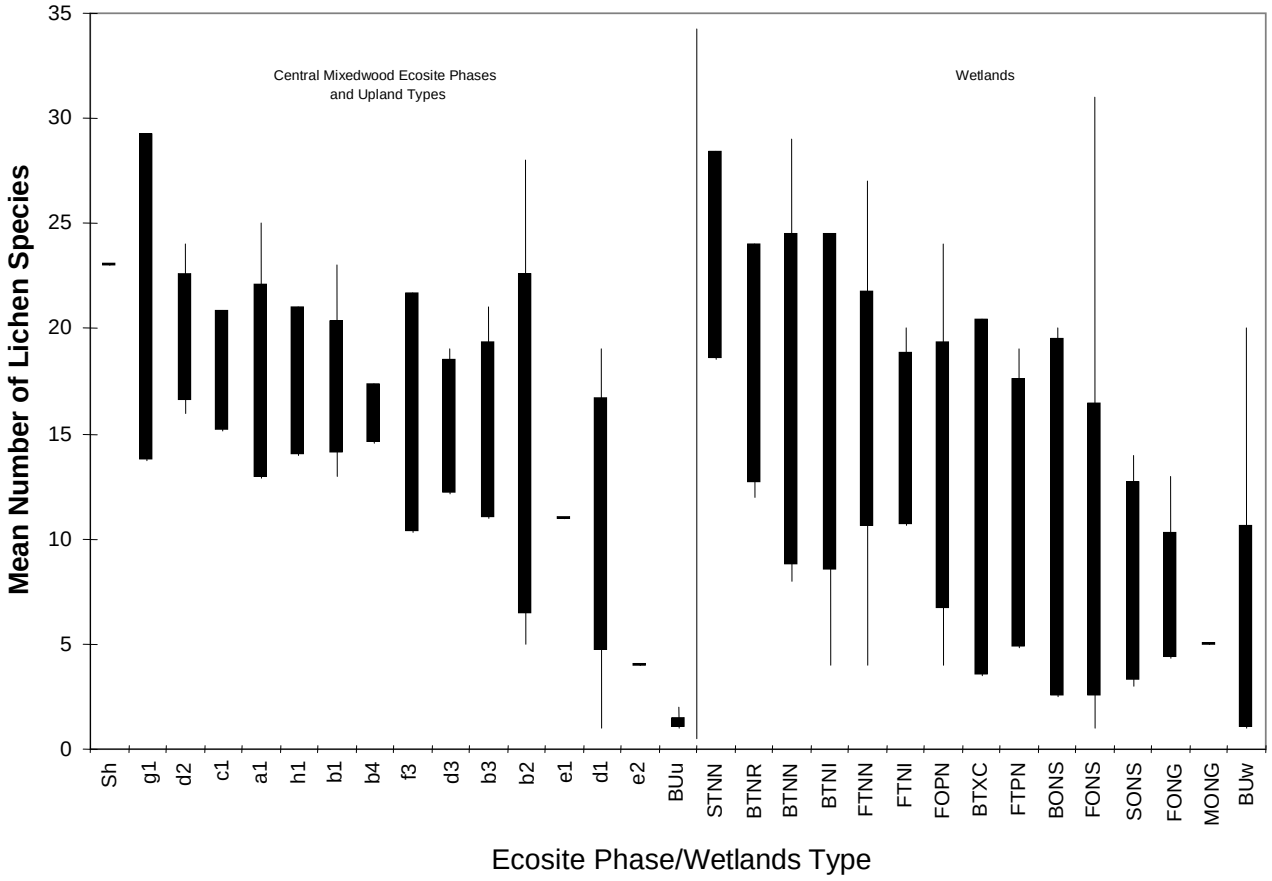
TITLE

BRYOPHYTE SPECIES RICHNESS BY VEGETATION TYPE WITHIN THE JACKPINE EXPANSION MINING AREA LOCAL STUDY AREA

Shell Canada Limited

PROJECT 05-1344-027.7640			FILE No.	Bryophyte
DESIGN	AA	21/08/07	SCALE AS SHOWN	REV. 0
CADD	YW	30/08/07	**FIGURE: 3.5-8**	
CHECK	AA	27/11/07		
REVIEW	WES/TC	27/11/07		

L:\2005\1344-OIL SANDS\05-1344-027-Shell Omnibus\7600\7640\Vegetation ESR\Fig 3.5-8 Bryophyte Species Richness by Vegetation Type.dwg Nov 28, 2007 - 3:44pm



L:\2005\1344-OIL SANDS\05-1344-027-Shell Omnibus\7600\7640\Vegetation ESR\Fig 3.5-9 Lichen Species Richness by Vegetation Type.dwg Nov 28, 2007 - 3:46pm

PROJECT

JACKPINE MINE EXPANSION &
PIERRE RIVER MINE PROJECT

TITLE

LICHEN SPECIES RICHNESS BY VEGETATION TYPE WITHIN THE JACKPINE EXPANSION MINING AREA LOCAL STUDY AREA

Shell Canada Limited

PROJECT 05-1344-027.7640			FILE No.	Lichen
DESIGN	AA	21/08/07	SCALE AS SHOWN	REV. 0
CADD	YW	28/08/07	**FIGURE: 3.5-9**	
CHECK	AA	27/11/07		
REVIEW	WES/TC	27/11/07		

3.5.1.7 Non-Native and Invasive Species

Six non-native and native invasive species (or "weeds") were found within the JEMA LSA. Two of the weeds, tall buttercup (*Ranunculus acris*) and perennial sow-thistle (*Sonchus arvensis*), were classed as noxious under the Alberta *Weed Control Act* (Province of Alberta 2002), while two other nuisance weeds were recorded including hemp-nettle (*Galeopsis tetrahit*), and common dandelion (*Taraxacum officinale*). Other non-native and native invasive species recorded were Kentucky bluegrass (*Poa pratensis*), and curled dock (*Rumex crispus*). These species were found in closed forest, open natural wetlands habitats and disturbances such as burns.

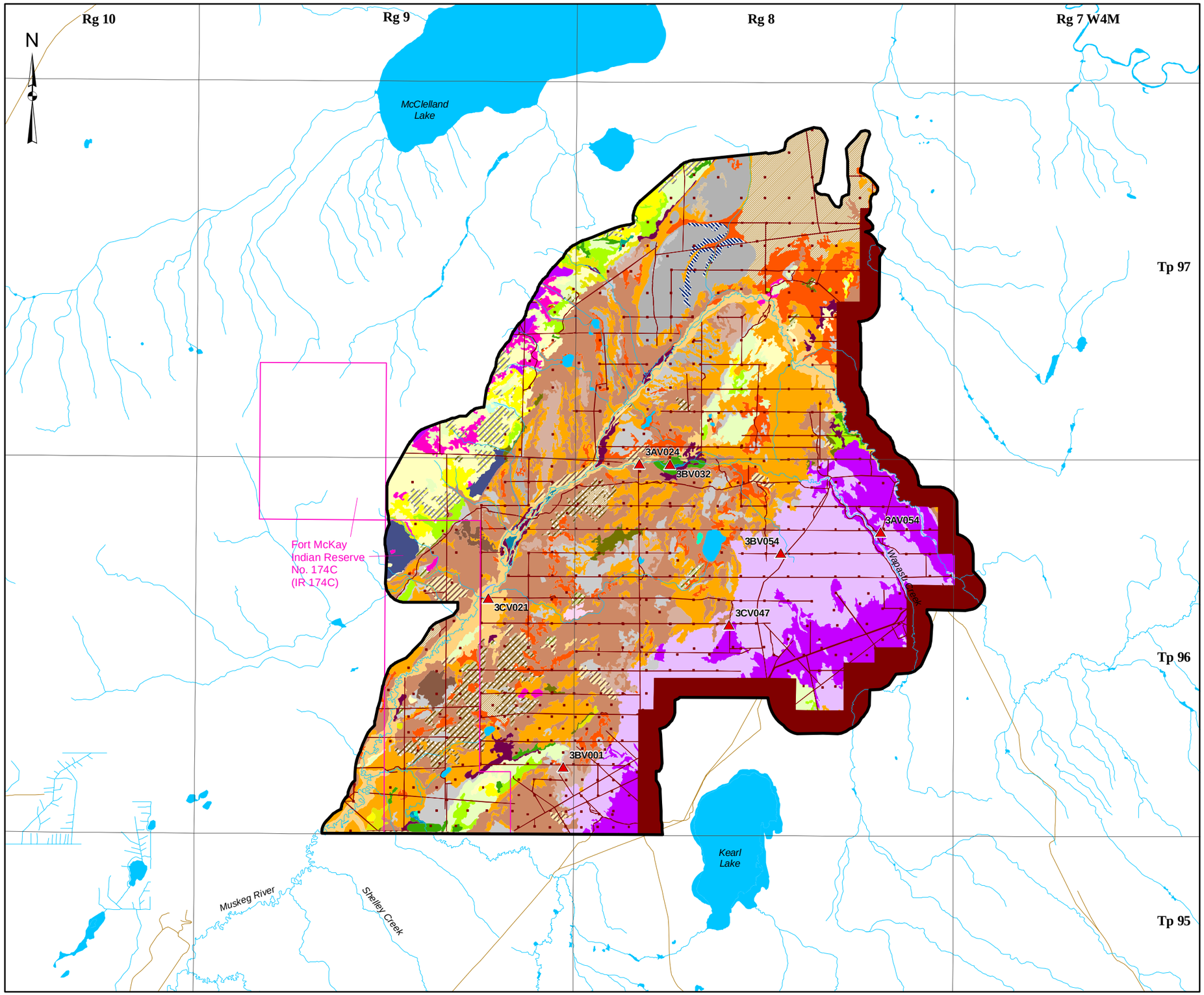
A list of non-native and native invasive species, the habitats they occur in and the number of sites where they were found within the JEMA LSA is provided in Table 3.5-11. Figure 3.5-10 shows the distribution of these species across the JEMA LSA.

Table 3.5-11 Non-Native and Invasive Species Within the Jackpine Expansion Mining Area Local Study Area

Species Name	Vegetation Type	Site Number	Number of Occurrences
Noxious Weeds[(a)]			
tall buttercup (*Ranunculus acris)*	SONS	3AV024	1
perennial sow-thistle (*Sonchus arvensis)*	wetlands burn (BUw)	3CV047	1
Nuisance Weeds[(a)]			
hemp-nettle (*Galeopsis tetrahit)*	SONS	3CV021	1
common dandelion (*Taraxacum officinale)*	b wetlands burn (BUw)	3AV054	1
Other Invasive Species[(b)]			
Kentucky bluegrass (*Poa pratensis)*	h1, wetlands burn (BUw)	3BV032, 3BV054	2
curled dock (*Rumex crispus)*	FONG	3BV001	1

(a) Listed under the *Alberta Weed Control Act* (Province of Alberta 2002).

(b) Agronomic invasive species or other invasive species that have been seen to invade and/or have become persistent in natural areas, or are known to be non-native (ANPC 2000b; NPWG 2001; ANHIC 2006c).



LEGEND

- JACKPINE EXPANSION MINING AREA
- LOCAL STUDY AREA
- INDIAN RESERVE
- OPEN WATER
- PUBLIC ROADWAY

DISTURBED

- EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE
- EXISTING AND APPROVED URBAN AND INDUSTRIAL LINEAR DISTURBANCE
- NON-NATIVE AND INVASIVE PLANT SPECIES LOCATION

ECOSITE PHASE

- LICHEN JACK PINE (a1)
- BLUEBERRY JACK PINE-ASPEN (b1)
- BLUEBERRY ASPEN (WHITE BIRCH) (b2)
- BLUEBERRY ASPEN-WHITE SPRUCE (b3)
- BLUEBERRY WHITE SPRUCE-JACK PINE (b4)
- LABRADOR TEA-MESIC JACK PINE-BLACK SPRUCE (c1)
- LOW-BUSH CRANBERRY ASPEN (d1)
- LOW-BUSH CRANBERRY ASPEN-WHITE SPRUCE (d2)
- LOW-BUSH CRANBERRY WHITE SPRUCE (d3)
- DOGWOOD BALSAM POPLAR-ASPEN (e1)
- DOGWOOD BALSAM POPLAR-WHITE SPRUCE (e2)
- DOGWOOD WHITE SPRUCE (e3)
- HORSETAIL WHITE SPRUCE (f3)
- LABRADOR TEA-SUBHYGRIC BLACK SPRUCE-JACK PINE (g1)
- LABRADOR TEA/HORSETAIL WHITE SPRUCE-BLACK SPRUCE (h1)
- JACK PINE-TAMARACK COMPLEX (Pj-Lt Complex)

WETLANDS TYPES

- FORESTED BOG (BFNN)
- OPEN BOG (BONN)
- WOODED BOG WITH INTERNAL LAWNS (BTNI)
- WOODED BOG (BTNN)
- WOODED BOG WITH INTERNAL LAWNS AND ISLANDS OF FORESTED PEAT PLATEAU (BTNR)
- WOODED PERMAFROST BOG WITH COLLAPSE SCAR (BTXC)
- FORESTED FEN (FFNN)
- GRAMINOID FEN (FONG)
- SHRUBBY FEN (FONS)
- OPEN PATTERNED FEN (FOPN)
- WOODED FEN WITH INTERNAL LAWNS (FTNI)
- WOODED FEN (FTNN)
- WOODED PATTERNED FEN (FTPN)
- SHRUBBY SWAMP (SONS)
- WOODED SWAMP (STNN)
- SHALLOW OPEN WATER (WONN)

OTHER

- BURN UPLAND (BUu)
- BURN WETLANDS (BUw)
- CUTBLOCK (CC)
- SHRUBLAND (Sh)

REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2004), and Alberta SRD, used under license.
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 12.

2.5 0 2.5
SCALE 1:100,000 KILOMETRES

PROJECT
JACKPINE MINE EXPANSION &
PIERRE RIVER MINE PROJECT

TITLE NON-NATIVE AND INVASIVE PLANT SPECIES IDENTIFIED WITHIN THE JACKPINE EXPANSION MINING AREA LOCAL STUDY AREA

Shell Canada Limited

PROJECT No. 05-1344-027.7600			SCALE AS SHOWN	REV. 0
DESIGN	AA	27 Aug. 2007	FIGURE: 3.5-10	
GIS	JH	14 Nov. 2007		
CHECK	AA	20 Nov. 2007		
REVIEW	TC	27 Nov. 2007		

Project: I:/CLIENTS/SHELL/05-1344-027/mapping/mxd/veg/DRAFT/jackpine/bl_ecosite_invasive_jp_esr.mxd - Plot: 2J\2005\GIS\ArcMapTemplates\templates\v91\MyProject.pdf?

3.5.1.8 Dust

The areas of ecosite phases/wetlands types within 50 m of potential dust sources are shown in Table 3.5-12. The total vegetated area potentially affected by dust is 229 ha (1% of the JEMA LSA).

Table 3.5-12 Areas Potentially Affected by Dust in the Jackpine Expansion Mining Area Local Study Area

Map Code	Description	Area	
		[ha]	% of LSA
Vegetated Land			
b1	blueberry jack pine-aspen	<1	<1
b4	blueberry white spruce-jack pine	2	<1
d1	low-bush cranberry aspen	7	<1
d2	low-bush cranberry aspen-white spruce	1	<1
d3	low-bush cranberry white spruce	4	<1
g1	Labrador tea-subhygric black spruce-jack pine	<1	<1
h1	Labrador tea/horsetail white spruce-black spruce	2	<1
BUu	burn upland	101	1
BTNN	wooded bog	2	<1
FONG	graminoid fen	7	<1
FONS	shrubby fen	9	<1
FOPN	open patterned fen	4	<1
FTNN	wooded fen	12	<1
SONS	shrubby swamp	20	<1
STNN	wooded swamp	7	<1
BUw	burn wetlands	49	<1
	vegetated subtotal	*229*	*1*
Non-Vegetated Land			
River	river	<1	<1
DIS	disturbance	1,548	8
	non-vegetated subtotal	*1,548*	*8*
Total		**1,776**	**10**

Note: Some numbers are rounded for presentation purposes. Therefore, it may appear that the totals do not equal the sum of the individual values.

3.5.2 Landscape-Level Analyses

3.5.2.1 Heterogeneity

Composition and Distribution of Ecosite Phases, Wetlands Types and Disturbed Areas

The composition and distribution of ecosite phases, wetlands types and disturbed areas in the JEMA LSA are represented in Figure 3.5-1.

The results of the heterogeneity analysis for the JEMA LSA are summarized according to ecosite phases (Table 3.5-13), wetlands types (Table 3.5-14) and disturbed areas (Table 3.5-15) as follows:

- There are a total of 39 patch types moderately well-distributed in the JEMA LSA (Shannon's evenness of 0.75 out of 1). The 17 ecosite phases cover 13% (2,366 ha) of the LSA, the 18 wetlands types cover 60% (10,942 ha) and 4 disturbed types make up the remaining 27% (5,039 ha) of the LSA (Figure 3.5-1).
- Low-bush cranberry aspen (d1) and blueberry jack pine-aspen (b1) are the most dominant ecosite phases, each occupying about 3% (484 and 518 ha, respectively) of the JEMA LSA (Table 3.5-13). Mean patch size is 5.4±9.3 ha for d1 and 6.2±16.3 ha for b1. Relative to all other ecosite phases, b1 has the most variable patch size (AREA_CV of 261%).
- With the exception of the one patch of jack pine-tamarack complex (Pj-Lt Comp) (14 ha), the largest ecosite phase patches in the JEMA LSA are blueberry aspen-white spruce (b3) and blueberry aspen-white birch (b2), with mean patch sizes of 8.9±12.4 ha and 8.7±14.1 ha, respectively. The smallest ecosite phase patches are shrublands (Sh), with a mean patch size of 0.8±0.8 ha.
- Of the dominant ecosite phases, b2 patches are the closest together on the landscape (ENN_MN of 30.9±28.1 m). Of the more dominant ecosite phases, blueberry white spruce-jack pine (b4) patches are the furthest apart (ENN_MN of 743.2±1,891.7 m). In general, the rarer ecosite phases tend to have greater distances between them.
- Mean nearest neighbour values for d1 and b1 patch types is also similar (ENN_MN of 117.7±376.8 m and 117.5±429.9 m, respectively). Median nearest neighbour values for d1 and b1 are much lower (ENN_MD of 12.0 m for both), which suggests that these two patch types are often separated by disturbance features.
- The d1 and b1 ecosite phases are the most evenly distributed of all patch types in the JEMA LSA (IJI of 71% and 72%, respectively). The rarer patch types tend to be poorly distributed on the landscape.
- The dominant wetlands types in the JEMA LSA are treed fen (FTNN) and shrubby fen (FONS), occupying 3,451 ha (19%) and 2,505 ha (14%) of the total LSA, respectively (Table 3.5-14). The 391 FTNN patches are moderately large (AREA_MN of 8.8±25.9 ha and AREA_MD of 1.6 ha) and variable in size (AREA_CV of 293%). The 416 FONS patches are smaller (AREA_MN of 6.0±14.3 ha and AREA_MD of 1.3 ha) and are likewise variable in size (AREA_CV of 238%).
- The largest wetlands type patches in the JEMA LSA are open patterned fens (FOPN), with a mean patch size of 27.3±64.2 ha. The smallest wetlands type patches are forested bogs (BFNN) and rivers, with mean patch sizes of less than 1 ha and 0.3±0.3 ha, respectively.

- Shrubby swamp (SONS) and wooded patterned fen (FTPN) are the next largest wetlands types, occupying 752 ha (4%) and 415 ha (2%) of the JEMA LSA, respectively. There are more, larger SONS patches (47 patches averaging 16.0±25.0 ha) compared to FTPN patches (28 patches averaging 14.8±23.9 ha), and the patch types have a similar size variability (AREA_CV of 156% and 161%, respectively). The SONS patches are more evenly distributed on the landscape (IJI of 62%) than are the FTPN patches (IJI of 48%).

- Open bog (BONN) and FTPN wetlands types are the closest together on the landscape (ENN_MN of 11.5±6.1 m and 11.2±4.7 m, respectively). Lakes and BFNN are the furthest apart of the wetlands types (ENN_MN of 1,267.0±971.7 m and 1,128.7±2,114.5 m, respectively).

- The FTNN and FONS patches are very similarly distributed within the JEMA LSA. These patch types are moderately aggregated (IJI of 62% and 61%, respectively) and are highly variable in their proximity to one another (ENN_CV of 307% and 257%). Mean distance between FTNN patches is 35.2±108.2 m, but 50% of patches are less than 12 m apart. On average, FONS patches are closer together than FTNN patches (ENN_MN of 25.4±65.4 m), also with 50% of patches less than 12 m apart. The 12 m distance illustrates that narrow disturbances (e.g., seismic lines) have fragmented many of these wetlands types patches.

- Of the disturbed areas, burned wetlands (BUw) and other human disturbances occupy the greatest portion of the JEMA LSA at 10% each (Table 3.5-15). There are 132 moderately large (AREA_MN 14.4±35.3 ha) burned wetlands patches that are unevenly distributed in the LSA (IJI of 33%). Other human disturbances patches are smaller (AREA_MN of 8.2±120.5 ha), but more abundant (NP of 231) and more evenly distributed (IJI of 69%) than burned wetlands.

- Mean patch size for natural patches in the JEMA LSA ranges from less than 1 ha (BFNN; forested bogs) to 27.3±64.2 ha (FOPN; open patterned fens). Median patch size ranges from 0.2 ha (other disturbances) to 33.5 ha (cutblocks) and IJI ranges from 16% (BTNR; wooded bogs with internal lawns and islands of forested peat plateau) to 72% (b1; blueberry jack pine-aspen). Overall, patch size is highly variable (AREA_CV more than 100%), except when there are very few patches within a patch type. Taken together, this indicates that there are disproportionately more small patches than large patches for all patch types within the JEMA LSA. Ecosite phases, wetlands types and disturbed areas are generally aggregated within the JEMA LSA.

Table 3.5-13 Landscape Heterogeneity of Ecosite Phases Within the Jackpine Expansion Mining Area Local Study Area

Landscape Measurement[a]	Unit	Ecosite Phase[b]																
		a1	b1	b2	b3	b4	c1	d1	d2	d3	e1	e2	e3	f3	g1	h1	Pj-Lt Comp	Sh
class area (CA)	ha	164	518	201	231	89	59	484	239	93	7	5	4	16	72	167	14	5
CA proportion of LSA	%	1	3	1	1	<1	<1	3	1	1	<1	<1	<1	<1	<1	1	<1	<1
number of patches (NP)	n/a	48	83	23	26	17	26	89	48	20	2	2	1	5	30	47	1	6
patch size mean (AREA_MN)	ha	3.4	6.2	8.7	8.9	5.2	2.3	5.4	5.0	4.6	3.4	2.4	4.2	3.2	2.4	3.5	14.0	0.8
patch size median (AREA_MD)	ha	1.8	2.0	2.6	2.7	2.1	1.6	1.0	1.3	2.4	3.4	2.4	4.2	3.8	0.9	2.3	14.0	0.6
patch size standard deviation (AREA_SD)	ha	5.4	16.3	14.1	12.4	7.3	1.9	9.3	7.4	5.3	3.4	0.9	<1	1.9	5.8	5.2	<1	0.8
patch size coefficient of variation (AREA_CV)	%	160	261	161	140	140	84	170	150	115	100	37	<1	59	243	146	<1	93
nearest neighbour mean (ENN_MN)	m	98.7	117.5	30.9	453.6	743.2	288.9	117.7	129.0	355.5	8.9	9,967.1	n/a	2,232.0	214.3	136.4	n/a	440.6
nearest neighbour median (ENN_MD)	m	12.0	12.0	17.9	12.0	36.9	12.0	12.0	12.0	127.6	8.9	9,967.1	n/a	1140.2	12.0	12.0	n/a	224.3
nearest neighbour standard deviation (ENN_SD)	m	196.8	429.9	28.1	915.3	1,891.7	629.7	376.8	361.8	562.7	<1	<1	n/a	2,666.7	977.3	404.9	n/a	455.9
nearest neighbour coefficient of variation (ENN_CV)	%	200	366	91	202	255	218	320	280	158	<1	<1	n/a	119	456	297	n/a	103
distribution (IJI)	%	58	72	54	61	67	68	71	70	70	27	33	40	41	58	59	10	41

[a] A description of landscape measurements is provided in Appendix J.

[b] Full names of ecosite phases are provided in Table 3.3-2.

n/a = Not applicable.

Note: Some numbers are rounded for presentation purposes.

Table 3.5-14 Landscape Heterogeneity of Wetlands Types Within the Jackpine Expansion Mining Area Local Study Area

Landscape Measurement[a]	Unit	Wetlands Type[b]																
		BFNN	BONN	BTNI	BTNN	BTNR	BTXC	FFNN	FONG	FONS	FOPN	FTNI	FTNN	FTPN	Lake	River	SONS	STNN	WONN
class area (CA)	ha	<1	61	714	632	17	89	2	878	2,505	791	409	3,451	415	59	<1	752	164	2
CA proportion of LSA	%	<1	<1	4	3	<1	<1	<1	5	14	4	2	19	2	<1	<1	4	1	<1
number of patches (NP)	n/a	5	11	55	200	3	12	1	228	416	29	62	391	28	9	1	47	32	1
patch size mean (AREA_MN)	ha	<1	5.6	13.0	3.2	5.8	7.4	1.7	3.9	6.0	27.3	6.6	8.8	14.8	6.6	0.3	16.0	5.1	1.6
patch size median (AREA_MD)	ha	<1	1.7	2.7	1.1	2.6	0.5	1.7	1.2	1.3	3.0	1.4	1.6	4.3	4.0	0.3	2.8	3.7	1.6
patch size standard deviation (AREA_SD)	ha	<1	6.6	28.1	5.9	4.9	14.1	<1	8.9	14.3	64.2	10.9	25.9	23.9	9.1	<1	25.0	5.9	<1
patch size coefficient of variation (AREA_CV)	%	98	118	216	187	85	190	<1	231	238	235	166	293	161	139	<1	156	115	<1
nearest neighbour mean (ENN_MN)	m	1,128.7	11.5	12.2	59.6	143.7	29.5	n/a	59.0	25.4	75.2	31.1	35.2	11.2	1,267.0	n/a	56.1	245.7	n/a
nearest neighbour median (ENN_MD)	m	88.8	8.9	8.9	12.0	28.3	12.0	n/a	12.0	12.0	8.9	8.9	12.0	8.9	1,226.1	n/a	12.0	12.0	n/a
nearest neighbour standard deviation (ENN_SD)	m	2,114.5	6.1	14.3	137.9	163.2	33.6	n/a	180.1	65.4	345.4	96.8	108.2	4.7	971.7	n/a	230.1	667.1	n/a
nearest neighbour coefficient of variation (ENN_CV)	%	187	53	117	231	114	114	n/a	305	257	459	311	307	42	77	n/a	410	272	n/a
distribution (IJI)	%	36	33	47	59	16	40	18	59	61	41	45	62	48	36	<1	62	59	<1

[a] A description of landscape measurements is provided in Appendix J.

[b] Full names of wetlands types are provided in Table 3.3-2.

n/a = Not applicable.

Note: Some numbers are rounded for presentation purposes.

Table 3.5-15 Landscape Heterogeneity of Disturbed Areas Within the Jackpine Expansion Mining Area Local Study Area

Landscape Measurement[(a)]	Unit	BUu	BUw	Cutblocks	Other Disturbances[(b)]
class area (CA)	ha	1,124	1,902	120	1,893
CA proportion of LSA	%	6	10	1	10
number of patches (NP)	n/a	121	132	3	231
mean patch area (AREA_MN)	ha	9.3	14.4	39.8	8.2
median patch area (AREA_MD)	ha	2.4	1.4	33.5	0.2
patch area standard deviation (AREA_SD)	ha	19.0	35.3	32.4	120.5
patch area co-efficient of variation (AREA_CV)	%	205	245	81	1,471
nearest neighbour mean (ENN_MN)	m	17.1	22.5	596.0	189.6
nearest neighbour median (ENN_MD)	m	8.9	8.9	8.9	160.0
nearest neighbour standard deviation (ENN_SD)	m	31.9	49.7	830.2	161.5
nearest neighbour co-efficient of variation (ENN_CV)	%	186	221	139	85
distribution (IJI)	%	29	33	55	69

(a) A description of landscape measurements is provided in Appendix J.

(b) Other disturbances comprise urban and agricultural areas and industrial developments.

Note: Some numbers are rounded for presentation purposes.

3.5.2.2 Fragmentation

Natural Areas and Human Disturbed Areas

Landscape fragmentation was assessed by examining the distribution of natural areas and human disturbed areas in the JEMA LSA (Figure 3.5-11, Table 3.5-16). A summary of fragmentation results are as follows:

- Natural areas cover 89% (16,335 ha) of the JEMA LSA (Table 3.5-16). The 229 patches of existing human disturbance covering 2,013 ha have fragmented the natural areas in the LSA into 149 patches.
- Natural patches are much larger on average (AREA_MN of 109.6±224.0 ha and AREA_MD of 18.2 ha) and less variable in size (AREA_CV of 204%) than human disturbed patches (AREA_MN of 8.8±123.6 ha, AREA_MD of 0.2 ha and AREA_CV of 1,406%).
- Natural patches have a more complex shape (FRAC_MN of 1.08) than human disturbed patches, which are almost circular or square (FRAC_MN of 1.01).

- Only 58% of the natural areas category is considered core area habitat, accounting for a total of 9,480 ha (52%) of the JEMA LSA. This indicates that slightly more than half of the landscape consists of habitat suitable for wildlife species sensitive to human disturbance. There is no core habitat available in disturbed patches.
- Total edge between natural and human disturbed areas is 771 km.

Table 3.5-16 Fragmentation of Natural Areas by Human Disturbed Areas Within the Jackpine Expansion Mining Area Local Study Area

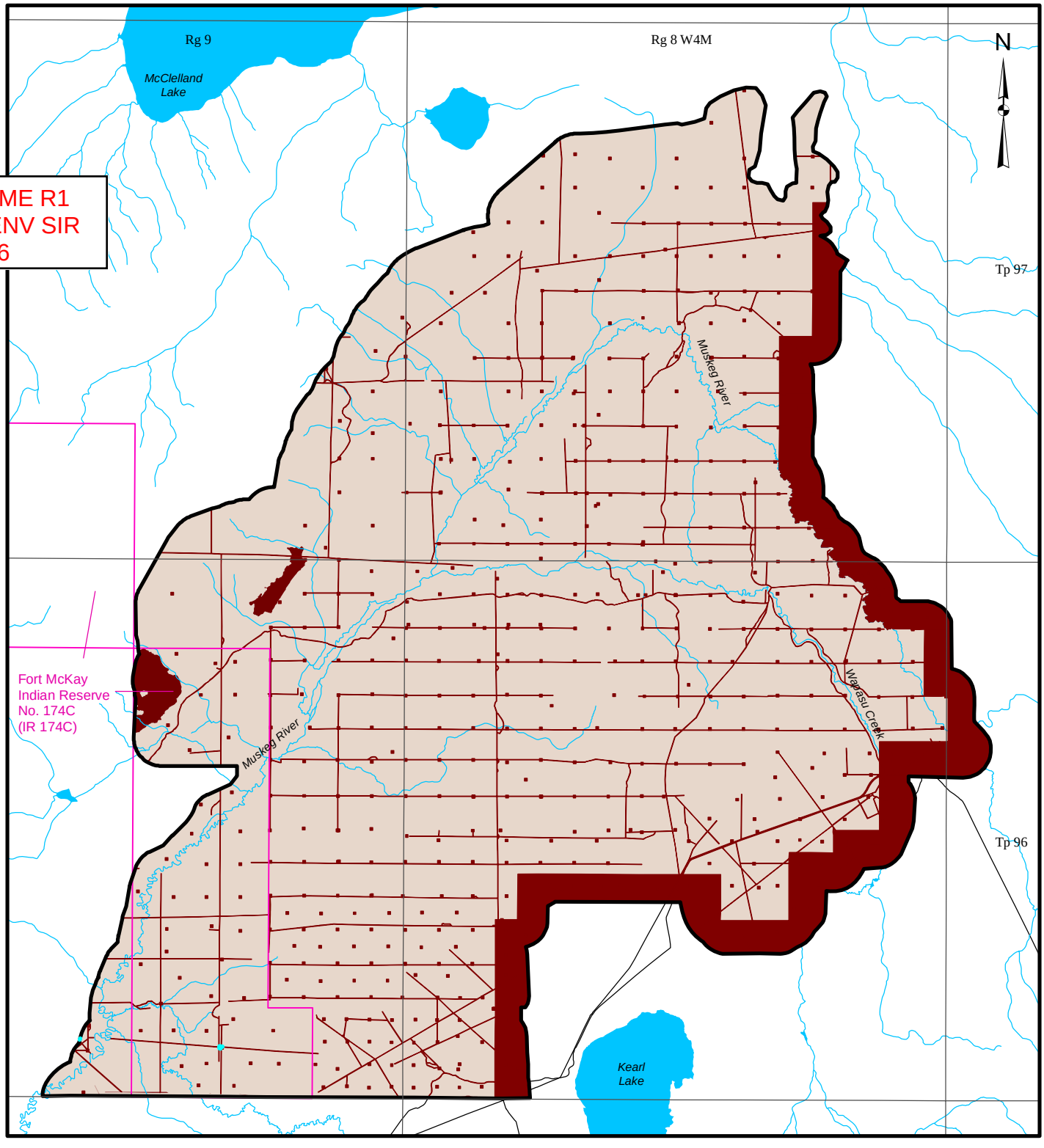
Landscape Measurement[a]	Unit	Natural	Human Disturbed[b]
class area (CA)	ha	16,335	2,013
CA proportion of LSA	%	89	11
number of patches (NP)	n/a	149	229
patch size mean (AREA_MN)	ha	109.6	8.8
patch size median (AREA_MD)	ha	18.2	0.2
patch size standard deviation (AREA_SD)	ha	224.0	123.6
patch size coefficient of variation (AREA_CV)	%	204	1,406
shape complexity (FRAC_MN)	n/a	1.08	1.01
total core area (TCA)	ha	9,480	n/a
TCA proportion of LSA	%	52	n/a
core area index area weighted mean (CAI_AM)	%	58	n/a
total edge (TE)	km	771	

(a) A description of landscape measurements is provided in Appendix J.

(b) Some values do not equal values presented in Table 3.5-15 due to differences in patch definition between the heterogeneity and fragmentation analyses.

n/a = Not applicable.

Note: Some numbers are rounded for presentation purposes.



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LEGEND

- JACKPINE EXPANSION MINING AREA LOCAL STUDY AREA
- INDIAN RESERVE
- OPEN WATER
- PUBLIC ROADWAY

NATURAL AND HUMAN DISTURBED AREAS

- NATURAL AREAS
- HUMAN DISTURBED AREAS

3 0 3

SCALE 1:100,000 KILOMETRES

REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2004), and Alberta SRD, used under license.
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 12.

PROJECT
JACKPINE MINE EXPANSION &
PIERRE RIVER MINE PROJECT

TITLE
NATURAL AND HUMAN DISTURBED AREAS
WITHIN THE JACKPINE EXPANSION
MINING AREA LOCAL STUDY AREA

Shell Canada Limited

PROJECT No. 05-1344-027.7600			SCALE AS SHOWN	REV. 0
DESIGN	VR	03 Aug. 2007	FIGURE: 3.5-11	
GIS	VR	17 Nov. 2007		
CHECK	AA	17 Nov. 2007		
REVIEW	WES/TC	20 Nov. 2007		

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Forested and Non-Forested Areas

Landscape fragmentation and core area habitat were assessed by examining the distribution of forested and non-forested areas in the JEMA LSA (Figure 3.5-12 and Table 3.5-17). A summary of fragmentation results are as follows:

- Forested areas are slightly more abundant (8,254 ha) than non-forested areas (8,081 ha), but are distributed among fewer patches (457 forested patches compared to 556 non-forested patches).
- Forested and non-forested patches are relatively similar in mean patch size (18.1±61.2 ha and 14.5±46.9 ha, respectively); however, median forested patch size is much smaller (1.2 ha) than non-forested patches (18.2 ha). Therefore, there are more large non-forested patches than large forested patches in the JEMA LSA.
- Forested and non-forested patches are highly complex in shape (FRAC_MN of 1.11 and 1.12, respectively) compared to the quite regularly-shaped human disturbed patches (FRAC_MN of 1.01, Table 3.5-16).
- A total of 32% of forested patches is considered core area, accounting for 2,655 ha (14%) of the JEMA LSA. This indicates that there is limited core area within forested patches and that only a very small portion of the landscape consists of habitat suitable for interior forest-dwelling species. Only 30% of non-forested patches is considered core area, accounting for 2,415 ha (13%) of the JEMA LSA. Very little core habitat is available for non-forest-dwelling species as well.
- Forested patches are typically further apart (ENN_MN of 22.0±56.3 m) than non-forested patches (ENN_MN of 17.6±31.3 m).

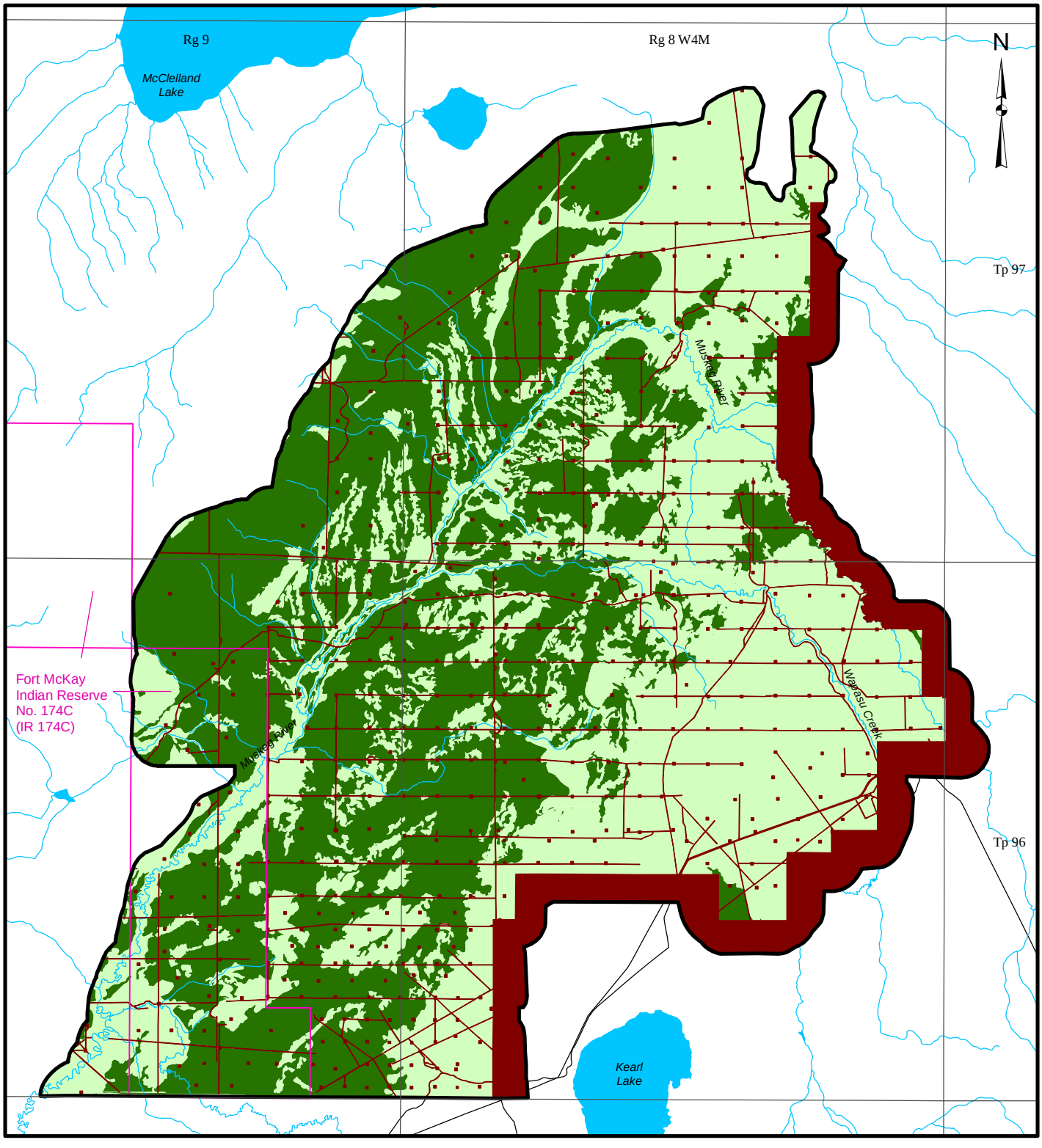
Table 3.5-17 Fragmentation of Forested and Non-Forested Areas Within the Jackpine Expansion Local Study Area

Landscape Measurement[(a)]	Unit	Forested	Non-Forested
class area (CA)	ha	8,254	8,081
CA proportion of LSA	%	45	44
number of patches (NP)	n/a	457	556
patch size mean (AREA_MN)	ha	18.1	14.5
patch size median (AREA_MD)	ha	1.2	18.2
patch size standard deviation (AREA_SD)	ha	61.2	46.9
patch size coefficient of variation (AREA_CV)	%	339	323
shape complexity (FRAC_MN)	n/a	1.11	1.12
total core area (TCA)	ha	2,655	2,415
TCA proportion of LSA	%	14	13
core area index area weighted mean (CAI_AM)	%	32	30
nearest neighbour mean (ENN_MN)	m	22.0	17.6
nearest neighbour median (ENN_MD)	m	11.3	11.3
nearest neighbour standard deviation (ENN_SD)	m	56.3	31.3
nearest neighbour coefficient of variation (ENN_CV)	%	256	177
total edge (TE)	km	1,141	1,252

(a) A description of landscape measurements is provided in Appendix J.

n/a = Not applicable.

Note: Some numbers are rounded for presentation purposes.



LEGEND

- JACKPINE EXPANSION MINING AREA LOCAL STUDY AREA
- INDIAN RESERVE
- OPEN WATER
- PUBLIC ROADWAY

FORESTED AND NON-FORESTED AREAS

- FORESTED
- NON-FORESTED

DISTURBED

- EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE
- EXISTING AND APPROVED URBAN AND INDUSTRIAL LINEAR DISTURBANCE

3 0 3

SCALE 1:100,000 KILOMETRES

REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2004), and Alberta SRD, used under license.
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 12.

PROJECT

JACKPINE MINE EXPANSION & PIERRE RIVER MINE PROJECT

TITLE

FORESTED AND NON-FORESTED AND HUMAN DISTURBED AREAS WITHIN THE JACKPINE EXPANSION MINING AREA LOCAL STUDY AREA

Shell Canada Limited

PROJECT No. 05-1344-027.7600			SCALE AS SHOWN	REV. 0
DESIGN	VR	03 Aug. 2007		
GIS	VR	17 Nov. 2007		
CHECK	AA	17 Nov. 2007	FIGURE: 3.5-12	
REVIEW	WES/TC	20 Nov. 2007		

Project: I:\CLIENTS\SHELL\05-1344-027\mapping\mxd\biodiversity\DRAFT\lsa_biodiversity_forest_JP.mxd - Plot: I:\CLIENTS\SHELL\05-1344-027\mapping\pdf\biodiversity\DRAFT\lsa_biodiversity_forest_JP.pdf

Riparian Areas

Spatial attributes of riparian patches were assessed for the JEMA LSA (Figure 3.5-13, Table 3.5-18). A summary of the results are as follows:

- Riparian patches cover 1,684 ha (9%) of the JEMA LSA.
- There are 98 riparian patches with a mean patch size of 17.2±34.5 ha and a median patch size of 5.2 ha. Riparian patches are highly variable in size (AREA_CV of 201%).
- Riparian patches, on average, are 28.8±71.6 m apart. However, median nearest neighbour is much lower (8.9 m), indicating that 50% of riparian patches are less than 8.9 m apart. This result is expected given the connected nature of riparian areas.
- Riparian communities are concentrated in the northern and western portions of the JEMA LSA, mainly adjacent to the Muskeg River (Figure 3.5-13).

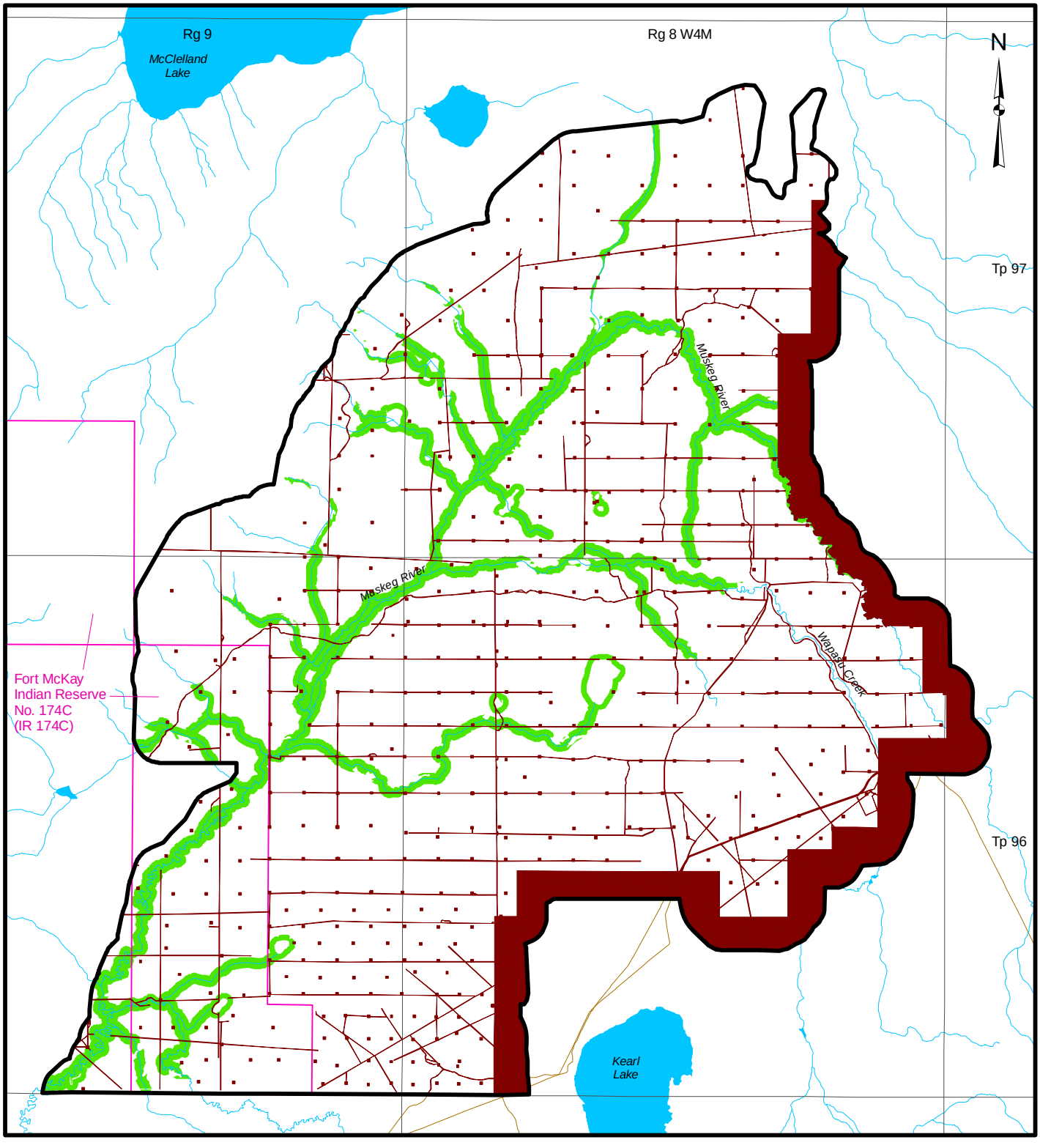
Table 3.5-18 Spatial Analysis of Riparian Areas Within the Jackpine Expansion Local Study Area

Landscape Measurement[(a)]	Unit	Riparian
class area (CA)	ha	1,684
CA proportion of LSA	%	9
number of patches (NP)	n/a	98
patch size mean (AREA_MN)	ha	17.2
patch size median (AREA_MD)	ha	5.2
patch size standard deviation (AREA_SD)	ha	34.5
patch size coefficient of variation (AREA_CV)	%	201
nearest neighbour mean (ENN_MN)	m	28.8
nearest neighbour median (ENN_MD)	m	8.9
nearest neighbour standard deviation (ENN_SD)	m	71.6
nearest neighbour coefficient of variation (ENN_CV)	%	248

[(a)] A description of landscape measurements is provided in Appendix J.

n/a = Not applicable.

Note: Some numbers are rounded for presentation purposes.



LEGEND

- JACKPINE EXPANSION MINING AREA LOCAL STUDY AREA
- INDIAN RESERVE
- OPEN WATER
- PUBLIC ROADWAY
- RIPARIAN ZONES

DISTURBED

- EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE
- EXISTING AND APPROVED URBAN AND INDUSTRIAL LINEAR DISTURBANCE

3 0 3

SCALE 1:100,000 KILOMETRES

REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2004), and Alberta SRD, used under license.
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 12.

PROJECT

JACKPINE MINE EXPANSION & PIERRE RIVER MINE PROJECT

TITLE

RIPARIAN ZONES WITHIN THE JACKPINE EXPANSION MINING AREA LOCAL STUDY AREA

Shell Canada Limited

PROJECT No. 05-1344-027.7600			SCALE AS SHOWN	REV. 0
DESIGN	VR	06 Jun. 2007		
GIS	JH	14 Nov. 2007		
CHECK	AA	20 Nov. 2007	FIGURE: 3.5-13	
REVIEW	TC	27 Nov. 2007		

Project: I:\CLIENTS\SHELL\05-1344-027\mapping\mxd\veg\DRAFT\jackpine\bl_rip_jp_esr.mxd- Plot: ?J:\2005\GIS\ArcMapTemplates\templatesv91\MyProject.pdf?

Old Growth Areas

Spatial attributes of old growth patches were assessed for the JEMA LSA (Figure 3.5-14, Table 3.5-19). A summary of the results are as follows:

- There are 66 patches of old growth forest comprising a total of 840 ha (5%) of the JEMA. The old growth forest patches have a mean patch size of 12.7±33.5 ha and a median patch size of 0.9 ha. Most patches of old growth forest are very small, but patch size is highly variable (AREA_CV of 263%).
- Old growth patches have a highly complex shape (FRAC_MN of 1.13).
- Only 17% of old growth forest is considered core area, accounting for a total of 147 ha (1%) of the JEMA. This small amount of core area is due to fragmentation by existing disturbances in the LSA.
- Mean distance between old growth patches is 107.0±518.9 m, but median distance is lower (ENN_MD of 12.0 m). This indicates that 50% of old growth patches are separated by 12 m or less. This distance illustrates that narrow disturbances (e.g., seismic lines) have fragmented many old growth patches.
- Most of the old growth patches are found along the north-western boundary of the JEMA LSA (Figure 3.5-14) and most of these patches are dominated by aspen.

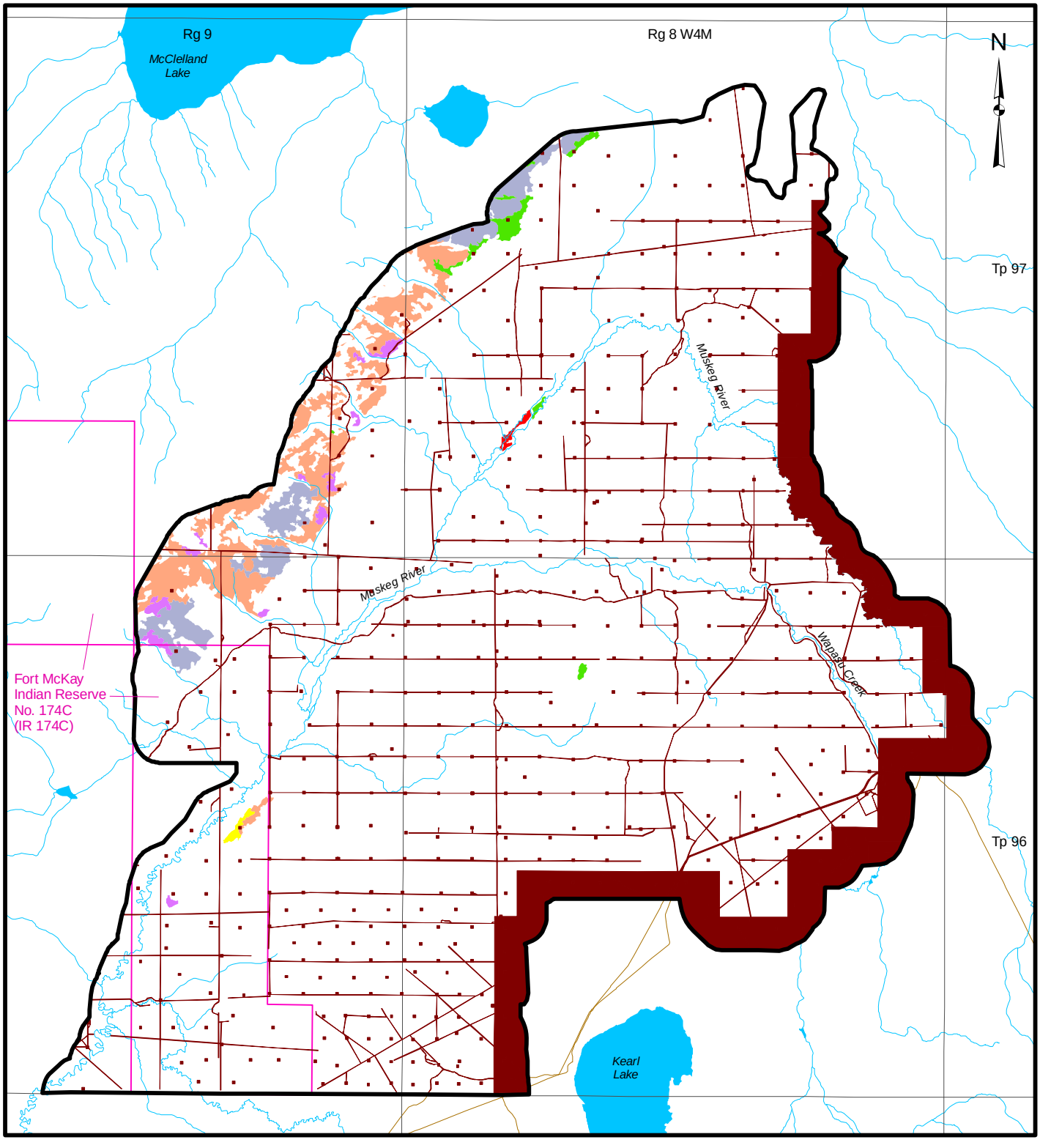
Table 3.5-19 Spatial Analyses of Old Growth Areas Within the Jackpine Expansion Local Study Area

Landscape Measurement[(a)]	Unit	Old Growth
class area (CA)	ha	840
CA proportion of LSA	%	5
number of patches (NP)	n/a	66
patch size mean (AREA_MN)	ha	12.7
patch size median (AREA_MD)	ha	0.9
patch size standard deviation (AREA_SD)	ha	33.5
patch size coefficient of variation (AREA_CV)	%	263
shape complexity (FRAC_MN)	n/a	1.13
total core area (TCA)	ha	147
TCA proportion of LSA	%	1
core area index area weighted mean (CAI_AM)	%	17
nearest neighbour mean (ENN_MN)	m	107.0
nearest neighbour median (ENN_MD)	m	12.0
nearest neighbour standard deviation (ENN_SD)	m	518.9
nearest neighbour coefficient of variation (ENN_CV)	%	485
total edge (TE)	km	150

[(a)] A description of landscape measurements is provided in Appendix J.

n/a = Not applicable.

Note: Some numbers are rounded for presentation purposes.



LEGEND

- JACKPINE EXPANSION MINING AREA LOCAL STUDY AREA
- INDIAN RESERVE
- OPEN WATER
- PUBLIC ROADWAY

OLD GROWTH FOREST

- TREMBLING ASPEN (Aw)
- WHITE BIRCH (Bw)
- BALSAM POPLAR (Pb)
- JACK PINE (Pj)
- WHITE SPRUCE (Sw)
- BLACK SPRUCE (Sb)

DISTURBED

- EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE
- EXISTING AND APPROVED URBAN AND INDUSTRIAL LINEAR DISTURBANCE

3 0 3

SCALE 1:100,000 KILOMETRES

REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2004), and Alberta SRD, used under license.
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 12.

PROJECT

JACKPINE MINE EXPANSION & PIERRE RIVER MINE PROJECT

TITLE

OLD GROWTH FORESTS WITHIN THE JACKPINE EXPANSION MINING AREA LOCAL STUDY AREA

Shell Canada Limited

PROJECT No. 05-1344-027.7600			SCALE AS SHOWN	REV. 0
DESIGN	VR	06 Jun. 2007		
GIS	JH	14 Nov. 2007		
CHECK	AA	20 Nov. 2007		
REVIEW	TC	27 Nov. 2007		

FIGURE: 3.5-14

Project: I:\CLIENTS\SHELL\05-1344-027\mapping\mxd\veg\DRAFT\jackpine\bl_ogr_jp_esri.mxd - Plot: 7J:\2005\GIS\ArcMapTemplates\templates\v91\MyProject.pdf?

3.5.3 Key Indicator Resources

3.5.3.1 Community-Level Key Indicator Resource Descriptions in the Jackpine Expansion Mining Area Local Study Area

Lichen jack pine communities, riparian communities, old growth forests, peatlands (bogs and fens), patterned fens, rare plant communities and productive forests have been selected as community-level vegetation KIRs within the JEMA LSA.

Lichen Jack Pine (a1) Communities

Six detailed vegetation inventory plots were established in the lichen jack pine (a1) ecosite phase during field surveys conducted in 2006. A total of 164 ha (1%) of this community has been mapped within the JEMA LSA (Table 3.5-1).

Riparian Communities

Riparian communities were selected as a community-level KIR primarily for their wildlife resource value, ecological and social importance, and vulnerability to disturbance. Riparian communities account for 1,767 ha (10%) of the JEMA LSA (Table 3.5-20). They are composed mostly of wetlands vegetation and dominated by shrubby swamps (SONS) which comprise 28% of all riparian communities. The Labrador tea/horsetail white spruce-black spruce (h1) ecosite phase represents the largest terrestrial component of all riparian communities covering 55 ha (less than 1%) of the JEMA LSA (Figure 3.5-13).

Table 3.5-20 Area and Percent Cover of Riparian Communities Within the Jackpine Expansion Mining Area Local Study Area

Map Code	Description	Area		
		[ha]	% of Riparian Zone	% of LSA
Central Mixedwood Ecosite Phases				
e1	dogwood balsam poplar-aspen	3	<1	<1
e2	dogwood balsam poplar-white spruce	2	<1	<1
f3	horsetail white spruce	13	1	<1
h1	Labrador tea/horsetail white spruce-black spruce	55	3	<1
	central mixedwood ecosite phase subtotal	*72*	*4*	*<1*
Wetlands				
FONG	graminoid fen	118	7	1
FONS	shrubby fen	422	24	2
FOPN	open patterned fen	12	1	<1
FTNI	wooded fen with internal lawns	18	1	<1
FTNN	wooded fen	485	27	3
FTPN	wooded patterned fen	33	2	<1
MONG	marsh	83	5	<1
SONS	shrubby swamp	499	28	3
STNN	wooded swamp	25	1	<1
	wetlands subtotal	*1,693*	*96*	*9*
Other Vegetation types				
Sh	shrubland	1	<1	<1
	other vegetation types subtotal	*1*	*<1*	*<1*
Total		**1,767**	**100**	**10**

Note: Some numbers are rounded for presentation purposes. Therefore, it may appear that the totals do not equal the sum of the individual values.

Old Growth Forests

The results for the analysis of the composition and configuration of old growth forests within the JEMA LSA are presented below. The distribution of old growth forests within the LSA is shown in Figure 3.5-14.

Table 3.5-21 provides a breakdown of the JEMA LSA land base according to three variables: timber productivity potential, age class and primary tree species.

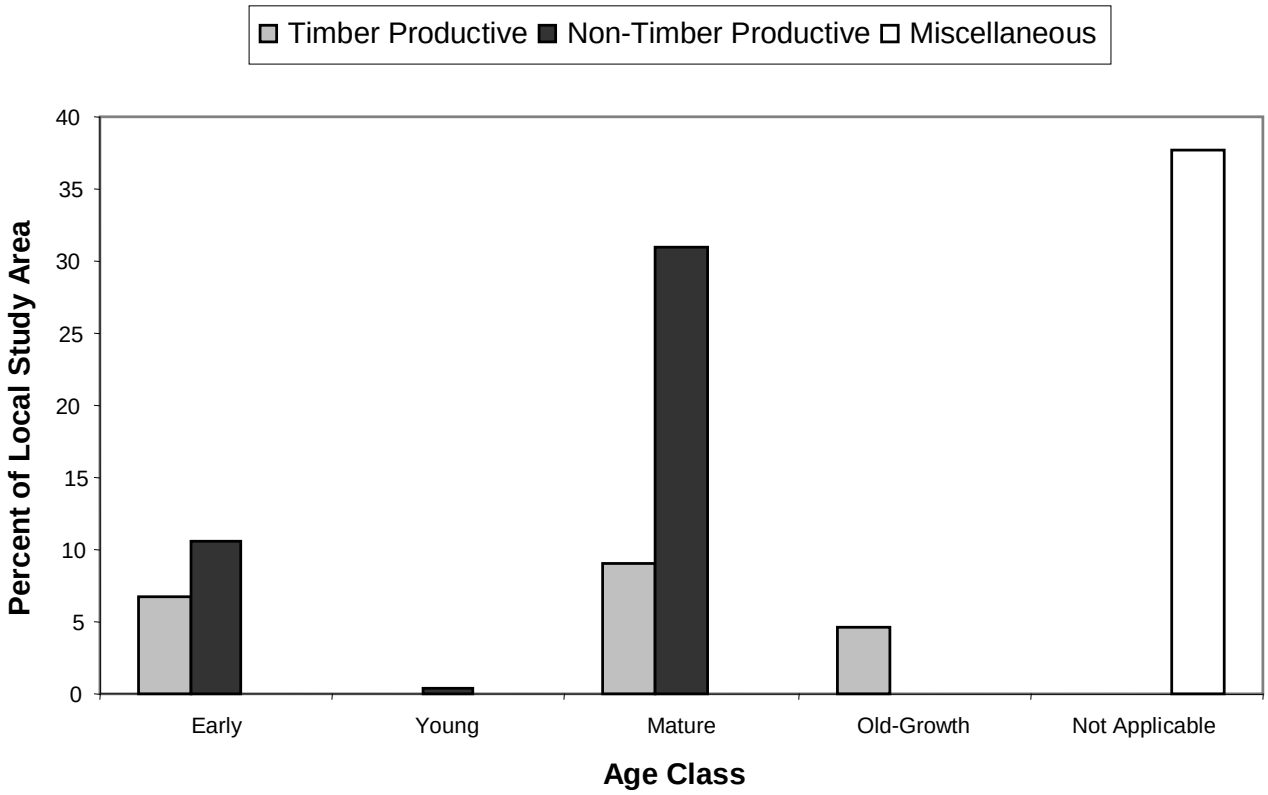
Among timber productive sites, mature stands are most common and cover 1,590 ha (9%) of the JEMA LSA (Table 3.5-21, Figure 3.5-15). Young stands are the least common among timber productive sites and cover only 8 ha (less than 1%) of the JEMA LSA.

Among the non-timber productive sites, mature stands also dominate the landscape covering 5,690 ha (31%) of the JEMA LSA (Table 3.5-21, Figure 3.5-15). Young stands composed of tamarack and black spruce stands are the least common age class among the non-timber group with only 83 ha (less than 1%) present within the JEMA LSA.

Timber productive old growth forest occupies 840 ha (5%) of the JEMA LSA, accounting for 100% of the old growth forest. Aspen forest accounts for 479 ha (3% of the LSA) or 57% of the old growth area. There is no non-timber productive old growth in the JEMA LSA.

Among timber productive stands, 10 ecosite phases were identified as belonging to the old growth age class within the JEMA LSA (Table 3.5-22). The blueberry jack pine-aspen (b1), blueberry aspen (white birch) (b2), and blueberry aspen-white spruce (b3) ecosite phases account for 73% of all timber productive old growth.

L:\2005\1344-OIL SANDS\05-1344-027-Shell Omnibus\7600\7640\Vegetation ESR\Fig 3.5-15 Age Class Distribution Within the Jackpine Expansion Mining Area.dwg Nov 28, 2007 - 3:50pm



PROJECT

JACKPINE MINE EXPANSION &
PIERRE RIVER MINE PROJECT

TITLE

AGE CLASS DISTRIBUTION WITHIN THE JACKPINE EXPANSION MINING AREA LOCAL STUDY AREA

Shell Canada Limited

PROJECT 05-1344-027.7640			FILE No.	Age Class
DESIGN	AA	21/08/07	SCALE AS SHOWN	REV. 0
CADD	YW	28/08/07	**FIGURE: 3.5-15**	
CHECK	AA	27/11/07		
REVIEW	WES/TC	27/11/07		

Table 3.5-21 Total Area and Percent Distribution of Timber Productive and Non-Timber Productive Forest Cover Types by Age Class Within the Jackpine Expansion Mining Area Local Study Area

Age Class	Primary Tree Species	Area [ha]	% of LSA
Timber Productive			
early	burn upland	1,124	6
	cutblock	120	1
	early subtotal	*1,244*	*7*
young	aspen	8	<1
	black spruce	<1	<1
	young subtotal	*8*	*<1*
mature	aspen	650	4
	white birch	48	<1
	tamarack	10	<1
	jack pine	383	2
	black spruce	174	1
	white spruce	325	2
	mature subtotal	*1,590*	*9*
old growth	aspen	479	3
	white birch	247	1
	balsam poplar	8	<1
	jack pine	51	<1
	black spruce	8	<1
	white spruce	47	<1
	old growth subtotal	*840*	*5*
	timber productive subtotal	*3,680*	*20*
Non-Timber Productive			
early	burn wetlands	1,902	10
	black spruce	43	<1
	early subtotal	*1,945*	*11*
young	tamarack	21	<1
	black spruce	61	<1
	young subtotal	*83*	*<1*
mature	tamarack	3,189	17
	black spruce	2,503	14
	mature subtotal	*5,690*	*31*
not applicable	disturbance	1,893	10
	non-forested wetlands	4,990	27
	other non-forested	64	<1
	non-applicable subtotal	*6,947*	*38*
	non-timber productive subtotal	*14,667*	*80*
Total		**18,348**	**100**

Note: Some numbers are rounded for presentation purposes. Therefore, it may appear that the totals do not equal the sum of the individual values.

Table 3.5-22 Total Area and Percent Occurrence of Old Growth Within the Jackpine Expansion Mining Area Local Study Area

Map Code	Description	Old Growth in the JEMA LSA	
		[ha]	% of LSA Old Growth
Timber Productive Old Growth[a]			
a1	lichen jack pine	4	<1
b1	blueberry jack pine-aspen	258	31
b2	blueberry aspen (white birch)	154	18
b3	blueberry aspen-white spruce	203	24
d1	low-bush cranberry aspen	112	13
d2	low-bush cranberry aspen-white spruce	84	10
d3	low-bush cranberry white spruce	6	1
e2	dogwood balsam poplar-white spruce	3	<1
e3	dogwood white spruce	4	1
h1	Labrador tea/horsetail white spruce-black spruce	11	1
Total[b]		**840**	**100**

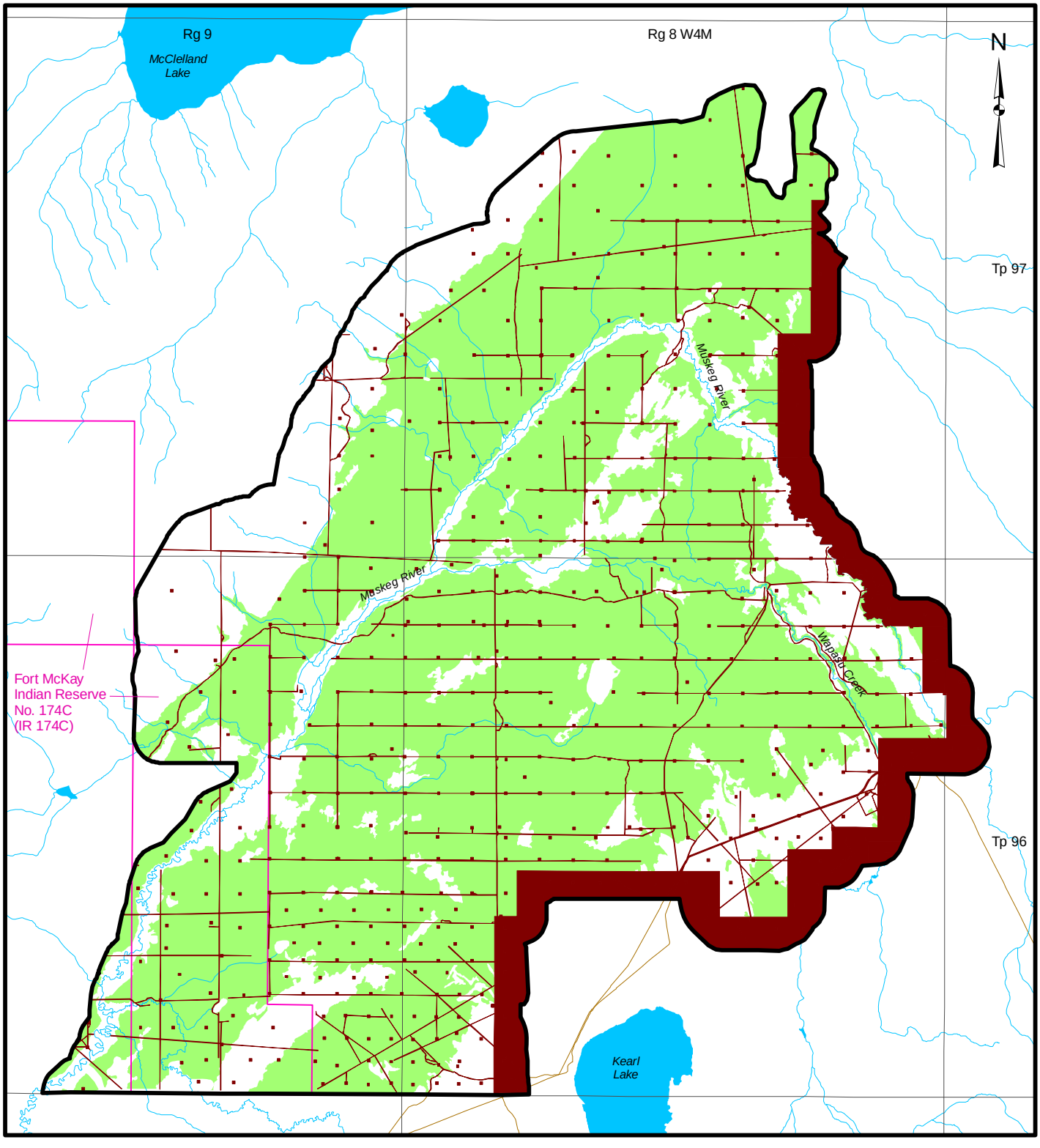
(a) With primary tree species being aspen, white birch, balsam poplar, jack pine or white spruce.

(b) Total values shown represent the old growth portions of the JEMA LSA.

Note: Some numbers are rounded for presentation purposes. Therefore, it may appear that the totals do not equal the sum of the individual values.

Peatlands (Fens and Bogs)

Peatlands are the dominant wetlands types and overall dominant vegetation types within the JEMA LSA, covering a total of 11,868 ha (65%) (Figure 3.5-16, Table 3.5-23). Wooded bogs (BTNN) and wooded fens (FTNN) make up the majority of all peatlands and cover 632 ha (3%) and 3,452 ha (19%) within the JEMA LSA. Peatlands cover most of the JEMA LSA, contained between the Fort Hills to the north and the uplands above Kearl Lake to the south (Figure 3.5-16).



LEGEND

- JACKPINE EXPANSION MINING AREA LOCAL STUDY AREA
- INDIAN RESERVE
- OPEN WATER
- PUBLIC ROADWAY
- PEATLANDS

DISTURBED

- EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE
- EXISTING AND APPROVED URBAN AND INDUSTRIAL LINEAR DISTURBANCE

3 0 3

SCALE 1:100,000 KILOMETRES

REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2004), and Alberta SRD, used under license.
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 12.

PROJECT

JACKPINE MINE EXPANSION & PIERRE RIVER MINE PROJECT

TITLE

PEATLANDS WITHIN THE JACKPINE EXPANSION MINING AREA LOCAL STUDY AREA

Shell Canada Limited

PROJECT No. 05-1344-027.7600			SCALE AS SHOWN	REV. 0
DESIGN	VR	06 Jun. 2007		
GIS	JH	14 Nov. 2007		
CHECK	AA	20 Nov. 2007	FIGURE: 3.5-16	
REVIEW	TC	27 Nov. 2007		

Project: I:\CLIENTS\SHELL\05-1344-027\mapping\mxd\veg\DRAFT\jackpine\bl_peat_jp_esr.mxd - Plot: 2J\2005\GIS\ArcMapTemplates\templates\v91\MyProject.pdf?

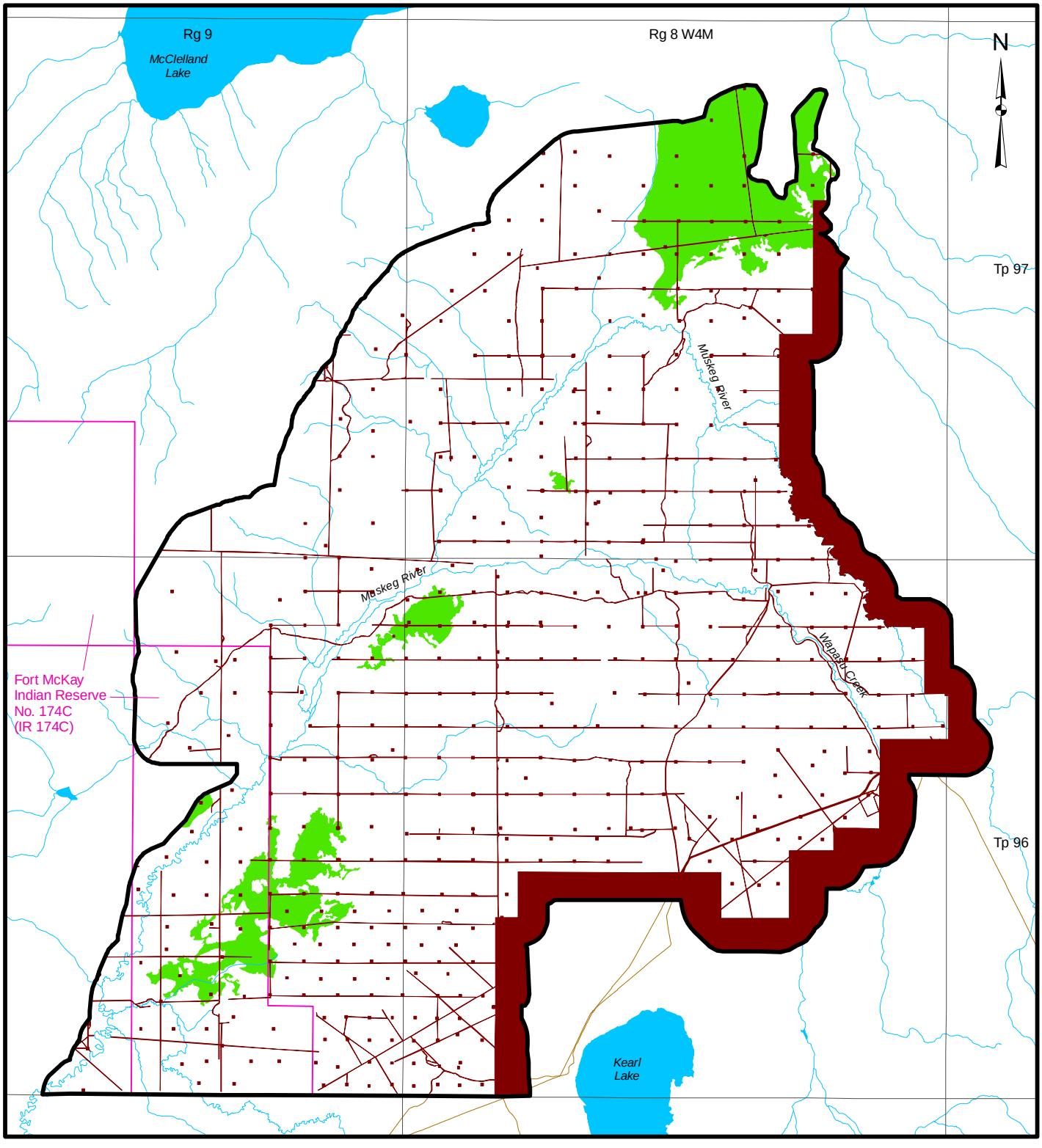
Table 3.5-23 Area and Percent Cover of Peatlands Within the Jackpine Expansion Mining Area Local Study Area

Map Code	Description	Area		
		[ha]	% of Peatlands	% of LSA
Forested and Wooded Peatlands				
BFNN	forested bog	<1	<1	<1
BTNI	wooded bog with internal lawns	714	6	4
BTNN	wooded bog	632	5	3
BTNR	wooded bog with internal lawns and islands of forested peat plateau	17	<1	<1
BTXC	wooded permafrost bog with collapse scar	89	1	<1
FFNN	forested fen	2	<1	<1
FTNI	wooded fen with internal lawns	409	3	2
FTNN	wooded fen	3,452	29	19
FTPN	wooded patterned fen	415	3	2
	forested and wooded peatlands subtotal	*5,730*	*48*	*31*
Non-Forested Peatlands				
BONN	open bog	61	1	<1
FONG	graminoid fen	878	7	5
FONS	shrubby fen	2,505	21	14
FOPN	open patterned fen	792	7	4
BUw	burn wetlands	1,902	16	10
	non-forested peatlands subtotal	*6,138*	*52*	*33*
Total		**11,868**	**100**	**65**

Note: Some numbers are rounded for presentation purposes. Therefore, it may appear that the totals do not equal the sum of the individual values.

Patterned Fens

Patterned fens were selected as a community-level KIR primarily for their ecological importance and vulnerability to disturbance. Within the JEMA LSA, patterned fens (FTPN, FOPN) account for 1,207 ha (7%) of the LSA (Figure 3.5-17). These types of fens are unique as they are characterized by alternating strings (woody ridges) and flarks (herbaceous pools) that run parallel to the groundwater flow direction. Four rare vascular species (Table 3.5-4) and eight rare lichens (Table 3.5-6) were found in a patterned fens within the JEMA LSA. The lenticular patterned fen community within the JEMA LSA is also described as a special plant community (Section 3.6.1.5).



LEGEND

- JACKPINE EXPANSION MINING AREA LOCAL STUDY AREA
- INDIAN RESERVE
- OPEN WATER
- PUBLIC ROADWAY
- PATTERNED FEN

DISTURBED

- EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE
- EXISTING AND APPROVED URBAN AND INDUSTRIAL LINEAR DISTURBANCE

3 0 3

SCALE 1:100,000 KILOMETRES

REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2004), and Alberta SRD, used under license.
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 12.

PROJECT

JACKPINE MINE EXPANSION & PIERRE RIVER MINE PROJECT

TITLE

PATTERNED FENS WITHIN THE JACKPINE EXPANSION MINING AREA LOCAL STUDY AREA

Shell Canada Limited

PROJECT No. 05-1344-027.7600			SCALE AS SHOWN	REV. 0
DESIGN	VR	06 Jun. 2007		
GIS	JH	14 Nov. 2007		
CHECK	AA	20 Nov. 2007	FIGURE: 3.5-17	
REVIEW	TC	27 Nov. 2007		

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Productive Forests

Productive forest was selected as a community-level KIR because of its economic importance. Within the JEMA LSA, there is 3,330 ha (18%) of potentially productive forest land (Table 3.5-24, Figure 3.5-18). This includes all forested, upland burn and harvested stands (cutblocks) with a good, medium or fair timber productivity rating. Timber productive land excludes black spruce and tamarack stands as well as non-forested wetlands, water and disturbances. Details on economic forests, including MAI and Long Run Sustained Yield Average (LRYSA) within the LSA are presented in the Forestry Environmental Setting Report (Section 4).

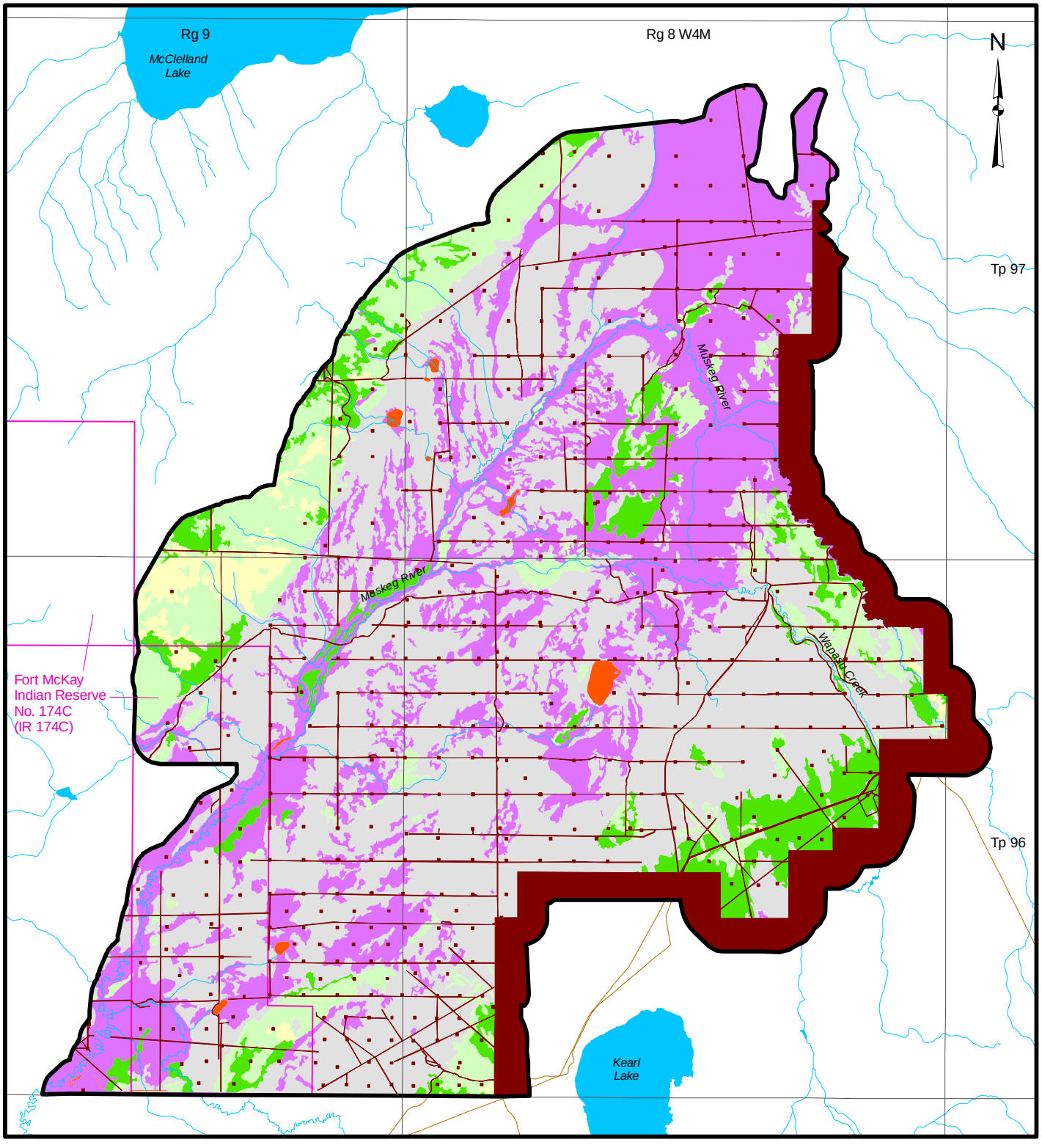
Table 3.5-24 Area and Percent Cover of Timber Productive and Non-Productive Sites Within the Jackpine Expansion Mining Area Local Study Area

Timber Productivity Rating Description	Local Study Area	
	[ha]	% of LSA
Timber Productive		
good	1,200	7
medium	1,835	10
fair	295	2
timber productive subtotal	*3,330*	*18*
Non-Timber Productive		
unproductive	8,070	44
non-treed[(a)]	4,993	27
non-vegetated[(b)]	1,954	11
non-timber productive subtotal	*15,017*	*82*
Total	**18,348**	**100**

(a) Non-treed types include open terrestrial and wetlands types.

(b) non-vegetated types include water types and disturbances.

Note: Some numbers are rounded for presentation purposes. Therefore, it may appear that the totals do not equal the sum of the individual values.



LEGEND

- JACKPINE EXPANSION MINING AREA LOCAL STUDY AREA
- INDIAN RESERVE
- OPEN WATER
- PUBLIC ROADWAY

TIMBER PRODUCTIVITY RATING

- GOOD
- MEDIUM
- FAIR
- UNPRODUCTIVE
- NON-FORESTED
- NON-VEGETATED

DISTURBED

- EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE
- EXISTING AND APPROVED URBAN AND INDUSTRIAL LINEAR DISTURBANCE

3 0 3

SCALE 1:100,000 KILOMETRES

REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2004), and Alberta SRD, used under license.
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 12.

PROJECT

JACKPINE MINE EXPANSION & PIERRE RIVER MINE PROJECT

TITLE

FOREST PRODUCTIVITY WITHIN THE JACKPINE EXPANSION MINING AREA LOCAL STUDY AREA

Shell Canada Limited

PROJECT No. 05-1344-027.7600			SCALE AS SHOWN	REV. 0
DESIGN	VR	06 Jun. 2007		
GIS	JH	14 Nov. 2007		
CHECK	AA	20 Nov. 2007	FIGURE: 3.5-18	
REVIEW	TC	27 Nov. 2007		

Project: I:\CLIENTS\SHELL\05-1344-027\mapping\mxd\veg\DRAFT\jackpinelbl_tpr_jp_esr.mxd- Plot: ?J:\2005\GIS\ArcMapTemplates\templates\v91\MyProject.pdf?

3.5.3.2 Species-Level Key Indicator Resource Descriptions in the Jackpine Expansion Mining Area Local Study Area

Rare plants and traditional use plants have been selected as species-level vegetation KIRs within the JEMA LSA because of their resource use value, ecological and social importance, and vulnerability to disturbance.

Rare Plant Potential

Rare plant potential within the JEMA LSA is provided in Table 3.5-25 and Figure 3.5-19. There is 9,272 ha of high (51%), 4,592 ha of moderate (25%) and 4,484 ha of low (24%) rare plant potential habitat within the LSA. High rare plant potential comprises most of the wetlands within the JEMA LSA.

Table 3.5-25 Area and Percent Cover of Rare Plant Potential Within the Jackpine Expansion Mining Area Local Study Area

Rare Plant Potential	Local Study Area	
	[ha]	% of LSA
high	9,272	51
moderate	4,592	25
low	4,484	24
Total	**18,348**	**100**

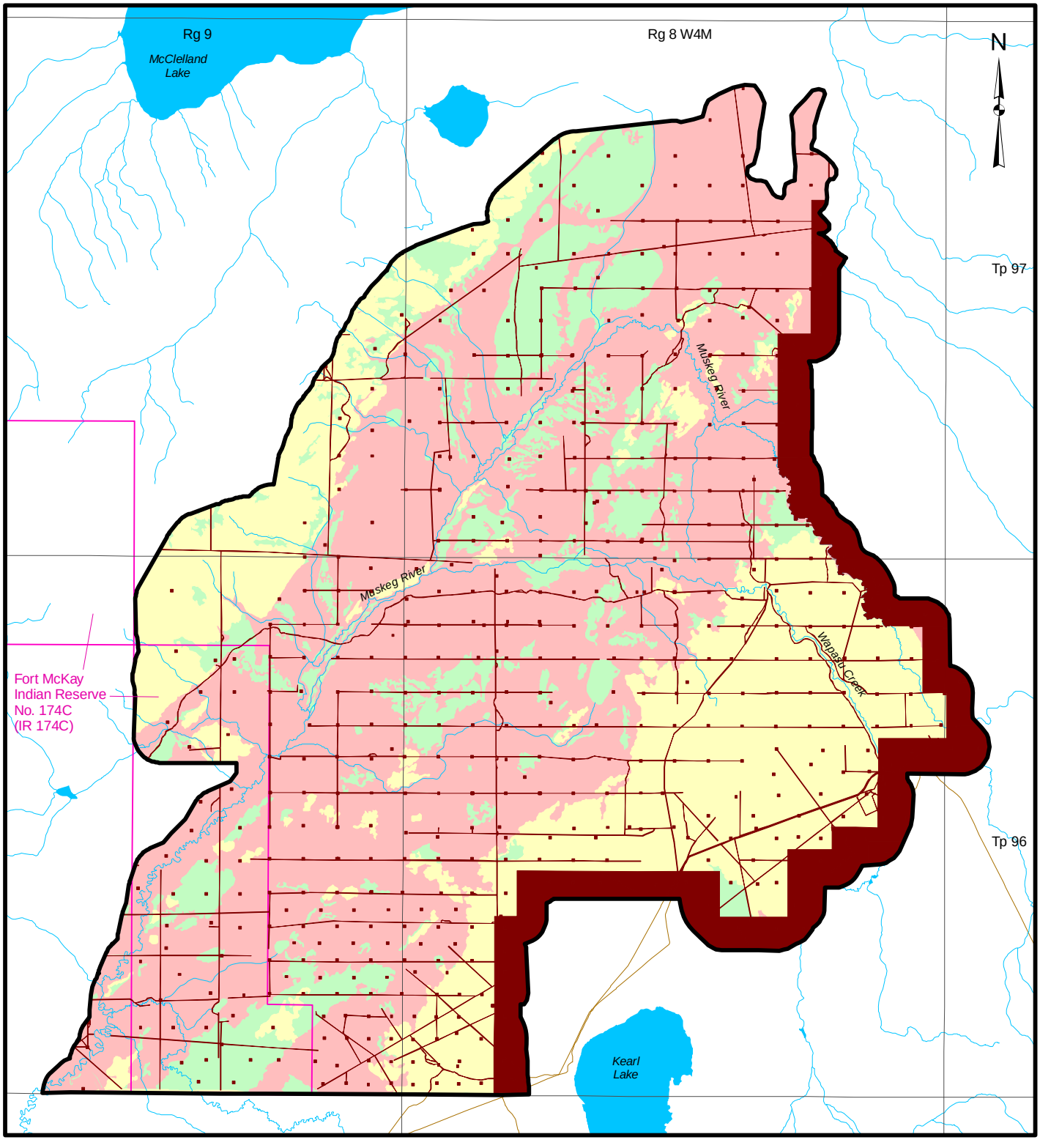
Traditional Plant Potential

There are four Registered Fur Management Areas (RFMA) that correspond with the JEMA LSA. The RFMA holders were interviewed and traditional plant use is detailed in Volume 4, Section 3. The collection of food berries (blueberries, high-bush cranberries, raspberries, saskatoons, mooseberries and strawberries) is the primary traditional plant activity. Medicinal plants are also noted to exist, and are collected occasionally.

Traditional plant potential within the JEMA LSA is provided in Table 3.5-26 and Figure 3.5-20. There is 1,870 ha of high (10%), 7,926 ha of moderate (43%) and 8,552 ha (47%) of low traditional plant potential habitat within the LSA.

Table 3.5-26 Area and Percent Cover of Traditional Plant Potential Within the Jackpine Expansion Mining Area Local Study Area

Traditional Plant Potential	Local Study Area	
	[ha]	% of LSA
high	1,870	10
moderate	7,926	43
low	8,552	47
Total	**18,348**	**100**



LEGEND

- JACKPINE EXPANSION MINING AREA LOCAL STUDY AREA
- INDIAN RESERVE
- OPEN WATER
- PUBLIC ROADWAY

RARE PLANT POTENTIAL

- HIGH
- MODERATE
- LOW

DISTURBED

- EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE
- EXISTING AND APPROVED URBAN AND INDUSTRIAL LINEAR DISTURBANCE

REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2004), and Alberta SRD, used under license.
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 12.

3 0 3
SCALE 1:100,000 KILOMETRES

PROJECT
JACKPINE MINE EXPANSION & PIERRE RIVER MINE PROJECT

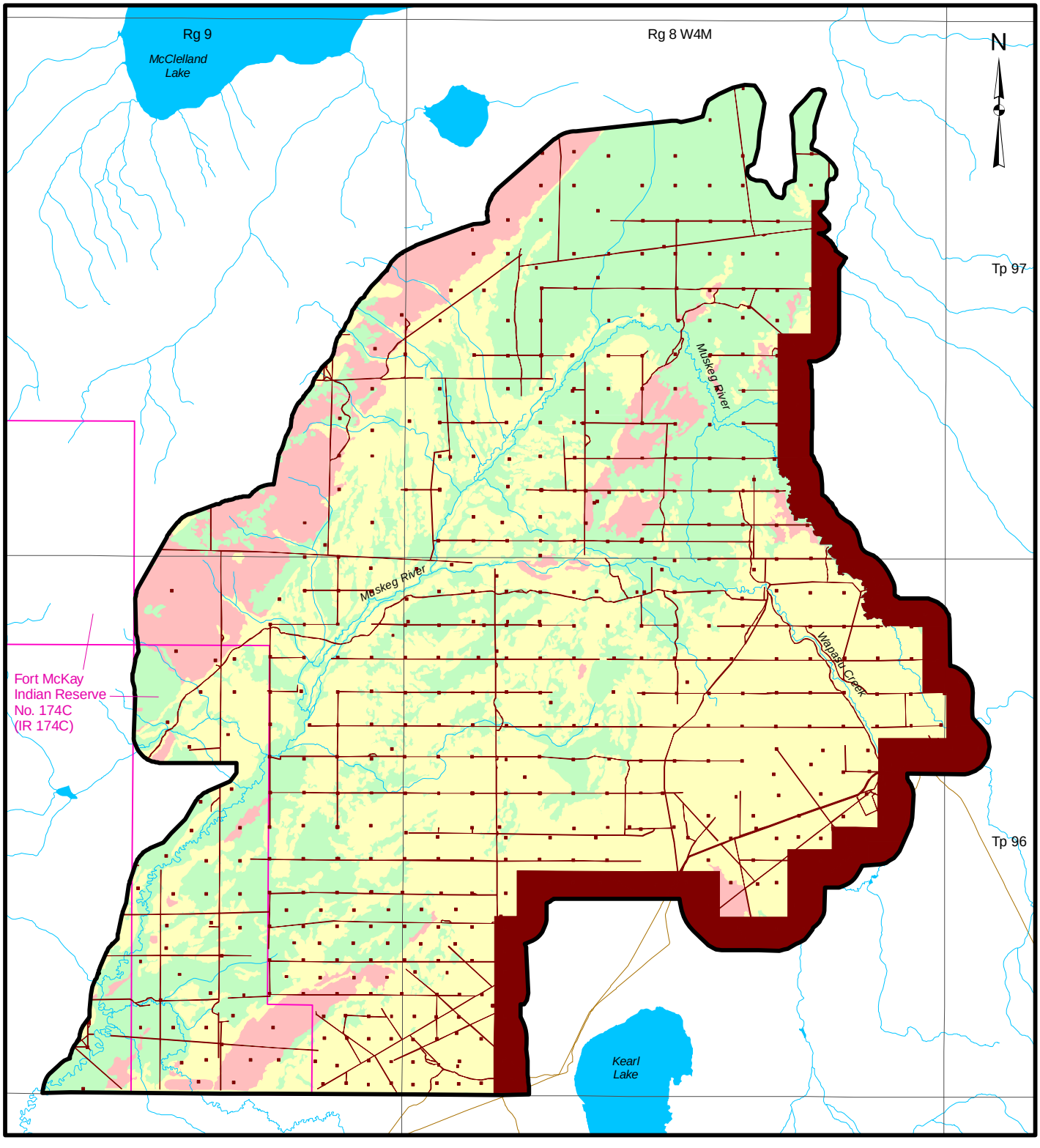
TITLE
RARE PLANT POTENTIAL WITHIN THE JACKPINE EXPANSION MINING AREA LOCAL STUDY AREA

Shell Canada Limited

PROJECT No. 05-1344-027.7600			SCALE AS SHOWN	REV. 0
DESIGN	VR	06 Jun. 2007		
GIS	JH	14 Nov. 2007		
CHECK	AA	20 Nov. 2007		
REVIEW	TC	27 Nov. 2007		

FIGURE: 3.5-19

Project: I:\CLIENTS\SHELL\05-1344-027\mapping\mxd\veg\DRAFT\jackpinelbl_rpp_jp_esr.mxd- Plot: 2J:\2005\GIS\ArcMapTemplates\templates\v91\MyProject.pdf?



LEGEND

- JACKPINE EXPANSION MINING AREA LOCAL STUDY AREA
- INDIAN RESERVE
- OPEN WATER
- PUBLIC ROADWAY

TRADITIONAL PLANT POTENTIAL

- HIGH
- MODERATE
- LOW

DISTURBED

- EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE
- EXISTING AND APPROVED URBAN AND INDUSTRIAL LINEAR DISTURBANCE

REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2004), and Alberta SRD, used under license.
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 12.

3 0 3
SCALE 1:100,000 KILOMETRES

PROJECT
JACKPINE MINE EXPANSION & PIERRE RIVER MINE PROJECT

TITLE
TRADITIONAL PLANT POTENTIAL WITHIN THE JACKPINE EXPANSION MINING AREA LOCAL STUDY AREA

Shell Canada Limited

PROJECT No. 05-1344-027.7600		SCALE AS SHOWN	REV. 0
DESIGN	VR	06 Jun. 2007	
GIS	JH	14 Nov. 2007	
CHECK	AA	20 Nov. 2007	
REVIEW	TC	27 Nov. 2007	

FIGURE: 3.5-20

Project: I:\CLIENTS\SHELL\05-1344-027\mapping\mxd\veg\DRAFT\jackpinelbl_tpp_jp_esr.mxd- Plot: 2J:\2005\GIS\ArcMapTemplates\templates\v91\MyProject.pdf?

3.6 PIERRE RIVER MINING AREA RESULTS

3.6.1 Pierre River Mining Area Terrestrial Vegetation and Wetlands

3.6.1.1 Overview

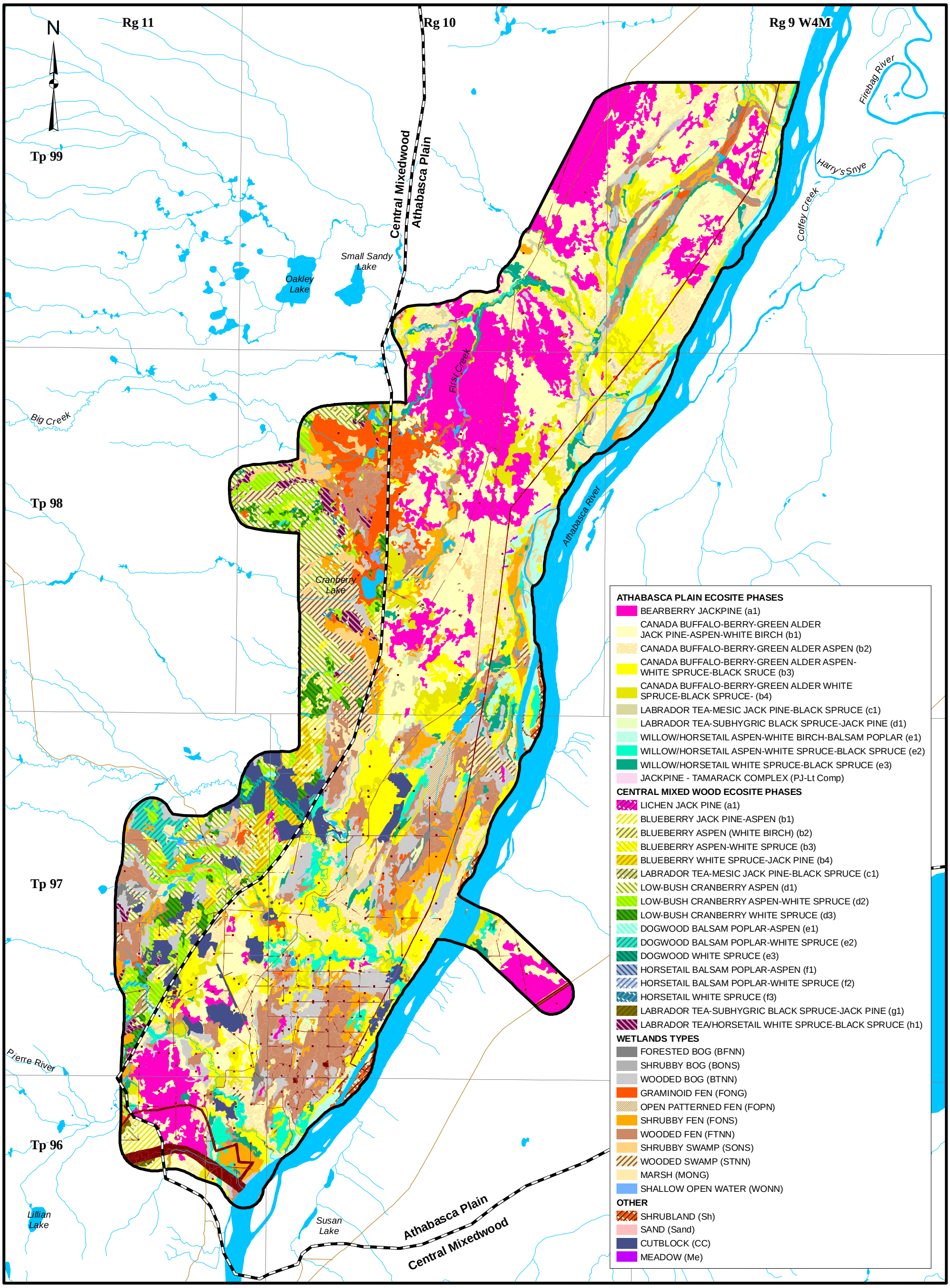
The PRMA LSA covers an area of 21,136 ha. There are a total of 46 cover types that occur within the LSA including:

- 17 Central Mixedwood terrestrial ecosite phases;
- 11 Athabasca Plain terrestrial ecosite phases;
- 11 wetlands types;
- 2 miscellaneous vegetation types;
- 3 non-vegetation types; and
- 2 disturbance types.

The PRMA LSA contains more uplands than typical in the Boreal Mixedwood Natural Region (NRC 2006). This includes a higher proportion of merchantable timber (including mature aspen and large tracts of jackpine), as evidenced by several cutblocks in the LSA (Figure 3.6-1). The PRMA LSA also contains the Calumet Old Growth Forest and the Eymundson Sinkhole Environmentally Significant Areas (ESA), as described in the Resource Use Environmental Setting (Golder 2007).

The PRMA LSA includes portions of both the Athabasca Plain and Central Mixedwood Natural Subregions (NRC 2006). The Athabasca Plain Natural Subregion is at its furthest southern extent in the PRMA LSA, and thus ecosite phases in the area reflect the transitory nature between the two Natural Subregion ecosite phase classifications. Figure 3.6-1 is mapped based on the Natural Subregions boundaries, but individual polygons within each Natural Subregion may be better reflected by the other Natural Subregion, or a composite of both.

Terrestrial ecosite phases represent 14,070 ha (66%) of the PRMA LSA (Table 3.6-1, Figure 3.6-1). The Central Mixedwood Natural Subregion comprises 21% of the PRMA LSA, on the west side (Figure 3.6-1). The most common Central Mixedwood terrestrial vegetation type is represented by the low-bush cranberry aspen (d1) ecosite phase occupying 734 ha (3%) of the study area. The least common terrestrial vegetation types are the horsetail balsam poplar-aspen (f1) and horsetail balsam poplar-white spruce (f2) ecosite phases, covering 4 ha (less than 1%) each within the PRMA LSA.



LEGEND

- PIERRE RIVER MINING AREA LOCAL STUDY AREA
- OPEN WATER
- PUBLIC ROADWAY

DISTURBED

- EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE
- EXISTING AND APPROVED URBAN AND INDUSTRIAL LINEAR DISTURBANCE
- NATURAL SUBREGION

2.5 0 2.5
SCALE 1:100,000 KILOMETRES

REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2004), and Alberta SRD, used under license.
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 12.

PROJECT
JACKPINE MINE EXPANSION &
PIERRE RIVER MINE PROJECT

TITLE
ECOSITE PHASES AND WETLANDS TYPES WITHIN THE PIERRE RIVER MINING AREA LOCAL STUDY AREA

Shell Canada Limited

PROJECT No. 05-1344-027.7600			SCALE AS SHOWN	REV. 0
DESIGN	AA	27 Aug. 2007	FIGURE: 3.6-1	
GIS	JH	14 Nov. 2007		
CHECK	AA	20 Nov. 2007		
REVIEW	TC	27 Nov. 2007		

Project: I:\CLIENTS\SHELL\05-1344-027\mapping\mxd\veg\DRAFT\pierreriver\bl_ecosite_ph_pr.mxd Plot: ?J:\2005\GIS\ArcMapTemplates\templates\v91\MyProject.pdf?

Table 3.6-1 Total Area and Percent Cover of Ecosite Phases and Wetlands Types Within the Pierre River Mining Area Local Study Area

Map Code	Description	Area		Number of Surveyed Sites			
		[ha]	% of LSA	Detailed Inventory and Rare Plant	Vegetation Aerial Survey	Rare Plant	Total
Central Mixedwood Natural Subregion Ecosite Phases							
a1	lichen jack pine	16	<1	3 (0)	0 (6)	0 (0)	**3 (6)**
b1	blueberry jack pine-aspen	242	1	9 (0)	2 (9)	1 (0)	**12 (9)**
b2	blueberry aspen (white birch)	43	<1	1 (0)	0 (5)	0 (0)	**1 (5)**
b3	blueberry aspen-white spruce	104	<1	2 (2)	0 (9)	0 (0)	**2 (11)**
b4	blueberry white spruce-jack pine	173	1	4 (0)	0 (2)	0 (0)	**4 (2)**
c1	Labrador tea-mesic jack pine-black spruce	19	<1	3 (0)	0 (3)	0 (0)	**3 (3)**
d1	low-bush cranberry aspen	734	3	9 (16)	5 (43)	1 (0)	**15 (59)**
d2	low-bush cranberry aspen-white spruce	478	2	18 (28)	2 (27)	1 (0)	**21 (55)**
d3	low-bush cranberry white spruce	250	1	6 (7)	0 (11)	0 (0)	**6 (18)**
e1	dogwood balsam poplar-aspen	6	<1	1 (0)	0 (0)	0 (0)	**1 (0)**
e2	dogwood balsam poplar-white spruce	121	1	1 (2)	2 (3)	0 (0)	**3 (5)**
e3	dogwood white spruce	45	<1	2 (4)	0 (1)	0 (0)	**2 (5)**
f1	horsetail balsam poplar-aspen	4	<1	1 (1)	0 (1)	0 (0)	**1 (2)**
f2	horsetail balsam poplar-white spruce	4	<1	4 (4)	0 (0)	0 (0)	**4 (4)**
f3	horsetail white spruce	7	<1	3 (4)	0 (2)	0 (0)	**3 (6)**
g1	Labrador tea-subhygric black spruce-jack pine	12	<1	2 (2)	0 (4)	0 (0)	**2 (6)**
h1	Labrador tea/horsetail white spruce-black spruce	118	1	3 (1)	0 (1)	0 (0)	**3 (2)**
central mixedwood ecosite phase subtotal		*2,375*	*11*	*72 (71)*	*11 (127)*	*3 (0)*	*86 (198)*
Athabasca Plain Natural Subregion Ecosite Phases							
a1	bearberry jack pine	2,740	13	21 (9)	13 (5)	2 (0)	**36 (14)**
b1	Canada buffalo-berry–green alder jack pine-aspen-white birch	2,922	14	32 (15)	17 (7)	0 (0)	**39 (22)**
b2	Canada buffalo-berry–green alder aspen	2,151	10	13 (4)	3 (2)	1 (0)	**17 (6)**
b3	Canada buffalo-berry–green alder aspen-white spruce-black spruce	1,728	8	5 (5)	7 (0)	0 (0)	**12 (5)**
b4	Canada buffalo-berry–green alder white spruce-black spruce-jack pine	927	4	10 (1)	5 (9)	1 (0)	**16 (10)**
c1	Labrador tea-mesic jack pine-black spruce	60	<1	3 (1)	5 (1)	0 (0)	**8 (2)**
d1	Labrador tea-subhygric black spruce-jack pine	130	1	4 (0)	11 (8)	0 (0)	**15 (8)**
e1	willow/horsetail aspen-white birch-balsam poplar	325	2	5 (0)	7 (0)	0 (0)	**12 (0)**
e2	willow/horsetail aspen-white spruce-black spruce	404	2	0 (1)	3 (0)	0 (0)	**3 (1)**
e3	willow/horsetail white spruce-black spruce	307	1	0 (0)	5 (1)	0 (0)	**5 (1)**
PJ-Lt Comp	jack pine-tamarack complex	3	<1	0 (0)	0 (0)	0 (0)	**0 (0)**
Athabasca plain ecosite phase subtotal		*11,695*	*55*	*93 (36)*	*96 (35)*	*4 (0)*	*193 (71)*

Table 3.6-1 Total Area and Percent Cover of Ecosite Phases and Wetlands Types Within the Pierre River Mining Area Local Study Area (continued)

Map Code	Description	Area		Number of Surveyed Sites			
		[ha]	% of LSA	Detailed Inventory and Rare Plant	Vegetation Aerial Survey	Rare Plant	Total
Wetlands							
BFNN	forested bog	73	<1	1 (0)	0 (0)	0 (0)	**1 (0)**
BONS	shrubby bog	1	<1	0 (0)	1 (2)	0 (0)	**1 (2)**
BTNI[(a)]	wooded bog with raised islands of forested peat plateau	n/a	n/a	1 (0)	0 (1)	0 (0)	**1 (1)**
BTNN	wooded bog	1,186	6	10 (7)	4 (22)	2 (1)	**16 (30)**
FFNN[(a)]	forested fen	n/a	n/a	1 (0)	0 (0)	0 (0)	**1 (0)**
FONG	graminoid fen	702	3	1 (1)	10 (23)	1 (0)	**12 (24)**
FONS	shrubby fen	905	4	4 (0)	8 (21)	2 (0)	**14 (21)**
FOPN	open patterned fen	69	<1	1 (0)	0 (8)	0 (0)	**1 (8)**
FTNN	wooded fen	1,580	7	10 (2)	21 (42)	0 (0)	**31 (44)**
FTPN[(a)]	wooded patterned fen	n/a	n/a	1 (0)	0 (13)	0 (0)	**1 (13)**
MONG	marsh	146	1	4 (3)	2 (7)	0 (0)	**6 (10)**
SONS	shrubby swamp	372	2	5 (8)	5 (17)	0 (0)	**10 (25)**
STNN	wooded swamp	517	2	4 (15)	10 (39)	0 (0)	**14 (54)**
WONN	shallow open water	57	<1	1 (0)	0 (0)	0 (0)	**1 (0)**
wetlands subtotal		*5,609*	*27*	*44 (36)*	*61 (195)*	*5 (1)*	*110 (232)*
Miscellaneous Vegetation Types							
Me	meadow	7	<1	0 (0)	0 (2)	0 (0)	**0 (2)**
Sh	shrubland	87	<1	1 (0)	1 (2)	0 (0)	**2 (2)**
RiSh[(a)]	riparian shrubland	n/a	n/a	3 (0)	0 (0)	0 (0)	**3 (0)**
SpS[(a)]	sparsely vegetated slope	n/a	n/a	1 (0)	0 (0)	0 (0)	**1 (0)**
miscellaneous vegetation types subtotal		*95*	*<1*	*5 (0)*	*1 (4)*	*0 (0)*	*6 (4)*
Non-Vegetation Types							
lake	lake	84	<1	0 (0)	0 (0)	0 (0)	**0 (0)**
river	river	263	1	0 (0)	0 (0)	0 (0)	**0 (0)**
sand	sand	41	<1	0 (0)	0 (0)	0 (0)	**0 (0)**
non-vegetation types subtotal		*388*	*2*	*0 (0)*	*0 (0)*	*0 (0)*	*0 (0)*
Disturbances							
CC	cutblock	535	3	0 (0)	0 (2)	0 (0)	**0 (2)**
DIS	disturbance	439	2	0 (0)	0 (0)	1 (0)	**1 (0)**
disturbances subtotal		*974*	*5*	*0 (0)*	*0 (2)*	*1 (0)*	*1 (2)*
Total		**21,136**	**100**	**214 (143)**	**169 (363)**	**13 (2)**	**396 (508)**

[(a)] Indicates Wetlands Types and Miscellaneous Vegetation Types too small for mapping to include as their own polygon areas. However, plots were conducted in these types.

n/a = Not applicable.

Note: Some numbers are rounded for presentation purposes. Therefore, it may appear that the totals do not equal the sum of the individual values.

The majority of the PRMA LSA (79%) falls within the Athabasca Plain Natural Subregion (Table 3.6-1, Figure 3.6-1). The most common Athabasca Plain terrestrial vegetation type is represented by the Canada buffalo-berry–green alder jack pine-aspen-white birch (b1) ecosite phase occupying 2,922 ha (14%) of the study area. This is followed closely by the bearberry jack pine (a1) ecosite phase at 2,740 (13%) and the Canada buffalo-berry–green alder aspen (b2) ecosite phase at 2,151 ha (10%) of the PRMA LSA. The least common terrestrial vegetation type

is the jack pine-tamarack complex, covering 3 ha (less than 1%) within the PRMA LSA.

Wetlands cover 5,609 ha (27%) of the PRMA LSA (Table 3.6-1). Peatlands, represented by bogs and fens account for 4,516 ha (21%) of the PRMA LSA. The most common wetlands type is the wooded fen (FTNN) covering 1,580 ha (7%) of the PRMA LSA followed by the wooded bog (BTNN) representing 1,186 ha (6%) of the LSA. Non-peatland wetlands, including marshes, swamps and shallow open water account for 1,093 ha (5%) of the PRMA LSA. Wooded swamps (STNN) cover 517 ha (2%) of the PRMA LSA or 47% of all non-peatland wetlands. The least common wetlands types are the shrubby bog (BONS) and shallow open water (WONN), covering 1 ha (less than 1%) and 57 ha (less than 1%), respectively within the PRMA LSA.

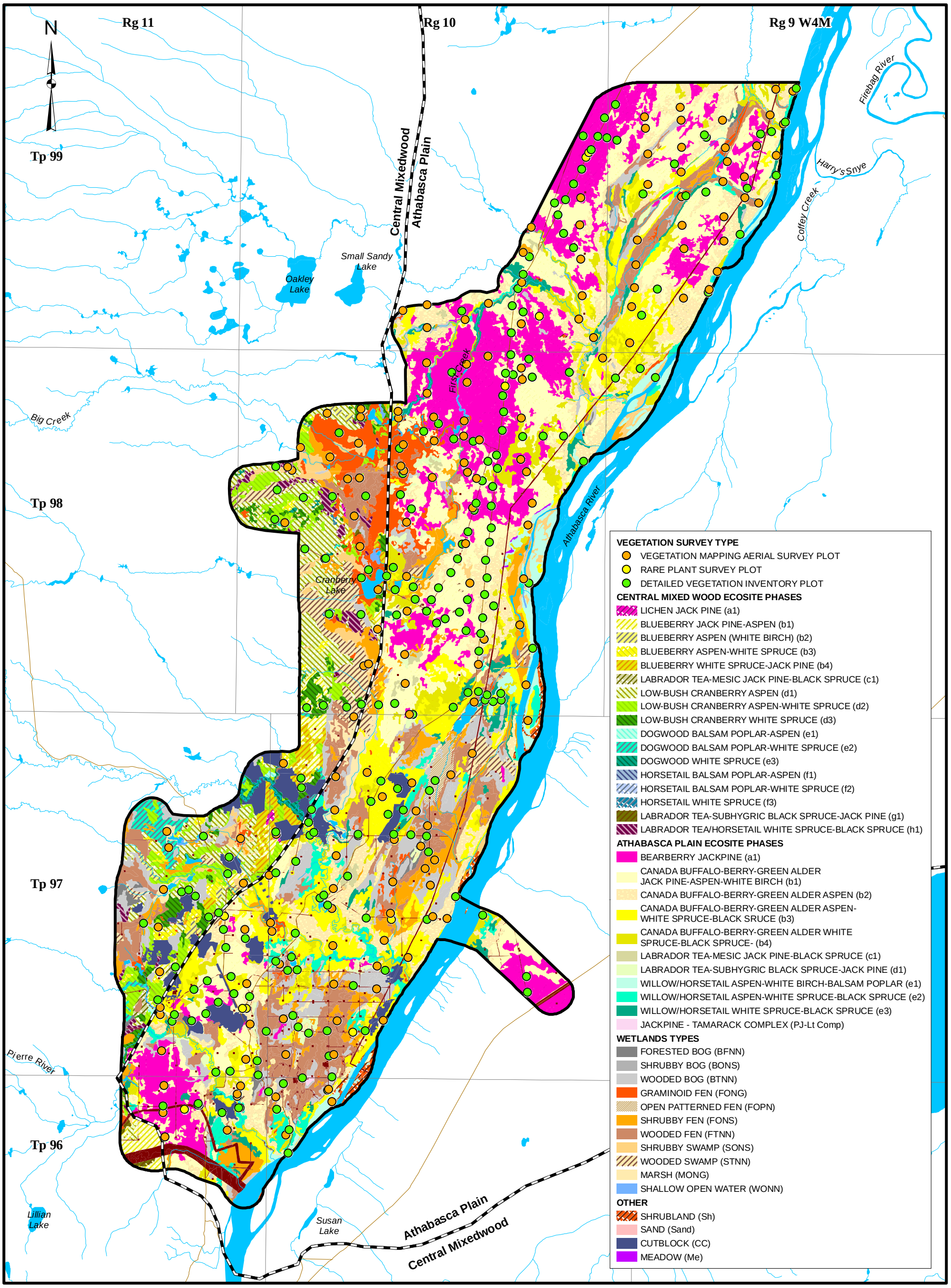
Miscellaneous vegetation types account for 95 ha (less than 1%) of the PRMA LSA, which include meadows and shrublands. Small inclusions (too small to be mapped) of riparian shrubland and sparsely vegetated slopes were also found during field surveys. Non-vegetation types cover 388 ha (2%) of the PRMA LSA and include rivers, lakes and sand bars.

Disturbances cover 974 ha (5%) of the PRMA LSA including 535 ha (3%) of cutblocks and 439 ha (2%) of other disturbances, which represent borrow pits, well sites, borehole pads, clearings, roads, rights-of-ways, trails and seismic lines.

The PRMA LSA includes portions of both the Central Mixedwood (21%) and Athabasca Plain (79%) Natural Subregions (NRC 2006). Descriptions of ecosite phases, wetlands types and other vegetation types mapped within the PRMA LSA are provided in Appendix N. These descriptions are based on established descriptions for ecosites phases and wetlands types in the region (Beckingham and Archibald 1996; Halsey et al. 2003). In cases where needed, the descriptions are supplemented with vegetation and soils data collected from the PRMA LSA. Appendix N also contains full species lists for all vegetation types sampled.

3.6.1.2 Plot Data Summary

Data were collected from 396 vegetation survey sites across the range of vegetation types within the PRMA LSA. This included 214 detailed vegetation plots, 169 vegetation aerial survey plots and 13 rare plant survey sites (Table 3.6-1, Figure 3.6-2). Based on these data, a species list for the PRMA LSA was generated and is provided in Appendix N. Site data for each site is provided in Appendix M.



LEGEND

- PIERRE RIVER MINING AREA LOCAL STUDY AREA
- OPEN WATER
- PUBLIC ROADWAY

DISTURBED

- EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE
- EXISTING AND APPROVED URBAN AND INDUSTRIAL LINEAR DISTURBANCE
- NATURAL SUBREGION

2.5 0 2.5

SCALE 1:100,000 KILOMETRES

REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2004), and Alberta SRD, used under license.
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 12.

PROJECT

JACKPINE MINE EXPANSION & PIERRE RIVER MINE PROJECT

TITLE

VEGETATION PLOTS AND RARE PLANT SURVEY SITES WITHIN THE PIERRE RIVER MINING AREA LOCAL STUDY AREA

Shell Canada Limited

PROJECT No. 05-1344-027.7600			SCALE AS SHOWN	REV. 0
DESIGN	AA	27 Aug. 2007	FIGURE: 3.6-2	
GIS	JH	14 Nov. 2007		
CHECK	AA	20 Nov. 2007		
REVIEW	TC	27 Nov. 2007		

Project: I:\CLIENTS\SHELL\05-1344-027\mapping\mxd\veg\DRAFT\pierreriver\bl_ecosite_veg_survey_sites_pr.mxd Plot: ?J\2005\GIS\ArcMapTemplates\templates\v91\MyProject.pdf?

3.6.1.3 Forest Resources – Stand Attributes

Data were summarized from AVI to provide descriptions for each vegetation type with respect to main tree canopy composition and density as well as stand structure (Table 3.6-2). The main tree canopy is the uppermost structural level of a forest stand that contains the leading tree species. Stand structure provides information on the number of layers or type of layering evident in the stand and may include those with the following structures:

- single layer: tree stand with a single main tree canopy;
- multi-layered: tree stand with a well-defined main canopy and secondary canopy or understorey;
- complex structure: tree stand with a high variation in heights but with no distinct tree layers; usually associated with forest peatlands; and
- horizontal structure: structure of a polygon in cases where two unique stands occur adjacent to each other but are both too small to map separately.

There were no obvious trends in main canopy tree density among vegetation types except to show that canopy density is variable, and this variation may be related to factors including, but not limited to stand age and stand density (Table 3.6-2).

Main canopy tree species composition is strongly associated with vegetation type mainly because tree species are often good indicators of the broad ecological characteristics of a site (Table 3.6-2). For example, species such as jack pine and aspen are not typically found in wetlands, while tamarack is rarely present within uplands. Black spruce on the other hand, while a dominant species in wetlands, can also be dominant in both the Labrador tea–subhygric black spruce-jack pine (g1) and Labrador tea/horsetail white spruce-black spruce (h1) ecosite phases. These ecosite phases are transitional between terrestrial and wetlands ecosystems, and therefore, share certain characteristics with both environments.

From an ecological mapping perspective, classifying black spruce-dominated stands can be difficult when groundtruth data is lacking within specific AVI polygons. Often, two or more of these black spruce-dominated vegetation types occur together in the same area with only subtle differences in topography and elevation required to affect a change in the ecology of the site. Main tree canopy composition as shown in Table 3.6-2 relates well to ecosite phases and wetlands types as described in more detail in Appendix N.

Table 3.6-2 Percent Distribution of Overstorey Density Class, Tree Species Composition and Stand Structure Class Within the Pierre River Mining Area Local Study Area

Map Code	Description	Area [ha]	Percent Distribution by Overstorey Density Class [%]					Percent Distribution by Overstorey Tree Species [%]								Percent Distribution by Structure Class [%]			
			0 to 5	6 to 30	31 to 50	51 to 70	71 to 100	Aspen	White Birch	Balsam Poplar	Balsam Fir	White Spruce	Jack Pine	Black Spruce	Tamarack	S	M	C	H
Central Mixedwood Natural Subregion Ecosite Phases																			
a1	lichen jack pine	16	0	0	0	61	39	0	0	0	0	0	100	0	0	100	0	0	0
b1	blueberry jack pine-aspen	242	0	12	6	49	33	48	3	0	0	3	47	0	0	76	24	0	0
b2	blueberry aspen (white birch)	43	0	24	0	44	32	11	87	0	0	3	0	0	0	44	56	0	0
b3	blueberry aspen-white spruce	104	0	30	56	11	3	82	4	0	0	12	1	0	0	6	94	0	0
b4	blueberry white spruce-jack pine	173	0	4	4	91	1	8	0	1	0	40	51	0	0	92	8	0	0
c1	Labrador tea-mesic jack pine-black spruce	19	0	63	0	37	0	13	3	0	0	23	57	3	0	37	63	0	0
d1	low-bush cranberry aspen	734	0	3	2	29	66	97	2	0	0	<1	0	<1	<1	51	49	0	0
d2	low-bush cranberry aspen-white spruce	478	<1	7	11	69	14	56	4	0	0	32	2	5	0	47	53	<1	0
d3	low-bush cranberry white spruce	250	0	19	31	51	0	5	0	0	0	93	1	1	0	73	27	0	0
e1	dogwood balsam poplar-aspen	6	0	0	0	52	48	93	0	8	0	0	0	0	0	0	100	0	0
e2	dogwood balsam poplar-white spruce	121	0	2	5	93	0	7	3	8	0	55	0	27	0	22	2	76	0
e3	dogwood white spruce	45	0	8	89	3	0	4	0	5	0	91	0	0	0	92	8	0	0
f1	horsetail balsam poplar-aspen[(a)]	4	100	0	0	0	0	0	0	0	0	0	0	0	0	0	100	0	0
f2	horsetail balsam poplar-white spruce	4	2	0	0	98	0	23	7	0	0	37	0	33	0	88	12	0	0
f3	horsetail white spruce	7	0	36	0	64	0	0	5	0	0	95	0	0	0	64	36	0	0
g1	Labrador tea-subhygric black spruce-jack pine	12	0	49	14	36	0	3	0	0	0	3	35	60	0	51	49	0	0
h1	Labrador tea/horsetail white spruce-black spruce	118	0	30	39	29	3	3	<1	0	0	69	0	27	<1	66	30	4	0
Athabasca Plain Natural Subregion Ecosite Phases																			
a1	bearberry jack pine	2,740	0	3	14	43	39	0	0	0	0	<1	100	0	0	96	4	0	0
b1	Canada buffalo-berry–green alder jack pine-aspen-white birch	2,922	0	6	22	56	16	41	<1	0	0	3	56	<1	0	80	20	0	0
b2	Canada buffalo-berry–green alder aspen	2,151	0	1	1	32	66	96	3	0	0	<1	1	<1	0	39	61	0	0
b3	Canada buffalo-berry–green alder aspen-white spruce-black spruce	1,728	0	2	18	64	16	51	2	1	0	37	1	9	0	57	41	2	0
b4	Canada buffalo-berry–green alder white spruce-black spruce-jack pine	927	0	14	38	47	1	6	<1	0	0	84	10	<1	0	75	24	0	1
c1	Labrador tea-mesic jack pine-black spruce	60	0	0	44	56	0	1	0	0	0	6	55	38	0	55	11	34	0
d1	Labrador tea-subhygric black spruce-jack pine	130	0	3	2	80	14	3	0	0	0	0	11	85	0	97	3	0	0
e1	willow/horsetail aspen-white birch-balsam poplar	325	0	1	7	72	20	27	0	72	0	1	0	0	0	79	21	0	0
e2	willow/horsetail aspen-white spruce-black spruce	404	0	17	23	45	14	16	1	14	0	48	0	21	<1	65	28	7	0
e3	willow/horsetail white spruce-black spruce	307	0	6	17	76	1	0	0	0	0	43	0	57	0	77	8	14	0
PJ-Lt Comp	jack pine-tamarack complex	3	0	100	0	0	0	0	0	0	0	0	60	0	40	0	100	0	0
Forested and Wooded Wetlands																			
BFNN	forested bog	73	0	0	0	0	100	0	0	0	0	0	0	100	0	72	0	28	0
BTNN	wooded bog	1	0	6	27	67	0	0	0	0	0	0	0	99	1	31	6	63	0
FTNN	wooded fen	1,186	1	35	25	39	0	<1	<1	0	0	1	<1	58	41	33	38	30	0
STNN	wooded swamp	702	15	36	25	24	<1	4	40	0	0	15	0	22	18	40	46	14	0
Non-Forested Wetlands																			
BONS	shrubby bog	905	100	0	0	0	0	0	0	0	0	0	0	0	0	100	0	0	0
FONG	graminoid fen	69	100	<1	0	0	0	0	30	0	0	50	0	20	0	22	78	0	0
FONS	shrubby fen	1,580	64	15	17	4	<1	3	0	0	0	1	2	63	30	20	61	19	0
FOPN	open patterned fen	146	0	100	0	0	0	0	0	0	0	0	0	40	60	0	100	0	0
MONG	marsh	372	96	0	4	0	0	0	0	0	0	0	0	100	0	5	91	4	0
SONS	shrubby swamp	517	98	2	<1	<1	0	32	0	0	0	32	0	36	0	91	9	0	0
WONN	shallow open water	57	100	0	0	0	0	-	-	-	-	-	-	-	-	88	12	0	0
Miscellaneous Vegetation Types																			
Me	meadow	7	100	0	0	0	0	0	0	0	0	0	0	0	0	100	0	0	0
Sh	shrubland	87	100	0	0	0	0	0	0	0	0	0	0	0	0	100	0	0	0
Non-Vegetation Types																			
Lake	lake	84	100	0	0	0	0	-	-	-	-	-	-	-	-	-	-	-	-
River	river	263	100	0	0	<1	<1	-	-	-	-	-	-	-	-	-	-	-	-
Sand	sand	41	100	0	0	0	0	-	-	-	-	-	-	-	-	100	0	0	0
Disturbances																			
CC	cutblock	535	100	0	0	0	0	n/d	n/d	n/d	n/d	n/d	n/d	n/d	n/d	100	0	0	0
DIS	disturbance	439	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

[(a)] The area for the horsetail balsam poplar-aspen (f1) ecosite was reclassed based on detailed plot data. The AVI data does not match the re-interpreted class.

– = Not applicable.

n/d = No data or only partial data available (e.g., cutblocks).

Note: Stand structure classes: S = single storey; M = multi-layered; C = complex; H = horizontal.

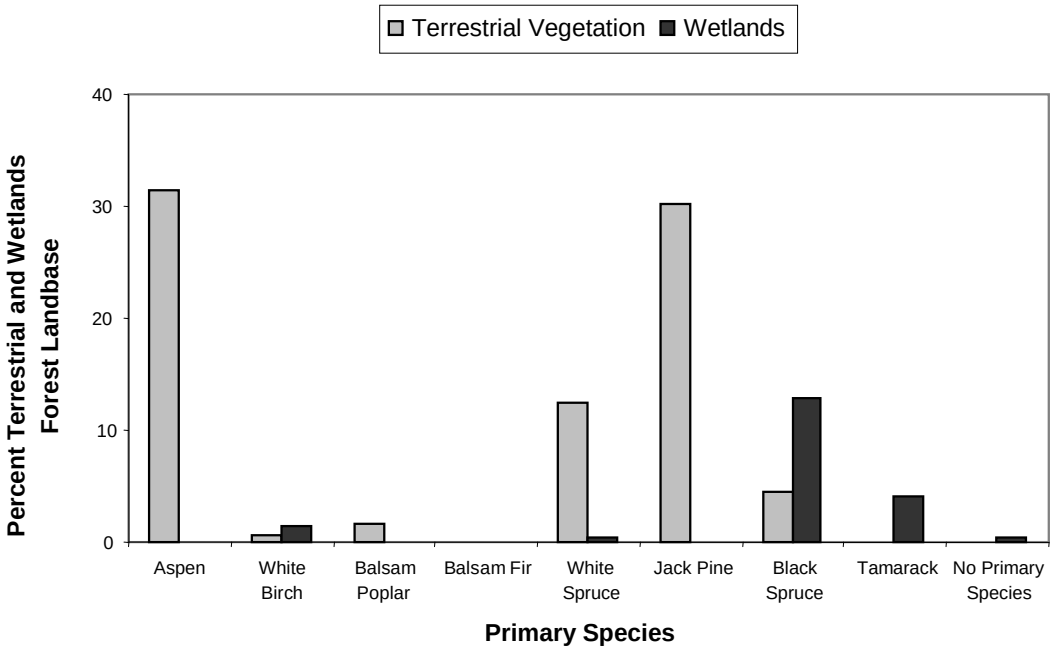
Stand structure among vegetation types is also summarized in Table 3.6-2. Single and multi-storied stands are most commonly associated with terrestrial vegetation types while treed wetlands tend to have a more complex canopy structure.

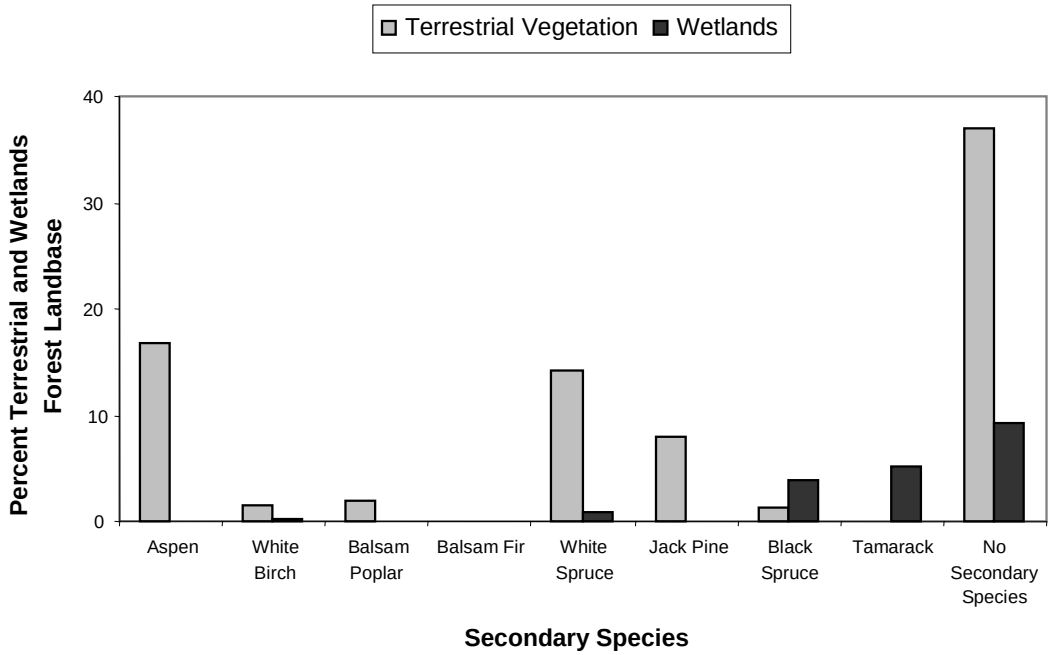
Figure 3.6-3 shows the percent occurrence of primary and secondary tree canopy species among terrestrial and wetlands forest vegetation. Among terrestrial ecosite phases, aspen and jack pine are the dominant species, both covering over 30% of the forested land base. Among wetlands, black spruce is the dominant species covering over 13% of that same forest land base. Secondary tree canopy species (i.e., the species with the second most coverage in the main canopy) are shown in the bottom graph of Figure 3.6-3. This shows that there is commonly no secondary tree species within both terrestrial and wetlands forests. When there is a secondary species, aspen and white spruce are most common in terrestrial forests and tamarack in wetlands.

Stand Height, Age and Timber Productivity

The AVI data were summarized to provide descriptions for each vegetation type with respect to main tree canopy height, stand age and timber productivity (Table 3.6-3). The tallest mean stand height was attributed to the dogwood balsam poplar-aspen (e1) ecosite phase (24 m). The lowest mean height for a terrestrial vegetation type was attributed to the Labrador tea-subhygric black spruce-jack pine (g1) ecosite phase (10 m). Mean height values for the treed bog and fen wetlands types are less than 10 m. The wooded swamp (STNN) is the tallest wetlands type with a mean height of 11 m.

The oldest mean stand age was associated with the Athabasca Plain Canada buffalo-berry–green alder white spruce-black spruce-jack pine (b4) ecosite phase (129 years) (Table 3.6-3). At nearly half that age, the youngest mean stand age was associated with the Central Mixedwood Labrador tea-mesic jack pine-black spruce (c1) ecosite phase (67 years). Forest succession relationships are illustrated with the mean ages of “b” ecosite phases of both Natural Subregions. Among these vegetation types, stand age increases as forest succession progresses from an aspen state (both “b2” ecosite phases, 74 and 78 years) to a mixedwood state (both “b3” ecosite phases, 85 and 91 years) and finally towards a pure coniferous state (both “b4” ecosite phases, 115 and 129 years). Note, the “b1” ecosites are commonly influenced by xeric moisture conditions and do not follow a typical forest succession.





PROJECT

JACKPINE MINE EXPANSION &
PIERRE RIVER MINE PROJECT

TITLE

PERCENT OCCURRENCE OF PRIMARY AND SECONDARY TREE SPECIES AMONG TERRESTRIAL AND WETLANDS FOREST VEGETATION IN THE PIERRE RIVER MINING AREA LOCAL STUDY AREA

Shell Canada Limited

PROJECT 05-1344-027.7640			FILE No. Tree Species-PRMA	
DESIGN	AA	21/08/07	SCALE AS SHOWN	REV. 0
CADD	YW	30/08/07	**FIGURE: 3.6-3**	
CHECK	AA	27/11/07		
REVIEW	WES/TC	27/11/07		

L:\2005\1344-OIL SANDS\05-1344-027-Shell Omnibus\7600\7640\Vegetation ESR\Fig 3.6-3 Percent Occurence of Tree Species Among Terrestrial and Wetlands.dwg Nov 28, 2007 - 3:55pm

Table 3.6-3 Percent Distribution of Height, Age and Timber Productivity Rating Classes Within the Pierre River Mining Area Local Study Area

Map Code	Description	Area [ha]	Mean Height, Age and TPR			Percent Distribution by Height Class						Percent Distribution by Age Class [years]								Percent Distribution by Timber Productivity Rating Class			
			Height [m]	Age [years]	TPR[a]	0 to 6	7 to 12	13 to 18	19 to 24	25 to 30	31 to 36	0 to 59	60 to 79	80 to 99	100 to 119	120 to 139	140 to 159	160 to 179	180 to 199	Good	Medium	Fair	Unproductive
Central Mixedwood Natural Subregion Ecosite Phases																							
a1	lichen jack pine	16	16	75	2.6	0	0	100	0	0	0	0	61	39	0	0	0	0	0	58	42	0	0
b1	blueberry jack pine-aspen	242	18	86	2.4	0	1	65	34	0	0	0	16	63	6	15	0	0	0	26	74	0	0
b2	blueberry aspen (white birch)	43	16	74	2.6	0	0	100	0	0	0	0	73	27	0	0	0	0	0	49	51	0	0
b3	blueberry aspen-white spruce	104	19	85	2.6	0	0	23	46	30	0	0	22	32	15	30	0	0	0	49	51	0	0
b4	blueberry white spruce-jack pine	173	21	115	2.5	0	0	6	79	15	0	0	1	6	50	30	14	0	0	47	53	0	0
c1	Labrador tea-mesic jack pine-black spruce	19	13	67	2.3	0	72	28	0	0	0	0	100	0	0	0	0	0	0	28	72	0	0
d1	low-bush cranberry aspen	734	21	85	2.8	0	<1	7	83	10	0	0	21	66	13	1	0	0	0	86	14	0	<1
d2	low-bush cranberry aspen-white spruce	478	18	85	2.5	<1	11	42	33	13	0	4	40	31	11	7	4	3	0	59	33	0	8
d3	low-bush cranberry white spruce	250	22	120	2.4	0	12	17	33	38	0	1	12	13	12	42	14	6	0	39	46	4	11
e1	dogwood balsam poplar-aspen	6	24	115	3.0	0	0	48	0	52	0	0	48	0	0	52	0	0	0	100	0	0	0
e2	dogwood balsam poplar-white spruce	121	18	108	1.7	76	0	3	6	15	0	0	76	1	8	2	13	0	0	4	20	0	76
e3	dogwood white spruce	45	22	131	2.3	4	2	3	4	87	0	0	2	3	8	0	0	87	0	3	97	0	0
f1	horsetail balsam poplar-aspen[b]	4	1	0	0.0	100	0	0	0	0	0	100	0	0	0	0	0	0	0	0	0	0	100
f2	horsetail balsam poplar-white spruce	4	12	73	1.8	2	72	12	13	0	0	2	12	72	0	0	13	0	0	2	25	0	72
f3	horsetail white spruce	7	13	90	2.0	0	0	100	0	0	0	0	0	100	0	0	0	0	0	0	100	0	0
g1	Labrador tea-subhygric black spruce-jack pine	12	10	80	0.5	14	36	49	0	0	0	0	17	83	0	0	0	0	0	0	49	0	51
h1	Labrador tea/horsetail white spruce-black spruce	118	14	95	1.7	0	38	51	12	0	0	0	2	72	0	26	0	0	0	12	59	0	29
Athabasca Plain Natural Subregion Ecosite Phases																							
a1	bearberry jack pine	2,740	16	85	2.4	0	<1	92	8	0	0	<1	66	25	5	1	0	4	0	35	65	<1	0
b1	Canada buffalo-berry–green alder jack pine-aspen-white birch	2,922	17	83	2.4	<1	<1	77	23	<1	0	<1	47	36	8	2	0	7	0	41	59	<1	0
b2	Canada buffalo-berry–green alder aspen	2,151	18	78	2.5	0	1	51	49	0	0	0	47	52	1	<1	0	0	0	61	38	1	0
b3	Canada buffalo-berry–green alder aspen-white spruce-black spruce	1,728	18	91	2.2	1	9	51	23	14	<1	1	44	31	8	5	9	2	0	48	44	<1	8
b4	Canada buffalo-berry–green alder white spruce-black spruce-jack pine	927	23	129	2.3	0	2	18	42	33	5	0	8	10	11	24	16	30	1	27	72	1	0
c1	Labrador tea-mesic jack pine-black spruce	60	14	73	1.9	6	36	48	10	0	0	0	77	23	0	0	0	0	0	39	27	0	34
d1	Labrador tea-subhygric black spruce-jack pine	130	10	82	0.0	3	95	3	0	0	0	0	43	43	10	3	0	0	0	0	0	0	100
e1	willow/horsetail aspen-white birch-balsam poplar	325	23	104	2.7	0	5	10	30	55	0	5	1	29	17	32	6	0	10	68	32	0	0
e2	willow/horsetail aspen-white spruce-black spruce	404	18	109	1.8	<1	30	21	34	15	0	<1	6	45	22	14	10	<1	3	32	38	<1	29
e3	willow/horsetail white spruce-black spruce	307	13	101	1.0	9	47	9	17	19	0	0	9	35	23	13	3	17	0	11	31	3	54
PJ-Lt Comp	jack pine-tamarack complex	3	14	90	2.0	0	0	100	0	0	0	0	0	100	0	0	0	0	0	0	100	0	0
Forested and Wooded Wetlands																							
BFNN	forested bog	73	7	73	0.0	35	65	0	0	0	0	0	60	40	0	0	0	0	0	0	0	0	100
BTNN	wooded bog	1	6	79	0.0	60	39	<1	0	0	0	1	54	37	7	0	0	0	0	0	0	0	100
FTNN	wooded fen	1,186	9	92	0.0	31	61	8	0	0	0	1	29	35	27	7	1	0	0	0	0	0	100
STNN	wooded swamp	702	11	80	1.1	33	17	47	3	<1	0	15	46	26	1	11	<1	1	0	2	43	13	42
Non-Forested Wetlands																							
BONS	shrubby bog	905	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
FONG	graminoid fen	69	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
FONS	shrubby fen	1,580	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
FOPN	open patterned fen	146	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MONG	marsh	372	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SONS	shrubby swamp	517	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
WONN	shallow open water	57	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Miscellaneous Vegetation Types																							
Me	meadow	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sh	shrubland	87	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Non-Vegetation Types																							
Lake	lake	84	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
River	river	263	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sand	sand	41	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Disturbances																							
CC	cutblock	535	0	2	2.8	0	0	0	0	0	0	100	0	0	0	0	0	0	0	93	7	0	0
DIS	disturbance	439	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

[a] Timber Productivity Rating (TPR) values: 0 = unproductive (including all black spruce and tamarack leading stands); 1 = fair; 2 = moderate; 3 = good.

[b] The area for the horsetail balsam poplar-aspen (f1) ecosite was reclassed based on detailed plot data. The AVI data does not match the re-interpreted class.

– = Not applicable.

A timber productivity rating of good, medium, fair or unproductive is assigned to all forested stands and cutblocks within the AVI. All stands with leading black spruce or tamarack were assigned an unproductive rating because they are not typically harvested. The highest mean timber productivity was attributed to the Central Mixedwood dogwood balsam poplar-aspen (e1) ecosite phase followed closely by the low-bush cranberry aspen (d1) ecosite phase (Table 3.6-3). The lowest timber productivity for a terrestrial vegetation type was associated with the Central Mixedwood Labrador tea–subhygric black spruce-jack pine (g1) and Athabasca Plain Labrador tea–subhygric black spruce-jack pine (d1) ecosite phases. Forested wetlands tended to unproductive because they are usually dominated by black spruce or tamarack.

Some wooded swamps are classed to Forest Capability Class 3 or 4 (i.e., timber productive), possibly due to well decomposed organic horizons that provide a source of nutrients, as well as having adequate soil aeration for at least a portion of the growing season (refer to the Soil Environmental Setting Report (Section 2) for additional information).

The variation in canopy height among all forested terrestrial vegetation and wetlands types is shown in Figure 3.6-4. The most common height class for terrestrial stands occurs between 13 and 18 m. Among treed wetlands, most stands occur within either the 0 to 6 m or the 7 to 12 m height classes.

The range of age classes among all forested terrestrial vegetation and wetlands types is also shown in Figure 3.6-4. The greatest proportion of both terrestrial vegetation and wetlands has a stand age that ranges between 60 and 99 years. More details on the occurrence of old growth forests within the PRMA LSA are provided in Section 3.6.3.1.

3.6.1.4 Rare Plants

This section documents the occurrences of rare vascular plants, bryophytes and lichen species within the PRMA LSA. Relative to previous Shell projects, there are a higher number of rare plants listed here. A change in methodology resulted in an increase in bryophyte and lichen samples collected compared to previous projects and expert bryologists and lichenologists were available to identify the high number of collections. Rare plants found in parts of the PRMA LSA surveyed in previous years were also included in the rare species lists provided. Thus, the record of more rare plant species likely reflects the change in methodology rather than a change in the presence of rare species in the particular study area.

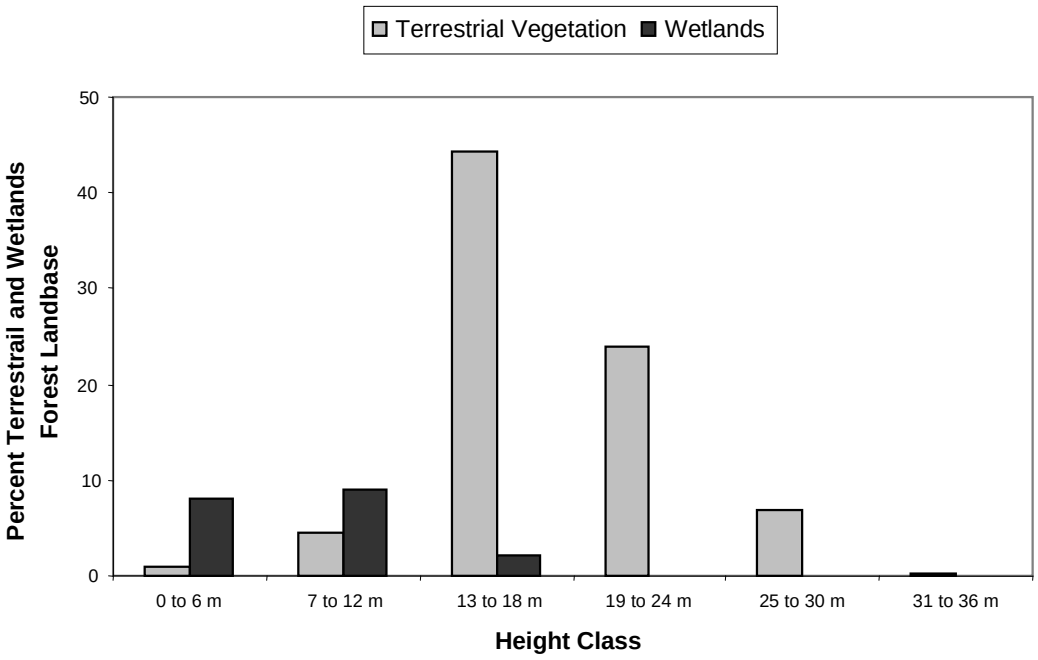
Rare Vascular Plant Species

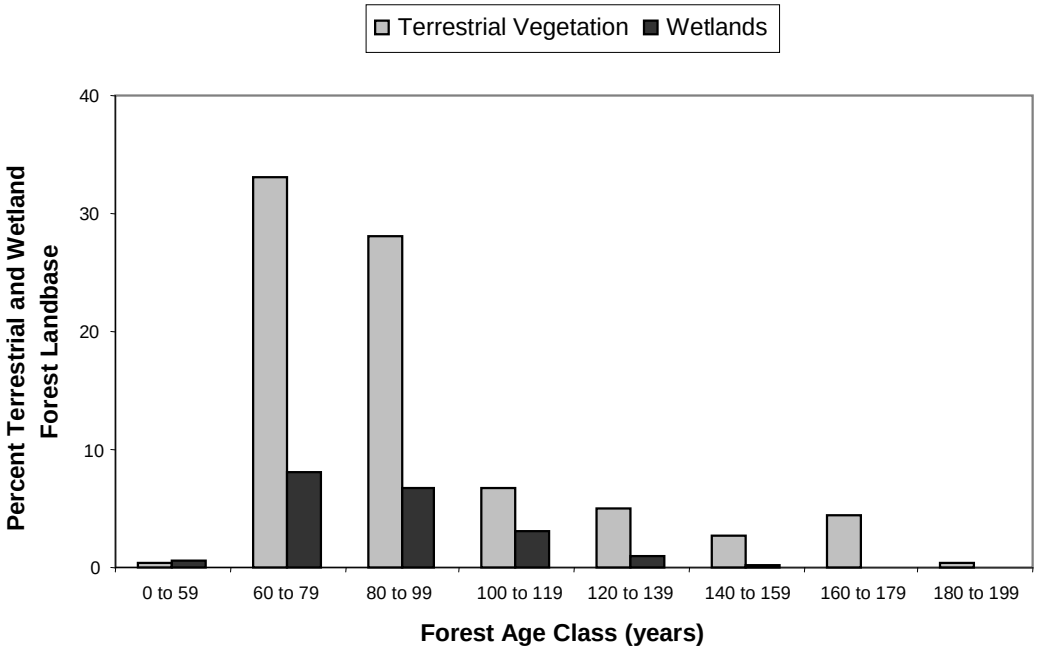
There were six rare vascular plant species observed within the PRMA LSA at a total of eight different sites (Figure 3.6-5, Table 3.6-4 and Appendix N). Four of these species are from the ANHIC Tracking List and two species are from the Watch List (Gould 2006). Additionally, three occurrences of large white-flowered ground cherry (*Leucophysalis grandiflora*) were found; this species has not been previously recorded in Alberta (ANHIC 2006d).

The species on the Tracking List observed within the PRMA LSA have also been observed within the RSA, either previously (ANHIC 2006d) or during PRMA fields surveys, but outside the LSA. Pitcher-plant (*Sarracenia purpurea*) and stemless lady's-slipper (*Cypripedium acaule*) were documented most often in the RSA, with 20 and 8 populations being reported, respectively.

Table 3.6-4 provides a list of all rare vascular plants species found within the PRMA LSA (Figure 3.6-5). The ANHIC rank indicates the “rarity” of the species, globally and within the province. Refer to Section 3.3.6.3 for more information on rare plant status rankings. The vegetation type(s) associated with a rare plant indicates the characteristic ecosite phase, wetlands type or miscellaneous vegetation type where the species was found. Associated site numbers are also provided so that the species can be located (Figure 3.6-5 and Appendix N). The total number of populations recorded within the LSA is based on results from the 2006 and 2007 surveys for the Project.

Note that many of the rare plant habitat descriptions were interpreted as Central Mixedwood Natural Subregion ecosite phases, even if falling in the Athabasca Plain Natural Subregion. As the PRMA LSA is found at the southernmost edge of the Athabasca Plains Natural Subregion, often survey information indicated that the area was transitionary between the two Natural Subregions. Therefore, ecosite phase interpretation followed the classification description most appropriate based on on-the-ground field survey observations. Appendix H provides descriptions of each species characteristic vegetation type and distribution ranges.





PROJECT

JACKPINE MINE EXPANSION &
PIERRE RIVER MINE PROJECT

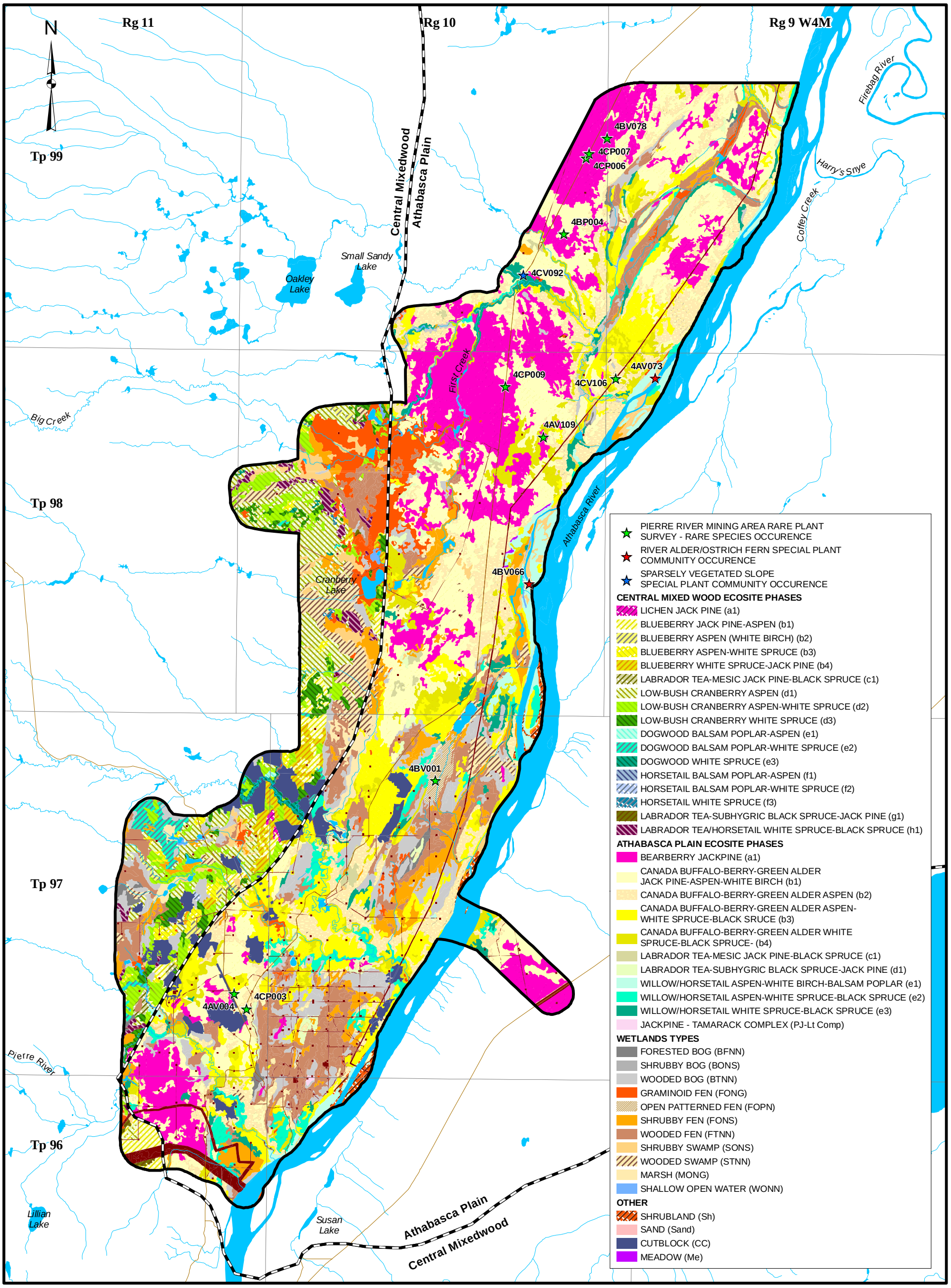
TITLE

PERCENT VARIABILITY IN CANOPY HEIGHT AND STAND AGE BETWEEN TERRESTRIAL AND WETLANDS FOREST VEGETATION IN THE PIERRE RIVER MINING AREA LOCAL STUDY AREA

Shell Canada Limited

PROJECT 05-1344-027.7640			FILE No.	Height+Age-JEMA
DESIGN	AA	21/08/07	SCALE AS SHOWN	REV. 0
CADD	YW	28/08/07	**FIGURE: 3.6-4**	
CHECK	AA	27/11/07		
REVIEW	WES/TC	27/11/07		

L:\2005\1344-OIL SANDS\05-1344-027-Shell Omnibus\7600\7640\Vegetation ESR\Fig 3.6-4 Percent Variability in Canopy Height and Stand Age Between Terrestrial and Wetlands.dwg Nov 28, 2007 - 4:00pm



LEGEND

- PIERRE RIVER MINING AREA
- LOCAL STUDY AREA
- OPEN WATER
- PUBLIC ROADWAY

DISTURBED

- EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE
- EXISTING AND APPROVED URBAN AND INDUSTRIAL LINEAR DISTURBANCE
- NATURAL SUBREGION

DRAFT

REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2004), and Alberta SRD, used under license.
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 12.

2.5 0 2.5
SCALE 1:100,000 KILOMETRES

PROJECT
JACKPINE MINE EXPANSION & PIERRE RIVER MINE PROJECT

TITLE RARE VASCULAR PLANT SPECIES AND SPECIAL PLANT COMMUNITIES IDENTIFIED WITHIN THE PIERRE RIVER MINING AREA LOCAL STUDY AREA

Shell Canada Limited

PROJECT No. 05-1344-027.7600			SCALE AS SHOWN	REV. 0
DESIGN	AA	27 Aug. 2007		
GIS	JH	14 Nov. 2007		
CHECK	AA	20 Nov. 2007		
REVIEW	TC	27 Nov. 2007		

FIGURE: 3.6-5

Project: I:\CLIENTS\SHELL\05-1344-027\mapping\mxd\veg\DRAFT\pierreriver\bl_ecosite_rare_vascular_plants_pr.mxd Plot: ?J\2005\GIS\ArcMapTemplates\templates\v91\MyProject.pdf?

Table 3.6-4 Rare Vascular Plant Species Observed Within the Pierre River Mining Area Local Study Area

Common Name and Scientific Name	ANHIC Rank[a]	COSEWIC (2005) Status	Vegetation Type Within the LSA[b]	Site Number	Number of Populations Recorded in the LSA	Number of Populations Reported in the RSA[c]
Tracking List						
northern slender ladies'-tresses *(Spiranthes lacera)*	S1 G5	May be at risk	b4	4BP004	1	3 (2)
umbellate sedge *(Carex umbellata)*	S1 G5	Undetermined	a1	4CP006	1	1
pitcher plant *(Sarracenia purpurea)*	S2 G5	Sensitive	FOPN	4BV001	1	20 (23)
stemless lady's-slipper *(Cypripedium acaule)*	S3 G5	Sensitive	a1, b4	4AV109, 4BV078	2	8 (1)
Watch List[d]						
goldthread (Coptis trifolia)	S3 G5	Secure	b1, d2	4AV004, 4CP003	2	0
hairy-fruited sedge *(Carex lasiocarpa)*	S4 G5	Secure	WONN	4CV106	1	1 (18)
Unranked[e]						
large white-flowered ground cherry *(Leucophysalis grandiflora*)	not ranked	Not assessed	a1 (AP)	4CP006, 4CP009	2	1 (0)

(a) Rare plant status ranks according to the Alberta Heritage Information Centre (Gould 2006); G = global; S = Alberta.

(b) Ecosites phases reported follow Central Mixedwood or Athabasca Plain descriptions, according to the best on-the-ground fit. Therefore, despite which Natural Subregion the plot location falls in, all ecosite phases refer to Central Mixedwood descriptions unless otherwise indicated as Athabasca Plain (AP).

(c) Numbers of rare vascular plant populations within the RSA is based on historical data from the Alberta Natural Heritage Information Centre (ANHIC 2006d) and contributing data from the 2006/2007 vegetation and rare plant surveys of the PRMA program that located the listed species outside of the PRMA Local Study Area. The number in brackets indicates occurrences found during the 2006 JEMA vegetation and rare plant surveys, and are in addition to the RSA tally.

(d) The number of occurrences of species on the ANHIC Watch List at the RSA level has not been presented as these species are not mapped by ANHIC (Rintoul 2007, pers. comm.).

(e) Species not on the ANHIC complete vascular plant element list (ANHIC 2006c).

Rare Bryophyte Species

There were two rare bryophyte species observed within the PRMA LSA (Figure 3.6-6, Table 3.6-5 and Appendix N). One of these species is from the ANHIC Tracking List and the other is from the Watch List (Gould 2006). None of the species found on the Tracking List or Watch List have been reported within the RSA (ANHIC 2006d).

Table 3.6-5 provides a list of all bryophyte species found within the PRMA LSA and the RSA. The ANHIC rank indicates the "rarity" of the species, globally and within the province. Refer to Section 3.3.6.2 for more information on rare plant status rankings. The vegetation type(s) associated with a rare bryophyte indicates the characteristic ecosite phase, wetlands type or miscellaneous vegetation type where the species was found. Associated site numbers are also provided so that the species can be located (Figure 3.6-6 and Appendix N). The total number of populations recorded within the LSA is based on results from the 2006 and 2007

surveys for the Project. Appendix H provides descriptions of each species characteristic vegetation type or microhabitat and distribution ranges.

Table 3.6-5 Rare and Unranked Bryophyte Species Observed Within the Pierre River Mining Area Local Study Area

Common Name and Scientific Name	ANHIC Rank[a]	COSEWIC Status (2005)	Vegetation Type Within the LSA[b]	Site Number	Number of Populations Recorded in the LSA	Number of Populations Reported in the RSA[c]
Tracking List						
Muller's liverwort *(Calypogeia muelleriana)*	SNR G5	not assessed	BTNN	4AV021	1	0
Unranked in Alberta[d]						
cedar shake liverwort (Plagiochila porelloides)	–	not assessed	h1, BTNN	4AV005, 4AV021	2	0 (2)

[a] Rare plant status ranks according to the Alberta Heritage Information Centre (Gould 2006); G = global; S = Alberta. – = Not ranked.

[b] Ecosites phases reported follow Central Mixedwood or Athabasca Plain descriptions, according to the best on-the-ground fit. Therefore, despite which Natural Subregion the plot location falls in, all ecosite phases refer to Central Mixedwood descriptions unless otherwise indicated as Athabasca Plain (AP).

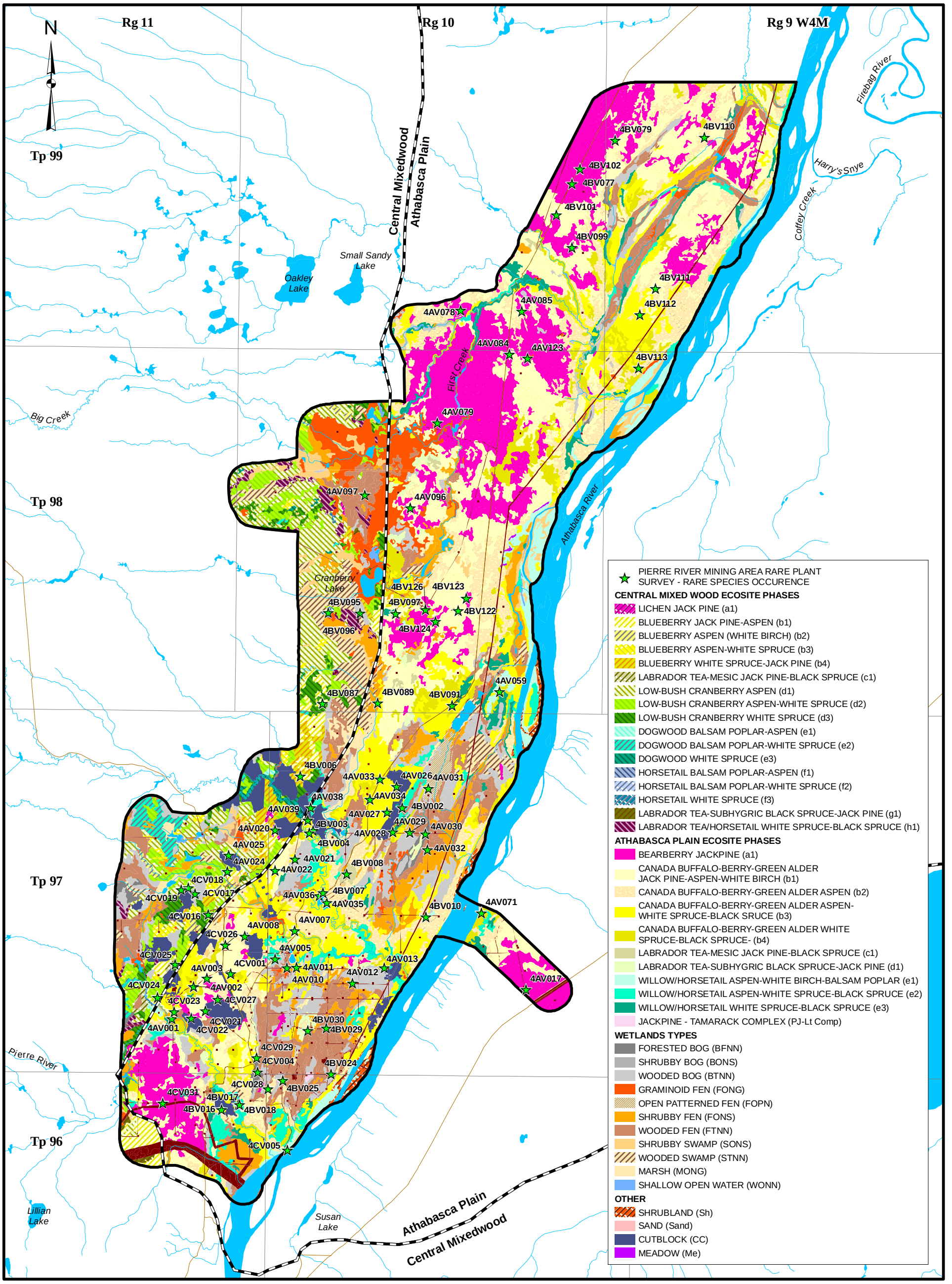
[c] Numbers of rare bryophytes within the RSA is based on historical data from the ANHIC (2006d) and contributing data from the 2006/ 2007 vegetation and rare plant surveys of the PRMA program that located the listed species outside of the PRMA Local Study Area. The number in brackets indicates occurrences found during the 2006 JEMA vegetation and rare plant surveys, and are in addition to the RSA tally.

[d] Species not on the ANHIC complete bryophyte element list (ANHIC 2006a). Many of these species are unranked globally and with incomplete known ranges (NatureServe 2006, website).

Rare Lichen Species

There were 37 rare lichen species observed at a total of 228 sites within the PRMA LSA (Figure 3.6-6, Table 3.6-6, Appendix N). Of these species, 13 are included on the ANHIC Tracking List (Gould 2000). Twenty-four species are yet unranked by Alberta (Gould 2000; ANHIC 2006b). Only three of the 37 lichens have been reported previously within the RSA (ANHIC 2006d). COSEWIC (2007) does not list any of the listed lichen species (Table 3.6-6) and therefore they are categorized as *not assessed*.

The relatively high number of rare lichens documented within the PRMA LSA is due in part to the high number of samples collected for the project. In addition, the lichen flora of Alberta is poorly known, especially in the north and eastern portions of the province (Goward 2007, pers. comm). Thus, benchmark information for the region is generally lacking, and there is little information on lichen species presence and abundance to compare with data collected for the Project.



LEGEND

- PIERRE RIVER MINING AREA LOCAL STUDY AREA
- OPEN WATER
- PUBLIC ROADWAY

DISTURBED

- EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE
- EXISTING AND APPROVED URBAN AND INDUSTRIAL LINEAR DISTURBANCE
- NATURAL SUBREGION

2.5 0 2.5
SCALE 1:100,000 KILOMETRES

REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2004), and Alberta SRD, used under license.
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 12.

PROJECT
JACKPINE MINE EXPANSION & PIERRE RIVER MINE PROJECT

TITLE
RARE NON-VASCULAR PLANTS IDENTIFIED WITHIN THE PIERRE RIVER MINING AREA LOCAL STUDY AREA

Shell Canada Limited

PROJECT No. 05-1344-027.7600			SCALE AS SHOWN	REV. 0
DESIGN	AA	27 Aug. 2007	FIGURE: 3.6-6	
GIS	JH	14 Nov. 2007		
CHECK	AA	20 Nov. 2007		
REVIEW	TC	27 Nov. 2007		

Project: I:\CLIENTS\SHELL\05-1344-027\mapping\mxd\veg\DRAFT\pierreriver\bl_ecosite_rare_NonVascular_plants_pr.mxd Plot: ?J:\2005\GIS\ArcMapTemplates\templatesv91\MyProject.pdf?

Similar results have been noted in other jurisdictions. For example, the Wisconsin State University has compiled a list of 166 lichens that appear rare; however, the genera have been poorly surveyed and so are thought to be undercollected in the state (Thomson and Will-Wolf 2000, website). The United States National Parks also found many lichen species within their national park system (79 species) that were not listed in the North American Checklist (Esslinger 2006, website; USGS 2007, website). These examples illustrate that lichens as a group are undercollected, at least in certain regions, which has resulted in lack of species presence, abundance and distribution information.

Table 3.6-6 provides a list of all lichen species found within the PRMA LSA. The ANHIC rank indicates the "rarity" of the species, globally and within the province. Refer to Section 3.3.6.2 for more information on rare plant status rankings. The vegetation type(s) associated with a rare lichen indicates the characteristic ecosite phase, wetlands type or miscellaneous vegetation type where the species was found. Associated site numbers are also provided so that the species can be located (Figure 3.6-6). The total number of occurrences recorded within the PRMA LSA is based on results from the 2006 and 2007 surveys for the Project. The number of occurrences reported in the RSA is based on historical ANHIC records. Appendix H provides descriptions of each species characteristic vegetation type or microhabitat and distribution ranges.

Table 3.6-6 Rare and Unranked Lichen Species Observed Within the Pierre River Mining Area Local Study Area

Common Name and Scientific Name	ANHIC Rank[(a)]	COSEWIC (2005) Status	Vegetation Type Within the LSA[(b)]	Site Number	Number of Populations Recorded in the LSA	Number of Populations Reported in the RSA[(c)]
Tracking List						
Lecanora subintricata (no common name)	S1 G?	not assessed	a1, b1, b2, b4, c1, d2, f2, g1, BFNN, BTNN, FONS, FTNN, FTPN	4AV001, 4AV010, 4AV020, 4AV021, 4AV027, 4AV030, 4AV031, 4AV032, 4AV038, 4BV008, 4CV019, 4CV021, 4CV022, 4CV023, 4CV024, 4CV026, 4CV029, 4CV031	18	1 (29)
Lecidella elaeochroma (no common name)	S1 G?	not assessed	a1, b4, d2, f2, h1, BFNN, BTNN	4AV002, 4AV026, 4AV028, 4AV030, 4BV024, 4CV017, 4CV027	7	1 (13)
Trapeliopsis flexuosa (no common name)	S1 G?	not assessed	b1	4CV021	1	0
Cyphelium tigillare (no common name)	S2 G?	not assessed	FTNN	4AV032	1	1
hooded ramalina *(Ramalina obtusata)*	S2 G?	not assessed	d2	4AV027	1	0
Rinodina metaboliza (no common name)	S2 G?	not assessed	b3, d2, FTNN	4AV008, 4AV024, 4BV030, 4CV024	4	0 (2)

Table 3.6-6 Rare and Unranked Lichen Species Observed Within the Pierre River Mining Area Local Study Area (continued)

Common Name and Scientific Name	ANHIC Rank[a]	COSEWIC (2005) Status	Vegetation Type Within the LSA[b]	Site Number	Number of Populations Recorded in the LSA	Number of Populations Reported in the RSA[c]
American starburst lichen *(Imshaugia placorodia)*	S2 G3G5	not assessed	a1, b1, c1, a1 (AP), b1 (AP), b4 (AP), BTNN	4AV003, 4AV020, 4AV071, 4AV078, 4AV079, 4AV084, 4AV085, 4AV096, 4AV123, 4BV077, 4BV079, 4BV096, 4BV099, 4BV101, 4BV102, 4BV122, 4BV123, 4BV126, 4CV021, 4CV022, 4CV023, 4CV026, 4CV031, 4CV056	24	20 (6)
alpine kidney lichen *(Nephroma bellum)*	S2 G3G5	not assessed	Sh	4AV035	1	0
punctured ramalina *(Ramalina dilacerata)*	S2 G3G5	not assessed	b1, b2, b3, b4, c1, d1, d2, d3, e2, f2, f3, h1, Sh, FTNN, SONS, b2 (AP)	4AV001, 4AV002, 4AV007, 4AV008, 4AV011, 4AV013, 4AV022, 4AV024, 4AV025, 4AV026, 4AV028, 4AV033, 4AV034, 4AV035, 4BV003, 4BV004, 4BV007, 4BV008, 4BV017, 4BV018, 4BV030, 4BV087, 4BV089, 4BV097, 4CV016, 4CV017, 4CV018, 4CV019, 4CV024, 4CV026, 4CV028	31	7 (12)
Melanelia trabeculata (no common name)	S2? G?	not assessed	b1, d2, d3, FTNN	4AV011, 4AV013, 4AV022, 4AV024, 4BV030, 4CV018, 4CV021	7	0 (6)
old man's beard *(Bryoria simplicior)*	S2S3 G?	not assessed	c1, FONS	4AV010, 4BV008	2	3 (4)
Arthonia patellulata (no common name)	s3? G5	not assessed	c1, d1, d2, SONS, b1 (AP), b2 (AP), b3 (AP)	4AV007, 4AV013, 4AV020, 4AV022, 4AV025, 4AV027, 4BV087, 4BV091, 4BV097, 4BV110, 4BV111, 4BV112, 4BV113, 4BV124, 4BV126	15	10 (6)
Usnea scabiosa (no common name)	SU G?	not assessed	b1, Sh, d1 (AP)	4AV035, 4AV059, 4CV031	3	6
Unranked in Alberta[d]						
Biatora carneoalbida (also *Mycobilimbia carneoalbida* – no common name)	–	not assessed	d1	4BV010	1	0
Candelariella lutella (no common name)	–	not assessed	d1	4AV025, 4CV028	2	0 (1)
smooth–footed powderhorn *(Cladonia ochrochlora)*	–	not assessed	d2	4BV003	1	1
Cliostomum pallens (no common name)	–	not assessed	b1, d2, g1, h1, FTNN	4BV002, 4BV029, 4CV004, 4CV021, 4CV024	5	0 (10)
Lecanora boligera (no common name)	–	not assessed	h1	4BV002	1	0 (5)

Table 3.6-6 Rare and Unranked Lichen Species Observed Within the Pierre River Mining Area Local Study Area (continued)

Common Name and Scientific Name	ANHIC Rank[(a)]	COSEWIC (2005) Status	Vegetation Type Within the LSA[(b)]	Site Number	Number of Populations Recorded in the LSA	Number of Populations Reported in the RSA[(c)]
Lecanora laxa (no common name)	–	not assessed	a1, b1	4AV003, 4CV026	2	1 (3)
Lecanora persimilis (no common name)	–	not assessed	a1, b1, c1, f3	4AV020, 4BV006, 4BV007, 4CV021, 4CV022	5	1 (13)
Lecidea leprarioides (no common name)	–	not assessed	d2	4AV027	1	0 (2)
Lecidea nylanderi (no common name)	–	not assessed	a1, b1, c1, d1, d2, e3, Sh	4AV003, 4AV025, 4AV035, 4AV039, 4BV016, 4CV021, 4CV022, 4CV023, 4CV024, 4CV025, 4CV026	11	0 (4)
Lecidea porphyrospoda (no common name)	–	not assessed	b1	4CV023	1	0
Micarea denigrata (no common name)	–	not assessed	d2	4BV003	1	0 (1)
Micarea prasina (no common name)	–	not assessed	f2	4CV017	1	0
Micarea sylvicola (no common name)	–	not assessed	a1, b2, d2, h1, Sh	4AV035, 4BV002, 4CV016, 4CV019, 4CV027	5	0 (4)
alder needles *(Phaeocalicium compressulum)*	–	not assessed	b1, b4, d1, SONS	4AV007, 4CV001, 4CV026, 4CV028	4	0
Phlyctis argena (no common name)	–	not assessed	a1	4CV027	1	0
Rinodina anomala (no common name)	–	not assessed	d2	4AV027	1	0
Rinodina capensis (no common name)	–	not assessed	SONS	4AV007	1	0
Rinodina disjuncta (no common name)	–	not assessed	b1, b2, d3	4AV026, 4AV033, 4AV034, 4CV016, 4CV021	5	0 (1)
Rinodina orculata (no common name)	–	not assessed	b2, f2, SONS	4AV001, 4AV007, 4CV019	3	1 (1)

Table 3.6-6 Rare and Unranked Lichen Species Observed Within the Pierre River Mining Area Local Study Area (continued)

Common Name and Scientific Name	ANHIC Rank[a]	COSEWIC (2005) Status	Vegetation Type Within the LSA[b]	Site Number	Number of Populations Recorded in the LSA	Number of Populations Reported in the RSA[c]
Scoliciosporum perpusillum (no common name)	–	not assessed	a1, b1, b2, b3, b4, c1, d1, d2, d3, e1, e3, f2, g1, h1, BFNN, BTNI, BTNN, FTNN, FTPN	4AV001, 4AV002, 4AV003, 4AV005, 4AV008, 4AV011, 4AV012, 4AV013, 4AV017, 4AV020, 4AV021, 4AV022, 4AV024, 4AV025, 4AV026, 4AV027, 4AV028, 4AV029, 4AV030, 4AV031, 4AV032, 4AV034, 4AV036, 4AV038, 4AV039, 4BV002, 4BV004, 4BV006, 4BV008, 4BV016, 4BV017, 4BV024, 4BV025, 4CV001, 4CV004, 4CV005, 4CV016, 4CV017, 4CV018, 4CV019, 4CV021, 4CV022, 4CV023, 4CV024, 4CV025, 4CV026, 4CV029, 4CV031	48	1 (76)
Scoliciosporum umbrinum (no common name)	–	not assessed	f2	4AV001	1	0 (3)
alder stickpin *(Stenocybe pullatula)*	–	not assessed	b1, f2, SONS	4AV007, 4BV004, 4CV026	3	1 (1)
variable wrinkle–lichen *(Tuckermannopsis orbata* (also *Cetraria orbata)*	–	not assessed	a1, b1, d2, g1, BTNN, FTNN, STNN	4AV003, 4AV012, 4AV017, 4AV096, 4AV097, 4BV003, 4BV095, 4CV004	8	4 (5)
Usnea angulata (no common name)	–	not assessed	e3	4AV039	1	0

[a] Rare plant status ranks according to the Alberta Heritage Information Centre (Gould 2006); G = global; S = Alberta; - = Not ranked.

[b] Ecosites phases reported follow Central Mixedwood or Athabasca Plain descriptions, according to the best on-the-ground fit. Therefore, despite which Natural Subregion the plot location falls in, all ecosite phases refer to Central Mixedwood descriptions unless otherwise indicated as Athabasca Plain (AP).

[c] Numbers of rare vascular plant populations within the RSA is based on historical data from the Alberta Natural Heritage Information Centre (ANHIC 2006d) plus contributing data from the 2006/2007 vegetation and rare plant surveys of the PRMA program that located the listed species outside of the PRMA Local Study Area. The figure in the brackets indicates occurrences found during the 2006 JEMA vegetation and rare plant surveys, and are in addition to the RSA tally.

[d] Species unranked in Alberta and no occurrences reported in Alberta by ANHIC (ANHIC 2006b). Many of these species are unranked globally and with incomplete known ranges (NatureServe 2006, website).

3.6.1.5 Rare and Special Plant Communities

Rare and special plant communities were selected as community-level vegetation KIRs because of their ecological and social importance, and vulnerability to disturbance.

Rare Plant Communities

No rare plant communities were observed within the PRMA LSA during field surveys. This finding was later verified through a comparison of sites surveyed with those listed in the Preliminary Ecological Community Tracking List (Allen 2006).

Special Plant Communities

Two special plant communities were observed within the PRMA LSA (Table 3.6-7). Special plant communities are not included on ANHIC's Tracking List because of a lack of information. Therefore, documenting the presence of these plant communities is important to facilitate a status assessment in the future. Based on the data available, confirmation on the special status of the communities listed here was provided by Lorna Allen (Allen 2007, pers. comm.). Descriptions of the communities and habitats they occur in are provided below and their locations are provided in Figure 3.6-5.

Two of the special plant communities (river alder/ostrich fern and sparsely vegetated slope or sandy bank) are uncommon within the PRMA LSA. The sites that were identified during field surveys were too small to map at the PRMA LSA scale. Descriptions of these two special plant communities are provided below.

Table 3.6-7 Special Plant Communities Within the Pierre River Mining Area Local Study Area

Special Plant Community		Vegetation Type	Site Number
Scientific Name	Common Name		
Alnus incana ssp. tenuifolia/ Matteuccia struthiopteris	river alder/ostrich fern	Riparian shrubland (RiSh)	4AV073, 4BV066
Not applicable	sandy bank	Sparsely vegetated slope (SpS)	4CV092

River Alder/Ostrich Fern Special Plant Community

River alder/ostrich fern communities were encountered along the west bank of the Athabasca River within the PRMA LSA (Photo 5), and were also observed on islands within the river itself. Due to the community's close proximity to the Athabasca River in association with fluvial-deposited soil, the habitat is subject to intermittent flooding and fluctuating groundwater levels. Moisture conditions were found to be hygric, while the nutrient regime is considered to be rich. Two detailed vegetation plots were conducted within this special plant community type.

Vegetation cover was recorded as being dominated by two main species. River alder (*Alnus incana* ssp. *tenuifolia*) was present as the dominant tree canopy species at 45% cover, while contributing heavily to the tall shrub cover at 70%. Ostrich fern (*Matteuccia struthiopteris*) was the other prevalent species and dominated the forb layer at a cover class of about 85%. Due to the heavy cover of these two species, available light to the forest floor was minimal (Photo 6), preventing other species from establishing. See the species list in Appendix N for a full species listing and average percent cover.

Photo 5 River Alder/Ostrich Fern Special Plant Community (Site 4AV073)

Photo 6 River Alder/Ostrich Fern Special Plant Community Understorey Ground Cover (Site 4AV073)

Sparsely Vegetated Slope

A vegetation plot (4CV092) was established on a bank of exposed sand adjacent to the main trunk road within the PRMA LSA (Figure 3.6-5). With an east-facing slope of about 40%, the sandy substrate creates a very xeric moisture regime for which plants to take root (Photo 7). Therefore, few species were found and in very little percent coverages. Sparse low shrubs of aspen (*Populus tremuloides*) provided the maximum coverage of the plot at only 2%, while mixed grass species such as foxtail barley (*Hordeum jubatum*) and hairy wild rye (*Leymus innovatus*) were present in trace amounts (less than 1%). Only six forb species were found including: plains wormwood (*Artemesia campestris*) purple milk vetch (*Astragalus agrestis*), spreading dogbane (*Apocynum androsaemifolium*) and mustard family species that were present only in trace amounts as well.

Photo 7 Sparsely Vegetated Slope Shown as a Sandy Bank Within the Pierre River Mining Local Study Area

3.6.1.6 Species Diversity and Richness

Plant species were distributed across 28 ecosite phases (Central Mixedwood and Athabasca Plain types), 11 wetlands types, two miscellaneous vegetation types and five non-vegetated or disturbance types within the PRMA LSA. In total, 564 plant species were identified within the PRMA LSA. This includes 68 woody species (trees and shrubs), 187 forbs, 71 graminoids, 84 terrestrial bryophytes, 60 terrestrial lichens and 94 epiphytes (primarily lichens but including bryophytes as well).

Species diversity measures calculated by vegetation type are as follows and detailed below:

- total number of vascular species;
- total number of rare vascular species;
- total number of vascular species unique to ecosite phase or wetlands type; and
- mean number of species (species richness).

Total Number of Vascular Species

The number of vascular plant species among vegetation types was calculated as one measure of species diversity. The greatest numbers of vascular plant species occurred within the Central Mixedwood low-bush cranberry aspen-white spruce (d2) ecosite phase which accounted for 115 species, or 39% of all vascular plants recorded within the PRMA LSA (Table 3.6-8). This was followed closely by the Athabasca Plain Canada buffalo-berry–green alder jack pine-aspen-white birch (b1) ecosite phase (94 species) and the wooded swamp (STNN) wetlands type (83 species).

The lowest numbers of vascular plant species were within the riparian shrubland (RiSh) type (representing the river alder/ostrich fern special plant community) at six vascular species. In this type, the dense cover of ostrich fern limited the ability of competitors on the forest floor.

Total Number of Rare Vascular Species

The highest numbers of rare vascular species were found in the Athabasca Plain bearberry jack pine (a1) ecosite phase with three rare vascular species (Table 3.6-8).

Table 3.6-8 Diversity Measures of Vascular Plant Species Within the Pierre River Mining Area Local Study Area

Map Code	Description	Number of Sites in LSA[(a)]	Number of Vascular Species	Percent of All Vascular Species	Number of Rare Vascular Species	Number of Vascular Species Unique to Vegetation Type
Central Mixedwood Natural Subregion Ecosite Phases						
a1	lichen jack pine	3	25	9	0	1
b1	blueberry jack pine-aspen	10	49	17	1	1
b2	blueberry aspen (white birch)	1	14	5	0	0
b3	blueberry aspen-white spruce	2	44	15	0	0
b4	blueberry white spruce-jack pine	4	45	15	0	3
c1	Labrador tea-mesic jack pine-black spruce	3	36	12	0	1
d1	low-bush cranberry aspen	26	76	26	0	2
d2	low-bush cranberry aspen-white spruce	47	115	39	1	16
d3	low-bush cranberry white spruce	13	84	29	0	5
e1	dogwood balsam poplar-aspen	1	24	8	0	1
e2	dogwood balsam poplar-white spruce	3	42	14	0	0
e3	dogwood white spruce	6	79	27	0	9
f1	horsetail balsam poplar-aspen	2	33	11	0	0
f2	horsetail balsam poplar-white spruce	8	70	24	0	5
f3	horsetail white spruce	7	71	24	0	5
g1	Labrador tea-subhygric black spruce-jack pine	4	32	11	0	1
h1	Labrador tea/horsetail white spruce-black spruce	4	30	10	0	0

Table 3.6-8 Diversity Measures of Vascular Plant Species by Ecosite Phase and Wetlands Type Within the Pierre River Mining Area Local Study Area (continued)

Map Code	Description	Number of Sites in LSA[(a)]	Number of Vascular Species	Percent of All Vascular Species	Number of Rare Vascular Species	Number of Vascular Species Unique to Vegetation Type
Athabasca Plain Natural Subregion Ecosite Phases						
a1	bearberry jack pine	30	58	20	3	4
b1	Canada buffalo-berry–green alder jack pine-aspen-white birch	47	94	32	0	16
b2	Canada buffalo-berry–green alder aspen	18	66	23	0	4
b3	Canada buffalo-berry–green alder aspen-white spruce-black spruce	10	67	23	0	1
b4	Canada buffalo-berry–green alder white spruce-black spruce-jack pine	12	71	24	2	4
c1	Labrador tea-mesic jack pine-black spruce	4	37	13	0	0
d1	Labrador tea-subhygric black spruce-jack pine	4	47	16	0	5
e1	willow/horsetail aspen-white birch-balsam poplar	5	45	15	0	2
e2	willow/horsetail aspen-white spruce-black spruce	1	17	6	0	0
e3	willow/horsetail white spruce-black spruce	0	0	0	0	0
PJ-Lt Comp	jack pine-tamarack complex	0	0	0	0	0
Wetlands						
BFNN	forested bog	1	12	4	0	0
BONS	shrubby bog	0	0	0	0	0
BTNI	wooded bog with raised islands of forested peat plateau	1	9	3	0	0
BTNN	wooded bog	20	67	23	0	9
FFNN	forested fen	1	10	3	0	0
FONG	graminoid fen	3	22	8	0	2
FONS	shrubby fen	6	37	13	0	2
FOPN	open patterned fen	1	12	4	1	4
FTNN	wooded fen	12	58	20	0	4
FTPN	wooded patterned fen	1	24	8	0	7
MONG	marsh	7	59	20	0	19
SONS	shrubby swamp	13	69	24	0	11
STNN	wooded swamp	19	83	28	0	15
WONN	shallow open water	1	18	6	1	3
Miscellaneous Vegetation Types						
Me	meadow	0	0	0	0	0
Sh	shrubland	1	35	12	0	7
RiSh	riparian shrubland	3	6	2	0	0
SpS	sparsely vegetated slope	1	11	4	0	2
Non-Vegetation Types						
Lake	lake	0	0	0	0	0
River	river	0	0	0	0	0
Sand	sand	0	0	0	0	0
Disturbances						
CC	cutblock	0	0	0	0	0
DIS	disturbance	0	0	0	1	0

[(a)] Includes all detailed vegetation inventory and rare plant survey sites. Number of rare vascular species is within the PRMA LSA only.

Total Number of Unique Species

Graminoid marsh (MONG) had the highest number of unique vascular species (Table 3.6-8), followed closely by the wooded swamp (STNN) and shrubby swamp (SONS) wetlands types (19, 15 and 11 vascular species, respectively).

Mean Species Richness

Species richness for vascular plants, bryophytes and lichens are shown in Table 3.6-9. Overall in the Central Mixedwood, the low-bush cranberry (d), dogwood (e) and horsetail (f) ecosites tended to have among the highest values for vascular species richness (Table 3.6-9, Figure 3.6-7). The Canada buffalo-berry–green alder (b) ecosites had the highest values in the Athabasca Plain Natural Subregion. In addition, the wooded patterned fen (FTPN) wetlands type as well as the shrubland (Sh) and riparian (Ri) vegetation types also had relatively high numbers of vascular plant species. The nutrient-poor, pine- and black spruce-dominated vegetation types (e.g., Central Mixedwood a1, c1 and g1, Athabasca Plain a1 and c1 and bog wetlands types), the riparian shrubland (river alder/ostrich fern special plant community) and the sparsely vegetated slope vegetation type had the lowest values of vascular species richness among all vegetation types.

The highest values for bryophyte species richness tend to be associated with the Central Mixedwood horsetail balsam poplar-white spruce (f2) and Labrador tea/horsetail white spruce-black spruce (h1) ecosite phases, as well as the forested bog (BFNN) and wooded patterned fen (FTPN) wetlands types (Table 3.6-9, Figure 3.6-8). Low values for bryophyte species richness tended to be associated with vegetation types that lack a tree canopy including riparian and shrubland areas, and open wetlands (i.e., MONG, SONS and FOPN).

The highest values for lichen species richness tended to be associated with upland pine-dominated sites including the Central Mixedwood lichen jack pine (a1), Labrador tea–mesic jack pine-black spruce (c1) and Labrador tea/subhygric black spruce-jack pine (g1) ecosite phases (Table 3.6-9, Figure 3.6-9). In wetlands, lichen diversity was highest in forested bogs (BFNN) and wetlands types with defined microhabitats, such as wooded bog with internal lawns (BTNI) and wooded patterned fen (FTPN). The lowest values of lichen species richness are associated dogwood (e) ecosites and wooded swamp (STNN).

Table 3.6-9 Species Richness Within the Pierre River Mining Area Local Study Area

Ecosite Phase/ Wetlands Type	Description	n[a]	Vascular Plant Species Richness				Bryophyte Species Richness				Lichen Species Richness			
Map Code			Mean	St. Dev.[b]	Min.	Max.	Mean	St. Dev.[b]	Min.	Max.	Mean	St. Dev.[b]	Min.	Max.
Central Mixedwood Ecosite Phases														
a1	lichen jack pine	3	15.0	2.0	13	17	5.0	1.0	4	6	28.0	6.6	21	34
b1	blueberry jack pine-aspen	9(6)	19.2	2.5	17	25	4.8	2.0	2	8	22.8	9.6	10	35
b2	blueberry aspen (white birch)	1	14.0	0.0	14	14	4.0	1.4	3	5				
b3	blueberry aspen-white spruce	4(1)	20.5	3.9	17	26	8.0	0.0	8	8	16.0	0.0	16	16
b4	blueberry white spruce-jack pine	4	23.8	3.8	20	27	6.0	2.9	3	10	17.0	5.1	12	24
c1	Labrador tea-mesic jack pine-black spruce	3	17.3	5.0	12	22	5.7	0.6	5	6	22.0	6.9	18	30
d1	low-bush cranberry aspen	25(5,6)	21.9	5.0	10	31	6.2	3.5	3	12	9.2	8.3	1	22
d2	low-bush cranberry aspen-white spruce	46(15)	24.4	4.9	12	35	6.2	3.0	3	13	16.5	7.0	2	27
d3	low-bush cranberry white spruce	13(4)	20.7	7.0	9	29	8.0	1.2	7	9	14.8	6.6	5	19
e1	dogwood balsam poplar-aspen	1	24.0	0.0	24	24	4.0	0.0	4	4	5.0	0.0	5	5
e2	dogwood balsam poplar-white spruce	3(1)	22.7	2.1	21	25	3.0	0.0	3	3	7.0	0.0	7	7
e3	dogwood white spruce	6(1)	27.2	8.5	14	39	7.0	0.0	7	7	15.0	0.0	15	15
f1	horsetail balsam poplar-aspen	2	21.0	15.6	10	32	–	–	–	–	–	–	–	–
f2	horsetail balsam poplar-white spruce	8(4)	22.9	3.0	17	26	8.5	5.4	2	15	18.3	7.4	10	27
f3	horsetail white spruce	7(1)	24.3	5.5	19	35	6.0	0.0	6	6	13.0	0.0	13	13
g1	Labrador tea-subhygric black spruce-jack pine	4(2)	12.0	5.7	6	19	5.0	1.4	4	6	18.0	1.4	17	19
h1	Labrador tea/horsetail white spruce-black spruce	4(3)	12.5	4.8	8	19	9.7	7.1	2	16	16.0	2.6	13	18
Athabasca Plain Ecosite Phases														
a1	bearberry jack pine	30(2,11)	14.7	4.6	3	28	5.0	1.4	4	6	19.3	7.3	8	29
b1	Canada buffalo-berry–green alder jack pine-aspen-white birch	47(7,11)	23.2	4.8	11	32	7.9	2.4	4	12	14.9	4.5	8	21
b2	Canada buffalo-berry–green alder aspen	17(0,2)	24.5	4.6	16	32	–	–	–	–	6.0	1.4	5	7
b3	Canada buffalo-berry–green alder aspen-white spruce-black spruce	10(0,3)	25.2	4.8	19	35	–	–	–	–	17.0	2.0	15	19
b4	Canada buffalo-berry–green alder white spruce-black spruce-jack pine	10(2)	23.0	4.5	18	31	8.5	0.7	8	9	15.5	3.5	13	18
c1	Labrador tea-mesic jack pine-black spruce	4(1,0)	15.0	5.0	8	19	7.0	0	7	7	–	–	–	–
d1	Labrador tea-subhygric black spruce-jack pine	4(0,1)	20.8	6.8	11	26	–	–	–	–	12.0	0	12	12
e1	willow/horsetail aspen-white birch-balsam poplar	5(2)	21.0	8.7	9	30	5.0	2.8	3	7	11.0	2.8	9	13
e2	willow/horsetail aspen-white spruce-black spruce	1(1)	17.0	0.0	17	17	5.0	0	5	5	18	0	18	18

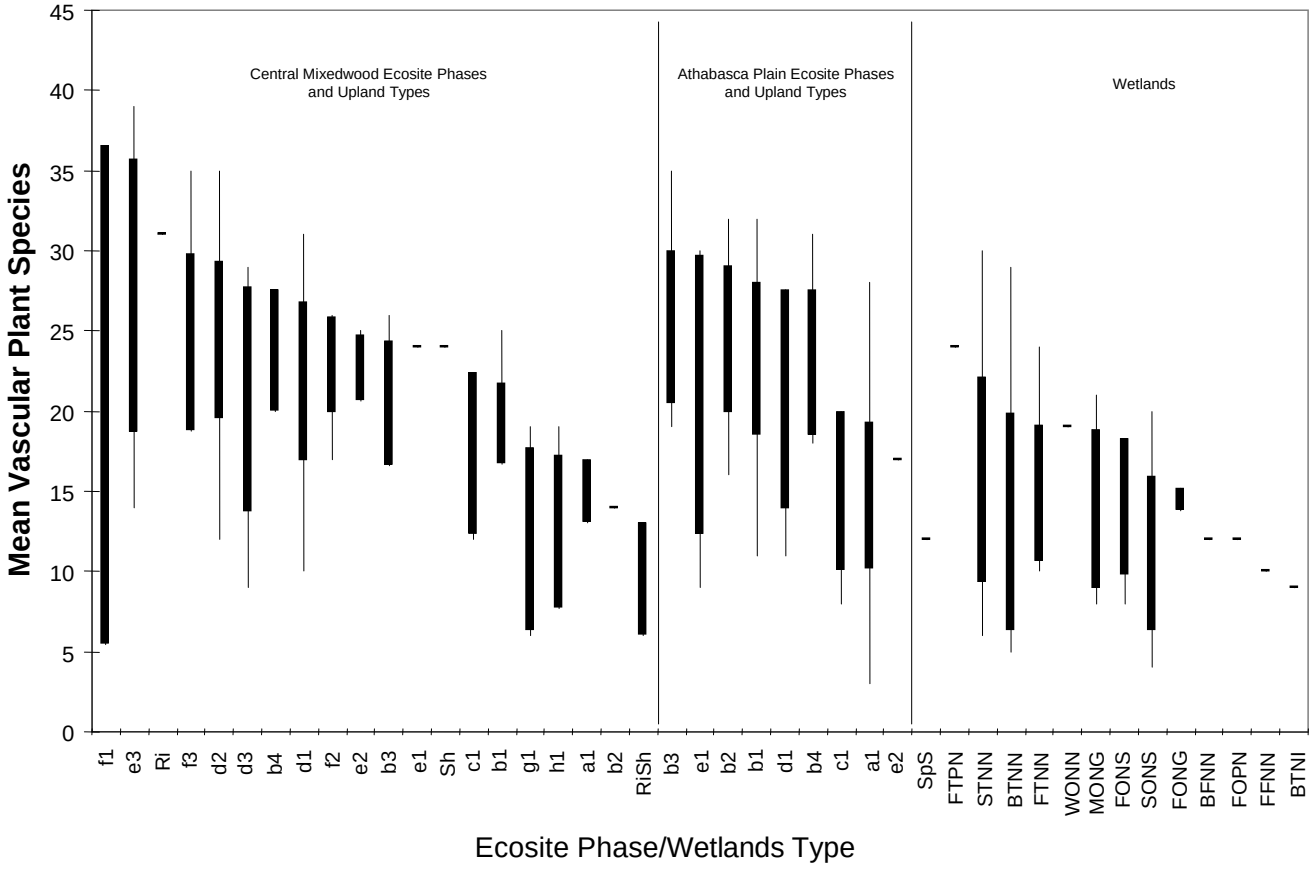
Table 3.6-9 Species Richness Within the Pierre River Mining Area Local Study Area (continued)

Ecosite Phase/ Wetlands Type	Description	n[a]	Vascular Plant Species Richness				Bryophyte Species Richness				Lichen Species Richness			
Map Code			Mean	St. Dev.[b]	Min.	Max.	Mean	St. Dev.[b]	Min.	Max.	Mean	St. Dev.[b]	Min.	Max.
Forested and Wooded Wetlands														
BFNN	forested bog	1	12.0	0.0	12	12	10.0	0.0	10	10	23.0	0.0	23	23
BTNI	wooded bog with internal lawns	1	9.0	0.0	9	9	7.0	0.0	7	7	21.0	0.0	21	21
BTNN	wooded bog	17(7)	13.1	6.8	5	29	7.0	3.0	3	12	16.1	6.8	8	25
FFNN	forested fen	1	10.0	0.0	10	10	–	–	–	–	–	–	–	–
FTNN	wooded fen	12(7)	14.8	4.3	10	24	6.7	2.2	3	9	14.5	3.6	9	19
FTPN	wooded patterned fen	1	24.0	0.0	24	24	11.0	0.0	11	11	17.0	0.0	17	17
STNN	wooded swamp	19(2)	15.7	6.4	6	30	9.0	2.8	7	11	5.5	6.4	1	10
Non-Forested Wetlands														
FONG	graminoid fen	2	14.5	0.7	14	15	–	–	–	–	–	–	–	–
FONS	shrubby fen	4(3,2)	14.0	4.2	8	18	6.0	3.0	3	9	10.0	0.0	10	10
FOPN	open patterned fen	1	12.0	0.0	12	12	3.0	0.0	3	3	8.0	0.0	8	8
MONG	open marsh	7(2,1)	13.9	4.9	8	21	2.5	0.7	2	3	–	–	–	–
SONS	shrubby swamp	13(1)	11.1	4.8	4	20	3.0	0.0	3	3	17.0	0.0	17	17
WONN	shallow open water	1	19.0	0.0	19	19	–	–	–	–	–	–	–	–
Miscellaneous Vegetation Types														
Ri	riparian	1	31.0	0.0	31	31	1.0	0.0	1	1	–	–	–	–
RiSh	riparian shrubland	2	9.5	3.5	7	12	–	–	–	–	–	–	–	–
Sh	shrubland	1	24.0	0.0	24	24	2.0	0.0	2	2	18.0	0.0	18	18
SpS	sparsely vegetated	1	12.0	0.0	12	12	–	–	–	–	–	–	–	–

[a] n = number of detailed vegetation plots. Where there are two numbers shown, the first relates to the number of plots used in calculating vascular species richness. The number shown in parentheses refers to the number of plots used in calculating species richness for bryophytes and lichens as complete non-vascular species lists were not available for some plots.

[b] St. Dev. = standard deviation of the sample mean.

– = No data.



PROJECT

JACKPINE MINE EXPANSION &
PIERRE RIVER MINE PROJECT

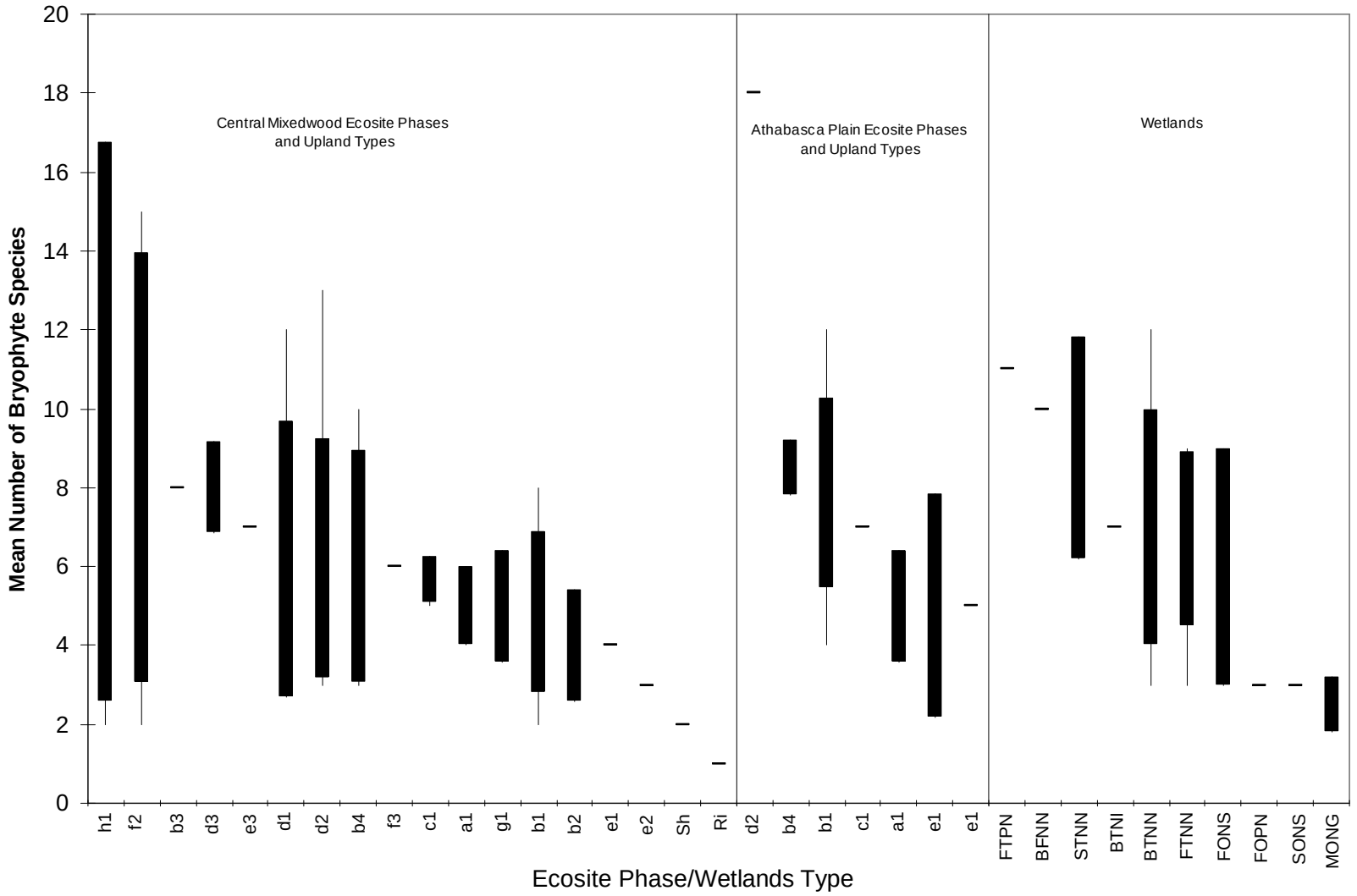
TITLE

VASCULAR PLANT SPECIES RICHNESS BY VEGETATION TYPE WITHIN THE PIERRE RIVER MINING AREA LOCAL STUDY AREA

Shell Canada Limited

PROJECT 05-1344-027.7640			FILE No. Plant Species-PRMA	
DESIGN	AA	21/08/07	SCALE AS SHOWN	REV. 0
CADD	YW	30/08/07	**FIGURE: 3.6-7**	
CHECK	AA	27/11/07		
REVIEW	WES/TC	27/11/07		

L:\2005\1344-OIL SANDS\05-1344-027-Shell Omnibus\7600\7640\Vegetation ESR\Fig 3.6-7 Vascular Plant Species Richness by Vegetation Type Within the Pierre River.dwg Nov 28, 2007 - 4:03pm



PROJECT

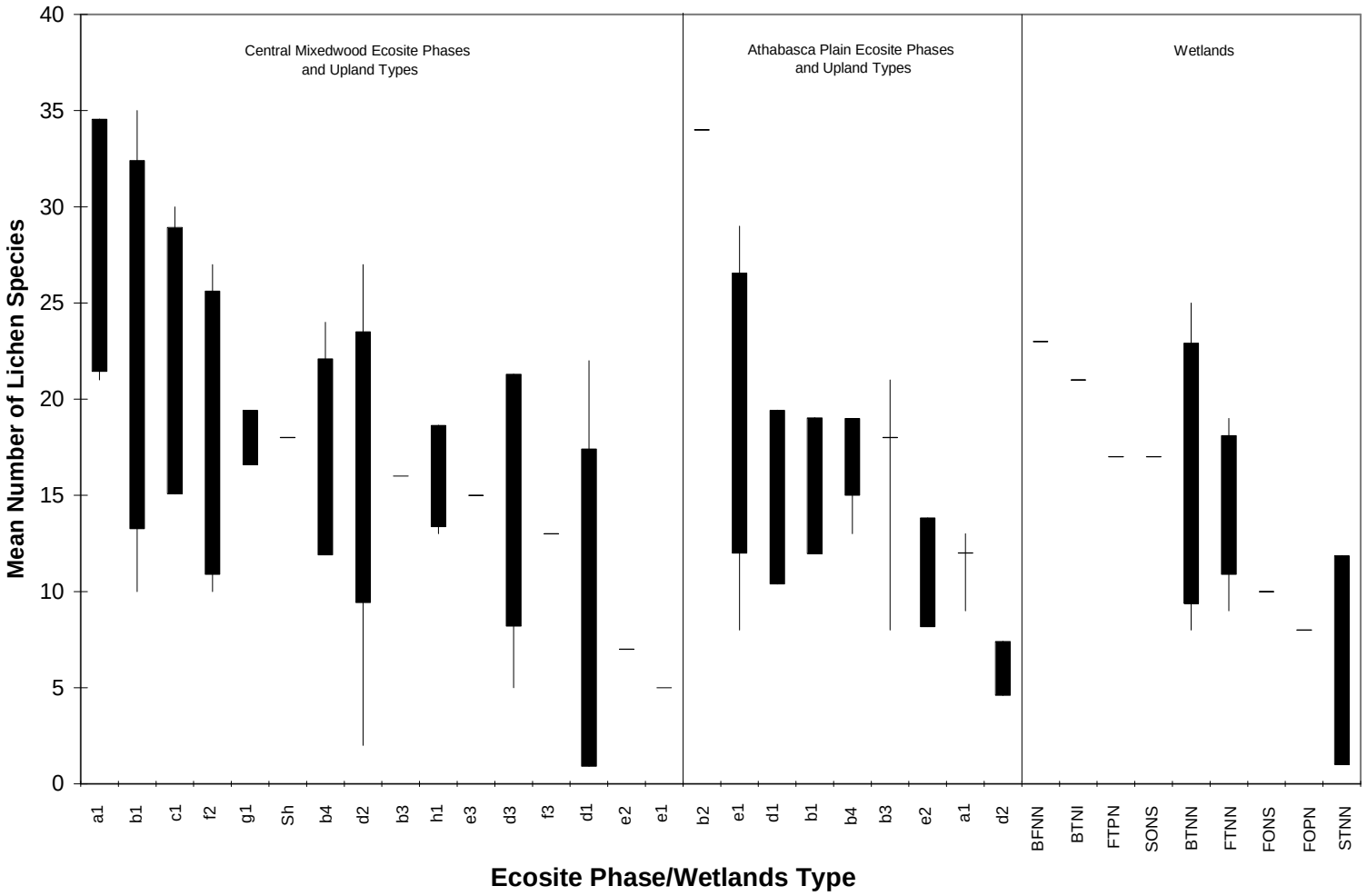
JACKPINE MINE EXPANSION &
PIERRE RIVER MINE PROJECT

TITLE

BRYOPHYTE SPECIES RICHNESS BY VEGETATION TYPE WITHIN THE PIERRE RIVER MINING AREA LOCAL STUDY AREA

Shell Canada Limited

PROJECT 05-1344-027.7640			FILE No. Wetlands Class	
DESIGN	AA	21/08/07	SCALE AS SHOWN	REV. 0
CADD	TRE	20/11/07	**FIGURE: 3.6-8**	
CHECK	AA	27/11/07		
REVIEW	WES/TC	27/11/07		



PROJECT

JACKPINE MINE EXPANSION &
PIERRE RIVER MINE PROJECT

TITLE

LICHEN SPECIES RICHNESS BY VEGETATION TYPE WITHIN THE PIERRE RIVER MINING AREA LOCAL STUDY AREA

Shell Canada Limited

PROJECT 05-1344-027.7640			FILE No. Lichen Species-PRMA	
DESIGN	AA	21/08/07	SCALE AS SHOWN	REV. 0
CADD	TRE	20/11/07	FIGURE: 3.6-9	
CHECK	AA	27/11/07		
REVIEW	WES/TC	27/11/07		

3.6.1.7 Non-Native and Invasive Species

Ten non-native and native invasive species (or "weeds") were found within the PRMA LSA. Spreading dogbane (*Apocynum androsaemifolium*) was classed as a noxious weed under the Alberta *Weed Control Act* (Province of Alberta 2002), while five other nuisance weeds were recorded including: quack grass (*Elytrigia repen*), wormseed mustard (*Erysimum cheiranthoides*), hemp-nettle (*Galeopsis tetrahit*), rough cinquefoil (*Potentilla norvegica*) and common dandelion (*Taraxacum officinale*). Other non-native and native invasive species recorded were common tall manna grass (*Glyceria grandis*), common plantain (*Plantago major*), Kentucky bluegrass (*Poa pratensis*), and curled dock (*Rumex crispus*). These species were found in closed forest, open natural habitats and riparian areas.

A list of non-native and native invasive species, the habitats they occur in and the number of sites where they were observed within the PRMA LSA is provided in Table 3.6-10. Figure 3.6-10 shows the distribution of these species across the PRMA LSA.

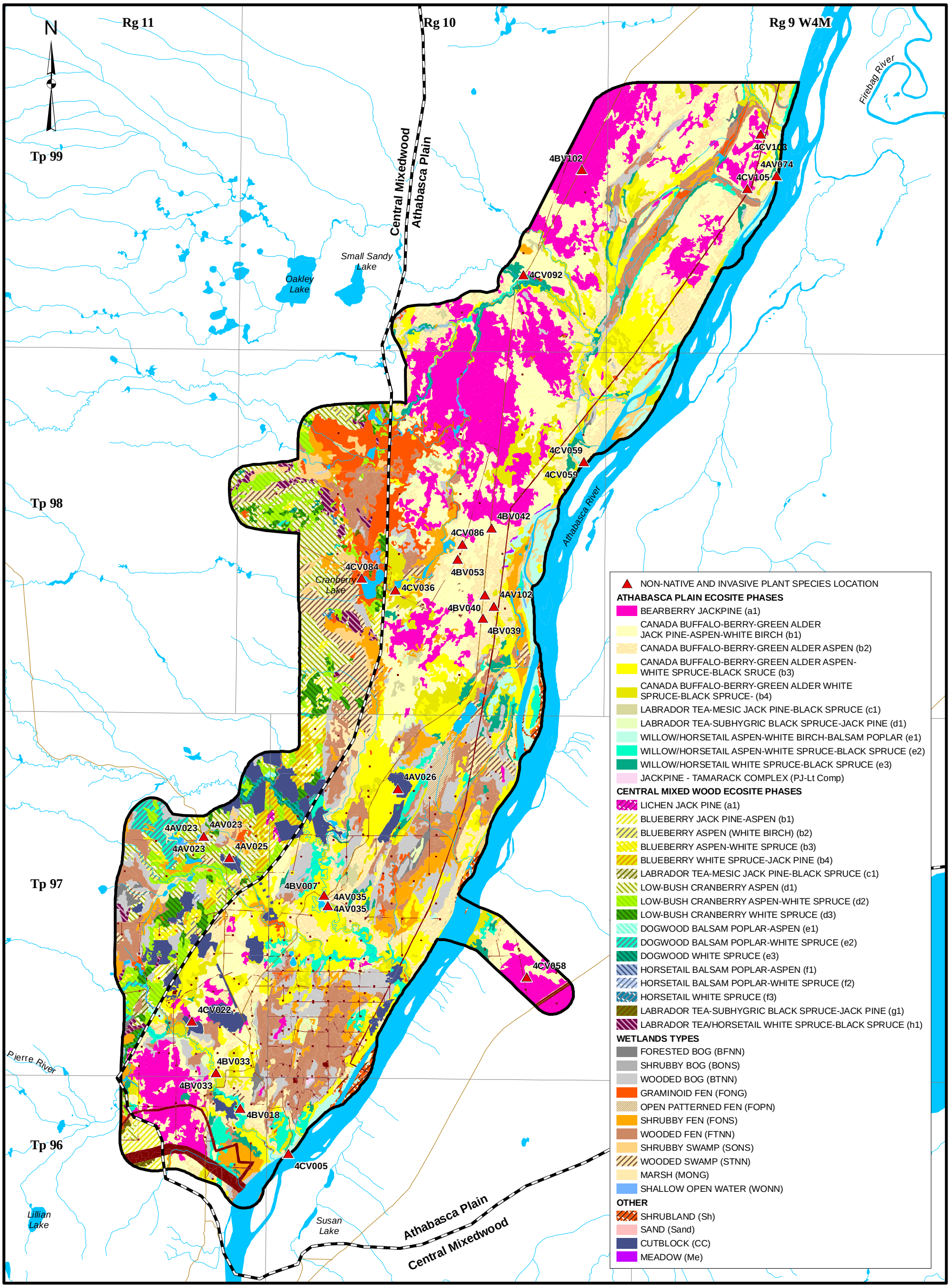
Table 3.6-10 Non-Native and Invasive Species Within the Pierre River Mining Area Local Study Area

Species Name	Vegetation Type	Site Number	Number of Occurrences
Noxious Weeds[a]			
spreading dogbane (*Apocynum androsaemifolium)*	a1 (AP and CM), b1 (AP), b2 (AP), b3 (AP), b4 (AP), d2 (CM),e1 (AP), Sh (CM), SpS (AP)	4AV026, 4AV035, 4AV074, 4AV102, 4BV039, 4BV040, 4BV042, 4BV102, 4CV022, 4CV058, 4CV059, 4CV086, 4CV092, 4CV103	14
Nuisance Weeds[a]			
quack grass (*Elytrigia repens* var *repens* (also *Agropyron repens*))	b1 (AP)	4CV105	1
wormseed mustard (*Erysimum cheiranthoides)*	e3 (CM)	4BV033	1
hemp-nettle (*Galeopsis tetrahit)*	Ri (CM)	4AV023	1
rough cinquefoil (*Potentilla norvegica)*	e3 (CM), SONS (AP), Ri (CM)	4AV023, 4BV033, 4BV053	3
common dandelion (*Taraxacum officinale)*	e1 (AP and CM)	4CV005, 4CV059	2
Other Invasive Species[b]			
common tall manna grass *(Glyceria grandis)*	f3 (CM)	4BV007	1
common plantain *(Plantago major)*	Ri (CM)	4AV023	1
Kentucky bluegrass *(Poa pratensis)*	d1 (CM), e2 (CM), Sh (CM)	4AV025, 4AV035, 4BV018	3
curled dock *(Rumex crispus)*	MONG (AP and CM)	4CV036, 4CV084	2

(a) Listed under the *Alberta Weed Control Act* (Province of Alberta 2002).

(b) Agronomic invasive species or other invasive species that have been seen to invade and/or have become persistent in natural areas, or are known to be non-native (ANPC 2000b; NPWG 2001; ANHIC 2006c).

Note: CM represents the Central Mixedwood Natural Subregion (NRC 2006), while AP represents the Athabasca Plain Natural Subregion.



LEGEND

- PIERRE RIVER MINING AREA LOCAL STUDY AREA
- OPEN WATER
- PUBLIC ROADWAY

DISTURBED

- EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE
- EXISTING AND APPROVED URBAN AND INDUSTRIAL LINEAR DISTURBANCE
- NATURAL SUBREGION

REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2004), and Alberta SRD, used under license.
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 12.

2.5 0 2.5
SCALE 1:100,000 KILOMETRES

PROJECT
JACKPINE MINE EXPANSION & PIERRE RIVER MINE PROJECT

TITLE
NON-NATIVE AND INVASIVE PLANT SPECIES IDENTIFIED WITHIN THE PIERRE RIVER MINING AREA LOCAL STUDY AREA

Shell Canada Limited

PROJECT No. 05-1344-027.7600			SCALE AS SHOWN	REV. 0
DESIGN	AA	27 Aug. 2007	FIGURE: 3.6-10	
GIS	JH	14 Nov. 2007		
CHECK	AA	20 Nov. 2007		
REVIEW	TC	27 Nov. 2007		

Project: I:\CLIENTS\SHELL\05-1344-027\mapping\mxd\veg\DRAFT\pierreriver\bl_ecosite_invasive_plants_pr.mxd Plot: ?J:\2005\GIS\ArcMapTemplates\templates\v91\MyProject.pdf?

3.6.1.8 Dust

The areas of ecosite phases/wetlands types within 50 m of potential dust sources are shown in Table 3.6-11. The total vegetated area potentially affected by dust is 806 ha (4% of the LSA).

Table 3.6-11 Areas Potentially Affected by Dust in the Pierre River Mining Area Local Study Area

Natural Subregion	Map Code	Description	Area	
			ha	% of LSA
Vegetated Land				
Central Mixedwood	b1	blueberry jack pine-aspen	10	<1
	b2	blueberry aspen (white birch)	2	<1
	b3	blueberry aspen-white spruce	2	<1
	d1	low-bush cranberry aspen	11	<1
	d2	low-bush cranberry aspen-white spruce	6	<1
	d3	low-bush cranberry white spruce	<1	<1
	g1	Labrador tea-subhygric black spruce-jack pine	4	<1
	h1	Labrador tea/horsetail white spruce-black spruce	1	<1
Athabasca Plain	a1	bearberry jackpine	145	1
	b1	Canada buffalo-berry–green alder jack pine-aspen-white birch	110	1
	b2	Canada buffalo-berry–green alder aspen	163	1
	b3	Canada buffalo-berry–green alder aspen-white spruce-black s	110	1
	b4	Canada buffalo-berry–green alder white spruce-black spruce-	38	<1
	c1	Labrador tea-mesic jack pine-black spruce	5	<1
	d1	Labrador tea-subhygric black spruce-jack pine	3	<1
	e1	willow/horsetail aspen-white birch-balsam poplar	4	<1
	e2	willow/horsetail aspen-white spruce-black spruce	27	<1
	e3	willow/horsetail white spruce-black spruce	11	<1
Both Natural Subregions	BFNN	forested bog	4	<1
	BTNN	wooded bog	36	<1
	FTNN	wooded fen	33	<1
	STNN	wooded swamp	10	<1
	FONG	graminoid fen	5	<1
	FONS	shrubby fen	39	<1
	SONS	shrubby swamp	5	<1
	WONN	shallow open water	1	<1
	Me	meadow	1	<1
	Sh	shrubland	2	<1
	CC	cutblock	19	<1
		vegetated subtotal	*806*	*4*
Non-Vegetated Land				
Both Natural Subregions	Lake	lake	1	<1
	River	river	3	<1
	Sand	sand	<1	<1
	DIS	disturbance	276	1
		non-vegetated subtotal	*280*	*1*
Total			**1,086**	**5**

Note: Some numbers are rounded for presentation purposes. Therefore, it may appear that the totals do not equal the sum of the individual values.

3.6.2 Landscape-Level Analyses

3.6.2.1 Heterogeneity

Composition and Distribution of Ecosite Phases, Wetlands Types and Disturbed Areas

The composition and distribution of ecosite phases, wetlands types and disturbed areas in the PRMA LSA are represented in Figure 3.6-1. The PRMA LSA consists of two Natural Subregions, Central Mixedwood (21%) and Athabasca Plain (79%). Sections 3.2.2 and 3.2.3 provide a more detailed description of these subregions. To consider landscape composition and distribution over the PRMA as a whole, all Central Mixedwood ecosite phases were classified according to Athabasca Plain ecosite phases for the heterogeneity and fragmentation analyses. This approach was taken because the majority of the PRMA LSA falls within the Athabasca Plain. Ecosite phases were correlated between Natural Subregions by comparing attributes including canopy cover species and composition, moisture regime and nutrient regime (Table 3.6-12). The results of the heterogeneity analyses for the PRMA are summarized according to ecosite phases (Table 3.6-13), wetlands types (Table 3.6-14) and disturbed areas (Table 3.6-15) as follows:

- There are a total of 29 patch types, which are relatively evenly distributed in the PRMA LSA (Shannon's evenness of 0.80 out of 1). The 13 ecosite phases are more abundant (67% of the PRMA LSA) than the 14 wetlands types (28%) and the two disturbance classes (5%) (Figure 3.6-1).
- Canada buffalo-berry–green alder jack pine-aspen-white birch (b1) is the most dominant ecosite phase covering 3,164 ha (15%) of the PRMA LSA. Canada buffalo-berry–green alder aspen (b2), bearberry jackpine (a1), and Canada buffalo-berry–green alder aspen-white spruce-black spruce (b3) also occupy significant portions of the PRMA LSA (Table 3.6-13).
- The largest ecosite phase patches in the PRMA LSA are a1 and b1, with mean patch sizes of 17.0±46.1 ha and 12.2±30.8 ha, respectively. The smallest ecosite phase patches are meadows (Me), with a mean patch size of 0.8±0.6 ha. Relative to all other ecosite phases, a1 has the most variable patch size (AREA_CV of 271%).
- Of the more dominant ecosite phases, b1 patches are the closest together on the landscape (ENN_MN of 66.8±23.7 m) and a1 patches are furthest apart (ENN_MN of 91.7±262.9 m). In general, the rarer ecosite phases tend to have greater distances between them. The dominant patch types are not well connected in the PRMA LSA. Smaller patches in the south tend to be separated by linear disturbance features, but overall they are

primarily separated by wetlands, including the Athabasca River (Figure 3.6-1).

- Of the more dominant ecosite phases, b3 and b2 ecosite phases are the most evenly distributed (IJI of 76% and 75%, respectively), and a1 and b1 are the least evenly distributed throughout the PRMA LSA (IJI of 50% and 62%, respectively). Of the rarer patch types, willow/horsetail white spruce-black spruce (e3) is the most evenly distributed and jack pine-tamarack complex (Pj-Lt Comp) is the most aggregated on the landscape (IJI of 78% and 31%, respectively).

- Among wetlands types, treed fen (FTNN) and treed bog (BTNN) are dominant, occupying 1,580 ha (7%) and 1,186 ha (6%) of the total PRMA LSA, respectively (Table 3.6-14). The 196 FTNN patches are moderately large (AREA_MN of 8.1±17.4 ha and AREA_MD of 2.2 ha) and variable in size (AREA_CV of 216%). The 263 BTNN patches are smaller (AREA_MN of 4.5±8.7 ha and AREA_MD of 1.5 ha) and are likewise variable in size (AREA_CV of 192%).

- Mean distance between FTNN patches is 78.2±221.1 m, but 50% of patches are less than 12 m apart. BTNN patches are on average further apart than FTNN (ENN_MN of 102.8±235.4 m), also with 50% of patches less than 12 m apart. Most FTNN and BTNN patches are located in the southern two-thirds of the lease where they are separated by linear disturbance features (e.g., seismic lines) that are typically 12 m wide. A few patches are found in the northern portion, thus accounting for the high variation in nearest neighbour values.

- The largest wetlands type patch in the PRMA LSA is patterned fen (FOPN), with a mean patch size of 34.7±33.4 ha. The smallest wetlands type patches are shrubby bogs (BONS), with a mean patch size of 0.4±0.4 ha.

- Shrubby fen (FONS) and graminoid fen (FONG) are the next largest wetlands types occupying 905 ha (4%) and 702 ha (3%) of the PRMA LSA, respectively. There are more, small FONS (190 patches averaging 4.8±11.8 ha) compared to FONG patches (82 patches averaging 8.6±53.5 ha), and FONS patches are less variable in size than FONG patches (AREA_CV of 247% versus 625%). Both patch types are more evenly dispersed than most of the other wetlands types (IJI of 79% and 81% for FONS and FONG, respectively).

- Of the more dominant wetlands types, FTNN is the closest together and wooded swamp (STNN) is furthest apart on the landscape (ENN_MN of 78.2±221.1 m and 528.4±881.2 m). In general, rarer wetlands types are further apart on the landscape with the exception of BONS and FOPN, of which each is comprised of only two patches.

- The BONS and FOPN patches are the most aggregated wetlands types (IJI of 41% and 45%, respectively). The most evenly distributed

wetlands types are FONG, FONS and shrubby swamp (SONS) (IJI of 81%, 79% and 79%, respectively).

- Cutblocks and other human disturbances occupy 535 ha (3%) and 439 ha (2%) of the PRMA LSA, respectively (Table 3.6-15). There are few (NP of 77), large (AREA_MN 6.9±11.0 ha) and aggregated (IJI of 65%) cleared areas compared with many (NP of 164), small (AREA_MN of 2.7±29.8 ha) and less aggregated patches of other disturbances (IJI of 74%).
- Mean patch size in the PRMA LSA ranges from 0.4±0.4 ha (BONS) to 34.7±33.4 ha (FOPN). Median patch size ranges from less than 1 ha (river) to 34.7 ha (FOPN) and IJI ranges from 31% (Pj-Lt) to 81% (FONG). Patch size of each ecosite phase, wetlands type and disturbed area is highly variable (AREA_CV more than 100%), except when there are very few patches. Taken together, this indicates that there are disproportionately more small patches than large patches for all classes within the PRMA LSA.

Table 3.6-12 Correlation of Ecosite Phases Within the Central Mixedwood and Athabasca Plain Natural Subregions

Central Mixedwood Ecosite Phase		Athabasca Plain Ecosite Phase	
Code	**Name**	**Code**	**Name**
a1	lichen jack pine	a1	bearberry jack pine
b1	blueberry jack pine-aspen	b1	Canada buffalo-berry–green alder jack pine-aspen-white birch
b2	blueberry aspen (white birch)	b2	Canada buffalo-berry–green alder aspen
b3	blueberry aspen-white spruce	b3	Canada buffalo-berry–green alder aspen-white spruce-black spruce
b4	blueberry white spruce-jack pine	b4	Canada buffalo-berry–green alder white spruce-black spruce-jack pine
c1	Labrador tea-mesic jack pine-black spruce	c1	Labrador tea-mesic jack pine-black spruce
d1	low-bush cranberry aspen	b2	Canada buffalo-berry–green alder aspen
d2	low-bush cranberry aspen-white spruce	b3	Canada buffalo-berry–green alder aspen-white spruce-black spruce
d3	low-bush cranberry white spruce	b4	Canada buffalo-berry–green alder white spruce-black spruce-jack pine
e1	dogwood balsam poplar-aspen	e1	willow/horsetail aspen-white birch-balsam poplar
e2	dogwood balsam poplar-white spruce	e2	willow/horsetail aspen-white spruce-black spruce
e3	dogwood white spruce	e3	willow/horsetail white spruce-black spruce
f1	horsetail balsam poplar-aspen	e1	willow/horsetail aspen-white birch-balsam poplar
f2	horsetail balsam poplar-white spruce	e2	willow/horsetail aspen-white spruce-black spruce
f3	horsetail white spruce	e3	willow/horsetail white spruce-black spruce
g1	Labrador tea-subhygric black spruce-jack pine	d1	Labrador tea-subhygric black spruce-jack pine
h1	Labrador tea/horsetail white spruce-black spruce	e2	willow/horsetail aspen-white spruce-black spruce

Table 3.6-13 Landscape Heterogeneity of Ecosite Phases Within the Pierre River Mining Area Local Study Area

Landscape Measurement[a]	Unit	Ecosite Phase[b]												
		a1	b1	b2	b3	b4	c1	d1	e1	e2	e3	Me	PJ-Lt Comp	Sh
class area (CA)	ha	2,756	3,164	2,928	2,309	1,350	79	142	335	647	358	7	3	87
proportion of LSA	%	13	15	14	11	6	<1	1	2	3	2	<1	<1	<1
number of patches (NP)	n/a	162	260	349	387	292	25	45	37	135	90	9	2	17
patch size mean (AREA_MN)	ha	17.0	12.2	8.4	6.0	4.6	3.1	3.1	9.0	4.8	4.0	0.8	1.6	5.1
patch size median (AREA_MD)	ha	2.2	3.4	1.7	1.6	2.0	1.5	1.8	3.8	1.9	1.8	1.0	1.6	1.7
patch size standard deviation (AREA_SD)	ha	46.1	30.8	19.7	13.6	8.9	3.9	3.1	10.6	8.8	6.3	0.6	1.0	6.6
patch size coefficient of variation (AREA_CV)	n/a	271	253	235	227	194	122	98	118	183	159	68	61	129
nearest neighbour mean (ENN_MN)	m	91.7	66.8	68.3	73.2	106.4	276.1	275.4	350.1	192.1	275.4	3,137.6	12.0	367.8
nearest neighbour median (ENN_MD)	m	22.1	23.7	12.0	12.0	32.0	8.9	12.0	30.5	26.8	42.8	734.7	12.0	116.3
nearest neighbour standard deviation (ENN_SD)	m	262.9	220.0	150.1	146.8	186.2	496.8	475.9	943.6	348.0	431.8	3,957.7	<1	520.8
nearest neighbour coefficient of variation (ENN_CV)	n/a	287	330	220	200	175	180	173	270	181	157	126	<1	142
distribution (IJI)	%	50	62	75	76	72	71	75	71	75	78	52	31	64

[a] Detailed descriptions of the indices assessed are located in Appendix J.

[b] Full names of ecosite phases are provided in Table 3.3-2.

n/a = Not applicable.

Note: Some numbers are rounded for presentation purposes.

Table 3.6-14 Landscape Heterogeneity of Wetlands Types Within the Pierre River Mining Area Local Study Area

Landscape Measurement[a]	Unit	Wetlands Type[b]													
		BFNN	BONS	BTNN	FONG	FONS	FOPN	FTNN	MONG	Lake	River	Sand	SONS	STNN	WONN
class area (CA)	ha	73	1	1,186	702	905	69	1,580	146	84	263	41	372	517	57
proportion of LSA	%	<1	<1	6	3	4	<1	7	1	<1	1	<1	2	2	<1
number of patches (NP)	n/a	17	2	263	82	190	2	196	8	21	62	6	92	49	24
patch size mean (AREA_MN)	ha	4.3	0.4	4.5	8.6	4.8	34.7	8.1	18.3	4.0	4.2	6.8	4.0	10.6	2.4
patch size median (AREA_MD)	ha	2.7	0.4	1.5	1.2	1.5	34.7	2.2	1.5	1.8	<1	1.8	1.8	1.8	1.8
patch size standard deviation (AREA_SD)	ha	3.9	0.4	8.7	53.5	11.8	33.4	17.4	36.2	6.4	12.6	10.9	6.6	41.4	1.9
patch size coefficient of variation (AREA_CV)	%	90	91	192	625	247	96	216	198	160	298	159	163	392	79
nearest neighbour mean (ENN_MN)	m	544.2	11.3	102.8	387.2	136.0	8.9	78.2	122.3	835.5	35.3	1,860.3	232.3	528.4	667.7
nearest neighbour median (ENN_MD)	m	12.0	11.3	12.0	78.6	12.0	8.9	12.0	12.0	232.0	14.4	94.1	48.0	88.8	281.7
nearest neighbour standard deviation (ENN_SD)	m	1,422.8	<1	235.4	570.0	343.2	<1	221.1	294.2	1,098.6	80.4	3,366.6	632.5	881.2	1,051.3
nearest neighbour coefficient of variation (ENN_CV)	%	261	<1	229	147	252	<1	283	241	131	228	181	272	167	157
distribution (IJI)	%	67	41	76	81	79	45	73	68	63	62	46	79	75	71

[a] A description of landscape measurements is provided in Appendix J.

[b] Full names of wetlands types are provided in Table 3.3-2.

n/a = Not applicable.

Note: Some numbers are rounded for presentation purposes. Therefore, it may appear that the totals do not equal the sum of the individual values.

Table 3.6-15 Landscape Heterogeneity of Disturbed Areas Within the Pierre River Mining Area Local Study Area

Landscape Measurement[a]	Unit	Cutblocks	Other Disturbances[b]
class area	ha	535	439
proportion of LSA	%	3	2
number of patches	n/a	77	164
mean patch area (AREA_MN)	ha	6.9	2.7
median patch area (AREA_MD)	ha	0.9	0.2
patch area standard deviation (AREA_SD)	ha	11.0	29.8
patch area co-efficient of variation (AREA_CV)	%	158	1,113
nearest neighbour mean (ENN_MN)	m	68.9	331.7
nearest neighbour median (ENN_MD)	m	8.9	232.4
nearest neighbour standard deviation (ENN_SD)	m	221.4	363.9
nearest neighbour co-efficient of variation (ENN_CV)	%	321	110
distribution (IJI)	%	65	74

[a] A description of landscape measurements is provided in Appendix J.

[b] Other disturbances comprise urban and industrial developments.

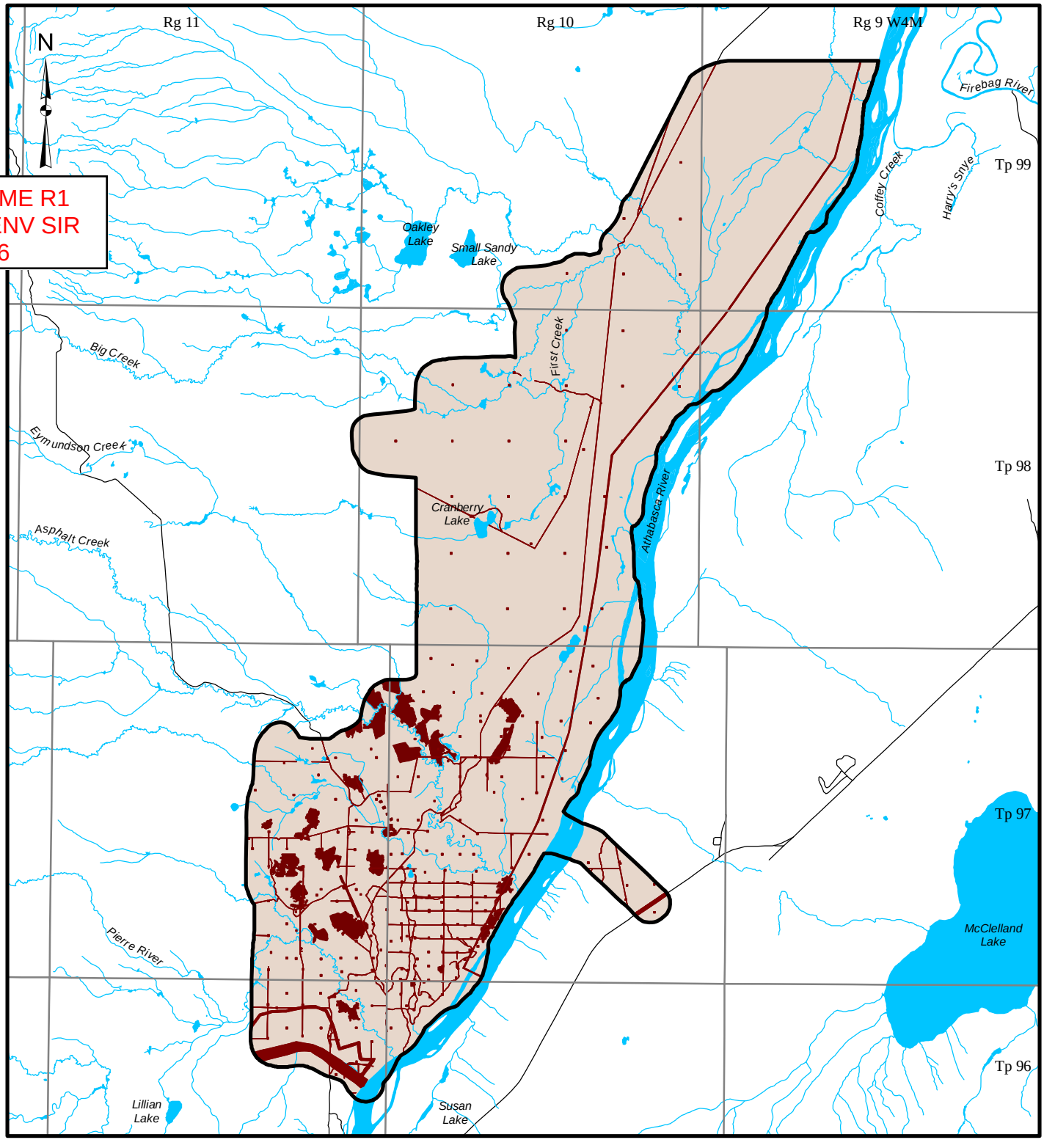
Note: Some numbers are rounded for presentation purposes. Therefore, it may appear that the totals do not equal the sum of the individual values.

3.6.2.2 Fragmentation

Natural Areas and Human Disturbed Areas

Landscape fragmentation was assessed by examining the distribution of natural areas versus human disturbed areas in the PRMA LSA (Figure 3.6-11, Table 3.6-16). A summary of fragmentation results are as follows:

- Natural areas cover 95% (20,162 ha) of the PRMA LSA (Table 3.6-16). The 170 patches of existing human disturbance covering 974 ha have fragmented the natural areas in the PRMA LSA into 148 patches.
- Natural patches are on average much larger (AREA_MN of 136.2±616.4 ha and AREA_MD of 2.4 ha) and less variable in size (AREA_CV of 452%) than human disturbed patches (AREA_MN of 5.7±58.6 ha, AREA_MD of 0.2 ha, and AREA_CV of 1,022%).
- Natural patches have a much more complex shape (FRAC_MN of 1.10) than human disturbed patches, which are almost circular or square (FRAC_MN of 1.02). Most of the human disturbed patches are the result of linear disturbance in the southern portion of the PRMA LSA (Figure 3.6-11).
- A total of 74% of the natural areas category is considered core area habitat, accounting for 14,870 ha (70%) of the PRMA LSA. This indicates that a moderate portion of the landscape consists of habitat suitable for wildlife species sensitive to human disturbance. There is no core area habitat available in disturbed patches.
- Total edge between natural areas and human disturbed areas is 600 km (Table 3.6-16).



JPME R1
AENV SIR
516

LEGEND

- PIERRE RIVER MINING AREA LOCAL STUDY AREA
- OPEN WATER
- ACCESS ROAD

NATURAL AND HUMAN DISTURBED AREAS

- NATURAL AREAS
- HUMAN DISTURBED AREAS

4 0 4
SCALE 1:160,000 KILOMETRES

PROJECT
JACKPINE MINE EXPANSION &
PIERRE RIVER MINE PROJECT

TITLE
NATURAL AND HUMAN DISTURBED AREAS
WITHIN THE PIERRE RIVER
MINING AREA LOCAL STUDY AREA

REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2004), and Alberta SRD, used under license.
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 12.

Shell Canada Limited

PROJECT No. 05-1344-027.7600			SCALE AS SHOWN REV. 0
DESIGN	VR	02 Aug. 2007	
GIS	VR	17 Nov. 2007	
CHECK	AA	17 Nov. 2007	FIGURE: 3.6-11
REVIEW	WES/TC	20 Nov. 2007	

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Table 3.6-16 Fragmentation of Natural Areas by Human Disturbed Areas Within the Pierre River Mining Area Local Study Area

Landscape Measurement[a]	Unit	Natural	Human Disturbed[b]
class area (CA)	ha	20,162	974
CA proportion of LSA	%	95	5
number of patches (NP)	n/a	148	170
patch size mean (AREA_MN)	ha	136.2	5.7
patch size median (AREA_MD)	ha	2.4	0.2
patch size standard deviation (AREA_SD)	ha	616.4	58.6
patch size coefficient of variation (AREA_CV)	%	452	1,022
shape complexity (FRAC_MN)	n/a	1.10	1.02
total core area (TCA)	ha	14,870	n/a
TCA proportion of LSA	%	70	n/a
core area index area weighted mean (CAI_AM)	%	74	n/a
total edge (TE)	km	600	

[a] A description of landscape measurements is provided in Appendix J.

[b] Some values do not equal values presented in Table 3.6-14 due to differences in patch definition between the heterogeneity and fragmentation analyses.

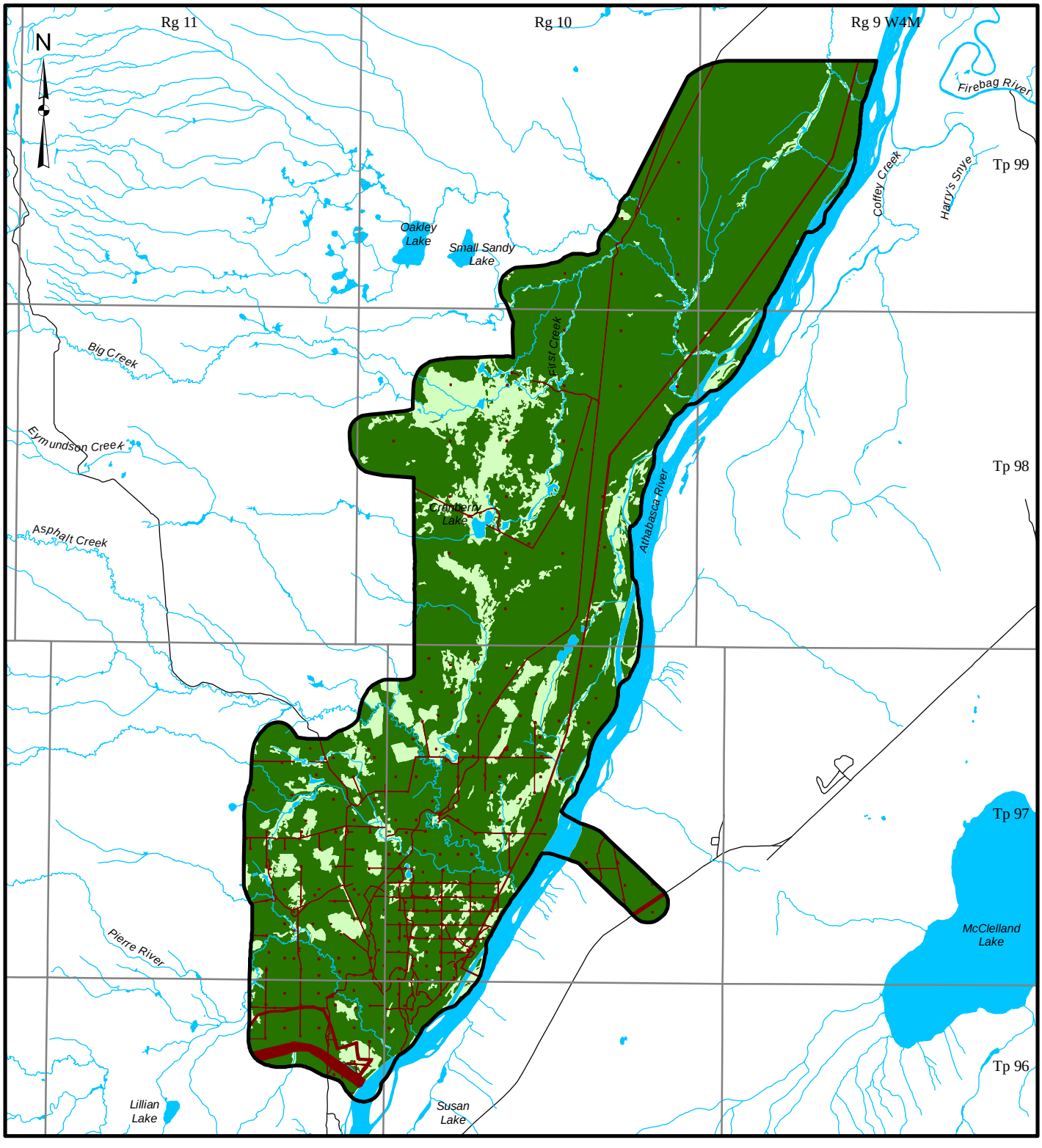
n/a = Not applicable.

Note: Some numbers are rounded for presentation purposes.

Forested and Non-Forested Areas

Landscape fragmentation and core area habitat were assessed by examining the distribution of forested and non-forested areas in the PRMA LSA (Figure 3.6-12 and Table 3.6-17). A summary of fragmentation results are as follows:

- Forested areas are much more abundant (17,442 ha) than non-forested areas (2,720 ha) and are distributed among fewer patches (260 forested patches compared to 326 non-forested patches) (Table 3.6-17).
- Forested and non-forested patches have similar median patch sizes (1.5 and 1.1 ha, respectively); however, mean forested patch size is much larger (67.1±349.8 ha) than mean non-forested patch size (AREA_MN of 8.3±41.1 ha). This is primarily because the non-forested areas in the southern portion of the PRMA LSA are highly fragmented by linear disturbance, while the largely forested northern portion of the PRMA LSA has few linear disturbances and hence more, large, forested patches (Figure 3.6-12).
- Forested and non-forested patches in the PRMA LSA are highly complex in shape (FRAC_MN of 1.11 and 1.12, respectively).
- A total of 58% of forested patches is considered core area, accounting for 10,047 ha (48%) of the PRMA LSA. This indicates that only half of the landscape consists of habitat suitable for interior forest-dwelling species. Only 17% of non-forested patches is considered core area, accounting for 472 ha (2%) of the PRMA LSA. Very little core habitat is available for non-forest-dwelling species.
- Forested patches, on average, are closer together (ENN_MN of 19.2±24.1 m, ENN_MD of 8.9 m) than non-forested patches (ENN_MN of 79.6±165.7 m, ENN_MD of 13.5 m).



LEGEND

- PIERRE RIVER MINING AREA LOCAL STUDY AREA
- OPEN WATER
- ACCESS ROAD

FORESTED AND NON-FORESTED AREAS

- FORESTED
- NON-FORESTED

DISTURBED

- EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE
- EXISTING AND APPROVED URBAN AND INDUSTRIAL LINEAR DISTURBANCE

4 0 4

SCALE 1:160,000 KILOMETRES

REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2004), and Alberta SRD, used under license.
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 12.

PROJECT

JACKPINE MINE EXPANSION & PIERRE RIVER MINE PROJECT

TITLE

FORESTED, NON-FORESTED AND HUMAN DISTURBED AREAS WITHIN THE PIERRE RIVER MINING AREA LOCAL STUDY AREA

Shell Canada Limited

PROJECT No. 05-1344-027.7600			SCALE AS SHOWN	REV. 0
DESIGN	VR	02 Aug. 2007		
GIS	VR	17 Nov. 2007		
CHECK	AA	17 Nov. 2007		
REVIEW	WES/TC	20 Nov. 2007		

FIGURE: 3.6-12

Project: I:\CLIENTS\SHELL\05-1344-027\mapping\mxd\biodiversity\DRAFT\lsa_biodiversity_forest_PR.mxd - Plot: I:\CLIENTS\SHELL\05-1344-027\mapping\pdf\biodiversity\DRAFT\lsa_biodiversity_forest_PR.pdf

Table 3.6-17 Fragmentation of Forested and Non-Forested Areas Within the Pierre River Mining Area Local Study Area

Landscape Measurement[(a)]	Unit	Forested	Non-Forested
class area (CA)	ha	17,442	2,720
CA proportion of RSA	%	83	13
number of patches (NP)	n/a	260	326
patch size mean (AREA_MN)	ha	67.1	8.3
patch size median (AREA_MD)	ha	1.5	1.1
patch size standard deviation (AREA_SD)	ha	349.8	41.1
patch size coefficient of variation (AREA_CV)	%	521	493
shape complexity (FRAC_MN)	n/a	1.11	1.12
total core area (TCA)	ha	10,047	472
TCA proportion of LSA	%	48	2
core area index area weighted mean (CAI_AM)	%	58	17
nearest neighbour mean (ENN_MN)	m	19.2	79.6
nearest neighbour median (ENN_MD)	m	8.9	13.5
nearest neighbour standard deviation (ENN_SD)	m	24.1	165.7
nearest neighbour coefficient of variation (ENN_CV)	%	125	208
total edge (TE)	km	1,109	611

(a) A description of landscape measurements is provided in Appendix J.

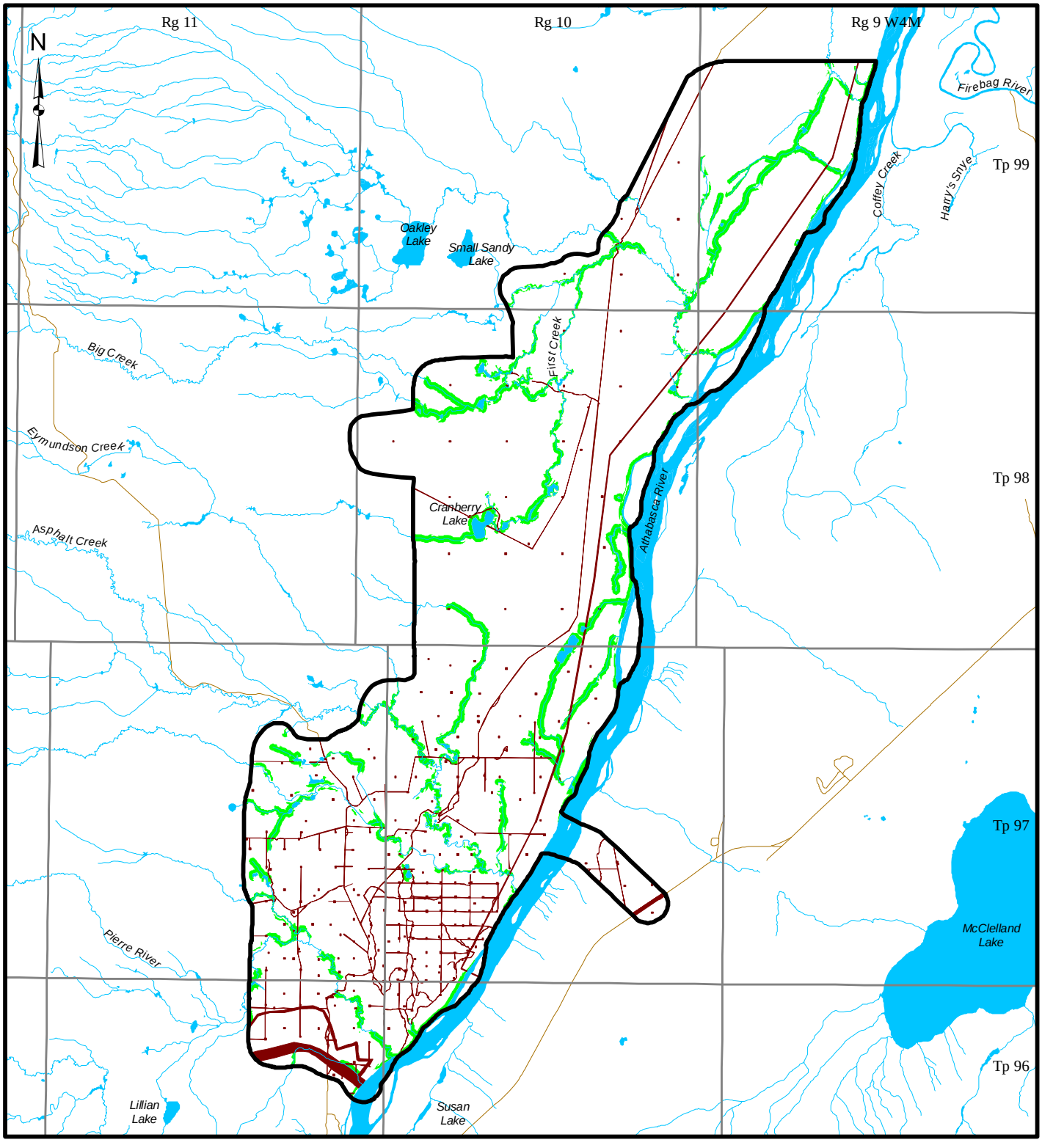
n/a = Not applicable.

Note: Some numbers are rounded for presentation purposes.

Riparian Areas

Spatial attributes of riparian patches were assessed for the PRMA LSA (Figure 3.6-13, Table 3.6-18). A summary of the results are as follows:

- Riparian patches make up 1,721 ha (8%) of the PRMA LSA (Table 3.6-18).
- There are 152 riparian patches with a mean patch size of 11.3±26.6 ha and a median patch size of 2.2 ha. Riparian patches are highly variable in size (AREA_CV of 235%).
- Riparian patches, on average, are 64.5±159.1 m apart. However, median nearest neighbour is much lower (18.9 m), indicating that 50% of riparian patches are less than 18.9 m apart. This result is expected given the connected nature of riparian areas.
- Riparian communities are distributed throughout the PRMA LSA, however they are more concentrated in the southern half of the PRMA LSA. There are no riparian communities located in the proposed bridge area on the eastern side of the Athabasca River (Figure 3.6-13).



LEGEND

- PIERRE RIVER MINING AREA LOCAL STUDY AREA
- OPEN WATER
- ROAD
- RIPARIAN ZONES

DISTURBED

- EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE
- EXISTING AND APPROVED URBAN AND INDUSTRIAL LINEAR DISTURBANCE

REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2004), and Alberta SRD, used under license.
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 12.

4 0 4
SCALE 1:160,000 KILOMETRES

PROJECT
JACKPINE MINE EXPANSION & PIERRE RIVER MINE PROJECT

TITLE
RIPARIAN ZONES WITHIN THE PIERRE RIVER MINING AREA LOCAL STUDY AREA

Shell Canada Limited

PROJECT No. 05-1344-027.7600			SCALE AS SHOWN	REV. 0
DESIGN	VR	10 Aug. 2007		
GIS	JH	14 Nov. 2007		
CHECK	AA	27 Nov. 2007		
REVIEW	TC	27 Nov. 2007		

FIGURE: 3.6-13

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Table 3.6-18 Spatial Analysis of Riparian Areas Within the Pierre River Mining Area Local Study Area

Landscape Measurement[(a)]	Unit	Riparian
class area (CA)	ha	1,721
CA proportion of LSA	%	8
number of patches (NP)	n/a	152
patch size mean (AREA_MN)	ha	11.3
patch size median (AREA_MD)	ha	2.2
patch size standard deviation (AREA_SD)	ha	26.6
patch size coefficient of variation (AREA_CV)	%	235
nearest neighbour mean (ENN_MN)	m	64.5
nearest neighbour median (ENN_MD)	m	18.9
nearest neighbour standard deviation (ENN_SD)	m	159.1
nearest neighbour coefficient of variation (ENN_CV)	%	247

(a) A description of landscape measurements is provided in Appendix J.

n/a = Not applicable.

Note: Some numbers are rounded for presentation purposes

Old Growth Areas

Spatial attributes of old growth patches were assessed for the PRMA LSA (Figure 3.6-14, Table 3.6-19). A summary of the results are as follows:

- There are 259 patches of old growth forest comprising a total of 2,088 ha (10%) of the PRMA LSA. Mean patch size of old-growth forest is 8.1±21.9 ha and median patch size is 2.7 ha. Most patches of old growth forest are small, but patch size is highly variable (AREA_CV of 271%) (Table 3.6-19).
- Old growth patches have a highly complex shape (FRAC_MN of 1.13).
- Only 11% of old growth forest is considered core area, accounting for a total of 222 ha (1%) of the PRMA LSA. This small amount of core area is due to fragmentation by existing disturbances (e.g., seismic lines) in the PRMA LSA (Figure 3.6-14).
- Mean distance between old growth patches is 77.2±121.3 m, but median distance is lower (ENN_MD of 31.2 m). This indicates that most old growth patches are separated by approximately 30 m and a few patches are isolated by much greater distances.
- The largest patch of old growth forest is dominated by jack pine and is located in the northern half of the PRMA LSA about 1 km west of the Athabasca River (Figure 3.6-14).

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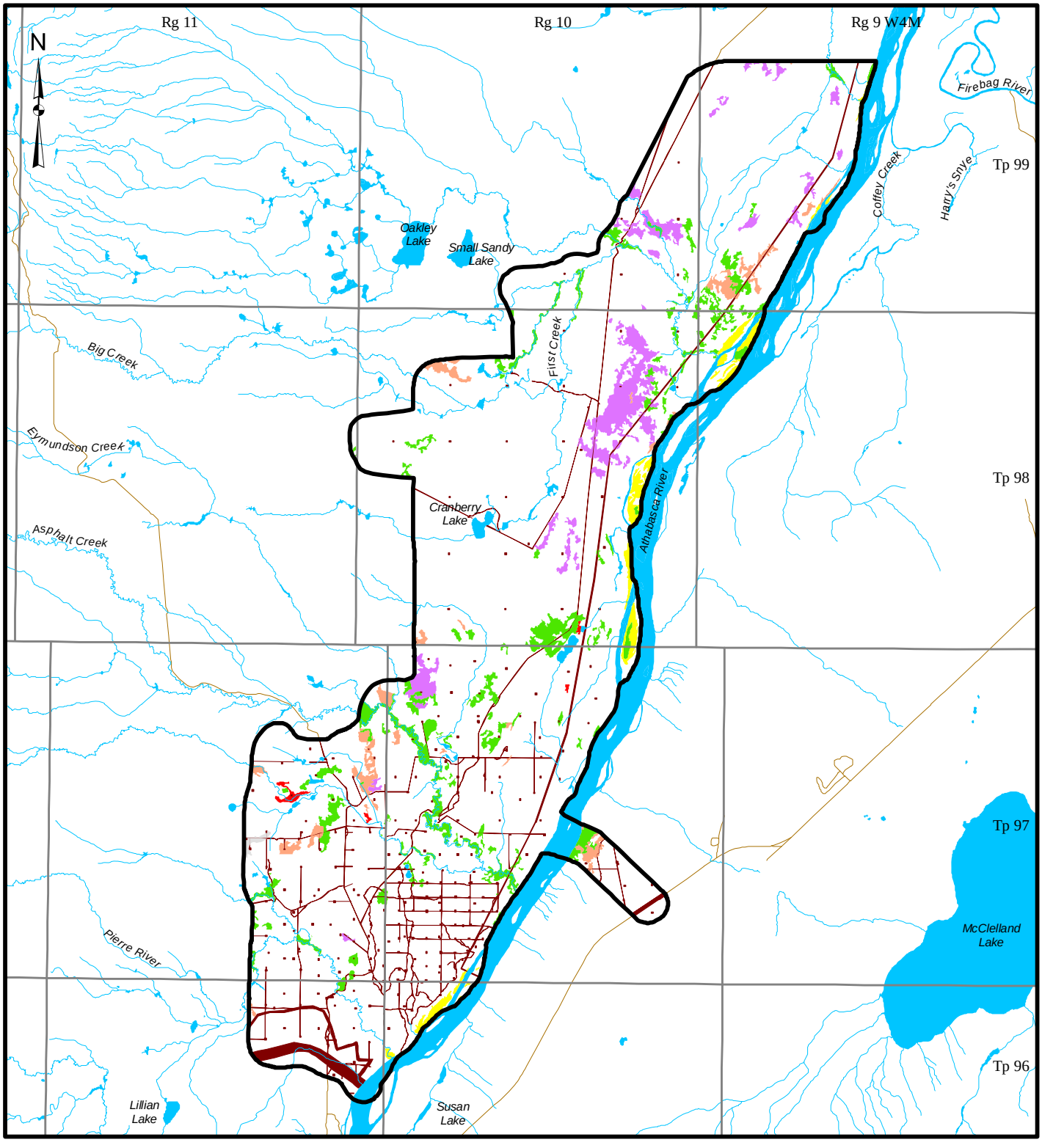

LEGEND

- PIERRE RIVER MINING AREA LOCAL STUDY AREA
- OPEN WATER
- ROAD

OLD GROWTH FOREST

- TREMBLING ASPEN (Aw)
- BALSAM POPLAR (Pb)
- JACK PINE (Pj)
- WHITE SPRUCE (Sw)
- BLACK SPRUCE (Sb)
- TAMARACK (Lt)

DISTURBED

- EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE
- EXISTING AND APPROVED URBAN AND INDUSTRIAL LINEAR DISTURBANCE

REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2004), and Alberta SRD, used under license.
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 12.

4 0 4
SCALE 1:160,000 KILOMETRES

PROJECT
JACKPINE MINE EXPANSION & PIERRE RIVER MINE PROJECT

TITLE
OLD GROWTH FORESTS WITHIN THE PIERRE RIVER MINING AREA LOCAL STUDY AREA

Shell Canada Limited

PROJECT No. 05-1344-027.7600			SCALE AS SHOWN	REV. 0
DESIGN	VR	10 Aug. 2007		
GIS	JH	14 Nov. 2007		
CHECK	AA	27 Nov. 2007		
REVIEW	TC	27 Nov. 2007		

FIGURE: 3.6-14

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Table 3.6-19 Spatial Analyses of Old Growth Areas Within the Pierre River Mining Area Local Study Area

Landscape Measurement[(a)]	Unit	Old Growth
class area (CA)	ha	2,088
CA proportion of LSA	%	10
number of patches (NP)	n/a	259
patch size mean (AREA_MN)	ha	8.1
patch size median (AREA_MD)	ha	2.7
patch size standard deviation (AREA_SD)	ha	21.9
patch size coefficient of variation (AREA_CV)	%	271
shape complexity (FRAC_MN)	n/a	1.13
total core area (TCA)	ha	222
TCA proportion LSA	%	1
core area index area weighted mean (CAI_AM)	%	11
nearest neighbour mean (ENN_MN)	m	77.2
nearest neighbour median (ENN_MD)	m	31.2
nearest neighbour standard deviation (ENN_SD)	m	121.3
nearest neighbour coefficient of variation (ENN_CV)	%	157
total edge (TE)	km	526

[(a)] A description of landscape measurements is provided in Appendix J.

n/a = Not applicable.

Note: Some numbers are rounded for presentation purposes

3.6.3 Key Indicator Resources

3.6.3.1 Community-Level Key Indicator Resource Descriptions in the Pierre River Mining Area Local Study Area

Lichen jack pine communities, riparian communities, old growth forests, peatlands (bogs and fens), patterned fens, rare plant communities and productive forests have been selected as community-level vegetation KIRs within the PRMA LSA.

Lichen Jack Pine (a1) Communities

Three detailed vegetation inventory plots were established in the Central Mixedwood lichen jack pine (a1) ecosite phase during field surveys conducted in 2006/2007, and 21 detailed vegetation inventory plots were established in the Athabasca Plain bearberry jack pine (a1) ecosites phase. A total of 16 ha (less than 1%) of Central Mixedwood lichen jack pine (a1) and 2,740 (13%) of Athabasca Plain bearberry jackpine (a1) ecosites phases have been mapped within the PRMA LSA (Table 3.6-1).

Riparian Communities

Riparian communities were selected as a community-level KIR primarily for their wildlife resource value, ecological and social importance, and vulnerability to disturbance. Riparian communities account for 1,615 ha (8%) of the PRMA LSA (Table 3.6-20). They are composed mostly of wetlands vegetation and dominated by shrubby fens (FONS) which comprise 18% of all riparian communities. The Athabasca Plain willow/horsetail aspen-white spruce-black spruce (e2) ecosite phase represents the largest terrestrial component of all riparian communities covering 147 ha (9%) of the PRMA LSA (Figure 3.6-13).

Table 3.6-20 Area and Percent Cover of Riparian Communities Within the Pierre River Mining Area Local Study Area

Map Code	Description	Area		
		[ha]	% of Riparian Zone	% of LSA
Central Mixedwood Ecosite Phases				
e1	dogwood balsam poplar-aspen	3	<1	<1
e2	dogwood balsam poplar-white spruce	24	1	<1
e3	dogwood white spruce	38	2	<1
f1	horsetail balsam poplar-aspen	4	<1	<1
h1	Labrador tea/horsetail white spruce-black spruce	3	<1	<1
	central mixedwood ecosite phase subtotal	*71*	*4*	*<1*
Athabasca Plain Ecosite Phases				
e1	willow/horsetail aspen-white birch-balsam poplar	85	5	<1
e2	willow/horsetail aspen-white spruce-black spruce	147	9	1
e3	willow/horsetail white spruce-black spruce	118	7	1
	Athabasca plain ecosite phase subtotal	350	22	2
	terrestrial ecosite phase subtotal	*422*	*26*	2
Wetlands				
FONG	graminoid fen	237	15	1
FONS	shrubby fen	290	18	1
FOPN	open patterned fen	33	2	<1
FTNN	wooded fen	276	17	1
MONG	marsh	83	5	<1
SONS	shrubby swamp	134	8	1
STNN	wooded swamp	112	7	1
	wetlands subtotal	*1,164*	*72*	*6*
Other Vegetation types				
Me	meadow	2	<1	<1
Sh	shrubland	23	1	<1
Sand	sand	4	<1	<1
	other vegetation types subtotal	*29*	*2*	*<1*
Total		**1,615**	**100**	**8**

Note: Some numbers are rounded for presentation purposes. Therefore, it may appear that the totals do not equal the sum of the individual values.

Old Growth Forests

The results for the analysis of the composition and configuration of old growth forests within the PRMA LSA are presented below. The distribution of old growth forests within the LSA is shown in Figure 3.6-14. The PRMA LSA includes the Calumet Old Growth Forest Environmentally Significant Area (ESA), which is described in the Resource Use Environmental Setting Report (Golder 2007). The area in and around the Calumet Oil Growth Forest ESA was

studied during the field reconnaissance from this project and by interpreting areal photographs and AVI data. The ESA location described by Westworth (1990) was found not to contain any old growth forest. However, an area of balsam poplar dominant old growth forest was observed approximately 500 m east of this location outside of the project development area, on the banks of the Athabasca River (Figure 3.6-14).

Table 3.6-21 provides a breakdown of the PRMA LSA land base according to three variables: timber productivity potential, age class and primary tree species.

Among timber productive sites, mature stands are most common and cover 12,373 ha (59%) of the PRMA LSA (Table 3.6-21, Figure 3.6-15). Young stands are the least common among timber productive sites and cover only 68 ha (less than 1%) of the PRMA LSA.

Among the non-timber productive sites, mature stands also dominate the landscape covering 2,801 ha (13%) of the PRMA LSA (Table 3.6-21, Figure 3.6-15). Early aged stands composed of recently burnt peatlands are the least common age class among the non-timber group with 8 ha (less than 1%) present within the PRMA LSA.

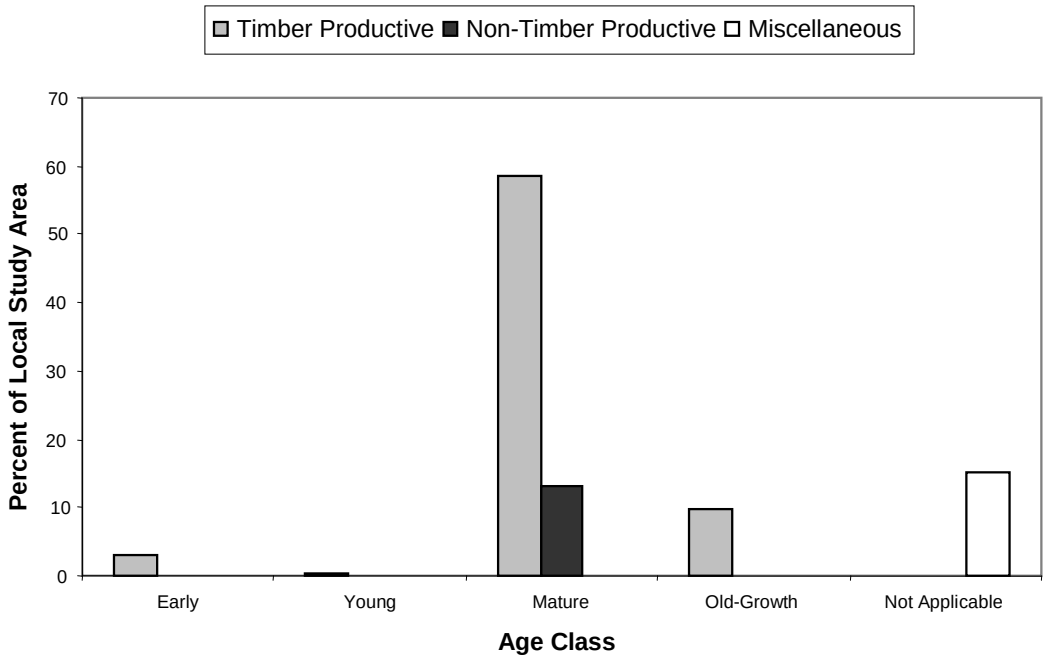
A summary of the characteristics of old growth forest within the PRMA LSA is presented below:

- the total amount of old growth forest occupies 2,089 ha (10%) of the PRMA LSA;
- timber productive old growth forest occupies 2,072 ha (10%) of the PRMA LSA, and 99% of all old growth forest; and
- non-timber productive old growth forest occupies 17 ha (less than 1%) of the PRMA LSA, and 1% of all old growth forest.

Among timber productive stands, 18 ecosite phases and one wetlands type were identified as belonging to the old growth age class within the PRMA LSA (Table 3.6-22). The Athabasca Plain Canada buffalo-berry–green alder (b) ecosite phases account for 53% of all old growth, and also 53% of all timber productive old growth.

Among non-timber productive stands, the wooded fen (FTNN) wetlands type account for 100% of all non-timber productive old growth (Table 3.6-22).

L:\2005\1344-OIL SANDS\05-1344-027-Shell Omnibus\7600\7640\Vegetation ESR\Fig 3.6-15 Age Class Distribution Within the Pierre River Mining Area Local Study Area.dwg Nov 28, 2007 - 4:48pm



PROJECT

JACKPINE MINE EXPANSION &
PIERRE RIVER MINE PROJECT

TITLE

AGE CLASS DISTRIBUTION WITHIN THE PIERRE RIVER MINING AREA LOCAL STUDY AREA

Shell Canada Limited

PROJECT 05-1344-027.7640			FILE No.	Age Class
DESIGN	AA	21/08/07	SCALE AS SHOWN	REV. 0
CADD	YW	28/08/07	FIGURE: 3.6-15	
CHECK	AA	27/11/07		
REVIEW	WES/TC	27/11/07		

Table 3.6-21 Total Area and Percent Distribution of Timber Productive and Non-Timber Productive Forest Cover Types by Age Class Within the Pierre River Mining Area Local Study Area

Age Class	Primary Tree Species	Area [ha]	% of LSA
Timber Productive			
early	aspen or balsam poplar[(a)]	81	<1
	cutblock	535	3
	early subtotal	*616*	*3*
young	aspen	29	<1
	white birch	3	<1
	cutblock - Aw	7	<1
	cutblock - Pb	1	<1
	balsam poplar	17	<1
	jack pine	8	<1
	black spruce	1	<1
	white spruce	3	<1
	young subtotal	*68*	*<1*
mature	aspen	5,143	24
	white birch	327	2
	tamarack	47	<1
	balsam poplar	32	<1
	jack pine	4,664	22
	black spruce	847	4
	white spruce	1,314	6
	mature subtotal	*12,373*	59
old growth	aspen	288	1
	tamarack	5	<1
	balsam poplar	245	1
	jack pine	600	3
	black spruce	23	<1
	white spruce	911	4
	old growth subtotal	*2,072*	*10*
	timber productive subtotal	*15,130*	*72*
Non-Timber Productive			
early	black spruce or tamarack[(a)]	8	<1
	early subtotal	*8*	*<1*
young	black spruce	14	<1
	young subtotal	*14*	*<1*
mature	tamarack	664	3
	black spruce	2,137	10
	mature subtotal	*2,801*	*13*
old growth	tamarack	13	<1
	black spruce	3	<1
	old growth subtotal	*17*	*<1*
not applicable	disturbance	431	2
	non-forested wetlands	2,252	11
	other non-forested	483	2
	non-applicable subtotal	*3,166*	*15*
	non-timber productive subtotal	*6,006*	*28*
Total		**21,136**	**100**

(a) Early ecosites where the tree species is undetermined. Species is inferred based on ecosite phase or wetlands type.

Note: Some numbers are rounded for presentation purposes. Therefore, it may appear that the totals do not equal the sum of the individual values.

Table 3.6-22 Total Area and Percent Occurrence of Old Growth Within the Pierre River Mining Area Local Study Area

Map Code	Description	Old Growth in the PRMA LSA	
		[ha]	% of LSA Old Growth
Timber Productive Old Growth[a]			
Central Mixedwood Natural Subregion Ecosite Phases			
b1	blueberry jack pine-aspen	36	2
b3	blueberry aspen-white spruce	47	2
b4	blueberry white spruce-jack pine	72	3
d1	low-bush cranberry aspen	100	5
d2	low-bush cranberry aspen-white spruce	96	5
d3	low-bush cranberry white spruce	49	2
e1	dogwood balsam poplar-aspen	3	<1
e2	dogwood balsam poplar-white spruce	23	1
e3	dogwood white spruce	39	2
f2	horsetail balsam poplar-white spruce	<1	0
	central mixedwood ecosite phase subtotal	*467*	*22*
Athabasca Plain Natural Subregion Ecosite Phases			
a1	bearberry jack pine	123	6
b1	Canada buffalo-berry–green alder jack pine-aspen-white birch	291	14
b2	Canada buffalo-berry–green alder aspen	31	1
b3	Canada buffalo-berry–green alder aspen-white spruce-black spruce	330	16
b4	Canada buffalo-berry–green alder white spruce-black spruce-jack pine	459	22
e1	willow/horsetail aspen-white birch-balsam poplar	209	10
e2	willow/horsetail aspen-white spruce-black spruce	95	5
e3	willow/horsetail white spruce-black spruce	61	3
	Athabasca plain ecosite phase subtotal	*1,599*	*77*
Forested and Wooded Wetlands[b]			
STNN	wooded swamp	5	<1
	timber productive wetlands subtotal		*<1*
	timber productive subtotal	*2,072*	*99*
Non-Timber Productive Old Growth[c]			
Forested and Wooded Wetlands			
FTNN	wooded fen	17	1
	non-timber productive wetlands subtotal	*17*	*1*
Total[d]		**2,088**	**100**

(a) With primary tree species being aspen, white birch, balsam poplar, jack pine or white spruce.

(b) With primary tree species being white spruce.

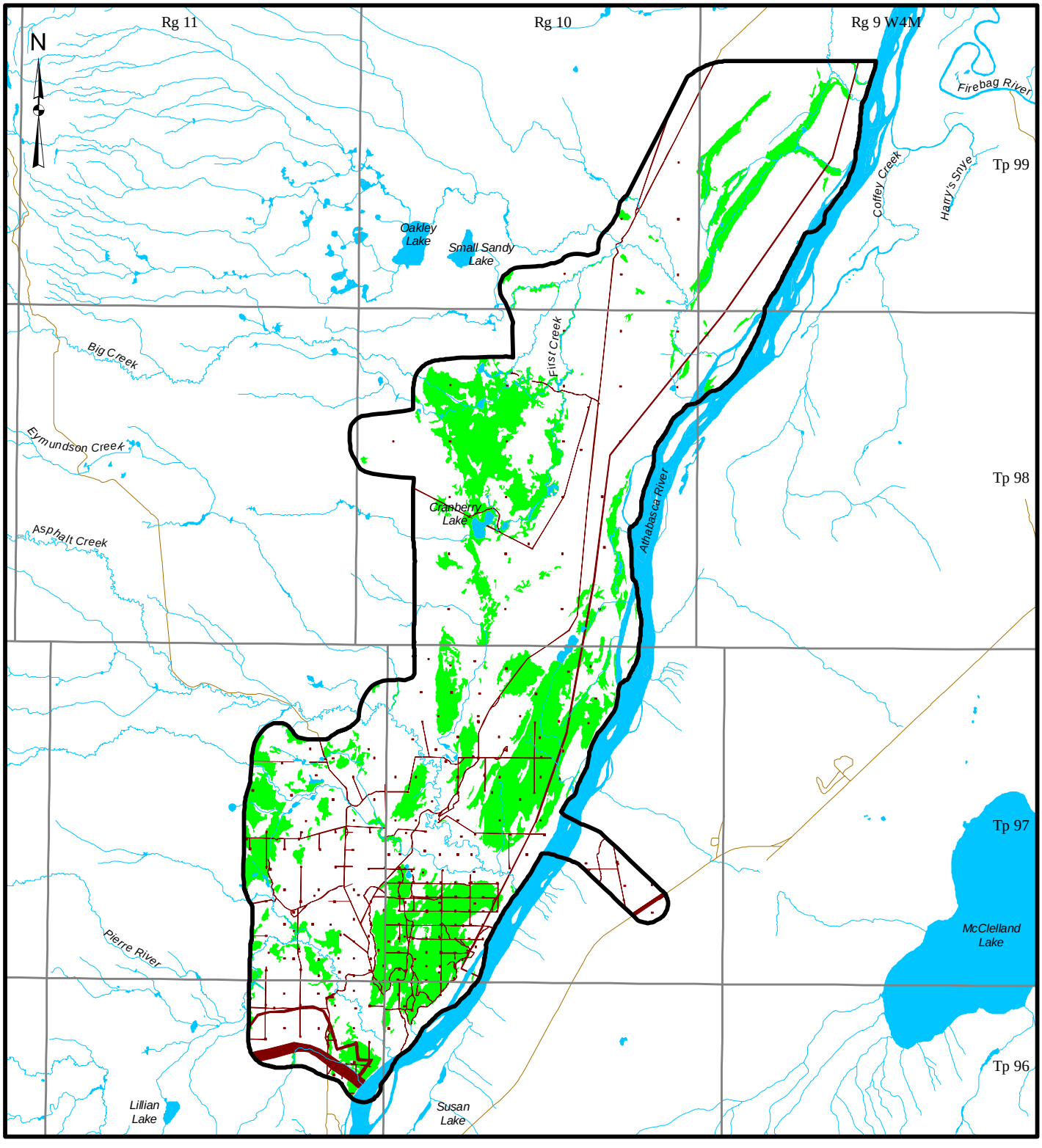
(c) With primary tree species being tamarack.

(d) Total values shown represent the old growth portions of the PRMA LSA.

Note: Some numbers are rounded for presentation purposes. Therefore, it may appear that the totals do not equal the sum of the individual values.

Peatlands (Fens and Bogs)

Peatlands, another KIR, are the dominant wetlands types within the PRMA LSA and cover a total of 4,516 ha (21%) (Figure 3.6-16, Table 3.6-23). Wooded bogs (BTNN) and wooded fens (FTNN) make up the majority of all peatlands and cover 1,186 ha (6%) and 1,580 ha (7%) within the PRMA LSA. Peatlands occur throughout the PRMA LSA, but are found primarily within an ancient river meander. (Figure 3.6-16).



LEGEND

- PIERRE RIVER MINING AREA LOCAL STUDY AREA
- OPEN WATER
- ROAD
- PEATLANDS

DISTURBED

- EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE
- EXISTING AND APPROVED URBAN AND INDUSTRIAL LINEAR DISTURBANCE

REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2004), and Alberta SRD, used under license.
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 12.

4 0 4
SCALE 1:160,000 KILOMETRES

PROJECT
JACKPINE MINE EXPANSION & PIERRE RIVER MINE PROJECT

TITLE
PEATLANDS WITHIN THE PIERRE RIVER MINING AREA LOCAL STUDY AREA

Shell Canada Limited

PROJECT No. 05-1344-027.7600			SCALE AS SHOWN	REV. 0
DESIGN	VR	10 Aug. 2007	FIGURE: 3.6-16	
GIS	JH	14 Nov. 2007		
CHECK	AA	27 Nov. 2007		
REVIEW	TC	27 Nov. 2007		

Project: I:\CLIENTS\SHELL\05-1344-027\mapping\mxd\veg\DRAFT\pierriver\bl_peat_pr.mxd Plot: ?J:\2005\GIS\ArcMapTemplates\templates\v91\MyProject.pdf?

Table 3.6-23 Area and Percent Cover of Peatlands Within the Pierre River Mining Area Local Study Area

Map Code	Description	Area		
		[ha]	% of Peatlands	% of LSA
Forested and Wooded Peatlands				
BFNN	forested bog	73	2	<1
BTNN	wooded bog	1,186	26	6
FTNN	wooded fen	1,580	35	7
	forested and wooded peatlands subtotal	*2,839*	*63*	*13*
Non-Forested Peatlands				
BONS	shrubby bog	1	0	<1
FONG	graminoid fen	702	16	3
FONS	shrubby fen	905	20	4
FOPN	open patterned fen	69	2	<1
	non-forested peatlands subtotal	*1,677*	*37*	*8*
Total		**4,516**	**100**	**21**

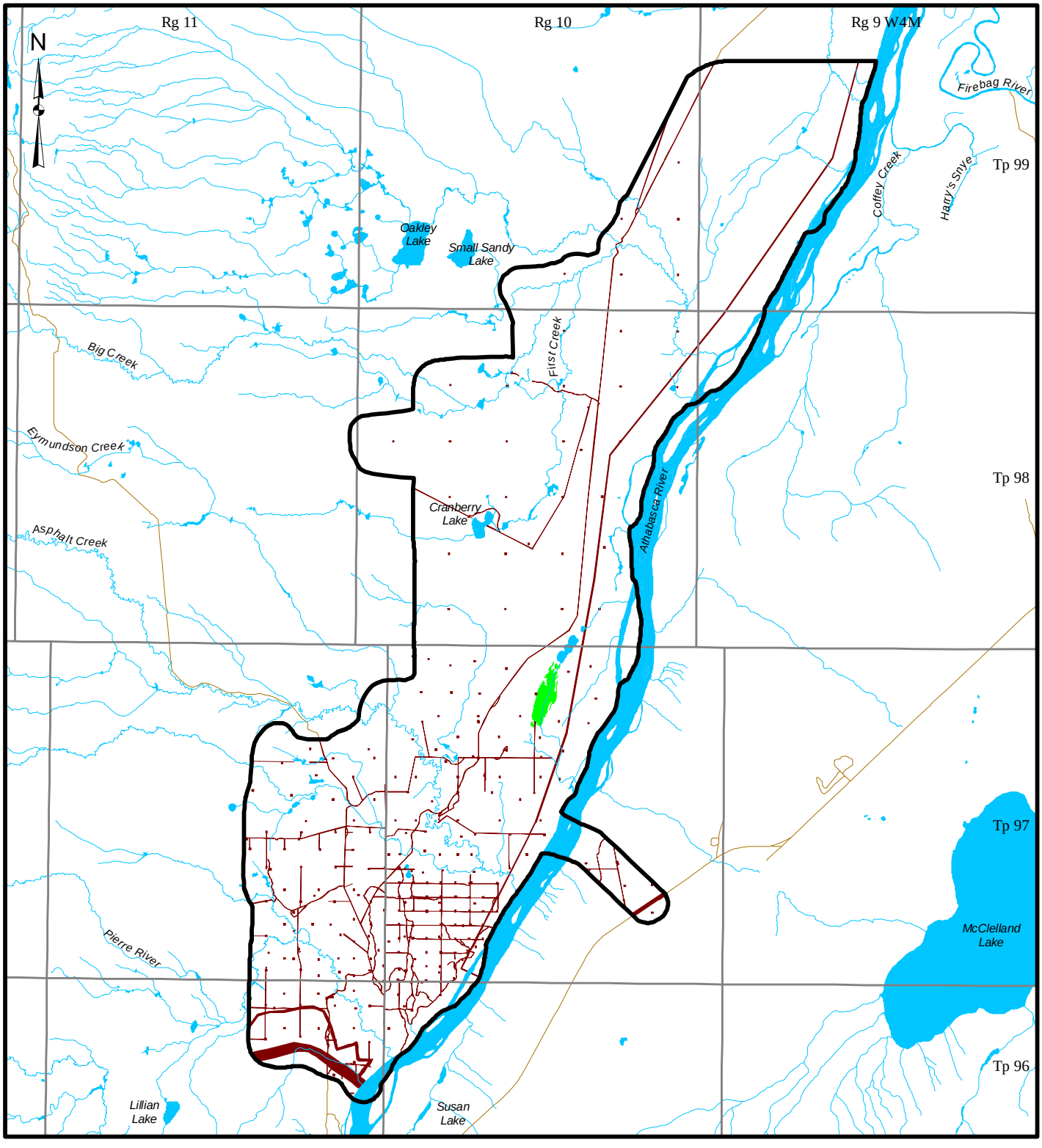
Note: Some numbers are rounded for presentation purposes. Therefore, it may appear that the totals do not equal the sum of the individual values.

Patterned Fens

Patterned fens were selected as a community-level KIR primarily for their ecological importance and vulnerability to disturbance. Within the PRMA LSA, a single patch of open patterned fen (FOPN) accounts for 69 ha (less than 1%) of the PRMA LSA (Figure 3.6-17). These types of fens are unique as they are characterized by alternating strings (woody ridges) and flarks (herbaceous pools) that run parallel to the groundwater flow direction. One rare vascular species, pitcher-plant (*Sarracenia purpurea*), and two rare lichens, *Lecanora subintricata* (ANHIC Tracking List) and *Scoliciosporum perpusillum* (Unranked) were found in a patterned fen within the PRMA LSA.

Productive Forests

Productive forest was selected as a community-level KIR because of its economic importance. Within the PRMA LSA, there is 14,127 ha (67%) of potentially productive forest land (Table 3.6-24, Figure 3.6-18). This includes all forested and harvested stands (cutblocks) with a good, medium or fair timber productivity rating. Timber productive land excludes black spruce and tamarack stands as well as non-forested wetlands, water and disturbances. Details on economic forests, including MAI and LRYSA within the LSA are presented in the Project Forestry Environmental Setting Report (Section 4).



LEGEND

- PIERRE RIVER MINING AREA LOCAL STUDY AREA
- OPEN WATER
- ROAD
- PATTERNED FEN

DISTURBED

- EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE
- EXISTING AND APPROVED URBAN AND INDUSTRIAL LINEAR DISTURBANCE

REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2004), and Alberta SRD, used under license.
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 12.

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SCALE 1:160,000 KILOMETRES

PROJECT
JACKPINE MINE EXPANSION & PIERRE RIVER MINE PROJECT

TITLE
PATTERNED FENS WITHIN THE PIERRE RIVER MINING AREA LOCAL STUDY AREA

Shell Canada Limited

PROJECT No. 05-1344-027.7600			SCALE AS SHOWN	REV. 0
DESIGN	VR	10 Aug. 2007		
GIS	JH	14 Nov. 2007		
CHECK	AA	27 Nov. 2007		
REVIEW	TC	27 Nov. 2007		

FIGURE: 3.6-17

Project: I:\CLIENTS\SHELL\05-1344-027\mapping\mxd\veg\DRAFT\pierreriver\bl_patt_fens_pr.mxd Plot: ?J:\2005\GIS\ArcMapTemplatestemplates\v91\MyProject.pdf?

Table 3.6-24 Area and Percent Cover of Timber Productive and Non-Productive Sites Within the Pierre River Mining Area Local Study Area

Timber Productivity Rating Description	Local Study Area	
	[ha]	% of LSA
Timber Productive		
good	6,735	32
medium	7,260	34
fair	131	1
timber productive subtotal	*14,127*	*67*
Non-Timber Productive		
unproductive	3,843	18
non-treed[(a)]	2,290	11
non-vegetated[(b)]	877	4
non-timber productive subtotal	*7,009*	*33*
Total	**21,136**	**100**

(a) non-treed types include open terrestrial and wetlands types.

(b) non-vegetated types include water types and disturbances.

Note: Some numbers are rounded for presentation purposes. Therefore, it may appear that the totals do not equal the sum of the individual values.

3.6.3.2 Species-Level Key Indicator Resource Descriptions in the Pierre River Mining Area Local Study Area

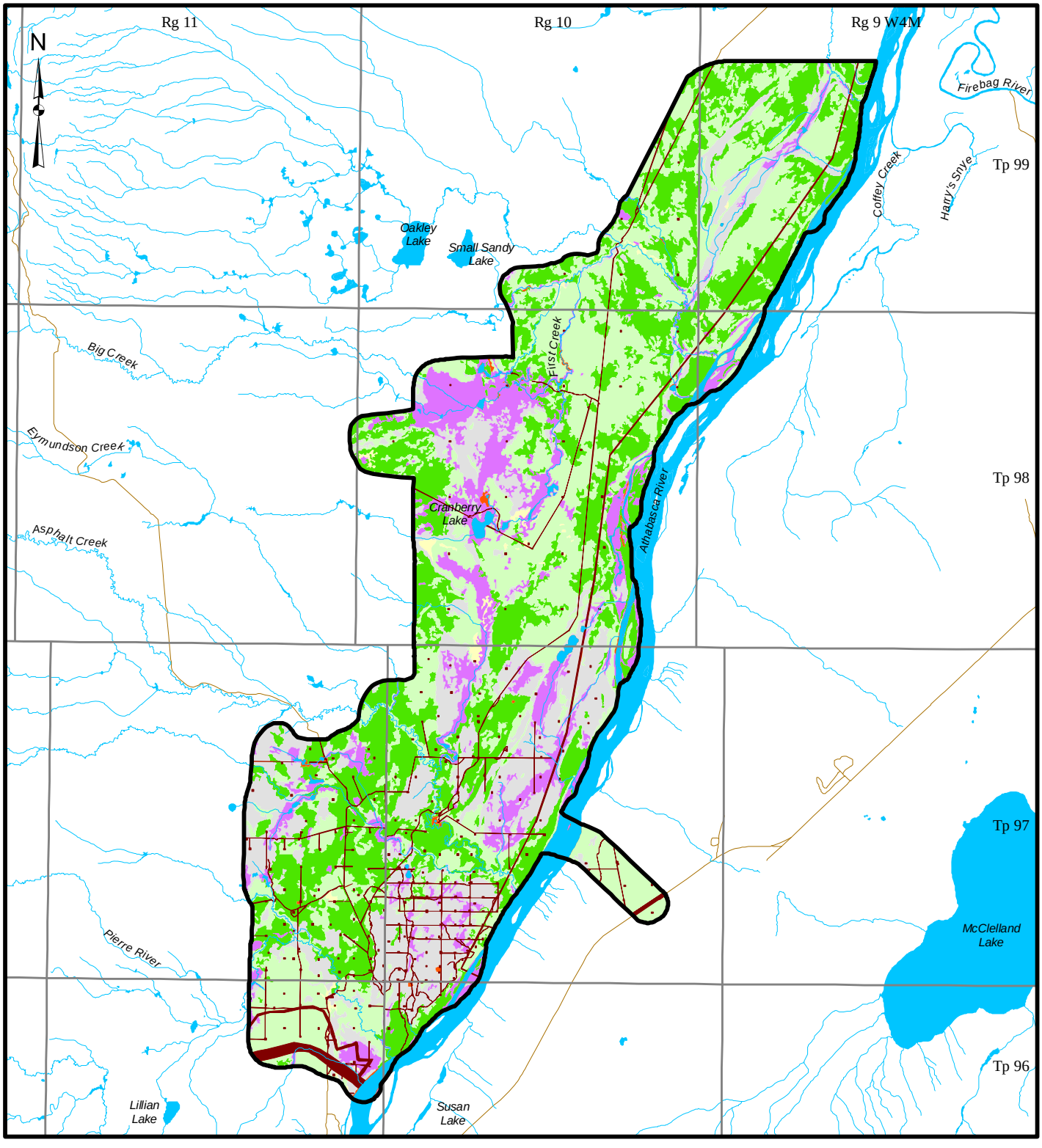
Rare plants and traditional use plants have been selected as species-level vegetation KIRs within the PRMA LSA because of their resource use value, ecological and social importance, and vulnerability to disturbance.

Rare Plant Potential

Rare plant potential within the PRMA LSA is provided in Table 3.6-25 and Figure 3.6-19. There is 3,920 ha of high (19%), 12,522 ha of moderate (59%) and 4,694 ha of low (22%) rare plant potential habitat within the PRMA LSA.

Table 3.6-25 Area and Percent Cover of Rare Plant Potential Within the Pierre River Mining Area Local Study Area

Rare Plant Potential	Local Study Area	
	[ha]	% of LSA
high	3,920	19
moderate	12,522	59
low	4,694	22
Total	**21,136**	**100**



LEGEND

- PIERRE RIVER MINING AREA LOCAL STUDY AREA
- OPEN WATER
- ROAD

TIMBER PRODUCTIVITY RATING

- GOOD
- MEDIUM
- FAIR
- UNPRODUCTIVE
- NON-FORESTED
- NON-VEGETATED

DISTURBED

- EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE
- EXISTING AND APPROVED URBAN AND INDUSTRIAL LINEAR DISTURBANCE

REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2004), and Alberta SRD, used under license.
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 12.

4 0 4
SCALE 1:160,000 KILOMETRES

PROJECT
JACKPINE MINE EXPANSION & PIERRE RIVER MINE PROJECT

TITLE
FOREST PRODUCTIVITY WITHIN THE PIERRE RIVER MINING AREA LOCAL STUDY AREA

Shell Canada Limited

PROJECT No. 05-1344-027.7600			SCALE AS SHOWN	REV. 0
DESIGN	VR	10 Aug. 2007		
GIS	JH	14 Nov. 2007		
CHECK	AA	27 Nov. 2007		
REVIEW	TC	27 Nov. 2007		

FIGURE: 3.6-18

Project: I:\CLIENTS\SHELL\05-1344-027\mapping\mxd\veg\DRAFT\pierreriver\bl_tpr_pr.mxd Plot: 2J:\2005\GIS\ArcMapTemplates\templates\v91\MyProject.pdf?

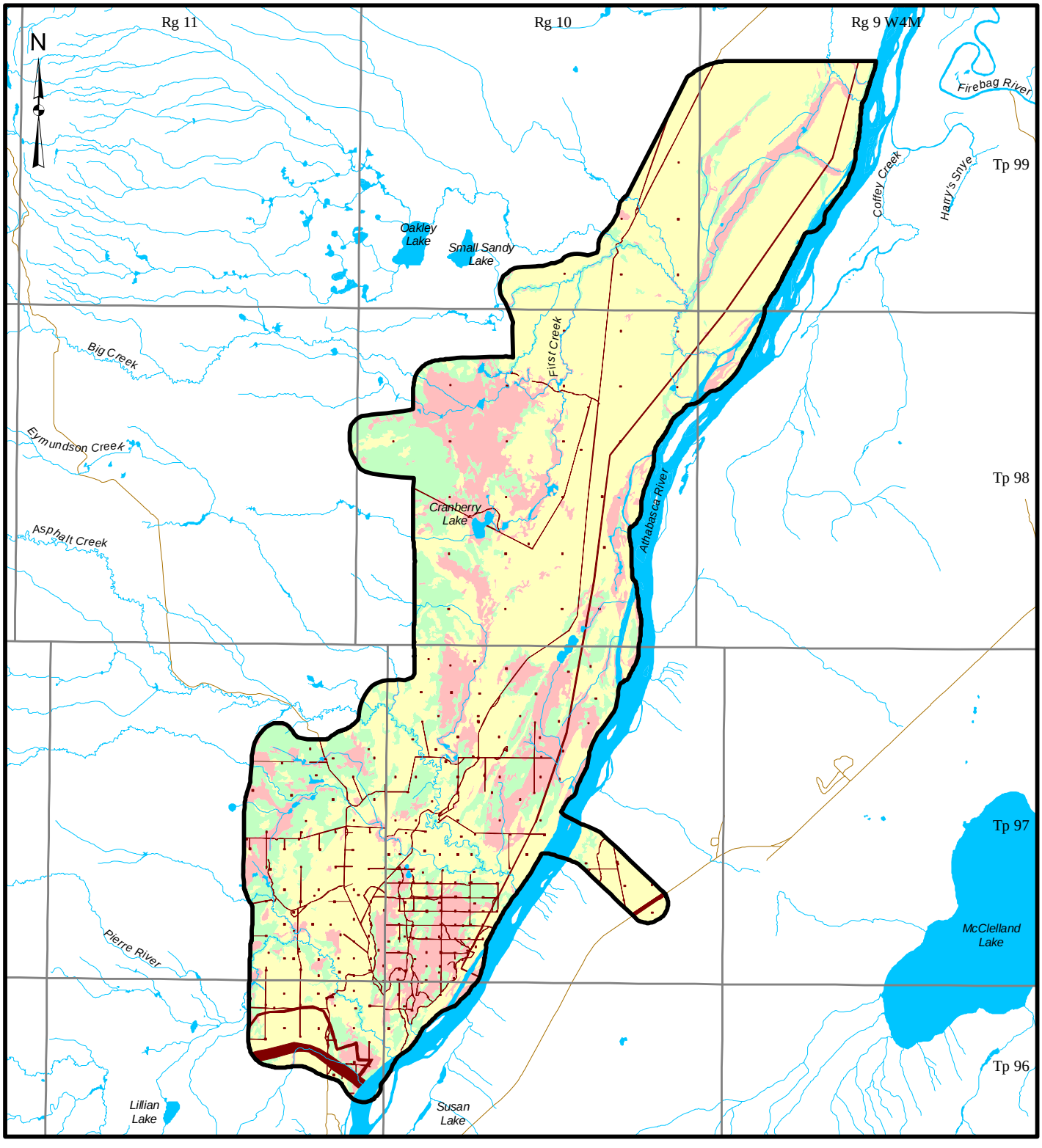
Traditional Plant Potential

There are two RFMAs that correspond with the PRMA LSA. The RFMA holders were interviewed and traditional plant use is detailed in Volume 4, Section 3. The collection of food berries (blueberries, low-bush cranberries, and raspberries) is the primary traditional plant activity. Fiddleheads (young ferns) are also collected as a food and as a digestive aid.

Traditional plant potential within the PRMA LSA is provided in Table 3.6-26 and Figure 3.6-20. There is 11,092 ha of high (52%), 3,490 ha of moderate (17%) and 6,554 ha (31%) of low traditional plant potential habitat within the PRMA LSA.

Table 3.6-26 Area and Percent Cover of Traditional Plant Potential Within the Pierre River Mining Area Local Study Area

Traditional Plant Potential	Local Study Area	
	[ha]	% of LSA
high	11,092	52
moderate	3,490	17
low	6,554	31
Total	**21,136**	**100**



LEGEND

- PIERRE RIVER MINING AREA LOCAL STUDY AREA
- OPEN WATER
- ROAD

RARE PLANT POTENTIAL
- HIGH
- MODERATE
- LOW

DISTURBED
- EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE
- EXISTING AND APPROVED URBAN AND INDUSTRIAL LINEAR DISTURBANCE

REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2004), and Alberta SRD, used under license.
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 12.

4 0 4
SCALE 1:160,000 KILOMETRES

PROJECT
JACKPINE MINE EXPANSION & PIERRE RIVER MINE PROJECT

TITLE
RAREPLANT POTENTIAL WITHIN THE PIERRE RIVER MINING AREA LOCAL STUDY AREA

Shell Canada Limited

PROJECT No. 05-1344-027.7600			SCALE AS SHOWN	REV. 0
DESIGN	VR	10 Aug. 2007		
GIS	JH	14 Nov. 2007		
CHECK	AA	27 Nov. 2007		
REVIEW	TC	27 Nov. 2007		

FIGURE: 3.6-19

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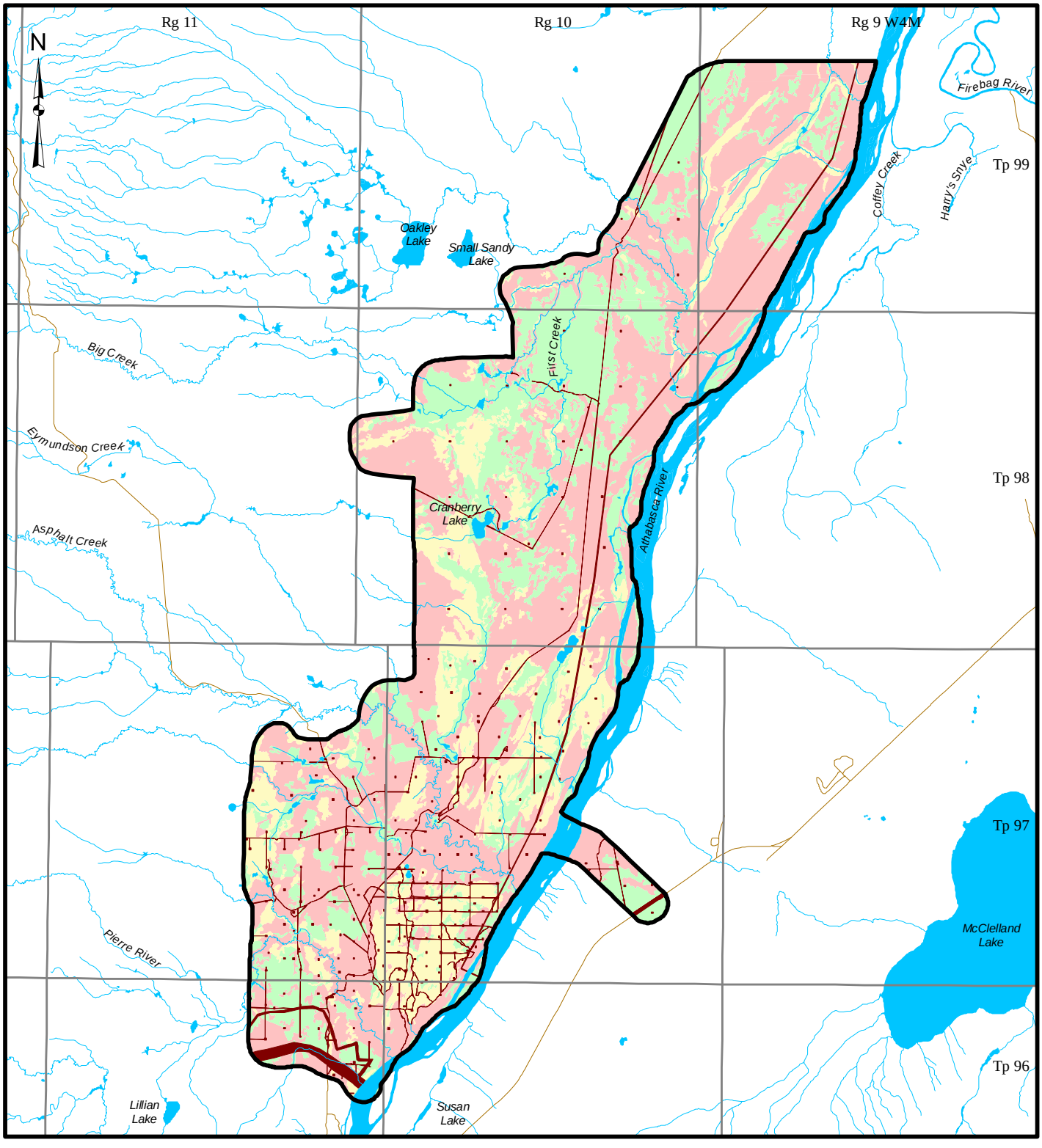

LEGEND

- PIERRE RIVER MINING AREA LOCAL STUDY AREA
- OPEN WATER
- ROAD

TRADITIONAL PLANT POTENTIAL
- HIGH
- MODERATE
- LOW

DISTURBED
- EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE
- EXISTING AND APPROVED URBAN AND INDUSTRIAL LINEAR DISTURBANCE

4 0 4
SCALE 1:160,000 KILOMETRES

REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2004), and Alberta SRD, used under license.
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 12.

PROJECT
JACKPINE MINE EXPANSION & PIERRE RIVER MINE PROJECT

TITLE
TRADITIONAL PLANT POTENTIAL WITHIN THE PIERRE RIVER MINING AREA LOCAL STUDY AREA

Shell Canada Limited

PROJECT No. 05-1344-027.7600			SCALE AS SHOWN	REV. 0
DESIGN	VR	10 Aug. 2007		
GIS	JH	14 Nov. 2007		
CHECK	AA	27 Nov. 2007		
REVIEW	TC	27 Nov. 2007		

FIGURE: 3.6-20

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3.7 SUMMARY

This report described the terrestrial vegetation and wetlands communities in the Terrestrial Resources RSA and Project LSAs for the Project. These study areas are required to adequately describe the potential regional effects of planned projects and local effects from the Project to vegetation and wetlands. Before project assessments can be undertaken, the environmental setting vegetation resources in these study areas must be described and quantified. The information contained in this report was based on interpretation of satellite imagery, 1:20,000 aerial photographs and the results of four vegetation and rare plant surveys completed in June and July of 2006 and 2007 and two vegetation mapping aerial surveys conducted in 2005 and 2006. The description and mapping of the environmental setting for vegetation resources provides the basis for assessing potential impacts of the Project on terrestrial vegetation and wetlands resources.

The RSA is situated within the Central Mixedwood, Upper and Lower Boreal Highlands and the Athabasca Plain natural subregions. All of these subregions occur within the Boreal Natural Region. Regional vegetation is a mixture of wetlands in areas of poor drainage and terrestrial vegetation in better drained locations. Terrestrial vegetation occurs on well to moderately well drained soils and is typically dominated by aspen or mixed stands of aspen, white spruce, balsam poplar and/or white birch. On drier sites with coarse-textured soils, jack pine is the dominant tree species. In poorly drained areas of the regional landscape, there is a diverse range of forested and non-forested wetlands types including peatlands represented by bogs and fens, and non-peatland marshes and swamps.

The RSA covers an area of 2,277,376 ha and is represented by 13 land cover classes. Of this total, terrestrial vegetation covers 800,902 ha (35%) of the RSA while wetlands cover 1,039,328 ha (46%). Existing disturbances and cutblocks account for 181,153 ha (8%) of the RSA. The remaining 255,993 ha (11%) is burnt or represented by lakes and rivers.

Riparian communities within the RSA account for 203,463 ha (9%), while peatlands cover 1,039,328 ha (46%) of the RSA. Potentially productive forest accounts for 800,902 ha (35%) of the RSA. There is 513,982 ha (23%) of high rare plant habitat and 523,910 ha (23%) of high traditional plant habitat within the RSA.

The JEMA LSA falls completely within the Central Mixedwood Natural Subregion and Townships 96 to 97, Ranges 8 to 9, West of the 4th Meridian and covers an area of 18,348 ha. Terrestrial ecosite phases represent 2,362 ha (13%)

of the JEMA LSA. The blueberry jack pine-aspen (b1) ecosite phase is the most common terrestrial vegetation type covering 518 ha (3%) of the JEMA LSA. Wetlands cover 10,884 ha (59%) of the JEMA LSA, the most common of which is the wooded fen (FTNN) wetlands type covering 3,452 ha (19%), followed by shrubby fen (FONS) representing 2,505 ha (14%). Disturbances cover 2,013 ha (11%) of the JEMA LSA including 120 ha (1%) of cutblocks and 1,893 ha (10%) of other disturbances.

In total, 539 plant species were identified within the JEMA LSA. This includes 65 woody species (trees and shrubs), 168 forbs, 67 graminoids, 104 terrestrial bryophytes, 41 terrestrial lichens and 94 epiphytes. The burned wetlands (BUw), shrubby fens (FONS) and wooded fens (FTNN) tended to have among the highest values for vascular species richness.

There were eight rare vascular plant species, 12 rare bryophytes and 31 rare lichen species observed within this LSA. The relatively high number of rare lichens documented within the JEMA LSA is in part due to the fact that the distribution and abundance of lichen flora of Alberta is poorly known, especially in the north and eastern portions of the province.

No rare plant communities were observed within the JEMA LSA; however, a special plant community (lenticular patterened fen) was observed. There is 9,272 ha (51%) of high rare plant potential and 1,870 ha (10%) of high traditional plant potential habitat within the JEMA LSA.

Six non-native and native invasive species (or “weeds”) were found within the JEMA LSA. Two of the weeds were classed as noxious under the *Alberta Weed Control Act*, two other species were classed as nuisance weeds and the other two species were classed as non-native or native invasive species. These species were found in closed forest, open natural habitats and disturbances such as cutblocks and clearings.

Riparian communities account for 1,767 ha (10%) of the JEMA LSA. They are composed mostly of wetlands vegetation and dominated by shrubby swamps. Shrubland (Sh) represents the terrestrial component of riparian communities.

The total amount of old growth forest occupies 840 ha (5%) of the JEMA LSA. All old growth forest in the Jackpine Expansion Mining Area LSA is considered timber productive old growth forest.

The PRMA LSA falls within the Central Mixedwood and Athabasca Plain Natural Subregions and the following townships:

- Township 97, Ranges 10 to 11, W4M;
- Township 98, Ranges 10 to 11, W4M;
- Township 99, Ranges 9 to 11, W4M; and
- Township 100, Ranges 9 to 10, W4M.

Terrestrial ecosite phases represent 14,070 ha (67%) of the PRMA LSA. Central Mixedwood ecosite phases comprise 2,375 ha and Athabasca Plain ecosite phases account for 11,695 ha. The Athabasca Plain Canada buffalo-berry–green alder jack pine-aspen-white birch (b1) ecosite phase is the most common terrestrial vegetation type covering 2,922 ha (14%) of the PRMA LSA. Wetlands cover 5,609 ha (27%) of the PRMA LSA. The most common wetlands type is the wooded fen (FTNN) covering 1,580 ha (7%) of the PRMA LSA, followed by the wooded bog (BTNN) representing 1,186 ha (60%). Disturbances cover 974 ha (5%) of the PRMA LSA including 535 ha (3%) of cutblocks and 439 ha (2%) of other disturbances.

In total, 564 plant species were identified within the PRMA LSA. This includes 68 woody species (trees and shrubs), 187 forbs, 71 graminoids, 84 terrestrial bryophytes, 60 terrestrial lichens and 94 epiphytes. The Central Mixedwood low-bush cranberry aspen-white spruce (d2) ecosite phase had the highest vascular species richness, followed by the Athabasca Plain Canada buffalo-berry–green alder jack pine-aspen-white birch (b1) ecosite phase and the wooded swamp (STNN) wetlands type.

There were six rare vascular plant species, two rare bryophytes and 61 rare lichen species observed within the PRMA LSA. The relatively high number of rare lichens documented within the PRMA LSA is in part due to the fact that the distribution and abundance of lichen flora of Alberta is poorly known, especially in the north and eastern portions of the province.

No rare plant communities were observed within the PRMA LSA; however, two special plant communities were observed. There is 3,920 ha (19%) of high rare plant potential and 11,092 ha (52%) of high traditional plant potential habitat within the PRMA LSA.

Ten non-native and native invasive species (or “weeds”) were found within the PRMA LSA. One weed was classed as noxious under the *Alberta Weed Control Act*, five other species were classed as nuisance weeds and four other species were classed as non-native or native invasive species. These species were found in closed forest, open natural habitats and disturbances such as cutblocks and clearings.

Riparian communities account for 1,615 ha (8%) of the PRMA LSA. They are composed mostly of wetlands vegetation and dominated by shrubby fens (FONS). The Athabasca Plain willow/horsetail aspen-white spruce-black spruce (e2) ecosite phase represents the largest terrestrial component of all riparian communities.

The total amount of old growth forest occupies 2,088 ha (10%) of the PRMA LSA. Timber productive old growth forest occupies 2,072 ha (10%) of the LSA and 99% of all old growth forest. Non-timber productive old growth forest occupies 17 ha (less than 1%) of the PRMA LSA.

Landscape-level indicators were used to measure heterogeneity and fragmentation of the RSA, JEMA LSA and PRMA LSA. Heterogeneity analyses were conducted on regional land cover classes in the RSA and ecosite phases, wetlands types and disturbed areas in the JEMA and PRMA LSAs. Fragmentation analyses were used to evaluate the structure of the environmental setting landscape, by assessing natural and human disturbed areas, forested and non-forested areas, riparian areas and old growth areas.

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APPENDIX H

POTENTIAL RARE PLANTS IN THE OIL SANDS REGION

Submitted to:
Shell Canada Limited

Prepared by:
Golder Associates Ltd.

December 2007 **05-1344-027**

TABLE OF CONTENTS

SECTION **PAGE**

1 POTENTIAL RARE PLANTS FOUND IN NORTHEASTERN ALBERTA OIL SANDS REGION 1

2 RARE PLANT DESCRIPTIONS FOR THE JACKPINE EXPANSION MINING AREA LOCAL STUDY AREA 10

2.1 RARE VASCULAR PLANT SPECIES ON THE ALBERTA NATURAL HERITAGE INFORMATION CENTRE TRACKING LIST 10

2.1.1 Chrysosplenium Iowense – Golden Saxifrage 10

2.1.2 Chrysosplenium Tetrandrum – Green Saxifrage 10

2.1.3 Drosera Linearis – Slender-Leaved Sundew 11

2.1.4 *Nymphaea Tetragona* – White Water-Lily 11

2.1.5 *Pinguicula Villosa* – Small Butterwort (Hairy Butterwort) 12

2.1.6 Sarracenia Purpurea – Pitcher Plant 12

2.1.7 Spiranthes Lacera – Northern Slender Ladies'-Tresses 13

2.2 VASCULAR PLANT SPECIES ON THE ALBERTA NATURAL HERITAGE INFORMATION CENTRE WATCH LIST 13

2.2.1 Carex Lasiocarpa – Hairy-Fruited Sedge 14

2.3 RARE BRYOPHYTE SPECIES ON THE ALBERTA NATURAL HERITAGE INFORMATION CENTRE TRACKING LIST 14

2.3.1 Anastrophyllum Helleranum 14

2.3.2 Calypogeia Integristipula 15

2.3.3 *Conocephalum Conicum* – Snake Liverwort 15

2.3.4 Lophozia Rutheana 15

2.3.5 Pseudobryum Cinclidioides 16

2.3.6 *Splachnum Ampullaceum* – Flagon-Fruited Splachnum 16

2.3.7 Splachnum Luteum – Yellow Collar Moss 16

2.3.8 *Splachnum Sphaericum* – Globe-Fruited Splachnum 17

2.3.9 Warnstorfia Tundrae 17

2.4 RARE BRYOPHYTE SPECIES ON THE ALBERTA NATURAL HERITAGE INFORMATION CENTRE WATCH LIST 18

2.4.1 Calypogeia Sphagnicola 18

2.4.2 Campylium Polygamum 18

2.5 UNRANKED BRYOPHYTE SPECIES IN ALBERTA 19

2.5.1 Plagiochila Porelloides – Cedar-Shake Liverwort 19

2.6 RARE LICHEN SPECIES ON THE ALBERTA NATURAL HERITAGE INFORMATION CENTRE TRACKING LIST 19

2.6.1 Arthonia Patellulata 19

2.6.2 *Bryoria Simplicior* – Old Man's Beard 20

2.6.3 Candelariella Efflorescens – Powdery Goldspeck Lichen 20

2.6.4 Flavopunctelia Soredica – Powder-Edged Speckled Greenshield 21

2.6.5 Imshaugia Placorodia – American Starburst Lichen 21

2.6.6 Lecanora Expallens 21

2.6.7 Lecanora Subintricata 22

2.6.8 Lecidella Elaeochroma 22

2.6.9 Melanelia Trabeculata 23

2.6.10 Ochrolechia Gowardii 23

2.6.11 Ramalina Dilacerata – Punctured Ramalina 24

2.6.12 Ramalina Intermedia – Rock Ramalina 24

2.6.13 Rinodina Metaboliza 25

2.7 LICHEN SPECIES UNRANKED BY THE ALBERTA NATURAL HERITAGE INFORMATION CENTRE....25
2.7.1 Candelariella Lutella....25
2.7.2 Cliostomum Pallens....25
2.7.3 Lecanora Boligera....26
2.7.4 Lecanora Laxa....26
2.7.5 Lecanora Persimilis....27
2.7.6 Lecidea Amaurospoda....27
2.7.7 Lecidea Leprarioides....27
2.7.8 Lecidea Nylanderi....28
2.7.9 *Leptorhaphis Epidermidis* – Birchbark Dot Lichen....28
2.7.10 Micarea Denigrata....28
2.7.11 Micarea Sylvicola....29
2.7.12 Rinodina Disjuncta....29
2.7.13 Rinodina Orculata....29
2.7.14 Scoliciosporum Perpusillum....30
2.7.15 Scoliciosporum Umbrinum....30
2.7.16 *Stenocybe Pullatula* – Alder Stickpin....31
2.7.17 *Tuckermannopsis Orbata* – Variable Wrinkle-Lichen....31

3 RARE PLANT DESCRIPTIONS FOR THE PIERRE RIVER MINING AREA LOCAL STUDY AREA....33
3.1 RARE VASCULAR PLANT SPECIES ON THE ALBERTA NATURAL HERITAGE INFORMATION CENTRE TRACKING LIST....33
3.1.1 *Carex Umbellata* – Umbellate Sedge....33
3.1.2 *Cypripedium Acaule* – Stemless Lady's-Slipper....33
3.1.3 *Sarracenia Purpurea* – Pitcher Plant....34
3.1.4 *Spiranthes Lacera* – Northern Slender Ladies'-Tresses....35
3.2 VASCULAR PLANT SPECIES ON THE ALBERTA NATURAL HERITAGE INFORMATION CENTRE WATCH LIST....35
3.2.1 Carex Lasiocarpa – Hairy-Fruited Sedge....36
3.2.2 *Coptis Trifolia* – Goldthread....36
3.3 VASCULAR SPECIES UNRANKED BY THE ALBERTA NATURAL HERITAGE INFORMATION CENTRE....37
3.3.1 Leucophysalis Grandiflora – Large White-Flowered Ground Cherry....37
3.4 RARE BRYOPHYTE SPECIES ON THE ALBERTA NATURAL HERITAGE INFORMATION CENTRE TRACKING LIST....37
3.4.1 Calypogeia Muelleriana – Mueller's Puchwort....38
3.5 BRYOPHYTE SPECIES UNRANKED BY THE ALBERTA NATURAL HERITAGE INFORMATION CENTRE....38
3.5.1 Plagiochila Porelloides – Cedar-Shake Liverwort....38
3.6 RARE LICHEN SPECIES ON THE ALBERTA NATURAL HERITAGE INFORMATION CENTRE TRACKING LIST....39
3.6.1 Arthonia Patellulata....39
3.6.2 Bryoria Simplicior – Old Man's Beard....39
3.6.3 Cyphelium Tigillare....40
3.6.4 Imshaugia Placorodia – American Starburst Lichen....40
3.6.5 Lecanora Subintricata....41
3.6.6 Lecidella Elaeochroma....41
3.6.7 Melanelia Trabeculata....42
3.6.8 Nephroma Bellum – Alpine Kidney Lichen....43
3.6.9 Ramalina Dilacerata – Punctured Ramalina....43
3.6.10 Ramalina Obtusata – Hooded Ramalina....44
3.6.11 Rinodina Metaboliza....44

3.6.12 Trapeliopsis Flexuosa 45
3.6.13 Usnea Scabiosa 45
3.7 LICHEN SPECIES UNRANKED BY THE ALBERTA NATURAL HERITAGE INFORMATION CENTRE 45
3.7.1 Biatora Carneoalbida 46
3.7.2 Candelariella Lutella 46
3.7.3 Cladonia Ochrochlora – Smooth-Footed Powderhorn 46
3.7.4 Cliostomum Pallens 47
3.7.5 Lecanora Boligera 47
3.7.6 Lecanora Laxa 47
3.7.7 Lecanora Persimilis 48
3.7.8 Lecidea Leprarioides 48
3.7.9 Lecidea Nylanderi 48
3.7.10 Lecidea Porphyrospoda 49
3.7.11 Micarea Denigrata 49
3.7.12 Micarea Prasina 49
3.7.13 Micarea Sylvicola 50
3.7.14 Phaeocalicium Compressulum – Alder Needles 50
3.7.15 Phlyctis Argena 51
3.7.16 Rhindina Anomala 51
3.7.17 Rinodina Capensis 51
3.7.18 Rinodina Disjuncta 51
3.7.19 Rinodina Orculata 52
3.7.20 Scoliciosporum Perpusillum 52
3.7.21 Scoliciosporum Umbrinum 53
3.7.22 Stenocybe Pullatula – Alder Stickpin 53
3.7.23 Tuckermannopsis Orbata – Variable Wrinkle-Lichen 54
3.7.24 Usnea Angulata 54

LIST OF TABLES

Table H-1 Potential Rare Vascular Plant Species in the Northeastern Alberta Oil Sands Region 1
Table H-2 Potential Rare Non-Vascular Plant Species Within the Northeastern Alberta Oil Sands Region 5

1 POTENTIAL RARE PLANTS FOUND IN NORTHEASTERN ALBERTA OIL SANDS REGION

An Alberta Natural History Information Centre (ANHIC) Element Occurrence Record (EOR) was conducted to identify potential rare plants in the Oil Sands Region (ANHIC 2006d). Table H-1 identifies potential rare vascular plants in the region, where Table H-2 identifies non-vasculars (bryophytes and lichens).

Table H-1 Potential Rare Vascular Plant Species in the Northeastern Alberta Oil Sands Region

Scientific Name	Common Name	ANHIC Rank[(a)]	Habitat Information
Shrub			
Salix tyrrellii	Tyrrell's willow	G5T2 S1	active sand dunes south of Lake Athabasca (Argus and Steele 1979)
Forb (Dicot)			
Arabidopsis salsuginea	mouse-ear cress	G4G5 S1	saline areas by springs and lakes; open, sandy alkaline soils in dry lakes; salt plains and meadows (Kershaw et al. 2001)
Artemisia tilesii	Herriot's sagewort	G5 S2	open woods and river flats; open, rocky or gravelly alpine slopes; heathlands (Kershaw et al. 2001)
Astragalus bodinii	Bodin's milk vetch	G4 S1	moist meadows and gravel banks; thickets; disturbed areas along roads (Kershaw et al. 2001)
Brasenia schreberi	watershield	G5 S1	shallow, calm or slow-moving water (Kershaw et al. 2001)
Campanula aparinoides	marsh bellflower	G5 S1	bogs, swamps, sedge meadows and thickets (Curtis 1959)
Cardamine pratensis	meadow bitter cress	G5 S2	moist meadows; swamps; calcareous shallow water; springs, wooded swamps, meadows and thickets; along creeks (Kershaw et al. 2001)
Chrysosplenium iowense	golden saxifrage	G3 S3	moist, shady sites, especially on nutrient-rich soil and in wetlands (Johnson et al. 1995)
Chrysosplenium tetrandrum	green saxifrage	G5 S3	moist, shady sites, especially on nutrient-rich soil and in wetlands (Johnson et al. 1995)
Drosera linearis	slender-leaved sundew	G4 S2	bogs; marly sites; requires alkaline conditions; wet, calcareous shores (Kershaw et al. 2001)
Elatine triandra	waterwort	G5 S1	shallow water and mud flats by ponds and slow moving streams (Kershaw et al. 2001)
Epilobium halleanum	willowherb	G5 S1	moist ground; moist coniferous forests (Kershaw et al. 2001)
Eupatorium maculatum	spotted Joe-pye weed	G5 S1S2	wet to moist meadows and open woods (Kershaw et al. 2001)
Gentianopsis detonsa ssp raupii	northern fringed gentian	G3G5T3T5 S1	wet meadows and saline flats (Kershaw et al. 2001)
Hypericum majus	large Canada St. John's-wort	G5 S2	wet sites in the plains, foothills and boreal forest (Kershaw et al. 2001)
Lactuca biennis	tall blue lettuce	G5 S2	moist woods and clearings; swampy sites; hot springs (Kershaw et al. 2001)
Lobelia dortmanna	water lobelia	G4G5 S1	shallow water near the edges of ponds, lakes and on sandy shores; gravelly, silty or muddy bottoms, sometimes deeply submersed but with flower stalks above water (Kershaw et al. 2001)
Nymphaea leibergii	pygmy water-lily	G5 S1	quiet streams, ponds and lakes (Kershaw et al. 2001)

Table H-1 Potential Rare Vascular Plant Species in the Northeastern Alberta Oil Sands Region (continued)

Scientific Name	Common Name	ANHIC Rank[(a)]	Habitat Information
Nymphaea tetragona	white water-lily	G5 S1	ponds, lakes and quiet streams (Kershaw et al. 2001)
Physostegia ledinghamii	false dragonhead	G3? S2	moist woods and streambanks; lake shores and marshes (Kershaw et al. 2001)
Plantago maritima	sea-side plantain	G5 S1	saline marshes and alkaline soil (Kershaw et al. 2001)
Polygala paucifolia	fringed milkwort	G5 S1	moist coniferous woods or mixedwoods (Kershaw et al. 2001)
Potentilla multifida	branched cinquefoil	G5 S1	gravel bars; open slopes; scree slopes; open gravelly or sandy ground often near streams and lakes or on roadsides (Kershaw et al. 2001)
Sarracenia purpurea	pitcher-plant	G5 S2	wetlands, usually with *Sphagnum* moss (Kershaw et al. 2001)
Spergularia salina	salt-marsh sand spurry	G5 S2	brackish or saline mud and sands (Kershaw et al. 2001)
Stellaria arenicola	sand-dune chickweed	G5T3 S1	shifting sand of sand dunes (Kershaw et al. 2001)
Tanacetum bipinnatum ssp huronense	Indian tansy	G5T4T5 S2	sandy or gravelly shores, sand dunes and gravel bars (Kershaw et al. 2001)
Utricularia cornuta	horned bladderwort	G5 S1	poor fens, muddy shores and calcareous wetlands (Kershaw et al. 2001)
Viola pallens	Macloskey's violet	G5T5 S2	wet ground in moist woods; coniferous stands and bogs on *Sphagnum* hummocks; swamps, wet thickets, hollows, crevices and meadows (Kershaw et al. 2001)
Forb (Monocot)			
Cypripedium acaule	stemless lady's-slipper	G5 S3	wetlands, woods and sand dunes; sites with acidic soil and light shade including sand ridges, jack pine woods and *Sphagnum* bogs (Kershaw et al. 2001)
Liparis loeselii	Loesel's twayblade	G5 S1	fens, wet sandy meadows, marly and sandy lakeshores, ditches, abandoned gravel pits and old fields; prefers sterile, moist conditions; upland deciduous forests (Whiting and Catling 1986)
Malaxis monophylla	white adder's-mouth	G5 S2	damp woods, thickets and the drier parts of bogs and fens (Kershaw et al. 2001)
Malaxis paludosa	bog adder's-mouth	G4 S1	mossy ground in bogs and fens (Kershaw et al. 2001)
Najas flexilis	slender naiad	G5 S1S2	ponds and streams; clear, shallow to deep fresh or brackish water (Kershaw et al. 2001)
Potamogeton foliosus	leafy pondweed	G5 S2	shallow, standing water (Kershaw et al. 2001)
Potamogeton obtusifolius	blunt-leaved pondweed	G5 S2	shallow lakes and ponds, in organic sediment (Kershaw et al. 2001)
Potamogeton strictifolius	linear-leaved pondweed	G5 S2	shallow lakes and ponds (Kershaw et al. 2001)
Sagittaria latifolia	broad-leaved arrowhead	G5 S1	ponds, lakes and ditches (Kershaw et al. 2001)
Sisyrinchium septentrionale	pale blue-eyed grass	G3G4 S2S3	moist meadows and grassy streambanks (Kershaw et al. 2001)
Sparganium hyperboreum	northern bur-reed	G5 S1	shallow water up to 50 cm deep (Kershaw et al. 2001)
Spiranthes lacera	northern slender ladies'-tresses	G5 S1	dry, rocky, open woods; grassy areas in or near jack pine/lichen forests (Kershaw et al. 2001)

Table H-1 Potential Rare Vascular Plant Species in the Northeastern Alberta Oil Sands Region (continued)

Scientific Name	Common Name	ANHIC Rank[(a)]	Habitat Information
Fern or Fern Ally			
Botrychium lanceolatum	lance-leaved grape fern	G5 S2	moist open woodlands, meadows and roadsides; occasionally present in closed canopy coniferous forests (Farrar 2006a)
Botrychium michiganense	–	G1 SU	gravel pits; ditches and roadsides (Chadde and Kudray 2001); herbaceous openings; moist to dry brush fields (Wilfahrt 2001)
Botrychium minganense	Mingan grape fern	G4 S2S3	variety of habitats (Kershaw et al. 2001); dense forest, dry meadows, fens, seeps and old disturbances such as logging roads and road shoulders (Farrar 2006b)
Botrychium pinnatum	–	G4? S1	closed canopy forests but commonly in moist, grassy sites in open forests and meadows; near streams and other sites where soil moisture is constant (Farrar 2006c)
Cystopteris montana	mountain bladder fern	G5 S2	damp, calcareous sites by springs or along streams in mixed or coniferous forests (Kershaw et al. 2001)
Diphasiastrum sitchense	ground-fir	G5 S2	open woods and alpine tundra (Kershaw et al. 2001); jack pine-black spruce forest on sandy to sandy loam soil (Golder 2003)
Dryopteris filix-mas	male fern	G5 S1	moist, wooded slopes (Kershaw et al. 2001)
Gymnocarpium disjunctum	–	G4 S1	shaded, rocky slopes and ravines, mixed coniferous woods, moist stream and creek banks (Flora of North America Editorial Committee, 1993)
Huperzia selago	mountain club-moss	G5 S1	bogs and cold woods; moist tundra (Kershaw et al. 2001)
Isoetes echinospora	northern quillwort	G5? S1	submerged in clear, nutrient-poor, non-calcareous lakes and ponds in shallow water up to 1 m deep (Kershaw et al. 2001)
Lycopodiella inundata	bog club-moss	G5 S1	*sphagnum* bogs; sandy shores and in marshes and other wet sites (Kershaw et al. 2001)
Pellaea glabella	smooth cliff brake	G5 S2	calcareous cliffs and ledges, usually on limestone (Flora of North America Editorial Committee, 1993)
Pellaea glabella ssp simplex	–	G5T4? S2	calcareous cliffs and ledges, usually on limestone (Flora of North America Editorial Committee,1993)
Grass			
Danthonia spicata	poverty oat grass	G5 S1S2	sandy and rocky sites; dry woods; moist meadows; dry prairie (Kershaw et al. 2001)
Muhlenbergia racemosa	marsh muhly	G5 S1	dry sandy hills, slopes and eroded banks; prairies, meadows, streambanks, edges of woodland, dry rocky slopes and waste areas (Kershaw et al. 2001)
Panicum acuminatum	hot-springs millet	G5 SU	marshy places, around hot springs; moist, sandy soil at woodland edges (Kershaw et al. 2001)
Spartina pectinata	prairie cord grass	G5 S1	saline shores and marshes; moist prairie, riverbanks and shores and in ditches and marshes (Kershaw et al. 2001)
Sedge			
Blysmus rufus	red bulrush	G5 S1	saline marshes (Kershaw et al. 2001)
Carex adusta	browned sedge	G5 S1	dry, acidic, sandy soil in pine stands; disturbed sandy areas (Kershaw et al. 2001)
Carex backii	Back's sedge	G4 S2	dry to moist closed-canopied woods; riparian forests (Kershaw et al. 2001)
Carex heleonastes	Hudson Bay sedge	G4 S2	calcareous fens and marshes (Kershaw et al. 2001)
Carex houghtoniana	sand sedge	G5 S2	dry, acidic, sandy or gravelly soils; often in pine forests (Kershaw et al. 2001)
Carex lacustris	lakeshore sedge	G5 S2	marshes; swampy woods; lakeshores (Kershaw et al. 2001)

Table H-1 Potential Rare Vascular Plant Species in the Northeastern Alberta Oil Sands Region (continued)

Scientific Name	Common Name	ANHIC Rank[(a)]	Habitat Information
Carex oligosperma	few-fruited sedge	G5? S1S2	wet meadows and bogs (Kershaw et al. 2001); open-canopied bog (Golder 2003)
Carex umbellata	umbellate sedge	G5 S1	open woods (mainly pine); disturbed sandy areas (Kershaw et al. 2001)
Carex vulpinoidea	fox sedge	G5 S2	swamps and wet meadows; requires wet but not permanently saturated non-saline, non-acid soils (Kershaw et al. 2001)
Eleocharis compressa var borealis	flattened spike-rush	G5T5 S1	wet places, usually neutral or calcareous conditions (Kershaw et al. 2001)
Eleocharis tenuis	slender spike-rush	G5 SU	wet places, usually neutral or calcareous conditions (Kershaw et al. 2001)
Scirpus pallidus	pale bulrush	G5 S1	marshes and wet meadows (Kershaw et al. 2001)
Rush			
Juncus brevicaudatus	short-tail rush	G5 S2	marshes and shores (Kershaw et al. 2001)
Juncus stygius var americanus	marsh rush	G5T5 S2	fens; mossy areas around springs and seepages (Kershaw et al. 2001)

[(a)] Rare plant status ranks according to the Alberta Heritage Information Centre (Gould 2006); G = global; S = Alberta. Refer to Section 2.3.5.4 for rank definitions.

– = No common name.

Note: List of species from ANHIC (2006d).

Table H-2 Potential Rare Non-Vascular Plant Species Within the Northeastern Alberta Oil Sands Region

Scientific Name	Common Name	ANHIC Rank[(a)]	Habitat Information
Mosses			
Aloina brevirostris	short-beaked rigid screw moss	G3G5 S2	bare calcareous silt, road banks and river bluffs (Crum and Anderson 1981)
Amblyodon dealbatus	moss	G3G5 S2	calcareous substrates (Belland 2005)
Anomodon minor	moss	G5 S1	on tree bark, calcareous rock, logs and stumps (Crum and Anderson 1981)
Blindia acuta	sharp-pointed weissia	G5 S2	crevices of cliffs and boulders in wet, shaded habitats along streams, typically submerged when the water is high (Crum and Anderson 1981)
Brachythecium frigidum	moss	G4 SU	common on logs (Vitt et al. 1988)
Brachythecium rutabulum	moss	G5 S2?	mesic to dry habitats on logs, humus and soil (AXYS 2005)
Bryum algovicum	moss	G4G5 S2	on calcareous soil, sand or gravel; on rock in seeps (Crum and Anderson 1981)
Bryum cyclophyllum	moss	G4G5 S2	wet soil on ditch edges; among tree roots that are submerged (Crum and Anderson 1981)
Bryum flaccidum	moss	G5 SU	no information available
Bryum pallens	moss	G4G5 S2	wet soil or peat humus (AXYS 2001)
Bryum uliginosum	moss	G3G5 S2	–
Callicladium haldanianum	moss	G5 S1	on hardwood trees (McGee and Kimmerer 2002)
Campylium radicale	moss	G3G5 S2	over decaying leaves and humus; bog (Vitt and Belland 1995)
Conardia compacta	moss	G3G5 S2	wetlands edges where the topography is flat to slight sloping (COSEWIC 2007)
Dicranum ontariense	cushion moss	G4G5 S1	humus, soil or soil over rock; usually in mesic to dry coniferous woods; sometimes swamps and bogs (Peterson 1977)
Dicranum spadiceum	cushion moss	G5? S2	fens, wet meadows and willow thickets; humus or soil on or around rocks at lake margins; occasionally drier habitats, such as beach ridges (Ireland 2002, website)
Drepanocladus sendtneri	brown moss	G5? S1	flark (Vitt and Belland 1995)
Entodon schleicheri	moss	G3G5 S1	old growth forest (AXYS 2005)
Fontinalis antipyretica	moss	G5 S1	submerged in shallow, flowing water (Crum and Anderson 1981)
Funaria americana	cord moss	G3? S1	exposed calcareous soils among loosely tufted grasses; moist, disturbed habitat (Miller and Miller 2006 internet site)
Hygroamblystegium noterophilum	moss	G4 SU	on calcareous rocks, submerged in shallow running water (Crum and Anderson 1981)
Hygroamblystegium tenax	moss	G5 S2	on wet rocks in and beside streams (Crum and Anderson 1981)
Hypnum callichroum	moss	G5? S1	–
Hypnum pallescens	moss	G5 S2	on rocks and tree trunks (Crum and Anderson 1981)
Leptodictyum humile	moss	G5 S1	–
Limprichtia cossonii	moss	GU SU	–
Meesia longiseta	moss	G4? S1	patterned moderate rich fen (Vitt and Belland 1995)
Mnium ambiguum	moss	G5 S2	–
Myurella tenerrima	moss	G3G4 S2	calcareous rock crevices; occasionally in forested fen depressions (Vitt et al. 1988)
Neckera pennata	moss	G5 S2S3	on rocks in the interior B.C. and on trees near coastal B.C. (Vitt et al. 1988)

Table H-2 Potential Rare Non-Vascular Plant Species Within the Northeastern Alberta Oil Sands Region (continued)

Scientific Name	Common Name	ANHIC Rank[(a)]	Habitat Information
Plagiomnium ciliare	moss	G5 S2	–
Plagiomnium rostratum	moss	G5 S1	–
Polytrichum longisetum	slender hairy-cap	G5 S1	acid soil and humus; moist coniferous woods (Smith Merrill 2006, website)
Pseudobryum cinclidioides	moss	G5 S2	bog, swamp and poor fen (Vitt and Belland 1995)
Pseudoleskea patens	moss	G5 S2	–
Pseudoleskeella sibirica	moss	G5? S2	sheltered spots; usually on calcareous rock (AXYS 2005)
Racomitrium microcarpon	moss	GNRQ S1?	–
Rhizomnium magnifolium	moss	G4G5 S2	–
Rhodobryum ontariense	moss	G5 S2	on calcareous soil or soil-covered rocks often in deciduous woods (AXYS 2005)
Schistidium agassizii	elf bloom moss	G3G5 S1	–
Seligeria calcarea	chalk brittle moss	G4? S1	–
Sphagnum balticum	peat moss	G2G4 S1	bog and poor fen (Vitt and Belland 1995)
Sphagnum compactum	neat bog moss	G5 S2	patterned fen (Vitt and Belland 1995)
Sphagnum contortum	twisted bog moss	G5 S2	moderate rich fen (AXYS 2005)
Sphagnum fallax	peat moss	G5 S2	bog and poor fen (Vitt and Belland 1995)
Sphagnum fimbriatum	fringed bog moss	G5 S2	moderate rich fen (Vitt and Belland 1995)
Sphagnum lindbergii	Lindberg's bog moss	G5? S2	bog and poor fen (Vitt and Belland 1995)
Sphagnum platyphyllum	moss	G5 S1	in shallow water at edges of waterbodies; sedge meadows; eutrophic habitats (AXYS 2005)
Splachnum ampullaceum	flagon-fruited splachnum	G5 S2	on animal dung in muskeg (Vitt et al. 1988)
Splachnum luteum	yellow collar moss	G3 S3	on animal dung in muskeg (Vitt et al. 1988)
Splachnum rubrum	red collar moss	G3 S3	on animal dung in muskeg (Vitt et al. 1988)
Splachnum sphaericum	globe-fruited splachnum	G3G5 S2	on animal dung in muskeg (Vitt et al. 1988)
Splachnum vasculosum	large-fruited splachnum	G3G5 S2	on animal dung in muskeg (AXYS 2005)
Tayloria serrata	slender splachnum	G4 S2	–
Thuidium philibertii	moss	G5 S1S2	–
Warnstorfia pseudostraminea	brown moss	G3 S1	poor fens and pools (AXYS 2001)
Warnstorfia tundrae	brown moss	GU S2	moderate rich fen (Vitt and Belland 1995)
Weissia controversa	green-cushioned weissia	G5 S2	–
Zygodon viridissimus	moss	G5 S1	on tree trunks and boulders, in spruce-fir forests and in lowland hardwoods (Crum and Anderson 1981)

Table H-2 Potential Rare Non-Vascular Plant Species Within the Northeastern Alberta Oil Sands Region (continued)

Scientific Name	Common Name	ANHIC Rank[(a)]	Habitat Information
Liverworts			
Anastrophyllum helleranum	liverwort	G5 S2	–
Barbilophozia kunzeana	liverwort	G5 S2	calcareous substrates (National Botanic Gardens of Ireland 1995, website)
Blasia pusilla	liverwort	G5 S1	–
Calypogeia suecica	liverwort	G5 S1	dead wood on the forest floor (Odor 2005)
Cephalozia loitlesbergeri	liverwort	G5 S1	bogs (Cain and Fulford 1948)
Cephaloziella hampeana	liverwort	G5 S1	bogs (Vitt and Belland 1995)
Chiloscyphus pallescens	liverwort	G5 S1	on moist rotting wood, soil and sandstone (Hall 1958)
Chiloscyphus polyanthos	liverwort	G5 S1	–
Conocephalum conicum	liverwort	G5 S2	constantly moist, sandy substrates or on acidic rock surfaces; usually under overhanging rock cliffs near waterfalls and rushing streams (Vitt et al. 1988)
Gymnocolea inflata	liverwort	G5 S1	poor fen (Vitt and Belland 1995)
Lophozia guttulata	liverwort	G4G5 S2	rock outcrops, lakeshores, treed fens and *Sphagnum* wetlands (AXYS 2005)
Lophozia heterocolpos	liverwort	G5 S2	–
Lophozia incisa	liverwort	G5 S2	decaying logs and organic soils (AXYS 2005)
Lophozia laxa	liverwort	G4 S1	rich fen (Ryan 1996)
Lophozia longidens	liverwort	G5 S1	rotting logs (Vitt et al. 1988)
Lophozia obtusa	liverwort	G4G5 S1	patterned fen (Vitt and Belland 1995)
Lophozia rutheana	liverwort	G4? S1	poor fen and patterned fen (Vitt and Belland 1995)
Pellia endiviifolia	liverwort	G5 S2	inorganic soil along streams, on lake margins and sedge hummocks in swampy areas (Vitt et al. 1988)
Riccardia latifrons	liverwort	G4G5 S2	bogs (Vitt and Belland 1995)
Riccardia multifida	liverwort	G5 S2S3	on moist, shady sites; on wet rocks; marly wetlands, swamps, fens and calcareous ditches (AXYS 2005)
Riccardia palmata	liverwort	G5 S1	–
Riccia cavernosa	liverwort	G5 S1	on disturbed, exposed, moist and compact soils (AXYS 2005)
Riccia fluitans	liverwort	G5 S2	in water and along the shorelines of slow-moving streams (AXYS 2005)
Scapania apiculata	liverwort	G5? S1	on moist logs in mixed and coniferous forests; limestone outcrops (AXYS 2005)
Scapania cuspiduligera	liverwort	G5 S2	crevices of calcareous rocks (Vitt et al. 1988)
Scapania glaucocephala	liverwort	G4G5 S2	–
Scapania paludicola	liverwort	G5 S2	spruce muskeg; on humus and *Sphagnum* in bogs (Ryan 1996)
Scapania paludosa	liverwort	G5 S2	calcareous bogs; margins of streams (AXYS 2005)
Terrestrial Lichens			
Cladina portentosa	lichen	G? S1	dry or wet habitats; bog hummocks (Brodo et al. 2001)
Cladina stygia	lichen	G5 S1	bogs or wet sites in the open (Brodo et al. 2001)
Cladonia bacilliformis	lichen	G3G4 S2S3	over decaying wood and occasionally over moss (Goward 1999, website)
Cladonia bellidiflora	lichen	G5 S2S3	on rotting wood, stumps, moss or soil (Brodo et al. 2001)

Table H-2 Potential Rare Non-Vascular Plant Species Within the Northeastern Alberta Oil Sands Region (continued)

Scientific Name	Common Name	ANHIC Rank[(a)]	Habitat Information
Cladonia cyanipes	lichen	G? S2	over mossy rock (Goward 1999, website)
Cladonia macrophylla	lichen	G? S2	over humus and mossy rock (Goward 1999, website)
Cladonia ramulosa	lichen	G? S1	rotting logs and stumps (Thomson 2003)
Cladonia rei	lichen	G? S2	on soil or wood in the open (Brodo et al. 2001)
Cladonia squamosa	lichen	G5 S2	over acidic soil, moss, mossy rock and occasionally decaying wood and conifer bark at the base of trees (Goward 1999, website)
Peltigera horizontalis	lichen	G5 S1S2	on mossy soil, logs and rocks in forests (Brodo et al. 2001)
Peltigera polydactyla	lichen	G5 S1S2	logs, soil, moss, mossy rock and tree bases (Thomson 2003)
Stereocaulon condensatum	lichen	G4 S1	sandy soil (Thomson 2003)
Epiphytic Lichens and Other Lichen Forms			
Arctoparmelia separata	lichen	S1	on beach rocks (Geiser et al. 1998)
Arthonia patellulata	lichen	G? S3?	on bark of deciduous trees, particularly aspen (Johnson et al. 1995; Brodo et al. 2001)
Bacidia bagliettoana	lichen	G? S2	aspen trunks; on bark and mosses on the north side of the tree (Case 1977)
Bryoria nadvornikiana	old man's beard	G? S2	deeply shaded or open boreal woodlands on conifers and birch (Brodo et al. 2001)
Bryoria simplicior	old man's beard	G? S2S3	on conifers, birch and occasionally on old wood (Johnson et al. 1995)
Bryoria trichodes	old man's beard	G3G5 SU	on conifers and birch in forests; in open bogs and along lake shores (Brodo et al. 2001)
Cyphelium tigillare	lichen	G? S2	on wood (Thompson 2003)
Dermatocarpon moulinsii	lichen	G? S2	on steep surface, southwest facing (Ryan 1990)
Flavopunctelia soredica	lichen	G? S2	on bark in open woods (Brodo et al. 2001)
Imshaugia placorodia	lichen	G? S2	bark of pine trees and Douglas-fir; on wood (Brodo et al. 2001)
Lecanora cateilea	lichen	G? S2	on willow (Geiser et al. 1998)
Lepraria incana	lichen	G? S2	on bark and sandstone (Thomson 2003)
Melanelia olivacea	lichen	G? S1	on bark especially birch (Brodo et al. 2001)
Melanelia panniformis	lichen	G? S1	on non-calcereous rock (Brodo et al. 2001)
Micarea denigrata	lichen	SNR	on wood and stumps (Thomson 2003)
Mycobilimbia sabuletorum	lichen	G? S2	on moss over rocks, especially calcareous rocks; on mossy tree bases and sometimes directly on bark (Brodo et al. 2001)
Mycoblastus affinis	lichen	G? S2	on bark (Geiser et al. 1998)
Nephroma bellum	lichen	G? S2	on branches and twigs of trees especially conifers; on mossy rocks in humid forests (Brodo et al. 2001)
Pannaria conoplea	lichen	G3G4 SNR	on bark; less frequently on rock (Brodo et al. 2001)
Phaeophyscia adiastola	lichen	G4 S1	shaded, mossy granitic rocks; on bark, especially hardwood trees (Brodo et al. 2001)
Phaeophyscia endococcina	lichen	S2?	on rocks and among mosses on rocks (Geiser et al. 1998)
Phaeophyscia nigricans	lichen	S2	on bark and rock (Thomson 2003)
Physcia tenella	lichen	G4 S2	on twigs, bark and rock (Brodo et al. 2001)

Table H-2 Potential Rare Non-Vascular Plant Species Within the Northeastern Alberta Oil Sands Region (continued)

Scientific Name	Common Name	ANHIC Rank[(a)]	Habitat Information
Placynthiella uliginosa	lichen	G? S2	on consolidating soil (Kneiper 2005, website)
Ramalina dilacerata	lichen	G? S2	on twigs and branches of various trees in the open (Brodo et al. 2001)
Ramalina farinacea	lichen	G? S2S3	on trees and shrubs (Brodo et al. 2001)
Ramalina obtusata	lichen	G? S2	on trees and rocks (Brodo et al. 2001)
Ramalina sinensis	lichen	G? SU	on twigs and branches of trees and shrubs in the open (Brodo et al. 2001)
Rinodina exigua	lichen	G? S1	on aspen (Jonescu 1970)
Umbilicaria muehlenbergii	lichen	G? S2	on boulders and steep rock walls in forests and in the open (Brodo et al. 2001)

[(a)] Rare plant status ranks according to the Alberta Heritage Information Centre (Gould 2006); G = global; S = Alberta. Refer to Section 2.3.5.4 for rank definitions. List of species from ANHIC (2006d).

– = No habitat information available.

2 RARE PLANT DESCRIPTIONS FOR THE JACKPINE EXPANSION MINING AREA LOCAL STUDY AREA

2.1 RARE VASCULAR PLANT SPECIES ON THE ALBERTA NATURAL HERITAGE INFORMATION CENTRE TRACKING LIST

The ANHIC tracking list include plants that are of high priority because they are rare or of conservation concern in some other way (Gould 2006). They are most commonly ranked S1, S2 or occasionally S3. See Section 3.3.6 of the ESR for an explanation of ANHIC rankings. The text below provides descriptions of each species' characteristic vegetation type and distribution ranges.

2.1.1 Chrysosplenium Iowense – Golden Saxifrage

Golden saxifrage, a member of the Saxifragaceae family, generally appears as golden-yellow in colour, but may also be green. Its prominent differentiation from the similar looking green saxifrage is the conspicuous venation on the upper surface of the leaves. Leaf shape is also more angular than that of green saxifrage (see below). It is found in moist shady sites, especially in rich soil and in wetlands. It is widespread across the northern boreal forest and north to the Arctic (Johnson et al. 1995). It is ranked by ANHIC (Gould 2006) as S3G3. The Committee on the Status of Endangered Wildlife in Canada (COSEWIC 2007) lists this species as *Sensitive*.

One occurrence of golden saxifrage was documented in the Jackpine Expansion Mining Area (JEMA) Local Study Area (LSA), found in an open bog (BONN) wetlands. In the Regional Study Area (RSA), there are seven recorded observations of golden saxifrage reported by ANHIC (2006d). This species has been previously documented in the JEMA LSA (Volume 3, Section 3, Table 3.5-7). One additional occurrence of golden saxifrage was found during the Pierre River Mining Area (PRMA) vegetation and rare plant surveys in 2006/ 2007.

2.1.2 Chrysosplenium Tetrandrum – Green Saxifrage

Green saxifrage, a member of the Saxifragaceae family, is a yellowish green creeping perennial, but can also appear golden in colour. The primary differentiation between green and golden saxifrage is that green saxifrage has round to kidney shaped leaves with inconspicuous venation. It is found in moist shady sites, especially in rich soil and in wetlands. It is widespread across the northern boreal forest and north to the Arctic (Johnson et al. 1995). It is ranked

as S3G5 by ANHIC (Gould 2006). The COSEWIC (2007) lists green saxifrage as *Secure*.

Two occurrences of green saxifrage were documented in the JEMA LSA, found in a wooded fen (FTNN) and an open shrubby swamp (SONS). In the RSA, there are three recorded observations of green saxifrage reported by ANHIC (2006d).

2.1.3 Drosera Linearis – Slender-Leaved Sundew

Slender-leaved sundew is a small insectivorous perennial herb with reddish, tentacle-like, gland-tipped hairs (Kershaw et al. 2001). Slender-leaved sundew requires alkaline conditions which are often associated with open fens and is ranked globally as apparently secure under present conditions (G4) and as provincially rare having low or less than 20 occurrences (S2). In North America, the slender-leaved sundew is considered rare across the Prairies and Montana and in Quebec, New Brunswick, Minnesota, Wisconsin and Newfoundland, but is not considered rare in Ontario, Michigan and the Northwest Territories (Kershaw et al. 2001). The COSEWIC (2007) ranks slender-leaved sundew as *Sensitive*, reporting that few occurrences of this species have been recorded with threats that include habitat loss through conversion and potential desiccation resulting from climate change.

There were seven populations of slender-leaved sundew documented in the JEMA LSA. Five occurrences were in open patterned fen (FOPN), and one occurrence in each of graminoid fen (FONG) and wooded patterned fen (FTPN) wetlands types. In the RSA, there has been one other recorded observation of slender-leaved sundew as reported by ANHIC (2006d). One additional occurrence was also found during the PRMA vegetation and rare plant surveys in 2006/ 2007.

2.1.4 *Nymphaea Tetragona* – White Water-Lily

White water-lily (*Nymphaea tetragona*) although widespread, is less common than yellow pond-lilies (Johnson et al. 1995). In North America, the white water-lily is considered rare in Alberta, Saskatchewan, Quebec, Minnesota, Michigan and New Brunswick, but is not considered rare in Ontario, Manitoba, British Columbia and Montana. This species has been extirpated in Idaho (Kershaw et al. 2001). This species has been reported by ANHIC as occurring less than five times within Alberta (S1 provincial rank) (Gould 2006), with three occurrences previously surveyed within the RSA. The COSEWIC (2007) ranks this species as *May Be At Risk*.

Within the JEMA LSA, white water-lily was surveyed in one location during the 2006 survey along a lake edge in a shrubby fen (FONS) wetlands type.

2.1.5 *Pinguicula Villosa* – Small Butterwort (Hairy Butterwort)

Small butterwort (*Pinguicula villosa*), an insectivorous forb, was documented in a single location within the JEMA LSA. It is less common and smaller than common butterwort (*Pinguicula vulgaris*), and typically grows in bogs, sphagnum hummocks and pool edges across the boreal forest (Johnson et al. 1995). In North America, small butterwort is considered rare in British Columbia, Alberta, Saskatchewan and Ontario. It is not considered rare in the rest of Canada with the exception of the Maritimes where it does not occur, or has not been documented (Kershaw et al 2001). No previous occurrences of small butterwort have been documented within the RSA. It is ranked as an S1 species by ANHIC (Gould 2006), indicating five or fewer occurrences (or only a few remaining individuals) have been reported within Alberta. The COSEWIC (2007) lists small butterwort at *Sensitive*. This species may be easily overlooked if not flowering, as the basal leaves are only a few centimetres in length, with a flowering stem only 2 to 5 cm in height (Johnson et al. 1995).

2.1.6 Sarracenia Purpurea – Pitcher Plant

Pitcher plant is an insectivorous perennial plant with leaves that develop into pitcher-shaped structures designed to capture rain water and insects (Kershaw et al. 2001). It is a provincially rare species (Gould 2006) having low or less than 20 occurrences (S2) while it maintains a global secure rank (G5). The habitats typically associated with pitcher plants are open wetlands and areas with high abundance of sphagnum moss. In North America, pitcher plant is considered rare in British Columbia, Alberta, Northwest Territories, Illinois, Ohio and Virginia. It is not considered rare in the rest of Canada with the exception of the Yukon where it does not occur, or has not been documented. It is also not considered rare in California, Minnesota, Wisconsin, Michigan, Indiana, West Virginia, Pennsylvania and the Eastern Seaboard of the United States (Kershaw et al. 2001). The COSEWIC (2007) ranks the pitcher plant as *Sensitive* within Alberta, noting that their habitat is under threat of desiccation resulting from climate change.

The spring and summer 2006 surveys within the JEMA LSA resulted in 19 population occurrences of pitcher plants, found primarily in open patterned fens (FOPN) with 10 occurrences. Graminoid fens (FONG) accounted for five occurrences, shrubby fens (FONS) for two occurrences and two populations were documented in wooded patterned fens (FOPN). Four additional plots studied during the 2006 field program contained pitcher plants, but are located outside of

the LSA. This species has been previously documented in the JEMA LSA (Volume 3, Section 3, Table 3.5-7). In the RSA, there are 21 occurrences of pitcher plant have been documented in the RSA (ANHIC 2006d), and an additional three occurrences were documented during the PRMA vegetation and rare plant surveys in 2006/ 2007.

2.1.7 Spiranthes Lacera – Northern Slender Ladies'-Tresses

Northern slender ladies'-tresses, a member of the orchid family (Orchidaceae), is typically found in dry, rocky, open woods and grassy areas near jack pine forests and often with common blueberry (Kershaw et al. 2001). Northern slender ladies'-tresses are provincially rare with equal to or less than five occurrences or only a few remaining individuals (S1) and globally secure (G5) (ANHIC 2006d). In North America, this species is considered rare in Alberta, Saskatchewan and Vermont. It is not considered rare in the rest of Canada and the United States with the exception of British Columbia, Yukon Territory, Newfoundland and States west and south of Missouri where it does not occur, or has not been documented (Kershaw et al. 2001). The COSEWIC (2007) reports that this species ranks as *May Be At Risk*, with few occurrences reported and provincial restrictions limited to northeast Alberta.

During the 2006 surveys, two occurrences of northern slender ladies'-tresses were encountered, one within a recovering burned area consisting of two to five individuals, and the other within a Labrador tea–mesic jack pine-black spruce (c1) ecosite phase consisting of one individual. In the RSA, three occurrences of northern slender ladies'-tresses are reported (ANHIC 2006d). This species has been previously documented in the JEMA LSA (Volume 3, Section 3, Table 3.5-7). Additionally, one other occurrence of northern slender ladies'-tresses was found during the PRMA vegetation and rare plant surveys in 2006/2007.

2.2 VASCULAR PLANT SPECIES ON THE ALBERTA NATURAL HERITAGE INFORMATION CENTRE WATCH LIST

Species on the ANHIC watch list are typically species that have restricted distributions in Alberta but are common within their range (Gould 2006). Information is collected to ascertain trends in populations. The below text provides descriptions of each species' characteristic vegetation type and distribution ranges.

2.2.1 Carex Lasiocarpa – Hairy-Fruited Sedge

Hairy-fruited sedge is a loosely tufted perennial that has long-creeping, tough and scaly rhizomes. Dark reddish, shredding stems are characteristic, with stalkless flower clusters and densely hairy perigynia (capsule enclosing the seed). Habitat generally includes fen areas and edges of ponds and lakes. It is widespread across the boreal forest, north and west to Great Bear Lake (Northwest Territories) and disjunct in southern Alaska (Johnson et al. 1995). The ANHIC (Gould 2006) ranks hairy-fruited sedge as an S4G5 species. The COSEWIC (2007) ranks this species as *Secure*.

Fourteen occurrences of hairy-fruited sedge were recorded within the JEMA LSA. All occurrences were within wetlands types, and included five samples in open patterned fen (FOPN), three occurrences in shrubby fen (FONS), two occurrences in both graminoid fen (FONG) and wooded patterned fen (FTPN) and a single occurrence each within a wooded fen (FTNN) and a graminoid marsh (MONG) wetlands. Four other occurrences of hairy-fruited sedge were found but are not within the LSA. The ANHIC (2006d) reports no occurrences of hairy-fruited sedge within the RSA; however two additional occurrences were documented during the PRMA (Section 3.6.1) vegetation and rare plant surveys in 2006/2007.

2.3 RARE BRYOPHYTE SPECIES ON THE ALBERTA NATURAL HERITAGE INFORMATION CENTRE TRACKING LIST

The ANHIC tracking list include plants that are of high priority because they are rare or of conservation concern in some other way (Gould 2006). They are most commonly ranked S1, S2 or occasionally S3. The below text provides descriptions of each species' characteristic vegetation type and distribution ranges.

2.3.1 Anastrophyllum Helleranum

Anastrophyllum helleranum (liverwort species) is reported by ANHIC (Gould 2006) as S2G5, that is 6 to 20 occurrences or with many individuals in fewer occurrences reported within the province of Alberta. In North America, it is found in Alberta, New Brunswick, Ontario, Quebec, Wisconsin, Michigan, Tennessee, Vermont and Indiana (NatureServe 2006, website).

Within the Jackpine Expansion, a single occurrence of *Anastrophyllum helleranum* was found within a low-bush cranberry white spruce (d3) ecosite

phase. The ANHIC (2006d) reports five occurrences of *Anastrophyllum helleranum* within the RSA.

2.3.2 Calypogeia Integristipula

Calypogeia integristipula (liverwort species) is reported by ANHIC (Gould 2006) as an S1G4G5? species, that is less than or equal to five occurrences of this species reported in Alberta. In North America, it is found in Alberta, Ontario, Quebec, Michigan and Wisconsin (NatureServe 2006, website).

Within the JEMA LSA, a single occurrence of *Calypogeia integristipula* was documented and sampled from the side of a decomposing moss hummock within a former burned area. Within the RSA, ANHIC (2006d) reports no occurrences of this species.

2.3.3 *Conocephalum Conicum* – Snake Liverwort

Snake liverwort is one of the larger species of liverwort in the boreal forest region. It appears as yellow-green in colour, with easily identifiable hexagonal patterning on the upper thallus (leaf-like) surface. Each hexagon contains a single pore in the centre. Habitat includes consistently moist, sandy substrates, acidic rock surfaces, usually under overhanging rock cliffs near waterfalls and rushing streams (Vitt et al. 1988). In North America, it is found in Alberta, Manitoba, Ontario, Quebec, Delaware, Georgia, Indiana, Michigan, Tennessee, Virginia, Vermont and Wisconsin (NatureServe 2006, website).

The ANHIC (Gould 2006) ranks this species as S2G5.

2.3.4 Lophozia Rutheana

The provincial and global ANHIC (Gould 2006) rank for *Lophozia rutheana* (liverwort species) is S1G4?; that is, five or less reported occurrences of this species within Alberta, and is questionably secure globally. In North America, it is found across Canada from British Columbia to Quebec, Yukon Territory, Alaska, Michigan, Minnesota, New York and Vermont (NatureServe 2006, website).

One occurrence of *Lophozia rutheana* was found within the JEMA LSA, situated in a wooded bog (BTNN) wetlands type. The ANHIC (2006d) reports no occurrences within the RSA.

One occurrence of snake liverwort was found in the JEMA LSA, consisting of a small sample located on the bank of a creek within a horsetail white spruce (f3) ecosite phase. The ANHIC (2006d) has two records of this species occurring within the RSA.

2.3.5 Pseudobryum Cinclidioides

Two occurrences of *Pseudobryum cinclidioides* (a green leafy moss) were found within the JEMA LSA. The ANHIC (Gould 2006) ranks this species as having between 6 to 20 occurrences (S2G5) within the province of Alberta. In North America, it is found across Canada from British Columbia to Quebec, New Brunswick, Newfoundland, Michigan, Virginia, Wisconsin and Vermont (NatureServe 2006, website). Two other occurrences of *Pseudobryum cinclidioides* have been reported within the RSA (ANHIC 2006d).

2.3.6 *Splachnum Ampullaceum* – Flagon-Fruited Splachnum

Flagon-fruited splachnum is a dung moss that occurs primarily on herbivore dung. The reproductive structures appear as small spherical capsules supported by long red stems. Flagon-fruited splachnum is often found with the showy yellow collar moss (*Splachnum luteum*) and red collar moss (*Splachnum rubrum*) (Vitt et al. 1988). The ANHIC (Gould 2006) ranks flagon-fruited splachnum as an S2G5 species. In North America, it is found across Canada from British Columbia to the Maritimes, Michigan, New York, Oregon, Wisconsin and Vermont (NatureServe 2006, website).

One occurrence of flagon-fruited splachnum was documented in the JEMA LSA, found within a Labrador tea-subhygric black spruce-jack pine (g1) ecosite phase. In the RSA, three flagon-fruited splachnum occurrences are reported by ANHIC (2006d) and another occurrence was found during the Project study, but was located outside of the JEMA LSA.

2.3.7 Splachnum Luteum – Yellow Collar Moss

Yellow collar moss only grows on animal dung (primarily moose) in fens and bogs across the boreal forest. Its reproductive structures occur as bright yellow "umbrellas" with yellow to reddish stems that reach 5 to 10 cm above the substrate (Vitt et al. 1988). The ranking for yellow collar moss by ANHIC (Gould 2006) has a status of S3G3. In North America, it is found across Canada from British Columbia to Quebec, New Brunswick, Yukon Territory, Northwest Territories, Alaska and Michigan (NatureServe 2006, website).

One occurrence of yellow collar moss was found growing with flagon-fruited splachnum within a Labrador tea-subhygric black spruce-jack pine (g1) ecosite phase. Within the RSA, ANHIC (2006d) reports four confirmed occurrences of yellow collar moss, and an additional occurrence was documented during the PRMA vegetation and rare plant surveys in 2006/ 2007.

2.3.8 *Splachnum Sphaericum* – Globe-Fruited Splachnum

Globe fruited splachnum is a dung moss that can often be found growing with other dung mosses such as red and yellow collar moss. Its reproductive structures appear as oblong reddish spheres on rigid yellow-orange stems. The ANHIC (Gould 2006) ranks this species as S2G3G5. In North America, it is found in British Columbia, Alberta, Manitoba, Quebec, New Brunswick, Newfoundland, Colorado, Michigan, Montana and Wyoming (NatureServe 2006, website).

One occurrence of globe-fruited Splachnum was recorded during the JEMA surveys found growing with red collar moss and flagon-fruited splachnum in a Labrador tea-subhygric black spruce-jack pine (g1) ecosite phase. This species has been previously documented in the JEMA LSA (Volume 3, Section 3, Table 3.5-7). Five occurrences of globe-fruited splachnum have been reported by ANHIC (2006d) within the RSA.

2.3.9 Warnstorfia Tundrae

Warnstorfia tundrae, also known as *Drepanocladus tundrae* (Arnell) Loeske was found in a single occurrence within the JEMA LSA. The provincial and global ANHIC (Gould 2006) rank is reported as S2GU. In North America, it is found in British Columbia, Alberta, Ontario, Colorado and Wyoming (NatureServe 2006, website).

The single occurrence of *Warnstorfia tundrae* found was situated within a graminoid fen (FONG) wetlands type. This species has been previously documented in the JEMA LSA (Volume 3, Section 3, Table 3.5-7). The ANHIC (2006d) reports two other occurrences within the RSA.

2.4 RARE BRYOPHYTE SPECIES ON THE ALBERTA NATURAL HERITAGE INFORMATION CENTRE WATCH LIST

Species on the ANHIC watch list are typically species that have restricted distributions in Alberta but are common within their range (Gould 2006). Information is collected to ascertain trends in populations. The below text provides descriptions of each species' characteristic vegetation type and distribution ranges.

2.4.1 Calypogeia Sphagnicola

Calypogeia sphagnicola (a liverwort species) was documented once within the JEMA LSA. It was situated within a wooded bog with internal lawns (BTNI) wetlands type, and is reported by ANHIC (Gould 2006) as being SNRG4, that is its status has not yet been ranked in Alberta. In North America, it is found in Alberta, Manitoba, Ontario, Quebec, Michigan, Oregon, Tennessee and Wisconsin (NatureServe 2006, website). This species has been previously documented in the JEMA LSA (Volume 3, Section 3, Table 3.5-7). No occurrences of this species have been reported within the RSA by ANHIC (2006d).

2.4.2 Campylium Polygamum

The genus *Campylium* contains moss species with squarrose (spreading at right angles) leaves with broad bases narrowing to a channeled, slender apex. *Campylium polygamum* occurs in moderate to moderately rich sites and has a costa (midrib or nerve in leaves) (Johnson et al. 1995). The ANHIC (Gould 2006) ranks this species as S3G5. In North America, it is found across Canada from British Columbia to Quebec, New Brunswick, Nova Scotia, Prince Edward Island, Delaware, Georgia, Indiana, Michigan, Missouri, Montana, Tennessee, Virginia, Vermont, Wisconsin and Wyoming (NatureServe 2006, website).

Two occurrences of *Campylium polygamum* were found within the JEMA LSA. The wetlands habitats the samples were found in included a graminoid marsh (MONG) and a shrubby swamp (SONS). Within the RSA, ANHIC (2006d) reports no occurrences of *Campylium polygamum;* however one additional occurrence was found during the PRMA vegetation and rare plant surveys in 2006/2007.

2.5 UNRANKED BRYOPHYTE SPECIES IN ALBERTA

The status of bryophyte species that are listed as being *Unranked in Alberta* may be due to insufficient provincial data, unreported occurrences or may not have been previously identified in Alberta. These species do not appear on the complete element list (all bryophytes, rare and not rare) for Alberta (ANHIC 2006a).

2.5.1 Plagiochila Porelloides – Cedar-Shake Liverwort

Two occurrences of *Plagiochila porelloides*, an olive-green to dark green leafy moss, were documented as being within the JEMA LSA. Both occurrences were found within wooded fen (FTNN) wetlands. In North America, it is found in Manitoba, Ontario, Quebec, Alabama, Indiana, Michigan, Tennessee, Vermont and Wisconsin (NatureServe 2006, website).

The ANHIC does not report this species within the species list for Alberta. The *Unranked in Alberta* status of *Plagiochila porelloides* (Volume 3, Section 3, Table 3.5-5) may be due to insufficient provincial data, unreported occurrences or may not have been previously identified in Alberta. In addition to the two occurrences in the JEMA LSA, two other occurrences were documented during the PRMA vegetation and rare plant surveys in 2006/2007.

2.6 RARE LICHEN SPECIES ON THE ALBERTA NATURAL HERITAGE INFORMATION CENTRE TRACKING LIST

The ANHIC tracking list include plants that are of high priority because they are rare or of conservation concern in some other way (Gould 2006). They are most commonly ranked S1, S2 or occasionally S3. The below text provides descriptions of each species' characteristic vegetation type and distribution ranges.

2.6.1 Arthonia Patellulata

Arthonia patellulata is an epiphyte lichen with hidden thallus (vegetative body) that creates a look of pale patches on the bark of poplars and other hardwoods, and is found almost exclusively on trembling aspen (*Populus tremuloides*) trees, northern temperate to southern boreal (Brodo et al. 2001). Its fruiting bodies are black and round. The ANHIC (Gould 2006) reports this species as S3?G5, and as indicated (S3?), is not yet ranked in the province of Alberta. In North

America, it is found in Alberta, Saskatchewan, Ontario and Quebec (NatureServe 2006, website).

Five samples of *Arthonia patellulata* were sampled in the JEMA LSA. Two samples occurred in the low-bush cranberry aspen (d1) ecosite phase, two samples in the low-bush cranberry aspen-white spruce (d2) ecosite phase and one in a blueberry aspen-white spruce (b3) ecosite phase. A single occurrence of *Arthonia patellulata* was also observed during the Project field program but was located outside of the LSA. In the RSA, ANHIC (2006d) reports one other additional occurrence of *Arthonia patellulata*, and 24 other occurrences were found during the concurrent PRMA vegetation and rare plant surveys in 2006/2007.

2.6.2 *Bryoria Simplicior* – Old Man's Beard

Old man's beard is a tufted, brown to black species with abundant white to greenish-black soralia (small, powdery propagule), and can often be found intertwined with *Bryoria lanestris* that is often found in wetlands forests of black spruce and tamarack (Vitt et al. 1988). The ANHIC (Gould 2006) ranks old man's beard as S2S3G?. In North America, it is found in Alberta, Saskatchewan, Manitoba, Ontario, Quebec and Montana (NatureServe 2006, website).

Old man's beard occurred twice within the JEMA LSA, which included one occurrence in a wooded patterned fen (FTPN) and one in burned wetlands (BUw). Two other instances of this species was document during the Project study, but do not fall within the LSA. In the RSA, ANHIC (2006d) reports two additional occurrences of old man's beard, and three more occurrences were documented during the PRMA vegetation and rare plant surveys in 2006/2007.

2.6.3 Candelariella Efflorescens – Powdery Goldspeck Lichen

The epiphyte (tree moss) powdery goldspeck lichen was sampled at one plot within the JEMA LSA, within a horsetail white spruce (f3) ecosite phase. It is found on bark of many species of trees and dead wood and is bright yellow, powdery or crustose in appearance (Environment Canada 2007, website). The ANHIC (Gould 2006) reports this species as S1G?; that is, having five or fewer documented reports within Alberta, and globally unknown as to population density. In North America, it is found in Alberta, Ontario, Quebec, Colorado, North Carolina and Pennsylvania (NatureServe 2006, website).

There were no reported occurrences by ANHIC of this species being recorded within the RSA.

2.6.4 *Flavopunctelia Soredica* – Powder-Edged Speckled Greenshield

Powder-edged speckled greenshield is a yellow to orange crustose lichen with a lobed (crinkled) growth pattern and soralia (small, powdery propagule) that are exclusively marginal. Habitat includes many kinds of bark in open woods (Brodo et al. 2001). The ANHIC (Gould 2006) ranks powder-edged speckled greenshield as an S2G3G5 species in Alberta. In North America, it is found in Alberta, Saskatchewan, Ontario, Colorado and Pennsylvania (NatureServe 2006, website).

Powder-edged speckled greenshield occurred at three locations within the JEMA LSA. The habitat included one occurrence in each of an open patterned fen (FOPN), a wooded patterned fen (FTPN) and an open shrubby swamp (SONS). Within the RSA, no records of powder-edged speckled greenshield have been reported by ANHIC (2006d).

2.6.5 *Imshaugia Placorodia* – American Starburst Lichen

American starburst lichen is a pale grey, narrow-lobed spreading lichen with pale brown, sometimes concave apothecia (disk or cup-shaped structures) towards the centre. Its habitat is almost restricted to the bark of pine trees (Brodo et al. 2001). The ANHIC (Gould 2006) ranks this species as S2G3G5. In North America, it is found in Alberta, Saskatchewan, Ontario, Quebec, Colorado, North Carolina and Pennsylvania (NatureServe 2006, website).

American starburst lichen was recorded a total of three times within the JEMA LSA, all within upland ecosite phases. A single occurrence was found in each of the lichen jack pine (a1), blueberry aspen-white spruce (b3) and Labrador tea-mesic jack pine-black spruce (c1) ecosite phases. Three additional occurrences were documented on this program, but are not located within the LSA and the RSA has five previous occurrences of American starburst lichen reported by ANHIC (2006d). An additional 39 occurrences were documented during the PRMA vegetation and rare plant surveys in 2006/2007.

2.6.6 *Lecanora Expallens*

The *Lecanora* genus are extremely species rich, appearing as crustose rim lichens varying in form from lobe-like to dot-like in appearance, with a wide variety of colours. They inhabit multiple substrates from the tropics to the Arctic (Brodo et al. 2001). The ANHIC (Gould 2006) reports *Lecanora expallens* as S1G?. In

North America, it is found in Alberta, Quebec and Colorado (NatureServe 2006, website).

Within the JEMA LSA, *Lecanora expallens* was recorded two times, with one recording each in low-bush cranberry aspen-white spruce (d2) ecosite phase and an open patterned fen (FOPN) wetlands type. The RSA shows no records of *Lecanora expallens* as reported by ANHIC (2006d).

2.6.7 Lecanora Subintricata

Lecanora subintricata is a wood-dwelling rim lichen with narrowly ellipsoid spores and granular epihymenium (uppermost portion of the spore bearing layer) (Brodo et al. 2001). The ANHIC (2006d) reports this species as S1G?. In North America, it is found in Alberta, Saskatchewan, Ontario, Quebec and Colorado (NatureServe 2006, website).

Within the JEMA LSA, *Lecanora subintricata* was identified 21 times and was primarily found inhabiting wetlands types. It occurred five times within wooded fens (FTNN), four times within open shrubby fens (FONS), three within open patterned fens (FOPN), twice within wooded bog with internal lawns (BTNI) and additional single occurrences within a wooded patterned fen (FTPN), wooded bog (BTNN) wetlands types. One occurrence of *Lecanora subintricata* was found in a blueberry jack pine-aspen (b1) ecosite phase, as well as single occurrences within a former burned wetlands site, low-bush cranberry aspen (d1), horsetail white spruce (f3) and Labrador tea/horsetail white spruce-black spruce (h1) ecosite phases. *Lecanora subintricata* was also documented eight times on this program, but outside the JEMA LSA. The ANHIC (2006d) reports no occurrences of *Lecanora subintricata* within the RSA, however 19 occurrences were documented during the PRMA vegetation and rare plant surveys in 2006/2007.

2.6.8 Lecidella Elaeochroma

The *Lecidella* genus are referred to as disk lichens that are crustose in nature, most being primarily grey in colour and inhabit rock (favouring calcium rich rock), bark, wood or soil. *Lecidella elaeochroma* is chemically similar to other *Lecidella* species especially *Lecidella euphoria* (Brodo et al. 2001). The ANHIC (Gould 2006) ranks *Lecidella elaeochroma* as S1G?. In North America, it is found in Alberta, Saskatchewan, Ontario and Quebec (NatureServe 2006, website).

Eleven occurrences of *Lecidella elaeochroma* were found within the JEMA LSA. Upland ecosite habitats included three occurrences within low-bush cranberry aspen-white spruce (d2) ecosite phase, one within blueberry jack pine-aspen (b1) ecosite phase, and one within the Labrador tea-mesic jack pine-black spruce (c1) ecosite phase. Wetlands types included two occurrences within open patterned fen (FOPN), and single occurrences of *Lecidella elaeochroma* within wooded fen (FTNN), wooded bog (BTNN), wooded bog with internal lawns of forested peat plateau (BTNR) and within a burned shrubby wetlands (BUw). Two additional occurrences were also found during the 2006 surveys that are not located within the JEMA LSA. Within the RSA, ANHIC (2006d) reports no occurrences of *Lecidella elaeochroma*. Eight additional occurrences have been recorded however, during the PRMA vegetation and rare plant surveys in 2006/2007.

2.6.9 Melanelia Trabeculata

The *Melanelia* genus is comprised of small to medium-sized dark brown to olive coloured lichens that may appear shiny or dull. They are the most common brown to olive coloured lichens, and inhabit bark or rock. *Melanelia trabeculata* is a southern boreal species that has overlapping plates of tissue on the lower surface as opposed to being simply wrinkled, contains norstictic acid and has spherical pores (Brodo et al. 2001). The ANHIC (Gould 2006) ranks *Melanelia trabeculata* as S2?G?. In North America, it is found in Alberta and Quebec (NatureServe 2006, website).

The JEMA vegetation surveys found five occurrences of *Melanelia trabeculata* within five different habitat types, including low-bush cranberry aspen (d1), low-bush cranberry aspen-white spruce (d2) and Labrador tea/ horsetail white spruce-black spruce (h1) uplands ecosite phases, as well as wooded bog with internal lawns (BTNI) and wooded swamp (STNN) wetlands types. One additional occurrence was documented during the surveys that is not within the JEMA LSA, and was found in a blueberry aspen-white spruce (b3) ecosite phase. The ANHIC (2006d) reports no additional occurrences within the RSA, however, seven more occurrences were documented during the PRMA vegetation and rare plant surveys in 2006/2007.

2.6.10 Ochrolechia Gowardii

The *Ochrolechia* genus are described as saucer lichens that are crustose in form with thin to very thick thalli (vegetative body) and are white to ash grey in colour. Trees, mosses, rocks and wood compose the habitat most typical of *Ochrolechia* (Brodo et al. 2001). The ANHIC (Gould 2006) ranks *Ochrolechia gowardii* as S1G?. In North America, it is found in Alberta (NatureServe 2006, website).

One occurrence of *Ochrolechia gowardii* was found during the JEMA vegetation surveys, and was located in a shrubby swamp (SONS) wetlands type. In the RSA, ANHIC (2006d) reports no occurrences of *Ochrolechia gowardii.*

2.6.11 Ramalina Dilacerata – Punctured Ramalina

Ramalina dilacerata (synonym: *Fistulariella dilacerata*) appears as pale green, short and densely shrubby lichen that have more or less hollow branches with many perforations into the inner surface. It is found on twigs and branches of various trees and shrubs in open habitat (Brodo et al. 2001). The ANHIC (Gould 2006) ranks punctured ramalina as an S2G3G5 species. In North America, it is found in Alberta, Saskatchewan, Ontario and Quebec (NatureServe 2006, website).

Eleven occurrences of punctured ramalina were found in the JEMA LSA. Of these occurrences, three were within the low-bush cranberry aspen-white spruce (d2) ecosite phase, two within the low-bush cranberry aspen (d1) ecosite phase, two within horsetail white spruce (f3) and one within a low-bush cranberry white spruce (d3) ecosite phases. Wetlands with occurrences of punctured ramalina included two within wooded swamp (STNN) and one within an open bog (BONN). One occurrence of punctured ramalina was documented during the program that did not occur within the LSA. Within the RSA, ANHIC (2006d) reports no other occurrences of this species, however, 38 additional occurrences were documented during the concurrent PRMA vegetation and rare plant surveys in 2006/2007.

2.6.12 Ramalina Intermedia – Rock Ramalina

Rock ramalina is a pale yellow-green lichen with finely divided flat branches that are typically curled and has coarsely granular fruiting bodies at the branch tips and margins. Rock faces and boulders in forests are the typical habitat of this lichen, and it occurs rarely on bark (Brodo et al. 2001). The ANHIC (Gould 2006) ranks this species as S1G?. In North America, it is found in Alberta, Saskatchewan, Manitoba, Ontario, Quebec, Missouri, Ohio and Pennsylvania (NatureServe 2006, website).

Within the JEMA LSA, a single occurrence of rock ramalina was found in a Labrador tea/horsetail white spruce-black spruce (h1) ecosite type. The ANHIC (2006d) reports no occurrences of rock ramalina within the RSA.

2.6.13 Rinodina Metaboliza

The *Rinodina* genus are referred to as pepper-spore lichens and are described as thick or thin crustose lichens that are grey to brownish or olive in coloration. Bark, wood, rock, soil or dead vegetation are typical habitats for *Rinodina* species (Brodo et al. 2001). The ANHIC (Gould 2006) reports *Rinodina metaboliza* as having a provincial and global rank of S2G?. In North America, it is found in Alberta, Saskatchewan and Colorado (NatureServe 2006, website).

Two occurrences of *Rinodina metaboliza* were found within the low-bush cranberry aspen-white spruce (d2) ecosite phase in the JEMA LSA. No records have been reported within the RSA by ANHIC (2006d), however four additional occurrences were found during the PRMA vegetation and rare plant surveys in 2006/2007.

2.7 LICHEN SPECIES UNRANKED BY THE ALBERTA NATURAL HERITAGE INFORMATION CENTRE

The status of lichen species that are listed as being *Unranked in Alberta* may be due to insufficient provincial data, unreported occurrences or may not have been previously identified in Alberta. These species do not appear on the complete element list (all lichens, rare and common) for Alberta (ANHIC 2006b).

2.7.1 Candelariella Lutella

Candelariella are crustose or squamulose species often referred to as goldspeck lichens or yolk lichens due to their colouration. Their habitat includes rocks, bark and wood of different types, as well as on soil or tundra peat (Brodo et al. 2001).

One occurrence of *Candelariella lutella* was found within a low-bush cranberry aspen (d1) ecosite. There are no reports of this species in the RSA by ANHIC (2006d), however, two occurrences were found during the PRMA vegetation and rare plant surveys in 2006/2007.

2.7.2 Cliostomum Pallens

Cliostomum (dot lichens) species are crustose lichens with thin moderately thick, continuous granular vegetative bodies. They inhabit bark or wood, usually in oceanic regions (Brodo et al. 2001).

Cliostomum pallens occurred at ten sites sampled within the JEMA LSA, primarily within wetlands types. Six occurrences were recorded in wooded fen wetlands (FTNN) habitat, and a single occurrence each within an open shrubby fen (FONS), open patterned fen (FOPN), wooded fen with internal lawns (FTNI) wetlands type and a horsetail white spruce (f3) ecosite phase. The ANHIC (2006d) data reports no occurrences of *Cliostomum pallens* within the RSA, however, five additional occurrences were found during the PRMA vegetation and rare plant surveys in 2006/2007.

2.7.3 Lecanora Boligera

The *Lecanora* genus are extremely species rich, appearing as crustose rim lichens varying in form from lobe-like to dot-like in appearance, with a wide variety of colours. They inhabit multiple substrates from the Tropics to the Arctic (Brodo et al. 2001). In North America, *Lecanora boligera* is found in Quebec (NatureServe 2006, website).

Lecanora boligera was sampled four times within the JEMA LSA. A single occurrence each was found in four wetlands types that included: open shrubby fen (FONS), wooded fen with internal lawns (FTNI), open patterned fen (FOPN) and wooded fen (FTNN). One occurrence of *Lecanora boligera* was documented during the field program that was not situated within the LSA. This species has not been reported within the RSA by ANHIC (2006d), and may be new to Alberta. One additional occurrence was identified however during the concurrent PRMA vegetation and rare plant surveys in 2006/2007.

2.7.4 Lecanora Laxa

The *Lecanora* genus are extremely species rich, appearing as crustose rim lichens varying in form from lobe-like to dot-like in appearance, with a wide variety of colours. They inhabit multiple substrates from the tropics to the Arctic (Brodo et al. 2001).

Three occurrences of *Lecanora laxa* were recorded within the JEMA LSA, with two occurring within wooded fen (FTNN) wetlands type and one within a wooded bog with internal lawn (BTNI) wetlands type. The ANHIC (2006d) does not report this species occurring within the RSA, however three other occurrences of *Lecanora laxa* were found during the PRMA vegetation and rare plant surveys in 2006/2007.

2.7.5 Lecanora Persimilis

The *Lecanora* genus are extremely species rich, appearing as crustose rim lichens varying in form from lobe-like to dot-like in appearance, with a wide variety of colours. They inhabit multiple substrates from the tropics to the Arctic (Brodo et al. 2001).

Lecanora persimilis occurred 12 times within the JEMA LSA. The habitat it occurred in most often was within wooded fen (FTNN) with three recordings. The open shrubby fen (FONS) wetlands type accounted for two occurrences. One occurrence of *Lecanora persimilis* was found in each of open patterned fen (FOPN) and wooded bog with internal lawns (BTNI) wetlands types, and within lichen jack pine (a1), blueberry jack pine-aspen (b1), low-bush cranberry aspen-white spruce (d2) and Labrador tea-subhygric black spruce-jack pine (g1) ecosite phases. The ANHIC (2006d) reports no occurrences of *Lecanora persimilis* within the RSA, however six other occurrences were found during the PRMA vegetation and rare plant surveys in 2006/2007.

2.7.6 Lecidea Amaurospoda

The *Lecidea* genus is described as dot or tile lichens. They are crustose in form with black to dark brown fruiting body and can be found on bark, rock, wood, soil and peat (Brodo et al. 2001).

A single occurrence of *Lecidea amaurospoda* was found in the JEMA LSA, occurring in a wooded fen (FTNN) wetlands type. No occurrences have been reported in the RSA by ANHIC (2006d).

2.7.7 Lecidea Leprarioides

The *Lecidea* genus is described as “dot” or “tile” lichens. They are crustose in form with black to dark brown fruiting body and can be found on bark, rock, wood, soil and peat (Brodo et al. 2001).

Two occurrences of *Lecidea leprarioides* were found within the JEMA LSA, with one occurring in a low-bush cranberry aspen (d1) ecosite phase and a wooded fen (FTNN) wetlands type. Within the RSA, *Lecidea leprarioides* has not been reported by ANHIC (2006d); however one additional occurrence was identified during the PRMA vegetation and rare plant surveys in 2006/2007.

2.7.8 Lecidea Nylanderi

The *Lecidea* genus is described as dot or tile lichens. They are crustose in form with black to dark brown fruiting body and can be found on bark, rock, wood, soil and peat (Brodo et al. 2001). In North America, *Lecidea nylanderi* is found in Saskatchewan, Ontario, Quebec and Colorado (NatureServe 2006, website).

Within the JEMA LSA, three occurrences of *Lecidea nylanderia* were found, each within upland sites including blueberry aspen (white birch) (b2), blueberry white spruce-jack pine (b4) and low-bush cranberry aspen (d1) ecosite phases. Another occurrence was found in a dogwood balsam poplar-aspen (e1) ecosite phase during the field program that does not fall within the LSA. *Lecidea nylanderia* is not reported as being within the RSA by ANHIC (2006d); however 11 additional occurrences were identified as a result of the PRMA vegetation and rare plant surveys in 2006/2007.

2.7.9 *Leptorhaphis Epidermidis* – Birchbark Dot Lichen

Leptorhaphis epidermidis occurred three times within the JEMA LSA. Two occurrences were within blueberry aspen-white birch (b2) ecosite phase and one occurrence was within a wooded fen (FTNN) wetlands type. In North America, it is found in Saskatchewan, Ontario, Quebec and Pennsylvania (NatureServe 2006).

An additional occurrence was documented during the program that is located outside of the JEMA LSA, and was situated within a dogwood balsam poplar-aspen (e1) ecosite phase. The ANHIC (2006d) does not report any additional occurrences of this species in the RSA.

2.7.10 Micarea Denigrata

The *Micarea* genus are described as dot lichens that are smooth to granular in appearance and are generally thin with grey, olive, brownish or dark green colouration. Typical habitat includes wood, bark, rock or mosses that are shaded or humid (Brodo et al. 2001). In North America, it is found in Alberta and Colorado (NatureServe 2006).

A single occurrence of *Micarea denigrata* was found during the JEMA LSA vegetation surveys within a shrubby fen (FONS) wetlands type. No occurrences are reported within the RSA by ANHIC (2006d), however a single occurrence was additionally found during the PRMA vegetation and rare plant surveys in 2006/2007.

2.7.11 Micarea Sylvicola

The *Micarea* genus are described as dot lichens that are smooth to granular in appearance and are generally thin with grey, olive, brownish or dark green colouration. Typical habitat includes wood, bark, rock or mosses that are shaded or humid (Brodo et al. 2001). In North America, it is found in Colorado (NatureServe 2006, website).

Three occurrences of *Micarea sylvicola* were discovered to be present in three different habitats within the JEMA LSA, including Labrador tea-mesic jack pine-black spruce (c1) and Labrador tea-subhygric black spruce-jack pine (g1) ecosite phases, and a shrubby swamp (SONS) wetlands type. One occurrence was documented during the program that was not within the LSA, and was found within a lichen jack pine (a1) ecosite phase. No records of *Micarea sylvicola* are reported within the study area by ANHIC (2006d), however five additional occurrences resulted from the PRMA vegetation and rare plant surveys in 2006/2007.

2.7.12 Rinodina Disjuncta

The *Rinodina* genus are referred to as pepper-spore lichens and are described as thick or thin crustose lichens that are grey to brownish or olive in colouration. Bark, wood, rock, soil or dead vegetation are typical habitats for *Rinodina* species.

A single occurrence of *Rinodina disjuncta* was found in the JEMA LSA within a wooded fen (FTNN) wetlands type. The ANHIC (2006d) does not report any occurrences of *Rinodina disjuncta* within the RSA, however five additional occurrences were identified from the PRMA vegetation and rare plant surveys in 2006/2007.

2.7.13 Rinodina Orculata

The *Rinodina* genus are referred to as “pepper-spore” lichens and are described as thick or thin crustose lichens that are grey to brownish or olive in colouration. Bark, wood, rock, soil or dead vegetation are typical habitats for *Rinodina* species.

A single occurrence of *Rinodina orculata* was found in the JEMA LSA within a low-bush cranberry aspen (d1) ecosite phase. The ANHIC (2006d) does not report any occurrences of *Rinodina orculata* within the RSA although four

additional occurrences have been identified as a result of the PRMA vegetation and rare plant surveys in 2006/2007.

2.7.14 Scoliciosporum Perpusillum

The *Scoliciosporum* genus are crustose lichens, with thin, dark green to grey finely granular thalli (vegetative body). Bark, wood or rocks make up the typical substrate habitat and they often occur in deeply shaded areas (Brodo et al. 2001).

Scoliciosporum perpusillum occurred 55 times in 21 different habitat types within the JEMA LSA. Twenty documented finds were within uplands ecosite phases. Occurrences within upland ecosite phases included four samples within low-bush cranberry aspen-white spruce (d2), three occurrences each within low-bush cranberry aspen (d1) and low-bush cranberry white spruce (d3), two occurrences each within blueberry white spruce-jack pine (b4), horsetail white spruce (f3) and Labrador tea/ horsetail white spruce-black spruce (h1) ecosite phases, as well as individual occurrences within lichen jack pine (a1), blueberry jack pine-aspen (b1), blueberry aspen-white spruce (b3) and Labrador tea-subhygric black spruce-jack pine (g1) ecosite phases. Thirty-five documented finds were within various wetlands habitats. Wetlands types that *Scoliciosporum perpusillum* were found in included 10 occurrences within wooded fens (FTNN), five occurrences each within wooded bogs (BTNN) and open patterned fens (FOPN), four occurrences in wooded bogs (BTNN), three occurrences in shrubby fens (FONS), two occurrences each within wooded fens with internal lawns (FTNI) and burned shrubby wetlands (BUw), and single occurrences within a wooded bog with islands of peat plateau (BTNR), graminoid fen (FONG), shrubby swamp (SONS) and treed swamp (STNN).

Twenty-one other occurrences of *Scoliciosporum perpusillum* were found during the field studies that are not located within the JEMA LSA. The ANHIC (2006d) has no records of *Scoliciosporum perpusillum* in the RSA, however, 49 additional occurrences of *Scoliciosporum perpusillum* have been identified as a result of the concurrent PRMA vegetation and rare plant surveys in 2006/2007.

2.7.15 Scoliciosporum Umbrinum

The *Scoliciosporum* genus is described as crustose lichens, with thin, dark green to grey finely granular thalli (vegetative body). Bark, wood or rocks make up the typical substrate habitat and they often occur in deeply shaded areas (Brodo et al. 2001). In North America, it is found in Ontario, Quebec, Colorado and Pennsylvania (NatureServe 2006, website).

Scoliciosporum umbrinum occurred two times in two different habitat types within the JEMA LSA. The habitats included a low-bush cranberry aspen (d1) upland ecosite and a wooded swamp (STNN) wetlands type. An additional occurrence of *Scoliciosporum umbrinum* was documented during the field studies that fell within a blueberry jack pine-aspen (b1) ecosite type, however is not located within the JEMA LSA. The ANHIC (2006d) has no records of *Scoliciosporum umbrinum* in the RSA, although a single additional occurrence was found during the PRMA vegetation and rare plant surveys in 2006/2007.

2.7.16 *Stenocybe Pullatula* – Alder Stickpin

The *Stenocybe* genus are referred to as "stickpins", and are lichens that are minute "fruiticose" (club-like) microfungi, with basal fungal threads and stalked apothecia (disk or cup-shaped structures). They are either parasitic (living off lichens or free-living algae) or saprobic (living off dead bark, wood or other organic matter). Their primary substrate inhabited is bark. *Stenocybe pullatula* inhabits the bark of alder species (hence the common name alder stickpin) (Goward 1999). In North America, it is found in Ontario (NatureServe 2006, website).

A single occurrence of *Stenocybe pullatula* was found in a wooded fen (FTNN) within the JEMA LSA. The ANHIC (2006d) reports no records of this species within the RSA, however, four additional occurrences have been identified as a result of the PRMA vegetation and rare plant surveys in 2006/2007.

2.7.17 *Tuckermannopsis Orbata* – Variable Wrinkle-Lichen

Tuckermannopsis orbata is olive-brown to pale green with abundant apothecia (disk or cup-shaped structures) on the margins or surface of the ruffled lobes. Common substrate includes branches and twigs of conifers and birch and rarely on other hardwoods (Brodo et al. 2001). In North America, it is found in British Columbia, Alberta, Ontario, Quebec, the Maritimes, Washington, Idaho, Oregon, California, North Carolina, South Carolina, New York and Vermont (Brodo et al. 2001).

Four occurrences of *Tuckermannopsis orbata* were found in the JEMA LSA, each within different ecosite phases/wetlands types including a Labrador tea/ horsetail white spruce-black spruce (h1) ecosite phase and wooded bog with internal lawns of forested peat plateaus (BTNR), open patterned fen (FOPN) and wooded swamp (STNN) wetlands types. An additional site surveyed during the 2006 field study documented *Tuckermannopsis orbata* in a blueberry jack pine aspen (b1) ecosite phase, but is not situated within the JEMA LSA. The ANHIC

(2006d) reports no additional records of *Tuckermannopsis orbata* within the RSA, however, 13 additional occurrences have been identified from the PRMA vegetation and rare plant surveys in 2006/2007.

3 RARE PLANT DESCRIPTIONS FOR THE PIERRE RIVER MINING AREA LOCAL STUDY AREA

3.1 RARE VASCULAR PLANT SPECIES ON THE ALBERTA NATURAL HERITAGE INFORMATION CENTRE TRACKING LIST

The ANHIC tracking list include plants that are of high priority because they are rare or of conservation concern in some other way (Gould 2006). They are most commonly ranked S1, S2 or occasionally S3. See Section 3.3.4.3 for an explanation of ANHIC rankings. The text below provides descriptions of each species' characteristic vegetation type and distribution ranges.

3.1.1 *Carex Umbellata* – Umbellate Sedge

Umbellate sedge is a low-growing sedge that inhabits open woods and sandy areas in the boreal forest and Rocky Mountains, and often favours disturbed areas. It is identified by its soft, narrow leaves (1 to 3 mm wide), with distinctly hairy, small perigynia (seed capsule) with shorter beaks (Kershaw et al. 2001). Umbellate sedge is provincially rare with equal to or less than five occurrences or only a few remaining individuals (S1) and globally secure (G5) (Gould 2006). COSEWIC (2007) reports that this species is ranked as *Undetermined*. In North America, it is found Alberta, British Columbia, Manitoba, New Brunswick, Newfoundland and Labrador, Nova Scotia, Nunavut, Ontario, Quebec, Saskatchewan, Alabama, Arkansas, Connecticut, District of Columbia, Delaware, Georgia, Iowa, Illinois, Indiana, Kansas, Maine, Maryland, Massachusetts, Michigan, Minnesota, Missouri, Mississippi, North Carolina, North Dakota, Nebraska, New Hampshire, New Jersey, New York, Ohio, Oregon, Pennsylvania, Rhode Island, South Carolina, Tennessee, Texas, Virginia, Vermont, Wisconsin and West Virginia (NatureServe 2006, website).

During the 2006/2007 surveys, a single occurrence of umbellate sedge was encountered within the Athabasca Plains Natural Subregion, in a bearberry jack pine (a1) ecosite phase. One other occurrence of umbellate sedge has been reported within the RSA (ANHIC 2006d).

3.1.2 *Cypripedium Acaule* – Stemless Lady's-Slipper

Stemless lady's-slipper is a perennial herb with a 10 to 30 cm tall single, erect, leafless, hairy stem that supports a deep to pale pink inflated and showy flower. It grows in a variety of habitat types, including wetlands, woods and sand dunes

(Kershaw et al. 2001). Stemless lady's slipper is ranked provincially by ANHIC as S3 and globally as G5 (Gould 2006). COSEWIC (2007) ranks this species as *Sensitive*, reporting that moderate threats such as off-highway vehicle use, logging and industrial activity, as well as harvesting for commercial purposes puts stress on its security.

In North America, it is found in Alberta, Manitoba, New Brunswick, Newfoundland and Labrador, Nova Scotia, Northwest Territories, Ontario, Prince Edward Island, Quebec, Saskatchewan, Alabama, Connecticut, District of Columbia, Delaware, Georgia, Illinois, Indiana, Kentucky, Massachusetts, Maryland, Maine, Michigan, Minnesota, North Carolina, New Hampshire, New Jersey, New York, Ohio, Pennsylvania, Rhode Island, South Carolina, Tennessee, Virginia, Vermont, Wisconsin and West Virginia (NatureServe 2006, website).

Within the PRMA LSA, stemless lady's slipper populations occurred twice, both within the Athabasca Plains Natural Subregion. One occurrence was in a bearberry jack pine (a1) ecosite phase and the other in a Canada buffalo-berry-green alder white spruce-black spruce-jack pine (b4) ecosite phase. There are seven occurrences of stemless lady's slipper within the RSA as reported by ANHIC (2006d), and an additional occurrence was found during the PRMA survey that is located outside of the LSA. One other occurrence of northern slender ladies'-tresses was found during the JEMA vegetation and rare plant surveys in 2006.

3.1.3 *Sarracenia Purpurea* – Pitcher Plant

The pitcher plant is an insectivorous perennial plant with leaves that develop into pitcher-shaped structures designed to capture rain water and insect (Kershaw et al. 2001). According to ANHIC, it is a provincially rare species (Gould 2006) having low or less than 20 occurrences (S2) while it maintains a global secure rank (G5). The habitats typically associated with pitcher plants are open wetlands and areas with high abundance of sphagnum moss (Kershaw et al. 2001). COSEWIC (2007) ranks the pitcher plant as *Sensitive* within Alberta, noting that their habitat is under threat of desiccation resulting from climate change. In North America, pitcher plant is considered rare in British Columbia, Alberta, Northwest Territories, Illinois, Ohio and Virginia. It is not considered rare in the rest of Canada with the exception of the Yukon where it does not occur, or has not been documented. It is also not considered rare in California, Minnesota, Wisconsin, Michigan, Indiana, West Virginia, Pennsylvania and the Eastern Seaboard of the United States (Kershaw et al. 2001).

The 2006/2007 surveys within the PRMA LSA resulted in one population occurrences of pitcher plants, found within an open patterned fen (FOPN) in the Athabasca Plain Natural Subregion. Of the 20 occurrences documented in the RSA, two plots studied during the field program contained pitcher plants, but are located outside of the LSA, and 18 recorded occurrences of pitcher plant populations were previously reported by ANHIC (2006d). An additional 23 occurrences were documented during the JEMA vegetation and rare plant surveys in 2006.

3.1.4 *Spiranthes Lacera* – Northern Slender Ladies'-Tresses

Northern slender ladies'-tresses, a member of the orchid family (Orchidaceae), is typically found in dry, rocky, open woods and grassy areas near jack pine forests and often with common blueberry (Kershaw et al. 2001). Northern slender ladies'-tresses are provincially rare with equal to or less than five occurrences or only a few remaining individuals (S1) and globally secure (G5) (Gould 2006). COSEWIC (2007) reports that this species ranks as *May Be At Risk*, with few occurrences reported and provincial restrictions limited to northeast Alberta. In North America, this species is considered rare in Alberta, Saskatchewan and Vermont. It is not considered rare in the rest of Canada and the United States with the exception of British Columbia, Yukon Territory, Newfoundland and States west and south of Missouri where it does not occur, or has not been documented (Kershaw et al. 2001).

During the 2006/2007 surveys, a single occurrence of northern slender ladies' tresses was encountered within an Athabasca Plain Canada buffalo-berry-green alder white spruce-black spruce-jack pine (b4) ecosite phase. In the RSA, three occurrences of northern slender ladies'-tresses were reported (ANHIC 2006d). Additionally, two other occurrences of northern slender ladies'-tresses were found during the JEMA vegetation and rare plant surveys in 2006.

3.2 VASCULAR PLANT SPECIES ON THE ALBERTA NATURAL HERITAGE INFORMATION CENTRE WATCH LIST

Species on the ANHIC watch list are typically species that have restricted distributions in Alberta but are common within their range (Gould 2006). Information is collected to ascertain trends in populations. The below text provides descriptions of each species' characteristic vegetation type and distribution ranges.

3.2.1 *Carex Lasiocarpa* – Hairy-Fruited Sedge

Hairy-fruited sedge is a loosely tufted perennial that has long-creeping, tough and scaly rhizomes. Dark reddish, shredding stems are characteristic, with stalkless flower clusters and densely hairy perigynia (capsule enclosing the seed). Habitat generally includes fen areas and edges of ponds and lakes (Johnson et al. 1995). The ANHIC (Gould 2006) ranks hairy-fruited sedge as an S4G5 species. COSEWIC (2007) ranks this species as *Secure*. It is widespread across the boreal forest, north and west to Great Bear Lake (Northwest Territories) and disjunct in southern Alaska (Johnson et al. 1995).

One occurrence of hairy-fruited sedge was recorded within the PRMA LSA, discovered within a shallow open water (WONN) wetlands type. In the RSA, one other occurrence of hairy-fruited sedge was found during PRMA field surveys, but does not occur within the PRMA LSA. Eighteen additional occurrences were documented during the JEMA vegetation and rare plant surveys in 2006.

3.2.2 *Coptis Trifolia* – Goldthread

Goldthread is a small perennial herb with small white star-shaped flowers. Basal evergreen, shiny leaves and bright yellow or orange underground stems are characteristic features. Habitat includes dark, mossy woods, muskeg, willow scrub and tundra (Kershaw et. al 2001). The ANHIC (Gould 2006) reports goldthread as having a rank of S3G5. COSEWIC (2007) reports this species as secure. In North America, goldthread is found in Alberta, British Columbia Manitoba, New Brunswick, Newfoundland and Labrador, Nova Scotia, Nunavut, Ontario, Prince Edward Island, Quebec, Saskatchewan, Alaska, Connecticut, Indiana, Massachusetts, Maryland, Maine, Michigan, Minnesota, North Carolina, New Hampshire, New Jersey, New York, Ohio, Oregon, Pennsylvania, Rhode Island, Virginia, Vermont, Washington, Wisconsin and West Virginia (NatureServe 2006, website).

Two occurrences of goldthread were recorded within the PRMA study within the Athabasca Plain Natural Subregion. They were located within Central Mixedwood (interpreted) blueberry jack pine-aspen (b1) and low-bush cranberry aspen-white spruce (d2) ecosite phases. Within the RSA, ANHIC (2006d) reports no occurrences of goldthread, as watch list species are not mapped (Rintoul 2007, pers. comm.).

3.3 VASCULAR SPECIES UNRANKED BY THE ALBERTA NATURAL HERITAGE INFORMATION CENTRE

The status of plant species that are listed as being *Unranked in Alberta* may be due to insufficient provincial data, unreported occurrences or may not have been previously identified in Alberta. These species do not appear on the complete element list (all lichens, rare and common) for Alberta (ANHIC 2006c).

3.3.1 Leucophysalis Grandiflora – Large White-Flowered Ground Cherry

Large white-flowered ground cherry is a tall erect annual plant with hairy and somewhat sticky stems 40 to 60 cm high. It has shallowly bell-shaped flowers that are white with pale yellow centres, and grows primarily in disturbed areas and open woodlands, especially around sandy soils (Budd 1962). The ANHIC (ANHIC 2006c) does not report large white-flowered ground cherry on its complete vascular plant element list of Alberta. The Saskatchewan Conservation Data Centre ranks large white-flowered ground cherry as S4?G2 (SCDC 2007, website). In North America, it is found in Alberta, Manitoba, Ontario, Quebec, Saskatchewan, Michigan, Minnesota, New York, Vermont and Wisconsin. It is an exotic in Alberta and New York, and is extirpated in South Dakota (NatureServe 2006, website).

Two occurrences of large white-flowered ground cherry were recorded within the PRMA LSA, discovered associated with the Athabasca Plain bearberry jack pine (a1) ecosite phase. The occurrences were found on exposed, sandy soil, usually associated with a cutline. Another occurrence was discovered during PRMA surveys, but falls outside the LSA. The ANHIC (2006d) reports no occurrences of large white-flowered ground cherry within the RSA.

3.4 RARE BRYOPHYTE SPECIES ON THE ALBERTA NATURAL HERITAGE INFORMATION CENTRE TRACKING LIST

The ANHIC tracking list include plants that are of high priority because they are rare or of conservation concern in some other way (Gould 2006). They are most commonly ranked S1, S2 or occasionally S3. The below text provides descriptions of each species' characteristic vegetation type and distribution ranges.

3.4.1 Calypogeia Muelleriana – Mueller's Puchwort

Calypogeia muelleriana (liverwort species) is a leafy moss, with obtuse, oval or bi-lobed leaves. The underlying leaves are divided into two lobes for about 1/3 of their length. Defining this species from others in its genus is the absence of triangular thickening in the corner of the leaf cells. This species typically inhabits humid loamy places, sometimes on humus or rotten wood (Becker 2000, website). The ANHIC reports this species as SNRG5 (Gould 2006). In North America, it is found in Alberta, Manitoba, Ontario, Quebec, Delaware, Georgia, Indiana, North Carolina, Tennessee and Wisconsin (NatureServe 2006, website).

A single occurrence of *Calypogeia muelleriana* was found in the PRMA within a wooded bog (BTNN) wetlands type (Volume 3, Section 3 Figure 3.6-6). Within the RSA, ANHIC (2006d) reports no occurrences of this species.

3.5 BRYOPHYTE SPECIES UNRANKED BY THE ALBERTA NATURAL HERITAGE INFORMATION CENTRE

The status of bryophyte species that are listed as being *Unranked in Alberta* may be due to insufficient provincial data, unreported occurrences or may not have been previously identified in Alberta. These species do not appear on the complete element list (all bryophytes, rare and not rare) for Alberta (ANHIC 2006a).

3.5.1 Plagiochila Porelloides – Cedar-Shake Liverwort

Cedar shake liverwort is a relatively large, leafy species that can grow up to 10 cm in length, and can be identified by its large, oval and unlobed leaves that have toothed leaf margins (UBC 2007, website). The ANHIC (ANHIC 2006a) does not report cedar-shake liverwort on its complete bryophyte element list of Alberta.

The two occurrences of cedar shake liverwort that was found was located in a wooded bog (BTNN) wetlands type and a Labrador tea/horsetail white spruce-black spruce (h1) ecosite phase (Volume 3, Section 3, Figure 3.6-6). The ANHIC (2006d) does not report any other occurrences within the RSA, however, two occurrences were found during the JEMA study in 2006. COSEWIC (2007) has not ranked this species.

3.6 RARE LICHEN SPECIES ON THE ALBERTA NATURAL HERITAGE INFORMATION CENTRE TRACKING LIST

The ANHIC tracking list include plants that are of high priority because they are rare or of conservation concern in some other way (Gould 2006). They are most commonly ranked S1, S2 or occasionally S3. The below text provides descriptions of each species' characteristic vegetation type and distribution ranges.

3.6.1 Arthonia Patellulata

Arthonia patellulata is an epiphyte lichen with hidden thallus (vegetative body) that creates a look of pale patches on the bark of poplars and other hardwoods, and is found almost exclusively on trembling aspen (*Populus tremuloides*) trees, northern temperate to southern boreal (Brodo et al. 2001). Its fruiting bodies are black and round. The ANHIC (Gould 2006) reports this species as S3?G5 and as indicated (S3?) is not yet ranked in the province of Alberta. In North America, it is found in Alberta, Saskatchewan, Ontario and Quebec (NatureServe 2006, website).

Fifteen samples of *Arthonia patellulata* were sampled in the PRMA LSA (Volume 3, Section 3, Table 3.6-6, Figure 3.6-6). Within Central Mixedwood interpreted ecosite phases, five occurrences were found within a low-bush cranberry aspen-white spruce (d2), and one occurrence each within a Labrador tea-mesic jack pine-black spruce (c1), a low-bush cranberry aspen (d1). Within Athabasca Plain interpreted ecosite phases, three occurrences each were found within Canada buffalo-berry-green alder jack-pine-aspen-white birch (b1) and Canada buffalo-berry-green alder aspen (b2) ecosite phases, and another single occurrence within a Canada buffalo-berry-green alder aspen-white spruce-black spruce (b3) ecosite phase. One occurrence was found in a shrubby swamp (SONS) wetlands type.

Nine other occurrences of *Arthonia patellulata* were also sampled during the Project field studies but are located outside of the LSA, plus ANHIC (2006d) reports one other additional occurrence of *Arthonia patellulata*. Six other occurrences were found during the concurrent JEMA 2006 vegetation and rare plant surveys.

3.6.2 Bryoria Simplicior – Old Man's Beard

Old man's beard is a tufted, brown to black species with abundant white to greenish-black soredia (small, powdery propagule), and can often be found

intertwined with *Bryoria lanestris* that is often found in wetlands forests of black spruce and tamarack (Vitt et al. 1988). The ANHIC (Gould 2006) ranks old man's beard as S2S3G?. In North America, it is found in Alberta, Saskatchewan, Manitoba, Ontario, Quebec, and Montana (NatureServe 2006, website).

Old man's beard occurred twice within the PRMA LSA, including one occurrence in an Athabasca Plains Labrador tea-mesic jack pine-black spruce (c1) ecosite phase and one occurrence in a shrubby fen (FONS) wetlands type (Volume 3, Section 3, Table 3.6-6, Figure 3.6-6). Of three occurrences in the RSA, one instance of this species was documented during the Project study, but does not fall within the LSA, and ANHIC (2006d) reports two additional occurrences of old man's beard. Four more occurrences were documented during the JEMA vegetation and rare plant surveys in 2006.

3.6.3 *Cyphelium Tigillare*

The *Cyphelium* genus is crustose in nature, with thin to thick thalli (vegetative body) and is generally grey or yellow. Their loose, sooty mass of spores gives this genus its reference as being called soot lichens. *Cyphelium* species inhabit such substrates as hard, weathered conifer wood or bark. *Cyphelium tigillare* appear bright yellow or greenish yellow in colour, with apothecia (disk or cup-shaped structures) often very hidden within the thallus (Brodo et al. 2001). The ANHIC (Gould 2006) ranks *Cyphelium tigillare* as an S2G? species. In North America, it is found in Alberta, Saskatchewan, Ontario, Quebec, Colorado, Pennsylvania and Utah.

One occurrence of *Cyphelium tigillare* was found within the Central Mixedwood Natural Subregion, in a wooded fen (FTNN) during the PRMA surveys (Volume 3, Section 3, Table 3.6-6, Figure 3.6-6). Within the RSA, one other occurrence is reported by ANHIC (2006d).

3.6.4 *Imshaugia Placorodia* – American Starburst Lichen

American starburst lichen is a pale grey, narrow-lobed spreading lichen with pale brown, sometimes concave apothecia (disk or cup-shaped structures) towards the centre. Its habitat is almost restricted to the bark of pine trees (Brodo et al. 2001). The ANHIC (Gould 2006) ranks this species as S2G3G5. In North America, it is found in Alberta, Saskatchewan, Ontario, Quebec, Colorado, North Carolina and Pennsylvania (NatureServe 2006, website).

American starburst lichen was recorded a total of 24 times within the PRMA LSA, all within upland ecosites with the exception of a single wetlands

occurrence (Volume 3, Section 3, Table 3.6-5, Figure 3.6-6). Within Central Mixedwood interpreted sites, five occurrences were found within blueberry jack pine-aspen (b1), two within lichen jack pine (a1), and one occurrence within Labrador tea-mesic jack pine-black spruce (c1) ecosite phases. Athabasca Plain interpreted sites yielded eight occurrences of American starburst lichen within Canada buffalo-berry-green alder jack pine-aspen-white birch (b1), five occurrences in bearberry jack pine (a1) and two within Canada buffalo-berry-green alder white spruce-black spruce-jack pine (b4) ecosite phases, with an additional single occurrence within a wooded bog (BTNN) wetlands type. Of 20 occurrences in the RSA, 15 additional occurrences were documented on this program, but are not located within the LSA, and five previous occurrences of American starburst lichen as reported by ANHIC (2006d). An additional six occurrences were documented during the JEMA vegetation and rare plant surveys in 2006.

3.6.5 Lecanora Subintricata

Lecanora subintricata is a wood dwelling rim lichen with narrowly ellipsoid spores and granular epihymenium (uppermost portion of the spore bearing layer) (Brodo et al. 2001). The ANHIC (Gould 2006) reports this species as S1G?. In North America, *Lecanora subintricata* is found in Alberta, Saskatchewan, Ontario, Quebec and Colorado (NatureServe 2006).

Within the PRMA LSA, *Lecanora subintricata* was identified 18 times, primarily inhabiting upland types (Volume 3, Section 3, Table 3.6-5, Figure 3.6-6). Using Central Mixedwood ecosite phase descriptions, four occurrences were found in blueberry jack pine-aspen (b1), two occurrences in each Labrador tea-mesic jack pine-black spruce (c1) and low-bush cranberry aspen-white spruce (d2), and individual occurrences each within lichen jack pine (a1), blueberry aspen (white birch) (b2), blueberry white spruce-jack pine (b4), horsetail balsam poplar-white spruce (f2) and Labrador tea-subhygric black spruce-jack pine (g1) ecosite phases. Five separate occurrences were found in five different wetlands types including: forested bog (BFNN), wooded bog (BTNN), shrubby fen (FONS), wooded fen (FTNN) and wooded patterned fen (FTPN). The ANHIC (2006d) reports no occurrences of *Lecanora subintricata* within the RSA, however one other occurrence was documented during the PRMA survey but is outside of the LSA. Additionally, 29 occurrences were noted from the JEMA vegetation and rare plant surveys in 2006.

3.6.6 Lecidella Elaeochroma

The *Lecidella* genus are referred to as disk lichens that are crustose in nature, most being primarily grey in colour and inhabiting rock (favouring calcium-rich

rock), bark, wood or soil. *Lecidella elaeochroma* is chemically similar to other *Lecidella* species especially *Lecidella euphoria* (Brodo et al. 2001). The ANHIC (Gould 2006) ranks *Lecidella elaeochroma* as S1G?. In North America, it is found in Alberta, Saskatchewan, Ontario and Quebec (NatureServe 2006).

Seven occurrences of *Lecidella elaeochroma* were found within the PRMA LSA, all within seven different habitats in the Central Mixedwood Natural Subregion (Volume 3, Section 3, Table 3.6-5, Figure 3.6-6). Upland sites included Central Mixedwood interpreted lichen jack pine (a1), blueberry white spruce-jack pine (b4), low-bush cranberry aspen-white spruce (d2), horsetail balsam poplar-white spruce (f2) and Labrador tea/ horsetail black spruce-white spruce (h1) ecosite phases. Wetlands types included forested bog (BFNN) and wooded bog (BTNN). One additional occurrence was also found during the 2006/2007 surveys that is not located within the PRMA LSA, while ANHIC (2006) reports no previous occurrences of *Lecidella elaeochroma* in the RSA. An additional 13 occurrences were recorded during the JEMA vegetation and rare plant surveys in 2006.

3.6.7 Melanelia Trabeculata

The *Melanelia* genus is comprised of small to medium-sized dark brown to olive coloured lichens that may appear shiny or dull. They are the most common brown to olive coloured lichens and inhabit bark or rock. *Melanelia trabeculata* is a southern boreal species that has overlapping plates of tissue on the lower surface as opposed to being simply wrinkled, contains norstictic acid and has spherical pores (Brodo et al. 2001). The ANHIC (Gould 2006) ranks *Melanelia trabeculata* as S2?G?. In North America, it is found in Alberta and Quebec (NatureServe 2006).

The PRMA surveys found seven occurrences of *Melanelia trabeculata* within four different habitat types interpreted as Central Mixedwood ecosite phases (Volume 3, Section 3, Table 3.6-5, Figure 3.6-6). Ecosite phases included four occurrences within low-bush cranberry aspen-white spruce (d2), and one occurrence each within a blueberry jack pine-aspen (b1) and low-bush cranberry white spruce (d3). A single occurrence in a wooded fen (FTNN) was also documented. The ANHIC (2006d) reports no additional occurrences within the RSA, however, six more occurrences were documented during the JEMA vegetation and rare plant surveys in 2006.

3.6.8 Nephroma Bellum – Alpine Kidney Lichen

Alpine kidney lichen appears as small, crisp, crinkled lobes that are pale yellow-green to brown in colour and can be found growing in mosses in arctic tundra and northern boreal forest (Brodo et al. 2001). Alpine kidney lichen is listed by ANHIC (2006) as an S2G3G5 species. In North America, it is found in Alberta, Saskatchewan, New Brunswick, Ontario, Quebec, Colorado, Pennsylvania and Wisconsin (NatureServe 2006).

One occurrence of alpine kidney lichen was found in shrubland habitat (Athabasca Plain Natural Subregion) within the PRMA LSA (Volume 3, Section 3, Table 3.6-5, Figure 3.6-6). Within the RSA no occurrences of alpine kidney lichen have been reported by ANHIC (2006d).

3.6.9 Ramalina Dilacerata – Punctured Ramalina

Ramalina dilacerata (synonym: *Fistulariella dilacerata*) appears as pale green, short and densely shrubby lichen that have more or less hollow branches with many perforations into the inner surface. It is found on twigs and branches of various trees and shrubs in open habitat (Brodo et al. 2001). The ANHIC (Gould 2006) ranks punctured ramalina as an S2G3G5 species. In North America, it is found in Alberta, Saskatchewan, Ontario and Quebec (NatureServe 2006).

Thirty-one occurrences of punctured ramalina were found in the PRMA LSA (Volume 3, Section 3, Table 3.6-5, Figure 3.6-6). Eight occurrences were situated within the Central Mixedwood Natural Subregion and 23 in the Athabasca Plains Natural Subregion. Within Central Mixedwood interpreted ecosite phases, 10 occurrences were within low-bush cranberry aspen-white spruce (d2), three in both low-bush cranberry white spruce (d3) and horsetail balsam poplar-white spruce (f2) and two within low-bush cranberry aspen (d1). Single occurrences within upland sites were found within blueberry jack pine-aspen (b1), blueberry aspen (white birch) (b2), blueberry aspen-white spruce (b3), blueberry white spruce-jack pine (b4), Labrador tea-mesic jack pine-black spruce (c1), dogwood balsam poplar-white spruce (e2), horsetail white spruce (f3), Labrador tea/ horsetail white spruce-black spruce (h1) and shrubland (Sh). One site was described as an Athabasca Plain Canada buffalo-berry-green alder aspen (b2) ecosite phase. Wetlands habitat types found in included two occurrences in shrubby swamp (SONS) and one occurrence in a wooded fen (FTNN).

Within the RSA, seven other occurrences of punctured ramalina were documented during the program that did not occur within the LSA, while ANHIC (2006d) reports no other occurrences of this species. However, 12 additional occurrences were documented during the JEMA vegetation and rare plant surveys in 2006.

3.6.10 Ramalina Obtusata – Hooded Ramalina

Hooded ramalina lichen may appear light whitish-green in colour, with broad but short branches appearing almost foliose (leafy). Typical substrate habitat includes trees and rocks (Brodo et al. 2001). The ANHIC (Gould 2006) reports hooded ramalina as an S2G? species. In North America, it is found in Alberta, Saskatchewan, Manitoba, Ontario, Colorado and Montana (NatureServe 2006).

A single occurrence of hooded ramalina was surveyed within a Central Mixedwood interpreted low-bush cranberry aspen-white spruce (d2) ecosite type of the Athabasca Plain Natural Subregion (Volume 3, Section 3, Table 3.6-5, Figure 3.6-6). Within the RSA, ANHIC (2006d) reports no occurrences of this species.

3.6.11 Rinodina Metaboliza

The *Rinodina* genus are referred to as pepper-spore lichens and are described as thick or thin crustose lichens that are grey to brownish or olive in colour. Bark, wood, rock, soil or dead vegetation are typical habitats for *Rinodina* species (Brodo et al. 2001). The ANHIC (Gould 2006) reports *Rinodina metaboliza* as having a provincial and global rank of S2G?. In North America, it is found in Alberta, Saskatchewan and Colorado (NatureServe 2006).

Four occurrences of *Rinodina metaboliza* were found within the PRMALSA (Volume 3, Section 3, Table 3.6-5, Figure 3.6-6). Three upland occurrences were found in the Athabasca Plain Natural Subregion, two within Central Mixedwood interpreted low-bush cranberry aspen-white spruce (d2) and one within blueberry aspen-white spruce (b3) ecosite phases. The only wetlands type occurrence was found within a wooded fen (FTNN) wetlands type. No records have been reported within the RSA by ANHIC (2006d), however two additional occurrences were found during the JEMA vegetation and rare plant surveys in 2006.

3.6.12 Trapeliopsis Flexuosa

Trapeliopsis flexuosa is a crustose lichen with the thallus (vegetative body) composed of dark, steel grey to greenish-black coloured granules. Habitat substrate includes weathered wood, especially fences and boards with exposure to full sun (Brodo et al. 2001). The ANHIC (Gould 2006) ranks this species as S1G?. In North America, it is found in Alberta, Saskatchewan, Ontario, Colorado and Pennsylvania (NatureServe 2006).

A single occurrence of *Trapeliopsis flexuosa* was found in the PRMA (site 4CV021 - Volume 3, Section 3, Table 3.6-5, Figure 3.6-6). Within the RSA, ANHIC (2006d) reports no records of this species.

3.6.13 Usnea Scabiosa

The *Usnea* genus appears as shrubby, filamentous lichen that is yellow-green in colour or occasionally reddish. *Usnea* species inhabit trees and shrubs. *Usnea scabiosa* appears very similar to *Usnea scabrata*, but specimens may have branches with only shallow depressions, consistently small, thin papillae and isidiate soralia (Brodo et al. 2001). The ANHIC (Gould 2000) recognizes *Usnea scabiosa* as found in Alberta, but is not currently ranked (SU) as more information is required. In North America, it is found in Alberta, Saskatchewan and Quebec (NatureServe 2006).

Three occurrences of *Usnea scabiosa* were found in the PRMA LSA, with two samples being located within Central Mixedwood interpreted a blueberry jack pine-aspen (b1) ecosite phase and shrubland (Sh) habitat (Volume 3, Section 3, Table 3.6-5, Figure 3.6-6). Within Athabasca Plain interpreted plots, one occurrence was situated within a Labrador tea-subhygric black spruce-jack pine (d1) ecosite phase. The ANHIC (2006d) reports no records of *Usnea angulata* within the RSA. However, six other occurrences were documented during the surveys that do not occur within the PRMA LSA.

3.7 LICHEN SPECIES UNRANKED BY THE ALBERTA NATURAL HERITAGE INFORMATION CENTRE

The status of lichen species that are listed as being *Unranked in Alberta* may be due to insufficient provincial data, unreported occurrences or may not have been previously identified in Alberta. These species do not appear on the complete element list (all lichens, rare and common) for Alberta (ANHIC 2006b).

3.7.1 *Biatora Carneoalbida*

The genus *Biatora* are known as "dot" lichens or crustose lichens with thin or thick, continuous granular thalli (vegetative body), frequently sorediate (with algal and fungal "dots") (Brodo et al. 2001). In North America, it is found in Ontario (NatureServe 2006).

Biatora carneoalbida occurred in only one site in the Athabasca Plains Natural Subregion (Volume 3, Section 3, Table 3.6-5, Figure 3.6-6). There are no reported ANHIC (2006d) occurrences of this species within the RSA.

3.7.2 *Candelariella Lutella*

Candellariella are crustose or squamulose species often referred to as goldspeck lichens or yolk lichens due to their colouration. Their habitat includes rocks, bark and wood of different types, as well as on soil or tundra peat (Brodo et al. 2001).

Two occurrences of *Candellariella lutella* were found within plots interpreted as the Central Mixedwood low-bush cranberry aspen (d1) ecosite phase (Volume 3, Section 3, Table 3.6-5, Figure 3.6-6). There are no reports of this species in the RSA by ANHIC (2006d), however, one other occurrence was found during the JEMA vegetation and rare plant surveys in 2006.

3.7.3 *Cladonia Ochrochlora* – Smooth-Footed Powderhorn

Smooth-footed powderhorn is a small terrestrial lichen that forms 10 to 35mm tall unbranched stalks above a leaf-like base. The stalks have a mealy soredia (vegetative structures appearing as a coating) rather than powdery one (Brodo et al. 2001). In North America, it is found in Saskatchewan, Quebec, Colorado, North Carolina and Pennsylvania (NatureServe 2006).

A single occurrence of smooth-footed powderhorn was found in a low-bush cranberry aspen-white spruce (d2) ecosite within the Central Mixedwood Natural Subregion (Volume 3, Section 3, Table 3.6-5, Figure 3.6-6). There are no reports of this species in the RSA by ANHIC (2006d), however, one additional occurrence was found during the Project study but is not situated within the LSA.

3.7.4 Cliostomum Pallens

Cliostomum (dot lichens) species are crustose lichens with thin moderately thick, continuous granular vegetative bodies. They inhabit bark or wood, usually in oceanic regions (Brodo et al. 2001).

Cliostomum pallens occurred at five sites sampled within the PRMA LSA (Volume 3, Section 3, Table 3.6-5, Figure 3.6-6). A single occurrence was found within each habitat type that included Central Mixedwood interpreted blueberry jack pine-aspen (b1), low-bush cranberry aspen-white spruce (d2), Labrador tea-subhygric black spruce-jack pine (g1) and Labrador tea/ horsetail white spruce-black spruce (h1) upland ecosite phases, and a wooded fen (FTNN) wetlands type. The ANHIC (2006d) data reports no occurrences of *Cliostomum pallens* within the RSA, however, 10 additional occurrences were found during the JEMA vegetation and rare plant surveys in 2006.

3.7.5 Lecanora Boligera

The *Lecanora* genus are extremely species rich, appearing as crustose rim lichens varying in form from lobe-like to dot-like in appearance, with a wide variety of colours. They inhabit multiple substrates from the tropics to the Arctic (Brodo et al. 2001). In North America, *Lecanora boligera* is found in Quebec (NatureServe 2006).

Lecanora boligera was sampled in only one plot within the PRMA LSA, within a Central Mixedwood interpreted Labrador tea/ horsetail white spruce-black spruce (h1) ecosite phase (Volume 3, Section 3, Table 3.6-5, Figure 3.6-6). This species has not been reported within the RSA by ANHIC (2006d), and may be new to Alberta. Five additional occurrences were identified however during the concurrent JEMA vegetation and rare plant surveys in 2006.

3.7.6 Lecanora Laxa

The *Lecanora* genus are extremely species rich, appearing as crustose rim lichens varying in form from lobe-like to dot-like in appearance, with a wide variety of colours. They inhabit multiple substrates from the tropics to the Arctic (Brodo et al. 2001).

Two occurrences of *Lecanora laxa* were recorded within the PRMA LSA (Volume 3, Section 3, Table 3.6-5, Figure 3.6-6). The individual occurrences were located within Central Mixedwood interpreted lichen jack pine (a1) and blueberry jack pine-aspen (b1) ecosite phases. One other occurrence was found

during the Project study but does not occur within the LSA. Three other occurrences of *Lecanora laxa* were found during the JEMA vegetation and rare plant surveys in 2006.

3.7.7 Lecanora Persimilis

The *Lecanora* genus are extremely species rich, appearing as crustose rim lichens varying in form from lobe-like to dot-like in appearance, with a wide variety of colours. They inhabit multiple substrates from the tropics to the Arctic (Brodo et al. 2001).

Lecanora persimilis occurred five times within the PRMA LSA (Volume 3, Section 3, Table 3.6-5, Figure 3.6-6). Two occurrences were in Central Mixedwood interpreted blueberry jack pine-aspen (b1) ecosite phases, and single occurrences were situated each within low-bush cranberry aspen-white spruce (d2), Labrador tea-subhygric black spruce-jack pine (g1) and Labrador tea/ horsetail white spruce-black spruce (h1) ecosite types, and a wooded fen (FTNN) wetlands type. An additional occurrence was found during surveys that are not within the LSA. Another 13 other occurrences were found during the JEMA vegetation and rare plant surveys in 2006.

3.7.8 Lecidea Leprarioides

The *Lecidea* genus is described as dot or tile lichens. They are crustose in form with black to dark brown fruiting body and can be found on bark, rock, wood, soil and peat (Brodo et al. 2001).

One occurrence of *Lecidea leprarioides* was found within the PRMA LSA. The occurrence was found in a Central Mixedwood interpreted low-bush cranberry aspen-white spruce (d2) ecosite type (Volume 3, Section 3, Table 3.6-5, Figure 3.6-6). Within the RSA, *Lecidea leprarioides* has not been reported by ANHIC (2006d); however two additional occurrences were identified during the JEMA vegetation and rare plant surveys in 2006.

3.7.9 Lecidea Nylanderi

The *Lecidea* genus is described as dot or tile lichens. They are crustose in form with black to dark brown fruiting body and can be found on bark, rock, wood, soil and peat (Brodo et al. 2001).

Within the PRMA LSA, 11 occurrences of *Lecidea nylanderia* were found (Volume 3, Section 3, Table 3.6-5, Figure 3.6-6). Upland ecosite phases

included three occurrences within Central Mixedwood interpreted blueberry jack pine-aspen (b1), two occurrences each within lichen jack pine (a1) and low-bush cranberry aspen-white spruce (d2), and single occurrences each within a Labrador tea-mesic jack pine-black spruce (c1), low-bush cranberry aspen (d1), dogwood white spruce (e3) ecosite and one in a shrubland (Sh). *Lecidea nylanderia* is not reported as being within the RSA by ANHIC (2006d); however, four additional occurrences were identified as a result of JEMA vegetation and rare plant surveys in 2006.

3.7.10 Lecidea Porphyrospoda

The genus *Lecidea* is known as "disk" or "tile" lichens. They are crustose in form with black or dark brown apothecia (disk or cup-shaped structures) with the thallus (leaf-like) surface appearing grey, brown or rusty orange in colour. Habitat potentially includes rock, bark, wood, moss or soil (Brodo et al. 2001).

A single occurrence of *Lecidea porphyrospoda* was found in a Central Mixedwood interpreted blueberry jack pine (b1) ecosite phase (Volume 3, Section 3, Table 3.6-5, Figure 3.6-6).

3.7.11 Micarea Denigrata

The *Micarea* genus are described as "dot" lichens that are smooth to granular in appearance and are generally thin with grey, olive, brownish or dark green colouration. Typical habitat includes wood, bark, rock or mosses that are shaded or humid (Brodo et al. 2001). *Micarea denigrata* does not occur on the ANHIC (2006b) elemental list of Alberta species. In North America, it is found in Alberta and Colorado (NatureServe 2006).

A single occurrence of *Micarea denigrata* was found during the JEMA vegetation surveys within a shrubby fen (FONS) wetlands type (Volume 3, Section 3, Table 3.6-5, Figure 3.6-6). No occurrences are reported within the RSA by ANHIC (2006d), however, an additional occurrence was found during the Pierre River Mining vegetation and rare plant surveys in 2006/ 2007.

3.7.12 Micarea Prasina

The *Micarea* genus are described as "dot" lichens that are smooth to granular in appearance and are generally thin with grey, olive, brownish or dark green colouration. Typical habitat includes wood, bark, rock or mosses that are shaded or humid (Brodo et al. 2001). In North America, it is found in Ontario, Quebec and Colorado (NatureServe 2006).

Micarea prasina was found as a single occurrence in the PRMA LSA, situated within a Central Mixedwood interpreted horsetail balsam poplar-white spruce (f2) ecosite phase (Volume 3, Section 3, Table 3.6-5, Figure 3.6-6).

3.7.13 Micarea Sylvicola

The *Micarea* genus are described as "dot" lichens that are smooth to granular in appearance and are generally thin with grey, olive, brownish or dark green colouration. Typical habitat includes wood, bark, rock or mosses that are shaded or humid (Brodo et al. 2001). In North America, it is found in Colorado (NatureServe 2006).

Five occurrences of *Micarea sylvicola* were discovered to be present in five different habitats within the PRMA LSA (Volume 3, Section 3, Table 3.6-5, Figure 3.6-6). Ecosite phases included Central Mixedwood interpreted lichen jack pine (a1), blueberry aspen (white birch) (b2), low-bush cranberry aspen-white spruce (d2), Labrador tea/horsetail white spruce-black spruce (h1) and shrubland (Sh). No records of *Micarea sylvicola* are reported within the RSA by ANHIC (2006d), however, four additional occurrences resulted from the JEMA vegetation and rare plant surveys in 2006.

3.7.14 Phaeocalicium Compressulum – Alder Needles

Lichen species of the genus *Phaeocalicium* are referred to as "the needles" to describe their general appearance and are minute "fruiticose" (club-like) microfungi, with basal fungal threads and stalked apothecia (disk or cup-shaped structures). They are either parasitic (living off lichens or free-living algae) or saprobic (living off dead bark, wood or other organic matter). They generally occur over the bark of deciduous trees and shrubs. *Phaeocalicium compressulum* is usually found over thin dead twigs of green alder (*Alnus crispa*) or white birch (*Betula papyrifera*) in humid forest. The stalked apothecia (disk or cup-shaped structures) with laterally compressed heads and occurrence over alder or birch are diagnostic features (Goward 1999, website). In North America, it is found in Ontario (NatureServe 2006).

Within the PRMA LSA, *Phaeocalicium compressulum* occurred a total of four times in Central Mixedwood interpreted upland habitats, including blueberry jack pine-aspen (b1), blueberry white spruce-jack pine (b4), low-bush cranberry aspen (d1), and a shrubby swamp (SONS) (Volume 3, Section 3, Table 3.6-5, Figure 3.6-6).

3.7.15 Phlyctis Argena

The *Phlyctis* genus are referred to as whitewash lichens that are crustose in form, pale yellowish-grey to almost white in colour with a coarsely granular texture. *Phlyctis argena* is a smooth to very rough species, with a rough, warty surface. Typical habitat includes the bark of deciduous trees, and occasionally on conifers or rocks (Brodo et al. 2001). In North America, it is found in Ontario and Quebec (NatureServe 2006, website).

A single occurrence of *Phlyctis argena* was found within a Central Mixedwood interpreted lichen jack pine (a1) ecosite phase (Volume 3, Section 3, Table 3.6-5, Figure 3.6-6).

3.7.16 Rhindina Anomala

The *Rinodina* genus are referred to as pepper-spore lichens and are described as thick or thin crustose lichens that are grey to brownish or olive in colouration. Bark, wood, rock, soil or dead vegetation are typical habitats for *Rinodina* species.

One occurrence of *Rhindina anomala* was found within the PRMA LSA, and was situated in a Central Mixedwood interpreted low-bush cranberry aspen-white spruce (d2) ecosite phase (Volume 3, Section 3, Table 3.6-5, Figure 3.6-6). The ANHIC (2006d) does not report any occurrences of this species within the RSA.

3.7.17 Rinodina Capensis

Lichens of the *Rinodina* genus are referred to as pepper-spore lichens that are crustose in form with thick or thin thalli (vegetative body) that are grey to brownish-olive in colour. Habitat substrates include bark, wood, rock, soil or dead vegetation (Brodo et al. 2001).

A single occurrence of *Rinodina capensis* was found within the PRMA LSA, situated within a shrubby swamp (SONS) wetlands (Volume 3, Section 3, Table 3.6-5, Figure 3.6-6).

3.7.18 Rinodina Disjuncta

The *Rinodina* genus are referred to as pepper-spore lichens and are described as thick or thin crustose lichens that are grey to brownish or olive in colouration.

Bark, wood, rock, soil or dead vegetation are typical habitats for *Rinodina* species.

Five occurrences of *Rinodina disjuncta* were found within the PRMA LSA (Volume 3, Section 3, Table 3.6-5, Figure 3.6-6). Two occurrences each were within Central Mixedwood interpreted low-bush cranberry aspen-white spruce (d2) and low-bush cranberry white spruce (d3) ecosite phases, and one occurrence was within a blueberry jack pine-aspen (b1) ecosite phase. The ANHIC (2006d) does not report any occurrences of *Rinodina disjuncta* within the RSA; however, one additional occurrence was identified from the JEMA vegetation and rare plant surveys in 2006.

3.7.19 Rinodina Orculata

The *Rinodina* genus are referred to as "pepper-spore" lichens and are described as thick or thin crustose lichens that are grey to brownish or olive in colouration. Bark, wood, rock, soil or dead vegetation are typical habitats for *Rinodina* species.

Three occurrences of *Rinodina orculata* were found within the PRMA LSA (Volume 3, Section 3, Table 3.6-5, Figure 3.6-6). Ecosite phases included Central Mixedwood interpreted blueberry aspen (white birch) (b2) and horsetail balsam poplar-white spruce (f2); and one occurrence was found within a shrubby swamp (SONS) wetlands type. One additional occurrence was found during Project surveys, but is not located within the LSA. The ANHIC (2006d) does not report any occurrences of *Rinodina orculata* within the RSA, although one additional occurrence has been identified as a result of the JEMA vegetation and rare plant surveys in 2006.

3.7.20 Scoliciosporum Perpusillum

The *Scoliciosporum* genus is described as crustose lichens, with thin, dark green to grey finely granular thalli (vegetative body). Bark, wood or rocks make up the typical substrate habitat and they often occur in deeply shaded areas (Brodo et al. 2001).

Scoliciosporum perpusillum occurred 48 times in 19 different habitat types within the PRMA LSA (Volume 3, Section 3, Table 3.6-5, Figure 3.6-6). Forty of the documented finds were within uplands ecosite types. Occurrences were all described by Central Mixedwood interpreted ecosite phases, including 10 in low-bush cranberry aspen-white spruce (d2), six occurrences within blueberry jack pine-aspen (b1), four within horsetail balsam poplar-white spruce (f2), three

occurrences each within blueberry white spruce-jack pine (b4), Labrador tea-mesic jack pine-black spruce (c1) and Labrador tea/ horsetail white spruce-black spruce (h1) ecosites, two occurrences each within lichen jack pine (a1), low-bush cranberry white spruce (d3) and Labrador tea-subhygric black spruce-jack pine (g1) ecosites, and one occurrence each within blueberry aspen (white birch) (b2), blueberry aspen-white spruce (b3), low-bush cranberry aspen (d1), dogwood balsam poplar-aspen (e1) and dogwood white spruce (e3) ecosite phases. Occurrences of *Scoliciosporum perpusillum* within wetlands types included four within wooded bog (BTNN) and single occurrences each within forested bog (BFNN), wooded bog with internal lawns (BTNI), wooded fen (FTNN) and wooded patterned fen (FTPN).

One other occurrence of *Scoliciosporum perpusillum* that is not located within the PRMA LSA was found during field studies. The ANHIC (2006d) has no records of *Scoliciosporum perpusillum* in the RSA; however, 76 additional occurrences of *Scoliciosporum perpusillum* have been identified as a result of the concurrent JEMA vegetation and rare plant surveys in 2006.

3.7.21 Scoliciosporum Umbrinum

The *Scoliciosporum* genus is described as crustose lichens, with thin, dark green to grey finely granular thalli (vegetative body). Bark, wood or rocks make up the typical substrate habitat and they often occur in deeply shaded areas (Brodo et al. 2001). In North America, it is found in Ontario, Quebec, Colorado and Pennsylvania (NatureServe 2006).

Scoliciosporum umbrinum occurred only once within the PRMA LSA, found in a horsetail balsam poplar-white spruce (f2) ecosite within the Central Mixedwood Natural Subregion (Volume 3, Section 3, Table 3.6-5, Figure 3.6-6). The ANHIC (2006d) has no records of *Scoliciosporum umbrinum* in the RSA, although three additional occurrences were found during the JEMA vegetation and rare plant surveys in 2006.

3.7.22 Stenocybe Pullatula – Alder Stickpin

The *Stenocybe* genus is referred to as “stickpins”, and are lichens that are minute “fruiticose” (club-like) microfungi, with basal fungal threads and stalked apothecia (disk or cup-shaped structures). They are either parasitic (living off lichens or free-living algae) or saprobic (living off dead bark, wood or other organic matter). Primary substrate inhabited is bark. *Stenocybe pullatula* inhabits the bark of alder species (hence the common name alder stickpin)

(Goward 1999, website). In North America, it is found in Ontario (NatureServe 2006).

Three occurrences of *Stenocybe pullatula* were found the PRMA LSA (Volume 3, Section 3, Table 3.6-5, Figure 3.6-6). Occurrences were found in Central Mixedwood interpreted blueberry jack pine-aspen (b1) and horsetail balsam poplar-white spruce (f2) ecosite phases, and a shrubby swamp (SONS) wetlands type. One additional occurrence was documented, but remains outside of the LSA. The ANHIC (2006d) reports no records of this species within the RSA; however, one other occurrence was identified as a result of the JEMA vegetation and rare plant surveys in 2006.

3.7.23 Tuckermannopsis Orbata – Variable Wrinkle-Lichen

Tuckermannopsis orbata is olive-brown to pale green with abundant apothecia (disk or cup-shaped structures) on the margins or surface of the ruffled lobes. Common substrate includes branches and twigs of conifers and birch and rarely on other hardwoods (Brodo et al. 2001). In North America, it is found in British Columbia, Alberta, Ontario, Quebec, the Maritimes, Washington, Idaho, Oregon, California, North Carolina, South Carolina, New York and Vermont (Brodo et al. 2001).

Eight occurrences of *Tuckermannopsis orbata* were found in the PRMA LSA (Volume 3, Section 3, Table 3.6-5, Figure 3.6-6). Upland occurrences included two occurrences within a Central Mixedwood interpreted blueberry jack pine-aspen (b1) ecosite, and single occurrences each within Central Mixedwood interpreted lichen jack pine (a1), blueberry jack pine-aspen (b1), low-bush cranberry aspen-white spruce (d2) and Labrador tea-subhygric black spruce-jack pine (g1) upland ecosite phases; and one other occurrence each within wooded bog (BTNN), wooded swamp (STNN) and wooded fen (FTNN) wetlands types. Four additional occurrences were documented but remain outside of the PRMA LSA. The ANHIC (2006d) reports no additional records of *Tuckermannopsis orbata* within the RSA; however, five additional occurrences have been identified from the JEMA vegetation and rare plant surveys in 2006.

3.7.24 Usnea Angulata

The *Usnea* genus appears as shrubby, filamentous lichen that is yellow-green in colour or occasionally reddish. *Usnea* species inhabit trees and shrubs. *Usnea angulata* is a pendant beard lichen with prominently ridged and angular branches (Brodo et al. 2001). In North America, it is found in Missouri, North

Carolina, Pennsylvania, and Texas. It is extirpated in Wisconsin (NatureServe 2006).

A single occurrence of *Usnea angulata* was found in the PRMA LSA, within a Central Mixedwood interpreted dogwood white spruce (e3) ecosite type (Volume 3, Section 3, Table 3.6-5, Figure 3.6-6).

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APPENDIX I

RARE PLANT COMMUNITIES OF THE BOREAL FOREST NATURAL REGION

Submitted to:
Shell Canada Limited

Prepared by:
Golder Associates Ltd.

December 2007 **05-1344-027**

50 BEST EMPLOYERS IN CANADA 2007

CANADA'S 50 BEST MANAGED PRIVATE COMPANIES

OFFICES ACROSS NORTH AMERICA, SOUTH AMERICA, EUROPE, ASIA AND AUSTRALIA

LIST OF TABLES

Table I-1 Rare Plant Communities of the Boreal Forest Natural Region.....1

Table I-1 Rare Plant Communities of the Boreal Forest Natural Region

Scientific Name	Common Name	ANHIC Rank[(a)]	Group	Element Code
Amelanchier alnifolia / Arctostaphylos uva-ursi / Oryzopsis pungens	saskatoon/ common bearberry/ northern rice grass	S2S3	shrubland	CEAB000029
Andromeda polifolia / Sarracenia purpurea / Sphagnum angustifolium	bog rosemary/pitcher plant / peat moss	S1S2	shrubland	CEAB000120
Atriplex subspicata - Puccinellia nuttalliana - Triglochin palustris string fen	spearscale saltbrush - Nuttall's salt-meadow grass - slender arrow grass	S1S3	herbaceous	CEAB000161
Betula neoalaskana / Ledum groenlandicum / Calamagrostis canadensis	Alaska birch/ Labrador tea/bluejoint	SU	forest/ woodland	CEAB000175
Calamagrostis stricta - Triglochin maritima string fen	narrow reed grass - seaside arrowgrass string fen	S1S3	herbaceous	CEAB000160
Carex limosa - Menyanthes trifoliata - Cardamine pratensis	mud sedge - buck-bean - meadow bitter cress	S1S2	herbaceous	CEAB000179
Carex limosa - Scheuchzeria palustris / Sphagnum teres - S. subsecundum	mud sedge – scheuchzeria / peat moss	S1	herbaceous	CEAB000113
Carex limosa / Sphagnum jensenii	mud sedge/pendant branch peat moss	S1	herbaceous	CEAB000031
Carex oligosperma / Sphagnum subsecundum	few-fruited sedge/twisted bog moss	S1S2	herbaceous	CEAB000121
Carex pseudocyperus - Calla palustris	cypress-like sedge - water arum	S1S2	herbaceous	CEAB000037
Carex rostrata marsh	beaked sedge marsh	S2	herbaceous	CEAB000191
Chamaedaphne calyculata - Kalmia polifolia / Cladina mitis	leatherleaf - northern laurel / green reindeer lichen	S1S2	shrubland	CEAB000122
Cymbella pusilla - Mastogloia smithii - Nitzschia palea	diatom ponds	S1S3	aquatic	CEAB000162
Eleocharis quinqueflora community	few-flowered spike-rush community	S1S2	herbaceous	CEAB000190
Elymus lanceolatus - Pascopyrum smithii	northern wheat grass - western wheat grass	S2?	herbaceous	CEAB000146
Elymus trachycaulus - Distichlis stricta	slender wheat grass - salt grass	S1	herbaceous	CEAB000148
Elymus trachycaulus - Hierochloe odorata	slender wheat grass - sweet grass	SU	herbaceous	CEAB000149
Elymus trachycaulus - Koeleria macrantha	slender wheat grass - June grass	SU	herbaceous	CEAB000150
Isoetes echinospora aquatic community	northern quillwort aquatic community	S1	aquatic	CEAB000036
Larix laricina / Carex prairea	tamarack/ prairie sedge	S1	forest/ woodland	CEAB000038
Larix laricina - Picea mariana / Cornus stolonifera - Rubus idaeus	tamarack - black spruce / redosier dogwood - wild red raspberry	S1S2	forest/ woodland	CEAB000188
Pascopyrum smithii - Artemisia tilesii - Artemisia frigida	western wheat grass - Herriot's sagewort - pasture sagewort	S1	herbaceous	CEAB000136
Picea glauca / Alnus tenuifolia – Betula neoalaskana / Equisetum pratense / Hylocomium splendens	white spruce / river alder - Alaska birch / meadow horsetail / stair-step moss	S3	forest/ woodland	CEAB000040
Picea glauca / Cetraria islandica	white spruce / lichen	S1?	forest/ woodland	CEAB000041
Picea mariana / Cornus stolonifera / feathermoss	black spruce / red-osier dogwood / feathermoss	S1S2	forest/ woodland	CEAB000189

Table I-1 Rare Plant Communities of the Boreal Forest Natural Region (continued)

Scientific Name	Common Name	ANHIC Rank[(a)]	Group	Element Code
Populus balsamifera / Alnus tenuifolia - Cornus stolonifera / Equisetum pratense	balsam poplar / river alder - red-osier dogwood / meadow horsetail	S3	forest/ woodland	CEAB000042
Populus balsamifera / Rhamnus alnifolia / Equisetum arvense	balsam poplar / alder-leaved buckthorn	S1	forest/ woodland	CEAB000114
Populus balsamifera / Viburnum opulus / Matteuccia struthiopteris	balsam poplar / high-bush cranberry / ostrich fern	S1S2	forest/ woodland	CEAB000043
Populus tremuloides / Rosa acicularis / Apocynum androsaemifolium	aspen / prickly rose / spreading dogbane	SU	forest/ woodland	CEAB000170
Populus tremuloides / Rubus parviflorus / Aralia nudicaulis	aspen / thimbleberry / wild sarsaparilla	S2S3	forest/ woodland	CEAB000044
Populus tremuloides / Salix bebbiana - Corylus cornuta / Calamagrostis canadensis – Matteuccia struthiopteris	aspen / beaked willow - beaked hazelnut / bluejoint - ostrich fern	S1	forest/ woodland	CEAB000045
Puccinellia nuttalliana community	Nuttall's salt-meadow grass community	S3?G3?	herbaceous	CEGL001799
Puccinellia nuttalliana – Suaeda calceoliformis – Spergularia marina barren	Nuttall's salt-meadow grass - western sea-blite - salt-marsh sand spurry barren	S2	sparsely vegetated	CEAB000046
Salicornia rubra emergent marsh	samphire emergent marsh	S2/G2G3	sparsely vegetated	CEGL001999
Salix athabascensis string shrubland	Athabasca willow string shrubland	SNR	shrubland	CEAB000048
Salix drummondiana / Scirpus microcarpus – Calamagrostis canadensis	Drummond's willow / smallfruited bulrush - bluejoint	S1	shrubland	CEAB000049

[(a)] Rare plant status ranks according to the Alberta Heritage Information Centre (Allen 2006); G = global; S = Alberta. Refer to Section 2.3.5.3 for rank definitions.

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APPENDIX J

METHODS FOR LANDSCAPE-LEVEL ANALYSES

Submitted to:
Shell Canada Limited

Prepared by:
Golder Associates Ltd.

December 2007 **05-1344-027**

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TABLE OF CONTENTS

SECTION **PAGE**

1 LANDSCAPE-LEVEL ANALYSES METHODS 1
1.1 ECOLOGICAL ISSUES AT THE LANDSCAPE LEVEL 1
1.1.1 Landscape Ecology and Diversity 1
1.1.2 Fragmentation 2
1.2 ANALYSIS OF LANDSCAPE STRUCTURE 3
1.2.1 Measurement of Landscape Heterogeneity and Fragmentation 4
1.2.2 Class Area 4
1.2.3 Number of Patches 4
1.2.4 Patch Size 5
1.2.5 Patch Richness 6
1.2.6 Shannon's Evenness Index 7
1.2.7 Total Edge 8
1.2.8 Euclidean Nearest Neighbour 9
1.2.9 Core Area Index and Area Weighted Mean 11
1.2.10 Mean Patch Fractal Dimension 13
1.2.11 Interspersion Juxtaposition Index 14

LIST OF FIGURES

Figure J-1 Example of Landscape Richness 7
Figure J-2 Example of Landscape Evenness 8
Figure J-3 Example of Total Edge 9
Figure J-4 Effect of Fragmentation on Habitat Core Areas 13

1 LANDSCAPE-LEVEL ANALYSES METHODS

1.1 ECOLOGICAL ISSUES AT THE LANDSCAPE LEVEL

A process for relating biodiversity values to ecological land cover classes (ecosite phases/wetlands types) and regional land cover classes (RLCCs) was developed for the Oil Sands Region. This approach measures the arrangement and distribution of vegetation types and RLCCs on the landscape. The objectives of this appendix are to describe the ecological issues at the landscape level and define the indices of landscape structure.

1.1.1 Landscape Ecology and Diversity

Preservation of landscape diversity is essential for maintaining ecological integrity. Diversity of landscapes and diversity within landscapes provide the necessary base to ensure that genetic, species and ecosystem diversity are conserved (Canadian Forest Service 1997). This concept has led to a surge of interest towards a landscape-level understanding of ecological processes (i.e., the science of landscape ecology). This is due, in large part, to the growing recognition that these processes affect and are affected by the dynamic interaction among ecosystems (McGarigal and Marks 1995).

The science of landscape ecology focuses on the interaction of biotic and abiotic elements as they occur over the entire landscape. In most cases, the landscape is defined as an interacting mosaic of patches relevant to the phenomenon under consideration (McGarigal and Marks 1995), with a patch being a relatively homogeneous area that differs from its surroundings (Forman 1995). Overall, landscape ecology considers three main characteristics of the landscape (Forman and Gordon 1986):

- *Structure*, which is the spatial relationships among the distinctive ecosystems or elements present. More specifically, it is the distribution of energy, materials and species in relation to the size, shape, number, kind and configuration of the ecosystems.
- *Function*, which is the interactions among the spatial elements (i.e., the flow of energy, materials and species among the component ecosystems).
- *Change*, which is the alteration in the structure and function of the ecological mosaic over time.

Landscapes are distinguished by the spatial relations among their component parts and can be characterized by both their composition and configuration. These two aspects of a landscape can independently, or in combination, affect ecological processes and organisms (McGarigal and Marks 1995).

Landscape composition focuses on the variety and abundance of patch types within a landscape, but not the placement or location of patches within the landscape mosaic (McGarigal and Marks 1995). Measures of landscape composition include the proportion of patch types in the landscape, patch richness, patch evenness and patch diversity.

Landscape configuration refers to the physical distribution or spatial character of patches within the landscape. The most commonly measured aspects of landscape configuration include patch isolation or patch contagion (i.e., measures of the placement of patch types relative to other patch types or the landscape boundary) and, patch shape and core area, which are measures of the spatial character of the patches (McGarigal and Marks 1995).

1.1.2 Fragmentation

By definition, fragmentation is the breaking up of contiguous environmental patches into smaller and more disjointed or isolated patches (Morrison et al. 1998). The effects of fragmentation include:

- reducing the area of the remaining fragments (e.g., decreased core area or habitat);
- increasing isolation of the fragments from each other (e.g., insularity); and
- increasing disturbance from the surroundings (e.g., edge effects) (Haila 1999).

This change in landscape structure may have impacts on complex biological interactions (e.g., grazing, seed dispersal, predation and nest parasitism) (Matlack and Litvaitis 1999) as well as on various ecosystem processes (e.g., nutrient cycling and decomposition, as affected by light availability and temperature regimes and air movement).

Zipperer (1993) defined three general types of forest disturbance patterns that increase forest edge relative to the area of the patch: internal, external and bisecting. Internal disturbances are one of the initial processes that occur when the landscape is nearly continuously forested. In this type of disturbance, the

forest is removed in a central area leaving forest surrounding the disturbance. This is analogous to many developments in the boreal forest, including oil sands developments. External disturbances occur from the outside of the forest patch and include indentation, which results in peninsulas of forest, or cropping, which reduces the size of a patch. Both types increase edge relative to area. Bisection may involve only a small area of removal (e.g., a pipeline route cut through a forest), but creates a new perimeter as it divides the forest into two patches. Although many fragmentation examples are described for forests, any natural patch type (e.g., grasslands and shrublands) can be disturbed and fragmented.

Determination of the impacts of fragmentation requires a landscape-scale point-of-view. Studying the effects of fragmentation at too small a scale makes it very difficult to differentiate between the effects of habitat loss and breaking apart of habitat (Fahrig 1999). For this reason, all analyses depicting fragmentation effects are performed at the larger landscape scale.

1.2 ANALYSIS OF LANDSCAPE STRUCTURE

The area of a particular patch type reflects both the amount of a patch type present (composition) and its spatial distribution (configuration). However, because they both differ with spatial heterogeneity of the landscape, it is more appropriate that they be considered measurements of landscape configuration (McGarigal and Marks 1995).

There are three possible scales of analysis for landscape structure: entire landscape (Regional Study Area [RSA] or Local Study Area [LSA]), macroterrain units and ecosystems. In some instances, the LSA in question can be comprised of distinct landform units (i.e., ecodistricts). Natural topography, terrain and vegetation features define the boundaries of each ecodistrict. When ecodistricts are distinguishable in the study area, landscape structure analysis can also be conducted for each unit. The scope of the study being performed will determine which scales will be used to describe landscape structure.

Landscape structure is described and analyzed to quantify the heterogeneity (or spatial variability) within the landscape and to quantify the degree of fragmentation.

Heterogeneity is a measure of landscape structure based on patch type. Patch type is defined as ecosite phases, wetlands types and disturbed areas in the LSA and RLCCs and disturbed classes in the RSA.

Fragmentation analyses relates to the edges between categories of patch types. For example, the "natural" category (consisting of all natural habitat) is fragmented or bordered by human disturbed areas (such as roads, seismic lines, industrial developments). Similarly, fragmentation analyses can spatially describe how "forested" and "non-forested" areas are fragmented by human disturbed areas or how old growth forest is distributed on the landscape.

1.2.1 Measurement of Landscape Heterogeneity and Fragmentation

Metrics are defined in the following section in terms of method of calculation and biological interpretation. Methods provided follow McGarigal and Marks (1995) and Elkie et al. (1999). The terminology and codes are based on the FRAGSTATS Version 3 software program (McGarigal and Marks 1995).

1.2.2 Class Area

Class area (CA) describes how much of the landscape is comprised of a particular patch type. It is determined by the sum of the areas (in hectares) of all patches for a given patch type. Class area values can be compared between different scenarios (e.g., baseline, impact) to examine changes in the composition of the landscape due to habitat loss.

Class area is of biological importance because it indicates how much habitat or living space is provided for the species occurring in a landscape. It can also be used to determine rarity of patch types.

The value of class area is reported in hectares and is limitless (i.e., it is not an index).

1.2.3 Number of Patches

The number of patches (NP) is the total number of patches within each patch type (where patches are a defined by the edges between patch types).

Number of patches is most valuable as the basis for calculating other measurements of fragmentation and heterogeneity. In addition, it can be a measure of the amount of dissection or fragmentation of the landscape particularly when comparing between scenarios.

The number of patches has no units and is limitless (i.e., it is not an index).

1.2.4 Patch Size

1.2.4.1 Mean

Mean patch size (AREA_MN) is determined by dividing the sum of all patch areas (i.e., class area) of a patch type by the number of patches within that type.

The mean patch size may be related to biological features such as the minimum size requirement for a patch before a given species will occupy or use it as habitat. For example, a mean patch size of 1 ha may be too small for moose or caribou to make use of as habitat, while 100 ha may be large enough.

The value of mean patch size is reported in hectares and is limitless (i.e., is not an index).

1.2.4.2 Median

Median patch size (AREA_MD) is determined by identifying the midpoint of the rank order distribution for patches of the corresponding patch type. That is, when individual patch size values for a particular patch type are ordered from smallest to largest, the median value would be the patch size that exists at the half-way point. When there are an odd number of patches, the median is the middle entry in the list after sorting the list into increasing order. When there is an even number of patches, the median is equal to the sum of the two middle numbers (after sorting the list into increasing order) divided by two.

This measure is important when used in conjunction with other patch measurements to describe how patches are distributed on the landscape. For example, if the median patch size for a patch type is similar to the mean, patch sizes are distributed evenly across the range of observations. Conversely, if median patch size is smaller than mean patch size, the patch type is represented by more small patches and fewer large patches.

The value of median patch size is reported in hectares and is limitless (i.e., it is not an index).

1.2.4.3 Standard Deviation

Standard deviation in patch size (AREA_SD) is useful in describing the variability in patch size within a patch type and is expressed relative to the mean patch size. It is determined by taking the square root of the sum of the squared deviations from the mean patch size of the corresponding patch type, divided by

the number of patches of the same type. This is also the root mean deviation from the mean patch size.

A large standard deviation indicates that there is considerable variation in patch size within the patch type (i.e., some patches are very small and other patches are very large). If all measured patch sizes are similar to the mean patch size, then the standard deviation will be close to zero.

The value of patch size standard deviation is reported in hectares and is limitless (i.e., it is not an index).

1.2.4.4 Coefficient of Variation

Patch size coefficient of variation (AREA_CV) is an expression of the variability of patch size relative to the mean. Patch size coefficient of variation is calculated by dividing the patch size standard deviation by mean patch size and multiplying by 100 to convert to a percentage. Unlike standard deviation, this value can be compared directly among different patch types because it has been standardized (i.e., divided by the mean). When all the patches are the same size or there is only one patch, the patch size coefficient of variation will be zero. When there is a range of sizes, the patch size coefficient of variation is greater than zero. When the patch size coefficient of variation equals 100%, standard deviation in patch size equals mean patch size.

This measurement is important because it determines, on average, how much larger or smaller patches are compared to the mean. For example, if a patch type has a mean patch size of 10 ha with a patch size coefficient of variation of 100%, the range in patch size is between 0 and 20 ha. When patch size coefficient of variation is greater than 100%, the largest patch size is more than double the mean.

The value of patch size coefficient of variation is reported as a percentage and is limitless (i.e., it is not an index).

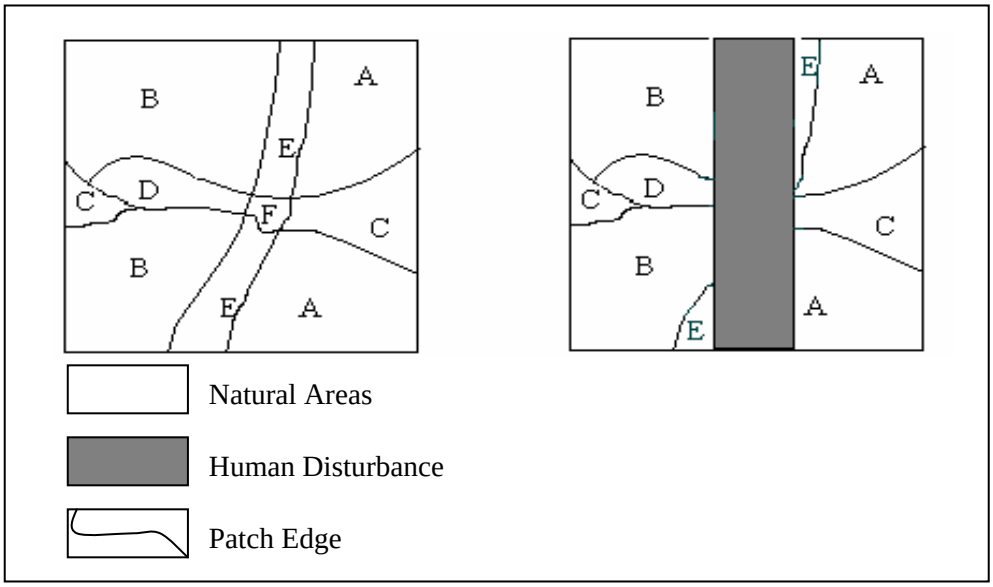
1.2.5 Patch Richness

Patch richness (PR) is a measure of the number of different patch types that occur within a landscape.

For example, in the diagrams of landscape fragmentation shown below in Figure J-1, the patch richness in the square on the left is six (A to F) and in the

square on the right it is five (A to E). One natural patch type has been lost due to human disturbance (i.e., fragmentation).

Figure J-1 Example of Landscape Richness



Patch richness is of biological importance because different species have unique ecosystem preferences. Therefore, greater patch richness increases the likelihood that more species can exist in a landscape.

The value of patch richness has no units and is limitless (i.e., it is not an index).

1.2.6 Shannon's Evenness Index

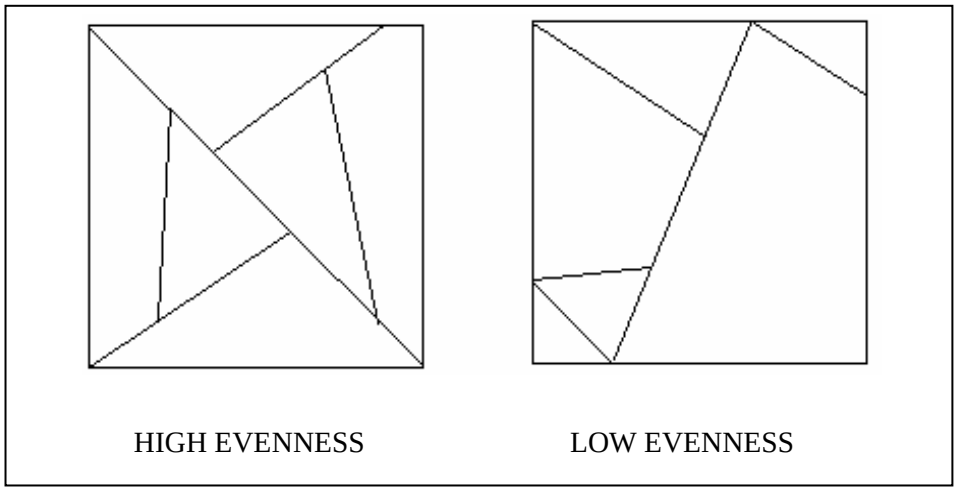
Shannon's Evenness Index (SHEI) is a measure of the relative diversity of different patch types in a landscape. This metric expresses the homogeneity of the landscape. Patch evenness is high when there are many patch types with a similar class area. The formula for SHEI is:

$$SHEI = \frac{-\sum_{i=1}^{m} P_i \ln P_i}{\ln m}$$

where: P_i is the proportion of the landscape occupied by patch type i;
m is the number of patch types present in the landscape; and
ln is the natural logarithm.

Figure J-2 depicts a landscape with six patch types. In the square on the left, the patches are approximately the same size; therefore, evenness of this landscape is high. The square on the right represents a landscape, also with six patch types, that is dominated by one or two large types and four small types; therefore, evenness of this landscape is low.

Figure J-2 Example of Landscape Evenness



Evenness is of biological importance because it provides a measure of the area dominance of patch types. Landscapes dominated by a few patch types (i.e., uneven) are thought to have reduced potential to support a large number of species. In contrast, it is expected that a highly even landscape can support more species.

Values for SHEI have no units and can range from 0 to 1. SHEI = 0 when the landscape contains only one patch (i.e., no diversity because the landscape is dominated by one type). SHEI approaches a value of 1 as the distribution of area among different patch types becomes more even (i.e., proportional abundances among patch types are the same).

1.2.7 Total Edge

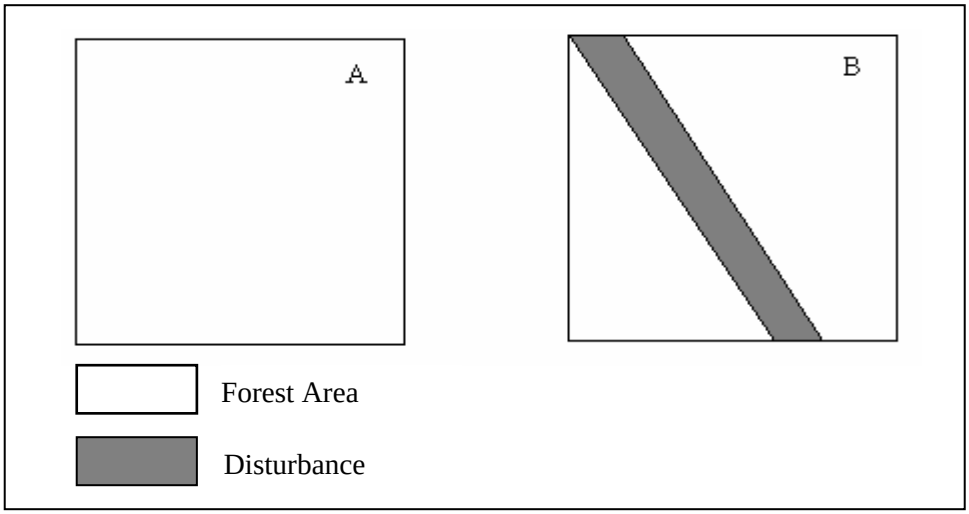
Total edge (TE) is a measure of the total length of all patch boundaries. Patch boundary is the border line between two patches.

This measurement has biological importance because many species use the edges between patch types to provide optimal habitat. Depending on the species, edge may be either positive or negative. For example, black bear and deer may benefit from habitat often associated with edges, such as abundant berry-producing and browse shrubs. Conversely, marten avoid edge habitat and instead seek the

relative seclusion of the interior portions of forest stands. Edges can also represent areas where invasive species, such as brown-headed cowbirds, can gain access to nests of forest-dwelling birds.

In Figure J-3, the continuous forest area shown in A has only the outside of the square as edge, but the amount of edge increases dramatically in square B when a disturbance is introduced.

Figure J-3 Example of Total Edge



The value of total edge is reported in kilometres and is limitless (i.e., it is not an index).

1.2.8 Euclidean Nearest Neighbour

The Euclidean nearest neighbour (ENN) distance is used to quantify the distance between patches of the same type. Euclidean nearest neighbour uses simple Euclidean geometry as the shortest straight-line distance (m) to the nearest neighbouring patch of the same type, based on patch edge-to-edge distance. These measurements provide an estimate of the degree of patch isolation from similar patches based on the distance of the patches from each other.

1.2.8.1 Mean

Mean Euclidean nearest neighbour is determined by dividing the sum of all nearest neighbour distances between patches of a patch type by the number of patches within that type.

This measure is biologically important because it relates to the mean distance that a species would have to travel between patches and thus defines the level of connectivity in the landscape. Where the mean distance is high, the connectivity is low and vice versa. Once the mean distance exceeds a certain threshold, a species may not effectively use the habitat, such as a carnivore that moves between isolated patches in search of prey items.

The value of mean Euclidean nearest neighbour is reported in metres and is limitless (i.e., it is not an index).

1.2.8.2 Median

Median Euclidean nearest neighbour is determined by identifying the midpoint of the rank order distribution for nearest neighbour distances between patches of the same patch type. That is, when all nearest neighbour distances between patches for a particular patch type are ordered from smallest to largest, the median value would be the nearest neighbour distance that exists at the half-way point. For example, where there are five different nearest neighbour distances of one, two, three, seven and nine metres between patches of a single patch type, the median Euclidean nearest neighbour is three metres (whereas the mean ENN is 4.4 m).

The value of median Euclidean nearest neighbour is reported in metres and is limitless (i.e., it is not an index).

1.2.8.3 Standard Deviation

Standard deviation in Euclidean nearest neighbour (ENN_SD) is useful in describing the variability in the distance between patches within a patch type and is expressed relative to the mean distance. It is determined by taking the square root of the sum of the squared deviations from the nearest neighbour distances between patches of the corresponding patch type, divided by the number of patches of the same type. This is also the root mean deviation from the nearest neighbour distances between patches.

The Euclidean nearest neighbour standard deviation describes variability in the mean nearest neighbour distance between patches of the same type and is expressed relative to ENN_MN. A large standard deviation indicates that distances between patch types is highly variable (i.e., some patches are very close together and other patches are very far apart). If all nearest neighbour distances are similar to the mean nearest neighbour distance, then the standard deviation will be close to zero.

The value of the Euclidean nearest neighbour standard deviation is reported in metres and is limitless (i.e., it is not an index).

1.2.8.4 Coefficient of Variation

Euclidean nearest neighbour coefficient of variation (ENN_CV) is an expression of the variability of patch size relative to the mean. Euclidean nearest neighbour coefficient of variation is determined by dividing the Euclidean nearest neighbour standard deviation by mean Euclidean nearest neighbour and multiplying by 100 to convert to a percentage. Unlike standard deviation, this value can be compared directly among different patch types because it has been standardized (i.e., divided by the mean). When all the patches of a patch type are the same distance apart or there is only one patch, ENN_CV is zero. When there is a range of distances between patches of a given patch type, ENN_CV is greater than zero. When the ENN_CV equals 100%, ENN_SD is equal to ENN_MN.

This measurement is important because it determines, on average, how much nearer or farther apart patches are compared to the mean. For example, if a patch type has a mean nearest neighbour of 10 m with an ENN_CV of 100%, the range in nearest neighbour distance is between 0 and 20 m. When ENN_CV is greater than 100%, the largest distance between patches is more than double the mean.

The value of Euclidean nearest neighbour coefficient of variation is reported as a percentage and is limitless (i.e., it is not an index).

1.2.9 Core Area Index and Area Weighted Mean

Core area index (CAI) represents the percentage of a patch that is comprised of core area. Core area is defined as the area of a patch that is a minimum set distance (e.g., 100 m) from the edge of the patch. The core area index is an effective tool for determining natural levels of core area as well as changes in core area values due to fragmentation of the landscape.

Core area index is determined by dividing the patch core area (ha) by total patch area (ha), and multiplying by 100 to convert to a percentage. The formula for core area index is:

$$CAI = \frac{a_{ij}^{c}}{a_{ij}}(100)$$

where: a_{ij}^{c} is the core area (ha) of patch *ij* based on a specified edge depth (m); and

a_{ij} is the area (ha) of patch *ij*.

Similarly, core area index area-weighted mean (CAI_AM) quantifies core area for the entire patch type as a percentage of total patch type. It is determined by multiplying the sum of the CAI values for all patches of the same type in the landscape, by the proportional abundance of the patch (i.e., core area [m^2] divided by the sum of core areas). The formula for core area index area-weighted mean is:

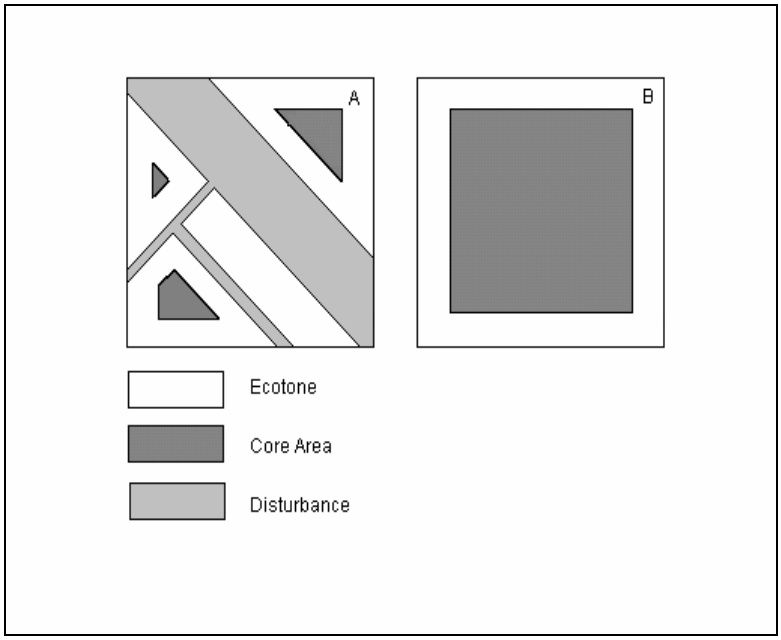
$$CAI\_AM = \sum_{j=1}^{n}\left[CAI_{ij}\left(\frac{a_{ij}}{\sum_{j=1}^{n} a_{ij}}\right)\right]$$

where: a_{ij} is the area (ha) of patch *ij*;); and

CAI_{ij} is the core area index (ha) of patch *ij*

The schematic diagram in Figure J-4A shows a forest area that is highly dissected by linear disturbance with little core area present within natural patches. Ecotone in the figure represents the buffer distance from the patch edge used to calculate core area. Figure J-4B illustrates the same forest area with no linear disturbance, which results in a larger core area than in the previous scenario.

Figure J-4 Effect of Fragmentation on Habitat Core Areas



The biological importance of core area analysis of different patch types within a landscape is related to isolation. The edge area (within 100 m of the patch edge) of each patch type often differs in terms of microclimate and soil conditions and supports an ecotone or area of species overlap. An ecotone is the overlap zone between two habitat types or a disturbance and a habitat type. The edge also represents the area where otherwise suitable habitat becomes less suitable for certain species because it is adjacent to non-habitat patches. Reductions in habitat suitability due to edge effects may result from predation, increased competition, microclimatic changes between patch types or disturbance from human activities. A landscape with a high total core area has a large amount of natural, isolated and homogeneous habitat critical for species that prefer isolation from disturbance (e.g., woodland caribou or brown creeper).

The CAI_AM values are reported as percentages and therefore range between 0 and 100. CAI_AM approaches 0 when the patch type contains no core area and CAI_AM approaches 100 when the patch type, because of size, shape and edge width, contains mostly core area. Large, square or circular patches will have more core area compared to irregularly shaped patches of the same size.

1.2.10 Mean Patch Fractal Dimension

The mean patch fractal dimension (FRAC_MN) reflects the mean shape complexity across a range of patches. This measurement is helpful in the interpretation of core area because patch types with the same CA can have a

different core area index (CAI) depending on the shape complexity of the patch types. As discussed in the Section 1.2.9, simple shapes will have more core area than complex shapes of the same size.

Mean patch fractal dimension (FRAC_MN) is the sum across all patches, of two times the logarithm of patch perimeter (m) divided by the logarithm of patch area (m^2) and divided by the number of patches. The perimeter is adjusted to correct for the raster bias in perimeter. The formula for FRAC_MN is:

$$FRAC\_MN = \frac{\sum_{j=1}^{n} \frac{2\ln(0.25 p_{ij})}{\ln a_{ij}}}{n_i}$$

where: p_{ij} is perimeter (m) of patch *ij*;
a_{ij} is area (m^2) of patch *ij*; and
n_i is the number of patches of type *i*.

The biological importance of FRAC_MN is related to edge effects and core area. As patch types become more complex in shape, the edge area between patch types increases providing more habitat for species that make use of edges between patch types (e.g., black bear and deer). Conversely, patch types with complex shapes have less core area habitat making it less suitable for species that require isolation within a specific patch type.

The FRAC_MN values have no units and range between 1 and 2. The value approaches 1 for shapes with very simple perimeters such as squares, and approaches 2 for shapes with highly convoluted perimeters.

1.2.11 Interspersion Juxtaposition Index

The Interspersion Juxtaposition Index (IJI) is a measure of how evenly patch types are distributed on the landscape. It is determined from patch adjacency and measures the interspersion or intermixing of patch types. The IJI is higher when patch types are more evenly distributed. The IJI is calculated as the actual interspersion over the maximum possible interspersions for the different patch types.

The IJI is determined by the negative sum of the length (m) of each patch type edge divided by the total landscape edge (m), multiplied by the logarithm of the previous quantity, summed over each unique edge type; divided by the logarithm

of the number of patch types minus one; multiplied by 100 (to convert to a percentage). The formula for IJI is:

$$IJI = \frac{-\sum_{k=1}^{m}\left[\left(\frac{e_{ik}}{\sum_{k=1}^{m} e_{ik}}\right)\ln\left(\frac{e_{ik}}{\sum_{k=1}^{m} e_{ik}}\right)\right]}{\ln(m-1)}(100)$$

where: e_{ij} is total length (m) of edge in landscape between patch types *i* and *k*;

m is the number of patch types present in the landscape, including the border, if present; and

ln is the natural logarithm.

The ecological function of a landscape is altered with increased habitat fragmentation (Saunders et al. 1991). The biological importance of IJI is that a patch type that is highly interspersed may resist disturbances and may be more likely to persist in a landscape than a patch type that is aggregated close together (Franklin and Forman 1987). Wildlife management focuses on maximizing habitat interspersion because it is thought that the juxtaposition of different habitats will increase species diversity (Leopold 1933).

Values of IJI are reported as percentages and range between 0 and 100. The IJI value approaches 0 when the corresponding patch type is adjacent to only 1 other patch type and the number of patch types increases. When the corresponding patch type is equally adjacent to all other patch types (i.e., maximally interspersed and juxtaposed to other patch types), IJI = 100.

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APPENDIX K

RANKING INFORMATION ON TRADITIONAL PLANTS WITHIN THE OIL SANDS REGION

Submitted to:
Shell Canada Limited

Prepared by:
Golder Associates Ltd.

December 2007 **05-1344-027**

LIST OF TABLES

Table K-1 List of Traditional Plants Within the Oil Sands Region 1
Table K-2 Traditional Plant Species Abundance Scoring Classification Based on Percent Species Cover and Frequency of Occurrence 3
Table K-3 Traditional Plant Species Scores for High Ranked Ecosite Phases and Wetlands Types Within the Local Study Area 4
Table K-4 Traditional Plant Species Scores for Moderate Ranked Ecosite Phases and Wetlands Types Within the Local Study Area 6
Table K-5 Traditional Plant Species Scores for Low Ranked Ecosite Phases and Wetlands Types Within the Local Study Area 8

1 SITE SUMMARY DATA

Tables K-1 to K-3 provide detailed information relating to the development of the traditional plant potential ranking for vegetation types. Table K-1 provides a list of traditional use plants that were included in the scoring system. Table K-2 provides the criteria for the scoring of each plant, based on presence and cover. Table K-3 provides the scoring for each vegetation type, which is based on the typical composition of each tradition use plant in that vegetation type. This data was used to create the rankings found in Section 3.3.6.

Table K-1 List of Traditional Plants Within the Oil Sands Region

Traditional Plant Species Name[(a)]	Scientific Name
blueberry	*Vaccinium myrtilloides*
low-bush cranberry (high-bush cranberry)	*Viburnum edule*
bog cranberry	*Oxycoccus microcarpus, Vaccinium vitis-idaea*
dewberry (trailing raspberry)	*Rubus pubescens*
saskatoon	*Amelanchier alnifolia*
pincherry	*Prunus pensylvanica*
chokecherry	*Prunus virginiana*
cloudberry	*Rubus chamaemorus*
raspberry	*Rubus idaeus*
huckleberry	*Vaccinium caespitosum, V. ovalifolium*
dwarf raspberry	*Rubus arcticus* (also *R. acaulis)*
red currant	*Ribes triste, R. glandulosum*
black currant	*R. hudsonianum, R. americanum*
snowberry	*Symphoricarpos albus, S. occidentalis*
strawberry	*Fragaria vesca, F. virginiana*
gooseberry	*Ribes lacustre, Ribes oxyacanthoides, R. hirtellum*
rose hip	*Rosa acicularis, R. woodsii*
twisted stalk	*Streptopus amplexifolius*
red-osier dogwood (moose berry)	*Cornus stolonifera*
kinnikinnik (bearberry)	*Arctostaphylos uva-ursi*
dogwood (bunchberry, bearberry)	*Cornus canadensis*
common juniper	*Juniperus communis, J. horizontalis*
common yarrow	*Achillea millefolium*
common plantain	*Plantago major*
buffaloberry	*Shepherdia canadensis*
hazelnut	*Corylus cornuta*
balsam fir	*Abies balsamea*
lodgepole pine	*Pinus contorta*
jack pine	*Pinus banksiana*
green alder	*Alnus viridis ssp crispa, A. viridis*
river alder	*Alnus incana ssp tenuifolia* (also *A. rugosa*)
trembling aspen	*Populus tremuloides*
tamarack	*Larix laricina*
white birch	*Betula papyrifera*
red birch (bog birch)	*Betula glandulosa, B. pumila*

Table K-1 List of Traditional Plants Within the Oil Sands Region (continued)

Traditional Plant Species Name[a]	Scientific Name
willow(s)	*Salix* spp.
stiff club moss	*Lycopodium annotinum*
chamomile	*Matricaria recutita*
spruce	*Picea glauca, P. mariana*
black poplar	*Populus balsamifera*
harebell (bluebell)	*Campanula rotundifolia*
frying pan plant	– [b]
green frog plant (pitcher plant)	*Sarracenia purpurea*
fly honeysuckle	*Lonicera caerulea* (also *L. villosa*)
twining honeysuckle	*Lonicera dioica*
bracted honeysuckle	*Lonicera involucrata*
Labrador tea	*Ledum groenlandicum*
rat root (sweet flag)	*Acorus americanus*
wild mint	*Mentha arvensis*
common pink wintergreen	*Pyrola asarifolia*
white wintergreen	*Pyrola elliptica*
moss	common mosses: *Aulacomnium palustre, Brachythecium* spp.*, Drepanocladus* spp., *Hylocomium splendens, Pleurozium schreberi, Ptilium crista-castrensis, Sphagnum* spp., *Tomentypnum nitens*
horsetail	*Equisetum* spp.
bulrush	*Schoenoplectus acutus* (also *Scirpus acutus*)*, S. tabernaemontani* (also *Scirpus validus*)*, Scirpus microcarpus*
nettle	*Urtica dioica*
northern bedstraw	*Galium boreale*
sweet scented bedstraw	*Galium triflorum*
fungi - dry dead wood	– [c]
ground fungus - puffball	– [c]
bracket fungus	– [c]
tuckahoe	– [b]
red touchwood fungus	– [b]
rock tripe	– [b]
seneca root	*Polygala senega*
wild sarsaparilla	*Aralia nudicaulis*
western dock	*Rumex occidentalis*
willow fungus	– [c]
showy aster	*Aster ciliolatus, A. puniceus*
sweet grass	*Hierochloe hirta ssp arctica* (also *H. odorata*)
common tansy	*Tanacetum bipinnatum*
common cattail	*Typha latifolia*

[a] List of traditional plant species names dervived from Golder (2003a,b, 2005). Associated scientific names inferred from common names.

[b] Unknown species.

[c] No data.

Note: Traditional plant species names in brackets are alternate common names used in Golder (2003).

Table K-2 Traditional Plant Species Abundance Scoring Classification Based on Percent Species Cover and Frequency of Occurrence

Percent Frequency Class	Abundance Scores by Percent Cover Class			
	Very Low [1 to 2%]	Low [>2 to 10%]	Moderate [>10 to 20%]	High [>20%]
rare (>0 to 10%)	0	0	n/a	n/a
occasional (>10 to 40%)	0	1	2	n/a
common (>40 to 70%)	0	2	2	3
very common (>70%)	1	3	3	4

n/a = Not applicable.

Table K-3 Traditional Plant Species Scores for High Ranked Ecosite Phases and Wetlands Types Within the Local Study Area

Traditional Plant Species Name	Scientific Name	Species Abundance Scores for High Ranked Ecosite Phases and Wetlands Types[a]										
		b1	b2	b3	b4	d1	d2	d3	e1	e2	e3	f2
number of plots		64	21	23	20	92	138	35	10	19	11	12
Trees[b]												
balsam fir	*Abies balsamea*						1	1		1	2	
black poplar	*Populus balsamifera*								2	2		2
jack pine	*Pinus banksiana*	4		2	4							
spruce	*Picea glauca, P. mariana*	3	3	4	4	3	4	4	2	3	4	3
tamarack	*Larix laricina*											
trembling aspen	*Populus tremuloides*	3	4	3	2	4	4	2	4	3		2
white birch	*Betula papyrifera*	2	2	2	2	2	2		2	2		3
	tree subtotal	*12*	*9*	*11*	*12*	*9*	*11*	*7*	*10*	*11*	*6*	*10*
Shrubs												
blueberry	*Vaccinium myrtilloides*	3	3	3	3							
bog cranberry	*Oxycoccus microcarpus, Vaccinium vitis-idaea*	3	3	3	3		2					
bracted honeysuckle	*Lonicera involucrata*									1		
buffaloberry	*Shepherdia canadensis*				2	1	2					
dewberry (trailing raspberry)	*Rubus pubescens*		1				2	2		3	3	2
green alder	*Alnus viridis ssp crispa, A. viridis*	2	2	1	1	2	1	1				
kinnikinnik (bearberry)	*Arctostaphylos uva-ursi*	2		1	1							
Labrador tea	*Ledum groenlandicum*	2	1	2	2	2	2	1				1
low-bush cranberry	*Viburnum edule*					3	3	3	2	3	2	2
raspberry	*Rubus idaeus*								3		2	1
red currant	*Ribes triste, R. glandulosum*								2	3	2	
red-osier dogwood	*Cornus stolonifera*								3	2	2	
river alder	*Alnus incana ssp tenuifolia (also A. rugosa)*								2	2	2	2
rose hip	*Rosa acicularis, R. woodsii*		3	3	3	3	3	3	2	3	3	3
willow	*Salix spp.*						2		1	1	1	2
	shrub subtotal	*12*	*13*	*13*	*15*	*11*	*17*	*10*	*15*	*18*	*17*	*13*

Table K-3 Traditional Plant Species Scores for High Ranked Ecosite Phases and Wetlands Types Within the Local Study Area (continued)

Traditional Plant Species Name	Scientific Name	Species Abundance Scores for High Ranked Ecosite Phases and Wetlands Types[a]										
		b1	b2	b3	b4	d1	d2	d3	e1	e2	e3	f2
Forbs												
dogwood (bunchberry)	*Cornus canadensis*	3	3	3	3	3	3	3	2	2	2	3
horsetail	*Equisetum spp.*								3	3	3	3
showy aster	*Aster ciliolatus, A. puniceus*										2	
stiff club moss	*Lycopodium annotinum*			1	1	1	1	1				
wild sarsaparilla	*Aralia nudicaulis*		3			2	2	2	1	2	1	1
	forb subtotal	*3*	*6*	*4*	*4*	*6*	*6*	*6*	*6*	*7*	*8*	*7*
Mosses												
moss	various common mosses	4	3	4	4	3	4	4		3	4	4
	moss subtotal	*4*	*3*	*4*	*4*	*3*	*4*	*4*	*0*	*3*	*4*	*4*
Total Score		**31**	**31**	**32**	**35**	**29**	**38**	**27**	**31**	**39**	**35**	**34**

[a] Traditional plant potential abundance scores: 4 = very common with high cover; 3 = very common with low to moderate cover or common with high cover; 2 = common with low to moderate cover or occassional with moderate cover; 1 = occassional with low cover or very common with very low cover. Blank cells = not recorded.

[b] Tree species occurring in both the tree and shrub layers.

Note: Traditional plant species names in brackets are alternate common names used in Golder (2003).

Table K-4 Traditional Plant Species Scores for Moderate Ranked Ecosite Phases and Wetlands Types Within the Local Study Area

Traditional Plant Species Name	Scientific Name	Species Abundance Scores for Moderate Ranked Ecosite Phases and Wetlands Types[a]									
		burn	**c1**	**f1**	**f3**	**h1**	**BTNN**	**FTNI**	**FTNN**	**FTNR**	**STNN**
number of plots		24	101	2	16	34	117	7	293	1	67
Trees[b]											
jack pine	*Pinus banksiana*	2	3								
spruce	*Picea glauca, P. mariana*		4	1	4	4	4	2	3	4	3
tamarack	*Larix laricina*							3	3	1	2
trembling aspen	*Populus tremuloides*	2									
white birch	*Betula papyrifera*			4		2					2
	tree subtotal	*4*	*7*	*5*	*4*	*6*	*4*	*5*	*6*	*5*	*7*
Shrubs											
blueberry	*Vaccinium myrtilloides*	2	3								
bog cranberry	*Oxycoccus microcarpus, Vaccinium vitis-idaea*		3			3	3	2	3	4	
dewberry (trailing raspberry)	*Rubus pubescens*			1	3						
gooseberry	*Ribes lacustre, Ribes oxyacanthoides, R. hirtellum*			1							
kinnikinnik (bearberry)	*Arctostaphylos uva-ursi*	1									
Labrador tea	*Ledum groenlandicum*	3	3			3	4	2	3	3	2
low-bush cranberry	*Viburnum edule*				2						
raspberry	*Rubus idaeus*			3							
red birch (bog birch)	*Betula glandulosa, B. pumila*							3	3	1	2
red currant	*Ribes triste, R. glandulosum*			3							
river alder	*Alnus incana ssp tenuifolia (also A. rugosa)*			4	1						2
rose hip	*Rosa acicularis, R. woodsii*	2			2						
willow	*Salix spp.*	2				2	2	2	3		3
	shrub subtotal	*10*	*9*	*12*	*8*	*8*	*9*	*9*	*12*	*8*	*9*

Table K-4 Traditional Plant Species Scores for Moderate Ranked Ecosite Phases and Wetlands Types Within the Local Study Area (continued)

Traditional Plant Species Name	Scientific Name	Species Abundance Scores for Moderate Ranked Ecosite Phases and Wetlands Types[a]									
		burn	**c1**	**f1**	**f3**	**h1**	**BTNN**	**FTNI**	**FTNN**	**FTNR**	**STNN**
Forbs											
cloudberry	*Rubus chamaemorus*						2			3	
dogwood (bunchberry)	*Cornus canadensis*	2	3		3						
horsetail	*Equisetum spp.*	3		3	4	3	2	3	2	1	3
	forb subtotal	*5*	*3*	*3*	*7*	*3*	*4*	*3*	*2*	*4*	*3*
Mosses											
moss	various common mosses	2	4	3	4	4	4	4	4	4	4
	moss subtotal	*2*	*4*	*3*	*4*	*4*	*4*	*4*	*4*	*4*	*4*
	Total score	**21**	**23**	**23**	**23**	**21**	**21**	**21**	**24**	**21**	**23**

[a] Traditional plant potential abundance scores: 4 = very common with high cover; 3 = very common with low to moderate cover or common with high cover; 2 = common with low to moderate cover or occassional with moderate cover; 1 = occassional with low cover or very common with very low cover. Blank cells = not recorded.

[b] Tree species occurring in both the tree and shrub layers.

Note: Traditional plant species names in brackets are alternate common names used in Golder (2003).

Table K-5 Traditional Plant Species Scores for Low Ranked Ecosite Phases and Wetlands Types Within the Local Study Area

Traditional Plant Species Name	Scientific Name	Species Abundance Scores for Low Ranked Ecosite Phase and Wetlands Type[a]																
		a1	g1	Me	Sh	BFNN	BONN	BTNI	BTNR	BTXC	FONG	FONS	FOPN	FTPN	MONG	SONS	CC	DIS
number of plots		37	114	2	9	2	19	9	4	2	48	111	18	10	36	51	6	3
Trees[b]																		
black poplar	*Populus balsamifera*																2	2
jack pine	*Pinus banksiana*	4	1		1													
spruce	*Picea glauca, P. mariana*	2	4			4	3	4	4	3		2	2	2				
tamarack	*Larix laricina*											3	2	3				
trembling aspen	*Populus tremuloides*			2													2	
white birch	*Betula papyrifera*															1	2	
	tree subtotal	*6*	*5*	*2*	*1*	*4*	*3*	*4*	*4*	*3*	*0*	*5*	*4*	*5*	*0*	*1*	*6*	*2*
Shrubs																		
blueberry	*Vaccinium myrtilloides*	3	2	2													1	
bog cranberry	*Oxycoccus microcarpus, Vaccinium vitis-idaea*	3	3	2		1	3	1	3	4								
kinnikinnik (bearberry)	*Arctostaphylos uva-ursi*	2		2														
Labrador tea	*Ledum groenlandicum*	1	4		1	3	3	4	4	3		2		1		1		
raspberry	*Rubus idaeus*				1												2	
red birch (bog birch)	*Betula glandulosa, B. pumila*						1			2	2	4	3	3		1		
red currant	*Ribes triste, R. glandulosum*				1													
red-osier dogwood	*Cornus stolonifera*				1													
river alder	*Alnus incana ssp tenuifolia (also A. rugosa)*				2											2		
rose hip	*Rosa acicularis, R. woodsii*				2													
saskatoon	*Amelanchier alnifolia*				1													
willow	*Salix spp.*				2		2			2	1	2				4	2	2
	shrub subtotal	*9*	*9*	*6*	*11*	*4*	*9*	*5*	*7*	*11*	*3*	*8*	*3*	*4*	*0*	*8*	*5*	*2*

Table K-5 Traditional Plant Species Scores for Low Ranked Ecosite Phases and Wetlands Types Within the Local Study Area (continued)

Traditional Plant Species Name	Scientific Name	Species Abundance Scores for Low Ranked Ecosite Phase and Wetlands Type[a]																
		a1	g1	Me	Sh	BFNN	BONN	BTNI	BTNR	BTXC	FONG	FONS	FOPN	FTPN	MONG	SONS	CC	DIS
Forbs																		
cloudberry	*Rubus chamaemorus*							3	2									
common cattail	*Typha latifolia*														2			
horsetail	*Equisetum spp.*				2	3	1				1	2			1	2	3	3
strawberry	*Fragaria vesca, F. virginiana*																2	
	forb subtotal	*0*	*0*	*0*	*2*	*3*	*1*	*3*	*2*	*0*	*1*	*2*	*0*	*0*	*3*	*2*	*5*	*3*
Mosses																		
moss	various common mosses	4	4	3	2	4	4	4	4	4	3	4	4	3		2		4
	moss subtotal	*4*	*4*	*3*	*2*	*4*	*4*	*4*	*4*	*4*	*3*	*4*	*4*	*3*	*0*	*2*	*0*	*4*
Total score		**19**	**18**	**11**	**16**	**15**	**17**	**16**	**17**	**18**	**7**	**19**	**11**	**12**	**3**	**13**	**16**	**11**

[a] Traditional plant potential abundance scores: 4 = very common with high cover; 3 = very common with low to moderate cover or common with high cover; 2 = common with low to moderate cover or occassional with moderate cover; 1 = occassional with low cover or very common with very low cover. Blank cells = not recorded.

[b] Tree species occurring in both the tree and shrub layers.

Note: Traditional plant species names in brackets are alternate common names used in Golder (2003).

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APPENDIX L

VEGETATION TYPES AND DISTRIBUTIONS IN THE JACKPINE EXPANSION MINING AREA

Submitted to:
Shell Canada Limited

Prepared by:
Golder Associates Ltd.

December 2007 **05-1344-027**

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TABLE OF CONTENTS

SECTION **PAGE**

1 VEGETATION DESCRIPTIONS AND DISTRIBUTION 1
1.1 CENTRAL MIXEDWOOD NATURAL SUBREGION ECOSITE PHASES.....1
1.2 WETLANDS VEGETATION DESCRIPTIONS AND DISTRIBUTIONS.....8
1.3 MISCELLANEOUS VEGETATION TYPES DESCRIPTIONS AND DISTRIBUTIONS.....15
1.4 WATER COVER TYPE DESCRIPTIONS AND DISTRIBUTIONS.....16
1.5 DISTURBANCES DESCRIPTIONS AND DISTRIBUTIONS.....17

2 SPECIES COMPOSITION AND PERCENT COVER BY VEGETATION TYPE 18

LIST OF TABLES

Table L-1 Species Composition and Percent Cover by Vegetation Type.....18

1 VEGETATION DESCRIPTIONS AND DISTRIBUTION

Descriptions of ecosite phases, wetlands types and other vegetation types mapped within the Jackpine Expansion Mining Area (JEMA) Local Study Area (LSA) are provided in the following subsections. These descriptions are based on established descriptions for ecosites phases and wetlands types in the region (Beckingham and Archibald 1996; Halsey et al. 2003). In cases where needed, the descriptions are supplemented with vegetation and soils data collected from the JEMA LSA. Section 2 contains full species lists for all vegetation types sampled. Note that not all vegetation types sampled were mapped due to size. Conversely, not all types mapped were sampled, due to small size, inaccessibility or limited value (e.g., disturbances and water types contain limited vegetation).

Common names are generally provided in the vegetation descriptions below. In cases where there is no common name or the common name can be confused with two or more species, a scientific name is given. For a list of common and scientific names, refer to Table L-1.

The JEMA LSA falls completely within the Central Mixedwood Natural Subregion (NRC 2006). All ecosite phase descriptions below are of the ecosite phases found within this Natural Subregion.

1.1 CENTRAL MIXEDWOOD NATURAL SUBREGION ECOSITE PHASES

a1 Lichen Jack Pine

The lichen jack pine (a1) ecosite phase is characterized by a xeric moisture regime and a poor nutrient regime. This vegetation type is typically located in crest, upper slope and level landscape positions. Soils are rapidly drained due to the coarse-textured, glaciofluvial parent material. Eluviated Dystric Brunisolic soils are most common for this vegetation type.

This ecosite phase has an open canopy of jack pine, a moderate cover of low shrubs including common blueberry, bog cranberry and common bearberry and a high cover of reindeer lichen. The diversity of vascular plants is low but lichen diversity is the highest among all vegetation types sampled within the LSA. The lichen jack pine (a1) ecosite phase covers 164 ha (1%) of the JEMA LSA and occurs mostly in the Fort Hills in the northwest (Volume 3, Section 3.5, Figure 3.5-1).

b1 Blueberry Jack Pine-Aspen

The blueberry jack pine-aspen (b1) ecosite phase has a subxeric to submesic moisture regime and a poor to medium nutrient regime. This vegetation type is typically located in crest, upper slope and level landscape positions within the landscape. The soil is relatively dry due to rapidly to well-drained, coarse-textured glaciofluvial parent material. Eluviated Dystric Brunisolic soils are most common.

This ecosite phase is comprised of an open canopy of jack pine and aspen and prominent shrub, forb, bryophyte and terrestrial lichen layers. The low shrub layer commonly includes green alder, Canada buffaloberry, common blueberry and bog cranberry. Bunchberry is the most common forb while Schreber's moss and reindeer lichen (*Cladina mitis*) are common in the bryophyte and lichen layers, respectively. The blueberry jack pine-aspen (b1) ecosite phase covers 518 ha (3%) of the JEMA LSA and largely occurs along the northwest boundary in the Fort Hills (Volume 3, Section 3.5, Figure 3.5-1).

b2 Blueberry Aspen (White Birch)

The blueberry aspen (white birch) (b2) ecosite phase is relatively dry due to the rapidly to well-drained, coarse-textured glaciofluvial or glaciofluvial over moraine parent materials. Soil moisture regime ranges between subxeric and submesic while nutrient regime ranges between poor and medium. This vegetation type is generally located in upper slope positions within the landscape. Eluviated Dystric Brunisolic soils are most commonly encountered.

This ecosite phase is dominated by a canopy of aspen. The low shrub and forb layers exhibit moderate vegetation cover. The most common understorey species are saskatoon, common blueberry, prickly rose and wild sarsaparilla. There are usually very low amounts of moss and terrestrial lichens. The blueberry aspen (white birch) (b2) ecosite phase covers 201 ha (1%) of the JEMA LSA in a few patches in the Fort Hills (Volume 3, Section 3.5, Figure 3.5-1).

b3 Blueberry Aspen-White Spruce

The blueberry aspen-white spruce (b3) ecosite phase is rapidly to well-drained and relatively dry as a result of the moderately coarse to coarse-textured, glaciofluvial or glaciofluvial over moraine parent material. Eluviated Dystric Brunisolic soils are most common for this vegetation type. Moisture regime ranges from subxeric to mesic while nutrient regime ranges between poor to medium. This vegetation type is generally located in upper slope positions within the landscape.

The tree layer of the blueberry aspen-white spruce ecosite phase consists of an open canopy of aspen, white spruce and jack pine. A moderate cover of low shrubs is commonly represented by green alder, common blueberry, prickly rose and Labrador tea. A prominent forb layer includes species such as bunchberry, ground-cedar and three-leaved Solomon's-seal. Common species in the bryophyte layer include Schreber's moss and stair-step moss. The blueberry aspen-white spruce (b3) ecosite phase covers 230 ha (1%) of the JEMA LSA and is found sparingly in the Fort Hills (Volume 3, Section 3.5, Figure 3.5-1).

b4 Blueberry White Spruce-Jack Pine

The blueberry white spruce-jack pine (b4) ecosite phase is characterized by a subxeric to mesic moisture regime and a poor to medium nutrient regime. Typically, this vegetation type is located in crest to upper slope landscape positions. Soils are rapidly to well-drained due to the relatively coarse texture of the soil or shallow depth to bedrock. The soil associated with this vegetation type has mainly developed from a thin deposit of glaciofluvial material overlying moraine or bedrock. Eluviated Dystric or Orthic Eutric Brunisolic soils are most common.

A relatively open canopy of jack pine and white spruce dominates the tree layer. A moderate cover of low shrubs is represented by species such as common blueberry, bog cranberry, Labrador tea, common bearberry and Canada buffaloberry. Schreber's moss is the most dominant moss while a high diversity of lichens is present in both the terrestrial lichen and epiphyte layers. The most common of these species are reindeer lichen (*Cladina mitis*) and *Evernia mesomorpha*. Forbs and grasses are not prominent within this vegetation type. The blueberry white spruce-jack pine (b4) ecosite phase covers 89 ha (less than 1%) of the JEMA LSA and largely occurs as a minor component in the Fort Hills portion of the LSA (Volume 3, Section 3.5, Figure 3.5-1).

c1 Labrador Tea–Mesic Jack Pine-Black Spruce

The Labrador tea–mesic jack pine-black spruce (c1) ecosite phase typically has a submesic to mesic moisture regime and a poor nutrient regime. This vegetation type is typically located in upper slope to level landscape positions. Soil drainage ranges from rapid to moderately well-drained within material developed from glaciofluvial deposits. Eluviated Dystric Brunisolic soils are most commonly encountered within this vegetation type.

The open tree layer of this ecosite phase is typically composed of a mixture of jack pine and black spruce. The shrub layer is dominated by a high amount of Labrador tea while a carpet of feather mosses, including Schreber's moss and knight's plume moss, usually covers the forest floor. Reindeer lichen

(*Cladina mitis* and *C. stellaris*) is often present while forb and graminoid cover is usually very low. The Labrador tea–mesic jack pine-black spruce (c1) ecosite phase covers 59 ha (less than 1%) of the JEMA LSA and occupies low rise uplands within the wetlands complex that comprises most of the LSA (Volume 3, Section 3.5, Figure 3.5-1).

d1 Low-Bush Cranberry Aspen

The low-bush cranberry aspen (d1) ecosite phase generally occurs in midslope landscape positions where mesic moisture conditions exist. Soils are usually well to moderately well-drained but imperfectly drained soils are occasionally encountered where topography is level or slightly depressed. Orthic Gray and Gleyed Gray Luvisolic soils developed from morainal parent materials are most commonly associated with this vegetation type. A medium nutrient regime for this vegetation type is typical.

This ecosite phase is typically composed of a dense cover of aspen in the tree layer and a rich shrub layer often including species such as twinflower, Canada buffaloberry, prickly rose, Labrador tea and low-bush cranberry. The forb layer is also usually rich with bunchberry and wild sarsaparilla being the most prominent species. The graminoid, bryophyte and lichen layers are usually inconspicuous. The low-bush cranberry aspen (d1) ecosite phase is the most common terrestrial vegetation type within the JEMA LSA. It covers 484 ha (3%) of the JEMA LSA and is distributed in a few patches throughout the northwest, north-central and south-central portions of the LSA (Volume 3, Section 3.5, Figure 3.5-1).

d2 Low-Bush Cranberry Aspen-White Spruce

The low-bush cranberry aspen-white spruce (d2) ecosite phase is a mixedwood community that has a characteristic mesic moisture regime and medium nutrient regime. It generally occurs in midslope to level positions in the landscape where well to imperfectly drained soils exist. Orthic Gray and Gleyed Gray Luvisolic soils that have developed from morainal parent material are most common.

This ecosite phase has a relatively high level of vascular species diversity. It usually contains a closed canopy of aspen and white spruce and a moderate to high cover of shrubs that may include Labrador tea, twinflower, prickly rose and low-bush cranberry. There is usually a moderate cover of forbs with bunchberry being the most prominent species. Other typical forbs that may be present include wild sarsaparilla, northern starflower, dewberry, palmate-leaved coltsfoot, common fireweed, wild lily-of-the-valley, stiff club-moss and wild strawberry. Schreber's moss and stair-step moss often occur together as common mosses on the forest floor. The low-bush cranberry aspen-white spruce (d2)

ecosite phase covers 239 ha (1%) of the JEMA LSA and is distributed within the Fort Hills and scattered within the central portion of the LSA (Volume 3, Section 3.5, Figure 3.5-1).

d3 Low-Bush Cranberry White Spruce

The low-bush cranberry white spruce (d3) ecosite phase represents a mature modal forest type within the Boreal Mixedwood ecological area. Moisture conditions are usually mesic but may be slightly moister in areas where drainage is imperfect. Nutrient regime is typically medium. The soils most commonly associated with this vegetation type are Orthic Gray and Gleyed Gray Luvisols, which typically develop from morainal parent material.

This ecosite phase is dominated by an open canopy of white spruce. Low-bush cranberry and Labrador tea tend to be moderately abundant in the low shrub layer. The diversity of the forb layer is variable and correlated with canopy closure. The most common forbs include bunchberry and wild sarsaparilla. A layer of mosses including Schreber's moss, stair-step moss and knight's plume moss usually covers the forest floor. The low-bush cranberry white spruce (d3) ecosite phase covers 93 ha (1%) of the JEMA LSA and is distributed throughout the western and central portions of the LSA (Volume 3, Section 3.5, Figure 3.5-1).

e1 Dogwood Balsam Poplar-Aspen

The dogwood balsam poplar (e1) ecosite phase is characterized by a mesic to subhygric moisture regime and a rich nutrient regime. It is found in relatively level to slightly depressed areas where morainal parent materials exist. Additionally, this ecosite phase occurs in riparian areas where nutrient-rich soil horizons have developed from fluvial deposited material. Orthic Gray Luvisol and Cumulic Regosolic soils are most commonly encountered within this vegetation type.

This ecosite phase most often occurs with balsam poplar and aspen in the tree layer. Shrub diversity is usually high and may include species such as river alder, low-bush cranberry, prickly rose, Canada buffaloberry, common wild rose, willow, wild red raspberry and bristly black currant. Forb cover is often dominated by a layer of wild sarsaparilla. The graminoid, bryophyte and lichen layers most often occur with very low abundances. The dogwood balsam poplar-aspen (e1) ecosite phase covers 7 ha (less than 1%) of the JEMA LSA and is largely distributed along riparian areas (Volume 3, Section 3.5, Figure 3.5-1).

e2 Dogwood Balsam Poplar-White Spruce

The dogwood balsam poplar-white spruce (e2) ecosite phase is characterized by a mesic to subhygric moisture regime and a rich nutrient regime. The moist, rich condition of this ecosite phase supports a rich diversity of plant species. Soils are moderately well to imperfectly drained and have developed from morainal and fluvial parent materials. Cumulic Humic Regosol, Orthic Gray Luvisol and Rego Gleysolic soils are often found within this vegetation type.

This ecosite phase has a rich diversity of vascular plant species. The tree canopy may include a mix of species such as aspen, white spruce, balsam poplar and white birch. The shrub layer is equally diverse and commonly includes red-osier dogwood, low-bush cranberry, willow, prickly rose and river alder. The forb layer also contains many species, which may include species such as wild sarsaparilla, palmate-leaved coltsfoot, dewberry and meadow horsetail. The grass layer is often dominated by bluejoint. The dogwood balsam poplar-white spruce (e2) ecosite phase covers 5 ha (less than 1%) of the JEMA LSA and is largely distributed along riparian areas (Volume 3, Section 3.5, Figure 3.5-1).

e3 Dogwood White Spruce

The dogwood white spruce (e3) ecosite phase is characterized by a mesic to subhygric moisture regime and a rich nutrient regime. Soils are moderately well-drained and have developed from morainal parent material and fluvial deposits within riparian zones. Gleyed Cumulic Humic Regosol, Orthic Luvic Gleysol and Orthic Gray Luvisolic soils are commonly encountered within this vegetation type.

This ecosite phase is composed of an open canopy of white spruce and a moderate cover of shrubs that may include species such as wild red raspberry, low-bush cranberry, river alder and red-osier dogwood. There is usually a prominent forb layer that may include common horsetail, tall lungwort, wild sarsaparilla and bishop's-cap. The bryophyte layer usually covers most of the forest floor and often includes the three most common feather mosses: Schreber's moss, knight's plume moss and stair-step moss. The dogwood white spruce (e3) ecosite phase covers 4 ha (less than 1%) of the JEMA LSA and is associated with riparian areas (Volume 3, Section 3.5, Figure 3.5-1).

f3 Horsetail White Spruce

The horsetail white spruce (f3) ecosite phase is characterized by a subhygric to hygric moisture regime and a medium to rich nutrient regime. Soils are imperfectly to poorly drained and have developed from morainal parent material and fluvial deposits within riparian zones. Cumulic Regosol, Orthic Gleysol and Gleyed Gray Luvisolic soils are associated with this vegetation type.

The horsetail white spruce (f3) ecosite phase is dominated by white spruce in the tree layer. In the tall shrub layer, there is a moderate cover of river alder while the low shrub layer includes species such as common wild rose and low-bush cranberry. Typical forb species include woodland horsetail, common horsetail, bunchberry and dewberry. A low to moderate cover of graminoids may be present and two-seeded sedge is the most prominent species within this layer. A moderate to high number of bryophyte species occur within this ecosite phase; however, Schreber's moss, stair-step moss and knight's plume moss typically dominate this layer and carpet the forest floor. The horsetail white spruce (f3) ecosite phase covers 16 ha (less than 1%) of the JEMA LSA and is found as a small patch west of the small lake in the centre of the LSA (Volume 3, Section 3.5, Figure 3.5-1).

g1 Labrador Tea−Subhygric Black Spruce-Jack Pine

The Labrador tea–subhygric black spruce-jack pine (g1) ecosite phase is characterized by a subhygric to hygric moisture regime and a poor nutrient regime. Ecologically, it is a transitional vegetation type between the well-drained Labrador tea–mesic jack pine-black spruce (c1) ecosite phase and the wooded bog (BTNN) wetlands type. This vegetation type also shares similar ecological characteristics to the Labrador tea/horsetail white spruce-black spruce (h1) ecosite phase and the wooded swamp (STNN) wetlands type.

This vegetation type is located in lower slope to undulating and level positions in the landscape where imperfect to poor drainage occurs. In some sites there is a seasonally high water table. Soils often contain a layer of organic material that is between 20 and 40 cm thick. Morainal and glaciofluvial parent materials are common and Orthic Gleysol, peaty phase Rego Gleysol and Orthic Luvic Gleysolic soils are often encountered.

This ecosite phase is composed of black spruce in the tree layer and a moderate cover of shrubs, with Labrador tea being the most prominent species. Vascular species diversity in this vegetation type is low. There is usually a carpet of feather mosses present that includes Schreber's moss and stair-step moss. Reindeer lichen (*Cladina mitis*) may also be present and scattered about the forest floor. The Labrador tea–subhygric black spruce-jack pine (g1) ecosite phase covers 72 ha (less than 1%) of the JEMA LSA and mainly occurs primarily as a large patch in the centre of the LSA (Volume 3, Section 3.5, Figure 3.5-1).

h1 Labrador Tea/Horsetail White Spruce-Black Spruce

The Labrador tea/horsetail white spruce-black spruce (h1) ecosite phase is characterized by a subhygric to hygric moisture regime and a medium nutrient regime. Ecologically, this vegetation type shares similar characteristics with both

the Labrador tea–subhygric black spruce-jack pine (g1) and horsetail white spruce (f3) ecosite phases. This vegetation type also overlaps ecologically with the wooded swamp (STNN) wetlands type.

Soil of the Labrador tea/horsetail white spruce-black spruce (h1) ecosite phase is often imperfectly to poorly drained. Organic matter thickness is usually thick and may occasionally include organic types. Morainal and glaciolacustrine parent materials are common and Orthic Gleysol, Terric Mesisol and peaty phase Orthic Luvic Gleysolic soils are often encountered.

This ecosite phase has a moderate cover of trees consisting primarily of black and white spruce but may also contain aspen and tall willow. There is also a moderate cover of shrubs that may include willow, Labrador tea and river alder. Species composition in the forb layer varies among sites; however, the most prominent species include common horsetail, woodland horsetail, palmate-leaved coltsfoot, bunchberry and dewberry. Two-seeded sedge is the most prominent species in the sparse graminoid layer. A carpet of mosses covers the forest floor with the most abundant species represented by Schreber's moss, stair-step moss, peat moss (*Sphagnum warnstorfii* and *S. angustifolium*) and golden moss. The Labrador tea/horsetail white spruce-black spruce (h1) ecosite phase covers 167 ha (1%) of the JEMA LSA and is found in small patches along the Muskeg River, and as a transition from the Fort Hills to the wetlands complex in the northeast of the LSA (Volume 3, Section 3.5, Figure 3.5-1).

Pj-Lt Comp Jack Pine-Tamarack Complex

The jack pine-tamarack complex (Pj-Lt Comp) is a 14 ha unit (less than 1% of the JEMA LSA) based on the AVI data rather than Beckingham and Archibald (1996). The dominant tree species indicate that the unit consists of an undulating landscape with typical upland and lowland species grouped together in one polygon, which does not fit a conventional ecosite phase description. The jack pine-tamarack complex consists of a moist to wet moisture regime, dominated by jack pine in the main canopy and containing tamarack as a secondary species. The complex may also contain aspen or black spruce. The jack pine-tamarack complex is found in one patch in the centre of the JEMA LSA.

1.2 WETLANDS VEGETATION DESCRIPTIONS AND DISTRIBUTIONS

Bogs

Bogs are acidic, mineral-poor peatlands that are raised above the groundwater by an accumulation of peat. In general, they are characterized by a hummocky

ground surface covered with *Sphagnum* moss, ericaceous shrubs and black spruce. Bogs develop under ombrotrophic conditions where water, minerals and nutrients are derived solely from precipitation. Groundwater and associated minerals are not able to reach the bog rooting layer because it is blocked by a layer of impermeable peat. The pH level in bogs generally ranges between three and four (Crum 1992).

Bogs are found along drainage divides, stagnation zones of peatland complexes and small isolated basins (Halsey et al. 2003). All bogs contain peat layers that are at least 40 cm thick. Bogs are subdivided into categories based on forest cover and on the presence of permafrost and internal lawns.

BFNN Forested Bog

Forested bogs (BFNN) are densely treed peatlands (more than 70% cover) without internal lawns or permafrost. The stunted tree layer (often less than 10 m tall) is composed entirely of black spruce. This wetlands type is a minor component, covering less than 1 ha (less than 1%) of the JEMA LSA (Volume 3, Section 3.5, Figure 3.5-1).

BTNI Wooded Bog With Internal Lawns

Wooded bogs with internal lawns (BTNI) are peatlands characterized by the presence of wet, open peat moss- and sedge-dominated internal lawns within a wooded bog island or peninsula. The lawns within the wetlands type are about 40 to 60 cm lower than the surrounding bog surface. Internal lawns were formed from the collapse of old permafrost zones (Halsey et al. 2003). The tree layer is typically composed of stunted black spruce less than 10 m tall. This wetlands type covers 714 ha (4%) of the JEMA LSA and is found in patches, and in a large bog complex in the north of the LSA (Volume 3, Section 3.5, Figure 3.5-1).

BTNN Wooded Bog

Wooded bogs (BTNN) are open-canopied peatlands (6 to 70% cover) without internal lawns or permafrost. The landform associated with this peatlands type is usually flat and uniformly wooded (Halsey et al. 2003). Soils are poorly to very poorly drained commonly resulting in the development of Terric Mesisol or Terric Fibrisol soil types.

The stunted tree layer (often less than 10 m tall) is composed entirely of black spruce. The low shrub layer often contains Labrador tea, black spruce and bog cranberry. The forb and graminoid layers are usually sparse but often include cloudberry, three-leaved Solomon's-seal and some sedges (*Carex* spp.) or sheathed cotton grass. The ground surface is covered by low hummocks 20 to

40 cm high with bryophyte species composition varying from the hummock top to hollow. Common bryophytes found in wooded bogs include Schreber's moss, stair-step moss, *Sphagnum fuscum*, *S. warnstorfii*, *S. angustifolium*, *S. capillifolium* and golden moss. There is often a prominent layer of lichens on the tops of the *Sphagnum* hummocks with reindeer lichen (*Cladina mitis*) being the most dominant species. The wooded bog wetlands type covers 632 ha (3%) of the JEMA LSA and is found in the south, central and northern portions of the LSA Volume 3, Section 3.5, Figure 3.5-1.

BTNR Wooded Bog With Forested Permafrost Bog And Internal Lawns

Wooded bogs with forested permafrost bog and internal lawns (BTNR) are bogs that influenced by relict permafrost. Forested permafrost bogs are characterized by elevated areas, termed frost mounds, that are elevated from the surrounding bog by more than 40 cm. Internal lawns are associated with these dense black spruce forested areas are internal lawns that are characterized by *Sphagnum* and *Carex* species and dead standing trees. These open internal lawns are 40 to 60 cm lower than the surrounding wooded bog, giving BTNR areas three distinct levels; the typical wooded bog, the lower internal lawns and the raised forested peat plateaus. At 17 ha (less than 1% of the LSA) BTNR is a component of the bog/fen complex in the north of the LSA.

BTXC Wooded Bog Permafrost Bog With Collapse Scars

Wooded permafrost bogs with collapse scars (BTXC) have a relatively flat, raised surface that is dominated by a ground layer of lichens, sometimes interspersed with moss. Collapse scars are typically 100 cm lower than the surrounding bog surface and may be present as isolated, circular areas or as interconnected, elongate drainage channels. Wooded permafrost bogs with collapse scars account for 89 ha (less than 1%) of the JEMA LSA. There are two primary patches along the west side of the JEMA LSA (Volume 3, Section 3.5, Figure 3.5-1).

BONN Open Bog

Open bogs (BONN) are bog peatlands without a black spruce tree layer and with very limited cover in the shrub layer as well. This wetlands type covers 61 ha (less than 1%) of the JEMA LSA (Volume 3, Section 3.5, Figure 3.5-1) in the northern bog/fen complex.

Fens

Fens are peatlands that are influenced by mineral-rich groundwater or surface water. Fens receive minerals and nutrients from precipitation and groundwater. A distinguishing feature of fens is that they are characterized by a prominent

layer of sedges. Soil chemistry in fens ranges widely with pH values varying from about 4 in extreme poor fens to more than 7 in extreme rich fens (Crum 1992). Fens in the JEMA LSA are often characterized by basic, calcium-rich soil chemistry.

Fens are divided on the basis of landform, forest cover that typically includes black spruce and tamarack, and the presence of peat plateaus and internal lawns in wooded fens (Halsey et al. 2003). All fens contain peat layers that are at least 40 cm thick.

FFNN Forested Fen

Forested fens (FFNN) are similar to treed fens; however, the tree canopy layers have a combined cover value greater than 70%. Soils are poorly to very poorly drained and are organic. Vegetation is dominated by a dense cover of black spruce and tamarack in the tree layer, Labrador tea in the shrub layer and peat moss (*Sphagnum warnstorfii*) and *Pohlia wahlenbergii* in the moss layer. The forested fen wetlands type covers 2 ha (less than 1%) of the JEMA LSA (Volume 3, Section 3.5, Figure 3.5-1).

FTNN Wooded Fen

Wooded fens (FTNN) are open-canopied peatlands (6 to 70% cover) without internal lawns or permafrost. Soils are poorly to very poorly drained commonly resulting in the development of Terric Mesisol or Terric Fibrisol soil types.

The wooded fen wetlands type has an open canopy of black spruce and tamarack in the tree layer. A moderate cover of shrubs is typical including species such as Labrador tea, tamarack, black spruce, dwarf birch, bog cranberry and willow. There is usually a scattered cover of forbs including species such as woodland horsetail, common horsetail and three-leaved Solomon's-seal. Graminoid cover is often prominent and typically includes water sedge and bluejoint. The diversity of mosses that carpet the forest floor ranges between moderate and high with the most prominent species being golden moss, stair-step moss, peat moss (*Sphagnum warnstorfii* and *S. angustifolium*), Schreber's moss and *Helodium blandowii*. The wooded fen wetlands type covers 3,452 ha (19%) of the JEMA LSA. Interspersed with shrubby fens (FONS), FTNN comprises the large fen complex that runs along the Muskeg River, comprising most of the JEMA LSA (Volume 3, Section 3.5, Figure 3.5-1).

FTNI Wooded Fen With Internal Lawns

Wooded fens with internal lawns (FTNI) are peatlands characterized by the presence of wet, open peat moss-, brown moss- and sedge-dominated internal

lawns surrounded by wooded fen. Internal lawns were formed from the collapse of old permafrost zones (Halsey et al. 2003). The tree layer is typically composed of black spruce and tamarack. This wetlands type covers 409 ha (2%) of the JEMA LSA (Volume 3, Section 3.5, Figure 3.5-1) and is found in the north and northwest sections.

FTPN Wooded Patterned Fen

The wooded patterned fen (FTPN) wetlands type is characterized by alternating strings (woody ridges) and flarks (herbaceous pools) that run parallel to the groundwater flow direction. Topography of the patterned fen appears level but has a slightly sloping grade (0.1 to 1.0%). The pattern of flarks and strings results from the perpendicular orientation of the direction of water flow to the landforms.

In wooded patterend fens, strings dominate, allowing these patterned fens to be considered wooded. The vegetation cover on the strings may be any combination of tamarack, black spruce, birch and willow. Potential ground cover varies, ranging from species of peat moss to golden moss and associated brown mosses to feather moss. Within the JEMA LSA there is 415 ha (2%) of FTPN. There is a large patterend fen in the south of the JEMA LSA, and another smaller fen more central at the confluence of the Muskeg River and Wapasu Creek (Volume 3, Section 3.5, Figure 3.5-1).

FOPN Open Patterned Fen

The open patterned fen (FOPN) wetlands type is also characterized by alternating strings and flarks that run parallel to the groundwater flow direction. Topography of the patterned fen appears level but has a slightly sloping grade (0.1 to 1.0%). Tree cover in this wetlands type is always low (less than 6%) while shrubs are most common along the string portions. The flarks form the wettest part of this wetlands type and are dominated by various sedge species.

Along the strings, there is a dense cover of dwarf birch, northern laurel and tamarack. The flarks may contain hairy-fruited sedge, buck-bean, pitcher-plant, northern grass-of-parnassus and oblong-leaved sundew. *Warnstorfia fluitans* is the dominant moss species within this wetlands type. The open patterned fen wetlands type covers 792 ha (4%) of the JEMA LSA (Volume 3, Section 3.5, Figure 3.5-1). The major component of this vegetation type is the lenticular patterned fen complex in the north of the LSA, discussed in, Volume 3, Section 3.5.1.5 of the ESR.

FONS Shrubby Fen

The shrubby fen (FONS) wetlands type lacks a tree layer due to saturated soil conditions. It is poorly to very poorly drained although usually not as wet as the graminoid fen where woody species are less likely to become established. This wetlands type is commonly associated with Terric Mesisol, Typic Fibrisol and Typic Mesisol soil types.

There is a moderate to high cover of woody species present in the shrub layer including dwarf birch, bog willow, willow, sweet gale, tamarack, Labrador tea and alder-leaved buckthorn. The forb layer is usually less conspicuous but may include buck-bean and marsh-marigold. The graminoid layer is usually prominent with the presence of species such as water sedge, bluejoint, two-stamened sedge and hairy-fruited sedge. Bryophytes most common to the graminoid fen include brown moss (*Hamatocaulis vernicosus*), tufted moss, golden moss, peat moss (*Sphagnum warnstorfii*) and *Calliergon giganteum*. The shrubby fen wetlands type covers 2,505 ha (14%) of the JEMA LSA (Volume 3, Section 3.5, Figure 3.5-1). Interspersed with treed fens (FTNN), shrubby fens make up the large fen complex that runs along the Muskeg River, comprising most of the JEMA LSA (Volume 3, Section 3.5, Figure 3.5-1).

FONG Graminoid Fen

The graminoid fen (FONG) wetlands type is saturated and poorly to very poorly drained. Nutrient regime ranges between poor and rich, depending upon pH and the content of minerals in the groundwater. This wetlands type is commonly associated with Typic Fibrisol, Terric Mesisol and Terric Humisol soil types.

Tree cover is absent to sparse within this wetlands type. The shrub and forb layers are usually not prominent but may contain willow, marsh cinquefoil and other species usually with a combined cover of less than 20%. The graminoid layer is prominent often containing many sedge species, most commonly water sedge, awned sedge and two-stamened sedge. Bryophyte cover is typically low because the high water table substantially restricts the development of this layer; however, species such as *Warnstorfia fluitans* and *Bryum pseudotriquetrum* are the most common. The graminoid fen wetlands type covers 878 ha (5%) of the JEMA LSA and is found throughout the LSA, including a large patch in the fen complex in the northeast of the LSA (Volume 3, Section 3.5, Figure 3.5-1).

Swamps

Swamps are wetlands that are rich in minerals and highly productive. They are typically located next to waterbodies that are subjected to flooding, or in areas influenced by fluctuating water levels such as along peat margins (Halsey et al.

2003). Fluctuating water levels within swamps may be the result of seasonal variation or slope drainage. The groundwater moving through the soil is typically well oxygenated, which in part leads to higher decomposition rates compared to fens (Crum 1992).

SONS Shrubby Swamp

The shrubby swamp (SONS) wetlands type lacks tree cover but has an open or closed shrub layer that is usually 2 to 5 m tall. Landforms associated with this vegetation type include floodplains, stream terraces and peat margins (Halsey et al. 2003). Soils are poorly to very poorly drained commonly resulting in the development of Terric Mesisol, Rego Gleysol, Orthic Gleysol and Orthic Humic Gleysolic soil types.

The shrubby swamp wetlands type has a moderately dense cover of woody species in the tall and low shrub layer represented by a rich mix of species such as willow, river alder, dwarf birch, alder-leaved buckthorn and white birch. Species composition in the forb layer is quite variable; however, the most common species are swamp horsetail and marsh-marigold. There is typically a prominent graminoid layer that includes species such as bluejoint, water sedge and awned sedge. The bryophyte layer is usually not very well developed due to fluctuating watertable levels; however, the most common species include *Climacium dendroides*, *Plagiomnium cuspidatum*, tufted moss and *Pseudobryum cinclidioides*. The shrubby swamp wetlands type covers 752 ha (4%) of the JEMA LSA and is the primary vegetation type comprising the banks of the Muskeg River (Volume 3, Section 3.5, Figure 3.5-1).

STNN Wooded Swamp

The wooded swamp (STNN) wetlands type is commonly found in broad plains associated with groundwater discharge as well as floodplains and along peat margins (Halsey et al. 2003). Tree heights are typically greater than in fens because the peaty soils are well aerated, at least during part of the year. The diversity of microhabitats in wooded swamps is usually high including features such as wet pools, rotting wood on the ground, stumps and mossy ground. Vascular species diversity is also high within this wetlands type. Typical soils are represented by Terric Mesisol, Terric Humisol, Orthic Luvic Gleysol (peaty phase) and Orthic Gleysol (peaty phase) soil types.

Tree canopy species composition of the wooded swamp wetlands type is variable depending upon the site and may include a mix of white birch, tamarack, black spruce and white spruce. Typical understorey species include Labrador tea, river alder and willow in the shrub layer, and common horsetail and marsh-marigold in the forb layer. Various sedges are present but bluejoint (a grass species) is the

most prominent species in the graminoid layer. Moss cover is quite varied but includes species such as acute-leaved peat moss (*Sphagnum capillifolium*), Schreber's moss, tufted moss and *Calliergon richardsonii*. The wooded swamp wetlands type covers 164 ha (1%) of the JEMA LSA and is found in small amounts in the central and southeast portions of the LSA (Volume 3, Section 3.5, Figure 3.5-1).

WONN Shallow Open Water

The shallow open water (WONN) wetlands type represents ponds and stagnated water zones typically resulting from beaver dams. These areas are found in association with marshes and shrubby swamps, and where water levels are less than 2 m deep. This wetlands type is characterized by submergent and floating vegetation commonly including water arum, common cattail, water sedge and common duckweed. The shallow open water wetlands type covers 2 ha (less than 1%) of the JEMA LSA (Volume 3, Section 3.5, Figure 3.5-1).

1.3 MISCELLANEOUS VEGETATION TYPES DESCRIPTIONS AND DISTRIBUTIONS

Sh Shrubland

The shrubland (Sh) vegetation type commonly occurs within the riparian zones of creeks and rivers where a disturbance regime such as periodic flooding prevents the establishment and development of a tree layer. The shrub layer can be dense and reach a height of 5 m. Soils are rich as a result of groundwater seepage transporting nutrients from upslope areas and/or inputs from deposits of fluvial-laden soil material. Soils are usually imperfectly drained and may include Orthic Humic Regosol and Eluviated Dystric Brunisolic soil types.

The shrub layer can be diverse and may include species such as red-osier dogwood, wild red raspberry, yellow willow and river alder. There is usually a prominent and diverse forb layer that may consist of species such as common horsetail, common fireweed, veiny meadow rue, tall lungwort, Canada goldenrod and common yarrow. Bluejoint is the most prominent grass species. The shrubland vegetation type covers 5 ha (less than 1%) of the JEMA LSA and is found in one patch in the Fort Hills (Volume 3, Section 3.5, Figure 3.5-1).

BUu Burn Uplands

The burn uplands (BUu) vegetation type represents uplands areas that have been recently burned by wildfire. This vegetation type typically has a mesic moisture regime and medium nutrient regime, and well to imperfectly drained soils

developed from morainal material. Orthic Gray Luvisol and Gleyed Gray Luvisolic soils are commonly associated with this vegetation unit.

The burn uplands vegetation type is generally devoid of a tree layer due to the fire but tends to have a moderate cover of shrubs, forbs and grasses. The most common species include willow, aspen, balsam poplar and Canada buffaloberry in the shrub layer, bunchberry and common fireweed in the forb layer and purple horn-toothed moss in the bryophyte layer. The burn uplands vegetation type covers 1,124 ha (6%) of the JEMA LSA and comprises upland portions of the 2002 Kearl Lake wildfire area in the southeast of the LSA (Volume 3, Section 3.5, Figure 3.5-1). Smaller upland burn areas are found in the Fort Hills in the northwest of the JEMA LSA.

BUw Burn Wetlands

The burn wetlands (BUw) vegetation type occurs in areas with organic soils that have been burnt over by wildfire within the last ten years. Based on reconnaissance field level field data, bog vegetation appears to be the most common wetlands type within these areas. Soil drainage is generally poor within the organic or peaty phase soil types.

Common species within the burn wetlands vegetation type includes a shrub layer consisting of willow, bog birch and shrubby cinquefoil, a forb layer with common fireweed and meadow horsetail, and bluejoint and sedges in the graminoid layer. The burn wetlands vegetation type covers 1,902 ha (10%) of the JEMA LSA and is most prominent in the southeast of the LSA, in lowland areas of the 2002 Kearl Lake wildfire (Volume 3, Section 3.5, Figure 3.5-1).

1.4 WATER COVER TYPE DESCRIPTIONS AND DISTRIBUTIONS

Lake Lake

The lake cover type is comprised of lakes and large ponds, greater than 2 m deep. There are six main waterbodies within the JEMA LSA; two in the south, two in the centre and three in the northwest. This cover type occupies 59 ha (less than 1%) of the JEMA LSA (Volume 3, Section 3.5, Figure 3.5-1).

River River

The river class refers to open, moving bodies of water. In the JEMA LSA, the major river systems include the Muskeg River and Wapasu Creek. There are also several small creeks feeding the Muskeg River from the Fort Hills. Rivers comprise less than 1 ha (less than 1%) of the JEMA LSA.

1.5 DISTURBANCES DESCRIPTIONS AND DISTRIBUTIONS

CC Cutblock

The cutblock (CC) cover type is represented by harvested stands at various stages of regrowth. Typically, there are prominent shrub, forb and graminoid layers that contribute to the high level of vascular plant species richness within this disturbance type. Moisture and nutrient regime is typically mesic and medium, respectively. Soils are generally well to imperfectly drained, Orthic Gray or Gleyed Gray Luvisols.

Some of the most common species in the shrub layer of cutblocks are common blueberry, wild red raspberry, aspen, white birch, balsam poplar, common bearberry and willow. Prominent forbs include wild strawberry, common fireweed and meadow horsetail. On younger and less shrubby cutblocks, the graminoid layer is generally thick, with bluejoint as one of the more common grass species present. The cutblock cover type occupies 120 ha (1%) of the JEMA LSA (Volume 3, Section 3.5, Figure 3.5-1). In the northwest, there are two major cutblocks in the Fort Hills portion of the JEMA LSA.

DIS Disturbance

The disturbance (DIS) cover type represents the baseline disturbance layer for the LSA. This cover type includes all sites that have been disturbed through anthropogenic (man-made) means such as borrow pits, well sites, borehole pads, clearings, roads, rights-of-ways, trails and seismic lines.

Portions of this cover type may contain vegetation that has been highly modified. For example, seismic lines have been cleared to the ground but vegetation has re-grown or colonized in some areas depending upon the age of the disturbance. However, roads and borrow pits are non-vegetated. The disturbance map unit covers 1,893 ha (10%) of the JEMA LSA and is found throughout the LSA (Volume 3, Section 3.5, Figure 3.5-1). The Syncrude Aurora South and Imperial Kearl Lake leases that abut the Shell JEMA LSA are considered disturbed for this Environmental Setting Report.

2 SPECIES COMPOSITION AND PERCENT COVER BY VEGETATION TYPE

Table L-1 provides a complete species list and the average percent cover for all ecosite phases and wetlands types sampled during the 2006 JEMA field surveys.

Table L-1 Species Composition and Percent Cover by Vegetation Type

Ecosite Phase/ Wetlands Type	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
a1	canopy	*Pinus banksiana*	jack pine	19
		Populus tremuloides	aspen	<1
	subcanopy	*Betula papyrifera*	white birch	1
		Picea glauca	white spruce	1
	tall shrub	*Betula papyrifera*	white birch	<1
		Picea glauca	white spruce	1
		Populus tremuloides	aspen	1
	low shrub	*Alnus viridis ssp crispa*	green alder	15
		Amelanchier alnifolia	saskatoon	1
		Arctostaphylos uva-ursi	common bearberry	11
		Betula papyrifera	white birch	<1
		Linnaea borealis	twinflower	1
		Picea glauca	white spruce	<1
		Pinus banksiana	jack pine	1
		Populus tremuloides	aspen	<1
		Prunus pensylvanica	pin cherry	<1
		Rosa acicularis	prickly rose	1
		Vaccinium myrtilloides	common blueberry	6
		Vaccinium vitis-idaea	bog cranberry	5
	forb	*Apocynum androsaemifolium*	spreading dogbane	<1
		Aralia nudicaulis	wild sarsaparilla	1
		Aster laevis	smooth aster	<1
		Campanula rotundifolia	harebell	<1
		Comandra umbellata	bastard toadflax	<1
		Cornus canadensis	bunchberry	3
		Diphasiastrum complanatum (also Lycopodium complanatum)	ground-cedar	5
		Equisetum arvense	common horsetail	1
		Galium boreale	northern bedstraw	<1
		Geocaulon lividum	northern bastard toadflax	1
		Hieracium umbellatum	narrow-leaved hawkweed	<1
		Lathyrus ochroleucus	cream-colored vetchling	1

Table L-1 Species Composition and Percent Cover by Vegetation Type (continued)

Ecosite Phase/ Wetlands Type	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
a1 (continued)	forb (continued)	*Lycopodium annotinum*	stiff club-moss	10
		Lycopodium obscurum	ground-pine	2
		Maianthemum canadense	wild lily-of-the-valley	2
		Melampyrum lineare	cow-wheat	<1
		Smilacina trifolia	three-leaved Solomon's-seal	3
		Solidago canadensis	Canada goldenrod	<1
		Solidago simplex ssp simplex (also S. spathulata)	mountain goldenrod	<1
		Trientalis borealis	northern starflower	3
		unknown forb species	unknown forb species	1
		unknown forb species	unknown forb species	1
		unknown Pyrola species	unknown Pyrola species	1
		unknown Pyrola species	unknown Pyrola species	<1
	graminoid	*Hierochloe hirta ssp arctica (also H. odorata)*	sweet grass	1
		Leymus innovatus (also Elymus innovatus)	hairy wild rye	1
		Oryzopsis asperifolia	white-grained mountain rice grass	<1
		Oryzopsis pungens	northern rice grass	<1
		unknown graminoid species	unknown graminoid species	1
		unknown graminoid species	unknown graminoid species	<1
	moss	*Brachythecium salebrosum*	*no common name*	1
		Dicranum polysetum	wavy dicranum	6
		Dicranum scoparium	broom moss	<1
		Ditrichum flexicaule	slender-stemmed hair moss	1
		Hylocomium splendens	stair-step moss	8
		Lepidozia reptans	liverwort	1
		Pleurozium schreberi	Schreber's moss	54
		Polytrichum juniperinum	juniper hair-cap	1
		Ptilium crista-castrensis	knight's plume moss	5
		Warnstorfia fluitans (also Drepanocladus fluitans)	warnstorfia moss	1
	lichen	*Cetraria nivalis (also Flavocetraria nivalis)*	*no common name*	<1
		Cladina mitis	reindeer lichen	23
		Cladina rangiferina	reindeer lichen	3
		Cladina stellaris	reindeer lichen	3
		Cladonia borealis	red pixie-cup	<1
		Cladonia botrytes	wooden soldiers	<1

Table L-1 Species Composition and Percent Cover by Vegetation Type (continued)

Ecosite Phase/ Wetlands Type	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
a1 (continued)	lichen (continued)	*Cladonia cenotea*	powdered funnel lichen	<1
		Cladonia chlorophaea	mealy pixie-cup	<1
		Cladonia coniocraea	cup lichen	<1
		Cladonia cornuta	bighorn cladonia	<1
		Cladonia gracilis	smooth cladonia	<1
		Cladonia pyxidata	pebbled pixie-cup	<1
		Cladonia sulphurina	greater sulphur cup	<1
		Cladonia uncialis	thorn cladonia	1
		Peltigera aphthosa	studded leather lichen	<1
		Peltigera canina	dog lichen	1
	epiphyte	*Arthonioid group*	Arthonioid group	<1
		Bryoria furcellata	old man's beard	<1
		Bryoria fuscescens	old man's beard	<1
		Bryoria lanestris	old man's beard	<1
		Evernia mesomorpha	boreal oakmoss lichen	<1
		Hypocenomyce scalaris	common clam lichen	<1
		Hypogymnia physodes	monk's-hood lichen	<1
		Imshaugia aleurites	salted starburst lichen	<1
		Imshaugia placorodia	American starburst lichen	<1
		Lecanora persimilis	*no common name*	<1
		Lecanora pulicaris	*no common name*	<1
		Lecanora symmicta	fused rim-lichen	<1
		Micarea sylvicola	*no common name*	<1
		Parmelia sulcata	hammered shield moss	<1
		Parmeliopsis ambigua	green starburst lichen	<1
		Parmeliopsis hyperopta	gray starburst lichen	<1
		Scoliciosporum perpusillum	*no common name*	<1
		Tuckermannopsis americana (also Cetraria halei or C. ciliaris)	fringed wrinkle-lichen	<1
		Tuckermannopsis sepincola	chestnut wrinkle-lichen	<1
		Usnea hirta	old man's beard	<1
		Usnea lapponica	old man's beard	<1
		Usnea scabrata	old man's beard	<1
		Usnea subfloridana	old man's beard	<1
		Usnea substerilis	old man's beard	<1
		Vulpicida pinastri (also Tuckermannopsis pinastri)	powdered sunshine lichen	<1

Table L-1 Species Composition and Percent Cover by Vegetation Type (continued)

Ecosite Phase/ Wetlands Type	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
b1	canopy	*Betula papyrifera*	white birch	1
		Picea glauca	white spruce	1
		Picea mariana	black spruce	5
		Pinus banksiana	jack pine	17
		Populus tremuloides	aspen	11
	subcanopy	*Betula papyrifera*	white birch	2
		Picea glauca	white spruce	1
		Populus tremuloides	aspen	2
	tall shrub	*Alnus viridis ssp crispa*	green alder	<1
		Betula papyrifera	white birch	1
		Picea glauca	white spruce	<1
		Populus tremuloides	aspen	2
		Prunus pensylvanica	pin cherry	1
	low shrub	*Alnus viridis ssp crispa*	green alder	7
		Amelanchier alnifolia	saskatoon	4
		Arctostaphylos uva-ursi	common bearberry	9
		Betula papyrifera	white birch	1
		Ledum groenlandicum	common Labrador tea	10
		Linnaea borealis	twinflower	3
		Lonicera dioica	twining honeysuckle	1
		Picea glauca	white spruce	1
		Picea mariana	black spruce	1
		Populus tremuloides	aspen	1
		Prunus pensylvanica	pin cherry	1
		Rosa acicularis	prickly rose	1
		Salix bebbiana	beaked willow	1
		Salix discolor	pussy willow	2
		Shepherdia canadensis	Canada buffaloberry	3
		Symphoricarpos albus	snowberry	1
		Vaccinium myrtilloides	common blueberry	13
		Vaccinium vitis-idaea	bog cranberry	7
		Viburnum edule	low-bush cranberry	2
	forb	*Achillea millefolium*	common yarrow	1
		Apocynum androsaemifolium	spreading dogbane	1
		Aralia nudicaulis	wild sarsaparilla	4
		Castilleja miniata	common red paintbrush	1
		Comandra umbellata	bastard toadflax	1

Table L-1 Species Composition and Percent Cover by Vegetation Type (continued)

Ecosite Phase/ Wetlands Type	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
b1 (continued)	forb (continued)	*Cornus canadensis*	bunchberry	4
		Diphasiastrum complanatum (also Lycopodium complanatum)	ground-cedar	7
		Epilobium angustifolium	common fireweed	<1
		Equisetum arvense	common horsetail	1
		Equisetum pratense	meadow horsetail	1
		Fragaria virginiana	wild strawberry	1
		Galium boreale	northern bedstraw	<1
		Galium trifidum	small bedstraw	1
		Geocaulon lividum	northern bastard toadflax	<1
		Goodyera repens	lesser rattlesnake plantain	<1
		Lathyrus ochroleucus	cream-colored vetchling	1
		Lycopodium annotinum	stiff club-moss	<1
		Lycopodium obscurum	ground-pine	2
		Maianthemum canadense	wild lily-of-the-valley	3
		Melampyrum lineare	cow-wheat	2
		Orthilia secunda (also Pyrola secunda)	one-sided wintergreen	1
		Rubus pubescens	dewberry	1
		Trientalis borealis	northern starflower	3
		unknown Aster species	unknown Aster species	1
		unknown forb species	unknown forb species	1
	graminoid	*Calamagrostis purpurascens*	purple reed grass	3
		Oryzopsis asperifolia	white-grained mountain rice grass	2
		Oryzopsis pungens	northern rice grass	1
		unknown Deschampsia species	unknown Deschampsia species	3
		unknown graminoid species	unknown graminoid species	1
		unknown Oryzopsis species	unknown Oryzopsis species	1
		unknown Stipa species	unknown Stipa species	1
	moss	*Brachythecium salebrosum*	*no common name*	<1
		Dicranum polysetum	wavy dicranum	3
		Dicranum undulatum	wavy dicranum	1
		Hylocomium splendens	stair-step moss	6
		Lepidozia reptans	liverwort	<1
		Orthotrichum speciosum	*no common name*	<1
		Pleurozium schreberi	Schreber's moss	38
		Pohlia nutans	copper wire moss	<1

Table L-1 Species Composition and Percent Cover by Vegetation Type (continued)

Ecosite Phase/ Wetlands Type	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
b1 (continued)	moss (continued)	*Ptilium crista-castrensis*	knight's plume moss	5
		Pylaisiella polyantha	pylaisiella moss	<1
		unknown Splachnum species	unknown Splachnum species	<1
	lichen	*Cetraria ericetorum*	*no common name*	<1
		Cladina mitis	reindeer lichen	5
		Cladina rangiferina	reindeer lichen	1
		Cladina stellaris	reindeer lichen	1
		Cladonia borealis	red pixie-cup	<1
		Cladonia botrytes	wooden soldiers	<1
		Cladonia chlorophaea	mealy pixie-cup	<1
		Cladonia gracilis	smooth cladonia	<1
		Cladonia pyxidata	pebbled pixie-cup	<1
		Cladonia sulphurina	greater sulphur cup	<1
		Cladonia uncialis	thorn cladonia	<1
		Peltigera canina	dog lichen	<1
		Peltigera neopolydactyla	carpet pelt	<1
		unknown Cladonia species	unknown Cladonia species	<1
	epiphyte	*Arthonioid group*	Arthonioid group	<1
		Bryoria furcellata	old man's beard	<1
		Bryoria fuscescens	old man's beard	<1
		Bryoria lanestris	old man's beard	<1
		Buellia triphragmioides	*no common name*	<1
		Evernia mesomorpha	boreal oakmoss lichen	<1
		Hypogymnia physodes	monk's-hood lichen	<1
		Imshaugia aleurites	salted starburst lichen	<1
		Imshaugia placorodia	American starburst lichen	<1
		Lecanora circumborealis	black-eyed rim lichen	<1
		Lecanora persimilis	*no common name*	<1
		Lecanora pulicaris	*no common name*	<1
		Lecanora rugosella	*no common name*	<1
		Lecanora subintricata	*no common name*	<1
		Lecanora symmicta	fused rim-lichen	<1
		Lecidella elaeochroma	*no common name*	<1
		Melanelia septentrionalis	northern camoflage lichen	<1
		Melanelia subaurifera	abraded camoflage lichen	<1
		Ochrolechia arborea	no common name	<1
		Parmelia sulcata	hammered shield moss	<1
		Parmeliopsis ambigua	green starburst lichen	<1

Table L-1 Species Composition and Percent Cover by Vegetation Type (continued)

Ecosite Phase/ Wetlands Type	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
b1 (continued)	epiphyte (continued)	*Parmeliopsis hyperopta*	gray starburst lichen	<1
		Scoliciosporum perpusillum	*no common name*	<1
		Scoliciosporum umbrinum	*no common name*	<1
		Tuckermannopsis americana (also Cetraria halei or C. ciliaris)	fringed wrinkle-lichen	<1
		Tuckermannopsis orbata (also Cetraria orbata)	variable wrinkle-lichen	<1
		Tuckermannopsis sepincola	chestnut wrinkle-lichen	<1
		unknown Parmeliopsis species	unknown Parmeliopsis species	<1
		unknown Usnea species	unknown Usnea species	<1
		Usnea hirta	old man's beard	1
		Usnea lapponica	old man's beard	<1
		Usnea scabrata	old man's beard	<1
		Usnea subfloridana	old man's beard	<1
		Usnea substerilis	old man's beard	<1
		Vulpicida pinastri (also Tuckermannopsis pinastri)	powdered sunshine lichen	<1
b2	canopy	*Abies balsamea*	balsam fir	1
		Betula papyrifera	white birch	32
		Picea glauca	white spruce	1
		Populus tremuloides	aspen	15
		Prunus pensylvanica	pin cherry	1
	subcanopy	*Picea glauca*	white spruce	1
	tall shrub	*Alnus incana ssp tenuifolia (also A. rugosa)*	river alder	2
		Betula papyrifera	white birch	1
		Populus tremuloides	aspen	3
		Prunus pensylvanica	pin cherry	5
	low shrub	*Alnus viridis ssp crispa*	green alder	2
		Amelanchier alnifolia	saskatoon	1
		Arctostaphylos uva-ursi	common bearberry	10
		Betula papyrifera	white birch	<1
		Linnaea borealis	twinflower	3
		Picea glauca	white spruce	1
		Populus tremuloides	aspen	1
		Prunus pensylvanica	pin cherry	3
		Rosa acicularis	prickly rose	<1
		Vaccinium myrtilloides	common blueberry	5

Table L-1 Species Composition and Percent Cover by Vegetation Type (continued)

Ecosite Phase/ Wetlands Type	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
b2 (continued)	low shrub (continued)	*Vaccinium vitis-idaea*	bog cranberry	2
		Viburnum edule	low-bush cranberry	<1
	forb	*Aralia nudicaulis*	wild sarsaparilla	5
		Comandra umbellata	bastard toadflax	1
		Cornus canadensis	bunchberry	6
		Diphasiastrum complanatum (also Lycopodium complanatum)	ground-cedar	2
		Epilobium angustifolium	common fireweed	1
		Goodyera repens	lesser rattlesnake plantain	<1
		Lycopodium annotinum	stiff club-moss	15
		Lycopodium obscurum	ground-pine	2
		Maianthemum canadense	wild lily-of-the-valley	2
		Melampyrum lineare	cow-wheat	1
		Smilacina trifolia	three-leaved Solomon's-seal	3
		Trientalis borealis	northern starflower	3
	graminoid	*Carex siccata*	hay sedge	1
		Hierochloe hirta ssp arctica (also H. odorata)	sweet grass	1
		Oryzopsis asperifolia	white-grained mountain rice grass	1
		unknown graminoid species	unknown graminoid species	1
		unknown graminoid species	unknown graminoid species	1
	moss	*Brachythecium salebrosum*	*no common name*	1
		Dicranum flagellare	whip fork moss	1
		Dicranum polysetum	wavy dicranum	3
		Dicranum scoparium	broom moss	<1
		Dicranum undulatum	wavy dicranum	<1
		Ditrichum flexicaule	slender-stemmed hair moss	1
		Hylocomium splendens	stair-step moss	<1
		Hylocomium splendens	stair-step moss	5
		Lepidozia reptans	liverwort	<1
		Pleurozium schreberi	Schreber's moss	20
		Pohlia nutans	copper wire moss	<1
		Polytrichum juniperinum	juniper hair-cap	1
		Ptilidium ciliare	liverwort	<1
		Ptilidium pulcherrimum	liverwort	<1
		Ptilium crista-castrensis	knight's plume moss	1
		Pylaisiella polyantha	pylaisiella moss	1

Table L-1 Species Composition and Percent Cover by Vegetation Type (continued)

Ecosite Phase/ Wetlands Type	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
b2 (continued)	lichen	*Cladina mitis*	reindeer lichen	<1
		Cladina rangiferina	reindeer lichen	<1
		Cladina stellaris	reindeer lichen	<1
		Cladonia botrytes	wooden soldiers	<1
		Cladonia cenotea	powdered funnel lichen	1
		Cladonia chlorophaea	mealy pixie-cup	<1
		Cladonia coniocraea	cup lichen	<1
		Cladonia cornuta	bighorn cladonia	<1
		Cladonia gracilis	smooth cladonia	<1
		Cladonia multiformis	sieve lichen	<1
		Cladonia sulphurina	greater sulphur cup	<1
		Hypocenomyce scalaris	common clam lichen	<1
		Peltigera neopolydactyla	carpet pelt	1
	epiphyte	*Bryoria fuscescens*	old man's beard	<1
		Bryoria glabra	old man's beard	<1
		Evernia mesomorpha	boreal oakmoss lichen	<1
		Hypocenomyce scalaris	common clam lichen	<1
		Hypogymnia physodes	monk's-hood lichen	<1
		Lecidea nylanderi	*no common name*	<1
		Leptorhaphis epidermidis	*no common name*	<1
		Parmelia sulcata	hammered shield moss	<1
		Parmeliopsis ambigua	green starburst lichen	<1
		Parmeliopsis hyperopta	gray starburst lichen	<1
		Scoliciosporum perpusillum	*no common name*	<1
		Usnea hirta	old man's beard	<1
		Usnea lapponica	old man's beard	<1
		Usnea subfloridana	old man's beard	<1
		Vulpicida pinastri (also Tuckermannopsis pinastri)	powdered sunshine lichen	<1
b3	canopy	*Betula papyrifera*	white birch	5
		Picea glauca	white spruce	20
		Pinus banksiana	jack pine	15
		Populus tremuloides	aspen	13
	subcanopy	*Betula papyrifera*	white birch	5
		Picea glauca	white spruce	5
		Populus tremuloides	aspen	<1

Table L-1 Species Composition and Percent Cover by Vegetation Type (continued)

Ecosite Phase/ Wetlands Type	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
b3 (continued)	tall shrub	*Alnus viridis ssp crispa*	green alder	1
		Amelanchier alnifolia	saskatoon	<1
		Betula papyrifera	white birch	1
		Picea glauca	white spruce	1
		Pinus banksiana	jack pine	5
		Populus tremuloides	aspen	5
		Prunus pensylvanica	pin cherry	<1
	low shrub	*Alnus viridis ssp crispa*	green alder	8
		Amelanchier alnifolia	saskatoon	2
		Arctostaphylos uva-ursi	common bearberry	13
		Betula occidentalis	water birch	3
		Betula papyrifera	white birch	<1
		Linnaea borealis	twinflower	1
		Picea glauca	white spruce	2
		Populus tremuloides	aspen	2
		Prunus pensylvanica	pin cherry	2
		Rosa acicularis	prickly rose	2
		Rubus idaeus	wild red raspberry	<1
		Vaccinium myrtilloides	common blueberry	12
		Vaccinium vitis-idaea	bog cranberry	5
		Viburnum edule	low-bush cranberry	2
	forb	*Apocynum androsaemifolium*	spreading dogbane	2
		Aralia nudicaulis	wild sarsaparilla	5
		Campanula rotundifolia	harebell	<1
		Comandra umbellata	bastard toadflax	5
		Cornus canadensis	bunchberry	3
		Diphasiastrum complanatum (also Lycopodium complanatum)	ground-cedar	<1
		Epilobium angustifolium	common fireweed	<1
		Equisetum sylvaticum	woodland horsetail	<1
		Geocaulon lividum	northern bastard toadflax	3
		Hieracium umbellatum	narrow-leaved hawkweed	<1
		Lathyrus ochroleucus	cream-colored vetchling	1
		Lycopodium annotinum	stiff club-moss	20
		Maianthemum canadense	wild lily-of-the-valley	2
		Melampyrum lineare	cow-wheat	1
		Petasites frigidus var palmatus	palmate-leaved coltsfoot	2

Table L-1 Species Composition and Percent Cover by Vegetation Type (continued)

Ecosite Phase/ Wetlands Type	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
b3 (continued)	forb (continued)	*Rubus pubescens*	dewberry	<1
		Trientalis borealis	northern starflower	1
		unknown Aster species	unknown Aster species	<1
		Vicia americana	wild vetch	<1
	graminoid	*Leymus innovatus (also Elymus innovatus)*	hairy wild rye	2
		Oryzopsis pungens	northern rice grass	<1
		unknown graminoid species	unknown graminoid species	1
	moss	*Dicranum polysetum*	wavy dicranum	4
		Dicranum undulatum	wavy dicranum	<1
		Hylocomium splendens	stair-step moss	17
		Lepidozia reptans	liverwort	<1
		Leptobryum pyriforme	leptobryum moss	<1
		Orthotrichum obtusifolium	obtuseleaf aspen moss	<1
		Orthotrichum speciosum	*no common name*	<1
		Pleurozium schreberi	Schreber's moss	40
		Polytrichum juniperinum	juniper hair-cap	<1
		Polytrichum strictum	slender hair-cap	<1
		Ptilium crista-castrensis	knight's plume moss	2
		Pylaisiella polyantha	pylaisiella moss	1
	lichen	*Cladina mitis*	reindeer lichen	10
		Cladonia borealis	red pixie-cup	<1
		Cladonia botrytes	wooden soldiers	<1
		Cladonia cervicornis (also C. verticillata)	ladder lichen	<1
		Cladonia chlorophaea	mealy pixie-cup	<1
		Cladonia cornuta	bighorn cladonia	<1
		Cladonia gracilis	smooth cladonia	<1
		Cladonia multiformis	sieve lichen	<1
		Cladonia pyxidata	pebbled pixie-cup	<1
		Hypocenomyce scalaris	common clam lichen	<1
		Peltigera neopolydactyla	carpet pelt	3
	epiphyte	*Arthonia patellulata*	*no common name*	<1
		Arthonioid group	Arthonioid group	<1
		Bryoria furcellata	old man's beard	<1
		Bryoria fuscescens	old man's beard	<1
		Caloplaca cerina	*no common name*	<1
		Evernia mesomorpha	boreal oakmoss lichen	2
		Hypogymnia physodes	monk's-hood lichen	<1

Table L-1 Species Composition and Percent Cover by Vegetation Type (continued)

Ecosite Phase/ Wetlands Type	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
b3 (continued)	epiphyte (continued)	*Imshaugia placorodia*	American starburst lichen	<1
		Lecanora pulicaris	*no common name*	<1
		Lecanora symmicta	fused rim-lichen	<1
		Melanelia subaurifera	abraded camoflage lichen	<1
		Melanelia trabeculata	*no common name*	<1
		Parmelia sulcata	hammered shield moss	<1
		Parmeliopsis ambigua	green starburst lichen	<1
		Parmeliopsis hyperopta	gray starburst lichen	<1
		Scoliciosporum perpusillum	*no common name*	<1
		Tuckermannopsis americana (also Cetraria halei or C. ciliaris)	fringed wrinkle-lichen	<1
		Usnea hirta	old man's beard	<1
		Usnea lapponica	old man's beard	<1
		Usnea scabrata	old man's beard	<1
		Usnea subfloridana	old man's beard	<1
		Usnea substerilis	old man's beard	<1
		Vulpicida pinastri (also Tuckermannopsis pinastri)	powdered sunshine lichen	<1
b4	canopy	*Picea glauca*	white spruce	8
		Picea mariana	black spruce	1
		Pinus banksiana	jack pine	28
		Populus tremuloides	aspen	1
	subcanopy	*Picea glauca*	white spruce	7
	tall shrub	*Betula papyrifera*	white birch	<1
		Picea glauca	white spruce	<1
		Populus tremuloides	aspen	1
	low shrub	*Alnus viridis ssp crispa*	green alder	1
		Ledum groenlandicum	common Labrador tea	2
		Picea glauca	white spruce	5
		Populus tremuloides	aspen	5
		Rosa acicularis	prickly rose	<1
		Vaccinium myrtilloides	common blueberry	5
		Vaccinium vitis-idaea	bog cranberry	1

Table L-1 Species Composition and Percent Cover by Vegetation Type (continued)

Ecosite Phase/ Wetlands Type	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
b4 (continued)	forb	*Cornus canadensis*	bunchberry	2
		Diphasiastrum complanatum (also Lycopodium complanatum)	ground-cedar	2
		Epilobium angustifolium	common fireweed	1
		Equisetum arvense	common horsetail	1
		Equisetum pratense	meadow horsetail	<1
		Equisetum sylvaticum	woodland horsetail	3
		Geocaulon lividum	northern bastard toadflax	<1
		Goodyera repens	lesser rattlesnake plantain	1
		Lycopodium annotinum	stiff club-moss	3
		Maianthemum canadense	wild lily-of-the-valley	1
		Smilacina trifolia	three-leaved Solomon's-seal	<1
		Trientalis borealis	northern starflower	<1
	graminoid	*unknown graminoid species*	unknown graminoid species	2
	moss	*Brachythecium salebrosum*	*no common name*	1
		Dicranum fuscescens	fuscous moss	1
		Dicranum polysetum	wavy dicranum	1
		Dicranum scoparium	broom moss	1
		Dicranum undulatum	wavy dicranum	1
		Ditrichum flexicaule	slender-stemmed hair moss	1
		Hylocomium splendens	stair-step moss	15
		Pleurozium schreberi	Schreber's moss	70
		Polytrichum commune	common hair-cap	1
		Ptilium crista-castrensis	knight's plume moss	3
	lichen	*Cladina mitis*	reindeer lichen	<1
		Cladina rangiferina	reindeer lichen	<1
		Cladina stellaris	reindeer lichen	<1
		Cladonia carneola	crowned pixie-cup	<1
		Cladonia chlorophaea	mealy pixie-cup	<1
		Cladonia coniocraea	cup lichen	<1
		Cladonia gracilis	smooth cladonia	<1
		Parmeliopsis hyperopta	gray starburst lichen	<1
		Peltigera aphthosa	studded leather lichen	1

Table L-1 Species Composition and Percent Cover by Vegetation Type (continued)

Ecosite Phase/ Wetlands Type	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
b4 (continued)	epiphyte	*Arthonioid group*	Arthonioid group	<1
		Bryoria furcellata	old man's beard	<1
		Bryoria fuscescens	old man's beard	<1
		Bryoria glabra	old man's beard	<1
		Evernia mesomorpha	boreal oakmoss lichen	<1
		Hypogymnia physodes	monk's-hood lichen	<1
		Lecanora pulicaris	*no common name*	<1
		Lecanora symmicta	fused rim-lichen	<1
		Lecidea nylanderi	*no common name*	<1
		Parmelia sulcata	hammered shield moss	<1
		Parmeliopsis ambigua	green starburst lichen	<1
		Parmeliopsis hyperopta	gray starburst lichen	<1
		Rinodina septentrionalis	*no common name*	<1
		Scoliciosporum perpusillum	*no common name*	<1
		Usnea hirta	old man's beard	<1
		Usnea subfloridana	old man's beard	<1
		Vulpicida pinastri (also Tuckermannopsis pinastri)	powdered sunshine lichen	<1
BONS	canopy	*Picea mariana*	black spruce	5
	subcanopy	*Larix laricina*	tamarack	1
	tall shrub	*Picea mariana*	black spruce	5
	low shrub	*Andromeda polifolia*	bog rosemary	15
		Betula papyrifera	white birch	1
		Betula pumila	dwarf birch	15
		Chamaedaphne calyculata	leatherleaf	28
		Kalmia polifolia	northern laurel	5
		Larix laricina	tamarack	1
		Ledum groenlandicum	common Labrador tea	2
		Myrica gale	sweet gale	10
		Oxycoccus microcarpus	small bog cranberry	1
		Picea mariana	black spruce	4
		Ribes hudsonianum	northern black currant	1
		Salix myrtillifolia	myrtle-leaved willow	1
		Salix planifolia	flat-leaved willow	3

Table L-1 Species Composition and Percent Cover by Vegetation Type (continued)

Ecosite Phase/ Wetlands Type	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
BONS (continued)	forb	*Caltha palustris*	marsh-marigold	1
		Chrysosplenium iowense	golden saxifrage	1
		Drosera rotundifolia	round-leaved sundew	1
		Galium triflorum	sweet-scented bedstraw	1
		Mitella nuda	bishop's-cap	1
		Orthilia secunda (also Pyrola secunda)	one-sided wintergreen	1
		Potentilla palustris	marsh cinquefoil	1
		Pyrola asarifolia	common pink wintergreen	1
		Ranunculus gmelinii	yellow water crowfoot	1
		Ranunculus lapponicus	Lapland buttercup	1
		Rubus chamaemorus	cloudberry	1
		Rubus pubescens	dewberry	1
		Smilacina trifolia	three-leaved Solomon's-seal	10
		Stellaria longipes	long-stalked chickweed	1
		unknown forb species	unknown forb species	1
		unknown Rubus species	unknown Rubus species	1
	graminoid	*Carex aquatilis*	water sedge	50
		Eriophorum vaginatum	sheathed cotton grass	4
	moss	*Amblystegium serpens*	*no common name*	<1
		Aulacomnium palustre	tufted moss	30
		Bryum pseudotriquetrum	*no common name*	1
		Dicranum undulatum	wavy dicranum	1
		Drepanocladus aduncus	brown moss	20
		Hylocomium splendens	stair-step moss	1
		Plagiomnium ellipticum	elliptic plagiomnium moss	10
		Pleurozium schreberi	Schreber's moss	1
		Polytrichum commune	common hair-cap	1
		Sphagnum angustifolium	peat moss	35
		Sphagnum fuscum	rusty peat moss	38
		Sphagnum magellanicum	midway peat moss	9
		Sphagnum riparium	shore-growing peat moss	5
		Sphagnum squarrosum	squarrose peat moss	1
		Sphagnum warnstorfii	peat moss	30
		Tomentypnum nitens	golden moss	1

Table L-1 Species Composition and Percent Cover by Vegetation Type (continued)

Ecosite Phase/ Wetlands Type	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
BONS (continued)	lichen	*Cladina mitis*	reindeer lichen	<1
		Cladonia cenotea	powdered funnel lichen	<1
		Cladonia cornuta	bighorn cladonia	<1
		Cladonia gracilis	smooth cladonia	<1
		Cladonia sulphurina	greater sulphur cup	<1
		Peltigera neopolydactyla	carpet pelt	<1
	epiphyte	*Arthonioid group*	Arthonioid group	<1
		Bryoria fuscescens	old man's beard	<1
		Bryoria glabra	old man's beard	1
		Bryoria simplicior	old man's beard	<1
		Evernia mesomorpha	boreal oakmoss lichen	<1
		Hypogymnia physodes	monk's-hood lichen	<1
		Lecanora pulicaris	*no common name*	<1
		Lecanora subintricata	*no common name*	<1
		Lecanora symmicta	fused rim-lichen	<1
		Ochrolechia arborea	no common name	<1
		Parmelia sulcata	hammered shield moss	<1
		Ramalina dilacerata	punctured ramalina	<1
		Scoliciosporum perpusillum	*no common name*	<1
		Tuckermannopsis americana (also Cetraria halei or C. ciliaris)	fringed wrinkle-lichen	<1
		Tuckermannopsis sepincola	chestnut wrinkle-lichen	<1
		unknown Bryoria species	unknown Bryoria species	<1
		unknown lichen species	unknown lichen species	<1
		unknown Usnea species	unknown Usnea species	<1
		Usnea lapponica	old man's beard	<1
		Usnea scabrata	old man's beard	<1
		Usnea subfloridana	old man's beard	<1
		Usnea substerilis	old man's beard	1
		Vulpicida pinastri (also Tuckermannopsis pinastri)	powdered sunshine lichen	<1
BTNI	canopy	*Picea mariana*	black spruce	9
	subcanopy	*Picea mariana*	black spruce	3
	tall shrub	*Picea mariana*	black spruce	5

Table L-1 Species Composition and Percent Cover by Vegetation Type (continued)

Ecosite Phase/ Wetlands Type	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
BTNI (continued)	low shrub	*Andromeda polifolia*	bog rosemary	3
		Chamaedaphne calyculata	leatherleaf	26
		Kalmia polifolia	northern laurel	3
		Ledum groenlandicum	common Labrador tea	25
		Oxycoccus microcarpus	small bog cranberry	1
		Picea mariana	black spruce	5
		Vaccinium vitis-idaea	bog cranberry	2
	forb	*Drosera rotundifolia*	round-leaved sundew	<1
		Rubus chamaemorus	cloudberry	2
	graminoid	*Eriophorum vaginatum*	sheathed cotton grass	8
	moss	*Bryum pseudotriquetrum*	*no common name*	<1
		Calypogeia sphagnicola	liverwort	<1
		Cephalozia connivens	liverwort	1
		Cephalozia lunulifolia	liverwort	<1
		Cephalozia pleniceps	liverwort	<1
		Dicranum fuscescens	fuscous moss	1
		Dicranum polysetum	wavy dicranum	<1
		Dicranum undulatum	wavy dicranum	1
		Jamesoniella autumnalis	liverwort	1
		Mylia anomala	liverwort	<1
		Pleurozium schreberi	Schreber's moss	23
		Pohlia nutans	copper wire moss	<1
		Ptilidium pulcherrimum	liverwort	<1
		Sphagnum angustifolium	peat moss	25
		Sphagnum capillifolium	acute-leaved peat moss	1
		Sphagnum fuscum	rusty peat moss	41
		Sphagnum girgensohnii	Girgensohn's moss	<1
		Sphagnum magellanicum	midway peat moss	16
		Sphagnum squarrosum	squarrose peat moss	1
		Sphagnum warnstorfii	peat moss	<1
	lichen	*Cladina mitis*	reindeer lichen	19
		Cladina rangiferina	reindeer lichen	3
		Cladina stellaris	reindeer lichen	1
		Cladonia borealis	red pixie-cup	<1
		Cladonia cenotea	powdered funnel lichen	<1
		Cladonia chlorophaea	mealy pixie-cup	<1

Table L-1 Species Composition and Percent Cover by Vegetation Type (continued)

Ecosite Phase/ Wetlands Type	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
BTNI (continued)	lichen (continued)	*Cladonia cornuta*	bighorn cladonia	<1
		Cladonia gracilis	smooth cladonia	<1
		Cladonia sulphurina	greater sulphur cup	<1
		Icmadophila ericetorum	spraypaint	<1
		unknown Flavoparmelia species	unknown Flavoparmelia species	<1
	epiphyte	*Arthonioid group*	Arthonioid group	<1
		Bryoria furcellata	old man's beard	<1
		Bryoria fuscescens	old man's beard	<1
		Bryoria lanestris	old man's beard	1
		Evernia mesomorpha	boreal oakmoss lichen	1
		Hypogymnia physodes	monk's-hood lichen	<1
		Imshaugia aleurites	salted starburst lichen	<1
		Lecanora circumborealis	black-eyed rim lichen	<1
		Lecanora laxa	*no common name*	<1
		Lecanora persimilis	*no common name*	<1
		Lecanora pulicaris	*no common name*	<1
		Lecanora subintricata	*no common name*	<1
		Lecanora symmicta	fused rim-lichen	<1
		Melanelia trabeculata	*no common name*	<1
		Ochrolechia arborea	no common name	<1
		Parmelia sulcata	hammered shield moss	<1
		Parmeliopsis ambigua	green starburst lichen	<1
		Ramalina pollinaria	chalky ramalina	1
		Scoliciosporum perpusillum	*no common name*	<1
		Tuckermannopsis americana (also Cetraria halei or C. ciliaris)	fringed wrinkle-lichen	<1
		Tuckermannopsis sepincola	chestnut wrinkle-lichen	<1
		unknown Bryoria species	unknown Bryoria species	<1
		unknown Usnea species	unknown Usnea species	<1
		Usnea hirta	old man's beard	<1
		Usnea lapponica	old man's beard	<1
		Usnea scabrata	old man's beard	<1
		Usnea subfloridana	old man's beard	<1
		Usnea substerilis	old man's beard	<1
		Vulpicida pinastri (also Tuckermannopsis pinastri)	powdered sunshine lichen	<1

Table L-1 Species Composition and Percent Cover by Vegetation Type (continued)

Ecosite Phase/ Wetlands Type	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
BTNN	canopy	*Larix laricina*	tamarack	4
		Picea mariana	black spruce	18
		Pinus banksiana	jack pine	<1
	tall shrub	*Larix laricina*	tamarack	2
		Picea mariana	black spruce	4
		unknown Salix species	unknown Salix species	<1
	low shrub	*Andromeda polifolia*	bog rosemary	3
		Arctostaphylos rubra	alpine bearberry	<1
		Arctostaphylos uva-ursi	common bearberry	2
		Betula pumila	dwarf birch	5
		Larix laricina	tamarack	4
		Ledum groenlandicum	common Labrador tea	35
		Linnaea borealis	twinflower	1
		Oxycoccus microcarpus	small bog cranberry	2
		Picea mariana	black spruce	9
		Rosa acicularis	prickly rose	<1
		Salix myrtillifolia	myrtle-leaved willow	<1
		unknown Salix species	unknown Salix species	1
		Vaccinium caespitosum	dwarf bilberry	1
		Vaccinium myrtilloides	common blueberry	<1
		Vaccinium vitis-idaea	bog cranberry	1
	forb	*Achillea millefolium*	common yarrow	<1
		Aster ciliolatus	Lindley's aster	<1
		Cornus canadensis	bunchberry	<1
		Drosera rotundifolia	round-leaved sundew	<1
		Epilobium angustifolium	common fireweed	<1
		Equisetum fluviatile	swamp horsetail	<1
		Equisetum pratense	meadow horsetail	<1
		Equisetum scirpoides	dwarf scouring-rush	1
		Equisetum sylvaticum	woodland horsetail	<1
		Fragaria virginiana	wild strawberry	<1
		Galium trifidum	small bedstraw	<1
		Maianthemum canadense	wild lily-of-the-valley	<1
		Mitella nuda	bishop's-cap	<1
		Petasites frigidus var palmatus	palmate-leaved coltsfoot	<1
		Platanthera hyperborea (also Habenaria hyperborea)	northern green bog orchid	<1
		Ranunculus lapponicus	Lapland buttercup	<1

Table L-1 Species Composition and Percent Cover by Vegetation Type (continued)

Ecosite Phase/ Wetlands Type	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
BTNN (continued)	forb (continued)	*Rubus arcticus (also R. acaulis)*	dwarf raspberry	1
		Rubus chamaemorus	cloudberry	1
		Rubus pubescens	dewberry	1
		Smilacina trifolia	three-leaved Solomon's-seal	3
		Tofieldia glutinosa	sticky false asphodel	<1
		unknown Aster species	unknown Aster species	<1
		Viola renifolia	kidney-leaved violet	<1
	graminoid	*Carex aquatilis*	water sedge	14
		Carex limosa	mud sedge	<1
		Leymus innovatus (also Elymus innovatus)	hairy wild rye	<1
		Scirpus hudsonianus	Hudson Bay bulrush	<1
		unknown graminoid species	unknown graminoid species	<1
	moss	*Aulacomnium palustre*	tufted moss	<1
		Dicranum scoparium	broom moss	<1
		Dicranum undulatum	wavy dicranum	<1
		Helodium blandowii	Blandlow's feather moss	<1
		Hylocomium splendens	stair-step moss	3
		Pleurozium schreberi	Schreber's moss	51
		Polytrichum commune	common hair-cap	<1
		Ptilidium ciliare	liverwort	1
		Sphagnum angustifolium	peat moss	7
		Sphagnum fuscum	rusty peat moss	47
		Sphagnum magellanicum	midway peat moss	5
		Sphagnum warnstorfii	peat moss	1
		Tomentypnum nitens	golden moss	<1
		Warnstorfia fluitans (also Drepanocladus fluitans)	warnstorfia moss	1
	lichen	*Cetraria nivalis (also Flavocetraria nivalis)*	*no common name*	<1
		Cladina mitis	reindeer lichen	9
		Cladina rangiferina	reindeer lichen	6
		Cladina stellaris	reindeer lichen	3
		Cladonia borealis	red pixie-cup	<1
		Cladonia cervicornis (also C. verticillata)	ladder lichen	<1
		Cladonia chlorophaea	mealy pixie-cup	<1
		Cladonia cornuta	bighorn cladonia	<1
		Cladonia gracilis	smooth cladonia	<1
		Cladonia sulphurina	greater sulphur cup	<1

Table L-1 Species Composition and Percent Cover by Vegetation Type (continued)

Ecosite Phase/ Wetlands Type	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
BTNN (continued)	lichen (continued)	*Icmadophila ericetorum*	spraypaint	<1
		Peltigera aphthosa	studded leather lichen	<1
		Peltigera neopolydactyla	carpet pelt	<1
		unknown lichen species	unknown lichen species	<1
	epiphyte	*Amandinea punctata (also Buellia punctata)*	*no common name*	1
		Arthonioid group	Arthonioid group	<1
		Bryoria furcellata	old man's beard	<1
		Bryoria fuscescens	old man's beard	<1
		Bryoria lanestris	old man's beard	<1
		Cladonia amaurocraea	*no common name*	<1
		Evernia mesomorpha	boreal oakmoss lichen	<1
		Hypogymnia physodes	monk's-hood lichen	<1
		Lecanora pulicaris	*no common name*	<1
		Lecanora subintricata	*no common name*	<1
		Lecanora symmicta	fused rim-lichen	<1
		Lecidella elaeochroma	*no common name*	<1
		Ochrolechia arborea	no common name	<1
		Parmelia sulcata	hammered shield moss	1
		Parmeliopsis ambigua	green starburst lichen	<1
		Parmeliopsis hyperopta	gray starburst lichen	<1
		Scoliciosporum perpusillum	*no common name*	<1
		Tuckermannopsis americana (also Cetraria halei or C. ciliaris)	fringed wrinkle-lichen	<1
		Tuckermannopsis sepincola	chestnut wrinkle-lichen	<1
		unknown Buellia species	unknown Buellia species	<1
		unknown lichen species	unknown lichen species	<1
		Usnea hirta	old man's beard	1
		Usnea lapponica	old man's beard	<1
		Usnea scabrata	old man's beard	1
		Usnea subfloridana	old man's beard	<1
		Usnea substerilis	old man's beard	<1
		Vulpicida pinastri (also Tuckermannopsis pinastri)	powdered sunshine lichen	<1
BTNR	canopy	*Picea mariana*	black spruce	18
	tall shrub	*Betula papyrifera*	white birch	1
		Betula pumila	dwarf birch	1
		Picea mariana	black spruce	8
	low shrub	*Betula pumila*	dwarf birch	3

Table L-1 Species Composition and Percent Cover by Vegetation Type (continued)

Ecosite Phase/ Wetlands Type	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
BTNR (continued)	low shrub (continued)	*Chamaedaphne calyculata*	leatherleaf	2
		Kalmia polifolia	northern laurel	20
		Ledum groenlandicum	common Labrador tea	33
		Oxycoccus microcarpus	small bog cranberry	<1
		Picea mariana	black spruce	4
		Salix lutea	yellow willow	2
		Salix myrtillifolia	myrtle-leaved willow	1
		Vaccinium myrtilloides	common blueberry	1
		Vaccinium vitis-idaea	bog cranberry	1
	forb	*Achillea millefolium*	common yarrow	1
		Drosera rotundifolia	round-leaved sundew	1
		Epilobium angustifolium	common fireweed	1
		Ranunculus lapponicus	Lapland buttercup	1
		Rubus chamaemorus	cloudberry	4
		Rubus pubescens	dewberry	1
		Smilacina trifolia	three-leaved Solomon's-seal	5
		Stellaria longifolia	long-leaved chickweed	2
	graminoid	*Calamagrostis canadensis*	bluejoint	5
		Carex aquatilis	water sedge	5
		Eriophorum vaginatum	sheathed cotton grass	5
	moss	*Aulacomnium palustre*	tufted moss	10
		Bryum pseudotriquetrum	*no common name*	1
		Calliergon richardsonii	Richardson's water moss	1
		Cinclidium stygium	common northern lantern moss	5
		Dicranum scoparium	broom moss	1
		Dicranum undulatum	wavy dicranum	1
		Drepanocladus aduncus	brown moss	25
		Hylocomium splendens	stair-step moss	3
		Lepidozia reptans	liverwort	1
		Marchantia polymorpha	liverwort	1
		Mylia anomala	liverwort	3
		Pleurozium schreberi	Schreber's moss	30
		Polytrichum commune	common hair-cap	1
		Polytrichum strictum	slender hair-cap	2
		Sphagnum angustifolium	peat moss	19
		Sphagnum fuscum	rusty peat moss	50
		Sphagnum magellanicum	midway peat moss	1
		Sphagnum squarrosum	squarrose peat moss	1

Table L-1 Species Composition and Percent Cover by Vegetation Type (continued)

Ecosite Phase/ Wetlands Type	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
BTNR (continued)	moss (continued)	*Tomentypnum nitens*	golden moss	25
	lichen	*Cladina mitis*	reindeer lichen	3
		Cladina rangiferina	reindeer lichen	1
		Cladina stellaris	reindeer lichen	1
		Cladonia bacillaris	*no common name*	<1
		Cladonia borealis	red pixie-cup	<1
		Cladonia botrytes	wooden soldiers	<1
		Cladonia cenotea	powdered funnel lichen	<1
		Cladonia cervicornis (also C. verticillata)	ladder lichen	<1
		Cladonia chlorophaea	mealy pixie-cup	<1
		Cladonia cornuta	bighorn cladonia	<1
		Cladonia deformis	lesser sulphur-cup	<1
		Cladonia gracilis	smooth cladonia	<1
		Cladonia sulphurina	greater sulphur cup	<1
		Cladonia uncialis	thorn cladonia	<1
		Icmadophila ericetorum	spraypaint	<1
		Peltigera aphthosa	studded leather lichen	<1
	epiphyte	*Arthonioid group*	Arthonioid group	<1
		Bryoria furcellata	old man's beard	<1
		Bryoria fuscescens	old man's beard	<1
		Bryoria glabra	old man's beard	<1
		Evernia mesomorpha	boreal oakmoss lichen	2
		Hypogymnia physodes	monk's-hood lichen	<1
		Imshaugia aleurites	salted starburst lichen	<1
		Lecanora pulicaris	*no common name*	<1
		Lecidella elaeochroma	*no common name*	<1
		Ochrolechia arborea	*no common name*	<1
		Parmelia sulcata	hammered shield moss	<1
		Scoliciosporum perpusillum	*no common name*	<1
		Tuckermannopsis americana (also Cetraria halei or C. ciliaris)	fringed wrinkle-lichen	<1
		Tuckermannopsis orbata (also Cetraria orbata)	variable wrinkle-lichen	<1
		Tuckermannopsis sepincola	chestnut wrinkle-lichen	<1
		unknown Bryoria species	unknown Bryoria species	1
		unknown Usnea species	unknown Usnea species	1
		Usnea hirta	old man's beard	<1
		Usnea lapponica	old man's beard	<1

Table L-1 Species Composition and Percent Cover by Vegetation Type (continued)

Ecosite Phase/ Wetlands Type	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
BTNR (continued)	epiphyte (continued)	*Usnea subfloridana*	old man's beard	<1
		Usnea substerilis	old man's beard	<1
		Vulpicida pinastri (also Tuckermannopsis pinastri)	powdered sunshine lichen	<1
BTXC	canopy	*Picea mariana*	black spruce	50
	tall shrub	*Picea mariana*	black spruce	1
	low shrub	*Betula pumila*	dwarf birch	10
		Chamaedaphne calyculata	leatherleaf	3
		Kalmia polifolia	northern laurel	2
		Ledum groenlandicum	common Labrador tea	9
		Oxycoccus microcarpus	small bog cranberry	30
		Picea mariana	black spruce	2
		Salix lutea	yellow willow	5
		Vaccinium vitis-idaea	bog cranberry	1
	forb	*Drosera rotundifolia*	round-leaved sundew	<1
		Maianthemum canadense	wild lily-of-the-valley	<1
		Potentilla palustris	marsh cinquefoil	2
		Rubus chamaemorus	cloudberry	1
		Smilacina trifolia	three-leaved Solomon's-seal	3
		Stellaria longifolia	long-leaved chickweed	1
	graminoid	*Carex aquatilis*	water sedge	4
		Carex canescens	short sedge	1
		Carex limosa	mud sedge	2
		Carex tenuiflora	thin-flowered sedge	1
		Eriophorum vaginatum	sheathed cotton grass	6
	moss	*Aulacomnium palustre*	tufted moss	5
		Brachythecium rivulare	*no common name*	1
		Calliergon giganteum	giant water moss	<1
		Calliergon richardsonii	Richardson's water moss	1
		Calliergon stramineum	straw-coloured water moss	<1
		Cephalozia lunulifolia	liverwort	<1
		Cinclidium stygium	common northern lantern moss	1
		Dicranum undulatum	wavy dicranum	5
		Helodium blandowii	Blandlow's feather moss	1
		Hylocomium splendens	stair-step moss	10
		Meesia triquetra	Meesia moss	1
		Mylia anomala	liverwort	<1
		Pleurozium schreberi	Schreber's moss	10

Table L-1 Species Composition and Percent Cover by Vegetation Type (continued)

Ecosite Phase/ Wetlands Type	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
BTXC (continued)	moss (continued)	*Pohlia nutans*	copper wire moss	1
		Polytrichum strictum	slender hair-cap	1
		Sphagnum angustifolium	peat moss	53
		Sphagnum fuscum	rusty peat moss	9
		Sphagnum girgensohnii	Girgensohn's moss	2
		Sphagnum magellanicum	midway peat moss	10
		Splachnum ampullaceum	flagon-fruited splachnum	1
		Splachnum rubrum	red collar moss	1
		Warnstorfia fluitans (also Drepanocladus fluitans)	warnstorfia moss	3
	lichen	*Cladina mitis*	reindeer lichen	1
		Cladina rangiferina	reindeer lichen	<1
		Cladina stellaris	reindeer lichen	<1
		Cladonia borealis	red pixie-cup	<1
		Cladonia coniocraea	cup lichen	<1
		Cladonia cornuta	bighorn cladonia	<1
		Cladonia gracilis	smooth cladonia	<1
		Cladonia pyxidata	pebbled pixie-cup	<1
		Cladonia sulphurina	greater sulphur cup	<1
		Peltigera aphthosa	studded leather lichen	<1
	epiphyte	*Arthonioid group*	Arthonioid group	<1
		Bryoria furcellata	old man's beard	<1
		Bryoria fuscescens	old man's beard	<1
		Evernia mesomorpha	boreal oakmoss lichen	2
		Hypogymnia physodes	monk's-hood lichen	<1
		Lecanora pulicaris	*no common name*	<1
		Lecanora subintricata	*no common name*	<1
		Parmelia sulcata	hammered shield moss	<1
		Scoliciosporum perpusillum	*no common name*	<1
		Tuckermannopsis sepincola	chestnut wrinkle-lichen	<1
		Usnea scabrata	old man's beard	<1
		Usnea substerilis	old man's beard	<1
		Vulpicida pinastri (also Tuckermannopsis pinastri)	powdered sunshine lichen	<1
burn (shrubby uplands)	tall shrub	*Populus tremuloides*	aspen	12
	low shrub	*Alnus incana ssp tenuifolia (also A. rugosa)*	river alder	<1
		Alnus viridis ssp crispa	green alder	3

Table L-1 Species Composition and Percent Cover by Vegetation Type (continued)

Ecosite Phase/ Wetlands Type	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
burn (shrubby uplands) (continued)	low shrub (continued)	*Amelanchier alnifolia*	saskatoon	3
		Arctostaphylos uva-ursi	common bearberry	1
		Betula glandulosa	bog birch	2
		Betula papyrifera	white birch	1
		Betula pumila	dwarf birch	1
		Cornus stolonifera	red-osier dogwood	1
		Ledum groenlandicum	common Labrador tea	5
		Linnaea borealis	twinflower	1
		Lonicera caerulea (also L. villosa)	fly honeysuckle	<1
		Lonicera dioica	twining honeysuckle	<1
		Picea glauca	white spruce	<1
		Picea mariana	black spruce	<1
		Pinus banksiana	jack pine	4
		Populus tremuloides	aspen	18
		Potentilla fruticosa	shrubby cinquefoil	10
		Ribes hudsonianum	northern black currant	<1
		Ribes triste	wild red currant	<1
		Rosa acicularis	prickly rose	5
		Rubus idaeus	wild red raspberry	<1
		Salix lutea	yellow willow	<1
		Salix maccalliana	velvet-fruited willow	5
		Salix myrtillifolia	myrtle-leaved willow	40
		Salix planifolia	flat-leaved willow	2
		Salix scouleriana	Scouler's willow	2
		Shepherdia canadensis	Canada buffaloberry	2
		unknown Salix species	unknown Salix species	<1
		Vaccinium myrtilloides	common blueberry	21
		Vaccinium vitis-idaea	bog cranberry	<1
		Viburnum edule	low-bush cranberry	2
	forb	*Achillea millefolium*	common yarrow	<1
		Aster ciliolatus	Lindley's aster	<1
		Aster conspicuus	showy aster	2
		Cornus canadensis	bunchberry	3
		Epilobium anagallidifolium	alpine willowherb	3
		Epilobium angustifolium	common fireweed	4
		Equisetum arvense	common horsetail	<1

Table L-1 Species Composition and Percent Cover by Vegetation Type (continued)

Ecosite Phase/ Wetlands Type	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
burn (shrubby uplands) (continued)	forb (continued)	*Equisetum scirpoides*	dwarf scouring-rush	<1
		Equisetum sylvaticum	woodland horsetail	3
		Fragaria virginiana	wild strawberry	1
		Galium boreale	northern bedstraw	1
		Gentianella amarella	felwort	<1
		Geranium bicknellii	Bicknell's geranium	<1
		Hieracium umbellatum	narrow-leaved hawkweed	<1
		Lathyrus ochroleucus	cream-colored vetchling	1
		Lilium philadelphicum	western wood lily	<1
		Lycopodium obscurum	ground-pine	1
		Maianthemum canadense	wild lily-of-the-valley	2
		Melampyrum lineare	cow-wheat	<1
		Mertensia paniculata	tall lungwort	<1
		Orthilia secunda (also Pyrola secunda)	one-sided wintergreen	<1
		Parnassia palustris	northern grass-of-parnassus	1
		Petasites frigidus var palmatus	palmate-leaved coltsfoot	2
		Platanthera hyperborea (also Habenaria hyperborea)	northern green bog orchid	<1
		Potentilla tridentata (also P. tridentata)	three-toothed cinquefoil	1
		Pyrola asarifolia	common pink wintergreen	<1
		Rhinanthus minor	yellow rattle	<1
		Rubus pubescens	dewberry	2
		Smilacina trifolia	three-leaved Solomon's-seal	<1
		Solidago canadensis	Canada goldenrod	<1
		Spiranthes lacera	northern slender ladies'-tresses	<1
		Spiranthes romanzoffiana	hooded ladies'-tresses	<1
		Taraxacum officinale	common dandelion	<1
		Trientalis borealis	northern starflower	<1
		unknown Aster species	unknown Aster species	1
		unknown Aster species	unknown Aster species	<1
		unknown forb species	unknown forb species	1
		unknown forb species	unknown forb species	<1
		unknown Rumex species	unknown Rumex species	1
		unknown Selaginella species	unknown Selaginella species	<1
		Vicia americana	wild vetch	<1

Table L-1 Species Composition and Percent Cover by Vegetation Type (continued)

Ecosite Phase/ Wetlands Type	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
burn (shrubby uplands) (continued)	forb (continued)	*Viola renifolia*	kidney-leaved violet	<1
	graminoid	*Agrostis scabra*	rough hair grass	2
		Calamagrostis canadensis	bluejoint	11
		Calamagrostis purpurascens	purple reed grass	3
		Carex aenea	silvery-flowered sedge	1
		Carex siccata	hay sedge	5
		Leymus innovatus (also Elymus innovatus)	hairy wild rye	11
		Oryzopsis asperifolia	white-grained mountain rice grass	3
		Oryzopsis pungens	northern rice grass	2
		unknown Carex species	unknown Carex species	5
		unknown graminoid species	unknown graminoid species	5
	moss	*Aulacomnium palustre*	tufted moss	1
		Brachythecium salebrosum	*no common name*	<1
		Ceratodon purpureus	purple horn-toothed moss	11
		Leptobryum pyriforme	leptobryum moss	1
		Marchantia polymorpha	liverwort	<1
		Pohlia nutans	copper wire moss	<1
		Polytrichum juniperinum	juniper hair-cap	1
		Polytrichum strictum	slender hair-cap	2
		unknown moss species	unknown moss species	4
	lichen	*Hypocenomyce scalaris*	common clam lichen	<1
		Peltigera aphthosa	studded leather lichen	<1
		Peltigera canina	dog lichen	<1
		Peltigera malacea	veinless pelt	<1
		Peltigera neopolydactyla	carpet pelt	1
burn (shrubby wetlands)	canopy	*Larix laricina*	tamarack	3
		Picea mariana	black spruce	6
	tall shrub	*Picea mariana*	black spruce	2
		unknown Salix species	unknown Salix species	5
		unknown Salix species	unknown Salix species	15
	low shrub	*Amelanchier alnifolia*	saskatoon	1
		Arctostaphylos rubra	alpine bearberry	1
		Arctostaphylos rubra	alpine bearberry	2
		Arctostaphylos uva-ursi	common bearberry	1

Table L-1 Species Composition and Percent Cover by Vegetation Type (continued)

Ecosite Phase/ Wetlands Type	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
burn (shrubby wetlands) (continued)	low shrub (continued)	*Betula papyrifera*	white birch	<1
		Betula pumila	dwarf birch	6
		Kalmia polifolia	northern laurel	1
		Larix laricina	tamarack	1
		Ledum groenlandicum	common Labrador tea	18
		Linnaea borealis	twinflower	<1
		Lonicera caerulea (also L. villosa)	fly honeysuckle	1
		Lonicera dioica	twining honeysuckle	2
		Oxycoccus microcarpus	small bog cranberry	<1
		Picea mariana	black spruce	1
		Pinus banksiana	jack pine	3
		Populus balsamifera	balsam poplar	<1
		Populus tremuloides	aspen	1
		Potentilla fruticosa	shrubby cinquefoil	<1
		Rhamnus alnifolia	alder-leaved buckthorn	2
		Ribes hudsonianum	northern black currant	3
		Ribes oxyacanthoides	northern gooseberry	<1
		Ribes triste	wild red currant	1
		Rosa acicularis	prickly rose	2
		Rubus idaeus	wild red raspberry	1
		Salix bebbiana	beaked willow	10
		Salix candida	hoary willow	2
		Salix glauca	smooth willow	10
		Salix lutea	yellow willow	16
		Salix maccalliana	velvet-fruited willow	5
		Salix myrtillifolia	myrtle-leaved willow	4
		Salix pedicellaris	bog willow	1
		Shepherdia canadensis	Canada buffaloberry	<1
		Symphoricarpos albus	snowberry	<1
		unknown Salix species	unknown Salix species	1
		unknown Salix species	unknown Salix species	9
		unknown Salix species	unknown Salix species	12
		unknown Salix species	unknown Salix species	15
		Vaccinium caespitosum	dwarf bilberry	<1
		Vaccinium myrtilloides	common blueberry	26
		Vaccinium vitis-idaea	bog cranberry	1

Table L-1 Species Composition and Percent Cover by Vegetation Type (continued)

Ecosite Phase/ Wetlands Type	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
burn (shrubby wetlands) (continued)	low shrub (continued)	*Viburnum edule*	low-bush cranberry	5
	forb	*Achillea millefolium*	common yarrow	<1
		Actaea rubra	red and white baneberry	1
		Amerorchis rotundifolia (also Orchis rotundifolia)	round-leaved orchid	1
		Aster ciliolatus	Lindley's aster	<1
		Caltha palustris	marsh-marigold	1
		Cornus canadensis	bunchberry	1
		Drosera rotundifolia	round-leaved sundew	<1
		Epilobium angustifolium	common fireweed	2
		Epilobium ciliatum	northern willowherb	1
		Epilobium palustre	marsh willowherb	<1
		Equisetum arvense	common horsetail	10
		Equisetum fluviatile	swamp horsetail	<1
		Equisetum palustre	marsh horsetail	1
		Equisetum pratense	meadow horsetail	1
		Equisetum scirpoides	dwarf scouring-rush	1
		Equisetum sylvaticum	woodland horsetail	10
		Fragaria vesca	woodland strawberry	1
		Fragaria virginiana	wild strawberry	25
		Galium boreale	northern bedstraw	<1
		Galium triflorum	sweet-scented bedstraw	1
		Geranium bicknellii	Bicknell's geranium	<1
		Hieracium umbellatum	narrow-leaved hawkweed	<1
		Lathyrus ochroleucus	cream-colored vetchling	1
		Lilium philadelphicum	western wood lily	<1
		Lycopodium obscurum	ground-pine	1
		Maianthemum canadense	wild lily-of-the-valley	1
		Melampyrum lineare	cow-wheat	<1
		Mertensia paniculata	tall lungwort	<1
		Mitella nuda	bishop's-cap	2
		Orthilia secunda (also Pyrola secunda)	one-sided wintergreen	<1
		Parnassia palustris	northern grass-of-parnassus	3
		Petasites frigidus var palmatus	palmate-leaved coltsfoot	3
		Petasites frigidus var sagittatus	arrow-leaved coltsfoot	3

Table L-1 Species Composition and Percent Cover by Vegetation Type (continued)

Ecosite Phase/ Wetlands Type	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
burn (shrubby wetlands) (continued)	forb (continued)	*Platanthera hyperborea (also Habenaria hyperborea)*	northern green bog orchid	<1
		Potentilla tridentata (also P. tridentata)	three-toothed cinquefoil	1
		Ranunculus lapponicus	Lapland buttercup	<1
		Rubus arcticus (also R. acaulis)	dwarf raspberry	2
		Rubus chamaemorus	cloudberry	1
		Rubus pubescens	dewberry	2
		Senecio congestus	marsh ragwort	1
		Senecio pauperculus	balsam groundsel	<1
		Smilacina trifolia	three-leaved Solomon's-seal	2
		Solidago canadensis	Canada goldenrod	<1
		Sonchus arvensis	perennial sow-thistle	<1
		Stellaria longipes	long-stalked chickweed	1
		unknown Arenaria species	unknown Arenaria species	1
		unknown forb species	unknown forb species	<1
		unknown Platanthera (Habenaria) species	unknown Platanthera (Habenaria) species	1
		unknown Pyrola species	unknown Pyrola species	<1
		unknown violet species	unknown violet species	1
		Urtica dioica	common nettle	2
		Vicia americana	wild vetch	<1
		Viola renifolia	kidney-leaved violet	1
	graminoid	*Calamagrostis canadensis*	bluejoint	10
		Carex aenea	silvery-flowered sedge	1
		Carex aquatilis	water sedge	14
		Carex capillaris	hair-like sedge	1
		Carex chordorrhiza	prostrate sedge	1
		Carex disperma	two-seeded sedge	<1
		Carex gynocrates	northern bog sedge	1
		Carex leptalea	bristle-stalked sedge	<1
		Carex richardsonii	Richardson's sedge	1
		Carex siccata	hay sedge	1
		Carex trisperma	three-seeded sedge	<1
		Carex vaginata	sheathed sedge	1
		Deschampsia cespitosa	tufted hair grass	4
		Eleocharis palustris	creeping spike-rush	1

Table L-1 Species Composition and Percent Cover by Vegetation Type (continued)

Ecosite Phase/ Wetlands Type	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
burn (shrubby wetlands) (continued)	graminoid (continued)	*Elymus trachycaulus ssp trachycaulus (also Agropyron trachycaulum)*	slender wheat grass	4
		Eriophorum angustifolium	tall cotton-grass	<1
		Poa pratensis	Kentucky bluegrass	<1
		unknown Carex species	unknown Carex species	1
	moss	*Abietinella abietina (also Thuidium abietinum)*	*no common name*	<1
		Aulacomnium palustre	tufted moss	13
		Brachythecium turgidum	*no common name*	1
		Bryum pseudotriquetrum	*no common name*	2
		Calliergon giganteum	giant water moss	<1
		Calliergon richardsonii	Richardson's water moss	1
		Calypogeia integristipula	liverwort	<1
		Campylium stellatum	yellow star moss	<1
		Ceratodon purpureus	purple horn-toothed moss	16
		Dicranum polysetum	wavy dicranum	<1
		Dicranum undulatum	wavy dicranum	1
		Drepanocladus aduncus	brown moss	<1
		Hamatocaulis vernicosus (also Drepanocladus vernicosus)	brown moss	<1
		Hylocomium splendens	stair-step moss	1
		Leptarrhena pyrolifolia	leather-leaved saxifrage	1
		Lophozia rutheana	liverwort	1
		Marchantia polymorpha	liverwort	<1
		Plagiomnium ellipticum	elliptic plagiomnium moss	<1
		Pleurozium schreberi	Schreber's moss	20
		Pohlia nutans	copper wire moss	11
		Polytrichum commune	common hair-cap	1
		Polytrichum juniperinum	juniper hair-cap	1
		Polytrichum strictum	slender hair-cap	2
		Sphagnum angustifolium	peat moss	12
		Sphagnum fuscum	rusty peat moss	19
		Sphagnum magellanicum	midway peat moss	10
		Sphagnum warnstorfii	peat moss	10
		Tomentypnum nitens	golden moss	5
		unknown Mnium species	unknown Mnium species	1
		unknown Pohlia species	unknown Pohlia species	19
		Warnstorfia fluitans (also Drepanocladus fluitans)	warnstorfia moss	<1

Table L-1 Species Composition and Percent Cover by Vegetation Type (continued)

Ecosite Phase/ Wetlands Type	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
burn (shrubby wetlands) (continued)	lichen	*Cladina mitis*	reindeer lichen	10
		Cladina rangiferina	reindeer lichen	1
		Cladina stellaris	reindeer lichen	1
		Peltigera aphthosa	studded leather lichen	<1
		Peltigera canina	dog lichen	<1
		Peltigera neopolydactyla	carpet pelt	<1
	epiphyte	*Arthonioid group*	Arthonioid group	<1
		Bryoria furcellata	old man's beard	<1
		Bryoria fuscescens	old man's beard	<1
		Bryoria lanestris	old man's beard	<1
		Bryoria simplicior	old man's beard	<1
		Evernia mesomorpha	boreal oakmoss lichen	<1
		Hypogymnia physodes	monk's-hood lichen	<1
		Imshaugia aleurites	salted starburst lichen	<1
		Lecanora circumborealis	black-eyed rim lichen	<1
		Lecanora subintricata	*no common name*	<1
		Lecanora symmicta	fused rim-lichen	<1
		Lecidella elaeochroma	*no common name*	<1
		Ochrolechia arborea	*no common name*	<1
		Parmelia sulcata	hammered shield moss	<1
		Scoliciosporum perpusillum	*no common name*	<1
		Tuckermannopsis americana (also Cetraria halei or C. ciliaris)	fringed wrinkle-lichen	<1
		Tuckermannopsis sepincola	chestnut wrinkle-lichen	<1
		Usnea hirta	old man's beard	<1
		Usnea lapponica	old man's beard	<1
		Usnea scabrata	old man's beard	<1
		Usnea substerilis	old man's beard	<1
		Vulpicida pinastri (also Tuckermannopsis pinastri)	powdered sunshine lichen	<1
c1	canopy	*Picea mariana*	black spruce	15
		Pinus banksiana	jack pine	8
	subcanopy	*Picea glauca*	white spruce	1
	tall shrub	*Picea mariana*	black spruce	1
	low shrub	*Arctostaphylos uva-ursi*	common bearberry	3
		Ledum groenlandicum	common Labrador tea	13

Table L-1 Species Composition and Percent Cover by Vegetation Type (continued)

Ecosite Phase/ Wetlands Type	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
c1 (continued)	low shrub (continued)	*Linnaea borealis*	twinflower	1
		Picea mariana	black spruce	5
		Rosa acicularis	prickly rose	10
		Shepherdia canadensis	Canada buffaloberry	5
		Vaccinium myrtilloides	common blueberry	5
		Vaccinium vitis-idaea	bog cranberry	3
	forb	*Cornus canadensis*	bunchberry	1
		Epilobium angustifolium	common fireweed	1
		Equisetum pratense	meadow horsetail	1
		Equisetum scirpoides	dwarf scouring-rush	1
	graminoid	*unknown graminoid species*	unknown graminoid species	1
		unknown graminoid species	unknown graminoid species	1
	moss	*Brachythecium salebrosum*	*no common name*	1
		Dicranum polysetum	wavy dicranum	5
		Dicranum undulatum	wavy dicranum	1
		Hylocomium splendens	stair-step moss	10
		Lepidozia reptans	liverwort	1
		Pleurozium schreberi	Schreber's moss	68
		Polytrichum juniperinum	juniper hair-cap	5
		Ptilidium pulcherrimum	liverwort	1
		Sanionia uncinata (also Drepanocladus uncinatus)	brown moss	1
	lichen	*Cladina mitis*	reindeer lichen	11
		Cladina rangiferina	reindeer lichen	2
		Cladina stellaris	reindeer lichen	1
		Cladonia borealis	red pixie-cup	<1
		Cladonia cariosa	split-peg lichen	<1
		Cladonia cenotea	powdered funnel lichen	<1
		Cladonia chlorophaea	mealy pixie-cup	<1
		Cladonia cornuta	bighorn cladonia	<1
		Cladonia gracilis	smooth cladonia	<1
		Cladonia sulphurina	greater sulphur cup	<1
		Lecidella elaeochroma	*no common name*	<1
		Micarea sylvicola	*no common name*	<1
		Peltigera aphthosa	studded leather lichen	1
		Peltigera canina	dog lichen	<1
		Stereocaulon tomentosum	wooly foam lichen	1
	epiphyte	*Bryoria furcellata*	old man's beard	<1
		Bryoria fuscescens	old man's beard	<1

Table L-1 Species Composition and Percent Cover by Vegetation Type (continued)

Ecosite Phase/ Wetlands Type	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
c1 (continued)	epiphyte (continued)	*Cladonia chlorophaea*	mealy pixie-cup	<1
		Evernia mesomorpha	boreal oakmoss lichen	<1
		Hypogymnia physodes	monk's-hood lichen	<1
		Imshaugia placorodia	American starburst lichen	<1
		Lecanora pulicaris	*no common name*	<1
		Parmelia sulcata	hammered shield moss	<1
		Parmeliopsis ambigua	green starburst lichen	<1
		Parmeliopsis hyperopta	gray starburst lichen	<1
		Tuckermannopsis americana (also Cetraria halei or C. ciliaris)	fringed wrinkle-lichen	<1
		Usnea hirta	old man's beard	<1
		Usnea lapponica	old man's beard	<1
		Usnea scabrata	old man's beard	<1
		Usnea substerilis	old man's beard	<1
		Vulpicida pinastri (also Tuckermannopsis pinastri)	powdered sunshine lichen	<1
d1	canopy	*Betula papyrifera*	white birch	1
		Picea glauca	white spruce	2
		Populus tremuloides	aspen	41
	subcanopy	*Picea glauca*	white spruce	5
	tall shrub	*Alnus viridis ssp crispa*	green alder	9
		Amelanchier alnifolia	saskatoon	1
		Betula papyrifera	white birch	2
		Picea glauca	white spruce	2
		Populus balsamifera	balsam poplar	1
		Populus tremuloides	aspen	1
		Prunus pensylvanica	pin cherry	1
		Salix bebbiana	beaked willow	1
	low shrub	*Alnus viridis ssp crispa*	green alder	9
		Amelanchier alnifolia	saskatoon	5
		Arctostaphylos uva-ursi	common bearberry	3
		Betula papyrifera	white birch	1
		Ledum groenlandicum	common Labrador tea	5
		Linnaea borealis	twinflower	8
		Lonicera dioica	twining honeysuckle	1
		Picea glauca	white spruce	<1
		Populus balsamifera	balsam poplar	<1
		Populus tremuloides	aspen	1

Table L-1 Species Composition and Percent Cover by Vegetation Type (continued)

Ecosite Phase/ Wetlands Type	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
d1 (continued)	forb	*Prunus pensylvanica*	pin cherry	10
		Rhamnus alnifolia	alder-leaved buckthorn	<1
		Ribes oxyacanthoides	northern gooseberry	<1
		Rosa acicularis	prickly rose	14
		Salix bebbiana	beaked willow	3
		Salix lutea	yellow willow	<1
		Shepherdia canadensis	Canada buffaloberry	8
		Symphoricarpos albus	snowberry	<1
		unknown Salix species	unknown Salix species	<1
		Vaccinium myrtilloides	common blueberry	1
		Vaccinium vitis-idaea	bog cranberry	2
		Viburnum edule	low-bush cranberry	19
		Achillea millefolium	common yarrow	<1
		Aralia nudicaulis	wild sarsaparilla	7
		Aster ciliolatus	Lindley's aster	<1
		Chimaphila umbellata	prince's-pine	1
		Cornus canadensis	bunchberry	8
		Diphasiastrum complanatum (also Lycopodium complanatum)	ground-cedar	1
		Epilobium angustifolium	common fireweed	2
		Equisetum scirpoides	dwarf scouring-rush	1
		Fragaria virginiana	wild strawberry	1
		Galium boreale	northern bedstraw	<1
		Galium trifidum	small bedstraw	1
		Lathyrus ochroleucus	cream-colored vetchling	1
		Lathyrus venosus	purple peavine	<1
		Lycopodium annotinum	stiff club-moss	8
		Lycopodium obscurum	ground-pine	2
		Maianthemum canadense	wild lily-of-the-valley	2
		Melampyrum lineare	cow-wheat	1
		Mertensia paniculata	tall lungwort	1
		Mitella nuda	bishop's-cap	<1
		Orthilia secunda (also Pyrola secunda)	one-sided wintergreen	<1
		Platanthera orbiculata (also Habenaria orbiculata)	round-leaved bog orchid	1
		Pyrola asarifolia	common pink wintergreen	1
		Pyrola chlorantha (also Pyrola virens)	greenish-flowered wintergreen	<1

Table L-1 Species Composition and Percent Cover by Vegetation Type (continued)

Ecosite Phase/ Wetlands Type	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
d1 (continued)	forb (continued)	*Rubus pubescens*	dewberry	1
		Smilacina trifolia	three-leaved Solomon's-seal	1
		Trientalis borealis	northern starflower	3
		unknown Galium species	unknown Galium species	<1
		Vicia americana	wild vetch	1
		Viola nephrophylla	bog violet	1
		Viola renifolia	kidney-leaved violet	<1
	graminoid	*Carex siccata*	hay sedge	1
		Leymus innovatus (also Elymus innovatus)	hairy wild rye	2
		Oryzopsis asperifolia	white-grained mountain rice grass	<1
		Oryzopsis pungens	northern rice grass	1
		unknown graminoid species	unknown graminoid species	1
		unknown graminoid species	unknown graminoid species	2
		unknown graminoid species	unknown graminoid species	10
	moss	*Brachythecium salebrosum*	*no common name*	<1
		Dicranum flagellare	whip fork moss	1
		Dicranum polysetum	wavy dicranum	<1
		Dicranum undulatum	wavy dicranum	1
		Eurhynchium pulchellum	eurhynchiummoss	<1
		Hylocomium splendens	stair-step moss	3
		Orthotrichum obtusifolium	obtuseleaf aspen moss	<1
		Plagiomnium cuspidatum	toothed plagiomnium moss	<1
		Pleurozium schreberi	Schreber's moss	2
		Polytrichum juniperinum	juniper hair-cap	<1
		Ptilidium pulcherrimum	liverwort	<1
		Ptilium crista-castrensis	knight's plume moss	<1
		Pylaisiella polyantha	pylaisiella moss	1
		Sanionia uncinata (also Drepanocladus uncinatus)	brown moss	<1
	lichen	*Cladonia botrytes*	wooden soldiers	<1
		Cladonia cenotea	powdered funnel lichen	<1
		Cladonia cervicornis (also C. verticillata)	ladder lichen	<1
		Cladonia chlorophaea	mealy pixie-cup	<1
		Cladonia coniocraea	cup lichen	<1
		Cladonia cornuta	bighorn cladonia	<1
		Cladonia fimbriata	trumpet lichen	<1
		Cladonia gracilis	smooth cladonia	<1

Table L-1 Species Composition and Percent Cover by Vegetation Type (continued)

Ecosite Phase/ Wetlands Type	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
d1 (continued)	lichen (continued)	*Cladonia sulphurina*	greater sulphur cup	<1
		Cladonia uncialis	thorn cladonia	<1
		Peltigera aphthosa	studded leather lichen	<1
		Peltigera canina	dog lichen	<1
		Peltigera neopolydactyla	carpet pelt	<1
	epiphyte	*Arthonia patellulata*	*no common name*	<1
		Arthonioid group	Arthonioid group	<1
		Bryoria furcellata	old man's beard	<1
		Bryoria fuscescens	old man's beard	<1
		Buellia disciformis	*no common name*	<1
		Caloplaca holocarpa	*no common name*	<1
		Candelariella lutella	*no common name*	<1
		Candelariella vitellina	*no common name*	<1
		Evernia mesomorpha	boreal oakmoss lichen	<1
		Hypogymnia physodes	monk's-hood lichen	<1
		Lecanora pulicaris	*no common name*	<1
		Lecanora subintricata	*no common name*	<1
		Lecanora symmicta	fused rim-lichen	<1
		Lecidea leprarioides	*no common name*	<1
		Lecidea nylanderi	*no common name*	<1
		Melanelia septentrionalis	northern camoflage lichen	<1
		Melanelia subaurifera	abraded camoflage lichen	<1
		Melanelia trabeculata	*no common name*	<1
		Parmelia sulcata	hammered shield moss	<1
		Physcia adscendens	hooded rosette lichen	<1
		Physcia aipolia	hoary rosette lichen	<1
		Physcia stellaris	star rosette lichen	<1
		Ramalina dilacerata	punctured ramalina	<1
		Ramalina sinensis	fan ramalina	<1
		Rinodina orculata	*no common name*	<1
		Scoliciosporum perpusillum	*no common name*	<1
		Scoliciosporum umbrinum	*no common name*	<1
		Tuckermannopsis americana (also Cetraria halei or C. ciliaris)	fringed wrinkle-lichen	<1
		Usnea hirta	old man's beard	<1
		Usnea lapponica	old man's beard	<1
		Usnea scabrata	old man's beard	<1
		Usnea subfloridana	old man's beard	<1

Table L-1 Species Composition and Percent Cover by Vegetation Type (continued)

Ecosite Phase/ Wetlands Type	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
d1 (continued)	epiphyte (continued)	*Vulpicida pinastri (also Tuckermannopsis pinastri)*	powdered sunshine lichen	<1
d2	canopy	*Betula papyrifera*	white birch	3
		Picea glauca	white spruce	17
		Pinus banksiana	jack pine	<1
		Populus balsamifera	balsam poplar	3
		Populus tremuloides	aspen	18
	subcanopy	*Betula papyrifera*	white birch	10
		Picea glauca	white spruce	7
		Populus tremuloides	aspen	4
	tall shrub	*Alnus viridis ssp crispa*	green alder	3
		Betula papyrifera	white birch	<1
		Picea glauca	white spruce	6
		unknown Salix species	unknown Salix species	<1
	low shrub	*Alnus viridis ssp crispa*	green alder	10
		Amelanchier alnifolia	saskatoon	1
		Betula papyrifera	white birch	1
		Ledum groenlandicum	common Labrador tea	1
		Linnaea borealis	twinflower	10
		Lonicera dioica	twining honeysuckle	1
		Picea glauca	white spruce	1
		Picea mariana	black spruce	<1
		Populus tremuloides	aspen	<1
		Ribes triste	wild red currant	5
		Rosa acicularis	prickly rose	7
		Shepherdia canadensis	Canada buffaloberry	2
		Symphoricarpos albus	snowberry	1
		unknown Salix species	unknown Salix species	<1
		Vaccinium myrtilloides	common blueberry	2
		Vaccinium vitis-idaea	bog cranberry	4
		Viburnum edule	low-bush cranberry	7
	forb	*Achillea millefolium*	common yarrow	<1
		Actaea rubra	red and white baneberry	2
		Apocynum androsaemifolium	spreading dogbane	5
		Aralia nudicaulis	wild sarsaparilla	5
		Aster ciliolatus	Lindley's aster	<1
		Calypso bulbosa	Venus'-slipper	<1
		Cornus canadensis	bunchberry	8

Table L-1 Species Composition and Percent Cover by Vegetation Type (continued)

Ecosite Phase/ Wetlands Type	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
d2 (continued)	forb (continued)	*Diphasiastrum complanatum (also Lycopodium complanatum)*	ground-cedar	<1
		Epilobium angustifolium	common fireweed	1
		Equisetum pratense	meadow horsetail	1
		Fragaria virginiana	wild strawberry	1
		Galium boreale	northern bedstraw	<1
		Goodyera repens	lesser rattlesnake plantain	<1
		Lathyrus ochroleucus	cream-colored vetchling	<1
		Lycopodium annotinum	stiff club-moss	10
		Lycopodium clavatum	running club-moss	<1
		Lycopodium obscurum	ground-pine	3
		Maianthemum canadense	wild lily-of-the-valley	3
		Mertensia paniculata	tall lungwort	1
		Mitella nuda	bishop's-cap	<1
		Orthilia secunda (also Pyrola secunda)	one-sided wintergreen	1
		Platanthera orbiculata (also Habenaria orbiculata)	round-leaved bog orchid	1
		Pyrola asarifolia	common pink wintergreen	1
		Rubus pubescens	dewberry	1
		Trientalis borealis	northern starflower	1
		unknown Galium species	unknown Galium species	<1
		Viola canadensis	western Canada violet	<1
		Viola renifolia	kidney-leaved violet	1
	graminoid	*Calamagrostis canadensis*	bluejoint	2
		Carex utriculata	small bottle sedge	1
		Oryzopsis asperifolia	white-grained mountain rice grass	5
		unknown graminoid species	unknown graminoid species	2
		unknown graminoid species	unknown graminoid species	8
	moss	*Brachythecium erythrorrhizon*	*no common name*	<1
		Brachythecium salebrosum	*no common name*	<1
		Dicranum flagellare	whip fork moss	<1
		Dicranum fuscescens	fuscous moss	1
		Dicranum polysetum	wavy dicranum	2
		Eurhynchium pulchellum	eurhynchiummoss	<1
		Hylocomium splendens	stair-step moss	13
		Jamesoniella autumnalis	liverwort	1
		Lepidozia reptans	liverwort	<1
		Leptobryum pyriforme	leptobryum moss	<1

Table L-1 Species Composition and Percent Cover by Vegetation Type (continued)

Ecosite Phase/ Wetlands Type	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
d2 (continued)	moss (continued)	*Orthotrichum obtusifolium*	obtuseleaf aspen moss	<1
		Orthotrichum speciosum	*no common name*	<1
		Plagiomnium cuspidatum	toothed plagiomnium moss	1
		Pleurozium schreberi	Schreber's moss	19
		Pohlia nutans	copper wire moss	<1
		Polytrichum juniperinum	juniper hair-cap	1
		Ptilium crista-castrensis	knight's plume moss	5
		Pylaisiella polyantha	pylaisiella moss	1
		Sanionia uncinata (also Drepanocladus uncinatus)	brown moss	1
		Warnstorfia fluitans (also Drepanocladus fluitans)	warnstorfia moss	2
	lichen	*Cladina mitis*	reindeer lichen	<1
		Cladonia botrytes	wooden soldiers	<1
		Cladonia chlorophaea	mealy pixie-cup	<1
		Cladonia coniocraea	cup lichen	<1
		Cladonia cornuta	bighorn cladonia	<1
		Cladonia gracilis	smooth cladonia	<1
		Cladonia pyxidata	pebbled pixie-cup	<1
		Cladonia sulphurina	greater sulphur cup	<1
		Hypocenomyce scalaris	common clam lichen	<1
		Icmadophila ericetorum	spraypaint	<1
		Parmeliopsis hyperopta	gray starburst lichen	<1
		Peltigera canina	dog lichen	<1
		Peltigera neopolydactyla	carpet pelt	<1
	epiphyte	*Arthonia patellulata*	*no common name*	<1
		Arthonioid group	Arthonioid group	<1
		Bryoria furcellata	old man's beard	<1
		Bryoria fuscescens	old man's beard	<1
		Caloplaca cerina	*no common name*	<1
		Evernia mesomorpha	boreal oakmoss lichen	<1
		Hypocenomyce scalaris	common clam lichen	<1
		Hypogymnia physodes	monk's-hood lichen	<1
		Lecanora epibryon	*no common name*	<1
		Lecanora expallens	*no common name*	<1
		Lecanora persimilis	*no common name*	<1
		Lecanora pulicaris	*no common name*	<1
		Lecanora symmicta	fused rim-lichen	<1
		Lecidella elaeochroma	*no common name*	<1

Table L-1 Species Composition and Percent Cover by Vegetation Type (continued)

Ecosite Phase/ Wetlands Type	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
d2 (continued)	epipyte (continued)	*Melanelia septentrionalis*	northern camoflage lichen	<1
		Melanelia subaurifera	abraded camoflage lichen	<1
		Melanelia trabeculata	*no common name*	<1
		Ochrolechia arborea	*no common name*	<1
		Parmelia sulcata	hammered shield moss	<1
		Parmeliopsis hyperopta	gray starburst lichen	<1
		Physcia stellaris	star rosette lichen	<1
		Ramalina dilacerata	punctured ramalina	<1
		Rinodina metaboliza	*no common name*	<1
		Scoliciosporum perpusillum	*no common name*	<1
		Tuckermannopsis americana (also Cetraria halei or C. ciliaris)	fringed wrinkle-lichen	<1
		Usnea hirta	old man's beard	<1
		Usnea lapponica	old man's beard	1
		Usnea scabrata	old man's beard	<1
		Usnea subfloridana	old man's beard	<1
		Vulpicida pinastri (also Tuckermannopsis pinastri)	powdered sunshine lichen	<1
d3	canopy	*Picea glauca*	white spruce	22
		Populus tremuloides	aspen	1
	subcanopy	*Picea glauca*	white spruce	7
		Picea mariana	black spruce	5
		Populus balsamifera	balsam poplar	3
	tall shrub	*Picea glauca*	white spruce	2
		Picea mariana	black spruce	1
		Populus balsamifera	balsam poplar	1
		unknown Salix species	unknown Salix species	<1
	low shrub	*Arctostaphylos rubra*	alpine bearberry	<1
		Arctostaphylos uva-ursi	common bearberry	2
		Ledum groenlandicum	common Labrador tea	10
		Linnaea borealis	twinflower	2
		Lonicera dioica	twining honeysuckle	<1
		Lonicera involucrata	bracted honeysuckle	<1
		Picea glauca	white spruce	1
		Populus balsamifera	balsam poplar	<1
		Populus tremuloides	aspen	1
		Ribes hudsonianum	northern black currant	<1
		Ribes oxyacanthoides	northern gooseberry	<1

Table L-1 Species Composition and Percent Cover by Vegetation Type (continued)

Ecosite Phase/ Wetlands Type	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
d3 (continued)	low shrub (continued)	*Rosa acicularis*	prickly rose	8
		Salix lutea	yellow willow	<1
		Salix myrtillifolia	myrtle-leaved willow	1
		Shepherdia canadensis	Canada buffaloberry	13
		Symphoricarpos albus	snowberry	<1
		Vaccinium myrtilloides	common blueberry	1
		Vaccinium vitis-idaea	bog cranberry	1
		Viburnum edule	low-bush cranberry	2
	forb	*Achillea millefolium*	common yarrow	<1
		Aster ciliolatus	Lindley's aster	<1
		Cornus canadensis	bunchberry	<1
		Epilobium angustifolium	common fireweed	<1
		Equisetum arvense	common horsetail	<1
		Equisetum pratense	meadow horsetail	<1
		Equisetum scirpoides	dwarf scouring-rush	<1
		Fragaria virginiana	wild strawberry	<1
		Galium boreale	northern bedstraw	<1
		Geocaulon lividum	northern bastard toadflax	<1
		Lathyrus ochroleucus	cream-colored vetchling	<1
		Melampyrum lineare	cow-wheat	<1
		Mertensia paniculata	tall lungwort	<1
		Mitella nuda	bishop's-cap	<1
		Orthilia secunda (also Pyrola secunda)	one-sided wintergreen	<1
		Pyrola asarifolia	common pink wintergreen	<1
		Rubus arcticus (also R. acaulis)	dwarf raspberry	<1
		Rubus pubescens	dewberry	2
		Smilacina trifolia	three-leaved Solomon's-seal	<1
		Trientalis borealis	northern starflower	<1
		unknown Aster species	unknown Aster species	<1
		Vicia americana	wild vetch	<1
		Viola renifolia	kidney-leaved violet	<1
	graminoid	*unknown Calamagrostis species*	unknown Calamagrostis species	3
		unknown graminoid species	unknown graminoid species	2
		unknown graminoid species	unknown graminoid species	<1
	moss	*Anastrophyllum helleranum*	liverwort	<1
		Brachythecium erythrorrhizon	*no common name*	<1

Table L-1 Species Composition and Percent Cover by Vegetation Type (continued)

Ecosite Phase/ Wetlands Type	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
d3 (continued)	moss (continued)	*Dicranum flagellare*	whip fork moss	<1
		Dicranum polysetum	wavy dicranum	1
		Dicranum undulatum	wavy dicranum	1
		Eurhynchium pulchellum	eurhynchiummoss	<1
		Hylocomium splendens	stair-step moss	28
		Plagiomnium cuspidatum	toothed plagiomnium moss	<1
		Pleurozium schreberi	Schreber's moss	37
		Ptilidium pulcherrimum	liverwort	<1
		Ptilium crista-castrensis	knight's plume moss	14
		Pylaisiella polyantha	pylaisiella moss	<1
	lichen	*Cladina mitis*	reindeer lichen	5
		Cladina stellaris	reindeer lichen	<1
		Cladonia borealis	red pixie-cup	<1
		Cladonia cenotea	powdered funnel lichen	<1
		Cladonia coniocraea	cup lichen	<1
		Cladonia cornuta	bighorn cladonia	<1
		Cladonia fimbriata	trumpet lichen	<1
		Cladonia gracilis	smooth cladonia	<1
		Cladonia sulphurina	greater sulphur cup	<1
		Peltigera aphthosa	studded leather lichen	<1
		Peltigera neopolydactyla	carpet pelt	<1
	epiphyte	*Arthonioid group*	Arthonioid group	<1
		Bryoria fuscescens	old man's beard	<1
		Evernia mesomorpha	boreal oakmoss lichen	<1
		Hypogymnia physodes	monk's-hood lichen	<1
		Lecanora pulicaris	*no common name*	<1
		Lecanora symmicta	fused rim-lichen	<1
		Melanelia septentrionalis	northern camoflage lichen	<1
		Melanelia subaurifera	abraded camoflage lichen	<1
		Parmelia sulcata	hammered shield moss	<1
		Physcia stellaris	star rosette lichen	<1
		Ramalina dilacerata	punctured ramalina	<1
		Rinodina septentrionalis	*no common name*	<1
		Scoliciosporum perpusillum	*no common name*	<1
		Usnea lapponica	old man's beard	<1
		Usnea scabrata	old man's beard	<1
		Usnea substerilis	old man's beard	<1
		Vulpicida pinastri (also Tuckermannopsis pinastri)	powdered sunshine lichen	<1

Table L-1 Species Composition and Percent Cover by Vegetation Type (continued)

Ecosite Phase/ Wetlands Type	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
e1	canopy	*Betula papyrifera*	white birch	20
		Picea glauca	white spruce	7
		Populus tremuloides	aspen	1
	tall shrub	*Populus balsamifera*	balsam poplar	1
	low shrub	*Arctostaphylos uva-ursi*	common bearberry	1
		Linnaea borealis	twinflower	1
		Picea glauca	white spruce	1
		Populus balsamifera	balsam poplar	1
		Ribes lacustre	bristly black currant	1
		Ribes triste	wild red currant	1
		Rubus idaeus	wild red raspberry	2
		Viburnum edule	low-bush cranberry	10
	forb	*Achillea millefolium*	common yarrow	1
		Achillea sibirica	many-flowered yarrow	1
		Actaea rubra	red and white baneberry	1
		Aralia nudicaulis	wild sarsaparilla	10
		Aster ciliolatus	Lindley's aster	1
		Cornus canadensis	bunchberry	5
		Equisetum pratense	meadow horsetail	15
		Equisetum sylvaticum	woodland horsetail	10
		Galium triflorum	sweet-scented bedstraw	1
		Gymnocarpium dryopteris	oak fern	10
		Lycopodium annotinum	stiff club-moss	10
		Mertensia paniculata	tall lungwort	1
		Mitella nuda	bishop's-cap	1
		Petasites frigidus var palmatus	palmate-leaved coltsfoot	1
		Rubus pubescens	dewberry	2
		Trientalis borealis	northern starflower	1
		unknown Arenaria species	unknown Arenaria species	1
		Viola renifolia	kidney-leaved violet	2
	graminoid	*unknown graminoid species*	unknown graminoid species	4
	moss	*Dicranum fragilifolium*	cushion moss	1
		Hylocomium splendens	stair-step moss	2
		Pleurozium schreberi	Schreber's moss	2
	lichen	*Cladonia coniocraea*	cup lichen	<1
		Cladonia cornuta	bighorn cladonia	<1
	epiphyte	*Bryoria fuscescens*	old man's beard	<1
		Bryoria simplicior	old man's beard	<1

Table L-1 Species Composition and Percent Cover by Vegetation Type (continued)

Ecosite Phase/ Wetlands Type	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
e1 (continued)	epiphyte (continued)	*Evernia mesomorpha*	boreal oakmoss lichen	<1
		Lecidea nylanderi	*no common name*	<1
		Leptorhaphis epidermidis	*no common name*	<1
		Parmelia sulcata	hammered shield moss	<1
		Tuckermannopsis sepincola	chestnut wrinkle-lichen	<1
		Usnea lapponica	old man's beard	<1
		Vulpicida pinastri (also Tuckermannopsis pinastri)	powdered sunshine lichen	<1
e2	canopy	*Picea glauca*	white spruce	30
		Populus balsamifera	balsam poplar	20
	subcanopy	*Betula papyrifera*	white birch	65
	low shrub	*Populus balsamifera*	balsam poplar	2
		Ribes oxyacanthoides	northern gooseberry	1
		Ribes triste	wild red currant	1
		Rosa acicularis	prickly rose	5
		Viburnum edule	low-bush cranberry	25
	forb	*Aralia nudicaulis*	wild sarsaparilla	10
		Cornus canadensis	bunchberry	20
		Epilobium angustifolium	common fireweed	2
		Equisetum arvense	common horsetail	15
		Lathyrus ochroleucus	cream-colored vetchling	1
		Lycopodium annotinum	stiff club-moss	10
		Pyrola asarifolia	common pink wintergreen	1
		Pyrola chlorantha (also Pyrola virens)	greenish-flowered wintergreen	1
		Rubus pubescens	dewberry	10
		Trientalis borealis	northern starflower	10
		Viola renifolia	kidney-leaved violet	1
	moss	*Hylocomium splendens*	stair-step moss	8
		Pleurozium schreberi	Schreber's moss	7
	epiphyte	*Evernia mesomorpha*	boreal oakmoss lichen	<1
		Hypogymnia physodes	monk's-hood lichen	<1
		Parmelia sulcata	hammered shield moss	<1
		Usnea subfloridana	old man's beard	1
f3	canopy	*Betula papyrifera*	white birch	<1
		Picea glauca	white spruce	33
	subcanopy	*Betula papyrifera*	white birch	5
	tall shrub	*Alnus incana ssp tenuifolia (also A. rugosa)*	river alder	7

Table L-1 Species Composition and Percent Cover by Vegetation Type (continued)

Ecosite Phase/ Wetlands Type	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
f3 (continued)	tall shrub (continued)	*Betula papyrifera*	white birch	5
		Salix bebbiana	beaked willow	<1
	low shrub	*Alnus incana ssp tenuifolia (also A. rugosa)*	river alder	2
		Amelanchier alnifolia	saskatoon	1
		Betula papyrifera	white birch	<1
		Cornus stolonifera	red-osier dogwood	5
		Corylus cornuta	beaked hazelnut	5
		Ledum groenlandicum	common Labrador tea	15
		Linnaea borealis	twinflower	1
		Ribes oxyacanthoides	northern gooseberry	1
		Rosa acicularis	prickly rose	3
		Salix lucida (also S. lasiandra)	shining willow	5
		Vaccinium vitis-idaea	bog cranberry	2
		Viburnum edule	low-bush cranberry	10
	forb	*Achillea millefolium*	common yarrow	1
		Actaea rubra	red and white baneberry	1
		Anemone canadensis	Canada anemone	1
		Aralia nudicaulis	wild sarsaparilla	2
		Cornus canadensis	bunchberry	1
		Epilobium angustifolium	common fireweed	<1
		Equisetum arvense	common horsetail	10
		Equisetum pratense	meadow horsetail	30
		Equisetum sylvaticum	woodland horsetail	40
		Galium boreale	northern bedstraw	1
		Galium trifidum	small bedstraw	1
		Geocaulon lividum	northern bastard toadflax	1
		Maianthemum canadense	wild lily-of-the-valley	1
		Mertensia paniculata	tall lungwort	1
		Mitella nuda	bishop's-cap	1
		Petasites frigidus var palmatus	palmate-leaved coltsfoot	1
		Ranunculus lapponicus	Lapland buttercup	<1
		Rubus pubescens	dewberry	5
		Thalictrum venulosum	veiny meadow rue	1
		Trientalis borealis	northern starflower	1
		unknown Aster species	unknown Aster species	1
		unknown Aster species	unknown Aster species	<1
		Viola renifolia	kidney-leaved violet	1

Table L-1 Species Composition and Percent Cover by Vegetation Type (continued)

Ecosite Phase/ Wetlands Type	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
f3 (continued)	graminoid	*Calamagrostis canadensis*	bluejoint	<1
		Carex aquatilis	water sedge	1
		Schizachne purpurascens	purple oat grass	1
		unknown graminoid species	unknown graminoid species	7
	moss	*Brachythecium salebrosum*	*no common name*	<1
		Calliergon stramineum	straw-coloured water moss	1
		Cinclidium stygium	common northern lantern moss	<1
		Climacium dendroides	common tree moss	1
		Conocephalum conicum	snake liverwort	1
		Dicranum flagellare	whip fork moss	1
		Dicranum polysetum	wavy dicranum	1
		Hylocomium splendens	stair-step moss	4
		Lepidozia reptans	liverwort	1
		Lophocolea heterophylla	liverwort	<1
		Marchantia polymorpha	liverwort	1
		Plagiothecium laetum	plagiothecium moss	<1
		Pleurozium schreberi	Schreber's moss	33
		Pohlia nutans	copper wire moss	<1
		Pohlia wahlenbergii	Wahlenberg's pohlia moss	1
		Ptilium crista-castrensis	knight's plume moss	10
		Sphagnum angustifolium	peat moss	1
	lichen	*Cladonia coniocraea*	cup lichen	<1
		Cladonia pyxidata	pebbled pixie-cup	<1
		Peltigera canina	dog lichen	<1
	epiphyte	*Arthonioid group*	Arthonioid group	<1
		Bryoria fuscescens	old man's beard	<1
		Bryoria lanestris	old man's beard	<1
		Candelariella efflorescens	*no common name*	<1
		Cliostomum pallens	*no common name*	<1
		Evernia mesomorpha	boreal oakmoss lichen	<1
		Hypogymnia physodes	monk's-hood lichen	<1
		Lecanora pulicaris	*no common name*	<1
		Lecanora subintricata	*no common name*	<1
		Lecanora symmicta	fused rim-lichen	<1
		Ochrolechia arborea	*no common name*	<1
		Parmelia sulcata	hammered shield moss	<1
		Ramalina dilacerata	punctured ramalina	<1
		Scoliciosporum perpusillum	*no common name*	<1

Table L-1 Species Composition and Percent Cover by Vegetation Type (continued)

Ecosite Phase/ Wetlands Type	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
f3 (continued)	epiphyte (continued)	*Tuckermannopsis americana (also Cetraria halei or C. ciliaris)*	fringed wrinkle-lichen	<1
		unknown Usnea species	unknown Usnea species	<1
		Usnea hirta	old man's beard	<1
		Usnea lapponica	old man's beard	<1
		Usnea subfloridana	old man's beard	<1
		Vulpicida pinastri (also Tuckermannopsis pinastri)	powdered sunshine lichen	<1
FONG	low shrub	*Andromeda polifolia*	bog rosemary	<1
		Betula glandulosa	bog birch	2
		Betula pumila	dwarf birch	5
		Kalmia polifolia	northern laurel	1
		Larix laricina	tamarack	<1
		Myrica gale	sweet gale	3
		Salix candida	hoary willow	1
		Salix maccalliana	velvet-fruited willow	1
		Salix pedicellaris	bog willow	1
	forb	*Calla palustris*	water arum	1
		Callitriche verna	vernal water-starwort	<1
		Caltha palustris	marsh-marigold	1
		Drosera anglica	oblong-leaved sundew	2
		Drosera linearis	slender-leaved sundew	1
		Drosera rotundifolia	round-leaved sundew	1
		Epilobium ciliatum	northern willowherb	<1
		Epilobium leptophyllum	narrow-leaved willowherb	<1
		Epilobium palustre	marsh willowherb	<1
		Equisetum fluviatile	swamp horsetail	7
		Equisetum hyemale	common scouring-rush	<1
		Galium labradoricum	Labrador bedstraw	1
		Galium trifidum	small bedstraw	3
		Galium triflorum	sweet-scented bedstraw	<1
		Lemna minor	common duckweed	<1
		Menyanthes trifoliata	buck-bean	13
		Nuphar lutea ssp variegata	yellow pond-lily	2
		Parnassia palustris	northern grass-of-parnassus	<1
		Pedicularis parviflora	swamp lousewort	1
		Platanthera hyperborea (also Habenaria hyperborea)	northern green bog orchid	<1
		Potentilla glandulosa	sticky cinquefoil	<1

Table L-1 Species Composition and Percent Cover by Vegetation Type (continued)

Ecosite Phase/ Wetlands Type	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
FONG (continued)	forb (continued)	*Potentilla palustris*	marsh cinquefoil	1
		Rumex crispus	curled dock	1
		Sarracenia purpurea	pitcher-plant	1
		Scheuchzeria palustris	scheuchzeria	5
		Smilacina trifolia	three-leaved Solomon's-seal	<1
		Sparganium angustifolium	narrow-leaved bur-reed	<1
		Spiranthes romanzoffiana	hooded ladies'-tresses	<1
		Stellaria longifolia	long-leaved chickweed	<1
		Stellaria longipes	long-stalked chickweed	<1
		Tofieldia glutinosa	sticky false asphodel	1
		Triglochin maritima	seaside arrow-grass	2
		Triglochin palustris	slender arrow-grass	<1
		Typha latifolia	common cattail	1
		unknown Galium species	unknown Galium species	<1
		unknown Pyrola species	unknown Pyrola species	<1
		unknown Rumex species	unknown Rumex species	<1
		Utricularia intermedia	flat-leaved bladderwort	1
		Utricularia vulgaris	common bladderwort	2
	graminoid	*Carex aquatilis*	water sedge	19
		Carex chordorrhiza	prostrate sedge	1
		Carex diandra	two-stamened sedge	33
		Carex lasiocarpa	hairy-fruited sedge	52
		Carex limosa	mud sedge	11
		Carex livida	livid sedge	1
		Carex pachystachya	sedge	5
		Carex utriculata	small bottle sedge	10
		Eleocharis acicularis	needle spike-rush	50
		Eleocharis quinqueflora	few-flowered spike-rush	40
		Eriophorum angustifolium	tall cotton-grass	3
		Eriophorum chamissonis	russett cotton grass	1
		Eriophorum gracile	slender cotton grass	4
		Eriophorum vaginatum	sheathed cotton grass	35
		Schoenoplectus acutus var acutus (also Scirpus lacustris)	hardstem bulrush	2
		unknown Carex species	unknown Carex species	<1
	moss	*Aulacomnium palustre*	tufted moss	9
		Brachythecium turgidum	*no common name*	<1
		Bryum pseudotriquetrum	*no common name*	1
		Calliergon giganteum	giant water moss	28

Table L-1 Species Composition and Percent Cover by Vegetation Type (continued)

Ecosite Phase/ Wetlands Type	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
FONG (continued)	moss (continued)	*Cinclidium stygium*	common northern lantern moss	<1
		Drepanocladus aduncus	brown moss	24
		Helodium blandowii	Blandlow's feather moss	1
		Myurella julacea	myurella moss	1
		Scorpidium scorpioides (also Drepanocladus revolvens)	scorpidium moss	28
		Sphagnum angustifolium	peat moss	5
		Sphagnum fuscum	rusty peat moss	5
		Tomentypnum nitens	golden moss	10
		Warnstorfia fluitans (also Drepanocladus fluitans)	warnstorfia moss	42
		Warnstorfia tundrae	brown moss	<1
	epiphyte	*Arthonioid group*	Arthonioid group	<1
		Bryoria fuscescens	old man's beard	<1
		Evernia mesomorpha	boreal oakmoss lichen	<1
		Hypogymnia physodes	monk's-hood lichen	<1
		Lecanora subintricata	*no common name*	<1
		Lecanora symmicta	fused rim-lichen	<1
		Melanelia septentrionalis	northern camoflage lichen	<1
		Parmelia sulcata	hammered shield moss	<1
		Scoliciosporum perpusillum	*no common name*	<1
		Tuckermannopsis americana (also Cetraria halei or C. ciliaris)	fringed wrinkle-lichen	<1
		Tuckermannopsis sepincola	chestnut wrinkle-lichen	<1
		unknown Mycobilimbia species	unknown Mycobilimbia species	<1
		Usnea hirta	old man's beard	<1
		Usnea lapponica	old man's beard	<1
		Usnea subfloridana	old man's beard	<1
		Usnea substerilis	old man's beard	<1
		Vulpicida pinastri (also Tuckermannopsis pinastri)	powdered sunshine lichen	<1
FONS	canopy	*Larix laricina*	tamarack	1
		Picea mariana	black spruce	1
	tall shrub	*Larix laricina*	tamarack	6
		Picea mariana	black spruce	11
	low shrub	*Alnus incana ssp tenuifolia (also A. rugosa)*	river alder	5
		Andromeda polifolia	bog rosemary	14
		Betula glandulosa	bog birch	24

Table L-1 Species Composition and Percent Cover by Vegetation Type (continued)

Ecosite Phase/ Wetlands Type	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
FONS (continued)	low-shrub (continued)	*Betula pumila*	dwarf birch	32
		Kalmia polifolia	northern laurel	<1
		Larix laricina	tamarack	6
		Ledum groenlandicum	common Labrador tea	4
		Myrica gale	sweet gale	18
		Oxycoccus microcarpus	small bog cranberry	1
		Picea mariana	black spruce	2
		Populus tremuloides	aspen	1
		Salix bebbiana	beaked willow	3
		Salix candida	hoary willow	2
		Salix discolor	pussy willow	5
		Salix glauca	smooth willow	1
		Salix lutea	yellow willow	2
		Salix pedicellaris	bog willow	1
		unknown Salix species	unknown Salix species	2
		Vaccinium vitis-idaea	bog cranberry	2
	forb	*Agastache foeniculum*	giant hyssop	1
		Calla palustris	water arum	4
		Callitriche verna	vernal water-starwort	<1
		Caltha palustris	marsh-marigold	2
		Cicuta maculata	water-hemlock	<1
		Corallorhiza maculata	spotted coralroot	1
		Dracocephalum parviflorum	American dragonhead	<1
		Drosera rotundifolia	round-leaved sundew	<1
		Epilobium angustifolium	common fireweed	<1
		Epilobium latifolium	broad-leaved fireweed	<1
		Epilobium leptophyllum	narrow-leaved willowherb	<1
		Epilobium palustre	marsh willowherb	<1
		Equisetum fluviatile	swamp horsetail	<1
		Equisetum hyemale	common scouring-rush	1
		Fragaria virginiana	wild strawberry	<1
		Galium boreale	northern bedstraw	<1
		Galium labradoricum	Labrador bedstraw	1
		Galium trifidum	small bedstraw	<1
		Galium triflorum	sweet-scented bedstraw	2
		Hippuris vulgaris	common mare's-tail	2
		Lemna minor	common duckweed	1
		Lysimachia thyrsiflora	tufted loosestrife	1

Table L-1 Species Composition and Percent Cover by Vegetation Type (continued)

Ecosite Phase/ Wetlands Type	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
FONS (continued)	forb (continued)	*Maianthemum canadense*	wild lily-of-the-valley	18
		Menyanthes trifoliata	buck-bean	9
		Moehringia lateriflora	blunt-leaved sandwort	1
		Nuphar lutea ssp variegata	yellow pond-lily	1
		Nymphaea tetragona	white water-lily	<1
		Orthilia secunda (also Pyrola secunda)	one-sided wintergreen	1
		Pedicularis parviflora	swamp lousewort	1
		Platanthera dilatata (also Habenaria dilatata)	tall white bog orchid	<1
		Platanthera hyperborea (also Habenaria hyperborea)	northern green bog orchid	<1
		Potamogeton gramineus	various-leaved pondweed	<1
		Potentilla palustris	marsh cinquefoil	1
		Pyrola asarifolia	common pink wintergreen	<1
		Rumex occidentalis	western dock	<1
		Rumex triangulivalvis	narrow-leaved dock	1
		Sarracenia purpurea	pitcher plant	1
		Smilacina trifolia	three-leaved Solomon's-seal	3
		Stellaria longifolia	long-leaved chickweed	<1
		Stellaria longipes	long-stalked chickweed	<1
		Triglochin maritima	seaside arrow-grass	2
		Typha latifolia	common cattail	2
		unknown Epilobium species	unknown Epilobium species	1
		unknown Galium species	unknown Galium species	<1
		unknown Pyrola species	unknown Pyrola species	<1
		unknown Ranunculus species	unknown Ranunculus species	1
		unknown Rumex species	unknown Rumex species	<1
		Utricularia intermedia	flat-leaved bladderwort	1
		Utricularia vulgaris	common bladderwort	5
	graminoid	*Agrostis scabra*	rough hair grass	<1
		Calamagrostis canadensis	bluejoint	1
		Carex aquatilis	water sedge	12
		Carex chordorrhiza	prostrate sedge	5
		Carex diandra	two-stamened sedge	18
		Carex disperma	two-seeded sedge	<1
		Carex interior	inland sedge	1
		Carex lasiocarpa	hairy-fruited sedge	23
		Carex leptalea	bristle-stalked sedge	1

Table L-1 Species Composition and Percent Cover by Vegetation Type (continued)

Ecosite Phase/ Wetlands Type	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
FONS (continued)	graminoid (continued)	*Carex limosa*	mud sedge	5
		Carex livida	livid sedge	<1
		Carex pauciflora	few-flowered sedge	10
		Carex tenuiflora	thin-flowered sedge	1
		Carex utriculata	small bottle sedge	60
		Carex viridula	green sedge	1
		Eriophorum angustifolium	tall cotton-grass	2
		Eriophorum chamissonis	russett cotton grass	10
		Eriophorum gracile	slender cotton grass	4
		Eriophorum vaginatum	sheathed cotton grass	16
		Muhlenbergia glomerata	bog muhly	<1
		Scirpus hudsonianus	Hudson Bay bulrush	6
		Scirpus microcarpus	small-fruited bulrush	15
		unknown Carex species	unknown Carex species	5
		unknown graminoid species	unknown graminoid species	1
		unknown graminoid species	unknown graminoid species	<1
		unknown graminoid species	unknown graminoid species	<1
	moss	*Abietinella abietina (also Thuidium abietinum)*	*no common name*	<1
		Aneura pinguis	liverwort	1
		Aulacomnium palustre	tufted moss	4
		Brachythecium turgidum	*no common name*	<1
		Bryum pseudotriquetrum	*no common name*	1
		Calliergon giganteum	giant water moss	15
		Calliergon richardsonii	Richardson's water moss	9
		Calliergonella cuspidata	pointed spear moss	80
		Campylium stellatum	yellow star moss	2
		Cinclidium stygium	common northern lantern moss	<1
		Dicranum scoparium	broom moss	<1
		Dicranum undulatum	wavy dicranum	3
		Distichium inclinatum	inclined-fruited didymodon	1
		Drepanocladus aduncus	brown moss	3
		Funaria hygrometrica	cord moss	1
		Hamatocaulis vernicosus (also Drepanocladus vernicosus)	brown moss	32
		Helodium blandowii	Blandlow's feather moss	25
		Hylocomium splendens	stair-step moss	<1
		Leptobryum pyriforme	leptobryum moss	<1

Table L-1 Species Composition and Percent Cover by Vegetation Type (continued)

Ecosite Phase/ Wetlands Type	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
FONS (continued)	moss (continued)	*Paludella squarrosa*	angled paludella moss	1
		Plagiomnium cuspidatum	toothed plagiomnium moss	1
		Plagiomnium ellipticum	elliptic plagiomnium moss	<1
		Pleurozium schreberi	Schreber's moss	<1
		Pohlia nutans	copper wire moss	1
		Polytrichum strictum	slender hair-cap	<1
		Ptilidium pulcherrimum	liverwort	<1
		Scorpidium scorpioides (also Drepanocladus revolvens)	scorpidium moss	5
		Sphagnum angustifolium	peat moss	8
		Sphagnum capillifolium	acute-leaved peat moss	4
		Sphagnum fuscum	rusty peat moss	34
		Sphagnum magellanicum	midway peat moss	7
		Sphagnum squarrosum	squarrose peat moss	5
		Sphagnum teres	thin-leafed peat moss	5
		Sphagnum warnstorfii	peat moss	13
		Tomentypnum nitens	golden moss	24
		unknown moss species	unknown moss species	2
		unknown moss species	unknown moss species	2
		Warnstorfia fluitans (also Drepanocladus fluitans)	warnstorfia moss	30
	lichen	*Cladina mitis*	reindeer lichen	<1
		Cladina rangiferina	reindeer lichen	<1
		Cladonia borealis	red pixie-cup	<1
		Cladonia botrytes	wooden soldiers	<1
		Cladonia cenotea	powdered funnel lichen	<1
		Cladonia cervicornis (also C. verticillata)	ladder lichen	<1
		Cladonia chlorophaea	mealy pixie-cup	<1
		Cladonia cornuta	bighorn cladonia	<1
		Cladonia crispata	organ-pipe lichen	<1
		Cladonia fimbriata	trumpet lichen	<1
		Cladonia gracilis	smooth cladonia	<1
		Cladonia pyxidata	pebbled pixie-cup	<1
		Cladonia sulphurina	greater sulphur cup	<1
		Peltigera canina	dog lichen	<1
	epiphyte	*Arthonioid group*	Arthonioid group	<1
		Bryoria furcellata	old man's beard	<1
		Bryoria fuscescens	old man's beard	<1

Table L-1 Species Composition and Percent Cover by Vegetation Type (continued)

Ecosite Phase/ Wetlands Type	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
FONS (continued)	epiphyte (continued)	*Bryoria lanestris*	old man's beard	<1
		Cliostomum pallens	*no common name*	<1
		Evernia mesomorpha	boreal oakmoss lichen	<1
		Evernia prunastri	oakmoss lichen	<1
		Hypogymnia physodes	monk's-hood lichen	<1
		Imshaugia aleurites	salted starburst lichen	<1
		Lecanora boligera	*no common name*	<1
		Lecanora circumborealis	black-eyed rim lichen	<1
		Lecanora persimilis	*no common name*	<1
		Lecanora pulicaris	*no common name*	<1
		Lecanora subintricata	*no common name*	<1
		Lecanora symmicta	fused rim-lichen	<1
		Lecidella elaeochroma	*no common name*	<1
		Melanelia septentrionalis	northern camoflage lichen	<1
		Melanelia subaurifera	abraded camoflage lichen	<1
		Micarea denigrata	*no common name*	<1
		Ochrolechia arborea	*no common name*	<1
		Parmelia sulcata	hammered shield moss	<1
		Parmeliopsis ambigua	green starburst lichen	<1
		Parmeliopsis hyperopta	gray starburst lichen	<1
		Ramalina pollinaria	chalky ramalina	<1
		Rinodina septentrionalis	*no common name*	<1
		Scoliciosporum perpusillum	*no common name*	<1
		Tuckermannopsis americana (also Cetraria halei or C. ciliaris)	fringed wrinkle-lichen	<1
		Tuckermannopsis sepincola	chestnut wrinkle-lichen	<1
		unknown Bryoria species	unknown Bryoria species	<1
		unknown lichen species	unknown lichen species	<1
		unknown Mycobilimbia species	unknown Mycobilimbia species	<1
		unknown Usnea species	unknown Usnea species	<1
		Usnea hirta	old man's beard	<1
		Usnea lapponica	old man's beard	<1
		Usnea scabrata	old man's beard	<1
		Usnea subfloridana	old man's beard	<1
		Usnea substerilis	old man's beard	<1
		Vulpicida pinastri (also Tuckermannopsis pinastri)	powdered sunshine lichen	<1
FOPN	canopy	*Larix laricina*	tamarack	<1

Table L-1 Species Composition and Percent Cover by Vegetation Type (continued)

Ecosite Phase/ Wetlands Type	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
FOPN (continued)	canopy (continued)	*Picea mariana*	black spruce	1
	subcanopy	*Picea mariana*	black spruce	8
	tall shrub	*Larix laricina*	tamarack	3
		Picea mariana	black spruce	5
	low shrub	*Andromeda polifolia*	bog rosemary	5
		Betula glandulosa	bog birch	8
		Betula pumila	dwarf birch	9
		Chamaedaphne calyculata	leatherleaf	6
		Kalmia polifolia	northern laurel	10
		Larix laricina	tamarack	2
		Ledum groenlandicum	common Labrador tea	4
		Myrica gale	sweet gale	3
		Oxycoccus microcarpus	small bog cranberry	2
		Picea mariana	black spruce	4
		Salix candida	hoary willow	1
		Salix lutea	yellow willow	1
		Salix pedicellaris	bog willow	1
		unknown Salix species	unknown Salix species	1
		unknown Salix species	unknown Salix species	<1
		Vaccinium vitis-idaea	bog cranberry	2
	forb	*Callitriche verna*	vernal water-starwort	<1
		Drosera anglica	oblong-leaved sundew	1
		Drosera linearis	slender-leaved sundew	<1
		Drosera rotundifolia	round-leaved sundew	<1
		Equisetum fluviatile	swamp horsetail	1
		Equisetum hyemale	common scouring-rush	<1
		Maianthemum canadense	wild lily-of-the-valley	<1
		Menyanthes trifoliata	buck-bean	3
		Pinguicula vulgaris	common butterwort	<1
		Platanthera hyperborea (also Habenaria hyperborea)	northern green bog orchid	<1
		Potentilla palustris	marsh cinquefoil	1
		Rubus chamaemorus	cloudberry	1
		Sarracenia purpurea	pitcher-plant	2
		Smilacina trifolia	three-leaved Solomon's-seal	5
		Spiranthes romanzoffiana	hooded ladies'-tresses	<1
		Tofieldia glutinosa	sticky false asphodel	1
		Triglochin maritima	seaside arrow-grass	<1
		unknown forb species	unknown forb species	1

Table L-1 Species Composition and Percent Cover by Vegetation Type (continued)

Ecosite Phase/ Wetlands Type	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
FOPN (continued)	forb (continued)	*unknown utricularia species*	unknown utricularia species	1
		Utricularia intermedia	flat-leaved bladderwort	1
	graminoid	*Calamagrostis purpurascens*	purple reed grass	<1
		Carex aquatilis	water sedge	10
		Carex capillaris	hair-like sedge	10
		Carex chordorrhiza	prostrate sedge	8
		Carex diandra	two-stamened sedge	5
		Carex disperma	two-seeded sedge	<1
		Carex interior	inland sedge	<1
		Carex lasiocarpa	hairy-fruited sedge	34
		Carex leptalea	bristle-stalked sedge	1
		Carex limosa	mud sedge	7
		Carex livida	livid sedge	8
		Carex rostrata	beaked sedge	<1
		Eleocharis acicularis	needle spike-rush	5
		Eriophorum angustifolium	tall cotton-grass	5
		Eriophorum vaginatum	sheathed cotton grass	10
		Juncus albescens	white rush	40
		Juncus bufonius	toad rush	<1
		Scirpus cespitosus	tufted bulrush	43
		unknown Carex species	unknown Carex species	6
		unknown Carex species	unknown Carex species	10
		unknown Eriophorum species	unknown Eriophorum species	60
		unknown graminoid species	unknown graminoid species	1
		unknown Scirpus species	unknown Scirpus species	40
	moss	*Aneura pinguis*	liverwort	1
		Aulacomnium palustre	tufted moss	12
		Brachythecium turgidum	*no common name*	2
		Bryum pseudotriquetrum	*no common name*	<1
		Calliergon giganteum	giant water moss	3
		Calliergon stramineum	straw-coloured water moss	2
		Campylium stellatum	yellow star moss	18
		Catoscopium nigritum	black golf club moss	1
		Dicranum flagellare	whip fork moss	<1
		Dicranum undulatum	wavy dicranum	1
		Drepanocladus aduncus	brown moss	3
		Drepanocladus revolvens	*no common name*	1
		Hylocomium splendens	stair-step moss	<1

Table L-1 Species Composition and Percent Cover by Vegetation Type (continued)

Ecosite Phase/ Wetlands Type	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
FOPN (continued)	moss (continued)	*Hypnum lindbergii*	Lindberg's hypnum moss	<1
		Mylia anomala	liverwort	1
		Plagiomnium ellipticum	elliptic plagiomnium moss	1
		Plagiothecium laetum	plagiothecium moss	1
		Pleurozium schreberi	Schreber's moss	1
		Pohlia nutans	copper wire moss	<1
		Polytrichum strictum	slender hair-cap	1
		Scorpidium scorpioides (also Drepanocladus revolvens)	scorpidium moss	27
		Sphagnum angustifolium	peat moss	24
		Sphagnum fuscum	rusty peat moss	38
		Sphagnum magellanicum	midway peat moss	10
		Sphagnum squarrosum	squarrose peat moss	5
		Sphagnum teres	thin-leafed peat moss	1
		Sphagnum warnstorfii	peat moss	<1
		Tomentypnum nitens	golden moss	30
		Warnstorfia fluitans (also Drepanocladus fluitans)	warnstorfia moss	17
	lichen	*Cetraria ericetorum*	*no common name*	<1
		Cladina mitis	reindeer lichen	8
		Cladina rangiferina	reindeer lichen	2
		Cladonia bacillaris	*no common name*	<1
		Cladonia borealis	red pixie-cup	1
		Cladonia botrytes	wooden soldiers	1
		Cladonia cenotea	powdered funnel lichen	<1
		Cladonia chlorophaea	mealy pixie-cup	<1
		Cladonia coniocraea	cup lichen	<1
		Cladonia cornuta	bighorn cladonia	<1
		Cladonia deformis	lesser sulphur-cup	<1
		Cladonia fimbriata	trumpet lichen	<1
		Cladonia gracilis	smooth cladonia	<1
		Cladonia sulphurina	greater sulphur cup	1
		Icmadophila ericetorum	spraypaint	1
		Peltigera aphthosa	studded leather lichen	<1
	epiphyte	*Arthonioid group*	Arthonioid group	<1
		Bryoria furcellata	old man's beard	1
		Bryoria fuscescens	old man's beard	<1
		Cliostomum pallens	*no common name*	<1
		Evernia mesomorpha	boreal oakmoss lichen	<1

Table L-1 Species Composition and Percent Cover by Vegetation Type (continued)

Ecosite Phase/ Wetlands Type	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
FOPN (continued)	epiphyte (continued)	*Flavopunctelia soredica*	powder-edged speckled greenshield	<1
		Hypogymnia physodes	monk's-hood lichen	<1
		Imshaugia aleurites	salted starburst lichen	<1
		Lecanora boligera	*no common name*	<1
		Lecanora circumborealis	black-eyed rim lichen	<1
		Lecanora expallens	*no common name*	<1
		Lecanora persimilis	*no common name*	<1
		Lecanora pulicaris	*no common name*	<1
		Lecanora subintricata	*no common name*	<1
		Lecanora symmicta	fused rim-lichen	<1
		Lecidella elaeochroma	*no common name*	<1
		Melanelia septentrionalis	northern camoflage lichen	<1
		Ochrolechia arborea	*no common name*	<1
		Parmelia sulcata	hammered shield moss	<1
		Parmeliopsis ambigua	green starburst lichen	<1
		Rinodina septentrionalis	*no common name*	<1
		Scoliciosporum perpusillum	*no common name*	<1
		Tuckermannopsis americana (also Cetraria halei or C. ciliaris)	fringed wrinkle-lichen	<1
		Tuckermannopsis orbata (also Cetraria orbata)	variable wrinkle-lichen	<1
		Tuckermannopsis sepincola	chestnut wrinkle-lichen	<1
		unknown lichen species	unknown lichen species	1
		unknown Mycobilimbia species	unknown Mycobilimbia species	<1
		unknown Rinodina species	unknown Rinodina species	<1
		Usnea hirta	old man's beard	1
		Usnea lapponica	old man's beard	<1
		Usnea scabrata	old man's beard	1
		Vulpicida pinastri (also Tuckermannopsis pinastri)	powdered sunshine lichen	<1
FTNI	canopy	*Larix laricina*	tamarack	5
	subcanopy	*Larix laricina*	tamarack	1
	tall shrub	*Betula glandulosa*	bog birch	2
		Betula pumila	dwarf birch	10
		Larix laricina	tamarack	10
		Picea mariana	black spruce	1
		Betula glandulosa	bog birch	28
		Betula pumila	dwarf birch	6

Table L-1 Species Composition and Percent Cover by Vegetation Type (continued)

Ecosite Phase/ Wetlands Type	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
FTNI (continued)	tall shrub (continued)	*Larix laricina*	tamarack	8
		Ledum groenlandicum	common Labrador tea	<1
		Oxycoccus microcarpus	small bog cranberry	3
		Picea mariana	black spruce	<1
		Salix pedicellaris	bog willow	3
		Salix planifolia	flat-leaved willow	2
		unknown Salix species	unknown Salix species	<1
		Vaccinium vitis-idaea	bog cranberry	<1
	forb	*Amerorchis rotundifolia (also Orchis rotundifolia)*	round-leaved orchid	<1
		Calla palustris	water arum	1
		Callitriche verna	vernal water-starwort	<1
		Caltha palustris	marsh-marigold	1
		Cicuta maculata	water-hemlock	<1
		Corallorhiza trifida	pale coralroot	<1
		Drosera rotundifolia	round-leaved sundew	<1
		Epilobium palustre	marsh willowherb	1
		Equisetum fluviatile	swamp horsetail	4
		Galium boreale	northern bedstraw	<1
		Galium trifidum	small bedstraw	<1
		Lysimachia thyrsiflora	tufted loosestrife	1
		Menyanthes trifoliata	buck-bean	25
		Mitella nuda	bishop's-cap	<1
		Orthilia secunda (also Pyrola secunda)	one-sided wintergreen	1
		Potentilla palustris	marsh cinquefoil	1
		Pyrola asarifolia	common pink wintergreen	1
		Rumex occidentalis	western dock	<1
		Smilacina trifolia	three-leaved Solomon's-seal	4
		Spiranthes romanzoffiana	hooded ladies'-tresses	<1
		Stellaria longifolia	long-leaved chickweed	<1
		Stellaria longipes	long-stalked chickweed	<1
		Triglochin maritima	seaside arrow-grass	1
		unknown Galium species	unknown Galium species	<1
		Utricularia vulgaris	common bladderwort	<1
	graminoid	*Carex aquatilis*	water sedge	12
		Carex diandra	two-stamened sedge	14
		Carex interior	inland sedge	5
		Carex leptalea	bristle-stalked sedge	5

Table L-1 Species Composition and Percent Cover by Vegetation Type (continued)

Ecosite Phase/ Wetlands Type	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
FTNI (continued)	graminoid (continued)	*Carex limosa*	mud sedge	8
		Carex pachystachya	sedge	5
		Eriophorum gracile	slender cotton grass	6
		Eriophorum vaginatum	sheathed cotton grass	2
		unknown graminoid species	unknown graminoid species	<1
		unknown graminoid species	unknown graminoid species	<1
	moss	*Aulacomnium palustre*	tufted moss	4
		Brachythecium salebrosum	*no common name*	<1
		Brachythecium turgidum	*no common name*	2
		Calliergon giganteum	giant water moss	13
		Calliergon richardsonii	Richardson's water moss	30
		Campylium stellatum	yellow star moss	<1
		Cinclidium stygium	common northern lantern moss	<1
		Dicranum undulatum	wavy dicranum	2
		Drepanocladus aduncus	brown moss	65
		Hamatocaulis vernicosus (also Drepanocladus vernicosus)	brown moss	25
		Helodium blandowii	Blandlow's feather moss	5
		Hylocomium splendens	stair-step moss	10
		Plagiomnium ellipticum	elliptic plagiomnium moss	1
		Pohlia nutans	copper wire moss	<1
		Ptilidium pulcherrimum	liverwort	<1
		Scorpidium scorpioides (also Drepanocladus revolvens)	scorpidium moss	15
		Sphagnum angustifolium	peat moss	20
		Sphagnum magellanicum	midway peat moss	3
		Sphagnum squarrosum	squarrose peat moss	1
		Sphagnum teres	thin-leafed peat moss	20
		Tomentypnum nitens	golden moss	10
		Warnstorfia fluitans (also Drepanocladus fluitans)	warnstorfia moss	10
	lichen	*Cladina mitis*	reindeer lichen	<1
		Cladina rangiferina	reindeer lichen	<1
		Cladonia cenotea	powdered funnel lichen	<1
		Cladonia cervicornis (also C. verticillata)	ladder lichen	<1
		Cladonia chlorophaea	mealy pixie-cup	<1
		Cladonia coniocraea	cup lichen	<1

Table L-1 Species Composition and Percent Cover by Vegetation Type (continued)

Ecosite Phase/ Wetlands Type	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
FTNI (continued)	lichen (continued)	*Cladonia cornuta*	bighorn cladonia	<1
		Cladonia gracilis	smooth cladonia	<1
		Cladonia sulphurina	greater sulphur cup	<1
		Peltigera aphthosa	studded leather lichen	<1
	epiphyte	*Arthonioid group*	Arthonioid group	<1
		Bryoria furcellata	old man's beard	<1
		Bryoria fuscescens	old man's beard	<1
		Bryoria lanestris	old man's beard	<1
		Cliostomum pallens	*no common name*	<1
		Evernia mesomorpha	boreal oakmoss lichen	1
		Hypogymnia physodes	monk's-hood lichen	<1
		Lecanora boligera	*no common name*	<1
		Lecanora circumborealis	black-eyed rim lichen	<1
		Lecanora persimilis	*no common name*	<1
		Lecanora pulicaris	*no common name*	<1
		Lecanora symmicta	fused rim-lichen	<1
		Melanelia septentrionalis	northern camoflage lichen	<1
		Melanelia subaurifera	abraded camoflage lichen	<1
		Parmelia sulcata	hammered shield moss	<1
		Parmeliopsis ambigua	green starburst lichen	<1
		Scoliciosporum perpusillum	*no common name*	<1
		Tuckermannopsis americana (also Cetraria halei or C. ciliaris)	fringed wrinkle-lichen	<1
		Tuckermannopsis sepincola	chestnut wrinkle-lichen	<1
		unknown Mycobilimbia species	unknown Mycobilimbia species	<1
		Usnea hirta	old man's beard	<1
		Usnea lapponica	old man's beard	<1
		Usnea subfloridana	old man's beard	<1
		Usnea substerilis	old man's beard	<1
		Vulpicida pinastri (also Tuckermannopsis pinastri)	powdered sunshine lichen	<1
FTNN	canopy	*Larix laricina*	tamarack	14
		Picea mariana	black spruce	8
	subcanopy	*Larix laricina*	tamarack	2
		Picea mariana	black spruce	2
	tall shrub	*Betula pumila*	dwarf birch	4
		Larix laricina	tamarack	6
		Picea mariana	black spruce	3

Table L-1 Species Composition and Percent Cover by Vegetation Type (continued)

Ecosite Phase/ Wetlands Type	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
FTNN (continued)	low shrub	*Andromeda polifolia*	bog rosemary	5
		Arctostaphylos rubra	alpine bearberry	1
		Betula glandulosa	bog birch	22
		Betula pumila	dwarf birch	19
		Chamaedaphne calyculata	leatherleaf	7
		Kalmia polifolia	northern laurel	8
		Larix laricina	tamarack	5
		Ledum groenlandicum	common Labrador tea	8
		Ledum palustre	northern Labrador tea	1
		Myrica gale	sweet gale	17
		Oxycoccus microcarpus	small bog cranberry	1
		Picea mariana	black spruce	3
		Ribes hudsonianum	northern black currant	<1
		Salix bebbiana	beaked willow	2
		Salix candida	hoary willow	1
		Salix discolor	pussy willow	<1
		Salix glauca	smooth willow	1
		Salix lutea	yellow willow	<1
		Salix pedicellaris	bog willow	3
		Salix serissima	autumn willow	2
		unknown Salix species	unknown Salix species	<1
		Vaccinium vitis-idaea	bog cranberry	4
	forb	*Calla palustris*	water arum	10
		Callitriche verna	vernal water-starwort	<1
		Caltha palustris	marsh-marigold	1
		Chimaphila umbellata	prince's-pine	<1
		Chrysosplenium tetrandrum	green saxifrage	1
		Corallorhiza trifida	pale coralroot	<1
		Cypripedium parviflorum var pubescens (also C. calceolus)	large yellow lady's-slipper	1
		Drosera rotundifolia	round-leaved sundew	<1
		Epilobium angustifolium	common fireweed	<1
		Epilobium ciliatum	northern willowherb	1
		Epilobium palustre	marsh willowherb	<1
		Equisetum fluviatile	swamp horsetail	5
		Equisetum hyemale	common scouring-rush	1
		Fragaria vesca	woodland strawberry	<1
		Galium boreale	northern bedstraw	<1
		Galium labradoricum	Labrador bedstraw	1

Table L-1 Species Composition and Percent Cover by Vegetation Type (continued)

Ecosite Phase/ Wetlands Type	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
FTNN (continued)	forb (continued)	*Galium trifidum*	small bedstraw	<1
		Galium triflorum	sweet-scented bedstraw	<1
		Geocaulon lividum	northern bastard toadflax	1
		Hippuris vulgaris	common mare's-tail	<1
		Lysimachia thyrsiflora	tufted loosestrife	1
		Maianthemum canadense	wild lily-of-the-valley	7
		Menyanthes trifoliata	buck-bean	6
		Mitella nuda	bishop's-cap	<1
		Moehringia lateriflora	blunt-leaved sandwort	1
		Orthilia secunda (also Pyrola secunda)	one-sided wintergreen	<1
		Petasites frigidus var palmatus	palmate-leaved coltsfoot	<1
		Platanthera hyperborea (also Habenaria hyperborea)	northern green bog orchid	<1
		Potentilla palustris	marsh cinquefoil	1
		Pyrola asarifolia	common pink wintergreen	<1
		Pyrola chlorantha (also Pyrola virens)	greenish-flowered wintergreen	<1
		Ranunculus lapponicus	Lapland buttercup	<1
		Rubus arcticus (also R. acaulis)	dwarf raspberry	<1
		Rubus chamaemorus	cloudberry	1
		Rubus pubescens	dewberry	1
		Rumex occidentalis	western dock	<1
		Smilacina trifolia	three-leaved Solomon's-seal	3
		Stellaria longifolia	long-leaved chickweed	<1
		Stellaria longipes	long-stalked chickweed	<1
		Triglochin maritima	seaside arrow-grass	<1
		unknown Arenaria species	unknown Arenaria species	1
		unknown Epilobium species	unknown Epilobium species	1
		unknown Galium species	unknown Galium species	<1
		unknown Pyrola species	unknown Pyrola species	<1
		unknown Ranunculus species	unknown Ranunculus species	<1
		unknown Rumex species	unknown Rumex species	1
		unknown Stellaria species	unknown Stellaria species	<1
	graminoid	*Agrostis scabra*	rough hair grass	<1
		Calamagrostis canadensis	bluejoint	1
		Carex aquatilis	water sedge	13
		Carex canescens	short sedge	11

Table L-1 Species Composition and Percent Cover by Vegetation Type (continued)

Ecosite Phase/ Wetlands Type	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
FTNN (continued)	graminoid (continued)	*Carex chordorrhiza*	prostrate sedge	1
		Carex diandra	two-stamened sedge	2
		Carex disperma	two-seeded sedge	3
		Carex gynocrates	northern bog sedge	3
		Carex interior	inland sedge	<1
		Carex lasiocarpa	hairy-fruited sedge	10
		Carex leptalea	bristle-stalked sedge	<1
		Carex limosa	mud sedge	2
		Carex pauciflora	few-flowered sedge	3
		Carex paupercula	bog sedge	1
		Carex prairea	prairie sedge	10
		Carex tenuiflora	thin-flowered sedge	<1
		Carex utriculata	small bottle sedge	5
		Carex viridula	green sedge	1
		Eriophorum angustifolium	tall cotton-grass	<1
		Eriophorum gracile	slender cotton grass	1
		Eriophorum vaginatum	sheathed cotton grass	2
		Scirpus microcarpus	small-fruited bulrush	5
		unknown Carex species	unknown Carex species	1
		unknown Carex species	unknown Carex species	3
		unknown graminoid species	unknown graminoid species	1
		unknown graminoid species	unknown graminoid species	1
		unknown graminoid species	unknown graminoid species	<1
	moss	*Abietinella abietina (also Thuidium abietinum)*	*no common name*	<1
		Aulacomnium palustre	tufted moss	6
		Blepharostoma trichophyllum	liverwort	1
		Brachythecium rivulare	*no common name*	1
		Bryum pseudotriquetrum	*no common name*	<1
		Calliergon giganteum	giant water moss	6
		Calliergon richardsonii	Richardson's water moss	9
		Calliergon stramineum	straw-coloured water moss	<1
		Campylium stellatum	yellow star moss	<1
		Cinclidium stygium	common northern lantern moss	<1
		Climacium dendroides	common tree moss	<1
		Dicranum fuscescens	fuscous moss	2
		Dicranum polysetum	wavy dicranum	<1
		Dicranum scoparium	broom moss	3

Table L-1 Species Composition and Percent Cover by Vegetation Type (continued)

Ecosite Phase/ Wetlands Type	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
FTNN (continued)	moss (continued)	*Dicranum undulatum*	wavy dicranum	2
		Drepanocladus aduncus	brown moss	1
		Hamatocaulis vernicosus (also Drepanocladus vernicosus)	brown moss	15
		Helodium blandowii	Blandlow's feather moss	5
		Hylocomium splendens	stair-step moss	4
		Hypnum lindbergii	Lindberg's hypnum moss	<1
		Hypnum pratense	hypnum moss	1
		Jamesoniella autumnalis	liverwort	1
		Lepidozia reptans	liverwort	1
		Lophocolea heterophylla	liverwort	<1
		Lophozia ventricosa	liverwort	1
		Marchantia polymorpha	liverwort	<1
		Meesia triquetra	*Meesia* moss	1
		Meesia uliginosa	*Meesia* moss	<1
		Orthotrichum speciosum	*no common name*	<1
		Plagiochila porelloides	*no common name*	<1
		Plagiomnium cuspidatum	toothed plagiomnium moss	<1
		Plagiomnium ellipticum	elliptic plagiomnium moss	1
		Pleurozium schreberi	Schreber's moss	10
		Pohlia nutans	copper wire moss	<1
		Polytrichum commune	common hair-cap	<1
		Polytrichum juniperinum	juniper hair-cap	1
		Polytrichum strictum	slender hair-cap	<1
		Pseudobryum cinclidioides	no common name	<1
		Ptilidium pulcherrimum	liverwort	<1
		Rhizomnium gracile	rhizomnium moss	<1
		Rhizomnium pseudopunctatum	rhizomnium moss	1
		Sphagnum angustifolium	peat moss	18
		Sphagnum fuscum	rusty peat moss	15
		Sphagnum girgensohnii	Girgensohn's moss	15
		Sphagnum magellanicum	midway peat moss	10
		Sphagnum riparium	shore-growing peat moss	1
		Sphagnum squarrosum	squarrose peat moss	9
		Sphagnum teres	thin-leafed peat moss	1
		Sphagnum warnstorfii	peat moss	25
		Tomentypnum nitens	golden moss	22

Table L-1 Species Composition and Percent Cover by Vegetation Type (continued)

Ecosite Phase/ Wetlands Type	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
FTNN (continued)	moss (continued)	*unknown Dicranum species*	unknown Dicranum species	1
		Warnstorfia fluitans (also Drepanocladus fluitans)	warnstorfia moss	14
	lichen	*Cladina mitis*	reindeer lichen	1
		Cladina rangiferina	reindeer lichen	<1
		Cladonia bacillaris	*no common name*	<1
		Cladonia borealis	red pixie-cup	<1
		Cladonia botrytes	wooden soldiers	<1
		Cladonia cenotea	powdered funnel lichen	<1
		Cladonia cervicornis (also C. verticillata)	ladder lichen	<1
		Cladonia chlorophaea	mealy pixie-cup	<1
		Cladonia coniocraea	cup lichen	<1
		Cladonia cornuta	bighorn cladonia	<1
		Cladonia crispata	organ-pipe lichen	<1
		Cladonia deformis	lesser sulphur-cup	<1
		Cladonia gracilis	smooth cladonia	<1
		Cladonia pyxidata	pebbled pixie-cup	<1
		Cladonia scabriuscula	mealy forked cladonia	<1
		Cladonia sulphurina	greater sulphur cup	<1
		Hypocenomyce scalaris	common clam lichen	<1
		Peltigera aphthosa	studded leather lichen	<1
		Peltigera canina	dog lichen	<1
		Peltigera neopolydactyla	carpet pelt	<1
	epiphyte	*Amandinea punctata (also Buellia punctata)*	*no common name*	1
		Arthonia patellulata	*no common name*	<1
		Arthonioid group	Arthonioid group	<1
		Bryoria furcellata	old man's beard	1
		Bryoria fuscescens	old man's beard	<1
		Bryoria lanestris	old man's beard	<1
		Cliostomum pallens	*no common name*	<1
		Evernia mesomorpha	boreal oakmoss lichen	1
		Hypocenomyce scalaris	common clam lichen	1
		Hypogymnia physodes	monk's-hood lichen	<1
		Imshaugia aleurites	salted starburst lichen	<1
		Lecanora boligera	*no common name*	<1
		Lecanora circumborealis	black-eyed rim lichen	<1
		Lecanora laxa	*no common name*	<1

Table L-1 Species Composition and Percent Cover by Vegetation Type (continued)

Ecosite Phase/ Wetlands Type	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
FTNN (continued)	epiphyte (continued)	*Lecanora persimilis*	*no common name*	<1
		Lecanora pulicaris	*no common name*	<1
		Lecanora rugosella	*no common name*	<1
		Lecanora subintricata	*no common name*	<1
		Lecanora symmicta	fused rim-lichen	<1
		Lecidea amaurospoda	*no common name*	<1
		Lecidea leprarioides	*no common name*	<1
		Lecidella elaeochroma	*no common name*	<1
		Melanelia septentrionalis	northern camoflage lichen	<1
		Melanelia subaurifera	abraded camoflage lichen	<1
		Ochrolechia arborea	no common name	<1
		Parmelia sulcata	hammered shield moss	<1
		Parmeliopsis ambigua	green starburst lichen	<1
		Parmeliopsis hyperopta	gray starburst lichen	<1
		Rinodina disjuncta	*no common name*	<1
		Scoliciosporum perpusillum	*no common name*	<1
		Stenocybe pullatula	alder stickpin	<1
		Tuckermannopsis americana (also Cetraria halei or C. ciliaris)	fringed wrinkle-lichen	<1
		Tuckermannopsis sepincola	chestnut wrinkle-lichen	<1
		unknown Bryoria species	unknown Bryoria species	1
		unknown Mycobilimbia species	unknown Mycobilimbia species	<1
		unknown Parmeliopsis species	unknown Parmeliopsis species	<1
		unknown Usnea species	unknown Usnea species	2
		Usnea hirta	old man's beard	<1
		Usnea lapponica	old man's beard	<1
		Usnea scabrata	old man's beard	<1
		Usnea subfloridana	old man's beard	<1
		Usnea substerilis	old man's beard	<1
		Vulpicida pinastri (also Tuckermannopsis pinastri)	powdered sunshine lichen	<1
FTPN	canopy	*Larix laricina*	tamarack	5
		Picea mariana	black spruce	3
	subcanopy	*Larix laricina*	tamarack	2
	tall shrub	*Larix laricina*	tamarack	3
		Picea mariana	black spruce	2
	low shrub	*Andromeda polifolia*	bog rosemary	9

Table L-1 Species Composition and Percent Cover by Vegetation Type (continued)

Ecosite Phase/ Wetlands Type	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
FTPN (continued)	low shrubs (continued)	*Betula pumila*	dwarf birch	7
		Larix laricina	tamarack	4
		Ledum groenlandicum	common Labrador tea	10
		Oxycoccus microcarpus	small bog cranberry	1
		Picea mariana	black spruce	1
		Salix candida	hoary willow	1
		Salix maccalliana	velvet-fruited willow	1
		Salix pedicellaris	bog willow	1
		Salix pseudomonticola (also S. monticola)	false mountain willow	1
		unknown Salix species	unknown Salix species	1
	forb	*Caltha palustris*	marsh-marigold	5
		Corallorhiza trifida	pale coralroot	1
		Cypripedium parviflorum var pubescens (also C. calceolus)	large yellow lady's-slipper	1
		Drosera anglica	oblong-leaved sundew	2
		Drosera linearis	slender-leaved sundew	<1
		Drosera rotundifolia	round-leaved sundew	1
		Equisetum fluviatile	swamp horsetail	<1
		Equisetum hyemale	common scouring-rush	1
		Galium labradoricum	Labrador bedstraw	1
		Menyanthes trifoliata	buck-bean	4
		Orthilia secunda (also Pyrola secunda)	one-sided wintergreen	1
		Pedicularis parviflora	swamp lousewort	<1
		Platanthera hyperborea (also Habenaria hyperborea)	northern green bog orchid	<1
		Pyrola asarifolia	common pink wintergreen	1
		Rubus pubescens	dewberry	1
		Sarracenia purpurea	pitcher-plant	1
		Smilacina trifolia	three-leaved Solomon's-seal	9
		Stellaria longifolia	long-leaved chickweed	1
		Tofieldia glutinosa	sticky false asphodel	1
		Triglochin maritima	seaside arrow-grass	<1
	graminoid	*Carex aquatilis*	water sedge	10
		Carex chordorrhiza	prostrate sedge	1
		Carex diandra	two-stamened sedge	8
		Carex lasiocarpa	hairy-fruited sedge	5
		Carex leptalea	bristle-stalked sedge	1
		Carex limosa	mud sedge	30

Table L-1 Species Composition and Percent Cover by Vegetation Type (continued)

Ecosite Phase/ Wetlands Type	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
FTPN (continued)	graminoid (continued)	*Carex tenuiflora*	thin-flowered sedge	5
		Eleocharis acicularis	needle spike-rush	5
		Eriophorum angustifolium	tall cotton-grass	1
		Eriophorum gracile	slender cotton grass	25
		Eriophorum vaginatum	sheathed cotton grass	<1
		Schoenoplectus acutus (also Scirpus acutus)	great bulrush	1
		unknown Carex species	unknown Carex species	20
		unknown graminoid species	unknown graminoid species	1
	moss	*Aulacomnium palustre*	tufted moss	5
		Barbilophozia barbata	liverwort	1
		Bryum pseudotriquetrum	*no common name*	1
		Calliergon giganteum	giant water moss	8
		Calliergon richardsonii	Richardson's water moss	1
		Campylium stellatum	yellow star moss	13
		Cinclidium stygium	common northern lantern moss	1
		Dicranum scoparium	broom moss	2
		Dicranum undulatum	wavy dicranum	3
		Hamatocaulis vernicosus (also Drepanocladus vernicosus)	brown moss	1
		Hylocomium splendens	stair-step moss	5
		Hypnum lindbergii	Lindberg's hypnum moss	1
		Jamesoniella autumnalis	liverwort	1
		Lepidozia reptans	liverwort	1
		Meesia triquetra	*Meesia* moss	1
		Pleurozium schreberi	Schreber's moss	30
		Ptilidium pulcherrimum	liverwort	1
		Rhizomnium pseudopunctatum	*Rhizomnium* moss	1
		Scorpidium scorpioides (also Drepanocladus revolvens)	scorpidium moss	49
		Sphagnum fuscum	rusty peat moss	25
		Tomentypnum nitens	golden moss	27
		Warnstorfia fluitans (also Drepanocladus fluitans)	warnstorfia moss	1
	lichen	*Cladina mitis*	reindeer lichen	1
		Cladina rangiferina	reindeer lichen	8
		Cladonia botrytes	wooden soldiers	<1
		Cladonia cornuta	bighorn cladonia	<1
		Cladonia pyxidata	pebbled pixie-cup	<1

Table L-1 Species Composition and Percent Cover by Vegetation Type (continued)

Ecosite Phase/ Wetlands Type	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
FTPN (continued)	lichen (continued)	*Flavopunctelia flaventior*	speckled greenshield	1
		Peltigera leucophlebia	ruffled freckle pelt	<1
		Peltigera neopolydactyla	carpet pelt	1
		unknown Cladonia species	unknown Cladonia species	<1
		unknown Cladonia species	unknown Cladonia species	<1
	epiphyte	*Arthonioid group*	Arthonioid group	<1
		Bryoria furcellata	old man's beard	<1
		Bryoria fuscescens	old man's beard	<1
		Bryoria simplicior	old man's beard	<1
		Evernia mesomorpha	boreal oakmoss lichen	<1
		Flavopunctelia flaventior	speckled greenshield	<1
		Flavopunctelia soredica	powder-edged speckled greenshield	<1
		Hypogymnia physodes	monk's-hood lichen	<1
		Lecanora circumborealis	black-eyed rim lichen	<1
		Lecanora subintricata	*no common name*	<1
		Parmelia sulcata	hammered shield moss	<1
		Tuckermannopsis americana (also Cetraria halei or C. ciliaris)	fringed wrinkle-lichen	<1
		Usnea cavernosa	old man's beard	<1
		Usnea hirta	old man's beard	<1
		Usnea lapponica	old man's beard	<1
		Usnea scabrata	old man's beard	<1
		Usnea subfloridana	old man's beard	<1
		Usnea substerilis	old man's beard	<1
		Vulpicida pinastri (also Tuckermannopsis pinastri)	powdered sunshine lichen	<1
g1	canopy	*Picea mariana*	black spruce	35
	subcanopy	*Picea mariana*	black spruce	<1
	tall shrub	*Picea mariana*	black spruce	2
	low shrub	*Ledum groenlandicum*	common Labrador tea	20
		Picea mariana	black spruce	1
		Rosa acicularis	prickly rose	1
		Vaccinium myrtilloides	common blueberry	1
		Vaccinium vitis-idaea	bog cranberry	1
	forb	*Cornus canadensis*	bunchberry	1
		Equisetum pratense	meadow horsetail	9
		Equisetum sylvaticum	woodland horsetail	<1
		Geocaulon lividum	northern bastard toadflax	<1

Table L-1 Species Composition and Percent Cover by Vegetation Type (continued)

Ecosite Phase/ Wetlands Type	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
g1 (continued)	moss	*Dicranum polysetum*	wavy dicranum	2
		Dicranum scoparium	broom moss	<1
		Dicranum undulatum	wavy dicranum	1
		Hylocomium splendens	stair-step moss	8
		Leptobryum pyriforme	leptobryum moss	<1
		Pleurozium schreberi	Schreber's moss	70
		Pohlia nutans	copper wire moss	<1
		Polytrichum juniperinum	juniper hair-cap	1
		Ptilidium pulcherrimum	liverwort	3
		Ptilium crista-castrensis	knight's plume moss	5
	lichen	*Cladina mitis*	reindeer lichen	4
		Cladina stellaris	reindeer lichen	<1
		Cladonia borealis	red pixie-cup	<1
		Cladonia botrytes	wooden soldiers	1
		Cladonia chlorophaea	mealy pixie-cup	<1
		Cladonia coniocraea	cup lichen	<1
		Cladonia cornuta	bighorn cladonia	<1
		Cladonia gracilis	smooth cladonia	1
		Cladonia pyxidata	pebbled pixie-cup	<1
		Peltigera aphthosa	studded leather lichen	1
		Peltigera neopolydactyla	carpet pelt	<1
	epiphyte	*Arthonioid group*	Arthonioid group	<1
		Bryoria furcellata	old man's beard	<1
		Bryoria fuscescens	old man's beard	<1
		Bryoria glabra	old man's beard	<1
		Evernia mesomorpha	boreal oakmoss lichen	<1
		Hypocenomyce scalaris	common clam lichen	<1
		Hypogymnia physodes	monk's-hood lichen	1
		Imshaugia aleurites	salted starburst lichen	<1
		Lecanora persimilis	*no common name*	<1
		Lecanora pulicaris	*no common name*	<1
		Lecanora symmicta	fused rim-lichen	<1
		Micarea sylvicola	*no common name*	<1
		Ochrolechia arborea	*no common name*	<1
		Parmeliopsis ambigua	green starburst lichen	<1
		Parmeliopsis hyperopta	gray starburst lichen	<1
		Scoliciosporum perpusillum	*no common name*	<1
		Tuckermannopsis americana (also Cetraria halei or C. ciliaris)	fringed wrinkle-lichen	<1

Table L-1 Species Composition and Percent Cover by Vegetation Type (continued)

Ecosite Phase/ Wetlands Type	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
g1 (continued)	epiphyte (continued)	*Tuckermannopsis sepincola*	chestnut wrinkle-lichen	<1
		Usnea hirta	old man's beard	<1
		Usnea lapponica	old man's beard	<1
		Usnea scabrata	old man's beard	<1
		Usnea subfloridana	old man's beard	<1
		Usnea substerilis	old man's beard	<1
		Vulpicida pinastri (also Tuckermannopsis pinastri)	powdered sunshine lichen	<1
h1	canopy	*Betula papyrifera*	white birch	5
		Picea glauca	white spruce	30
		Picea mariana	black spruce	70
		Populus tremuloides	aspen	1
	subcanopy	*Picea mariana*	black spruce	<1
	tall shrub	*Betula papyrifera*	white birch	1
		Picea mariana	black spruce	2
		Populus tremuloides	aspen	1
	low shrub	*Alnus incana ssp tenuifolia (also A. rugosa)*	river alder	<1
		Arctostaphylos uva-ursi	common bearberry	5
		Betula papyrifera	white birch	1
		Ledum groenlandicum	common Labrador tea	20
		Picea mariana	black spruce	1
		Populus tremuloides	aspen	1
		Rhamnus alnifolia	alder-leaved buckthorn	<1
		Rosa acicularis	prickly rose	1
		Rubus idaeus	wild red raspberry	<1
		Shepherdia canadensis	Canada buffaloberry	15
		Vaccinium myrtilloides	common blueberry	10
		Vaccinium vitis-idaea	bog cranberry	5
	forb	*Cornus canadensis*	bunchberry	5
		Epilobium angustifolium	common fireweed	<1
		Equisetum arvense	common horsetail	1
		Equisetum pratense	meadow horsetail	4
		Equisetum scirpoides	dwarf scouring-rush	1
		Equisetum sylvaticum	woodland horsetail	1
		Galium triflorum	sweet-scented bedstraw	<1
		Gymnocarpium dryopteris	oak fern	<1
		Lycopodium annotinum	stiff club-moss	2
		Mertensia paniculata	tall lungwort	<1

Table L-1 Species Composition and Percent Cover by Vegetation Type (continued)

Ecosite Phase/ Wetlands Type	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
h1 (continued)	forb (continued)	*Mitella nuda*	bishop's-cap	1
		Rubus arcticus (also R. acaulis)	dwarf raspberry	<1
		Rubus pubescens	dewberry	1
		Trientalis borealis	northern starflower	<1
		Viola renifolia	kidney-leaved violet	<1
	graminoid	*Carex disperma*	two-seeded sedge	<1
		Poa pratensis	Kentucky bluegrass	<1
		unknown graminoid species	unknown graminoid species	1
	moss	*Dicranum polysetum*	wavy dicranum	<1
		Dicranum undulatum	wavy dicranum	<1
		Hylocomium splendens	stair-step moss	20
		Pleurozium schreberi	Schreber's moss	65
		Ptilium crista-castrensis	knight's plume moss	5
	lichen	*Cladina mitis*	reindeer lichen	10
		Cladina stellaris	reindeer lichen	1
		Cladonia gracilis	smooth cladonia	<1
		Cladonia sulphurina	greater sulphur cup	<1
		Peltigera aphthosa	studded leather lichen	<1
	epiphyte	*Arthonioid group*	Arthonioid group	<1
		Bryoria furcellata	old man's beard	<1
		Bryoria fuscescens	old man's beard	<1
		Evernia mesomorpha	boreal oakmoss lichen	1
		Hypogymnia physodes	monk's-hood lichen	<1
		Lecanora pulicaris	*no common name*	<1
		Lecanora subintricata	*no common name*	<1
		Lecanora symmicta	fused rim-lichen	<1
		Melanelia subaurifera	abraded camoflage lichen	<1
		Melanelia trabeculata	*no common name*	<1
		Parmelia sulcata	hammered shield moss	<1
		Ramalina intermedia	rock ramalina	<1
		Scoliciosporum perpusillum	*no common name*	<1
		Tuckermannopsis americana (also Cetraria halei or C. ciliaris)	fringed wrinkle-lichen	<1
		Tuckermannopsis orbata (also Cetraria orbata)	variable wrinkle-lichen	<1
		Tuckermannopsis sepincola	chestnut wrinkle-lichen	<1
		Usnea hirta	old man's beard	<1
		Usnea lapponica	old man's beard	<1

Table L-1 Species Composition and Percent Cover by Vegetation Type (continued)

Ecosite Phase/ Wetlands Type	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
h1 (continued)	epiphyte (continued)	*Usnea subfloridana*	old man's beard	<1
		Usnea substerilis	old man's beard	<1
		Vulpicida pinastri (also Tuckermannopsis pinastri)	powdered sunshine lichen	<1
MONG	forb	*Calla palustris*	water arum	5
		Cerastium nutans	long-stalked mouse-ear chickweed	1
		Galium triflorum	sweet-scented bedstraw	1
		Lemna minor	common duckweed	1
		Menyanthes trifoliata	buck-bean	5
		Nuphar lutea ssp variegata	yellow pond-lily	5
		Sagittaria cuneata	arum-leaved arrowhead	1
		Stellaria longipes	long-stalked chickweed	1
		Triglochin maritima	seaside arrow-grass	1
		Typha latifolia	common cattail	5
		unknown forb species	unknown forb species	<1
		unknown Rumex species	unknown Rumex species	1
	graminoid	*Carex diandra*	two-stamened sedge	75
		Carex lasiocarpa	hairy-fruited sedge	5
		Eriophorum angustifolium	tall cotton-grass	2
		unknown Carex species	unknown Carex species	1
		unknown graminoid species	unknown graminoid species	1
	moss	*Campylium polygamum*	campylium moss	2
Sh	canopy	*Betula papyrifera*	white birch	<1
		Picea glauca	white spruce	1
		Pinus banksiana	jack pine	1
		Populus tremuloides	aspen	3
	tall shrub	*Picea glauca*	white spruce	1
		Populus tremuloides	aspen	3
	low shrub	*Alnus viridis ssp crispa*	green alder	1
		Arctostaphylos uva-ursi	common bearberry	20
		Linnaea borealis	twinflower	3
		Picea glauca	white spruce	<1
		Populus tremuloides	aspen	<1
		Vaccinium myrtilloides	common blueberry	25
		Vaccinium vitis-idaea	bog cranberry	5
		Achillea millefolium	common yarrow	<1
		Anemone multifida	cut-leaved anemone	<1
		Apocynum androsaemifolium	spreading dogbane	2

Table L-1 Species Composition and Percent Cover by Vegetation Type (continued)

Ecosite Phase/ Wetlands Type	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
Sh (continued)	low shrub (continued)	*Arabis hirsuta*	hairy rock cress	<1
		Aralia nudicaulis	wild sarsaparilla	1
		Artemisia campestris	plains wormwood	<1
		Campanula rotundifolia	harebell	<1
		Comandra umbellata	bastard toadflax	5
		Diphasiastrum complanatum (also Lycopodium complanatum)	ground-cedar	10
		Fragaria virginiana	wild strawberry	<1
		Hieracium umbellatum	narrow-leaved hawkweed	<1
		Maianthemum canadense	wild lily-of-the-valley	5
		Melampyrum lineare	cow-wheat	<1
		Trientalis borealis	northern starflower	2
		unknown Aster species	unknown Aster species	<1
	graminoid	*Agrostis scabra*	rough hair grass	<1
		unknown graminoid species	unknown graminoid species	<1
	moss	*Dicranum polysetum*	wavy dicranum	5
		Hylocomium splendens	stair-step moss	1
		Orthotrichum obtusifolium	obtuseleaf aspen moss	<1
		Pleurozium schreberi	Schreber's moss	14
		Polytrichum juniperinum	juniper hair-cap	<1
		Polytrichum strictum	slender hair-cap	<1
		Pylaisiella polyantha	pylaisiella moss	<1
	lichen	*Cladina mitis*	reindeer lichen	35
		Cladina stellaris	reindeer lichen	3
		Cladonia borealis	red pixie-cup	<1
		Cladonia botrytes	wooden soldiers	<1
		Cladonia chlorophaea	mealy pixie-cup	<1
		Cladonia cornuta	bighorn cladonia	<1
		Cladonia gracilis	smooth cladonia	<1
		Cladonia multiformis	sieve lichen	<1
		Cladonia pyxidata	pebbled pixie-cup	<1
		Hypocenomyce scalaris	common clam lichen	<1
		Peltigera neopolydactyla	carpet pelt	2
	epiphyte	*Bryoria furcellata*	old man's beard	<1
		Bryoria fuscescens	old man's beard	<1
		Caloplaca cerina	*no common name*	<1
		Evernia mesomorpha	boreal oakmoss lichen	<1

Table L-1 Species Composition and Percent Cover by Vegetation Type (continued)

Ecosite Phase/ Wetlands Type	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
Sh (continued)	epiphyte (continued)	*Hypogymnia physodes*	monk's-hood lichen	<1
		Lecanora circumborealis	black-eyed rim lichen	<1
		Lecanora pulicaris	*no common name*	<1
		Parmelia sulcata	hammered shield moss	<1
		Scoliciosporum perpusillum	*no common name*	<1
		Tuckermannopsis americana (also Cetraria halei or C. ciliaris)	fringed wrinkle-lichen	<1
		Usnea lapponica	old man's beard	<1
		Vulpicida pinastri (also Tuckermannopsis pinastri)	powdered sunshine lichen	<1
SONS	canopy	*Betula papyrifera*	white birch	1
		Larix laricina	tamarack	1
		Picea mariana	black spruce	1
		Populus balsamifera	balsam poplar	1
		unknown Salix species	unknown Salix species	2
	tall shrub	*Alnus incana ssp tenuifolia (also A. rugosa)*	river alder	40
		Betula pumila	dwarf birch	10
		Picea mariana	black spruce	2
		Populus balsamifera	balsam poplar	1
		Rosa acicularis	prickly rose	1
		Salix bebbiana	beaked willow	7
		Salix planifolia	flat-leaved willow	17
		unknown Salix species	unknown Salix species	20
		unknown Salix species	unknown Salix species	30
	low shrub	*Alnus incana ssp tenuifolia (also A. rugosa)*	river alder	12
		Betula papyrifera	white birch	1
		Betula pumila	dwarf birch	10
		Cornus stolonifera	red-osier dogwood	2
		Larix laricina	tamarack	1
		Lonicera caerulea (also L. villosa)	fly honeysuckle	1
		Myrica gale	sweet gale	5
		Picea glauca	white spruce	1
		Picea mariana	black spruce	1
		Populus balsamifera	balsam poplar	1
		Rhamnus alnifolia	alder-leaved buckthorn	1
		Ribes americanum	wild black currant	3

Table L-1 Species Composition and Percent Cover by Vegetation Type (continued)

Ecosite Phase/ Wetlands Type	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
SONS (continued)	low shrubs (continued)	*Ribes hudsonianum*	northern black currant	2
		Ribes oxyacanthoides	northern gooseberry	1
		Rosa acicularis	prickly rose	1
		Salix bebbiana	beaked willow	2
		Salix discolor	pussy willow	20
		Salix lutea	yellow willow	20
		Salix planifolia	flat-leaved willow	8
		unknown Salix species	unknown Salix species	5
		unknown Salix species	unknown Salix species	30
	forb	*Calla palustris*	water arum	2
		Callitriche verna	vernal water-starwort	1
		Caltha palustris	marsh-marigold	4
		Chrysosplenium tetrandrum	green saxifrage	1
		Cicuta maculata	water-hemlock	1
		Cornus canadensis	bunchberry	1
		Epilobium angustifolium	common fireweed	1
		Equisetum arvense	common horsetail	1
		Equisetum scirpoides	dwarf scouring-rush	1
		Galeopsis tetrahit	hemp-nettle	1
		Galium labradoricum	Labrador bedstraw	1
		Galium triflorum	sweet-scented bedstraw	1
		Hippuris vulgaris	common mare's-tail	1
		Lysimachia thyrsiflora	tufted loosestrife	1
		Maianthemum canadense	wild lily-of-the-valley	1
		Mentha arvensis	wild mint	1
		Menyanthes trifoliata	buck-bean	1
		Mertensia paniculata	tall lungwort	1
		Mitella nuda	bishop's-cap	1
		Moehringia lateriflora	blunt-leaved sandwort	1
		Petasites frigidus var sagittatus	arrow-leaved coltsfoot	1
		Potentilla palustris	marsh cinquefoil	1
		Pyrola asarifolia	common pink wintergreen	2
		Ranunculus acris	tall buttercup	1
		Ranunculus gmelinii	yellow water crowfoot	1
		Ranunculus macounii	Macoun's buttercup	1
		Rubus arcticus (also R. acaulis)	dwarf raspberry	3
		Rubus pubescens	dewberry	1

Table L-1 Species Composition and Percent Cover by Vegetation Type (continued)

Ecosite Phase/ Wetlands Type	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
SONS (continued)	forb (continued)	*Rumex triangulivalvis*	narrow-leaved dock	1
		Smilacina trifolia	three-leaved Solomon's-seal	1
		Stellaria crassifolia	fleshy stitchwort	1
		Stellaria longipes	long-stalked chickweed	1
		Thalictrum venulosum	veiny meadow rue	1
		unknown Arenaria species	unknown Arenaria species	1
		unknown Equisetum species	unknown Equisetum species	1
		unknown Equisetum species	unknown Equisetum species	5
		unknown forb species	unknown forb species	1
		unknown forb species	unknown forb species	1
		unknown Potamogeton species	unknown Potamogeton species	<1
		unknown Pyrola species	unknown Pyrola species	1
		unknown violet species	unknown violet species	1
		Urtica dioica	common nettle	1
		Viola nephrophylla	bog violet	1
	graminoid	*Calamagrostis canadensis*	bluejoint	38
		Carex aquatilis	water sedge	31
		Carex canescens	short sedge	1
		Carex disperma	two-seeded sedge	1
		Carex utriculata	small bottle sedge	5
		Poa palustris	fowl bluegrass	5
		unknown graminoid species	unknown graminoid species	1
	moss	*Amblystegium serpens*	*no common name*	1
		Aulacomnium palustre	tufted moss	3
		Bryum pseudotriquetrum	*no common name*	3
		Campylium polygamum	campylium moss	1
		Campylium stellatum	yellow star moss	1
		Cinclidium stygium	common northern lantern moss	1
		Climacium dendroides	common tree moss	1
		Dicranum undulatum	wavy dicranum	1
		Funaria hygrometrica	cord moss	15
		Hylocomium splendens	stair-step moss	1
		Marchantia polymorpha	liverwort	5
		Plagiomnium ellipticum	elliptic plagiomnium moss	13
		Pohlia nutans	copper wire moss	1
		Pylaisiella polyantha	pylaisiella moss	1
		Sphagnum angustifolium	peat moss	55

Table L-1 Species Composition and Percent Cover by Vegetation Type (continued)

Ecosite Phase/ Wetlands Type	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
SONS (continued)	moss (continued)	*Tomentypnum nitens*	golden moss	1
		unknown moss species	unknown moss species	1
		Warnstorfia fluitans (also Drepanocladus fluitans)	warnstorfia moss	50
	lichen	*Cladonia chlorophaea*	mealy pixie-cup	<1
		Cladonia cornuta	bighorn cladonia	<1
		Peltigera aphthosa	studded leather lichen	<1
		Peltigera neopolydactyla	carpet pelt	<1
	epiphyte	*Arthonioid group*	Arthonioid group	<1
		Cladonia coniocraea	cup lichen	<1
		Evernia mesomorpha	boreal oakmoss lichen	<1
		Flavopunctelia soredica	powder-edged speckled greenshield	<1
		Hypogymnia physodes	monk's-hood lichen	<1
		Lecanora symmicta	fused rim-lichen	<1
		Melanelia septentrionalis	northern camoflage lichen	<1
		Melanelia subaurifera	abraded camoflage lichen	<1
		Micarea sylvicola	*no common name*	<1
		Ochrolechia gowardii	*no common name*	<1
		Parmelia sulcata	hammered shield moss	<1
		Physcia adscendens	hooded rosette lichen	<1
		Rinodina septentrionalis	*no common name*	<1
		Scoliciosporum perpusillum	*no common name*	<1
		Tuckermannopsis americana (also Cetraria halei or C. ciliaris)	fringed wrinkle-lichen	<1
		Usnea hirta	old man's beard	<1
		Usnea substerilis	old man's beard	<1
		Vulpicida pinastri (also Tuckermannopsis pinastri)	powdered sunshine lichen	<1
STNN	canopy	*Picea mariana*	black spruce	20
	subcanopy	*Betula papyrifera*	white birch	15
		Larix laricina	tamarack	<1
		Picea mariana	black spruce	<1
		Populus balsamifera	balsam poplar	3
		Salix bebbiana	beaked willow	5
		unknown Salix species	unknown Salix species	3
	tall shrub	*Betula papyrifera*	white birch	5
		Larix laricina	tamarack	<1
		Picea mariana	black spruce	1

Table L-1 Species Composition and Percent Cover by Vegetation Type (continued)

Ecosite Phase/ Wetlands Type	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
STNN (continued)	tall shrub (continued)	*unknown Salix species*	unknown Salix species	4
	low shrub	*Betula papyrifera*	white birch	<1
		Betula pumila	dwarf birch	<1
		Larix laricina	tamarack	<1
		Ledum groenlandicum	common Labrador tea	20
		Linnaea borealis	twinflower	<1
		Lonicera dioica	twining honeysuckle	1
		Picea mariana	black spruce	1
		Rhamnus alnifolia	alder-leaved buckthorn	5
		Ribes hudsonianum	northern black currant	<1
		Ribes oxyacanthoides	northern gooseberry	<1
		Ribes triste	wild red currant	<1
		Salix myrtillifolia	myrtle-leaved willow	2
		unknown Salix species	unknown Salix species	<1
		Vaccinium caespitosum	dwarf bilberry	1
		Vaccinium vitis-idaea	bog cranberry	1
	forb	*Achillea millefolium*	common yarrow	<1
		Actaea rubra	red and white baneberry	<1
		Aster ciliolatus	Lindley's aster	<1
		Aster puniceus	purple-stemmed aster	<1
		Caltha palustris	marsh-marigold	3
		Cornus canadensis	bunchberry	<1
		Equisetum pratense	meadow horsetail	30
		Equisetum scirpoides	dwarf scouring-rush	1
		Fragaria virginiana	wild strawberry	<1
		Galium trifidum	small bedstraw	<1
		Galium triflorum	sweet-scented bedstraw	<1
		Geocaulon lividum	northern bastard toadflax	<1
		Mitella nuda	bishop's-cap	<1
		Monotropa uniflora	Indian-pipe	<1
		Petasites frigidus var sagittatus	arrow-leaved coltsfoot	<1
		Pyrola asarifolia	common pink wintergreen	<1
		Rubus pubescens	dewberry	1
		Smilacina trifolia	three-leaved Solomon's-seal	1
		Viola renifolia	kidney-leaved violet	<1
	graminoid	*Agrostis scabra*	rough hair grass	<1
		Bromus ciliatus	fringed brome	<1
		Carex disperma	two-seeded sedge	<1

Table L-1 Species Composition and Percent Cover by Vegetation Type (continued)

Ecosite Phase/ Wetlands Type	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
STNN (continued)	graminoid (continued)	*Carex limosa*	mud sedge	<1
		Carex vaginata	sheathed sedge	1
		Elymus trachycaulus ssp trachycaulus (also Agropyron trachycaulum)	slender wheat grass	<1
		Hierochloe hirta ssp arctica (also H. odorata)	sweet grass	<1
		unknown graminoid species	unknown graminoid species	<1
	moss	*Aulacomnium palustre*	tufted moss	4
		Climacium dendroides	common tree moss	<1
		Dicranum polysetum	wavy dicranum	<1
		Dicranum scoparium	broom moss	<1
		Eurhynchium pulchellum	Eurhynchium moss	<1
		Hylocomium splendens	stair-step moss	30
		Plagiomnium ellipticum	elliptic plagiomnium moss	25
		Pleurozium schreberi	Schreber's moss	30
		Ptilium crista-castrensis	knight's plume moss	<1
		Pylaisiella polyantha	pylaisiella moss	<1
		Sanionia uncinata (also Drepanocladus uncinatus)	brown moss	<1
		Sphagnum squarrosum	squarrose peat moss	<1
	lichen	*Cladina mitis*	reindeer lichen	<1
		Cladina rangiferina	reindeer lichen	<1
		Cladonia cervicornis (also C. verticillata)	ladder lichen	<1
		Cladonia chlorophaea	mealy pixie-cup	<1
		Cladonia gracilis	smooth cladonia	<1
		Cladonia multiformis	sieve lichen	<1
		Cladonia scabriuscula	mealy forked cladonia	<1
		Peltigera aphthosa	studded leather lichen	1
		Peltigera canina	dog lichen	<1
		Peltigera neopolydactyla	carpet pelt	<1
	epiphyte	*Bryoria fuscescens*	old man's beard	<1
		Evernia mesomorpha	boreal oakmoss lichen	2
		Hypogymnia physodes	monk's-hood lichen	<1
		Lecanora circumborealis	black-eyed rim-lichen	<1
		Lecanora pulicaris	*no common name*	<1
		Lecanora symmicta	fused rim-lichen	<1
		Melanelia septentrionalis	northern camoflage lichen	<1
		Melanelia subaurifera	abraded camoflage lichen	<1

Table L-1 Species Composition and Percent Cover by Vegetation Type (continued)

Ecosite Phase/ Wetlands Type	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
STNN (continued)	epiphyte (continued)	*Melanelia trabeculata*	*no common name*	<1
		Ochrolechia arborea	*no common name*	<1
		Parmelia sulcata	hammered shield moss	<1
		Ramalina dilacerata	punctured ramalina	<1
		Rinodina septentrionalis	*no common name*	<1
		Scoliciosporum perpusillum	*no common name*	<1
		Scoliciosporum umbrinum	*no common name*	<1
		Tuckermannopsis americana (also Cetraria halei or C. ciliaris)	fringed wrinkle-lichen	<1
		Tuckermannopsis orbata (also Cetraria orbata)	variable wrinkle-lichen	<1
		Tuckermannopsis sepincola	chestnut wrinkle-lichen	<1
		unknown Mycobilimbia species	unknown Mycobilimbia species	<1
		Usnea glabrata	old man's beard	<1
		Usnea hirta	old man's beard	<1
		Usnea lapponica	old man's beard	<1
		Usnea scabrata	old man's beard	<1
		Usnea subfloridana	old man's beard	<1
		Vulpicida pinastri (also Tuckermannopsis pinastri)	powdered sunshine lichen	<1

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APPENDIX M

SITE SUMMARY DATA

Submitted to:
Shell Canada Limited

Prepared by:
Golder Associates Ltd.

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TABLE OF CONTENTS

SECTION **PAGE**

1 SITE SUMMARY DATA 1

LIST OF TABLES

Table M-1 Detailed Vegetation Inventory and Rare Plant Site Summary Data 2
Table M-2 Vegetation Mapping Aerial Survey Site Summary Data 22

1 SITE SUMMARY DATA

Tables M-1 and M-2 provide the non-species specific data compiled for the Jackpine Mine Expansion & Pierre River Mine Project. This data was used in the mapping and analysis of the Project, as per Sections 3.5.1 and 3.6.1.

Table M-1 Detailed Vegetation Inventory and Rare Plant Site Summary Data

Plot Number	Plot Type	UTM Easting (NAD 83)	UTM Northing (NAD 83)	Survey Date (dd/mm/yyyy)	Observers	Ecosite Phase/Wetlands Type	Slope Percent	Aspect (Degrees)	Surface Expression	Riparian Subclass	Flood Hazard	Surface Shape	Slope Position	Moisture Regime	Nutrient Regime	Shrub Cover [%]	Canopy Cover [%]	Forb Cover [%]	Graminoid Cover [%]	Bryophyte Cover [%]	Terrestrial Lichen [%]	Epiphyte Cover [%]
3AV001	detailed vegetation and rare plant	481473	6352517	03/06/2006	AA/DH	FTNI	0	n/a	horizontal (organic soil)	n/a	n/a	Straight	Level	Subhydric	Medium	4	15	25	25	40	0	0.5
3AV002	detailed vegetation and rare plant	479127	6352524	03/06/2006	AA/DH	FOPN	0	n/a	ribbed (organic soil)	n/a	n/a	Straight	Level	Subhydric	Medium	0.5	n/a	5	50	60	0	0.5
3AV003	detailed vegetation and rare plant	478353	6351810	03/06/2006	AA/DH	FONG	0	n/a	floating (organic soil)	n/a	Expected	Straight	Level	Hygric	Medium	5	n/a	10	60	60	0	0.5
3AV004	detailed vegetation and rare plant	478404	6352578	03/06/2006	AA/DH	FTPN	0	n/a	ribbed (organic soil)	n/a	n/a	Convex	Level	Hygric	Poor	25	7	0.5	15	70	10	0.5
3AV005	detailed vegetation and rare plant	488444	6358596	04/06/2006	AA/DH	burn (shrubby uplands)	3	360	inclined	n/a	n/a	Straight	Crest	Subxeric	Poor	70	n/a	10	15	5	0	0
3AV006	detailed vegetation and rare plant	487476	6358544	04/06/2006	AA/DH	burn (shrubby wetlands)	0	n/a	blanket	n/a	n/a	Straight	Level	Subhydric	Poor	70	n/a	15	25	40	0.5	0
3AV007	detailed vegetation and rare plant	487902	6357331	04/06/2006	AA/DH	burn (shrubby wetlands)	0	n/a	horizontal (organic soil)	n/a	n/a	Convex	Level	Subhydric	Poor	25	10	5	1	80	10	1
3AV008	detailed vegetation and rare plant	488939	6368322	09/06/2006	AA/DH	FOPN	0	n/a	ribbed (organic soil)	n/a	n/a	Straight	Level	Subhydric	Rich	30	0.5	5	20	80	0	0.5
3AV009	detailed vegetation and rare plant	487876	6365962	09/06/2006	AA/DH	FOPN	0	n/a	ribbed (organic soil)	n/a	n/a	Straight	Level	Hydric	Rich	5	n/a	5	90	80	0	0
3AV010	detailed vegetation and rare plant	487857	6365958	09/06/2006	AA/DH	FOPN	0	n/a	ribbed (organic soil)	n/a	n/a	Convex	Level	Hygric	Poor	40	n/a	1	5	60	40	1
3AV011	detailed vegetation and rare plant	490028	6368324	09/06/2006	AA/DH	FONS	0	n/a	hummocky	n/a	n/a	Straight	Level	Hydric	Rich	60	0.5	3	25	60	0	0.5
3AV012	detailed vegetation and rare plant	490515	6368374	09/06/2006	AA/DH	FTNN	0	n/a	hummocky	n/a	n/a	Straight	Level	Hydric	Rich	30	10	5	30	80	0.5	0.5
3AV013	detailed vegetation and rare plant	490760	6367684	09/06/2006	AA/DH	BTXC	0	n/a	horizontal (organic soil)	n/a	n/a	Irregular	Level	Hygric	Poor	30	50	5	5	60	25	2
3AV014	detailed vegetation and rare plant	489860	6366972	09/06/2006	AA/DH	FONS	0	n/a	floating (organic soil)	n/a	n/a	Straight	Level	Hydric	Very Rich	40	0.5	20	75	60	0	0.5
3AV015	detailed vegetation and rare plant	487196	6364739	09/06/2006	AA/DH	d1	1	14	inclined	n/a	n/a	Convex	Midslope	Mesic	Medium	52	55	20	1	5	0.5	0.5
3AV016	detailed vegetation and rare plant	479777	6363370	10/06/2006	AA/DH	b2	3	n/a	undulating	n/a	n/a	Irregular	Upper Slope	Subxeric	Poor	7	35	2	0.5	25	0.5	0.5
3AV017	detailed vegetation and rare plant	480283	6362982	10/06/2006	AA/DH	a1	30	360	undulating	n/a	n/a	Irregular	Upper Slope	Xeric	Poor	20	20	15	0.5	90	0.5	0.5
3AV018	detailed vegetation and rare plant	481020	6363081	10/06/2006	AA/DH	d2	30	35	undulating	n/a	n/a	Convex	Midslope	Mesic	Medium	35	45	40	0.5	50	0.5	0.5
3AV019	detailed vegetation and rare plant	481615	6364029	10/06/2006	AA/DH	b4	1	70	depressional	Inactive Channel	Rare	Concave	Depression	Subhygric	Poor	7	30	3	0	75	0.5	0.5
3AV020	detailed vegetation and rare plant	481369	6363641	10/06/2006	AA/DH	b1	5	180	undulating	n/a	n/a	Irregular	Midslope	Subxeric	Poor	50	18	20	0.5	75	0.5	0.5
3AV021	detailed vegetation and rare plant	481944	6358574	11/06/2006	AA/DH	FTPN	0	n/a	ribbed (organic soil)	n/a	n/a	Straight	Level	Subhydric	Rich	35	6	10	30	50	0.5	3
3AV022	detailed vegetation and rare plant	481320	6358607	11/06/2006	AA/DH	FTNN	0	n/a	blanket	n/a	n/a	Straight	Level	Subhydric	Rich	55	10	1	10	75	0.5	3
3AV023	detailed vegetation and rare plant	480658	6358436	11/06/2006	AA/DH	FONS	0	n/a	blanket	Inactive Channel	Frequent	Irregular	Level	Aquatic	Rich	20	0.5	5	50	25	0	0.5
3AV024	detailed vegetation and rare plant	483208	6359673	11/06/2006	AA/DH	SONS	0	n/a	level	Active Channel	Frequent	Straight	Level	Hydric	Very Rich	80	n/a	10	25	25	0	0.5
3AV025	detailed vegetation and rare plant	487925	6364619	12/06/2006	AA/DH	FONS	0	n/a	hummocky	n/a	n/a	Straight	Level	Hydric	Medium	65	0.5	15	40	80	0	0.5
3AV026	detailed vegetation and rare plant	488002	6363469	12/06/2006	AA/DH	d2	1	250	inclined	n/a	n/a	Convex	Upper Slope	Mesic	Medium	45	50	10	0.5	20	0.5	0.5
3AV027	detailed vegetation and rare plant	487921	6363491	12/06/2006	AA/DH	h1	3	270	undulating	n/a	n/a	Concave	Toe Slope	Subhygric	Poor	50	30	5	0.5	80	10	2
3AV028	detailed vegetation and rare plant	488405	6362819	12/06/2006	AA/DH	BTNR	0	n/a	ribbed (organic soil)	n/a	n/a	Concave	Upper Slope	Subhydric	Medium	10	20	5	10	70	5	2
3AV029	detailed vegetation and rare plant	482366	6368749	12/06/2006	AA/DH	BONS	0	n/a	bowl (organic soil)	n/a	n/a	Straight	Level	Subhydric	Poor	45	0.5	10	3	95	0	0.5
3AV030	detailed vegetation and rare plant	482336	6368881	12/06/2006	AA/DH	b1	5	235	undulating	n/a	n/a	Concave	Upper Slope	Subxeric	Poor	40	40	10	0.5	60	2	1

Table M-1 Detailed Vegetation Inventory and Rare Plant Site Summary Data (continued)

Plot Number	Plot Type	UTM Easting (NAD 83)	UTM Northing (NAD 83)	Survey Date (dd/mm/yyyy)	Observers	Ecosite Phase/Wetlands Type	Slope Percent	Aspect (Degrees)	Surface Expression	Riparian Subclass	Flood Hazard	Surface Shape	Slope Position	Moisture Regime	Nutrient Regime	Shrub Cover [%]	Canopy Cover [%]	Forb Cover [%]	Graminoid Cover [%]	Bryophyte Cover [%]	Terrestrial Lichen [%]	Epiphyte Cover [%]
3AV031	detailed vegetation and rare plant	487128	6363397	12/06/2006	AA/DH	c1	3	55	undulating	n/a	n/a	Convex	Lower Slope	Submesic	Poor	35	20	2	0.5	70	20	2
3AV032	detailed vegetation and rare plant	480479	6352468	18/07/2006	AA/DH	FTNN	0	n/a	horizontal (organic soil)	n/a	n/a	Straight	Level	Subhygric	Rich	30	n/a	0.05	40	80	2	2
3AV033	detailed vegetation and rare plant	480023	6352076	18/07/2006	AA/DH	d3	0	n/a	subdued	n/a	n/a	Straight	Level	Mesic	Medium	30	25	5	3	70	10	1
3AV034	detailed vegetation and rare plant	479107	6352470	18/07/2006	AA/DH	d1	0	n/a	level	n/a	n/a	Straight	Level	Mesic	Medium	55	30	15	3	15	0.05	0.05
3AV035	detailed vegetation and rare plant	486402	6365278	19/07/2006	AA/DH	FOPN	0	n/a	ribbed (organic soil)	n/a	n/a	Straight	Level	Subhygric	Poor	12	10	15	5	90	5	1
3AV036	detailed vegetation and rare plant	486388	6365281	19/07/2006	AA/DH	FOPN	0	n/a	ribbed (organic soil)	n/a	n/a	Straight	Level	Hydric	Very Rich	5	n/a	5	80	50	0	0
3AV037	detailed vegetation and rare plant	490699	6368539	19/07/2006	AA/DH	FONG	0	n/a	floating (organic soil)	n/a	n/a	Straight	Level	Hydric	Very Rich	10	n/a	15	95	5	0	0.05
3AV038	detailed vegetation and rare plant	491019	6367780	19/07/2006	AA/DH	FTNN	0	n/a	horizontal (organic soil)	n/a	n/a	Straight	Level	Subhydric	Medium	80	10	0.05	1	70	5	3
3AV039	detailed vegetation and rare plant	491124	6369370	19/07/2006	AA/DH	b1	0	n/a	subdued	n/a	n/a	Straight	Level	Xeric	Poor	50	30	10	3	25	10	3
3AV040	detailed vegetation and rare plant	483989	6363521	20/07/2006	AA/DH	BTNI	0	n/a	horizontal (organic soil)	n/a	n/a	Straight	Level	Hygric	Poor	82	18	2	3	85	10	2
3AV041	detailed vegetation and rare plant	484891	6364650	20/07/2006	AA/DH	BTNI	0	n/a	horizontal (organic soil)	n/a	n/a	Straight	Level	Hygric	Poor	90	15	3	3	90	5	3
3AV042	detailed vegetation and rare plant	484945	6364629	20/07/2006	AA/DH	FONS	0	n/a	floating (organic soil)	Active Channel	Frequent	Straight	Level	Hydric	Rich	-	n/a	25	15	75	0.05	0
3AV043	detailed vegetation and rare plant	483443	6361084	20/07/2006	AA/DH	FTNN	0	n/a	horizontal (organic soil)	n/a	n/a	Straight	Level	Subhydric	Rich	75	30	5	2	70	1	1
3AV044	detailed vegetation and rare plant	481970	6367590	20/07/2006	AA/DH	FTNN	0	n/a	floating (organic soil)	n/a	n/a	Straight	Level	Hydric	Rich	65	15	25	15	70	0	2
3AV045	detailed vegetation and rare plant	481519	6362477	20/07/2006	AA/DH	FONS	0	n/a	floating (organic soil)	Bank	Expected	Straight	Level	Hydric	Very Rich	35	n/a	15	20	10	0	0
3AV046	detailed vegetation and rare plant	482102	6361588	20/07/2006	AA/DH	FTNN	0	n/a	horizontal (organic soil)	n/a	n/a	Straight	Level	Subhydric	Medium	25	25	5	10	90	5	2
3AV047	detailed vegetation and rare plant	479298	6359911	21/07/2006	AA/DH	b2	5	10	undulating	n/a	n/a	Concave	Midslope	Subxeric	Medium	25	50	15	1	30	0.05	0.05
3AV048	detailed vegetation and rare plant	478903	6361437	21/07/2006	AA/DH	b1	14	50	subdued	n/a	n/a	Straight	Midslope	Subxeric	Medium	20	30	10	3	40	0.05	0.05
3AV049	detailed vegetation and rare plant	478879	6361164	21/07/2006	AA/DH	a1	0	n/a	subdued	n/a	n/a	Straight	Midslope	Xeric	Poor	20	20	5	0.05	40	40	1
3AV050	detailed vegetation and rare plant	480259	6361123	21/07/2006	AA/DH	f3	0	n/a	subdued	n/a	n/a	Convex	Depression	Hygric	Very Rich	20	25	40	0.05	80	0.05	0.05
3AV051	detailed vegetation and rare plant	480225	6361115	21/07/2006	AA/DH	d2	12	60	subdued	n/a	n/a	Convex	Midslope	Mesic	Medium	30	30	15	2	60	0.05	0.05
3AV052	detailed vegetation and rare plant	478455	6359840	21/07/2006	AA/DH	b3	0	n/a	subdued	n/a	n/a	Straight	Level	Xeric	Poor	25	25	5	0.05	70	10	0.05
3AV053	detailed vegetation and rare plant	489539	6357958	25/07/2006	AA/DH	burn (shrubby uplands)	0	n/a	subdued	n/a	n/a	Straight	Level	Xeric	Poor	70	n/a	5	10	20	0.05	0
3AV054	detailed vegetation and rare plant	489429	6357914	24/07/2006	AA/DH	burn (shrubby uplands)	0	n/a	subdued	n/a	n/a	Straight	Level	Mesic	Medium	80	n/a	25	30	15	0.05	0
3AV055	detailed vegetation and rare plant	489507	6357774	24/07/2006	AA/DH	burn (shrubby uplands)	0	n/a	subdued	n/a	n/a	Straight	Level	Subxeric	Poor	40	n/a	3	30	15	0.05	n/a
3AV056	detailed vegetation and rare plant	489077	6358587	24/07/2006	AA/DH	burn (shrubby uplands)	0	n/a	subdued	n/a	n/a	Straight	Level	Submesic	Poor	65	n/a	20	15	45	0	0
3AV057	detailed vegetation and rare plant	488011	6359342	24/07/2006	AA/DH	burn (shrubby uplands)	0	n/a	subdued	n/a	n/a	Straight	Level	Subxeric	Medium	40	n/a	30	15	10	0.05	n/a
3AV058	detailed vegetation and rare plant	478934	6363739	26/07/2006	AA/DH	a1	0	n/a	subdued	n/a	n/a	Irregular	Level	Xeric	Poor	22	25	20	0.05	90	2	2
3AV059	detailed vegetation and rare plant	478946	6364103	26/07/2006	AA/DH	Sh	1	10	undulating	n/a	n/a	Concave	Depression	Xeric	Poor	53	5	30	0.05	20	40	0.05
3AV060	detailed vegetation and rare plant	480463	6363989	24/07/2006	AA/DH	b3	37	250	ridged	n/a	n/a	Convex	Crest	Submesic	Medium	50	45	20	1	50	15	3

Table M-1 Detailed Vegetation Inventory and Rare Plant Site Summary Data (continued)

Plot Number	Plot Type	UTM Easting (NAD 83)	UTM Northing (NAD 83)	Survey Date (dd/mm/yyyy)	Observers	Ecosite Phase/Wetlands Type	Slope Percent	Aspect (Degrees)	Surface Expression	Riparian Subclass	Flood Hazard	Surface Shape	Slope Position	Moisture Regime	Nutrient Regime	Shrub Cover [%]	Canopy Cover [%]	Forb Cover [%]	Graminoid Cover [%]	Bryophyte Cover [%]	Terrestrial Lichen [%]	Epiphyte Cover [%]
3AV061	detailed vegetation and rare plant	480406	6364000	24/07/2006	AA/DH	d2	0	n/a	ridged	n/a	n/a	Irregular	Crest	Mesic	Medium	30	40	20	15	60	0.05	2
3AV062	detailed vegetation and rare plant	485408	6358519	27/07/2006	AA/DH	FONG	0	n/a	horizontal (organic soil)	n/a	n/a	Straight	Level	Hydric	Medium	0.05	n/a	20	15	2	0	0
3AV063	detailed vegetation and rare plant	485010	6358605	27/07/2006	AA/DH	g1	0	n/a	subdued	n/a	n/a	Straight	Level	Subhygric	Poor	35	36	10	0	70	10	0.05
3AV064	detailed vegetation and rare plant	484400	6358565	27/07/2006	AA/DH	FTNI	0	n/a	horizontal (organic soil)	n/a	n/a	Irregular	Level	Hydric	Rich	65	15	10	25	50	0.05	3
3BV001	detailed vegetation and rare plant	481246	6351860	02/06/2006	JK,/JS/AA/ DH/CW/ PM	FONG	0	n/a	bowl (organic soil)	n/a	n/a	Concave	Level	Subhydric	Rich	2	n/a	10	80	70	0	0
3BV002	detailed vegetation and rare plant	479551	6353730	03/06/2006	JK/JS	FONS	0	n/a	blanket	n/a	n/a	Straight	Level	Hygric	Medium	55	n/a	10	70	10	0.5	0.5
3BV003	detailed vegetation and rare plant	478165	6353851	03/06/2006	JK/JS	BTNN	0	n/a	horizontal (organic soil)	n/a	n/a	Irregular	Level	Subhygric	Poor	70	1	0.5	0	45	50	2
3BV004	detailed vegetation and rare plant	489879	6356744	04/06/2006	JK/JS	burn (shrubby uplands)	5	64	inclined	adjacent to riparian area	No Hazard	Convex	Upper Slope	Subxeric	Medium	40	n/a	15	60	15	0.5	0
3BV005	detailed vegetation and rare plant	489243	6356687	04/06/2006	JK/JS	burn (shrubby wetlands)	0	n/a	horizontal (organic soil)	n/a	n/a	Irregular	Level	Hygric	Rich	70	n/a	10	70	10	0	0
3BV006	detailed vegetation and rare plant	488539	6356707	04/06/2006	JK/JS	burn (shrubby wetlands)	0	n/a	horizontal (organic soil)	n/a	n/a	Straight	Level	Subxeric	Medium	70	n/a	4	20	10	0.5	0
3BV007	detailed vegetation and rare plant	487199	6356712	04/06/2006	JK/JS	burn (shrubby wetlands)	0	n/a	horizontal (organic soil)	n/a	n/a	Straight	Level	Hygric	Medium	50	5	4	5	90	0.5	0.5
3BV008	detailed vegetation and rare plant	487721	6368275	09/06/2006	JK/JS	FOPN	0	n/a	horizontal (organic soil)	n/a	n/a	Straight	Level	Subhydric	Rich	55	0.5	1	85	70	0.5	0.5
3BV009	detailed vegetation and rare plant	486445	6366448	09/06/2006	JK/JS	FOPN	0	n/a	horizontal (organic soil)	n/a	n/a	Straight	Level	Subhydric	Rich	25	3	8	80	60	0.5	0.5
3BV010	detailed vegetation and rare plant	484666	6362209	09/06/2006	JK/JS	FONS	0	n/a	horizontal (organic soil)	n/a	n/a	Straight	Level	Subhydric	Medium	40	3	2	80	70	0.5	0.5
3BV011	detailed vegetation and rare plant	484686	6362214	09/06/2006	JK/JS	d1	2	n/a	level	n/a	n/a	Straight	Level	Mesic	Medium	85	30	40	0.5	1	0.5	0.5
3BV012	detailed vegetation and rare plant	488096	6362226	09/06/2006	JK/JS	SONS	0	n/a	horizontal (organic soil)	n/a	n/a	Straight	Level	Subhydric	Rich	50	0.5	20	50	30	0	0.5
3BV013	detailed vegetation and rare plant	488101	6362231	09/06/2006	JK/JS	BONS	2	n/a	bowl (organic soil)	n/a	n/a	Concave	Depression	Subhydric	Medium	25	10	6	50	60	0.5	0
3BV014	detailed vegetation and rare plant	480270	6365896	10/06/2006	JK/JS	e1	0	n/a	ridged	n/a	n/a	Straight	Level	Subhygric	Very Rich	15	25	65	4	4	0.5	0.5
3BV015	detailed vegetation and rare plant	480312	6365187	10/06/2006	JK/JS	b1	0	n/a	undulating	n/a	n/a	Straight	Crest	Subxeric	Poor	10	50	25	0.5	45	0.5	0.5
3BV016	detailed vegetation and rare plant	480117	6364928	10/06/2006	JK/JS	a1	0	n/a	level	n/a	n/a	Straight	Level	Subxeric	Poor	10	30	5	0.5	85	16	0.5
3BV017	detailed vegetation and rare plant	479537	6364629	10/06/2006	JK/JS	b2	11	338	inclined	n/a	n/a	Straight	Midslope	Submesic	Poor	25	40	40	0.5	60	0.5	0.5
3BV018	detailed vegetation and rare plant	478885	6363981	10/06/2006	JK/JS	d1	6	102	hummocky	n/a	n/a	Concave	Toe Slope	Mesic	Medium	38	40	20	0.5	8	0.5	0.5
3BV019	detailed vegetation and rare plant	485064	6357956	11/06/2006	JK/JS	MONG	0	n/a	floating (organic soil)	fringe	Expected	Straight	Level	Hydric	Rich	-	n/a	25	80	2	0	0
3BV020	detailed vegetation and rare plant	484199	6357990	11/06/2006	JK/JS	FTNN	0	n/a	horizontal (organic soil)	n/a	n/a	Irregular	Level	Subhydric	Rich	45	20	25	0.5	90	0.5	0.5
3BV021	detailed vegetation and rare plant	480956	6357313	11/06/2006	JK/JS	FONG	0	n/a	horizontal (organic soil)	n/a	n/a	Straight	Level	Hydric	Rich	-	n/a	2	90	70	0	0
3BV022	detailed vegetation and rare plant	480369	6357484	11/06/2006	JK/JS	FTNI	0	n/a	horizontal (organic soil)	n/a	n/a	Straight	Level	Subhydric	Medium	10	2	15	75	80	0.5	0.5
3BV023	detailed vegetation and rare plant	486403	6362789	12/06/2006	JK/JS	b1	15	1	level	n/a	n/a	Concave	Crest	Xeric	Poor	50	7	3	5	3	15	0.5
3BV024	detailed vegetation and rare plant	483383	6360615	12/06/2006	JK/JS	FONS	0	n/a	floating (organic soil)	lakeshore	Expected	Straight	Level	Hydric	Rich	40	n/a	5	70	80	0	0.5
3BV025	detailed vegetation and rare plant	485853	6360064	12/06/2006	JK/JS	SONS	0	n/a	horizontal (organic soil)	n/a	n/a	Irregular	Level	Subhydric	Medium	80	n/a	2	10	60	0.5	0.5

Table M-1 Detailed Vegetation Inventory and Rare Plant Site Summary Data (continued)

Plot Number	Plot Type	UTM Easting (NAD 83)	UTM Northing (NAD 83)	Survey Date (dd/mm/yyyy)	Observers	Ecosite Phase/Wetlands Type	Slope Percent	Aspect (Degrees)	Surface Expression	Riparian Subclass	Flood Hazard	Surface Shape	Slope Position	Moisture Regime	Nutrient Regime	Shrub Cover [%]	Canopy Cover [%]	Forb Cover [%]	Graminoid Cover [%]	Bryophyte Cover [%]	Terrestrial Lichen [%]	Epiphyte Cover [%]
3BV026	detailed vegetation and rare plant	488975	6360213	12/06/2006	JK/JS	f3	5	90	inclined	Fringe	Rare	Irregular	Toe Slope	Subhygric	Rich	30	40	40	7	20	0.5	0.5
3BV027	detailed vegetation and rare plant	490096	6357167	12/06/2006	JK/JS	burn (shrubby wetlands)	0	n/a	level	n/a	n/a	Straight	Level	Subxeric	Poor	50	n/a	3	5	0.5	0	0
3BV028	detailed vegetation and rare plant	481905	6354297	18/07/2006	JK/JS	STNN	0	n/a	horizontal (organic soil)	n/a	n/a	Straight	Level	Subhygric	Very Rich	20	35	40	3	60	0.05	0.05
3BV029	detailed vegetation and rare plant	480277	6354404	18/07/2006	JK/JS	FONG	0	n/a	horizontal (organic soil)	n/a	n/a	Straight	Level	Subhydric	Rich	-	n/a	40	50	5	0	0
3BV030	detailed vegetation and rare plant	479052	6355417	18/07/2006	JK/JS	d1	3	110	level	n/a	n/a	Straight	Upper Slope	Mesic	Medium	50	50	15	0.05	0.05	0	0
3BV031	detailed vegetation and rare plant	480827	6355354	18/07/2006	JK/JS	FTNN	0	n/a	horizontal (organic soil)	n/a	n/a	Straight	Level	Hygric	Rich	40	30	2	60	35	0.05	0.05
3BV032	detailed vegetation and rare plant	483999	6359658	19/07/2006	JK/JS	h1	0	n/a	undulating	Floodplain	No Hazard	Irregular	Level	Subhygric	Rich	21	35	14	1	70	0.05	0.05
3BV033	detailed vegetation and rare plant	484264	6361026	19/07/2006	JK/JS	FTPN	0	n/a	horizontal (organic soil)	n/a	n/a	Straight	Level	Subhydric	Rich	5	n/a	10	55	95	0	0
3BV034	detailed vegetation and rare plant	485426	6361000	19/07/2006	JK/JS	BTNN	0	n/a	horizontal (organic soil)	n/a	n/a	Straight	Level	Subhygric	Poor	40	25	6	1	90	0.05	0.05
3BV035	detailed vegetation and rare plant	485279	6362950	19/07/2006	JK/JS	FTNI	0	n/a	horizontal (organic soil)	n/a	n/a	Straight	Level	Subhydric	Rich	0.05	n/a	50	40	60	0	0
3BV036	detailed vegetation and rare plant	485758	6362870	19/07/2006	JK/JS	BTNN	0	n/a	horizontal (organic soil)	n/a	n/a	Straight	Level	Subhygric	Poor	50	20	3	0.05	90	5	0.05
3BV037	detailed vegetation and rare plant	485970	6362956	20/07/2006	JK/JS	d1	0	n/a	level	n/a	n/a	Straight	Level	Mesic	Medium	30	40	10	10	5	0.05	0.05
3BV038	detailed vegetation and rare plant	485211	6362746	20/07/2006	JK/JS	FONS	0	n/a	horizontal (organic soil)	n/a	n/a	Straight	Level	Subhydric	Medium	70	n/a	10	30	85	0.05	0.05
3BV039	detailed vegetation and rare plant	487031	6363522	20/07/2006	JK/JS	FONS	0	n/a	horizontal (organic soil)	n/a	n/a	Straight	Level	Subhydric	Medium	40	2	1	60	30	0.05	0.05
3BV040	detailed vegetation and rare plant	486485	6360997	20/07/2006	JK/JS	FONS	0	n/a	horizontal (organic soil)	n/a	n/a	Straight	Level	Subhydric	Medium	30	n/a	2	50	70	0	0.05
3BV041	detailed vegetation and rare plant	487501	6361065	20/07/2006	JK/JS	FTNN	0	n/a	horizontal (organic soil)	n/a	n/a	Straight	Depression	Hygric	Rich	60	15	7	3	70	0.05	0.05
3BV042	detailed vegetation and rare plant	487553	6360115	20/07/2006	JK/JS	FONS	0	n/a	horizontal (organic soil)	n/a	n/a	Straight	Level	Hydric	Rich	70	2	3	40	30	0	0.05
3BV043	detailed vegetation and rare plant	482653	6360504	21/07/2006	JK/JS	FONS	0	n/a	horizontal (organic soil)	n/a	n/a	Straight	Level	Hygric	Rich	65	n/a	2	1	80	0.05	1
3BV044	detailed vegetation and rare plant	483974	6360337	21/07/2006	JK/JS	FONG	0	n/a	horizontal (organic soil)	n/a	n/a	Straight	Level	Hydric	Rich	20	n/a	4	70	15	0	0.05
3BV045	detailed vegetation and rare plant	483358	6358646	21/07/2006	JK/JS	FONS	0	n/a	horizontal (organic soil)	n/a	n/a	Straight	Level	Subhydric	Rich	65	n/a	35	40	60	0	2
3BV046	detailed vegetation and rare plant	483560	6356702	21/07/2006	JK/JS	FTNN	0	n/a	horizontal (organic soil)	n/a	n/a	Straight	Level	Hygric	Rich	30	15	10	1	70	0.05	1
3BV047	detailed vegetation and rare plant	479871	6356743	21/07/2006	JK/JS	FTNN	0	n/a	horizontal (organic soil)	n/a	n/a	Straight	Level	Subhygric	Rich	30	30	10	25	70	0.05	1
3BV048	detailed vegetation and rare plant	476861	6351233	21/07/2006	JK/JS	d3	4	270	level	n/a	n/a	Straight	Level	Submesic	Medium	30	33	5	0.05	60	0.05	0.05
3BV049	detailed vegetation and rare plant	486351	6354941	25/07/2006	JK/JS	burn (shrubby wetlands)	0	n/a	horizontal (organic soil)	n/a	n/a	Straight	Level	Subhygric	Poor	30	n/a	35	3	21	0.05	n/a
3BV050	detailed vegetation and rare plant	485791	6355516	25/07/2006	JK/JS	burn (shrubby wetlands)	0	n/a	horizontal (organic soil)	n/a	n/a	Straight	Level	Subhygric	Rich	32	n/a	60	30	60	0.05	0
3BV051	detailed vegetation and rare plant	486346	6356112	25/07/2006	JK/JS	burn (shrubby wetlands)	0	n/a	horizontal (organic soil)	n/a	n/a	Straight	Level	Hygric	Poor	55	n/a	10	30	50	0.05	0
3BV052	detailed vegetation and rare plant	486863	6356170	25/07/2006	JK/JS	burn (shrubby wetlands)	0	n/a	horizontal (organic soil)	n/a	n/a	Straight	Level	Hygric	Rich	20	n/a	60	20	50	0.05	0
3BV053	detailed vegetation and rare plant	486209	6356726	25/07/2006	JK/JS	burn (shrubby wetlands)	0	n/a	horizontal (organic soil)	n/a	n/a	Straight	Level	Subhygric	Medium	30	n/a	50	20	50	0.05	0
3BV054	detailed vegetation and rare plant	486855	6357374	25/07/2006	JK/JS	burn (shrubby wetlands)	0	n/a	horizontal (organic soil)	n/a	n/a	Straight	Level	Mesic	Poor	45	n/a	10	10	50	0.05	n/a
3BV055	detailed vegetation and rare plant	479647	6365445	26/07/2006	JK/JS	g1	0	n/a	level	n/a	n/a	Straight	Level	Subhygric	Poor	10	40	0.05	0	90	0.05	1

Table M-1 Detailed Vegetation Inventory and Rare Plant Site Summary Data (continued)

Plot Number	Plot Type	UTM Easting (NAD 83)	UTM Northing (NAD 83)	Survey Date (dd/mm/yyyy)	Observers	Ecosite Phase/Wetlands Type	Slope Percent	Aspect (Degrees)	Surface Expression	Riparian Subclass	Flood Hazard	Surface Shape	Slope Position	Moisture Regime	Nutrient Regime	Shrub Cover [%]	Canopy Cover [%]	Forb Cover [%]	Graminoid Cover [%]	Bryophyte Cover [%]	Terrestrial Lichen [%]	Epiphyte Cover [%]
3BV056	detailed vegetation and rare plant	479689	6364836	26/07/2006	JK/JS	d2	0	n/a	undulating	n/a	n/a	Straight	Lower Slope	Mesic	Medium	30	40	30	10	8	0	0.05
3BV057	detailed vegetation and rare plant	481071	6364835	26/07/2006	JK/JS	b3	4	5	undulating	n/a	n/a	Straight	Midslope	Mesic	Medium	20	40	30	2	65	0.05	0.05
3BV058	detailed vegetation and rare plant	481451	6364759	26/07/2006	JK/JS	b4	6	5	undulating	n/a	n/a	Straight	Upper Slope	Submesic	Poor	15	45	10	2	80	0.05	0.05
3BV059	detailed vegetation and rare plant	483403	6357391	27/07/2006	JK/JS	FTNI	0	n/a	horizontal (organic soil)	n/a	n/a	Straight	Level	Subhydric	Rich	30	10	20	5	80	1	2
3BV060	detailed vegetation and rare plant	484293	6356680	27/07/2006	JK/JS	BTNN	0	n/a	horizontal (organic soil)	n/a	n/a	Straight	Level	Hygric	Medium	30	3	5	6	90	5	1
3BV061	detailed vegetation and rare plant	483659	6356699	27/07/2006	JK/JS	FONG	0	n/a	horizontal (organic soil)	n/a	n/a	Straight	Level	Hydric	Rich	3	n/a	25	75	80	0	0.05
3BV062	detailed vegetation and rare plant	483688	6356267	27/07/2006	JK/JS	BTNN	0	n/a	horizontal (organic soil)	n/a	n/a	Straight	Level	Hygric	Poor	70	50	4	20	80	2	0.05
3CV001	detailed vegetation and rare plant	480608	6351905	02/06/2006	PM/CW	d2	0	n/a	level	n/a	n/a	Straight	Level	Mesic	Medium	75	35	10	2	3	0.5	0.5
3CV002	detailed vegetation and rare plant	481744	6351908	03/06/2006	PM/CW	FONS	0	n/a	level	n/a	n/a	Straight	Level	Subhydric	Medium	40	1	5	25	95	0	0.5
3CV003	detailed vegetation and rare plant	479929	6354898	03/06/2006	PM/CW	FTPN	0	n/a	level	n/a	n/a	Straight	Level	Subhydric	Medium	45	10	20	20	95	1	0.5
3CV004	detailed vegetation and rare plant	479063	6355152	03/06/2006	PM/CW	SONS	0	n/a	delta	Floodplain	Expected	Concave	Depression	Hydric	Medium	40	2	2	60	50	0.5	1
3CV005	detailed vegetation and rare plant	488871	6357909	04/06/2006	PM/CW	burn (shrubby wetlands)	0	n/a	level	n/a	n/a	Straight	Level	Hygric	Poor	20	n/a	10	5	75	0.5	0
3CV006	detailed vegetation and rare plant	487220	6357939	04/06/2006	PM/CW	burn (shrubby uplands)	3	280	ridged	n/a	n/a	Convex	Crest	Submesic	Very Poor	50	n/a	3	25	3	0.5	0
3CV007	detailed vegetation and rare plant	484830	6357796	04/06/2006	PM/CW	e2	3	270	ridged	n/a	n/a	Convex	Crest	Mesic	Rich	30	75	70	0	15	0	1
3CV008	detailed vegetation and rare plant	485884	6368839	09/06/2006	PM/CW	FONS	0	n/a	horizontal (organic soil)	n/a	n/a	Straight	Level	Subhydric	Medium	23	n/a	5	75	95	0	0.5
3CV009	detailed vegetation and rare plant	487157	6367022	09/06/2006	PM/CW	FOPN	0	n/a	horizontal (organic soil)	n/a	n/a	Straight	Level	Subhydric	Poor	-	n/a	8	95	90	0	0
3CV010	detailed vegetation and rare plant	487165	6367021	09/06/2006	PM/CW	FOPN	0	n/a	ribbed (organic soil)	n/a	n/a	Straight	Level	Hygric	Poor	30	0.5	1	1	100	1	5
3CV011	detailed vegetation and rare plant	485244	6366981	09/06/2006	PM/CW	BTNI	0	n/a	horizontal (organic soil)	n/a	n/a	Straight	Level	Hygric	Poor	35	n/a	0.5	10	100	0	0.5
3CV012	detailed vegetation and rare plant	484692	6366319	09/06/2006	PM/CW	BTNR	0	n/a	level	n/a	n/a	Straight	Level	Subhygric	Poor	32	n/a	0.5	5	100	0.5	3
3CV013	detailed vegetation and rare plant	485320	6365512	09/06/2006	PM/CW	BONS	0	n/a	horizontal (organic soil)	n/a	n/a	Straight	Level	Subhydric	Poor	45	n/a	0.5	4	100	0	0.5
3CV014	detailed vegetation and rare plant	485356	6365461	09/06/2006	PM/CW	FONG	0	n/a	sloping (organic soil)	n/a	n/a	Concave	Depression	Hydric	Medium	3	n/a	3	85	75	0	0.5
3CV015	detailed vegetation and rare plant	478102	6362205	10/06/2006	PM/CW	d1	5	110	undulating	n/a	n/a	Convex	Midslope	Mesic	Medium	20	43	22	0.5	2	0.5	0.5
3CV016	detailed vegetation and rare plant	478108	6360925	10/06/2006	PM/CW	b2	2	310	undulating	n/a	n/a	Convex	Crest	Submesic	Medium	14	45	15	1	1	0	0.5
3CV017	detailed vegetation and rare plant	476300	6360016	10/06/2006	PM/CW	a1	1	184	inclined	n/a	n/a	Straight	Crest	Xeric	Poor	14	10	14	0.5	60	26	0.5
3CV018	detailed vegetation and rare plant	478109	6363223	10/06/2006	PM/CW	b1	3	295	undulating	n/a	n/a	Concave	Midslope	Submesic	Poor	25	30	20	0.5	70	3	0.5
3CV019	detailed vegetation and rare plant	482450	6356234	11/06/2006	PM/CW	FTNN	0	n/a	horizontal (organic soil)	n/a	n/a	Straight	Level	Hydric	Rich	58	10	22	4	91	1	1
3CV020	detailed vegetation and rare plant	481797	6356178	11/06/2006	PM/CW	c1	3	120	undulating	n/a	n/a	Straight	Upper Slope	Submesic	Poor	25	25	0.5	0.5	95	8	0.5
3CV021	detailed vegetation and rare plant	479307	6356207	11/06/2006	PM/CW	SONS	2	308	inclined	Floodplain	Expected	Concave	Depression	Subhygric	Very Rich	55	n/a	2	70	1	0	1
3CV022	detailed vegetation and rare plant	485813	6364691	12/06/2006	PM/CW	BTNI	0	n/a	horizontal (organic soil)	n/a	n/a	Straight	Level	Subhygric	Very Poor	55	n/a	0	0.5	15	66	3
3CV023	detailed vegetation and rare plant	483146	6363441	12/06/2006	PM/CW	FTNN	0	n/a	horizontal (organic soil)	n/a	n/a	Straight	Level	Subhydric	Medium	50	10	1	10	95	0.5	5

Table M-1 Detailed Vegetation Inventory and Rare Plant Site Summary Data (continued)

Plot Number	Plot Type	UTM Easting (NAD 83)	UTM Northing (NAD 83)	Survey Date (dd/mm/yyyy)	Observers	Ecosite Phase/Wetlands Type	Slope Percent	Aspect (Degrees)	Surface Expression	Riparian Subclass	Flood Hazard	Surface Shape	Slope Position	Moisture Regime	Nutrient Regime	Shrub Cover [%]	Canopy Cover [%]	Forb Cover [%]	Graminoid Cover [%]	Bryophyte Cover [%]	Terrestrial Lichen [%]	Epiphyte Cover [%]
3CV024	detailed vegetation and rare plant	482173	6363227	12/06/2006	PM/CW	FTNN	0	n/a	horizontal (organic soil)	n/a	n/a	Straight	Level	Subhygric	Medium	41	10	2	3	82	0.5	1
3CV025	detailed vegetation and rare plant	487914	6363070	12/06/2006	PM/CW	FONS	0	n/a	floating (organic soil)	n/a	n/a	Straight	Level	Hydric	Rich	30	n/a	25	12	95	0.5	0.5
3CV026	detailed vegetation and rare plant	487064	6368923	19/07/2006	PM/CW	FOPN	0	n/a	blanket (organic soil)	n/a	n/a	Straight	Level	Hydric	Medium	41	0.5	5	60	85	0	0.5
3CV027	detailed vegetation and rare plant	486418	6367091	19/07/2006	PM/CW	FOPN	0	n/a	horizontal (organic soil)	n/a	n/a	Straight	Level	Hydric	Medium	24	1	4	60	80	n/a	0.05
3CV028	detailed vegetation and rare plant	484753	6366723	19/07/2006	PM/CW	BTNR	0	n/a	domed (organic soil)	n/a	n/a	Convex	Crest	Subhydric	Poor	80	15	4	0	95	5	1
3CV029	detailed vegetation and rare plant	484579	6365371	19/07/2006	PM/CW	BTNI	0	n/a	blanket	n/a	n/a	Straight	Level	Subhydric	Poor	35	0.05	0.05	25	95	n/a	0.05
3CV030	detailed vegetation and rare plant	483495	6365285	19/07/2006	PM/CW	BTNI	0	n/a	domed (organic soil)	n/a	n/a	Convex	Crest	Hygric	Poor	55	10	1	0	85	9	2
3CV031	detailed vegetation and rare plant	482438	6362876	20/07/2006	PM/CW	FONS	0	n/a	horizontal (organic soil)	n/a	n/a	Straight	Level	Hydric	Medium	70	1	15	20	90	0.05	2
3CV032	detailed vegetation and rare plant	483444	6362741	20/07/2006	PM/CW	FTNN	0	n/a	horizontal (organic soil)	n/a	n/a	Straight	Level	Hydric	Medium	70	15	0.05	2	95	2	3
3CV033	detailed vegetation and rare plant	482636	6362255	20/07/2006	PM/CW	FTNN	0	n/a	horizontal (organic soil)	n/a	n/a	Straight	Level	Subhygric	Medium	20	60	2	2	90	1	1
3CV034	detailed vegetation and rare plant	482697	6362255	20/07/2006	PM/CW	FONS	0	n/a	horizontal (organic soil)	n/a	n/a	Straight	Level	Hydric	Rich	50	n/a	20	30	95	n/a	0.05
3CV035	detailed vegetation and rare plant	482687	6361712	20/07/2006	PM/CW	FTNN	0	n/a	horizontal (organic soil)	n/a	n/a	Straight	Level	Subhygric	Poor	37	35	5	1	90	0.05	0.05
3CV036	detailed vegetation and rare plant	477448	6355438	21/07/2006	PM/CW	FOPN	0	n/a	ribbed (organic soil)	n/a	n/a	Irregular	Level	Hydric	Poor	19	n/a	12	62	95	0	1
3CV037	detailed vegetation and rare plant	479520	6357620	21/07/2006	PM/CW	FTNN	0	n/a	horizontal (organic soil)	n/a	n/a	Straight	Level	Subhydric	Medium	25	10	20	17	95	n/a	1
3CV038	detailed vegetation and rare plant	478765	6358070	21/07/2006	PM/CW	BTXC	0	n/a	bowl (organic soil)	n/a	n/a	Concave	Depression	Subhygric	Poor	68	n/a	0.05	15	97	0.05	0
3CV039	detailed vegetation and rare plant	479491	6357922	21/07/2006	PM/CW	FONG	0	n/a	horizontal (organic soil)	n/a	n/a	Straight	Level	Hydric	Medium	2	n/a	24	70	90	n/a	n/a
3CV040	detailed vegetation and rare plant	476895	6354826	21/07/2006	PM/CW	FONS	0	n/a	horizontal (organic soil)	n/a	n/a	Straight	Level	Subhygric	Medium	56	n/a	18	10	74	0	0.05
3CV041	detailed vegetation and rare plant	476881	6354865	21/07/2006	PM/CW	FONG	0	n/a	horizontal (organic soil)	n/a	n/a	Straight	Level	Hydric	Medium	-	n/a	32	80	90	n/a	n/a
3CV042	detailed vegetation and rare plant	483769	6354788	25/07/2006	PM/CW	burn (shrubby uplands)	5	25	inclined	n/a	n/a	Convex	Midslope	Xeric	Poor	25	n/a	5	5	21	0	0
3CV043	detailed vegetation and rare plant	484287	6354831	25/07/2006	PM/CW	burn (shrubby wetlands)	0	n/a	horizontal (organic soil)	n/a	n/a	Straight	Level	Subhydric	Poor	45	n/a	5	5	12	0.05	n/a
3CV044	detailed vegetation and rare plant	484930	6354818	02/07/2006	PM/CW	burn (shrubby wetlands)	1	300	level	n/a	n/a	Straight	Midslope	Subhygric	Medium	9	n/a	22	0.05	0.05	2	0.05
3CV045	detailed vegetation and rare plant	485499	6355122	25/07/2006	PM/CW	burn (shrubby uplands)	1	290	inclined	n/a	n/a	Straight	Midslope	Mesic	Medium	75	n/a	8	1	5	n/a	n/a
3CV046	detailed vegetation and rare plant	485567	6355296	25/07/2006	PM/CW	burn (shrubby uplands)	1	340	inclined	n/a	n/a	Straight	Upper Slope	Xeric	Poor	35	n/a	4	0.05	3	0.05	0
3CV047	detailed vegetation and rare plant	485526	6355512	25/07/2006	PM/CW	burn (shrubby wetlands)	1	30	level	n/a	n/a	Straight	Toe Slope	Subhygric	Medium	20	n/a	10	6	10	0.05	n/a
3CV048	detailed vegetation and rare plant	479076	6359933	26/07/2006	PM/CW	b2	3	310	inclined	n/a	n/a	Straight	Upper Slope	Submesic	Medium	20	51	26	1	1	0.05	0.05
3CV049	detailed vegetation and rare plant	477257	6360024	26/07/2006	PM/CW	a1	0	n/a	depressional	n/a	n/a	Concave	Depression	Xeric	Poor	35	10	8	0.05	2	80	0.05
3CV050	detailed vegetation and rare plant	477311	6360037	26/07/2006	PM/CW	d1	0	n/a	level	n/a	n/a	Straight	Level	Mesic	Medium	41	40	30	1	1	0.05	0.05
3CV051	detailed vegetation and rare plant	481126	6350576	27/07/2006	PM/CW	STNN	1	360	level	n/a	n/a	Straight	Level	Subhygric	Poor	27	25	1	1	90	1	3
3CV052	detailed vegetation and rare plant	478525	6350180	27/07/2006	PM/CW	d3	0	n/a	level	n/a	n/a	Straight	Level	Mesic	Medium	12	25	5	2	90	0.05	0.05
3CV053	detailed vegetation and rare plant	478312	6350267	27/07/2006	PM/CW	d1	0	n/a	level	n/a	n/a	Straight	Level	Mesic	Medium	50	50	13	3	2	0.05	0.05

Table M-1 Detailed Vegetation Inventory and Rare Plant Site Summary Data (continued)

Plot Number	Plot Type	UTM Easting (NAD 83)	UTM Northing (NAD 83)	Survey Date (dd/mm/yyyy)	Observers	Ecosite Phase/Wetlands Type	Slope Percent	Aspect (Degrees)	Surface Expression	Riparian Subclass	Flood Hazard	Surface Shape	Slope Position	Moisture Regime	Nutrient Regime	Shrub Cover [%]	Canopy Cover [%]	Forb Cover [%]	Graminoid Cover [%]	Bryophyte Cover [%]	Terrestrial Lichen [%]	Epiphyte Cover [%]
4AV001	detailed vegetation and rare plant	459569	6371155	05/06/2006	AA/DH	f2	0	n/a	level	Floodplain	Rare	Straight	Level	Mesic	Rich	20	50	20	10	15	0.5	0.5
4AV002	detailed vegetation and rare plant	460150	6372005	05/06/2006	AA/DH	b4	3	70	hummocky	n/a	n/a	Convex	Midslope	Submesic	Medium	10	50	10	1	70	0.5	5
4AV003	detailed vegetation and rare plant	460503	6372227	05/06/2006	AA/DH	a1	1	20	undulating	n/a	n/a	Convex	Midslope	Xeric	Poor	-	40	1	0.5	40	40	1
4AV004	detailed vegetation and rare plant	461216	6371890	05/06/2006	AA/DH	b1	0	n/a	level	n/a	n/a	Straight	Level	Subxeric	Poor	25	60	2	0.5	25	1	0.5
4AV005	detailed vegetation and rare plant	462331	6372751	06/06/2006	AA/DH	h1	1	100	undulating	n/a	n/a	Convex	Midslope	Subhygric	Medium	0.5	60	0.5	0.5	75	0	2
4AV006	detailed vegetation and rare plant	462759	6372859	05/06/2006	AA/DH	MONG	0	n/a	level	lakeshore	Expected	Straight	Level	Hydric	Rich	3	n/a	1	80	50	0	0
4AV007	detailed vegetation and rare plant	462861	6373501	06/06/2006	AA/DH	SONS	5	310	inclined	Floodplain	Expected	Straight	Toe Slope	Subhydric	Very Rich	55	55	10	3	0.5	0.5	0.5
4AV008	detailed vegetation and rare plant	461526	6373358	06/06/2006	AA/DH	b3	0	n/a	undulating	n/a	n/a	Irregular	Level	Submesic	Medium	40	40	10	0.5	45	0.5	0.5
4AV009	detailed vegetation and rare plant	461637	6371817	06/06/2006	AA/DH	d1	7	110	inclined	n/a	n/a	Convex	Midslope	Mesic	Medium	10	35	15	0.5	5	0.5	0.5
4AV010	detailed vegetation and rare plant	462655	6372515	07/06/2006	AA/DH	FONS	0	n/a	blanket	n/a	n/a	Straight	Level	Subhydric	Rich	70	0.5	0.5	40	40	0	0.5
4AV011	detailed vegetation and rare plant	462904	6372528	07/06/2006	AA/DH	d3	0	n/a	hummocky	n/a	n/a	Irregular	Level	Mesic	Medium	30	50	5	0.5	25	0.5	1
4AV012	detailed vegetation and rare plant	464411	6372105	07/06/2006	AA/DH	BTNN	0	n/a	horizontal (organic soil)	n/a	n/a	Straight	Level	Hygric	Poor	75	n/a	0	10	70	10	3
4AV013	detailed vegetation and rare plant	465250	6372507	07/06/2006	AA/DH	d2	0	n/a	level	n/a	n/a	Straight	Level	Mesic	Medium	35	45	15	5	30	0.5	0.5
4AV014	detailed vegetation and rare plant	473720	6366538	08/06/2006	AA/DH	FTPN	0	n/a	ribbed (organic soil)	n/a	n/a	Straight	Level	Hydric	Medium	15	n/a	5	70	60	0	0.5
4AV015	detailed vegetation and rare plant	473425	6366928	08/06/2006	AA/DH	FOPN	0	n/a	floating (organic soil)	n/a	n/a	Straight	Level	Hydric	Rich	8	0.5	25	75	60	0	0
4AV016	detailed vegetation and rare plant	467885	6372243	08/06/2006	AA/DH	b3	0	n/a	undulating	n/a	n/a	Irregular	Level	Submesic	Medium	35	25	5	0.5	75	0.5	2
4AV017	detailed vegetation and rare plant	469051	6371922	08/06/2006	AA/DH	b1	0	n/a	undulating	n/a	n/a	Irregular	Level	Subxeric	Poor	15	40	5	0.5	80	0.5	1
4AV018	detailed vegetation and rare plant	474319	6365927	08/06/2006	AA/DH	FONG	0	n/a	floating (organic soil)	n/a	n/a	Straight	Level	Hydric	Rich	0.5	6	20	60	60	0	0.5
4AV019	detailed vegetation and rare plant	478029	6361240	08/06/2006	AA/DH	FONG	0	n/a	bowl (organic soil)	n/a	n/a	Concave	Depression	Subhydric	Medium	-	n/a	0	80	80	0	0
4AV020	detailed vegetation and rare plant	462334	6376208	22/07/2006	AA/DH	c1	0	n/a	subdued	n/a	n/a	Straight	Level	Subxeric	Poor	30	50	5	0.05	90	0.05	0.05
4AV021	detailed vegetation and rare plant	462866	6375415	22/07/2006	AA/DH	BTNN	0	n/a	horizontal (organic soil)	n/a	n/a	Straight	Level	Hygric	Poor	40	25	5	1	70	25	0.05
4AV022	detailed vegetation and rare plant	462335	6375114	22/07/2006	AA/DH	d2	0	n/a	subdued	n/a	n/a	Straight	Level	Mesic	Medium	50	30	40	0.05	70	0.05	0.05
4AV023	detailed vegetation and rare plant	460403	6376094	22/07/2006	AA/DH	Ri	10	45	inclined	Bank	Expected	Straight	Crest	Hydric	Very Rich	10	n/a	20	80	0.05	0	0
4AV024	detailed vegetation and rare plant	461049	6375090	22/07/2006	AA/DH	d2	0	n/a	subdued	n/a	n/a	Straight	Level	Mesic	Medium	8	60	30	2	50	0.05	0.05
4AV025	detailed vegetation and rare plant	461091	6375527	22/07/2006	AA/DH	d1	0	n/a	subdued	n/a	n/a	Straight	Level	Mesic	Medium	30	40	40	1	15	0.05	0.05
4AV026	detailed vegetation and rare plant	465583	6377364	23/07/2006	AA/DH	d2	5	n/a	subdued	n/a	n/a	Convex	Crest	Mesic	Medium	10	25	15	0.05	25	0.05	1
4AV027	detailed vegetation and rare plant	465334	6376677	02/07/2006	AA/DH	d2	0	n/a	subdued	n/a	n/a	Irregular	Level	Mesic	Medium	68	30	45	3	40	0.05	1
4AV028	detailed vegetation and rare plant	465487	6376139	23/07/2006	AA/DH	h1	0	n/a	subdued	n/a	n/a	Straight	Level	Hydric	Medium	70	30	25	0.05	80	0.05	2
4AV029	detailed vegetation and rare plant	465943	6376134	23/07/2006	AA/DH	BTNI	0	n/a	horizontal (organic soil)	n/a	n/a	Straight	Level	Hygric	Poor	35	25	1	5	65	20	3
4AV030	detailed vegetation and rare plant	466356	6376086	23/07/2006	AA/DH	BFNN	0	n/a	horizontal (organic soil)	n/a	n/a	Straight	Level	Hygric	Poor	35	75	15	15	90	10	3

Table M-1 Detailed Vegetation Inventory and Rare Plant Site Summary Data (continued)

Plot Number	Plot Type	UTM Easting (NAD 83)	UTM Northing (NAD 83)	Survey Date (dd/mm/yyyy)	Observers	Ecosite Phase/Wetlands Type	Slope Percent	Aspect (Degrees)	Surface Expression	Riparian Subclass	Flood Hazard	Surface Shape	Slope Position	Moisture Regime	Nutrient Regime	Shrub Cover [%]	Canopy Cover [%]	Forb Cover [%]	Graminoid Cover [%]	Bryophyte Cover [%]	Terrestrial Lichen [%]	Epiphyte Cover [%]
4AV031	detailed vegetation and rare plant	466442	6377308	23/07/2006	AA/DH	FTPN	0	n/a	ribbed (organic soil)	n/a	n/a	Straight	Level	Hydric	Rich	35	10	10	20	80	5	3
4AV032	detailed vegetation and rare plant	466415	6375666	23/07/2006	AA/DH	FTNN	0	n/a	horizontal (organic soil)	n/a	n/a	Straight	Level	Subhygric	Rich	70	35	15	30	70	0.05	1
4AV033	detailed vegetation and rare plant	465145	6377561	24/07/2006	AA/DH	d3	0	n/a	subdued	n/a	n/a	Straight	Level	Mesic	Medium	5	50	15	2	95	0.05	3
4AV034	detailed vegetation and rare plant	464871	6377021	24/07/2006	AA/DH	d3	0	n/a	subdued	n/a	n/a	Straight	Level	Mesic	Medium	3	50	3	0.05	95	0.05	1
4AV035	detailed vegetation and rare plant	463725	6374249	24/07/2006	AA/DH	Sh	65	150	ridged	n/a	n/a	Straight	Upper Slope	Submesic	Rich	30	0.05	20	20	5	0.05	0
4AV036	detailed vegetation and rare plant	463521	6374434	24/07/2006	AA/DH	f2	0	n/a	level	Floodplain	Rare	Straight	Level	Subhydric	Very Rich	35	45	50	2	10	0.05	1
4AV037	detailed vegetation and rare plant	464537	6376135	24/07/2006	AA/DH	BTNN	0	n/a	horizontal (organic soil)	n/a	n/a	Straight	Level	Subhydric	Poor	45	n/a	10	5	90	5	3
4AV038	detailed vegetation and rare plant	463285	6376798	24/07/2006	AA/DH	b4	0	n/a	subdued	n/a	n/a	Straight	Level	Submesic	Medium	30	25	30	5	75	0.05	1
4AV039	detailed vegetation and rare plant	463209	6376456	24/07/2006	AA/DH	e3	70	270	inclined	Active Channel	No Hazard	Straight	Upper Slope	Mesic	Medium	20	50	30	5	75	3	1
4AV040	detailed vegetation and rare plant	455799	6379876	02/06/2007	JK/JS	d1	0	n/a	level	n/a	No Hazard	Straight	Level	Mesic	Medium	35	45	10	0.5	1	0.5	0.5
4AV041	detailed vegetation and rare plant	455870	6380397	02/06/2007	JK/JS	d2	0	n/a	level	n/a	No Hazard	Straight	Level	Mesic	Medium	35	50	5	5	40	0.5	3
4AV042	detailed vegetation and rare plant	455573	6382362	02/06/2007	JK/JS	d2	0	n/a	level	n/a	No Hazard	Straight	Level	Mesic	Medium	30	25	5	5	40	0.5	0.5
4AV043	detailed vegetation and rare plant	460005	6383635	03/06/2007	JK/JS	STNN	0	n/a	horizontal (organic soil)	n/a	No Hazard	Straight	Level	Subhydric	Rich	60	30	4.5	55	35	n/a	0.5
4AV044	detailed vegetation and rare plant	461667	6383934	03/06/2007	JK/JS	d1	0	n/a	level	n/a	No Hazard	Straight	Level	Mesic	Medium	30	40	20	20	1	0.5	0.5
4AV045	detailed vegetation and rare plant	462740	6383976	03/06/2007	JK/JS	e3	0	n/a	level	n/a	No Hazard	Straight	Level	Subhygric	Poor	15	45	10	12	85	0.5	0.5
4AV046	detailed vegetation and rare plant	463667	6383499	03/06/2007	JK/JS	STNN	0	n/a	horizontal (organic soil)	n/a	No Hazard	Concave	Level	Subhygric	Rich	30	50	5	70	35	n/a	0.5
4AV047	detailed vegetation and rare plant	464816	6383194	03/06/2007	JK/JS	d3	6	130	undulating	n/a	No Hazard	Concave	Lower Slope	Submesic	Poor	10	35	5	0.5	90	n/a	7
4AV048	detailed vegetation and rare plant	459562	6384215	04/06/2007	JK/JS	e3	0	n/a	level	n/a	No Hazard	Straight	Lower Slope	Mesic	Medium	40	50	15	3	70	0.5	5
4AV049	detailed vegetation and rare plant	459547	6385471	07/06/1994	JK/JS	d1	0	n/a	level	n/a	No Hazard	Straight	Level	Mesic	Medium	35	40	15	0.5	3	n/a	n/a
4AV050	detailed vegetation and rare plant	460704	6386925	04/06/2007	JK/JS	f3	0	n/a	level	n/a	No Hazard	Straight	Level	Mesic	Rich	50	36	20	1	55	n/a	5
4AV051	detailed vegetation and rare plant	458945	6388145	04/06/2007	JK/JS	STNN	0	n/a	horizontal (organic soil)	n/a	No Hazard	Straight	Level	Hygric	Rich	20	60	2	40	0.5	n/a	0.5
4AV052	detailed vegetation and rare plant	459526	6387391	05/06/2007	JK/JS	e2	0	n/a	level	n/a	No Hazard	Straight	Level	Mesic	Medium	20	50	40	6	30	0.5	0.5
4AV053	detailed vegetation and rare plant	458790	6386876	05/06/2007	JK/JS	e3	0	n/a	level	n/a	No Hazard	Straight	Level	Subhygric	Rich	65	40	15	5	76	0.5	0.5
4AV054	detailed vegetation and rare plant	458077	6386931	05/06/2007	JK/JS	d1	0	n/a	level	n/a	No Hazard	Straight	Level	Mesic	Medium	22	40	15	0.5	1	0.5	0.5
4AV055	detailed vegetation and rare plant	459490	6386176	05/06/2007	JK/JS	d3	0	n/a	level	n/a	n/a	Straight	Level	Subhygric	Rich	60	40	15	n/a	60	0.5	0.5
4AV056	detailed vegetation and rare plant	465472	6383262	05/06/2007	JK/JS	a1	7	70	hummocky	n/a	No Hazard	Convex	Midslope	Subxeric	Very Poor	15	30	10	0.5	25	55	15
4AV057	detailed vegetation and rare plant	467970	6379865	06/06/2007	JK/JS	BTNN	0	n/a	horizontal (organic soil)	n/a	No Hazard	Concave	Level	Subhygric	Poor	30	35	4	1	95	1	20
4AV058	detailed vegetation and rare plant	467921	6379718	06/06/2007	JK/JS	FONG	0	n/a	floating (organic soil)	n/a	No Hazard	Concave	Level	Hydric	Rich	15	10	3	40	15	n/a	0.5
4AV059	detailed vegetation and rare plant	468335	6379902	06/06/2007	JK/JS	d1	0	n/a	level	n/a	No Hazard	Straight	Level	Mesic	Poor	6	40	7	0.5	95	1	15
4AV060	detailed vegetation and rare plant	468919	6386756	06/06/2007	JK/JS	b1	2	256	undulating	n/a	No Hazard	Convex	Crest	Subxeric	Poor	50	15	10	5	30	n/a	5

Table M-1 Detailed Vegetation Inventory and Rare Plant Site Summary Data (continued)

Plot Number	Plot Type	UTM Easting (NAD 83)	UTM Northing (NAD 83)	Survey Date (dd/mm/yyyy)	Observers	Ecosite Phase/Wetlands Type	Slope Percent	Aspect (Degrees)	Surface Expression	Riparian Subclass	Flood Hazard	Surface Shape	Slope Position	Moisture Regime	Nutrient Regime	Shrub Cover [%]	Canopy Cover [%]	Forb Cover [%]	Graminoid Cover [%]	Bryophyte Cover [%]	Terrestrial Lichen [%]	Epiphyte Cover [%]
4AV061	detailed vegetation and rare plant	469104	6391551	07/06/2007	JK/JS	b1	2	180	inclined	n/a	No Hazard	Straight	Upper Slope	Mesic	Medium	31	25	18	0.5	64	0.5	10
4AV062	detailed vegetation and rare plant	468407	6391625	07/06/2007	JK/JS	BTNN	0	n/a	level	n/a	Rare	Concave	Depression	Hygric	Poor	70	5	5	n/a	90	0.5	15
4AV063	detailed vegetation and rare plant	467431	6391669	07/06/2007	JK/JS	b2	0	n/a	level	n/a	n/a	Concave	Level	Submesic	Poor	20	30	10	0.5	4	0.5	0.5
4AV064	detailed vegetation and rare plant	466394	6391621	07/06/2007	JK/JS	b2	0	n/a	level	n/a	No Hazard	Straight	Level	Subxeric	Poor	34	28	4	0.5	88	10	15
4AV065	detailed vegetation and rare plant	465754	6392368	07/06/2007	JK/JS	b1	0	n/a	level	n/a	No Hazard	Straight	Level	Submesic	Medium	15	40	10	0.5	45	0.5	15
4AV066	detailed vegetation and rare plant	468492	6394732	08/06/2007	JK/JS	b1	1	270	level	n/a	No Hazard	Straight	Midslope	Xeric	Poor	40	20	5	0.5	95	16	15
4AV067	detailed vegetation and rare plant	467766	6394768	08/06/2007	JK/JS	b2	1	n/a	inclined	n/a	No Hazard	Concave	Upper Slope	Subxeric	Poor	57	30	7	0.5	40	7	2
4AV068	detailed vegetation and rare plant	467464	6394698	08/06/2007	JK/JS	BTNN	0	n/a	level	n/a	No Hazard	Concave	Depression	Hygric	Poor	70	10	5	n/a	75	10	30
4AV069	detailed vegetation and rare plant	466545	6394688	08/06/2007	JK/JS	f2	0	n/a	level	n/a	No Hazard	Straight	Level	Mesic	Medium	20	65	15	0.5	8	0.5	0.5
4AV070	detailed vegetation and rare plant	465927	6394773	08/06/2007	JK/JS	d1	0	n/a	level	n/a	No Hazard	Straight	Level	Mesic	Medium	50	40	8	0.5	2	0.5	0.5
4AV071	detailed vegetation and rare plant	467856	6373980	09/06/2007	JK/JS	b4	12	280	level	n/a	No Hazard	Convex	Midslope	Mesic	Rich	30	42	10	0.5	87	0.5	5
4AV072	detailed vegetation and rare plant	469189	6381108	09/06/2007	JK/JS	e1	3	270	ridged	Terrace	Expected	Convex	Crest	Hygric	Rich	85	50	25	0.5	0.5	n/a	0.5
4AV073	detailed vegetation and rare plant	472463	6388330	09/06/2007	JK/JS	RiSh	2	270	inclined	Terrace	Expected	Convex	Crest	Hygric	Rich	2	50	90	n/a	0.5	n/a	0.5
4AV074	detailed vegetation and rare plant	475698	6393722	09/06/2007	JK/JS	b3	55	90	inclined	Bank	Rare	Straight	Upper Slope	Submesic	Poor	7	50	4	0.5	30	0.5	25
4AV075	detailed vegetation and rare plant	476164	6398008	09/06/2007	JK/JS	b3	2	90	inclined	n/a	No Hazard	Concave	Level	Mesic	Medium	33	31	5	1	25	n/a	8
4AV076	detailed vegetation and rare plant	473770	6394803	09/06/2007	JK/JS	b2	5	160	inclined	n/a	No Hazard	Straight	Upper Slope	Submesic	Medium	75	25	26	1	1	n/a	0.5
4AV077	detailed vegetation and rare plant	462386	6394896	10/06/2007	JK/JS	FTNN	0	n/a	level	n/a	No Hazard	Straight	Level	Hygric	Medium	75	20	0.5	0.5	82	0.5	3
4AV078	detailed vegetation and rare plant	467295	6390106	01/06/2007	JK/JS	b1	3	60	inclined	n/a	n/a	Straight	Midslope	Subxeric	Poor	17	40	3	0.5	90	0.5	5
4AV079	detailed vegetation and rare plant	466683	6387094	10/06/2007	JK/JS	a1	1	180	level	n/a	No Hazard	Convex	Level	Xeric	Poor	77	25	2	0.5	2	38	15
4AV080	detailed vegetation and rare plant	457502	6389283	10/06/2007	JK/JS	d1	0	n/a	level	n/a	No Hazard	Straight	Level	Mesic	Medium	55	35	12	0.5	3	0.5	0.5
4AV081	detailed vegetation and rare plant	460782	6380335	10/06/2007	JK/JS	d2	0	n/a	level	n/a	No Hazard	Straight	Level	Subhygric	Medium	14	32	20	65	1	n/a	0.5
4AV082	detailed vegetation and rare plant	459826	6382007	10/06/2007	JK/JS	g1	0	n/a	level	n/a	No Hazard	Straight	Level	Submesic	Poor	3	40	1	0.5	90	0.5	4
4AV083	detailed vegetation and rare plant	469177	6388341	11/06/2007	JK/JS	b2	3	350	level	n/a	No Hazard	Straight	Midslope	Submesic	Medium	75	29	1	0.5	6	0.5	4
4AV084	detailed vegetation and rare plant	468603	6388938	11/06/2007	JK/JS	b1	0	n/a	level	n/a	No Hazard	Convex	Level	Mesic	Medium	13	35	25	0.5	96	0.5	4
4AV085	detailed vegetation and rare plant	468940	6390079	11/06/2007	JK/JS	a1	11	100	inclined	n/a	No Hazard	Convex	Midslope	Xeric	Poor	11	15	1	0.5	0.5	80	1
4AV086	detailed vegetation and rare plant	455803	6380799	17/07/2007	JK/JS	f3	0	n/a	level	n/a	No Hazard	Straight	Level	Subhygric	Rich	12	35	65	1	50	0.5	15
4AV087	detailed vegetation and rare plant	455744	6381569	17/07/2007	JK/JS	d1	0	n/a	level	n/a	No Hazard	Straight	Level	Mesic	Medium	25	45	17	15	5	0.5	0.5
4AV088	detailed vegetation and rare plant	456448	6381373	17/07/2007	JK/JS	STNN	0	n/a	horizontal (organic soil)	n/a	No Hazard	Straight	Level	Subhygric	Rich	10	20	35	5	40	0.5	15
4AV089	detailed vegetation and rare plant	459514	6388291	18/07/2007	JK/JS	f1	0	n/a	level	Terrace	Expected	Straight	Level	Subhygric	Rich	15	45	90	2	0.5	0	2
4AV090	detailed vegetation and rare plant	459477	6387835	18/07/2007	JK/JS	STNN	0	n/a	level	n/a	No Hazard	Straight	Level	Subhygric	Rich	35	40	2	80	0.5	0.5	1

Table M-1 Detailed Vegetation Inventory and Rare Plant Site Summary Data (continued)

Plot Number	Plot Type	UTM Easting (NAD 83)	UTM Northing (NAD 83)	Survey Date (dd/mm/yyyy)	Observers	Ecosite Phase/Wetlands Type	Slope Percent	Aspect (Degrees)	Surface Expression	Riparian Subclass	Flood Hazard	Surface Shape	Slope Position	Moisture Regime	Nutrient Regime	Shrub Cover [%]	Canopy Cover [%]	Forb Cover [%]	Graminoid Cover [%]	Bryophyte Cover [%]	Terrestrial Lichen [%]	Epiphyte Cover [%]
4AV091	detailed vegetation and rare plant	459477	6386836	18/07/2007	JK/JS	d2	0	n/a	level	n/a	No Hazard	Straight	Level	Mesic	Medium	25	50	30	0.5	4	0.5	0.5
4AV092	detailed vegetation and rare plant	458433	6386875	18/07/2007	JK/JS	d1	0	n/a	level	n/a	No Hazard	Straight	Level	Mesic	Medium	35	38	30	0.5	0.5	0	0.5
4AV093	detailed vegetation and rare plant	457533	6386943	18/07/2007	JK/JS	d2	0	n/a	level	n/a	No Hazard	Straight	Level	Mesic	Medium	30	40	25	5	5	0.5	2
4AV094	detailed vegetation and rare plant	465721	6385766	19/07/2007	JK/JS	FTNN	0	n/a	horizontal (organic soil)	n/a	No Hazard	Straight	Level	Hygric	Rich	70	15	11	45	25	1	5
4AV095	detailed vegetation and rare plant	465636	6386443	19/07/2007	JK/JS	SONS	0	n/a	horizontal (organic soil)	n/a	No Hazard	Straight	Level	Hygric	Rich	50	0	5	85	0	0	0
4AV096	detailed vegetation and rare plant	465958	6384826	19/07/2007	JK/JS	b1	1	160	level	n/a	No Hazard	Straight	Midslope	Submesic	Medium	30	35	15	5	35	0.5	5
4AV097	detailed vegetation and rare plant	464731	6385171	19/07/2007	JK/JS	FTNN	0	n/a	level	n/a	No Hazard	Straight	Level	Subhygric	Poor	60	20	4	0.5	62	3	2
4AV098	detailed vegetation and rare plant	463846	6385153	19/07/2007	JK/JS	FFNN	0	n/a	horizontal (organic soil)	n/a	No Hazard	Straight	Level	Subhygric	Poor	2	35	0.5	4	50	0.5	5
4AV099	detailed vegetation and rare plant	463069	6385135	19/07/2007	JK/JS	d2	0	n/a	level	n/a	No Hazard	Straight	Level	Mesic	Medium	20	40	42	5	3	0	0.5
4AV100	detailed vegetation and rare plant	467755	6381033	20/07/2007	JK/JS	b2	3	90	level	n/a	No Hazard	Straight	Midslope	Mesic	Medium	50	37	6	0.5	18	0.5	4
4AV101	detailed vegetation and rare plant	467813	6381499	20/07/2007	JK/JS	b2	2	270	undulating	n/a	No Hazard	Concave	Lower Slope	Mesic	Medium	20	40	15	25	5	0.5	3
4AV102	detailed vegetation and rare plant	468154	6382240	20/07/2007	JK/JS	b4	0	n/a	undulating	n/a	No Hazard	Convex	Upper Slope	Mesic	Medium	40	42	8	0.5	2	n/a	0.5
4AV103	detailed vegetation and rare plant	467977	6382982	20/07/2007	JK/JS	b2	0	n/a	level	n/a	No Hazard	Straight	Level	Mesic	Medium	55	25	8	2	5	0.5	0.5
4AV104	detailed vegetation and rare plant	468042	6383932	20/07/2007	JK/JS	b1	0	n/a	undulating	n/a	No Hazard	Straight	Crest	Mesic	Medium	50	30	15	2	5	n/a	0.5
4AV105	detailed vegetation and rare plant	468087	6384903	20/07/2007	JK/JS	b1	0	n/a	undulating	n/a	No Hazard	Straight	Crest	Submesic	Poor	45	38	20	7	1	n/a	1
4AV106	detailed vegetation and rare plant	468125	6385422	20/07/2007	JK/JS	b4	1	90	undulating	n/a	No Hazard	Straight	Upper Slope	Mesic	Medium	17	25	24	7	60	0.5	15
4AV107	detailed vegetation and rare plant	466284	6386894	21/07/2007	JK/JS	a1	4	70	undulating	n/a	No Hazard	Concave	Upper Slope	Subxeric	Poor	28	30	3	0.5	43	18	10
4AV108	detailed vegetation and rare plant	470015	6386768	21/07/2007	JK/JS	b1	0	n/a	level	n/a	No Hazard	Straight	Level	Mesic	Medium	20	30	40	0.5	80	0.5	3
4AV109	detailed vegetation and rare plant	469477	6386763	21/07/2007	JK/JS	b4	6	250	undulating	n/a	No Hazard	Convex	Upper Slope	Subxeric	Poor	55	20	22	1	30	2	5
4AV110	detailed vegetation and rare plant	468381	6386914	21/07/2007	JK/JS	b1	0	n/a	undulating	n/a	No Hazard	Straight	Level	Subxeric	Poor	40	20	13	2	45	4	2
4AV111	detailed vegetation and rare plant	470169	6388464	21/07/2007	JK/JS	b1	15	180	undulating	n/a	No Hazard	Convex	Upper Slope	Subxeric	Poor	35	15	8	0.5	0	3	2
4AV112	detailed vegetation and rare plant	462923	6392753	22/07/2007	JK/JS	STNN	0	n/a	horizontal (organic soil)	n/a	No Hazard	Straight	Level	Hygric	Rich	20	50	6	35	3	n/a	2
4AV113	detailed vegetation and rare plant	463344	6393024	22/07/2007	JK/JS	STNN	0	n/a	hummocky	n/a	No Hazard	Straight	Level	Hygric	Rich	20	30	0.5	n/a	60	0.5	0.5
4AV114	detailed vegetation and rare plant	464156	6392140	22/07/2007	JK/JS	d2	0	n/a	level	n/a	No Hazard	Straight	Level	Mesic	Medium	30	30	15	1	10	0.5	0.5
4AV115	detailed vegetation and rare plant	464627	6391596	28/07/2007	JK/JS	d2	2	210	undulating	n/a	No Hazard	Straight	Upper Slope	Mesic	Medium	27	40	9	4	0.5	n/a	0.5
4AV116	detailed vegetation and rare plant	463774	6391127	22/07/2007	JK/JS	d2	0	n/a	level	n/a	No Hazard	Straight	Level	Mesic	Medium	30	35	13	0.5	1	0.5	0.5
4AV117	detailed vegetation and rare plant	463370	6390141	22/07/2007	JK/JS	BTNN	0	n/a	horizontal (organic soil)	n/a	No Hazard	Straight	Level	Subhygric	Poor	40	10	2	1	20	6	0.5
4AV118	detailed vegetation and rare plant	475559	6398058	23/07/2007	JK/JS	b3	0	n/a	level	n/a	No Hazard	Straight	Level	Mesic	Medium	27	40	10	0.5	85	0.5	2
4AV119	detailed vegetation and rare plant	472980	6394030	23/07/2007	JK/JS	b4	0	n/a	level	n/a	No Hazard	Straight	Level	Submesic	Medium	45	20	5	1	90	0.5	10
4AV120	detailed vegetation and rare plant	473277	6393178	23/07/2007	JK/JS	MONG	0	n/a	horizontal (organic soil)	Floodplain	Frequent	Straight	Level	Hygric	Rich	10	n/a	7	90	0.5	n/a	0.5

Table M-1 Detailed Vegetation Inventory and Rare Plant Site Summary Data (continued)

Plot Number	Plot Type	UTM Easting (NAD 83)	UTM Northing (NAD 83)	Survey Date (dd/mm/yyyy)	Observers	Ecosite Phase/Wetlands Type	Slope Percent	Aspect (Degrees)	Surface Expression	Riparian Subclass	Flood Hazard	Surface Shape	Slope Position	Moisture Regime	Nutrient Regime	Shrub Cover [%]	Canopy Cover [%]	Forb Cover [%]	Graminoid Cover [%]	Bryophyte Cover [%]	Terrestrial Lichen [%]	Epiphyte Cover [%]
4AV121	detailed vegetation and rare plant	473812	6393279	23/07/2007	JK/JS	b1	0	n/a	level	n/a	No Hazard	Straight	Level	Submesic	Poor	20	40	8	0.5	90	n/a	1
4AV122	detailed vegetation and rare plant	472139	6393230	23/07/2007	JK/JS	b1	0	n/a	level	n/a	No Hazard	Straight	Level	Mesic	Medium	55	30	7	3	5	n/a	0.5
4AV123	detailed vegetation and rare plant	469092	6388828	23/07/2007	JK/JS	b4	0	n/a	level	n/a	No Hazard	Straight	Level	Submesic	Medium	12	42	12	2	45	0.5	0.5
4AV124	detailed vegetation and rare plant	462388	6393337	23/07/2007	JK/JS	STNN	0	n/a	horizontal (organic soil)	n/a	No Hazard	Concave	Level	Subhygric	Rich	80	35	21	60	6	n/a	0.5
4AV125	detailed vegetation and rare plant	460665	6391061	24/07/2007	JK/JS	d2	0	n/a	undulating	n/a	No Hazard	Straight	Level	Mesic	Medium	45	30	15	3	10	0.5	0.5
4AV126	detailed vegetation and rare plant	464018	6386862	24/07/2007	JK/JS	SONS	0	n/a	level	n/a	No Hazard	Straight	Level	Subhygric	Medium	50	n/a	n/a	75	12	0.5	0.5
4AV127	detailed vegetation and rare plant	457193	6388619	24/07/2007	JK/JS	d2	0	n/a	level	n/a	No Hazard	Straight	Level	Mesic	Poor	12	32	5	2	75	0.5	2
4AV128	detailed vegetation and rare plant	452868	6379488	24/07/2007	JK/JS	d2	0	n/a	level	n/a	No Hazard	Straight	Level	Mesic	Medium	20	40	30	1	65	0.5	0.5
4AV129	detailed vegetation and rare plant	466983	6394664	25/07/2007	JK/JS	b4	0	n/a	level	n/a	No Hazard	Straight	Level	Mesic	Poor	9	50	5	0.5	45	0.5	0.5
4AV130	detailed vegetation and rare plant	469093	6393418	25/07/2007	JK/JS	b1	0	n/a	level	n/a	No Hazard	Straight	Level	Submesic	Medium	35	35	13	1	75	0.5	2
4AV131	detailed vegetation and rare plant	472936	6397511	25/07/2007	JK/JS	a1	6	250	undulating	n/a	No Hazard	Convex	Midslope	Xeric	Very Poor	10	15	4	0.5	2	85	7
4AV132	detailed vegetation and rare plant	473307	6397850	25/07/2007	JK/JS	b1	0	n/a	level	n/a	No Hazard	Straight	Level	Submesic	Poor	65	25	4	2	70	1	8
4AV133	detailed vegetation and rare plant	473678	6398229	25/07/2007	JK/JS	b1	0	n/a	level	n/a	No Hazard	Straight	Level	Submesic	Medium	80	18	6	4	70	0.5	4
4BV001	detailed vegetation and rare plant	466593	6377581	05/06/2006	JK/JS	FOPN	0	n/a	bowl (organic soil)	n/a	n/a	Straight	Level	Subhydric	Rich	5	n/a	2	90	65	0.5	0.5
4BV002	detailed vegetation and rare plant	465740	6376791	05/06/2006	JK/JS	h1	3	168	hummocky	n/a	n/a	Irregular	Midslope	Subhygric	Medium	50	40	2	0	95	0.5	2
4BV003	detailed vegetation and rare plant	463347	6376187	05/06/2006	JK/JS	d2	3	120	level	n/a	n/a	Straight	Midslope	Mesic	Medium	60	50	10	20	45	1	0.5
4BV004	detailed vegetation and rare plant	463250	6376115	06/06/2006	JK/JS	f2	0	n/a	depressional	Terrace	Rare	Concave	Toe Slope	Hygric	Rich	60	65	50	0.5	0.5	1	0.5
4BV005	detailed vegetation and rare plant	463016	6377387	06/06/2006	JK/JS	b4	5	246	inclined	n/a	n/a	Straight	Midslope	Submesic	Poor	40	30	5	0.5	70	2	0.5
4BV006	detailed vegetation and rare plant	463011	6377636	06/06/2006	JK/JS	b1	0	n/a	level	n/a	n/a	Irregular	Level	Subxeric	Poor	50	25	6	1	15	5	0.5
4BV007	detailed vegetation and rare plant	463617	6374517	06/06/2006	JK/JS	f3	0	n/a	level	adjacent to riparian area	No Hazard	Straight	Level	Subhydric	Rich	30	30	15	40	7	1	0.5
4BV008	detailed vegetation and rare plant	464255	6375027	07/06/2006	JK/JS	c1	0	n/a	level	n/a	n/a	Straight	Level	Mesic	Poor	5	30	3	0.5	40	50	0.5
4BV009	detailed vegetation and rare plant	464745	6373912	07/06/2006	JK/JS	STNN	0	n/a	depressional	n/a	n/a	Concave	Depression	Hygric	Rich	10	60	5	50	40	0.5	0.5
4BV010	detailed vegetation and rare plant	466376	6373869	07/06/2006	JK/JS	d1	0	n/a	level	n/a	n/a	Straight	Level	Mesic	Medium	60	15	10	30	40	0.5	0
4BV011	detailed vegetation and rare plant	479111	6358671	08/06/2006	JK/JS	FTNN	0	n/a	horizontal (organic soil)	n/a	n/a	Straight	Level	Hygric	Rich	75	30	3	3	90	0.5	0.5
4BV012	detailed vegetation and rare plant	475224	6358693	08/06/2006	JK/JS	b1	12	334	rolling	n/a	n/a	Straight	Midslope	Submesic	Poor	50	20	20	0.5	50	0.5	0.5
4BV013	detailed vegetation and rare plant	472310	6358753	08/06/2006	JK/JS	FONS	0	n/a	horizontal (organic soil)	n/a	n/a	Straight	Level	Hygric	Poor	90	5	0.5	15	80	0	0.5
4BV014	detailed vegetation and rare plant	462830	6361929	08/06/2006	JK/JS	SONS	0	n/a	bowl (organic soil)	Floodplain	Rare	Concave	Depression	Hydric	Rich	30	n/a	3	80	4	0	0.5
4BV015	detailed vegetation and rare plant	464729	6361215	08/06/2006	JK/JS	d1	44	n/a	undulating	n/a	n/a	Concave	Toe Slope	Mesic	Medium	16	30	22	0.5	0.5	0	0.5
4BV016	detailed vegetation and rare plant	460898	6368714	22/07/2006	JK/JS	d2	3	190	undulating	n/a	n/a	Straight	Crest	Mesic	Poor	10	30	2	0.05	60	0.05	1
4BV017	detailed vegetation and rare plant	461351	6368842	22/07/2006	JK/JS	d2	0	n/a	ridged	n/a	n/a	Irregular	Toe Slope	Mesic	Medium	10	40	14	0.05	50	0.05	1

Table M-1 Detailed Vegetation Inventory and Rare Plant Site Summary Data (continued)

Plot Number	Plot Type	UTM Easting (NAD 83)	UTM Northing (NAD 83)	Survey Date (dd/mm/yyyy)	Observers	Ecosite Phase/Wetlands Type	Slope Percent	Aspect (Degrees)	Surface Expression	Riparian Subclass	Flood Hazard	Surface Shape	Slope Position	Moisture Regime	Nutrient Regime	Shrub Cover [%]	Canopy Cover [%]	Forb Cover [%]	Graminoid Cover [%]	Bryophyte Cover [%]	Terrestrial Lichen [%]	Epiphyte Cover [%]
4BV018	detailed vegetation and rare plant	461384	6368834	22/07/2006	JK/JS	e2	10	180	undulating	Floodplain	Rare	Concave	Toe Slope	Subhygric	Rich	85	20	15	3	0.05	0	0.05
4BV019	detailed vegetation and rare plant	460271	6368950	22/07/2006	JK/JS	d1	3	180	undulating	n/a	n/a	Straight	Crest	Mesic	Medium	50	10	30	0.05	0.05	0.05	0
4BV020	detailed vegetation and rare plant	460254	6368921	22/07/2006	JK/JS	b2	0	n/a	undulating	n/a	n/a	Straight	Depression	Submesic	Medium	60	10	15	0.05	0.05	0	0
4BV021	detailed vegetation and rare plant	459909	6368795	22/07/2006	JK/JS	b1	0	n/a	undulating	n/a	n/a	Straight	Level	Mesic	Poor	6	30	7	0.05	95	0.05	0.05
4BV022	detailed vegetation and rare plant	463053	6369637	23/07/2006	JK/JS	FTNN	0	n/a	horizontal (organic soil)	n/a	n/a	Straight	Level	Hygric	Medium	30	10	4	15	70	0.05	2
4BV023	detailed vegetation and rare plant	463714	6369306	23/07/2006	JK/JS	BTNN	0	n/a	horizontal (organic soil)	n/a	n/a	Straight	Level	Subhygric	Medium	20	20	7	0.05	80	0.05	0.05
4BV024	detailed vegetation and rare plant	463829	6369670	23/07/2006	JK/JS	BTNN	0	n/a	horizontal (organic soil)	n/a	n/a	Straight	Level	Hygric	Medium	25	30	8	0.05	85	0.05	0.05
4BV025	detailed vegetation and rare plant	462536	6369488	23/07/2006	JK/JS	BTNN	0	n/a	horizontal (organic soil)	n/a	n/a	Straight	Level	Hygric	Poor	60	10	4	0	85	0.05	1
4BV026	detailed vegetation and rare plant	462697	6368254	23/07/2006	JK/JS	d2	0	n/a	level	n/a	n/a	Straight	Level	Mesic	Medium	20	30	15	2	45	0.05	0.05
4BV027	detailed vegetation and rare plant	462356	6368806	23/07/2006	JK/JS	d2	2	30	level	n/a	n/a	Straight	Midslope	Mesic	Medium	35	40	10	7	40	0.05	0.05
4BV028	detailed vegetation and rare plant	463755	6370222	24/07/2006	JK/JS	FTNN	0	n/a	horizontal (organic soil)	n/a	n/a	Straight	Level	Hygric	Rich	25	15	8	10	60	0.05	2
4BV029	detailed vegetation and rare plant	463706	6370892	24/07/2006	JK/JS	FTNN	0	n/a	horizontal (organic soil)	n/a	n/a	Straight	Level	Hygric	Rich	60	7	4	30	80	0.05	1
4BV030	detailed vegetation and rare plant	463214	6370838	24/07/2006	JK/JS	FTNN	0	n/a	horizontal (organic soil)	n/a	n/a	Straight	Level	Subhydric	Rich	60	8	1	50	60	0.05	0.05
4BV031	detailed vegetation and rare plant	462929	6371002	24/07/2006	JK/JS	FONS	0	n/a	horizontal (organic soil)	n/a	n/a	Straight	Level	Subhydric	Rich	60	0.05	3	60	70	0	0.05
4BV032	detailed vegetation and rare plant	462796	6371300	24/07/2006	JK/JS	BTNN	0	n/a	horizontal (organic soil)	n/a	n/a	Straight	Level	Hygric	Poor	40	17	4	5	90	0.05	1
4BV033	detailed vegetation and rare plant	460735	6369791	24/07/2006	JK/JS	e3	4	180	undulating	Floodplain	Rare	Convex	Lower Slope	Subhygric	Very Rich	60	40	25	70	0.05	0	0.05
4BV034	detailed vegetation and rare plant	454851	6383664	02/06/2007	CW/DH	d2	0	n/a	level	n/a	No Hazard	Straight	Level	Mesic	Medium	60	40	40	2	25	0.5	0.5
4BV035	detailed vegetation and rare plant	454127	6384181	02/06/2007	CW/DH	SONS	0	n/a	depressional	Floodplain	Expected	Straight	Depression	Hygric	Medium		10	n/a	15	0.5	0.5	0.5
4BV036	detailed vegetation and rare plant	456366	6384978	03/06/2007	CW/DH	f3	0	n/a	undulating	n/a	No Hazard	Straight	Level	Subhygric	Very Rich	35	45	35	2	5	0.5	0.5
4BV037	detailed vegetation and rare plant	456581	6384906	03/06/2007	CW/DH	d3	0	n/a	undulating	n/a	No Hazard	Straight	Level	Mesic	Medium	20	45	10	0.5	50	0.5	5
4BV038	detailed vegetation and rare plant	457658	6383421	03/06/2007	CW/DH	SONS	0	n/a	level	n/a	No Hazard	Straight	Level	Hygric	Medium	20	2	5	20	20	n/a	0.5
4BV039	detailed vegetation and rare plant	467860	6381921	04/06/2007	CW/DH	b2	1	90	level	n/a	No Hazard	Straight	Midslope	Mesic	Medium	35	40	15	0.5	4	n/a	0.5
4BV040	detailed vegetation and rare plant	467913	6382541	04/06/2007	CW/DH	b1	1	330	inclined	n/a	No Hazard	Straight	Upper Slope	Xeric	Medium	25	30	10	0.5	35	0.5	3
4BV041	detailed vegetation and rare plant	467939	6383459	04/06/2007	CW/DH	b2	0	n/a	level	n/a	No Hazard	Straight	Level	Mesic	Medium	30	25	20	0.5	5	0.5	0.5
4BV042	detailed vegetation and rare plant	468082	6384323	04/06/2007	CW/DH	b1	1	45	undulating	n/a	No Hazard	Concave	Depression	Submesic	Medium	23	25	25	0.5	40	n/a	3
4BV043	detailed vegetation and rare plant	468224	6386254	04/06/2007	CW/DH	a1	0	n/a	level	n/a	No Hazard	Straight	Level	Subxeric	Poor	25	25	1	0.5	30	50	5
4BV044	detailed vegetation and rare plant	468616	6389527	04/06/2007	CW/DH	a1	0	n/a	level	n/a	No Hazard	Straight	Level	Subxeric	Poor	15	25	2	0.5	75	15	5
4BV045	detailed vegetation and rare plant	468793	6390699	05/06/2007	CW/DH	b3	0	n/a	inclined	n/a	No Hazard	Straight	Midslope	Mesic	Medium	8	25	5	0.5	40	0.5	0.5
4BV046	detailed vegetation and rare plant	468651	6390242	05/06/2007	CW/DH	b2	2	40	undulating	n/a	No Hazard	Convex	Upper Slope	Mesic	Medium	20	55	18	0.5	6	n/a	0.5
4BV047	detailed vegetation and rare plant	468463	6388444	05/06/2007	CW/DH	b1	0	n/a	undulating	n/a	No Hazard	Convex	Crest	Submesic	Poor	6	35	7	0.5	60	1	2

Table M-1 Detailed Vegetation Inventory and Rare Plant Site Summary Data (continued)

Plot Number	Plot Type	UTM Easting (NAD 83)	UTM Northing (NAD 83)	Survey Date (dd/mm/yyyy)	Observers	Ecosite Phase/Wetlands Type	Slope Percent	Aspect (Degrees)	Surface Expression	Riparian Subclass	Flood Hazard	Surface Shape	Slope Position	Moisture Regime	Nutrient Regime	Shrub Cover [%]	Canopy Cover [%]	Forb Cover [%]	Graminoid Cover [%]	Bryophyte Cover [%]	Terrestrial Lichen [%]	Epiphyte Cover [%]
4BV048	detailed vegetation and rare plant	468395	6387846	05/06/2007	CW/DH	a1	0	n/a	undulating	n/a	No Hazard	Straight	Midslope	Submesic	Poor	25	30	2	0.5	90	1	2
4BV049	detailed vegetation and rare plant	468411	6387420	05/06/2007	CW/DH	a1	0	n/a	level	n/a	No Hazard	Straight	Level	Subxeric	Poor	2	20	1	0.5	10	25	2
4BV050	detailed vegetation and rare plant	468255	6385902	05/06/2007	CW/DH	b4	0	n/a	level	n/a	No Hazard	Straight	Level	Subxeric	Poor	35	24	4	0.5	86	1	1
4BV051	detailed vegetation and rare plant	466490	6382401	05/06/2007	CW/DH	b4	0	n/a	undulating	n/a	No Hazard	Straight	Midslope	Mesic	Medium	20	30	8	0.5	9	n/a	1
4BV052	detailed vegetation and rare plant	466681	6382721	06/06/2007	CW/DH	b1	0	n/a	level	n/a	No Hazard	Straight	Level	Mesic	Medium	15	20	10	0.5	60	0.5	2
4BV053	detailed vegetation and rare plant	467191	6383486	06/06/2007	CW/DH	SONS	0	n/a	depressional	n/a	Expected	Straight	Depression	Hygric	Medium	35	n/a	0.5	2	0.5	n/a	n/a
4BV054	detailed vegetation and rare plant	467467	6384218	06/06/2007	CW/DH	a1	0	n/a	level	n/a	No Hazard	Straight	Level	Submesic	Medium	8	35	2	0.5	70	5	3
4BV055	detailed vegetation and rare plant	467681	6384980	06/06/2007	CW/DH	a1	1	270	inclined	n/a	No Hazard	Straight	Midslope	Submesic	Medium	25	20	1	0.5	90	1	2
4BV056	detailed vegetation and rare plant	464135	6393004	07/06/2007	CW/DH	d2	0	n/a	subdued	n/a	No Hazard	Convex	Crest	Mesic	Medium	44	35	10	0.5	1	0.5	17
4BV057	detailed vegetation and rare plant	464831	6393108	07/06/2007	CW/DH	MONG	0	n/a	horizontal (organic soil)	n/a	No Hazard	Straight	Level	Hygric	Medium	10	n/a	0.5	40	3	0.5	0.5
4BV058	detailed vegetation and rare plant	468789	6395632	08/06/2007	CW/DH	a1	0	300	undulating	n/a	No Hazard	Straight	Midslope	Xeric	Poor	15	15	1	0.5	25	65	20
4BV059	detailed vegetation and rare plant	468978	6395143	08/06/2007	CW/DH	b1	0	n/a	level	n/a	No Hazard	Straight	Level	Subxeric	Poor	75	30	1	0.5	30	1	10
4BV060	detailed vegetation and rare plant	469144	6394697	08/06/2007	CW/DH	a1	0	n/a	undulating	n/a	No Hazard	Convex	Upper Slope	Xeric	Poor	25	20	0.5	0.5	25	45	5
4BV061	detailed vegetation and rare plant	469323	6394188	08/06/2007	CW/DH	a1	0	n/a	undulating	n/a	No Hazard	Concave	Lower Slope	Xeric	Poor	40	20	0.5	0.5	80	15	1
4BV062	detailed vegetation and rare plant	469554	6393579	08/06/2007	CW/DH	b1	0	n/a	level	n/a	No Hazard	Straight	Level	Xeric	Poor	40	27	2	0.5	80	0.5	20
4BV063	detailed vegetation and rare plant	469770	6392985	08/06/2007	CW/DH	b1	0	n/a	level	n/a	No Hazard	Straight	Level	Subxeric	Poor	20	40	3	0.5	40	0.5	25
4BV064	detailed vegetation and rare plant	470071	6393077	08/06/2007	CW/DH	a1	1	314	undulating	n/a	No Hazard	Concave	Lower Slope	Xeric	Poor	10	15	1	0.5	1	80	20
4BV065	detailed vegetation and rare plant	467129	6374482	09/06/2007	CW/DH	e1	0	n/a	inclined	Bank	Rare	Straight	Toe Slope	Hygric	Rich	40	65	3	0.5	0.5	n/a	n/a
4BV066	detailed vegetation and rare plant	469092	6382849	09/06/2007	CW/DH	RiSh	0	n/a	level	Floodplain	Frequent	Straight	Level	Hygric	Rich	73	n/a	80	0.5	n/a	n/a	n/a
4BV067	detailed vegetation and rare plant	473874	6390604	09/06/2007	CW/DH	b4	0	n/a	level	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
4BV068	detailed vegetation and rare plant	475932	6395142	09/06/2007	CW/DH	c1	0	n/a	level	Terrace	Rare	Straight	Level	Subhygric	Rich	65	25	3	n/a	1	n/a	0.5
4BV069	detailed vegetation and rare plant	477010	6398351	09/06/2007	CW/DH	e2	7	96	inclined	n/a	No Hazard	Concave	Toe Slope	Subhygric	Medium	33	30	1	0.5	0.5	0.5	0.5
4BV070	detailed vegetation and rare plant	475421	6396521	09/06/2007	CW/DH	b3	0	n/a	level	n/a	No Hazard	Straight	Level	Mesic	Medium	14	40	2	0.5	10	0.5	0.5
4BV071	detailed vegetation and rare plant	462396	6391684	10/06/2007	CW/DH	BTNN	0	n/a	horizontal (organic soil)	n/a	No Hazard	Straight	Level	Hygric	Poor	57	10	0.5	n/a	80	15	60
4BV072	detailed vegetation and rare plant	462330	6388257	10/06/2007	CW/DH	f2	0	n/a	level	n/a	No Hazard	Straight	Level	Subhygric	Medium	15	37	35	0.5	3	0.5	5
4BV073	detailed vegetation and rare plant	465657	6385209	10/06/2007	CW/DH	FONS	0	n/a	horizontal (organic soil)	n/a	No Hazard	Straight	Level	Hygric	Medium	55	3	3	0.5	85	n/a	30
4BV074	detailed vegetation and rare plant	456772	6387951	10/06/2007	CW/DH	d2	1	20	inclined	n/a	No Hazard	Straight	Midslope	Mesic	Medium	15	35	10	0.5	75	0.5	10
4BV075	detailed vegetation and rare plant	453850	6382267	10/06/2007	CW/DH	d2	0	n/a	level	n/a	No Hazard	Straight	Level	Mesic	Medium	32	50	5	0.5	30	0.5	10
4BV076	detailed vegetation and rare plant	459140	6381936	10/06/2007	CW/DH	d2	0	n/a	level	n/a	No Hazard	Straight	Level	Mesic	Medium	5	25	20	0.5	30	0.5	0.5
4BV077	detailed vegetation and rare plant	470289	6393499	11/06/2007	CW/DH	a1	0	n/a	undulating	n/a	No Hazard	Convex	Crest	Xeric	Poor	11	10	1	0.5	1	60	20

Table M-1 Detailed Vegetation Inventory and Rare Plant Site Summary Data (continued)

Plot Number	Plot Type	UTM Easting (NAD 83)	UTM Northing (NAD 83)	Survey Date (dd/mm/yyyy)	Observers	Ecosite Phase/Wetlands Type	Slope Percent	Aspect (Degrees)	Surface Expression	Riparian Subclass	Flood Hazard	Surface Shape	Slope Position	Moisture Regime	Nutrient Regime	Shrub Cover [%]	Canopy Cover [%]	Forb Cover [%]	Graminoid Cover [%]	Bryophyte Cover [%]	Terrestrial Lichen [%]	Epiphyte Cover [%]
4BV078	detailed vegetation and rare plant	471168	6394731	11/06/2007	CW/DH	a1	0	n/a	undulating	n/a	No Hazard	Straight	Upper Slope	Subxeric	Poor	2	20	2	0.5	65	12	20
4BV079	detailed vegetation and rare plant	471439	6394663	11/06/2007	CW/DH	b1	0	n/a	inclined	n/a	No Hazard	Straight	Upper Slope	Submesic	Medium	34	25	14	0.5	70	1	20
4BV080	detailed vegetation and rare plant	466858	6381891	17/07/2007	DH/QB	f1	0	n/a	level	n/a	Rare	Straight	Level	Hygric	Medium	17	58	38	1	3	0.5	0.5
4BV081	detailed vegetation and rare plant	455305	6383248	17/07/2007	DH/QB	d1	0	n/a	level	n/a	No Hazard	Straight	Level	Mesic	Medium	62	65	40	0.5	3	0.5	0.5
4BV082	detailed vegetation and rare plant	455637	6382600	17/07/2007	DH/QB	d2	0	n/a	level	n/a	No Hazard	Straight	Level	Mesic	Medium	45	40	20	2	2	0.5	1
4BV083	detailed vegetation and rare plant	457444	6380945	18/07/2007	DH/QB	f3	0	n/a	level	n/a	No Hazard	Straight	Level	Subhygric	Rich	50	28	65	0.5	0.5	0.5	0.5
4BV084	detailed vegetation and ra-re plant	456783	6381257	18/07/2007	DH/QB	d2	0	n/a	level	n/a	No Hazard	Straight	Level	Mesic	Medium	13	45	21	0.5	1	0.5	6
4BV086	detailed vegetation and rare plant	456270	6383153	18/07/2007	DH/ QB	d1	0	n/a	level	n/a	No Hazard	Straight	Level	Mesic	Medium	50	50	30	0.5	2	0.5	0.5
4BV087	detailed vegetation and rare plant	463608	6379576	19/07/2007	DH/ QB	d2	0	n/a	level	n/a	No Hazard	Straight	Level	Mesic	Medium	25	23	15	1	70	0.5	10
4BV088	detailed vegetation and rare plant	464232	6379530	19/07/2007	DH/ QB	f3	0	n/a	level	Terrace	Rare	Convex	Level	Subhygric	Rich	30	22	2	0.5	85	0.5	19
4BV089	detailed vegetation and rare plant	465081	6379599	19/07/2007	DH/ QB	SONS	0	n/a	hummocky	Floodplain	Expected	Straight	Level	Subhygric	Medium	35	n/a	4	40	24	n/a	0.5
4BV090	detailed vegetation and rare plant	465989	6379337	19/07/2007	DH/ QB	b3	2	304	level	n/a	No Hazard	Straight	Midslope	Submesic	Medium	11	32	7	0.5	70	0.5	23
4BV091	detailed vegetation and rare plant	467076	6379530	19/07/2007	DH/ QB	b1	0	n/a	level	n/a	n/a	Straight	Level	Mesic	Medium	45	45	12	3	40	1	0.5
4BV092	detailed vegetation and rare plant	467461	6379923	19/07/2007	DH/ QB	d1	0	n/a	inclined	Bank	Rare	Straight	Midslope	Subhygric	Poor	60	15	10	0.5	91	0.5	12
4BV093	detailed vegetation and rare plant	462169	6381974	20/07/2007	DH/ QB	STNN	0	n/a	level	Floodplain	Rare	Straight	Level	Subhygric	Medium	15	65	25	35	5	n/a	30
4BV094	detailed vegetation and rare plant	462949	6382053	20/07/2007	DH/ QB	STNN	0	n/a	level	Floodplain	Expected	Straight	Level	Subhygric	Medium	24	12	2	45	1	0.5	8
4BV095	detailed vegetation and rare plant	463752	6382014	20/07/2007	DH/ QB	STNN	0	n/a	level	Floodplain	Expected	Straight	Level	Subhygric	Medium	10	36	2	70	2	0.5	6
4BV096	detailed vegetation and rare plant	464606	6382004	20/07/2007	DH/ QB	BTNN	2	280	hummocky	n/a	No Hazard	Straight	Midslope	Hygric	Poor	43	24	1	n/a	83	3	41
4BV097	detailed vegetation and rare plant	465564	6381994	20/07/2007	DH/ QB	b2	3	10	level	n/a	No Hazard	Convex	Upper Slope	Mesic	Medium	30	43	10	0.5	28	0.5	8
4BV098	detailed vegetation and rare plant	466062	6382412	20/07/2007	DH/ QB	b2	2	20	level	n/a	No Hazard	Straight	Upper Slope	Mesic	Rich	44	47	21	0.5	20	0.5	38
4BV099	detailed vegetation and rare plant	470288	6391797	21/07/2007	DH/ QB	b1	0	n/a	undulating	n/a	No Hazard	Concave	Depression	Subxeric	Medium	12	35	1	0.5	60	1	50
4BV100	detailed vegetation and rare plant	470014	6392178	21/07/2007	DH/ QB	b1	0	238	undulating	n/a	No Hazard	Straight	Midslope	Subxeric	Medium	19	24	6	1	63	1	7
4BV101	detailed vegetation and rare plant	469867	6392670	21/07/2007	DH/ QB	a1	1	294	inclined	n/a	No Hazard	Straight	Midslope	Xeric	Poor	32	20	1	0.5	0.5	70	30
4BV102	detailed vegetation and rare plant	470500	6393885	21/07/2007	DH/ QB	a1	1	134	depressional	n/a	No Hazard	Concave	Depression	Submesic	Poor	54	n/a	2	0.5	30	16	19
4BV103	detailed vegetation and rare plant	470747	6394413	21/07/2007	DH/ QB	a1	2	108	undulating	n/a	No Hazard	Concave	Crest	Xeric	Poor	20	25	0.5	0.5	21	55	15
4BV104	detailed vegetation and rare plant	470535	6394783	21/07/2007	DH/ QB	a1	1	310	undulating	n/a	No Hazard	Convex	Crest	Xeric	Poor	8	25	1	0.5	40	50	9
4BV105	detailed vegetation and rare plant	463056	6394743	22/07/2007	DH/ QB	SONS	0	n/a	level	Floodplain	Rare	Straight	Level	Subhygric	Medium	20	1	0.5	83	5	0.5	1
4BV106	detailed vegetation and rare plant	463850	6394704	22/07/2007	DH/ QB	SONS	0	n/a	level	Floodplain	Rare	Straight	Level	Subhygric	Medium	41	0.5	4	83	6	0.5	1
4BV107	detailed vegetation and rare plant	464621	6394738	22/07/2007	DH/ QB	SONS	0	n/a	level	Floodplain	Rare	Straight	Level	Subhygric	Poor	17	n/a	1	70	5	0.5	0.5
4BV108	detailed vegetation and rare plant	465542	6394753	22/07/2008	DH/ QB	d2	0	n/a	level	n/a	No Hazard	Straight	Level	Mesic	Medium	2	64	239	0.5	6	0.5	3

Table M-1 Detailed Vegetation Inventory and Rare Plant Site Summary Data (continued)

Plot Number	Plot Type	UTM Easting (NAD 83)	UTM Northing (NAD 83)	Survey Date (dd/mm/yyyy)	Observers	Ecosite Phase/Wetlands Type	Slope Percent	Aspect (Degrees)	Surface Expression	Riparian Subclass	Flood Hazard	Surface Shape	Slope Position	Moisture Regime	Nutrient Regime	Shrub Cover [%]	Canopy Cover [%]	Forb Cover [%]	Graminoid Cover [%]	Bryophyte Cover [%]	Terrestrial Lichen [%]	Epiphyte Cover [%]
4BV109	detailed vegetation and rare plant	475524	6397306	23/07/2007	DH/QB	b1	0	n/a	level	n/a	No Hazard	Straight	Level	Mesic	Medium	15	41	7	0.5	90	n/a	15
4BV110	detailed vegetation and rare plant	473828	6394739	23/07/2007	DH/QB	d2	0	n/a	level	n/a	No Hazard	Straight	Level	Mesic	Medium	8	38	14	0.5	51	0.5	18
4BV111	detailed vegetation and rare plant	472514	6390691	23/07/2007	DH/QB	b3	0	n/a	level	n/a	No Hazard	Straight	Level	Mesic	Medium	25	35	7	2	20	0.5	15
4BV112	detailed vegetation and rare plant	472105	6389990	23/07/2007	DH/QB	b2	2	240	level	n/a	No Hazard	Straight	Midslope	Mesic	Medium	39	34	10	1	39	0.5	8
4BV113	detailed vegetation and rare plant	472055	6388572	23/07/2007	DH/QB	b2	0	n/a	level	n/a	No Hazard	Straight	Level	Mesic	Medium	17	60	35	0.5	35	0.5	8
4BV114	detailed vegetation and rare plant	467298	6393356	23/07/2007	DH/QB	SONS	0	n/a	depressional	Floodplain	Expected	Straight	Level	Subhygric	Medium	52	n/a	2	77	16	0.5	17
4BV115	detailed vegetation and rare plant	465626	6393249	23/07/2007	DH/QB	g1	0	n/a	level	n/a	No Hazard	Straight	Level	Subhygric	Poor	0.5	55	6	0.5	93	0.5	23
4BV116	detailed vegetation and rare plant	462537	6395029	23/07/2007	DH/QB	d2	0	n/a	level	n/a	No Hazard	Straight	Level	Mesic	Rich	7	54	3	0.5	17	0.5	6
4BV117	detailed vegetation and rare plant	468573	6392031	24/07/2007	DH/QB	c1	1	85	level	n/a	No Hazard	Straight	Level	Subhygric	Poor	3	45	0.5	n/a	91	1	23
4BV118	detailed vegetation and rare plant	464774	6388943	24/07/2007	DH/QB	d2	0	n/a	level	n/a	No Hazard	Straight	Level	Mesic	Medium	56	38	19	1	9	0.5	1
4BV119	detailed vegetation and rare plant	457485	6386840	24/07/2007	DH/QB	d1	0	n/a	level	n/a	No Hazard	Straight	Level	Mesic	Medium	11	42	80	0.5	7	0.5	1
4BV120	detailed vegetation and rare plant	456968	6384557	24/07/2007	DH/QB	f2	0	n/a	level	n/a	No Hazard	Straight	Level	Subhygric	Medium	0.5	54	5	5	2	0.5	1
4BV121	detailed vegetation and rare plant	462124	6380938	24/07/2007	DH/QB	d2	0	n/a	level	n/a	No Hazard	Straight	Level	Mesic	Rich	43	40	35	0.5	8	0.5	0.5
4BV122	detailed vegetation and rare plant	467238	6382073	25/07/2007	DH/QB	b1	2	45	undulating	n/a	No Hazard	Convex	Upper Slope	Mesic	Medium	12	25	6	0.5	95	0.5	24
4BV123	detailed vegetation and rare plant	467448	6382400	25/07/2007	DH/QB	b1	2	42	level	n/a	No Hazard	Straight	Midslope	Mesic	Medium	7	32	5	0.5	94	0.5	23
4BV124	detailed vegetation and rare plant	466633	6381772	25/07/2007	DH/QB	b1	2	250	undulating	n/a	No Hazard	Concave	Upper Slope	Mesic	Medium	19	21	9	0.5	90	0.5	14
4BV125	detailed vegetation and rare plant	465298	6383030	25/07/2007	DH/QB	b4	0	n/a	level	Floodplain	Rare	Straight	Level	Mesic	Medium	6	27	2	0.5	66	0.5	21
4BV126	detailed vegetation and rare plant	466358	6382099	25/07/2007	DH/QB	b1	2	180	undulating	n/a	No Hazard	Concave	Upper Slope	Mesic	Medium	54	40	5	0.5	60	17	0.5
4CV001	detailed vegetation and rare plant	461148	6372347	05/06/2006	PM/CW	b4	2	20	inclined	n/a	n/a	Straight	Midslope	Subxeric	Medium	80	20	10	10	20	0.5	1
4CV002	detailed vegetation and rare plant	460938	6373599	05/06/2006	PM/CW	d2	1	290	level	n/a	n/a	Straight	Midslope	Mesic	Medium	25	50	40	2	75	0.5	1
4CV003	detailed vegetation and rare plant	460811	6374040	05/06/2006	PM/CW	STNN	0	n/a	depressional	n/a	n/a	Concave	Depression	Mesic	Poor	68	80	3	1	85	0	1
4CV004	detailed vegetation and rare plant	461872	6369721	06/06/2006	PM/CW	g1	1	40	level	n/a	n/a	Straight	Level	Subhygric	Poor	8	60	2	0.5	95	1	5
4CV005	detailed vegetation and rare plant	462669	6367635	06/06/2006	PM/CW	e1	12	132	inclined	Bank	Expected	Concave	Toe Slope	Mesic	Rich	75	40	5	2	1	0	0.5
4CV006	detailed vegetation and rare plant	461112	6369812	06/06/2006	PM/CW	d3	0	n/a	level	n/a	n/a	Straight	Level	Mesic	Medium	7	40	5	0.5	95	0.5	5
4CV008	detailed vegetation and rare plant	462078	6370880	07/06/2006	PM/CW	FTNN	0	n/a	level	n/a	n/a	Straight	Level	Hygric	Medium	70	6	20	35	98	0.5	2
4CV009	detailed vegetation and rare plant	464728	6370898	07/06/2006	PM/CW	d2	0	n/a	level	n/a	n/a	Straight	Level	Mesic	Medium	13	40	25	0.5	50	0.5	0.5
4CV010	detailed vegetation and rare plant	462868	6365057	08/06/2006	PM/CW	FONS	0	n/a	depressional	Floodplain	Expected	Concave	Depression	Hygric	Poor	31	1	0.5	60	80	0	0.5
4CV011	detailed vegetation and rare plant	462956	6365109	08/06/2006	PM/CW	FONG	0	n/a	depressional	Floodplain	Expected	Concave	Depression	Hydric	Poor	5	0.5	0.5	90	80	0	0
4CV012	detailed vegetation and rare plant	466655	6371290	08/06/2006	PM/CW	FTNN	1	270	inclined	n/a	n/a	Straight	Midslope	Subhygric	Poor	80	15	1	0.5	95	1	5
4CV013	detailed vegetation and rare plant	465613	6369452	08/06/2006	PM/CW	b3	10	300	inclined	n/a	n/a	Straight	Midslope	Subxeric	Poor	23	45	1	0.5	75	0.5	2

Table M-1 Detailed Vegetation Inventory and Rare Plant Site Summary Data (continued)

Plot Number	Plot Type	UTM Easting (NAD 83)	UTM Northing (NAD 83)	Survey Date (dd/mm/yyyy)	Observers	Ecosite Phase/Wetlands Type	Slope Percent	Aspect (Degrees)	Surface Expression	Riparian Subclass	Flood Hazard	Surface Shape	Slope Position	Moisture Regime	Nutrient Regime	Shrub Cover [%]	Canopy Cover [%]	Forb Cover [%]	Graminoid Cover [%]	Bryophyte Cover [%]	Terrestrial Lichen [%]	Epiphyte Cover [%]
4CV014	detailed vegetation and rare plant	461877	6361833	08/06/2006	PM/CW	FTNN	1	340	sloping (organic soil)	n/a	n/a	Concave	Depression	Subhygric	Medium	63	12	1	5	98	0.5	0.5
4CV015	detailed vegetation and rare plant	461944	6363679	08/06/2006	PM/CW	MONG	0	n/a	bowl (organic soil)	pond	Frequent	Straight	Level	Aquatic	Medium	5	n/a	10	40	30	0.5	0.5
4CV016	detailed vegetation and rare plant	460550	6373929	22/07/2006	PM/CW	d2	3	10	inclined	n/a	n/a	Straight	Midslope	Mesic	Medium	19	40	7	1	25	0.05	0.05
4CV017	detailed vegetation and rare plant	460189	6374487	22/07/2006	PM/CW	f2	1	80	inclined	n/a	n/a	Straight	Midslope	Subhygric	Medium	20	35	20	1	95	1	1
4CV018	detailed vegetation and rare plant	460008	6374654	02/07/2006	PM/CW	d2	2	70	inclined	n/a	n/a	Straight	Midslope	Mesic	Medium	8	40	8	2	40	0.05	0.05
4CV019	detailed vegetation and rare plant	459822	6374601	22/07/2006	PM/CW	b2	1	260	inclined	n/a	n/a	Straight	Midslope	Submesic	Poor	60	33	10	0.05	40	0.05	0.05
4CV020	detailed vegetation and rare plant	458802	6373763	22/07/2006	PM/CW	FONS	0	n/a	horizontal (organic soil)	n/a	n/a	Straight	Level	Hydric	Medium	35	n/a	3	25	50	0.05	0.05
4CV021	detailed vegetation and rare plant	460470	6371356	23/07/2006	PM/CW	b1	0	n/a	level	n/a	n/a	Straight	Level	Subxeric	Poor	36	30	18	0.05	90	3	0.05
4CV022	detailed vegetation and rare plant	460090	6371167	23/07/2006	PM/CW	a1	5	30	undulating	n/a	n/a	Convex	Upper Slope	Xeric	Poor	13	30	4	0.5	30	40	0.5
4CV023	detailed vegetation and rare plant	459634	6371329	23/07/2006	PM/CW	b1	5	120	n/a	n/a	n/a	Concave	Midslope	Submesic	Poor	33	30	14	1	80	1	0.05
4CV024	detailed vegetation and rare plant	459181	6371719	23/07/2006	PM/CW	d2	0	n/a	level	n/a	n/a	Straight	Level	Mesic	Medium	25	30	14	0.05	26	0.05	0.05
4CV025	detailed vegetation and rare plant	459653	6372592	23/07/2006	PM/CW	c1	0	n/a	level	n/a	n/a	Straight	Level	Mesic	Medium	0.05	40	1	0.05	95	0.05	1
4CV026	detailed vegetation and rare plant	461003	6373119	23/07/2006	PM/CW	b1	0	n/a	level	n/a	n/a	Straight	Level	Submesic	Poor	20	40	5	2	97	0.05	0.05
4CV027	detailed vegetation and rare plant	460795	6371654	24/07/2006	PM/CW	a1	1	320	inclined	n/a	n/a	Straight	Midslope	Xeric	Poor	43	15	3	1	9	25	0.05
4CV028	detailed vegetation and rare plant	462151	6369272	24/07/2006	PM/CW	d1	1	300	inclined	n/a	n/a	Straight	Upper Slope	Mesic	Medium	25	40	50	1	2	n/a	0.05
4CV029	detailed vegetation and rare plant	461845	6370091	24/07/2006	PM/CW	g1	1	80	inclined	n/a	n/a	Straight	Level	Subhydric	Poor	19	40	0.05	0	60	1	1
4CV030	detailed vegetation and rare plant	460290	6368904	24/07/2006	PM/CW	d1	3	190	inclined	n/a	n/a	Straight	Midslope	Mesic	Medium	44	35	20	0.05	1	0.05	0.05
4CV031	detailed vegetation and rare plant	459330	6368893	24/07/2006	PM/CW	b1	20	50	undulating	n/a	n/a	Convex	Upper Slope	Submesic	Poor	24	40	15	0.05	20	0.05	0.05
4CV032	detailed vegetation and rare plant	462053	6379324	02/06/2007	PM/CW	d2	0	n/a	level	n/a	No Hazard	Straight	Level	Mesic	Medium	5	53	41	0.5	4	0.5	0.5
4CV033	detailed vegetation and rare plant	463165	6379514	02/06/2007	PM/CW	b1	4	340	inclined	n/a	No Hazard	Concave	Midslope	Submesic	Medium	7	65	45	0.5	80	0.5	10
4CV034	detailed vegetation and rare plant	464615	6379610	03/06/2007	PM/CW	f3	1	290	inclined	n/a	No Hazard	Straight	Midslope	Subhygric	Rich	15	60	46	14	4	0.5	3
4CV035	detailed vegetation and rare plant	465511	6379636	03/06/2007	PM/CW	c1	1	88	inclined	n/a	No Hazard	Straight	Midslope	Submesic	Poor	10	40	0.5	0.5	95	0.5	8
4CV036	detailed vegetation and rare plant	465520	6382668	03/06/2007	PM/CW	MONG	0	n/a	depressional	Bank	Expected	Straight	Depression	Aquatic	Medium	-	n/a	1	90	2	n/a	n/a
4CV037	detailed vegetation and rare plant	467408	6381571	03/06/2007	PM/CW	c1	1	280	inclined	n/a	No Hazard	Straight	Midslope	Submesic	Medium	7	30	1	1	95	0.5	21
4CV038	detailed vegetation and rare plant	462405	6384135	04/06/2007	PM/CW	f2	0	n/a	level	n/a	No Hazard	Straight	Level	Subhygric	Rich	8	30	48	4	8	0.5	10
4CV039	detailed vegetation and rare plant	462338	6385954	04/06/2007	PM/CW	d1	0	n/a	level	n/a	No Hazard	Straight	Level	Mesic	Medium	16	50	11	1	1	0.5	0
4CV040	detailed vegetation and rare plant	462287	6387599	04/06/2007	PM/CW	d1	0	n/a	level	n/a	No Hazard	Straight	Level	Mesic	Medium	3	50	1	70	2	n/a	1
4CV041	detailed vegetation and rare plant	462271	6387556	04/06/2007	PM/CW	d3	0	n/a	level	n/a	No Hazard	Straight	Level	Mesic	Medium	0.5	50	52	3	2	0	n/a
4CV042	detailed vegetation and rare plant	462356	6387549	05/06/2007	PM/CW	d3	0	n/a	level	n/a	No Hazard	Straight	Level	Subhygric	Medium	2	4.5	4	0.5	60	0.5	1
4CV043	detailed vegetation and rare plant	462281	6387290	05/06/2007	PM/CW	STNN	0	n/a	level	n/a	No Hazard	Straight	Level	Hygric	Medium	23	45	0.5	0.5	91	0.5	10

Table M-1 Detailed Vegetation Inventory and Rare Plant Site Summary Data (continued)

Plot Number	Plot Type	UTM Easting (NAD 83)	UTM Northing (NAD 83)	Survey Date (dd/mm/yyyy)	Observers	Ecosite Phase/Wetlands Type	Slope Percent	Aspect (Degrees)	Surface Expression	Riparian Subclass	Flood Hazard	Surface Shape	Slope Position	Moisture Regime	Nutrient Regime	Shrub Cover [%]	Canopy Cover [%]	Forb Cover [%]	Graminoid Cover [%]	Bryophyte Cover [%]	Terrestrial Lichen [%]	Epiphyte Cover [%]
4CV044	detailed vegetation and rare plant	462368	6385338	05/06/2007	PM/CW	d1	0	n/a	level	n/a	No Hazard	Straight	Level	Mesic	Medium	20	41	8	3.8	0.5	n/a	n/a
4CV045	detailed vegetation and rare plant	462316	6384548	05/06/2007	PM/CW	d3	0	n/a	level	n/a	No Hazard	Straight	Level	Mesic	Medium	62	55	14	0.5	4	0.5	6
4CV046	detailed vegetation and rare plant	463111	6383753	05/06/2007	PM/CW	d1	0	n/a	level	n/a	No Hazard	Straight	Level	Mesic	Medium	31	50	21	0.5	0.5	0.5	0
4CV047	detailed vegetation and rare plant	467743	6379949	06/06/2007	PM/CW	FTNN	0	n/a	level	n/a	No Hazard	Straight	Level	Hygric	Poor	27	10	0.5	0.5	90	15	80
4CV048	detailed vegetation and rare plant	468144	6379687	06/06/2007	PM/CW	b3	1	20	level	n/a	No Hazard	Straight	Level	Mesic	Medium	4	55	2	0.5	8	0.5	45
4CV049	detailed vegetation and rare plant	468354	6379723	06/06/2007	PM/CW	BTNN	0	n/a	inclined	n/a	No Hazard	Concave	Midslope	Subhygric	Poor	20	20	0.5	0.5	97	5	75
4CV050	detailed vegetation and rare plant	468668	6388409	06/06/2007	PM/CW	b1	1	180	level	n/a	No Hazard	Convex	Level	Subxeric	Poor	7	35	1	0.5	97	0.5	20
4CV051	detailed vegetation and rare plant	464194	6392543	07/06/2007	PM/QB	MONG	0	n/a	blanket	Active Channel	Expected	Concave	Level	Hygric	Rich	0.5	n/a	2	35	0.5	n/a	n/a
4CV052	detailed vegetation and rare plant	464001	6393313	07/06/2007	PM/JS	SONS	0	n/a	blanket	n/a	No Hazard	Straight	Level	Subhydric	Medium	40	5	0.5	70	15	0.5	n/a
4CV053	detailed vegetation and rare plant	473984	6398580	08/06/2007	PM/CW	b1	0	n/a	level	n/a	No Hazard	Straight	Level	Subxeric	Poor	24	25	7	1	90	0.5	15
4CV054	detailed vegetation and rare plant	472543	6397146	08/06/2007	PM/JS	a1	8	270	undulating	n/a	No Hazard	Convex	Crest	VeryXeric	Very Poor	1	20	0.5	0	4	95	10
4CV055	detailed vegetation and rare plant	471856	6396526	08/06/2007	PM/CW	b2	40	40	undulating	n/a	No Hazard	Concave	Midslope	Mesic	Medium	33	50	4	0.5	2	0.5	0.5
4CV056	detailed vegetation and rare plant	471400	6395613	08/06/2007	PM/JS	b1	2	321	undulating	n/a	No Hazard	Concave	Midslope	Subxeric	Poor	15	20	3	0.5	95	5	5
4CV057	detailed vegetation and rare plant	470931	6394764	08/06/2007	PM/CW	a1	1	288	undulating	n/a	No Hazard	Convex	Midslope	Xeric	Poor	6	20	2	0.5	50	50	2
4CV058	detailed vegetation and rare plant	469025	6372343	09/06/2007	PM/CW	a1	1	285	level	n/a	No Hazard	Straight	Midslope	Xeric	Poor	17	15	2	1	1	90	0.5
4CV059	detailed vegetation and rare plant	470544	6386089	09/06/2007	PM/JS	e1	0	n/a	level	Terrace	Rare	Straight	Level	Mesic	Rich	28	60	7	0.5	0.5	n/a	n/a
4CV060	detailed vegetation and rare plant	474728	6392146	09/06/2007	PM/CW	e1	30	98	inclined	n/a	No Hazard	Concave	Midslope	Submesic	Medium	26	8	5	0.5	0.5	0	0.5
4CV061	detailed vegetation and rare plant	476227	6396051	09/06/2007	PM/JS	e1	4	289	ridged	Floodplain	Frequent	Concave	Crest	Mesic	Rich	60	85	2	0.5	0.5	n/a	n/a
4CV062	detailed vegetation and rare plant	466856	6393260	09/06/2007	PM/CW	b1	0	n/a	level	n/a	No Hazard	Straight	Level	Submesic	Medium	27	30	12	4	70	0.5	8
4CV063	detailed vegetation and rare plant	463897	6390599	10/06/2007	PM/JS	BTNN	0	n/a	blanket	Floodplain	Expected	Straight	Level	Hygric	Poor	31	15	7	8	90	0.5	4
4CV064	detailed vegetation and rare plant	460473	6389533	10/06/2007	PM/CW	d1	0	n/a	level	n/a	No Hazard	Straight	Level	Mesic	Medium	41	55	9	3	1	0.5	n/a
4CV065	detailed vegetation and rare plant	465051	6388522	10/06/2007	PM/JS	b3	0	n/a	level	n/a	No Hazard	Convex	Level	Submesic	Medium	25	30	9	1	60	0.5	5
4CV066	detailed vegetation and rare plant	457214	6385445	10/06/2007	PM/CW	d2	0	n/a	level	n/a	No Hazard	Straight	Level	Mesic	Medium	34	50	9	5	1	0.5	0.5
4CV067	detailed vegetation and rare plant	457346	6380391	10/06/2007	PM/JS	e3	0	n/a	level	n/a	No Hazard	Straight	Level	Subhygric	Rich	75	35	14	2	50	n/a	5
4CV068	detailed vegetation and rare plant	461569	6381928	10/06/2007	PM/CW	d2	0	n/a	level	n/a	No Hazard	Straight	Level	Mesic	Medium	15	45	56	1	0.5	0.5	n/a
4CV069	detailed vegetation and rare plant	472216	6397773	10/06/2007	PM/JS	FONG	0	n/a	blanket	n/a	No Hazard	Straight	Level	Subhydric	Rich	2	n/a	5	80	60	n/a	n/a
4CV070	detailed vegetation and rare plant	472212	6397553	10/06/2007	PM/CW	FTNN	0	n/a	level	n/a	No Hazard	Straight	Level	Hygric	Poor	34	10	0.5	1	95	0.5	5
4CV071	detailed vegetation and rare plant	472005	6396809	10/06/2007	PM/JS	a1	0	n/a	level	n/a	No Hazard	Straight	Level	Xeric	Poor	3	20	0.5	n/a	2	90	4
4CV072	detailed vegetation and rare plant	457163	6384422	17/07/2007	PM/CW	d3	0	n/a	level	n/a	No Hazard	Straight	Level	Mesic	Rich	2	50	8	0.5	87	0	3
4CV073	detailed vegetation and rare plant	457364	6383824	17/07/2007	PM/CS	h1	0	n/a	level	n/a	No Hazard	Straight	Level	Subhygric	Rich	41	30	76	1	95	0	15

Table M-1 Detailed Vegetation Inventory and Rare Plant Site Summary Data (continued)

Plot Number	Plot Type	UTM Easting (NAD 83)	UTM Northing (NAD 83)	Survey Date (dd/mm/yyyy)	Observers	Ecosite Phase/Wetlands Type	Slope Percent	Aspect (Degrees)	Surface Expression	Riparian Subclass	Flood Hazard	Surface Shape	Slope Position	Moisture Regime	Nutrient Regime	Shrub Cover [%]	Canopy Cover [%]	Forb Cover [%]	Graminoid Cover [%]	Bryophyte Cover [%]	Terrestrial Lichen [%]	Epiphyte Cover [%]
4CV074	detailed vegetation and rare plant	458164	6383470	17/07/2007	PM/CW	d2	0	n/a	level	n/a	No Hazard	Straight	Level	Mesic	Rich	17	75	62	0.5	1	0	0.5
4CV075	detailed vegetation and rare plant	458875	6383536	18/07/2007	PM/CW	d1	0	n/a	level	n/a	No Hazard	Straight	Level	Mesic	Medium	24	60	47	7	1	0.5	0.5
4CV076	detailed vegetation and rare plant	459505	6385059	18/07/2007	PM/CS	b3	0	n/a	level	n/a	No Hazard	Straight	Level	Mesic	Medium	1	50	30	0.5	2	0.5	3
4CV077	detailed vegetation and rare plant	459601	6383618	18/07/2007	PM/CW	SONS	0	n/a	level	n/a	Rare	Straight	Level	Subhygric	Medium	30	n/a	4	80	3	0.5	0.5
4CV078	detailed vegetation and rare plant	460267	6383732	18/07/2007	PM/CS	STNN	0	n/a	level	n/a	No Hazard	Straight	Level	Subhygric	Rich	6	25	17	8	95	n/a	3
4CV079	detailed vegetation and rare plant	460842	6383839	18/07/2007	PM/CW	d1	0	n/a	level	n/a	No Hazard	Straight	Level	Mesic	Medium	10	65	45	5	0.5	n/a	0.5
4CV080	detailed vegetation and rare plant	461771	6383956	19/07/2007	PM/CW	d1	0	n/a	level	n/a	No Hazard	Straight	Level	Mesic	Medium	13	50	9	20	1	0.5	n/a
4CV081	detailed vegetation and rare plant	462307	6386844	19/07/2007	PM/CS	STNN	0	n/a	level	n/a	No Hazard	Straight	Level	Hygric	Medium	0.5	24	0.5	70	1	0.5	1
4CV082	detailed vegetation and rare plant	462210	6386517	19/07/2007	PM/CW	d3	0	n/a	level	n/a	No Hazard	Straight	Level	Mesic	Medium	4	75	10	0	0.5	0.5	0.5
4CV083	detailed vegetation and rare plant	463644	6383487	19/07/2007	PM/CS	STNN	0	n/a	level	n/a	No Hazard	Straight	Level	Subhygric	Medium	8	30	6	60	5	0	5
4CV084	detailed vegetation and rare plant	464616	6382983	19/07/2007	PM/CW	MONG	0	n/a	bowl (organic soil)	Fringe	Frequent	Straight	Level	Aquatic	Rich	0.5	n/a	3	80	0.5	0	0
4CV085	detailed vegetation and rare plant	467003	6383129	20/07/2007	PM/CS	d1	0	n/a	level	n/a	No Hazard	Straight	Level	Submesic	Poor	14	30	2	1	95	0.5	15
4CV086	detailed vegetation and rare plant	467312	6383890	20/07/2007	PM/CW	b2	1	240	inclined	n/a	No Hazard	Straight	Level	Mesic	Medium	51	65	7	0.5	5	0	0.5
4CV087	detailed vegetation and rare plant	467625	6384782	20/07/2007	PM/CS	b1	0	n/a	level	n/a	No Hazard	Convex	Level	Submesic	Poor	25	30	4	2	95	2	5
4CV088	detailed vegetation and rare plant	467846	6385580	20/07/2007	PM/CW	d1	0	n/a	level	n/a	No Hazard	Straight	Level	Submesic	Poor	16	25	5	0.5	90	0.5	5
4CV089	detailed vegetation and rare plant	467994	6386098	20/07/2007	PM/CS	b1	2	20	inclined	n/a	No Hazard	Convex	Midslope	Submesic	Poor	3	40	4	1	95	0.5	1
4CV090	detailed vegetation and rare plant	467599	6386625	20/07/2007	PM/CW	b1	2	280	inclined	n/a	No Hazard	Straight	Midslope	Submesic	Poor	10	35	5	0.5	90	0	2
4CV091	detailed vegetation and rare plant	467082	6386695	20/07/2007	PM/CS	a1	2	330	inclined	n/a	No Hazard	Convex	Midslope	Subxeric	Poor	20	20	1	0.5	45	50	10
4CV092	detailed vegetation and rare plant	468941	6391084	21/07/2007	PM/CW	SpS	40	110	inclined	n/a	No Hazard	Concave	Upper Slope	VeryXeric	Very Poor	2	n/a	1	1	0.5	0.5	n/a
4CV093	detailed vegetation and rare plant	467925	6391601	21/07/2007	PM/CS	b1	2	230	inclined	n/a	No Hazard	Convex	Midslope	Subxeric	Poor	-	n/a	n/a	n/a	n/a	n/a	n/a
4CV094	detailed vegetation and rare plant	467140	6391822	21/07/2007	PM/CW	STNN	0	n/a	level	Inactive Channel	Expected	Straight	Level	Subhygric	Poor	48	n/a	0.5	1	90	0	0.5
4CV095	detailed vegetation and rare plant	465831	6391849	21/07/2007	PM/CS	MONG	0	n/a	level	Floodplain	Expected	Straight	Level	Subhygric	Medium	10	0	1	85	n/a	n/a	n/a
4CV096	detailed vegetation and rare plant	465330	6392685	21/07/2007	PM/CW	STNN	0	n/a	level	n/a	Expected	Straight	Level	Hygric	Rich	30	15	8	70	15	0	0.5
4CV097	detailed vegetation and rare plant	473816	6396561	22/07/2007	PM/CS	b1	2	310	inclined	n/a	No Hazard	Convex	Crest	Subxeric	Poor	28	46	18	1	70	n/a	1
4CV098	detailed vegetation and rare plant	473316	6396369	22/07/2007	PM/CW	b1	15	20	inclined	n/a	No Hazard	Concave	Midslope	Subxeric	Poor	3	65	7	0.5	1	0.5	1
4CV099	detailed vegetation and rare plant	472708	6396577	22/07/2007	PM/CS	a1	0	n/a	level	n/a	No Hazard	Straight	Level	Xeric	Poor	25	15	3	0.5	90	7	1
4CV100	detailed vegetation and rare plant	472240	6396509	22/07/2007	PM/CW	b1	2	290	inclined	n/a	No Hazard	Straight	Midslope	Xeric	Poor	24	20	1	0.5	60	15	5
4CV101	detailed vegetation and rare plant	471108	6395255	22/07/2007	PM/CS	a1	1	n/a	inclined	n/a	No Hazard	Convex	Crest	Xeric	Poor	19	25	1	0.5	45	45	5
4CV102	detailed vegetation and rare plant	475368	6396469	23/07/2007	PM/CS	b3	2	n/a	inclined	n/a	No Hazard	Convex	Crest	Subxeric	Medium	10	65	2	1	25	0.5	2
4CV103	detailed vegetation and rare plant	475273	6394826	23/07/2007	PM/CW	b1	1	235	inclined	n/a	No Hazard	Straight	Crest	Submesic	Medium	15	55	8	4	70	0.5	1

Table M-1 Detailed Vegetation Inventory and Rare Plant Site Summary Data (continued)

Plot Number	Plot Type	UTM Easting (NAD 83)	UTM Northing (NAD 83)	Survey Date (dd/mm/yyyy)	Observers	Ecosite Phase/Wetlands Type	Slope Percent	Aspect (Degrees)	Surface Expression	Riparian Subclass	Flood Hazard	Surface Shape	Slope Position	Moisture Regime	Nutrient Regime	Shrub Cover [%]	Canopy Cover [%]	Forb Cover [%]	Graminoid Cover [%]	Bryophyte Cover [%]	Terrestrial Lichen [%]	Epiphyte Cover [%]
4CV104	detailed vegetation and rare plant	475561	6394892	23/07/2007	PM/CS	b3	45	50	inclined	n/a	No Hazard	Convex	Upper Slope	Subxeric	Medium	16	60	4	0.5	5	0.5	0.5
4CV105	detailed vegetation and rare plant	474921	6393386	23/07/2007	PM/CW	b1	0	n/a	level	n/a	No Hazard	Straight	Level	Submesic	Poor	29	28	13	1	80	0	0.5
4CV106	detailed vegetation and rare plant	471397	6388319	23/07/2007	PM/CS	WONN	0	n/a	bowl (organic soil)	Fringe	Frequent	Concave	Depression	Hygric	Very Rich	5	n/a	13	47	90	n/a	0.5
4CV107	detailed vegetation and rare plant	464566	6394684	23/07/2007	PM/CW	d2	25	90	inclined	n/a	No Hazard	Concave	Lower Slope	Submesic	Medium	21	55	9	1	1	0.5	0.5
4CV109	detailed vegetation and rare plant	468002	6392294	24/07/2007	PM/CS	BTNN	0	n/a	level	Bank	No Hazard	Straight	Level	Subhygric	Poor	8	30	0.5	n/a	90	0.5	2
4CV110	detailed vegetation and rare plant	467030	6388470	24/07/2007	PM/CW	b1	1	360	inclined	n/a	No Hazard	Straight	Upper Slope	Xeric	Poor	7	25	1	0.5	90	1	0.5
4CV111	detailed vegetation and rare plant	466004	6382745	24/07/2007	PM/CS	FTNN	1	80	sloping (organic soil)	Fringe	Expected	Straight	Level	Subhygric	Rich	22	12	5	0.5	84	n/a	5
4CV112	detailed vegetation and rare plant	462292	6383695	24/07/2007	PM/CW	d2	0	n/a	level	n/a	No Hazard	Straight	Level	Mesic	Medium	12	60	17	0.5	0.5	0	0.5
4CV113	detailed vegetation and rare plant	460212	6379519	24/07/2007	PM/CS	e2	0	n/a	level	n/a	No Hazard	Straight	Level	Mesic	Medium	16	60	10	2	2	0.5	1
4CV114	detailed vegetation and rare plant	471343	6398179	25/07/2007	PM/CW	a1	2	240	inclined	n/a	No Hazard	Straight	Midslope	Xeric	Poor	4	25	0.5	0.5	7	27	5
4CV115	detailed vegetation and rare plant	471881	6398113	25/07/2007	PM/CS	a1	0	n/a	level	n/a	No Hazard	Straight	Level	Xeric	Poor	14	25	0.5	0.5	3	33	5
4CV116	detailed vegetation and rare plant	472401	6398186	25/07/2007	PM/CW	b1	5	300	inclined	n/a	No Hazard	Concave	Midslope	Xeric	Poor	20	30	6	2	63	0	1
4CV117	detailed vegetation and rare plant	412051	6397141	25/07/2007	PM/CS	BTNN	0	n/a	level	n/a	No Hazard	Straight	Level	Mesic	Poor	0.5	45	0.5	0.5	90	0.5	2
4CV118	detailed vegetation and rare plant	472286	6396903	25/07/2007	PM/CW	b3	0	n/a	level	n/a	No Hazard	Straight	Level	Submesic	Poor	12	25	3	0.5	80	1	3
3AP001	rare plant	479085	6352480	6/2/2006	AA/DH	FOPN	0	n/a	level	n/a	n/a	n/a	Level	Subhydric	Medium	n/a	n/a	n/a	n/a	n/a	n/a	n/a
3AP002	rare plant	478403	6352602	6/2/2006	AA/DH	FTPN	0	n/a	level	n/a	n/a	n/a	Level	Mesic	Poor	n/a	n/a	n/a	n/a	n/a	n/a	n/a
3AP003	rare plant	489489	6357387	6/2/2006	AA/DH	b4	5	60	n/a	n/a	n/a	n/a	Midslope	Subxeric	Poor	n/a	n/a	n/a	n/a	n/a	n/a	n/a
3AP004	rare plant	479740	6363332	6/2/2006	AA/DH	clearing	3	270	level	n/a	n/a	n/a	Upper Slope	Xeric	Poor	n/a	n/a	n/a	n/a	n/a	n/a	n/a
3AP005	rare plant	480012	6352120	6/2/2006	AA/DH	g1	0	n/a	level	n/a	n/a	n/a	Level	Mesic	Poor	n/a	n/a	n/a	n/a	n/a	n/a	n/a
3AP006	rare plant	479353	6351757	6/2/2006	AA/DH	b1	1	360	level	n/a	n/a	n/a	Midslope	Subxeric	Poor	n/a	n/a	n/a	n/a	n/a	n/a	n/a
3AP007	rare plant	490972	6367791	19/07/2006	AA/DH	FONG	0	n/a	level	n/a	n/a	n/a	Level	Subhydric	Rich	n/a	n/a	n/a	n/a	n/a	n/a	n/a
3AP008	rare plant	489480	6357803	19/07/2006	AA/DH	burn (shrubby uplands)	0	n/a	level	n/a	n/a	n/a	Depression	Hydric	Rich	n/a	n/a	n/a	n/a	n/a	n/a	n/a
3BP001	rare plant	481337	6353731	03/06/2006	JK/JS	FONS	0	n/a	level	n/a	n/a	n/a	Level	Subhydric	Medium	n/a	n/a	n/a	n/a	n/a	n/a	n/a
3BP002	rare plant	480656	6353747	03/06/2006	JK/JS	a1	5	n/a	level	n/a	n/a	n/a	Upper Slope	Xeric	Very Poor	n/a	n/a	n/a	n/a	n/a	n/a	n/a
3BP003	rare plant	479117	6353526	03/06/2006	JK/JS	FOPN	0	n/a	level	n/a	n/a	n/a	Level	Subhydric	Rich	n/a	n/a	n/a	n/a	n/a	n/a	n/a
3BP004	rare plant	483174	6353204	03/06/2006	JK/JS	burn (shrubby uplands)	14	300	n/a	n/a	n/a	n/a	Upper Slope	Subxeric	Medium	n/a	n/a	n/a	n/a	n/a	n/a	n/a
3BP005	rare plant	482247	6357369	11/06/2006	JK/JS	g1	0	n/a	level	n/a	n/a	n/a	Level	Subhygric	Poor	n/a	n/a	n/a	n/a	n/a	n/a	n/a
3CP001	rare plant	483751	6350411	02/06/2006	PM/CW	b1	2	110	n/a	n/a	n/a	n/a	Midslope	VeryXeric	Poor	n/a	n/a	n/a	n/a	n/a	n/a	n/a
3CP007	rare plant	478058	6360727	10/06/2006	PM/CW	b1	2	180	level	n/a	n/a	n/a	Crest	Xeric	Poor	n/a	n/a	n/a	n/a	n/a	n/a	n/a
3CP020	rare plant	484748	6366703	19/07/2006	PM/CW	BTNN	0	n/a	level	n/a	n/a	n/a	Depression	Hydric	Poor	n/a	n/a	n/a	n/a	n/a	n/a	n/a
3CP021	rare plant	483408	6365158	19/07/2006	PM/CW	FONS	0	n/a	level	n/a	n/a	n/a	Level	Hydric	Rich	n/a	n/a	n/a	n/a	n/a	n/a	n/a
3CP022	rare plant	483435	6362822	20/07/2006	PM/CW	BTNN	0	n/a	level	n/a	n/a	n/a	Level	Subhygric	Poor	n/a	n/a	n/a	n/a	n/a	n/a	n/a
3CP023	rare plant	482584	6362235	20/07/2006	PM/CW	FONG	0	n/a	level	n/a	n/a	n/a	Level	Hydric	Rich	n/a	n/a	n/a	n/a	n/a	n/a	n/a
3CP024	rare plant	485665	6361685	20/07/2006	PM/CW	FOPN	0	n/a	level	n/a	n/a	n/a	Level	Hydric	Medium	n/a	n/a	n/a	n/a	n/a	n/a	n/a
3CP025	rare plant	476859	6354885	21/07/2006	PM/CW	FONG	0	n/a	level	n/a	n/a	n/a	Lower Slope	Hydric	Rich	n/a	n/a	n/a	n/a	n/a	n/a	n/a
4AP001	rare plant	478001	6361241	19/07/2006	AA/DH	FONG	0	n/a	level	n/a	n/a	n/a	Depression	Subhydric	Medium	n/a	n/a	n/a	n/a	n/a	n/a	n/a
4AP002	rare plant	464536	6376107	19/07/2006	AA/DH	BTNN	0	n/a	level	n/a	n/a	n/a	Level	7	Poor	n/a	n/a	n/a	n/a	n/a	n/a	n/a
4AP003	rare plant	469369	6389964	11/06/2007	JK/JS	b2	0	n/a	level	n/a	n/a	n/a	Level	Xeric	Poor	n/a	n/a	n/a	n/a	n/a	n/a	n/a
4BP001	rare plant	465426	6373864	07/06/2006	JK/JS	FONS	0	n/a	level	n/a	n/a	n/a	Level	Hygric	Medium	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Table M-1 Detailed Vegetation Inventory and Rare Plant Site Summary Data (continued)

Plot Number	Plot Type	UTM Easting (NAD 83)	UTM Northing (NAD 83)	Survey Date (dd/mm/yyyy)	Observers	Ecosite Phase/Wetlands Type	Slope Percent	Aspect (Degrees)	Surface Expression	Riparian Subclass	Flood Hazard	Surface Shape	Slope Position	Moisture Regime	Nutrient Regime	Shrub Cover [%]	Canopy Cover [%]	Forb Cover [%]	Graminoid Cover [%]	Bryophyte Cover [%]	Terrestrial Lichen [%]	Epiphyte Cover [%]
4BP002	rare plant	459899	6368803	22/07/2006	JK/JS	b1	0	n/a	level	n/a	n/a	n/a	Level	3	Poor	n/a	n/a	n/a	n/a	n/a	n/a	n/a
4BP004	rare plant	470015	6392175	22/07/2007	DH/QB	b4	0	238	level	n/a	n/a	n/a	Upper Slope	Subxeric	Medium	n/a	n/a	n/a	n/a	n/a	n/a	n/a
4CP001	rare plant	460969	6373955	05/06/2006	PM/CW	FONS	0	n/a	level	n/a	n/a	n/a	Depression	Subhygric	Medium	n/a	n/a	n/a	n/a	n/a	n/a	n/a
4CP002	rare plant	461448	6371500	06/06/2006	PM/CW	d1	5	100	n/a	n/a	n/a	n/a	Lower Slope	Mesic	Medium	n/a	n/a	n/a	n/a	n/a	n/a	n/a
4CP003	rare plant	461549	6371495	06/06/2006	PM/CW	d2	2	100	level	n/a	n/a	n/a	Lower Slope	Mesic	Medium	n/a	n/a	n/a	n/a	n/a	n/a	n/a
4CP004	rare plant	464398	6370860	07/06/2006	PM/CW	BTNN	0	n/a	level	n/a	n/a	n/a	Level	Subhygric	Rich	n/a	n/a	n/a	n/a	n/a	n/a	n/a
4CP005	rare plant	461988	6363675	08/06/2006	PM/CW	BTNN	0	n/a	level	n/a	n/a	n/a	Level	Subhygric	Medium	n/a	n/a	n/a	n/a	n/a	n/a	n/a
4CP006	rare plant	470614	6394202	22/07/2007	PM/CW	a1	2	200	level	n/a	n/a	n/a	Midslope	VeryXeric	Poor	n/a	n/a	n/a	n/a	n/a	n/a	n/a
4CP007	rare plant	470688	6394334	22/07/2007	PM/CW	a1	1	200	level	n/a	n/a	n/a	Midslope	VeryXeric	Poor	n/a	n/a	n/a	n/a	n/a	n/a	n/a
4CP009	rare plant	468459	6388104	25/07/2007	PM/DH	cutline	0	n/a	level	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

n/a = Not applicable.

Table M-2 Vegetation Mapping Aerial Survey Site Summary Data

Waypoint Name	UTM Easting (NAD 83)	UTM Northing (NAD 83)	Survey Date	Ecosite Phase/Wetlands Type	Dominant Species 1	Dominant Species 2	Dominant Species 3	Dominant Species 4
1	473888	6362277	Sept 2005	clearcut	Sw	Aw	BETUPAP	Grass
2	474100	6362901	Sept 2005	b1	Pj	Aw	Alnus	VACCMYR
3	474020	6363554	Sept 2005	d2	Aw	Sw	VIBUEDU	Alnus
4	473938	6364470	Sept 2005	FONG	Salix	BETU	Aw	Grass
5	473913	6365076	Sept 2005	d2	Aw	Sw	VIBU	–
6	473859	6365516	Sept 2005	FTNN	Sb	Lt	LEDU	SPHA
7	473226	6366450	Sept 2005	FOPN	Lt	Grass	SARRPUR	BETU
8	473017	6367242	Sept 2005	FTNN	Lt	BETUGLA	Grass	SPHA
9	474061	6367123	Sept 2005	FOPN	Lt	BETUGLA	SPHA	SARRPUR
10	474533	6366351	Sept 2005	FONG	Carex	MENYTRI	SPHA	Galium
11	474742	6365808	Sept 2005	e2	Sw	Pb	–	–
12	474949	6365090	Sept 2005	d2	Aw	Sw	VIBU	PETAPAL
13	475273	6363914	Sept 2005	d2	Aw	Sw	VIBU	–
14	475596	6361985	Sept 2005	SONS	Bw	Salix	Carex	BETUGLA
15	477094	6364854	Sept 2005	d1	Aw	Sw (5%)	CORNCAN	VACCMYR
16	477325	6365790	Sept 2005	d1	Aw	Sw	VIBUEDU	EPILANG
17	477233	6366142	Sept 2005	shrubland	VACCMYR	Aw (+)	CLADMIT	ALNUCRI
18	477233	6366322	Sept 2005	d2	Aw	Sw	VIBUEDU	CORNCAN
19	476709	6364949	Sept 2005	shrubland	Pj	CLADMIT	VACCMYR	ARCTUVA
20	476649	6363381	Sept 2005	a1	Pj	LEDUGRO	CLADMIT	PLEUSCH
21	476519	6361997	Sept 2005	g1	Sb	Pj	CLADMIT	LEDUGRO (50%)
22	476550	6361416	Sept 2005	FONG	Carex	ANDRPOL	SPHA	Sb
23	477056	6359898	Sept 2005	b1	Aw	Pj	Alnus	VACCMYR
24	476975	6358852	Sept 2005	a1	CLADMIT	Pj	ARCTUVA	CLADSTE
25	477350	6356881	Sept 2005	FONS	Sb	Lt	Carex	BETUGLA
26	477540	6355523	Sept 2005	FTPN	Lt	BETUGLA	Carex	SPHA
27	477647	6354545	Sept 2005	FONS	Salix	Carex	RUBUPUB	–
28	477679	6353543	Sept 2005	BTNN	Sb	Ledum	SPHAFUS	CLADMIT
29	477513	6350619	Sept 2005	e2	Sw	Pb	LEDUGRO	PLEUSCH
30	479398	6351050	Sept 2005	d1	Aw	Viburnum	Sw	Aw (shrub)
31	479180	6352377	Sept 2005	FONS	Lt	Carex	SPHA	SARRPUR
32	479087	6353615	Sept 2005	FTPN	Lt	Carex	BETUGLA	SPHA
33	478998	6355000	Sept 2005	FONS	Salix	Carex	SPHA	Pb (nearby)
34	478660	6357158	Sept 2005	FONS	Lt	Sb	BETUGLA	SPHA
35	478396	6358682	Sept 2005	b2	Bw	Pj	CLADMIT	ARCTUVA
36	478403	6360577	Sept 2005	b2	Bw	Pj	CLADMIT	VACCMYR
37	478346	6362261	Sept 2005	b1	Pj	Aw	CLADMIT	VACCMYR
38	478241	6363865	Sept 2005	a1	Pj	CLADMIT	PLEUSCH	VACCMYR
39	478973	6364777	Sept 2005	b2	Bw	Aw	Sw	VACCMYR
40	481185	6350435	Sept 2005	STNN	Sb	Lt	Salix	Carex
41	481464	6350766	Sept 2005	burn	VACCMYR	Carex	SPHA	PETASAG
42	481329	6351642	Sept 2005	BTNN	Sb	Lt	SPHA	Ledum
43	481715	6352621	Sept 2005	FONG	Carex	MENYTRI	SPHA	CALTPAL
44	481817	6353027	Sept 2005	b4	Pj	Sw	Ledum	PLEUSCH
45	482110	6354113	Sept 2005	FTNN	Lt	BETUGLA	Carex	SPHA
46	482532	6355149	Sept 2005	FTNN	Lt	Sb	Salix	SPHA
47	482479	6357438	Sept 2005	FTNN	Sb	Lt (few)	LEDUGRO	PLEUSCH
48	482254	6359195	Sept 2005	FONS	Lt	BETUGLA	Carex	SPHA
49	481752	6360983	Sept 2005	FTPN	Lt	Sb	BETUGLA	SPHA
50	481142	6362831	Sept 2005	d2	Aw	Sw	VIBUEDU	–
51	480933	6364152	Sept 2005	b1	Pj	Aw (+)	PLEUSCH	CLADMIT
52	481023	6364819	Sept 2005	b3	Aw	Sw	Bw	VACCMYR
53	482674	6364705	Sept 2005	FTNN	Lt	Sb	Carex	SPHAFUS

Table M-2 Vegetation Mapping Aerial Survey Site Summary Data (continued)

Waypoint Name	UTM Easting (NAD 83)	UTM Northing (NAD 83)	Survey Date	Ecosite Phase/Wetlands Type	Dominant Species 1	Dominant Species 2	Dominant Species 3	Dominant Species 4
54	482737	6363545	Sept 2005	FTNN	Sb	Lt	SPHA	LEDUGRO
55	482836	6362104	Sept 2005	FTNN	Lt	Sb	SPHA	BETULA
56	482909	6361105	Sept 2005	STNN	Lt	Bw	–	Sb
57	483015	6359696	Sept 2005	FONS	Salix	Carex	SPHA	ALNU
58	483120	6358334	Sept 2005	FONS	BETULA	CAREX	SPHA	MENYTRI
59	483214	6357188	Sept 2005	FONS	Lt	BETUGLA	Carex	SPHA
60	483198	6355387	Sept 2005	FTNN	Lt	Sb	BETUGLA	SPHA
61	483238	6353153	Sept 2005	Burn	Salix	CAREX	PETASAG	LEDUGRO
62	483884	6350561	Sept 2005	clearcut	Bw(shrub)	ALNUS	Aw	Grass
63	483142	6353748	Sept 2005	FONG	Carex	CALTPAL	MENYTRI	SPHA
64	482845	6355050	Sept 2005	BTNN	Sb	Lt	LEDUGRO	SPHAFUS
65	482848	6356761	Sept 2005	FTNN	Lt	BETULA	CAREX	SPHA1
66	482914	6357710	Sept 2005	FTNN	Sb	Lt	SPHAFUS	LEDUGRO
67	483217	6360071	Sept 2005	STNN	Sb	Bw	CAREX	TYPHA
68	482973	6362979	Sept 2005	FONS	Lt	BETUGLA	SPHA	CAREX
69	483826	6364877	Sept 2005	BTNN	Sb	SPHAFUS	CLADMIT	CHAMCAL
70	484314	6364797	Sept 2005	BONN	SPHAFUS	ANDRPOL	Sb	ERIOspp
71	485489	6367112	Sept 2005	BONN	Sb	LEDUGRO	SPHAFUS	CAREX
72	485631	6365930	Sept 2005	FOPN	BETUGLA	CAREX	MENYTRI	SPHA
73	485923	6364910	Sept 2005	BTNN	Sb	SPHAFUS	CLADMIT	LEDUGRO
74	485967	6363288	Sept 2005	FTNN	Lt	BETUGLA	CAREX	SPHA
75	486141	6362557	Sept 2005	d3	Aw	Sw	VACCMYR	ARCTUVA
76	486197	6361153	Sept 2005	FONS	BETUGLA	CAREX	SALIX	SPHA
77	486302	6359294	Sept 2005	STNN	Sb	Bw	Salix	Carex
78	486418	6357843	Sept 2005	FTNN	Lt	BETUGLA	CAREX	SPHA
79	487145	6354084	Sept 2005	d1	Aw	Bw	ALNUCRI	VIBUEDU
80	486379	6358053	Sept 2005	FONS	Lt	BETUGLA	Carex	SPHA
81	486544	6359143	Sept 2005	STNN	Sb	Bw	SALIX	CAREX
82	486662	6360773	Sept 2005	FONS	Lt	BETUGLA	Carex	SPHA
83	486366	6361969	Sept 2005	d1	Aw	Sw	VIBU	Grass
84	486299	6363110	Sept 2005	FONS	Salix	BETUGLA	Grass	SPHA
85	486199	6364760	Sept 2005	FONG	Carex	CHAMCAL	BETUGLA	SARRPUR
86	486359	6365530	Sept 2005	FTPN	Sb	SPHAFUS	LEDUGRO	CHAMCAL
87	486976	6367065	Sept 2005	FTPN	CHAMCAL	CLAPMIT	CAREX	SARRPUR
88	486975	6367063	Sept 2005	FTPN	Sb	Salix	SPHAFUS	CLADMIT
89	487055	6369054	Sept 2005	FOPN	Lt	BETUGLA	Salix	SPHA
90	487508	6370441	Sept 2005	FOPN	Lt	BETUGLA	MENYTRI	Carex
91	487592	6371419	Sept 2005	STNN	Sw	Lt	Aw	Bw
92	488458	6368261	Sept 2005	FOPN	Lt	BETUGLA	MENYTRI	Carex
93	488480	6367037	Sept 2005	FOPN	Lt	BETUGLA	LEDUGRO	Carex
94	488413	6365970	Sept 2005	FTPN	Lt	Sb	BETUGLA	LEDUGRO
95	488554	6364327	Sept 2005	d1	Aw	VIBUEDU	ALNU	CORNCAN
96	488466	6363939	Sept 2005	FONS	BETUGLA	CHAMCAL	Salix	CAREX
97	489252	6365040	Sept 2005	FTNN	Sb	Lt	Bw understorey	BETUGLA
98	489853	6366115	Sept 2005	FTNN	Lt	Sb understorey	SALIX	CAREX
99	490201	6366875	Sept 2005	FONG	CAREX	BETUGLA	Lt	SPHA
100	491325	6367798	Sept 2005	FTNN	Lt	Sb	LEDUGRO	CAREX
101	490779	6368366	Sept 2005	FTNN	Lt	BETUGLA	SALIX	CAREX
102	490737	6368563	Sept 2005	FONG	CAREX	TYPHA	POTEPAL	SPHA
103	489754	6369333	Sept 2005	FTNN	Lt	BETUGLA	CAREX	SPHA
104	489462	6369506	Sept 2005	FONG	CAREX	MENYTRI	SALIX(+)	EQUI
105	489901	6368922	Sept 2005	FONS	BETUGLA	CAREX	Lt	SALIX

Table M-2 Vegetation Mapping Aerial Survey Site Summary Data (continued)

Waypoint Name	UTM Easting (NAD 83)	UTM Northing (NAD 83)	Survey Date	Ecosite Phase/Wetlands Type	Dominant Species 1	Dominant Species 2	Dominant Species 3	Dominant Species 4
106	490251	6368168	Sept 2005	FTNN	Lt	BETUGLA	CAREX	SPHA
107	490647	6367215	Sept 2005	BTNN	Sb	LEDUGRO	SPHAFUS	CLADMIT
108	491448	6366410	Sept 2005	b3	Aw	Sw	VACCMYR	ARCTUVA
109	459372	6368067	Sept 2005	b1	Pj	Aw	CORNCAN	PLEUSCH
110	459325	6368716	Sept 2005	b1	Pj	Aw	ALNUS	–
111	459356	6369436	Sept 2005	d1	Aw	ALNUS	VIBEDU	CORNCAN
112	459289	6370370	Sept 2005	b4	Sw	Pj	Aw	PLEUSCH
113	459248	6371325	Sept 2005	e1	Aw	Pb	Sw in understorey	PETAPAL
114	459249	6371516	Sept 2005	Riparian	Bw	ALNU	CAREX	SALIX
115	459237	6372476	Sept 2005	b1	Aw	Pj	Sw	Grass
116	459202	6373660	Sept 2005	d2	Aw	Sw	Pj (Some)	VIBUEDU
117	459344	6374662	Sept 2005	MONG	CAREX	TYPHA	POTEPAL	SALIX(+)
118	459483	6375791	Sept 2005	e2	Sw	Pb	CLADMIT	PLEUSCH
119	459430	6376213	Sept 2005	MONS	CAREX	TYPHA	SALIX	Bw
120	461397	6376031	Sept 2005	FONG	CAREX (95%)	SALIX	RUMEX(+)	–
121	461476	6374830	Sept 2005	d1	Aw	EPIL	PETAPAL	–
122	461512	6373595	Sept 2005	b3	Sw (dominant)	Aw	Pj	Bw(+)
123	461564	6372150	Sept 2005	d2	Aw	Sw	Pj	ALNU
124	461646	6371076	Sept 2005	d2	Aw	Sw	Pj	PLEUSCH
125	461538	6370138	Sept 2005	b2	Aw	Bw	Sw	Pj
126	461400	6369430	Sept 2005	d1	Aw	ALNU	VIBU	Sw understorey
127	461306	6369141	Sept 2005	Riparian	ALNU	SALIX	–	–
128	461303	6369208	Sept 2005	STNN	Sb	Lt	Bw	SALIX
129	461040	6368239	Sept 2005	FTNN	Sb	Lt	RUBUCHA	SPHA
130	462604	6368119	Sept 2005	e1	Aw	Pb	Sw	VIBUEDU
131	462334	6369128	Sept 2005	FTNN	Sb	Lt	LEDUGRO	Moss
132	462605	6370265	Sept 2005	FTNN	Sb	Lt	LEDUGRO	SPHA
133	462540	6371208	Sept 2005	b1	Pj	Aw	Pb	PLEUSCH
134	462435	6372678	Sept 2005	BTNN	Sb	LEDUGRO	Moss	CLADMIT
135	462230	6373555	Sept 2005	d2	Aw	Sw	PLEUSCH	–
136	462193	6373784	Sept 2005	FONG	CAREX	SALIX	Bw	CALACAN
137	462162	6375054	Sept 2005	d2	Sw	Aw	PLEUSCH	Grass
138	462345	6376141	Sept 2005	b1	Aw	Pj	EPIL	ALNU
139	462536	6378029	Sept 2005	d1	Aw	Sw understorey	PLEUSCH	–
140	463937	6377677	Sept 2005	FTNN	Sb	Lt	SPHA	CLADMIT
141	463906	6376782	Sept 2005	MONG	Typha	CAREX	ARUM	ALNU
142	463945	6375567	Sept 2005	d2	Aw	Sw	VIBU	PLEUSCH
143	463878	6374699	Sept 2005	d2	Aw	Sw	PLEUSCH	EPIL
144	463836	6374159	Sept 2005	d2	Sw	Bw	Aw	PLEUSCH
145	463860	6373166	Sept 2005	d2	Aw	Sw	VIBU	LEDUGRO
146	463887	6372145	Sept 2005	FTNN	Sb	Lt	SPHAFUS	LEDUGRO
147	463973	6371166	Sept 2005	FTNN	Lt	BETUGLA	SPHA	CAREX
148	463891	6370262	Sept 2005	FTNN	Sb	Lt	LEDUGRO	SPHA
149	463751	6369333	Sept 2005	d2	Aw	Sw	VIBU	Grass
150	463840	6369003	Sept 2005	e1	Pb	–	–	–
151	465200	6371177	Sept 2005	d2	Aw	Sw	ROSA	Grass
152	465030	6372019	Sept 2005	BTNN	Sb	LEDUGRO	RUBUCHA	SPHA
153	465038	6372624	Sept 2005	d2	Aw	Sw	VIBU	CORNCAN
154	465226	6373310	Sept 2005	d1	Aw	Pb	Sw(+)	CORNCAN

Table M-2 Vegetation Mapping Aerial Survey Site Summary Data (continued)

Waypoint Name	UTM Easting (NAD 83)	UTM Northing (NAD 83)	Survey Date	Ecosite Phase/Wetlands Type	Dominant Species 1	Dominant Species 2	Dominant Species 3	Dominant Species 4
155	465394	6374031	Sept 2005	FONS	Lt	BETUGLA	CAREX	POTEPAL
156	465454	6374865	Sept 2005	BTNN	Sb	SALIX	LEDUGRO	SPHAFUS
157	465502	6375996	Sept 2005	d2	Sw	Aw	VIBU	PLEUSCH
158	465174	6377138	Sept 2005	d2	Aw	Sw	ROSA	EPIL
159	464771	6377795	Sept 2005	d2	Aw	Sw	Pb	PLEUSCH
160	465971	6377514	Sept 2005	d2	Aw	Sw	VIBU	–
161	466083	6376760	Sept 2005	d3	Sw	Sb	VIBU	LEDUGRO
162	466211	6375821	Sept 2005	g1	Sb	Pj	Lt	SPHA
163	466326	6375225	Sept 2005	FONS	Lt	SALIX	BETUGLA	CAREX
164	466457	6374777	Sept 2005	BTNN	Sb	LEDUGRO	PLEUSCH	CLADMIT
165	466530	6373946	Sept 2005	e1	Aw	Pb	Sw understorey	ROSA
166	465865	6372855	Sept 2005	d1	Aw	Sw	VIBU	ARALNUD
167	466909	6373892	Sept 2005	d1	Aw	EPIL	VIBU	Bw
168	466575	6375454	Sept 2005	FONS	BETUGLA	CAREX	SPHA	Lt
169	466390	6376375	Sept 2005	FTNN	Lt	BETUGLA	SPHA	CAREX
170	467014	6377733	Sept 2005	FTNN	Sb	Lt	SPHA	SPHAFUS
171	467579	6378294	Sept 2005	STNN	Aw	Bw	SALIX	Sw understorey
172	469060	6379174	Sept 2005	e3	Sw	Bw understorey	ALNU	–
173	469009	6380122	Sept 2005	shrubland	SALIX	VIBU	–	–
174	468849	6381733	Sept 2005	FONG	CAREX	TYPHA	EQUI	SALIX(+)
175	468951	6382962	Sept 2005	e1	Pb	Shrubs	–	–
176	469070	6384398	Sept 2005	e1	Aw	Pb	Sw(+)	shrubs
177	469173	6384979	Sept 2005	b1	Pj	Aw	PLEUSCH	ARCTUVA
178	469032	6385815	Sept 2005	a1	Pj	Aw	PLEUSCH	CLADMIT
179	467456	6385801	Sept 2005	b1	Pj	Aw	VACCMYR	ARCTUVA
180	467595	6384854	Sept 2005	a1	Pj	VACCMYR	ARCTUVA	CLADMIT
181	467407	6383898	Sept 2005	b1	Aw	Pj	VACCMYR	–
182	467517	6382839	Sept 2005	b1	Aw	Pj	Sw	PLEUSCH
183	467902	6381340	Sept 2005	d1	Aw	VIBU	ROSA	Sw understorey
184	467748	6380676	Sept 2005	FTNN	Sb	Lt	SALIX	LEDUGRO
185	467626	6379675	Sept 2005	STNN	Lt	Sb	Bw	SALIX
186	465906	6379344	Sept 2005	d2	Sw	Aw	PLEU	VIBU
187	465790	6380169	Sept 2005	b3	Aw	Sw	Pj	PLEU
188	465774	6380934	Sept 2005	SONS	Sb	SALIX (dom.)	Lt	–
189	465835	6382091	Sept 2005	b1	Pj	Aw	ALNU	–
190	465830	6383022	Sept 2005	STNN	Bw	ALNU	SALIX	CAREX
191	465827	6384468	Sept 2005	c1	Sb	Pj	VACCMYR	ARCTUVA
192	465754	6385846	Sept 2005	FONS	Lt	BETUGLA	SALIX	CAREX
193	465732	6386536	Sept 2005	FONG	CAREX	SALIX	Typha	–
194	464256	6385626	Sept 2005	FONS	Lt	SALIX	BETUGLA	CAREX
195	464425	6384638	Sept 2005	FTNN	Sb	Lt	LEDUGRO	SPHAFUS
196	464585	6383823	Sept 2005	FONG	CAREX	SPHA	BETUGLA	SALIX
197	465063	6382669	Sept 2005	d2	Aw	Sw	PLEU	–
198	465051	6381611	Sept 2005	b1	Pj	Aw	PLEU	FRAGVIR
199	464811	6380690	Sept 2005	SONS	Bw	SALIX	CAREX	–
200	464688	6380635	Sept 2005	STNN	Bw	ALNU	SALIX	CAREX
201	464414	6379273	Sept 2005	STNN	Bw	Lt	SALIX	CAREX
202	462383	6379414	Sept 2005	b3	Aw	Sw	VACCMYR	PLEUSCH
203	462379	6380197	Sept 2005	d2	Aw	Sw	VIBU	MAIACAN

Table M-2 Vegetation Mapping Aerial Survey Site Summary Data (continued)

Waypoint Name	UTM Easting (NAD 83)	UTM Northing (NAD 83)	Survey Date	Ecosite Phase/Wetlands Type	Dominant Species 1	Dominant Species 2	Dominant Species 3	Dominant Species 4
204	462292	6381424	Sept 2005	d1	Aw	Sw understorey	Grass	CORNCAN
205	462236	6382046	Sept 2005	STNN	Pb	ALNUS	SALIX	Grass
206	462501	6383409	Sept 2005	STNN	Sb	Aw	ALNU	SALIX
207	462574	6384451	Sept 2005	e2	Sw	Pb	SALIX	ALNU
208	462766	6385848	Sept 2005	d1	Aw	VIBU	Sw understorey	–
209	461131	6385809	Sept 2005	d1	Aw	VIBU	Pb	Sw
210	460940	6384874	Sept 2005	STNN	Sb	Lt	Aw	Bw
211	461099	6383063	Sept 2005	STNN	SALIX	ALNU	Bw	Grass
212	460741	6381489	Sept 2005	e3	Sw	Shrubs	–	–
213	460725	6380662	Sept 2005	e2	Sw	Pb	ALNU	VIBU
214	460913	6379392	Sept 2005	d2	Aw	Sw	VIBU (dom.)	ALDER
215	459331	6379346	Sept 2005	d1	Aw	VIBU	EPIL	CORNCAN
216	459312	6380282	Sept 2005	d1	Aw	VIBU	CORNCAN	Aw shrub and understorey
217	459008	6381349	Sept 2005	FONG	CAREX	CALACAN	Bw	–
218	458989	6383162	Sept 2005	SONS	SALIX	ALNU	Bw	CAREX
219	459216	6385067	Sept 2005	STNN	Lt	Sb	PLEU	–
220	459495	6386205	Sept 2005	d3	Sw	PLEU	CORNCAN	VIBU
221	458196	6385755	Sept 2005	d1	Aw	VIBU	ROSA	CORNCAN
222	458549	6383531	Sept 2005	STNN	Lt	Bw	SALIX	ALNUS
223	458609	6381819	Sept 2005	d2	Sw	Aw	VIBU	Aw (shrub)
224	457935	6379294	Sept 2005	d1	Aw	VIBU	–	–
225	456716	6379270	Sept 2005	FTNN	Lt	Sb	PLEU	–
226	456916	6380922	Sept 2005	f3	Sw	VIBU	EQUI	ALNUS
227	457152	6382001	Sept 2005	d3	Sw	VIBU	PLEU	Bw understorey
228	456877	6383221	Sept 2005	STNN	Bw	ALDER	SALIX	Grass
229	480342	6350362	Sept 2005	FTNN	Lt	Sb	BETUGLA	LEDUGRO
230	479880	6351420	Sept 2005	d2	Aw	Sw	VIBU	PLEU
231	479832	6352077	Sept 2005	h1	Sb understorey-like (shorter)	Sw	LEDUGRO	PLEU
232	479106	6352550	Sept 2005	FTPN	Sb	Lt	BETUGLA	CAREX (open areas)
233	479938	6353426	Sept 2005	BTNN	Sb	Lt	PLEU	SPHAFUS
234	480172	6354382	Sept 2005	FONG	CAREX	EQUI	SPHA	MENYTRI
235	480583	6355423	Sept 2005	FTNN	Lt	Sb understorey only	BETUGLA	LEDUGRO
236	481056	6356680	Sept 2005	FTNN	Lt	Sb	SPHA	SALIX
237	–	–	Sept 2005	–	–	–	–	–
238	–	–	Sept 2005	–	–	–	–	–
239	480079	6359982	Sept 2005	FONS	Lt (<5m)	Sw	BETUGLA	CAREX
240	479989	6360466	Sept 2005	d2	Aw	Sw	Pj	PLEU
241	474765	6360783	Sept 2005	b1	Aw	Pj	Bw	ARCTUVA
242	479702	6361969	Sept 2005	a1	Pj	Aw understorey	Bw understorey	CLADMIT
243	479601	6362845	Sept 2005	a1	Pj	CLADMIT	PLEU	ARTUVA
244	479547	6363660	Sept 2005	b2	Bw	Pj	Sw	PLEU
245	479884	6364724	Sept 2005	f1	Aw	Pb	Bw	SALIX
246	481787	6367871	Sept 2005	FONG	CAREX	SPHA	CALTPAL	BETUGLA
247	482065	6368354	Sept 2005	FONS	Lt (<5m)	BETUGLA	SPHA	CAREX
248	481074	6368531	Sept 2005	FTNN	Lt	SPHA	ALNU	Water - rich
249	482046	6364677	Sept 2005	STNN	Lt	Bw	PLEU	Sb (fringe)

Table M-2 Vegetation Mapping Aerial Survey Site Summary Data (continued)

Waypoint Name	UTM Easting (NAD 83)	UTM Northing (NAD 83)	Survey Date	Ecosite Phase/Wetlands Type	Dominant Species 1	Dominant Species 2	Dominant Species 3	Dominant Species 4
250	482167	6363552	Sept 2005	BTNI	Sb	PLEU	SPHAFUS	LEDUGRO
251	481863	6362200	Sept 2005	FTNN	Lt	Sb	BETUGLA	CAREX
252	481326	6359311	Sept 2005	STNN	Sb	Sw	Bw	ALNU
253	481154	6357491	Sept 2005	BTNN	Sb	LEDUGRO	SPHAFUS	CLADMIT
254	481078	6354997	Sept 2005	STNN	Sb	Bw understorey, tall ones are dead	SALIX	CAREX
255	480904	6355064	Sept 2005	c1	Pj	Sb	Aw (+ in understorey)	PLEU
256	481162	6353485	Sept 2005	FTNN	Lt	Sb	BETUGLA	CAREX
257	481522	6352797	Sept 2005	g1	Sb	Pj	LEDUGRO	PLEU
258	481368	6352346	Sept 2005	d1	Aw	Sw (some)	CORNCAN	VIBU
259	481794	6350486	Sept 2005	Burn	Bw	VACCMYR	PLEU	Grass
260	487869	6353509	Sept 2005	FTNN	Lt	Sb	CORNCAN	SALIX
261	487670	6354658	Sept 2005	Burn	Aw (shrub size)	ALNUS	Grass	VACYMYR
262	487684	6355693	Sept 2005	FTNN	Lt	Sb	ALNUS	SALIX
263	487818	6360538	Sept 2005	FTNN	Sb	Lt	LEDUGRO	SPHA
264	487971	6361741	Sept 2005	SONS	SALIX	ALNU	Bw	Grass
265	487996	6362410	Sept 2005	FONG	CAREX	TYPHA	EQUI	MENYTRI
266	488017	6363300	Sept 2005	d1	Aw	Sw understorey	VIBU	CORNCAN
267	488016	6363848	Sept 2005	BTNN	Sb	Lt (+)	LEDUGRO	SPHAFUS
268	488173	6364789	Sept 2005	FONS	BETUGLA	SPHA	CAREX	Lt (<5m, +)
269	487979	6365840	Sept 2005	FTPN	CAREX	SARRPUR	SPHA	–
270	488055	6366325	Sept 2005	FTPN	Sb	Lt	LEDUGRO	SPHAFUS
271	488013	6367359	Sept 2005	FOPN	CAREX	SPHA	SARRPUR	Lt
272	486560	6366953	Sept 2005	FTPN	Sb/Lt	CAREX	SPHA	SARRPUR
273	487644	6364356	Sept 2005	c1	Pj	Sb	LEDUGRO	PLEU
274	487968	6363652	Sept 2005	b1	Aw	Sw understorey	ARCTUVA	VIBU
275	488184	6362483	Sept 2005	SONS	SALIX	ALNU	CAREX	Bw (<5m)
276	488607	6361355	Sept 2005	c1	Sb	Pj	Bw understorey	CLADMIT almost exclusively
277	488849	6360493	Sept 2005	SONS	ALDER	SALIX	Grass	–
278	489478	6359712	Sept 2005	b2	Aw	Sw	VACCMYR	ALNU
279	489026	6360108	Sept 2005	b4	Sw	Pj	ALNU	SALIX
280	491056	6356036	Sept 2005	d1	Aw	Sw subcanopy	Grass	EPIL
001	452765	6379635	Sept 2006	d2	Aw	Sw	ALNUS	VIBUEDU
002	453065	6380481	Sept 2006	SONS	Sw	Aw	TYPHA	CAREX
003	453202	6380915	Sept 2006	d2	Aw	Sw	VIBUEDU	ALNUS
004	453526	6382051	Sept 2006	STNN	Bw	Sw	CAREX	ALNUS
005	453828	6382953	Sept 2006	MONG	Bw	CAREX	TYPHA	SALIX
006	453651	6383959	Sept 2006	d1	Aw	ALNUS	VIBUEDU	Bw
007	453800	6381163	Sept 2006	STNN	Sb	Bw	CAREX	ALNUS
008	454375	6380039	Sept 2006	STNN	Sb	Bw	CAREX	ALNUS
009	455070	6380808	Sept 2006	BTNN	Sb	LEDUGRO	feathermoss	CAREX
010	455252	6381893	Sept 2006	d1	Aw	VIBUEDU	Sw	–
011	455416	6383591	Sept 2006	d3	Sw	Pb	VIBUEDU	VACCMYR
012	455487	6384014	Sept 2006	SONS	SALIX	CAREX	–	–
013	455310	6384479	Sept 2006	STNN	Sb	Aw	Bw	SPHAG
014	455178	6387262	Sept 2006	d2	Sw	Pb	VIBUEDU	–
015	455067	6388627	Sept 2006	d1	Aw	Pb	VIBUEDU	–

Table M-2 Vegetation Mapping Aerial Survey Site Summary Data (continued)

Waypoint Name	UTM Easting (NAD 83)	UTM Northing (NAD 83)	Survey Date	Ecosite Phase/Wetlands Type	Dominant Species 1	Dominant Species 2	Dominant Species 3	Dominant Species 4
016	455481	6388868	Sept 2006	d2	Sw	Pb	VACCMYR	VIBUEDU
017	455514	6387639	Sept 2006	d2	Sw	Aw	feathermoss	VIBUEDU
018	455440	6386441	Sept 2006	d2	Sw	Aw	Pb	VIBUEDU
019	455330	6385412	Sept 2006	STNN	Bw	SALIX	ALNUS	CAREX
020	456027	6383929	Sept 2006	SONS	SALIX	ALNUS	CAREX	Bw
021	456105	6383428	Sept 2006	STNN	Sb	Bw	Pb	CAREX
022	456241	6382287	Sept 2006	d3	Sw	ALNUS	feathermoss	VIBUEDU
023	456319	6380702	Sept 2006	d2	Aw	Sw	feathermoss	VIBUEDU
024	456260	6379634	Sept 2006	Meadow	grass	Bw (shrub)	Aw (shrub)	–
025	456587	6379008	Sept 2006	FTNN	Sb	Lt	LEDUGRO	SPHAFUS
026	457206	6380340	Sept 2006	d3	Sw	Pb	feathermoss	ALNUS
027	457166	6381170	Sept 2006	SONS	SALIX	ALNUS	CAREX	–
028	457120	6381934	Sept 2006	d3	Sw	grass	VIBUEDU	Bw
029	457074	6382344	Sept 2006	d2	Pb	Sw	Aw	feathermoss
030	457024	6383154	Sept 2006	MONG	TYPHA	CAREX	ALNUS	Bw
031	457011	6384167	Sept 2006	MONG	CAREX	TYPHA	–	–
032	457151	6385545	Sept 2006	d1	Aw	CORNCAN	VIBUEDU	ALNUS
033	457193	6386396	Sept 2006	d2	Sw	Aw	Bw	ALNUS
034	457222	6387001	Sept 2006	Meadow	RUBUIDA	EPILANG	grass	–
035	457294	6387781	Sept 2006	d1	Bw	Aw	Pb	grass
036	457359	6388598	Sept 2006	d1	Aw	VIBUEDU	ARALNUD	Sw
037	457464	6388941	Sept 2006	BTNN	Sb	SPHAG	LEDUGRO	CLADMIT
038	458059	6389061	Sept 2006	BTNN	Sb	SPHAG	LEDUGRO	CLADMIT
039	458316	6388167	Sept 2006	d1	Aw	Bw	grass	ALNUS
040	458469	6387156	Sept 2006	d1	Aw	CORNCAN	VIBUEDU	Sw
041	458443	6386418	Sept 2006	d2	Aw	Sw	feathermoss	VIBUEDU
042	459360	6386179	Sept 2006	b3	Sw	Aw	VACCMYR	VIBUEDU
043	459255	6387148	Sept 2006	d2	Aw	Sw	Bw	grass
044	459111	6387895	Sept 2006	STNN	Bw	SALIX	ALNUS	grass
045	458888	6388486	Sept 2006	MONG	TYPHA	CAREX	–	–
046	458827	6388800	Sept 2006	BTNN	Sb	SPHAG	LEDUGRO	CLADMIT
047	458785	6389568	Sept 2006	d1	Aw	VIBUEDU	–	–
048	460247	6389898	Sept 2006	d1	Aw	Pb	VIBUEDU	ROSA
049	460381	6389411	Sept 2006	SONS	SALIX	CAREX	–	–
050	460378	6388723	Sept 2006	MONG	CAREX	TYPHA	SALIX	RUMEX
051	460349	6388033	Sept 2006	SONS	ALNUS	SALIX	Bw	CAREX
052	460342	6386445	Sept 2006	d3	Sw	ALNUS	feathermoss	grass
053	460543	6385652	Sept 2006	d1	Aw	feathermoss	CORNCAN	Sw (understorey)
054	461681	6386479	Sept 2006	d2	Aw	Pb	Sw	CORNCAN
055	461724	6386665	Sept 2006	d1	Aw	feathermoss	VIBUEDU	Sw (understorey)
056	461632	6387325	Sept 2006	STNN	Bw	Lt	CAREX	SALIX
057	461384	6387515	Sept 2006	STNN	Lt	Bw	SALIX	CAREX
058	461373	6388192	Sept 2006	FTNN	Sb	Lt	LEDUGRO	SPHAG
059	461417	6388573	Sept 2006	SONS	SALIX	ALNUS	grass	–
060	462508	6389157	Sept 2006	f3	Sw	EQUI	SPHA	ALNUS
061	462610	6387977	Sept 2006	d1	Aw	grass	EPILANG	–
062	462615	6387106	Sept 2006	b3	Sw	Aw	Bw	VACCMYR
063	462656	6385946	Sept 2006	STNN	Sb	Aw	Bw	ALNUS
064	462991	6386462	Sept 2006	FTNN	Lt	SPHAG	Bw	SALIX
065	462999	6387296	Sept 2006	d2	Sw	Bw	CORNCAN	SALIX
066	462956	6387923	Sept 2006	d1	Aw	EPILANG	CORNCAN	Sw (understorey)

Table M-2 Vegetation Mapping Aerial Survey Site Summary Data (continued)

Waypoint Name	UTM Easting (NAD 83)	UTM Northing (NAD 83)	Survey Date	Ecosite Phase/Wetlands Type	Dominant Species 1	Dominant Species 2	Dominant Species 3	Dominant Species 4
067	463030	6388520	Sept 2006	FTNN	Sb	SPHAG	LEDUGRO	EPILANG
068	463005	6388984	Sept 2006	FTNN	Lt	SPHAG	CAREX	ALNUS
069	461776	6389920	Sept 2006	d1	Aw	VIBUEDU	CORNCAN	ARALNUD
070	461740	6390408	Sept 2006	d1	Aw	VIBUEDU	ALNUS	Sw (understorey)
071	461731	6390878	Sept 2006	FTNN	Sb	Lt	SPHAFUS	LEDUGRO
072	461685	6391593	Sept 2006	d1	Aw	ALNUS	VIBUEDU	–
073	461623	6392046	Sept 2006	FTNN	Sb	Lt	SPHAFUS	VACCVIT
074	461577	6392640	Sept 2006	FONG	grass	TYPHA	EPILANG	SALIX
075	461545	6392884	Sept 2006	BTNN	Sb	SPHAFUS	LEDUGRO	CLADMIT
076	461602	6393978	Sept 2006	STNN	Bw	SALIX	CAREX	–
077	461587	6394732	Sept 2006	FTNN	Sb	SPHAG	SALIX	CAREX
078	461558	6395490	Sept 2006	b1	Aw	feathermoss	VACCVIT	Pj
079	461603	6395699	Sept 2006	STNN	Bw	SALIX	ALNUS	CAREX
080	461689	6396862	Sept 2006	d1	Aw	SALIX	ALNUS	–
081	461742	6397165	Sept 2006	FTNN	Sb	Bw	Lt	SPHAG
082	461800	6397913	Sept 2006	BTNN	Sb	SPHAFUS	LEDUGRO	CLADMIT
083	461835	6398898	Sept 2006	d1	Aw	feathermoss	CORNCAN	Sw (understorey)
084	462993	6398738	Sept 2006	FTNN	Sb	LEDUGRO	SPHAFUS	CAREX
085	463107	6397668	Sept 2006	STNN	Bw	SALIX	CAREX	SPHAG
086	462988	6396442	Sept 2006	STNN	Bw	SALIX	CAREX	–
087	462846	6395386	Sept 2006	d1	Aw	feathermoss	ROSA	–
088	462580	6394360	Sept 2006	d1	Aw	Sw (understorey)	CORNCAN	feathermoss
089	462454	6393763	Sept 2006	STNN	Bw	CAREX	ALNUS	SALIX
090	462017	6393157	Sept 2006	FONG	CAREX	TYPHA	SALIX	POTEPAL
091	462927	6391862	Sept 2006	STNN	SALIX	Bw	CAREX	ALNUS
092	462514	6390990	Sept 2006	d1	Aw	VIBUEDU	ROSA	Sw
093	462560	6389630	Sept 2006	BTNN	Sb	SPHAFUS	LEDUGRO	CLADMIT
094	463788	6386212	Sept 2006	SONS	SALIX	ALNUS	CAREX	TYPHA
095	463711	6387380	Sept 2006	d1	Aw	Bw	ALNUS	grass
096	463671	6388428	Sept 2006	FTNN	Sb	SALIX	SPHAG	Lt
097	463744	6389158	Sept 2006	BTNN	Sb	LEDUGRO	SPHAFUS	CLADMIT
098	463790	6389469	Sept 2006	b3	Sw	Pb	feathermoss	VACCMYR
099	463770	6390204	Sept 2006	d1	Aw	VIBUEDU	ROSA	feathermoss
100	463925	6390803	Sept 2006	b3	Sw	VACCMYR	feathermoss	VIBUEDU
101	463928	6391962	Sept 2006	d1	Aw	feathermoss	ROSA	VIBUEDU
102	464009	6392683	Sept 2006	STNN	SALIX	Bw	CAREX	ALNUS
103	463844	6393774	Sept 2006	d1	Aw	VIBUEDU	CORNCAN	Sw (understorey)
104	463862	6394488	Sept 2006	STNN	SALIX	Bw	BETULA	CAREX
105	464096	6395950	Sept 2006	d3	Sw	CORNCAN	feathermoss	VIBUEDU
106	464118	6396524	Sept 2006	STNN	Bw	Lt	SALIX	CAREX
107	464111	6397349	Sept 2006	d3	Sw	Aw	VIBUEDU	feathermoss
108	464085	6398449	Sept 2006	d2	Sw	Aw	ALNUS	grass
109	465142	6397807	Sept 2006	d2	Sw	Aw	CORNCAN	VIBUEDU
110	466979	6394197	Sept 2006	d1	Aw	CORNCAN	VIBUEDU	Sw (understorey)
111	464872	6395950	Sept 2006	a1	Pj	feathermoss	CLADMIT	VACCMYR
112	464663	6395058	Sept 2006	b1	Pj	Aw	CLADMIT	ARCTUVA
113	464422	6394032	Sept 2006	STNN	Bw	CAREX	SALIX	moss
114	465078	6392157	Sept 2006	b1	Pj	Aw	feathermoss	VACCMYR
115	464796	6391092	Sept 2006	BTNN	Sb	LEDUGRO	SPHAG	CLADMIT

Table M-2 Vegetation Mapping Aerial Survey Site Summary Data (continued)

Waypoint Name	UTM Easting (NAD 83)	UTM Northing (NAD 83)	Survey Date	Ecosite Phase/Wetlands Type	Dominant Species 1	Dominant Species 2	Dominant Species 3	Dominant Species 4
116	465058	6391481	Sept 2006	b3	Sw	Aw	feathermoss	CLADMIT
117	464744	6390163	Sept 2006	d1	Aw	ROSA	VIBUEDU	ALNUS
118	464657	6390023	Sept 2006	g1	Sb	LEDUGRO	SPHAG	CLADMIT
119	464786	6389405	Sept 2006	g1	Sb	LEDUGRO	SPHAFUS	Pj
120	464969	6389090	Sept 2006	FONG	CAREX	SALIX	BETULA	Lt (shrub)
121	464893	6388950	Sept 2006	FONG	CAREX	SALIX	–	–
122	464890	6388332	Sept 2006	b3	Aw	Sw	VACCMYR	feathermoss
123	465160	6388166	Sept 2006	BTNN	Sb	SPHAFUS	LEDUGRO	CLADMIT
124	464602	6387495	Sept 2006	STNN	Bw	Lt	SALIX	CAREX
125	464599	6387279	Sept 2006	STNN	Sb	Bw	CAREX	ALNUS
126	464545	6386572	Sept 2006	FONS	SALIX	ALNUS	CAREX	EQUISETUM
127	464568	6385655	Sept 2006	d1	Aw	feathermoss	VIBUEDU	Sw (understorey)
128	465673	6385971	Sept 2006	FONS	Lt	SALIX	SPHAG	CAREX
129	465608	6387251	Sept 2006	h1	Sw	feathermoss	EPILANG	CORNCAN
130	465597	6387425	Sept 2006	d1	Aw	feathermoss	VIBUEDU	–
131	465585	6388277	Sept 2006	b1	Pj	Aw	feathermoss	VACCMYR
132	465703	6388785	Sept 2006	b4	Pj	Sw	Bw	feathermoss
133	465544	6388600	Sept 2006	FONG	CHAMCAL	CAREX	SPHAG	–
134	465724	6390124	Sept 2006	g1	Sb	feathermoss	CLADMIT	LEDUGRO
135	465736	6390787	Sept 2006	FTNN	Lt	BETULA	SALIX	SPHAG
136	466015	6391887	Sept 2006	b2	Aw	VACCMYR	CORNCAN	EPILANG
137	466032	6392778	Sept 2006	b4	Sw	Pj	Aw	feathermoss
138	465933	6393791	Sept 2006	FONG	CAREX	SALIX	–	–
139	465924	6394708	Sept 2006	d1	Aw	VIBUEDU	ALNUS	CORNCAN
140	466103	6395027	Sept 2006	STNN	Sw	Bw	SALIX	CAREX
141	465562	6396339	Sept 2006	d1	Aw	VIBUEDU	CORNCAN	feathermoss
142	465544	6396896	Sept 2006	d3	Sw	ALNUS	CORNCAN	Bw (understorey)
143	465563	6398418	Sept 2006	d2	Aw	Sw	ALNUS	feathermoss
144	466546	6398562	Sept 2006	b4	Pj	Sw	CLADMIT	feathermoss
145	466538	6397738	Sept 2006	d1	Aw	CORNCAN	Sw, Bw, Pb (understorey)	–
146	466549	6396894	Sept 2006	b4	Sw	Pj	Aw	CORNCAN
147	466463	6394449	Sept 2006	FONS	SALIX	CALACAN	CAREX	–
148	466394	6393725	Sept 2006	b1	Pj	Aw	feathermoss	VACCVIT
149	466428	6392320	Sept 2006	b4	Pj	Sw	feathermoss	ALNUS
150	466362	6391347	Sept 2006	SONS	SALIX	Sw	Aw	CAREX
151	466337	6390640	Sept 2006	RIPARIAN	CAREX	CALACAN	SALIX	–
152	466377	6390269	Sept 2006	c1	Pj	feathermoss	ALNUS	Aw
153	466375	6389661	Sept 2006	RIPARIAN/ STNN	Sw	Lt (border of river)	SALIX	ALNUS
154	466355	6388725	Sept 2006	a1	Pj	feathermoss	CLADMIT	VACCVIT
155	466369	6387908	Sept 2006	e3	Sw	feathermoss	Pj	VACCVIT
156	466547	6387269	Sept 2006	a1	Pj	CLADMIT	feathermoss	VACCVIT
157	466558	6386641	Sept 2006	FONG	CAREX	SALIX	TYPHA	BETULA
158	466511	6385659	Sept 2006	a1	Pj	CLADMIT	feathermoss	VACCVIT
159	467364	6386061	Sept 2006	FONG	CAREX	SPHAG	LEDUGRO	BETULA
160	467347	6386770	Sept 2006	b1	Pj	Aw	feathermoss	ALNUS
161	467366	6387173	Sept 2006	FONG	CAREX	TYPHA	SALIX	–
162	467440	6388208	Sept 2006	a1	Pj	feathermoss	CLADMIT	ALNUS
163	467433	6388678	Sept 2006	RIPARIAN	CAREX	ALNUS	SALIX	TYPHA
164	467389	6389879	Sept 2006	f2	Sw	Pb	Aw	ALNUS
165	467402	6390834	Sept 2006	b1	Pj	Aw	CLADMIT	VACCMYR

Table M-2 Vegetation Mapping Aerial Survey Site Summary Data (continued)

Waypoint Name	UTM Easting (NAD 83)	UTM Northing (NAD 83)	Survey Date	Ecosite Phase/Wetlands Type	Dominant Species 1	Dominant Species 2	Dominant Species 3	Dominant Species 4
166	467450	6391247	Sept 2006	RIPARIAN	ALNUS	SALIX	CAREX	RUBUPUB
167	467544	6392127	Sept 2006	FONG	CAREX	CALACAN	–	–
168	467565	6392232	Sept 2006	g1	Sb	Pj	CLADMIT	LEDUGRO
169	467577	6393053	Sept 2006	BTNN	Sb	SPHAFUS	LEDUGRO	CLADMIT
170	467133	6393984	Sept 2006	SONS	SALIX	CAREX	Bw	PETASAG
171	466945	6395607	Sept 2006	d1	Aw	feathermoss	ALNUS	Sw (understorey)
172	467265	6397217	Sept 2006	b4	Pj	Sw	CLADMIT	VACCVIT
173	467290	6398329	Sept 2006	d1	Aw	Sw (understorey)	feathermoss	Pb
174	467331	6398981	Sept 2006	SONS	SALIX	ALNUS	Bw	water pools
175	468175	6398162	Sept 2006	MONG	TYPHA	CAREX	–	–
176	468198	6396972	Sept 2006	d1	Aw	CORNCAN	ALNUS	Sw
177	468184	6396273	Sept 2006	d1	Aw	Pj	feathermoss	VIBUEDU
178	468166	6395312	Sept 2006	b1	Pj	Aw	feathermoss	CORNCAN
179	468156	6394234	Sept 2006	a1	Pj	CLADMIT	feathermoss	VACCMYR
180	468160	6393321	Sept 2006	b1	Pj	Aw	feathermoss	VACCMYR
181	468172	6392805	Sept 2006	FONG	CAREX	SPHAG	TYPHA	POTEPAL
182	468312	6392631	Sept 2006	BTNN	Sb	LEDUGRO	SPHAG	CLADMIT
183	468059	6392072	Sept 2006	FONG	CAREX	SPHAG	CHAMCAL	ERIO
184	468036	6391438	Sept 2006	e3	Sw	feathermoss	ALNUS	–
185	468011	6390307	Sept 2006	e3 RIPARIAN	Sw	Pj	feathermoss	Bw
186	467997	6388900	Sept 2006	a1	Pj	feathermoss	CLADMIT	VACCVIT
187	467767	6386668	Sept 2006	a1	Pj	feathermoss	CORNCAN	VACCVIT
188	467694	6385634	Sept 2006	b1	Pj	Aw	feathermoss	ALNUS
189	468875	6386143	Sept 2006	a1	Pj	feathermoss	VACCVIT	CLADMIT
190	468881	6387246	Sept 2006	b3	Aw	Sw	Pj	ALNUS
191	468911	6388272	Sept 2006	a1	Pj	feathermoss	CLADMIT	VACCVIT
192	468889	6388581	Sept 2006	b3	Aw	Sw	feathermoss	Bw (understorey)
193	468891	6389763	Sept 2006	b2	Aw	ALNUS	VACCMYR	CORNCAN
194	468902	6390870	Sept 2006	e3 RIPARIAN	Sw	ALNUS	CAREX	Bw
195	468932	6391673	Sept 2006	FONS	CHAMCAL	SPHAG	CAREX	–
196	469159	6392337	Sept 2006	a1	Pj	feathermoss	CLADMIT	ALNUS
197	469158	6396617	Sept 2006	STNN	Sw	Bw	ALNUS	CAREX
198	469167	6397248	Sept 2006	FTNN	Lt	BETULA	SPHAG	ALNUS
199	469125	6397742	Sept 2006	STNN	SALIX	ALNUS	Bw	CAREX
200	469224	6398803	Sept 2006	FTPN	Sb	Lt	CAREX	BETULA
201	470400	6398718	Sept 2006	MONG	TYPHA	–	–	–
202	470484	6398008	Sept 2006	a1	Pj	CLADMIT	feathermoss	VACCVIT
203	470400	6397172	Sept 2006	FTPN	Lt	BETULA	CAREX	TYPHA
204	470416	6396441	Sept 2006	d1	Aw	ALNUS	CORNCAN	EPILANG
205	470388	6396079	Sept 2006	a1	Pj	feathermoss	ALNUS	CLADMIT
206	470471	6393133	Sept 2006	a1	Pj	CLADMIT	VACCMYR	feathermoss
207	470443	6392398	Sept 2006	b1	Aw	ALNUS	feathermoss	VACCMYR
208	470471	6391491	Sept 2006	b4	Pj	Sw	feathermoss	VACCMYR
209	470515	6390514	Sept 2006	b3	Sw	Aw	VACCMYR	ALNUS
210	470428	6389889	Sept 2006	RIPARIAN SONS	ALNUS	SALIX	Bw	Sw
211	470820	6389398	Sept 2006	f3 RIPARIAN	Sw	EQUISETUM	ALNUS	feathermoss
212	471055	6388850	Sept 2006	d3	Sw	Aw	feathermoss	ALNUS
213	471776	6389256	Sept 2006	d2	Aw	Sw	feathermoss	ALNUS
214	471832	6390224	Sept 2006	b3	Aw	Sw	Pj	ALNUS
215	471903	6390727	Sept 2006	d1	Aw	VIBUEDU	ROSA	Sw (understorey)

Table M-2 Vegetation Mapping Aerial Survey Site Summary Data (continued)

Waypoint Name	UTM Easting (NAD 83)	UTM Northing (NAD 83)	Survey Date	Ecosite Phase/Wetlands Type	Dominant Species 1	Dominant Species 2	Dominant Species 3	Dominant Species 4
216	471949	6391334	Sept 2006	FTNN	Sb	BETULA	SPHAG	LEDUGRO
217	471986	6391993	Sept 2006	d2	Aw	Sw	feathermoss	CORNCAN
218	472266	6393483	Sept 2006	b1	Pj	Aw	VACCMYR	grass
219	472264	6394300	Sept 2006	FTNN	Sb	Lt	LEDUGRO	SPHAG
220	472196	6394980	Sept 2006	d1	Bw	ALNUS	feathermoss	CORNCAN
221	472176	6395286	Sept 2006	a1	Pj	ALNUS	VACCMYR	feathermoss
222	472178	6397026	Sept 2006	c1	Pj	Sb	feathermoss	LEDUGRO
223	472172	6397323	Sept 2006	BTNN	Sb	SPHAFUS	LEDUGRO	CLADMIT
224	472337	6397798	Sept 2006	SONS	SALIX	ALNUS	CAREX	TYPHA
225	472204	6398882	Sept 2006	a1	Pj	ALNUS	CLADMIT	VACCVIT
226	473072	6398972	Sept 2006	RIPARIAN SONS	ALNUS	SALIX	CAREX	–
227	473024	6397303	Sept 2006	a1	Pj	CLADMIT	feathermoss	VACCMYR
228	473122	6396263	Sept 2006	d1	Aw	VIBUEDU	ALNUS	RUBUIDA
229	473123	6395538	Sept 2006	d1	Aw	ALNUS	VIBUEDU	VACCVIT
230	473155	6395194	Sept 2006	h1	Sw	Sb	feathermoss	LEDUGRO
231	473160	6394471	Sept 2006	b4	Pj	Sw	feathermoss	VACCMYR
232	473151	6393810	Sept 2006	b4	Sw	Pj	feathermoss	CORNCAN
233	473163	6393150	Sept 2006	FONG	CAREX	TYPHA	BETULA	–
234	473180	6392386	Sept 2006	b1	Pj	Aw	VACCMYR	grass
235	473233	6391772	Sept 2006	c1	Pj	feathermoss	ALNUS	CORNCAN
236	473222	6390452	Sept 2006	b2	Aw	ALNUS	VACCMYR	–
236b	480919	6357768	Sept 2006	FONG	CAREX	SPHA	SALIX(+)	MENYTRI(+)
236c	480477	6358611	Sept 2006	SONS	SALIX	ALNUS	Grass	–
237	473903	6390683	Sept 2006	d1	Aw	VIBUEDU	ALNUS	Sw (understorey)
238	474118	6391155	Sept 2006	e2	Sw	Pb	Bw	moss
239	474297	6391972	Sept 2006	b1	Aw	ALNUS	VIBUEDU	–
240	474298	6392618	Sept 2006	c1	Pj	feathermoss	ALNUS	VACCVIT
241	474269	6393554	Sept 2006	FTNN	Sb	Lt	SPHAG	LEDUGRO
242	474380	6394098	Sept 2006	c1 (b1)	Pj	feathermoss	Aw	CORNCAN
243	474332	6394455	Sept 2006	FONG	CAREX	TYPHA	SALIX	BETULA
244	474255	6395198	Sept 2006	b3	Sw	Aw	ALNUS	VACCMYR
245	474260	6396309	Sept 2006	b2	Aw	ALNUS	ARALNUD	Sw (understorey)
246	474215	6397224	Sept 2006	b1	Pj	Aw	feathermoss	EPILANG
247	474171	6398422	Sept 2006	b4	Pj	Sw	feathermoss	ALNUS
248	475208	6398733	Sept 2006	STNN	Bw	SALIX	ALNUS	CAREX
249	475546	6398258	Sept 2006	d2	Sw	Bw	feathermoss	VIBUEDU
250	475642	6397388	Sept 2006	b4	Pj	Sw	feathermoss	ALNUS
251	475607	6396632	Sept 2006	b4	Pj	Sw	feathermoss	ALNUS
252	475677	6396022	Sept 2006	FTNN	Sb	Lt	SPHAG	LEDUGRO
253	475526	6395340	Sept 2006	b4	Sw	Pj	feathermoss	ALNUS
254	475173	6394514	Sept 2006	b1	Pj	Aw	feathermoss	CORNCAN
255	474843	6393681	Sept 2006	b1	Pj	Aw	feathermoss	CORNCAN
256	474859	6393133	Sept 2006	FTNN	Sb	SPHAG	Lt	LEDUGRO
257	475224	6392986	Sept 2006	e2	Sw	ALNUS	Pb	feathermoss
258	475698	6394261	Sept 2006	e3 (e2?)	Sw	feathermoss	ALNUS	ARALNUD
259	475879	6395095	Sept 2006	e1	Pb	Aw	ALNUS	RIBES ?
260	476132	6395970	Sept 2006	e2	Sw	Bw	Pb	ARCTUVA
261	476435	6397243	Sept 2006	d2	Aw	Sw	VIBUEDU	ALNUS
262	476506	6398581	Sept 2006	b1	Pj	Aw	feathermoss	ALNUS

– = No Data.

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APPENDIX N

VEGETATION TYPES AND DISTRIBUTIONS IN THE PIERRE RIVER MINING AREA

Submitted to:
Shell Canada Limited

Prepared by:
Golder Associates Ltd.

December 2007 **05-1344-027**

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TABLE OF CONTENTS

SECTION **PAGE**

1 TERRESTRIAL VEGETATION DESCRIPTIONS AND DISTRIBUTIONS 1
1.1 CENTRAL MIXEDWOOD NATURAL SUBREGION ECOSITE PHASES 1
1.2 ATHABASCA PLAIN NATURAL SUBREGION ECOSITE PHASES 9
1.3 WETLANDS VEGETATION DESCRIPTIONS AND DISTRIBUTIONS 13
1.4 MISCELLANEOUS VEGETATION TYPES DESCRIPTIONS AND DISTRIBUTIONS 19
1.5 WATER COVER TYPE DESCRIPTIONS AND DISTRIBUTIONS 20
1.6 DISTURBANCES DESCRIPTIONS AND DISTRIBUTIONS 20

2 SPECIES COMPOSITION AND PERCENT COVER BY VEGETATION TYPE 22

LIST OF TABLES

Table N-1 Species Composition and Percent Cover by Vegetation Type in the Pierre River Mining Area 22

1 TERRESTRIAL VEGETATION DESCRIPTIONS AND DISTRIBUTIONS

Descriptions of ecosite phases, wetlands types and other vegetation types mapped within the Pierre River Mining Area (PRMA) Local Study Area (LSA) are provided in the following subsections. These descriptions are based on vegetation and soils data collected from the PRMA LSA. In cases where there was minimal plot data, other sources were referenced (Beckingham and Archibald 1996; Halsey et al. 2003). Section 2 contains full species lists for all vegetation types sampled. Note that not all vegetation types sampled were mapped due to size. Conversely, not all types mapped were sampled, due to small size inaccessibility or value (e.g., disturbances and water types contain limited vegetation).

Common names are generally provided in the vegetation descriptions below. In cases where there is no common name or the common name can be confused with two or more species, a scientific name is given. For a reference to common and scientific names, refer to Table N-1.

The PRMA LSA includes portions of both the Central Mixedwood (21%) and Athabasca Plain (79%) Natural Subregions (NRC 2006). The Central Mixedwood Natural Subregion corresponds with the Boreal Mixedwood Ecological Area ecosite phase classification (Beckingham and Archibald 1996). The Athabasca Plain Natural Subregion corresponds with the Canadian Shield Ecological Area ecosite phase classification (Beckingham and Archibald 1996). Descriptions are provided below for both Natural Subregions.

1.1 CENTRAL MIXEDWOOD NATURAL SUBREGION ECOSITE PHASES

a1 Lichen Jack Pine

The lichen jack pine (a1) ecosite phase is characterized by a xeric moisture regime and a poor nutrient regime. This vegetation type is typically located in crest, upper slope and level landscape positions. Soils are rapidly drained due to the coarse-textured, glaciofluvial parent material. Eluviated Dystric Brunisolic soils are most common for this vegetation type.

This ecosite phase has an open canopy of jack pine, a moderate cover of low shrubs including common blueberry, bog cranberry and common bearberry and a high cover of reindeer lichen (*Cladina mitis*). The diversity of vascular plants is low but lichen diversity is the highest among all vegetation types sampled within the LSA. The lichen jack pine (a1) ecosite phase covers 16 ha (less than 1%) of

the PRMA LSA and occurs near the Natural Subregion boundary (Volume 3, Section 3 of the ESR, Figure 3.6-1).

b1 Blueberry Jack Pine-Aspen

The blueberry jack pine-aspen (b1) ecosite phase has a subxeric to submesic moisture regime and a poor to medium nutrient regime. This vegetation type is typically located in crest, upper slope and level landscape positions within the landscape. The soil is relatively dry due to rapidly to well-drained, coarse-textured glaciofluvial parent material. Eluviated Dystric Brunisolic soils are most common.

This ecosite phase is comprised of an open canopy of jack pine and aspen and prominent shrub, forb, bryophyte and terrestrial lichen layers. The low shrub layer commonly includes green alder, Canada buffalo-berry, common blueberry and bog cranberry. Bunchberry is the most common forb while Schreber's moss and reindeer lichen (*Cladina mitis*) are common in the bryophyte and lichen layers, respectively. The blueberry jack pine-aspen (b1) ecosite phase covers 242 ha (1%) of the PRMA LSA and largely occurs interspersed with other "b" ecosite phases in the southwest of the LSA (Volume 3, Section 3 of the ESR, Figure 3.6-1).

b2 Blueberry Aspen (White Birch)

The blueberry aspen (white birch) (b2) ecosite phase is relatively dry due to the rapidly to well-drained, coarse-textured glaciofluvial or glaciofluvial over moraine parent materials. Soil moisture regime ranges between subxeric and submesic while nutrient regime ranges between poor and medium. This vegetation type is generally located in upper slope positions within the landscape. Eluviated Dystric Brunisolic soils are most commonly encountered.

This ecosite phase is dominated by a canopy of aspen. The low shrub and forb layers exhibit moderate vegetation cover. The most common understorey species are saskatoon, common blueberry, prickly rose and wild sarsaparilla. There are usually very low amounts of moss and terrestrial lichens. The blueberry aspen (white birch) (b2) ecosite phase covers 43 ha (less than 1%) of the PRMA LSA and largely occurs interspersed with other "b" ecosite phases in the southwest of the LSA (Volume 3, Section 3 of the ESR, Figure 3.6-1).

b3 Blueberry Aspen-White Spruce

The blueberry aspen-white spruce (b3) ecosite phase is rapidly to well-drained and relatively dry as a result of the moderately coarse to coarse-textured, glaciofluvial or glaciofluvial over moraine parent material. Eluviated Dystric

Brunisolic soils are most common for this vegetation type. Moisture regime ranges from subxeric to mesic while nutrient regime ranges between poor to medium. This vegetation type is generally located in upper slope positions within the landscape.

The tree layer of the blueberry aspen-white spruce ecosite phase consists of an open canopy of aspen, white spruce and jack pine. A moderate cover of low shrubs is commonly represented by green alder, common blueberry, prickly rose and Labrador tea. A prominent forb layer includes species such as bunchberry, ground-cedar and three-leaved Solomon's-seal. Common species in the bryophyte layer include Schreber's moss and stair-step moss. The blueberry aspen-white spruce (b3) ecosite phase covers 104 ha (less than 1%) of the PRMA LSA and largely occurs interspersed with other "b" ecosite phases in the southwest of the LSA (Volume 3, Section 3 of the ESR, Figure 3.6-1).

b4 Blueberry White Spruce-Jack Pine

The blueberry white spruce-jack pine (b4) ecosite phase is characterized by a subxeric to mesic moisture regime and a poor to medium nutrient regime. Typically, this vegetation type is located in crest to upper slope landscape positions. Soils are rapidly to well-drained due to the relatively coarse texture of the soil or shallow depth to bedrock. The soil associated with this vegetation type has mainly developed from a thin deposit of glaciofluvial material overlying moraine or bedrock. Eluviated Dystric or Orthic Eutric Brunisolic soils are most common.

A relatively open canopy of jack pine and white spruce dominates the tree layer. A moderate cover of low shrubs is represented by species such as common blueberry, bog cranberry, Labrador tea, common bearberry and Canada buffalo-berry. Schreber's moss is the most dominant moss while a high diversity of lichens is present in both the terrestrial lichen and epiphyte layers. The most common of these species are reindeer lichen (*Cladina mitis*) and *Evernia mesomorpha*. Forbs and grasses are not prominent within this vegetation type. The blueberry white spruce-jack pine (b4) ecosite phase covers 173 ha (1%) of the PRMA LSA and largely occurs interspersed with other "b" ecosite phases in the southwest of the LSA (Volume 3, Section 3 of the ESR, Figure 3.6-1).

c1 Labrador Tea–Mesic Jack Pine-Black Spruce

The Labrador tea–mesic jack pine-black spruce (c1) ecosite phase typically has a submesic to mesic moisture regime and a poor nutrient regime. This vegetation type is typically located in upper slope to level landscape positions. Soil drainage ranges from rapid to moderately well-drained within material developed

from glaciofluvial deposits. Eluviated Dystric Brunisolic soils are most commonly encountered within this vegetation type.

The open tree layer of this ecosite phase is typically composed of a mixture of jack pine and black spruce. The shrub layer is dominated by a high amount of Labrador tea while a carpet of feather mosses, including Schreber's moss and knight's plume moss, usually covers the forest floor. Reindeer lichen (*Cladina mitis* and *C. stellaris*) is often present while forb and graminoid cover is usually very low. The Labrador tea–mesic jack pine-black spruce (c1) ecosite phase covers 19 ha (less than 1%) of the PRMA LSA and is occurs in the southwest portion of the LSA, just north of the Pierre River (Volume 3, Section 3 of the ESR, Figure 3.6-1).

d1 Low-Bush Cranberry Aspen

The low-bush cranberry aspen (d1) ecosite phase generally occurs in midslope landscape positions where mesic moisture conditions exist. Soils are usually well to moderately well-drained but imperfectly drained soils are occasionally encountered where topography is level or slightly depressed. Orthic Gray and Gleyed Gray Luvisolic soils developed from morainal parent materials are most commonly associated with this vegetation type. A medium nutrient regime for this vegetation type is typical.

This ecosite phase is typically composed of a dense cover of aspen in the tree layer and a rich shrub layer often including species such as twinflower, Canada buffalo-berry, prickly rose, Labrador tea and low-bush cranberry. The forb layer is also usually rich with bunchberry and wild sarsaparilla being the most prominent species. The graminoid, bryophyte and lichen layers are usually inconspicuous. The low-bush cranberry aspen (d1) ecosite phase is the most common terrestrial vegetation type within the PRMA LSA. It covers 734 ha (3%) of the PRMA LSA and is distributed throughout the Central Mixewood portion of the LSA, but in larger patches in the central-west portion (Volume 3, Section 3 of the ESR, Figure 3.6-1).

d2 Low-Bush Cranberry Aspen-White Spruce

The low-bush cranberry aspen-white spruce (d2) ecosite phase is a mixedwood community that has a characteristic mesic moisture regime and medium nutrient regime. It generally occurs in midslope to level positions in the landscape where well to imperfectly drained soils exist. Orthic Gray and Gleyed Gray Luvisolic soils that have developed from morainal parent material are most common.

This ecosite phase has a relatively high level of vascular species diversity. It usually contains a closed canopy of aspen and white spruce and a moderate to

high cover of shrubs that may include Labrador tea, twinflower, prickly rose and low-bush cranberry. There is usually a moderate cover of forbs with bunchberry being the most prominent species. Other typical forbs that may be present include wild sarsaparilla, northern starflower, dewberry, palmate-leaved coltsfoot, common fireweed, wild lily-of-the-valley, stiff club-moss and wild strawberry. Schreber's moss and stair-step moss often occur together as common mosses on the forest floor. The low-bush cranberry aspen-white spruce (d2) ecosite phase covers 478 ha (2%) of the Central Mixedwood portion of the PRMA LSA (Volume 3, Section 3 of the ESR, Figure 3.6-1).

d3 Low-Bush Cranberry White Spruce

The low-bush cranberry white spruce (d3) ecosite phase represents a mature modal forest type within the Boreal Mixedwood ecological area. Moisture conditions are usually mesic but may be slightly moister in areas where drainage is imperfect. Nutrient regime is typically medium. The soils most commonly associated with this vegetation type are Orthic Gray and Gleyed Gray Luvisols, which typically develop from morainal parent material.

This ecosite phase is dominated by an open canopy of white spruce. Low-bush cranberry and Labrador tea tend to be moderately abundant in the low shrub layer. The diversity of the forb layer is variable and correlated with canopy closure. The most common forbs include bunchberry and wild sarsaparilla. A layer of mosses including Schreber's moss, stair-step moss and knight's plume moss usually covers the forest floor. The low-bush cranberry white spruce (d3) ecosite phase covers 250 ha (1%) of the Central Mixedwood portion of PRMA LSA (Volume 3, Section 3 of the ESR, Figure 3.6-1).

e1 Dogwood Balsam Poplar-Aspen

The dogwood balsam poplar (e1) ecosite phase is characterized by a mesic to subhygric moisture regime and a rich nutrient regime. It is found in relatively level to slightly depressed areas where morainal parent materials exist. Additionally, this ecosite phase occurs in riparian areas where nutrient-rich soil horizons have developed from fluvial deposited material. Orthic Gray Luvisol and Cumulic Regosolic soils are most commonly encountered within this vegetation type.

This ecosite phase most often occurs with balsam poplar and aspen in the tree layer. Shrub diversity is usually high and may include species such as river alder, low-bush cranberry, prickly rose, Canada buffalo-berry, common wild rose, willow, wild red raspberry and bristly black currant. Forb cover is often dominated by a layer of wild sarsaparilla. The graminoid, bryophyte and lichen layers most often occur with very low abundances. The dogwood balsam

poplar-aspen (e1) ecosite phase covers 6 ha (less than 1%) of the PRMA LSA and is found in the south of the LSA along Pierre River, and another patch along the unnamed creek north of Pierre River (Volume 3, Section 3 of the ESR, Figure 3.6-1).

e2 Dogwood Balsam Poplar-White Spruce

The dogwood balsam poplar-white spruce (e2) ecosite phase is characterized by a mesic to subhygric moisture regime and a rich nutrient regime. The moist, rich condition of this ecosite phase supports a rich diversity of plant species. Soils are moderately well to imperfectly drained and have developed from morainal and fluvial parent materials. Cumulic Humic Regosol, Orthic Gray Luvisol and Rego Gleysolic soils are often found within this vegetation type.

This ecosite phase has a rich diversity of vascular plant species. The tree canopy may include a mix of species such as aspen, white spruce, balsam poplar and white birch. The shrub layer is equally diverse and commonly includes red-osier dogwood, low-bush cranberry, willow, prickly rose and river alder. The forb layer also contains many species, which may include species such as wild sarsaparilla, palmate-leaved coltsfoot, dewberry and meadow horsetail. The grass layer is often dominated by bluejoint. The dogwood balsam poplar-white spruce (e2) ecosite phase covers 121 ha (1%) of the PRMA LSA and is largely distributed between drainages on the west side of the LSA (Volume 3, Section 3 of the ESR, Figure 3.6-1).

e3 Dogwood White Spruce

The dogwood white spruce (e3) ecosite phase is characterized by a mesic to subhygric moisture regime and a rich nutrient regime. Soils are moderately well-drained and have developed from morainal parent material and fluvial deposits within riparian zones. Gleyed Cumulic Humic Regosol, Orthic Luvic Gleysol and Orthic Gray Luvisolic soils are commonly encountered within this vegetation type.

This ecosite phase is composed of an open canopy of white spruce and a moderate cover of shrubs that may include species such as wild red raspberry, low-bush cranberry, river alder and red-osier dogwood. There is usually a prominent forb layer that may include common horsetail, tall lungwort, wild sarsaparilla and bishop's-cap. The bryophyte layer usually covers most of the forest floor and often includes the three most common feather mosses: Schreber's moss, knight's plume moss and stair-step moss. The dogwood white spruce (e3) ecosite phase covers 45 ha (less than 1%) of the PRMA LSA and is mainly found along the unnamed creek drainage in the central-west of the LSA (Volume 3, Section 3 of the ESR, Figure 3.6-1).

f1 Horsetail Balsam Poplar-Aspen

The horsetail balsam poplar-aspen (f1) ecosite phase has a hygric moisture regime and a rich nutrient regime. This vegetation type is located in areas where imperfectly drained soils have formed.

The tree canopy of this ecosite phase is composed of white birch and river alder. A tall shrub layer is also dominated by a cover of river alder with lesser amounts of alder-leaved buckthorn, skunk currant, wild red currant and wild red raspberry. Common horsetail dominates the forb layer while *Calliergon giganteum* is the dominant moss species. The horsetail balsam poplar-aspen (f1) ecosite phase covers 4 ha (less than 1%) of the PRMA LSA (Volume 3, Section 3 of the ESR, Figure 3.6-1).

f2 Horsetail Balsam Poplar-White Spruce

The horsetail balsam poplar-white spruce (f2) ecosite phase is not commonly encountered within the PRMA LSA. It occurs in areas where imperfectly drained soils have developed.

Balsam poplar and white spruce occur in the tree canopy of this ecosite phase. The shrub layer contains species such as river alder, red-osier dogwood, willows and currants while the forb layer is characterized by a high cover of horsetail. The horsetail balsam poplar-white spruce (f2) ecosite phase covers 4 ha (less than 1%) of the LSA and is a small patch in the south of the LSA (Volume 3, Section 3 of the ESR, Figure 3.6-1).

f3 Horsetail White Spruce

The horsetail white spruce (f3) ecosite phase is characterized by a subhygric to hygric moisture regime and a medium to rich nutrient regime. Soils are imperfectly to poorly drained and have developed from morainal parent material and fluvial deposits within riparian zones. Cumulic Regosol, Orthic Gleysol and Gleyed Gray Luvisolic soils are associated with this vegetation type.

The horsetail white spruce (f3) ecosite phase is dominated by white spruce in the tree layer. In the tall shrub layer, there is a moderate cover of river alder while the low shrub layer includes species such as common wild rose and low-bush cranberry. Typical forb species include woodland horsetail, common horsetail, bunchberry and dewberry. A low to moderate cover of graminoids may be present and two-seeded sedge is the most prominent species within this layer. A moderate to high number of bryophyte species occur within this ecosite phase; however, Schreber's moss, stair-step moss and knight's plume moss typically dominate this layer and carpet the forest floor. The horsetail white spruce (f3)

ecosite phase covers 7 ha (less than 1%) of the PRMA LSA and is found southwest of Cranberry Lake (Volume 3, Section 3 of the ESR, Figure 3.6-1).

g1 Labrador Tea−Subhygric Black Spruce-Jack Pine

The Labrador tea–subhygric black spruce-jack pine (g1) ecosite phase is characterized by a subhygric to hygric moisture regime and a poor nutrient regime. Ecologically, it is a transitional vegetation type between the well-drained Labrador tea–mesic jack pine-black spruce (c1) ecosite phase and the wooded bog (BTNN) wetlands type. This vegetation type also shares similar ecological characteristics to the Labrador tea/horsetail white spruce-black spruce (h1) ecosite phase and the wooded swamp (STNN) wetlands type.

This vegetation type is located in lower slope to undulating and level positions in the landscape where imperfect to poor drainage occurs. In some sites there is a seasonally high water table. Soils often contain a layer of organic material that is between 20 and 40 cm thick. Morainal and glaciofluvial parent materials are common and Orthic Gleysol, peaty phase Rego Gleysol and Orthic Luvic Gleysolic soils are often encountered.

This ecosite phase is composed of black spruce in the tree layer and a moderate cover of shrubs, with Labrador tea being the most prominent species. Vascular species diversity in this vegetation type is low. There is usually a carpet of feather mosses present that includes Schreber's moss and stair-step moss. Reindeer lichen (*Cladina mitis*) may also be present and scattered about the forest floor. The Labrador tea–subhygric black spruce-jack pine (g1) ecosite phase covers 12 ha (less than 1%) of the PRMA LSA (Volume 3, Section 3 of the ESR, Figure 3.6-1).

h1 Labrador Tea/Horsetail White Spruce-Black Spruce

The Labrador tea/horsetail white spruce-black spruce (h1) ecosite phase is characterized by a subhygric to hygric moisture regime and a medium nutrient regime. Ecologically, this vegetation type shares similar characteristics with both the Labrador tea–subhygric black spruce-jack pine (g1) and horsetail white spruce (f3) ecosite phases. This vegetation type also overlaps ecologically with the wooded swamp (STNN) wetlands type.

Soil of the Labrador tea/horsetail white spruce-black spruce (h1) ecosite phase is often imperfectly to poorly drained. Organic matter thickness is usually thick and may occasionally include organic types. Morainal and glaciolacustrine parent materials are common and Orthic Gleysol, Terric Mesisol and peaty phase Orthic Luvic Gleysolic soils are often encountered.

This ecosite phase has a moderate cover of trees consisting primarily of black and white spruce but may also contain aspen and tall willow. There is also a moderate cover of shrubs that may include willow, Labrador tea and river alder. Species composition in the forb layer varies among sites; however, the most prominent species include common horsetail, woodland horsetail, palmate-leaved coltsfoot, bunchberry and dewberry. Two-seeded sedge is the most prominent species in the sparse graminoid layer. A carpet of mosses covers the forest floor with the most abundant species represented by Schreber's moss, stair-step moss, peat moss (*Sphagnum warnstorfii* and *S. angustifolium*) and golden moss. The Labrador tea/horsetail white spruce-black spruce (h1) ecosite phase covers 118 ha (1%), distributed throughout the Central Mixedwood portion of the PRMA LSA (Volume 3, Section 3 of the ESR, Figure 3.6-1).

1.2 ATHABASCA PLAIN NATURAL SUBREGION ECOSITE PHASES

a1 Bearberry Jack Pine

The bearberry jack pine (a1) ecosite phase is characterized by a subxeric to xeric moisture regime and a poor nutrient regime. This vegetation type is typically located in crest, mid and upper slope, and level landscape positions. Soils are rapidly drained due to the coarse-textured, glaciofluvial parent material. Eluviated Eutric Brunisolic soils are most common for this vegetation type.

This ecosite phase has an open canopy of jack pine, a moderate cover of low shrubs including common blueberry and bog cranberry and a high cover of bearberry (*Arctostaphylos uva-ursi*) and reindeer lichen (*Cladina mitis*). The lichen jack pine (a1) ecosite phase covers 2,740 ha (13%) of the PRMA LSA and occurs in the north and south of the LSA, with a large patch surrounding First Creek (Volume 3, Section 3 of the ESR, Figure 3.6-1).

b1 Canada Buffalo-Berry-Green Alder Jack Pine-Aspen-White Birch

The Canada Buffalo-berry-green alder jack pine-aspen-white birch (b1) ecosite phase has a submesic to mesic moisture regime and a poor to medium nutrient regime. This vegetation type is typically located in upper to lower slope landscape positions within the landscape. The soil is relatively dry due to rapidly to well-drained, coarse-textured glaciolacustrine and glaciofluvial parent material. Eluviated Eutric Brunisolic soils are most common.

This ecosite phase is comprised of an open canopy of jack pine and aspen (occasionally white birch) and prominent shrub, bryophyte and terrestrial lichen layers. The low shrub layer commonly includes green alder, Canada buffalo-berry, bog cranberry and common blueberry. Bunchberry is the most

common of the limited forbs while Schreber's moss and reindeer lichen (*Cladina mitis*) are common in the bryophyte and lichen layers, respectively. The Canada Buffalo-berry-green alder (b1) ecosite phase covers 2,922 ha (14%) of the PRMA LSA and is well distributed throughout the LSA (Volume 3, Section 3 of the ESR, Figure 3.6-1).

b2 Canada Buffalo-Berry-Green Alder Aspen

The Canada Buffalo-berry-green alder aspen (b2) ecosite phase is relatively dry due to the well-drained to moderately well-drained, coarse-textured glaciolacustrine parent materials. Soil moisture regime ranges between mesic and submesic while nutrient regime ranges between medium and poor. This vegetation type is generally located in level, upper or mid slope positions within the landscape. Eluviated Eutric Brunisolic soils are most commonly encountered.

This ecosite phase is dominated by a canopy of aspen. The low shrub and forb layers exhibit moderate vegetation cover. The most common understorey species are Canada buffalo-berry, bunchberry, prickly rose and bog cranberry. Moderate amounts of hairy wild rye or marsh reed grass make up the graminoid layer. There are usually very low amounts of moss and terrestrial lichens. The Canada Buffalo-berry-green alder aspen (b2) ecosite phase covers 2,151 ha (10%) of the PRMA LSA and is well distributed throughout the LSA, with large tracts near the Athabasca River (Volume 3, Section 3 of the ESR, Figure 3.6-1).

b3 Canada Buffalo-Berry-Green Alder Aspen-White Spruce-Black Spruce

The Canada Buffalo-berry-green alder aspen-white spruce-black spruce (b3) ecosite phase is moderately well-drained and relatively mesic as a result of the moderately textured, glaciolacustrine parent material. Orthic grey luvisol soils are most common for this vegetation type. Moisture regime is mesic while nutrient regime is generally medium. This vegetation type is generally located in mid-slope or level positions within the landscape.

The tree layer of the Canada Buffalo-berry-green alder aspen-white spruce-black spruce (b3) ecosite phase consists of an open to moderate canopy of aspen, white spruce and black spruce. A moderate cover of low shrubs is commonly represented by Canada buffalo-berry, green alder, and Labrador tea. The forb layer includes species such as bunchberry, dewberry and fireweed. Common species in the bryophyte layer include Schreber's moss and stair-step moss. The Canada Buffalo-berry-green alder aspen-white spruce-black spruce (b3) ecosite phase covers 1,728 ha (8%) throughout the PRMA LSA (Volume 3, Section 3 of the ESR, Figure 3.6-1).

b4 Canada Buffalo-Berry-Green Alder White Spruce-Black Spruce-Jack Pine

The Canada Buffalo-berry-green alder white spruce-black spruce-jack pine (b4) ecosite phase is was created to capture coniferous dominant stands that fall in the Canada buffalo-berry-green alder (b) ecosite type in the PRMA LSA. While this ecosite phase is not documented in Beckingham and Archibald (1996), it is thought to be a succesional seral progression from the Canada Buffalo-berry-green alder aspen-white spruce-black spruce (b3) ecosite phase.

In the PRMA LSA, the tree layer is characterized by jack pine, white spruce and aspen, with black and white spruce common in the understorey. Green alder and Canada buffalo-berry are common in the shrublayer, with bearberry and Labrador tea as common low shrubs. Dwarf scouring rush is often found in the forb layer. Stair-step and Schreber's moss are also common; lichens are found in minor amounts. The Canada buffalo-berry-green alder white spruce-black spruce-jack pine (b4) ecosite phase covers 927 ha (4%) of the PRMA LSA and largely occurs in relation to other Athabasca Plain "b" ecosite phases (Volume 3, Section 3 of the ESR, Figure 3.6-1).

c1 Labrador Tea–Mesic Jack Pine-Black Spruce

The Labrador tea–mesic jack pine-black spruce (c1) ecosite phase typically has a subhygric to mesic moisture regime and a poor nutrient regime. This vegetation type is found in variable landscape positions. Soil drainage ranges from rapid to moderately well-drained within material developed from glaciolacustrine or glaciofluvial deposits. Eluviated Dystric Brunisolic soils are most commonly encountered within this vegetation type.

The open tree layer of this ecosite phase is typically composed of a mixture of jack pine and black spruce. The shrub layer is dominated by a high amount of Labrador tea and bog cranberry while a carpet of feather mosses, including Schreber's moss and stair step moss usually covers the forest floor. Reindeer lichen (*Cladina mitis*) is often present while forb cover is usually very low. The Labrador tea–mesic jack pine-black spruce (c1) ecosite phase covers 60 ha (less than 1%) of the PRMA LSA and is sporadic in the LSA (Volume 3, Section 3 of the ESR, Figure 3.6-1).

d1 Labrador Tea−Subhygric Black Spruce-Jack Pine

The Labrador tea–subhygric black spruce-jack pine (d1) ecosite phase is characterized by a subhygric to mesic moisture regime and a medium to poor nutrient regime. Ecologically, it is a transitional vegetation type between the well-drained Labrador tea–mesic jack pine-black spruce (c1) ecosite phase and the wooded bog (BTNN) wetlands type.

This vegetation type is located in lower slope to undulating and level positions in the landscape where imperfect to poor drainage occurs. In some sites there is a seasonally high water table. Morainal and glaciolacustrine parent materials are common and Orthic Gleysol soils are often encountered.

This ecosite phase is composed of black spruce in the tree layer and a moderate cover of shrubs, with bog cranberry, common blueberry and Labrador tea being the most prominent species. Vascular species diversity in this vegetation type is low. There is usually a carpet of feather mosses present that includes Schreber's moss and stair-step moss. Reindeer lichen (*Cladina mitis*) may also be present in high cover. The Labrador tea–subhygric black spruce-jack pine (g1) ecosite phase covers 130 ha (1%) of the PRMA LSA and mainly occurs in patches in the south of the LSA (Volume 3, Section 3 of the ESR, Figure 3.6-1).

e1 Willow/Horsetail Aspen-White Birch-Balsam Poplar

The willow/horsetail aspen-white birch-balsam poplar (e1) ecosite phase is characterized by a mesic to subhydric moisture regime and a rich nutrient regime. It is found in relatively level to slightly depressed areas where fluvial parent materials exist. Additionally, this ecosite phase occurs in riparian areas where nutrient-rich soil horizons have developed from fluvial deposited material. Terric Mesisol, Rego Gleysol, Orthic Gray Luvisol and Orthic Eutric Brunisols soils are commonly encountered within this vegetation type.

This ecosite phase most often occurs with balsam poplar, aspen and balsam poplar in the tree layer. Shrub diversity is usually high and may include species such as willow, prickly rose, river alder, twin-flower and low-bush cranberry. Forb cover is often dominated by a layer of common and meadow horsetails and bunchberry. There can be a moderate cover of brown mosses. The willow/horsetail aspen-white birch-balsam poplar (e1) ecosite phase covers 325 ha (2%) of the PRMA LSA and is primarily located along the Athabasca River (Volume 3, Section 3 of the ESR, Figure 3.6-1).

e2 Willow/Horsetail Aspen-White Spruce-Black Spruce

The willow/horsetail aspen-white spruce-black spruce (e2) ecosite phase is characterized by a subhygric moisture regime and a medium to rich nutrient regime. Soils are poorly drained and have developed from glaciolacustrine parent materials. Rego Humic Gleysol and Orthic Humic Gleysol soils are often found within this vegetation type.

The tree canopy may include a mix of species such as aspen, white spruce and black spruce. The shrub layer is diverse and commonly includes willows, Canada buffalo-berry, white and black spruce, prickly rose and twin-flower. The

forb layer contains species such as common horsetail, fireweed, bunchberry and wild vetch. The grass layer is often dominated by hairy wild rye. Moderate cover of stair-step and Scherber's mosses can be found. The willow/horsetail aspen-white spruce-black spruce (e2) ecosite phase covers 404 ha (2%) of the PRMA LSA and is largely distributed along drainages in the south of the LSA (Volume 3, Section 3 of the ESR, Figure 3.6-1).

e3 Willow/Horsetail White Spruce-Black Spruce-Jack Pine

The willow/horsetail aspen-white spruce-black spruce (e3) ecosite phase was created to capture coniferous dominant stands that fall in the willow/horsetail (e) ecosite type in the PRMA LSA. While this ecosite phase is not documented in Beckingham and Archibald (1996), it is thought to be a succesional seral progression from the willow/horsetail aspen-white spruce-black spruce (e2) ecosite phase. Nutrient regieme, mosture and soils are also thought to be similar to the willow/horsetail aspen-white spruce-black spruce (e2) ecosite phase.

The willow/horsetail aspen-white spruce-black spruce (e3) ecosite phase covers 307 ha (1% of the PRMA LSA) and is distributed along drainages in the south of the LSA (Volume 3, Section 3 of the ESR, Figure 3.6-1).

(Pj-Lt Comp) Jack Pine-Tamarack Complex

The jack pine-tamarack complex (Pj-Lt Comp) is a 3 ha unit (less than 1% of the PRMA LSA) based on the AVI. It is speculated that the unit consists of an undulating landscape with typical upland and lowland species grouped together in one polygon. The jack pine-tamarck complex consists of a moist to wet moisture regime, dominated by jack pine in the main canopy and containing tamarack as a secondary species. The complex may also contain aspen or black spruce. The jack pine-tamarack complex is found within a bog/fen complex in the south of the PRMA LSA.

1.3 WETLANDS VEGETATION DESCRIPTIONS AND DISTRIBUTIONS

Bogs

Bogs are acidic, mineral-poor peatlands that are raised above the groundwater by an accumulation of peat. In general, they are characterized by a hummocky ground surface covered with *Sphagnum* moss, ericaceous shrubs and black spruce. Bogs develop under ombrotrophic conditions where water, minerals and nutrients are derived solely from precipitation. Groundwater and associated minerals are not able to reach the bog rooting layer because it is blocked by a

layer of impermeable peat. The pH level in bogs generally ranges between three and four (Crum 1992).

Bogs are found along drainage divides, stagnation zones of peatland complexes and small isolated basins (Halsey et al. 2003). All bogs contain peat layers that are at least 40 cm thick. Bogs are subdivided into categories based on forest cover and on the presence of permafrost and internal lawns.

BFNN Forested Bog

Forested bogs (BFNN) are densely treed peatlands (greater than 70% cover) without internal lawns or permafrost. The stunted tree layer (often less than 10 m tall) is composed entirely of black spruce. This wetlands type covers 73 ha (less than 1%) in the south portion of the PRMA LSA (Volume 3, Section 3 of the ESR, Figure 3.6-1).

BTNN Wooded Bog

Wooded bogs (BTNN) are open-canopied peatlands (6 to 70% cover) without internal lawns or permafrost. The landform associated with this peatlands type is usually flat and uniformly wooded (Halsey et al. 2003). Soils are poorly to very poorly drained commonly resulting in the development of Terric Mesisol or Terric Fibrisol soil types.

The stunted tree layer (often less than 10 m tall) is composed entirely of black spruce. The low shrub layer often contains Labrador tea, black spruce and bog cranberry. The forb and graminoid layers are usually sparse but often include cloudberry, three-leaved Solomon's-seal and some sedges (*Carex* spp.) or sheathed cotton grass. The ground surface is covered by low hummocks 20 to 40 cm high with bryophyte species composition varying from the hummock top to hollow. Common bryophytes found in wooded bogs include Schreber's moss, stair-step moss, *Sphagnum fuscum*, *S. warnstorfii*, *S. angustifolium*, *S. capillifolium* and golden moss. There is often a prominent layer of lichens on the tops of the *Sphagnum* hummocks with reindeer lichen (*Cladina mitis*) being the most dominant species. The wooded bog wetlands type covers 1,186 ha (6%) of the PRMA LSA and is found primarily in the south of the LSA, and along drainages in the north (Volume 3, Section 3 of the ESR, Figure 3.6-1).

BONS Shrubby Bog

Shrubby bogs (BONS) are bog peatlands similar to wooded bogs (BTNN), without a black spruce tree layer but a defined cover in the shrub layer. This wetlands type covers 1 ha (less than 1%) of the PRMA LSA (Volume 3, Section 3 of the ESR, Figure 3.6-1).

Fens

Fens are peatlands that are influenced by mineral-rich groundwater or surface water. Fens receive minerals and nutrients from precipitation and groundwater. A distinguishing feature of fens is that they are characterized by a prominent layer of sedges. Soil chemistry in fens ranges widely with pH values varying from about 4 in extreme poor fens to more than 7 in extreme rich fens (Crum 1992).

Fens are divided on the basis of landform, forest cover that typically includes black spruce and tamarack, and the presence of peat plateaus and internal lawns in wooded fens (Halsey et al. 2003). All fens contain peat layers that are at least 40 cm thick.

FTNN Wooded Fen

Wooded fens (FTNN) are open-canopied peatlands (6 to 70% cover) without internal lawns or permafrost. Soils are poorly to very poorly drained commonly resulting in the development of Terric Mesisol or Terric Fibrisol soil types.

The wooded fen wetlands type has an open canopy of black spruce and tamarack in the tree layer. A moderate cover of shrubs is typical including species such as Labrador tea, tamarack, black spruce, dwarf birch, bog cranberry and willow. There is usually a scattered cover of forbs including species such as woodland horsetail, common horsetail and three-leaved Solomon's-seal. Graminoid cover is often prominent and typically includes water sedge and bluejoint. The diversity of mosses that carpet the forest floor ranges between moderate and high with the most prominent species being golden moss, stair-step moss, peat moss (*Sphagnum warnstorfii* and *S. angustifolium*), Schreber's moss and *Helodium blandowii*. The wooded fen wetlands type covers 1,580 ha (7%) of the PRMA LSA and is common in patches throughout the LSA (Volume 3, Section 3 of the ESR, Figure 3.6-1).

FOPN Open Patterned Fen

The open patterned fen (FOPN) wetlands type is characterized by alternating strings (woody ridges) and flarks (herbaceous pools) that run parallel to the groundwater flow direction. Topography of the patterned fen appears level but has a slightly sloping grade (0.1 to 1.0%). Tree cover in this wetlands type is always low (less than 6%) while shrubs are most common along the string portions. The flarks form the wettest part of this wetlands type and are dominated by various sedge species.

Along the strings, there is a dense cover of dwarf birch, northern laurel and tamarack. The flarks may contain hairy-fruited sedge, buck-bean, pitcher-plant, northern grass-of-parnassus and oblong-leaved sundew. *Warnstorfia fluitans* is the dominant moss species within this wetlands type. The open patterned fen wetlands type covers 69 ha (less than 1%) and is found in one patch in the centre of the PRMA LSA (Volume 3, Section 3 of the ESR, Figure 3.6-1).

FONS Shrubby Fen

The shrubby fen (FONS) wetlands type lacks a tree layer due to saturated soil conditions. It is poorly to very poorly drained although usually not as wet as the graminoid fen where woody species are less likely to become established. This wetlands type is commonly associated with Terric Mesisol, Typic Fibrisol and Typic Mesisol soil types.

There is a moderate to high cover of woody species present in the shrub layer including dwarf birch, bog willow, willow, sweet gale, tamarack, Labrador tea and alder-leaved buckthorn. The forb layer is usually less conspicuous but may include buck-bean and marsh-marigold. The graminoid layer is usually prominent with the presence of species such as water sedge, bluejoint, two-stamened sedge and hairy-fruited sedge. Bryophytes most common to the graminoid fen include brown moss (*Hamatocaulis vernicosus*), tufted moss, golden moss, peat moss (*Sphagnum warnstorfii*) and *Calliergon giganteum*. The shrubby fen wetlands type covers 905 ha (4%) of the PRMA LSA and is mostly found near wooded fens throughout the LSA (Volume 3, Section 3 of the ESR, Figure 3.6-1).

FONG Graminoid Fen

The graminoid fen (FONG) wetlands type is saturated and poorly to very poorly drained. Nutrient regime ranges between poor and rich, depending upon pH and the content of minerals in the groundwater. This wetlands type is commonly associated with Typic Fibrisol, Terric Mesisol and Terric Humisol soil types.

Tree cover is absent to sparse within this wetlands type. The shrub and forb layers are usually not prominent but may contain willow, marsh cinquefoil and other species usually with a combined cover of less than 20%. The graminoid layer is prominent often containing many sedge species, most commonly water sedge, awned sedge and two-stamened sedge. Bryophyte cover is typically low because the high water table substantially restricts the development of this layer; however, species such as *Warnstorfia fluitans* and *Bryum pseudotriquetrum* are the most common. The graminoid fen wetlands type covers 702 ha (3%) of the Pierre River Mining LSA and is found primarily north of Cranberry Lake (Volume 3, Section 3 of the ESR, Figure 3.6-1).

Swamps

Swamps are wetlands that are rich in minerals and highly productive. They are typically located next to waterbodies that are subjected to flooding, or in areas influenced by fluctuating water levels such as along peat margins (Halsey et al. 2003). Fluctuating water levels within swamps may be the result of seasonal variation or slope drainage. The groundwater moving through the soil is typically well oxygenated, which in part leads to higher decomposition rates compared to fens (Crum 1992).

SONS Shrubby Swamp

The shrubby swamp (SONS) wetlands type lacks tree cover but has an open or closed shrub layer that is usually 2 to 5 m tall. Landforms associated with this vegetation type include floodplains, stream terraces and peat margins (Halsey et al. 2003). Soils are poorly to very poorly drained commonly resulting in the development of Terric Mesisol, Rego Gleysol, Orthic Gleysol and Orthic Humic Gleysolic soil types.

The shrubby swamp wetlands type has a moderately dense cover of woody species in the tall and low shrub layer represented by a rich mix of species such as willow, river alder, dwarf birch, alder-leaved buckthorn and white birch. Species composition in the forb layer is quite variable; however, the most common species are swamp horsetail and marsh-marigold. There is typically a prominent graminoid layer that includes species such as bluejoint, water sedge and awned sedge. The bryophyte layer is usually not very well developed due to fluctuating water table levels; however, the most common species include *Climacium dendroides*, *Plagiomnium cuspidatum*, tufted moss and *Pseudobryum cinclidioides*. The shrubby swamp wetlands type covers 372 ha (2%), scattered pirimarily in the Central Mixedwood portion of the PRMA LSA (Volume 3, Section 3 of the ESR, Figure 3.6-1).

STNN Wooded Swamp

The wooded swamp (STNN) wetlands type is commonly found in broad plains associated with groundwater discharge as well as floodplains and along peat margins (Halsey et al. 2003). Tree heights are typically greater than in fens because the peaty soils are well aerated, at least during part of the year. The diversity of microhabitats in wooded swamps is usually high including features such as wet pools, rotting wood on the ground, stumps and mossy ground. Vascular species diversity is also high within this wetlands type. Typical soils are represented by Terric Mesisol, Terric Humisol, Orthic Luvic Gleysol (peaty phase) and Orthic Gleysol (peaty phase) soil types.

Tree canopy species composition of the wooded swamp wetlands type is variable depending upon the site and may include a mix of white birch, tamarack, black spruce and white spruce. Typical understorey species include Labrador tea, river alder and willow in the shrub layer, and common horsetail and marsh-marigold in the forb layer. Various sedges are present but bluejoint (a grass species) is the most prominent species in the graminoid layer. Moss cover is quite varied but includes species such as acute-leaved peat moss (*Sphagnum capillifolium*), Schreber's moss, tufted moss and *Calliergon richardsonii*. The wooded swamp wetlands type covers 517 ha (2%) of the PRMA LSA and is mostly found south of Cranberry Lake (Volume 3, Section 3 of the ESR, Figure 3.6-1).

MONG Marsh

Marshes (MONG) are open wetlands that have developed on a mineral substrate and with water levels above the ground surface for at least a part of the year. The pH level in a marsh is usually at or above neutral. Vegetation production is high but decomposition is rapid, limiting the accumulation of organic matter (Crum 1992). Trees and shrubs are lacking due to the seasonally high water table. Marshes are found adjacent to waterbodies where there is fluctuating water levels during the growing season (Halsey et al. 2003). Gleysols and shallow organic soils are most common within this wetlands type.

Species composition in the marsh wetlands type is dominated by sedges and common cattail. Some of the sedges include water sedge, small bottle sedge, awned sedge and two-stamened sedge. Besides cattail, water arum, creeping spike-rush, northern reed grass and common duckweed are other forbs that may occur within the marsh wetlands type. Mosses and lichens are generally lacking. The marsh wetlands type covers 146 ha (1%) of the PRMA LSA and is found primarily along a drainage in the centre of the LSA (Volume 3, Section 3 of the ESR, Figure 3.6-1).

WONN Shallow Open Water

The shallow open water (WONN) wetlands type represents ponds and stagnated water zones typically resulting from beaver dams. These areas are found in association with marshes and shrubby swamps, and where water levels are less than 2 m deep. This wetlands type is characterized by submergent and floating vegetation commonly including water arum, common cattail, water sedge and common duckweed. The shallow open water wetlands type covers 57 ha (less than 1%) of the PRMA LSA, and is found in low areas of the LSA (Volume 3, Section 3 of the ESR, Figure 3.6-1).

1.4 MISCELLANEOUS VEGETATION TYPES DESCRIPTIONS AND DISTRIBUTIONS

Me Meadow

Meadows (Me) are non-forested, open grassy areas found next to rivers and streams. They are usually elevated substantially above the water table, and on average, tend to be better drained than swamps. Meadows are thought to have formed in response to disturbance regimes such as periodic flooding and possibly tree removal from beavers. Moisture conditions range between mesic and hygric while nutrient regime may be medium or rich.

There is a high diversity of vascular species within the meadow vegetation type in part due to open canopy, moist and medium to rich soil conditions, and close proximity to other vegetation types. Cumulic Regosolic soils that have developed from fluvial deposits are most common.

The graminoid layer dominates the meadow vegetation type. Species such as bluejoint, awned sedge, brownish sedge and common tall manna grass are the most prominent grass and sedge species. A tree layer is lacking but an open shrub layer may include species such as wild red raspberry and white birch. Forbs that may be present include woodland horsetail, small bedstraw and marsh hedge-nettle. The meadow vegetation type covers 7 ha (less than 1%) of the PRMA LSA (Volume 3, Section 3 of the ESR, Figure 3.6-1).

Sh Shrubland

The shrubland (Sh) vegetation type commonly occurs within the riparian zones of creeks and rivers where a disturbance regime such as periodic flooding prevents the establishment and development of a tree layer. The shrub layer can be dense and reach a height of 5 m. Soils are rich as a result of groundwater seepage transporting nutrients from upslope areas and/or inputs from deposits of fluvial laden soil material. Soils are usually imperfectly drained and may include Orthic Humic Regosol and Eluviated Dystric Brunisolic soil types.

The shrub layer can be diverse and may include species such as red-osier dogwood, wild red raspberry, yellow willow and river alder. There is usually a prominent and diverse forb layer that may consist of species such as common horsetail, common fireweed, veiny meadow rue, tall lungwort, Canada goldenrod and common yarrow. Bluejoint is the most prominent grass species. The shrubland vegetation type covers 87 ha (less than 1%) of the PRMA LSA and is found primarily on the shores of the Athabasca River (Volume 3, Section 3 of the ESR, Figure 3.6-1).

1.5 WATER COVER TYPE DESCRIPTIONS AND DISTRIBUTIONS

Lake — Lake

The lake cover type is comprised of lakes and large ponds, greater than 2 m deep. There are small waterbodies throughout the LSA, Cranberry Lake being the largest. This cover type occupies 84 ha (less than 1%) of the PRMA LSA (Volume 3, Section 3 of the ESR, Figure 3.6-1).

River — River

Drainages feed primarily west to east in the PRMA LSA, feeding into the Athabasca River. Rivers occupy 263 ha (1%) of the PRMA LSA (Volume 3, Section 3 of the ESR, Figure 3.6-1).

Sand — Sand

Areas of open sandy soils can be found along lake shores and the Athabasca River. Sand occupies 41 ha (less than 1%) of the PRMA LSA (Volume 3, Section 3 of the ESR, Figure 3.6-1).

1.6 DISTURBANCES DESCRIPTIONS AND DISTRIBUTIONS

CC — Cutblock

The cutblock (CC) cover type is represented by harvested stands at various stages of regrowth. Typically, there are prominent shrub, forb and graminoid layers that contribute to the high level of vascular plant species richness within this disturbance type. Moisture and nutrient regime is typically mesic and medium, respectively. Soils are generally well to imperfectly drained, Orthic Gray or Gleyed Gray Luvisols.

Some of the most common species in the shrub layer of cutblocks are common blueberry, wild red raspberry, aspen, white birch, balsam poplar, common bearberry and willow. Prominent forbs include wild strawberry, common fireweed and meadow horsetail. On younger and less shrubby cutblocks, the graminoid layer is generally thick, with bluejoint as one of the more common grass species present. The cutblock cover type occupies 535 ha (3%) and occurs mostly in the southwest of the PRMA LSA (Volume 3, Section 3 of the ESR, Figure 3.6-1).

DIS Disturbance

The disturbance (DIS) cover type represents the baseline disturbance layer for the LSA. This cover type includes all sites that have been disturbed through anthropogenic (man-made) means such as borrow pits, well sites, borehole pads, clearings, roads, rights-of-ways, trails and seismic lines.

Portions of this cover type may contain vegetation that has been highly modified. For example, seismic lines have been cleared to the ground but vegetation has re-grown or colonized in some areas depending upon the age of the disturbance. However, roads and borrow pits are non-vegetated. The disturbance map unit covers 439 ha (2%), primarily in the south of the PRMA LSA, but includes the north-south forestry trunk road (Volume 3, Section 3 of the ESR, Figure 3.6-1).

2 SPECIES COMPOSITION AND PERCENT COVER BY VEGETATION TYPE

Table N-1 provides a complete speices list and the average percent cover for all ecosite phases and wetlands types sampled durning the 2006/2007 PRMA field surveys.

Table N-1 Species Composition and Percent Cover by Vegetation Type in the Pierre River Mining Area

Ecosite Phase	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
Central Mixedwood				
Lichen jack pine (a1)	canopy	*Pinus banksiana*	jack pine	28
	tall shrub	*Alnus viridis ssp crispa*	green alder	3
	low shrub	*Pinus banksiana*	jack pine	<1
		Amelanchier alnifolia	saskatoon	<1
		Populus balsamifera	balsam poplar	<1
		Picea glauca	white spruce	<1
		Shepherdia canadensis	Canada buffalo-berry	2
		Alnus viridis ssp crispa	green alder	2
		Linnaea borealis	twinflower	3
		Arctostaphylos uva-ursi	common bearberry	10
		Vaccinium vitis-idaea	bog cranberry	10
		Vaccinium myrtilloides	common blueberry	12
	forb	*Melampyrum lineare*	cow-wheat	<1
		Anemone multifida	cut-leaved anemone	<1
		Campanula rotundifolia	harebell	<1
		Apocynum androsaemifolium	spreading dogbane	<1
		Aralia nudicaulis	wild sarsaparilla	<1
		Galium boreale	northern bedstraw	<1
		Anemone patens	prairie crocus	<1
		Geocaulon lividum	northern bastard toadflax	<1
		Comandra umbellata	bastard toadflax	<1
		Maianthemum canadense	wild lily-of-the-valley	1
		Smilacina trifolia	three-leaved Solomon's-seal	1
		Diphasiastrum complanatum (also Lycopodium complanatum)	ground-cedar	2
	graminoid	*unknown Carex species*	*unknown Carex species*	<1
		Oryzopsis pungens	northern rice grass	<1
		unknown graminoid species	*unknown graminoid species*	<1
	moss	*Dicranum fuscescens*	fuscous moss	<1
		Ptilidium pulcherrimum	liverwort	<1
		Dicranum flagellare	whip fork moss	<1
		Dicranum fragilifolium	cushion moss	<1

Table N-1 Species Composition and Percent Cover by Vegetation Type in the Pierre River Mining Area (continued)

Ecosite Phase	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
Lichen jack pine (a1) (continued)	moss (continued)	*Lepidozia reptans*	liverwort	<1
		Dicranum undulatum	wavy dicranum	<1
		Dicranum polysetum	wavy dicranum	<1
		Polytrichum juniperinum	juniper hair-cap	2
		Hylocomium splendens	stair-step moss	3
		Pleurozium schreberi	Schreber's moss	23
	lichen	*Cladonia cornuta*	bighorn cladonia	<1
		Cladonia coniocraea	cup lichen	<1
		Peltigera canina	dog lichen	<1
		Cetraria nivalis (also Flavocetraria nivalis)	flattened snow lichen	<1
		Cladonia sulphurina	greater sulphur cup	<1
		Cladonia cervicornis (also C. verticillata)	ladder lichen	<1
		Cladonia deformis	lesser sulphur-cup	<1
		Cladonia chlorophaea	mealy pixie-cup	<1
		Cladonia amaurocraea	*no common name*	<1
		Cladonia bacillaris	*no common name*	<1
		Cladonia macilenta	*no common name*	<1
		Cladonia phyllophora	*no common name*	<1
		Trapeliopsis granulosa	*no common name*	<1
		Cladonia crispata	organ-pipe lichen	<1
		Cladonia pyxidata	pebbled pixie-cup	<1
		Cladonia borealis	red pixie-cup	<1
		Cladonia gracilis	smooth cladonia	<1
		Peltigera aphthosa	studded leather lichen	<1
		Cladonia botrytes	wooden soldiers	<1
		Cladonia uncialis	thorn cladonia	<1
		Cladina stellaris	reindeer lichen	1
		Cladina rangiferina	reindeer lichen	3
		Cladina mitis	reindeer lichen	32
	epiphyte	*Imshaugia placorodia*	American starburst lichen	<1
		Arthonioid group	*Arthonioid* group	<1
		Evernia mesomorpha	boreal oakmoss lichen	<1
		Tuckermannopsis sepincola	chestnut wrinkle-lichen	<1
		Hypocenomyce scalaris	common clam lichen	<1
		Tuckermannopsis americana (also Cetraria halei or C. ciliaris)	fringed wrinkle-lichen	<1
		Lecanora symmicta	fused rim-lichen	<1
		Parmeliopsis hyperopta	gray starburst lichen	<1
		Parmeliopsis ambigua	green starburst lichen	<1
		Parmelia sulcata	hammered shield moss	<1
		Lecanora laxa	*no common name*	<1
		Lecanora persimilis	*no common name*	<1

Table N-1 Species Composition and Percent Cover by Vegetation Type in the Pierre River Mining Area (continued)

Ecosite Phase	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
Lichen jack pine (a1) (continued)	epiphyte (continued)	*Lecanora pulicaris*	*no common name*	<1
		Lecanora subintricata	*no common name*	<1
		Lecidea nylanderi	*no common name*	<1
		Lecidella elaeochroma	*no common name*	<1
		Micarea sylvicola	*no common name*	<1
		Ochrolechia arborea	*no common name*	<1
		Phlyctis argena	*no common name*	<1
		Scoliciosporum perpusillum	*no common name*	<1
		Bryoria furcellata	old man's beard	<1
		Bryoria fuscescens	old man's beard	<1
		Bryoria glabra	old man's beard	<1
		Usnea hirta	old man's beard	<1
		Usnea lapponica	old man's beard	<1
		Usnea scabrata	old man's beard	<1
		Usnea substerilis	old man's beard	<1
		Vulpicida pinastri (also Tuckermannopsis pinastri)	powdered sunshine lichen	<1
		Imshaugia aleurites	salted starburst lichen	<1
		Tuckermannopsis orbata (also Cetraria orbata)	variable wrinkle-lichen	<1
		Hypogymnia physodes	monk's-hood lichen	<1
Blueberry jack pine-aspen (b1)	canopy	*Populus tremuloides*	aspen	8
		Pinus banksiana	jack pine	30
		Betula papyrifera	white birch	35
	subcanopy	*Betula papyrifera*	white birch	3
		Picea glauca	white spruce	4
		Populus tremuloides	aspen	5
	tall shrub	*Betula papyrifera*	white birch	<1
		Picea glauca	white spruce	<1
		Alnus viridis ssp crispa	green alder	1
		Populus tremuloides	aspen	1
		Prunus pensylvanica	pin cherry	2
	low shrub	*Betula papyrifera*	white birch	<1
		Vaccinium vitis-idaea	bog cranberry	<1
		Vaccinium vitis-idaea	bog cranberry	<1
		Prunus pensylvanica	pin cherry	<1
		Lonicera dioica	twining honeysuckle	<1
		Picea glauca	white spruce	1
		Linnaea borealis	twinflower	1
		Amelanchier alnifolia	saskatoon	1
		Shepherdia canadensis	Canada buffalo-berry	1
		Populus tremuloides	aspen	2
		Viburnum edule	low-bush cranberry	2
		Arctostaphylos uva-ursi	common bearberry	2

Table N-1 Species Composition and Percent Cover by Vegetation Type in the Pierre River Mining Area (continued)

Ecosite Phase	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
Blueberry jack pine-aspen (b1) (continued)	low shrub (continued)	*Rosa acicularis*	prickly rose	3
		Vaccinium vitis-idaea	bog cranberry	4
		Alnus viridis ssp crispa	green alder	5
		Vaccinium myrtilloides	common blueberry	11
		Ledum groenlandicum	common Labrador tea	20
	forb	*Melampyrum lineare*	cow-wheat	<1
		Anemone multifida	cut-leaved anemone	<1
		Campanula rotundifolia	harebell	<1
		Fragaria virginiana	wild strawberry	<1
		Geocaulon lividum	northern bastard toadflax	<1
		Antennaria neglecta	broad-leaved everlasting	<1
		Lycopodium obscurum	ground-pine	<1
		Galium boreale	northern bedstraw	<1
		Trientalis borealis	northern starflower	<1
		Epilobium angustifolium	common fireweed	<1
		unknown Pyrola species	*unknown Pyrola species*	<1
		Coptis trifolia	goldthread	<1
		Viola renifolia	kidney-leaved violet	<1
		Goodyera repens	lesser rattlesnake plantain	<1
		Moneses uniflora	one-flowered wintergreen	<1
		Orthilia secunda (also Pyrola secunda)	one-sided wintergreen	<1
		Corallorhiza trifida	pale coralroot	<1
		Actaea rubra	red and white baneberry	<1
		unknown forb species	*unknown forb species*	<1
		Comandra umbellata	bastard toadflax	<1
		Rubus pubescens	dewberry	<1
		Diphasiastrum complanatum (also Lycopodium complanatum)	ground-cedar	<1
		Maianthemum canadense	wild lily-of-the-valley	1
		Lathyrus ochroleucus	cream-colored vetchling	2
		Aralia nudicaulis	wild sarsaparilla	3
		Smilacina trifolia	three-leaved Solomon's-seal	3
		Cornus canadensis	bunchberry	4
		Lycopodium annotinum	stiff club-moss	11
	graminoid	*Oryzopsis pungens*	northern rice grass	<1
		unknown graminoid species	*unknown graminoid species*	<1
		Calamagrostis canadensis	bluejoint	<1

Table N-1 Species Composition and Percent Cover by Vegetation Type in the Pierre River Mining Area (continued)

Ecosite Phase	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
Blueberry jack pine-aspen (b1) (continued)	graminoid (continued)	*Oryzopsis asperifolia*	white-grained mountain rice grass	<1
		Leymus innovatus (also Elymus innovatus)	hairy wild rye	1
		unknown graminoid species	*unknown graminoid species*	5
	moss	*Ptilidium pulcherrimum*	liverwort	<1
		Dicranum flagellare	whip fork moss	<1
		Dicranum fuscescens	fuscous moss	<1
		Polytrichum juniperinum	juniper hair-cap	<1
		Pylaisiella polyantha	pylaisiella moss	<1
		Polytrichum commune	common hair-cap	<1
		Lepidozia reptans	liverwort	<1
		Ptilium crista-castrensis	knight's plume moss	<1
		Dicranum polysetum	wavy dicranum	1
		Hylocomium splendens	stair-step moss	5
		Pleurozium schreberi	Schreber's moss	56
	lichen	*Cladonia cristatella*	*no common name*	<1
		Cladonia cornuta	bighorn cladonia	<1
		Peltigera neopolydactyla	carpet pelt	<1
		Peltigera canina	dog lichen	<1
		Tuckermannopsis americana (also Cetraria halei or C. ciliaris)	fringed wrinkle-lichen	<1
		Cladonia sulphurina	greater sulphur cup	<1
		Cladonia chlorophaea	mealy pixie-cup	<1
		Cladonia crispata	organ-pipe lichen	<1
		Cladonia pyxidata	pebbled pixie-cup	<1
		Cladonia borealis	red pixie-cup	<1
		Cladina rangiferina	reindeer lichen	<1
		Cladonia uncialis	thorn cladonia	<1
		Cladonia botrytes	wooden soldiers	<1
		Cladonia coniocraea	cup lichen	<1
		Cladonia gracilis	smooth cladonia	<1
		Parmeliopsis hyperopta	gray starburst lichen	<1
		Parmeliopsis ambigua	green starburst lichen	<1
		Cladonia cervicornis (also C. verticillata)	ladder lichen	<1
		unknown lichen species	*unknown lichen species*	<1
		Cladina mitis	*reindeer lichen*	1
	epiphyte	*Cliostomum pallens*	*no common name*	<1
		Lecanora laxa	*no common name*	<1
		Lecanora persimilis	*no common name*	<1
		Lecanora pulicaris	*no common name*	<1
		Lecanora subintricata	*no common name*	<1
		Lecidea nylanderi	*no common name*	<1
		Lecidea porphyrospoda	*no common name*	<1

Table N-1 Species Composition and Percent Cover by Vegetation Type in the Pierre River Mining Area (continued)

Ecosite Phase	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
Blueberry jack pine-aspen (b1) (continued)	epiphyte (continued)	*Melanelia trabeculata*	*no common name*	<1
		Ochrolechia arborea	*no common name*	<1
		Rinodina disjuncta	*no common name*	<1
		Rinodina septentrionalis	*no common name*	<1
		Scoliciosporum perpusillum	*no common name*	<1
		Trapeliopsis flexuosa	*no common name*	<1
		Usnea scabiosa	*no common name*	<1
		Phaeocalicium compressulum	alder needles	<1
		Stenocybe pullatula	alder stickpin	<1
		Arthonioid group	*Arthonioid* group	<1
		Evernia mesomorpha	boreal oakmoss lichen	<1
		Tuckermannopsis sepincola	chestnut wrinkle-lichen	<1
		Hypocenomyce scalaris	common clam lichen	<1
		Cladonia coniocraea	cup lichen	<1
		Tuckermannopsis americana (also Cetraria halei or C. ciliaris)	fringed wrinkle-lichen	<1
		Lecanora symmicta	fused rim-lichen	<1
		Parmeliopsis hyperopta	gray starburst lichen	<1
		Bryoria furcellata	old man's beard	<1
		Bryoria fuscescens	old man's beard	<1
		Usnea lapponica	old man's beard	<1
		Usnea subfloridana	old man's beard	<1
		Usnea substerilis	old man's beard	<1
		Ramalina dilacerata	punctured *ramalina*	<1
		Imshaugia aleurites	salted starburst lichen	<1
		Parmelia sulcata	hammered shield moss	<1
		Vulpicida pinastri (also Tuckermannopsis pinastri)	powdered sunshine lichen	<1
		Imshaugia placorodia	American starburst lichen	<1
		Parmeliopsis ambigua	green starburst lichen	<1
		Hypogymnia physodes	monk's-hood lichen	<1
		Usnea hirta	old man's beard	<1
		Tuckermannopsis orbata (also Cetraria orbata)	variable wrinkle-lichen	<1
		unknown epiphyte species	*unknown epiphyte species*	10
Blueberry aspen (white birch) (b2)	canopy	*Populus tremuloides*	aspen	10
	tall shrub	*Alnus viridis ssp crispa*	green alder	4
	low shrub	*Populus tremuloides*	aspen	<1
		Viburnum edule	low-bush cranberry	<1
		Linnaea borealis	twinflower	<1
		Alnus viridis ssp crispa	green alder	2
		Vaccinium vitis-idaea	bog cranberry	7

Table N-1 Species Composition and Percent Cover by Vegetation Type in the Pierre River Mining Area (continued)

Ecosite Phase	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
Blueberry aspen (white birch) (b2) (continued)	low shrub (continued)	*Vaccinium myrtilloides*	common blueberry	58
	forb	*Lycopodium obscurum*	ground-pine	<1
		Maianthemum canadense	wild lily-of-the-valley	<1
		Lycopodium annotinum	stiff club-moss	1
		Aralia nudicaulis	wild sarsaparilla	1
		Epilobium angustifolium	common fireweed	3
		Trientalis borealis	northern starflower	3
		Cornus canadensis	bunchberry	8
	graminoid	*Calamagrostis canadensis*	bluejoint	<1
	moss	*Pylaisiella polyantha*	pylaisiella moss	<1
		Hylocomium splendens	stair-step moss	<1
		Dicranum flagellare	whip fork moss	<1
Blueberry aspen-white spruce (b3)	canopy	*Pinus banksiana*	jack pine	5
		Picea mariana	black spruce	20
		Picea glauca	white spruce	22
		Populus tremuloides	aspen	25
	subcanopy	*Picea glauca*	white spruce	<1
		Betula papyrifera	white birch	1
	tall shrub	*Populus tremuloides*	aspen	<1
		Ribes oxyacanthoides	northern gooseberry	<1
		Prunus pensylvanica	pin cherry	<1
		Rosa acicularis	prickly rose	<1
		Lonicera dioica	twining honeysuckle	<1
		Picea glauca	white spruce	<1
		Ribes triste	wild red currant	<1
		unknown Salix species	*unknown Salix species*	1
		Picea mariana	black spruce	1
		Betula papyrifera	white birch	1
	low shrub	*Amelanchier alnifolia*	saskatoon	<1
		Lonicera dioica	twining honeysuckle	<1
		unknown Salix species	*unknown Salix species*	<1
		Populus tremuloides	aspen	1
		Picea mariana	black spruce	1
		Vaccinium vitis-idaea	bog cranberry	1
		Linnaea borealis	twinflower	1
		Rosa acicularis	prickly rose	4
		Viburnum edule	low-bush cranberry	5
		Shepherdia canadensis	Canada buffalo-berry	8
		Vaccinium myrtilloides	common blueberry	8
		Alnus viridis ssp crispa	green alder	25
	forb	*unknown Pyrola species*	*unknown Pyrola species*	<1
		Mitella nuda	bishop's-cap	<1

Table N-1 Species Composition and Percent Cover by Vegetation Type in the Pierre River Mining Area (continued)

Ecosite Phase	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
Blueberry aspen-white spruce (b3) (continued)	forb (continued)	*Epilobium angustifolium*	common fireweed	<1
		Pyrola asarifolia	common pink wintergreen	<1
		Lathyrus ochroleucus	cream-colored vetchling	<1
		Rubus pubescens	dewberry	<1
		Pyrola chlorantha (also Pyrola virens)	greenish-flowered wintergreen	<1
		Goodyera repens	lesser rattlesnake plantain	<1
		Stellaria longifolia	long-leaved chickweed	<1
		Geocaulon lividum	northern bastard toadflax	<1
		Galium boreale	northern bedstraw	<1
		Orthilia secunda (also Pyrola secunda)	one-sided wintergreen	<1
		Fragaria virginiana	wild strawberry	<1
		Vicia americana	wild vetch	<1
		Equisetum sylvaticum	woodland horsetail	<1
		Mertensia paniculata	tall lungwort	<1
		Aralia nudicaulis	wild sarsaparilla	<1
		Lycopodium obscurum	ground-pine	1
		Trientalis borealis	northern starflower	1
		Maianthemum canadense	wild lily-of-the-valley	2
		Cornus canadensis	bunchberry	10
	graminoid	*Calamagrostis canadensis*	bluejoint	<1
		Carex brunnescens	brownish sedge	<1
		Leymus innovatus (also Elymus innovatus)	hairy wild rye	<1
		unknown graminoid species	*unknown graminoid species*	<1
		Oryzopsis asperifolia	white-grained mountain rice grass	<1
	moss	*Sanionia uncinata (also Drepanocladus uncinatus)*	brown moss	<1
		Plagiomnium drummondii	Drummond's plagiomnium moss	<1
		Eurhynchium pulchellum	eurhynchiummoss	<1
		unknown moss species	*unknown moss species*	<1
		unknown moss species	*unknown moss species*	<1
		Dicranum flagellare	whip fork moss	<1
		Pylaisiella polyantha	pylaisiella moss	<1
		Ptilium crista-castrensis	knight's plume moss	1
		Dicranum polysetum	wavy dicranum	1
		Brachythecium salebrosum	*no common name*	2
		Hylocomium splendens	stair-step moss	10

Table N-1 Species Composition and Percent Cover by Vegetation Type in the Pierre River Mining Area (continued)

Ecosite Phase	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
Blueberry aspen-white spruce (b3) (continued)	moss (continued)	*Pleurozium schreberi*	Schreber's moss	33
	lichen	*Peltigera neopolydactyla*	carpet pelt	<1
		Cladonia sulphurina	greater sulphur cup	<1
		Cladonia pyxidata	pebbled pixie-cup	<1
		Cladonia botrytes	wooden soldiers	<1
		Cladonia coniocraea	cup lichen	<1
		Peltigera canina	dog lichen	<1
		Cladonia chlorophaea	mealy pixie-cup	<1
		Cladina mitis	reindeer lichen	<1
		Cladonia ochrochlora	smooth-footed powderhorn	<1
	epiphyte	*Rinodina metaboliza*	*no common name*	<1
		Scoliciosporum perpusillum	*no common name*	<1
		unknown Usnea species	*unknown Usnea species*	<1
		Lecanora symmicta	fused rim-lichen	<1
		Bryoria fuscescens	old man's beard	<1
		Usnea lapponica	old man's beard	<1
		Usnea scabrata	old man's beard	<1
		Ramalina dilacerata	punctured ramalina	<1
		Melanelia subaurifera	abraded camoflage lichen	<1
		Parmelia sulcata	hammered shield moss	<1
		Vulpicida pinastri (also Tuckermannopsis pinastri)	powdered sunshine lichen	<1
		Evernia mesomorpha	boreal oakmoss lichen	<1
		Hypogymnia physodes	monk's-hood lichen	1
		Usnea hirta	old man's beard	4
Blueberry white spruce-jack pine (b4)	canopy	*Betula papyrifera*	white birch	5
		Populus tremuloides	aspen	7
		Picea mariana	black spruce	10
		Picea glauca	white spruce	11
		Pinus banksiana	jack pine	15
	subcanopy	*Abies balsamea*	balsam fir	<1
		Populus tremuloides	aspen	<1
		Pinus banksiana	jack pine	<1
		Picea mariana	black spruce	2
		Picea glauca	white spruce	3
		Betula papyrifera	white birch	5
	tall shrub	*unknown Salix species*	*unknown Salix species*	<1
		Rubus idaeus	wild red raspberry	<1
		Vaccinium myrtilloides	common blueberry	1
		Betula papyrifera	white birch	1

Table N-1 Species Composition and Percent Cover by Vegetation Type in the Pierre River Mining Area (continued)

Ecosite Phase	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
Blueberry white spruce-jack pine (b4) (continued)	tall shrub (continued)	*Abies balsamea*	balsam fir	7
		Picea glauca	white spruce	8
		Alnus viridis ssp crispa	green alder	20
	low shrub	*Betula papyrifera*	white birch	<1
		Salix pyrifolia	balsam willow	<1
		Prunus virginiana	choke cherry	<1
		Amelanchier alnifolia	saskatoon	<1
		Symphoricarpos albus	snowberry	<1
		Lonicera dioica	twining honeysuckle	<1
		Vaccinium myrtilloides	common blueberry	2
		Alnus viridis ssp crispa	green alder	2
		Linnaea borealis	twinflower	3
		Abies balsamea	balsam fir	3
		Populus tremuloides	aspen	5
		Picea glauca	white spruce	5
		Rosa acicularis	prickly rose	6
		Shepherdia canadensis	Canada buffalo-berry	6
		Arctostaphylos uva-ursi	common bearberry	6
		Vaccinium vitis-idaea	bog cranberry	10
		Ledum groenlandicum	common Labrador tea	13
	forb	*Geocaulon lividum*	northern bastard toadflax	<1
		unknown Pyrola species	*unknown Pyrola species*	<1
		Comandra umbellata	bastard toadflax	<1
		Mitella nuda	bishop's-cap	<1
		Antennaria neglecta	broad-leaved everlasting	<1
		Pyrola asarifolia	common pink wintergreen	<1
		Achillea millefolium	common yarrow	<1
		Viola adunca	early blue violet	<1
		Lycopodium obscurum	ground-pine	<1
		Arnica chamissonis	leafy arnica	<1
		Mertensia paniculata	tall lungwort	<1
		Fragaria virginiana	wild strawberry	<1
		Lathyrus ochroleucus	cream-colored vetchling	<1
		Galium boreale	northern bedstraw	<1
		Rubus pubescens	dewberry	1
		Epilobium angustifolium	common fireweed	1
		Lycopodium annotinum	stiff club-moss	2
		Diphasiastrum complanatum (also Lycopodium complanatum)	ground-cedar	2
		Trientalis borealis	northern starflower	2

Table N-1 Species Composition and Percent Cover by Vegetation Type in the Pierre River Mining Area (continued)

Ecosite Phase	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
Blueberry white spruce-jack pine (b4) (continued)	forb (continued)	*Cornus canadensis*	bunchberry	3
		Aralia nudicaulis	wild sarsaparilla	3
		Maianthemum canadense	wild lily-of-the-valley	4
	graminoid	*unknown graminoid species*	*unknown graminoid species*	<1
		unknown graminoid species	*unknown graminoid species*	<1
		Leymus innovatus (also Elymus innovatus)	hairy wild rye	5
		unknown graminoid species	*unknown graminoid species*	10
	moss	*Bryum pseudotriquetrum*	*no common name*	<1
		Orthotrichum speciosum	*no common name*	<1
		Polytrichum commune	common hair-cap	<1
		Leptobryum pyriforme	*leptobryum* moss	<1
		Lepidozia reptans	liverwort	<1
		Pylaisiella polyantha	*pylaisiella* moss	<1
		Polytrichum juniperinum	juniper hair-cap	<1
		Pohlia nutans	copper wire moss	<1
		Ptilidium ciliare	liverwort	<1
		Dicranum polysetum	wavy *dicranum*	<1
		Dicranum undulatum	wavy *dicranum*	<1
		Ptilium crista-castrensis	knight's plume moss	7
		Hylocomium splendens	stair-step moss	20
		Pleurozium schreberi	Schreber's moss	39
	lichen	*Peltigera neopolydactyla*	carpet pelt	<1
		Hypocenomyce scalaris	common clam lichen	<1
		Cladonia coniocraea	cup lichen	<1
		Cladonia sulphurina	greater sulphur cup	<1
		Cladonia chlorophaea	mealy pixie-cup	<1
		Cladonia crispata	organ-pipe lichen	<1
		Cladina mitis	reindeer lichen	<1
		Cladina stellaris	reindeer lichen	<1
		Cladonia multiformis	sieve lichen	<1
		Cladonia gracilis	smooth cladonia	<1
		Peltigera aphthosa	studded leather lichen	<1
		Cladonia fimbriata	trumpet lichen	<1
		Cladonia botrytes	wooden soldiers	<1
	epiphyte	*Lecanora pulicaris*	*no common name*	<1
		Lecanora subintricata	*no common name*	<1
		Lecidella elaeochroma	*no common name*	<1
		Ochrolechia arborea	*no common name*	<1
		Rinodina septentrionalis	*no common name*	<1
		Scoliciosporum perpusillum	*no common name*	<1

Table N-1 Species Composition and Percent Cover by Vegetation Type in the Pierre River Mining Area (continued)

Ecosite Phase	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
Blueberry white spruce-jack pine (b4) (continued)	epiphyte (continued)	*Melanelia subaurifera*	abraded camoflage lichen	<1
		Phaeocalicium compressulum	alder needles	<1
		Arthonioid group	*Arthonioid* group	<1
		Tuckermannopsis americana (also Cetraria halei or C. ciliaris)	fringed wrinkle-lichen	<1
		Lecanora symmicta	fused rim-lichen	<1
		Parmeliopsis ambigua	green starburst lichen	<1
		Parmelia sulcata	hammered shield moss	<1
		Cladonia chlorophaea	mealy pixie-cup	<1
		Bryoria furcellata	old man's beard	<1
		Bryoria fuscescens	old man's beard	<1
		Bryoria glabra	old man's beard	<1
		Usnea hirta	old man's beard	<1
		Usnea lapponica	old man's beard	<1
		Usnea subfloridana	old man's beard	<1
		Usnea substerilis	old man's beard	<1
		Vulpicida pinastri (also Tuckermannopsis pinastri)	powdered sunshine lichen	<1
		Ramalina dilacerata	punctured ramalina	<1
		Evernia mesomorpha	boreal oakmoss lichen	<1
		Usnea scabrata	old man's beard	<1
		Hypogymnia physodes	monk's-hood lichen	2
Labrador tea-mesic jack pine-black spruce (c1)	canopy	*Populus tremuloides*	aspen	2
		Betula papyrifera	white birch	2
		Populus balsamifera	balsam poplar	5
		Pinus banksiana	jack pine	26
		Picea mariana	black spruce	33
	tall shrub	*Prunus pensylvanica*	pin cherry	<1
		Betula papyrifera	white birch	<1
		Picea glauca	white spruce	<1
		Picea mariana	black spruce	<1
	low shrub	*Amelanchier alnifolia*	saskatoon	<1
		Salix lutea	yellow willow	<1
		Vaccinium vitis-idaea	bog cranberry	<1
		Arctostaphylos rubra	alpine bearberry	<1
		Picea mariana	black spruce	<1
		Vaccinium myrtilloides	common blueberry	<1
		Viburnum edule	low-bush cranberry	1
		Linnaea borealis	twinflower	1
		Salix myrtillifolia	myrtle-leaved willow	2
		Rosa acicularis	prickly rose	2
		Ledum groenlandicum	common Labrador tea	5
		Shepherdia canadensis	Canada buffalo-berry	6

Table N-1 Species Composition and Percent Cover by Vegetation Type in the Pierre River Mining Area (continued)

Ecosite Phase	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
Labrador tea-mesic jack pine-black spruce (c1) (continued)	forb	*Lathyrus ochroleucus*	cream-colored vetchling	<1
		Rubus pubescens	dewberry	<1
		Diphasiastrum complanatum (also Lycopodium complanatum)	ground-cedar	<1
		Lycopodium clavatum	running club-moss	<1
		Petasites frigidus var palmatus	palmate-leaved coltsfoot	<1
		unknown Aster species	*unknown Aster species*	<1
		Equisetum scirpoides	dwarf scouring-rush	<1
		Goodyera repens	lesser rattlesnake plantain	<1
		Erigeron acris	northern daisy fleabane	<1
		Cornus canadensis	bunchberry	<1
		Equisetum pratense	meadow horsetail	<1
		Galium boreale	northern bedstraw	<1
		Geocaulon lividum	northern bastard toadflax	1
		Maianthemum canadense	wild lily-of-the-valley	1
		Epilobium angustifolium	common fireweed	3
	graminoid	*unknown graminoid species*	*unknown graminoid species*	<1
		Oryzopsis asperifolia	white-grained mountain rice grass	<1
		Carex concinna	beautiful sedge	<1
		unknown graminoid species	*unknown graminoid species*	<1
	moss	*Orthotrichum speciosum*	*no common name*	<1
		Dicranum fuscescens	*fuscous* moss	<1
		Ptilium crista-castrensis	knight's plume moss	<1
		Pylaisiella polyantha	*pylaisiella* moss	<1
		Dicranum polysetum	wavy *dicranum*	<1
		Tomentypnum nitens	golden moss	<1
		Ptilidium ciliare	liverwort	<1
		Dicranum flagellare	whip fork moss	1
		Dicranum undulatum	wavy *dicranum*	2
		Hylocomium splendens	stair-step moss	20
		Pleurozium schreberi	Schreber's moss	53
	lichen	*unknown Flavoparmelia species*	*unknown Flavoparmelia* species	<1
		Cladonia cornuta	bighorn *cladonia*	<1
		Peltigera neopolydactyla	carpet pelt	<1
		Hypocenomyce scalaris	common clam lichen	<1
		Cladonia coniocraea	cup lichen	<1

Table N-1 Species Composition and Percent Cover by Vegetation Type in the Pierre River Mining Area (continued)

Ecosite Phase	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
Labrador tea-mesic jack pine-black spruce (c1) (continued)	lichen (continued)	*Cladonia sulphurina*	greater sulphur cup	<1
		Cladonia borealis	red pixie-cup	<1
		Cladina rangiferina	reindeer lichen	<1
		Cladina stellaris	reindeer lichen	<1
		Cladonia gracilis	smooth cladonia	<1
		Peltigera aphthosa	studded leather lichen	<1
		Cladonia uncialis	thorn cladonia	<1
		Cladina mitis	reindeer lichen	15
	epiphyte	*Arthonia patellulata*	*no common name*	<1
		Lecanora persimilis	*no common name*	<1
		Lecanora pulicaris	*no common name*	<1
		Lecanora subintricata	*no common name*	<1
		Lecidea nylanderi	*no common name*	<1
		Ochrolechia arborea	*no common name*	<1
		Scoliciosporum perpusillum	*no common name*	<1
		Melanelia subaurifera	abraded camoflage lichen	<1
		Imshaugia placorodia	American starburst lichen	<1
		Arthonioid group	*Arthonioid* group	<1
		Evernia mesomorpha	boreal oakmoss lichen	<1
		Lecanora symmicta	fused rim-lichen	<1
		Parmeliopsis hyperopta	gray starburst lichen	<1
		Parmeliopsis ambigua	green starburst lichen	<1
		Parmelia sulcata	hammered shield moss	<1
		Hypogymnia physodes	monk's-hood lichen	<1
		Bryoria furcellata	old man's beard	<1
		Bryoria fuscescens	old man's beard	<1
		Bryoria glabra	old man's beard	<1
		Bryoria simplicior	old man's beard	<1
		Usnea lapponica	old man's beard	<1
		Usnea scabrata	old man's beard	<1
		Usnea subfloridana	old man's beard	<1
		Vulpicida pinastri (also Tuckermannopsis pinastri)	powdered sunshine lichen	<1
		Ramalina dilacerata	punctured *ramalina*	<1
		Tuckermannopsis americana (also Cetraria halei or C. ciliaris)	fringed wrinkle-lichen	<1
Low-bush cranberry aspen (d1)	canopy	*Populus balsamifera*	balsam poplar	2
		Picea glauca	white spruce	5
		Betula papyrifera	white birch	11
		Populus tremuloides	aspen	38
	subcanopy	*Populus balsamifera*	balsam poplar	<1

Table N-1 Species Composition and Percent Cover by Vegetation Type in the Pierre River Mining Area (continued)

Ecosite Phase	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
Low-bush cranberry aspen (d1) (continued)	subcanopy (continued)	*Salix bebbiana*	beaked willow	<1
		Picea glauca	white spruce	6
		Betula papyrifera	white birch	7
		Populus tremuloides	aspen	8
	tall shrub	*Arctostaphylos uva-ursi*	common bearberry	<1
		Rosa acicularis	prickly rose	<1
		Linnaea borealis	twinflower	<1
		unknown Salix species	*unknown Salix species*	<1
		Ribes oxyacanthoides	northern gooseberry	1
		Alnus incana ssp tenuifolia (also A. rugosa)	river alder	1
		Betula papyrifera	white birch	1
		Populus balsamifera	balsam poplar	2
		Viburnum edule	low-bush cranberry	2
		Picea glauca	white spruce	2
		Populus tremuloides	aspen	3
		Rosa woodsii	common wild rose	10
		Alnus viridis ssp crispa	green alder	10
	low shrub	*unknown Salix species*	*unknown Salix species*	<1
		Lonicera dioica	twining honeysuckle	<1
		Cornus stolonifera	red-osier dogwood	<1
		Ribes glandulosum	skunk currant	<1
		Betula papyrifera	white birch	<1
		Symphoricarpos occidentalis	buckbrush	1
		Alnus incana ssp tenuifolia (also A. rugosa)	river alder	1
		Ledum groenlandicum	common Labrador tea	1
		Symphoricarpos albus	snowberry	1
		Lonicera dioica	twining honeysuckle	1
		Picea glauca	white spruce	1
		Vaccinium vitis-idaea	bog cranberry	2
		Populus balsamifera	balsam poplar	2
		Salix bebbiana	beaked willow	2
		Ribes oxyacanthoides	northern gooseberry	2
		Populus tremuloides	aspen	2
		Ribes triste	wild red currant	2
		Rubus idaeus	wild red raspberry	3
		Linnaea borealis	twinflower	3
		Linnaea borealis	twinflower	4
		Ribes lacustre	bristly black currant	4
		Amelanchier alnifolia	saskatoon	4
		Vaccinium myrtilloides	common blueberry	5
		Rosa woodsii	common wild rose	5
		Alnus viridis ssp crispa	green alder	8

Table N-1 Species Composition and Percent Cover by Vegetation Type in the Pierre River Mining Area (continued)

Ecosite Phase	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
Low-bush cranberry aspen (d1) (continued)	low shrub (continued)	*Shepherdia canadensis*	Canada buffalo-berry	8
		Rosa acicularis	prickly rose	9
		Viburnum edule	low-bush cranberry	10
	forb	*Goodyera repens*	lesser rattlesnake plantain	<1
		Aster brachyactis	rayless aster	<1
		Aster ciliolatus	Lindley's aster	<1
		Achillea millefolium	common yarrow	<1
		unknown Aster species	*unknown Aster species*	<1
		unknown Aster species	*unknown Aster species*	<1
		unknown Aster species	*unknown Aster species*	<1
		unknown Solidago species	*unknown Solidago species*	<1
		Comandra umbellata	bastard toadflax	<1
		Moehringia lateriflora	blunt-leaved sandwort	<1
		Anemone canadensis	Canada anemone	<1
		Viola renifolia	kidney-leaved violet	<1
		Stellaria longifolia	long-leaved chickweed	<1
		Achillea sibirica	many-flowered yarrow	<1
		Stachys palustris	marsh hedge-nettle	<1
		Orthilia secunda (also Pyrola secunda)	one-sided wintergreen	<1
		Actaea rubra	red and white baneberry	<1
		Galium trifidum	small bedstraw	<1
		Delphinium glaucum	tall larkspur	<1
		unknown forb species	*unknown forb species*	<1
		Viola canadensis	western Canada violet	<1
		Fragaria virginiana	wild strawberry	<1
		Vicia americana	wild vetch	<1
		Equisetum arvense	common horsetail	<1
		Pyrola asarifolia	common pink wintergreen	<1
		Petasites frigidus var palmatus	palmate-leaved coltsfoot	<1
		Mitella nuda	bishop's-cap	<1
		Lycopodium obscurum	ground-pine	<1
		Galium triflorum	sweet-scented bedstraw	<1
		Epilobium angustifolium	common fireweed	<1
		Fragaria virginiana	wild strawberry	<1

Table N-1 Species Composition and Percent Cover by Vegetation Type in the Pierre River Mining Area (continued)

Ecosite Phase	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
Low-bush cranberry aspen (d1) (continued)	forb (continued)	*Lathyrus ochroleucus*	cream-colored vetchling	<1
		Galium boreale	northern bedstraw	<1
		unknown Viola species	*unknown Viola species*	1
		Equisetum pratense	meadow horsetail	1
		Thalictrum venulosum	veiny meadow rue	1
		Trientalis borealis	northern starflower	1
		Maianthemum canadense	wild lily-of-the-valley	1
		Mertensia paniculata	tall lungwort	2
		Lycopodium annotinum	stiff club-moss	2
		Rubus pubescens	dewberry	3
		Equisetum sylvaticum	woodland horsetail	4
		Aralia nudicaulis	wild sarsaparilla	8
		Cornus canadensis	bunchberry	13
	graminoid	*Poa pratensis*	Kentucky bluegrass	<1
		Carex deweyana	Dewey's sedge	<1
		Elymus trachycaulus ssp trachycaulus (also Agropyron trachycaulum)	slender wheat grass	<1
		unknown graminoid species	*unknown graminoid species*	<1
		unknown Oryzopsis species	*unknown Oryzopsis species*	1
		Leymus innovatus (also Elymus innovatus)	hairy wild rye	1
		Oryzopsis asperifolia	white-grained mountain rice grass	5
		unknown graminoid species	*unknown graminoid species*	5
		Calamagrostis canadensis	bluejoint	14
		unknown graminoid species	*unknown graminoid species*	25
	moss	*Campylium chrysophyllum*	*no common name*	<1
		Orthotrichum speciosum	*no common name*	<1
		Dicranum flagellare	whip fork moss	<1
		Dicranum fuscescens	*fuscous* moss	<1
		Lepidozia reptans	liverwort	<1
		Ptilidium pulcherrimum	liverwort	<1
		Dicranum polysetum	wavy *dicranum*	<1
		unknown Mnium species	*unknown Mnium species*	<1
		Amblystegium serpens	*no common name*	<1
		Mnium spinulosum	*no common name*	<1
		Dicranum scoparium	broom moss	<1
		Sanionia uncinata (also Drepanocladus uncinatus)	brown moss	<1

Table N-1 Species Composition and Percent Cover by Vegetation Type in the Pierre River Mining Area (continued)

Ecosite Phase	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
Low-bush cranberry aspen (d1) (continued)	moss (continued)	*Plagiomnium ellipticum*	*elliptic plagiomnium* moss	<1
		Ptilium crista-castrensis	knight's plume moss	<1
		Oncophorus wahlenbergii	mountain curved-back moss	<1
		Plagiomnium cuspidatum	toothed *plagiomnium* moss	<1
		unknown moss species	*unknown moss species*	<1
		unknown moss species	*unknown moss species*	<1
		Warnstorfia fluitans (also Drepanocladus fluitans)	water hook moss	<1
		Dicranum undulatum	wavy *dicranum*	<1
		unknown moss species	*unknown moss species*	<1
		Eurhynchium pulchellum	eurhynchiummoss	<1
		Brachythecium salebrosum	*no common name*	<1
		Pylaisiella polyantha	pylaisiella moss	<1
		Hylocomium splendens	stair-step moss	1
		Pleurozium schreberi	Schreber's moss	1
	lichen	*Mycobilimbia tetramera (also M. fusca)*	Four-celled moss-dot	<1
		Peltigera aphthosa	studded leather lichen	<1
		Cladonia chlorophaea	mealy pixie-cup	<1
		Cladonia coniocraea	cup lichen	<1
		unknown Cladonia species	*unknown Cladonia species*	<1
		Melanelia subaurifera	abraded camoflage lichen	<1
		Cladonia cornuta	bighorn cladonia	<1
		Hypocenomyce scalaris	common clam lichen	<1
		Peltigera canina	dog lichen	<1
		Parmeliopsis hyperopta	gray starburst lichen	<1
		Cladonia sulphurina	greater sulphur cup	<1
		Vulpicida pinastri (also Tuckermannopsis pinastri)	powdered sunshine lichen	<1
		Cladonia fimbriata	trumpet lichen	<1
		unknown lichen species	*unknown lichen species*	<1
		Cladonia botrytes	wooden soldiers	<1
		Peltigera neopolydactyla	carpet pelt	<1
	epiphyte	*Biatora carneoalbida (also Mycobilimbia carneoalbida)*	*no common name*	<1
		Caloplaca holocarpa	*no common name*	<1
		Candelariella lutella	*no common name*	<1
		Lecidea nylanderi	*no common name*	<1
		Rinodina septentrionalis	*no common name*	<1

Table N-1 Species Composition and Percent Cover by Vegetation Type in the Pierre River Mining Area (continued)

Ecosite Phase	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
Low-bush cranberry aspen (d1) (continued)	epiphyte (continued)	*Scoliciosporum perpusillum*	*no common name*	<1
		unknown Usnea species	*unknown Usnea species*	<1
		unknown Usnea species	*unknown Usnea species*	<1
		Phaeocalicium compressulum	alder needles	<1
		Lecanora symmicta	fused rim-lichen	<1
		Melanelia septentrionalis	northern camoflage lichen	<1
		Bryoria fuscescens	old man's beard	<1
		Bryoria glabra	old man's beard	<1
		Usnea lapponica	old man's beard	<1
		Usnea scabrata	old man's beard	<1
		Usnea subfloridana	old man's beard	<1
		Usnea substerilis	old man's beard	<1
		Tuckermannopsis americana (also Cetraria halei or C. ciliaris)	fringed wrinkle-lichen	<1
		Ramalina dilacerata	punctured *ramalina*	<1
		Vulpicida pinastri (also Tuckermannopsis pinastri)	powdered sunshine lichen	<1
		Melanelia subaurifera	abraded camoflage lichen	<1
		Evernia mesomorpha	boreal oakmoss lichen	<1
		Arthonia patellulata	*no common name*	<1
		Parmelia sulcata	hammered shield moss	<1
		Hypogymnia physodes	monk's-hood lichen	<1
		Usnea subfusca	*no common name*	<1
		Xanthoria elegans	elegant orange lichen	<1
		Ramalina pollinaria	chalky *ramalina*	<1
		Tuckermannopsis sepincola	chestnut wrinkle-lichen	<1
		Parmeliopsis ambigua	green starburst lichen	<1
		Usnea hirta	old man's beard	<1
		Tuckermannopsis orbata (also Cetraria orbata)	variable wrinkle-lichen	<1
		unknown epiphyte species	*unknown epiphyte species*	2
Low-bush cranberry aspen-white spruce (d2)	canopy	*Pinus banksiana*	jack pine	<1
		Populus balsamifera	balsam poplar	7
		Picea glauca	white spruce	15
		Betula papyrifera	white birch	17
		Populus tremuloides	aspen	25
	subcanopy	*Pinus banksiana*	jack pine	<1
		Populus balsamifera	balsam poplar	2

Table N-1 Species Composition and Percent Cover by Vegetation Type in the Pierre River Mining Area (continued)

Ecosite Phase	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
Low-bush cranberry aspen-white spruce (d2) (continued)	subcanopy (continued)	*unknown Salix species*	*unknown Salix species*	2
		Betula papyrifera	white birch	4
		Alnus incana ssp tenuifolia (also A. rugosa)	river alder	5
		Populus tremuloides	aspen	9
		Picea mariana	black spruce	10
		Picea glauca	white spruce	11
	tall shrub	*Picea mariana*	black spruce	<1
		Arctostaphylos uva-ursi	common bearberry	<1
		Cornus stolonifera	red-osier dogwood	<1
		Salix glauca	smooth willow	<1
		Linnaea borealis	twinflower	<1
		unknown Salix species	*unknown Salix species*	<1
		Populus balsamifera	balsam poplar	1
		Betula papyrifera	white birch	1
		Alnus viridis ssp crispa	green alder	1
		Salix bebbiana	beaked willow	2
		Populus tremuloides	aspen	2
		Picea glauca	white spruce	3
		Rosa acicularis	prickly rose	10
		Ribes glandulosum	skunk currant	10
		Viburnum edule	low-bush cranberry	20
	low shrub	*unknown Salix species*	*unknown Salix species*	<1
		Salix planifolia	flat-leaved willow	<1
		Prunus pensylvanica	pin cherry	<1
		Lonicera involucrata	bracted honeysuckle	<1
		Lonicera dioica	twining honeysuckle	<1
		Picea mariana	black spruce	<1
		Ribes lacustre	bristly black currant	<1
		Symphoricarpos occidentalis	buckbrush	<1
		Vaccinium myrtilloides	common blueberry	<1
		Ribes glandulosum	skunk currant	<1
		Symphoricarpos albus	snowberry	<1
		Rhamnus alnifolia	alder-leaved buckthorn	<1
		unknown Salix species	*unknown Salix species*	<1
		Salix bebbiana	beaked willow	<1
		Cornus stolonifera	red-osier dogwood	<1
		Populus balsamifera	balsam poplar	<1
		Symphoricarpos albus	snowberry	<1
		Ribes oxyacanthoides	northern gooseberry	1

Table N-1 Species Composition and Percent Cover by Vegetation Type in the Pierre River Mining Area (continued)

Ecosite Phase	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
Low-bush cranberry aspen-white spruce (d2) (continued)	low shrub (continued)	*Ribes americanum*	wild black currant	1
		Betula papyrifera	white birch	1
		Picea glauca	white spruce	1
		Ribes triste	wild red currant	2
		Populus tremuloides	aspen	2
		Rubus idaeus	wild red raspberry	2
		Vaccinium vitis-idaea	bog cranberry	2
		Amelanchier alnifolia	saskatoon	3
		Arctostaphylos uva-ursi	common bearberry	3
		Alnus viridis ssp crispa	green alder	4
		Linnaea borealis	twinflower	4
		Rosa acicularis	prickly rose	5
		Vaccinium myrtilloides	common blueberry	5
		Shepherdia canadensis	Canada buffalo-berry	6
		Ledum groenlandicum	common Labrador tea	7
		Viburnum edule	low-bush cranberry	8
	forb	*Apocynum androsaemifolium*	spreading dogbane	<1
		Solidago canadensis	Canada goldenrod	<1
		Equisetum scirpoides	dwarf scouring-rush	<1
		Hieracium umbellatum	narrow-leaved hawkweed	<1
		Orthilia secunda (also Pyrola secunda)	one-sided wintergreen	<1
		Equisetum pratense	meadow horsetail	<1
		Smilacina trifolia	three-leaved Solomon's-seal	<1
		Goodyera repens	lesser rattlesnake plantain	<1
		Achillea millefolium	common yarrow	<1
		Vicia americana	wild vetch	<1
		unknown Aster species	*unknown Aster species*	<1
		unknown Galium species	*unknown Galium species*	<1
		Moehringia lateriflora	blunt-leaved sandwort	<1
		Astragalus canadensis	Canadian milk vetch	<1
		Taraxacum officinale	common dandelion	<1
		Equisetum hyemale	common scouring-rush	<1
		Rubus arcticus (also R. acaulis)	dwarf raspberry	<1
		Disporum trachycarpum	fairybells	<1
		Pyrola chlorantha (also Pyrola virens)	greenish-flowered wintergreen	<1
		Campanula rotundifolia	harebell	<1
		Achillea sibirica	many-flowered yarrow	<1

Table N-1 Species Composition and Percent Cover by Vegetation Type in the Pierre River Mining Area (continued)

Ecosite Phase	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
Low-bush cranberry aspen-white spruce (d2) (continued)	forb (continued)	*Scutellaria galericulata*	marsh skullcap	<1
		Adoxa moschatellina	moschatel	<1
		Moneses uniflora	one-flowered wintergreen	<1
		Chimaphila umbellata	prince's-pine	<1
		Actaea rubra	red and white baneberry	<1
		Amerorchis rotundifolia (also Orchis rotundifolia)	round-leaved orchid	<1
		Circaea alpina	small enchanter's nightshade	<1
		Pedicularis parviflora	swamp lousewort	<1
		Potentilla tridentata (also P. tridentata)	three-toothed cinquefoil	<1
		unknown forb species	*unknown forb species*	<1
		Impatiens noli-tangere	western jewelweed	<1
		Pyrola elliptica	white wintergreen	<1
		Geum aleppicum	yellow avens	<1
		Viola renifolia	kidney-leaved violet	<1
		Aster ciliolatus	Lindley's aster	<1
		Galium boreale	northern bedstraw	<1
		Viola canadensis	western Canada violet	<1
		Galium triflorum	sweet-scented bedstraw	<1
		Fragaria virginiana	wild strawberry	<1
		Lathyrus ochroleucus	cream-colored vetchling	<1
		Delphinium glaucum	tall larkspur	<1
		Epilobium angustifolium	common fireweed	<1
		Viola nephrophylla	bog violet	<1
		Mitella nuda	bishop's-cap	<1
		Thalictrum venulosum	veiny meadow rue	<1
		Trientalis borealis	northern starflower	<1
		Petasites frigidus var palmatus	palmate-leaved coltsfoot	<1
		unknown Pyrola species	*unknown Pyrola species*	1
		unknown Talictrum species	*unknown Talictrum species*	1
		Comandra umbellata	bastard toadflax	1
		Fragaria vesca	woodland strawberry	1
		Pyrola asarifolia	common pink wintergreen	2
		Geocaulon lividum	northern bastard toadflax	2
		Melampyrum lineare	cow-wheat	2

Table N-1 Species Composition and Percent Cover by Vegetation Type in the Pierre River Mining Area (continued)

Ecosite Phase	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
Low-bush cranberry aspen-white spruce (d2) (continued)	forb (continued)	*Maianthemum canadense*	wild lily-of-the-valley	2
		Diphasiastrum complanatum (also Lycopodium complanatum)	ground-cedar	2
		Lycopodium annotinum	stiff club-moss	2
		Mertensia paniculata	tall lungwort	2
		Equisetum sylvaticum	woodland horsetail	3
		unknown Aster species	*unknown Aster species*	3
		Aralia nudicaulis	wild sarsaparilla	4
		Rubus pubescens	dewberry	4
		Lycopodium obscurum	ground-pine	5
		Equisetum arvense	common horsetail	6
		Cornus canadensis	bunchberry	7
		Lycopodium clavatum	running club-moss	10
	graminoid	*unknown Carex species*	*unknown Carex species*	<1
		unknown Poa species	*unknown Poa species*	<1
		Carex capillaris	hair-like sedge	<1
		Carex siccata	hay sedge	<1
		Oryzopsis pungens	northern rice grass	<1
		Agrostis scabra	rough hair grass	<1
		Elymus trachycaulus	slender wheatgrass	<1
		Beckmannia syzigachne	slough grass	<1
		unknown Oryzopsis species	*unknown Oryzopsis species*	<1
		unknown graminoid species	*unknown graminoid species*	<1
		Bromus ciliatus	fringed brome	<1
		Leymus innovatus (also Elymus innovatus)	hairy wild rye	<1
		unknown graminoid species	*unknown graminoid species*	1
		unknown graminoid species	*unknown graminoid species*	2
		Calamagrostis canadensis	bluejoint	2
		Schizachne purpurascens	purple oat grass	2
		Oryzopsis asperifolia	white-grained mountain rice grass	2
		unknown graminoid species	*unknown graminoid species*	20

Table N-1 Species Composition and Percent Cover by Vegetation Type in the Pierre River Mining Area (continued)

Ecosite Phase	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
Low-bush cranberry aspen-white spruce (d2) (continued)	moss	*Brachythecium erythrorrhizon*	*no common name*	<1
		Bryum pseudotriquetrum	*no common name*	<1
		Thuidium recognitum	*no common name*	<1
		Ptilidium ciliare	liverwort	<1
		Brachythecium salebrosum	*no common name*	<1
		Polytrichum juniperinum	juniper hair-cap	<1
		Orthotrichum speciosum	*no common name*	<1
		Dicranum flagellare	whip fork moss	<1
		Pohlia nutans	copper wire moss	<1
		Aulacomnium palustre	tufted moss	<1
		Ptilidium pulcherrimum	liverwort	<1
		Plagiomnium drummondii	Drummond's *plagiomnium* moss	<1
		Ceratodon purpureus	purple horn-toothed moss	<1
		Dicranum undulatum	wavy *dicranum*	<1
		Lepidozia reptans	liverwort	<1
		Dicranum fuscescens	*fuscous* moss	<1
		unknown Mnium species	*unknown Mnium species*	<1
		unknown Ptilidium species	*unknown Ptilidium species*	<1
		unknown Splachnum species	*unknown Splachnum species*	<1
		Brachythecium rivulare	*no common name*	<1
		Mnium marginatum	*no common name*	<1
		Mnium spinulosum	*no common name*	<1
		Platygyrium repens	*no common name*	<1
		Sanionia uncinata (also Drepanocladus uncinatus)	brown moss	<1
		Climacium dendroides	common tree moss	<1
		Plagiomnium ellipticum	*elliptic plagiomnium* moss	<1
		Marchantia polymorpha	liverwort	<1
		Abietinella abietina (also Thuidium abietinum)	*no common name*	<1
		Orthotrichum obtusifolium	obtuseleaf aspen moss	<1
		Rhytidium rugosum	pipecleaner moss	<1
		Plagiomnium cuspidatum	toothed *plagiomnium* moss	<1
		unknown moss species	*unknown moss species*	<1
		unknown moss species	*unknown moss species*	<1
		unknown moss species	*unknown moss species*	<1

Table N-1 Species Composition and Percent Cover by Vegetation Type in the Pierre River Mining Area (continued)

Ecosite Phase	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
Low-bush cranberry aspen-white spruce (d2) (continued)	moss (continued)	*unknown moss species*	*unknown moss species*	<1
		unknown moss species	*unknown moss species*	<1
		Dicranum polysetum	wavy *dicranum*	<1
		Eurhynchium pulchellum	*Eurhynchium* moss	<1
		Dicranum scoparium	broom moss	1
		Pylaisiella polyantha	*pylaisiella* moss	1
		Ptilium crista-castrensis	knight's plume moss	1
		Hylocomium splendens	stair-step moss	12
		Pleurozium schreberi	Schreber's moss	18
	lichen	*unknown Lecanora species*	*unknown Lecanora species*	<1
		Micarea denigrata	*no common name*	<1
		Rinodina disjuncta	*no common name*	<1
		Hypocenomyce scalaris	common clam lichen	<1
		Cladonia sulphurina	greater sulphur cup	<1
		Cladonia crispata	organ-pipe lichen	<1
		Cladonia borealis	red pixie-cup	<1
		Cladina rangiferina	reindeer lichen	<1
		Cladonia ochrochlora	smooth-footed powderhorn	<1
		Cladina mitis	reindeer lichen	<1
		Peltigera neopolydactyla	carpet pelt	<1
		Cladonia cervicornis (also C. verticillata)	ladder lichen	<1
		Cladonia chlorophaea	mealy pixie-cup	<1
		Cladonia coniocraea	cup lichen	<1
		Cladonia gracilis	smooth cladonia	<1
		Icmadophila ericetorum	spraypaint	<1
		Cladonia botrytes	wooden soldiers	<1
		Peltigera aphthosa	studded leather lichen	<1
		Cladonia cornuta	bighorn cladonia	<1
		Peltigera canina	dog lichen	<1
		unknown Peltigera species	*unknown Peltigera species*	<1
		Cladonia scabriuscula	mealy forked cladonia	<1
		Cladonia cenotea	powdered funnel lichen	<1
		Cladonia fimbriata	trumpet lichen	<1
		unknown lichen species	*unknown lichen species*	<1
		unknown lichen species	*unknown lichen species*	<1
		Peltigera malacea	veinless pelt	<1

Table N-1 Species Composition and Percent Cover by Vegetation Type in the Pierre River Mining Area (continued)

Ecosite Phase	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
Low-bush cranberry aspen-white spruce (d2) (continued)	epiphyte	*Calicium viride*	*no common name*	<1
		Caloplaca holocarpa	*no common name*	<1
		Cliostomum pallens	*no common name*	<1
		Lecanora pulicaris	*no common name*	<1
		Lecanora subintricata	*no common name*	<1
		Lecidea leprarioides	*no common name*	<1
		Lecidea nylanderi	*no common name*	<1
		Lecidella elaeochroma	*no common name*	<1
		Melanelia trabeculata	*no common name*	<1
		Micarea sylvicola	*no common name*	<1
		Ochrolechia arborea	*no common name*	<1
		Rinodina anomala	*no common name*	<1
		Rinodina disjuncta	*no common name*	<1
		Rinodina metaboliza	*no common name*	<1
		Rinodina septentrionalis	*no common name*	<1
		Scoliciosporum perpusillum	*no common name*	<1
		Xanthoria candelaria	*no common name*	<1
		Arthonioid group	*Arthonioid* group	<1
		Lecanora symmicta	fused rim-lichen	<1
		Parmeliopsis hyperopta	gray starburst lichen	<1
		Ramalina obtusata	hooded *ramalina*	<1
		Bryoria furcellata	old man's beard	<1
		Bryoria glabra	old man's beard	<1
		Usnea lapponica	old man's beard	<1
		Usnea scabrata	old man's beard	<1
		Usnea substerilis	old man's beard	<1
		Physcia stellaris	star rosette lichen	<1
		Tuckermannopsis orbata (also Cetraria orbata)	variable wrinkle-lichen	<1
		Bryoria fuscescens	old man's beard	<1
		Usnea subfloridana	old man's beard	<1
		Ramalina dilacerata	punctured *ramalina*	<1
		Melanelia subaurifera	abraded camoflage lichen	<1
		Parmelia sulcata	hammered shield moss	<1
		Vulpicida pinastri (also Tuckermannopsis pinastri)	powdered sunshine lichen	<1
		Tuckermannopsis americana (also Cetraria halei or C. ciliaris)	fringed wrinkle-lichen	<1
		Parmeliopsis ambigua	green starburst lichen	<1
		Arthonia patellulata	*no common name*	<1
		unknown Bryoria species	*unknown*	<1
		Usnea scabiosa	*no common name*	<1

Table N-1 Species Composition and Percent Cover by Vegetation Type in the Pierre River Mining Area (continued)

Ecosite Phase	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
Low-bush cranberry aspen-white spruce (d2) (continued)	epiphyte (continued)	*unknown Usnea species*	*unknown Usnea species* s	<1
		Imshaugia placorodia	American starburst lichen	<1
		Amandinea punctata (also Buellia punctata)	*no common name*	<1
		Melanelia septentrionalis	northern camoflage lichen	<1
		Flavopunctelia flaventior	speckled greenshield	<1
		Tuckermannopsis sepincola	chestnut wrinkle-lichen	<1
		Evernia mesomorpha	boreal oakmoss lichen	<1
		unknown lichen species	*unknown lichen species*	1
		Hypogymnia physodes	monk's-hood lichen	1
		Usnea hirta	old man's beard	1
		unknown epiphyte species	*unknown epiphyte species*	1
		Usnea cavernosa	old man's beard	2
		unknown epiphyte species	*unknown epiphyte species*	6
Low-bush cranberry white spruce (d3)	canopy	*Populus balsamifera*	balsam poplar	<1
		Salix bebbiana	beaked willow	<1
		Picea mariana	black spruce	5
		Pinus banksiana	jack pine	10
		Populus tremuloides	aspen	19
		Picea glauca	white spruce	29
	subcanopy	*Populus balsamifera*	balsam poplar	<1
		Picea mariana	black spruce	<1
		Populus tremuloides	aspen	1
		Picea glauca	white spruce	14
		Betula papyrifera	white birch	14
	tall shrub	*Populus balsamifera*	balsam poplar	<1
		Alnus incana ssp tenuifolia (also A. rugosa)	river alder	<1
		Picea glauca	white spruce	<1
		Populus tremuloides	aspen	<1
		Betula papyrifera	white birch	1
		Alnus viridis ssp crispa	green alder	2
	low shrub	*unknown Ribes species*	*unknown Ribes species*	<1
		Populus balsamifera	balsam poplar	<1
		Vaccinium myrtilloides	common blueberry	<1
		unknown Ribes species	*unknown Ribes species*	<1

Table N-1 Species Composition and Percent Cover by Vegetation Type in the Pierre River Mining Area (continued)

Ecosite Phase	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
Low-bush cranberry white spruce (d3) (continued)	low shrub (continued)	*unknown Salix species*	*unknown Salix species*	<1
		Arctostaphylos uva-ursi	common bearberry	<1
		Vaccinium myrtilloides	common blueberry	<1
		Rubus idaeus	wild red raspberry	<1
		Betula papyrifera	white birch	<1
		Ribes oxyacanthoides	northern gooseberry	<1
		Cornus stolonifera	red-osier dogwood	<1
		Lonicera caerulea (also L. villosa)	fly honeysuckle	1
		Alnus viridis ssp crispa	green alder	1
		Lonicera dioica	twining honeysuckle	1
		Picea glauca	white spruce	1
		Populus tremuloides	aspen	1
		Symphoricarpos albus	snowberry	1
		Ribes triste	wild red currant	2
		Ribes lacustre	bristly black currant	2
		Ledum groenlandicum	common Labrador tea	2
		Salix myrtillifolia	myrtle-leaved willow	2
		Vaccinium vitis-idaea	bog cranberry	2
		Shepherdia canadensis	Canada buffalo-berry	4
		Linnaea borealis	twinflower	4
		Rosa acicularis	prickly rose	4
		Viburnum edule	low-bush cranberry	7
		Linnaea borealis	twinflower	60
	forb	*unknown Castilleja species*	*unknown Castilleja species*	<1
		unknown Corallorhiza species	*unknown Corallorhiza species*	<1
		Pyrola asarifolia	common pink wintergreen	<1
		Parnassia palustris	northern grass-of-parnassus	<1
		Vicia americana	wild vetch	<1
		Aster ciliolatus	Lindley's aster	<1
		unknown Aster species	*unknown Aster species*	<1
		Petasites frigidus var palmatus	palmate-leaved coltsfoot	<1
		Actaea rubra	red and white baneberry	<1
		Epilobium angustifolium	common fireweed	<1
		Equisetum arvense	common horsetail	<1
		Lathyrus ochroleucus	cream-colored vetchling	<1

Table N-1 Species Composition and Percent Cover by Vegetation Type in the Pierre River Mining Area (continued)

Ecosite Phase	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
Low-bush cranberry white spruce (d3) (continued)	forb (continued)	*Viola renifolia*	kidney-leaved violet	<1
		unknown Viola species	*unknown Viola species*	<1
		Platanthera obtusata (also Habenaria obtusata)	blunt-leaved bog orchid	<1
		Moehringia lateriflora	blunt-leaved sandwort	<1
		Pyrola chlorantha (also Pyrola virens)	greenish-flowered wintergreen	<1
		Cerastium nutans	long-stalked mouse-ear chickweed	<1
		Adoxa moschatellina	moschatel	<1
		Geocaulon lividum	northern bastard toadflax	<1
		Corallorhiza trifida	pale coralroot	<1
		Platanthera orbiculata (also Habenaria orbiculata)	round-leaved bog orchid	<1
		Galium trifidum	small bedstraw	<1
		Circaea alpina	small enchanter's nightshade	<1
		Smilacina trifolia	three-leaved Solomon's-seal	<1
		Calypso bulbosa	Venus'-slipper	<1
		Viola canadensis	western Canada violet	<1
		Fragaria virginiana	wild strawberry	<1
		Galium triflorum	sweet-scented bedstraw	<1
		Goodyera repens	lesser rattlesnake plantain	<1
		Trientalis borealis	northern starflower	<1
		Achillea millefolium	common yarrow	<1
		Galium boreale	northern bedstraw	<1
		Orthilia secunda (also Pyrola secunda)	one-sided wintergreen	<1
		Equisetum pratense	meadow horsetail	<1
		Moneses uniflora	one-flowered wintergreen	<1
		Equisetum scirpoides	dwarf scouring-rush	<1
		Viola nephrophylla	bog violet	1
		Maianthemum canadense	wild lily-of-the-valley	1
		Mitella nuda	bishop's-cap	2
		Mertensia paniculata	tall lungwort	2
		Thalictrum venulosum	veiny meadow rue	3
		Equisetum sylvaticum	woodland horsetail	3
		Cornus canadensis	bunchberry	3
		Rubus pubescens	dewberry	8
		Lycopodium annotinum	stiff club-moss	16
		Aralia nudicaulis	wild sarsaparilla	17

Table N-1 Species Composition and Percent Cover by Vegetation Type in the Pierre River Mining Area (continued)

Ecosite Phase	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
Low-bush cranberry white spruce (d3) (continued)	graminoid	*unknown graminoid species*	*unknown graminoid species*	<1
		Carex concinna	beautiful sedge	<1
		Carex brunnescens	brownish sedge	<1
		Leymus innovatus (also Elymus innovatus)	hairy wild rye	<1
		Carex norvegica	Norway sedge	<1
		Carex peckii	Peck's sedge	<1
		Hierochloe hirta ssp arctica (also H. odorata)	sweet grass	<1
		Carex disperma	two-seeded sedge	<1
		unknown graminoid species	*unknown graminoid species*	<1
		unknown graminoid species	*unknown graminoid species*	<1
		Calamagrostis canadensis	bluejoint	1
	moss	*Orthotrichum speciosum*	*no common name*	<1
		Leptobryum pyriforme	leptobryum moss	<1
		Lepidozia reptans	liverwort	<1
		Tetraphis pellucida	*no common name*	<1
		Sanionia uncinata (also Drepanocladus uncinatus)	brown moss	<1
		Tomentypnum nitens	golden moss	<1
		Polytrichum juniperinum	juniper hair-cap	<1
		Ptilidium pulcherrimum	liverwort	<1
		Plagiomnium cuspidatum	toothed plagiomnium moss	<1
		unknown moss species	*unknown moss species*	<1
		unknown moss species	*unknown moss species*	<1
		unknown moss species	*unknown moss species*	<1
		Dicranum undulatum	wavy *dicranum*	<1
		Brachythecium salebrosum	*no common name*	<1
		Eurhynchium pulchellum	*Eurhynchium* moss	<1
		Pylaisiella polyantha	*pylaisiella* moss	<1
		Dicranum flagellare	whip fork moss	<1
		Polytrichum strictum	slender hair-cap	1
		Aulacomnium palustre	tufted moss	2
		Dicranum polysetum	wavy *dicranum*	2
		Ptilium crista-castrensis	knight's plume moss	9
		Pleurozium schreberi	Schreber's moss	23
		Hylocomium splendens	stair-step moss	26
	lichen	*Hypocenomyce scalaris*	common clam lichen	<1
		Peltigera canina	dog lichen	<1
		Cladonia sulphurina	greater sulphur cup	<1

Table N-1 Species Composition and Percent Cover by Vegetation Type in the Pierre River Mining Area (continued)

Ecosite Phase	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
Low-bush cranberry white spruce (d3) (continued)	lichen (continued)	*Cladonia chlorophaea*	mealy pixie-cup	<1
		Cladina mitis	reindeer lichen	<1
		Cladonia gracilis	smooth cladonia	<1
		Peltigera aphthosa	studded leather lichen	<1
		Peltigera neopolydactyla	carpet pelt	<1
		Cladonia coniocraea	cup lichen	<1
		Cladonia cornuta	bighorn cladonia	<1
		Cladonia subulata	*no common name*	<1
		Cladonia cervicornis (also C. verticillata)	ladder lichen	<1
		unknown lichen species	*unknown lichen species*	<1
	epiphyte	*Melanelia trabeculata*	*no common name*	<1
		Ochrolechia arborea	*no common name*	<1
		Rinodina disjuncta	*no common name*	<1
		Scoliciosporum perpusillum	*no common name*	<1
		Melanelia subaurifera	abraded camoflage lichen	<1
		Arthonioid group	*Arthonioid* group	<1
		Lecanora symmicta	fused rim-lichen	<1
		Parmeliopsis hyperopta	gray starburst lichen	<1
		Bryoria fuscescens	old man's beard	<1
		Bryoria glabra	old man's beard	<1
		Usnea lapponica	old man's beard	<1
		Usnea scabrata	old man's beard	<1
		Usnea subfloridana	old man's beard	<1
		Usnea substerilis	old man's beard	<1
		Ramalina dilacerata	punctured ramalina	<1
		Hypogymnia physodes	monk's-hood lichen	<1
		Tuckermannopsis americana (also Cetraria halei or C. ciliaris)	fringed wrinkle-lichen	<1
		Vulpicida pinastri (also Tuckermannopsis pinastri)	powdered sunshine lichen	<1
		Usnea scabiosa	*no common name*	<1
		Xanthoria fallax	powdered orange lichen	<1
		Parmeliopsis ambigua	green starburst lichen	<1
		Usnea hirta	old man's beard	<1
		Evernia mesomorpha	boreal oakmoss lichen	2
		Parmelia sulcata	hammered shield moss	2
		unknown Usnea species	*unknown Usnea species*	2
		unknown Parmeliopsis species	*unknown Parmeliopsis species*	3

Table N-1 Species Composition and Percent Cover by Vegetation Type in the Pierre River Mining Area (continued)

Ecosite Phase	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
Low-bush cranberry white spruce (d3) (continued)	epiphyte (continued)	*unknown epiphyte species*	*unknown epiphyte species*	4
		unknown epiphyte species	*unknown epiphyte species*	8
Dogwood balsam poplar-aspen (e1)	canopy	*Alnus incana ssp tenuifolia (also A. rugosa)*	river alder	5
		Populus tremuloides	aspen	10
		Populus balsamifera	balsam poplar	10
		Prunus pensylvanica	pin cherry	10
	tall shrub	*Populus balsamifera*	balsam poplar	5
		unknown Salix species	*unknown Salix species*	10
		Prunus virginiana	choke cherry	10
		Picea glauca	white spruce	10
		Cornus stolonifera	red-osier dogwood	30
	low shrub	*Ribes oxyacanthoides*	northern gooseberry	<1
		Rubus idaeus	wild red raspberry	<1
		Rosa acicularis	prickly rose	1
		Populus balsamifera	balsam poplar	2
		Amelanchier alnifolia	saskatoon	2
		Populus tremuloides	aspen	3
		Prunus pensylvanica	pin cherry	3
		Alnus incana ssp tenuifolia (also A. rugosa)	river alder	5
	forb	*Solidago canadensis*	Canada goldenrod	<1
		Taraxacum officinale	common dandelion	<1
		Epilobium angustifolium	common fireweed	<1
		Achillea millefolium	common yarrow	<1
		Galium boreale	northern bedstraw	<1
		Mertensia paniculata	tall lungwort	<1
		Viola canadensis	western Canada violet	<1
		Fragaria virginiana	wild strawberry	<1
		Thalictrum venulosum	veiny meadow rue	1
		Anemone canadensis	Canada anemone	2
		Smilacina stellata	star-flowered Solomon's-seal	3
	graminoid	*unknown graminoid species*	*unknown graminoid species*	2
	moss	*Brachythecium salebrosum*	*no common name*	<1
		Eurhynchium pulchellum	*Eurhynchium* moss	<1
		Pylaisiella polyantha	*pylaisiella* moss	<1
		unknown moss species	*unknown moss species*	<1
	epiphyte	*Scoliciosporum perpusillum*	*no common name*	<1
		Tuckermannopsis americana (also Cetraria halei or C. ciliaris)	fringed wrinkle-lichen	<1
		Lecanora symmicta	fused rim-lichen	<1

Table N-1 Species Composition and Percent Cover by Vegetation Type in the Pierre River Mining Area (continued)

Ecosite Phase	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
Dogwood balsam poplar-aspen (e1) (continued)	epiphyte (continued)	*Parmelia sulcata*	hammered shield moss	<1
		Vulpicida pinastri (also Tuckermannopsis pinastri)	powdered sunshine lichen	<1
Dogwood balsam poplar-white spruce (e2)	canopy	*Populus tremuloides*	aspen	20
		Populus balsamifera	balsam poplar	20
		Picea glauca	white spruce	20
	subcanopy	*unknown Salix species*	*unknown Salix species*	4
		Alnus incana ssp tenuifolia (also A. rugosa)	river alder	6
	tall shrub	*Populus tremuloides*	aspen	<1
		Populus balsamifera	balsam poplar	<1
		unknown Salix species	*unknown Salix species*	2
		Alnus incana ssp tenuifolia (also A. rugosa)	river alder	2
	low shrub	*Ribes oxyacanthoides*	northern gooseberry	<1
		Ribes lacustre	bristly black currant	<1
		Populus balsamifera	balsam poplar	<1
		Ribes triste	wild red currant	<1
		Populus tremuloides	aspen	2
		Rubus idaeus	wild red raspberry	2
		unknown Salix species	*unknown Salix species*	3
		Viburnum edule	low-bush cranberry	7
		Alnus incana ssp tenuifolia (also A. rugosa)	river alder	10
		Rosa acicularis	prickly rose	19
		Cornus stolonifera	red-osier dogwood	25
	forb	*Epilobium angustifolium*	common fireweed	<1
		Pyrola asarifolia	common pink wintergreen	<1
		Vicia americana	wild vetch	<1
		Achillea millefolium	common yarrow	<1
		Aster ciliolatus	Lindley's aster	<1
		Fragaria virginiana	wild strawberry	<1
		Moehringia lateriflora	blunt-leaved sandwort	<1
		Lathyrus ochroleucus	cream-colored vetchling	<1
		Viola renifolia	kidney-leaved violet	<1
		Trientalis borealis	northern starflower	<1
		Galium triflorum	sweet-scented bedstraw	<1
		Delphinium glaucum	tall larkspur	<1
		Equisetum arvense	common horsetail	<1

Table N-1 Species Composition and Percent Cover by Vegetation Type in the Pierre River Mining Area (continued)

Ecosite Phase	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
Dogwood balsam poplar-white spruce (e2) (continued)	forb (continued)	*Galium boreale*	northern bedstraw	<1
		Thalictrum venulosum	veiny meadow rue	1
		Fragaria vesca	woodland strawberry	1
		Maianthemum canadense	wild lily-of-the-valley	1
		Cornus canadensis	bunchberry	3
		Mertensia paniculata	tall lungwort	3
		Mitella nuda	bishop's-cap	5
		Rubus pubescens	dewberry	10
		Adoxa moschatellina	moschatel	10
		Aralia nudicaulis	wild sarsaparilla	10
		Equisetum sylvaticum	woodland horsetail	10
	graminoid	*Carex deweyana*	Dewey's sedge	1
		Poa pratensis	Kentucky bluegrass	1
		Elymus trachycaulus ssp trachycaulus (also Agropyron trachycaulum)	slender wheat grass	1
		Elymus trachycaulus	slender wheatgrass	1
		Deschampsia cespitosa	tufted hair grass	1
		unknown graminoid species	*unknown graminoid species*	1
		unknown graminoid species	*unknown graminoid species*	5
	moss	*Plagiomnium ellipticum*	*elliptic plagiomnium* moss	<1
		Eurhynchium pulchellum	*Eurhynchium* moss	<1
		Plagiomnium cuspidatum	toothed *plagiomnium* moss	<1
		Pylaisiella polyantha	*pylaisiella* moss	<1
		unknown moss species	*unknown moss species*	2
		Pleurozium schreberi	Schreber's moss	5
		Hylocomium splendens	stair-step moss	20
	lichen	*Peltigera neopolydactyla*	carpet pelt	<1
		Peltigera canina	dog lichen	<1
		Cladonia chlorophaea	mealy pixie-cup	<1
		Peltigera aphthosa	studded leather lichen	<1
	epiphyte	*Evernia mesomorpha*	boreal oakmoss lichen	<1
		Hypogymnia physodes	monk's-hood lichen	<1
		Bryoria fuscescens	old man's beard	<1
		Usnea subfloridana	old man's beard	<1
		Usnea substerilis	old man's beard	<1
		Ramalina dilacerata	punctured *ramalina*	<1
		Parmelia sulcata	hammered shield moss	<1
		Melanelia subaurifera	abraded camoflage lichen	<1

Table N-1 Species Composition and Percent Cover by Vegetation Type in the Pierre River Mining Area (continued)

Ecosite Phase	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
Dogwood balsam poplar-white spruce (e2) (continued)	epiphyte (continued)	*Usnea hirta*	old man's beard	<1
		Vulpicida pinastri (also Tuckermannopsis pinastri)	powdered sunshine lichen	<1
Dogwood white spruce (e3)	canopy	*Betula papyrifera*	white birch	<1
		Populus tremuloides	aspen	5
		Populus balsamifera	balsam poplar	5
		Alnus incana ssp tenuifolia (also A. rugosa)	river alder	20
		Picea glauca	white spruce	38
	subcanopy	*unknown Salix species*	*unknown Salix species*	<1
	tall shrub	*unknown Salix species*	*unknown Salix species*	<1
		Populus balsamifera	balsam poplar	<1
		Alnus incana ssp tenuifolia (also A. rugosa)	river alder	3
	low shrub	*Shepherdia canadensis*	Canada buffalo-berry	<1
		Ribes oxyacanthoides	northern gooseberry	<1
		Amelanchier alnifolia	saskatoon	<1
		Ribes americanum	wild black currant	<1
		Vaccinium vitis-idaea	bog cranberry	<1
		unknown Ribes species	*unknown Ribes species*	<1
		Populus tremuloides	aspen	<1
		Ribes lacustre	bristly black currant	<1
		Symphoricarpos albus	snowberry	<1
		Betula papyrifera	white birch	<1
		Populus balsamifera	balsam poplar	<1
		unknown Salix species	*unknown Salix species*	<1
		Ribes glandulosum	skunk currant	<1
		Lonicera dioica	twining honeysuckle	<1
		Ribes triste	wild red currant	<1
		Alnus incana ssp tenuifolia (also A. rugosa)	river alder	1
		Viburnum edule	low-bush cranberry	2
		Abies balsamea	balsam fir	3
		Rosa acicularis	prickly rose	3
		Rubus idaeus	wild red raspberry	10
		Cornus stolonifera	red-osier dogwood	14
		Linnaea borealis	twinflower	14

Table N-1 Species Composition and Percent Cover by Vegetation Type in the Pierre River Mining Area (continued)

Ecosite Phase	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
Dogwood white spruce (e3) (continued)	forb	*unknown Aster species*	*unknown Aster species*	<1
		Corydalis aurea	golden corydalis	<1
		Aster ciliolatus	Lindley's aster	<1
		Ranunculus macounii	Macoun's buttercup	<1
		Stachys palustris	marsh hedge-nettle	<1
		Scutellaria galericulata	marsh skullcap	<1
		Solidago simplex ssp simplex (also S. spathulata)	mountain goldenrod	<1
		Geum rivale	purple avens	<1
		Aster puniceus	purple-stemmed aster	<1
		Aralia nudicaulis	wild sarsaparilla	<1
		Fragaria vesca	woodland strawberry	<1
		Vicia americana	wild vetch	<1
		Equisetum arvense	common horsetail	<1
		Achillea millefolium	common yarrow	<1
		Thalictrum venulosum	veiny meadow rue	<1
		unknown Viola species	*unknown Viola species*	<1
		Petasites frigidus var sagittatus	arrow-leaved coltsfoot	<1
		Moehringia lateriflora	blunt-leaved sandwort	<1
		Lathyrus ochroleucus	cream-colored vetchling	<1
		Viola renifolia	kidney-leaved violet	<1
		Stellaria longipes	long-stalked chickweed	<1
		Petasites frigidus var palmatus	palmate-leaved coltsfoot	<1
		Actaea rubra	red and white baneberry	<1
		Delphinium glaucum	tall larkspur	<1
		Fragaria virginiana	wild strawberry	<1
		Epilobium angustifolium	common fireweed	<1
		Dryopteris carthusiana (also D. austriaca)	narrow spinulose shield fern	<1
		Maianthemum canadense	wild lily-of-the-valley	<1
		Pyrola chlorantha (also Pyrola virens)	greenish-flowered wintergreen	1
		Galium triflorum	sweet-scented bedstraw	1
		Galium boreale	northern bedstraw	1
		Mitella nuda	bishop's-cap	2
		Equisetum sylvaticum	woodland horsetail	2
		Equisetum pratense	meadow horsetail	2
		Adoxa moschatellina	moschatel	2

Table N-1 Species Composition and Percent Cover by Vegetation Type in the Pierre River Mining Area (continued)

Ecosite Phase	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
Dogwood white spruce (e3) (continued)	forb (continued)	*unknown Anemone species*	*unknown Anemone species*	2
		Cornus canadensis	bunchberry	2
		Achillea sibirica	many-flowered yarrow	2
		Potentilla norvegica	rough cinquefoil	2
		Mertensia paniculata	tall lungwort	3
		Trientalis borealis	northern starflower	3
		Orthilia secunda (also Pyrola secunda)	one-sided wintergreen	3
		Erysimum cheiranthoides	wormseed mustard	3
		Pyrola asarifolia	common pink wintergreen	5
		Urtica dioica	common nettle	10
		Rubus pubescens	dewberry	19
	graminoid	*Elymus trachycaulus ssp trachycaulus (also Agropyron trachycaulum)*	slender wheat grass	<1
		Beckmannia syzigachne	slough grass	<1
		unknown Carex species	*unknown Carex species*	1
		Deschampsia cespitosa	tufted hair grass	2
		Carex disperma	two-seeded sedge	2
		unknown graminoid species	*unknown graminoid species*	4
		Bromus ciliatus	fringed brome	5
		Leymus innovatus (also Elymus innovatus)	hairy wild rye	5
		Cinna latifolia	drooping wood-reed	15
		Calamagrostis canadensis	bluejoint	26
	moss	*Brachythecium salebrosum*	*no common name*	<1
		Bryum pseudotriquetrum	*no common name*	<1
		Leptobryum pyriforme	*leptobryum* moss	<1
		Climacium dendroides	common tree moss	<1
		Eurhynchium pulchellum	*Eurhynchium* moss	<1
		unknown moss species	*unknown moss species*	<1
		Ptilium crista-castrensis	knight's plume moss	<1
		Dicranum flagellare	whip fork moss	1
		Dicranum polysetum	wavy *dicranum*	2
		Aulacomnium palustre	tufted moss	5
		Hylocomium splendens	stair-step moss	23
		Pleurozium schreberi	Schreber's moss	38
	lichen	*Icmadophila ericetorum*	spraypaint	<1
		Cladonia coniocraea	cup lichen	<1
		Cladonia chlorophaea	mealy pixie-cup	<1
		Cladonia sulphurina	greater sulphur cup	<1

Table N-1 Species Composition and Percent Cover by Vegetation Type in the Pierre River Mining Area (continued)

Ecosite Phase	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
Dogwood white spruce (e3) (continued)	lichen (continued)	*Peltigera aphthosa*	studded leather lichen	<1
		unknown lichen species	*unknown lichen species*	<1
		Peltigera canina	dog lichen	3
	epiphyte	*Lecidea nylanderi*	*no common name*	<1
		Scoliciosporum perpusillum	*no common name*	<1
		Evernia mesomorpha	boreal oakmoss lichen	<1
		Lecanora symmicta	fused rim-lichen	<1
		Usnea scabrata	old man's beard	<1
		Usnea subfloridana	old man's beard	<1
		Usnea substerilis	old man's beard	<1
		Melanelia subaurifera	abraded camoflage lichen	<1
		Vulpicida pinastri (also Tuckermannopsis pinastri)	powdered sunshine lichen	<1
		unknown Usnea species	*unknown Usnea species*	<1
		Tuckermannopsis americana (also Cetraria halei or C. ciliaris)	fringed wrinkle-lichen	<1
		Bryoria fuscescens	old man's beard	<1
		Parmelia sulcata	hammered shield moss	<1
		Usnea angulata	*no common name*	1
		Hypogymnia physodes	monk's-hood lichen	1
		Usnea hirta	old man's beard	2
Horsetail balsam poplar-aspen (f1)	canopy	*Picea glauca*	white spruce	7
		Populus balsamifera	balsam poplar	15
		Populus tremuloides	aspen	40
		Betula papyrifera	white birch	40
	subcanopy	*Picea glauca*	white spruce	<1
		Alnus incana ssp tenuifolia (also A. rugosa)	river alder	2
		Populus tremuloides	aspen	5
	tall shrub	*Populus tremuloides*	aspen	1
		Picea glauca	white spruce	1
		Populus balsamifera	balsam poplar	5
		Rosa acicularis	prickly rose	10
	low shrub	*Viburnum edule*	low-bush cranberry	<1
		Cornus stolonifera	red-osier dogwood	<1
		Symphoricarpos albus	snowberry	<1

Table N-1 Species Composition and Percent Cover by Vegetation Type in the Pierre River Mining Area (continued)

Ecosite Phase	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
Horsetail balsam poplar-aspen (f1) (continued)	low shrub (continued)	*Betula papyrifera*	white birch	<1
		Populus tremuloides	aspen	1
		Amelanchier alnifolia	saskatoon	1
		Ribes oxyacanthoides	northern gooseberry	2
		Rosa acicularis	prickly rose	2
		Ribes triste	wild red currant	2
		Populus balsamifera	balsam poplar	3
		Picea glauca	white spruce	4
	forb	*Mitella nuda*	bishop's-cap	<1
		Epilobium angustifolium	common fireweed	<1
		Pyrola asarifolia	common pink wintergreen	<1
		Equisetum pratense	meadow horsetail	<1
		Galium boreale	northern bedstraw	<1
		Trientalis borealis	northern starflower	<1
		Orthilia secunda (also Pyrola secunda)	one-sided wintergreen	<1
		Platanthera orbiculata (also Habenaria orbiculata)	round-leaved bog orchid	<1
		Thalictrum venulosum	veiny meadow rue	<1
		Aralia nudicaulis	wild sarsaparilla	<1
		Fragaria virginiana	wild strawberry	<1
		Vicia americana	wild vetch	<1
		Lathyrus ochroleucus	cream-colored vetchling	1
		Maianthemum canadense	wild lily-of-the-valley	1
		Cornus canadensis	bunchberry	2
		Petasites frigidus var palmatus	palmate-leaved coltsfoot	2
		Mertensia paniculata	tall lungwort	2
		Equisetum arvense	common horsetail	3
		Rubus pubescens	dewberry	3
		Equisetum sylvaticum	woodland horsetail	58
	graminoid	*Calamagrostis canadensis*	bluejoint	2
	moss	*unknown Mnium species*	*unknown Mnium species*	<1
		Eurhynchium pulchellum	eurhynchiummoss	<1
		Oncophorus wahlenbergii	mountain curved-back moss	<1
		Pleurozium schreberi	Schreber's moss	<1
		Aulacomnium palustre	tufted moss	<1
		unknown moss species	*unknown moss species*	<1
		Pylaisiella polyantha	pylaisiella moss	2
	lichen	*Cladonia cornuta*	bighorn cladonia	<1
		Peltigera canina	dog lichen	<1

Table N-1 Species Composition and Percent Cover by Vegetation Type in the Pierre River Mining Area (continued)

Ecosite Phase	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
Horsetail balsam poplar-aspen (f1) (continued)	lichen (continued)	*Cladonia gracilis*	smooth cladonia	<1
		Peltigera aphthosa	studded leather lichen	<1
	epiphyte	*unknown Bryoria species*	*unknown Bryoria species*	<1
		Usnea scabiosa	*no common name*	<1
		Melanelia subaurifera	abraded camoflage lichen	<1
		Evernia mesomorpha	boreal oakmoss lichen	<1
		Tuckermannopsis americana (also Cetraria halei or C. ciliaris)	fringed wrinkle-lichen	<1
		Parmeliopsis ambigua	green starburst lichen	<1
		Parmelia sulcata	hammered shield moss	<1
		Hypogymnia physodes	monk's-hood lichen	<1
		Vulpicida pinastri (also Tuckermannopsis pinastri)	powdered sunshine lichen	<1
		Usnea hirta	old man's beard	1
Horsetail balsam poplar-white spruce (f2)	canopy	*Larix laricina*	tamarack	2
		Populus balsamifera	balsam poplar	10
		Picea glauca	white spruce	17
		Picea mariana	black spruce	18
		Populus tremuloides	aspen	21
		Betula papyrifera	white birch	23
	subcanopy	*unknown Salix species*	*unknown Salix species*	<1
		Picea glauca	white spruce	3
		Populus balsamifera	balsam poplar	5
		Populus tremuloides	aspen	10
		Salix bebbiana	beaked willow	10
		Betula papyrifera	white birch	13
		Alnus incana ssp tenuifolia (also A. rugosa)	river alder	20
	tall shrub	*Abies balsamea*	balsam fir	1
		Picea glauca	white spruce	1
		unknown Salix species	*unknown Salix species*	1
		Salix bebbiana	beaked willow	2
		Alnus incana ssp tenuifolia (also A. rugosa)	river alder	2
		Betula papyrifera	white birch	3
	low shrub	*Populus tremuloides*	aspen	<1
		Arctostaphylos rubra	alpine bearberry	<1
		Abies balsamea	balsam fir	<1
		Salix bebbiana	beaked willow	<1
		Alnus incana ssp tenuifolia (also A. rugosa)	river alder	<1
		Ribes americanum	wild black currant	<1
		Lonicera dioica	twining honeysuckle	<1

Table N-1 Species Composition and Percent Cover by Vegetation Type in the Pierre River Mining Area (continued)

Ecosite Phase	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
Horsetail balsam poplar-white spruce (f2) (continued)	low shrub (continued)	*Vaccinium vitis-idaea*	bog cranberry	1
		Vaccinium myrtilloides	common blueberry	1
		Cornus stolonifera	red-osier dogwood	1
		Picea glauca	white spruce	1
		Populus balsamifera	balsam poplar	1
		Ribes oxyacanthoides	northern gooseberry	2
		Linnaea borealis	twinflower	2
		Ribes triste	wild red currant	2
		unknown Salix species	*unknown Salix species*	2
		Symphoricarpos albus	snowberry	2
		Betula papyrifera	white birch	2
		Shepherdia canadensis	Canada buffalo-berry	2
		Viburnum edule	low-bush cranberry	4
		Rosa acicularis	prickly rose	4
		Ledum groenlandicum	common Labrador tea	10
		Ribes glandulosum	skunk currant	10
		Rubus idaeus	wild red raspberry	15
	forb	*Smilacina trifolia*	three-leaved Solomon's-seal	<1
		Vicia americana	wild vetch	<1
		unknown Pyrola species	*unknown Pyrola species*	<1
		unknown Viola species	*unknown Viola species*	<1
		Lathyrus ochroleucus	cream-colored vetchling	<1
		Galium boreale	northern bedstraw	<1
		unknown Arnica species	*unknown Arnica species*	<1
		unknown Aster species	*unknown Aster species*	<1
		Moehringia lateriflora	blunt-leaved sandwort	<1
		Arnica latifolia	broad-leaved arnica	<1
		Pyrola asarifolia	common pink wintergreen	<1
		Achillea millefolium	common yarrow	<1
		Pyrola chlorantha (also Pyrola virens)	greenish-flowered wintergreen	<1
		Viola renifolia	kidney-leaved violet	<1
		Actaea rubra	red and white baneberry	<1
		Impatiens capensis	spotted touch-me-not	<1
		Galium triflorum	sweet-scented bedstraw	<1
		unknown forb species	*unknown forb species*	<1
		Thalictrum venulosum	veiny meadow rue	<1
		Trientalis borealis	northern starflower	<1

Table N-1 Species Composition and Percent Cover by Vegetation Type in the Pierre River Mining Area (continued)

Ecosite Phase	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
Horsetail balsam poplar-white spruce (f2) (continued)	forb (continued)	*Petasites frigidus var palmatus*	palmate-leaved coltsfoot	<1
		Epilobium angustifolium	common fireweed	<1
		Rubus arcticus (also R. acaulis)	dwarf raspberry	1
		Fragaria virginiana	wild strawberry	2
		Thalictrum dasycarpum	tall meadow rue	2
		Aralia nudicaulis	wild sarsaparilla	3
		Adoxa moschatellina	moschatel	3
		Lycopodium annotinum	stiff club-moss	3
		Epilobium anagallidifolium	alpine willowherb	3
		Rubus pubescens	dewberry	3
		Mitella nuda	bishop's-cap	3
		Mertensia paniculata	tall lungwort	4
		Maianthemum canadense	wild lily-of-the-valley	6
		Equisetum arvense	common horsetail	7
		Equisetum pratense	meadow horsetail	8
		Equisetum sylvaticum	woodland horsetail	13
		Cornus canadensis	bunchberry	14
	graminoid	*Leymus innovatus (also Elymus innovatus)*	hairy wild rye	<1
		unknown Calamagrostis species	*unknown Calamagrostis species*	<1
		Calamagrostis canadensis	bluejoint	2
		Poa palustris	fowl bluegrass	2
		Carex disperma	two-seeded sedge	2
		Carex canescens	short sedge	3
		unknown graminoid species	*unknown graminoid species*	4
	moss	*Orthotrichum speciosum*	*no common name*	<1
		Plagiomnium drummondii	Drummond's plagiomnium moss	<1
		Hypnum lindbergii	Lindberg's hypnum moss	<1
		Jamesoniella autumnalis	liverwort	<1
		Lepidozia reptans	liverwort	<1
		Mylia anomala	liverwort	<1
		Ptilidium pulcherrimum	liverwort	<1
		unknown moss species	*unknown moss species*	<1
		Mnium spinulosum	*no common name*	<1
		Polytrichum juniperinum	juniper hair-cap	<1
		Dicranum undulatum	wavy dicranum	<1
		Eurhynchium pulchellum	eurhynchiummoss	<1
		Dicranum polysetum	wavy dicranum	<1
		Brachythecium erythrorrhizon	*no common name*	<1
		unknown Mnium species	*unknown Mnium species*	<1

Table N-1 Species Composition and Percent Cover by Vegetation Type in the Pierre River Mining Area (continued)

Ecosite Phase	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
Horsetail balsam poplar-white spruce (f2) (continued)	moss (continued)	*Thuidium recognitum*	*no common name*	<1
		Sanionia uncinata (also Drepanocladus uncinatus)	brown moss	<1
		Polytrichum commune	common hair-cap	<1
		Climacium dendroides	common tree moss	<1
		Dicranum fuscescens	fuscous moss	<1
		Ceratodon purpureus	purple horn-toothed moss	<1
		Sphagnum riparium	shore-growing peat moss	<1
		Sphagnum squarrosum	squarrose peat moss	<1
		unknown moss species	*unknown moss species*	<1
		unknown moss species	*unknown moss species*	<1
		Dicranum flagellare	whip fork moss	<1
		Ptilium crista-castrensis	knight's plume moss	<1
		Aulacomnium palustre	tufted moss	<1
		Brachythecium salebrosum	*no common name*	1
		Abietinella abietina (also Thuidium abietinum)	*no common name*	1
		Pylaisiella polyantha	pylaisiella moss	1
		Pleurozium schreberi	Schreber's moss	10
		Hylocomium splendens	stair-step moss	11
	lichen	*Micarea prasina*	*no common name*	<1
		Peltigera canina	dog lichen	<1
		Cladonia sulphurina	greater sulphur cup	<1
		Cladonia cervicornis (also C. verticillata)	ladder lichen	<1
		Cladonia crispata	organ-pipe lichen	<1
		Cladonia borealis	red pixie-cup	<1
		Imshaugia aleurites	salted starburst lichen	<1
		Cladonia fimbriata	trumpet lichen	<1
		unknown lichen species	*unknown lichen species*	<1
		Cladonia botrytes	wooden soldiers	<1
		Cladonia coniocraea	cup lichen	<1
		Cladonia cornuta	bighorn cladonia	<1
		Peltigera neopolydactyla	carpet pelt	<1
		Cladonia gracilis	smooth cladonia	<1
		Peltigera aphthosa	studded leather lichen	<1
		unknown lichen species	*unknown lichen species*	<1

Table N-1 Species Composition and Percent Cover by Vegetation Type in the Pierre River Mining Area (continued)

Ecosite Phase	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
Horsetail balsam poplar-white spruce (f2) (continued)	epiphyte	*Lecanora pulicaris*	*no common name*	<1
		Lecanora rugosella	*no common name*	<1
		Lecanora subintricata	*no common name*	<1
		Lecidella elaeochroma	*no common name*	<1
		Ochrolechia arborea	*no common name*	<1
		Rinodina orculata	*no common name*	<1
		Rinodina septentrionalis	*no common name*	<1
		Scoliciosporum perpusillum	*no common name*	<1
		Scoliciosporum umbrinum	*no common name*	<1
		Stenocybe pullatula	alder stickpin	<1
		Arthonioid group	Arthonioid group	<1
		Tuckermannopsis americana (also Cetraria halei or C. ciliaris)	fringed wrinkle-lichen	<1
		Lecanora symmicta	fused rim-lichen	<1
		Bryoria furcellata	old man's beard	<1
		Bryoria fuscescens	old man's beard	<1
		Bryoria lanestris	old man's beard	<1
		Usnea lapponica	old man's beard	<1
		Usnea scabrata	old man's beard	<1
		Usnea substerilis	old man's beard	<1
		Ramalina dilacerata	punctured ramalina	<1
		Parmelia sulcata	hammered shield moss	<1
		Melanelia subaurifera	abraded camoflage lichen	<1
		Melanelia septentrionalis	northern camoflage lichen	<1
		Vulpicida pinastri (also Tuckermannopsis pinastri)	powdered sunshine lichen	<1
		Hypogymnia physodes	monk's-hood lichen	<1
		Usnea subfloridana	old man's beard	<1
		Usnea hirta	old man's beard	<1
		Imshaugia placorodia	American starburst lichen	<1
		Tuckermannopsis orbata (also Cetraria orbata)	variable wrinkle-lichen	<1
		Evernia mesomorpha	boreal oakmoss lichen	<1
		unknown epiphyte species	*unknown epiphyte species*	5
		unknown epiphyte species	*unknown epiphyte species*	5
Horsetail white spruce (f3)	canopy	*Populus tremuloides*	aspen	2
		Betula papyrifera	white birch	4
		Picea glauca	white spruce	26

Table N-1 Species Composition and Percent Cover by Vegetation Type in the Pierre River Mining Area (continued)

Ecosite Phase	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
Horsetail white spruce (f3) (continued)	subcanopy	*Picea glauca*	white spruce	2
		Betula papyrifera	white birch	18
	tall shrub	*Alnus incana ssp tenuifolia (also A. rugosa)*	river alder	<1
		Salix discolor	pussy willow	1
		unknown Salix species	*unknown Salix species*	2
		Alnus incana ssp tenuifolia (also A. rugosa)	river alder	5
		Betula papyrifera	white birch	5
	low shrub	*unknown Salix species*	*unknown Salix species*	<1
		Populus balsamifera	balsam poplar	<1
		Shepherdia canadensis	Canada buffalo-berry	<1
		Ledum groenlandicum	common Labrador tea	<1
		Alnus incana ssp tenuifolia (also A. rugosa)	river alder	<1
		Ribes glandulosum	skunk currant	<1
		Symphoricarpos albus	snowberry	<1
		Lonicera dioica	twining honeysuckle	<1
		Picea glauca	white spruce	<1
		Ribes americanum	wild black currant	<1
		Ribes triste	wild red currant	<1
		Lonicera dioica	twining honeysuckle	<1
		Vaccinium vitis-idaea	bog cranberry	1
		Vaccinium vitis-idaea	bog cranberry	1
		Cornus stolonifera	red-osier dogwood	1
		Alnus incana ssp tenuifolia (also A. rugosa)	river alder	1
		Ribes lacustre	bristly black currant	1
		Vaccinium vitis-idaea	bog cranberry	1
		Betula papyrifera	white birch	2
		Linnaea borealis	twinflower	2
		Ribes hudsonianum	northern black currant	2
		Rubus idaeus	wild red raspberry	8
		Rosa acicularis	prickly rose	11
		Viburnum edule	low-bush cranberry	12
	forb	*unknown Aster species*	*unknown Aster species*	<1
		unknown Talictrum species	*unknown Talictrum species*	<1
		Moehringia lateriflora	blunt-leaved sandwort	<1
		Urtica dioica	common nettle	<1
		Pyrola asarifolia	common pink wintergreen	<1
		Achillea millefolium	common yarrow	<1
		Lathyrus ochroleucus	cream-colored vetchling	<1
		Viola renifolia	kidney-leaved violet	<1

Table N-1 Species Composition and Percent Cover by Vegetation Type in the Pierre River Mining Area (continued)

Ecosite Phase	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
Horsetail white spruce (f3) (continued)	forb (continued)	*Geocaulon lividum*	northern bastard toadflax	<1
		Trientalis borealis	northern starflower	<1
		Stellaria calycantha	northern stitchwort	<1
		Epilobium ciliatum	northern willowherb	<1
		Moneses uniflora	one-flowered wintergreen	<1
		Orthilia secunda (also Pyrola secunda)	one-sided wintergreen	<1
		Petasites frigidus var palmatus	palmate-leaved coltsfoot	<1
		Galium trifidum	small bedstraw	<1
		Circaea alpina	small enchanter's nightshade	<1
		Delphinium glaucum	tall larkspur	<1
		Smilacina trifolia	three-leaved Solomon's-seal	<1
		Thalictrum venulosum	veiny meadow rue	<1
		Viola canadensis	western Canada violet	<1
		Maianthemum canadense	wild lily-of-the-valley	<1
		Fragaria virginiana	wild strawberry	<1
		Vicia americana	wild vetch	<1
		Galium triflorum	sweet-scented bedstraw	<1
		Epilobium angustifolium	common fireweed	<1
		Aralia nudicaulis	wild sarsaparilla	<1
		Galium boreale	northern bedstraw	<1
		Adoxa moschatellina	moschatel	1
		unknown fern species	*unknown fern species*	1
		Equisetum pratense	meadow horsetail	2
		Mitella nuda	bishop's-cap	2
		Cornus canadensis	bunchberry	2
		Mertensia paniculata	tall lungwort	4
		Impatiens noli-tangere	western jewelweed	5
		Gymnocarpium dryopteris	oak fern	6
		Rubus pubescens	dewberry	7
		Lycopodium annotinum	stiff club-moss	7
		Equisetum arvense	common horsetail	12
		Equisetum sylvaticum	woodland horsetail	19
	graminoid	*Glyceria grandis*	common tall manna grass	<1
		Leymus innovatus (also Elymus innovatus)	hairy wild rye	<1
		Carex peckii	Peck's sedge	<1
		Carex canescens	short sedge	<1
		Elymus trachycaulus	slender wheatgrass	<1
		Deschampsia cespitosa	tufted hair grass	<1

Table N-1 Species Composition and Percent Cover by Vegetation Type in the Pierre River Mining Area (continued)

Ecosite Phase	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
Horsetail white spruce (f3) (continued)	graminoid (continued)	*unknown graminoid species*	*unknown graminoid species*	<1
		unknown graminoid species	*unknown graminoid species*	1
		Carex disperma	two-seeded sedge	2
		unknown graminoid species	*unknown graminoid species*	2
		Calamagrostis canadensis	bluejoint	5
	moss	*unknown moss species*	*unknown moss species*	<1
		unknown Mnium species	*unknown Mnium species*	<1
		unknown Splachnum species	*unknown Splachnum species*	<1
		Dicranum fragilifolium	cushion moss	<1
		Lepidozia reptans	liverwort	<1
		Ptilidium pulcherrimum	liverwort	<1
		Plagiomnium cuspidatum	toothed plagiomnium moss	<1
		Aulacomnium palustre	tufted moss	<1
		unknown moss species	*unknown moss species*	<1
		Dicranum polysetum	wavy dicranum	<1
		Dicranum undulatum	wavy dicranum	<1
		Dicranum scoparium	broom moss	<1
		Ptilium crista-castrensis	knight's plume moss	4
		Hylocomium splendens	stair-step moss	12
		Pleurozium schreberi	Schreber's moss	17
	lichen	*Peltigera canina*	dog lichen	<1
		Cladonia chlorophaea	mealy pixie-cup	<1
		unknown lichen species	*unknown lichen species*	<1
		Cladonia coniocraea	cup lichen	<1
		Peltigera aphthosa	studded leather lichen	<1
		Cladonia fimbriata	trumpet lichen	<1
	epiphyte	*Lecanora persimilis*	*no common name*	<1
		Amandinea punctata (also Buellia punctata)	*no common name*	<1
		Bryoria glabra	old man's beard	<1
		Usnea cavernosa	old man's beard	<1
		Usnea scabrata	old man's beard	<1
		Ramalina dilacerata	punctured ramalina	<1
		Melanelia subaurifera	abraded camoflage lichen	<1
		Bryoria fuscescens	old man's beard	<1
		Tuckermannopsis americana (also Cetraria halei or C. ciliaris)	fringed wrinkle-lichen	<1

Table N-1 Species Composition and Percent Cover by Vegetation Type in the Pierre River Mining Area (continued)

Ecosite Phase	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
Horsetail white spruce (f3) (continued)	epiphyte (continued)	*Melanelia septentrionalis*	northern camoflage lichen	<1
		Vulpicida pinastri (also Tuckermannopsis pinastri)	powdered sunshine lichen	<1
		Imshaugia aleurites	salted starburst lichen	<1
		Parmelia sulcata	hammered shield moss	<1
		Usnea lapponica	old man's beard	1
		Evernia mesomorpha	boreal oakmoss lichen	1
		unknown epiphyte species	*unknown epiphyte species*	2
		Usnea scabiosa	*no common name*	2
		Hypogymnia physodes	monk's-hood lichen	2
		Usnea hirta	old man's beard	2
Labrador tea-subhygric black spruce-jack pine (g1)	canopy	*Pinus contorta*	lodgepole pine	<1
		Pinus banksiana	jack pine	<1
		Larix laricina	tamarack	20
		Picea mariana	black spruce	47
	subcanopy	*Picea mariana*	black spruce	23
	tall shrub	*unknown Salix species*	*unknown Salix species*	1
		Picea mariana	black spruce	2
	low shrub	*Ribes lacustre*	bristly black currant	<1
		Vaccinium myrtilloides	common blueberry	<1
		Lonicera caerulea (also L. villosa)	fly honeysuckle	<1
		Viburnum edule	low-bush cranberry	<1
		Rosa acicularis	prickly rose	<1
		Linnaea borealis	twinflower	<1
		Vaccinium vitis-idaea	bog cranberry	<1
		Picea mariana	black spruce	<1
		Salix bebbiana	beaked willow	3
		Ledum groenlandicum	common Labrador tea	5
	forb	*Maianthemum canadense*	wild lily-of-the-valley	<1
		unknown Aster species	*unknown Aster species*	<1
		Petasites frigidus var sagittatus	arrow-leaved coltsfoot	<1
		Equisetum arvense	common horsetail	<1
		Rubus pubescens	dewberry	<1
		Goodyera repens	lesser rattlesnake plantain	<1
		Solidago simplex ssp simplex (also S. spathulata)	mountain goldenrod	<1
		Galium boreale	northern bedstraw	<1
		Petasites frigidus var palmatus	palmate-leaved coltsfoot	<1
		Lycopodium annotinum	stiff club-moss	<1

Table N-1 Species Composition and Percent Cover by Vegetation Type in the Pierre River Mining Area (continued)

Ecosite Phase	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
Labrador tea-subhygric black spruce-jack pine (g1) (continued)	forb (continued)	*Smilacina trifolia*	three-leaved Solomon's-seal	<1
		Fragaria virginiana	wild strawberry	<1
		Cornus canadensis	bunchberry	1
		Equisetum scirpoides	dwarf scouring-rush	1
		Equisetum sylvaticum	woodland horsetail	1
	graminoid	*Calamagrostis canadensis*	bluejoint	<1
		Carex disperma	two-seeded sedge	<1
		unknown graminoid species	*unknown graminoid species*	<1
	moss	*Ptilidium pulcherrimum*	liverwort	<1
		Dicranum scoparium	broom moss	<1
		Polytrichum juniperinum	juniper hair-cap	<1
		Polytrichum strictum	slender hair-cap	<1
		Sphagnum angustifolium	peat moss	<1
		Dicranum polysetum	wavy dicranum	<1
		Aulacomnium palustre	tufted moss	1
		Ptilium crista-castrensis	knight's plume moss	9
		Hylocomium splendens	stair-step moss	14
		Pleurozium schreberi	Schreber's moss	64
	lichen	*Cladonia cornuta*	bighorn cladonia	<1
		Peltigera neopolydactyla	carpet pelt	<1
		Cladonia sulphurina	greater sulphur cup	<1
		Cladonia multiformis	sieve lichen	<1
		Cladina mitis	reindeer lichen	<1
		Peltigera aphthosa	studded leather lichen	<1
	epiphyte	*Cliostomum pallens*	*no common name*	<1
		Lecanora pulicaris	*no common name*	<1
		Lecanora subintricata	*no common name*	<1
		Ochrolechia arborea	*no common name*	<1
		Scoliciosporum perpusillum	*no common name*	<1
		Arthonioid group	Arthonioid group	<1
		Lecanora symmicta	fused rim-lichen	<1
		Parmelia sulcata	hammered shield moss	<1
		Bryoria furcellata	old man's beard	<1
		Usnea lapponica	old man's beard	<1
		Usnea scabrata	old man's beard	<1
		Usnea subfloridana	old man's beard	<1
		Tuckermannopsis orbata (also Cetraria orbata)	variable wrinkle-lichen	<1
		Vulpicida pinastri (also Tuckermannopsis pinastri)	powdered sunshine lichen	<1
		Imshaugia placorodia	American starburst lichen	<1
		Parmeliopsis hyperopta	gray starburst lichen	<1

Table N-1 Species Composition and Percent Cover by Vegetation Type in the Pierre River Mining Area (continued)

Ecosite Phase	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
Labrador tea-subhygric black spruce-jack pine (g1) (continued)	epiphyte (continued)	*unknown epiphyte species*	*unknown epiphyte species*	<1
		Evernia mesomorpha	boreal oakmoss lichen	<1
		Tuckermannopsis americana (also Cetraria halei or C. ciliaris)	fringed wrinkle-lichen	<1
		Melanelia subaurifera	abraded camoflage lichen	1
		Bryoria fuscescens	old man's beard	3
		Hypogymnia physodes	monk's-hood lichen	3
		Tuckermannopsis sepincola	chestnut wrinkle-lichen	3
		Usnea hirta	old man's beard	4
Labrador tea/horsetail white spruce-black spruce (h1)	canopy	*Populus balsamifera*	balsam poplar	<1
		Salix bebbiana	beaked willow	5
		Larix laricina	tamarack	5
		Picea mariana	black spruce	15
		Picea glauca	white spruce	26
	subcanopy	*Betula papyrifera*	white birch	<1
		Picea mariana	black spruce	5
		Picea glauca	white spruce	5
	tall shrub	*Betula papyrifera*	white birch	<1
		unknown Salix species	*unknown Salix species*	1
		Salix bebbiana	beaked willow	2
		Picea glauca	white spruce	6
	low shrub	*Ribes hudsonianum*	northern black currant	<1
		Rubus idaeus	wild red raspberry	<1
		Salix myrtillifolia	myrtle-leaved willow	<1
		Arctostaphylos rubra	alpine bearberry	<1
		Salix bebbiana	beaked willow	<1
		Picea mariana	black spruce	<1
		Ribes lacustre	bristly black currant	<1
		Arctostaphylos uva-ursi	common bearberry	<1
		Larix laricina	tamarack	<1
		Salix lutea	yellow willow	<1
		Vaccinium vitis-idaea	bog cranberry	2
		Picea glauca	white spruce	2
		Linnaea borealis	twinflower	15
		Ledum groenlandicum	common Labrador tea	35
	forb	*Achillea millefolium*	common yarrow	<1
		Rubus pubescens	dewberry	<1
		Equisetum scirpoides	dwarf scouring-rush	<1
		Viola renifolia	kidney-leaved violet	<1
		Goodyera repens	lesser rattlesnake plantain	<1
		Equisetum pratense	meadow horsetail	<1

Table N-1 Species Composition and Percent Cover by Vegetation Type in the Pierre River Mining Area (continued)

Ecosite Phase	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
Labrador tea/horsetail white spruce-black spruce (h1) (continued)	forb (continued)	*Smilacina trifolia*	three-leaved Solomon's-seal	<1
		Mitella nuda	bishop's-cap	<1
		Cornus canadensis	bunchberry	8
		Equisetum arvense	common horsetail	13
		Equisetum sylvaticum	woodland horsetail	21
	graminoid	*unknown graminoid species*	*unknown graminoid species*	<1
		Calamagrostis canadensis	bluejoint	1
		Polytrichum piliferum	awned hair-cap	<1
		Cinclidium stygium	common northern lantern moss	<1
		Leptobryum pyriforme	leptobryum moss	<1
		Marchantia polymorpha	liverwort	<1
		Plagiochila porelloides	*no common name*	<1
		Thuidium recognitum	*no common name*	<1
		Dicranum scoparium	broom moss	<1
		Sanionia uncinata (also Drepanocladus uncinatus)	brown moss	<1
		Eurhynchium pulchellum	eurhynchiummoss	<1
		Tomentypnum nitens	golden moss	<1
		Ptilidium ciliare	liverwort	<1
		Dicranum elongatum	long forked moss	<1
		Lepidozia reptans	liverwort	<1
		Dicranum undulatum	wavy dicranum	1
		Ptilium crista-castrensis	knight's plume moss	2
		Brachythecium salebrosum	*no common name*	3
		Aulacomnium palustre	tufted moss	4
		Dicranum polysetum	wavy dicranum	5
		Hylocomium splendens	stair-step moss	14
		Pleurozium schreberi	Schreber's moss	70
	lichen	*Hypocenomyce scalaris*	common clam lichen	<1
		Cladonia chlorophaea	mealy pixie-cup	<1
		Cladonia gracilis	smooth cladonia	<1
		Cladonia botrytes	wooden soldiers	<1
		Cladina mitis	reindeer lichen	<1
		Peltigera aphthosa	studded leather lichen	<1
		Cladonia sulphurina	greater sulphur cup	<1
	epiphyte	*Cliostomum pallens*	*no common name*	<1
		Lecanora boligera	*no common name*	<1
		Lecanora pulicaris	*no common name*	<1
		Lecidella elaeochroma	*no common name*	<1
		Micarea sylvicola	*no common name*	<1
		Ochrolechia arborea	*no common name*	<1
		Scoliciosporum perpusillum	*no common name*	<1
		Arthonioid group	Arthonioid group	<1

Table N-1 Species Composition and Percent Cover by Vegetation Type in the Pierre River Mining Area (continued)

Ecosite Phase	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
Labrador tea/horsetail white spruce-black spruce (h1) (continued)	epiphyte (continued)	*Evernia mesomorpha*	boreal oakmoss lichen	<1
		Tuckermannopsis americana (also Cetraria halei or C. ciliaris)	fringed wrinkle-lichen	<1
		Lecanora symmicta	fused rim-lichen	<1
		Parmeliopsis hyperopta	gray starburst lichen	<1
		Parmeliopsis ambigua	green starburst lichen	<1
		Usnea cavernosa	old man's beard	<1
		Usnea lapponica	old man's beard	<1
		Usnea scabrata	old man's beard	<1
		Vulpicida pinastri (also Tuckermannopsis pinastri)	powdered sunshine lichen	<1
		Ramalina dilacerata	punctured ramalina	<1
		Parmelia sulcata	hammered shield moss	<1
		Bryoria fuscescens	old man's beard	<1
		Bryoria furcellata	old man's beard	1
		Hypogymnia physodes	monk's-hood lichen	1
Athabasca Plain				
Bearberry jack pine (a1)	canopy	*Picea mariana*	black spruce	15
		Pinus banksiana	jack pine	21
	subcanopy	*Populus tremuloides*	aspen	<1
		Betula papyrifera	white birch	<1
		Picea glauca	white spruce	<1
		Pinus banksiana	jack pine	10
	tall shrub	*Pinus banksiana*	jack pine	<1
		Salix scouleriana	Scouler's willow	1
		Picea glauca	white spruce	1
	low shrub	*Ledum groenlandicum*	common Labrador tea	<1
		Prunus pensylvanica	pin cherry	<1
		unknown Salix species	*unknown Salix species*	<1
		Lonicera dioica	twining honeysuckle	<1
		Picea glauca	white spruce	<1
		Rubus idaeus	wild red raspberry	<1
		Shepherdia canadensis	Canada buffalo-berry	<1
		Linnaea borealis	twinflower	<1
		Amelanchier alnifolia	saskatoon	<1
		Pinus banksiana	jack pine	<1
		Populus tremuloides	aspen	<1
		Salix bebbiana	beaked willow	1
		Rosa acicularis	prickly rose	1
		Picea mariana	black spruce	1
		Alnus viridis ssp crispa	green alder	2
		Vaccinium vitis-idaea	bog cranberry	6
		Vaccinium myrtilloides	common blueberry	6
		Arctostaphylos uva-ursi	common bearberry	8

Table N-1 Species Composition and Percent Cover by Vegetation Type in the Pierre River Mining Area (continued)

Ecosite Phase	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
Bearberry jack pine (a1) (continued)	forb (continued)	*unknown Aster species*	*unknown Aster species*	<1
		unknown Aster species	*unknown Aster species*	<1
		unknown Aster species	*unknown Aster species*	<1
		Cornus canadensis	bunchberry	<1
		Epilobium angustifolium	common fireweed	<1
		Pyrola asarifolia	common pink wintergreen	<1
		Achillea millefolium	common yarrow	<1
		Melampyrum lineare	cow-wheat	<1
		Lathyrus ochroleucus	cream-colored vetchling	<1
		Anemone multifida	cut-leaved anemone	<1
		Arceuthobium americanum	dwarf mistletoe	<1
		Viola adunca	early blue violet	<1
		Pyrola chlorantha (also Pyrola virens)	greenish-flowered wintergreen	<1
		Diphasiastrum complanatum (also Lycopodium complanatum)	ground-cedar	<1
		Campanula rotundifolia	harebell	<1
		Goodyera repens	lesser rattlesnake plantain	<1
		Equisetum pratense	meadow horsetail	<1
		Solidago simplex	*no common name*	<1
		Galium boreale	northern bedstraw	<1
		Orthilia secunda (also Pyrola secunda)	one-sided wintergreen	<1
		Corallorhiza trifida	pale coralroot	<1
		Apocynum androsaemifolium	spreading dogbane	<1
		Cypripedium acaule	stemless lady's-slipper	<1
		Potentilla tridentata (also P. tridentata)	three-toothed cinquefoil	<1
		unknown forb species	*unknown forb species*	<1
		Aralia nudicaulis	wild sarsaparilla	<1
		Vicia americana	wild vetch	<1
		Comandra umbellata	bastard toadflax	<1
		Fragaria virginiana	wild strawberry	<1
		Anemone patens	prairie crocus	<1
		Maianthemum canadense	wild lily-of-the-valley	<1
		Geocaulon lividum	northern bastard toadflax	<1
	graminoid	*Poa palustris*	fowl bluegrass	<1
		Leymus innovatus (also Elymus innovatus)	hairy wild rye	<1
		Carex siccata	hay sedge	<1
		Oryzopsis pungens	northern rice grass	<1
		Carex richardsonii	Richardson's sedge	<1
		Hierochloe hirta ssp arctica (also H. odorata)	sweet grass	<1

Table N-1 Species Composition and Percent Cover by Vegetation Type in the Pierre River Mining Area (continued)

Ecosite Phase	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
Bearberry jack pine (a1) (continued)	graminoide (continued)	*unknown graminoid species*	*unknown graminoid species*	<1
		unknown graminoid species	*unknown graminoid species*	<1
		Oryzopsis asperifolia	white-grained mountain rice grass	<1
	moss	*Polytrichum piliferum*	awned hair-cap	<1
		Pohlia nutans	copper wire moss	<1
		Dicranum fuscescens	fuscous moss	<1
		Polytrichum juniperinum	juniper hair-cap	<1
		Ptilium crista-castrensis	knight's plume moss	<1
		Lepidozia reptans	liverwort	<1
		Ptilidium ciliare	liverwort	<1
		Ptilidium pulcherrimum	liverwort	<1
		Abietinella abietina (also Thuidium abietinum)	*no common name*	<1
		Polytrichum strictum	slender hair-cap	<1
		unknown moss species	*unknown moss species*	<1
		Warnstorfia fluitans (also Drepanocladus fluitans)	water hook moss	<1
		Dicranum undulatum	wavy dicranum	<1
		Dicranum flagellare	whip fork moss	1
		Dicranum polysetum	wavy dicranum	2
		Hylocomium splendens	stair-step moss	4
		Pleurozium schreberi	Schreber's moss	31
	lichen	*Cladonia cornuta*	bighorn cladonia	<1
		Peltigera neopolydactyla	carpet pelt	<1
		Cladonia coniocraea	cup lichen	<1
		Cladonia sulphurina	greater sulphur cup	<1
		Cladonia cervicornis (also C. verticillata)	ladder lichen	<1
		Cladonia chlorophaea	mealy pixie-cup	<1
		Cladina arbuscula	reindeer lichen	<1
		Cladonia gracilis	smooth cladonia	<1
		Cladonia fimbriata	trumpet lichen	<1
		unknown lichen species	*unknown lichen species*	<1
		unknown lichen species	*unknown lichen species*	<1
		unknown lichen species	*unknown lichen species*	<1
		Peltigera malacea	veinless pelt	<1
		Cladonia botrytes	wooden soldiers	<1
		Peltigera aphthosa	studded leather lichen	<1
		Cetraria nivalis (also Flavocetraria nivalis)	flattened snow lichen	<1
		Peltigera canina	dog lichen	<1

Table N-1 Species Composition and Percent Cover by Vegetation Type in the Pierre River Mining Area (continued)

Ecosite Phase	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
Bearberry jack pine (a1) (continued)	lichen (continued)	*unknown lichen species*	*unknown lichen species*	<1
		Cladonia crispata	organ-pipe lichen	1
		Cladonia multiformis	sieve lichen	1
		Cladonia uncialis	thorn cladonia	3
		Cladina stellaris	reindeer lichen	3
		Cladina rangiferina	reindeer lichen	4
		Cladina mitis	reindeer lichen	37
	epiphyte	*Parmeliopsis hyperopta*	gray starburst lichen	<1
		Parmeliopsis ambigua	green starburst lichen	<1
		Xanthoria fallax	powdered orange lichen	<1
		Vulpicida pinastri (also Tuckermannopsis pinastri)	powdered sunshine lichen	<1
		unknown epiphyte species	*unknown epiphyte species*	<1
		Bryoria furcellata	old man's beard	<1
		Tuckermannopsis sepincola	chestnut wrinkle-lichen	<1
		Imshaugia placorodia	American starburst lichen	1
		Bryoria fuscescens	old man's beard	2
		Tuckermannopsis americana (also Cetraria halei or C. ciliaris)	fringed wrinkle-lichen	2
		Hypogymnia physodes	monk's-hood lichen	3
		Usnea hirta	old man's beard	4
		unknown Bryoria species	*unknown Bryoria species*	5
		Evernia mesomorpha	boreal oakmoss lichen	6
		unknown epiphyte species	*unknown epiphyte species*	7
		Usnea lapponica	old man's beard	10
Canada buffalo-berry - green alder jack pine-aspen-white birch (b1)	canopy	*Abies balsamea*	balsam fir	2
		Picea glauca	white spruce	7
		Populus tremuloides	aspen	11
		Betula papyrifera	white birch	20
		Pinus banksiana	jack pine	21
		Picea mariana	black spruce	35
	subcanopy	*Pinus banksiana*	jack pine	1
		Picea glauca	white spruce	2
		Betula papyrifera	white birch	2
		Populus tremuloides	aspen	9
	tall shrub	*Betula pumila*	dwarf birch	<1
		Pinus banksiana	jack pine	<1
		Viburnum edule	low-bush cranberry	<1
		Linnaea borealis	twinflower	<1
		unknown Salix species	*unknown Salix species*	<1

Table N-1 Species Composition and Percent Cover by Vegetation Type in the Pierre River Mining Area (continued)

Ecosite Phase	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
Canada buffalo-berry - green alder jack pine-aspen-white birch (b1) (continued)	tall shrub (continued)	*Picea glauca*	white spruce	<1
		Prunus pensylvanica	pin cherry	<1
		Betula papyrifera	white birch	<1
		Rosa acicularis	prickly rose	1
		Populus tremuloides	aspen	1
		Alnus viridis ssp crispa	green alder	7
	low shrub	*unknown Salix species*	*unknown Salix species*	<1
		unknown Salix species	*unknown Salix species*	<1
		Lonicera involucrata	bracted honeysuckle	<1
		Prunus virginiana	choke cherry	<1
		Lonicera caerulea (also L. villosa)	fly honeysuckle	<1
		Pinus banksiana	jack pine	<1
		Cornus stolonifera	red-osier dogwood	<1
		Symphoricarpos albus	snowberry	<1
		Larix laricina	tamarack	<1
		Linnaea borealis	twinflower	<1
		Lonicera dioica	twining honeysuckle	<1
		Lonicera dioica	twining honeysuckle	<1
		Ribes triste	wild red currant	<1
		Rubus idaeus	wild red raspberry	<1
		Prunus pensylvanica	pin cherry	<1
		Betula papyrifera	white birch	<1
		unknown Salix species	*unknown Salix species*	<1
		Populus tremuloides	aspen	<1
		Picea glauca	white spruce	<1
		Abies balsamea	balsam fir	1
		Ledum groenlandicum	common Labrador tea	1
		Amelanchier alnifolia	saskatoon	1
		Viburnum edule	low-bush cranberry	1
		Salix bebbiana	beaked willow	2
		Linnaea borealis	twinflower	2
		Rosa acicularis	prickly rose	3
		Vaccinium vitis-idaea	bog cranberry	4
		Alnus incana ssp tenuifolia (also A. rugosa)	river alder	4
		Shepherdia canadensis	Canada buffalo-berry	5
		Vaccinium myrtilloides	common blueberry	6
		Arctostaphylos uva-ursi	common bearberry	7
		Alnus viridis ssp crispa	green alder	13
	forb	*unknown Aster species*	*unknown Aster species*	<1
		unknown Aster species	*unknown Aster species*	<1
		unknown Galium species	*unknown Galium species*	<1
		Solidago simplex	Rand's goldenrod	<1

Table N-1 Species Composition and Percent Cover by Vegetation Type in the Pierre River Mining Area (continued)

Ecosite Phase	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
Canada buffalo-berry - green alder jack pine-aspen-white birch (b1) (continued)	forb (continued)	*unknown Solidago species*	*unknown Solidago species*	<1
		Comandra umbellata	bastard toadflax	<1
		Mitella nuda	bishop's-cap	<1
		Antennaria neglecta	broad-leaved everlasting	<1
		Equisetum hyemale	common scouring-rush	<1
		Achillea millefolium	common yarrow	<1
		Anemone multifida	cut-leaved anemone	<1
		Equisetum scirpoides	dwarf scouring-rush	<1
		Viola adunca	early blue violet	<1
		Pyrola chlorantha (also Pyrola virens)	greenish-flowered wintergreen	<1
		Campanula rotundifolia	harebell	<1
		Viola renifolia	kidney-leaved violet	<1
		Athyrium filix-femina	lady fern	<1
		Goodyera repens	lesser rattlesnake plantain	<1
		Aster ciliolatus	Lindley's aster	<1
		Equisetum pratense	meadow horsetail	<1
		Solidago simplex ssp simplex (also S. spathulata)	mountain goldenrod	<1
		Hieracium umbellatum	narrow-leaved hawkweed	<1
		Orthilia secunda (also Pyrola secunda)	one-sided wintergreen	<1
		Artemisia campestris	plains wormwood	<1
		Aster puniceus	purple-stemmed aster	<1
		Platanthera orbiculata (also Habenaria orbiculata)	round-leaved bog orchid	<1
		Amerorchis rotundifolia (also Orchis rotundifolia)	round-leaved orchid	<1
		Circaea alpina	small enchanter's nightshade	<1
		Aster laevis	smooth aster	<1
		Apocynum androsaemifolium	spreading dogbane	<1
		Potentilla tridentata (also P. tridentata)	three-toothed cinquefoil	<1
		unknown forb species	*unknown forb species*	<1
		Thalictrum venulosum	veiny meadow rue	<1
		Lilium philadelphicum	western wood lily	<1
		Vicia americana	wild vetch	<1
		Galium boreale	northern bedstraw	<1
		Geocaulon lividum	northern bastard toadflax	<1
		Pyrola asarifolia	common pink wintergreen	<1
		Fragaria virginiana	wild strawberry	<1

Table N-1 Species Composition and Percent Cover by Vegetation Type in the Pierre River Mining Area (continued)

Ecosite Phase	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
Canada buffalo-berry - green alder jack pine-aspen-white birch (b1) (continued)	forb (continued)	*Anemone patens*	prairie crocus	<1
		Equisetum arvense	common horsetail	<1
		Lathyrus ochroleucus	cream-colored vetchling	<1
		Rubus pubescens	dewberry	<1
		Melampyrum lineare	cow-wheat	<1
		Lycopodium obscurum	ground-pine	<1
		Epilobium angustifolium	common fireweed	<1
		Mertensia paniculata	tall lungwort	1
		Lycopodium annotinum	stiff club-moss	2
		Maianthemum canadense	wild lily-of-the-valley	2
		Diphasiastrum complanatum (also Lycopodium complanatum)	ground-cedar	2
		Aralia nudicaulis	wild sarsaparilla	2
		Lycopodium clavatum	running club-moss	3
		Trientalis borealis	northern starflower	3
		Cornus canadensis	bunchberry	4
		Petasites frigidus var palmatus	palmate-leaved coltsfoot	4
	graminoid	*Calamagrostis canadensis*	bluejoint	<1
		Bromus ciliatus	fringed brome	<1
		Carex siccata	hay sedge	<1
		Koeleria macrantha	June grass	<1
		Elytrigia repens var repens (also Agropyron repens)	quack grass	<1
		Oryzopsis pungens	northern rice grass	<1
		unknown graminoid species	*unknown graminoid species*	<1
		Oryzopsis asperifolia	white-grained mountain rice grass	<1
		unknown graminoid species	*unknown graminoid species*	<1
		Schizachne purpurascens	purple oat grass	1
		Leymus innovatus (also Elymus innovatus)	hairy wild rye	1
	moss	*Polytrichum commune*	common hair-cap	<1
		Pohlia nutans	copper wire moss	<1
		Dicranum fragilifolium	cushion moss	<1
		Eurhynchium pulchellum	eurhynchiummoss	<1
		Dicranum fuscescens	fuscous moss	<1
		Polytrichum juniperinum	juniper hair-cap	<1
		Lepidozia reptans	liverwort	<1
		Ptilidium ciliare	liverwort	<1
		Ptilidium pulcherrimum	liverwort	<1

Table N-1 Species Composition and Percent Cover by Vegetation Type in the Pierre River Mining Area (continued)

Ecosite Phase	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
Canada buffalo-berry - green alder jack pine-aspen-white birch (b1) (continued)	moss (continued)	*unknown moss species*	*unknown moss species*	<1
		unknown moss species	*unknown moss species*	<1
		Dicranum undulatum	wavy dicranum	<1
		Ptilium crista-castrensis	knight's plume moss	<1
		Pylaisiella polyantha	pylaisiella moss	<1
		unknown moss species	*unknown moss species*	<1
		Dicranum scoparium	broom moss	<1
		Dicranum flagellare	whip fork moss	<1
		Brachythecium salebrosum	*no common name*	<1
		Dicranum polysetum	wavy dicranum	1
		Hylocomium splendens	stair-step moss	12
		Pleurozium schreberi	Schreber's moss	57
	lichen	*Cetraria nivalis (also Flavocetraria nivalis)*	flattened snow lichen	<1
		unknown Cladonia species	*unknown Cladonia species*	<1
		Cladonia cornuta	bighorn cladonia	<1
		Peltigera neopolydactyla	carpet pelt	<1
		Cladonia coniocraea	cup lichen	<1
		Peltigera canina	dog lichen	<1
		Parmeliopsis hyperopta	gray starburst lichen	<1
		Cladonia sulphurina	greater sulphur cup	<1
		Parmeliopsis ambigua	green starburst lichen	<1
		Cladonia cervicornis (also C. verticillata)	ladder lichen	<1
		Cladonia chlorophaea	mealy pixie-cup	<1
		Vulpicida pinastri (also Tuckermannopsis pinastri)	powdered sunshine lichen	<1
		Cladonia gracilis	smooth cladonia	<1
		Peltigera aphthosa	studded leather lichen	<1
		Cladonia uncialis	thorn cladonia	<1
		unknown lichen species	*unknown lichen species*	<1
		Peltigera malacea	veinless pelt	<1
		Cladonia botrytes	wooden soldiers	<1
		unknown lichen species	*unknown lichen species*	<1
		Cladina stellaris	reindeer lichen	<1
		Cladina rangiferina	reindeer lichen	1
		Cladina mitis	reindeer lichen	2
	epiphyte	*Arthonia patellulata*	*no common name*	<1
		unknown Tuckermannopsis species	*unknown Tuckermannopsis species*	<1

Table N-1 Species Composition and Percent Cover by Vegetation Type in the Pierre River Mining Area (continued)

Ecosite Phase	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
Canada buffalo-berry - green alder jack pine-aspen-white birch (b1) (continued)	epiphyte (continued)	*Xanthoria fallax*	powdered orange lichen	<1
		Parmeliopsis hyperopta	gray starburst lichen	<1
		Parmeliopsis ambigua	green starburst lichen	<1
		Parmelia sulcata	hammered shield moss	<1
		Vulpicida pinastri (also Tuckermannopsis pinastri)	powdered sunshine lichen	<1
		Ramalina dilacerata	punctured ramalina	<1
		Physcia stellaris	star rosette lichen	<1
		Imshaugia placorodia	American starburst lichen	<1
		Melanelia subaurifera	abraded camoflage lichen	<1
		Bryoria furcellata	old man's beard	1
		Bryoria fuscescens	old man's beard	1
		Tuckermannopsis sepincola	chestnut wrinkle-lichen	1
		unknown Bryoria species	*unknown Bryoria species*	2
		Tuckermannopsis americana (also Cetraria halei or C. ciliaris)	fringed wrinkle-lichen	3
		unknown epiphyte species	*unknown epiphyte species*	4
		Evernia mesomorpha	boreal oakmoss lichen	4
		Usnea hirta	old man's beard	4
		Hypogymnia physodes	monk's-hood lichen	4
		Usnea cavernosa	old man's beard	5
		unknown epiphyte species	*unknown epiphyte species*	9
Canada buffalo-berry - green alder aspen (b2)	canopy	*Picea glauca*	white spruce	6
		Pinus banksiana	jack pine	11
		Populus tremuloides	aspen	31
	subcanopy	*Betula papyrifera*	white birch	<1
		Populus tremuloides	aspen	8
		Picea glauca	white spruce	9
	tall shrub	*Prunus pensylvanica*	pin cherry	<1
		Cornus stolonifera	red-osier dogwood	<1
		Populus tremuloides	aspen	<1
		Picea glauca	white spruce	<1
		Amelanchier alnifolia	saskatoon	1
		Betula papyrifera	white birch	2
		Alnus viridis ssp crispa	green alder	2
		Salix bebbiana	beaked willow	3
		Alnus incana ssp tenuifolia (also A. rugosa)	river alder	5
		Prunus virginiana	choke cherry	15

Table N-1 Species Composition and Percent Cover by Vegetation Type in the Pierre River Mining Area (continued)

Ecosite Phase	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
Canada buffalo-berry - green alder aspen (b2) (continued)	low shrub	*Pinus banksiana*	jack pine	<1
		Viburnum edule	low-bush cranberry	<1
		Cornus stolonifera	red-osier dogwood	<1
		Symphoricarpos albus	snowberry	<1
		Betula papyrifera	white birch	<1
		Picea glauca	white spruce	<1
		Rubus idaeus	wild red raspberry	<1
		Populus tremuloides	aspen	<1
		unknown Salix species	*unknown Salix species*	<1
		Prunus pensylvanica	pin cherry	<1
		Lonicera dioica	twining honeysuckle	1
		Linnaea borealis	twinflower	3
		Viburnum edule	low-bush cranberry	3
		Vaccinium vitis-idaea	bog cranberry	4
		Rosa woodsii	common wild rose	5
		Arctostaphylos uva-ursi	common bearberry	6
		Salix bebbiana	beaked willow	7
		Amelanchier alnifolia	saskatoon	7
		Rosa acicularis	prickly rose	7
		Shepherdia canadensis	Canada buffalo-berry	7
		Alnus incana ssp tenuifolia (also A. rugosa)	river alder	7
		Vaccinium myrtilloides	common blueberry	8
		Alnus viridis ssp crispa	green alder	9
		Prunus virginiana	choke cherry	10
		Ledum groenlandicum	common Labrador tea	40
	forb	*unknown Aster species*	*unknown Aster species*	<1
		unknown Galium species	*unknown Galium species*	<1
		unknown Pyrola species	*unknown Pyrola species*	<1
		Achillea millefolium	common yarrow	<1
		Melampyrum lineare	cow-wheat	<1
		Viola adunca	early blue violet	<1
		Diphasiastrum complanatum (also Lycopodium complanatum)	ground-cedar	<1
		Viola renifolia	kidney-leaved violet	<1
		Goodyera repens	lesser rattlesnake plantain	<1
		Aster ciliolatus	Lindley's aster	<1
		Geocaulon lividum	northern bastard toadflax	<1
		Galium boreale	northern bedstraw	<1
		Platanthera hyperborea (also Habenaria hyperborea)	northern green bog orchid	<1
		Orthilia secunda (also Pyrola secunda)	one-sided wintergreen	<1

Table N-1 Species Composition and Percent Cover by Vegetation Type in the Pierre River Mining Area (continued)

Ecosite Phase	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
Canada buffalo-berry - green alder aspen (b2) (continued)	forb (continued)	*Petasites frigidus var palmatus*	palmate-leaved coltsfoot	<1
		Lathyrus venosus	purple peavine	<1
		Lycopodium annotinum	stiff club-moss	<1
		Thalictrum venulosum	veiny meadow rue	<1
		Lilium philadelphicum	western wood lily	<1
		Fragaria virginiana	wild strawberry	<1
		Vicia americana	wild vetch	<1
		Epilobium angustifolium	common fireweed	<1
		Pyrola asarifolia	common pink wintergreen	<1
		Lycopodium obscurum	ground-pine	<1
		Comandra umbellata	bastard toadflax	<1
		Lathyrus ochroleucus	cream-colored vetchling	<1
		Mertensia paniculata	tall lungwort	1
		Apocynum androsaemifolium	spreading dogbane	1
		Trientalis borealis	northern starflower	1
		Rubus pubescens	dewberry	2
		Lathyrus ochroleucus	cream-colored vetchling	2
		Maianthemum canadense	wild lily-of-the-valley	3
		Cornus canadensis	bunchberry	4
		Aralia nudicaulis	wild sarsaparilla	6
	graminoid	*unknown Carex species*	*unknown Carex species*	<1
		Calamagrostis canadensis	bluejoint	<1
		Cinna latifolia	drooping wood-reed	<1
		Carex siccata	hay sedge	<1
		Hierochloe hirta ssp arctica (also H. odorata)	sweet grass	<1
		Oryzopsis asperifolia	white-grained mountain rice grass	<1
		Leymus innovatus (also Elymus innovatus)	hairy wild rye	<1
		unknown graminoid species	*unknown graminoid species*	<1
		Elymus trachycaulus	slender wheatgrass	12
	moss	*Dicranum scoparium*	broom moss	<1
		Polytrichum commune	common hair-cap	<1
		Eurhynchium pulchellum	eurhynchiummoss	<1
		Dicranum fuscescens	fuscous moss	<1
		Polytrichum juniperinum	juniper hair-cap	<1
		Ptilidium pulcherrimum	liverwort	<1
		Plagiomnium cuspidatum	toothed plagiomnium moss	<1
		Dicranum polysetum	wavy dicranum	<1
		Dicranum undulatum	wavy dicranum	<1

Table N-1 Species Composition and Percent Cover by Vegetation Type in the Pierre River Mining Area (continued)

Ecosite Phase	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
Canada buffalo-berry - green alder aspen (b2) (continued)	moss (continued)	*Ptilium crista-castrensis*	knight's plume moss	<1
		Pylaisiella polyantha	pylaisiella moss	<1
		Dicranum flagellare	whip fork moss	1
		Hylocomium splendens	stair-step moss	6
		Pleurozium schreberi	Schreber's moss	15
	lichen	*Cladonia cornuta*	bighorn cladonia	<1
		Peltigera neopolydactyla	carpet pelt	<1
		Cladonia coniocraea	cup lichen	<1
		Peltigera canina	dog lichen	<1
		Cladonia cervicornis (also C. verticillata)	ladder lichen	<1
		Cladonia chlorophaea	mealy pixie-cup	<1
		Cladina stellaris	reindeer lichen	<1
		Cladonia gracilis	smooth cladonia	<1
		Peltigera aphthosa	studded leather lichen	<1
		unknown lichen species	*unknown lichen species*	<1
		Cladina mitis	reindeer lichen	6
	epiphyte	*unknown Bryoria species*	*unknown Bryoria species*	<1
		Usnea subfusca	*no common name*	<1
		Imshaugia placorodia	American starburst lichen	<1
		Parmeliopsis hyperopta	gray starburst lichen	<1
		Parmelia sulcata	hammered shield moss	<1
		Melanelia septentrionalis	northern camoflage lichen	<1
		Bryoria fuscescens	old man's beard	<1
		Vulpicida pinastri (also Tuckermannopsis pinastri)	powdered sunshine lichen	<1
		Ramalina dilacerata	punctured ramalina	<1
		unknown epiphyte species	*unknown epiphyte species*	<1
		unknown epiphyte species	*unknown epiphyte species*	<1
		Melanelia subaurifera	abraded camoflage lichen	<1
		Arthonia patellulata	*no common name*	<1
		Tuckermannopsis americana (also Cetraria halei or C. ciliaris)	fringed wrinkle-lichen	2
		Parmeliopsis ambigua	green starburst lichen	2
		Xanthoria fallax	powdered orange lichen	2
		Evernia mesomorpha	boreal oakmoss lichen	3
		Usnea hirta	old man's beard	3
		Hypogymnia physodes	monk's-hood lichen	3
		Tuckermannopsis sepincola	chestnut wrinkle-lichen	4

Table N-1 Species Composition and Percent Cover by Vegetation Type in the Pierre River Mining Area (continued)

Ecosite Phase	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
Canada buffalo-berry - green alder aspen-white spruce-black spruce (b3)	canopy	*Betula papyrifera*	white birch	2
		Picea mariana	black spruce	7
		Pinus banksiana	jack pine	8
		Picea glauca	white spruce	16
		Populus tremuloides	aspen	22
	subcanopy	*Populus tremuloides*	aspen	2
		Alnus incana ssp tenuifolia (also A. rugosa)	river alder	3
		Betula papyrifera	white birch	8
		Picea glauca	white spruce	12
	tall shrub	*Populus tremuloides*	aspen	<1
		Salix bebbiana	beaked willow	<1
		Prunus pensylvanica	pin cherry	<1
		Vaccinium vitis-idaea	bog cranberry	1
		Betula papyrifera	white birch	1
		Picea glauca	white spruce	2
		Alnus viridis ssp crispa	green alder	4
	low shrub	*Prunus pensylvanica*	pin cherry	<1
		Cornus stolonifera	red-osier dogwood	<1
		Symphoricarpos albus	snowberry	<1
		Betula papyrifera	white birch	<1
		Populus tremuloides	aspen	<1
		Vaccinium vitis-idaea	bog cranberry	<1
		Lonicera dioica	twining honeysuckle	<1
		Salix bebbiana	beaked willow	1
		Picea mariana	black spruce	1
		Salix discolor	pussy willow	1
		Linnaea borealis	twinflower	1
		Picea glauca	white spruce	2
		Shepherdia canadensis	Canada buffalo-berry	2
		Vaccinium myrtilloides	common blueberry	2
		Amelanchier alnifolia	saskatoon	2
		Ledum groenlandicum	common Labrador tea	2
		Alnus viridis ssp crispa	green alder	2
		Viburnum edule	low-bush cranberry	3
		Arctostaphylos uva-ursi	common bearberry	4
		Rosa acicularis	prickly rose	4
		Vaccinium myrtilloides	common blueberry	5
	forb	*unknown Aster species*	*unknown Aster species*	<1
		unknown Galium species	*unknown Galium species*	<1
		unknown Pyrola species	*unknown Pyrola species*	<1
		unknown Solidago species	*unknown Solidago species*	<1

Table N-1 Species Composition and Percent Cover by Vegetation Type in the Pierre River Mining Area (continued)

Ecosite Phase	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
Canada buffalo-berry - green alder aspen-white spruce-black spruce (b3) (continued)	forb (continued)	*Comandra umbellata*	bastard toadflax	<1
		Mitella nuda	bishop's-cap	<1
		Equisetum arvense	common horsetail	<1
		Pyrola asarifolia	common pink wintergreen	<1
		Achillea millefolium	common yarrow	<1
		Melampyrum lineare	cow-wheat	<1
		Rubus pubescens	dewberry	<1
		Equisetum scirpoides	dwarf scouring-rush	<1
		Pyrola chlorantha (also Pyrola virens)	greenish-flowered wintergreen	<1
		Diphasiastrum complanatum (also Lycopodium complanatum)	ground-cedar	<1
		Campanula rotundifolia	harebell	<1
		Goodyera repens	lesser rattlesnake plantain	<1
		Equisetum pratense	meadow horsetail	<1
		Galium boreale	northern bedstraw	<1
		Orthilia secunda (also Pyrola secunda)	one-sided wintergreen	<1
		Corallorhiza trifida	pale coralroot	<1
		Petasites frigidus var palmatus	palmate-leaved coltsfoot	<1
		Apocynum androsaemifolium	spreading dogbane	<1
		Mertensia paniculata	tall lungwort	<1
		Thalictrum venulosum	veiny meadow rue	<1
		Lilium philadelphicum	western wood lily	<1
		Fragaria virginiana	wild strawberry	<1
		Vicia americana	wild vetch	<1
		Equisetum sylvaticum	woodland horsetail	<1
		Lathyrus ochroleucus	cream-colored vetchling	<1
		Epilobium angustifolium	common fireweed	<1
		Geocaulon lividum	northern bastard toadflax	1
		Trientalis borealis	northern starflower	1
		Maianthemum canadense	wild lily-of-the-valley	1
		Aralia nudicaulis	wild sarsaparilla	1
		Cornus canadensis	bunchberry	1
		Lycopodium obscurum	ground-pine	2
		Lycopodium annotinum	stiff club-moss	2
	graminoid	*unknown Carex species*	*unknown Carex species*	<1
		Calamagrostis canadensis	bluejoint	<1

Table N-1 Species Composition and Percent Cover by Vegetation Type in the Pierre River Mining Area (continued)

Ecosite Phase	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
Canada buffalo-berry - green alder aspen-white spruce-black spruce (b3) (continued)	graminoid (continued)	*Bromus ciliatus*	fringed brome	<1
		Schizachne purpurascens	purple oat grass	<1
		unknown graminoid species	*unknown graminoid species*	<1
		Oryzopsis asperifolia	white-grained mountain rice grass	<1
		Leymus innovatus (also Elymus innovatus)	hairy wild rye	<1
		Carex siccata	hay sedge	1
	moss	*Dicranum scoparium*	broom moss	<1
		Sanionia uncinata (also Drepanocladus uncinatus)	brown moss	<1
		Dicranum fuscescens	fuscous moss	<1
		Polytrichum juniperinum	juniper hair-cap	<1
		Ptilidium pulcherrimum	liverwort	<1
		Rhytidium rugosum	pipecleaner moss	<1
		Dicranum flagellare	whip fork moss	<1
		Pylaisiella polyantha	pylaisiella moss	<1
		Ptilium crista-castrensis	knight's plume moss	<1
		Dicranum polysetum	wavy dicranum	2
		Pohlia nutans	copper wire moss	2
		Hylocomium splendens	stair-step moss	16
		Pleurozium schreberi	Schreber's moss	24
	lichen	*Cladonia cornuta*	bighorn cladonia	<1
		Peltigera neopolydactyla	carpet pelt	<1
		Cladonia coniocraea	cup lichen	<1
		Peltigera canina	dog lichen	<1
		Cladonia chlorophaea	mealy pixie-cup	<1
		Cladonia gracilis	smooth cladonia	<1
		Peltigera aphthosa	studded leather lichen	<1
		unknown lichen species	*unknown lichen species*	<1
		Cladina mitis	reindeer lichen	<1
	epiphyte	*Usnea scabiosa*	*no common name*	<1
		Melanelia subaurifera	abraded camoflage lichen	<1
		Tuckermannopsis americana (also Cetraria halei or C. ciliaris)	fringed wrinkle-lichen	<1
		Parmeliopsis ambigua	green starburst lichen	<1
		Parmelia sulcata	hammered shield moss	<1
		Usnea lapponica	old man's beard	<1
		Vulpicida pinastri (also Tuckermannopsis pinastri)	powdered sunshine lichen	<1
		Ramalina dilacerata	punctured ramalina	<1

Table N-1 Species Composition and Percent Cover by Vegetation Type in the Pierre River Mining Area (continued)

Ecosite Phase	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
Canada buffalo-berry - green alder aspen-white spruce-black spruce (b3) (continued)	epiphyte (continued)	*unknown Bryoria species*	*unknown Bryoria species*	<1
		Tuckermannopsis sepincola	chestnut wrinkle-lichen	2
		Arthonia patellulata	*no common name*	2
		Usnea hirta	old man's beard	4
		Evernia mesomorpha	boreal oakmoss lichen	5
		Hypogymnia physodes	monk's-hood lichen	6
		unknown epiphyte species	*unknown epiphyte species*	9
Canada buffalo-berry-green alder white spruce-black spruce-jack pine (b4)	canopy	*Pinus banksiana*	jack pine	13
		Populus tremuloides	aspen	15
		Picea glauca	white spruce	15
	subcanopy	*Abies balsamea*	balsam fir	1
		Alnus incana ssp tenuifolia (also A. rugosa)	river alder	4
		Picea mariana	black spruce	6
		Betula papyrifera	white birch	7
		Picea glauca	white spruce	8
	tall shrub	*Populus tremuloides*	aspen	<1
		Betula glandulosa	bog birch	<1
		Prunus pensylvanica	pin cherry	<1
		Betula papyrifera	white birch	<1
		unknown Salix species	*unknown Salix species*	1
		Picea mariana	black spruce	1
		Abies balsamea	balsam fir	2
		Alnus incana ssp tenuifolia (also A. rugosa)	river alder	2
		Picea glauca	white spruce	2
		Alnus viridis ssp crispa	green alder	3
	low shrub	*Populus balsamifera*	balsam poplar	<1
		Picea mariana	black spruce	<1
		Ribes oxyacanthoides	northern gooseberry	<1
		Prunus pensylvanica	pin cherry	<1
		Cornus stolonifera	red-osier dogwood	<1
		Symphoricarpos albus	snowberry	<1
		Lonicera dioica	twining honeysuckle	<1
		Rubus idaeus	wild red raspberry	<1
		Picea glauca	white spruce	<1
		Pinus banksiana	jack pine	<1
		Populus tremuloides	aspen	<1
		Vaccinium vitis-idaea	bog cranberry	<1
		unknown Salix species	*unknown Salix species*	1
		Amelanchier alnifolia	saskatoon	1

Table N-1 Species Composition and Percent Cover by Vegetation Type in the Pierre River Mining Area (continued)

Ecosite Phase	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
Canada buffalo-berry-green alder white spruce-black spruce-jack pine (b4)	low shrub (continued)	*Linnaea borealis*	twinflower	1
		Abies balsamea	balsam fir	2
		Viburnum edule	low-bush cranberry	2
		Vaccinium myrtilloides	common blueberry	3
		Shepherdia canadensis	Canada buffalo-berry	5
		Rosa acicularis	prickly rose	5
		Alnus viridis ssp crispa	green alder	11
		Arctostaphylos uva-ursi	common bearberry	14
		Ledum groenlandicum	common Labrador tea	15
	forb	*unknown Solidago species*	*unknown Solidago species*	<1
		Petasites frigidus var sagittatus	arrow-leaved coltsfoot	<1
		Comandra umbellata	bastard toadflax	<1
		Pyrola asarifolia	common pink wintergreen	<1
		Achillea millefolium	common yarrow	<1
		Viola adunca	early blue violet	<1
		Lycopodium obscurum	ground-pine	<1
		Campanula rotundifolia	harebell	<1
		Goodyera repens	lesser rattlesnake plantain	<1
		Aster ciliolatus	Lindley's aster	<1
		Equisetum pratense	meadow horsetail	<1
		Geocaulon lividum	northern bastard toadflax	<1
		Galium boreale	northern bedstraw	<1
		Trientalis borealis	northern starflower	<1
		Moneses uniflora	one-flowered wintergreen	<1
		Orthilia secunda (also Pyrola secunda)	one-sided wintergreen	<1
		Corallorhiza trifida	pale coralroot	<1
		Anemone patens	prairie crocus	<1
		Actaea rubra	red and white baneberry	<1
		Cypripedium acaule	stemless lady's-slipper	<1
		Galium triflorum	sweet-scented bedstraw	<1
		Mertensia paniculata	tall lungwort	<1
		Lilium philadelphicum	western wood lily	<1
		Fragaria virginiana	wild strawberry	<1
		Vicia americana	wild vetch	<1
		Equisetum sylvaticum	woodland horsetail	<1
		Lathyrus ochroleucus	cream-colored vetchling	<1

Table N-1 Species Composition and Percent Cover by Vegetation Type in the Pierre River Mining Area (continued)

Ecosite Phase	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
Canada buffalo-berry-green alder white spruce-black spruce-jack pine (b4) (continued)	forb (continued)	*Mitella nuda*	bishop's-cap	1
		Epilobium angustifolium	common fireweed	1
		Melampyrum lineare	cow-wheat	1
		Diphasiastrum complanatum (also Lycopodium complanatum)	ground-cedar	1
		Rubus pubescens	dewberry	1
		Apocynum androsaemifolium	spreading dogbane	2
		Aralia nudicaulis	wild sarsaparilla	2
		Equisetum arvense	common horsetail	3
		Maianthemum canadense	wild lily-of-the-valley	3
		Lycopodium annotinum	stiff club-moss	4
		Cornus canadensis	bunchberry	4
		Equisetum scirpoides	dwarf scouring-rush	24
	graminoid	*Cinna latifolia*	drooping wood-reed	<1
		Leymus innovatus (also Elymus innovatus)	hairy wild rye	<1
		unknown graminoid species	*unknown graminoid species*	<1
		unknown graminoid species	*unknown graminoid species*	<1
		Oryzopsis asperifolia	white-grained mountain rice grass	<1
		Oryzopsis pungens	northern rice grass	1
		Calamagrostis canadensis	bluejoint	1
		unknown graminoid species	*unknown graminoid species*	2
	moss	*Rhizomnium pseudopunctatum*	rhizomnium moss	<1
		Dicranum scoparium	broom moss	<1
		Polytrichum commune	common hair-cap	<1
		Pohlia nutans	copper wire moss	<1
		Eurhynchium pulchellum	eurhynchiummoss	<1
		Dicranum fuscescens	fuscous moss	<1
		Polytrichum juniperinum	juniper hair-cap	<1
		Ptilidium ciliare	liverwort	<1
		Ptilidium pulcherrimum	liverwort	<1
		Sphagnum teres	thin-leafed peat moss	<1
		unknown moss species	*unknown moss species*	<1
		Dicranum undulatum	wavy dicranum	<1
		Dicranum flagellare	whip fork moss	<1
		Pylaisiella polyantha	pylaisiella moss	<1
		Dicranum polysetum	wavy dicranum	<1
		unknown moss species	*unknown moss species*	1

Table N-1 Species Composition and Percent Cover by Vegetation Type in the Pierre River Mining Area (continued)

Ecosite Phase	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
Canada buffalo-berry-green alder white spruce-black spruce-jack pine (b4) (continued)	moss (continued)	*Aulacomnium palustre*	tufted moss	2
		Plagiomnium cuspidatum	toothed plagiomnium moss	4
		Ptilium crista-castrensis	knight's plume moss	6
		Hylocomium splendens	stair-step moss	12
		Pleurozium schreberi	Schreber's moss	40
	lichen	*Cladonia cornuta*	bighorn cladonia	<1
		Cladonia coniocraea	cup lichen	<1
		Peltigera canina	dog lichen	<1
		Cladonia sulphurina	greater sulphur cup	<1
		Cladonia cervicornis (also C. verticillata)	ladder lichen	<1
		Cladina rangiferina	reindeer lichen	<1
		Cladina stellaris	reindeer lichen	<1
		Cladonia gracilis	smooth cladonia	<1
		Icmadophila ericetorum	spraypaint	<1
		Peltigera aphthosa	studded leather lichen	<1
		unknown lichen species	*unknown lichen species*	<1
		Cladina mitis	reindeer lichen	<1
	epiphyte	*unknown Bryoria species*	*unknown Bryoria species*	<1
		Melanelia subaurifera	abraded camoflage lichen	<1
		Imshaugia placorodia	American starburst lichen	<1
		Tuckermannopsis sepincola	chestnut wrinkle-lichen	<1
		Tuckermannopsis americana (also Cetraria halei or C. ciliaris)	fringed wrinkle-lichen	<1
		Parmeliopsis hyperopta	gray starburst lichen	<1
		Parmeliopsis ambigua	green starburst lichen	<1
		Parmelia sulcata	hammered shield moss	<1
		Vulpicida pinastri (also Tuckermannopsis pinastri)	powdered sunshine lichen	<1
		unknown epiphyte species	*unknown epiphyte species*	<1
		unknown epiphyte species	*unknown epiphyte species*	1
		Hypogymnia physodes	monk's-hood lichen	2
		Evernia mesomorpha	boreal oakmoss lichen	3
		Usnea cavernosa	old man's beard	3
		Usnea hirta	old man's beard	5

Table N-1 Species Composition and Percent Cover by Vegetation Type in the Pierre River Mining Area (continued)

Ecosite Phase	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
Labrador tea-mesic jack pine-black spruce (c1)	canopy	*Betula papyrifera*	white birch	<1
		Populus tremuloides	aspen	4
		Picea mariana	black spruce	7
		Pinus banksiana	jack pine	18
		Populus balsamifera	balsam poplar	20
	subcanopy	*Populus balsamifera*	balsam poplar	<1
		Picea glauca	white spruce	5
		Picea mariana	black spruce	20
	tall shrub	*Viburnum edule*	low-bush cranberry	<1
		Betula papyrifera	white birch	<1
		Picea glauca	white spruce	1
		Picea mariana	black spruce	2
		Rubus idaeus	wild red raspberry	3
		Alnus incana ssp tenuifolia (also A. rugosa)	river alder	5
		Cornus stolonifera	red-osier dogwood	45
	low shrub	*Populus tremuloides*	aspen	<1
		Populus balsamifera	balsam poplar	<1
		Vaccinium vitis-idaea	bog cranberry	<1
		Ribes oxyacanthoides	northern gooseberry	<1
		Symphoricarpos albus	snowberry	<1
		Linnaea borealis	twinflower	<1
		Rosa acicularis	prickly rose	<1
		Vaccinium myrtilloides	common blueberry	<1
		Betula papyrifera	white birch	<1
		Picea mariana	black spruce	1
		Prunus pensylvanica	pin cherry	1
		Shepherdia canadensis	Canada buffalo-berry	2
		Rubus idaeus	wild red raspberry	2
		Ledum groenlandicum	common Labrador tea	2
		Viburnum edule	low-bush cranberry	3
		Cornus stolonifera	red-osier dogwood	10
	forb	*Cornus canadensis*	bunchberry	<1
		Epilobium angustifolium	common fireweed	<1
		Pyrola asarifolia	common pink wintergreen	<1
		Lathyrus ochroleucus	cream-colored vetchling	<1
		Rubus pubescens	dewberry	<1
		Geocaulon lividum	northern bastard toadflax	<1
		Galium boreale	northern bedstraw	<1
		Galium triflorum	sweet-scented bedstraw	<1
		Maianthemum canadense	wild lily-of-the-valley	<1
		Aralia nudicaulis	wild sarsaparilla	<1

Table N-1 Species Composition and Percent Cover by Vegetation Type in the Pierre River Mining Area (continued)

Ecosite Phase	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
Labrador tea-mesic jack pine-black spruce (c1) (continued)	forb (continued)	*Fragaria virginiana*	wild strawberry	<1
		Equisetum sylvaticum	woodland horsetail	<1
		Mitella nuda	bishop's-cap	1
		Equisetum pratense	meadow horsetail	1
		Trientalis borealis	northern starflower	1
		Mertensia paniculata	tall lungwort	1
	graminoid	*Calamagrostis canadensis*	bluejoint	<1
		Oryzopsis asperifolia	white-grained mountain rice grass	<1
	moss	*Sanionia uncinata (also Drepanocladus uncinatus)*	brown moss	<1
		Polytrichum juniperinum	juniper hair-cap	<1
		Ptilidium pulcherrimum	liverwort	<1
		unknown moss species	*unknown moss species*	<1
		unknown moss species	*unknown moss species*	<1
		Dicranum polysetum	wavy dicranum	<1
		Pylaisiella polyantha	pylaisiella moss	1
		unknown moss species	*unknown moss species*	1
		Ptilium crista-castrensis	knight's plume moss	5
		Hylocomium splendens	stair-step moss	31
		Pleurozium schreberi	Schreber's moss	61
	lichen	*unknown Peltigera species*	*unknown Peltigera species*	<1
		Cladonia crispata	organ-pipe lichen	<1
		Cladina rangiferina	reindeer lichen	<1
		Cladonia gracilis	smooth cladonia	<1
		Peltigera aphthosa	studded leather lichen	<1
		unknown lichen species	*unknown lichen species*	<1
		Cladina mitis	reindeer lichen	1
	epiphyte	*Melanelia septentrionalis*	northern camoflage lichen	<1
		Usnea cavernosa	old man's beard	<1
		Vulpicida pinastri (also Tuckermannopsis pinastri)	powdered sunshine lichen	<1
		unknown Bryoria species	*unknown Bryoria species*	2
		Tuckermannopsis americana (also Cetraria halei or C. ciliaris)	fringed wrinkle-lichen	3
		unknown epiphyte species	*unknown epiphyte species*	6
		unknown epiphyte species	*unknown epiphyte species*	7
		Usnea hirta	old man's beard	8
		Hypogymnia physodes	monk's-hood lichen	10

Table N-1 Species Composition and Percent Cover by Vegetation Type in the Pierre River Mining Area (continued)

Ecosite Phase	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
Labrador tea-subhygric black spruce-jack pine (d1)	canopy	*Populus balsamifera*	balsam poplar	1
		Populus tremuloides	aspen	6
		Pinus banksiana	jack pine	14
		Picea mariana	black spruce	18
	subcanopy	*unknown Salix species*	*unknown Salix species*	5
		Betula papyrifera	white birch	5
		Picea mariana	black spruce	15
	tall shrub	*Picea mariana*	black spruce	<1
		Alnus incana ssp tenuifolia (also A. rugosa)	river alder	5
		Alnus viridis ssp crispa	green alder	10
	low shrub	*Arctostaphylos rubra*	alpine bearberry	<1
		Populus balsamifera	balsam poplar	<1
		Picea mariana	black spruce	<1
		Betula papyrifera	white birch	<1
		Viburnum edule	low-bush cranberry	<1
		Prunus pensylvanica	pin cherry	<1
		Lonicera dioica	twining honeysuckle	<1
		Populus tremuloides	aspen	<1
		Amelanchier alnifolia	saskatoon	<1
		Salix planifolia	flat-leaved willow	<1
		Ribes hudsonianum	northern black currant	<1
		Rosa acicularis	prickly rose	1
		Shepherdia canadensis	Canada buffalo-berry	1
		Arctostaphylos uva-ursi	common bearberry	2
		Vaccinium myrtilloides	common blueberry	2
		Vaccinium vitis-idaea	bog cranberry	3
		Linnaea borealis	twinflower	2
		Ledum groenlandicum	common Labrador tea	28
	forb	*unknown Solidago species*	*unknown Solidago species*	<1
		Mitella nuda	bishop's-cap	<1
		Epilobium angustifolium	common fireweed	<1
		Achillea millefolium	common yarrow	<1
		Melampyrum lineare	cow-wheat	<1
		Lathyrus ochroleucus	cream-colored vetchling	<1
		Rubus pubescens	dewberry	<1
		Equisetum scirpoides	dwarf scouring-rush	<1
		Pyrola chlorantha (also Pyrola virens)	greenish-flowered wintergreen	<1
		Diphasiastrum complanatum (also Lycopodium complanatum)	ground-cedar	<1
		Goodyera repens	lesser rattlesnake plantain	<1

Table N-1 Species Composition and Percent Cover by Vegetation Type in the Pierre River Mining Area (continued)

Ecosite Phase	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
Labrador tea-subhygric black spruce-jack pine (d1) (continued)	forb (continued)	*Geocaulon lividum*	northern bastard toadflax	<1
		Galium boreale	northern bedstraw	<1
		Petasites frigidus var palmatus	palmate-leaved coltsfoot	<1
		Anemone patens	prairie crocus	<1
		Mertensia paniculata	tall lungwort	<1
		Fragaria virginiana	wild strawberry	<1
		Rubus arcticus (also R. acaulis)	dwarf raspberry	1
		Maianthemum canadense	wild lily-of-the-valley	1
		Aralia nudicaulis	wild sarsaparilla	1
		Cornus canadensis	bunchberry	3
		Equisetum arvense	common horsetail	10
	graminoid	*Carex aurea*	golden sedge	<1
		Oryzopsis asperifolia	white-grained mountain rice grass	<1
		unknown graminoid species	*unknown graminoid species*	<1
	moss	*Aulacomnium palustre*	tufted moss	<1
		Ptilium crista-castrensis	knight's plume moss	<1
		Tomentypnum nitens	golden moss	<1
		Dicranum undulatum	wavy dicranum	<1
		unknown moss species	*unknown moss species*	<1
		Calliergon giganteum	giant water moss	1
		Lepidozia reptans	liverwort	2
		Dicranum polysetum	wavy dicranum	8
		Hylocomium splendens	stair-step moss	38
		Pleurozium schreberi	Schreber's moss	52
	lichen	*Peltigera neopolydactyla*	carpet pelt	<1
		Cladonia cornuta	bighorn cladonia	<1
		Cladonia crispata	organ-pipe lichen	<1
		Cladonia gracilis	smooth cladonia	<1
		Cladina mitis	reindeer lichen	<1
		Peltigera aphthosa	studded leather lichen	<1
		unknown lichen species	*unknown lichen species*	<1
	epiphyte	*Tuckermannopsis americana (also Cetraria halei or C. ciliaris)*	fringed wrinkle-lichen	<1
		Parmeliopsis ambigua	green starburst lichen	<1
		Parmelia sulcata	hammered shield moss	<1
		Xanthoria fallax	powdered orange lichen	<1
		Vulpicida pinastri (also Tuckermannopsis pinastri)	powdered sunshine lichen	2

Table N-1 Species Composition and Percent Cover by Vegetation Type in the Pierre River Mining Area (continued)

Ecosite Phase	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
Labrador tea-subhygric black spruce-jack pine (d1) (continued)	epiphyte (continued)	*unknown Bryoria species*	*unknown Bryoria species*	3
		Evernia mesomorpha	boreal oakmoss lichen	3
		Usnea scabiosa	*no common name*	5
		Usnea hirta	old man's beard	7
		Hypogymnia physodes	monk's-hood lichen	8
Willow/horsetail aspen-white birch-balsam poplar (e1)	canopy	*Picea glauca*	white spruce	2
		Populus tremuloides	aspen	24
		Betula papyrifera	white birch	26
		Populus balsamifera	balsam poplar	64
	subcanopy	*Picea glauca*	white spruce	<1
		Alnus incana ssp tenuifolia (also A. rugosa)	river alder	1
		Prunus pensylvanica	pin cherry	2
		Betula papyrifera	white birch	10
		Populus balsamifera	balsam poplar	20
	tall shrub	*Populus tremuloides*	aspen	<1
		Viburnum edule	low-bush cranberry	<1
		unknown Salix species	*unknown Salix species*	1
		Alnus incana ssp tenuifolia (also A. rugosa)	river alder	1
		Abies balsamea	balsam fir	2
		Populus balsamifera	balsam poplar	3
		Prunus pensylvanica	pin cherry	4
		Amelanchier alnifolia	saskatoon	5
		Cornus stolonifera	red-osier dogwood	10
	low shrub	*Populus tremuloides*	aspen	<1
		Shepherdia canadensis	Canada buffalo-berry	<1
		Lonicera caerulea (also L. villosa)	fly honeysuckle	<1
		Prunus pensylvanica	pin cherry	<1
		Symphoricarpos albus	snowberry	<1
		Linnaea borealis	twinflower	<1
		Lonicera dioica	twining honeysuckle	<1
		Picea glauca	white spruce	<1
		Abies balsamea	balsam fir	1
		Populus balsamifera	balsam poplar	1
		Rubus idaeus	wild red raspberry	1
		Ribes oxyacanthoides	northern gooseberry	1
		Amelanchier alnifolia	saskatoon	2
		Rosa acicularis	prickly rose	4
		Viburnum edule	low-bush cranberry	8
		Cornus stolonifera	red-osier dogwood	23

Table N-1 Species Composition and Percent Cover by Vegetation Type in the Pierre River Mining Area (continued)

Ecosite Phase	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
Willow/horsetail aspen-white birch-balsam poplar (e1) (continued)	forb	*unknown Aster species*	*unknown Aster species*	<1
		Mitella nuda	bishop's-cap	<1
		Cornus canadensis	bunchberry	<1
		Taraxacum officinale	common dandelion	<1
		Pyrola asarifolia	common pink wintergreen	<1
		Equisetum hyemale	common scouring-rush	<1
		Disporum trachycarpum	fairybells	<1
		Pyrola chlorantha (also Pyrola virens)	greenish-flowered wintergreen	<1
		Apocynum androsaemifolium	spreading dogbane	<1
		Galium triflorum	sweet-scented bedstraw	<1
		Mertensia paniculata	tall lungwort	<1
		unknown forb species	*unknown forb species*	<1
		Thalictrum venulosum	veiny meadow rue	<1
		Fragaria virginiana	wild strawberry	<1
		Vicia americana	wild vetch	<1
		Lathyrus ochroleucus	cream-colored vetchling	<1
		Galium boreale	northern bedstraw	<1
		Orthilia secunda (also Pyrola secunda)	one-sided wintergreen	<1
		Maianthemum canadense	wild lily-of-the-valley	1
		Aralia nudicaulis	wild sarsaparilla	1
		Equisetum pratense	meadow horsetail	2
		Rubus pubescens	dewberry	13
		Equisetum arvense	common horsetail	13
	graminoid	*Calamagrostis canadensis*	bluejoint	<1
		Leymus innovatus (also Elymus innovatus)	hairy wild rye	<1
		unknown graminoid species	*unknown graminoid species*	<1
	moss	*Eurhynchium pulchellum*	eurhynchiummoss	<1
		Pylaisiella polyantha	pylaisiella moss	<1
		unknown moss species	*unknown moss species*	<1
	epiphyte	*Melanelia subaurifera*	abraded camoflage lichen	<1
		Parmeliopsis ambigua	green starburst lichen	<1
		Parmelia sulcata	hammered shield moss	<1
		Hypogymnia physodes	monk's-hood lichen	<1
		Vulpicida pinastri (also Tuckermannopsis pinastri)	powdered sunshine lichen	<1

Table N-1 Species Composition and Percent Cover by Vegetation Type in the Pierre River Mining Area (continued)

Ecosite Phase	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
Willow/horsetail aspen-white spruce-black spruce (e2)	canopy	*Populus tremuloides*	aspen	3
		Populus balsamifera	balsam poplar	3
		Picea glauca	white spruce	10
		Betula papyrifera	white birch	15
	tall shrub	*Betula papyrifera*	white birch	1
		Picea glauca	white spruce	3
		Cornus stolonifera	red-osier dogwood	10
	low shrub	*Populus tremuloides*	aspen	<1
		Populus balsamifera	balsam poplar	<1
		Amelanchier alnifolia	saskatoon	<1
		Symphoricarpos albus	snowberry	<1
		Picea glauca	white spruce	<1
		Rubus idaeus	wild red raspberry	<1
		Rosa acicularis	prickly rose	2
		Cornus stolonifera	red-osier dogwood	20
	forb	*Equisetum arvense*	common horsetail	<1
		Equisetum hyemale	common scouring-rush	<1
		Achillea millefolium	common yarrow	<1
		Galium boreale	northern bedstraw	<1
		Orthilia secunda (also Pyrola secunda)	one-sided wintergreen	<1
		Fragaria virginiana	wild strawberry	<1
		Aralia nudicaulis	wild sarsaparilla	1
	graminoid	*unknown graminoid species*	*unknown graminoid species*	<1
	moss	*unknown moss species*	*unknown moss species*	<1
	lichen	*Peltigera canina*	dog lichen	<1
		Cladonia fimbriata	trumpet lichen	<1
		unknown lichen species	*unknown lichen species*	<1
	epiphyte	*Melanelia subaurifera*	abraded camoflage lichen	<1
		Hypogymnia physodes	monk's-hood lichen	<1
		Vulpicida pinastri (also Tuckermannopsis pinastri)	powdered sunshine lichen	<1
		unknown epiphyte species	*unknown epiphyte species*	<1

Table N-1 Species Composition and Percent Cover by Vegetation Type in the Pierre River Mining Area (continued)

Ecosite Phase	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
Other Upland Types				
Riparian (Ri)	low shrub	*Salix maccalliana*	velvet-fruited willow	<1
		Rubus idaeus	wild red raspberry	10
	forb	*Epilobium glaberrimum*	smooth willowherb	<1
		Typha latifolia	common cattail	<1
		Lemna minor	common duckweed	<1
		Equisetum arvense	common horsetail	<1
		Ranunculus macounii	Macoun's buttercup	<1
		Scutellaria galericulata	marsh skullcap	<1
		Potentilla norvegica	rough cinquefoil	<1
		Galium trifidum	small bedstraw	<1
		Callitriche verna	vernal water-starwort	<1
		Plantago major	common plantain	1
		Caltha natans	floating marsh-marigold	1
		Bidens cernua	nodding beggarticks	1
		Circaea alpina	small enchanter's nightshade	1
		Equisetum fluviatile	swamp horsetail	1
		Polygonum coccineum	water smartweed	1
		Mentha arvensis	wild mint	1
		Equisetum sylvaticum	woodland horsetail	1
		Galeopsis tetrahit	hemp-nettle	2
		Aster puniceus	purple-stemmed aster	2
		Achillea sibirica	many-flowered yarrow	3
		Urtica dioica	common nettle	5
		Impatiens capensis	spotted touch-me-not	5
	graminoid	*Schoenoplectus tabernaemontani (also Scirpus validus)*	common great bulrush	<1
		Alopecurus aequalis	short-awned foxtail	<1
		Beckmannia syzigachne	slough grass	1
		Carex aquatilis	water sedge	2
		Carex utriculata	small bottle sedge	3
		Scirpus microcarpus	small-fruited bulrush	5
		Calamagrostis canadensis	bluejoint	70
	moss	*Cinclidium stygium*	common northern lantern moss	<1
Riparian shrubland (RiSh)	canopy	*unknown Salix species*	*unknown Salix species*	5
		Alnus incana ssp tenuifolia (also A. rugosa)	river alder	45
	tall shrub	*Salix lucida (also S. lasiandra)*	shining willow	2
		Cornus stolonifera	red-osier dogwood	2
		Alnus incana ssp tenuifolia (also A. rugosa)	river alder	70

Table N-1 Species Composition and Percent Cover by Vegetation Type in the Pierre River Mining Area (continued)

Ecosite Phase	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
Riparian shrubland (RiSh) (continued)	low shrub	*unknown Salix species*	*unknown Salix species*	<1
		Ribes lacustre	bristly black currant	<1
		Viburnum edule	low-bush cranberry	<1
		Picea glauca	white spruce	<1
		Cornus stolonifera	red-osier dogwood	1
		Alnus incana ssp tenuifolia (also A. rugosa)	river alder	1
		Rubus idaeus	wild red raspberry	2
	forb	*Equisetum arvense*	common horsetail	<1
		Urtica dioica	common nettle	<1
		Rubus pubescens	dewberry	<1
		Galium triflorum	sweet-scented bedstraw	<1
		Matteuccia struthiopteris	ostrich fern	85
	graminoid	*Calamagrostis canadensis*	bluejoint	<1
	moss	*Aulacomnium palustre*	tufted moss	<1
	epiphyte	*Melanelia subaurifera*	abraded camoflage lichen	<1
		Parmeliopsis ambigua	green starburst lichen	<1
		Hypogymnia physodes	monk's-hood lichen	<1
		Usnea hirta	old man's beard	<1
		unknown epiphyte species	*unknown epiphyte species*	<1
Sparsely vegetated slope (SpS)	low shrub	*Picea glauca*	white spruce	<1
		Populus tremuloides	aspen	2
	forb	*unknown Arabis species*	*unknown Arabis species*	<1
		unknown Arabis species	*unknown Arabis species*	<1
		Epilobium angustifolium	common fireweed	<1
		Artemisia campestris	plains wormwood	<1
		Astragalus dasyglottis	purple milk vetch	<1
		Apocynum androsaemifolium	spreading dogbane	<1
	graminoid	*Hordeum jubatum*	foxtail barley	<1
		Leymus innovatus (also Elymus innovatus)	hairy wild rye	<1
		Carex siccata	hay sedge	<1
		Oryzopsis pungens	northern rice grass	<1
	moss	*unknown moss species*	*unknown moss species*	<1
	lichen	*unknown lichen species*	*unknown lichen species*	<1
Shrubland (Sh)	canopy	*Populus tremuloides*	aspen	<1
		Picea glauca	white spruce	<1
	tall shrub	*Symphoricarpos albus*	snowberry	5
		Amelanchier alnifolia	saskatoon	20

Table N-1 Species Composition and Percent Cover by Vegetation Type in the Pierre River Mining Area (continued)

Ecosite Phase	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
Shrubland (Sh) (continued)	low shrub	*Lonicera dioica*	twining honeysuckle	<1
		Populus tremuloides	aspen	5
		Arctostaphylos uva-ursi	common bearberry	5
		Cornus stolonifera	red-osier dogwood	20
		Rosa acicularis	prickly rose	25
	forb	*Lilium philadelphicum*	western wood lily	<1
		Potentilla arguta	white cinquefoil	<1
		Comandra umbellata	bastard toadflax	1
		Achillea millefolium	common yarrow	1
		Agastache foeniculum	giant hyssop	1
		Aster ciliolatus	Lindley's aster	1
		Galium boreale	northern bedstraw	1
		Thalictrum venulosum	veiny meadow rue	1
		Maianthemum canadense	wild lily-of-the-valley	1
		Vicia americana	wild vetch	2
		Aquilegia brevistyla	blue columbine	3
		Apocynum androsaemifolium	spreading dogbane	3
		Aralia nudicaulis	wild sarsaparilla	5
	graminoid	*Poa pratensis*	Kentucky bluegrass	<1
		unknown graminoid species	*unknown graminoid species*	<1
		Schizachne purpurascens	purple oat grass	1
	moss	*Eurhynchium pulchellum*	eurhynchiummoss	<1
		Brachythecium salebrosum	*no common name*	5
	lichen	*Nephroma bellum*	alpine kidney lichen	<1
		Cladonia cornuta	bighorn cladonia	<1
		Hypocenomyce scalaris	common clam lichen	<1
		Cladonia coniocraea	cup lichen	<1
	epiphyte	*Lecidea nylanderi*	*no common name*	<1
		Micarea sylvicola	*no common name*	<1
		Usnea scabiosa	*no common name*	<1
		Melanelia subaurifera	abraded camoflage lichen	<1
		Arthonioid group	Arthonioid group	<1
		Evernia mesomorpha	boreal oakmoss lichen	<1
		Ramalina pollinaria	chalky ramalina	<1
		Lecanora symmicta	fused rim-lichen	<1
		Parmelia sulcata	hammered shield moss	<1
		Hypogymnia physodes	monk's-hood lichen	<1
		Bryoria fuscescens	old man's beard	<1
		Usnea lapponica	old man's beard	<1
		Usnea subfloridana	old man's beard	<1
		Ramalina dilacerata	punctured ramalina	<1

Table N-1 Species Composition and Percent Cover by Vegetation Type in the Pierre River Mining Area (continued)

Ecosite Phase	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
Wetlands Types (common to Boreal Mixedwood and Athabasca Plains Natural Subregions)				
Forested bog (BFNN)	canopy	*Picea mariana*	black spruce	75
	tall shrub	*Picea mariana*	black spruce	10
	low shrub	*Arctostaphylos rubra*	alpine bearberry	3
		Ledum groenlandicum	common Labrador tea	20
		Picea mariana	black spruce	2
		Salix myrtillifolia	myrtle-leaved willow	1
		Vaccinium myrtilloides	common blueberry	<1
		Vaccinium vitis-idaea	bog cranberry	2
	forb	*Equisetum arvense*	common horsetail	5
		Equisetum scirpoides	dwarf scouring-rush	5
		Geocaulon lividum	northern bastard toadflax	<1
		Mitella nuda	bishop's-cap	<1
		Smilacina trifolia	three-leaved Solomon's-seal	2
	graminoid	*unknown Carex species*	*unknown Carex species*	15
	moss	*Aulacomnium palustre*	tufted moss	5
		Bryum pseudotriquetrum	*no common name*	<1
		Hylocomium splendens	stair-step moss	15
		Pleurozium schreberi	Schreber's moss	60
		Pohlia nutans	copper wire moss	<1
		Polytrichum strictum	slender hair-cap	<1
		Sanionia uncinata (also Drepanocladus uncinatus)	brown moss	3
		Sphagnum angustifolium	peat moss	3
		Sphagnum fuscum	rusty peat moss	5
		Tomentypnum nitens	golden moss	<1
	lichen	*Cladina mitis*	reindeer lichen	3
		Cladonia botrytes	wooden soldiers	<1
		Cladonia cornuta	bighorn cladonia	<1
		Cladonia gracilis	smooth cladonia	<1
		Hypocenomyce scalaris	common clam lichen	<1
		Peltigera aphthosa	studded leather lichen	7
	epiphyte	*Arthonioid group*	Arthonioid group	<1
		Bryoria fuscescens	old man's beard	<1
		Evernia mesomorpha	boreal oakmoss lichen	3
		Hypogymnia physodes	monk's-hood lichen	<1
		Lecanora circumborealis	black-eyed rim lichen	<1
		Lecanora pulicaris	*no common name*	<1
		Lecanora subintricata	*no common name*	<1
		Lecanora symmicta	fused rim-lichen	<1
		Lecidella elaeochroma	*no common name*	<1
		Ochrolechia arborea	*no common name*	<1

Table N-1 Species Composition and Percent Cover by Vegetation Type in the Pierre River Mining Area (continued)

Ecosite Phase	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
Forested bog (BFNN) (continued)	epiphyte (continued)	*Parmelia sulcata*	hammered shield moss	<1
		Scoliciosporum perpusillum	*no common name*	<1
		Tuckermannopsis americana (also Cetraria halei or C. ciliaris)	fringed wrinkle-lichen	<1
		Usnea hirta	old man's beard	<1
		Usnea lapponica	old man's beard	<1
		Usnea substerilis	old man's beard	<1
		Vulpicida pinastri (also Tuckermannopsis pinastri)	powdered sunshine lichen	<1
Wooded bog with internal lawns (BTNI)	canopy	*Picea mariana*	black spruce	25
	tall shrub	*Chamaedaphne calyculata*	leatherleaf	5
		Oxycoccus microcarpus	small bog cranberry	<1
		Picea mariana	black spruce	10
		Vaccinium vitis-idaea	bog cranberry	1
	low shrub	*Ledum groenlandicum*	common Labrador tea	20
		Picea mariana	black spruce	5
	forb	*Drosera rotundifolia*	round-leaved sundew	<1
		Rubus chamaemorus	cloudberry	1
		Smilacina trifolia	three-leaved Solomon's-seal	<1
	graminoid	*Eriophorum vaginatum*	sheathed cotton grass	5
	moss	*Dicranum polysetum*	wavy dicranum	<1
		Jamesoniella autumnalis	liverwort	<1
		Pleurozium schreberi	Schreber's moss	5
		Sanionia uncinata (also Drepanocladus uncinatus)	brown moss	1
		Sphagnum angustifolium	peat moss	25
		Sphagnum fuscum	rusty peat moss	30
		Sphagnum magellanicum	midway peat moss	5
	lichen	*Cetraria nivalis (also Flavocetraria nivalis)*	flattened snow lichen	<1
		Cladina mitis	reindeer lichen	18
		Cladina rangiferina	reindeer lichen	1
		Cladina stellaris	reindeer lichen	2
		Cladonia borealis	red pixie-cup	<1
		Cladonia chlorophaea	mealy pixie-cup	<1
		Cladonia cornuta	bighorn cladonia	<1
		Icmadophila ericetorum	spraypaint	<1
	epiphyte	*Arthonioid group*	Arthonioid group	<1
		Bryoria fuscescens	old man's beard	<1
		Evernia mesomorpha	boreal oakmoss lichen	<1
		Hypogymnia physodes	monk's-hood lichen	<1
		Imshaugia aleurites	salted starburst lichen	<1
		Lecanora circumborealis	black-eyed rim lichen	<1

Table N-1 Species Composition and Percent Cover by Vegetation Type in the Pierre River Mining Area (continued)

Ecosite Phase	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
Wooded bog with internal lawns (BTNI) (continued)	epiphyte (continued)	*Lecanora pulicaris*	*no common name*	<1
		Parmeliopsis hyperopta	gray starburst lichen	<1
		Scoliciosporum perpusillum	*no common name*	<1
		Tuckermannopsis americana (also Cetraria halei or C. ciliaris)	fringed wrinkle-lichen	<1
		Tuckermannopsis sepincola	chestnut wrinkle-lichen	<1
		Usnea hirta	old man's beard	3
		Vulpicida pinastri (also Tuckermannopsis pinastri)	powdered sunshine lichen	<1
Wooded bog (BTNN)	canopy	*Larix laricina*	tamarack	4
		Picea mariana	black spruce	19
		Pinus banksiana	jack pine	<1
		Populus balsamifera	balsam poplar	<1
	subcanopy	*Picea mariana*	black spruce	10
		Betula papyrifera	white birch	10
		Picea mariana	black spruce	15
		unknown Salix species	*unknown Salix species*	5
	tall shrub	*Betula papyrifera*	white birch	<1
		Betula pumila	dwarf birch	2
		Larix laricina	tamarack	<1
		Picea mariana	black spruce	9
		Populus balsamifera	balsam poplar	<1
		Salix maccalliana	velvet-fruited willow	2
		unknown Salix species	*unknown Salix species*	5
	low shrub	*Alnus incana ssp tenuifolia (also A. rugosa)*	river alder	<1
		Arctostaphylos rubra	alpine bearberry	2
		Arctostaphylos uva-ursi	common bearberry	1
		Betula glandulosa	bog birch	<1
		Betula papyrifera	white birch	<1
		Betula pumila	dwarf birch	1
		Chamaedaphne calyculata	leatherleaf	8
		Cornus stolonifera	red-osier dogwood	<1
		Empetrum nigrum	crowberry	<1
		Larix laricina	tamarack	1
		Ledum groenlandicum	common Labrador tea	27
		Linnaea borealis	twinflower	2
		Oxycoccus microcarpus	small bog cranberry	1
		Picea mariana	black spruce	5
		Populus balsamifera	balsam poplar	<1
		Populus tremuloides	aspen	<1
		Ribes hudsonianum	northern black currant	<1
		Ribes lacustre	bristly black currant	<1

Table N-1 Species Composition and Percent Cover by Vegetation Type in the Pierre River Mining Area (continued)

Ecosite Phase	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
Wooded bog (BTNN) (continued)	low shrub (continued)	*Rosa acicularis*	prickly rose	2
		Salix lutea	yellow willow	1
		Salix maccalliana	velvet-fruited willow	1
		Salix myrtillifolia	myrtle-leaved willow	<1
		unknown Salix species	*unknown Salix species*	<1
		unknown Salix species	*unknown Salix species*	<1
		Shepherdia canadensis	Canada buffalo-berry	<1
		Vaccinium myrtilloides	common blueberry	<1
		Vaccinium vitis-idaea	bog cranberry	3
	forb	*Achillea millefolium*	common yarrow	<1
		Aralia nudicaulis	wild sarsaparilla	<1
		Aster ciliolatus	Lindley's aster	<1
		Cornus canadensis	bunchberry	<1
		Diphasiastrum complanatum (also Lycopodium complanatum)	ground-cedar	<1
		Drosera rotundifolia	round-leaved sundew	<1
		Epilobium angustifolium	common fireweed	<1
		Equisetum arvense	common horsetail	1
		Equisetum pratense	meadow horsetail	2
		Equisetum scirpoides	dwarf scouring-rush	2
		Equisetum sylvaticum	woodland horsetail	<1
		Fragaria virginiana	wild strawberry	<1
		Geocaulon lividum	northern bastard toadflax	<1
		Listera borealis	northern twayblade	<1
		Maianthemum canadense	wild lily-of-the-valley	<1
		Mitella nuda	bishop's-cap	<1
		Orthilia secunda (also Pyrola secunda)	one-sided wintergreen	<1
		Petasites frigidus var palmatus	palmate-leaved coltsfoot	<1
		Petasites frigidus var sagittatus	arrow-leaved coltsfoot	<1
		Potentilla palustris	marsh cinquefoil	<1
		Pyrola asarifolia	common pink wintergreen	<1
		Ranunculus lapponicus	Lapland buttercup	1
		Rubus arcticus (also R. acaulis)	dwarf raspberry	<1
		Rubus chamaemorus	cloudberry	2
		Rubus pubescens	dewberry	1
		Smilacina trifolia	three-leaved Solomon's-seal	1
		Typha latifolia	common cattail	2
	graminoid	*Calamagrostis canadensis*	bluejoint	4
		Carex aquatilis	water sedge	3

Table N-1 Species Composition and Percent Cover by Vegetation Type in the Pierre River Mining Area (continued)

Ecosite Phase	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
Wooded bog (BTNN) (continued)	graminoid (continued)	*Carex aurea*	golden sedge	1
		Carex canescens	short sedge	<1
		Carex concinna	beautiful sedge	<1
		Carex diandra	two-stamened sedge	<1
		Carex disperma	two-seeded sedge	<1
		Carex gynocrates	northern bog sedge	<1
		Carex vaginata	sheathed sedge	<1
		Elymus trachycaulus ssp trachycaulus (also Agropyron trachycaulum)	slender wheat grass	<1
		Eriophorum vaginatum	sheathed cotton grass	1
		Juncus balticus	wire rush	3
		unknown graminoid species	*unknown graminoid species*	<1
		unknown graminoid species	*unknown graminoid species*	<1
		unknown graminoid species	*unknown graminoid species*	1
	moss	*Aulacomnium palustre*	tufted moss	3
		Calypogeia muelleriana	liverwort	<1
		Climacium dendroides	common tree moss	<1
		Dicranum flagellare	whip fork moss	<1
		Dicranum polysetum	wavy dicranum	<1
		Dicranum scoparium	broom moss	<1
		Dicranum undulatum	wavy dicranum	<1
		Eurhynchium pulchellum	eurhynchiummoss	<1
		Hylocomium splendens	stair-step moss	31
		Lepidozia reptans	liverwort	<1
		Mylia anomala	liverwort	<1
		Plagiochila porelloides	*no common name*	<1
		Plagiomnium ellipticum	elliptic plagiomnium moss	<1
		Pleurozium schreberi	Schreber's moss	27
		Pohlia nutans	copper wire moss	<1
		Polytrichum commune	common hair-cap	5
		Polytrichum strictum	slender hair-cap	<1
		Ptilium crista-castrensis	knight's plume moss	2
		Sanionia uncinata (also Drepanocladus uncinatus)	brown moss	<1
		Sphagnum angustifolium	peat moss	17
		Sphagnum capillifolium	acute-leaved peat moss	<1
		Sphagnum fuscum	rusty peat moss	35
		Sphagnum magellanicum	midway peat moss	<1
		unknown Sphagnum species	*unknown Sphagnum species*	64
		Sphagnum squarrosum	squarrose peat moss	19

Table N-1 Species Composition and Percent Cover by Vegetation Type in the Pierre River Mining Area (continued)

Ecosite Phase	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
Wooded bog (BTNN) (continued)	moss (continued)	*Sphagnum teres*	thin-leafed peat moss	18
		Splachnum luteum	yellow collar moss	<1
		Tomentypnum nitens	golden moss	3
		unknown moss species	*unknown moss species*	<1
		unknown moss species	*unknown moss species*	<1
	lichen	*Cladina mitis*	reindeer lichen	5
		Cladina rangiferina	reindeer lichen	<1
		Cladina stellaris	reindeer lichen	3
		Cladonia amaurocraea	*no common name*	<1
		Cladonia borealis	red pixie-cup	<1
		Cladonia botrytes	wooden soldiers	<1
		Cladonia chlorophaea	mealy pixie-cup	<1
		Cladonia coccifera	British soldier lichen	<1
		Cladonia cornuta	bighorn cladonia	<1
		Cladonia deformis	lesser sulphur-cup	<1
		Cladonia fimbriata	trumpet lichen	<1
		Cladonia gracilis	smooth cladonia	<1
		Cladonia pyxidata	pebbled pixie-cup	<1
		Cladonia scabriuscula	mealy forked cladonia	<1
		Cladonia sulphurina	greater sulphur cup	<1
		Hypocenomyce scalaris	common clam lichen	<1
		Icmadophila ericetorum	spraypaint	<1
		Imshaugia placorodia	American starburst lichen	<1
		Peltigera aphthosa	studded leather lichen	<1
		Peltigera canina	dog lichen	<1
		Peltigera neopolydactyla	carpet pelt	<1
		unknown lichen species	*unknown lichen species*	<1
	epiphyte	*Arthonioid group*	Arthonioid group	<1
		Bryoria furcellata	old man's beard	1
		Bryoria fuscescens	old man's beard	<1
		Bryoria glabra	old man's beard	<1
		Bryoria lanestris	old man's beard	<1
		Bryoria simplicior	old man's beard	3
		unknown Bryoria species	*unknown Bryoria species*	<1
		Evernia mesomorpha	boreal oakmoss lichen	5
		Hypogymnia physodes	monk's-hood lichen	7
		Imshaugia aleurites	salted starburst lichen	<1
		Lecanora circumborealis	black-eyed rim lichen	<1
		Lecanora pulicaris	*no common name*	<1
		Lecanora subintricata	*no common name*	<1

Table N-1 Species Composition and Percent Cover by Vegetation Type in the Pierre River Mining Area (continued)

Ecosite Phase	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
Wooded bog (BTNN) (continued)	epiphyte (continued)	*Lecanora symmicta*	fused rim-lichen	<1
		Lecidella elaeochroma	*no common name*	<1
		Melanelia subaurifera	abraded camoflage lichen	2
		Ochrolechia arborea	*no common name*	<1
		Parmelia sulcata	hammered shield moss	<1
		Parmeliopsis ambigua	green starburst lichen	<1
		Scoliciosporum perpusillum	*no common name*	<1
		Tuckermannopsis americana (also Cetraria halei or C. ciliaris)	fringed wrinkle-lichen	<1
		Tuckermannopsis orbata (also Cetraria orbata)	variable wrinkle-lichen	<1
		Tuckermannopsis sepincola	chestnut wrinkle-lichen	1
		unknown epiphyte species	*unknown epiphyte species*	35
		unknown lichen species	*unknown lichen species*	2
		unknown lichen species	*unknown lichen species*	2
		unknown lichen species	*unknown lichen species*	3
		unknown lichen species	*unknown lichen species*	5
		unknown lichen species	*unknown lichen species*	10
		unknown lichen species	*unknown lichen species*	15
		Usnea cavernosa	old man's beard	2
		Usnea glabrata	old man's beard	<1
		Usnea hirta	old man's beard	5
		Usnea lapponica	old man's beard	<1
		Usnea scabiosa	*no common name*	<1
		Usnea scabrata	old man's beard	<1
		Usnea subfloridana	old man's beard	<1
		Usnea substerilis	old man's beard	<1
		Vulpicida pinastri (also Tuckermannopsis pinastri)	powdered sunshine lichen	<1
Forested fen (FFNN)	canopy	*Betula papyrifera*	white birch	1
		Larix laricina	tamarack	35
		Picea mariana	black spruce	2
	low shrub	*Ledum groenlandicum*	common Labrador tea	2
		Vaccinium vitis-idaea	bog cranberry	<1
	forb	*Cornus canadensis*	bunchberry	<1
		Lycopodium annotinum	stiff club-moss	<1
		Orthilia secunda (also Pyrola secunda)	one-sided wintergreen	<1

Table N-1 Species Composition and Percent Cover by Vegetation Type in the Pierre River Mining Area (continued)

Ecosite Phase	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
Forested fen (FFNN) (continued)	graminoid	*Carex disperma*	two-seeded sedge	4
		unknown graminoid species	*unknown graminoid species*	<1
	moss	*Aulacomnium palustre*	tufted moss	<1
		Dicranum polysetum	wavy dicranum	<1
		Dicranum undulatum	wavy dicranum	<1
		Hylocomium splendens	stair-step moss	3
		Pleurozium schreberi	Schreber's moss	45
		Ptilidium pulcherrimum	liverwort	<1
		Sphagnum squarrosum	squarrose peat moss	2
	lichen	*Cladonia cervicornis (also C. verticillata)*	ladder lichen	<1
		Cladonia coniocraea	cup lichen	<1
		Cladonia scabriuscula	mealy forked cladonia	<1
		Cladonia sulphurina	greater sulphur cup	<1
	epiphyte	*unknown Bryoria species*	*unknown Bryoria species*	<1
		Hypogymnia physodes	monk's-hood lichen	2
		Parmelia sulcata	hammered shield moss	<1
		Tuckermannopsis americana (also Cetraria halei or C. ciliaris)	fringed wrinkle-lichen	2
		Usnea hirta	old man's beard	2
		Vulpicida pinastri (also Tuckermannopsis pinastri)	powdered sunshine lichen	<1
Graminoid fen (FONG)	canopy	*Larix laricina*	tamarack	10
		Picea mariana	black spruce	2
	tall shrub	*Larix laricina*	tamarack	<1
		Ledum groenlandicum	common Labrador tea	1
	low shrub	*Betula glandulosa*	bog birch	10
		Larix laricina	tamarack	5
		Oxycoccus microcarpus	small bog cranberry	<1
		Picea mariana	black spruce	<1
		unknown Salix species	*unknown Salix species*	<1
		unknown Salix species	*unknown Salix species*	<1
		unknown Salix species	*unknown Salix species*	<1
		Vaccinium vitis-idaea	bog cranberry	<1
	forb	*Caltha palustris*	marsh-marigold	3
		Cicuta maculata	water-hemlock	<1
		Equisetum hyemale	common scouring-rush	<1
		Galium triflorum	sweet-scented bedstraw	<1

Table N-1 Species Composition and Percent Cover by Vegetation Type in the Pierre River Mining Area (continued)

Ecosite Phase	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
Graminoid fen (FONG) (continued)	forb (continued)	*unknown Lycopodium species*	*unknown Lycopodium species*	<1
		Potentilla palustris	marsh cinquefoil	2
		unknown Pyrola species	*unknown Pyrola species*	<1
		Smilacina trifolia	three-leaved Solomon's-seal	<1
		unknown Stellaria species	*unknown Stellaria species*	<1
	graminoid	*Carex aquatilis*	water sedge	40
		Carex capillaris	hair-like sedge	<1
		Carex paupercula	bog sedge	<1
		Carex prairea	prairie sedge	40
		Carex sartwellii	Sartwell's sedge	<1
		unknown Carex species	*unknown Carex species*	<1
	moss	*Aulacomnium palustre*	tufted moss	1
		Calliergon richardsonii	Richardson's water moss	2
		Cinclidium stygium	common northern lantern moss	5
		Sphagnum teres	thin-leafed peat moss	2
		Tomentypnum nitens	golden moss	10
		unknown moss species	*unknown moss species*	5
		unknown moss species	*unknown moss species*	8
		unknown moss species	*unknown moss species*	10
		unknown moss species	*unknown moss species*	10
		unknown moss species	*unknown moss species*	15
	epiphyte	*Usnea hirta*	old man's beard	<1
		Vulpicida pinastri (also Tuckermannopsis pinastri)	powdered sunshine lichen	<1
Shrubby fen (FONS)	canopy	*Larix laricina*	tamarack	<1
		Picea mariana	black spruce	1
	subcanopy	*Larix laricina*	tamarack	1
	tall shrub	*Betula glandulosa*	bog birch	9
		Betula pumila	dwarf birch	15
		Larix laricina	tamarack	3
		Picea mariana	black spruce	3
		Salix bebbiana	beaked willow	<1
		Salix candida	hoary willow	<1
		Salix discolor	pussy willow	2
		Salix lutea	yellow willow	20
		Salix maccalliana	velvet-fruited willow	10

Table N-1 Species Composition and Percent Cover by Vegetation Type in the Pierre River Mining Area (continued)

Ecosite Phase	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
Shrubby fen (FONS) (continued)	tall shrub (continued)	*Salix pedicellaris*	bog willow	10
	low shrub	*Betula glandulosa*	bog birch	5
		Betula pumila	dwarf birch	50
		Larix laricina	tamarack	4
		Ledum groenlandicum	common Labrador tea	<1
		Oxycoccus microcarpus	small bog cranberry	<1
		Salix planifolia	flat-leaved willow	10
		unknown Salix species	*unknown Salix species*	5
		unknown Salix species	*unknown Salix species*	20
		Vaccinium vitis-idaea	bog cranberry	2
	forb	*Caltha palustris*	marsh-marigold	<1
		Epilobium palustre	marsh willowherb	<1
		Equisetum fluviatile	swamp horsetail	<1
		Galium triflorum	sweet-scented bedstraw	<1
		Orthilia secunda (also Pyrola secunda)	one-sided wintergreen	<1
		Potentilla palustris	marsh cinquefoil	1
		Pyrola asarifolia	common pink wintergreen	<1
		Ranunculus lapponicus	Lapland buttercup	<1
		Rumex occidentalis	western dock	<1
		Rumex triangulivalvis	narrow-leaved dock	<1
		Smilacina trifolia	three-leaved Solomon's-seal	2
		Stellaria longifolia	long-leaved chickweed	<1
		unknown Stellaria species	*unknown Stellaria species*	<1
		Triglochin maritima	seaside arrow-grass	<1
		unknown Viola species	*unknown Viola species*	<1
	graminoid	*Calamagrostis canadensis*	bluejoint	5
		Carex aquatilis	water sedge	17
		Carex diandra	two-stamened sedge	18
		Carex disperma	two-seeded sedge	<1
		Carex limosa	mud sedge	18
		Eriophorum chamissonis	russett cotton grass	<1
		unknown graminoid species	*unknown graminoid species*	<1
	moss	*Aulacomnium palustre*	tufted moss	13
		Bryum pseudotriquetrum	*no common name*	<1
		Calliergon cordifolium	*no common name*	<1
		Calliergon giganteum	giant water moss	3

Table N-1 Species Composition and Percent Cover by Vegetation Type in the Pierre River Mining Area (continued)

Ecosite Phase	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
Shrubby fen (FONS) (continued)	moss (continued)	*Calliergon richardsonii*	Richardson's water moss	3
		Calliergon stramineum	straw-coloured water moss	<1
		Cinclidium stygium	common northern lantern moss	<1
		Dicranum undulatum	wavy dicranum	<1
		Helodium blandowii	Blandlow's feather moss	<1
		Hylocomium splendens	stair-step moss	<1
		Pohlia nutans	copper wire moss	1
		Polytrichum strictum	slender hair-cap	<1
		Sphagnum angustifolium	peat moss	70
		Sphagnum capillifolium	acute-leaved peat moss	<1
		Sphagnum girgensohnii	Girgensohn's moss	<1
		Sphagnum jensenii	pendant branch peat moss	20
		Sphagnum squarrosum	squarrose peat moss	5
		Sphagnum teres	thin-leafed peat moss	13
		Tomentypnum nitens	golden moss	1
		unknown moss species	*unknown moss species*	<1
		Warnstorfia fluitans (also Drepanocladus fluitans)	water hook moss	34
	epiphyte	*Bryoria fuscescens*	old man's beard	<1
		Bryoria simplicior	old man's beard	<1
		Candelariella vitellina	*no common name*	<1
		Evernia mesomorpha	boreal oakmoss lichen	<1
		Hypogymnia physodes	monk's-hood lichen	7
		Lecanora pulicaris	*no common name*	<1
		Lecanora subintricata	*no common name*	<1
		Lecanora symmicta	fused rim-lichen	<1
		Melanelia septentrionalis	northern camoflage lichen	<1
		unknown Mycobilimbia species	*unknown Mycobilimbia species*	<1
		Parmelia sulcata	hammered shield moss	<1
		Rinodina septentrionalis	*no common name*	<1
		Tuckermannopsis americana (also Cetraria halei or C. ciliaris)	fringed wrinkle-lichen	<1
		unknown epiphyte species	*unknown epiphyte species*	30
		Vulpicida pinastri (also Tuckermannopsis pinastri)	powdered sunshine lichen	<1

Table N-1 Species Composition and Percent Cover by Vegetation Type in the Pierre River Mining Area (continued)

Ecosite Phase	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
Open patterned fen (FOPN)	low shrub	*Andromeda polifolia*	bog rosemary	<1
		Betula pumila	dwarf birch	5
		Larix laricina	tamarack	2
		Salix planifolia	flat-leaved willow	<1
	forb	*Drosera anglica*	oblong-leaved sundew	<1
		Menyanthes trifoliata	buck-bean	<1
		Pedicularis parviflora	swamp lousewort	<1
		Sarracenia purpurea	pitcher-plant	<1
		Triglochin maritima	seaside arrow-grass	<1
	graminoid	*Carex aquatilis*	water sedge	5
		Carex limosa	mud sedge	<1
		Scirpus cespitosus	tufted bulrush	85
	moss	*Calliergon giganteum*	giant water moss	15
		Scorpidium scorpioides (also Drepanocladus revolvens)	scorpidium moss	35
		Tomentypnum nitens	golden moss	15
	lichen	*Cladonia borealis*	red pixie-cup	<1
		Cladonia chlorophaea	mealy pixie-cup	<1
	epiphyte	*Evernia mesomorpha*	boreal oakmoss lichen	<1
		Lecanora circumborealis	black-eyed rim lichen	<1
		Ochrolechia arborea	*no common name*	<1
		Tuckermannopsis americana (also Cetraria halei or C. ciliaris)	fringed wrinkle-lichen	<1
		Tuckermannopsis sepincola	chestnut wrinkle-lichen	<1
		Vulpicida pinastri (also Tuckermannopsis pinastri)	powdered sunshine lichen	<1
Wooded fen (FTNN)	canopy	*Larix laricina*	tamarack	11
		Picea mariana	black spruce	5
		unknown Salix species	*unknown Salix species*	<1
	subcanopy	*Picea mariana*	black spruce	10
	tall shrub	*Alnus incana ssp tenuifolia (also A. rugosa)*	river alder	3
		Betula glandulosa	bog birch	5
		Betula papyrifera	white birch	2
		Betula pumila	dwarf birch	2
		Larix laricina	tamarack	5
		Picea mariana	black spruce	4
		unknown Salix species	*unknown Salix species*	<1
		unknown Salix species	*unknown Salix species*	3
	low shrub	*Alnus incana ssp tenuifolia (also A. rugosa)*	river alder	5
		Arctostaphylos rubra	alpine bearberry	2

Table N-1 Species Composition and Percent Cover by Vegetation Type in the Pierre River Mining Area (continued)

Ecosite Phase	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
Wooded fen (FTNN) (continued)	low shrub (continued)	*Betula glandulosa*	bog birch	15
		Betula papyrifera	white birch	2
		Betula pumila	dwarf birch	24
		Larix laricina	tamarack	6
		Ledum groenlandicum	common Labrador tea	8
		Linnaea borealis	twinflower	<1
		Oxycoccus microcarpus	small bog cranberry	2
		Picea mariana	black spruce	4
		Pinus banksiana	jack pine	6
		Ribes oxyacanthoides	northern gooseberry	<1
		Ribes triste	wild red currant	<1
		Salix myrtillifolia	myrtle-leaved willow	3
		Salix pedicellaris	bog willow	10
		unknown Salix species	*unknown Salix species*	2
		unknown Salix species	*unknown Salix species*	10
		unknown Salix species	*unknown Salix species*	14
		Vaccinium myrtilloides	common blueberry	<1
		Vaccinium vitis-idaea	bog cranberry	1
	forb	*Achillea millefolium*	common yarrow	<1
		Caltha palustris	marsh-marigold	3
		Corallorhiza trifida	pale coralroot	<1
		Epilobium palustre	marsh willowherb	<1
		Equisetum arvense	common horsetail	<1
		Equisetum fluviatile	swamp horsetail	1
		Equisetum pratense	meadow horsetail	<1
		Equisetum scirpoides	dwarf scouring-rush	<1
		Equisetum sylvaticum	woodland horsetail	<1
		unknown Galium species	*unknown Galium species*	<1
		Galium triflorum	sweet-scented bedstraw	<1
		Geocaulon lividum	northern bastard toadflax	<1
		Lysimachia thyrsiflora	tufted loosestrife	<1
		Menyanthes trifoliata	buck-bean	5
		Mitella nuda	bishop's-cap	<1
		Orthilia secunda (also Pyrola secunda)	one-sided wintergreen	<1
		Petasites frigidus var palmatus	palmate-leaved coltsfoot	<1
		Petasites frigidus var sagittatus	arrow-leaved coltsfoot	<1
		Potentilla palustris	marsh cinquefoil	2
		Pyrola asarifolia	common pink wintergreen	<1

Table N-1 Species Composition and Percent Cover by Vegetation Type in the Pierre River Mining Area (continued)

Ecosite Phase	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
Wooded fen (FTNN) (continued)	forb (continued)	*unknown Pyrola species*	*unknown Pyrola species*	<1
		Rubus arcticus (also R. acaulis)	dwarf raspberry	<1
		Rubus chamaemorus	cloudberry	2
		Smilacina trifolia	three-leaved Solomon's-seal	4
		Stellaria longipes	long-stalked chickweed	<1
		Viola renifolia	kidney-leaved violet	<1
	graminoid	*Calamagrostis canadensis*	bluejoint	<1
		Carex aquatilis	water sedge	16
		Carex canescens	short sedge	<1
		Carex deweyana	Dewey's sedge	4
		Carex diandra	two-stamened sedge	15
		Carex disperma	two-seeded sedge	2
		Carex gynocrates	northern bog sedge	3
		Carex limosa	mud sedge	2
		Carex paupercula	bog sedge	<1
		Carex prairea	prairie sedge	<1
		unknown Carex species	*unknown Carex species*	20
		unknown Carex species	*unknown Carex species*	25
		Eriophorum vaginatum	sheathed cotton grass	<1
		Oryzopsis asperifolia	white-grained mountain rice grass	<1
		unknown graminoid species	*unknown graminoid species*	<1
	moss	*Aulacomnium palustre*	tufted moss	23
		Bryum pseudotriquetrum	*no common name*	4
		Calliergon giganteum	giant water moss	<1
		Calliergon richardsonii	Richardson's water moss	1
		Cinclidium stygium	common northern lantern moss	1
		Dicranum undulatum	wavy dicranum	<1
		Drepanocladus aduncus	brown moss	<1
		Helodium blandowii	Blandlow's feather moss	10
		Hylocomium splendens	stair-step moss	6
		Hypnum lindbergii	Lindberg's hypnum moss	<1
		Plagiomnium ellipticum	elliptic plagiomnium moss	1
		Pleurozium schreberi	Schreber's moss	11
		Polytrichum commune	common hair-cap	<1
		Polytrichum strictum	slender hair-cap	<1
		Sphagnum angustifolium	peat moss	16

Table N-1 Species Composition and Percent Cover by Vegetation Type in the Pierre River Mining Area (continued)

Ecosite Phase	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
Wooded fen (FTNN) (continued)	moss (continued)	*Sphagnum capillifolium*	acute-leaved peat moss	8
		Sphagnum fuscum	rusty peat moss	40
		Sphagnum girgensohnii	Girgensohn's moss	6
		Sphagnum squarrosum	squarrose peat moss	22
		Sphagnum teres	thin-leafed peat moss	5
		Tomentypnum nitens	golden moss	31
		unknown moss species	*unknown moss species*	<1
		unknown moss species	*unknown moss species*	<1
		unknown moss species	*unknown moss species*	5
		unknown moss species	*unknown moss species*	10
		Warnstorfia fluitans (also Drepanocladus fluitans)	water hook moss	5
	lichen	*Cladina mitis*	reindeer lichen	<1
		Cladina stellaris	reindeer lichen	<1
		Cladonia borealis	red pixie-cup	<1
		Cladonia botrytes	wooden soldiers	<1
		Cladonia cervicornis (also C. verticillata)	ladder lichen	<1
		Cladonia chlorophaea	mealy pixie-cup	<1
		Cladonia coniocraea	cup lichen	<1
		Cladonia cornuta	bighorn cladonia	<1
		Cladonia gracilis	smooth cladonia	<1
		Cladonia macilenta	*no common name*	<1
		Cladonia sulphurina	greater sulphur cup	<1
		Icmadophila ericetorum	spraypaint	<1
		Peltigera aphthosa	studded leather lichen	<1
		Peltigera canina	dog lichen	<1
		Peltigera neopolydactyla	carpet pelt	<1
		unknown lichen species	*unknown lichen species*	<1
		unknown lichen species	*unknown lichen species*	15
	epiphyte	*Arthonioid group*	Arthonioid group	<1
		Bryoria furcellata	old man's beard	<1
		Bryoria fuscescens	old man's beard	<1
		unknown Bryoria species	*unknown Bryoria species*	<1
		Cliostomum pallens	*no common name*	<1
		Cyphelium tigillare	*no common name*	<1
		Evernia mesomorpha	boreal oakmoss lichen	1
		Hypogymnia physodes	monk's-hood lichen	1
		Lecanora pulicaris	*no common name*	<1

Table N-1 Species Composition and Percent Cover by Vegetation Type in the Pierre River Mining Area (continued)

Ecosite Phase	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
Wooded fen (FTNN) (continued)	epiphyte (continued)	*Lecanora subintricata*	*no common name*	<1
		Lecanora symmicta	fused rim-lichen	<1
		Melanelia septentrionalis	northern camoflage lichen	<1
		Melanelia subaurifera	abraded camoflage lichen	<1
		Melanelia trabeculata	*no common name*	<1
		Ochrolechia arborea	*no common name*	<1
		Parmelia sulcata	hammered shield moss	<1
		unknown Parmeliopsis species	*unknown Parmeliopsis species*	1
		Ramalina dilacerata	punctured ramalina	<1
		Rinodina metaboliza	*no common name*	<1
		Scoliciosporum perpusillum	*no common name*	<1
		Tuckermannopsis americana (also Cetraria halei or C. ciliaris)	fringed wrinkle-lichen	<1
		Tuckermannopsis orbata (also Cetraria orbata)	variable wrinkle-lichen	<1
		Tuckermannopsis sepincola	chestnut wrinkle-lichen	<1
		unknown epiphyte species	*unknown epiphyte species*	5
		unknown epiphyte species	*unknown epiphyte species*	40
		unknown epiphyte species	*unknown epiphyte species*	40
		Usnea hirta	old man's beard	2
		Usnea lapponica	old man's beard	<1
		Usnea scabrata	old man's beard	<1
		unknown Usnea species	*unknown Usnea species*	1
		Usnea subfloridana	old man's beard	<1
		Usnea substerilis	old man's beard	<1
		Vulpicida pinastri (also Tuckermannopsis pinastri)	powdered sunshine lichen	<1
Wooded patterned fen (FTPN)	canopy	*Larix laricina*	tamarack	2
		Picea mariana	black spruce	8
	tall shrub	*Betula pumila*	dwarf birch	3
		Picea mariana	black spruce	10
	low shrub	*Betula glandulosa*	bog birch	3
		Chamaedaphne calyculata	leatherleaf	5
		Larix laricina	tamarack	1
		Ledum groenlandicum	common Labrador tea	7
		Myrica gale	sweet gale	5
		Oxycoccus microcarpus	small bog cranberry	1
		Picea mariana	black spruce	1

Table N-1 Species Composition and Percent Cover by Vegetation Type in the Pierre River Mining Area (continued)

Ecosite Phase	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
Wooded patterned fen (FTPN) (continued)	low shrub (continued)	*Vaccinium vitis-idaea*	bog cranberry	3
	forb	*Drosera anglica*	oblong-leaved sundew	<1
		Drosera rotundifolia	round-leaved sundew	<1
		unknown Galium species	*unknown Galium species*	<1
		Menyanthes trifoliata	buck-bean	5
		Platanthera hyperborea (also Habenaria hyperborea)	northern green bog orchid	<1
		Smilacina trifolia	three-leaved Solomon's-seal	5
		Spiranthes romanzoffiana	hooded ladies'-tresses	<1
		Tofieldia glutinosa	sticky false asphodel	<1
		Triglochin maritima	seaside arrow-grass	<1
		Utricularia intermedia	flat-leaved bladderwort	<1
	graminoid	*Carex aquatilis*	water sedge	4
		Carex diandra	two-stamened sedge	3
		Carex gynocrates	northern bog sedge	<1
		Carex pauciflora	few-flowered sedge	3
		Eleocharis acicularis	needle spike-rush	10
	moss	*Aulacomnium palustre*	tufted moss	5
		Campylium stellatum	yellow star moss	<1
		Dicranum undulatum	wavy dicranum	5
		Drepanocladus aduncus	brown moss	15
		Pleurozium schreberi	Schreber's moss	10
		Pohlia nutans	copper wire moss	<1
		Polytrichum strictum	slender hair-cap	<1
		Scorpidium scorpioides (also Drepanocladus revolvens)	scorpidium moss	15
		Sphagnum angustifolium	peat moss	10
		Sphagnum fuscum	rusty peat moss	15
		Tomentypnum nitens	golden moss	5
	lichen	*Cladina mitis*	reindeer lichen	3
		Cladina rangiferina	reindeer lichen	1
		Cladina stellaris	reindeer lichen	1
		Cladonia chlorophaea	mealy pixie-cup	<1
		Cladonia cornuta	bighorn cladonia	<1
	epiphyte	*Arthonioid group*	Arthonioid group	<1
		Bryoria furcellata	old man's beard	<1
		Evernia mesomorpha	boreal oakmoss lichen	3
		Hypogymnia physodes	monk's-hood lichen	<1
		Lecanora circumborealis	black-eyed rim lichen	<1
		Lecanora subintricata	*no common name*	<1
		Lecanora symmicta	fused rim-lichen	<1

Table N-1 Species Composition and Percent Cover by Vegetation Type in the Pierre River Mining Area (continued)

Ecosite Phase	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
Wooded patterned fen (FTPN) (continued)	epiphyte (continued)	*Ochrolechia arborea*	*no common name*	<1
		Scoliciosporum perpusillum	*no common name*	<1
		Tuckermannopsis americana (also Cetraria halei or C. ciliaris)	fringed wrinkle-lichen	<1
		Usnea hirta	old man's beard	<1
		Vulpicida pinastri (also Tuckermannopsis pinastri)	powdered sunshine lichen	<1
Graminoid marsh (MONG)	tall shrub	*Betula papyrifera*	white birch	5
		Salix discolor	pussy willow	<1
		unknown Salix species	*unknown Salix species*	<1
	low shrub	*Betula glandulosa*	bog birch	7
		Betula papyrifera	white birch	2
		Larix laricina	tamarack	<1
		Picea glauca	white spruce	<1
		Populus balsamifera	balsam poplar	<1
		Salix arbusculoides	shrubby willow	<1
		Salix bebbiana	beaked willow	<1
		Salix candida	hoary willow	1
		Salix discolor	pussy willow	2
		Salix exigua	sandbar willow	<1
		Salix lucida (also S. lasiandra)	shining willow	1
		Salix pseudomonticola (also S. monticola)	false mountain willow	<1
		unknown Salix species	*unknown Salix species*	<1
		unknown Salix species	*unknown Salix species*	5
		unknown Salix species	*unknown Salix species*	5
	forb	*Caltha natans*	floating marsh-marigold	1
		Cicuta maculata	water-hemlock	<1
		Epilobium angustifolium	common fireweed	<1
		Epilobium palustre	marsh willowherb	<1
		Equisetum arvense	common horsetail	<1
		Equisetum hyemale	common scouring-rush	<1
		Galium trifidum	small bedstraw	<1
		Geum macrophyllum	large-leaved yellow avens	<1
		Hippuris vulgaris	common mare's-tail	<1
		Lemna minor	common duckweed	<1
		Nuphar lutea ssp variegata	yellow pond-lily	<1
		Petasites frigidus var sagittatus	arrow-leaved coltsfoot	<1

Table N-1 Species Composition and Percent Cover by Vegetation Type in the Pierre River Mining Area (continued)

Ecosite Phase	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
Graminoid marsh (MONG) (continued)	forb (continued)	*Potamogeton filiformis*	thread-leaved pondweed	<1
		unknown Potamogeton species	*unknown Potamogeton species*	<1
		Potentilla norvegica	rough cinquefoil	<1
		Potentilla palustris	marsh cinquefoil	<1
		unknown Pyrola species	*unknown Pyrola species*	<1
		Ranunculus gmelinii	yellow water crowfoot	<1
		Ranunculus lapponicus	Lapland buttercup	<1
		Ranunculus macounii	Macoun's buttercup	<1
		Rubus pubescens	dewberry	1
		Rumex crispus	curled dock	<1
		unknown Rumex species	*unknown Rumex species*	<1
		Scutellaria galericulata	marsh skullcap	<1
		Senecio pauperculus	balsam groundsel	<1
		Stellaria longifolia	long-leaved chickweed	<1
		Stellaria longipes	long-stalked chickweed	<1
		Typha latifolia	common cattail	2
		unknown forb species	*unknown forb species*	<1
		unknown forb species	*unknown forb species*	<1
		Urtica dioica	common nettle	<1
		Utricularia vulgaris	common bladderwort	<1
		Vicia americana	wild vetch	<1
	graminoid	*Calamagrostis canadensis*	bluejoint	28
		Carex aenea	silvery-flowered sedge	35
		Carex aquatilis	water sedge	26
		Carex atherodes	awned sedge	1
		Carex brunnescens	brownish sedge	2
		Carex diandra	two-stamened sedge	40
		Carex praticola	meadow sedge	3
		Carex utriculata	small bottle sedge	35
		Eleocharis palustris	creeping spike-rush	<1
		unknown Eleocharis species	*unknown Eleocharis species*	2
		Koeleria macrantha	June grass	15
		Phragmites australis	reed	15
		Scirpus cyperinus	wool-grass	4
		unknown graminoid species	*unknown graminoid species*	21
	moss	*Aulacomnium palustre*	tufted moss	<1
		Calliergon giganteum	giant water moss	2
		Calliergon richardsonii	Richardson's water moss	1

Table N-1 Species Composition and Percent Cover by Vegetation Type in the Pierre River Mining Area (continued)

Ecosite Phase	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
Graminoid marsh (MONG) (continued)	moss (continued)	*Campylium stellatum*	yellow star moss	<1
		Ceratodon purpureus	purple horn-toothed moss	<1
		Dicranum fuscescens	fuscous moss	<1
		Drepanocladus aduncus	brown moss	<1
		Helodium blandowii	Blandlow's feather moss	<1
		Hypnum lindbergii	Lindberg's hypnum moss	<1
		Marchantia polymorpha	liverwort	<1
		Scorpidium scorpioides (also Drepanocladus revolvens)	scorpidium moss	50
		Sphagnum squarrosum	squarrose peat moss	<1
		unknown moss species	*unknown moss species*	<1
		unknown moss species	*unknown moss species*	<1
		unknown moss species	*unknown moss species*	<1
		Warnstorfia fluitans (also Drepanocladus fluitans)	water hook moss	1
	lichen	*Cladina mitis*	reindeer lichen	<1
		Cladonia botrytes	wooden soldiers	<1
		Cladonia coniocraea	cup lichen	<1
		Cladonia cornuta	bighorn cladonia	<1
		Cladonia gracilis	smooth cladonia	<1
		unknown lichen species	*unknown lichen species*	<1
	epiphyte	*Evernia mesomorpha*	boreal oakmoss lichen	<1
		Vulpicida pinastri (also Tuckermannopsis pinastri)	powdered sunshine lichen	<1
Shrubby swamp (SONS)	canopy	*Alnus incana ssp tenuifolia (also A. rugosa)*	river alder	40
		Betula papyrifera	white birch	2
		Picea glauca	white spruce	10
		Populus balsamifera	balsam poplar	1
		Populus tremuloides	aspen	3
	subcanopy	*Betula papyrifera*	white birch	2
	tall shrub	*Alnus incana ssp tenuifolia (also A. rugosa)*	river alder	5
		Alnus viridis ssp crispa	green alder	2
		Betula papyrifera	white birch	5
		Betula pumila	dwarf birch	2
		Larix laricina	tamarack	<1
		Picea glauca	white spruce	<1
		Salix bebbiana	beaked willow	20
		Salix discolor	pussy willow	1

Table N-1 Species Composition and Percent Cover by Vegetation Type in the Pierre River Mining Area (continued)

Ecosite Phase	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
Shrubby swamp (SONS) (continued)	tall shrub (continued)	*Salix lutea*	yellow willow	3
		Salix pseudomonticola (also S. monticola)	false mountain willow	<1
		unknown Salix species	*unknown Salix species*	10
		unknown Salix species	*unknown Salix species*	15
		unknown Salix species	*unknown Salix species*	15
	low shrub	*Alnus incana ssp tenuifolia (also A. rugosa)*	river alder	1
		Alnus viridis ssp crispa	green alder	<1
		Betula occidentalis	water birch	<1
		Betula papyrifera	white birch	8
		Betula pumila	dwarf birch	1
		Cornus stolonifera	red-osier dogwood	<1
		Larix laricina	tamarack	<1
		Ledum groenlandicum	common Labrador tea	<1
		Picea glauca	white spruce	<1
		Picea mariana	black spruce	<1
		Populus balsamifera	balsam poplar	<1
		Ribes americanum	wild black currant	<1
		Ribes glandulosum	skunk currant	5
		Ribes lacustre	bristly black currant	<1
		Ribes oxyacanthoides	northern gooseberry	<1
		Ribes triste	wild red currant	20
		Rosa acicularis	prickly rose	<1
		Rubus idaeus	wild red raspberry	<1
		Rubus idaeus	wild red raspberry	20
		Salix bebbiana	beaked willow	2
		Salix lutea	yellow willow	15
		Salix maccalliana	velvet-fruited willow	3
		Salix pedicellaris	bog willow	7
		Salix pseudomonticola (also S. monticola)	false mountain willow	5
		unknown Salix species	*unknown Salix species*	1
		unknown Salix species	*unknown Salix species*	5
		unknown Salix species	*unknown Salix species*	10
		unknown Salix species	*unknown Salix species*	34
	forb	*Caltha palustris*	marsh-marigold	5
		Chrysosplenium iowense	golden saxifrage	<1
		Cicuta bulbifera	bulb-bearing water-hemlock	<1

Table N-1 Species Composition and Percent Cover by Vegetation Type in the Pierre River Mining Area (continued)

Ecosite Phase	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
Shrubby swamp (SONS) (continued)	forb (continued)	*Cicuta maculata*	water-hemlock	<1
		Cornus canadensis	bunchberry	2
		Epilobium angustifolium	common fireweed	<1
		Epilobium ciliatum	northern willowherb	<1
		Epilobium glaberrimum	Epilobium glaberrimum	<1
		Epilobium palustre	marsh willowherb	<1
		Equisetum arvense	common horsetail	<1
		Equisetum hyemale	common scouring-rush	<1
		Equisetum sylvaticum	woodland horsetail	3
		Galium palustre	common marsh bedstraw	<1
		unknown Galium species	*unknown Galium species*	<1
		Galium trifidum	small bedstraw	<1
		Galium triflorum	sweet-scented bedstraw	<1
		unknown Geum species	*unknown Geum species*	<1
		Petasites frigidus var sagittatus	arrow-leaved coltsfoot	2
		Potentilla norvegica	rough cinquefoil	<1
		Potentilla palustris	marsh cinquefoil	3
		Rubus arcticus (also R. acaulis)	dwarf raspberry	<1
		Rubus pubescens	dewberry	<1
		unknown Rumex species	*unknown Rumex species*	<1
		Rumex triangulivalvis	narrow-leaved dock	<1
		Scutellaria galericulata	marsh skullcap	<1
		Smilacina trifolia	three-leaved Solomon's-seal	<1
		Stellaria calycantha	northern stitchwort	<1
		Stellaria longifolia	long-leaved chickweed	<1
		Stellaria longipes	long-stalked chickweed	<1
		Trientalis borealis	northern starflower	<1
		Viola canadensis	western Canada violet	<1
		Viola renifolia	kidney-leaved violet	<1
	graminoid	*Calamagrostis canadensis*	bluejoint	35
		Calamagrostis inexpansa	northern reed grass	3
		Calamagrostis purpurascens	purple reed grass	<1
		Carex aquatilis	water sedge	50
		Carex canescens	short sedge	<1
		Carex disperma	two-seeded sedge	1
		unknown Carex species	*unknown Carex species*	9

Table N-1 Species Composition and Percent Cover by Vegetation Type in the Pierre River Mining Area (continued)

Ecosite Phase	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
Shrubby swamp (SONS) (continued)	graminoid (continued)	*Carex utriculata*	small bottle sedge	30
		Cinna latifolia	drooping wood-reed	10
		unknown Poa species	*unknown Poa species*	<1
		unknown graminoid species	*unknown graminoid species*	3
		unknown graminoid species	*unknown graminoid species*	20
	moss	*Amblystegium serpens*	*no common name*	<1
		Aulacomnium palustre	tufted moss	4
		Brachythecium salebrosum	*no common name*	<1
		Bryum pseudotriquetrum	*no common name*	<1
		Calliergon giganteum	giant water moss	3
		Calliergon richardsonii	Richardson's water moss	2
		Ceratodon purpureus	purple horn-toothed moss	<1
		Dicranum flagellare	whip fork moss	<1
		Dicranum fuscescens	fuscous moss	<1
		Dicranum undulatum	wavy dicranum	<1
		Drepanocladus aduncus	brown moss	10
		Helodium blandowii	Blandlow's feather moss	<1
		Hylocomium splendens	stair-step moss	<1
		Marchantia polymorpha	liverwort	<1
		Plagiomnium ellipticum	elliptic plagiomnium moss	5
		Pleurozium schreberi	Schreber's moss	<1
		Pylaisiella polyantha	pylaisiella moss	<1
		Sphagnum angustifolium	peat moss	<1
		Sphagnum squarrosum	squarrose peat moss	5
		unknown moss species	*unknown moss species*	<1
		unknown moss species	*unknown moss species*	<1
		unknown moss species	*unknown moss species*	<1
	lichen	*Cladonia botrytes*	wooden soldiers	<1
		Cladonia coniocraea	cup lichen	<1
		Cladonia cornuta	bighorn cladonia	<1
		Cladonia gracilis	smooth cladonia	<1
		Cladonia sulphurina	greater sulphur cup	<1
		Peltigera aphthosa	studded leather lichen	<1
		Peltigera canina	dog lichen	<1
		unknown lichen species	*unknown lichen species*	<1

Table N-1 Species Composition and Percent Cover by Vegetation Type in the Pierre River Mining Area (continued)

Ecosite Phase	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
Shrubby swamp (SONS) (continued)	epiphyte	*Arthonia patellulata*	*no common name*	<1
		Arthonioid group	Arthonioid group	<1
		Buellia disciformis	*no common name*	<1
		Evernia mesomorpha	boreal oakmoss lichen	<1
		Hypogymnia physodes	monk's-hood lichen	3
		Imshaugia aleurites	salted starburst lichen	<1
		Melanelia septentrionalis	northern camoflage lichen	<1
		Melanelia subaurifera	abraded camoflage lichen	<1
		Parmelia sulcata	hammered shield moss	<1
		Parmeliopsis ambigua	green starburst lichen	<1
		Parmeliopsis hyperopta	gray starburst lichen	<1
		Phaeocalicium compressulum	alder needles	<1
		Ramalina dilacerata	punctured ramalina	<1
		Rinodina capensis	*no common name*	<1
		Rinodina orculata	*no common name*	<1
		Stenocybe pullatula	alder stickpin	<1
		Tuckermannopsis americana (also Cetraria halei or C. ciliaris)	fringed wrinkle-lichen	<1
		Tuckermannopsis sepincola	chestnut wrinkle-lichen	<1
		unknown epiphyte species	*unknown epiphyte species*	<1
		unknown epiphyte species	*unknown epiphyte species*	<1
		Usnea hirta	old man's beard	1
		Usnea lapponica	old man's beard	<1
		Usnea scabrata	old man's beard	<1
		Usnea subfloridana	old man's beard	<1
		Usnea substerilis	old man's beard	<1
		Vulpicida pinastri (also Tuckermannopsis pinastri)	powdered sunshine lichen	<1
Wooded swamp (STNN)	canopy	*Alnus incana ssp tenuifolia (also A. rugosa)*	river alder	17
		Betula papyrifera	white birch	11
		Larix laricina	tamarack	23
		Picea glauca	white spruce	2
		Picea mariana	black spruce	10
		Pinus banksiana	jack pine	<1
		Populus balsamifera	balsam poplar	2
		Populus tremuloides	aspen	5
		Salix arbusculoides	shrubby willow	40
		Salix bebbiana	beaked willow	2

Table N-1 Species Composition and Percent Cover by Vegetation Type in the Pierre River Mining Area (continued)

Ecosite Phase	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
Wooded swamp (STNN) (continued)	canopy (continued)	*unknown Salix species*	*unknown Salix species*	9
		unknown Salix species	*unknown Salix species*	20
	subcanopy	*Alnus incana ssp tenuifolia (also A. rugosa)*	river alder	17
		Betula papyrifera	white birch	14
		Picea glauca	white spruce	2
		Picea mariana	black spruce	<1
		Populus tremuloides	aspen	1
		Salix arbusculoides	shrubby willow	10
		Salix bebbiana	beaked willow	25
		unknown Salix species	*unknown Salix species*	11
	tall shrub	*Alnus incana ssp tenuifolia (also A. rugosa)*	river alder	11
		Betula papyrifera	white birch	6
		Betula pumila	dwarf birch	40
		Larix laricina	tamarack	20
		Picea glauca	white spruce	<1
		Picea mariana	black spruce	7
		Populus balsamifera	balsam poplar	<1
		Ribes triste	wild red currant	<1
		Rubus idaeus	wild red raspberry	2
		Salix arbusculoides	shrubby willow	15
		Salix bebbiana	beaked willow	6
		Salix maccalliana	velvet-fruited willow	15
		unknown Salix species	*unknown Salix species*	8
		unknown Salix species	*unknown Salix species*	12
		Viburnum edule	low-bush cranberry	1
	low shrub	*Alnus incana ssp tenuifolia (also A. rugosa)*	river alder	5
		Betula papyrifera	white birch	1
		Betula pumila	dwarf birch	1
		Cornus stolonifera	red-osier dogwood	8
		Larix laricina	tamarack	1
		Ledum groenlandicum	common Labrador tea	2
		Linnaea borealis	twinflower	<1
		Picea glauca	white spruce	2
		Picea mariana	black spruce	<1
		Populus balsamifera	balsam poplar	<1
		Populus tremuloides	aspen	<1
		Ribes glandulosum	skunk currant	<1
		Ribes hudsonianum	northern black currant	3
		Ribes lacustre	bristly black currant	2

Table N-1 Species Composition and Percent Cover by Vegetation Type in the Pierre River Mining Area (continued)

Ecosite Phase	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
Wooded swamp (STNN) (continued)	low shrub (continued)	*Ribes oxyacanthoides*	northern gooseberry	<1
		Ribes triste	wild red currant	1
		Rosa acicularis	prickly rose	<1
		Salix arbusculoides	shrubby willow	25
		Salix bebbiana	beaked willow	1
		Salix lutea	yellow willow	<1
		Salix pseudomonticola (also S. monticola)	false mountain willow	<1
		unknown Salix species	*unknown Salix species*	2
		unknown Salix species	*unknown Salix species*	6
		Symphoricarpos albus	snowberry	<1
		Vaccinium myrtilloides	common blueberry	<1
		Vaccinium vitis-idaea	bog cranberry	2
		Viburnum edule	low-bush cranberry	2
	forb	*Achillea millefolium*	common yarrow	<1
		Aralia nudicaulis	wild sarsaparilla	<1
		unknown Arenaria species	*unknown Arenaria species*	<1
		Aster puniceus	purple-stemmed aster	<1
		unknown Aster species	*unknown Aster species*	<1
		Caltha palustris	marsh-marigold	7
		Cardamine pensylvanica	bitter cress	<1
		Cornus canadensis	bunchberry	3
		Delphinium glaucum	tall larkspur	<1
		Dryopteris carthusiana (also D. austriaca)	narrow spinulose shield fern	<1
		Epilobium angustifolium	common fireweed	<1
		Epilobium ciliatum	northern willowherb	<1
		Epilobium palustre	marsh willowherb	<1
		Equisetum arvense	common horsetail	3
		Equisetum pratense	meadow horsetail	<1
		Equisetum sylvaticum	woodland horsetail	3
		Fragaria vesca	woodland strawberry	<1
		Fragaria virginiana	wild strawberry	<1
		Galium boreale	northern bedstraw	1
		Galium trifidum	small bedstraw	<1
		Galium triflorum	sweet-scented bedstraw	<1
		Impatiens capensis	spotted touch-me-not	7
		Lathyrus ochroleucus	cream-colored vetchling	<1
		Lycopodium annotinum	stiff club-moss	<1
		Maianthemum canadense	wild lily-of-the-valley	<1
		Mertensia paniculata	tall lungwort	3

Table N-1 Species Composition and Percent Cover by Vegetation Type in the Pierre River Mining Area (continued)

Ecosite Phase	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
Wooded swamp (STNN) (continued)	forb (continued)	*Mitella nuda*	bishop's-cap	<1
		Orthilia secunda (also Pyrola secunda)	one-sided wintergreen	<1
		Petasites frigidus var sagittatus	arrow-leaved coltsfoot	2
		Potentilla palustris	marsh cinquefoil	<1
		Pyrola asarifolia	common pink wintergreen	<1
		Pyrola chlorantha (also Pyrola virens)	greenish-flowered wintergreen	<1
		Ranunculus acris	tall buttercup	<1
		Rubus arcticus (also R. acaulis)	dwarf raspberry	1
		Rubus chamaemorus	cloudberry	1
		Rubus pubescens	dewberry	1
		Scutellaria galericulata	marsh skullcap	<1
		Smilacina trifolia	three-leaved Solomon's-seal	<1
		Stellaria longifolia	long-leaved chickweed	<1
		Stellaria longipes	long-stalked chickweed	<1
		Trientalis borealis	northern starflower	<1
		unknown forb species	*unknown forb species*	<1
		unknown forb species	*unknown forb species*	<1
		unknown forb species	*unknown forb species*	1
		Vicia americana	wild vetch	<1
		Viola canadensis	western Canada violet	<1
		Viola nephrophylla	bog violet	2
		Viola renifolia	kidney-leaved violet	<1
		unknown Viola species	*unknown Viola species*	<1
	graminoid	*Bromus ciliatus*	fringed brome	<1
		Calamagrostis canadensis	bluejoint	46
		Carex aquatilis	water sedge	<1
		Carex canescens	short sedge	<1
		Carex disperma	two-seeded sedge	<1
		Carex vaginata	sheathed sedge	<1
		unknown graminoid species	*unknown graminoid species*	1
		unknown graminoid species	*unknown graminoid species*	41
		unknown graminoid species	*unknown graminoid species*	50
	moss	*Abietinella abietina (also Thuidium abietinum)*	*no common name*	5
		Amblystegium serpens	*no common name*	<1
		Aulacomnium palustre	tufted moss	1

Table N-1 Species Composition and Percent Cover by Vegetation Type in the Pierre River Mining Area (continued)

Ecosite Phase	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
Wooded swamp (STNN) (continued)	moss (continued)	*Brachythecium rivulare*	*no common name*	3
		Calliergon giganteum	giant water moss	<1
		Cinclidium stygium	common northern lantern moss	<1
		Climacium dendroides	common tree moss	<1
		Dicranum undulatum	wavy *dicranum*	<1
		Drepanocladus aduncus	brown moss	9
		Eurhynchium pulchellum	*Eurhynchium* moss	<1
		Helodium blandowii	Blandlow's feather moss	5
		Hylocomium splendens	stair-step moss	28
		Marchantia polymorpha	liverwort	<1
		Plagiomnium cuspidatum	toothed *plagiomnium* moss	1
		Plagiomnium ellipticum	*elliptic plagiomnium* moss	8
		Pleurozium schreberi	Schreber's moss	30
		Pohlia nutans	copper wire moss	<1
		Polytrichum commune	common hair-cap	43
		Polytrichum juniperinum	juniper hair-cap	43
		Ptilidium pulcherrimum	liverwort	<1
		Ptilium crista-castrensis	knight's plume moss	9
		Pylaisiella polyantha	pylaisiella moss	<1
		Rhizomnium pseudopunctatum	rhizomnium moss	<1
		Sanionia uncinata (also Drepanocladus uncinatus)	brown moss	<1
		Sphagnum angustifolium	peat moss	9
		Sphagnum fuscum	rusty peat moss	40
		Sphagnum squarrosum	squarrose peat moss	2
		Sphagnum teres	thin-leafed peat moss	<1
		Tomentypnum nitens	golden moss	<1
		unknown moss species	*unknown moss species*	<1
		unknown moss species	*unknown moss species*	1
		unknown moss species	*unknown moss species*	2
		unknown moss species	*unknown moss species*	3
	lichen	*Cladina mitis*	reindeer lichen	<1
		Cladonia coniocraea	cup lichen	<1
		Cladonia cornuta	bighorn cladonia	<1
		Cladonia gracilis	smooth cladonia	<1
		Cladonia sulphurina	greater sulphur cup	<1
		Hypogymnia physodes	monk's-hood lichen	<1
		Melanelia subaurifera	abraded camoflage lichen	<1

Table N-1 Species Composition and Percent Cover by Vegetation Type in the Pierre River Mining Area (continued)

Ecosite Phase	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
Wooded swamp (STNN) (continued)	lichen (continued)	*Parmelia sulcata*	hammered shield moss	<1
		Peltigera aphthosa	studded leather lichen	<1
		Peltigera neopolydactyla	carpet pelt	<1
		unknown lichen species	*unknown lichen species*	<1
		Usnea hirta	old man's beard	<1
		Vulpicida pinastri (also Tuckermannopsis pinastri)	powdered sunshine lichen	<1
	epiphyte	*Arthonia patellulata*	*no common name*	6
		Bryoria fuscescens	old man's beard	<1
		Evernia mesomorpha	boreal oakmoss lichen	1
		Hypogymnia physodes	monk's-hood lichen	3
		Melanelia septentrionalis	northern camoflage lichen	<1
		Melanelia subaurifera	abraded camoflage lichen	<1
		Parmelia sulcata	hammered shield moss	2
		Parmeliopsis ambigua	green starburst lichen	1
		Ramalina dilacerata	punctured ramalina	<1
		Rinodina septentrionalis	*no common name*	<1
		Tuckermannopsis americana (also Cetraria halei or C. ciliaris)	fringed wrinkle-lichen	<1
		Tuckermannopsis orbata (also Cetraria orbata)	variable wrinkle-lichen	2
		unknown Tuckermannopsis species	*unknown Tuckermannopsis species*	2
		unknown epiphyte species	*unknown epiphyte species*	2
		unknown epiphyte species	*unknown epiphyte species*	3
		unknown lichen species	*unknown lichen species*	1
		Usnea hirta	old man's beard	1
		Usnea subfloridana	old man's beard	<1
		Vulpicida pinastri (also Tuckermannopsis pinastri)	powdered sunshine lichen	<1
Open water (WONN)	low shrub	*Betula pumila*	dwarf birch	5
		Larix laricina	tamarack	<1
		unknown Salix species	*unknown Salix species*	<1
		unknown Salix species	*unknown Salix species*	<1
	forb	*Epilobium palustre*	marsh willowherb	<1
		Galium trifidum	small bedstraw	<1
		Hippuris vulgaris	common mare's-tail	3

Table N-1 Species Composition and Percent Cover by Vegetation Type in the Pierre River Mining Area (continued)

Ecosite Phase	Vegetation Layer	Latin Name	Common Name	Average Percent Cover [%]
Open water (WONN) (continued)	forb (continued)	*Lemna minor*	common duckweed	<1
		Menyanthes trifoliata	buck-bean	4
		Nuphar lutea ssp variegata	yellow pond-lily	3
		Potentilla palustris	marsh cinquefoil	2
		Sparganium angustifolium	narrow-leaved bur-reed	<1
		Typha latifolia	common cattail	<1
	graminoid	*Carex canescens*	short sedge	<1
		Carex diandra	two-stamened sedge	2
		Carex lasiocarpa	hairy-fruited sedge	40
		Carex limosa	mud sedge	1
		Carex utriculata	small bottle sedge	3
		Eriophorum gracile	slender cotton grass	1
	moss	*Aulacomnium palustre*	tufted moss	5
		Calliergon giganteum	giant water moss	5
		Drepanocladus aduncus	brown moss	5
		Sphagnum girgensohnii	Girgensohn's moss	5
		Sphagnum squarrosum	squarrose peat moss	70

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FORESTRY ENVIRONMENTAL SETTING FOR THE JACKPINE MINE EXPANSION & PIERRE RIVER MINE PROJECT

Submitted to:
Shell Canada Limited

Prepared by:
Golder Associates Ltd.

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50 BEST EMPLOYERS IN CANADA 2007

CANADA'S 50 BEST MANAGED PRIVATE COMPANIES

TABLE OF CONTENTS

SECTION **PAGE**

4 FORESTRY 1
4.1 INTRODUCTION 1
4.1.1 Study Objectives 4
4.1.2 Study Areas 4
4.2 METHODS 6
4.2.1 Alberta Vegetation Inventory (Cover Map) 6
4.2.2 Timber Productivity 7
4.2.3 Forest Cover Area, Volume and Productivity Estimates 8
4.2.4 Regenerating Stands 9
4.2.5 Old Growth Forests 11
4.2.6 Multistorey Stands 12
4.3 JACKPINE EXPANSION MINING AREA RESULTS 12
4.3.1 Alberta Vegetation Inventory (Cover Map) 12
4.3.2 Forest Cover Area 12
4.3.3 Forest Volume and Productivity Estimates 17
4.3.4 Regenerating Stands 22
4.3.5 Old Growth Forests 25
4.3.6 Multistorey Stands 27
4.4 PIERRE RIVER MINING AREA RESULTS 28
4.4.1 Alberta Vegetation Inventory (Cover Map) 28
4.4.2 Forest Cover Area 28
4.4.3 Forest Volume and Productivity Estimates 33
4.4.4 Regenerating Stands 41
4.4.5 Old Growth Forests 43
4.4.6 Multistorey Stands 45
4.5 SUMMARY 46

LIST OF TABLES

Table 4.3-1 Area of Forest Cover Type and Timber Productivity Rating in the Jackpine Expansion Mining Area Local Study Area 15
Table 4.3-2 Merchantable and Non-Merchantable Forest Land Bases in the Jackpine Expansion Mining Area Local Study Area 16
Table 4.3-3 Volume of Coniferous Fibre by Forest Cover Types in the Jackpine Expansion Mining Area Local Study Area 18
Table 4.3-4 Volume of Deciduous Fibre by Forest Cover Types in the Jackpine Expansion Mining Area Local Study Area 19
Table 4.3-5 Summary of Volume of Forest Cover Types in the Jackpine Expansion Mining Area Local Study Area 20
Table 4.3-6 Coniferous Mean Annual Increment by Forest Cover Types in the Jackpine Expansion Mining Area Local Study Area 21
Table 4.3-7 Deciduous Mean Annual Increment by Forest Cover Types in the Jackpine Expansion Mining Area Local Study Area 22
Table 4.3-8 Regenerating Stands in the Jackpine Expansion Mining Area Local Study Area 23
Table 4.3-9 Old Growth Stands in the Jackpine Expansion Mining Area Local Study Area 25

Table 4.3-10 Multistorey Stands in the Jackpine Expansion Mining Area Local Study Area 27
Table 4.4-1 Area of Forest Cover Type and Timber Productivity Rating in the Pierre River Mining Area Local Study Area....29
Table 4.4-2 Merchantable and Non-Merchantable Forest Land Bases in the Pierre River Mining Area Local Study Area....31
Table 4.4-3 Volume of Coniferous Fibre by Forest Cover Types in the Pierre River Mining Area Local Study Area 34
Table 4.4-4 Volume of Deciduous Fibre by Forest Cover Types in the Pierre River Mining Area Local Study Area 36
Table 4.4-5 Summary of Volume of Forest Cover Types in the Pierre River Mining Area Local Study Area....38
Table 4.4-6 Coniferous Mean Annual Increment by Forest Cover Types in the Pierre River Mining Area Local Study Area....39
Table 4.4-7 Deciduous Mean Annual Increment by Forest Cover Types in the Pierre River Mining Area Local Study Area....40
Table 4.4-8 Regenerating Stands in the Pierre River Mining Area Local Study Area 41
Table 4.4-9 Old Growth Stands in the Pierre River Mining Area Local Study Area....43
Table 4.4-10 Multistorey Stands in the Pierre River Mining Area Local Study Area 45

LIST OF FIGURES

Figure 4.1-1 Forestry Management Unit Boundaries Within the Regional Study Area....2
Figure 4.1-2 Terrestrial Local Study Areas 3
Figure 4.2-1 Stand Productivity and Mean Annual Increment 10
Figure 4.3-1 Timber Productivity Rating in the Jackpine Expansion Mining Area Local Study Area 14
Figure 4.3-2 Regenerating Stands in the Jackpine Expansion Mining Area Local Study Area 24
Figure 4.3-3 Old Growth Forests in the Jackpine Expansion Mining Area Local Study Area 26
Figure 4.4-1 Timber Productivity Rating in the Pierre River Mining Area Local Study Area 32
Figure 4.4-2 Regenerating Stands in the Pierre River Mining Area Local Study Area 42
Figure 4.4-3 Old Growth Forests in the Pierre River Mining Area Local Study Area....44

LIST OF APPENDICES

Appendix O Jackpine Expansion Mining Area Alberta Vegetation Inventory Polygon Maps
Appendix P Pierre River Mining Area Alberta Vegetation Inventory Polygon Maps
Appendix Q Alberta Vegetation Inventory Timber Volume Look-Up Table

4 FORESTRY

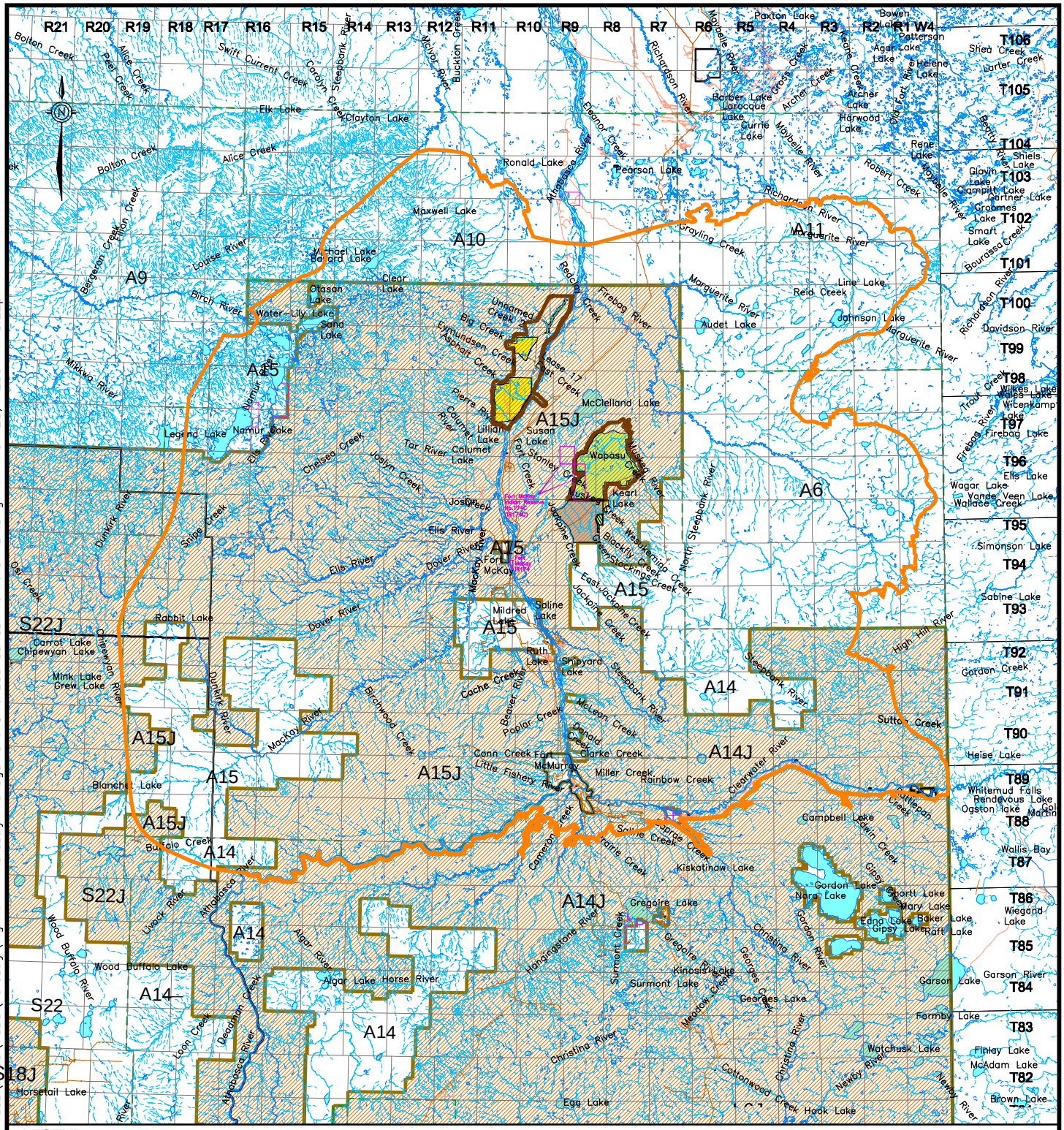
4.1 INTRODUCTION

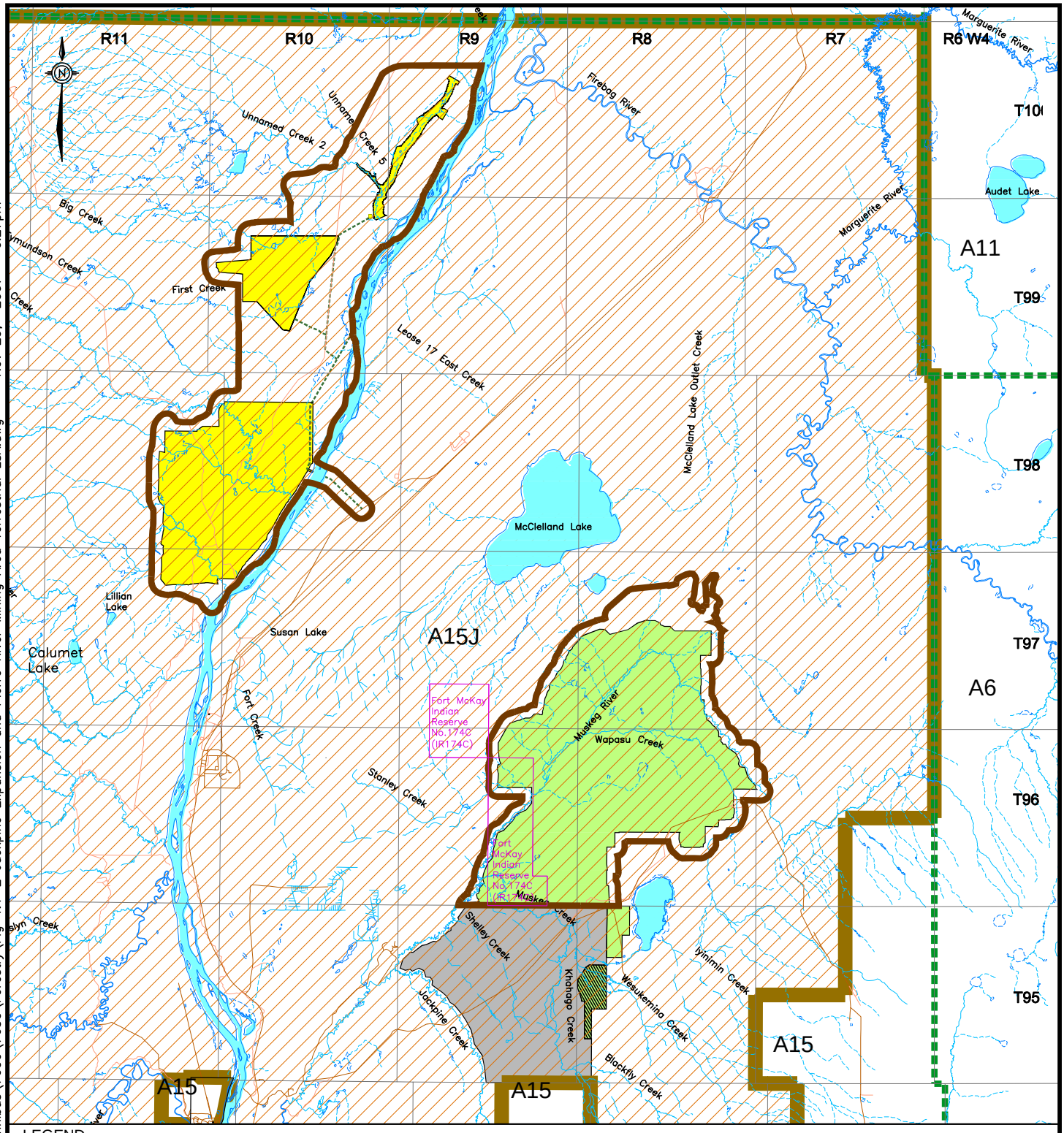
This forestry report provides information required to complete the Environmental Impact Assessment (EIA) for the Jackpine Mine Expansion & Pierre River Mine Project (the Project). Specific objectives of the Forestry Environmental Setting Report (ESR) were to detail the forestry resources in the Project Terrestrial Resources Local Study Areas (LSAs) as defined by the Alberta Vegetation Inventory (AVI) (AEP 1991).

Deciduous timber rights within most of the Project Terrestrial Resources Regional Study Area (RSA) (Figure 4.1-1) have been granted to Alberta-Pacific Forest Industries Inc. (Al-Pac) under the Forest Management Agreement (FMA) O.C. 193/98 by the Alberta Government (Government of Alberta 1998). The RSA is within Zone B, where Al-Pac retains and manages the deciduous rights within the FMA. Al-Pac harvests coniferous timber under a joint planning agreement with Northland Forest Products Ltd. (Al-Pac 2004) and shares coniferous cutting rights with other miscellaneous timber use operators.

The FMA grants rights to harvest timber volumes to the agreement holder (Al-Pac). The agreement holder is responsible for harvest scheduling and planning and is subject to an approved long-term forest management plan and associated annual allowable cut calculations.

The Project LSAs occur within Forestry Management Unit (FMU) A15 (Al-Pac 2006) (Figure 4.1-2). The Alberta Government designates Al-Pac as FMA holder “J”, thus portions of the FMU within the FMA are combined as A15J. Based on Al-Pac’s General Development Plan for the 2006 operating year, harvesting is currently planned for part of the Jackpine Expansion Mining Area (JEMA) LSA area in 2007 (Al-Pac 2006). However, Al-Pac is currently developing a new timber supply analysis in the Mineable Oil Sands Area that, if approved, will affect the current General Development Plan (Cheyne 2007, pers. comm.). Cutting plans for 2007 may change once Al-Pac’s new timber supply analysis is complete.


R21 R20 R19 R18 R17 R16 R15 R14 R13 R12 R11 R10 R9 R8 R7 R6 R5 R4 R3 R2 R1 W4
T106 T105 T104 T103 T102 T101 T100 T99 T98 T97 T96 T95 T94 T93 T92 T91 T90 T89 T88 T87 T86 T85 T84 T83 T82
A9 A10 A11 A5 A15J A15 A6 A14 A14J S22J S22 S18J
Bolton Creek
Alice Creek
Peer Creek
Swift Current Creek
Carolyn Creek
Steepbank River
McIvor River
Buckton Creek
Richardson River
Moberly River
Gregoire River
Christina River
Clearwater River
Athabasca River
Wood Buffalo River
Ells River
Dover River
Mackay River
Dunkirk River
Firebag River
Marguerite River
Namur Lake
Legend Lake
Mildred Lake
Ruth Lake
Shipyard Lake
Kearl Lake
Wapasu Creek
McClelland Lake
Susan Lake
Lilian Lake
Columbia Lake
Tar River Lake
Rabbit Lake
Carrot Lake
Chipewyan Lake
Mink Lake
Grew Lake
Blanchet Lake
Buffalo Creek
Wood Buffalo Lake
Algar Lake
Horse River
Horsetail Lake
Egg Lake
Hook Lake
Kiskotinaw Lake
Gregoire Lake
Surmont Lake
Kinosis Lake
Georges Lake
Gordon Lake
Mary Lake
Campbell Lake
Maxwell Lake
Ronald Lake
Pearson Lake
Clayton Lake
Elk Lake
Fort McKay
Fort McMurray
Anzac
Janvier
Conklin
Paxton Lake
Bowen Lake
Patterson Lake
Agar Lake
Barber Lake
Larocque Lake
Currie Lake
Archer Lake
Harwood Lake
Rene Lake
Shiels Lake
Glavin Lake
Clampitt Lake
Partner Lake
Groomes Lake
Smart Lake
Audet Lake
Reid Creek
Line Lake
Johnson Lake
Davidson River
Wilkes Lake
Wiles Lake
Wicenkamp Lake
Trout Creek
Firebag Lake
Ells Lake
Wagar Lake
Yander Lake
Veen Lake
Wallace Creek
Simonson Lake
Sabine Lake
Gordon Creek
Sutton Creek
Heise Lake
Whitemud Falls
Rendevous Lake
Ogston Lake
Wallis Bay
Wiegand Lake
Baker Lake
Gipsy Lake
Raft Lake
Garson Lake
Garson River
Formby Lake
Finlay Lake
McAdam Lake
Brown Lake
Watchusk Lake
Newby River
Cottonwood Creek
Meadow Creek
Surmont Creek
Hangingstone River
Loon Creek
Deadhorse Creek
Lease 17
Pierre River
Namur River
Joslyn Creek
Chelsea Creek
Snipe Creek
Birch River
Water Lily Lake
Sand Lake
Clear Lake
Michael Lake
Baird Lake
Orasan Lake
Unnamed Creek
Big Creek
Eymundsen Creek
Asphalt Creek
Trout Creek
Susan Creek
Fort Stanley Creek
Jackpine Creek
East Jackpine Creek
Blackfly Creek
Westmeeting Creek
Stockings Creek
Cache Creek
Beaver River
Poplar Creek
McLean Creek
Donald Creek
Clarke Creek
Conn Creek
Little Fishers Creek
Miller Creek
Rainbow Creek
Birchwood Creek
Dunkirk River
Liveck River
Algar Creek
Ruby River
Calumet River
Namur Creek
Ells River
Dover River
Mackay River
Steepbank River
North Steepbank River
High Hill River
Muskeg River
Kearl Creek
Jackpine Creek
Cameron Creek
Joslyn Creek
Fairie Creek
Sawbone Creek
Tar River
Columbia River
Pierre River
Namur River
Ells River
Dover River
Mackay River
Dunkirk River
Snipe Creek
Chelsea Creek
Joslyn Creek
Birch River
Firebag River
Marguerite River
Richardson River
Moberly River
Gregoire River
Christina River
Clearwater River
Athabasca River
Wood Buffalo River
Liveck River
Algar Creek
Ruby River
Loon Creek
Deadhorse Creek
Hangingstone River
Surmont Creek
Meadow Creek
Georges Creek
Cottonwood Creek
Newby River
Christina River
Gregoire



LEGEND

- PIERRE RIVER MINING AREA
- JACKPINE EXPANSION MINING AREA
- LEASE SWAPPED TO SYNCRUDE
- JACKPINE MINE – PHASE 1
- TERRESTRIAL RESOURCES LOCAL STUDY AREAS
- OPEN WATER

FOREST MANAGEMENT AGREEMENT HOLDERS

J ALPAC FOREST PRODUCTS INC.

A15 J

Designates Forest Management Unit

Designates Forest Management Agreement Holder

- FOREST MANAGEMENT UNIT BOUNDARY
- FOREST MANAGEMENT AGREEMENT BOUNDARY
- FOREST MANAGEMENT AGREEMENT

5 0 5

SCALE KM

REFERENCE

WESTWORTH AND ASSOCIATES 1990.
ALBERTA DIGITAL DATA OBTAINED FROM ALTALIS LTD. (SEPTEMBER 2004.)
USED UNDER LICENSE. PROJECTION: TRANSVERSE MERCATOR
DATUM: NAD 83 COORDINATE SYSTEM: UTM ZONE 12.

PROJECT

JACKPINE MINE EXPANSION & PIERRE RIVER MINE PROJECT

TITLE

TERRESTRIAL LOCAL STUDY AREAS

Shell Canada Limited

PROJECT 05-1344-027.7650			FILE No.		LSA
DESIGN	AA	31/07/07	SCALE	AS SHOWN	REV. 0
CADD	TE	26/09/07	FIGURE: 4.1-2		
CHECK	AA	26/09/07			
REVIEW	WES/TC	20/11/07			

L:\2005\1344-OIL SANDS\05-1344-027-Shell Omnibus\7600\7650\Forestry\Fig 4.1-2 Jackpine Expansion and Pierre River Mining Area Terrestrial LSA.dwg Nov 29, 2007 - 6:27pm

4.1.1 Study Objectives

This report provides a summary of environmental setting forestry resources as defined by the AVI for the Project LSAs. The *Alberta Forest Service Guidelines for the Assessment and Reforestation of Forest Land Disturbances* (Bondy 1991) outlines a method of assessment by industrial users of forest resources, which should include:

- cover maps at a scale of 1:20,000 based on AVI specifications;
- data on the merchantable and non-merchantable land bases;
- volume and area estimates by strata (cover group);
- estimates of timber volumes that will be salvaged;
- estimates of the growing stock that will be lost; and
- a reforestation or reclamation plan.

A summary of old growth forests and multistorey stands in the LSA is also provided in this report in Sections 4.3 and 4.4.

Timber volumes that will be salvaged and growing stock that will be lost are assessed and quantified in the Terrestrial Resources volume (Volume 5, Section 7) of the EIA for the Project.

The Closure, Conservation and Reclamation (C,C&R) Plan (Volume 5, Appendices 5-1 and 5-2) provides a revegetation plan that details the ecosite and wetlands types prescribed for the Project area following decommission, including prescriptions for planting stock species and densities (trees and shrubs) for the reclaimed landscape.

4.1.2 Study Areas

The Terrestrial LSAs and Regional Study Area (RSA) were developed with consideration of all terrestrial components (soil and terrain, terrestrial vegetation, wetlands and forest resources, wildlife and wildlife habitat and biodiversity). Therefore, the LSAs and RSA used for this report are also used for all Terrestrial Resources components. The use of the terms LSA and RSA in this report refer to the Terrestrial Resources LSAs or RSA.

The RSA was established to assess the the importance of the Project within a broad regional area (Figure 4.1-1). The RSA is in the Central Mixedwood and the Athabasca Plain Natural Subregions (Natural Regions Committee 2006).

These subregions are in the Boreal Natural Region. The RSA is 2,277,376 ha and covers nearly all of FMU A15, the northern portions of FMU A14, the eastern edge of S22 and areas of public land primarily to the north and east of FMU A15 (Figure 4.1-1). The RSA boundary was defined with consideration of the following terrestrial resources:

- ecodistrict boundaries;
- geographic or topographic boundaries such as the eastern shoulder of the Birch Mountains;
- defined woodland caribou habitat areas (e.g., Audet, Firebag and Steepbank caribou areas);
- average distance of two moose home ranges from oil sands developments (about 26 km);
- allowances for the major river systems (e.g., Athabasca and Clearwater rivers) that act as natural study boundaries; and
- inclusion of the community of Fort McMurray and other areas likely to expand in the future.

There are two LSAs for the Project (Figure 4.1-2). The Jackpine Expansion Mining Area (JEMA) LSA is located along the Muskeg River north and east of the approved Jackpine Mine – Phase 1 and covers an area of 18,348 ha. The Pierre River Mining Area (PRMA) LSA is located on the west side of the Athabasca River, north of the approved Canadian Natural Resources Limited (Canadian Natural) Horizon Project and covers an area of 21,136 ha.

The JEMA and PRMA LSAs are established to assess the effects of the Project at the local scale. They fall within the Central Mixedwood and Athabasca Plains Natural Subregions (Natural Regions Committee 2006) and the following townships:

- Township 96, Ranges 8 and 9, W4M;
- Township 97, Ranges 8 and 11, W4M;
- Township 98, Ranges 10 and 11, W4M;
- Township 99, Range 9, W4M; and
- Township 100, Ranges 9 and 10, W4M.

The extent of the Project LSAs was defined on the basis of the project development area plus a buffer zone to account for indirect effects of the project. This buffer zone is based on a 500 m offset from the Project

Development Area but varies in width depending on the configuration of the project footprint, as well as land uses and natural features in the surrounding area. To the east, the JEMA LSA is bounded by Imperial Oil Resources Ventures Limited (Imperial Oil) Kearl Lake Project. To the south, the JEMA LSA abuts the approved Shell Jackpine Mine – Phase 1 footprint. The PRMA LSA is bound by the Athabasca River to the east.

4.2 METHODS

4.2.1 Alberta Vegetation Inventory (Cover Map)

The AVI for the Project is based on the interpretation of 1:20,000 scale photographs covering all townships occurring fully or partially within the Project LSAs. The AVI process delineates detailed vegetation polygons on aerial photographs and transfers this information onto a 1:20,000 orthophotograph base map. This information is digitized, along with associated forestry attributes and is entered into a database. Forestry attributes assigned to each AVI polygon include:

- ecological moisture regime;
- crown closure;
- density;
- height;
- overstorey and understorey species composition (maximum of three dominant cover types);
- timber productivity rating;
- stand structure;
- non-forest, man-made or naturally non-vegetated land;
- age; and
- site condition.

Tree species attributes were assigned to AVI polygons if tree cover met or exceeded 6% cover, as per regulatory guidelines (AEP 1991). Polygons having less than 6% cover were classified as vegetated (dominated by a cover of shrubs, grasses, forbs or bryophytes) or non-vegetated classes (water, mineral or anthropogenically disturbed).

The minimum polygon size for AVI interpretation is 2 ha (AEP 1991). However, overlaying the environmental setting disturbance layer onto the AVI may reduce minimum polygon size to less than 2 ha.

A spatial database linking the forestry polygons (map units) and AVI attributes was compiled using Geographic Information System (GIS) ARCINFO software. The AVI database and orthophotograph were used to develop a revised cover map for both LSAs. The AVI cover maps are presented at a 1:10,000 scale with associated polygon data in digital format in Appendices O and P for the JEMA LSA and PRMA LSA, respectively.

Digital files of AVI data for Al-Pac's FMA, including both the AVI orthophotograph and database used in this assessment, have been approved by Alberta Sustainable Resource Development (ASRD) (Parry 2003, pers. comm.) as required under the AVI auditing process (AEP 1991).

Aerial photographs of the Project LSAs were acquired by Shell in 2005. Project vegetation mapping has employed these photos used with Project vegetation field survey data to create the most current land base possible. Recent harvest areas were delineated from these photographs to update the AVI database. Burn areas, including the 2002 Kearl Lake wildfire, were delineated for the Project using these photographs and historical wildfire GIS data (ASRD 2007a, website).

4.2.2 Timber Productivity

Timber productivity, determined using a Timber Productivity Rating (TPR), is "the potential timber productivity of a stand based on height and age of dominant and co-dominant trees of the leading species" (AEP 1991). Each AVI polygon was assigned a TPR rating of good, medium, fair or unproductive.

The TPR ratings incorporate site index range and breast height age, using tree species-specific formulae outlined in the AVI standards manual (AEP 1991). The TPR is a reflection of environmental factors affecting tree growth including soil type, topography, climate, elevation and moisture. Stand forest area, volume and productivity estimates are categorized by TPR to reflect these variable elements.

Stands are also subdivided into deciduous, coniferous and mixedwood stands. Deciduous stands are composed of more than or equal to 80% deciduous species (i.e., trembling aspen, white birch or balsam poplar) based on percent cover estimates. Coniferous stands are composed of more than or equal to 80% coniferous species (i.e., jack pine, balsam fir, white spruce, black spruce or

tamarack). The remaining species (less than or equal to 20%) in these stands are referred to as incidental fibre. Incidental fibre volume is not tracked in the landbase, but may be logged under the Timber Management Regulation (ASRD 2007b, website).

A mixedwood stand is defined as any stand where both the deciduous and the coniferous trees have a percent cover greater than 20% (e.g., 70% trembling aspen and 30% white spruce). In addition, multistorey stands are considered a mixedwood stand if the overstorey crown closure is classified as having an "a" density (i.e., crown closure of 6 to 30%), and if the primary overstorey species is deciduous and the dominant understorey species is coniferous or vice versa. Stands are further classified into 6 m interval height ranges.

Black spruce and tamarack dominated stands are not harvested for timber. In this assessment, these stands are considered non-merchantable timber, regardless of the TPR assigned. In addition, disturbed lands and unproductive, non-forested land including shrublands, open wetlands, lakes and rivers are quantified.

4.2.3 Forest Cover Area, Volume and Productivity Estimates

For each stand type and dominant tree species, total land base area, timber volume and mean volume per hectare were calculated for this assessment.

Total stand volume was calculated for each stand type using the ASRD 2006-2007 AVI Volume Look-Up Table (ASRD 2007c, website) (Appendix Q, Table Q-1). This table was developed from a collection of historical provincial AVI data, including the Central Mixedwood and Athabasca Plain Natural Subregions, based on height and crown closure for coniferous, deciduous and mixedwood stand types. These volume factors are multiplied by stand area to derive total stand volume. Forest cover type average volume per hectare is calculated by dividing the total volume by the total area. Volumes of merchantable forest cover types are calculated for all stands rated as having a good, medium or fair TPR.

Stand origin is included as an attribute of the AVI and is used with the above attributes to calculate empirical stand productivity referred to as Mean Annual Increment (MAI). The MAI is the volumetric measure of fibre (m^3) that accumulates per year from each hectare of forest. The MAI calculations for each stand type are summed together to provide an estimate of the Long Run Sustained Yield Average (LRSYA) for the Project LSAs. The LRSYA provides a reasonable estimate of sustained coniferous and deciduous fibre yield for the LSAs.

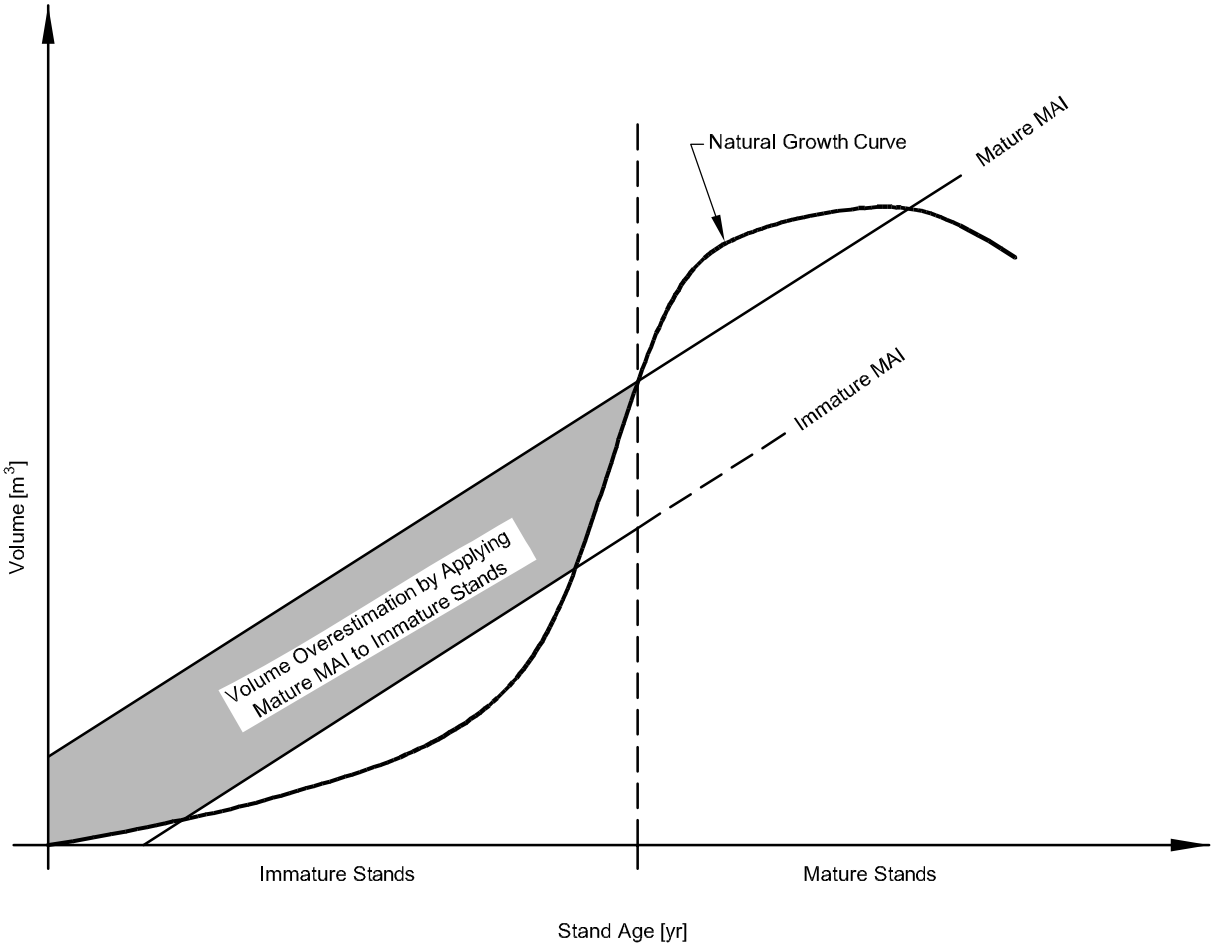
Typically, forestry information is calculated on a net land base, in which non-harvestable areas are removed from the total (i.e., gross) land base. Approved net land bases for the Project LSAs are not presently available from Al-Pac. For the purpose of this ESR, non-forested, non-vegetated and disturbed areas of the LSAs are not used in the approximation of the net land base productivity estimates. Non-merchantable stands (black spruce and tamarack) are reported, but not used in the productivity calculations. Non-harvestable areas such as stream edges and extreme-angle slopes remain part of the net land base. As such, results in this report provide an upper limit estimate of productivity of the net land base in the Project LSAs.

Mean annual increment (m^3/yr) follows a natural growth curve over time, increasing to maturity then gradually tapering as the stand approaches over-mature status (Figure 4.2-1). To approximate the natural growth curve of each tree species, separate MAI values were calculated for mature and immature stands of each predominant forest cover type. An estimated age at which stands reach harvestable age was used to distinguish between immature and mature stands. Separating these stands types into two groups allowed for a better estimate of stand productivity.

4.2.4 Regenerating Stands

Assessing the status of regenerating stands (i.e., areas previously harvested or burned and currently regrowing) can provide an indication of the sustainability of the land base for forestry and its post-logging or post-burn recovery capability.

Harvested stands represent cleared merchantable stands and are included in the merchantable land base. From the AVI data, polygons with an overstorey modifier of ‘CC’ (cutblock modifier) also have a cutblock modifier code between 1 and 5 representing the cleared extent within that polygon (AEP 1991). To determine the cutblock extent area, the stand area was multiplied by the mid-point value of the range represented by the extent code. For example, a stand with an extent code of “4” has been cutblock between 76 and 94%, with a mid-point value of 85%.



PROJECT

JACKPINE MINE EXPANSION &
PIERRE RIVER MINE PROJECT

TITLE

STAND PRODUCTIVITY AND MEAN ANNUAL INCREMENT

Shell Canada Limited

PROJECT 05-1344-027.7650			FILE No.	Stand Productivity
DESIGN	AA	01/08/07	SCALE NTS	REV. 0
CADD	YW	01/08/07		
CHECK	AA	20/09/07		
REVIEW	WES/TC	20/11/07		

FIGURE: 4.2-1

L:\2005\1344-OIL SANDS\05-1344-027-Shell Omnibus\7600\7650\Forestry\ Drawing file: Fig 4.2-1 Stand-Productivity.dwg Nov 20, 2007 - 11:54am

Mapping for the Project has been used to update the AVI database to create the most current landbase possible. Recent harvest areas were delineated from the aerial photographs acquired by Shell in 2005. These harvest areas were considered to be completely cleared. Burn areas, including the 2002 Kearl Lake wildfire, were delineated for the Project using these photographs and historical wildfire GIS data (ASRD 2007a, website). Burn areas are considered to be regenerating stands and also part of the productive landbase if the AVI data for the polygon indicated that it was previously dominated by merchantable tree species.

4.2.5 Old Growth Forests

Old growth forests are defined as those forested areas where annual growth equals annual losses, or where mean annual increment of timber volume equals zero. They can also be defined as those stands that are self-regenerating (i.e., maintaining a specific structure). The structure includes juvenile, mature, dying and decaying trees of the same species. Although age is often used as an indicator of old growth conditions, other definitions of old growth forests include parameters such as:

- height;
- diameter;
- density and spacing pattern;
- snag density and characteristics;
- cavity characteristics;
- nutrient cycling;
- energy flow characteristics; and
- structural heterogeneity.

The definition of an old growth forest, its age and its characteristics vary depending on the forest type (i.e., tree species composition) and geographic location. Although there is currently no documented definition of old growth specifically for the boreal forests in northern Alberta, a review of old growth stand characteristics by Schneider (2002) proposes criteria that will be used for this report. Black spruce, white spruce, tamarack and balsam fir stands were considered old growth at 140 years, jack pine stands at 120 years, and deciduous and mixedwood stands at 100 years. However, it is not known whether stands of this age in northern Alberta contain distinctive structural or compositional features (Schneider 2002).

The AVI interpretation records stand origin date in 10-year intervals unless the specific origin date is known. For the purpose of determining old growth stands within the LSAs for this report, the year 2007 was rounded to 2010 and used in conjunction with the origin variable in the AVI data to determine the age of the polygon.

4.2.6 Multistorey Stands

Multistorey stands are stands where two or three storeys exist and each storey is significant and clearly observable. Each storey has a height difference more than or equal to 3 m from the next storey. Shrubs are identified as a modifier in the AVI database and are often temporal due to recent disturbance. A shrub layer may often develop into an understorey given sufficient time. Multistorey stands provide an indication of the structural complexity of an area. The higher the number of multistorey stands, the higher (relatively) the structural complexity.

Forest stand attributes, including the distribution of multistorey stands, are discussed in the Terrestrial Vegetation, Wetlands and Forest Resources ESR (Volume 3, Section 3).

4.3 JACKPINE EXPANSION MINING AREA RESULTS

4.3.1 Alberta Vegetation Inventory (Cover Map)

Alberta Vegetation Inventory Polygon maps, including the cover map (orthophotograph) with AVI boundaries are in Appendix O, Figures O-1 to O-38. The cover map is presented at a 1:10,000 scale, which is a larger scale than the required minimum of 1:20,000 scale. The AVI database used in this assessment has been approved by ASRD (Parry 2003, pers. comm.).

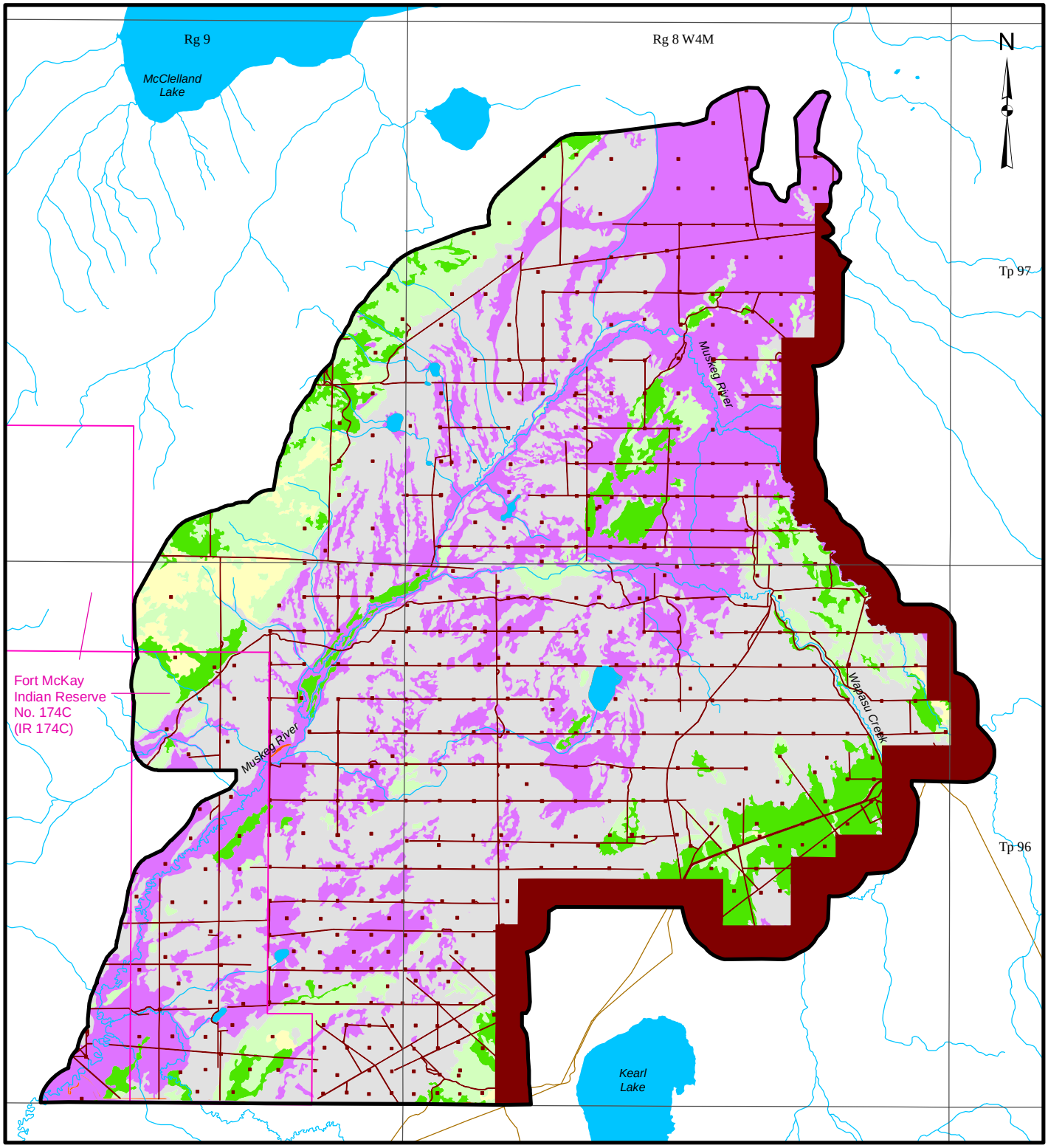
4.3.2 Forest Cover Area

The JEMA LSA is 18,348 ha with merchantable forests occupying 3,464 ha (19%) of the LSA (Tables 4.3-1 and 4.3-2). Merchantable forests are composed of the following (Table 4.3-1):

- 1,178 ha of deciduous stands with dominant species of trembling aspen, white birch or balsam poplar;
- 688 ha of coniferous stands with dominant species of jack pine or white spruce;

- 378 ha of mixedwood stands with dominant species of trembling aspen, white birch, jack pine or white spruce;
- 120 ha of harvested stands without a current identified dominant species; and
- 1,099 ha of burned upland stands without a current identified dominant species.

Overall, trembling aspen dominated stands, including both deciduous and mixedwood stands, occupy the greatest area of merchantable forest land covering 1,137 ha (6%) of the JEMA LSA (Table 4.3-2). Upland burns occupy the second greatest area of merchantable (or productive) forest, covering 1,099 ha (6%) of the JEMA LSA (Table 4.3-2). Burn areas were divided into upland productive and wetlands unproductive types by the previous dominant species as indicated by AVI polygons of the burn area. The remaining merchantable land base is composed of white birch, balsam poplar, jack pine, white spruce and harvested stands. The most productive stands (i.e., TPR value of good) occur along the Canterra road in the southeast of the JEMA LSA (Figure 4.3-1). Other productive areas of the JEMA LSA include the Fort Hills in the northwest, and the isolated island of upland forest in the north-central portion of the LSA.



LEGEND

- JACKPINE EXPANSION MINING AREA LOCAL STUDY AREA
- INDIAN RESERVE
- OPEN WATER
- PUBLIC ROADWAY

TIMBER PRODUCTIVITY RATING

- GOOD
- MEDIUM
- FAIR
- UNPRODUCTIVE
- NON-FORESTED
- NON-VEGETATED

DISTURBED

- EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE
- EXISTING AND APPROVED URBAN AND INDUSTRIAL LINEAR DISTURBANCE

3 0 3

SCALE 1:100,000 KILOMETRES

REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2004), and Alberta SRD, used under license.
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 12.

PROJECT

JACKPINE MINE EXPANSION & PIERRE RIVER MINE PROJECT

TITLE

TIMBER PRODUCTIVITY RATING IN THE JACKPINE EXPANSION MINING AREA LOCAL STUDY AREA

Shell Canada Limited

PROJECT No. 05-1344-027.7600			SCALE AS SHOWN	REV. 0
DESIGN	VR	03 Aug. 2007	FIGURE: 4.3-1	
GIS	VR	28 Sep. 2007		
CHECK	AA	16 Nov. 2007		
REVIEW	WESTC	20 Nov. 2007		

Project: I:\CLIENTS\SHELL\05-1344-027\mapping\mxd\forestry\DRAFT\jackpine\bl_tpr_esr.mxd - Plot: 2J:\2005\GIS\ArcMapTemplates\templates\v91\MyProject.pdf?

Table 4.3-1 Area of Forest Cover Type and Timber Productivity Rating in the Jackpine Expansion Mining Area Local Study Area

Predominant Forest Cover Types[a]	Dominant Species	TPR[b]	Areas by Tree height Class [ha]					Total [ha]
			0 to 6 m	6.1 to 12 m	12.1 to 18 m	18.1 to 24 m	24 to 30+m	
Merchantable Forest								
deciduous	trembling aspen (Aw)	good	–	–	3	225	–	228
	trembling aspen (Aw)	medium	2	6	290	243	–	541
	trembling aspen (Aw)	fair	–	4	159	–	–	163
	white birch (Bw)	good	–	–	1	8	–	10
	white birch (Bw)	medium	–	–	118	37	–	155
	white birch (Bw)	fair	–	–	73	–	–	73
	balsam poplar (Pb)	good	–	–	–	8	–	8
	Deciduous Total		**2**	**10**	**644**	**522**	**0**	**1,178**
coniferous	jack pine (Pj)	good	–	–	62	102	–	164
	jack pine (Pj)	medium	–	–	167	33	–	200
	jack pine (Pj)	fair	–	1	–	–	–	1
	white spruce (Sw)	good	–	–	65	31	65	160
	white spruce (Sw)	medium	–	17	33	83	30	163
	Coniferous Total		**0**	**18**	**326**	**249**	**95**	**688**
mixedwood	trembling aspen (Aw)	good	–	–	–	7	–	7
	trembling aspen (Aw)	medium	1	–	92	70	4	167
	trembling aspen (Aw)	fair	5	12	14	–	–	30
	white birch (Bw)	medium	–	–	–	46	–	46
	white birch (Bw)	fair	–	–	11	–	–	11
	jack pine (Pj)	good	–	–	13	20	–	33
	jack pine (Pj)	medium	–	3	26	7	–	36
	white spruce (Sw)	good	–	–	32	2	7	41
	white spruce (Sw)	medium	–	–	–	7	–	7
	Mixedwood Total		**6**	**14**	**188**	**159**	**11**	**378**
harvested	mixedwood none	medium	120	–	–	–	–	120
	Harvested Total		**120**	**0**	**0**	**0**	**0**	**120**
burn[c]	Upland Burn	n/a[d]	1,099	–	–	–	–	1,099
	Upland Burn Total		**1,099**	**0**	**0**	**0**	**0**	**1,099**
Total Merchantable Forest								**3,464**
Non-Merchantable Forest								
coniferous	black spruce (Sb)	good	159	38	25	–	–	222
	black spruce (Sb)	medium	419	1,127	43	–	–	1,588
	black spruce (Sb)	fair	199	119	–	–	–	319
	black spruce (Sb)	unproductive	603	13	–	–	–	616
	tamarack (Lt)	good	123	131	68	–	–	322
	tamarack (Lt)	medium	481	1,607	238	–	–	2,326
	tamarack (Lt)	fair	179	158	–	–	–	337
	tamarack (Lt)	unproductive	207	30	–	–	–	237
	Coniferous Total		**2,369**	**3,224**	**374**	**0**	**0**	**5,967**
mixedwood[e]	none[e]	unproductive	43	–	–	–	–	43
	Mixedwood Total		**43**	**0**	**0**	**0**	**0**	**43**
burn[c]	Wetlands Burn	n/a[d]	1,927	–	–	–	–	1,927
	Wetlands Burn Total		**1,927**	**0**	**0**	**0**	**0**	**1,927**
Total Non-Merchantable Forest								**7,937**
Total Non-forested[f]								**5,054**
Total Disturbance								**1,893**
Total Landbase (Local Study Area)								**18,348**

(a) Forest cover types described in Section 4.2.2.

(b) TPR = Timber Productivity Rating.

(c) Only burn areas with previously AVI identified merchantable species are considered merchantable.

(d) Dominant tree species have not yet been identified in burn areas.

(e) Areas re-interpreted through field investigations that do not have AVI tree species data.

(f) Non-forested areas include shrublands, meadows, sand, open wetlands, burns, lakes and rivers.

Note: Harvested stands include cutblocks identified through airphotos and disturbance layer and AVI identified cutblocks; all do not have an interpreted tree cover.

Some numbers are rounded for presentation purposes. Therefore, it may appear that the totals do not equal the sum of individual values.

– = No value.

Table 4.3-2 Merchantable and Non-Merchantable Forest Land Bases in the Jackpine Expansion Mining Area Local Study Area

Dominant Tree Species	Total Area [ha]	Percent of LSA	Percent of Total LSA Forest Land Base	Percent of LSA Merchantable/ Non-Merchantable Forest Land Base
Merchantable Land Base				
trembling aspen (Aw)	1,137	6	10	33
white birch (Bw)	294	2	3	8
balsam poplar (Pb)	8	<1	<1	<1
jack pine (Pj)	434	2	4	13
white spruce (Sw)	372	2	3	11
harvested (none)	120	1	1	3
upland burn	1,099	6	10	32
Total Merchantable	**3,464**	**19**	**30**	**100**
Non-Merchantable Land Base				
black spruce (Sb)	2,745	15	24	35
tamarack (Lt)	3,222	18	28	41
mixedwood none	43	<1	<1	1
wetlands burn	1,927	11	17	24
Total Non-merchantable	**7,937**	**43**	**70**	**100**
Total Forest Land Base	**11,400**	**62**	**100**	**not applicable**

Note: Some numbers are rounded for presentation purposes. Therefore, it may appear that the totals do not equal the sum of the individual values.

Non-merchantable forests, including all black spruce and tamarack dominated stands, occupy 7,937 ha (43%) of the JEMA LSA (Table 4.3-2). Black spruce stands occupy 2,745 ha (15%) of the JEMA LSA and tamarack stands occupy 3,222 ha (18%) of the LSA (Table 4.3-2). The remaining non-merchantable forest area (1,970 ha) is composed of wetlands burn area and areas field mapped as treed wetlands where AVI interpretation does not include a tree cover (Table 4.3-2). These stands were re-interpreted as treed ecosite phases during field survey mapping for the Project.

Unproductive non-forested areas include shrublands, meadows, sand, open wetlands, burns, lakes and rivers occupying 5,054 ha (28%) of the JEMA LSA (Table 4.3-1). Disturbed lands, which include roads, cleared areas and infrastructure, occupy 1,893 ha (10%) of the LSA (Table 4.3-1).

4.3.3 Forest Volume and Productivity Estimates

Within the AVI attribute database, all forested stands are rated as having a good, medium, fair or unproductive TPR. As black spruce and tamarack stands are not harvested, they are considered to be non-merchantable in this assessment. However, the total volumes of these stands were calculated for continuity. Timber volumes for coniferous and deciduous fibre are detailed in Tables 4.3-3 and 4.3-4, respectively. Of a total 332,571 m^3, there is an estimated 183,474 m^3 of merchantable coniferous fibre in the JEMA LSA. There is a total volume of 176,098 m^3 of deciduous fibre, of which 165,736 m^3 is considered merchantable.

Table 4.3-5 provides a summary of average timber volumes per hectare. The average volume of merchantable fibre within deciduous stands in the JEMA LSA is 113 m^3/ha of deciduous fibre and 35 m^3/ha of coniferous fibre. Conversely, the average volume of merchantable fibre within coniferous stands in the JEMA LSA is 155 m^3/ha of coniferous fibre and 16 m^3/ha of deciduous fibre. Overall, the average volume for merchantable forests, not including stands without an identifiable volume (harvested or burned), is 82 m^3/ha of coniferous fibre and 74 m^3/ha of deciduous fibre. The average volume of non-merchantable stands, consisting of black spruce and tamarack, is 19 m^3/ha of coniferous fibre and 1 m^3/ha of deciduous fibre.

Table 4.3-3 Volume of Coniferous Fibre by Forest Cover Types in the Jackpine Expansion Mining Area Local Study Area

Predominant Forest Cover Types[a]	Dominant Species	TPR[b]	Volume by Tree Height Class [m^3]					Total Volume [m^3]
			0 to 6 m	6.1 to 12 m	12.1 to 18 m	18.1 to 24 m	24.1 to 30 m	
Merchantable Forests								
deciduous	trembling aspen (Aw)	good	–	–	85	9,766	–	9,851
	trembling aspen (Aw)	medium	0	55	7,716	10,280	–	18,050
	trembling aspen (Aw)	fair	–	24	4,895	–	–	4,919
	white birch (Bw)	good	–	–	30	415	–	445
	white birch (Bw)	medium	–	–	3,560	1,822	–	5,382
	white birch (Bw)	fair	–	–	2,379	–	–	2,379
	balsam poplar (Pb)	good	–	–	–	357	–	357
	Deciduous Total		**0**	**79**	**18,665**	**22,640**	**0**	**41,384**
coniferous	jack pine (Pj)	good	–	–	11,237	18,739	–	29,976
	jack pine (Pj)	medium	–	–	20,288	5,720	–	26,008
	jack pine (Pj)	fair	–	46	–	–	–	46
	white spruce (Sw)	good	–	–	7,359	4,357	13,984	25,700
	white spruce (Sw)	medium	–	990	4,419	14,405	5,417	25,230
	Coniferous Total		**0**	**1,035**	**43,302**	**43,221**	**19,401**	**106,960**
mixedwood	trembling aspen (Aw)	good	–	–	–	897	–	897
	trembling aspen (Aw)	medium	3	–	7,001	7,170	355	14,528
	trembling aspen (Aw)	fair	8	288	731	–	–	1,027
	white birch (Bw)	medium	–	–	–	4,349		4,349
	white birch (Bw)	fair	–	–	812	–	–	812
	jack pine (Pj)	good	–	–	1,362	2,497	–	3,859
	jack pine (Pj)	medium	–	85	2,513	1,031	–	3,629
	white spruce (Sw)	good	–	–	4,077	323	696	5,096
	white spruce (Sw)	medium	–	–	–	933	–	933
	Mixedwood Total		**11**	**374**	**16,495**	**17,200**	**1,051**	**35,130**
harvested	mixedwood none	medium	0	–	–	–	–	0
	Harvested Total		**0**	**0**	**0**	**0**	**0**	**0**
burn[c]	Upland Burn	n/a[d]	0	0	0	0	0	0
	Upland Burn Total		**0**	**0**	**0**	**0**	**0**	**0**
Total Merchantable Forest								**183,474**
Non-Merchantable Forest								
coniferous	black spruce (Sb)	good	1,203	1,953	2,747	–	–	5,902
	black spruce (Sb)	medium	5,535	38,892	4,173	–	–	48,600
	black spruce (Sb)	fair	1,988	2,664	–	–	–	4,651
	black spruce (Sb)	unproductive	2,359	184	–	–	–	2,543
	tamarack (Lt)	good	1,348	4,171	5,351	–	–	10,869
	tamarack (Lt)	medium	4,831	42,067	22,828	–	–	69,726
	tamarack (Lt)	fair	1,523	2,862	–	–	–	4,385
	tamarack (Lt)	unproductive	1,809	611	–	–	–	2,419
	Coniferous Total		**20,595**	**93,404**	**35,099**	**0**	**0**	**149,097**
mixedwood[e]	none[e]	unproductive	0	–	–	–	–	0
	Mixedwood Total		**0**	**0**	**0**	**0**	**0**	**0**
burn[c]	wetlands burn	n/a[d]	0	0	0	–	–	0
	Wetlands Burn Total		**0**	**0**	**0**	**0**	**0**	**0**
Total Non-Merchantable Forest								**149,097**
Total Volume								**332,571**

(a) Forest cover types described in Section 4.2.2.

(b) TPR = Timber Productivity Rating.

(c) Only burn areas with previously AVI identified merchantable species are considered merchantable.

(d) Dominant tree species have not yet been identified in burn areas.

(e) Areas re-interpreted through field investigations that do not have AVI tree species data and consequently no volume.

Notes: Harvested stands include cutblocks identified through airphotos and disturbance layer and AVI identified cutblocks; all do not have an interpreted tree cover.

Some numbers are rounded for presentation purposes. Therefore, it may appear that the totals do not equal the sum of the individual values.

– = No value.

Table 4.3-4 Volume of Deciduous Fibre by Forest Cover Types in the Jackpine Expansion Mining Area Local Study Area

Predominant Forest Cover Types[a]	Dominant Species	TPR[b]	Volume by Tree Height Class [m^3]					Total Volume [m^3]
			0 to 6 m	6.1 to 12 m	12.1 to 18 m	18.1 to 24 m	24.1 to 30 m	
Merchantable Forests								
deciduous	trembling aspen (Aw)	good	–	–	351	34,875	–	35,226
	trembling aspen (Aw)	medium	4	85	28,957	30,890	–	59,936
	trembling aspen (Aw)	fair	–	39	12,673	–	–	12,711
	white birch (Bw)	good	–	–	86	1,285	–	1,372
	white birch (Bw)	medium	–	–	10,295	5,727	–	16,022
	white birch (Bw)	fair	–	–	6,792	–	–	6,792
	balsam poplar (Pb)	good	–	–	–	853	–	853
	Deciduous Total		**4**	**124**	**59,155**	**73,629**	**0**	**132,912**
coniferous	jack pine (Pj)	good	–	–	921	1,866	–	2,787
	jack pine (Pj)	medium	–	–	1,696	540	–	2,236
	jack pine (Pj)	fair	–	4	–	–	–	4
	white spruce (Sw)	good	–	–	656	459	2,113	3,228
	white spruce (Sw)	medium	–	70	349	1,523	748	2,691
	Coniferous Total		**0**	**74**	**3,622**	**4,388**	**2,861**	**10,945**
mixedwood	trembling aspen (Aw)	good	–	–	–	759	–	759
	trembling aspen (Aw)	medium	1	–	5,545	5,906	313	11,766
	trembling aspen (Aw)	fair	9	115	355	–	–	480
	white birch (Bw)	medium	–	–	–	3,433	–	3,433
	white birch (Bw)	fair	–	–	557	–	–	557
	jack pine (Pj)	good	–	–	437	926	–	1,364
	jack pine (Pj)	medium	–	30	811	393	–	1,234
	white spruce (Sw)	good	–	–	1,558	124	254	1,936
	white spruce (Sw)	medium	–	–	–	350	–	350
	Mixedwood Total		**11**	**146**	**9,263**	**11,892**	**568**	**21,879**
harvested	mixedwood none	medium	0	–	–	–	–	0
	Harvested Total		**0**	**0**	**0**	**0**	**0**	**0**
burn[c]	Upland Burn	n/a[d]	0	–	–	–	–	0
	Upland Burn Total		**0**	**0**	**0**	**0**	**0**	**0**
Total Merchantable Forest								**165,736**
Non-Merchantable Forest								
coniferous	black spruce (Sb)	Good	159	124	225	–	–	508
	black spruce (Sb)	medium	419	2,286	306	–	–	3,011
	black spruce (Sb)	fair	199	173	–	–	–	373
	black spruce (Sb)	unproductive	298	13	–	–	–	311
	tamarack (Lt)	good	123	271	403	–	–	797
	tamarack (Lt)	medium	468	2,770	1,595	–	–	4,832
	tamarack (Lt)	fair	164	180	–	–	–	343
	tamarack (Lt)	unproductive	157	30	–	–	–	187
	Coniferous Total		**1,986**	**5,847**	**2,529**	**0**	**0**	**10,362**
mixedwood[e]	None[e]	unproductive	0	–	–	–	–	0
	Mixedwood Total		**0**	**0**	**0**	**0**	**0**	**0**
burn[c]	Wetlands Burn	n/a[d]	0	–	–	–	–	0
	Wetlands Burn Total		**0**	**0**	**0**	**0**	**0**	**0**
Total Non-Merchantable Forest								**10,362**
Total Volume								**176,098**

(a) Forest cover types described in Section 4.2.2.

(b) TPR = Timber Productivity Rating.

(c) Only burn areas with previously AVI identified merchantable species are considered merchantable.

(d) Dominant tree species have not yet been identified in burn areas.

(e) Areas re-interpreted through field investigations that do not have AVI tree species data and consequently no volume.

Note: Harvested stands include cutblocks identified through airphotos and disturbance layer and AVI identified cutblocks; all do not have an interpreted tree cover.

Some numbers are rounded for presentation purposes. Therefore, it may appear that the totals do not equal the sum of the individual values.

– = No value.

Table 4.3-5 Summary of Volume of Forest Cover Types in the Jackpine Expansion Mining Area Local Study Area

Predominant Forest Cover Types[a]	Area [ha]	Volume of Coniferous Fibre [m^3/ha]	Volume of Deciduous Fibre [m^3/ha]
Merchantable Species			
Deciduous Stands			
trembling aspen (Aw)	932	35	116
white birch (Bw)	238	35	102
balsam poplar (Pb)	8	44	105
Mean Merchantable Deciduous (Aw, Bw, Pb)		**35**	**113**
Coniferous Stands			
jack pine (Pj)	365	154	14
white spruce (Sw)	324	157	18
Mean Merchantable Coniferous (Pj, Sw)		**155**	**16**
Mixedwood Stands			
trembling aspen (Aw)	204	80	64
white birch (Bw)	57	91	70
jack pine (Pj)	69	108	38
white spruce (Sw)	48	126	48
Mean Merchantable Mixedwood (Aw, Bw, Pb, Pj, Sw)		**93**	**58**
Regenerating Stands			
harvested mixedwood	120	0	0
Mean Merchantable Regenerating		**0**	**0**
upland burn	1,099	0	0
Mean Merchantable Burn		**0**	**0**
Mean Merchantable Forest		**53**	**48**
Mean Merchantable Forest (without areas with no current volume)		**82**	**74**
Non-Merchantable Species			
black spruce (Sb)	2,745	22	2
tamarack (Lt)	3,222	27	2
mixedwood[b]	43	0	0
wetlands burn	1927	0	0
Mean Non-Merchantable Forest		**19**	**1**
Mean All Types		**29**	**15**
Mean All Types (without areas with no current volume)		**33**	**17**

[a] Forest cover types described in Section 4.2.2.

[b] Areas re-interpreted through field investigations that do not have AVI tree species data and consequently no volume.

Notes: Total volumes are not summations of individual species volumes, but an overall average volume for the type.

Some numbers are rounded for presentation purposes. Therefore, it may appear that the totals do not equal the sum of the individual values.

Tables 4.3-6 and 4.3-7 provide estimates of stand productivity that are derived by reducing the Volume Look-Up Table estimates (Appendix Q, Table Q-1) by the age attribute in the AVI database for every merchantable stand. The resulting estimates provide the coniferous and deciduous MAIs for all merchantable stands in cubic metres per hectare per year (m^3/ha/yr). Tables 4.3-6 and 4.3-7 provide totals for cover types basis to arrive at LRSYA estimates for the JEMA LSA. The total LRSYA in the JEMA LSA is estimated at 2,150 m^3/yr for coniferous

fibre and 2,075 m^3/yr for deciduous fibre, both of which also include incidental fibre.

Table 4.3-6 Coniferous Mean Annual Increment by Forest Cover Types in the Jackpine Expansion Mining Area Local Study Area

Predominant Forest Cover Types[a]	Dominant Species	Mature and Old Growth[b]			Immature[b]			Total MAI [m^3/yr]
		Area [ha]	MAI [m^3/ha/yr]	Subtotal MAI [m^3/yr]	Area [ha]	MAI [m^3/ha/yr]	Subtotal MAI [m^3/yr]	
Merchantable Forest								
deciduous	trembling aspen (Aw)	818	0.43	352.62	114	0.60	68.20	420.83
	white birch (Bw)	236	0.39	92.92	1	0.44	0.60	93.52
	balsam poplar (Pb)	8	0.49	3.97	0	0.00	0.00	3.97
Total Deciduous								**518.32**
coniferous	jack pine (Pj)	340	1.86	631.35	25	1.19	29.55	660.90
	white spruce (Sw)	319	1.74	550.01	5	0.60	2.80	552.81
Total Coniferous								**1,213.71**
mixedwood	trembling aspen (Aw)	198	0.99	196.62	6	0.04	0.27	196.89
	white birch (Bw)	57	1.01	57.35	0	0.00	0	57.35
	jack pine (Pj)	60	1.22	73.09	9	1.51	13.69	86.78
	white spruce (Sw)	48	1.60	77.02	0	0.00	0	77.02
Total Mixedwood								**418.03**
harvested	mixedwood - none	0	0.00	0.00	120	0.00	0	0.00
burn	upland burn - none	0	0.00	0.00	1,099	0.00	0	0.00
Total Regenerating								**0.00**
Total Merchantable Forest								**2,150.06**
Non-Merchantable Forest[c]								
coniferous	black spruce (Sb)	2,002	0.31	625.67	743	0.14	100.49	726.15
	tamarack (Lt)	2,798	0.32	907.46	425	0.16	66.49	973.95
mixedwood	none[d]	0	0.00	0.00	43	0.00	0	0.00
burn	wetlands burn - none	0	0.00	0.00	1,927	0.00	0	0.00
Total Non-Merchantable Forest								**1,700.10**
Total Merchantable Deciduous (Aw, Bw, Pb)								**518.32**
Total Merchantable Coniferous (Pj, Sw)								**1,213.71**
Total Merchantable Mixedwood (Aw, Bw, Pj, Sw)								**418.03**
Total Merchantable Regenerating (harvested and burned)								**0.00**
Total Merchantable Forest								**2,150.06**
Total Non-Merchantable Forest (Sb, Lt, none)[c]								**1,700.10**
LRSYA								**2,150.06**

[a] Forest cover types described in Section 4.2.2.

[b] Mean Annual Increment (MAI) for mature coniferous fibre is derived from existing growing stock in mature and over-mature stands (more than or equal to 70 years), whereas immature MAI is calculated from immature stands (less than 70 years).

[c] Non-merchantable forest does not contribute to the net merchantable land base and is included in the table for comparative purposes only.

[d] Areas re-interpreted through field investigations that do not have AVI tree species data, and consequently no volume.

Note: Some numbers are rounded for presentation purposes. Therefore, it may appear that the totals do not equal the sum of the individual values.

Table 4.3-7 Deciduous Mean Annual Increment by Forest Cover Types in the Jackpine Expansion Mining Area Local Study Area

Predominant Forest Cover Types[a]	Dominant Species	Mature and Old Growth[b]			Immature[b]			Total MAI [m^3/yr]
		Area [ha]	MAI [m^3/ha/yr]	Subtotal MAI [m^3/yr]	Area [ha]	MAI [m^3/ha/yr]	Subtotal MAI [m^3/yr]	
Merchantable Forest								
deciduous	trembling aspen (Aw)	930	1.52	1,410.24	2	0.10	0.21	1,410.45
	white birch (Bw)	238	1.15	274.24	0	0.00	0.00	274.24
	balsam poplar (Pb)	8	1.17	9.47	0	0.00	0.00	9.47
Total Deciduous								**1,694.16**
coniferous	jack pine (Pj)	365	0.16	58.79	0	0.00	0.00	58.79
	white spruce (Sw)	324	0.20	63.67	0	0.00	0.00	63.67
Total Coniferous								**122.46**
mixedwood	trembling aspen (Aw)	198	0.78	154.88	6	0.05	0.28	155.16
	white birch (Bw)	57	0.78	44.34	0	0.00	0.00	44.34
	jack pine (Pj)	69	0.44	30.06	0	0.00	0.00	30.06
	white spruce (Sw)	48	0.61	29.27	0	0.00	0.00	29.27
Total Mixedwood								**258.82**
harvested	mixedwood - none	0	0.00	0.00	120	0.00	0.00	0.00
burn	upland burn - none	0	0.00	0.00	1,099	0.00	0.00	0.00
Total Regenerating								**0.00**
Total Merchantable								**2,075.45**
Non-Merchantable Forest[c]								
coniferous	black spruce (Sb)	2,683	0.02	50.20	62	0.00	0.02	50.22
	tamarack (Lt)	3,201	0.02	69.26	21	0.01	0.28	69.54
mixedwood	none[d]	0	0.00	0.00	43	0.00	0.00	0.00
burn	wetlands burn - none	0	0.00	0.00	1,927	0.00	0.00	0.00
Total Non-Merchantable Forest								**119.77**
Total Merchantable Deciduous (Aw, Bw, Pb)								**1,694.16**
Total Merchantable Coniferous (Pj, Sw)								**122.46**
Total Merchantable Mixedwood (Aw, Bw, Pj, Sw)								**258.82**
Total Merchantable Regenerating (harvested and burned)								**0.00**
Total Merchantable Forest								**2,075.45**
Total Non-Merchantable Forest (Sb, Lt, none)[c]								**119.77**
LRSYA								**2,075.45**

[a] Forest cover types described in Section 4.2.2.

[b] Mean Annual Increment (MAI) for mature deciduous fibre is derived from existing growing stock in mature and over-mature stands (more than or equal to 50 years), whereas immature MAI is calculated from immature stands (less than 50 years).

[c] Non-merchantable forest does not contribute to the net merchantable land base and is included in the table for comparative purposes only.

[d] Areas re-interpreted through field investigations that do not have AVI tree species data and consequently no volume.

Note: The numbers presented in the above table have been rounded for presentation purposes. Therefore, the totals may not appear to equal the sum of the individual values.

4.3.4 Regenerating Stands

Regenerating stands include harvested and burn areas in the JEMA LSA. The AVI polygons with a cutblock modifier (CC) are identified as regenerating stands in the JEMA LSA. Cutblocks that have been classified to a vegetation community are considered to have reached "free-to-grow" status and are therefore not considered as regenerating stands.

Burn areas are considered regenerating stands and part of the merchantable (or productive) land base if the AVI data for the polygon indicated that it was previously dominated by merchantable tree species.

There are 442 regenerating stands in the JEMA LSA (Table 4.3-8), accounting for 3,146 ha (28%) of the total forest land base in the LSA and 17% of the LSA itself.

Table 4.3-8 Regenerating Stands in the Jackpine Expansion Mining Area Local Study Area

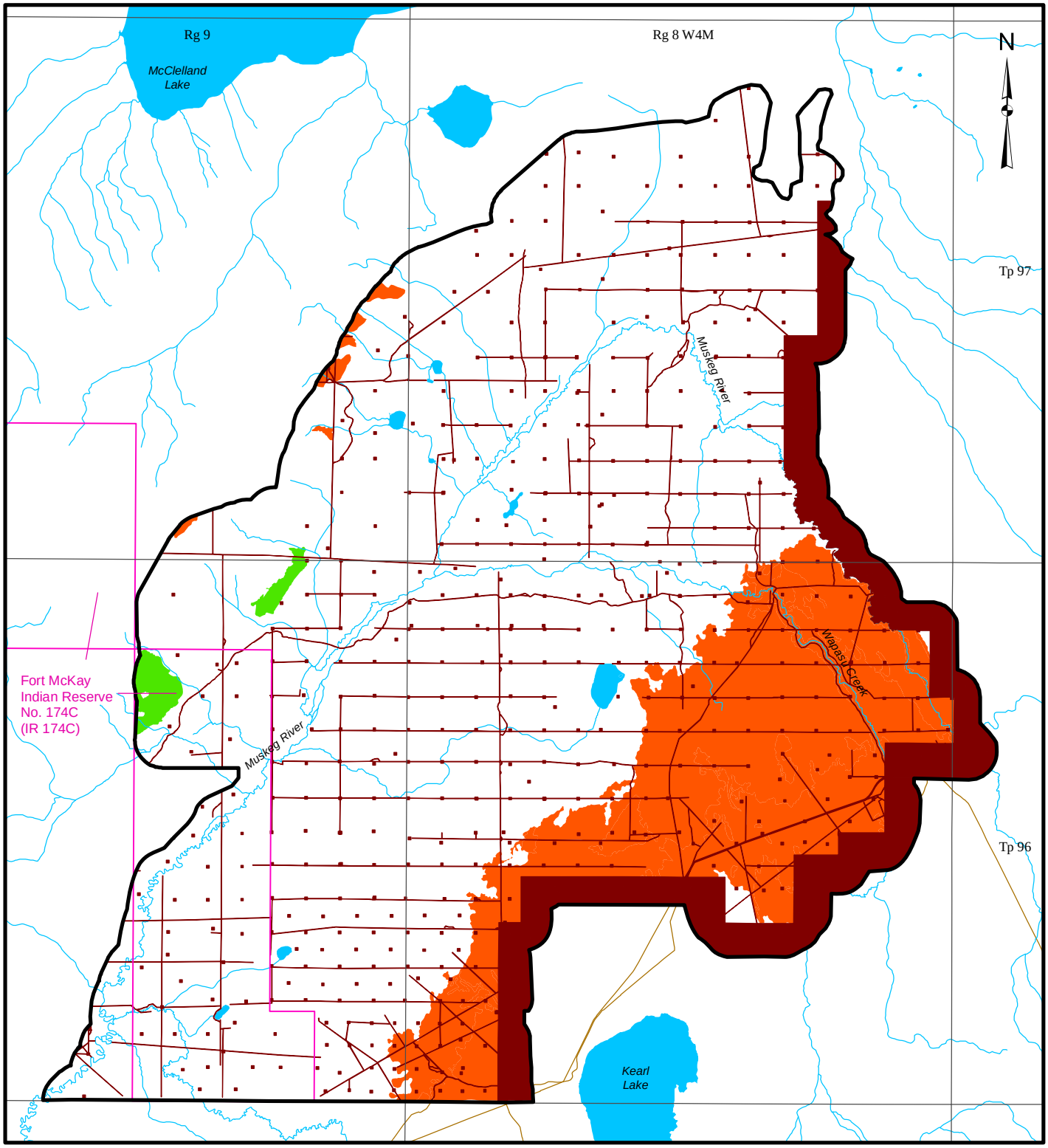
Predominant Forest Cover Type[a]	Dominant Species	Number of Stands	Stand Area [ha]	Cutblock Extent Area	
				ha	% of stand
Harvested					
harvested mixedwood	none[b]	4	120	120	100
	subtotal harvested	*4*	*120*	*120*	*100*
Burn					
upland burn	none[b]	6	8	8	100
	Aw	77	615	615	100
	Bw	1	3	3	100
	Lt	1	2	2	100
	Pj	33	164	164	100
	Sb	23	169	169	100
	Sw	48	164	164	100
wetlands burn	none[b]	31	132	132	100
	Bw	2	2	2	100
	Lt	71	284	284	100
	Pj	2	6	6	100
	Sb	140	1,473	1,473	100
	Sw	3	5	5	100
	subtotal burn	*438*	*3,026*	*3,026*	*100*
Total Regenerating		**442**	**3,146**	**3,146**	**100**

[a] Forest cover types described in Section 4.2.2.

[b] Regenerating stands that presently have no identified dominant species.

Note: Some numbers are rounded for presentation purposes. Therefore, it may appear that the totals do not equal the sum of the individual values.

The 2002 Kearl Lake wildfire in the southeast accounts for most of the regenerating stands in the JEMA LSA (Figure 4.3-2). There are some smaller burned areas in the Fort Hills in the northwest portion of the LSA. The harvested blocks are also in the Fort Hills, on the west side of the Jackpine Expansion Mining Area LSA. Reforestation standards require harvested areas, including cutblocks, to regenerate to a similar composition of the previous forest, with an 80% stocking and a “free-to-grow” status after 14 years (ASRD 2007b, website).



LEGEND

- JACKPINE EXPANSION MINING AREA LOCAL STUDY AREA
- INDIAN RESERVE
- OPEN WATER
- PUBLIC ROADWAY

REGENERATING STANDS

- HARVESTED
- BURNED

DISTURBED

- EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE
- EXISTING AND APPROVED URBAN AND INDUSTRIAL LINEAR DISTURBANCE

3 0 3

SCALE 1:100,000 KILOMETRES

REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2004), and Alberta SRD, used under license.
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 12.

PROJECT

JACKPINE MINE EXPANSION & PIERRE RIVER MINE PROJECT

TITLE

REGENERATING STANDS IN THE JACKPINE MINE EXPANSION MINING AREA LOCAL STUDY AREA

Shell Canada Limited

PROJECT No. 05-1344-027.7600			SCALE AS SHOWN	REV. 0
DESIGN	VR	03 Aug. 2007		
GIS	VR	28 Sep. 2007		
CHECK	AA	16 Nov. 2007		
REVIEW	WESTC	20 Nov. 2007		

FIGURE: 4.3-2

Project: I:\CLIENTS\SHELL\05-1344-027\mapping\mxd\forestry\DRAFT\jackpine\bl_reg_esr.mxd - Plot: ?:\J\2005\GIS\ArcMapTemplates\templates\v91\MyProject.pdf?

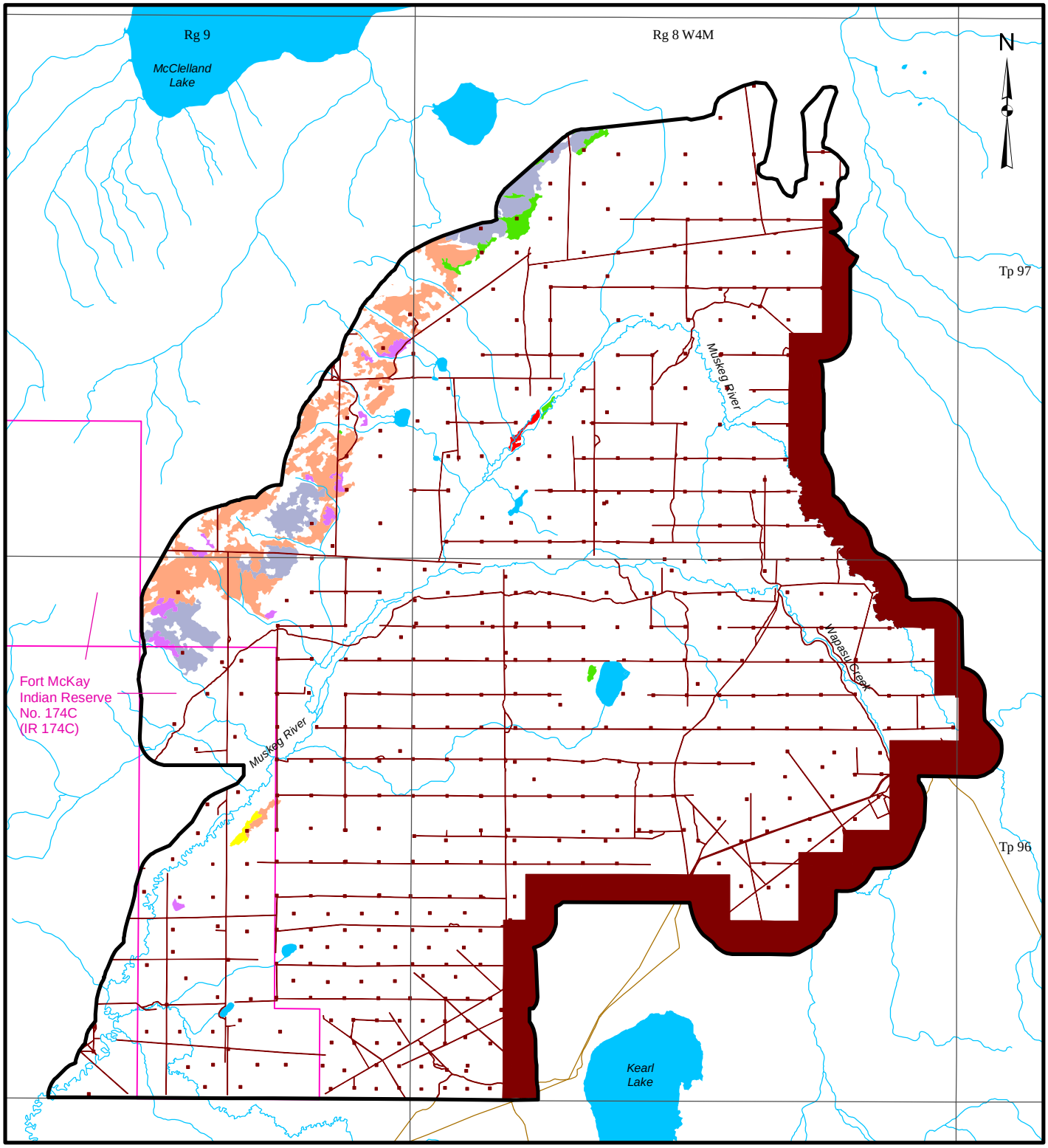
4.3.5 Old Growth Forests

There are 117 old growth stands ranging in age from 100 to 140 years in the JEMA LSA (Figure 4.3-3). Most old growth stands are in the Fort Hills in the northwest of the LSA and are primarily trembling aspen or white birch dominant.

For the purpose of this report, black spruce, white spruce, tamarack and balsam fir stands were considered old growth at 140 years, jack pine stands at 120 years and deciduous and mixedwood stands at 100 years. Table 4.3-9 shows that the 117 old growth stands in the JEMA LSA occupy an area of 840 ha. There are 39 stands of trembling aspen with a jack pine understorey that occupy 237 ha. There are 10 stands of white birch with a trembling aspen understorey that occupy 164 ha.

Table 4.3-9 Old Growth Stands in the Jackpine Expansion Mining Area Local Study Area

Dominant/Subdominant Species	Number of Stands	Area [ha]	Age Range [yr]
trembling aspen/none	8	21	100
trembling aspen/white birch	17	166	100
trembling aspen/balsam poplar	1	8	100
trembling aspen/jack pine	39	237	100 to 110
trembling aspen/white spruce	8	47	100 to 130
white birch/trembling aspen	10	164	100
white birch/jack pine	1	4	100
white birch/white spruce	7	79	100
balsam poplar/trembling aspen	1	8	100
jack pine/trembling aspen	14	51	100 to 130
black spruce/white spruce	1	8	140
white spruce/none	1	6	120
white spruce/trembling aspen	7	34	110 to 140
white spruce/balsam poplar	1	3	130
white spruce/black spruce	1	3	140
Total	**117**	**840**	**100 to 140**



LEGEND

- JACKPINE EXPANSION MINING AREA LOCAL STUDY AREA
- INDIAN RESERVE
- OPEN WATER
- PUBLIC ROADWAY

OLD GROWTH FOREST

- TREMBLING ASPEN (Aw)
- WHITE BIRCH (Bw)
- BALSAM POPLAR (Pb)
- JACK PINE (Pj)
- WHITE SPRUCE (Sw)
- BLACK SPRUCE (Sb)

DISTURBED

- EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE
- EXISTING AND APPROVED URBAN AND INDUSTRIAL LINEAR DISTURBANCE

3 0 3

SCALE 1:100,000 KILOMETRES

REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2004), and Alberta SRD, used under license.
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 12.

PROJECT

JACKPINE MINE EXPANSION & PIERRE RIVER MINE PROJECT

TITLE

OLD GROWTH FORESTS IN THE JACKPINE EXPANSION MINING AREA LOCAL STUDY AREA

Shell Canada Limited

PROJECT No. 05-1344-027.7600			SCALE AS SHOWN	REV. 0
DESIGN	VR	03 Aug. 2007	FIGURE: 4.3-3	
GIS	VR	28 Sep. 2007		
CHECK	AA	16 Nov. 2007		
REVIEW	WESTC	20 Nov. 2007		

Project: I:\CLIENTS\SHELL\05-1344-027\mapping\mxd\forestry\DRAFT\jackpine\bl_ogr_esr.mxd - Plot: ?:\12005\GIS\ArcMapTemplates\templates\v91\MyProject.pdf?

4.3.6 Multistorey Stands

Assessing multistorey stands provides a more complete picture of forest resources in the JEMA LSA, including the characterization of potentially recoverable understorey fibre and stand growth features. Table 4.3-10 provides a summary of all multistorey stands in the JEMA LSA. There are 907 multistorey stands that occupy 3,108 ha in the JEMA LSA. There are 441 multistorey tree stands and 234 multistorey shrub stands. Stands with tamarack in both the main canopy and understorey have the greatest number of treed multistorey stands (190). Stands composed of tamarack and closed shrub have the greatest number of stands containing a defined shrub layer (133).

The AVI also considers herbaceous grasslands and bryophyte cover as a multistorey structural layer. Although these layers are present in most vegetation types in some combination, multistorey stands with an AVI identified herbaceous grassland, or bryophyte layer are also presented in Table 4.3-10. There are 232 multistorey stands with an identified herbaceous grassland, or bryophyte layer in the JEMA LSA.

Table 4.3-10 Multistorey Stands in the Jackpine Expansion Mining Area Local Study Area

Dominant Overstorey	Dominant Understorey	Stands	Area [ha]
Treed Multistorey			
trembling aspen (Aw)	black spruce (Sb)	22	45
trembling aspen (Aw)	white spruce (Sw)	70	238
white birch (Bw)	white birch (Bw)	1	13
white birch (Bw)	white spruce (Sw)	10	59
jack pine (Pj)	black spruce (Sb)	27	53
white spruce (Sw)	white birch (Bw)	5	25
white spruce (Sw)	black spruce (Sb)	29	58
white spruce (Sw)	white spruce (Sw)	5	24
black spruce (Sb)	tamarack (Lt)	1	5
black spruce (Sb)	black spruce (Sb)	37	29
tamarack (Lt)	tamarack (Lt)	190	748
tamarack (Lt)	black spruce (Sb)	44	106
Total Treed Multistorey		**441**	**1,401**
Shrub			
trembling aspen (Aw)	closed shrub	38	124
white birch (Bw)	closed shrub	4	17
jack pine (Pj)	closed shrub	11	17
white spruce (Sw)	closed shrub	9	23
black spruce (Sb)	closed shrub	39	83
tamarack (Lt)	closed shrub	133	344
Total Shrub Multistorey		**234**	**608**
Forest Floor Multistorey			
jack pine (Pj)	bryophyte	7	4

Table 4.3-10 Multistorey Stands in the Jackpine Expansion Mining Area Local Study Area (continued)

Dominant Overstorey	Dominant Understorey	Stands	Area [ha]
black spruce (Sb)	bryophyte	3	2
tamarack (Lt)	bryophyte	4	11
trembling aspen (Aw)	herbaceous grassland	8	12
white birch (Bw)	herbaceous grassland	3	26
jack pine (Pj)	herbaceous grassland	8	23
white spruce (Sw)	herbaceous grassland	1	3
black spruce (Sb)	herbaceous grassland	82	429
tamarack (Lt)	herbaceous grassland	116	590
Total Forest Floor Multistorey		**232**	**1,100**
Total Multistorey Stands		**907**	**3,108**

Note: Some numbers are rounded for presentation purposes. Therefore, it may appear that the totals do not equal the sum of the individual values.

4.4 PIERRE RIVER MINING AREA RESULTS

4.4.1 Alberta Vegetation Inventory (Cover Map)

The AVI maps, including the cover map (orthophotograph) with AVI boundaries are found in Appendix P, Figures P-1 to P-54. The cover map is presented at a 1:10,000 scale, which is a larger scale than the required minimum of 1:20,000 scale. The AVI database used in this assessment has been approved by ASRD (Parry 2003, pers. comm.).

4.4.2 Forest Cover Area

The PRMA LSA is 21,136 ha with merchantable forests occupying 14,146 ha (67%) of the LSA (Tables 4.4-1 and 4.4-2). Merchantable forests are composed of the following (Table 4.4-1):

- 5,134 ha of deciduous stands with dominant species of trembling aspen, white birch, or balsam poplar;
- 6,839 ha of coniferous stands with dominant species of jack pine, or white spruce;
- 1,629 ha of mixedwood stands with dominant species of trembling aspen, white birch, balsam poplar, jack pine, white spruce, or no identified dominant species; and
- 543 ha of harvested regenerating stands with dominant species of trembling aspen, balsam poplar, or with no current identified dominant species.

Overall, trembling aspen dominated stands, including both deciduous and mixedwood stands, occupy the greatest area of merchantable forest land covering 5,460 ha (26%) of the PRMA LSA (Table 4.4-2). Jack pine dominant stands, including coniferous and mixedwood stands, occupy the second greatest area of merchantable forest, covering 5,272 ha (25%) of the PRMA LSA (Table 4.4-2). The remaining merchantable land base is composed of white birch, balsam poplar and white spruce and harvested regenerating stands. Productive stands (i.e., TPR value of good) occur throughout the PRMA LSA, but a high proportion is concentrated in the southwestern portion of the LSA (Figure 4.4-1).

Table 4.4-1 Area of Forest Cover Type and Timber Productivity Rating in the Pierre River Mining Area Local Study Area

Predominant Forest Cover Types[a]	Dominant Species	TPR[b]	Areas by Tree Height Class [ha]					Total Area [ha]
			0 to 6 m	6.1 to 12 m	12.1 to 18 m	18.1 to 24 m	24.1 to 30 m	
Merchantable Forests								
deciduous	trembling aspen (Aw)	good	<1	–	934	1,937	86	2,958
	trembling aspen (Aw)	medium	–	25	1,286	349	–	1,660
	trembling aspen (Aw)	fair	–	2	12	–	–	15
	white birch (Bw)	good	–	–	30	–	–	30
	white birch (Bw)	medium	–	9	130	–	–	139
	white birch (Bw)	fair	–	31	17	–	–	48
	balsam poplar (Pb)	good	<1	16	–	34	144	194
	balsam poplar (Pb)	medium	–	–	–	35	57	92
	Deciduous Total		**1**	**83**	**2,409**	**2,354**	**287**	**5,134**
coniferous	jack pine (Pj)	good	3	1	1,550	146	2	1,703
	jack pine (Pj)	medium	2	19	2,438	811	–	3,269
	jack pine (Pj)	fair	–	2	11	–	–	13
	white spruce (Sw)	good	–	26	213	95	266	601
	white spruce (Sw)	medium	3	42	242	397	540	1,223
	white spruce (Sw)	fair	–	8	12	10	–	30
	Coniferous Total		**7**	**98**	**4,465**	**1,460**	**808**	**6,839**
mixedwood	trembling aspen (Aw)	good	–	1	228	150	4	384
	trembling aspen (Aw)	medium	–	<1	375	33	31	440
	trembling aspen (Aw)	fair	–	3	1	–	–	4
	white birch (Bw)	good	–	–	19	–	–	19
	white birch (Bw)	medium	–	3	71	–	–	74
	white birch (Bw)	fair	10	11	–	–	–	21
	balsam poplar (Pb)	good	–	–	–	–	6	6
	balsam poplar (Pb)	medium	–	–	2	–	–	2
	jack pine (Pj)	good	–	–	126	11	–	137
	jack pine (Pj)	medium	–	12	91	48	–	150
	white spruce (Sw)	good	7	7	113	45	29	201
	white spruce (Sw)	medium	–	6	10	64	93	173

Table 4.4-1 Area of Forest Cover Type and Timber Productivity Rating in the Pierre River Mining Area Local Study Area (continued)

Predominant Forest Cover Types[a]	Dominant Species	TPR[b]	Areas by Tree Height Class [ha]					Total Area [ha]
			0 to 6 m	6.1 to 12 m	12.1 to 18 m	18.1 to 24 m	24.1 to 30 m	
	none[c]	fair	2	–	–	–	–	2
	none[c]	unproductive	17	–	–	–	–	17
	Mixedwood Total		**36**	**44**	**1,036**	**351**	**162**	**1,629**
harvested	deciduous trembling aspen (Aw)	good	7	–	–	–	–	7
	mixedwood balsam poplar (Pb)	good	–	–	1	–	–	1
	mixedwood (none)	good	496	–	–	–	–	496
	mixedwood (none)	medium	39	–	–	–	–	39
	Harvested Total		**542**	**0**	**1**	**0**	**0**	**543**
Total Merchantable Forest								**14,146**
Non-Merchantable Forest								
coniferous	black spruce (Sb)	good	124	517	19	–	–	660
	black spruce (Sb)	medium	589	1,087	19	–	–	1,695
	black spruce (Sb)	fair	400	46	–	–	–	446
	black spruce (Sb)	unproductive	168	29	–	–	–	198
	tamarack (Lt)	good	–	77	97	–	–	174
	tamarack (Lt)	medium	93	298	48	–	–	439
	tamarack (Lt)	fair	25	38	–	–	–	63
	tamarack (Lt)	unproductive	52	–	–	–	–	52
	Coniferous Total		**1,452**	**2,091**	**183**	**0**	**0**	**3,727**
mixedwood	black spruce (Sb)	good	–	23	–	–	–	23
	black spruce (Sb)	medium	–	3	–	–	–	3
	tamarack (Lt)	good	–	–	1	–	–	1
	none[c]	unproductive	86	–	–	–	–	86
	Total Mixedwood		**86**	**26**	**1**	**0**	**0**	**112**
Total Non-Merchantable Forest (Sb, Lt, none)								**3,839**
Total Non-Forested[d]								**2,720**
Total Disturbance								**431**
Total Landbase								**21,136**

[a] Forest cover types described in Section 4.2.2.

[b] TPR = Timber Productivity Rating.

[c] Areas re-interpreted through field investigations that do not have AVI tree species data.

[d] Non-forested areas include shrublands, meadows, sand, open wetlands, burns, lakes and rivers.

Note: Harvested stands include cutblocks identified through airphotos and disturbance layer and AVI identified cutblocks; all do not have an interpreted tree cover.

Some numbers are rounded for presentation purposes. Therefore, it may appear that the totals do not equal the sum of individual values.

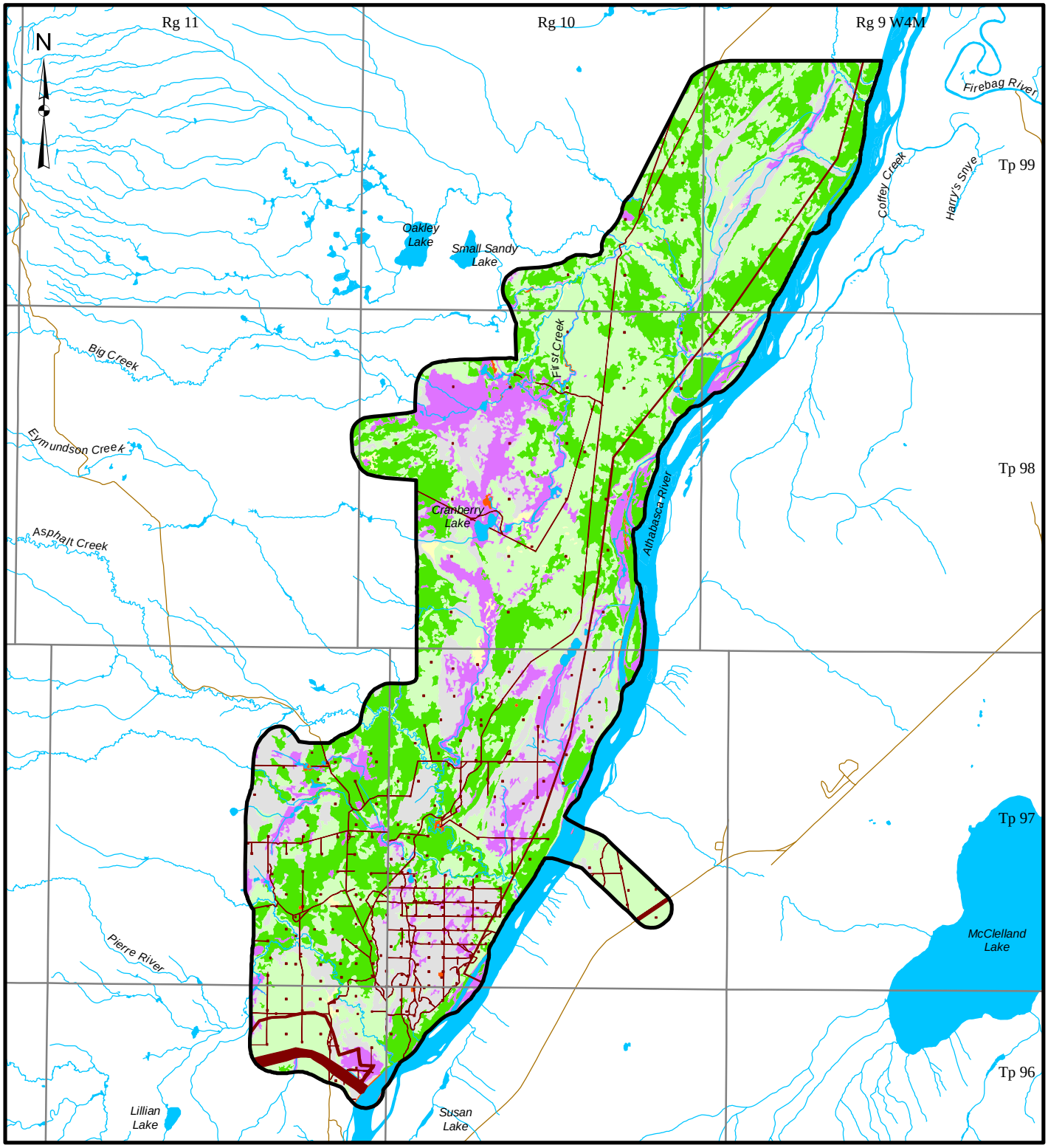
– = No value.

Table 4.4-2 Merchantable and Non-Merchantable Forest Land Bases in the Pierre River Mining Area Local Study Area

Dominant Tree Species	Total Area [ha]	Percent of LSA [%]	Percent of Total LSA Forest Land Base [%]	Percent of LSA Merchantable/ Non-Merchantable Forest Land Base [%]
Merchantable Landbase				
trembling aspen (Aw)	5,460	26	30	39
white birch (Bw)	330	2	2	2
balsam poplar (Pb)	293	1	2	2
jack pine (Pj)	5,272	25	29	37
white spruce (Sw)	2,228	11	12	16
mixedwood (none)	19	<1	<1	<1
harvested deciduous (Aw)	7	<1	<1	<1
harvested mixedwood (Pb)	1	<1	<1	<1
harvested (none)	535	3	3	4
Total Merchantable	**14,145**	**67**	**79**	**100**
Non-Merchantable Landbase				
black spruce (Sb)	3,025	14	17	79
tamarack (Lt)	729	3	4	19
mixedwood (none)	86	<1	<1	2
Total Non-Merchantable	**3,839**	**18**	**21**	**100**
Total Forest	**17,985**	**85**	**100**	**n/a**

Note: Some numbers are rounded for presentation purposes. Therefore, it may appear that the totals do not equal the sum of the individual values.

n/a = Not applicable.



LEGEND

- PIERRE RIVER MINING AREA LOCAL STUDY AREA
- OPEN WATER
- ACCESS ROAD

DISTURBED

- EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE
- EXISTING AND APPROVED URBAN AND INDUSTRIAL LINEAR DISTURBANCE

TIMBER PRODUCTIVITY RATING

- GOOD
- MEDIUM
- FAIR
- UNPRODUCTIVE
- NON-FORESTED
- NON-VEGETATED

4 0 4
SCALE 1:160,000 KILOMETRES

REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2004), and Alberta SRD, used under license.
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 12.

PROJECT
JACKPINE MINE EXPANSION & PIERRE RIVER MINE PROJECT

TITLE
TIMBER PRODUCTIVITY RATING IN THE PIERRE RIVER MINING AREA LOCAL STUDY AREA

Shell Canada Limited

PROJECT No. 05-1344-027.7600			SCALE AS SHOWN	REV. 0
DESIGN	VR	02 Aug. 2007	FIGURE: 4.4-1	
GIS	VR	28 Sep. 2007		
CHECK	AA	16 Nov. 2007		
REVIEW	WES/TC	20 Nov. 2007		

Project: I:\CLIENTS\SHELL\05-1344-027\mapping\mxd\forestry\DRAFT\pierreriverlnbl_tpr_esri.mxd - Plot: ?J:\2005\GIS\ArcMapTemplates\templatesv91\MyProject.pdf?

Non-merchantable forests, including all black spruce and tamarack dominated stands, occupy 3,839 ha (18%) of the PRMA LSA (Table 4.4-2). Black spruce stands occupy 3,025 ha (14%) of the PRMA LSA and tamarack stands occupy 729 ha (3%) of the LSA (Table 4.4-2). The remaining non-merchantable forest area (86 ha) is composed of non-merchantable mixedwood stands without an identified AVI tree cover (Table 4.4-2). These stands were re-interpreted as treed stands during field survey mapping for the Project.

Unproductive, non-forested areas include shrublands, meadows, sand, open wetlands, burns, lakes and rivers occupying 2,720 ha (13%) of the PRMA LSA (Table 4.4-1). Disturbed lands, which include roads, cleared areas and infrastructure, occupy 431 ha (2%) of the PRMA LSA (Table 4.4-1).

4.4.3 Forest Volume and Productivity Estimates

Within the AVI attribute database, all forested stands are rated as having a good, medium, fair, or unproductive TPR. As black spruce and tamarack stands are not harvested, they are considered to be non-merchantable in this assessment. However, the total volumes of these stands were calculated for continuity. Timber volumes for coniferous and deciduous fibre are detailed in Tables 4.4-3 and 4.4-4, respectively. Of a total 1,565,063 m^3, there is an estimated 1,445,967 m^3 of merchantable coniferous fibre in the PRMA LSA. There is a total volume of 859,706 m^3 of deciduous fibre, of which 851,550 m^3 is considered merchantable.

Table 4.4-5 provides a summary of average timber volumes per hectare (m^3/ha). The average volume of merchantable fibre within deciduous stands in the PRMA LSA is 129 m^3/ha of deciduous fibre and 38 m^3/ha of coniferous fibre. Conversely, the average volume of merchantable fibre within coniferous stands in the PRMA LSA is 160 m^3/ha of coniferous fibre and 14 m^3/ha of deciduous fibre. Overall, the average volume for merchantable forests, not including stands without identifiable volume (harvested), is 90 m^3/ha of coniferous fibre and 49 m^3/ha of deciduous fibre. The average volume of non-merchantable stands, consisting of black spruce and tamarack, is 31 m^3/ha of coniferous fibre and 2 m^3/ha of deciduous fibre.

Tables 4.4-6 and 4.4-7 provide estimates of stand productivity that are derived by reducing the Volume Look-Up Table estimates (Appendix Q, Table Q-1) by the age attribute found in the AVI database for every merchantable stand. The resulting estimates provide the coniferous and deciduous MAIs for all merchantable stands in cubic metres per hectare per year (m^3/ha/yr). The total LRSYA in the PRMA LSA is estimated at 18,471 m^3/yr for coniferous fibre (Table 4.4-6) and 11,840 m^3/yr (Table 4.4-7) for deciduous fibre, both of which also include incidental fibre.

Table 4.4-3 Volume of Coniferous Fibre by Forest Cover Types in the Pierre River Mining Area Local Study Area

Predominant Forest Cover Types[a]	Dominant Species	TPR[b]	Volume by Tree Height Class [m^3]					Total Volume [m^3]
			0 to 6 m	6.1 to 12 m	12.1 to 18 m	18.1 to 24 m	24.1 to 30 m	
Merchantable Forests								
deciduous	trembling aspen (Aw)	good	2	–	30,811	88,242	4,607	123,661
	trembling aspen (Aw)	medium	–	356	37,726	15,217	–	53,299
	trembling aspen (Aw)	fair	–	9	337	–	–	346
	white birch (Bw)	good	–	–	787	–	–	787
	white birch (Bw)	medium	–	53	2,599	–	–	2,653
	white birch (Bw)	fair	–	157	183	–	–	340
	balsam poplar (Pb)	good	<1	65	–	1,682	7,491	9,237
	balsam poplar (Pb)	medium	–	–	–	1,693	2,940	4,633
	Deciduous Total		**2**	**641**	**72,442**	**106,834**	**15,037**	**194,956**
coniferous	jack pine (Pj)	good	43	24	235,415	28,818	535	264,835
	jack pine (Pj)	medium	7	1,325	374,028	148,304	–	523,664
	jack pine (Pj)	fair	–	151	951	–	–	1,102
	white spruce (Sw)	good	–	1,930	30,256	18,516	50,719	101,421
	white spruce (Sw)	medium	28	1,751	30,543	66,576	101,586	200,484
	white spruce (Sw)	fair	–	479	973	1,012	–	2,464
	Coniferous Total		**77**	**5,660**	**672,166**	**263,226**	**152,840**	**1,093,969**
mixedwood	trembling aspen (Aw)	good	–	9	19,690	16,112	510	36,320
	trembling aspen (Aw)	medium	–	3	28,536	3,716	2,689	34,944
	trembling aspen (Aw)	fair	–	87	58	–	–	145
	white birch (Bw)	good	–	–	1,712	–	–	1,712
	white birch (Bw)	medium	–	31	4,224	–	–	4,255
	white birch (Bw)	fair	40	162	–	–	–	202
	balsam poplar (Pb)	good	–	–	–	–	767	767
	balsam poplar (Pb)	medium	–	–	102	–	–	102
	jack pine (Pj)	good	–	–	15,268	1,376	–	16,644
	jack pine (Pj)	medium	–	509	9,203	6,449	–	16,162
	white spruce (Sw)	good	70	277	12,344	6,766	3,622	23,080
	white spruce (Sw)	medium	–	266	804	9,120	12,482	22,672
	none[c]	fair	0	–	–	–	–	0
	none[c]	unproductive	0	–	–	–	–	0
	Mixedwood Total		**111**	**1,344**	**91,941**	**43,538**	**20,071**	**157,005**
harvested	deciduous trembling aspen (Aw)	good	15	–	–	–	–	15
	mixedwood balsam poplar (Pb)	good	–	–	23	–	–	23
	mixedwood none	good	0	–	–	–	–	0
	mixedwood none	medium	0	–	–	–	–	0
	Harvested Total		**15**	**0**	**23**	**0**	**0**	**38**
Total Merchantable Forest								**1,445,967**

Table 4.4-3 Volume of Coniferous Fibre by Forest Cover Types in the Pierre River Mining Area Local Study Area (continued)

Predominant Forest Cover Types[a]	Dominant Species	TPR[b]	Volume by Tree Height Class [m^3]					Total Volume [m^3]
			0 to 6 m	6.1 to 12 m	12.1 to 18 m	18.1 to 24 m	24.1 to 30 m	
Non-Merchantable Forest								
coniferous	black spruce (Sb)	good	2,414	26,120	1,952	–	–	30,486
	black spruce (Sb)	medium	7,603	42,888	1,829	–	–	52,320
	black spruce (Sb)	fair	2,674	1,433	–	–	–	4,107
	black spruce (Sb)	unproductive	578	445	–	–	–	1,024
	tamarack (Lt)	good	–	3,536	9,730	–	–	13,266
	tamarack (Lt)	medium	655	10,531	3,723	–	–	14,909
	tamarack (Lt)	fair	176	968		–	–	1,144
	tamarack (Lt)	unproductive	573	–	–	–	–	573
	Coniferous Total		**14,674**	**85,921**	**17,233**	**0**	**0**	**117,828**
mixedwood	black spruce (Sb)	good	–	1,004	–	–	–	1,004
	black spruce (Sb)	medium	–	189	–	–	–	189
	tamarack (Lt)	good	–	–	74	–	–	74
	none[c]	unproductive	0	–	–	–	–	0
	Mixedwood Total		**0**	**1,193**	**74**	**0**	**0**	**1,267**
Total Non-Merchantable Forest								**119,096**
Total Volume								**1,565,063**

[a] Forest cover types described in Section 4.2.2.

[b] TPR = Timber productivity rating.

[c] Areas re-interpreted through field investigations that do not have AVI tree species data and consequently no volume.

Note: Harvested stands include cutblocks identified through airphotos and disturbance layer and AVI identified cutblocks; all do not have an interpreted tree cover.

Some numbers are rounded for presentation purposes. Therefore, it may appear that the totals do not equal the sum of individual values.

– = No value.

Table 4.4-4 Volume of Deciduous Fibre by Forest Cover Types in the Pierre River Mining Area Local Study Area

Predominant Forest Cover Types[a]	Dominant Species	TPR[b]	Volume by Tree Height Class [m^3]					Total Volume [m^3]
			0 to 6 m	6.1 to 12 m	12.1 to 18 m	18.1 to 24 m	24.1 to 30 m	
Merchantable Forests								
deciduous	trembling aspen (Aw)	good	3	–	108,308	301,112	14,155	423,578
	trembling aspen (Aw)	medium	–	1,305	133,103	50,862	–	185,270
	trembling aspen (Aw)	fair	–	16	1,009	–	–	1,026
	white birch (Bw)	good	–	–	3,192	–	–	3,192
	white birch (Bw)	medium	–	90	6,273	–	–	6,364
	white birch (Bw)	fair	–	257	349	–	–	606
	balsam poplar (Pb)	good	2	436	–	5,158	22,219	27,814
	balsam poplar (Pb)	medium	–	–	–	4,257	9,302	13,558
	Deciduous Total		**5**	**2,104**	**252,235**	**361,388**	**45,676**	**661,408**
coniferous	jack pine (Pj)	good	3	1	17,330	3,115	78	20,528
	jack pine (Pj)	medium	0	87	23,411	15,761	–	39,259
	jack pine (Pj)	fair	–	10	79	–	–	90
	white spruce (Sw)	good	–	126	2,330	2,108	7,124	11,688
	white spruce (Sw)	medium	3	114	2,325	7,243	14,441	24,125
	white spruce (Sw)	fair	–	25	87	93	–	205
	Coniferous Total		**6**	**364**	**45,563**	**28,319**	**21,643**	**95,895**
mixedwood	trembling aspen (Aw)	good	–	5	17,709	13,100	412	31,225
	trembling aspen (Aw)	medium	–	3	24,163	3,129	2,377	29,671
	trembling aspen (Aw)	fair	–	35	47	–	–	82
	white birch (Bw)	good	–	–	1,432	–	–	1,432
	white birch (Bw)	medium	–	12	2,316	–	–	2,328
	white birch (Bw)	fair	20	76	–	–	–	96
	balsam poplar (Pb)	good	–	–	–	–	630	630
	balsam poplar (Pb)	medium	–	–	56	–	–	56
	jack pine (Pj)	good	–	–	5,558	490	–	6,048
	jack pine (Pj)	medium	–	146	3,172	2,333	–	5,651
	white spruce (Sw)	good	70	128	4,112	2,592	1,440	8,343
	white spruce (Sw)	medium	–	76	293	3,416	4,867	8,652
	none	fair	0	–	–	–	–	0
	none	unproductive	0	–	–	–	–	0
	Mixedwood Total		**90**	**481**	**58,859**	**25,060**	**9,725**	**94,216**
harvested	deciduous trembling aspen (Aw)	good	22	–	–	–	–	22
	mixedwood balsam poplar (Pb)	good	–	–	9	–	–	9
	mixedwood none	good	0	–	–	–	–	0
	mixedwood none	medium	0	–	–	–	–	0
	Harvested Total		**22**	**0**	**9**	**0**	**0**	**31**
Total Merchantable Forest								**851,550**

Table 4.4-4 Volume of Deciduous Fibre by Forest Cover Types in the Pierre River Mining Area Local Study Area (continued)

Predominant Forest Cover Types[a]	Dominant Species	TPR[b]	Volume by Tree Height Class [m^3]					Total Volume [m^3]
			0 to 6 m	6.1 to 12 m	12.1 to 18 m	18.1 to 24 m	24.1 to 30 m	
Non-Merchantable Forest								
coniferous	black spruce (Sb)	good	122	1,514	150	–	–	1,786
	black spruce (Sb)	medium	584	2,403	131	–	–	3,118
	black spruce (Sb)	fair	396	76	–	–	–	472
	black spruce (Sb)	unproductive	75	32	–	–	–	107
	tamarack (Lt)	good		253	710	–	–	963
	tamarack (Lt)	medium	44	702	274	–	–	1,020
	tamarack (Lt)	fair	25	78	–	–	–	103
	tamarack (Lt)	unproductive	52	–	–	–	–	52
	Coniferous Total		**1,299**	**5,057**	**1,265**	**0**	**0**	**7,621**
mixedwood	black spruce (Sb)	good	–	416	–	–	–	416
	black spruce (Sb)	medium	–	90	–	–	–	90
	tamarack (Lt)	good	–	–	29	–	–	29
	none	unproductive	0	–	–	–	–	0
	Total Mixedwood		**0**	**506**	**29**	**0**	**0**	**535**
Total Non-Merchantable Forest								**8,156**
Total Volume								**859,706**

[a] Forest cover types described in Section 4.2.2.

[b] TPR = Timber productivity rating.

[c] Areas re-interpreted through field investigations that do not have AVI tree species data, and consequently no volume.

Note: Harvested stands include cutblocks identified through airphotos and disturbance layer and AVI identified cutblocks; all do not have an interpreted tree cover.

Some numbers are rounded for presentation purposes. Therefore, it may appear that the totals do not equal the sum of individual values.

– = No value.

Table 4.4-5 Summary of Volume of Forest Cover Types in the Pierre River Mining Area Local Study Area

Predominant Forest Cover Types[a]	Area [ha]	Volume of Coniferous Fibre [m^3/ha]	Volume of Deciduous Fibre [m^3/ha]
Merchantable			
Deciduous Stands			
trembling aspen (Aw)	4,632	38	132
white birch (Bw)	216	17	47
balsam poplar (Pb)	286	49	145
Mean Merchantable Deciduous (Aw, Bw, Pb)		**38**	**129**
Coniferous Stands			
jack pine (Pj)	4,985	158	12
white spruce (Sw)	1,854	164	19
Mean Merchantable Coniferous (Pj, Sw)		**160**	**14**
Mixedwood Stands			
trembling aspen (Aw)	828	86	74
white birch (Bw)	114	54	34
jack pine (Pj)	287	114	41
white spruce (Sw)	374	122	45
mixedwood none[b]	19	0	0
Mean Merchantable Mixedwood (Aw, Bw, Pb, Pj, Sw)		**96**	**58**
Regenerating Stands			
harvested deciduous (Aw)	7	2	3
harvested mixedwood (Bw)	1	23	9
harvested mixedwood (none)	535	0	0
Mean Merchantable Regenerating (Harvested)		**<1**	**<1**
Mean Merchantable Forest		**102**	**60**
Mean Merchantable Forest (without areas with no current volume)		**106**	**63**
Non-Merchantable Species			
black spruce (Sb)	2,999	29	2
tamarack (Lt)	728	41	3
black spruce (Sb)	26	46	19
tamarack (Lt)	1	91	36
mixedwood[b]	86	0	0
Mean Non-Merchantable Forest		**31**	**2**
Mean All Types		**87**	**48**
Mean All Types (without areas with no current volume)		**90**	**49**

[a] Forest cover types described in Section 4.2.2.

[b] Areas re-interpreted through field investigations that do not have AVI tree species data and consequently no volume.

Note: Total volumes are not summation of individual species volumes, but an overall average volume for the type.

Some numbers are rounded for presentation purposes. Therefore, it may appear that the totals do not equal the sum of the individual values.

Table 4.4-6 Coniferous Mean Annual Increment by Forest Cover Types in the Pierre River Mining Area Local Study Area

Predominant Forest Cover Types[a]	Dominant Species	Mature and Old Growth[b]			Immature[b]			Total MAI [m^3/yr]
		Area [ha]	MAI [m^3/ha/yr]	Subtotal MAI [m^3/yr]	Area [ha]	MAI [m^3/ha/yr]	Subtotal MAI [m^3/yr]	
deciduous	trembling aspen (Aw)	2,588	0.56	1,446.84	2,044	0.55	1,133.18	2,580.02
	white birch (Bw)	72	0.32	23.02	144	0.25	35.63	58.65
	balsam poplar (Pb)	269	0.45	120.49	17	0.20	3.24	123.73
Total Deciduous								**2,762.39**
coniferous	jack pine (Pj)	2,444	1.91	4,669.01	2,541	2.42	6,147.01	10,816.02
	white spruce (Sw)	1,687	1.43	2,415.87	167	2.18	365.06	2,780.93
Total Coniferous								**13,596.95**
mixedwood	trembling aspen (Aw)	386	1.21	467.49	441	1.33	586.41	1,053.90
	white birch (Bw)	37	0.80	29.29	78	0.84	65.44	94.73
	balsam poplar (Pb)	8	1.21	9.13	-	0.00	0.00	9.13
	jack pine (Pj)	102	1.28	129.91	185	1.77	328.10	458.01
	white spruce (Sw)	296	1.20	354.90	78	1.79	139.38	494.29
	none[c]	–	0.00	0.00	19	0.00	0.00	0.00
Total Mixedwood								**2,110.05**
harvested	deciduous trembling aspen (Aw)	–	0.00	0.00	7	0.10	0.74	0.74
	mixedwood balsam poplar (Pb)	–	0.00	0.00	1	1.30	0.76	0.76
	mixedwood none	–	0.00	0.00	535	0.00	0.00	0.00
Total Regenerating								**1.50**
Total Merchantable								**18,470.89**
Non-Merchantable Forest[d]								
coniferous	black spruce (Sb)	1,637	0.47	763.52	1,362	0.30	403.82	1,167.34
	tamarack (Lt)	548	0.53	289.37	180	0.16	29.20	318.57
mixedwood	black spruce (Sb)	26	0.52	13.41	–	0.00	0.00	13.41
	tamarack (Lt)	1	1.30	1.06	–	0.00	0.00	1.06
	none[c]	–	0.00	0.00	86	0.00	0.00	0.00
Total Non-Merchantable Forest								**1,500.38**
Total Merchantable Deciduous (Aw, Bw, Pb)								**2,762.39**
Total Merchantable Coniferous (Pj, Sw)								**13,596.95**
Total Merchantable Mixedwood (Aw, Bw, Pb, Pj, Sw, none)								**2,110.05**
Total Merchantable Regenerating (harvested)								**1.50**
Total Merchantable								**18,470.89**
Total Non-Merchantable Forest (Sb, Lt, none)								**1,500.38**
LSRYA								**18,470.89**

[a] Forest cover types described in Section 4.2.2.

[b] Mean Annual Increment (MAI) for mature coniferous fibre is derived from existing growing stock in mature and over-mature stands (more than or equal to 70 years), whereas immature MAI is calculated from immature stands (less than 70 years).

[c] Areas re-interpreted through field investigations that do not have AVI tree species data, and consequently no volume.

[d] Non-merchantable forest does not contribute to the net merchantable land base and are included in the table for comparative purposes only.

Note: Some numbers are rounded for presentation purposes. Therefore, it may appear that the totals do not equal the sum of the individual values.

– = No value.

Table 4.4-7 Deciduous Mean Annual Increment by Forest Cover Types in the Pierre River Mining Area Local Study Area

Predominant Forest Cover Types[a]	Dominant Species	Mature and Old Growth[b]			Immature[b]			Total MAI [m^3/yr]
		Area [ha]	MAI [m^3/ha/yr]	Subtotal MAI [m^3/yr]	Area [ha]	MAI [m^3/ha/yr]	Subtotal MAI [m^3/yr]	
Merchantable Forest								
deciduous	trembling aspen (Aw)	4,605	1.92	8,858.23	28	1.60	44.09	8,902.31
	white birch (Bw)	216	0.72	156.03	-	0.00	0.00	156.03
	balsam poplar (Pb)	269	1.32	355.62	17	1.32	21.84	377.46
Total Deciduous								**9,435.80**
coniferous	jack pine (Pj)	4,977	0.16	779.82	8	0.38	3.04	782.85
	white spruce (Sw)	1,854	0.17	309.77	-	0.00	0.00	309.77
Total Coniferous								**1,092.62**
mixedwood	trembling aspen (Aw)	826	1.09	900.42	1	0.13	0.17	900.59
	white birch (Bw)	111	0.53	59.31	3	0.10	0.31	59.62
	balsam poplar (Pb)	8	0.94	7.10	-	0.00	0.00	7.10
	jack pine (Pj)	287	0.57	162.91	-	0.00	0.00	162.91
	white spruce (Sw)	371	0.48	177.08	3	0.95	3.25	180.33
	none[c]	–	0.00	0.00	19	0.00	0.00	0.00
Total Mixedwood								**1,310.55**
harvested	deciduous trembling aspen (Aw)	–	0.00	0.00	7	0.15	1.11	1.11
	mixedwood balsam poplar (Pb)	–	0.00	0.00	1	0.53	0.31	0.31
	mixedwood none	–	0.00	0.00	535	0.00	0.00	0.00
Total Regenerating								**1.42**
Total Merchantable								**11,840.39**
Non-Merchantable Forest								
coniferous	black spruce (Sb)	2,984	0.02	73.48	15	0.02	0.31	73.80
	tamarack (Lt)	728	0.03	22.74	-	0.00	0.00	22.74
mixedwood	black spruce (Sb)	26	0.22	5.75	-	0.00	0.00	5.75
	tamarack (Lt)	1	0.51	0.42	-	0.00	0.00	0.42
	none[c]	–	0.00	0.00	86	0.00	0.00	0.00
Total Non-Merchantable Forest								**102.70**
Total Merchantable Deciduous (Aw, Bw, Pb)								**9,435.80**
Total Merchantable Coniferous (Pj, Sw)								**1,092.62**
Total Merchantable Mixedwood (Aw, Bw, Pb, Pj, Sw, none)								**1,310.55**
Total Merchantable Regenerating (harvested)								**1.42**
Total Merchantable								**11,840.39**
Total Non-Merchantable Forest (Sb, Lt, none)								**102.70**
Total Long Run Sustained Yield Average (LSRYA) for the LSA								**11,840.39**

[a] Forest cover types described in Section 4.2.2.

[b] Mean Annual Increment (MAI) for mature deciduous fibre is derived from existing growing stock in mature and over-mature stands (more than or equal to 50 years), whereas immature MAI is calculated from immature stands (less than 50 years).

[c] Areas re-interpreted through field investigations that do not have AVI tree species data, and consequently no volume.

Note: The numbers presented in the above table have been rounded for presentation purposes. Therefore, the totals may not appear to equal the sum of the individual values.

– = No value.

4.4.4 Regenerating Stands

Regenerating stands include harvested areas in the PRMA LSA. The AVI polygons with a CC are identified as regenerating stands in the Pierre River Mining Area LSA. Cutblocks that have been classified to a vegetation community are considered to have reached "free-to-grow" status and are therefore not considered as regenerating stands. There are a total of 34 regenerating stands in the PRMA LSA (Table 4.4-8), accounting for 543 ha (3%) of the LSA.

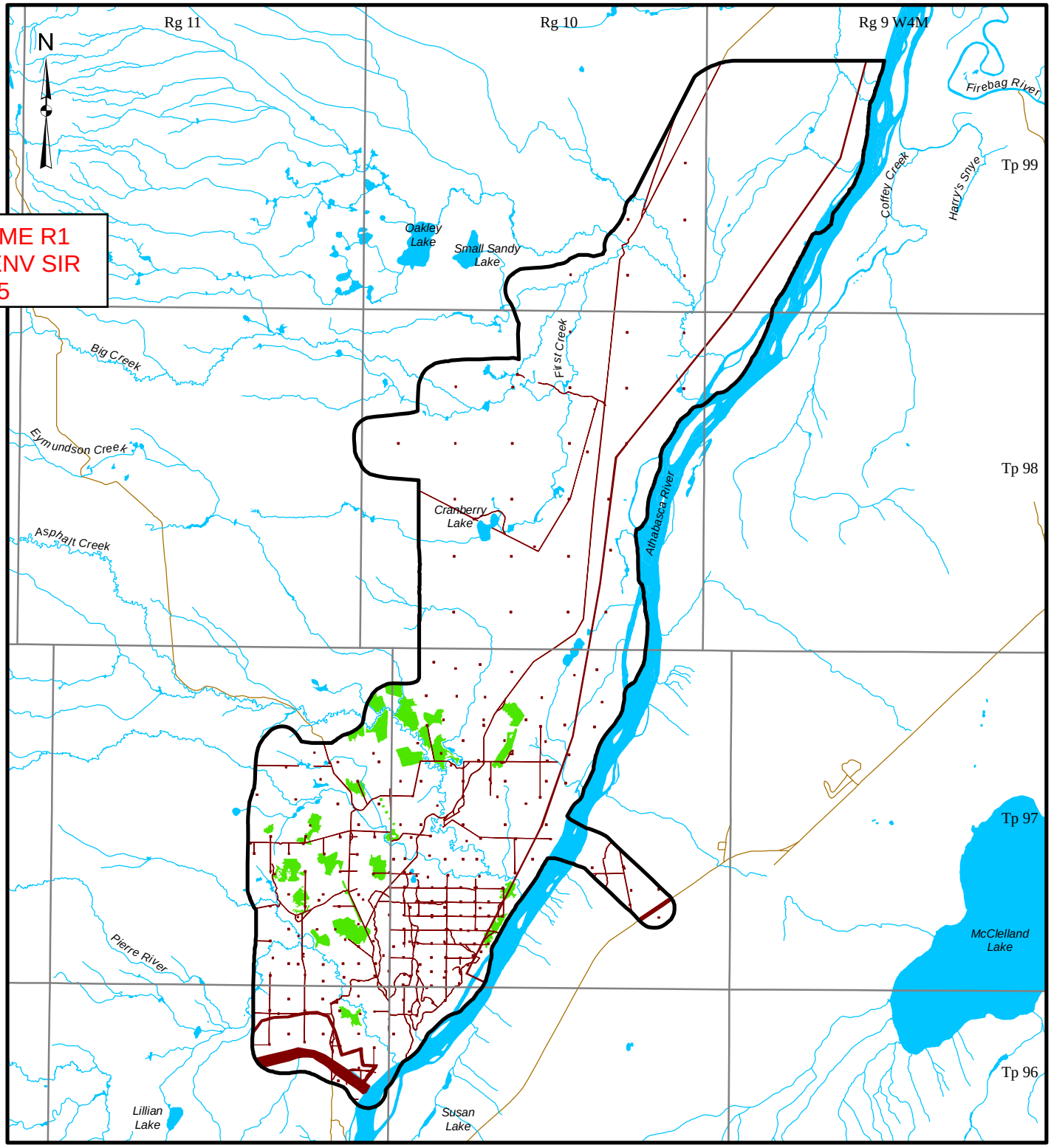
Table 4.4-8 Regenerating Stands in the Pierre River Mining Area Local Study Area

Predominant Forest Cover Type	Dominant Species	Number of Stands	Stand Area [ha]	Extent	
				ha	% of stand
Harvested					
harvested deciduous	trembling aspen (Aw)	1	7	7	100
harvested mixedwood	balsam poplar (Pb)	1	1	1	100
	none[(a)]	32	535	535	100
Total		**34**	**543**	**543**	**100**

[(a)] Regenerating stands that presently have no identified dominant species.

Note: Some numbers are rounded for presentation purposes. Therefore, it may appear that the totals do not equal the sum of the individual values.

The regenerating harvested blocks are found on the southern portion of the PRMA LSA (Figure 4.4-2). Reforestation standards require harvested areas, including cutblocks, to regenerate to a similar composition of the previous forest, with an 80% stocking and a "free-to-grow" status after 14 years (ASRD 2007b, website).



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LEGEND

- PIERRE RIVER MINING AREA
- LOCAL STUDY AREA
- OPEN WATER
- ACCESS ROAD

REGENERATING STANDS

- HARVESTED

DISTURBED

- EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE
- EXISTING AND APPROVED URBAN AND INDUSTRIAL LINEAR DISTURBANCE

4 0 4
SCALE 1:160,000 KILOMETRES

REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2004), and Alberta SRD, used under license.
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 12.

PROJECT
JACKPINE MINE EXPANSION &
PIERRE RIVER MINE PROJECT

TITLE
REGENERATING STANDS IN THE PIERRE RIVER MINING AREA LOCAL STUDY AREA

Shell Canada Limited

PROJECT No. 05-1344-027.7600			SCALE AS SHOWN	REV. 0
DESIGN	VR	02 Aug. 2007	FIGURE: 4.4-2	
GIS	VR	28 Sep. 2007		
CHECK	AA	16 Nov. 2007		
REVIEW	WES/TC	20 Nov. 2007		

Project: I:\CLIENTS\SHELL\05-1344-027\mapping\mxd\forestry\DRAFT\pierreriverlbl_reg_esr.mxd - Plot: ?J:\2005\GIS\ArcMapTemplates\templatesv91\MyProject.pdf?

4.4.5 Old Growth Forests

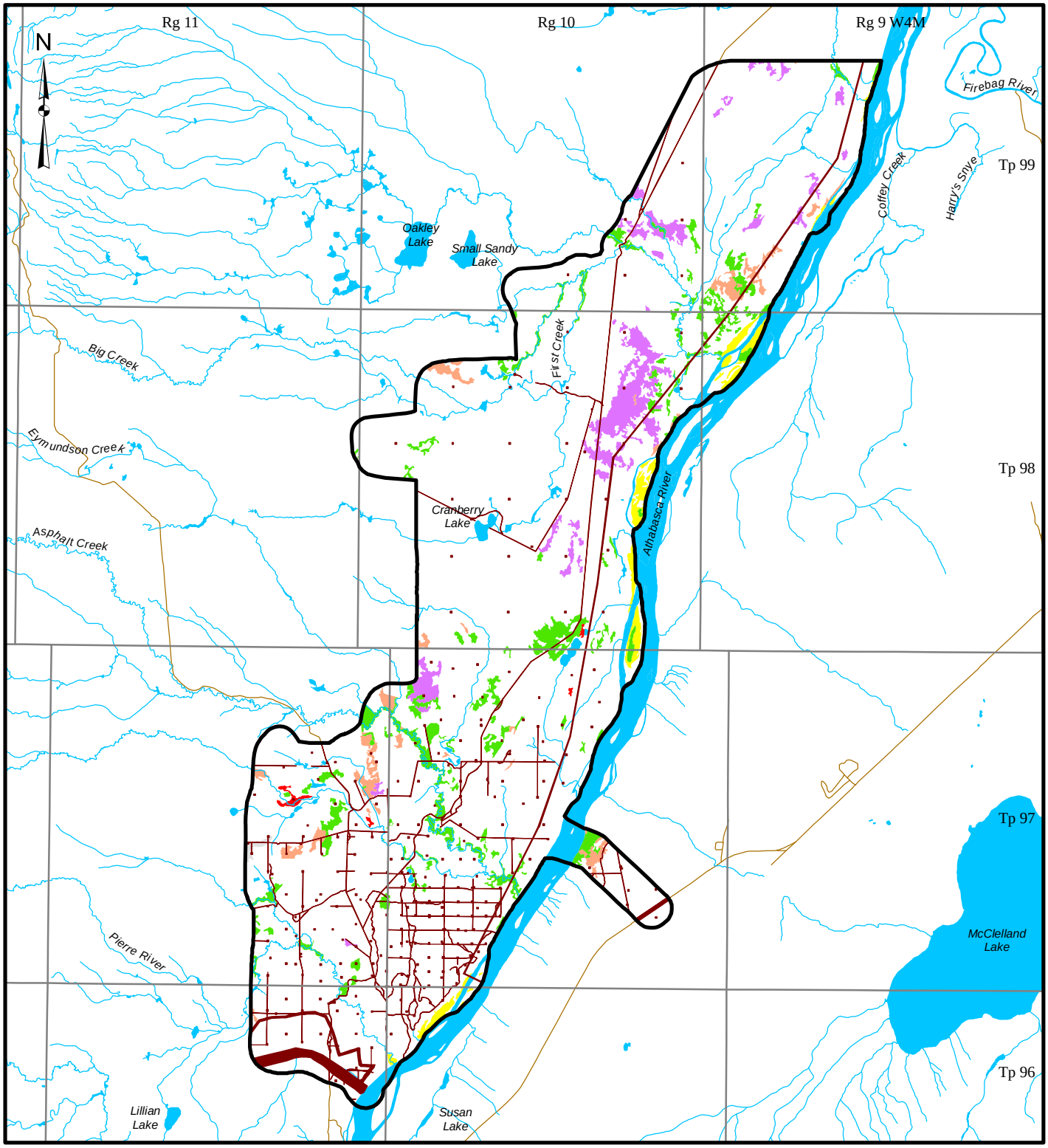
There are 306 old growth stands ranging in age from 100 to 190 years in the PRMA LSA (Figure 4.4-3). For the purpose of this report, black spruce, white spruce, tamarack and balsam fir stands were considered old growth at 140 years, jack pine stands at 120 years and deciduous and mixedwood stands at 100 years. Table 4.4-9 shows that the 306 old growth stands in the PRMA LSA occupy an area of 1,964 ha.

White spruce stands comprise most of the old growth area (911 ha, 46% of old growth). White spruce old growth forest occur throughout the PRMA LSA; however, they tend to be found primarily along drainages (Figure 4.4-3). Jack pine dominant old growth occurs in three main groupings; one on the west side of the PRMA LSA, one along the forestry trunk road near the Athabasca River, and the other in the north of the LSA. There are pockets of balsam poplar old growth in the Athabasca River Valley.

Table 4.4-9 Old Growth Stands in the Pierre River Mining Area Local Study Area

Dominant/Subdominant Species	Number of Stands	Area [ha]	Age Range [yr]
trembling aspen/white birch	1	9	100
trembling aspen/balsam poplar	4	12	110 to 130
trembling aspen/jack pine	2	6	100
trembling aspen/white spruce	21	137	100 to 130
balsam poplar/none	27	201	100 to 190
balsam poplar/trembling aspen	2	3	110 to 130
balsam poplar/white spruce	6	41	110 to 190
jack pine/none	13	117	120 to 170
jack pine/trembling aspen	14	119	100 to 170
jack pine/white spruce	21	364	110 to 170
white spruce/none	68	232	110 to 190
white spruce/trembling aspen	90	480	100 to 170
white spruce/balsam poplar	19	134	130 to 190
white spruce/jack pine	9	38	140 to 170
white spruce/black spruce	3	27	140 to 160
black spruce/trembling aspen	2	5	100 to 110
black spruce/white birch	1	18	100
black spruce/white spruce	1	3	140
tamarack/black spruce	2	18	140 to 160
Total	**306**	**1,964**	**100 to 190**

Note: Some numbers are rounded for presentation purposes. Therefore, it may appear that the totals do not equal the sum of the individual values.



LEGEND

- PIERRE RIVER MINING AREA
- LOCAL STUDY AREA
- OPEN WATER
- ACCESS ROAD

DISTURBED

- EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE
- EXISTING AND APPROVED URBAN AND INDUSTRIAL LINEAR DISTURBANCE

OLD GROWTH FOREST

- TREMBLING ASPEN (Aw)
- BALSAM POPLAR (Pb)
- JACK PINE (Pj)
- WHITE SPRUCE (Sw)
- BLACK SPRUCE (Sb)
- TAMARACK (Lt)

4 0 4

SCALE 1:160,000 KILOMETRES

REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2004), and Alberta SRD, used under license.
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 12.

PROJECT

JACKPINE MINE EXPANSION & PIERRE RIVER MINE PROJECT

TITLE

OLD GROWTH FORESTS IN THE PIERRE RIVER MINING AREA LOCAL STUDY AREA

Shell Canada Limited

PROJECT No. 05-1344-027.7600			SCALE AS SHOWN	REV. 0
DESIGN	VR	02 Aug. 2007		
GIS	VR	28 Sep. 2007		
CHECK	AA	16 Nov. 2007		
REVIEW	WES/TC	20 Nov. 2007		

FIGURE: 4.4-3

Project: I:\CLIENTS\SHELL\05-1344-027\mapping\mxd\forestry\DRAFT\pierreriverlnbl_ogr_esri.mxd - Plot: 2J\2005\GIS\ArcMapTemplates\templatesv91\MyProject.pdf?

4.4.6 Multistorey Stands

Assessing multistorey stands provides a characterization of potentially recoverable understorey fibre and stand growth features. Table 4.4-10 provides a summary of all multistorey stands in the PRMA LSA. There are 1,353 multistorey stands that occupy 5,021 ha in the PRMA LSA. There are 1,033 multistorey tree stands and 224 multistorey shrub stands. Stands containing trembling aspen and white spruce have the greatest number of multistorey stands (695). Stands composed of black spruce and closed shrub have the greatest number of stands containing a defined shrub layer (65).

The AVI also considers herbaceous grasslands and bryophyte cover as a multistorey structural layer. Although these layers are present in most vegetation types in some combination, multistorey stands with an AVI identified herbaceous grassland, or bryophyte layer are also presented in Table 4.4-10. There are 96 multistorey stands with an identified herbaceous grassland, or bryophyte layer in the PRMA LSA.

Table 4.4-10 Multistorey Stands in the Pierre River Mining Area Local Study Area

Dominant Overstorey Species	Dominant Understorey Species	Number of Stands	Area [ha]
Multistorey Tree Stands			
trembling aspen (Aw)	trembling aspen (Aw)	4	7
	black spruce (Sb)	34	60
	white spruce (Sw)	695	2,827
white birch (Bw)	tamarack (Lt)	1	7
	black spruce (Sb)	1	2
	white spruce (Sw)	10	35
tamarack (Lt)	tamarack (Lt)	25	131
	black spruce (Sb)	33	81
jack pine (Pj)	trembling aspen (Aw)	6	22
	white birch (Bw)	9	17
	jack pine (Pj)	20	61
	black spruce (Sb)	52	297
	white spruce (Sw)	12	78
black spruce (Sb)	black spruce (Sb)	9	23
white spruce (Sw)	trembling aspen (Aw)	23	63
	white birch (Bw)	6	19
	tamarack (Lt)	2	5
	balsam poplar (Pb)	1	7
	black spruce (Sb)	29	87
	white spruce (Sw)	61	169
Total Multistorey Treed		**1,033**	**3,998**

Table 4.4-10 Multistorey Stands in the Pierre River Mining Area Local Study Area (continued)

Dominant Overstorey Species	Dominant Understorey Species	Number of Stands	Area [ha]
Multistorey Shrub Stands			
trembling aspen (Aw)	closed shrub	2	6
white birch (Bw)	closed shrub	37	175
tamarack (Lt)	closed shrub	59	217
balsam poplar (Pb)	closed shrub	15	35
black spruce (Sb)	closed shrub	65	188
white spruce (Sw)	closed shrub	46	100
Total Multistorey Shrub		**224**	**722**
Multistorey Forest Floor Stands			
trembling aspen (Aw)	bryophyte	3	16
jack pine (Pj)	bryophyte	16	44
black spruce (Sb)	bryophyte	2	2
white spruce (Sw)	bryophyte	13	22
trembling aspen (Aw)	herbaceous grassland	6	17
white birch (Bw)	herbaceous grassland	6	4
tamarack (Lt)	herbaceous grassland	9	79
jack pine (Pj)	herbaceous grassland	18	81
black spruce (Sb)	herbaceous grassland	19	25
white spruce (Sw)	herbaceous grassland	4	11
Total Multistorey Forest Floor		**96**	**301**
Total Multistorey Stands		**1,353**	**5,021**

Note: Some numbers are rounded for presentation purposes. Therefore, it may appear that the totals do not equal the sum of the individual values.

4.5 SUMMARY

This Environmental Setting Report (ESR) details the forestry resources of the Jackpine Mine Expansion & Pierre River Mine Project (the Project) as defined by the Alberta Vegetation Inventory (AVI) (AEP 1991). The report includes data on the merchantable and non-merchantable land base, timber area, volume and productivity estimates, and summaries of old growth and multistorey stands.

The AVI data used for this ESR were based on the interpretation of 1:20,000 scale photographs of the Terrestrial Resources Local Study Areas (LSAs). Field data were also collected in the LSAs to validate preliminary mapping and associated attributes.

Timber rights within most of the Terrestrial Resources Regional Study Area (RSA) have been granted to Alberta-Pacific Forest Industries Inc. (Al-Pac) under a Forest Management Agreement (FMA). The Project LSAs occur within the A15 Forestry Management Unit (FMU). Most of the RSA is also within the A15 operating unit (Al-Pac 2004). The FMU A15 is part of Zone B where

coniferous cutting rights are shared between Al-Pac, Northland Forest Products Ltd. (the Quota Holder) and miscellaneous timber use operators.

Jackpine Expansion Mining Area

The Jackpine Expansion Mining Area (JEMA) LSA is 18,348 ha. It is comprised of 3,464 ha (19%) of merchantable forests, 7,937 ha (43%) of non-merchantable forests, 5,054 ha of non-forested land (28%) and 1,893 ha of disturbed land (10%). The estimate of coniferous volume from merchantable stands in the JEMA LSA is 183,474 m^3. The estimate of deciduous volume from merchantable stands is 165,736 m^3. The total volume per hectare of these merchantable stands is 82 m^3/ha of coniferous fibre and 74 m^3/ha of deciduous fibre. The estimate of Long Run Sustained Yield Average (LRSYA) in the JEMA LSA is 2,150 m^3/yr for coniferous fibre and 2,075 m^3/yr for deciduous fibre.

There are 840 ha of old growth forest in the JEMA LSA, ranging from 100 to 140 years old. There are 907 multistorey stands accounting for 3,108 ha (17%) of the JEMA LSA. These multistorey stands can have a dominant understorey tree, shrub, bryophyte or herbaceous grassland layer.

Pierre River Mining Area

The Pierre River Mining Area (PRMA) LSA is 21,136 ha. It is comprised of 14,146 ha (67%) of merchantable forests, 3,839 ha (18%) of non-merchantable forests, 2,720 ha of non-forested land (13%) and 431 ha of disturbed land (2%). The estimate of coniferous volume from merchantable stands in the PRMA LSA is 1,445,967 m^3. The estimate of deciduous volume from merchantable stands is 851,550 m^3. The total volume per hectare of these merchantable stands is 106 m^3/ha of coniferous fibre and 63 m^3/ha of deciduous fibre. The estimate of LRSYA in the PRMA LSA is 18,471 m^3/yr for coniferous fibre and 11,840 m^3/yr for deciduous fibre.

There are 1,964 ha of old growth forest in the PRMA LSA, ranging from 100 to 190 years old. There are 1,353 multistorey stands accounting for 5,021 ha (24%) of the PRMA LSA.

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Fax (403) 299-5606

APPENDIX O

JACKPINE EXPANSION MINING AREA
ALBERTA VEGETATION INVENTORY
POLYGON MAPS

Submitted to:
Shell Canada Limited

Prepared by:
Golder Associates Ltd.

December 2007 **05-1344-027**

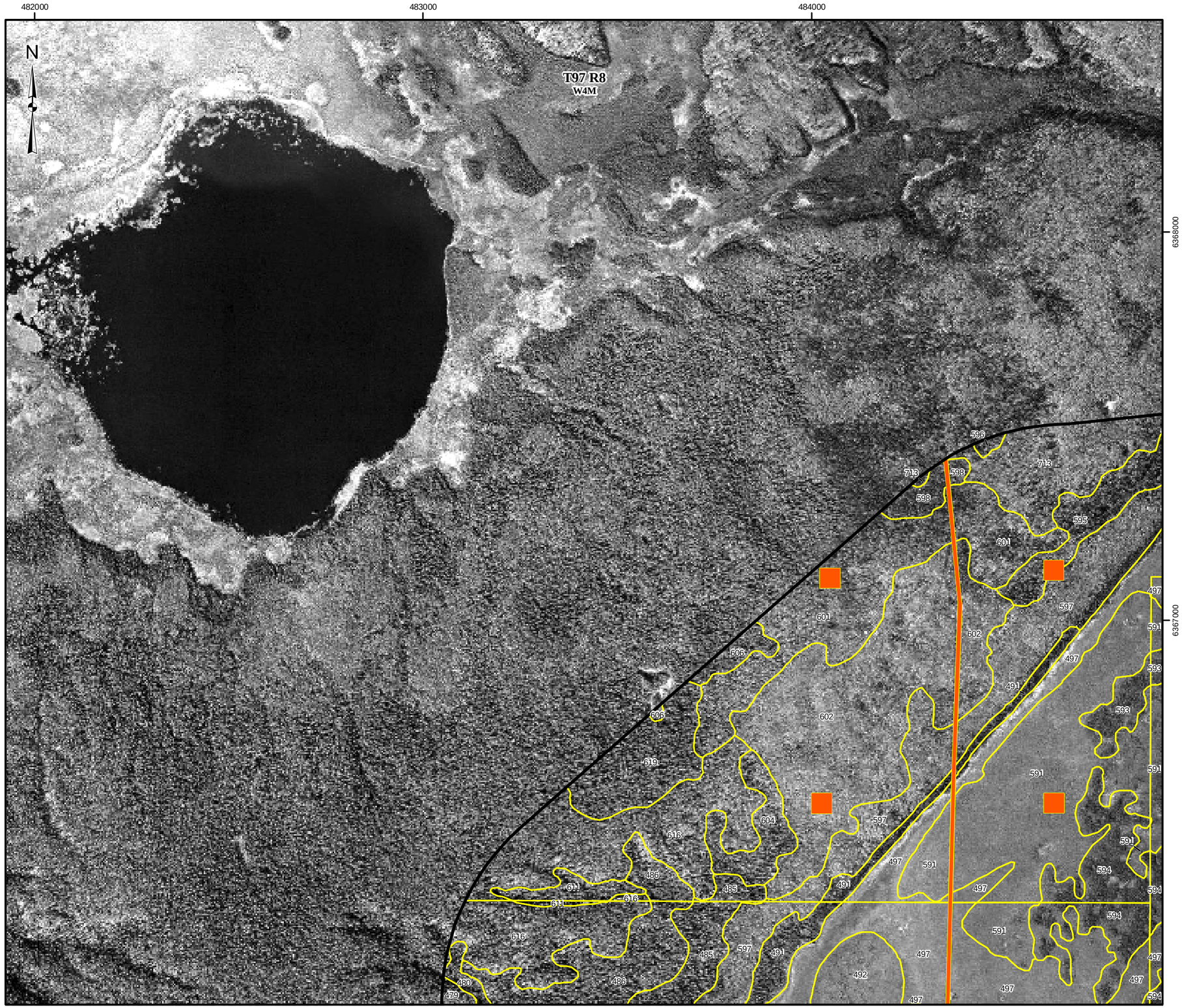
50 BEST EMPLOYERS IN CANADA 2007

CANADA'S 50 BEST MANAGED PRIVATE COMPANIES

OFFICES ACROSS NORTH AMERICA, SOUTH AMERICA, EUROPE, ASIA AND AUSTRALIA

LIST OF FIGURES

Figure O-1 Alberta Vegetation Inventory Polygon Map: Map 1 of 38 1
Figure O-2 Alberta Vegetation Inventory Polygon Map: Map 2 of 38 2
Figure O-3 Alberta Vegetation Inventory Polygon Map: Map 3 of 38 3
Figure O-4 Alberta Vegetation Inventory Polygon Map: Map 4 of 38 4
Figure O-5 Alberta Vegetation Inventory Polygon Map: Map 5 of 38 5
Figure O-6 Alberta Vegetation Inventory Polygon Map: Map 6 of 38 6
Figure O-7 Alberta Vegetation Inventory Polygon Map: Map 7 of 38 7
Figure O-8 Alberta Vegetation Inventory Polygon Map: Map 8 of 38 8
Figure O-9 Alberta Vegetation Inventory Polygon Map: Map 9 of 38 9
Figure O-10 Alberta Vegetation Inventory Polygon Map: Map 10 of 38 10
Figure O-11 Alberta Vegetation Inventory Polygon Map: Map 11 of 38 11
Figure O-12 Alberta Vegetation Inventory Polygon Map: Map 12 of 38 12
Figure O-13 Alberta Vegetation Inventory Polygon Map: Map 13 of 38 13
Figure O-14 Alberta Vegetation Inventory Polygon Map: Map 14 of 38 14
Figure O-15 Alberta Vegetation Inventory Polygon Map: Map 15 of 38 15
Figure O-16 Alberta Vegetation Inventory Polygon Map: Map 16 of 38 16
Figure O-17 Alberta Vegetation Inventory Polygon Map: Map 17 of 38 17
Figure O-18 Alberta Vegetation Inventory Polygon Map: Map 18 of 38 18
Figure O-19 Alberta Vegetation Inventory Polygon Map: Map 19 of 38 19
Figure O-20 Alberta Vegetation Inventory Polygon Map: Map 20 of 38 20
Figure O-21 Alberta Vegetation Inventory Polygon Map: Map 21 of 38 21
Figure O-22 Alberta Vegetation Inventory Polygon Map: Map 22 of 38 22
Figure O-23 Alberta Vegetation Inventory Polygon Map: Map 23 of 38 23
Figure O-24 Alberta Vegetation Inventory Polygon Map: Map 24 of 38 24
Figure O-25 Alberta Vegetation Inventory Polygon Map: Map 25 of 38 25
Figure O-26 Alberta Vegetation Inventory Polygon Map: Map 26 of 38 26
Figure O-27 Alberta Vegetation Inventory Polygon Map: Map 27 of 38 27
Figure O-28 Alberta Vegetation Inventory Polygon Map: Map 28 of 38 28
Figure O-29 Alberta Vegetation Inventory Polygon Map: Map 29 of 38 29
Figure O-30 Alberta Vegetation Inventory Polygon Map: Map 30 of 38 30
Figure O-31 Alberta Vegetation Inventory Polygon Map: Map 31 of 38 31
Figure O-32 Alberta Vegetation Inventory Polygon Map: Map 32 of 38 32
Figure O-33 Alberta Vegetation Inventory Polygon Map: Map 33 of 38 33
Figure O-34 Alberta Vegetation Inventory Polygon Map: Map 34 of 38 34
Figure O-35 Alberta Vegetation Inventory Polygon Map: Map 35 of 38 35
Figure O-36 Alberta Vegetation Inventory Polygon Map: Map 36 of 38 36
Figure O-37 Alberta Vegetation Inventory Polygon Map: Map 37 of 38 37
Figure O-38 Alberta Vegetation Inventory Polygon Map: Map 38 of 38 38



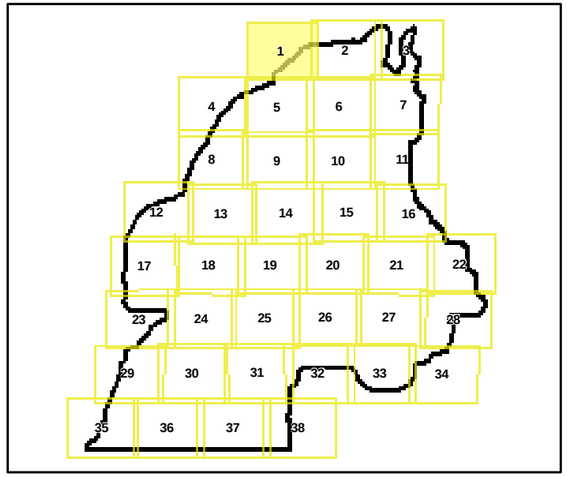
LEGEND

JACKPINE EXPANSION MINING AREA LOCAL STUDY AREA

AVI POLYGON

DISTURBED

EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE



REFERENCE

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Imagery (Orthophoto) obtained from Shell Canada (August 2005).
Projection: UTM Zone 12 Datum: NAD 83

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SCALE 1:10,000 METRES

PROJECT

JACKPINE MINE EXPANSION &
PIERRE RIVER MINE PROJECT

TITLE

ALBERTA VEGETATION INVENTORY
POLYGON MAP: MAP 1 OF 38

Shell Canada Limited

PROJECT No. 05-1344-027-7600			SCALE AS SHOWN	REV. 0
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GIS	WZ	15 Nov. 2007		
CHECK	AA	15 Nov. 2007		
REVIEW	TC	16 Nov. 2007		

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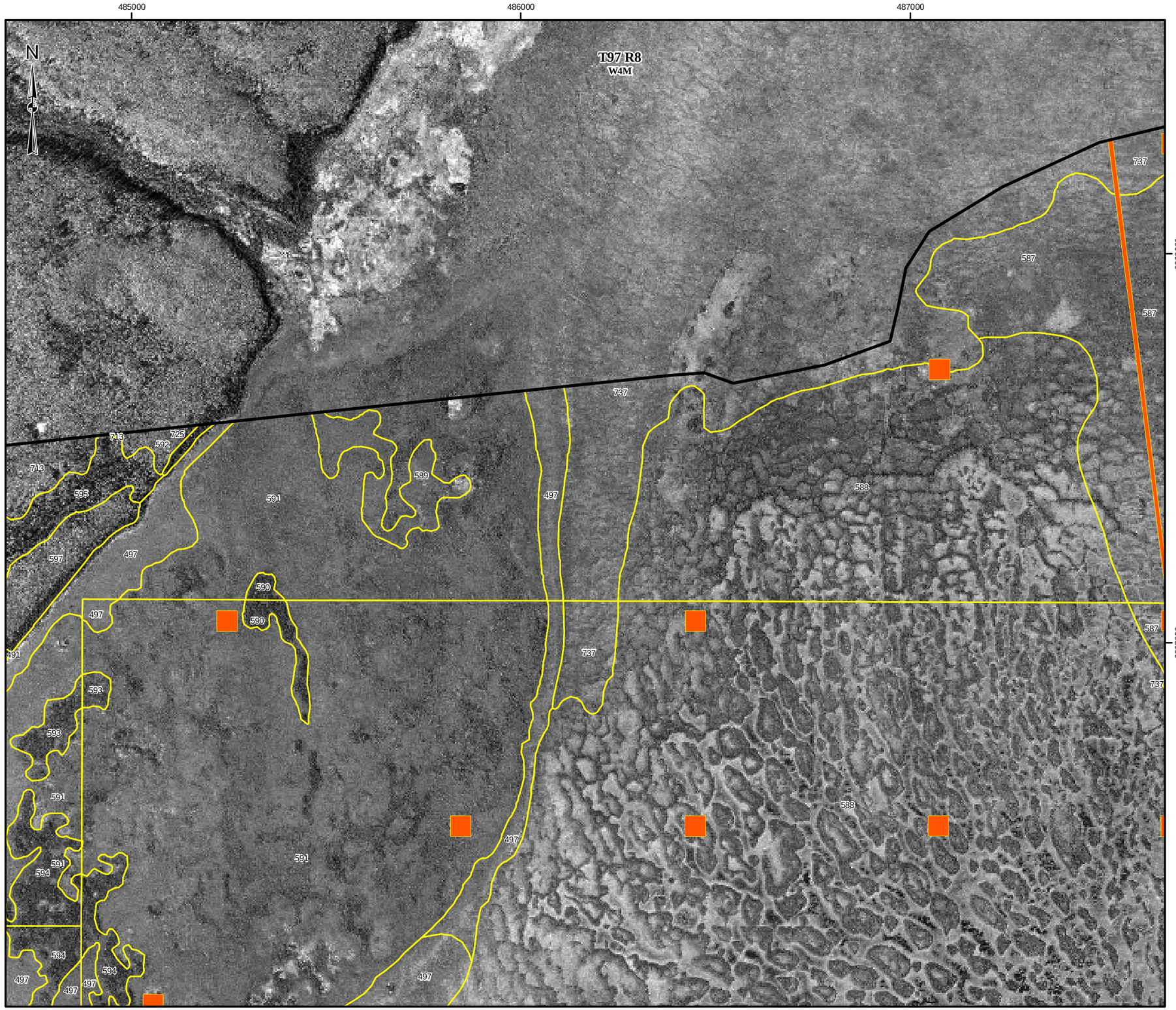
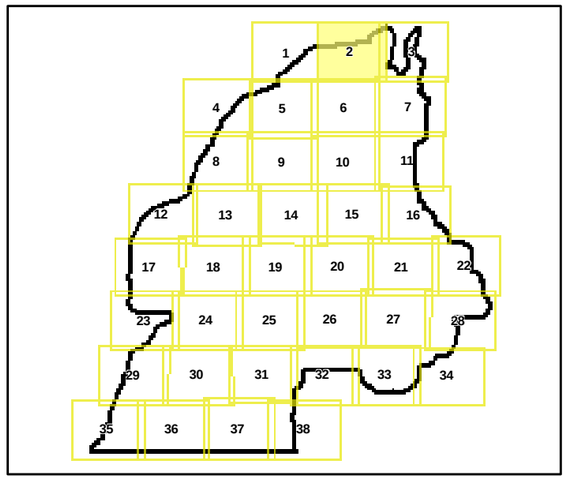


LEGEND

- JACKPINE EXPANSION MINING AREA LOCAL STUDY AREA
- AVI POLYGON

DISTURBED

- EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE



REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2005-2006), used under license.
Imagery (Orthophoto) obtained from Shell Canada (August 2005).
Projection: UTM Zone 12 Datum: NAD 83

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SCALE 1:10,000 METRES

PROJECT
JACKPINE MINE EXPANSION &
PIERRE RIVER MINE PROJECT

TITLE
ALBERTA VEGETATION INVENTORY
POLYGON MAP: MAP 2 OF 38

Shell Canada Limited

PROJECT No. 05-1344-027-7600			SCALE AS SHOWN	REV. 0
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GIS	EO	15 Nov. 2007		
CHECK	AA	15 Nov. 2007		
REVIEW	TC	16 Nov. 2007		

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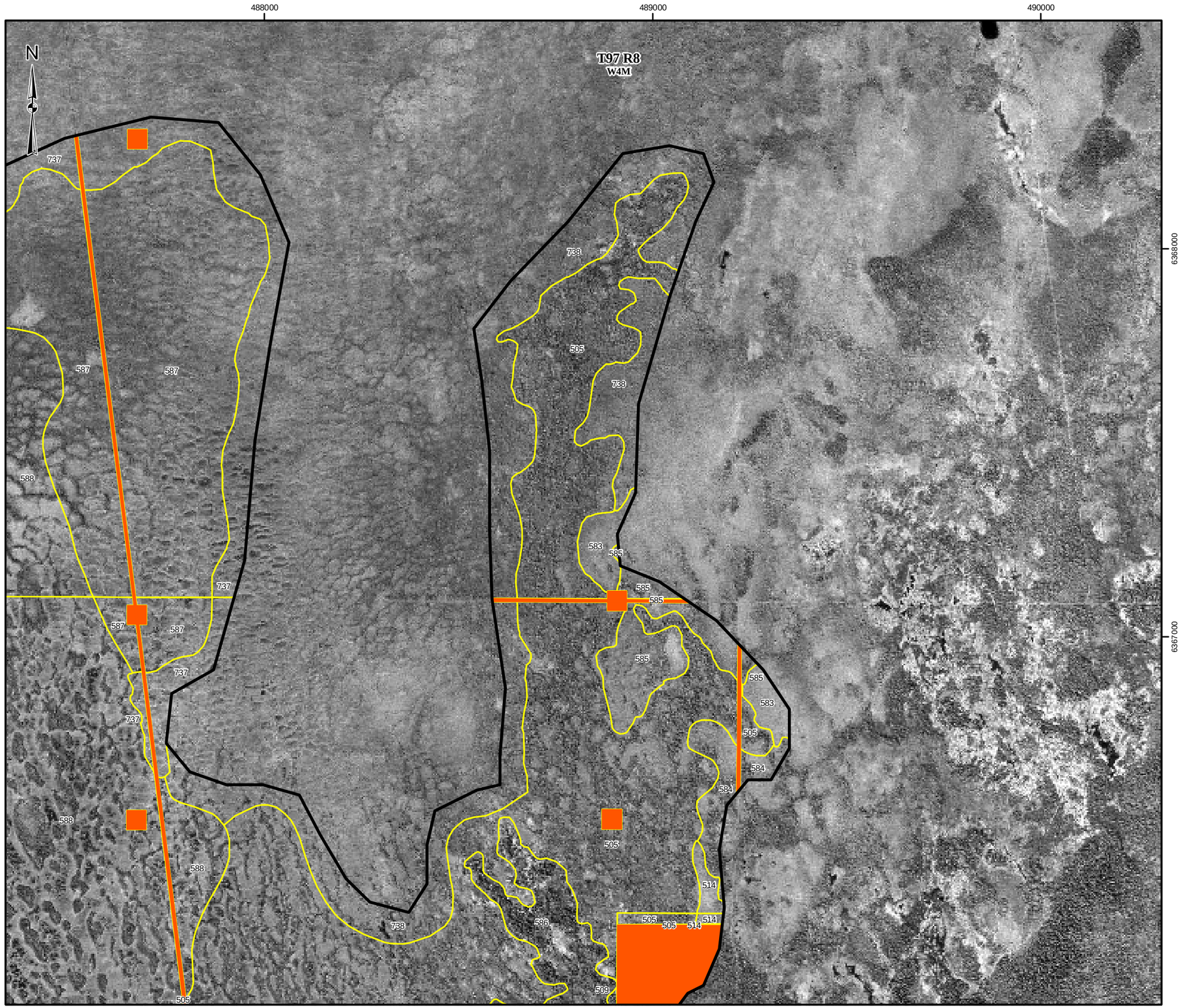

LEGEND

JACKPINE EXPANSION MINING AREA LOCAL STUDY AREA

AVI POLYGON

DISTURBED

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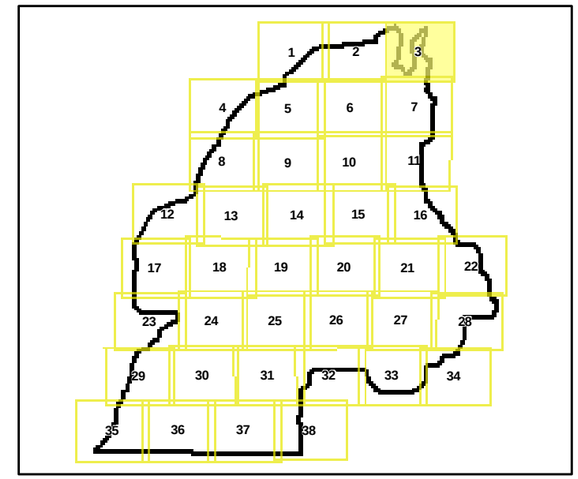

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Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2005-2006), used under license.
Imagery (Orthophoto) obtained from Shell Canada (August 2005).
Projection: UTM Zone 12 Datum: NAD 83

300 0 300

SCALE 1:10,000 METRES

PROJECT

JACKPINE MINE EXPANSION &
PIERRE RIVER MINE PROJECT

TITLE

ALBERTA VEGETATION INVENTORY
POLYGON MAP: MAP 3 OF 38

Shell Canada Limited

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CHECK	AA	15 Nov. 2007		
REVIEW	TC	16 Nov. 2007		

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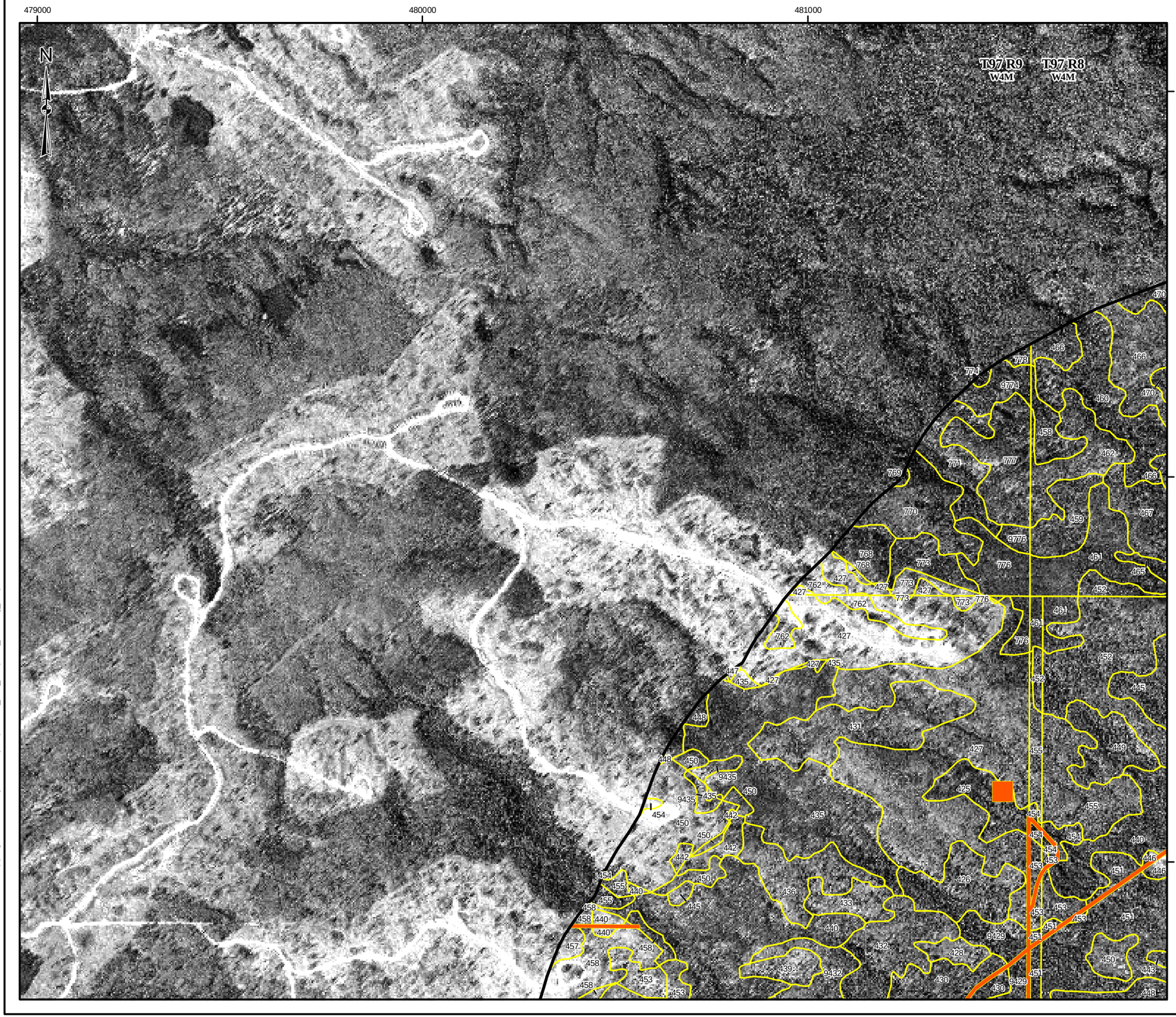

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- JACKPINE EXPANSION MINING AREA LOCAL STUDY AREA
- AVI POLYGON

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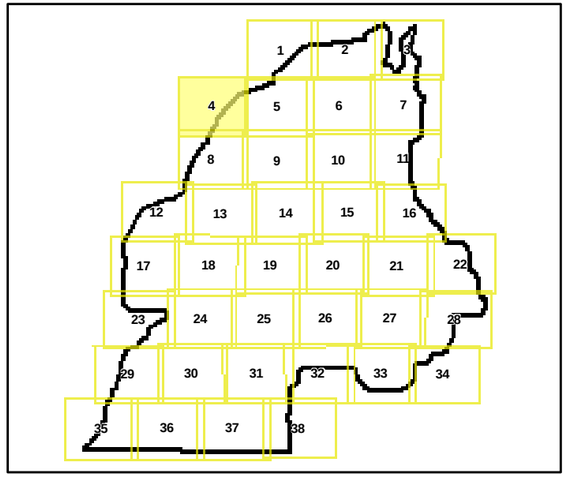
- EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE



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Projection: UTM Zone 12 Datum: NAD 83

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SCALE 1:10,000 METRES

PROJECT
JACKPINE MINE EXPANSION &
PIERRE RIVER MINE PROJECT

TITLE
ALBERTA VEGETATION INVENTORY
POLYGON MAP: MAP 4 OF 38

Shell Canada Limited

PROJECT No. 05-1344-027-7600			SCALE AS SHOWN	REV. 0
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T97 R8
W4M

N

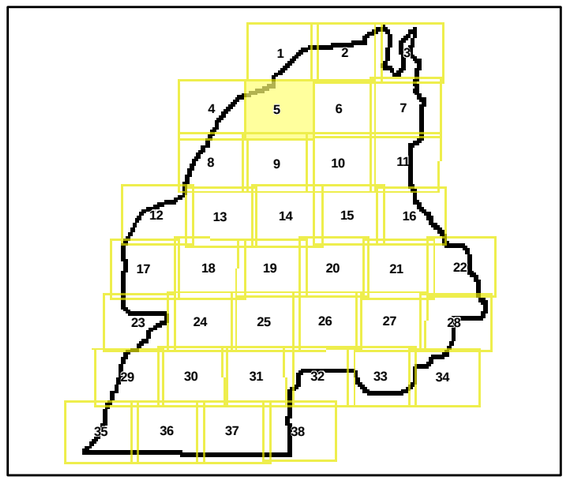
LEGEND

JACKPINE EXPANSION MINING AREA LOCAL STUDY AREA

AVI POLYGON

DISTURBED

EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE



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Imagery (Orthophoto) obtained from Shell Canada (August 2005).
Projection: UTM Zone 12 Datum: NAD 83

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SCALE 1:10,000 METRES

PROJECT
JACKPINE MINE EXPANSION &
PIERRE RIVER MINE PROJECT

TITLE
ALBERTA VEGETATION INVENTORY
POLYGON MAP: MAP 5 OF 38

Shell Canada Limited

PROJECT No. 05-1344-027-7600			SCALE AS SHOWN	REV. 0
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GIS	WZ	15 Nov. 2007		
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T97 R8
W4M

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LEGEND

JACKPINE EXPANSION MINING AREA LOCAL STUDY AREA

AVI POLYGON

DISTURBED

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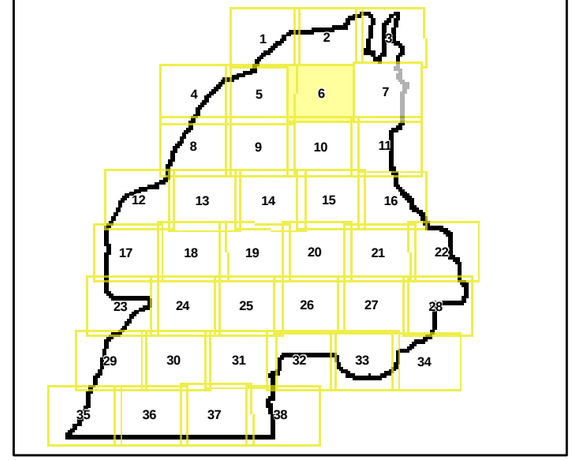

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Imagery (Orthophoto) obtained from Shell Canada (August 2005).
Projection: UTM Zone 12 Datum: NAD 83

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SCALE 1:10,000 METRES

PROJECT

JACKPINE MINE EXPANSION &
PIERRE RIVER MINE PROJECT

TITLE

ALBERTA VEGETATION INVENTORY
POLYGON MAP: MAP 6 OF 38

Shell Canada Limited

PROJECT No. 05-1344-027-7600			SCALE AS SHOWN	REV. 0
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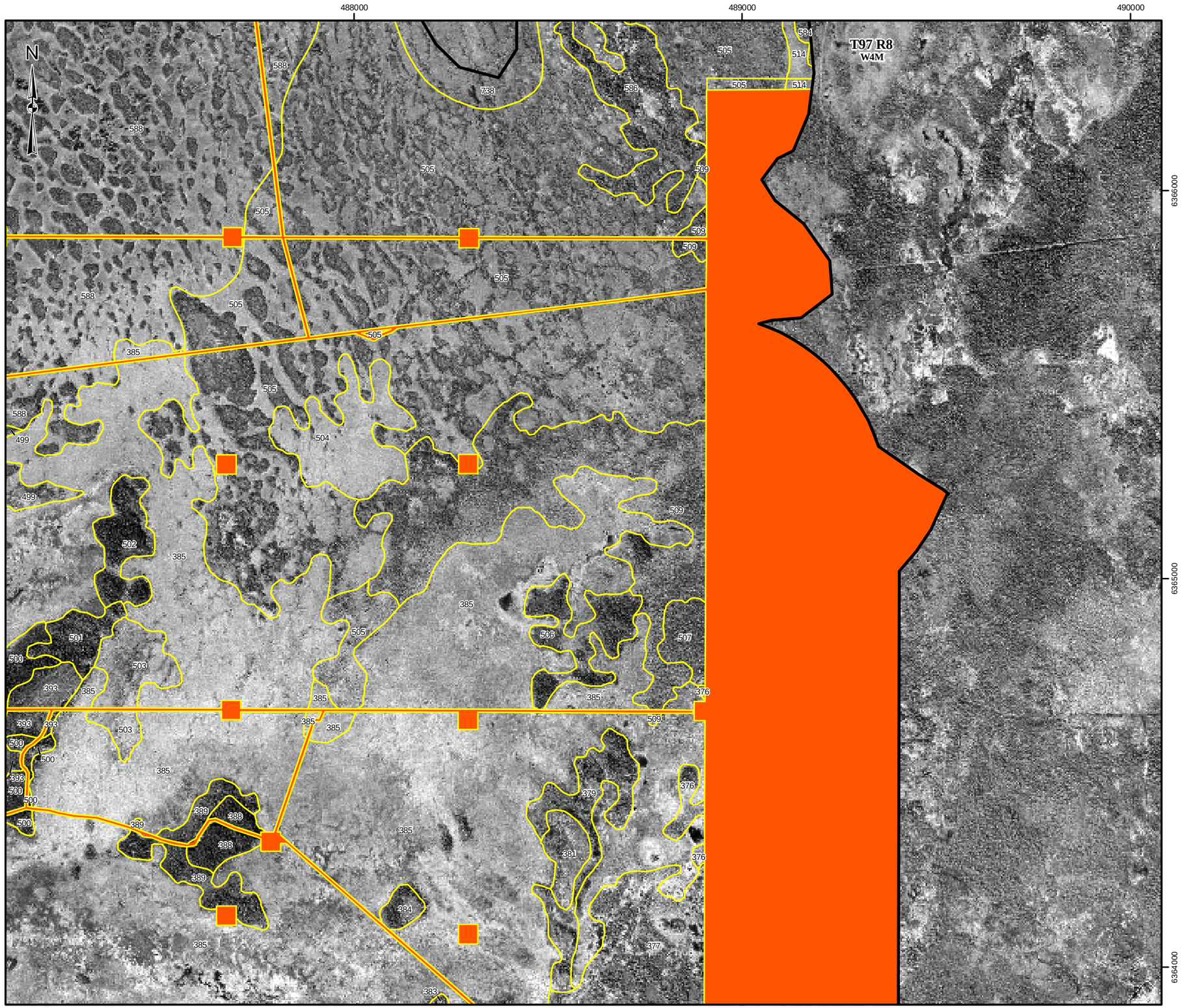


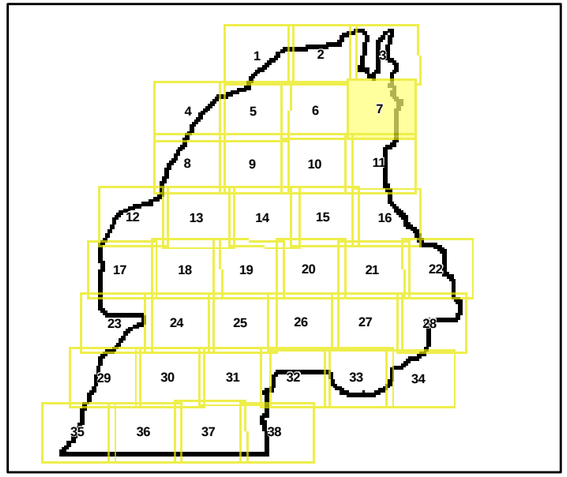
LEGEND

JACKPINE EXPANSION MINING AREA LOCAL STUDY AREA

AVI POLYGON

DISTURBED

EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE



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Imagery (Orthophoto) obtained from Shell Canada (August 2005).
Projection: UTM Zone 12 Datum: NAD 83

300 0 300

SCALE 1:10,000 METRES

PROJECT

JACKPINE MINE EXPANSION &
PIERRE RIVER MINE PROJECT

TITLE

ALBERTA VEGETATION INVENTORY
POLYGON MAP: MAP 7 OF 38

Shell Canada Limited

PROJECT No. 05-1344-027-7600			SCALE AS SHOWN	REV. 0
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T97 R9 W4M

T97 R8 W4M

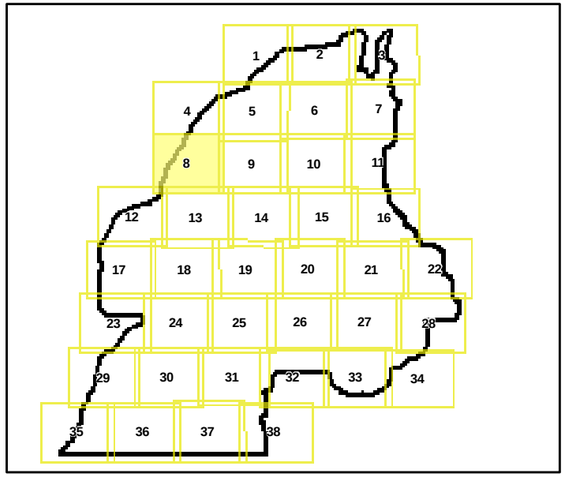
LEGEND

JACKPINE EXPANSION MINING AREA LOCAL STUDY AREA

AVI POLYGON

DISTURBED

EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE



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Imagery (Orthophoto) obtained fro Shell Canada (August 2005).
Projection: UTM Zone 12 Datum: NAD 83

300 0 300

SCALE 1:10,000 METRES

PROJECT

JACKPINE MINE EXPANSION & PIERRE RIVER MINE PROJECT

TITLE

ALBERTA VEGETATION INVENTORY POLYGON MAP: MAP 8 OF 38

Shell Canada Limited

PROJECT No. 05-1344-027-7600			SCALE AS SHOWN	REV. 0
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CHECK	AA	15 Nov. 2007		
REVIEW	TC	16 Nov. 2007		

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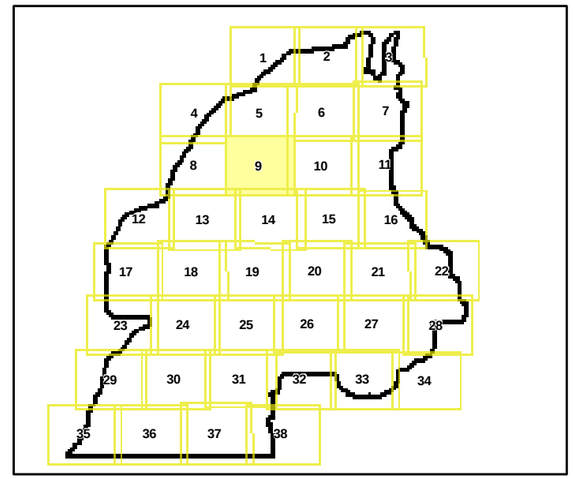
482000
483000
484000
6364000
6363000
6362000
T97 R8
W4M
N

LEGEND

JACKPINE EXPANSION MINING AREA LOCAL STUDY AREA
AVI POLYGON

DISTURBED

EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE



REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2005-2006), used under license.
Imagery (Orthophoto) obtained from Shell Canada (August 2005).
Projection: UTM Zone 12 Datum: NAD 83

300 0 300
SCALE 1:10,000 METRES

PROJECT
JACKPINE MINE EXPANSION &
PIERRE RIVER MINE PROJECT

TITLE
ALBERTA VEGETATION INVENTORY
POLYGON MAP: MAP 9 OF 38

Shell Canada Limited

PROJECT No. 05-1344-027-7600			SCALE AS SHOWN	REV. 0
DESIGN	VR	18 Jan. 2007	FIGURE: O-9	
GIS	WZ	15 Nov. 2007		
CHECK	AA	15 Nov. 2007		
REVIEW	TC	16 Nov. 2007		

I:\CLIENTS\SHELL\05-1344-027\mapping\mxd\Forestry\DRAFT\jackpine\JP_AVI_template_working_Map9.mxd

485000

486000

487000

6363000

6362000

T97 R8
W4M

N

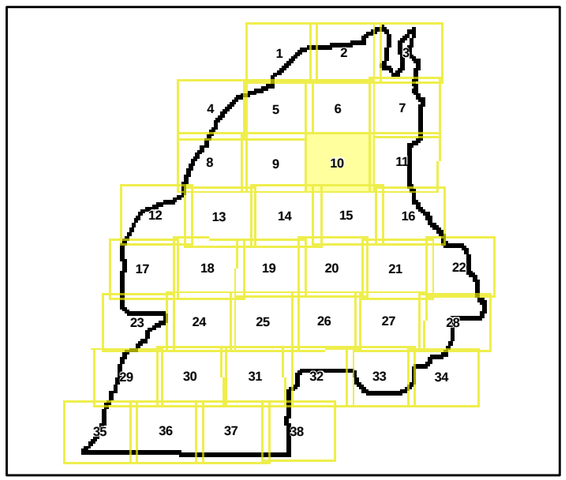
LEGEND

JACKPINE EXPANSION MINING AREA LOCAL STUDY AREA

AVI POLYGON

DISTURBED

EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE



REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2005-2006), used under license.
Imagery (Orthophoto) obtained from Shell Canada (August 2005).
Projection: UTM Zone 12 Datum: NAD 83

300 0 300

SCALE 1:10,000 METRES

PROJECT

JACKPINE MINE EXPANSION &
PIERRE RIVER MINE PROJECT

TITLE

ALBERTA VEGETATION INVENTORY
POLYGON MAP: MAP 10 OF 38

Shell Canada Limited

PROJECT No. 05-1344-027-7600			SCALE AS SHOWN	REV. 0
DESIGN	VR	18 Jan. 2007	FIGURE: O-10	
GIS	WZ	15 Nov. 2007		
CHECK	AA	15 Nov. 2007		
REVIEW	TC	16 Nov. 2007		

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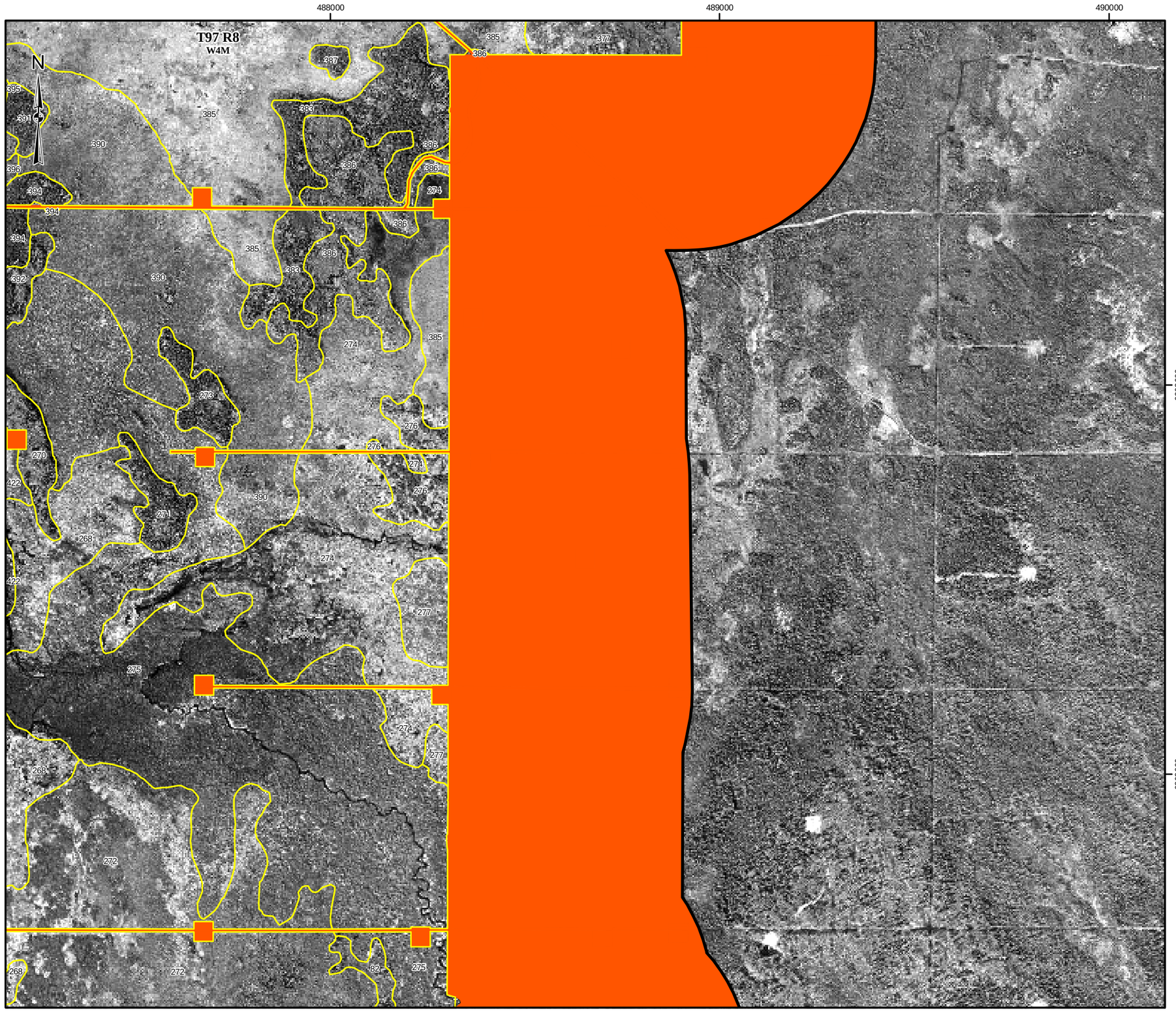
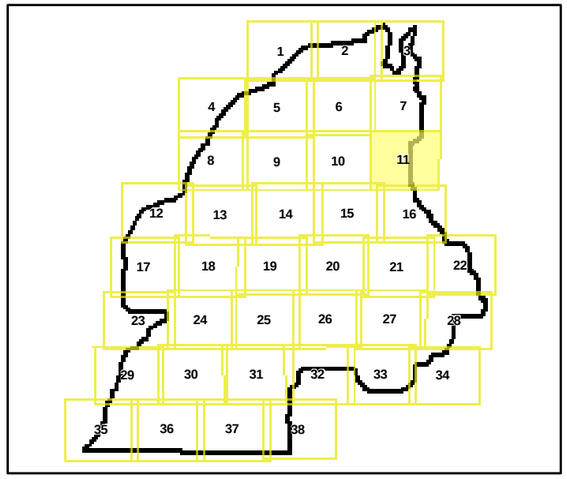


LEGEND

- JACKPINE EXPANSION MINING AREA LOCAL STUDY AREA
- AVI POLYGON

DISTURBED

- EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE



REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2005-2006), used under license.
Imagery (Orthophoto) obtained from Shell Canada (2005).
Projection: UTM Zone 12 Datum: NAD 83

300 0 300
SCALE 1:10,000 METRES

PROJECT
JACKPINE MINE EXPANSION &
PIERRE RIVER MINE PROJECT

TITLE
ALBERTA VEGETATION INVENTORY
POLYGON MAP: MAP 11 OF 38

Shell Canada Limited

PROJECT No. 05-1344-027-7600			SCALE AS SHOWN	REV. 0
DESIGN	VR	18 Jan. 2007		
GIS	WZ	15 Nov. 2007		
CHECK	AA	15 Nov. 2007		
REVIEW	TC	16 Nov. 2007		

FIGURE: O-11

I:\CLIENTS\SHELL\05-1344-027\mapping\mxd\Forestry\DRAFT\jackpine\JP_AVI_template_working_Map11.mxd

477000

478000

479000

6361000

6360000

N

FORT MCKAY INDIAN RESERVE No. 174C (R.174G)

T97 R9
W4M

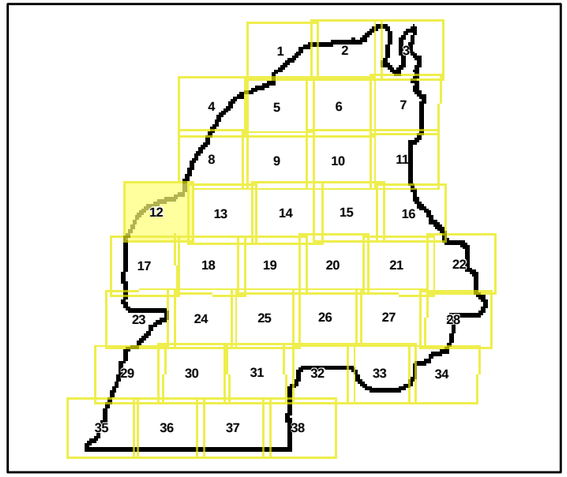
T96 R9
W4M

LEGEND

- JACKPINE EXPANSION MINING AREA LOCAL STUDY AREA
- AVI POLYGON
- INDIAN RESERVE

DISTURBED

- EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE



REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2005-2006), used under license.
Imagery (Orthophoto) obtained from Shell Canada (August 2005).
Projection: UTM Zone 12 Datum: NAD 83

300 0 300

SCALE 1:10,000 METRES

PROJECT

JACKPINE MINE EXPANSION &
PIERRE RIVER MINE PROJECT

TITLE

ALBERTA VEGETATION INVENTORY
POLYGON MAP: MAP 12 OF 38

Shell Canada Limited

PROJECT No. 05-1344-027-7600			SCALE AS SHOWN	REV. 0
DESIGN	VR	18 Jan. 2007	FIGURE: O-12	
GIS	WZ	15 Nov. 2007		
CHECK	AA	15 Nov. 2007		
REVIEW	TC	16 Nov. 2007		

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480000

481000

482000

6361000

6360000

T97 R9 W4M

T97 R8 W4M

T96 R9 W4M

T96 R8 W4M

N

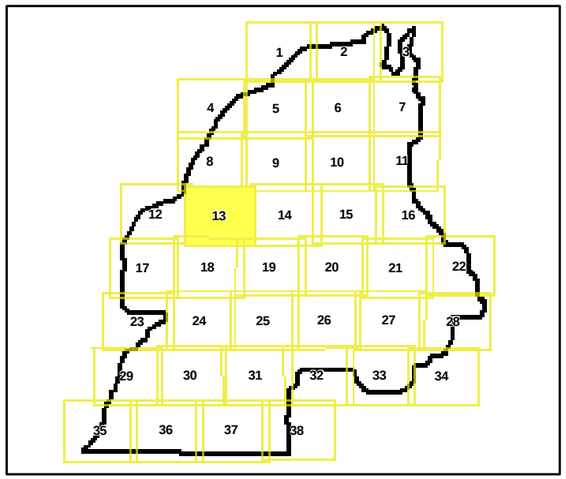
LEGEND

JACKPINE EXPANSION MINING AREA LOCAL STUDY AREA

AVI POLYGON

DISTURBED

EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE



REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2005-2006), used under license.
Imagery (Orthophoto) obtained from Shell Canada (August 2005).
Projection: UTM Zone 12 Datum: NAD 83

300 0 300

SCALE 1:10,000 METRES

PROJECT

JACKPINE MINE EXPANSION &
PIERRE RIVER MINE PROJECT

TITLE

ALBERTA VEGETATION INVENTORY
POLYGON MAP: MAP 13 OF 38

Shell Canada Limited

PROJECT No. 05-1344-027-7600			SCALE AS SHOWN	REV. 0
DESIGN	VR	18 Jan. 2007	FIGURE: O-13	
GIS	WZ	15 Nov. 2007		
CHECK	AA	15 Nov. 2007		
REVIEW	TC	16 Nov. 2007		

I:\CLIENTS\SHELL\05-1344-027\mapping\mxd\Forestry\DRAFT\jackpine\JP_AVI_template_working_Map13.mxd

483000

484000

485000

6361000

6360000

T97 R8
W4M

T96 R8
W4M

N

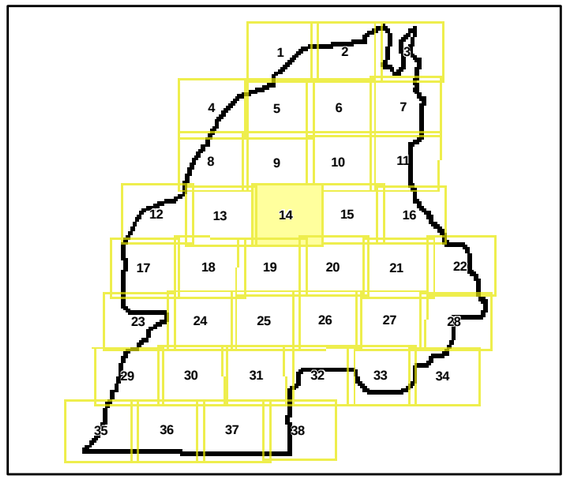
LEGEND

JACKPINE EXPANSION MINING AREA LOCAL STUDY AREA

AVI POLYGON

DISTURBED

EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE



REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2005-2006), used under license.
Imagery (Orthophoto) obtained from Shell Canada (August 2005).
Projection: UTM Zone 12 Datum: NAD 83

300 0 300

SCALE 1:10,000 METRES

PROJECT

JACKPINE MINE EXPANSION &
PIERRE RIVER MINE PROJECT

TITLE

ALBERTA VEGETATION INVENTORY POLYGON MAP: MAP 14 OF 38

Shell Canada Limited

PROJECT No. 05-1344-027-7600			SCALE AS SHOWN	REV. 0
DESIGN	VR	18 Jan. 2007		
GIS	WZ	15 Nov. 2007		
CHECK	AA	15 Nov. 2007		
REVIEW	TC	16 Nov. 2007		

FIGURE: O-14

I:\CLIENTS\SHELL\05-1344-027\mapping\mxd\Forestry\DRAFT\jackpine\JP_AVI_template_working_Map14.mxd

485000

486000

487000

6361000

6360000

T97 R8
W4M

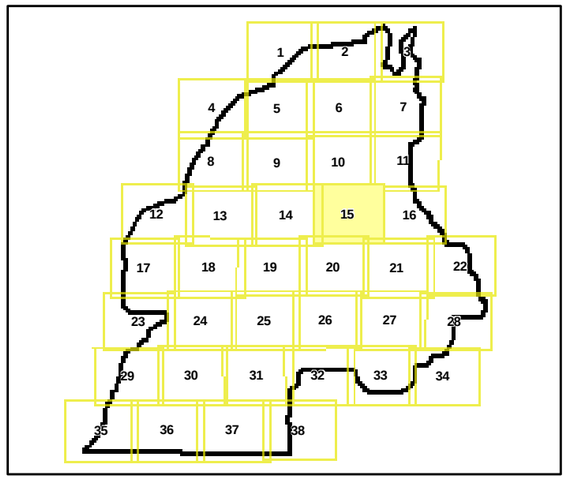
T96 R8
W4M

LEGEND

- JACKPINE EXPANSION MINING AREA LOCAL STUDY AREA
- AVI POLYGON

DISTURBED

- EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE



REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2005-2006), used under license.
Imagery (Orthophoto) obtained from Shell Canada (August 2005).
Projection: UTM Zone 12 Datum: NAD 83

300 0 300
SCALE 1:10,000 METRES

PROJECT
JACKPINE MINE EXPANSION &
PIERRE RIVER MINE PROJECT

TITLE
ALBERTA VEGETATION INVENTORY
POLYGON MAP: MAP 15 OF 38

Shell Canada Limited

PROJECT No. 05-1344-027-7600			SCALE AS SHOWN	REV. 0
DESIGN	VR	18 Jan. 2007		
GIS	WZ	15 Nov. 2007		
CHECK	AA	15 Nov. 2007		
REVIEW	TC	16 Nov. 2007		

FIGURE: O-15

I:\CLIENTS\SHELL\05-1344-027\mapping\mxd\Forestry\DRAFT\jackpine\JP_AVI_template_working_Map15.mxd

488000 489000 490000

6361000

6360000

T97 R8 W4M

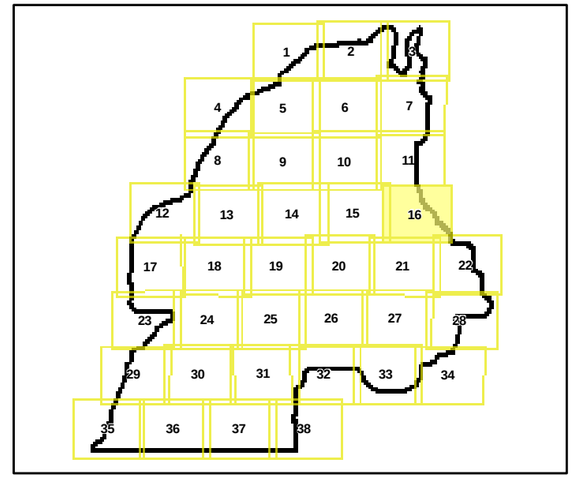
T96 R8 W4M

LEGEND

- JACKPINE EXPANSION MINING AREA LOCAL STUDY AREA
- AVI POLYGON

DISTURBED

- EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE



REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2005-2006), used under license.
Imagery (Orthophoto) obtained from Shell Canada (August 2005).
Projection: UTM Zone 12 Datum: NAD 83

300 0 300

SCALE 1:10,000 METRES

PROJECT

JACKPINE MINE EXPANSION &
PIERRE RIVER MINE PROJECT

TITLE

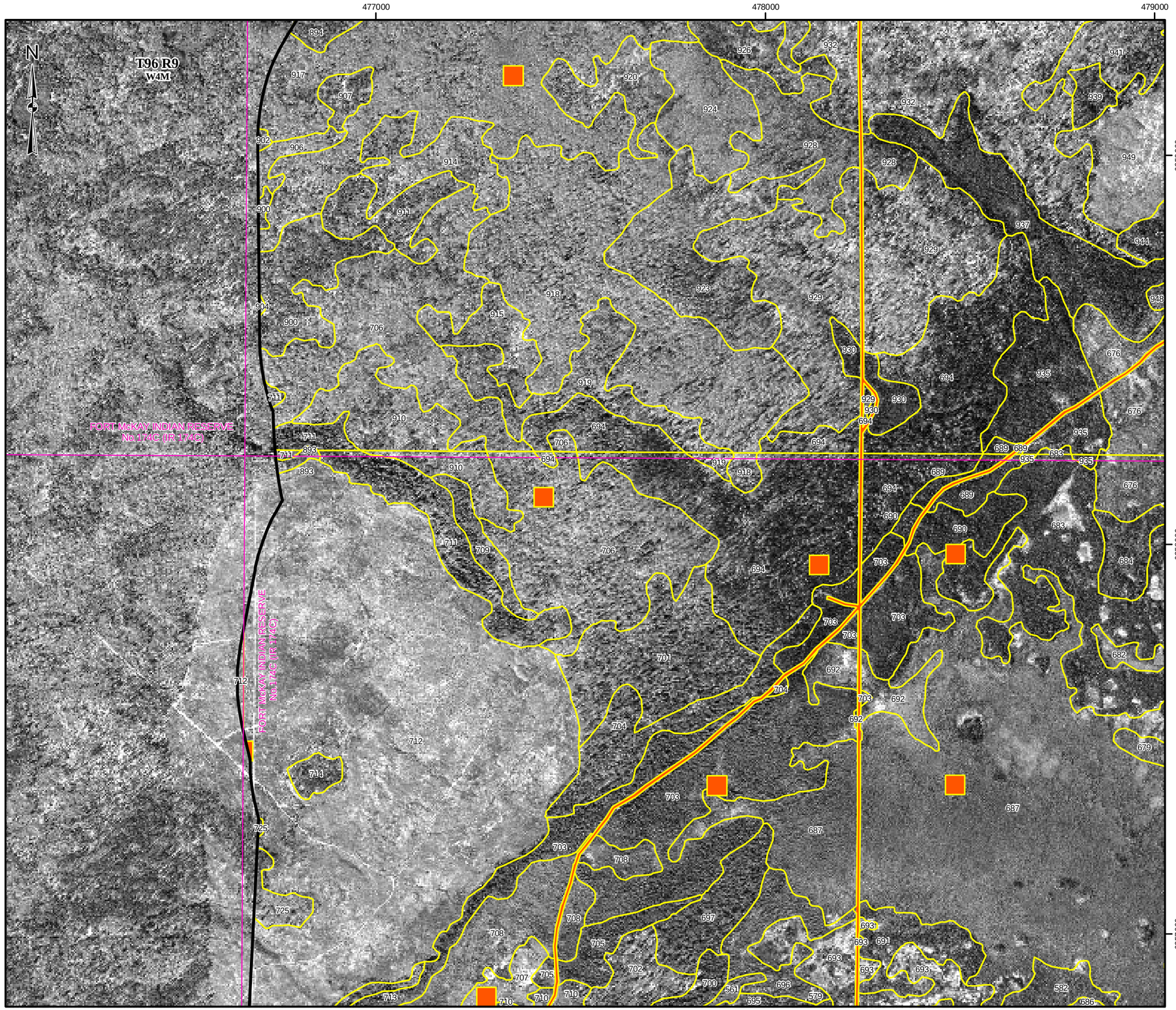
ALBERTA VEGETATION INVENTORY POLYGON MAP: MAP 16 OF 38

Shell Canada Limited

PROJECT No. 05-1344-027-7600			SCALE AS SHOWN	REV. 0
DESIGN	VR	18 Jan. 2007		
GIS	WZ	15 Nov. 2007		
CHECK	AA	15 Nov. 2007		
REVIEW	TC	16 Nov. 2007		

FIGURE: O-16

I:\CLIENTS\SHELL\05-1344-027\mapping\mxd\Forestry\DRAFT\jackpine\JP_AVI_template_working_Map16.mxd

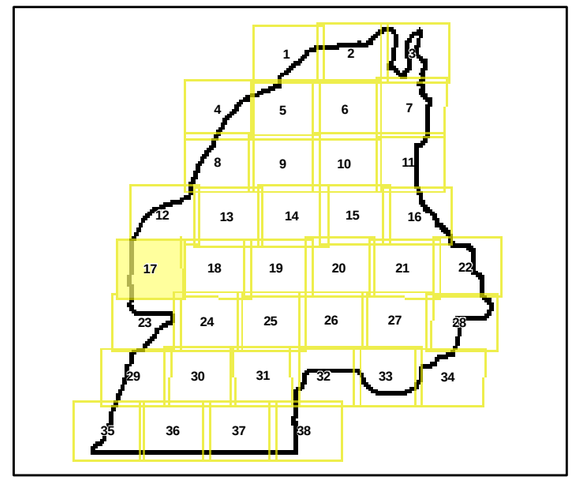


LEGEND

- JACKPINE EXPANSION MINING AREA LOCAL STUDY AREA
- AVI POLYGON
- INDIAN RESERVE

DISTURBED

- EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE



REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2005-2006), used under license.
Imagery (Orthophoto) obtained from Shell Canada (August 2005).
Projection: UTM Zone 12 Datum: NAD 83

300 0 300
SCALE 1:10,000 METRES

PROJECT
JACKPINE MINE EXPANSION &
PIERRE RIVER MINE PROJECT

TITLE
ALBERTA VEGETATION INVENTORY
POLYGON MAP: MAP 17 OF 38

Shell Canada Limited

PROJECT No. 05-1344-027-7600			SCALE AS SHOWN	REV. 0
DESIGN	VR	18 Jan. 2007	FIGURE: O-17	
GIS	WZ	15 Nov. 2007		
CHECK	AA	15 Nov. 2007		
REVIEW	TC	16 Nov. 2007		

I:\CLIENTS\SHELL\05-1344-027\mapping\mxd\Forestry\DRAFT\jackpineUP_AVI_template_working_Map17.mxd

479000 480000 481000

6359000

6358000

6357000

N

FORT McKAY INDIAN RESERVE No. 174C (IR 174C)

T96 R9 W4M

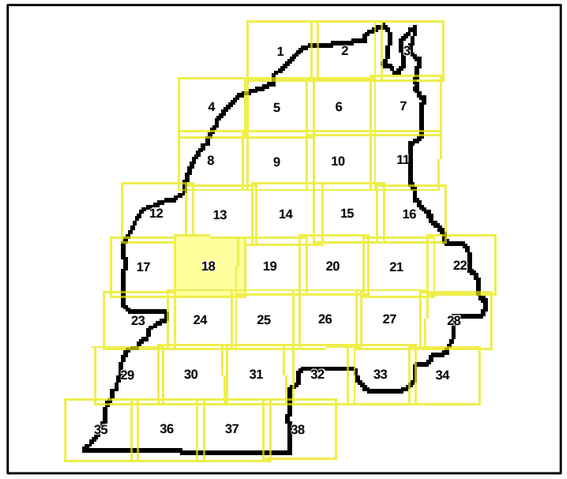
T96 R8 W4M

LEGEND

- JACKPINE EXPANSION MINING AREA LOCAL STUDY AREA
- AVI POLYGON
- INDIAN RESERVE

DISTURBED

- EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE



REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2005-2006), used under license.
Imagery (Orthophoto) obtained from Shell Canada (August 2005).
Projection: UTM Zone 12 Datum: NAD 83

300 0 300
SCALE 1:10,000 METRES

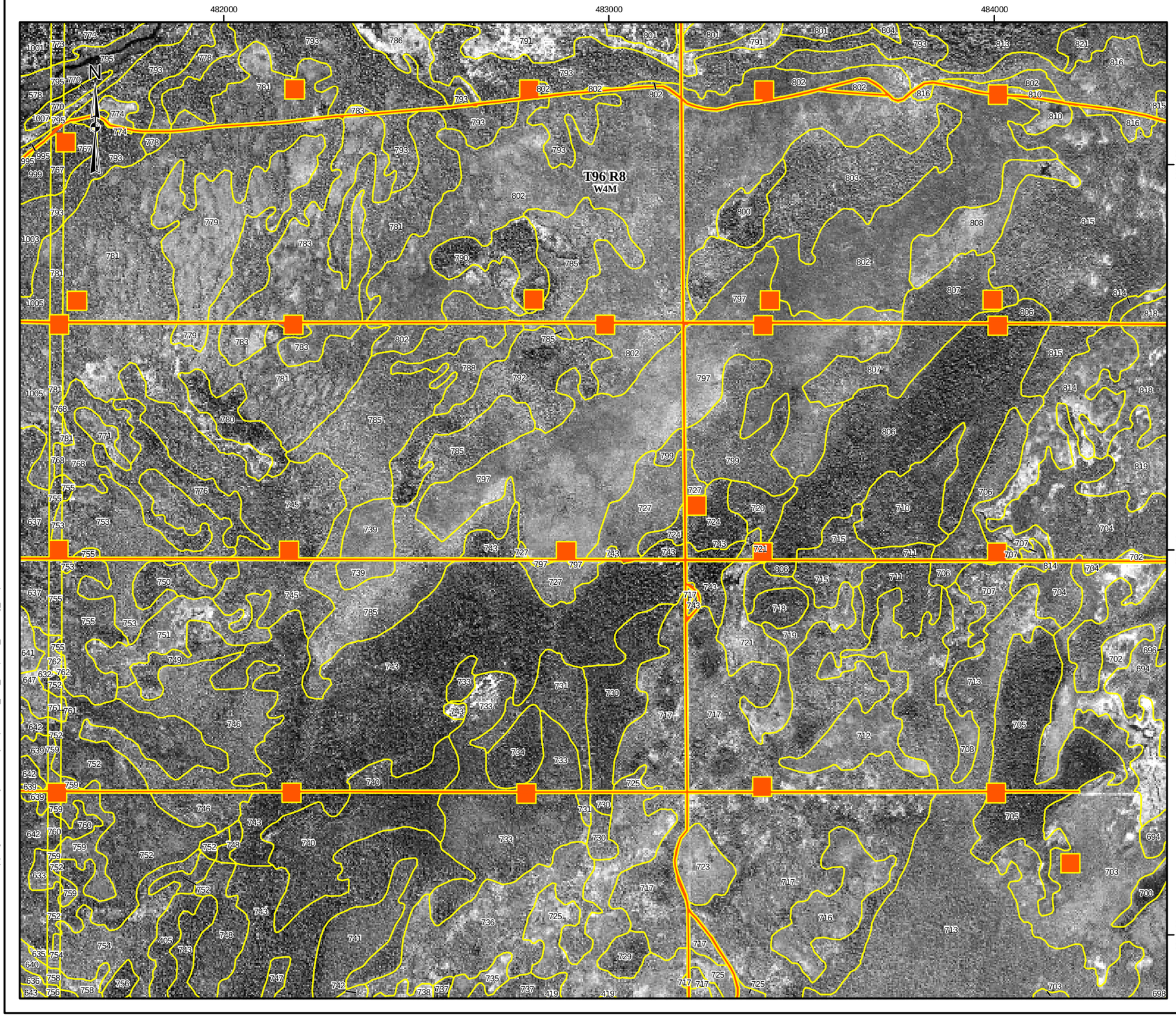
PROJECT
JACKPINE MINE EXPANSION &
PIERRE RIVER MINE PROJECT

TITLE
ALBERTA VEGETATION INVENTORY
POLYGON MAP: MAP 18 OF 38

Shell Canada Limited

PROJECT No. 05-1344-027-7600			SCALE AS SHOWN	REV. 0
DESIGN	VR	18 Jan. 2007	FIGURE: 0-18	
GIS	WZ	15 Nov. 2007		
CHECK	AA	15 Nov. 2007		
REVIEW	TC	16 Nov. 2007		

I:\CLIENTS\SHELL\05-1344-027\mapping\mxd\Forestry\DRAFT\jackpine\JP_AVI_template_working_Map18.mxd

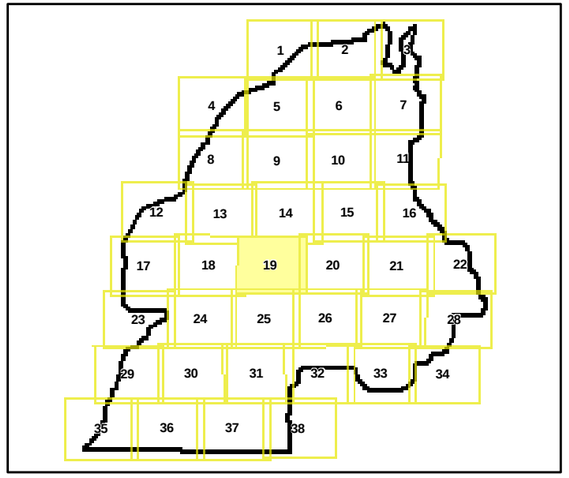


LEGEND

- JACKPINE EXPANSION MINING AREA LOCAL STUDY AREA
- AVI POLYGON

DISTURBED

- EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE



REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2005-2006), used under license.
Imagery (Orthophoto) obtained from Shell Canada (August 2005).
Projection: UTM Zone 12 Datum: NAD 83

300 0 300
SCALE 1:10,000 METRES

PROJECT
JACKPINE MINE EXPANSION &
PIERRE RIVER MINE PROJECT

TITLE
ALBERTA VEGETATION INVENTORY
POLYGON MAP: MAP 19 OF 38

Shell Canada Limited

PROJECT No. 05-1344-027-7600			SCALE AS SHOWN	REV. 0
DESIGN	VR	18 Jan. 2007		
GIS	WZ	15 Nov. 2007		
CHECK	AA	15 Nov. 2007		
REVIEW	TC	16 Nov. 2007		

FIGURE: O-19

I:\CLIENTS\SHELL\05-1344-027\mapping\mxd\Forestry\DRAFT\jackpine\JP_AVI_template_working_Map19.mxd

485000

486000

487000

6359000

6358000

6357000

T96 R8
W4M

N

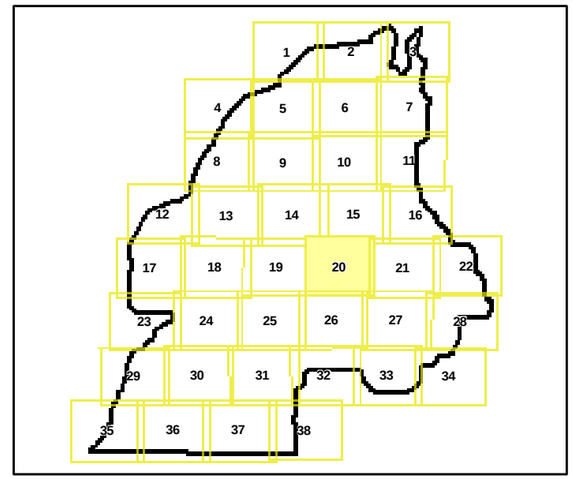
LEGEND

JACKPINE EXPANSION MINING AREA LOCAL STUDY AREA

AVI POLYGON

DISTURBED

EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE



REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2005-2006), used under license.
Imagery (Orthophoto) obtained from Shell Canada (August 2005).
Projection: UTM Zone 12 Datum: NAD 83

300 0 300

SCALE 1:10,000 METRES

PROJECT

JACKPINE MINE EXPANSION &
PIERRE RIVER MINE PROJECT

TITLE

ALBERTA VEGETATION INVENTORY POLYGON MAP: MAP 20 OF 38

Shell Canada Limited

PROJECT No. 05-1344-027-7600			SCALE AS SHOWN	REV. 0	
DESIGN	VR	18 Jan. 2007	FIGURE: O-20		
GIS	WZ	16 Nov. 2007			
CHECK	AA	15 Nov. 2007			
REVIEW	TC	16 Nov. 2007			

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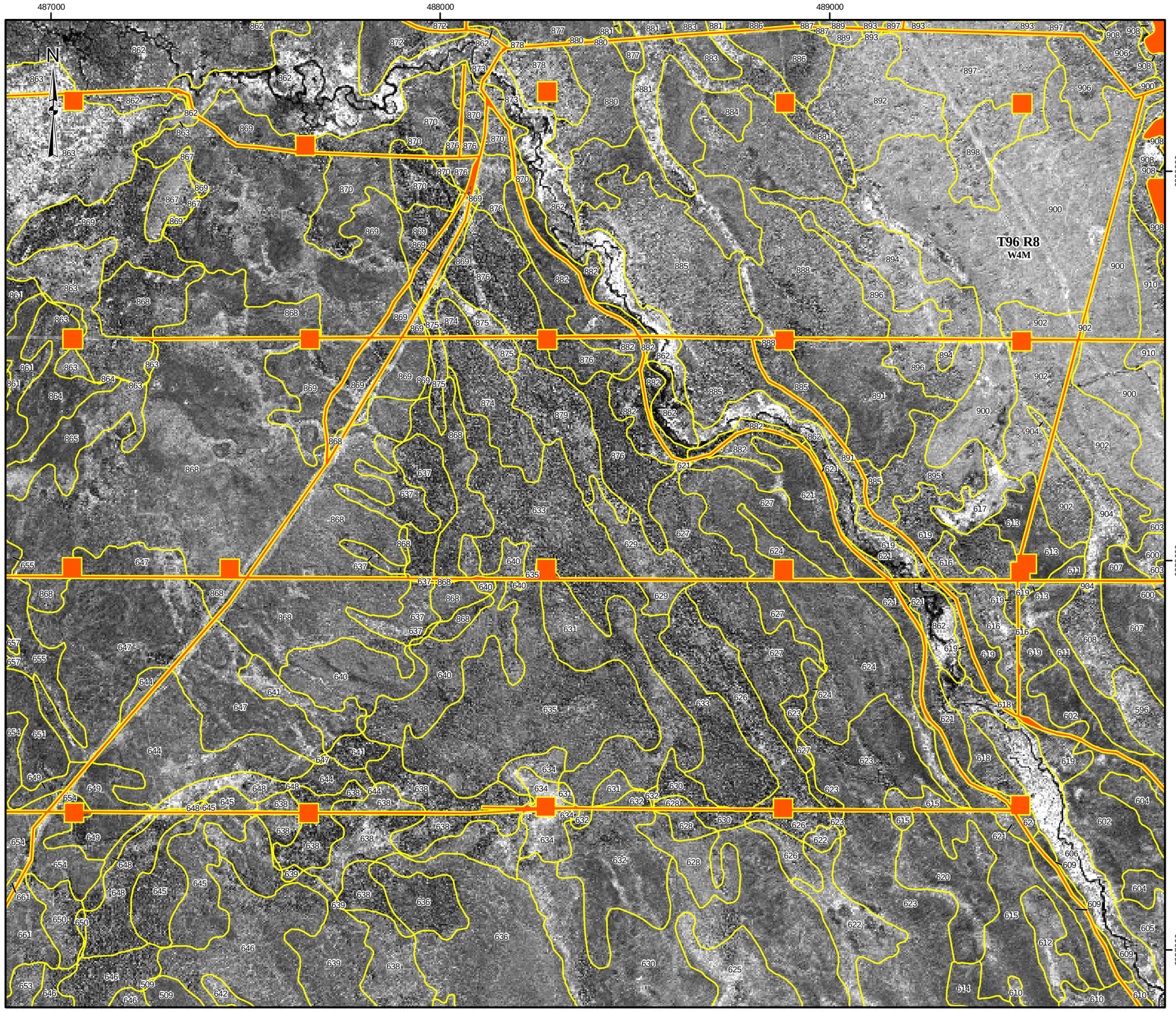
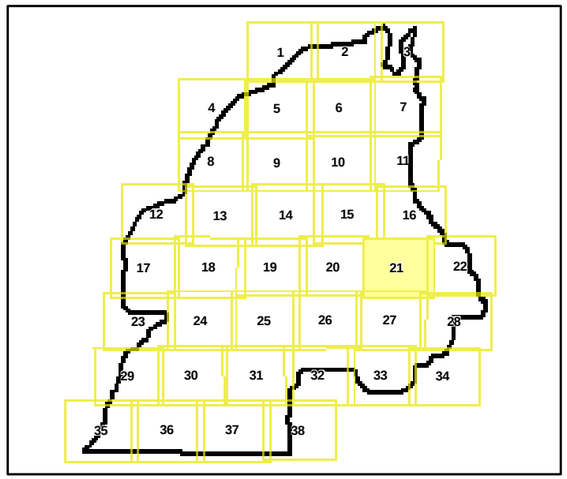


LEGEND

- JACKPINE EXPANSION MINING AREA LOCAL STUDY AREA
- AVI POLYGON

DISTURBED

- EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE



REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2005-2006), used under license.
Imagery (Orthophoto) obtained from Shell Canada (August 2005).
Projection: UTM Zone 12 Datum: NAD 83

300 0 300
SCALE 1:10,000 METRES

PROJECT
JACKPINE MINE EXPANSION &
PIERRE RIVER MINE PROJECT

TITLE
ALBERTA VEGETATION INVENTORY
POLYGON MAP: MAP 21 OF 38

Shell Canada Limited

PROJECT No. 05-1344-027-7600			SCALE AS SHOWN	REV. 0
DESIGN	VR	18 Jan. 2007	FIGURE: O-21	
GIS	WZ	16 Nov. 2007		
CHECK	AA	15 Nov. 2007		
REVIEW	TC	16 Nov. 2007		

I:\CLIENTS\SHELL\05-1344-027\mappingmxd\Forestry\DRAFT\jackpine\JP_AVI_template_working_Map21.mxd

490000
491000
492000
6359000
6358000
6357000

T96 R8
W4M

T96 R7
W4M

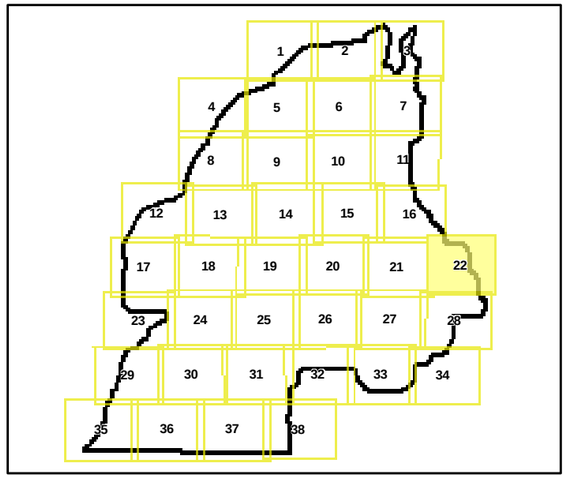
N

LEGEND

- JACKPINE EXPANSION MINING AREA LOCAL STUDY AREA
- AVI POLYGON

DISTURBED

- EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE



REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2005-2006), used under license.
Imagery (Orthophoto) obtained from Shell Canada (August 2005).
Projection: UTM Zone 12 Datum: NAD 83

300 0 300
SCALE 1:10,000 METRES

PROJECT
JACKPINE MINE EXPANSION &
PIERRE RIVER MINE PROJECT

TITLE
ALBERTA VEGETATION INVENTORY
POLYGON MAP: MAP 22 OF 38

Shell Canada Limited

PROJECT No. 05-1344-027-7600			SCALE AS SHOWN	REV. 0
DESIGN	VR	18 Jan. 2007	FIGURE: O-22	
GIS	WZ	15 Nov. 2007		
CHECK	AA	15 Nov. 2007		
REVIEW	TC	16 Nov. 2007		

I:\CLIENTS\SHELL\05-1344-027\mapping\mxd\Forestry\DRAFT\jackpine\JP_AVI_template_working_Map22.mxd

476000 477000 478000

6357000 6356000 6355000

N

T96 R9
W4M

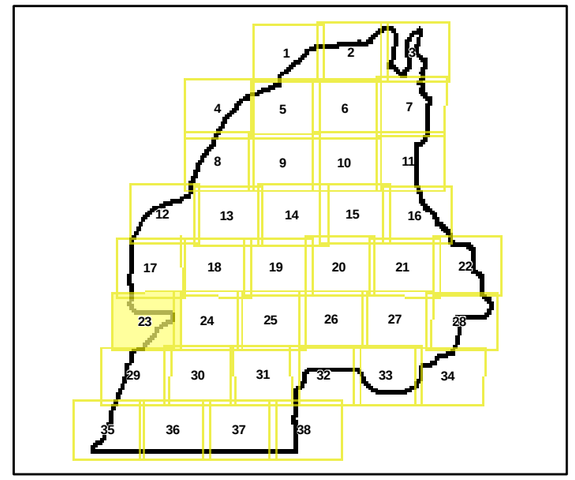
FORT McKAY INDIAN RESERVE
No. 174C (IR 174C)

LEGEND

- JACKPINE EXPANSION MINING AREA LOCAL STUDY AREA
- AVI POLYGON
- INDIAN RESERVE

DISTURBED

- EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE



REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2005-2006), used under license.
Imagery (Orthophoto) obtained from Shell Canada (August 2005).
Projection: UTM Zone 12 Datum: NAD 83

300 0 300
SCALE 1:10,000 METRES

PROJECT
JACKPINE MINE EXPANSION &
PIERRE RIVER MINE PROJECT

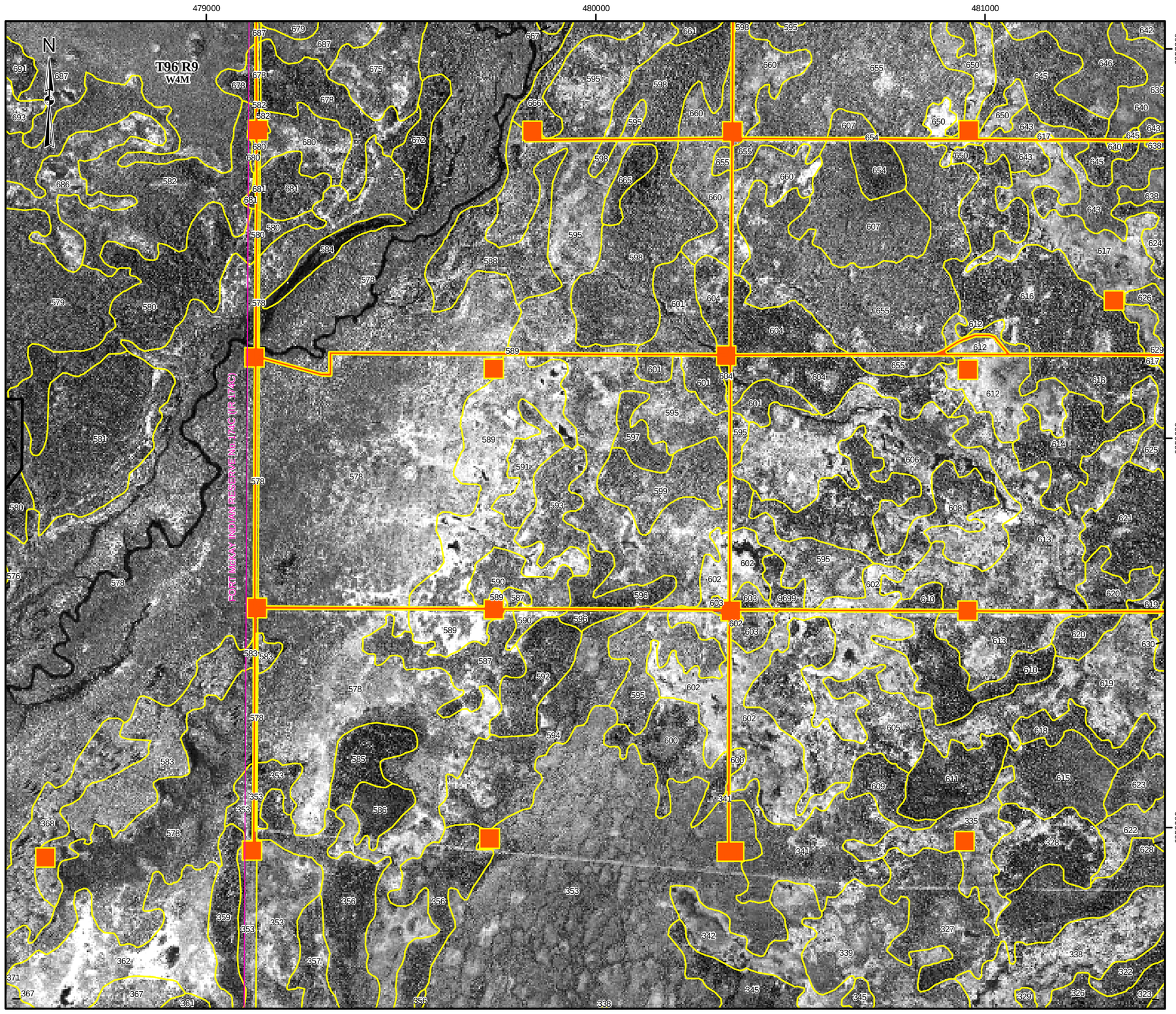
TITLE
ALBERTA VEGETATION INVENTORY
POLYGON MAP: MAP 23 OF 38

Shell Canada Limited

PROJECT No. 05-1344-027-7600			SCALE AS SHOWN	REV. 0
DESIGN	VR	18 Jan. 2007		
GIS	WZ	15 Nov. 2007		
CHECK	AA	15 Nov. 2007		
REVIEW	TC	16 Nov. 2007		

FIGURE: O-23

I:\CLIENTS\SHELL\05-1344-027\mapping\mxd\Forestry\DRAFT\jackpine\JP_AVI_template_working_Map23.mxd

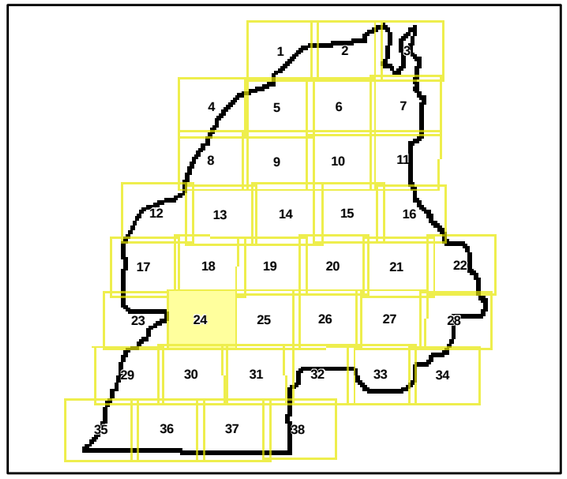


LEGEND

- JACKPINE EXPANSION MINING AREA LOCAL STUDY AREA
- AVI POLYGON
- INDIAN RESERVE

DISTURBED

- EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE



REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2005-2006), used under license.
Imagery (Orthophoto) obtained from Shell Canada (August 2005).
Projection: UTM Zone 12 Datum: NAD 83

300 0 300
SCALE 1:10,000 METRES

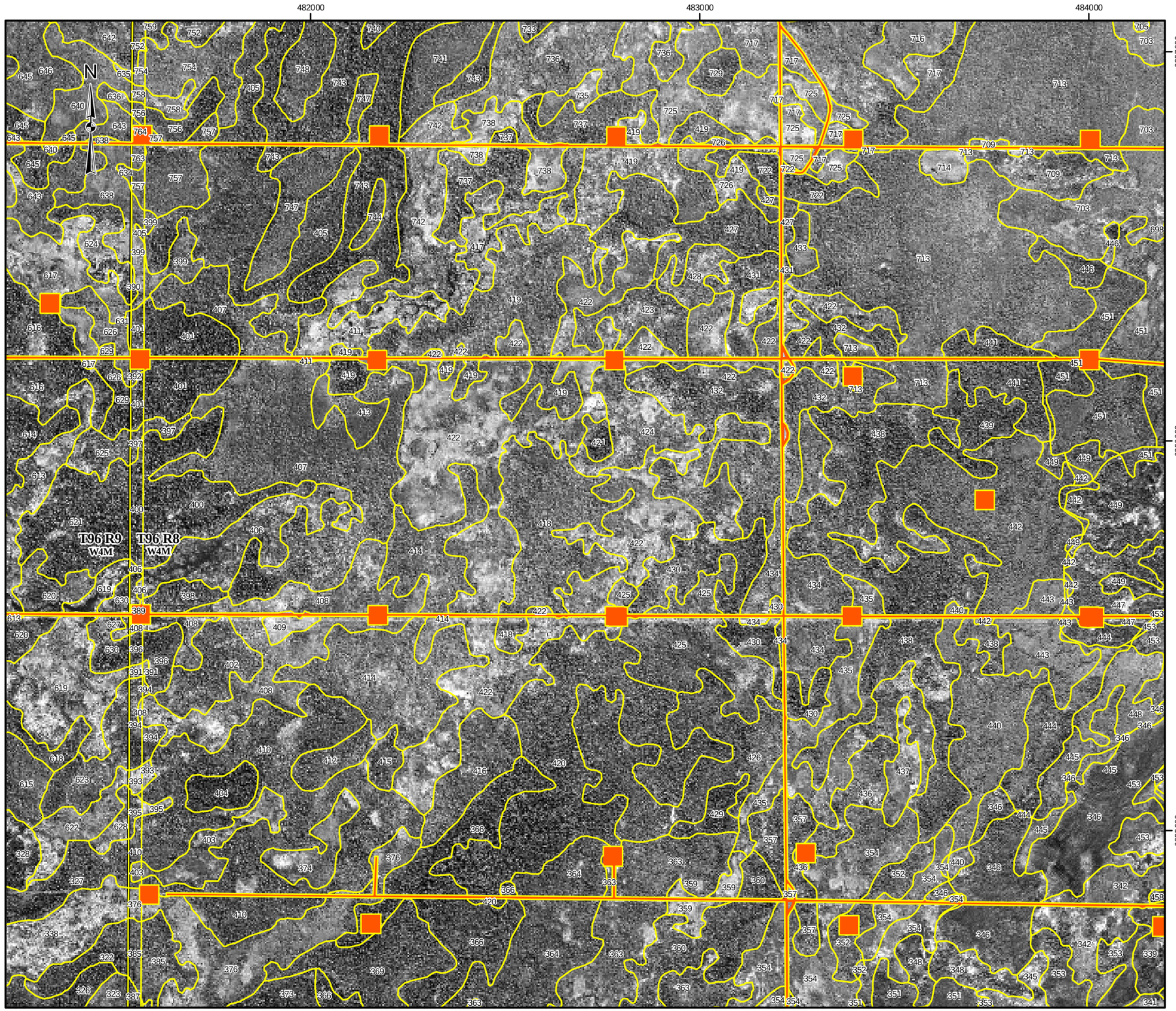
PROJECT
JACKPINE MINE EXPANSION &
PIERRE RIVER MINE PROJECT

TITLE
ALBERTA VEGETATION INVENTORY
POLYGON MAP: MAP 24 OF 38

Shell Canada Limited

PROJECT No. 05-1344-027-7600			SCALE AS SHOWN	REV. 0
DESIGN	VR	18 Jan. 2007	FIGURE: O-24	
GIS	WZ	16 Nov. 2007		
CHECK	AA	15 Nov. 2007		
REVIEW	TC	16 Nov. 2007		

I:\CLIENTS\SHELL\05-1344-027\mapping\mxd\Forestry\DRAFT\jackpine\JP_AVI_template_working_Map24.mxd

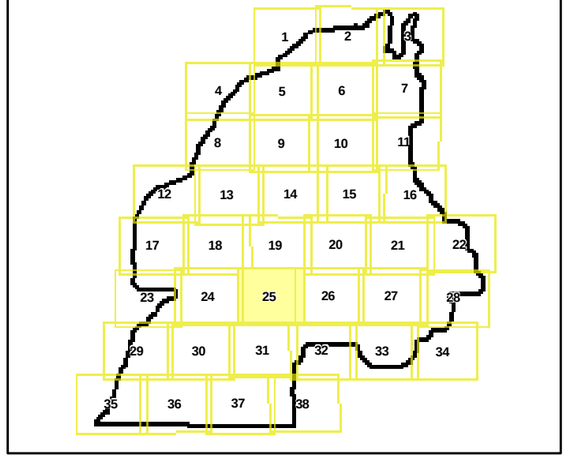


LEGEND

- JACKPINE EXPANSION MINING AREA LOCAL STUDY AREA
- AVI POLYGON

DISTURBED

- EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE



REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2005-2006), used under license.
Imagery (Orthophoto) obtained from Shell Canada (August 2005).
Projection: UTM Zone 12 Datum: NAD 83

300 0 300
SCALE 1:10,000 METRES

PROJECT
JACKPINE MINE EXPANSION &
PIERRE RIVER MINE PROJECT

TITLE
ALBERTA VEGETATION INVENTORY
POLYGON MAP: MAP 25 OF 38

Shell Canada Limited

PROJECT No. 05-1344-027-7600			SCALE AS SHOWN	REV. 0
DESIGN	VR	18 Jan. 2007	FIGURE: O-25	
GIS	WZ	16 Nov. 2007		
CHECK	AA	15 Nov. 2007		
REVIEW	TC	16 Nov. 2007		

I:\CLIENTS\SHELL\05-1344-027\mapping\mxd\Forestry\DRAFT\jackpine\JP_AVI_template_working_Map25.mxd

484000 485000 486000

6357000 6356000 6355000

N

T96 R8
W4M

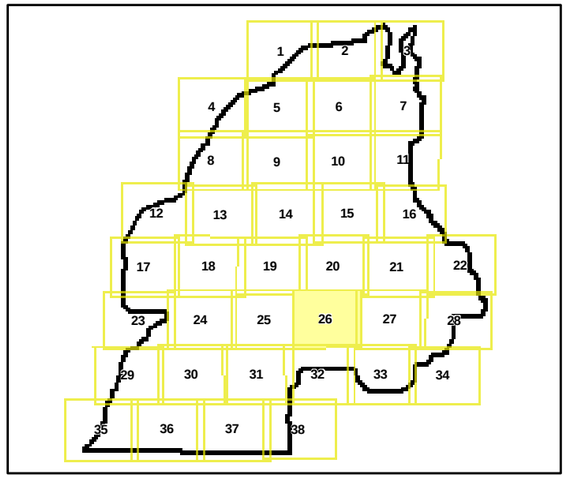
LEGEND

JACKPINE EXPANSION MINING AREA LOCAL STUDY AREA

AVI POLYGON

DISTURBED

EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE



REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2005-2006), used under license.
Imagery (Orthophoto) obtained from Shell Canada (August 2005).
Projection: UTM Zone 12 Datum: NAD 83

300 0 300
SCALE 1:10,000 METRES

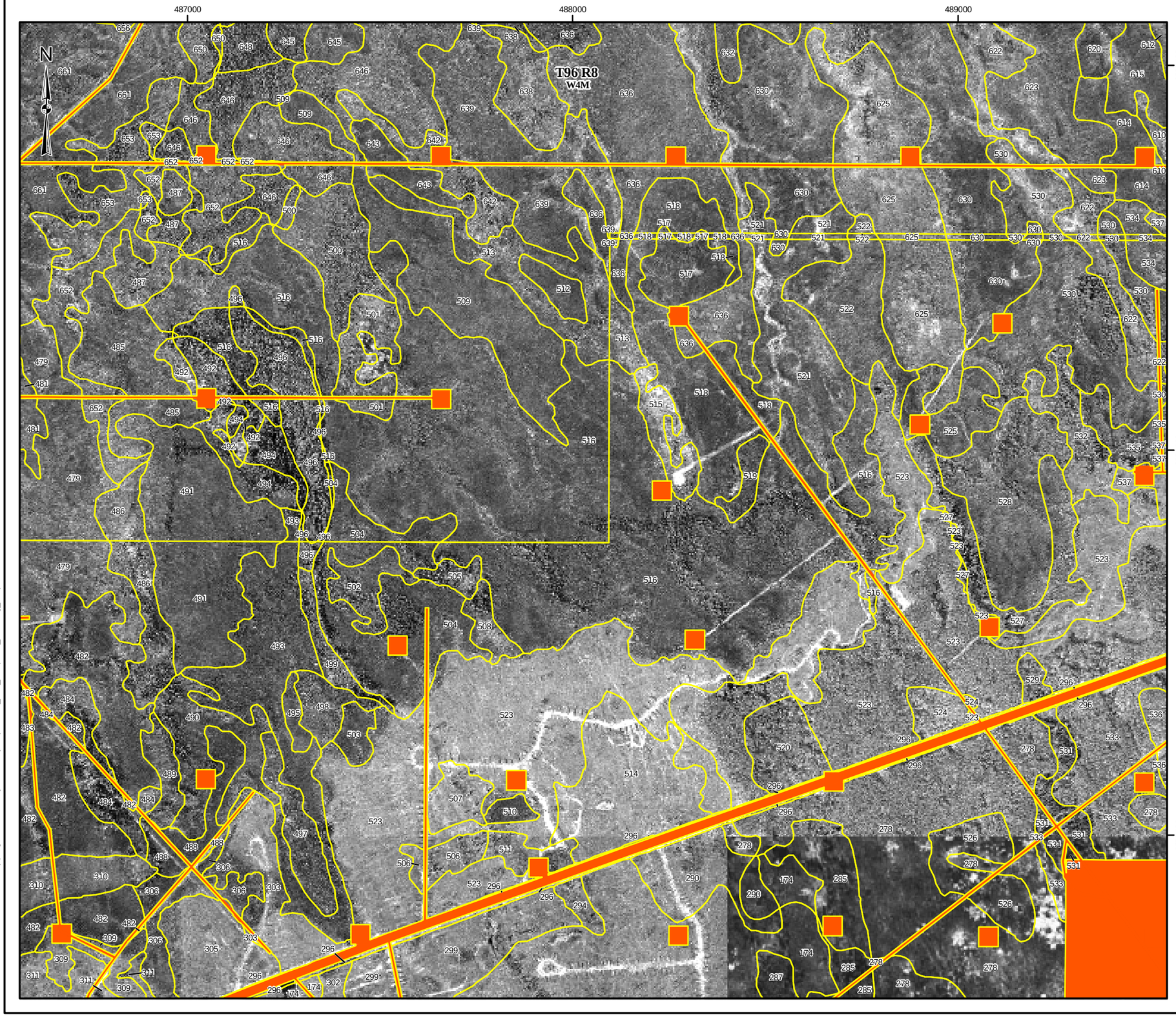
PROJECT
JACKPINE MINE EXPANSION &
PIERRE RIVER MINE PROJECT

TITLE
ALBERTA VEGETATION INVENTORY
POLYGON MAP: MAP 26 OF 38

Shell Canada Limited

PROJECT No. 05-1344-027-7600			SCALE AS SHOWN	REV. 0
DESIGN	VR	18 Jan. 2007	FIGURE: O-26	
GIS	WZ	16 Nov. 2007		
CHECK	AA	15 Nov. 2007		
REVIEW	TC	16 Nov. 2007		

I:\CLIENTS\SHELL\05-1344-027\mapping\mxd\Forestry\DRAFT\jackpine\JP_AVI_template_working_Map26.mxd

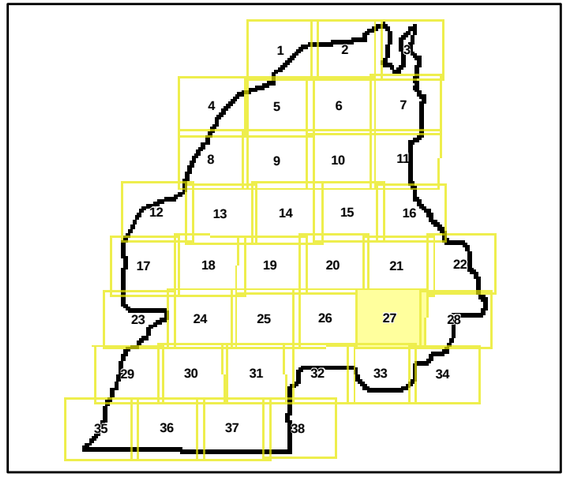


LEGEND

- JACKPINE EXPANSION MINING AREA LOCAL STUDY AREA
- AVI POLYGON

DISTURBED

- EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE



REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2005-2006), used under license.
Imagery (Orthophoto) obtained from Shell Canada (August 2005).
Projection: UTM Zone 12 Datum: NAD 83

300 0 300
SCALE 1:10,000 METRES

PROJECT
JACKPINE MINE EXPANSION &
PIERRE RIVER MINE PROJECT

TITLE
ALBERTA VEGETATION INVENTORY
POLYGON MAP: MAP 27 OF 38

Shell Canada Limited

PROJECT No. 05-1344-027-7600			SCALE AS SHOWN	REV. 0
DESIGN	VR	18 Jan. 2007		
GIS	WZ	16 Nov. 2007		
CHECK	AA	15 Nov. 2007		
REVIEW	TC	16 Nov. 2007		

FIGURE: O-27

I:\CLIENTS\SHELL\05-1344-027\mapping\mxd\Forestry\DRAFT\jackpine\JP_AVI_template_working_Map27.mxd

490000 491000 492000

6357000 6356000 6355000

T96 R8 W4M

T96 R7 W4M

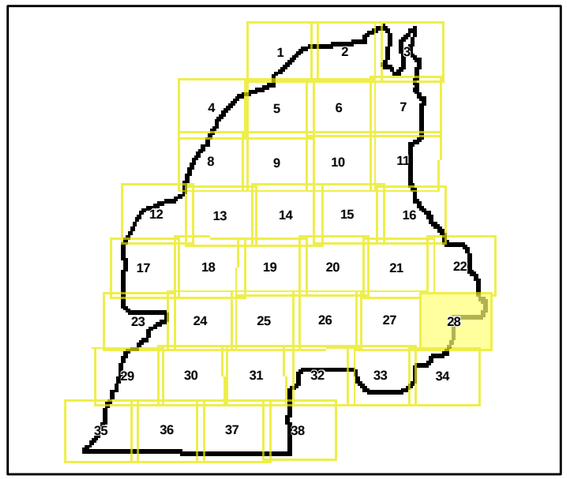
LEGEND

JACKPINE EXPANSION MINING AREA LOCAL STUDY AREA

AVI POLYGON

DISTURBED

EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE



REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2005-2006), used under license.
Imagery (Orthophoto) obtained from Shell Canada (August 2005).
Projection: UTM Zone 12 Datum: NAD 83

300 0 300

SCALE 1:10,000 METRES

PROJECT

JACKPINE MINE EXPANSION &
PIERRE RIVER MINE PROJECT

TITLE

ALBERTA VEGETATION INVENTORY
POLYGON MAP: MAP 28 OF 38

Shell Canada Limited

PROJECT No. 05-1344-027-7600			SCALE AS SHOWN	REV. 0
DESIGN	VR	18 Jan. 2007	FIGURE: O-28	
GIS	WZ	16 Nov. 2007		
CHECK	AA	15 Nov. 2007		
REVIEW	TC	16 Nov. 2007		

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476000

477000

478000

6354000

6353000

T96 R9
W4M

FORT McKAY INDIAN RESERVE
No. 174C (IR 174C)

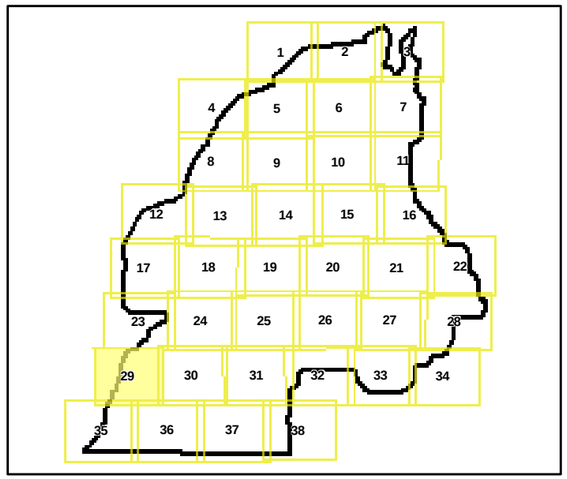
N

LEGEND

- JACKPINE EXPANSION MINING AREA LOCAL STUDY AREA
- AVI POLYGON
- INDIAN RESERVE

DISTURBED

- EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE



REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2005-2006), used under license.
Imagery (Orthophoto) obtained from Shell Canada (August 2005).
Projection: UTM Zone 12 Datum: NAD 83

300 0 300
SCALE 1:10,000 METRES

PROJECT
JACKPINE MINE EXPANSION &
PIERRE RIVER MINE PROJECT

TITLE
ALBERTA VEGETATION INVENTORY
POLYGON MAP: MAP 29 OF 38

Shell Canada Limited

PROJECT No. 05-1344-027-7600			SCALE AS SHOWN	REV. 0
DESIGN	VR	18 Jan. 2007	FIGURE: O-29	
GIS	WZ	16 Nov. 2007		
CHECK	AA	15 Nov. 2007		
REVIEW	TC	16 Nov. 2007		

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479000

480000

481000

6354000

6353000

T96 R9
W4M

FORT McKAY INDIAN RESERVE No. 174C (IR 174C)

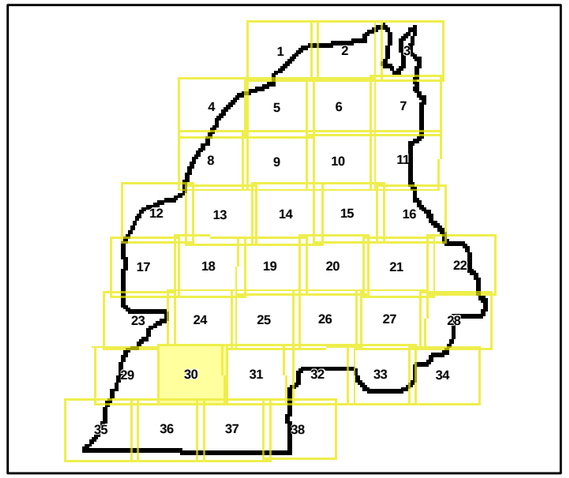
N

LEGEND

- JACKPINE EXPANSION MINING AREA LOCAL STUDY AREA
- AVI POLYGON
- INDIAN RESERVE

DISTURBED

- EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE



REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2005-2006), used under license.
Imagery (Orthophoto) obtained from Shell Canada (August 2005).
Projection: UTM Zone 12 Datum: NAD 83

300 0 300
SCALE 1:10,000 METRES

PROJECT
JACKPINE MINE EXPANSION &
PIERRE RIVER MINE PROJECT

TITLE
ALBERTA VEGETATION INVENTORY
POLYGON MAP: MAP 30 OF 38

Shell Canada Limited

PROJECT No. 05-1344-027-7600			SCALE AS SHOWN	REV. 0
DESIGN	VR	18 Jan. 2007	FIGURE: O-30	
GIS	WZ	16 Nov. 2007		
CHECK	AA	15 Nov. 2007		
REVIEW	TC	16 Nov. 2007		

I:\CLIENTS\SHELL\05-1344-027\mapping\mxd\Forestry\DRAFT\jackpine\JP_AVI_template_working_Map30.mxd

481000
482000
483000
6354000
6353000

N

T96 R9
W4M

T96 R8
W4M

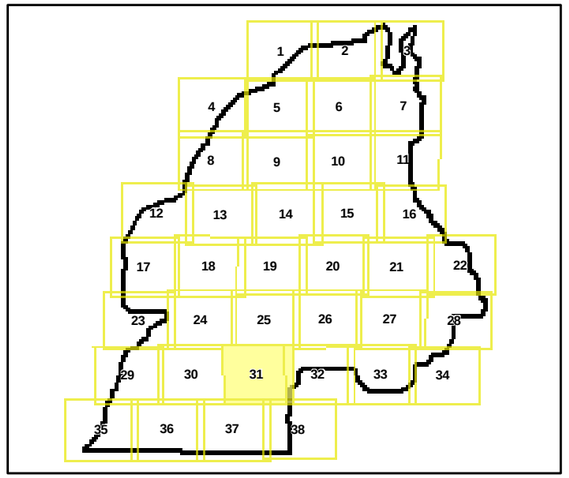
LEGEND

JACKPINE EXPANSION MINING AREA LOCAL STUDY AREA

AVI POLYGON

DISTURBED

EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE



REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2005-2006), used under license.
Imagery (Orthophoto) obtained from Shell Canada (August 2005).
Projection: UTM Zone 12 Datum: NAD 83

300 0 300
SCALE 1:10,000 METRES

PROJECT
JACKPINE MINE EXPANSION &
PIERRE RIVER MINE PROJECT

TITLE
ALBERTA VEGETATION INVENTORY
POLYGON MAP: MAP 31 OF 38

Shell Canada Limited

PROJECT No. 05-1344-027-7600			SCALE AS SHOWN	REV. 0
DESIGN	VR	18 Jan. 2007		
GIS	WZ	16 Nov. 2007		
CHECK	AA	15 Nov. 2007		
REVIEW	TC	16 Nov. 2007		

FIGURE: O-31

I:\CLIENTS\SHELL\05-1344-027\mapping\mxd\Forestry\DRAFT\jackpine\JP_AVI_template_working_Map31.mxd

484000

485000

486000

6354000

6353000

T96 R8
W4M

N

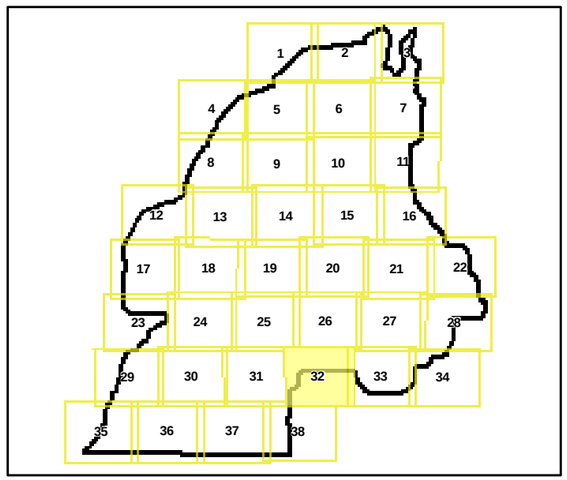
LEGEND

JACKPINE EXPANSION MINING AREA LOCAL STUDY AREA

AVI POLYGON

DISTURBED

EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE



REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2005-2006), used under license.
Imagery (Orthophoto) obtained from Shell Canada (August 2005).
Projection: UTM Zone 12 Datum: NAD 83

300 0 300

SCALE 1:10,000 METRES

PROJECT

JACKPINE MINE EXPANSION &
PIERRE RIVER MINE PROJECT

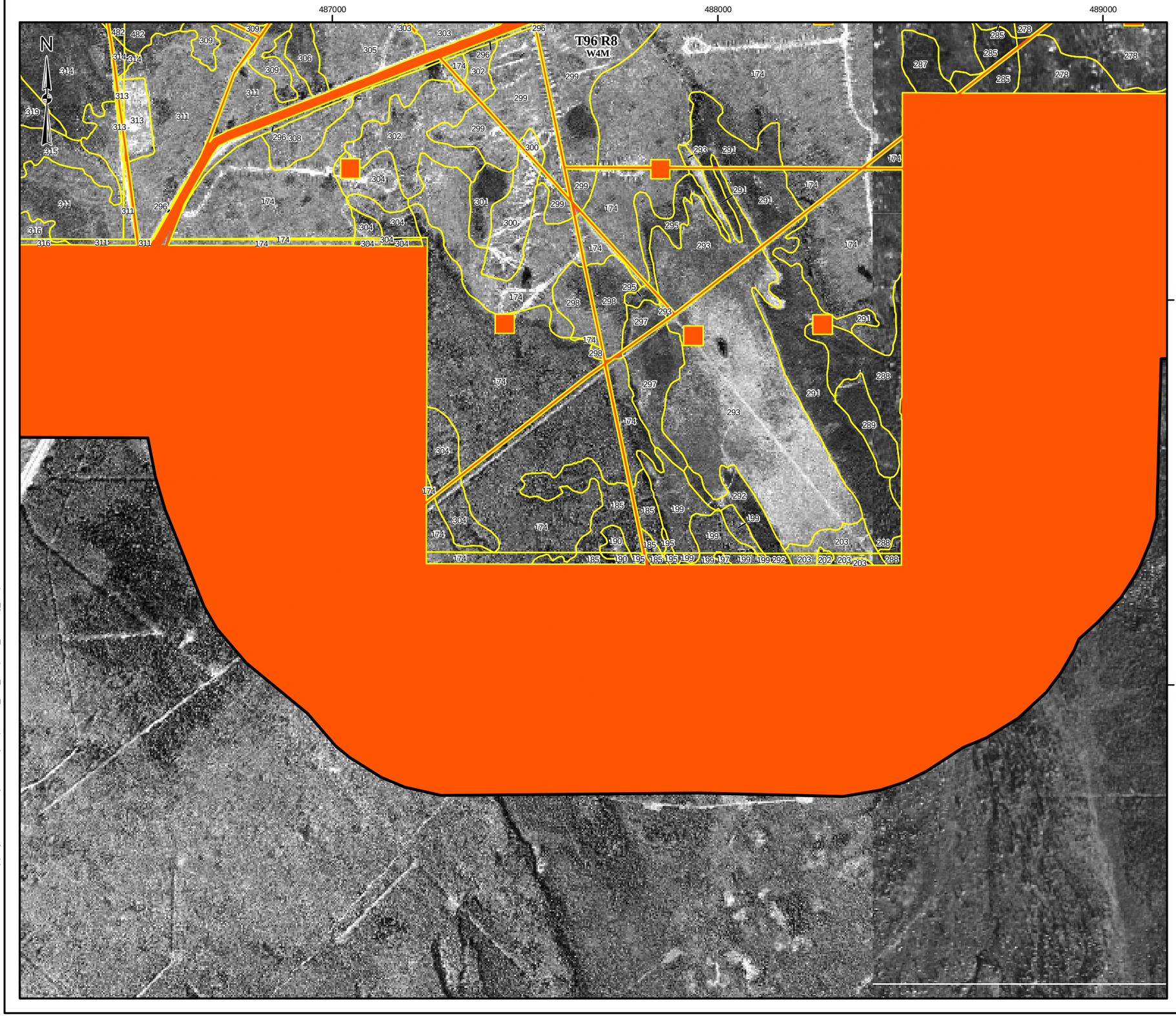
TITLE

ALBERTA VEGETATION INVENTORY
POLYGON MAP: MAP 32 OF 38

Shell Canada Limited

PROJECT No. 05-1344-027-7600			SCALE AS SHOWN	REV. 0
DESIGN	VR	18 Jan. 2007	FIGURE: O-32	
GIS	WZ	16 Nov. 2007		
CHECK	AA	15 Nov. 2007		
REVIEW	TC	16 Nov. 2007		

I:\CLIENTS\SHELL\05-1344-027\mapping\mxd\Forestry\DRAFT\jackpine\JP_AVI_template_working_Map32.mxd

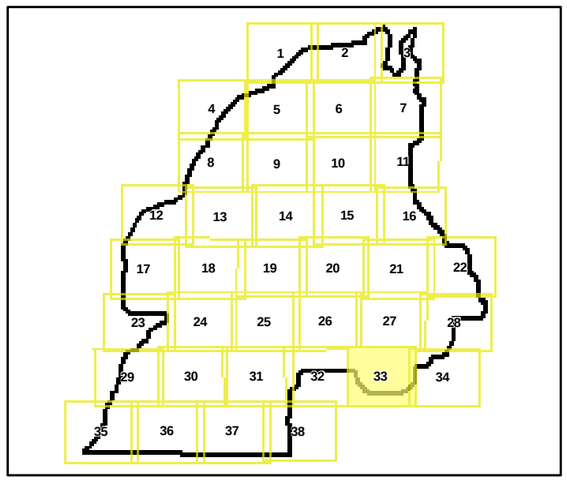


LEGEND

- JACKPINE EXPANSION MINING AREA LOCAL STUDY AREA
- AVI POLYGON

DISTURBED

- EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE



REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2005-2006), used under license.
Imagery (Orthophoto) obtained from Shell Canada (August 2005).
Projection: UTM Zone 12 Datum: NAD 83

300 0 300
SCALE 1:10,000 METRES

PROJECT
JACKPINE MINE EXPANSION &
PIERRE RIVER MINE PROJECT

TITLE
ALBERTA VEGETATION INVENTORY
POLYGON MAP: MAP 33 OF 38

Shell Canada Limited

PROJECT No. 05-1344-027-7600			SCALE AS SHOWN	REV. 0
DESIGN	VR	18 Jan. 2007		
GIS	WZ	16 Nov. 2007		
CHECK	AA	15 Nov. 2007		
REVIEW	TC	16 Nov. 2007		

FIGURE: O-33

I:\CLIENTS\SHELL\05-1344-027\mapping\mxd\Forestry\DRAFT\jackpine\JP_AVI_template_working_Map33.mxd

489000
490000
491000
6354000
6353000
278
273
N
T96 R8
W4M
T96 R7
W4M

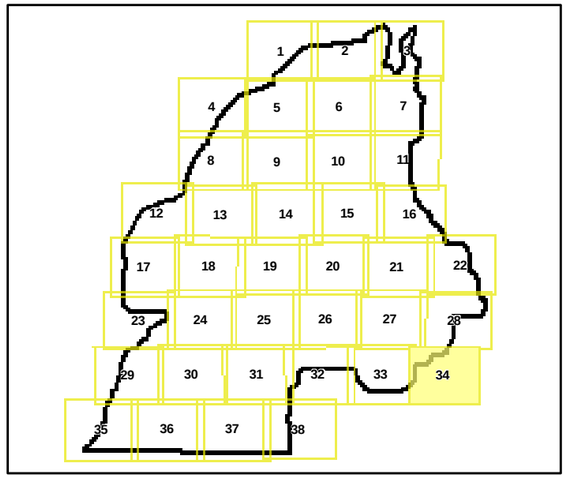
LEGEND

JACKPINE EXPANSION MINING AREA LOCAL STUDY AREA

AVI POLYGON

DISTURBED

EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE



REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2005-2006), used under license.
Imagery (Orthophoto) obtained from Shell Canada (August 2005).
Projection: UTM Zone 12 Datum: NAD 83

300 0 300
SCALE 1:10,000 METRES

PROJECT
JACKPINE MINE EXPANSION &
PIERRE RIVER MINE PROJECT

TITLE
ALBERTA VEGETATION INVENTORY
POLYGON MAP: MAP 34 OF 38

Shell Canada Limited

PROJECT No. 05-1344-027-7600			SCALE AS SHOWN	REV. 0
DESIGN	VR	18 Jan. 2007	FIGURE: O-34	
GIS	WZ	16 Nov. 2007		
CHECK	AA	15 Nov. 2007		
REVIEW	TC	16 Nov. 2007		

I:\CLIENTS\SHELL\05-1344-027\mapping\mxd\Forestry\DRAFT\jackpine\JP_AVI_template_working_Map34.mxd

475000 476000 477000

6352000 6351000 6350000

N

FORT MCKAY INDIAN RESERVE No. 174C (IR 174C)

T96 R9 W4M

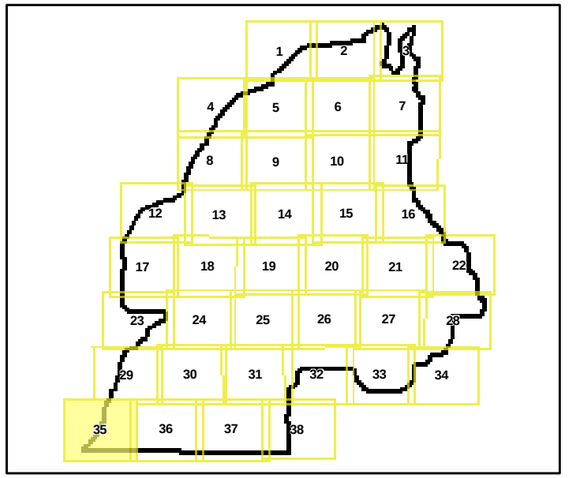
T95 R9 W4M

LEGEND

- JACKPINE EXPANSION MINING AREA LOCAL STUDY AREA
- AVI POLYGON
- INDIAN RESERVE

DISTURBED

- EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE



REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2005-2006), used under license.
Imagery (Orthophoto) obtained from Shell Canada (August 2005).
Projection: UTM Zone 12 Datum: NAD 83

300 0 300
SCALE 1:10,000 METRES

PROJECT
JACKPINE MINE EXPANSION &
PIERRE RIVER MINE PROJECT

TITLE
ALBERTA VEGETATION INVENTORY
POLYGON MAP: MAP 35 OF 38

Shell Canada Limited

PROJECT No. 05-1344-027-7600			SCALE AS SHOWN	REV. 0
DESIGN	VR	18 Jan. 2007	FIGURE: O-35	
GIS	WZ	16 Nov. 2007		
CHECK	AA	15 Nov. 2007		
REVIEW	TC	16 Nov. 2007		

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478000

479000

480000

6352000

6351000

6350000

N

FORT McKAY INDIAN RESERVE No. 174C (IR 174C)

T96 R9 W4M

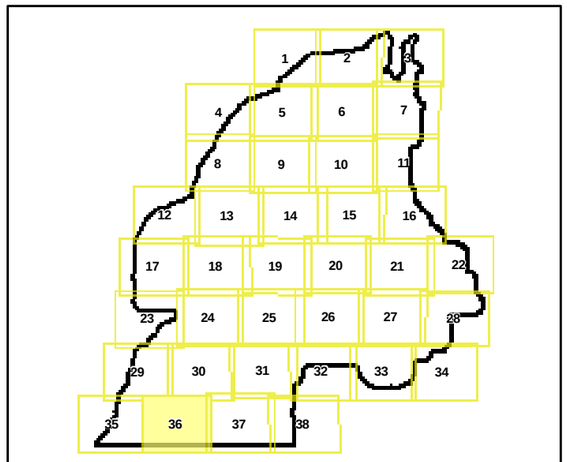
T95 R9 W4M

LEGEND

- JACKPINE EXPANSION MINING AREA LOCAL STUDY AREA
- AVI POLYGON
- INDIAN RESERVE

DISTURBED

- EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE



REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2005-2006), used under license.
Imagery (Orthophoto) obtained from Shell Canada (August 2005).
Projection: UTM Zone 12 Datum: NAD 83

300 0 300

SCALE 1:10,000 METRES

PROJECT

JACKPINE MINE EXPANSION & PIERRE RIVER MINE PROJECT

TITLE

ALBERTA VEGETATION INVENTORY
POLYGON MAP: MAP 36 OF 38

Shell Canada Limited

PROJECT No. 05-1344-027-7600		SCALE AS SHOWN	REV. 0
DESIGN	VR	18 Jan. 2007	
GIS	WZ	16 Nov. 2007	
CHECK	AA	15 Nov. 2007	
REVIEW	TC	16 Nov. 2007	

FIGURE: O-36

I:\CLIENTS\SHELL\05-1344-027\mapping\mxd\Forestry\DRAFT\jackpine\JP_AVI_template_working_Map36.mxd

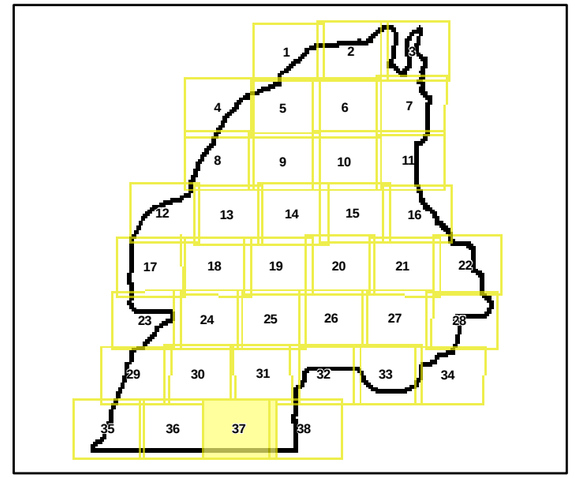
480000
481000
482000
6352000
6351000
6350000
T96 R9 W4M
T96 R8 W4M
T95 R9 W4M
T95 R8 W4M
FORT MCKAY INDIAN RESERVE No. 174C (IR 174C)

LEGEND

- JACKPINE EXPANSION MINING AREA LOCAL STUDY AREA
- AVI POLYGON
- INDIAN RESERVE

DISTURBED

- EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE



REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2005-2006), used under license.
Imagery (Orthophoto) obtained from Shell Canada (August 2005).
Projection: UTM Zone 12 Datum: NAD 83

300 0 300
SCALE 1:10,000 METRES

PROJECT
JACKPINE MINE EXPANSION &
PIERRE RIVER MINE PROJECT

TITLE
ALBERTA VEGETATION INVENTORY
POLYGON MAP: MAP 37 OF 38

Shell Canada Limited

PROJECT No. 05-1344-027-7600			SCALE AS SHOWN	REV. 0
DESIGN	VR	18 Jan. 2007	FIGURE: O-37	
GIS	WZ	16 Nov. 2007		
CHECK	AA	15 Nov. 2007		
REVIEW	TC	16 Nov. 2007		

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6351000
6350000
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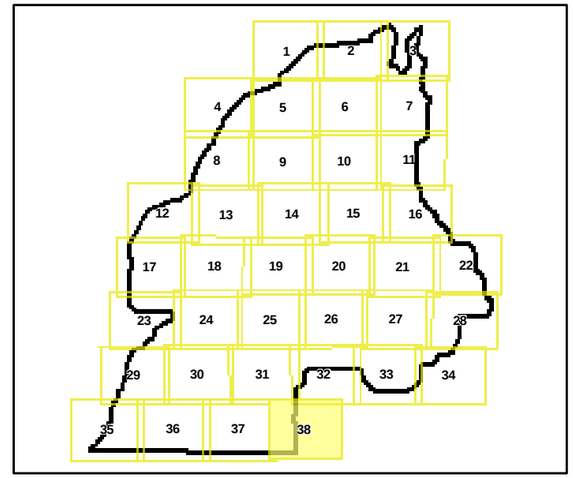
W4M
T95 R8
W4M

LEGEND

JACKPINE EXPANSION MINING AREA LOCAL STUDY AREA
AVI POLYGON

DISTURBED

EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE



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Imagery (Orthophoto) obtained from Shell Canada (August 2005).
Projection: UTM Zone 12 Datum: NAD 83

300 0 300
SCALE 1:10,000 METRES

PROJECT
JACKPINE MINE EXPANSION &
PIERRE RIVER MINE PROJECT

TITLE
ALBERTA VEGETATION INVENTORY
POLYGON MAP: MAP 38 OF 38

Shell Canada Limited

PROJECT No. 05-1344-027-7600			SCALE AS SHOWN	REV. 0
DESIGN	VR	18 Jan. 2007	FIGURE: O-38	
GIS	WZ	16 Nov. 2007		
CHECK	AA	15 Nov. 2007		
REVIEW	TC	16 Nov. 2007		

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Golder Associates Ltd.

1000, 940 6th Avenue S.W.
Calgary, Alberta, Canada T2P 3T1
Telephone (403) 299-5600
Fax (403) 299-5606

APPENDIX P

PIERRE RIVER MINING AREA
ALBERTA VEGETATION INVENTORY
POLYGON MAPS

Submitted to:
Shell Canada Limited

Prepared by:
Golder Associates Ltd.

December 2007 **05-1344-027**

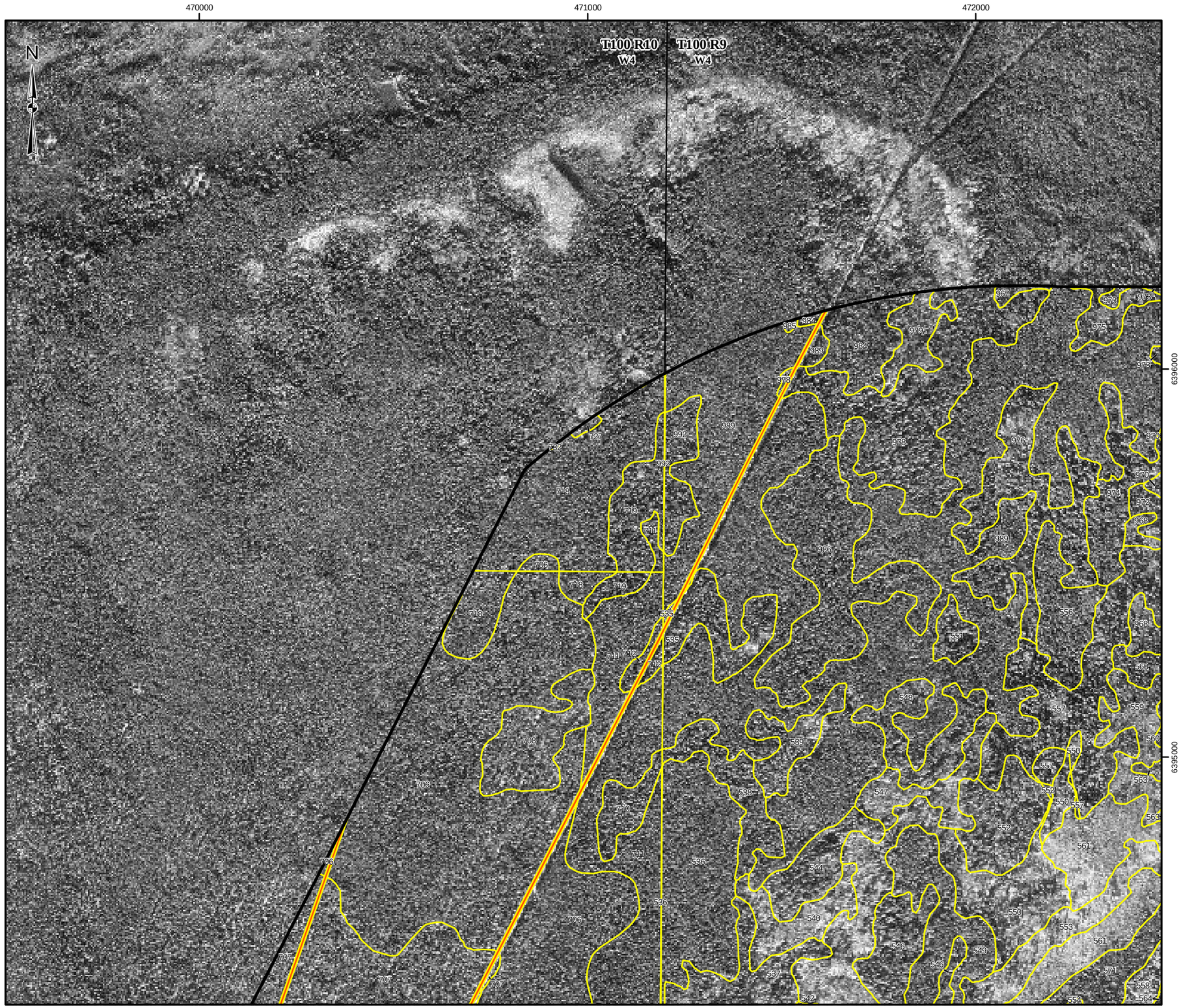
50 BEST EMPLOYERS IN CANADA 2007

CANADA'S 50 BEST MANAGED PRIVATE COMPANIES

OFFICES ACROSS NORTH AMERICA, SOUTH AMERICA, EUROPE, ASIA AND AUSTRALIA

LIST OF FIGURES

Figure P-1 Alberta Vegetation Inventory Polygon Map: Map 1 of 54 1
Figure P-2 Alberta Vegetation Inventory Polygon Map: Map 2 of 54 2
Figure P-3 Alberta Vegetation Inventory Polygon Map: Map 3 of 54 3
Figure P-4 Alberta Vegetation Inventory Polygon Map: Map 4 of 54 4
Figure P-5 Alberta Vegetation Inventory Polygon Map: Map 5 of 54 5
Figure P-6 Alberta Vegetation Inventory Polygon Map: Map 6 of 54 6
Figure P-7 Alberta Vegetation Inventory Polygon Map: Map 7 of 54 7
Figure P-8 Alberta Vegetation Inventory Polygon Map: Map 8 of 54 8
Figure P-9 Alberta Vegetation Inventory Polygon Map: Map 9 of 54 9
Figure P-10 Alberta Vegetation Inventory Polygon Map: Map 10 of 54 10
Figure P-11 Alberta Vegetation Inventory Polygon Map: Map 11 of 54 11
Figure P-12 Alberta Vegetation Inventory Polygon Map: Map 12 of 54 12
Figure P-13 Alberta Vegetation Inventory Polygon Map: Map 13 of 54 13
Figure P-14 Alberta Vegetation Inventory Polygon Map: Map 14 of 54 14
Figure P-15 Alberta Vegetation Inventory Polygon Map: Map 15 of 54 15
Figure P-16 Alberta Vegetation Inventory Polygon Map: Map 16 of 54 16
Figure P-17 Alberta Vegetation Inventory Polygon Map: Map 17 of 54 17
Figure P-18 Alberta Vegetation Inventory Polygon Map: Map 18 of 54 18
Figure P-20 Alberta Vegetation Inventory Polygon Map: Map 20 of 54 20
Figure P-21 Alberta Vegetation Inventory Polygon Map: Map 21 of 54 21
Figure P-22 Alberta Vegetation Inventory Polygon Map: Map 22 of 54 22
Figure P-23 Alberta Vegetation Inventory Polygon Map: Map 23 of 54 23
Figure P-24 Alberta Vegetation Inventory Polygon Map: Map 24 of 54 24
Figure P-25 Alberta Vegetation Inventory Polygon Map: Map 25 of 54 25
Figure P-26 Alberta Vegetation Inventory Polygon Map: Map 26 of 54 26
Figure P-27 Alberta Vegetation Inventory Polygon Map: Map 27 of 54 27
Figure P-28 Alberta Vegetation Inventory Polygon Map: Map 28 of 54 28
Figure P-29 Alberta Vegetation Inventory Polygon Map: Map 29 of 54 29
Figure P-30 Alberta Vegetation Inventory Polygon Map: Map 30 of 54 30
Figure P-31 Alberta Vegetation Inventory Polygon Map: Map 31 of 54 31
Figure P-32 Alberta Vegetation Inventory Polygon Map: Map 32 of 54 32
Figure P-33 Alberta Vegetation Inventory Polygon Map: Map 33 of 54 33
Figure P-34 Alberta Vegetation Inventory Polygon Map: Map 34 of 54 34
Figure P-35 Alberta Vegetation Inventory Polygon Map: Map 35 of 54 35
Figure P-36 Alberta Vegetation Inventory Polygon Map: Map 36 of 54 36
Figure P-37 Alberta Vegetation Inventory Polygon Map: Map 37 of 54 37
Figure P-38 Alberta Vegetation Inventory Polygon Map: Map 38 of 54 38
Figure P-39 Alberta Vegetation Inventory Polygon Map: Map 39 of 54 39
Figure P-40 Alberta Vegetation Inventory Polygon Map: Map 40 of 54 40
Figure P-41 Alberta Vegetation Inventory Polygon Map: Map 41 of 54 41
Figure P-42 Alberta Vegetation Inventory Polygon Map: Map 42 of 54 42
Figure P-43 Alberta Vegetation Inventory Polygon Map: Map 43 of 54 43
Figure P-44 Alberta Vegetation Inventory Polygon Map: Map 44 of 54 44
Figure P-45 Alberta Vegetation Inventory Polygon Map: Map 45 of 54 45
Figure P-46 Alberta Vegetation Inventory Polygon Map: Map 46 of 54 46
Figure P-47 Alberta Vegetation Inventory Polygon Map: Map 47 of 54 47
Figure P-48 Alberta Vegetation Inventory Polygon Map: Map 48 of 54 48
Figure P-50 Alberta Vegetation Inventory Polygon Map: Map 50 of 54 50
Figure P-51 Alberta Vegetation Inventory Polygon Map: Map 51 of 54 51
Figure P-52 Alberta Vegetation Inventory Polygon Map: Map 52 of 54 52
Figure P-53 Alberta Vegetation Inventory Polygon Map: Map 53 of 54 53
Figure P-54 Alberta Vegetation Inventory Polygon Map: Map 54 of 54 54



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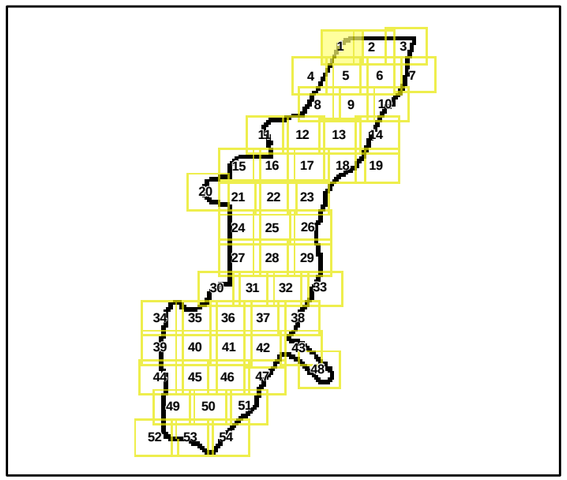
PIERRE RIVER MINING AREA LOCAL STUDY AREA

AVI POLYGON

DISTURBED

EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE



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Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2005-2006), used under license.
Imagery (Orthophoto) obtained from Shell Canada (August 2005).
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SCALE 1:10,000 METRES

PROJECT

JACKPINE MINE EXPANSION &
PIERRE RIVER MINE PROJECT

TITLE

ALBERTA VEGETATION INVENTORY
POLYGON MAP: MAP 1 OF 54

Shell Canada Limited

PROJECT No. 05-1344-027.7600			SCALE AS SHOWN	REV. 0
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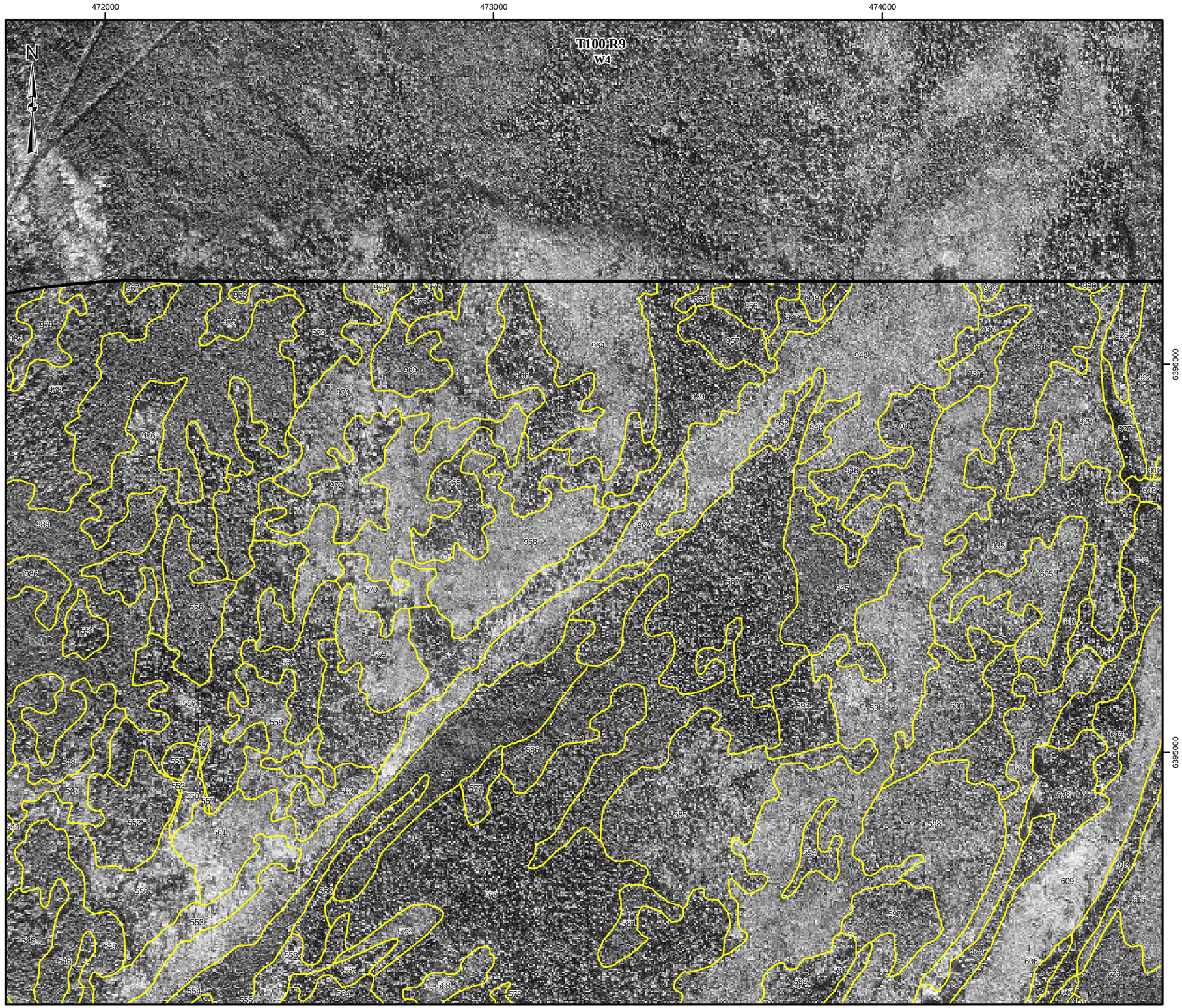

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PIERRE RIVER MINING AREA LOCAL STUDY AREA

AVI POLYGON

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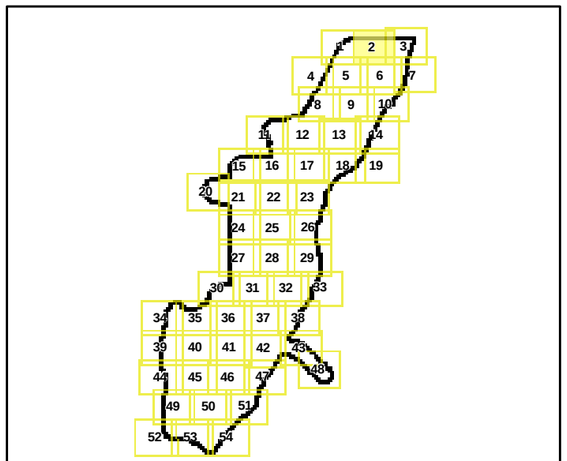

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Imagery (Orthophoto) obtained from Shell Canada (August 2005).
Projection: UTM Zone 12 Datum: NAD 83

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SCALE 1:10,000 METRES

PROJECT

JACKPINE MINE EXPANSION &
PIERRE RIVER MINE PROJECT

TITLE

ALBERTA VEGETATION INVENTORY
POLYGON MAP: MAP 2 OF 54

Shell Canada Limited

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LEGEND

PIERRE RIVER MINING AREA LOCAL STUDY AREA

AVI POLYGON

DISTURBED

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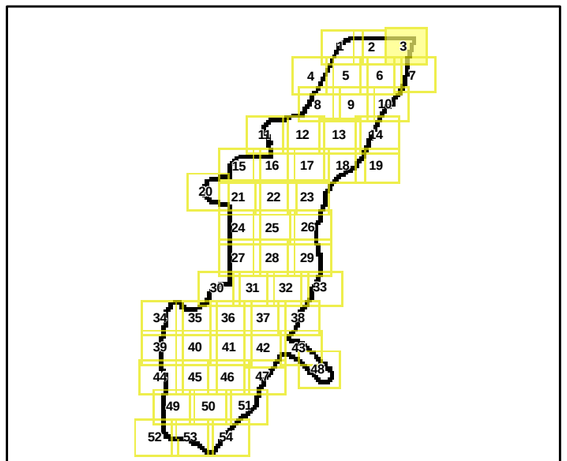

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SCALE 1:10,000 METRES

PROJECT

JACKPINE MINE EXPANSION &
PIERRE RIVER MINE PROJECT

TITLE

ALBERTA VEGETATION INVENTORY
POLYGON MAP: MAP 3 OF 54

Shell Canada Limited

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FIGURE: P-3

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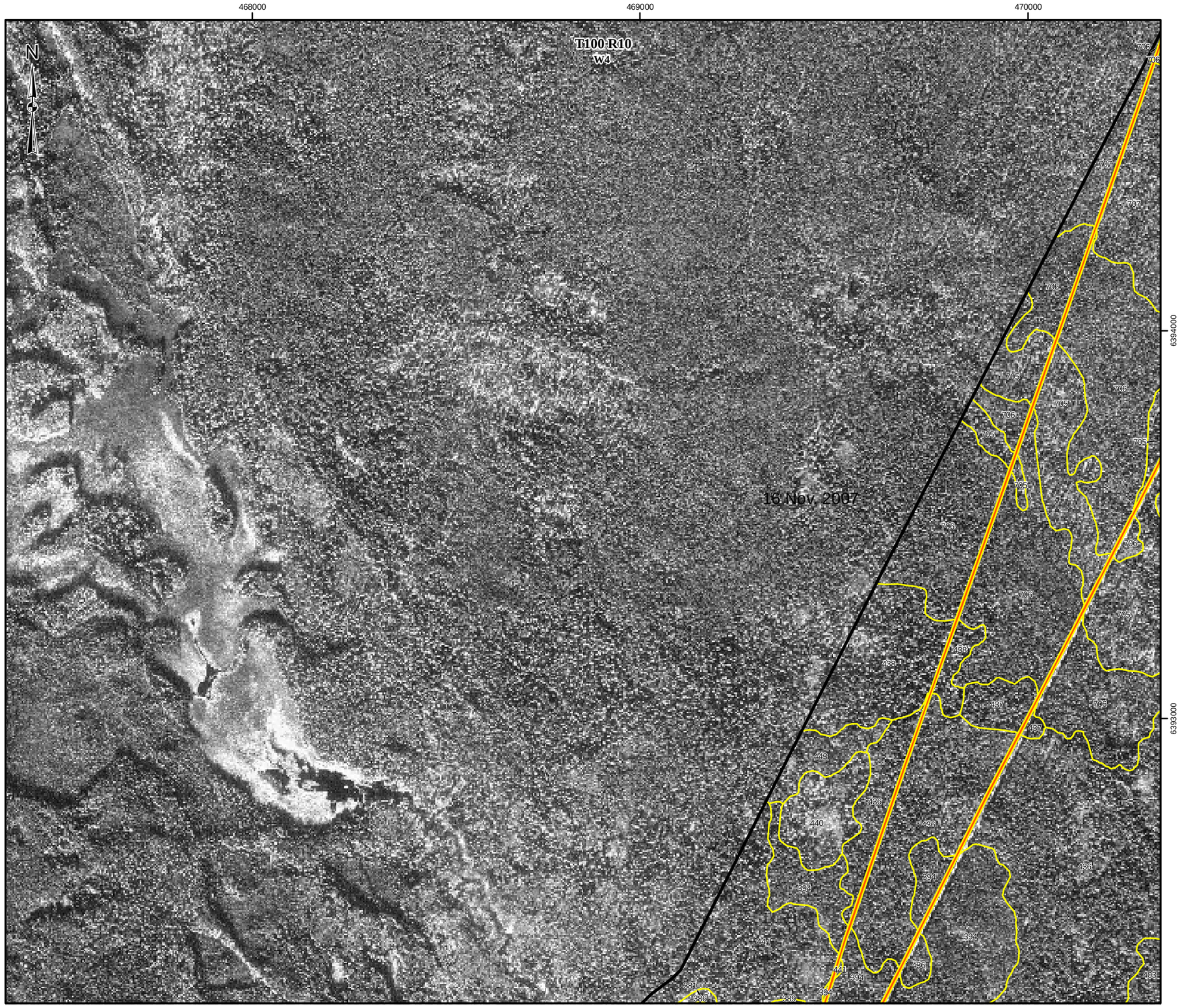

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PIERRE RIVER MINING AREA LOCAL STUDY AREA

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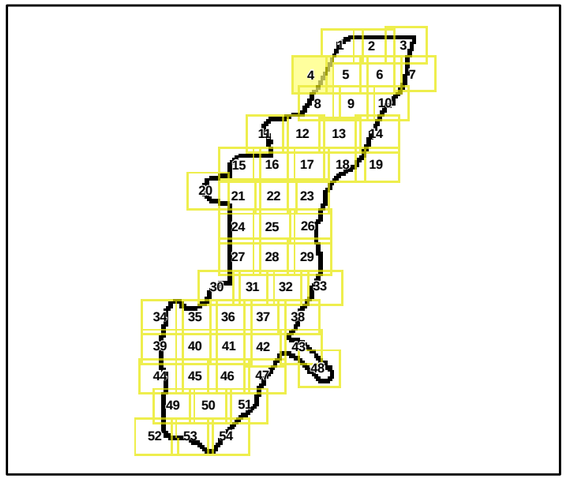

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Imagery (Orthophoto) obtained from Shell Canada (August 2005).
Projection: UTM Zone 12 Datum: NAD 83

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SCALE 1:10,000 METRES

PROJECT

JACKPINE MINE EXPANSION & PIERRE RIVER MINE PROJECT

TITLE

ALBERTA VEGETATION INVENTORY POLYGON MAP: MAP 4 OF 54

Shell Canada Limited

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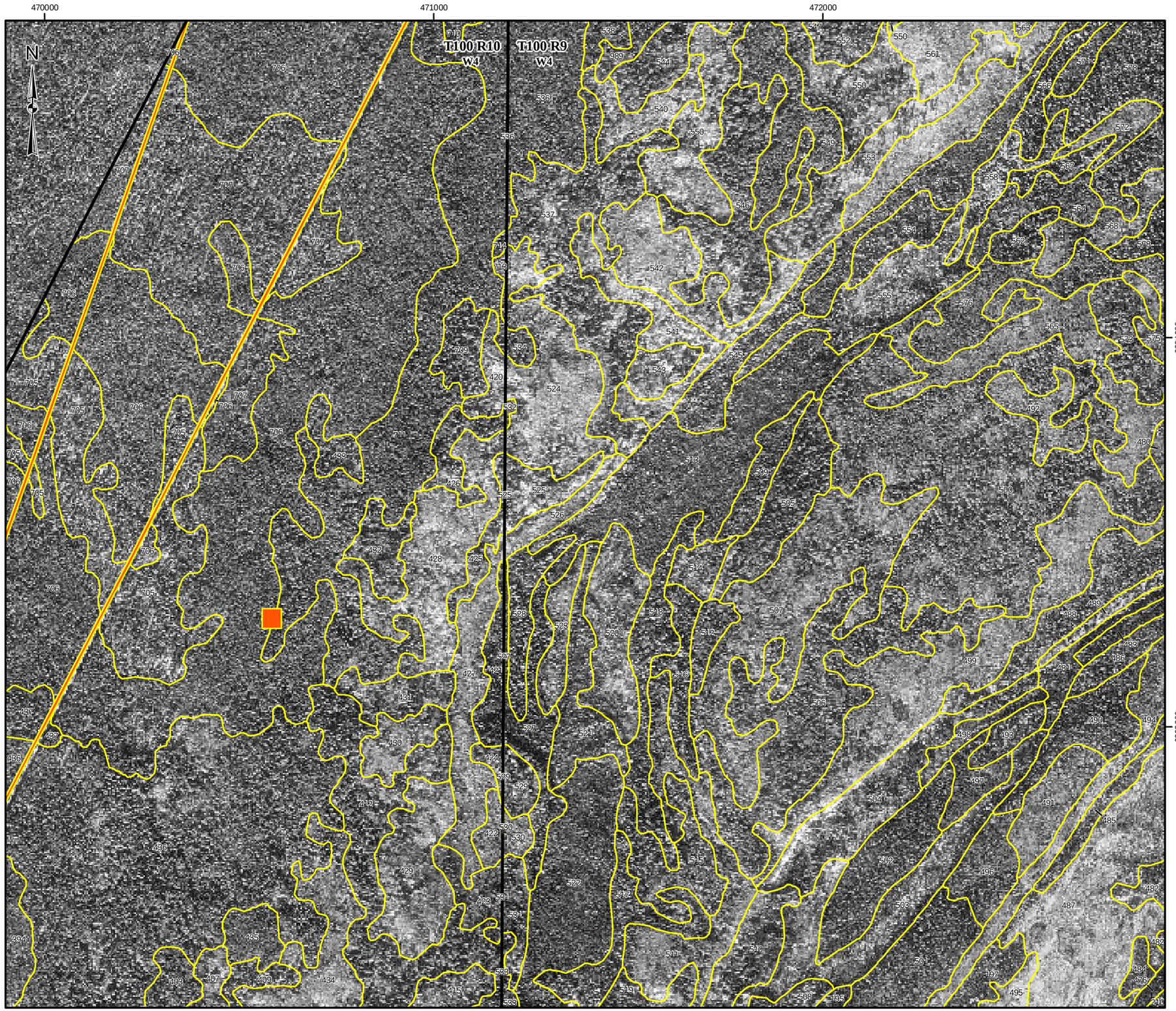

LEGEND

- PIERRE RIVER MINING AREA LOCAL STUDY AREA
- AVI POLYGON

DISTURBED

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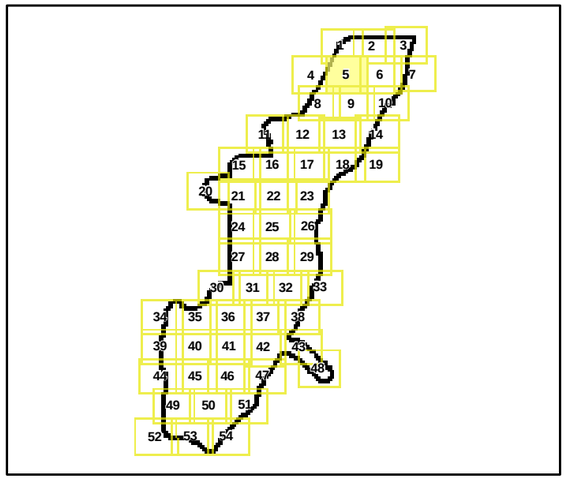

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PROJECT
JACKPINE MINE EXPANSION &
PIERRE RIVER MINE PROJECT

TITLE
ALBERTA VEGETATION INVENTORY
POLYGON MAP: MAP 5 OF 54

Shell Canada Limited

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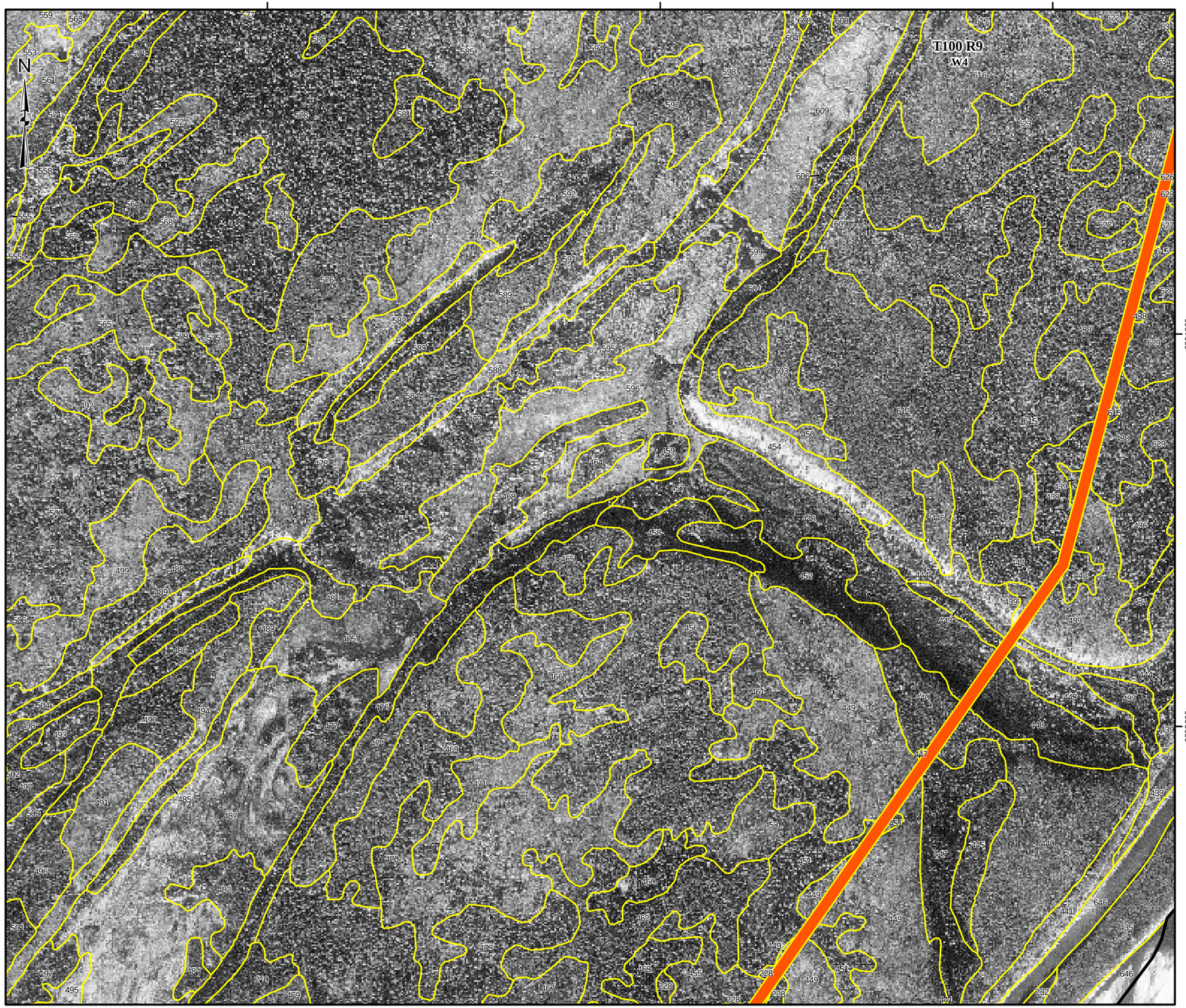
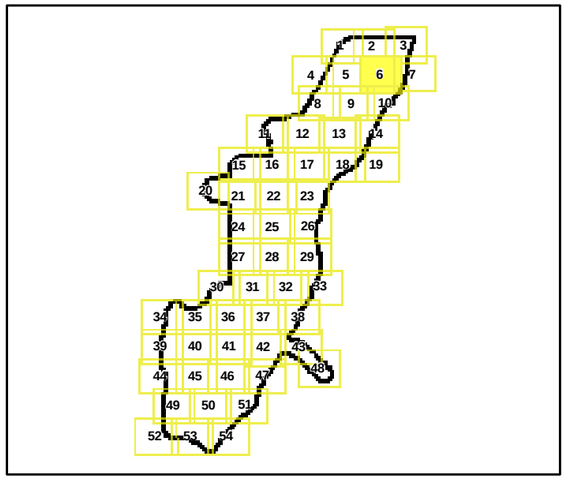


LEGEND

- PIERRE RIVER MINING AREA LOCAL STUDY AREA
- AVI POLYGON

DISTURBED

- EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE



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Imagery (Orthophoto) obtained from Shell Canada (August 2005).
Projection: UTM Zone 12 Datum: NAD 83

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SCALE 1:10,000 METRES

PROJECT
JACKPINE MINE EXPANSION &
PIERRE RIVER MINE PROJECT

TITLE
ALBERTA VEGETATION INVENTORY
POLYGON MAP: MAP 6 OF 54

Shell Canada Limited

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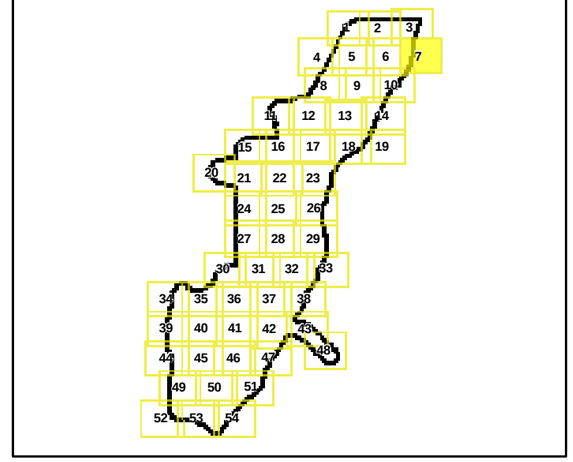
LEGEND

PIERRE RIVER MINING AREA LOCAL STUDY AREA
AVI POLYGON

DISTURBED

EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE



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Imagery (Orthophoto) obtained from Shell Canada (August 2005).
Projection: UTM Zone 12 Datum: NAD 83

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SCALE 1:10,000 METRES

PROJECT
JACKPINE MINE EXPANSION &
PIERRE RIVER MINE PROJECT

TITLE
ALBERTA VEGETATION INVENTORY
POLYGON MAP: MAP 7 OF 54

Shell Canada Limited

PROJECT No. 05-1344-027.7600			SCALE AS SHOWN	REV. 0
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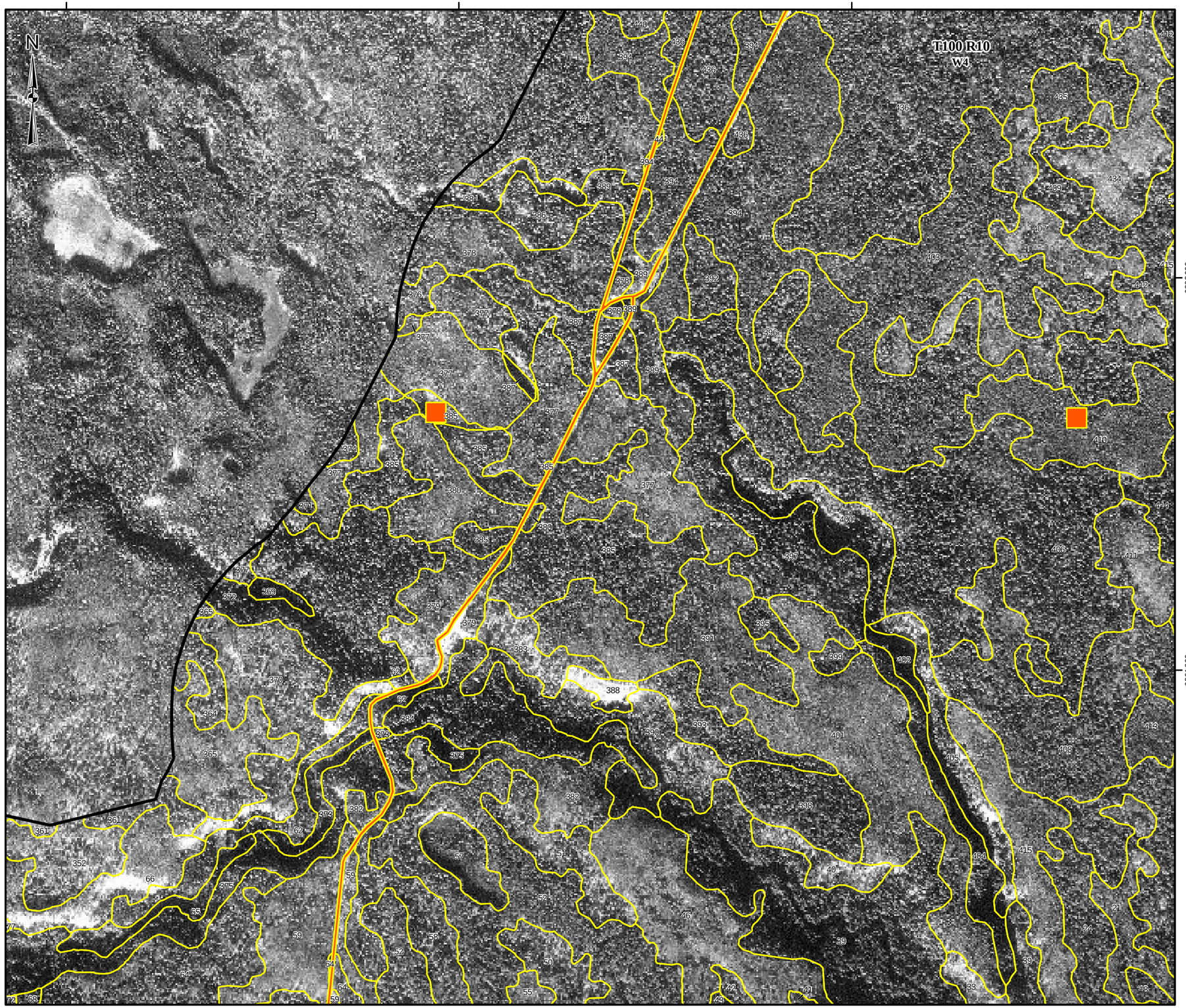
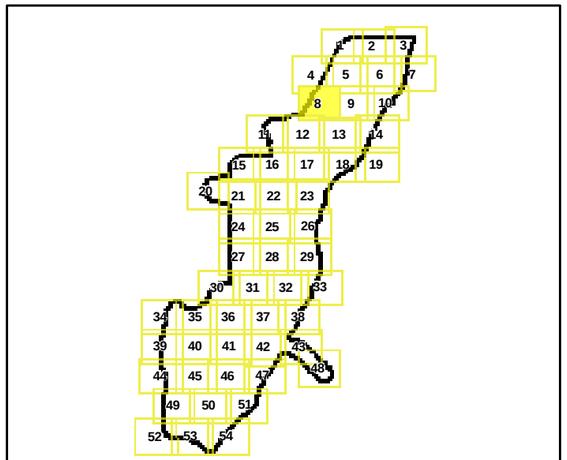


LEGEND

- PIERRE RIVER MINING AREA LOCAL STUDY AREA
- AVI POLYGON

DISTURBED

- EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE



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Projection: UTM Zone 12 Datum: NAD 83

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SCALE 1:10,000 METRES

PROJECT

JACKPINE MINE EXPANSION &
PIERRE RIVER MINE PROJECT

TITLE

ALBERTA VEGETATION INVENTORY
POLYGON MAP: MAP 8 OF 54

Shell Canada Limited

PROJECT No. 05-1344-027.7600			SCALE AS SHOWN	REV. 0
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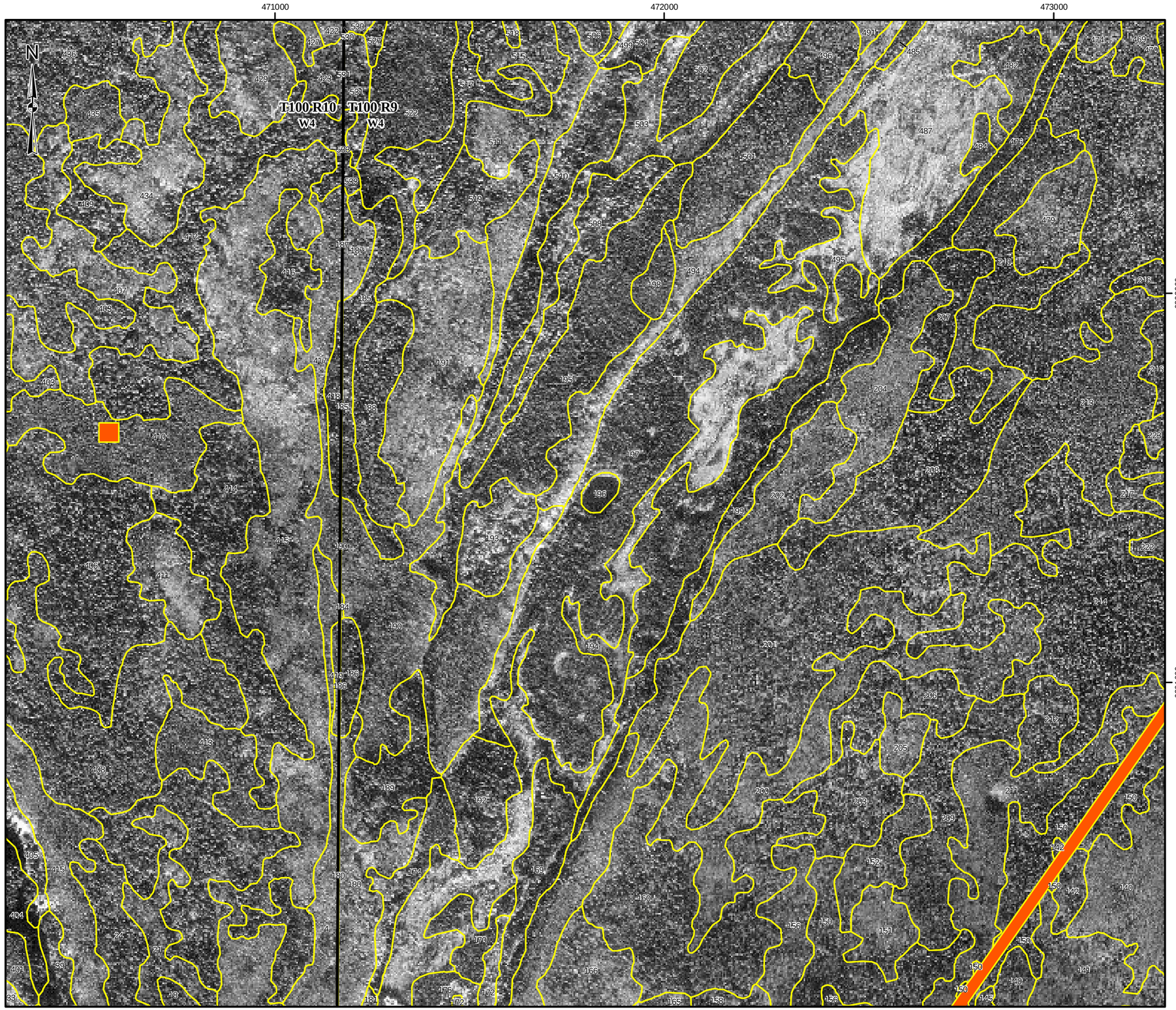


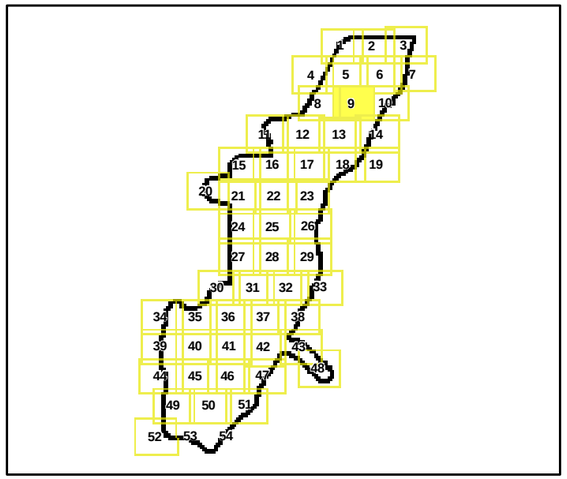
LEGEND

PIERRE RIVER MINING AREA LOCAL STUDY AREA

AVI POLYGON

DISTURBED

EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE



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Projection: UTM Zone 12 Datum: NAD 83

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SCALE 1:10,000 METRES

PROJECT

JACKPINE MINE EXPANSION &
PIERRE RIVER MINE PROJECT

TITLE

ALBERTA VEGETATION INVENTORY
POLYGON MAP: MAP 9 OF 54

Shell Canada Limited

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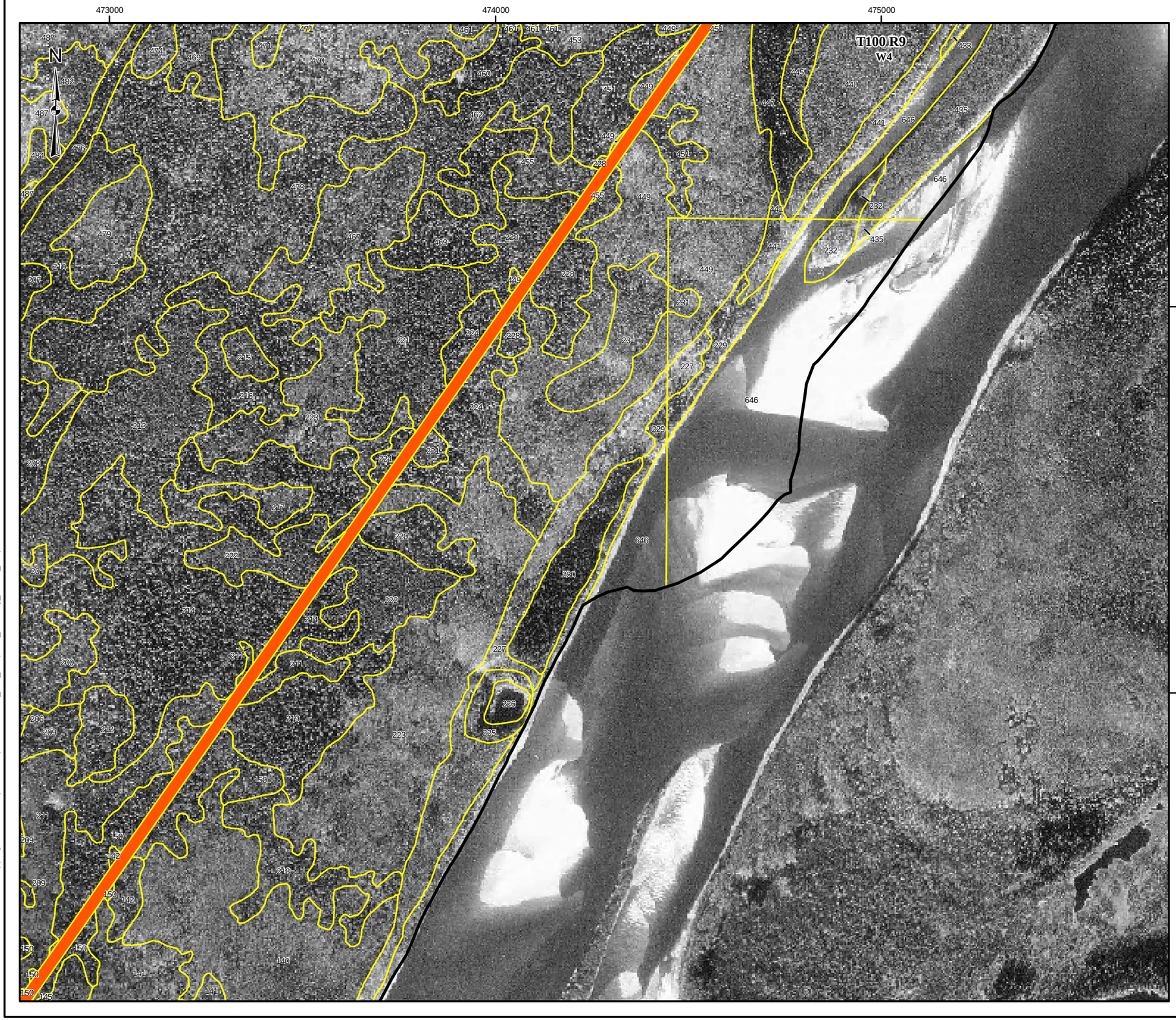
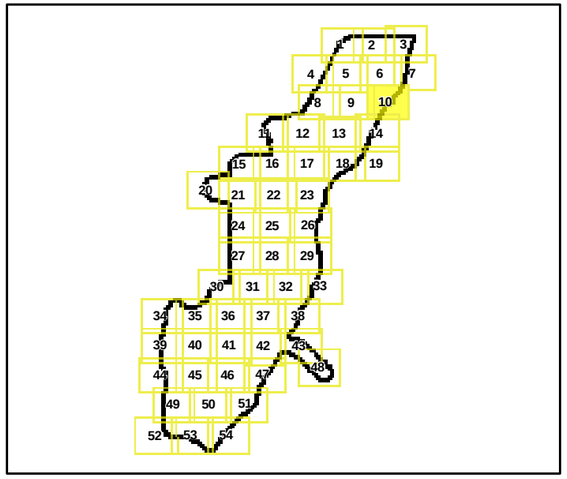


LEGEND

- PIERRE RIVER MINING AREA LOCAL STUDY AREA
- AVI POLYGON

DISTURBED

- EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE



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Imagery (Orthophoto) obtained from Shell Canada (August 2005).
Projection: UTM Zone 12 Datum: NAD 83

300 0 300

SCALE 1:10,000 METRES

PROJECT

JACKPINE MINE EXPANSION &
PIERRE RIVER MINE PROJECT

TITLE

ALBERTA VEGETATION INVENTORY
POLYGON MAP: MAP 10 OF 54

Shell Canada Limited

PROJECT No. 05-1344-027.7600			SCALE AS SHOWN	REV. 0
DESIGN	VR	18 Jan. 2007	FIGURE: P-10	
GIS	WZ	16 Nov. 2007		
CHECK	AA	15 Nov. 2007		
REVIEW	TC	16 Nov. 2007		

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464000

465000

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6390000

6389000

N

T100 R10
W4

T99 R10
W4

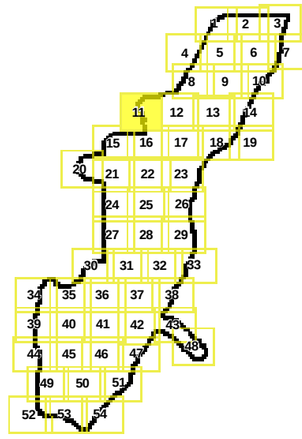
LEGEND

PIERRE RIVER MINING AREA LOCAL STUDY AREA

AVI POLYGON

DISTURBED

EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE



REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2005-2006), used under license.
Imagery (Orthophoto) obtained from Shell Canada (August 2005).
Projection: UTM Zone 12 Datum: NAD 83

300 0 300

SCALE 1:10,000 METRES

PROJECT

JACKPINE MINE EXPANSION &
PIERRE RIVER MINE PROJECT

TITLE

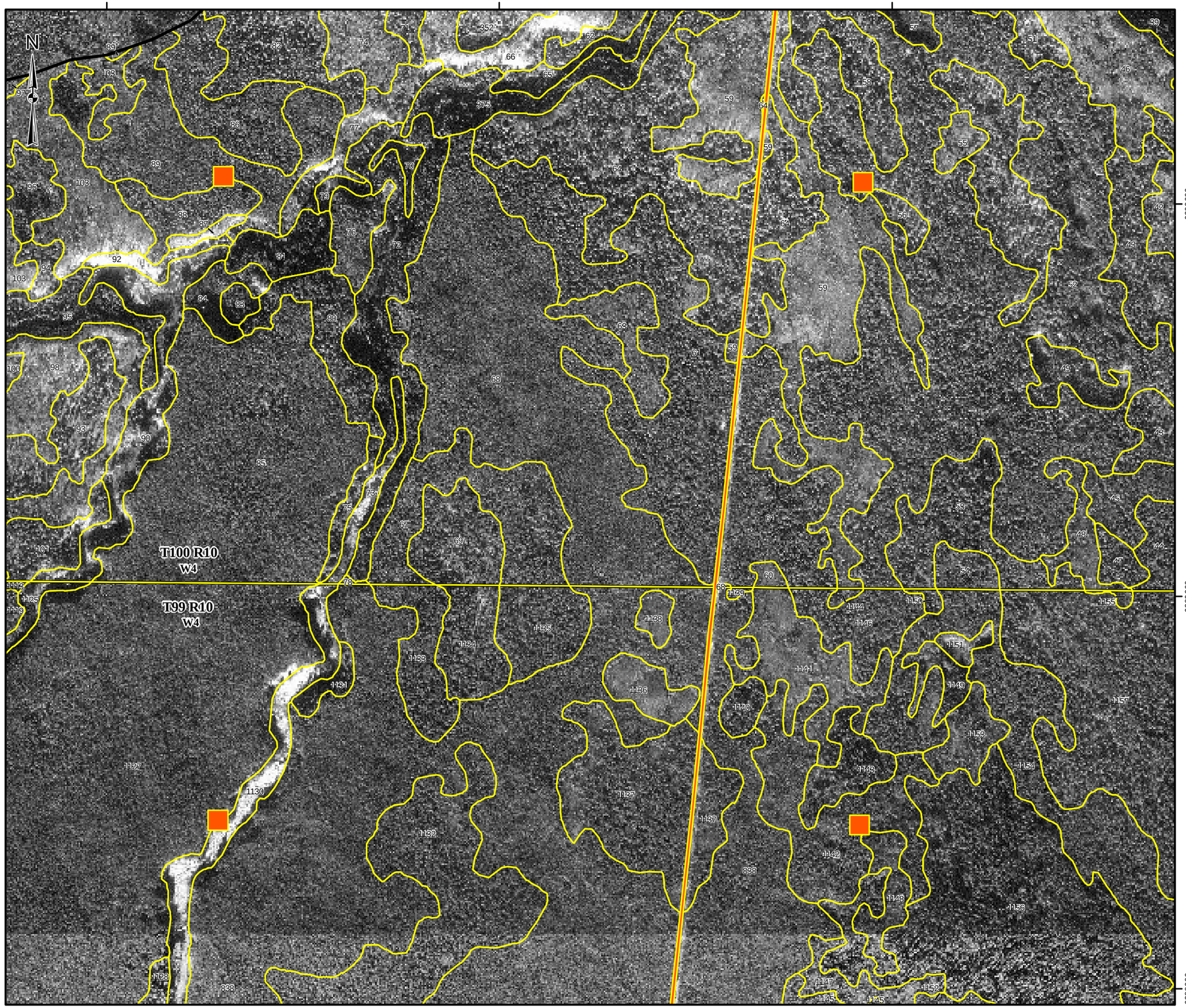
ALBERTA VEGETATION INVENTORY
POLYGON MAP: MAP 11 OF 54

Shell Canada Limited

PROJECT No. 05-1344-027.7600			SCALE AS SHOWN	REV. 0
DESIGN	VR	18 Jan. 2007		
GIS	WZ	16 Nov. 2007		
CHECK	AA	15 Nov. 2007		
REVIEW	TC	16 Nov. 2007		

FIGURE: P-11

I:\CLIENTS\SHELL\05-1344-027\mapping\mxd\Forestry\DRAFT\pierreriver\PR_AVI_template_working_11x17_Map11.mxd

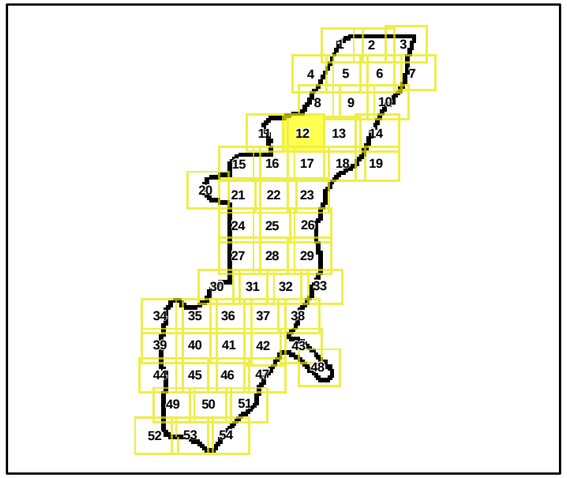


LEGEND

- PIERRE RIVER MINING AREA LOCAL STUDY AREA
- AVI POLYGON

DISTURBED

- EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE



REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2005-2006), used under license.
Imagery (Orthophoto) obtained from Shell Canada (August 2005).
Projection: UTM Zone 12 Datum: NAD 83

300 0 300
SCALE 1:10,000 METRES

PROJECT
JACKPINE MINE EXPANSION &
PIERRE RIVER MINE PROJECT

TITLE
ALBERTA VEGETATION INVENTORY
POLYGON MAP: MAP 12 OF 54

Shell Canada Limited

PROJECT No. 05-1344-027.7600			SCALE AS SHOWN	REV. 0
DESIGN	VR	18 Jan. 2007	FIGURE: P-12	
GIS	WZ	16 Nov. 2007		
CHECK	AA	15 Nov. 2007		
REVIEW	TC	16 Nov. 2007		

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470000
471000
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6390000
6389000
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T100 R10 W4
T100 R9 W4
T99 R10 W4
T99 R9 W4

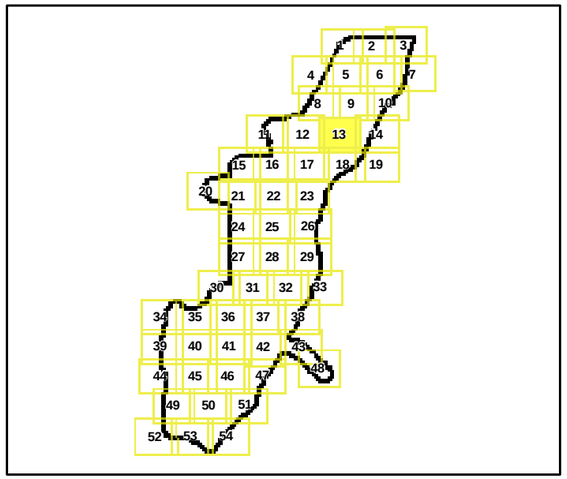
LEGEND

PIERRE RIVER MINING AREA LOCAL STUDY AREA

AVI POLYGON

DISTURBED

EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE



REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2005-2006), used under license.
Imagery (Orthophoto) obtained from Shell Canada (August 2005).
Projection: UTM Zone 12 Datum: NAD 83

300 0 300

SCALE 1:10,000 METRES

PROJECT

JACKPINE MINE EXPANSION & PIERRE RIVER MINE PROJECT

TITLE

ALBERTA VEGETATION INVENTORY POLYGON MAP: MAP 13 OF 54

Shell Canada Limited

PROJECT No. 05-1344-027.7600			SCALE AS SHOWN	REV. 0
DESIGN	VR	18 Jan. 2007		
GIS	WZ	16 Nov. 2007		
CHECK	AA	15 Nov. 2007		
REVIEW	TC	16 Nov. 2007		

FIGURE: P-13

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473000

474000

475000

6390000

6389000

6388000

T100 R9
W4

T99 R9
W4

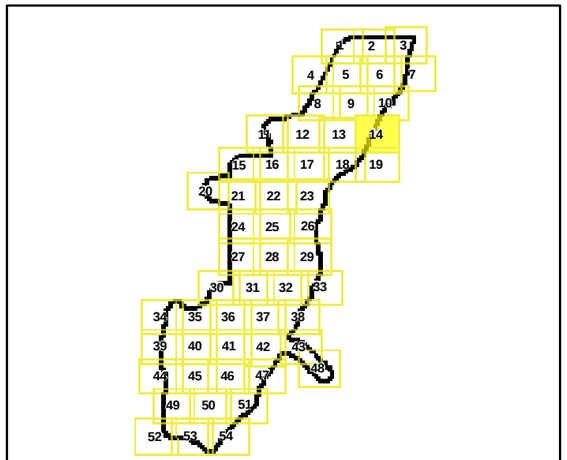
LEGEND

PIERRE RIVER MINING AREA LOCAL STUDY AREA

AVI POLYGON

DISTURBED

EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE



REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2005-2006), used under license.
Imagery (Orthophoto) obtained from Shell Canada (August 2005).
Projection: UTM Zone 12 Datum: NAD 83

300 0 300

SCALE 1:10,000 METRES

PROJECT

JACKPINE MINE EXPANSION &
PIERRE RIVER MINE PROJECT

TITLE

ALBERTA VEGETATION INVENTORY
POLYGON MAP: MAP 14 OF 54

Shell Canada Limited

PROJECT No. 05-1344-027.7600			SCALE AS SHOWN	REV. 0
DESIGN	VR	18 Jan. 2007		
GIS	WZ	16 Nov. 2007		
CHECK	AA	15 Nov. 2007		
REVIEW	TC	16 Nov. 2007		

FIGURE: P-14

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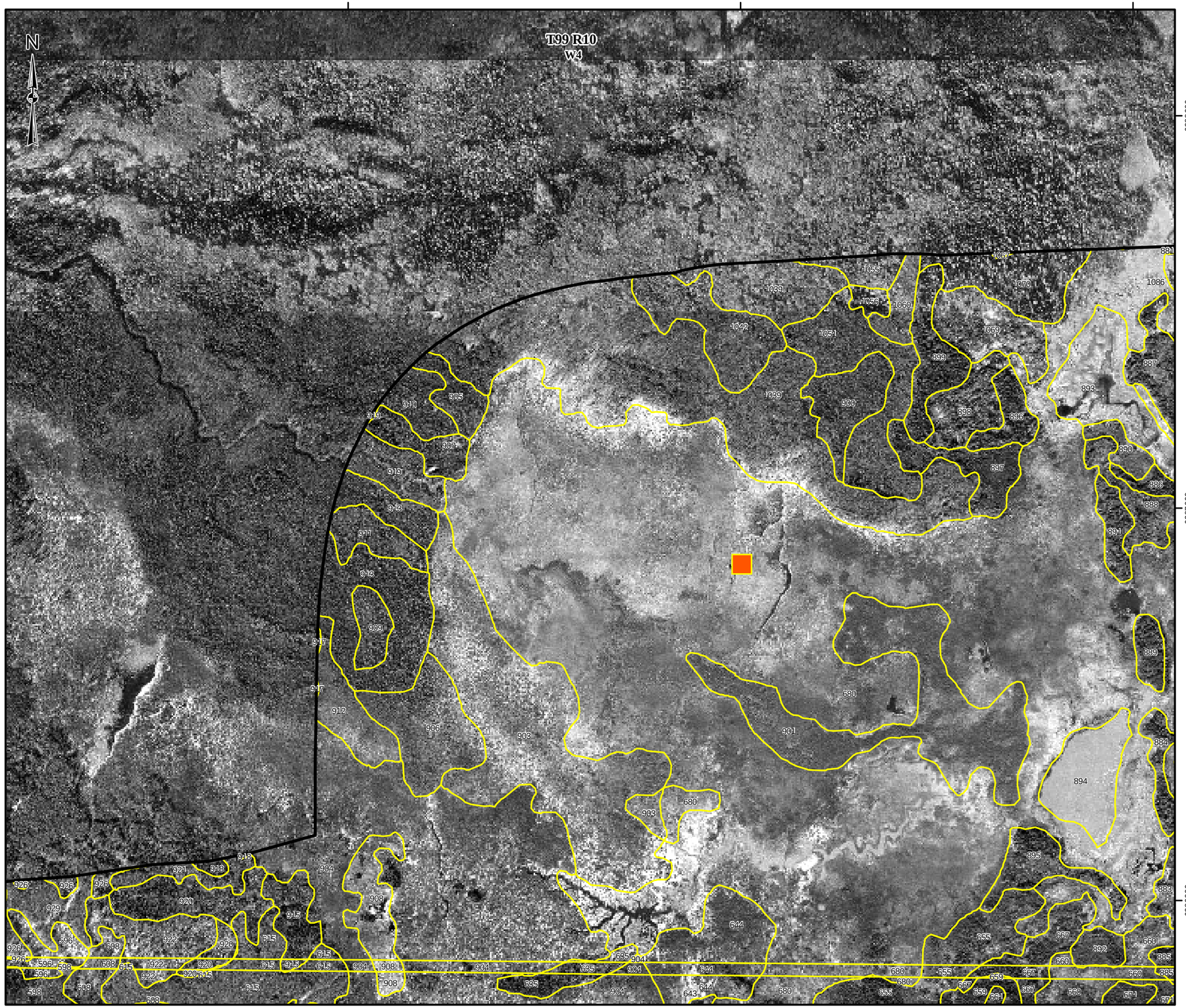
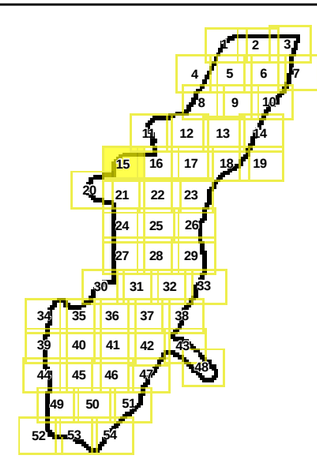


LEGEND

- PIERRE RIVER MINING AREA LOCAL STUDY AREA
- AVI POLYGON

DISTURBED

- EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE



REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2005-2006), used under license.
Imagery (Orthophoto) obtained from Shell Canada (August 2005).
Projection: UTM Zone 12 Datum: NAD 83

300 0 300
SCALE 1:10,000 METRES

PROJECT
JACKPINE MINE EXPANSION &
PIERRE RIVER MINE PROJECT

TITLE
ALBERTA VEGETATION INVENTORY
POLYGON MAP: MAP 15 OF 54

Shell Canada Limited

PROJECT No. 05-1344-027.7600			SCALE AS SHOWN	REV. 0	
DESIGN	VR	18 Jan. 2007	FIGURE: P-15		
GIS	WZ	16 Nov. 2007			
CHECK	AA	15 Nov. 2007			
REVIEW	TC	16 Nov. 2007			

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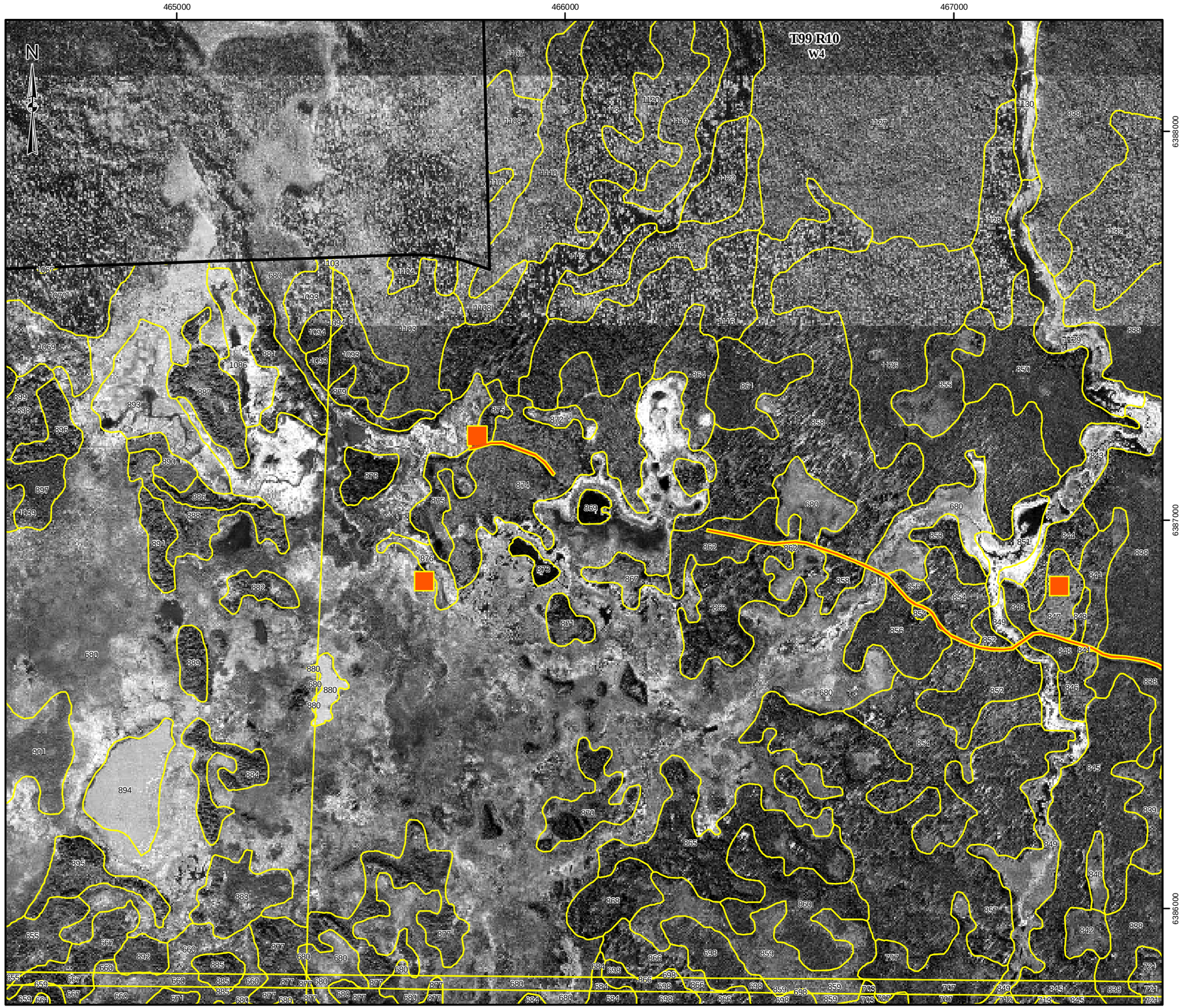


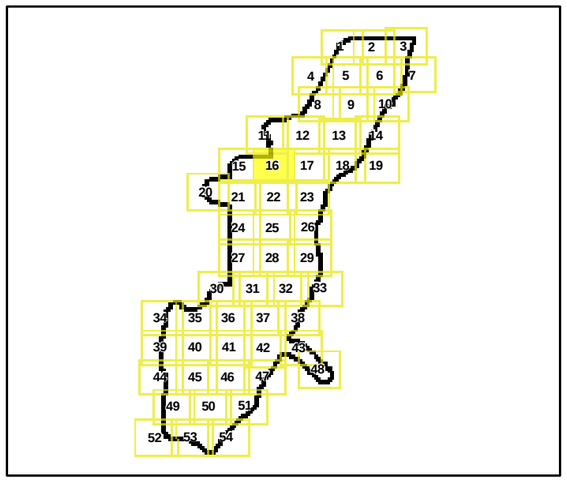
LEGEND

PIERRE RIVER MINING AREA LOCAL STUDY AREA

AVI POLYGON

DISTURBED

EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE



REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2005-2006), used under license.
Imagery (Orthophoto) obtained from Shell Canada (August 2005).
Projection: UTM Zone 12 Datum: NAD 83

300 0 300

SCALE 1:10,000 METRES

PROJECT

JACKPINE MINE EXPANSION &
PIERRE RIVER MINE PROJECT

TITLE

ALBERTA VEGETATION INVENTORY
POLYGON MAP: MAP 16 OF 54

Shell Canada Limited

PROJECT No. 05-1344-027.7600			SCALE AS SHOWN	REV. 0
DESIGN	VR	18 Jan. 2007		
GIS	WZ	16 Nov. 2007		
CHECK	AA	15 Nov. 2007		
REVIEW	TC	16 Nov. 2007		

FIGURE: P-16

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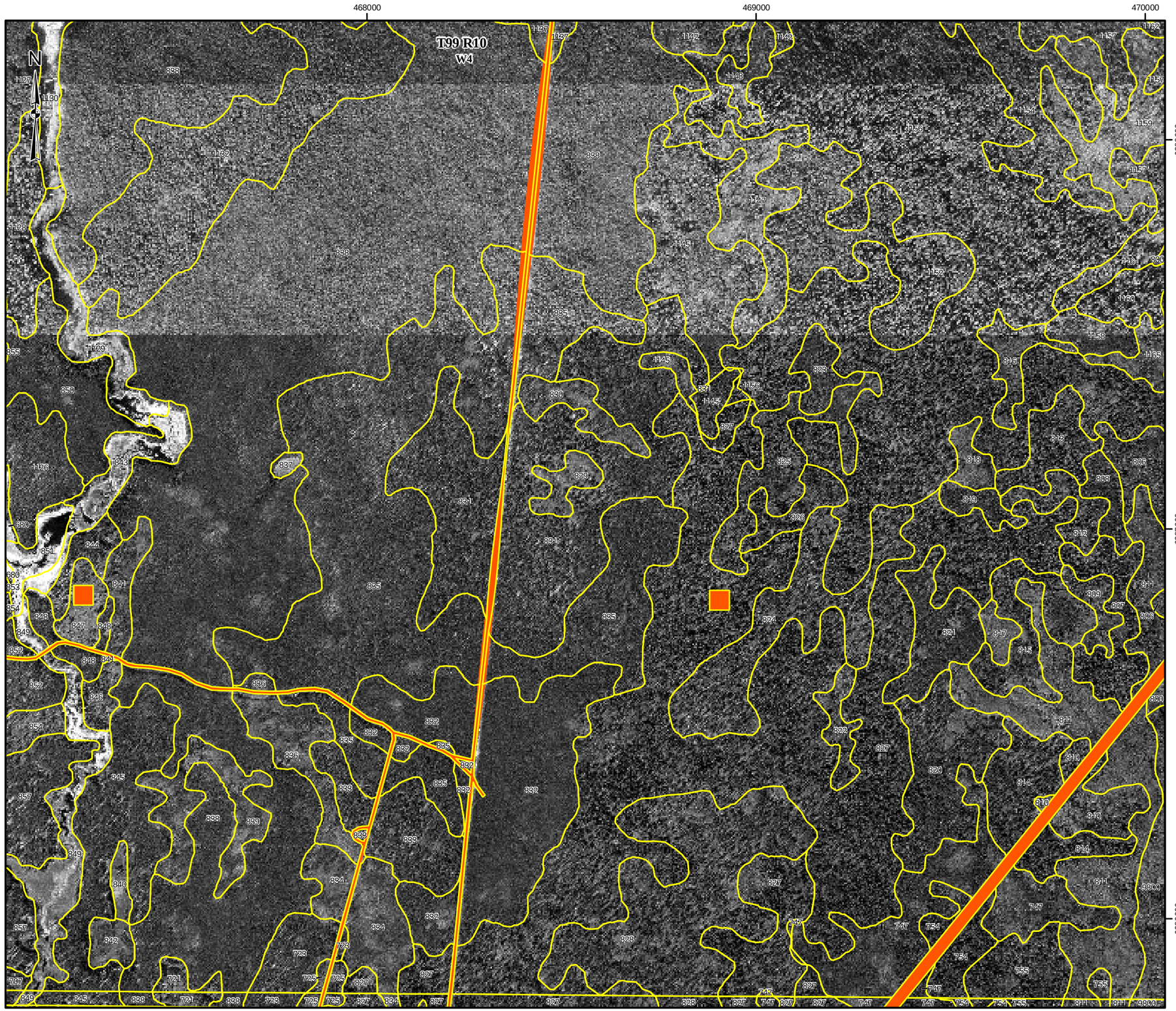
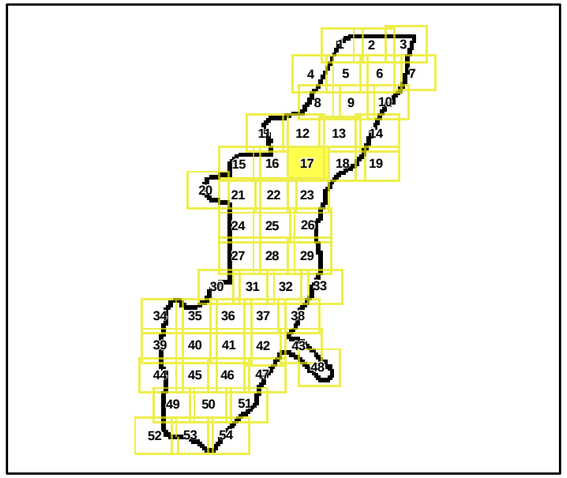


LEGEND

- PIERRE RIVER MINING AREA LOCAL STUDY AREA
- AVI POLYGON

DISTURBED

- EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE



REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2005-2006), used under license.
Imagery (Orthophoto) obtained from Shell Canada (August 2005).
Projection: UTM Zone 12 Datum: NAD 83

300 0 300

SCALE 1:10,000 METRES

PROJECT

JACKPINE MINE EXPANSION &
PIERRE RIVER MINE PROJECT

TITLE

ALBERTA VEGETATION INVENTORY
POLYGON MAP: MAP 17 OF 54

Shell Canada Limited

PROJECT No. 05-1344-027.7600			SCALE AS SHOWN	REV. 0
DESIGN	VR	18 Jan. 2007	FIGURE: P-17	
GIS	WZ	16 Nov. 2007		
CHECK	AA	15 Nov. 2007		
REVIEW	TC	16 Nov. 2007		

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W4

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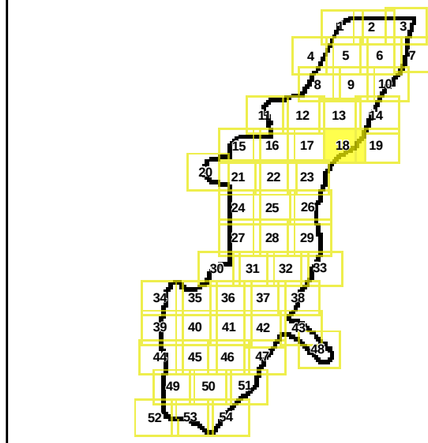
LEGEND

PIERRE RIVER MINING AREA LOCAL STUDY AREA

AVI POLYGON

DISTURBED

EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE



REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2005-2006), used under license.
Imagery (Orthophoto) obtained from Shell Canada (August 2005).
Projection: UTM Zone 12 Datum: NAD 83

300 0 300

SCALE 1:10,000 METRES

PROJECT

JACKPINE MINE EXPANSION &
PIERRE RIVER MINE PROJECT

TITLE

ALBERTA VEGETATION INVENTORY
POLYGON MAP: MAP 18 OF 54

Shell Canada Limited

PROJECT No. 05-1344-027.7600			SCALE AS SHOWN	REV. 0
DESIGN	VR	18 Jan. 2007	FIGURE: P-18	
GIS	WZ	16 Nov. 2007		
CHECK	AA	15 Nov. 2007		
REVIEW	TC	16 Nov. 2007		

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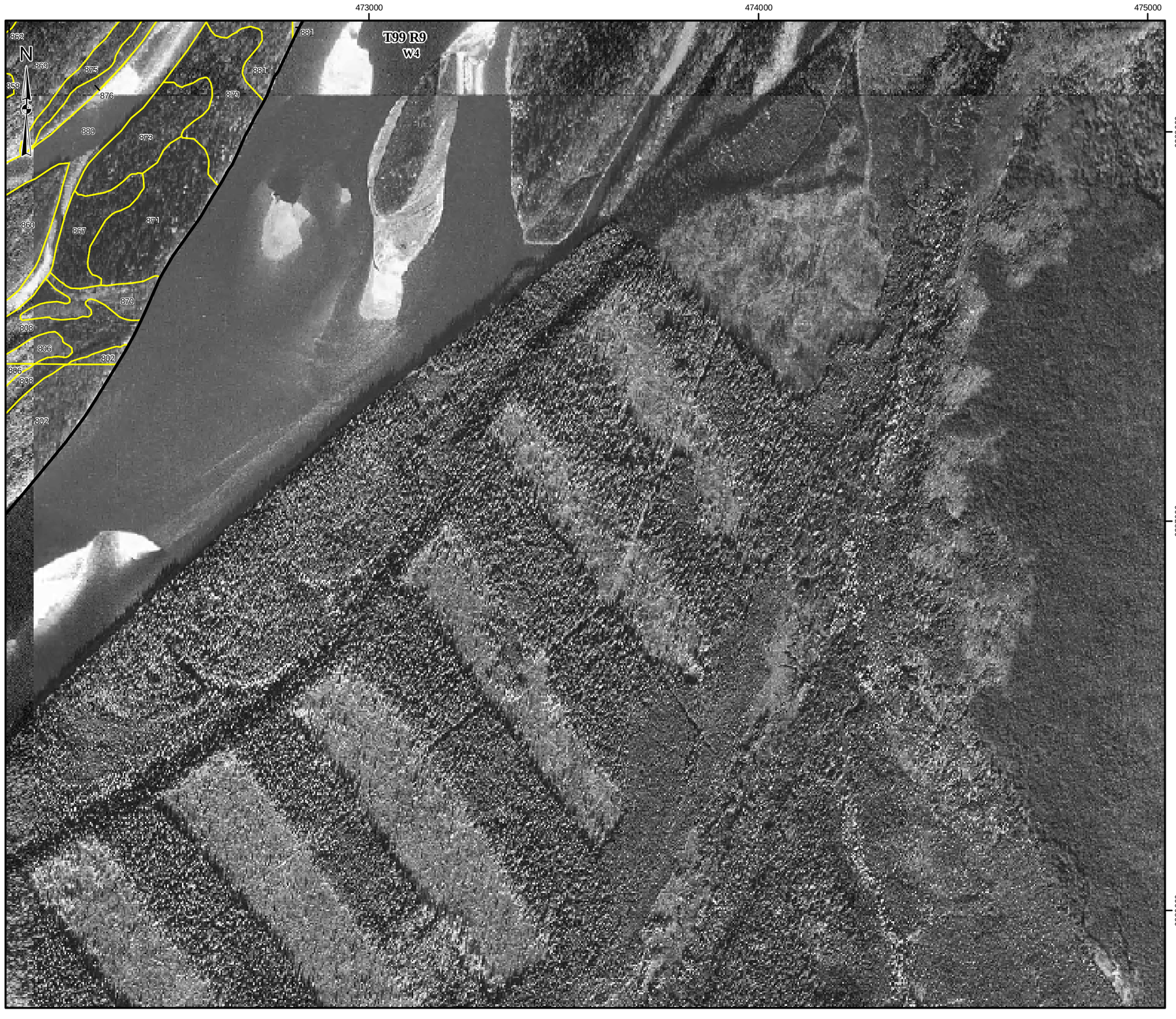
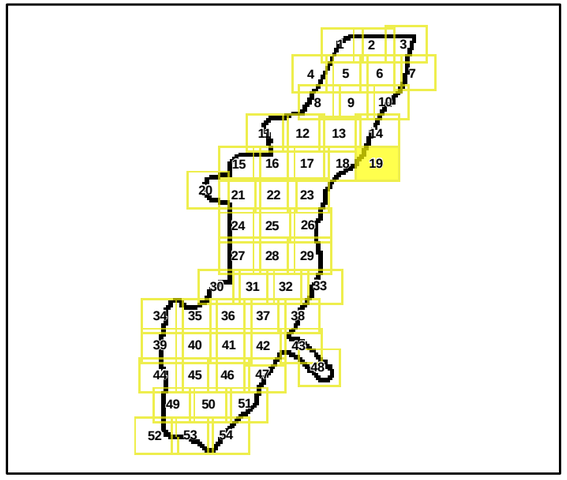


LEGEND

- PIERRE RIVER MINING AREA LOCAL STUDY AREA
- AVI POLYGON

DISTURBED

- EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE



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Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2005-2006), used under license.
Imagery (Orthophoto) obtained from Shell Canada (August 2005).
Projection: UTM Zone 12 Datum: NAD 83

300 0 300

SCALE 1:10,000 METRES

PROJECT

JACKPINE MINE EXPANSION &
PIERRE RIVER MINE PROJECT

TITLE

ALBERTA VEGETATION INVENTORY
POLYGON MAP: MAP 19 OF 54

Shell Canada Limited

PROJECT No. 05-1344-027.7600			SCALE AS SHOWN	REV. 0
DESIGN	VR	18 Jan. 2007	FIGURE: P-19	
GIS	WZ	16 Nov. 2007		
CHECK	AA	15 Nov. 2007		
REVIEW	TC	16 Nov. 2007		

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460000 461000 462000

6386000 6385000 6384000

T99 R11 W4 | T99 R10 W4

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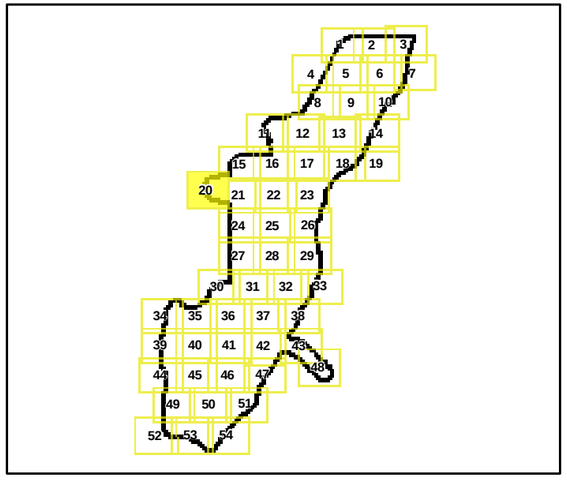
LEGEND

- PIERRE RIVER MINING AREA LOCAL STUDY AREA
- AVI POLYGON

DISTURBED

- EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE



REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2005-2006), used under license.
Imagery (Orthophoto) obtained from Shell Canada (August 2005).
Projection: UTM Zone 12 Datum: NAD 83

300 0 300
SCALE 1:10,000 METRES

PROJECT
JACKPINE MINE EXPANSION &
PIERRE RIVER MINE PROJECT

TITLE
ALBERTA VEGETATION INVENTORY
POLYGON MAP: MAP 20 OF 54

Shell Canada Limited

PROJECT No. 05-1344-027.7600			SCALE AS SHOWN	REV. 0
DESIGN	VR	18 Jan. 2007	FIGURE: P-20	
GIS	WZ	16 Nov. 2007		
CHECK	AA	15 Nov. 2007		
REVIEW	TC	16 Nov. 2007		

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463000

464000

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6385000

6384000

T99 R10
W4

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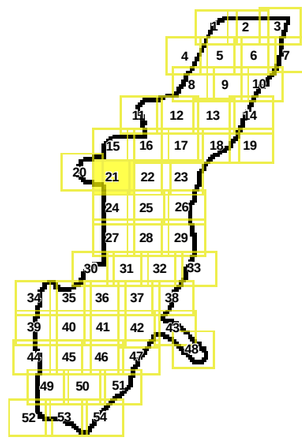
LEGEND

PIERRE RIVER MINING AREA LOCAL STUDY AREA

AVI POLYGON

DISTURBED

EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE



REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2005-2006), used under license.
Imagery (Orthophoto) obtained from Shell Canada (August 2005).
Projection: UTM Zone 12 Datum: NAD 83

300 0 300

SCALE 1:10,000 METRES

PROJECT

JACKPINE MINE EXPANSION &
PIERRE RIVER MINE PROJECT

TITLE

ALBERTA VEGETATION INVENTORY
POLYGON MAP: MAP 21 OF 54

Shell Canada Limited

PROJECT No. 05-1344-027.7600			SCALE AS SHOWN	REV. 0
DESIGN	VR	18 Jan. 2007		
GIS	WZ	16 Nov. 2007		
CHECK	AA	15 Nov. 2007		
REVIEW	TC	16 Nov. 2007		

FIGURE: P-21

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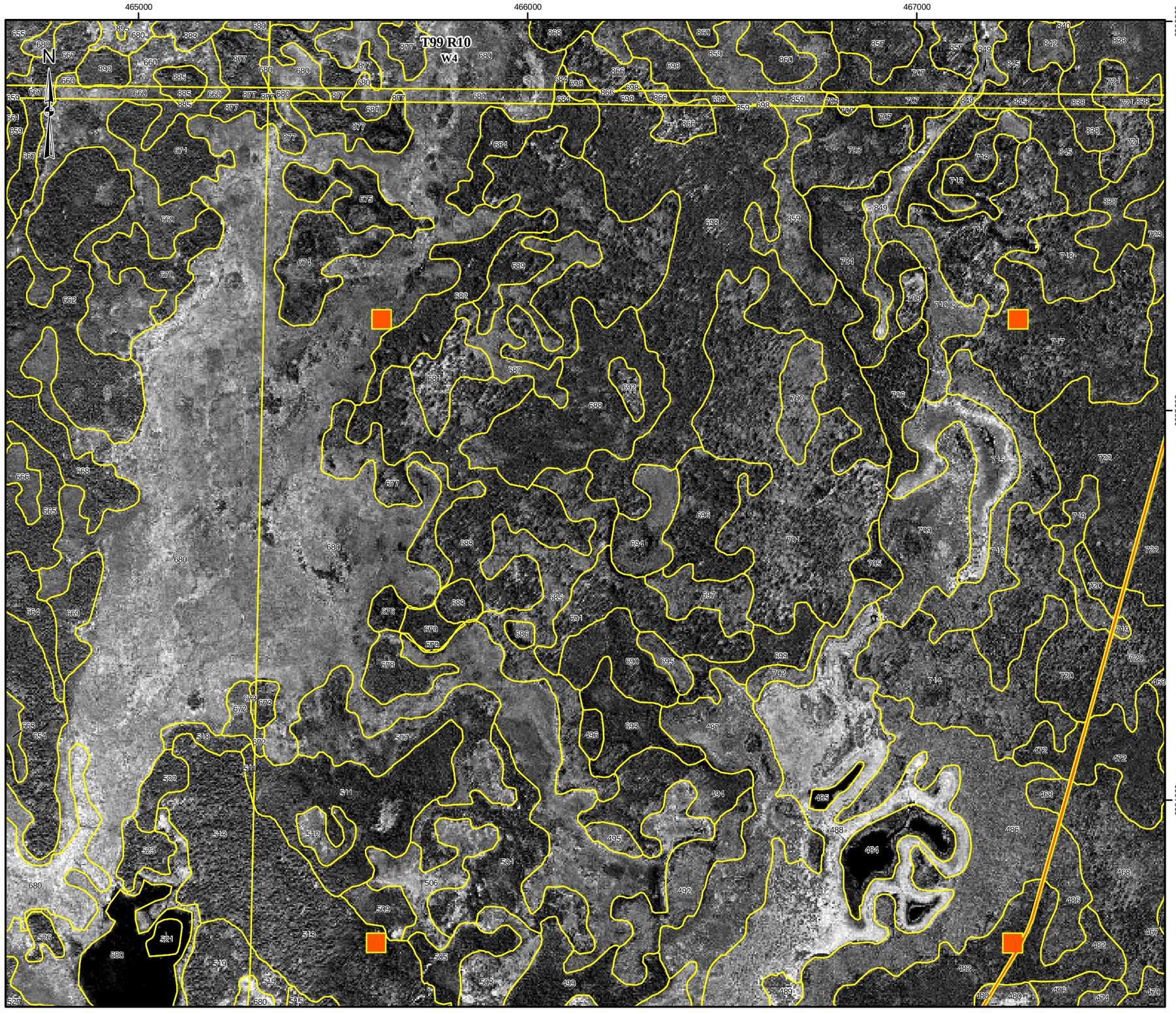
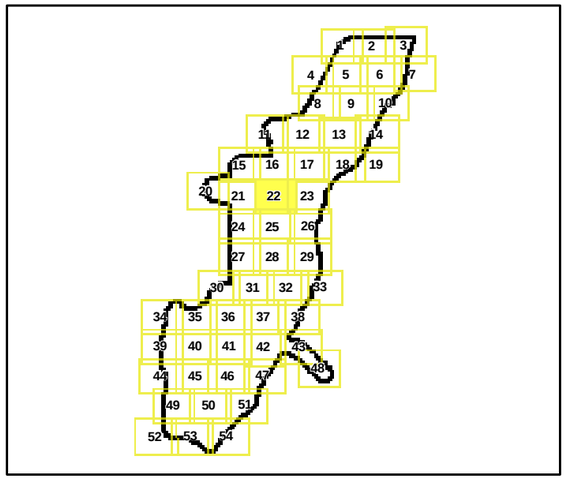


LEGEND

- PIERRE RIVER MINING AREA LOCAL STUDY AREA
- AVI POLYGON

DISTURBED

- EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE



REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2005-2006), used under license.
Imagery (Orthophoto) obtained from Shell Canada (August 2005).
Projection: UTM Zone 12 Datum: NAD 83

300 0 300
SCALE 1:10,000 METRES

PROJECT
JACKPINE MINE EXPANSION &
PIERRE RIVER MINE PROJECT

TITLE
ALBERTA VEGETATION INVENTORY
POLYGON MAP: MAP 22 OF 54

Shell Canada Limited

PROJECT No. 05-1344-027.7600			SCALE AS SHOWN	REV. 0
DESIGN	VR	18 Jan. 2007	FIGURE: P-22	
GIS	WZ	16 Nov. 2007		
CHECK	AA	15 Nov. 2007		
REVIEW	TC	16 Nov. 2007		

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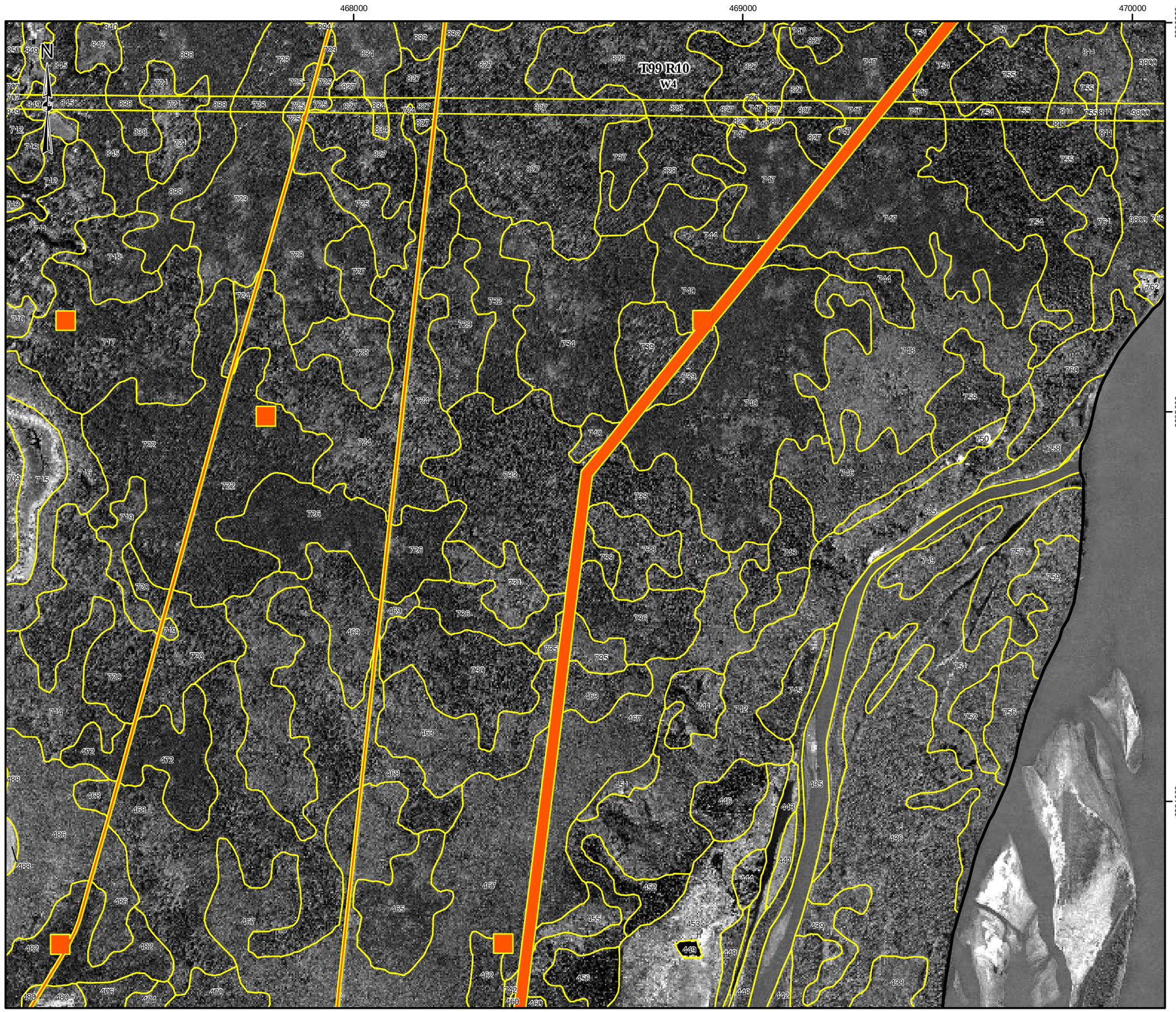


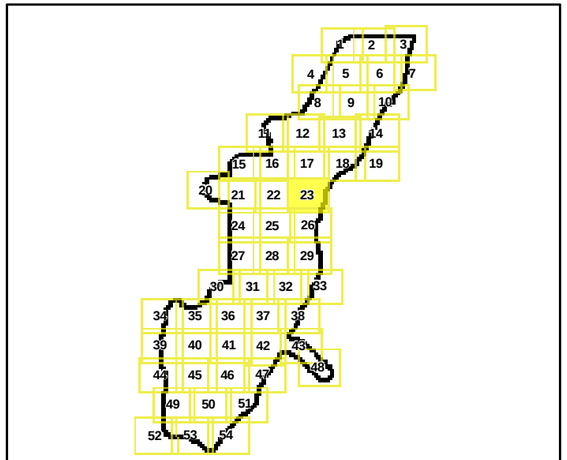
LEGEND

PIERRE RIVER MINING AREA LOCAL STUDY AREA

AVI POLYGON

DISTURBED

EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE



REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2005-2006), used under license.
Imagery (Orthophoto) obtained from Shell Canada (August 2005).
Projection: UTM Zone 12 Datum: NAD 83

300 0 300

SCALE 1:10,000 METRES

PROJECT

JACKPINE MINE EXPANSION &
PIERRE RIVER MINE PROJECT

TITLE

ALBERTA VEGETATION INVENTORY
POLYGON MAP: MAP 23 OF 54

Shell Canada Limited

PROJECT No. 05-1344-027.7600			SCALE AS SHOWN	REV. 0
DESIGN	VR	18 Jan. 2007	FIGURE: P-23	
GIS	WZ	16 Nov. 2007		
CHECK	AA	15 Nov. 2007		
REVIEW	TC	16 Nov. 2007		

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463000

464000

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6383000

6382000

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T99 R10
W4

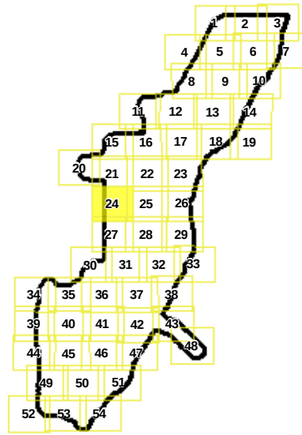
LEGEND

PIERRE RIVER MINING AREA LOCAL STUDY AREA

AVI POLYGON

DISTURBED

EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE



REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2005-2006), used under license.
Imagery (Orthophoto) obtained from Shell Canada (August 2005).
Projection: UTM Zone 12 Datum: NAD 83

300 0 300

SCALE 1:10,000 METRES

PROJECT

JACKPINE MINE EXPANSION &
PIERRE RIVER MINE PROJECT

TITLE

ALBERTA VEGETATION INVENTORY
POLYGON MAP: MAP 24 OF 54

Shell Canada Limited

PROJECT No. 05-1344-027.7600			SCALE AS SHOWN	REV. 0
DESIGN	VR	18 Jan. 2007	FIGURE: P-24	
GIS	WZ	16 Nov. 2007		
CHECK	AA	15 Nov. 2007		
REVIEW	TC	16 Nov. 2007		

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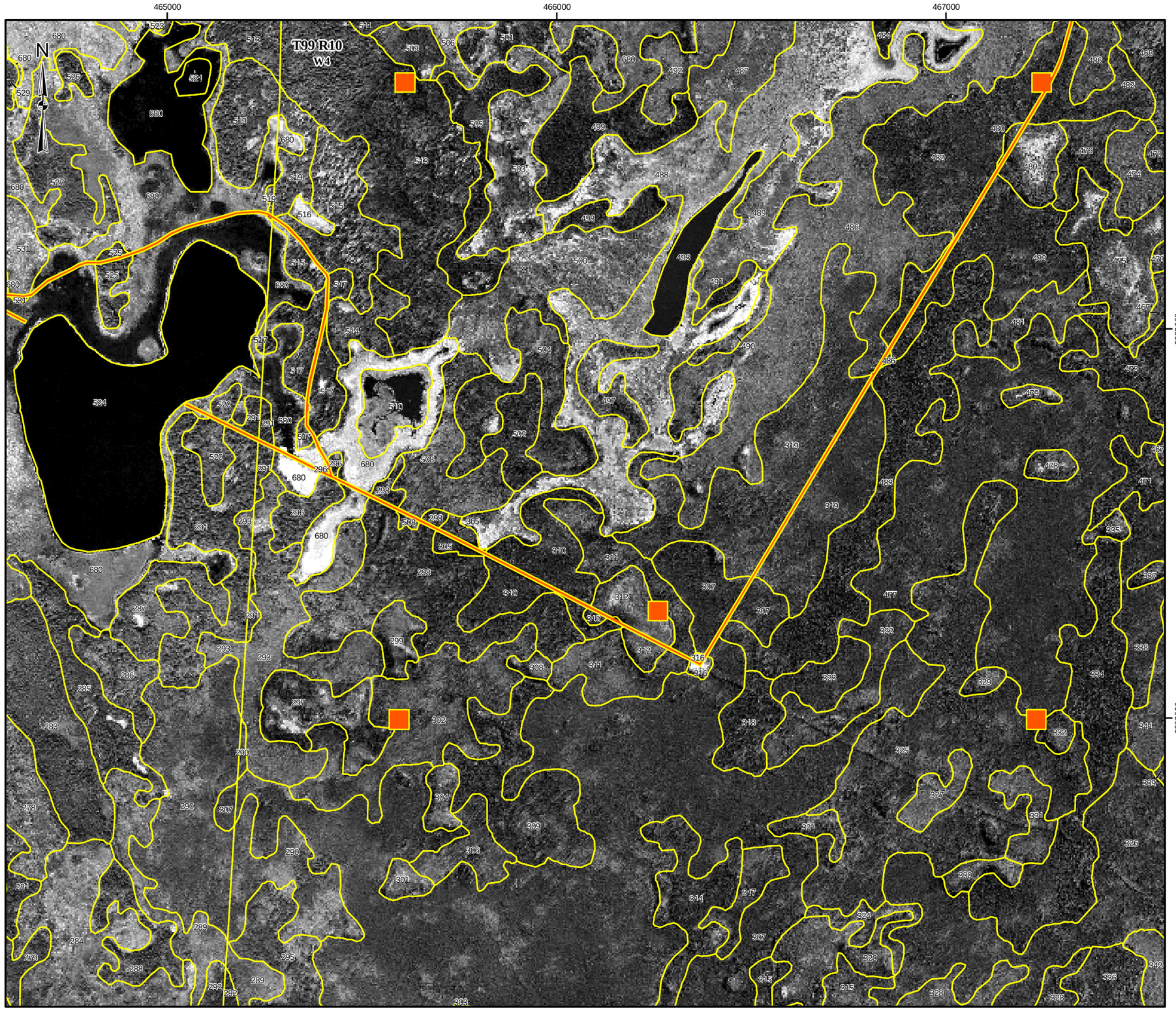
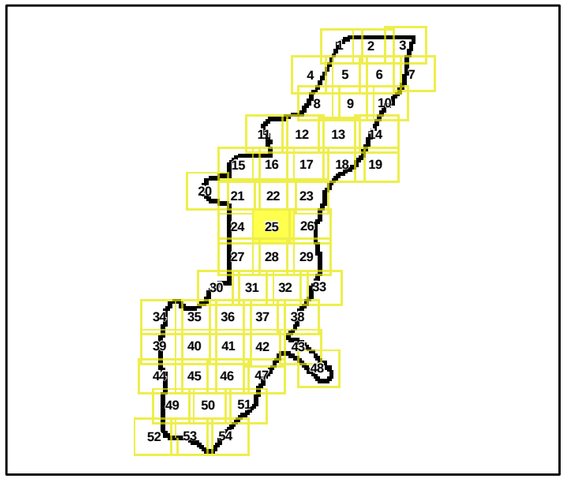


LEGEND

- PIERRE RIVER MINING AREA LOCAL STUDY AREA
- AVI POLYGON

DISTURBED

- EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE



REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2005-2006), used under license.
Imagery (Orthophoto) obtained from Shell Canada (August 2005).
Projection: UTM Zone 12 Datum: NAD 83

300 0 300

SCALE 1:10,000 METRES

PROJECT

JACKPINE MINE EXPANSION &
PIERRE RIVER MINE PROJECT

TITLE

ALBERTA VEGETATION INVENTORY
POLYGON MAP: MAP 25 OF 54

Shell Canada Limited

PROJECT No. 05-1344-027.7600			SCALE AS SHOWN	REV. 0
DESIGN	VR	18 Jan. 2007	FIGURE: P-25	
GIS	WZ	16 Nov. 2007		
CHECK	AA	15 Nov. 2007		
REVIEW	TC	16 Nov. 2007		

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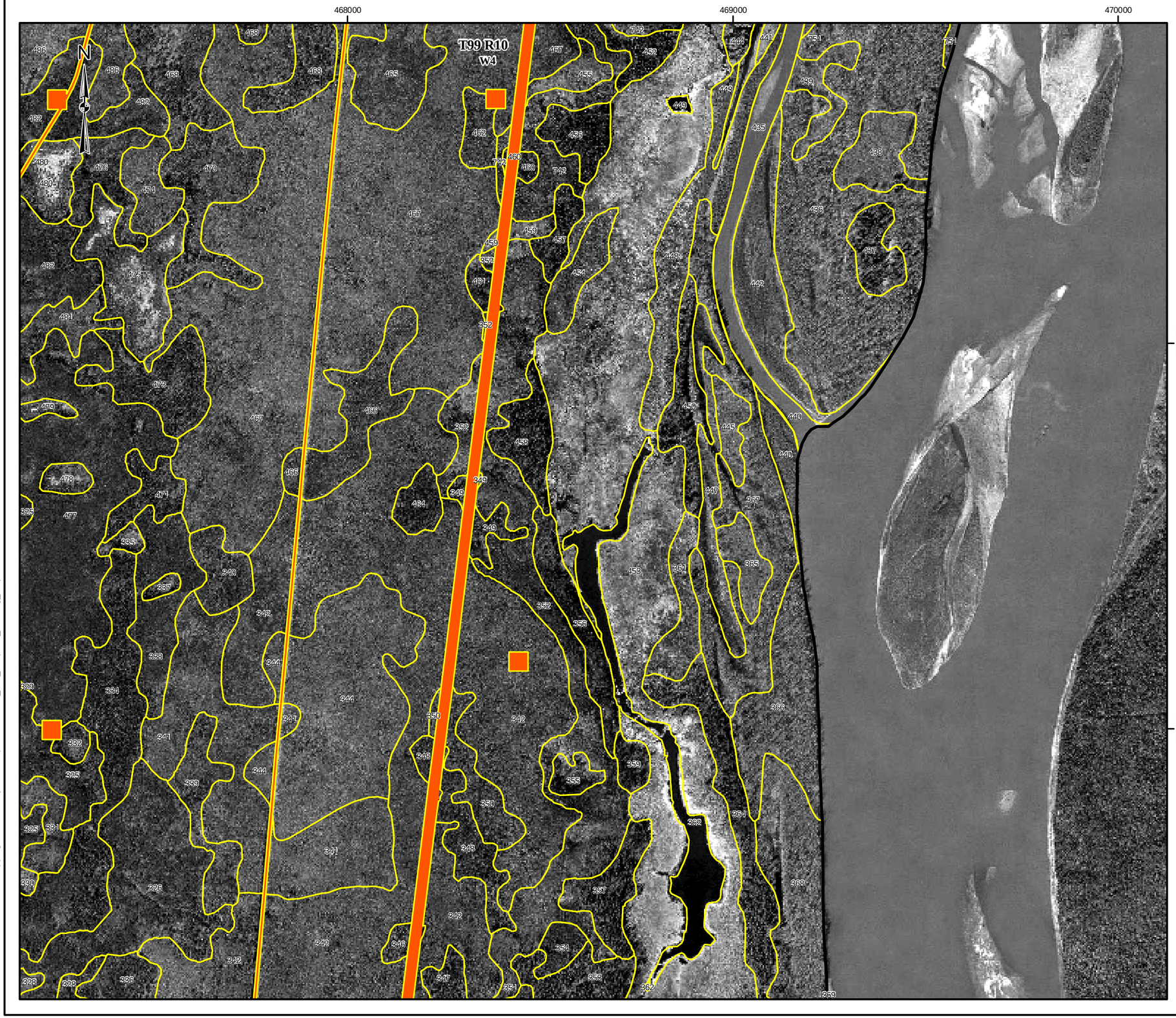
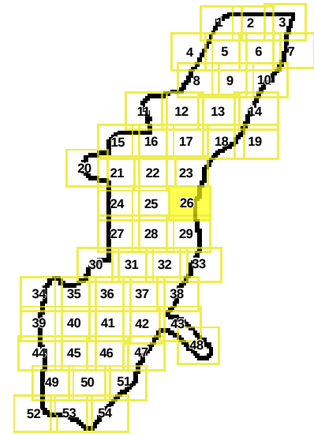


LEGEND

- PIERRE RIVER MINING AREA LOCAL STUDY AREA
- AVI POLYGON

DISTURBED

- EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE



REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2005-2006), used under license.
Imagery (Orthophoto) obtained from Shell Canada (August 2005).
Projection: UTM Zone 12 Datum: NAD 83

300 0 300

SCALE 1:10,000 METRES

PROJECT

JACKPINE MINE EXPANSION &
PIERRE RIVER MINE PROJECT

TITLE

ALBERTA VEGETATION INVENTORY
POLYGON MAP: MAP 26 OF 54

Shell Canada Limited

PROJECT No. 05-1344-027.7600			SCALE AS SHOWN	REV. 0
DESIGN	VR	18 Jan. 2007	FIGURE: P-26	
GIS	WZ	16 Nov. 2007		
CHECK	AA	15 Nov. 2007		
REVIEW	TC	16 Nov. 2007		

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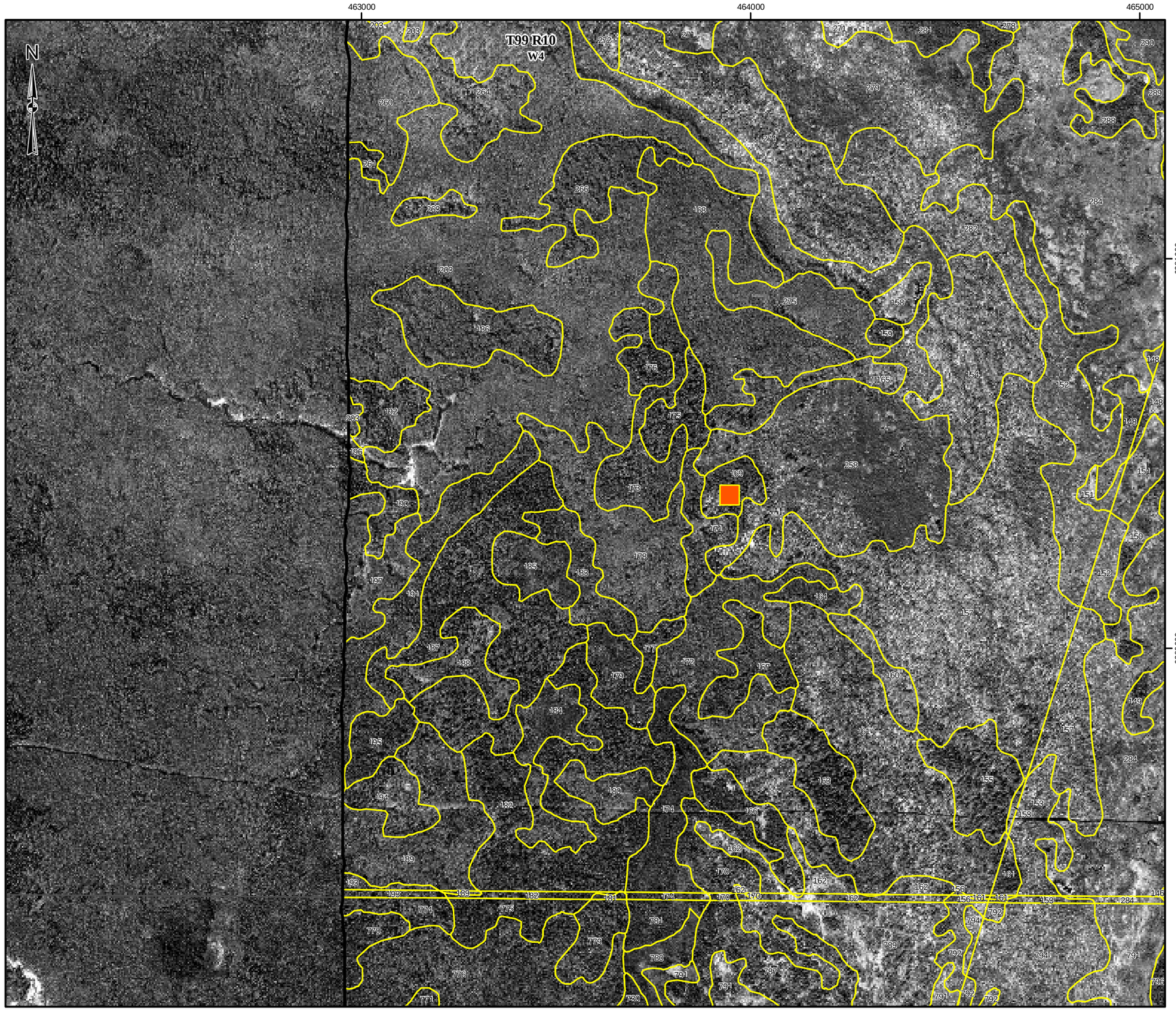
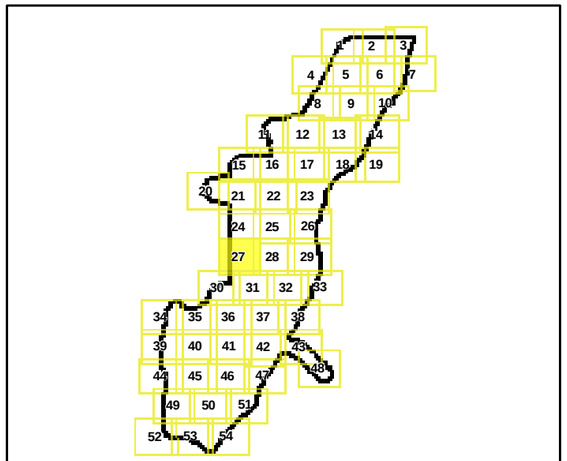


LEGEND

- PIERRE RIVER MINING AREA LOCAL STUDY AREA
- AVI POLYGON

DISTURBED

- EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE



REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2005-2006), used under license.
Imagery (Orthophoto) obtained from Shell Canada (August 2005).
Projection: UTM Zone 12 Datum: NAD 83

300 0 300
SCALE 1:10,000 METRES

PROJECT
JACKPINE MINE EXPANSION &
PIERRE RIVER MINE PROJECT

TITLE
ALBERTA VEGETATION INVENTORY
POLYGON MAP: MAP 27 OF 54

Shell Canada Limited

PROJECT No. 05-1344-027.7600			SCALE AS SHOWN	REV. 0
DESIGN	VR	18 Jan. 2007	FIGURE: P-27	
GIS	WZ	16 Nov. 2007		
CHECK	AA	15 Nov. 2007		
REVIEW	TC	16 Nov. 2007		

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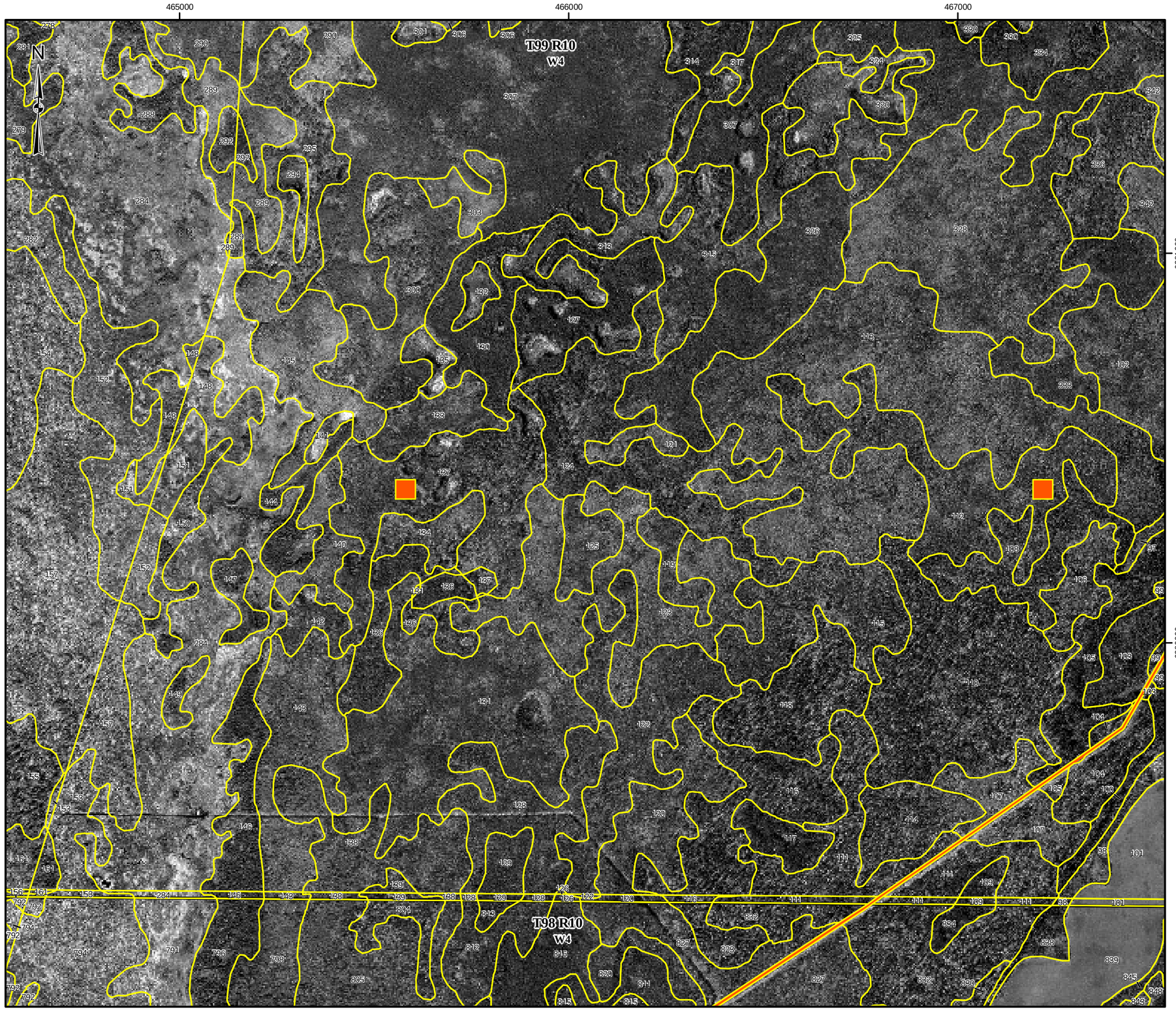


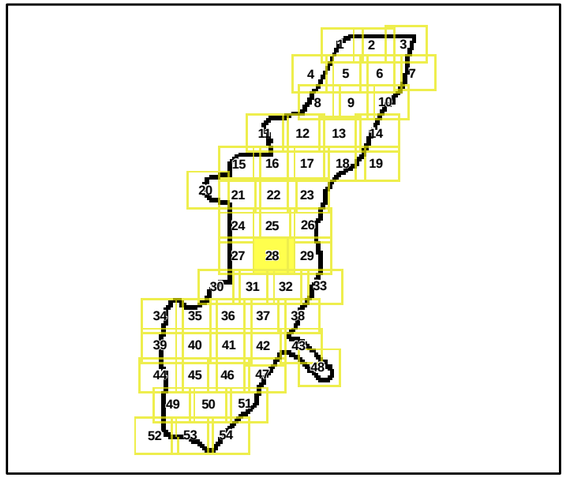
LEGEND

PIERRE RIVER MINING AREA LOCAL STUDY AREA

AVI POLYGON

DISTURBED

EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE



REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2005-2006), used under license.
Imagery (Orthophoto) obtained from Shell Canada (August 2005).
Projection: UTM Zone 12 Datum: NAD 83

300 0 300

SCALE 1:10,000 METRES

PROJECT

JACKPINE MINE EXPANSION &
PIERRE RIVER MINE PROJECT

TITLE

ALBERTA VEGETATION INVENTORY
POLYGON MAP: MAP 28 OF 54

Shell Canada Limited

PROJECT No. 05-1344-027.7600			SCALE AS SHOWN	REV. 0
DESIGN	VR	18 Jan. 2007		
GIS	WZ	16 Nov. 2007		
CHECK	AA	15 Nov. 2007		
REVIEW	TC	16 Nov. 2007		

FIGURE: P-28

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468000

469000

470000

6381000

6380000

T99 R10
W4

T98 R10
W4

N

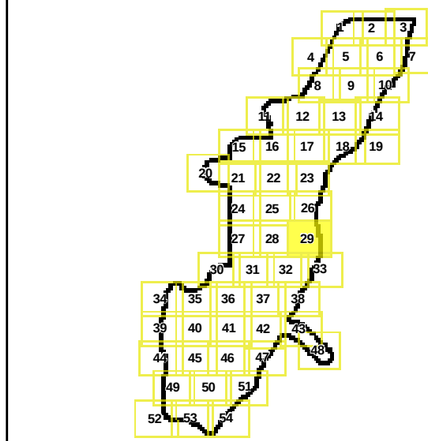
LEGEND

PIERRE RIVER MINING AREA LOCAL STUDY AREA

AVI POLYGON

DISTURBED

EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE



REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2005-2006), used under license.
Imagery (Orthophoto) obtained from Shell Canada (August 2005).
Projection: UTM Zone 12 Datum: NAD 83

300 0 300

SCALE 1:10,000 METRES

PROJECT

JACKPINE MINE EXPANSION &
PIERRE RIVER MINE PROJECT

TITLE

ALBERTA VEGETATION INVENTORY
POLYGON MAP: MAP 29 OF 54

Shell Canada Limited

PROJECT No. 05-1344-027.7600			SCALE AS SHOWN	REV. 0
DESIGN	VR	18 Jan. 2007		
GIS	WZ	16 Nov. 2007		
CHECK	AA	15 Nov. 2007		
REVIEW	TC	16 Nov. 2007		

FIGURE: P-29

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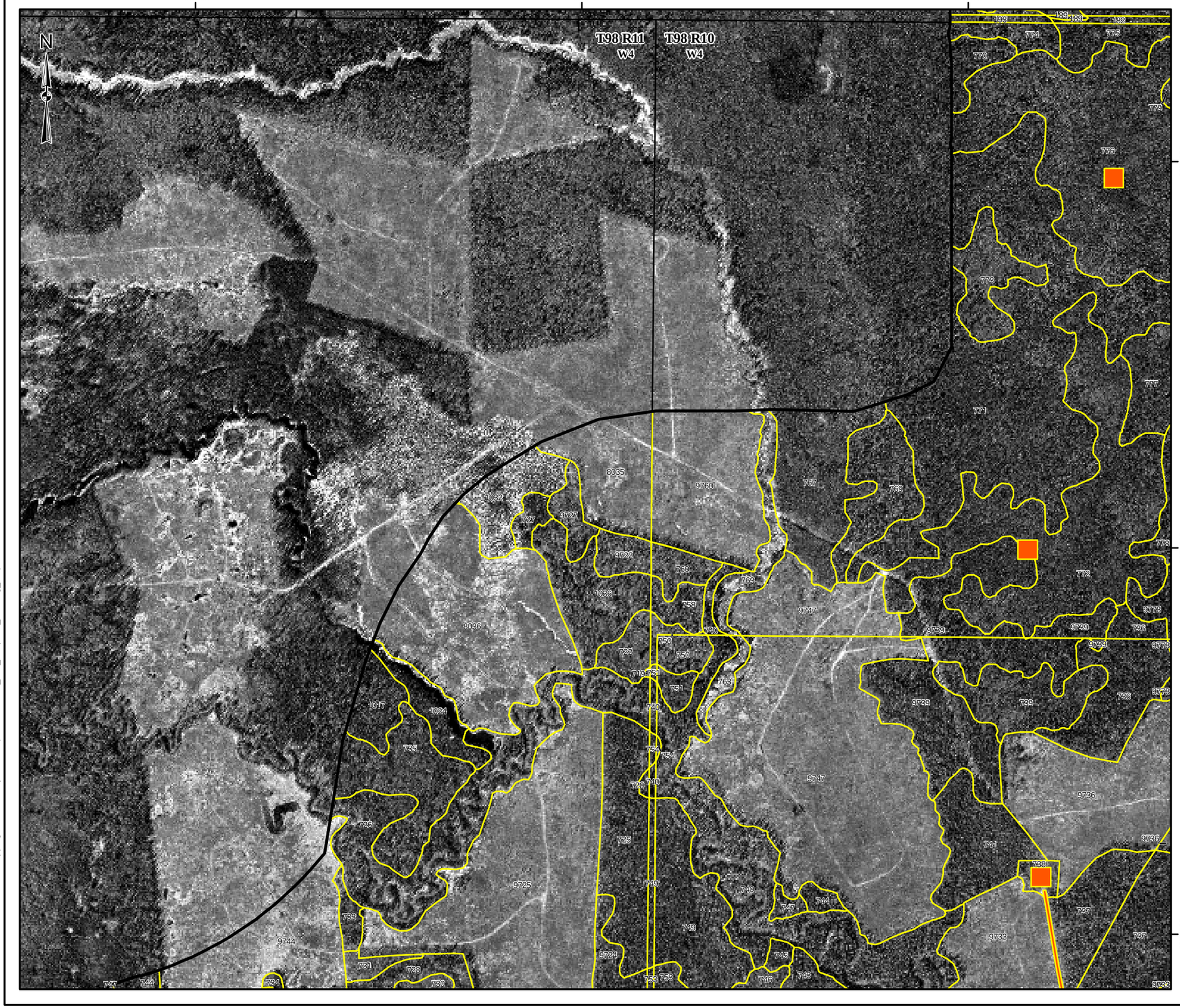
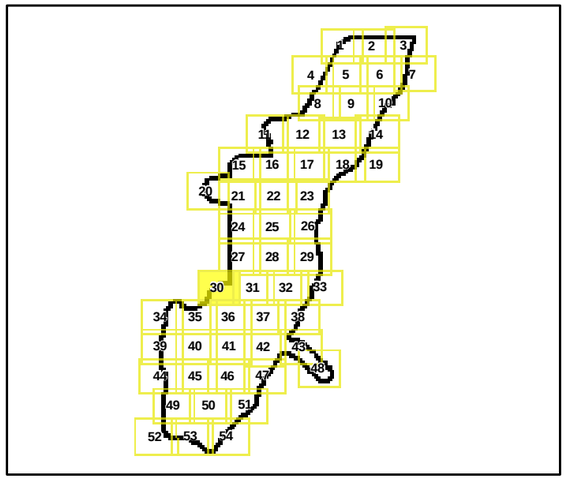


LEGEND

- PIERRE RIVER MINING AREA LOCAL STUDY AREA
- AVI POLYGON

DISTURBED

- EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE



REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2005-2006), used under license.
Imagery (Orthophoto) obtained from Shell Canada (August 2005).
Projection: UTM Zone 12 Datum: NAD 83

300 0 300
SCALE 1:10,000 METRES

PROJECT
JACKPINE MINE EXPANSION &
PIERRE RIVER MINE PROJECT

TITLE
ALBERTA VEGETATION INVENTORY
POLYGON MAP: MAP 30 OF 54

Shell Canada Limited

PROJECT No. 05-1344-027.7600			SCALE AS SHOWN	REV. 0
DESIGN	VR	18 Jan. 2007	FIGURE: P-30	
GIS	WZ	16 Nov. 2007		
CHECK	AA	15 Nov. 2007		
REVIEW	TC	16 Nov. 2007		

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464000

465000

466000

6379000

6378000

6377000

T98 R10
W4

N

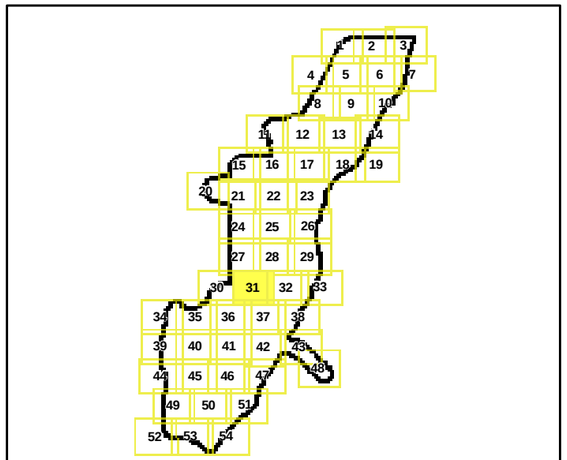
LEGEND

PIERRE RIVER MINING AREA LOCAL STUDY AREA

AVI POLYGON

DISTURBED

EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE



REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2005-2006), used under license.
Imagery (Orthophoto) obtained from Shell Canada (August 2005).
Projection: UTM Zone 12 Datum: NAD 83

300 0 300

SCALE 1:10,000 METRES

PROJECT

JACKPINE MINE EXPANSION &
PIERRE RIVER MINE PROJECT

TITLE

ALBERTA VEGETATION INVENTORY
POLYGON MAP: MAP 31 OF 54

Shell Canada Limited

PROJECT No. 05-1344-027.7600			SCALE AS SHOWN	REV. 0
DESIGN	VR	18 Jan. 2007		
GIS	WZ	16 Nov. 2007		
CHECK	AA	15 Nov. 2007		
REVIEW	TC	16 Nov. 2007		

FIGURE: P-31

I:\CLIENTS\SHELL\05-1344-027\mapping\mxd\Forestry\DRAFT\pierreriver\PR_AVI_template_working_Map31.mxd

466000

467000

468000

6379000

6378000

6377000

T98 R10
W4

N

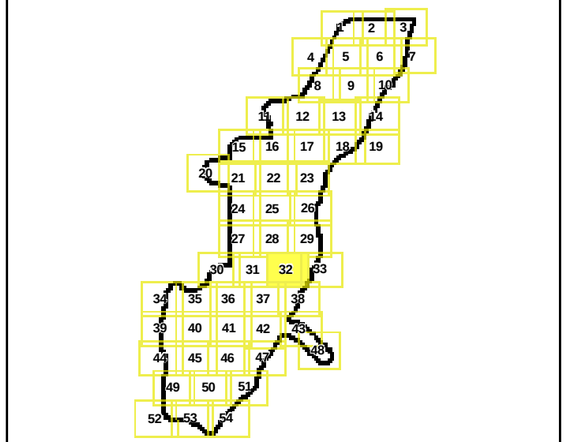
LEGEND

PIERRE RIVER MINING AREA LOCAL STUDY AREA

AVI POLYGON

DISTURBED

EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE



REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2005-2006), used under license.
Imagery (Orthophoto) obtained from Shell Canada (August 2005).
Projection: UTM Zone 12 Datum: NAD 83

300 0 300

SCALE 1:10,000 METRES

PROJECT

JACKPINE MINE EXPANSION &
PIERRE RIVER MINE PROJECT

TITLE

ALBERTA VEGETATION INVENTORY
POLYGON MAP: MAP 32 OF 54

Shell Canada Limited

PROJECT No. 05-1344-027.7600			SCALE AS SHOWN	REV. 0
DESIGN	VR	18 Jan. 2007		
GIS	WZ	16 Nov. 2007		
CHECK	AA	15 Nov. 2007		
REVIEW	TC	16 Nov. 2007		

FIGURE: P-32

I:\CLIENTS\SHELL\05-1344-027\mapping\mxd\Forestry\DRAFT\pierreriver\PR_AVI_template_working_Map32.mxd

469000

470000

6379000

6378000

6377000

T99 R10
W4

T98 R10
W4

N

566

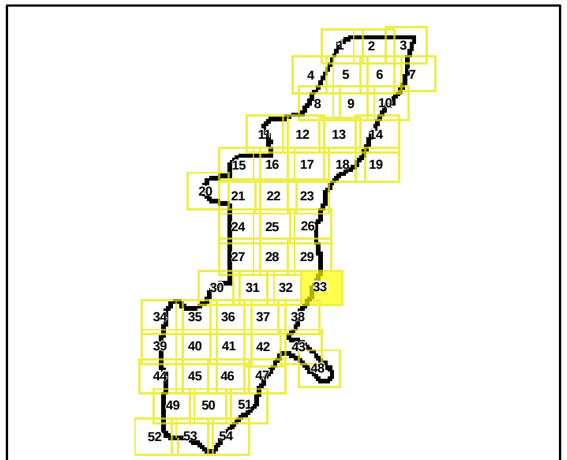
LEGEND

PIERRE RIVER MINING AREA LOCAL STUDY AREA

AVI POLYGON

DISTURBED

EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE



REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2005-2006), used under license.
Imagery (Orthophoto) obtained from Shell Canada (August 2005).
Projection: UTM Zone 12 Datum: NAD 83

300 0 300

SCALE 1:10,000 METRES

PROJECT

JACKPINE MINE EXPANSION &
PIERRE RIVER MINE PROJECT

TITLE

ALBERTA VEGETATION INVENTORY
POLYGON MAP: MAP 33 OF 54

Shell Canada Limited

PROJECT No. 05-1344-027.7600			SCALE AS SHOWN	REV. 0
DESIGN	VR	18 Jan. 2007	FIGURE: P-33	
GIS	WZ	16 Nov. 2007		
CHECK	AA	15 Nov. 2007		
REVIEW	TC	16 Nov. 2007		

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457000

458000

459000

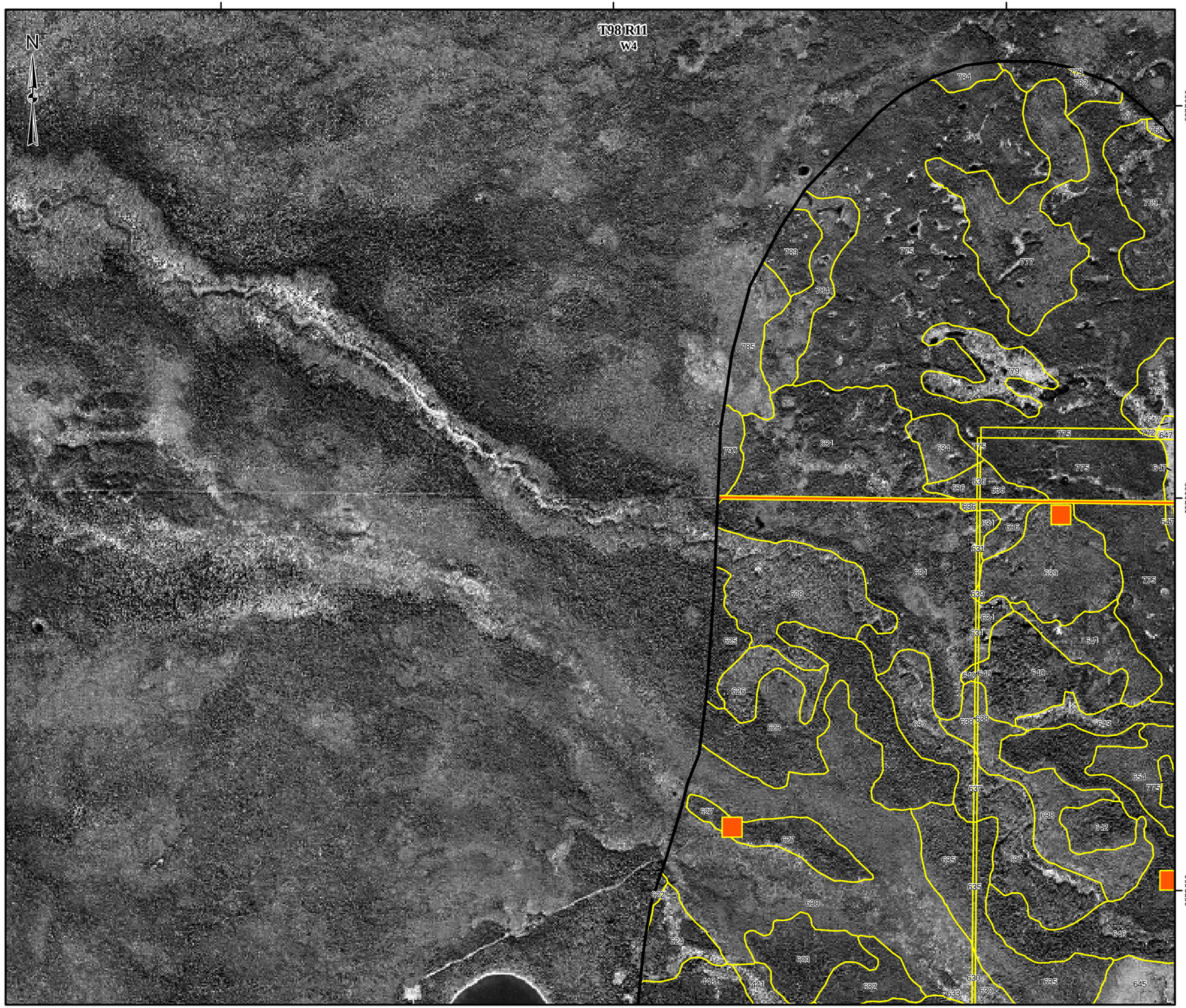
6377000

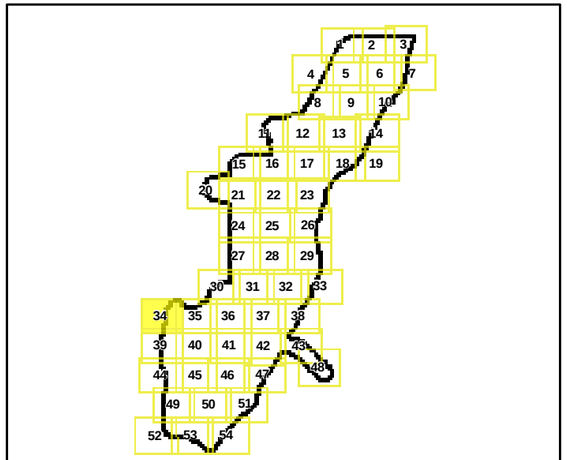
6376000

6375000

T98 R11
W4

N





LEGEND

- PIERRE RIVER MINING AREA LOCAL STUDY AREA
- AVI POLYGON

DISTURBED

- EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE

REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2005-2006), used under license.
Imagery (Orthophoto) obtained from Shell Canada (August 2005).
Projection: UTM Zone 12 Datum: NAD 83

300 0 300

SCALE 1:10,000 METRES

PROJECT

JACKPINE MINE EXPANSION &
PIERRE RIVER MINE PROJECT

TITLE

ALBERTA VEGETATION INVENTORY
POLYGON MAP: MAP 34 OF 54

Shell Canada Limited

PROJECT No. 05-1344-027.7600			SCALE AS SHOWN	REV. 0
DESIGN	VR	18 Jan. 2007	FIGURE: P-34	
GIS	WZ	16 Nov. 2007		
CHECK	AA	15 Nov. 2007		
REVIEW	TC	16 Nov. 2007		

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459000 460000 461000

6377000 6376000 6375000

T98 R11
W4

N

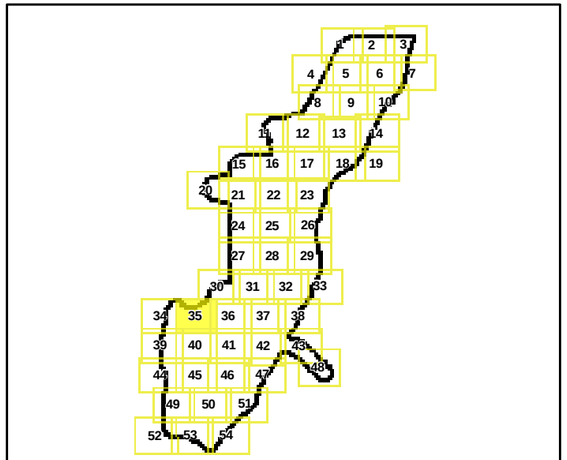
LEGEND

PIERRE RIVER MINING AREA LOCAL STUDY AREA

AVI POLYGON

DISTURBED

EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE



REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2005-2006), used under license.
Imagery (Orthophoto) obtained from Shell Canada (August 2005).
Projection: UTM Zone 12 Datum: NAD 83

300 0 300

SCALE 1:10,000 METRES

PROJECT

JACKPINE MINE EXPANSION &
PIERRE RIVER MINE PROJECT

TITLE

ALBERTA VEGETATION INVENTORY
POLYGON MAP: MAP 35 OF 54

Shell Canada Limited

PROJECT No. 05-1344-027.7600			SCALE AS SHOWN	REV. 0	
DESIGN	VR	18 Jan. 2007	FIGURE: P-35		
GIS	WZ	16 Nov. 2007			
CHECK	AA	15 Nov. 2007			
REVIEW	TC	16 Nov. 2007			

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462000 463000 464000

6377000 6376000 6375000

T98 R11 W4 T98 R10 W4

N

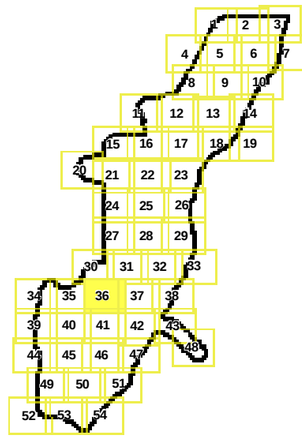
LEGEND

PIERRE RIVER MINING AREA LOCAL STUDY AREA

AVI POLYGON

DISTURBED

EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE



REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2005-2006), used under license.
Imagery (Orthophoto) obtained from Shell Canada (August 2005).
Projection: UTM Zone 12 Datum: NAD 83

300 0 300

SCALE 1:10,000 METRES

PROJECT

JACKPINE MINE EXPANSION &
PIERRE RIVER MINE PROJECT

TITLE

ALBERTA VEGETATION INVENTORY
POLYGON MAP: MAP 36 OF 54

Shell Canada Limited

PROJECT No. 05-1344-027.7600			SCALE AS SHOWN	REV. 0
DESIGN	VR	18 Jan. 2007	FIGURE: P-36	
GIS	WZ	16 Nov. 2007		
CHECK	AA	15 Nov. 2007		
REVIEW	TC	16 Nov. 2007		

I:\CLIENTS\SHELL\05-1344-027\mapping\mxd\Forestry\DRAFT\pierreriver\PR_AVI_template_working_Map36.mxd

464000 465000 466000

6377000 6376000 6375000

T98 R10
W4

N

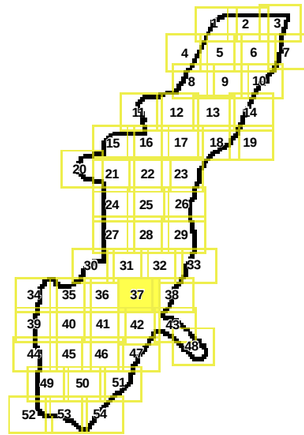
LEGEND

PIERRE RIVER MINING AREA LOCAL STUDY AREA

AVI POLYGON

DISTURBED

EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE



REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2005-2006), used under license.
Imagery (Orthophoto) obtained from Shell Canada (August 2005).
Projection: UTM Zone 12 Datum: NAD 83

300 0 300

SCALE 1:10,000 METRES

PROJECT

JACKPINE MINE EXPANSION &
PIERRE RIVER MINE PROJECT

TITLE

ALBERTA VEGETATION INVENTORY
POLYGON MAP: MAP 37 OF 54

Shell Canada Limited

PROJECT No. 05-1344-027.7600			SCALE AS SHOWN	REV. 0
DESIGN	VR	18 Jan. 2007	FIGURE: P-37	
GIS	WZ	16 Nov. 2007		
CHECK	AA	15 Nov. 2007		
REVIEW	TC	16 Nov. 2007		

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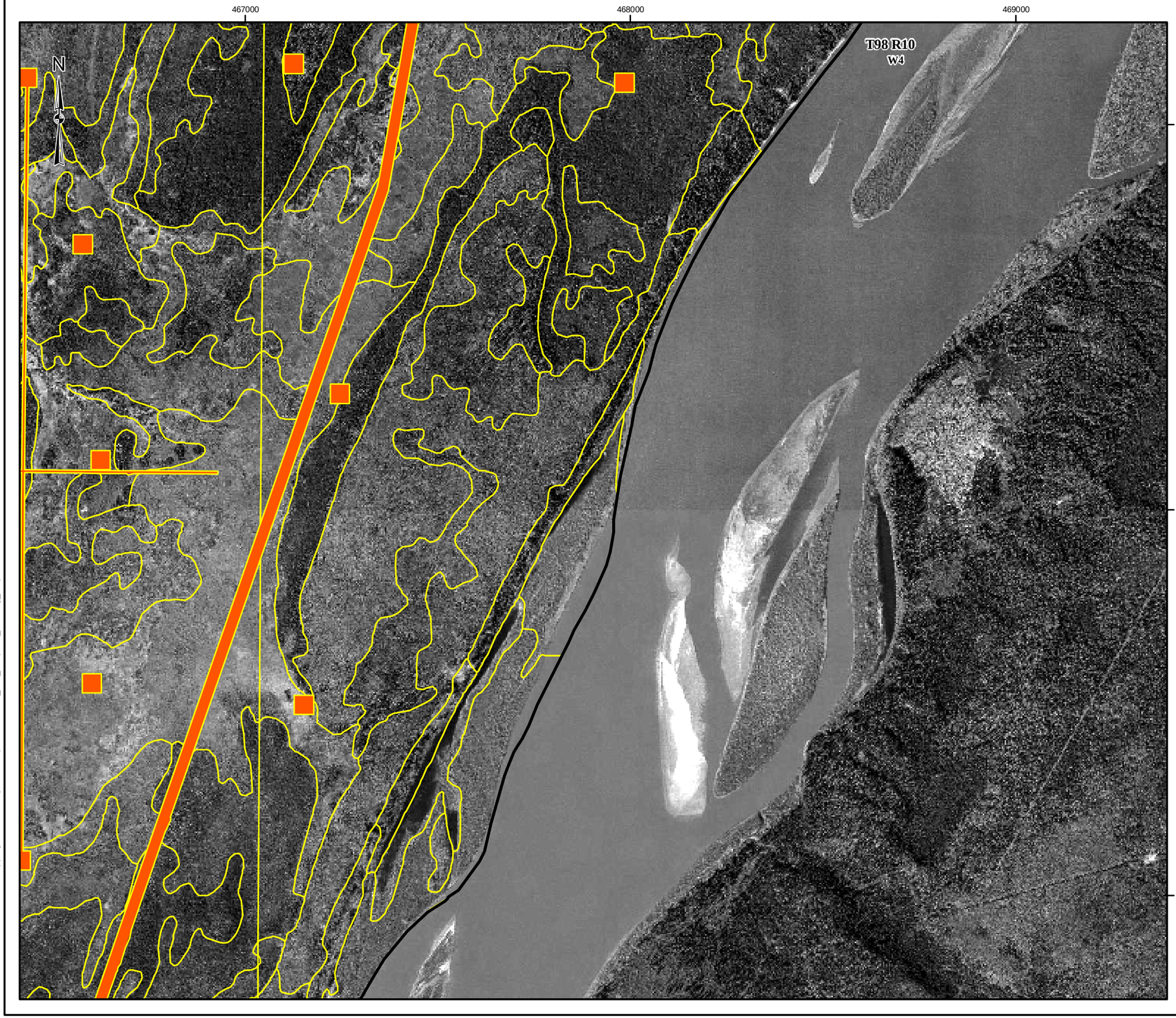


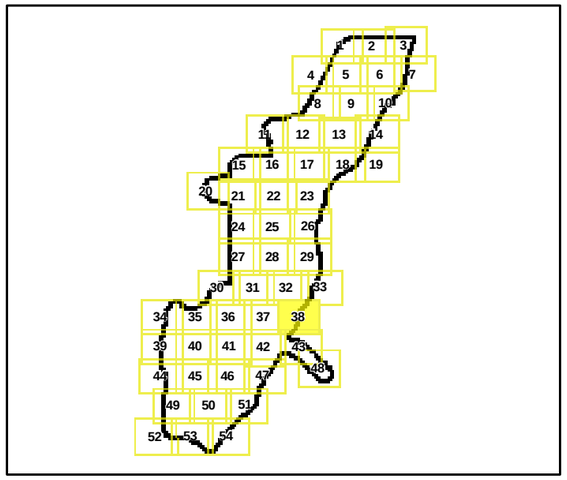
LEGEND

PIERRE RIVER MINING AREA LOCAL STUDY AREA

AVI POLYGON

DISTURBED

EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE



REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2005-2006), used under license.
Imagery (Orthophoto) obtained from Shell Canada (August 2005).
Projection: UTM Zone 12 Datum: NAD 83

300 0 300

SCALE 1:10,000 METRES

PROJECT

JACKPINE MINE EXPANSION &
PIERRE RIVER MINE PROJECT

TITLE

ALBERTA VEGETATION INVENTORY
POLYGON MAP: MAP 38 OF 54

Shell Canada Limited

PROJECT No. 05-1344-027.7600			SCALE AS SHOWN	REV. 0
DESIGN	VR	18 Jan. 2007	FIGURE: P-38	
GIS	WZ	16 Nov. 2007		
CHECK	AA	15 Nov. 2007		
REVIEW	TC	16 Nov. 2007		

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457000

458000

459000

6375000

6374000

6373000

T98 R11
W4

N

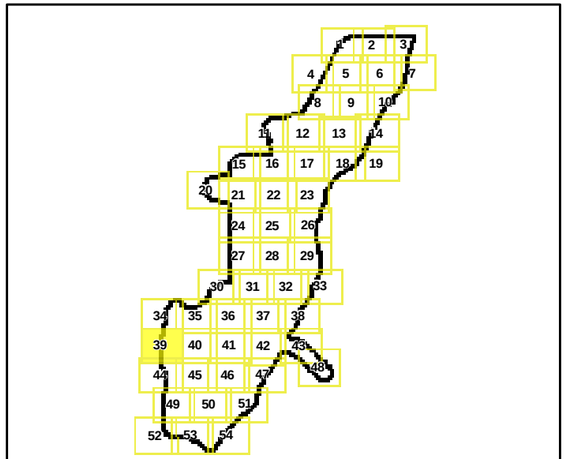
LEGEND

PIERRE RIVER MINING AREA LOCAL STUDY AREA

AVI POLYGON

DISTURBED

EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE



REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2005-2006), used under license.
Imagery (Orthophoto) obtained from Shell Canada (August 2005).
Projection: UTM Zone 12 Datum: NAD 83

300 0 300

SCALE 1:10,000 METRES

PROJECT

JACKPINE MINE EXPANSION &
PIERRE RIVER MINE PROJECT

TITLE

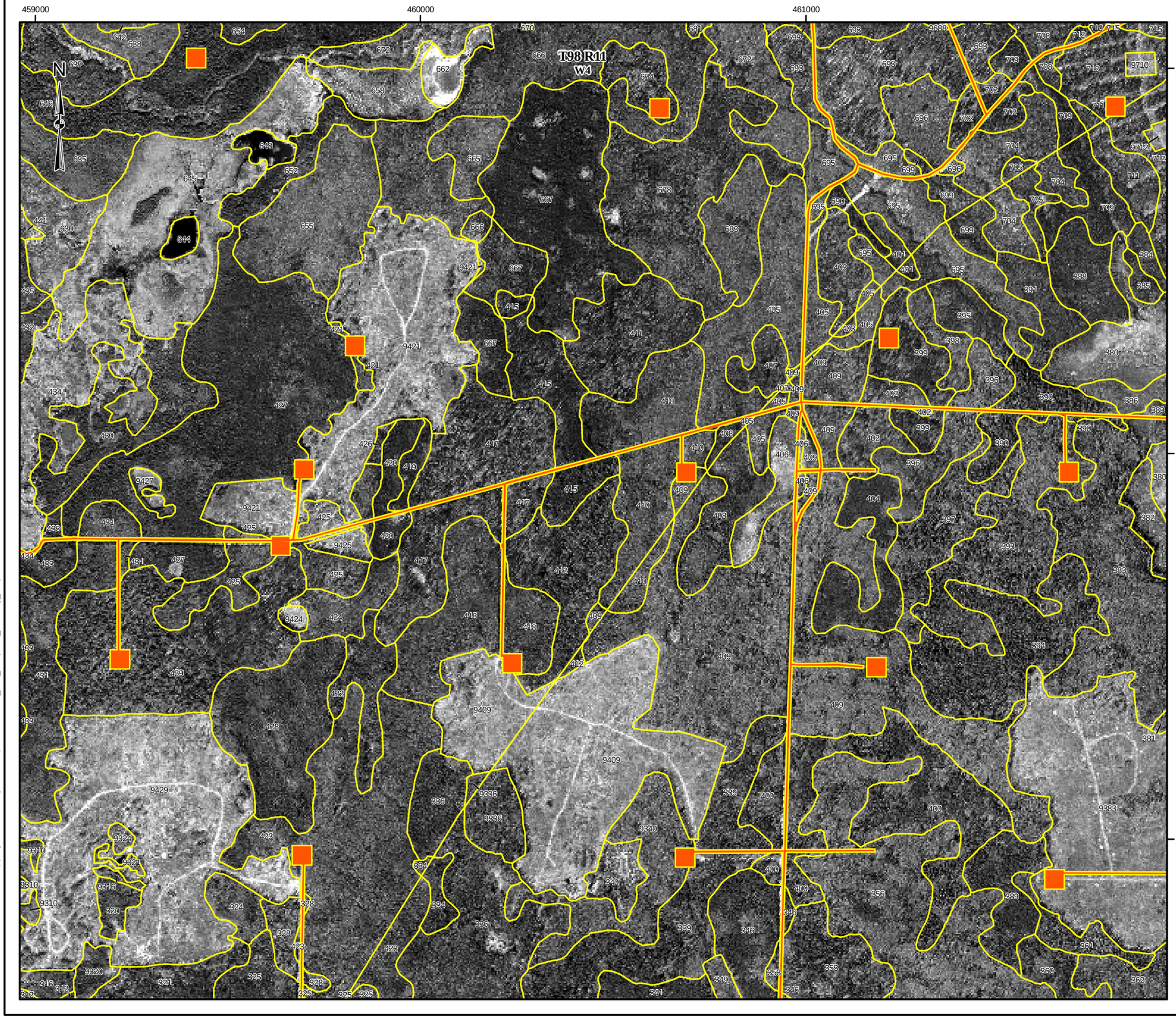
ALBERTA VEGETATION INVENTORY
POLYGON MAP: MAP 39 OF 54

Shell Canada Limited

PROJECT No. 05-1344-027.7600			SCALE AS SHOWN	REV. 0
DESIGN	VR	18 Jan. 2007		
GIS	WZ	16 Nov. 2007		
CHECK	AA	15 Nov. 2007		
REVIEW	TC	16 Nov. 2007		

FIGURE: P-39

I:\CLIENTS\SHELL\05-1344-027\mapping\mxd\Forestry\DRAFT\pierreriver\PR_AVI_template_working_Map39.mxd



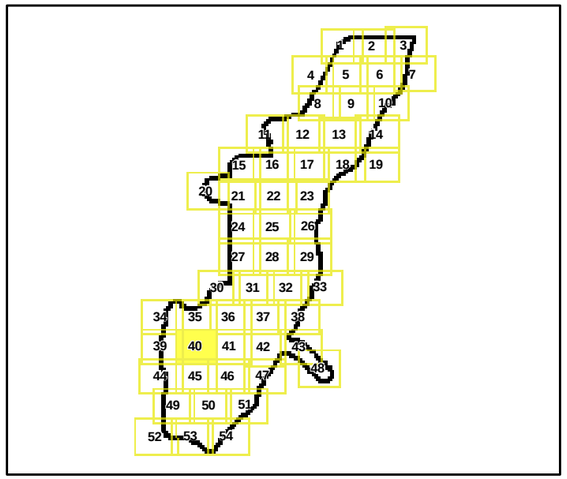
LEGEND

PIERRE RIVER MINING AREA LOCAL STUDY AREA

AVI POLYGON

DISTURBED

EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE



REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2005-2006), used under license.
Imagery (Orthophoto) obtained from Shell Canada (August 2005).
Projection: UTM Zone 12 Datum: NAD 83

300 0 300

SCALE 1:10,000 METRES

PROJECT

JACKPINE MINE EXPANSION &
PIERRE RIVER MINE PROJECT

TITLE

ALBERTA VEGETATION INVENTORY
POLYGON MAP: MAP 40 OF 54

Shell Canada Limited

PROJECT No. 05-1344-027.7600			SCALE AS SHOWN	REV. 0
DESIGN	VR	18 Jan. 2007	FIGURE: P-40	
GIS	WZ	16 Nov. 2007		
CHECK	AA	15 Nov. 2007		
REVIEW	TC	16 Nov. 2007		

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462000

463000

464000

6375000

6374000

6373000

T98 R11 W4

T98 R10 W4

N

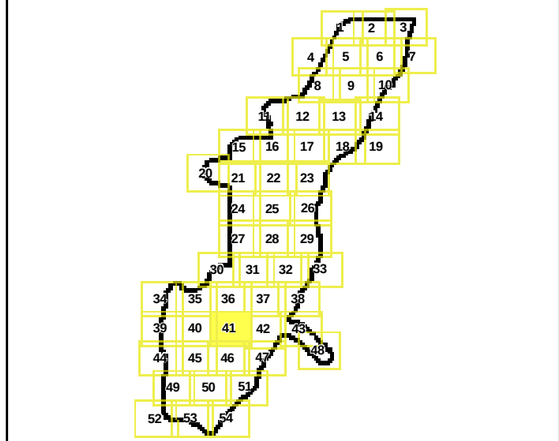
LEGEND

PIERRE RIVER MINING AREA LOCAL STUDY AREA

AVI POLYGON

DISTURBED

EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE



REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2005-2006), used under license.
Imagery (Orthophoto) obtained from Shell Canada (August 2005).
Projection: UTM Zone 12 Datum: NAD 83

300 0 300

SCALE 1:10,000 METRES

PROJECT

JACKPINE MINE EXPANSION &
PIERRE RIVER MINE PROJECT

TITLE

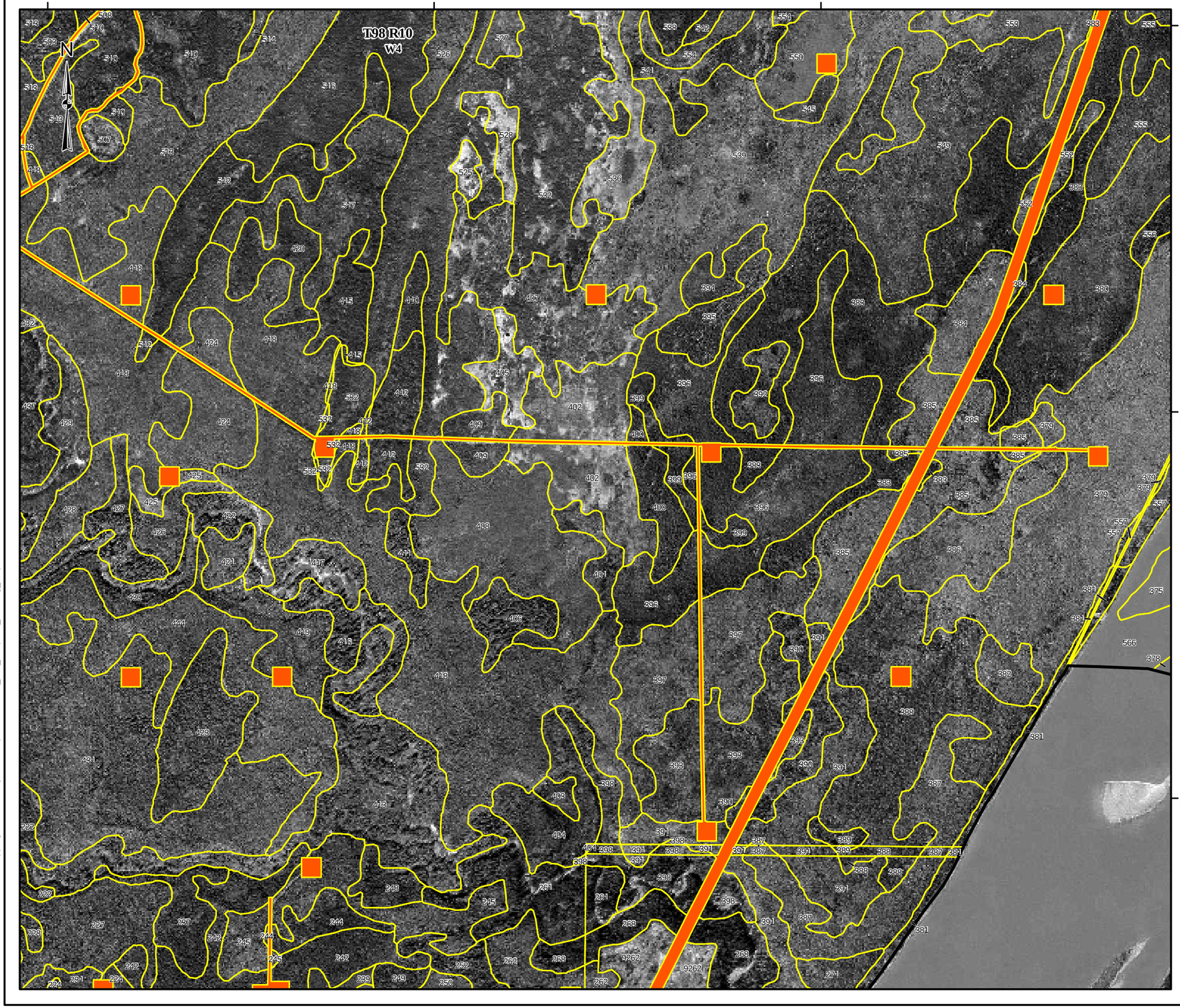
ALBERTA VEGETATION INVENTORY
POLYGON MAP: MAP 41 OF 54

Shell Canada Limited

PROJECT No. 05-1344-027.7600			SCALE AS SHOWN	REV. 0	
DESIGN	VR	18 Jan. 2007			
GIS	WZ	16 Nov. 2007			
CHECK	AA	15 Nov. 2007			
REVIEW	TC	16 Nov. 2007			

FIGURE: P-41

I:\CLIENTS\SHELL\05-1344-027\mapping\mxd\Forestry\DRAFT\PierreriverPR_AVI_template_working_Map41.mxd



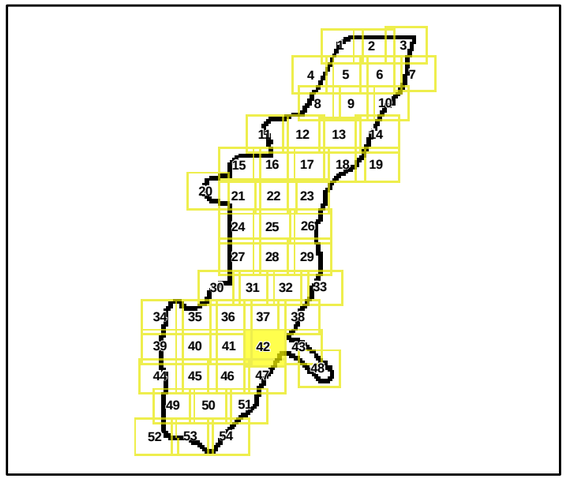
LEGEND

PIERRE RIVER MINING AREA LOCAL STUDY AREA

AVI POLYGON

DISTURBED

EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE



REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2005-2006), used under license.
Imagery (Orthophoto) obtained from Shell Canada (August 2005).
Projection: UTM Zone 12 Datum: NAD 83

300 0 300

SCALE 1:10,000 METRES

PROJECT

JACKPINE MINE EXPANSION &
PIERRE RIVER MINE PROJECT

TITLE

ALBERTA VEGETATION INVENTORY
POLYGON MAP: MAP 42 OF 54

Shell Canada Limited

PROJECT No. 05-1344-027.7600			SCALE AS SHOWN	REV. 0
DESIGN	VR	18 Jan. 2007	FIGURE: P-42	
GIS	WZ	16 Nov. 2007		
CHECK	AA	15 Nov. 2007		
REVIEW	TC	16 Nov. 2007		

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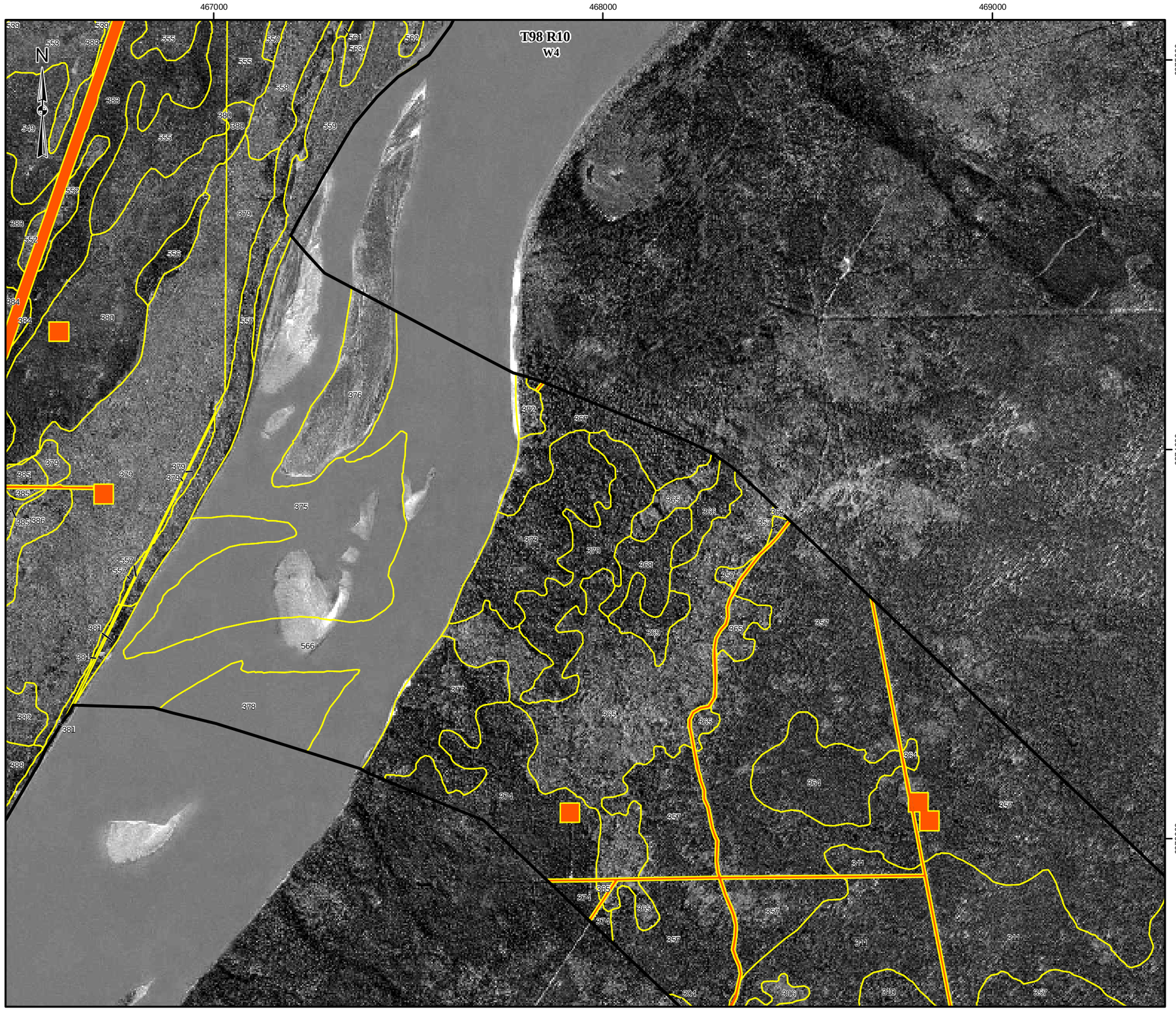
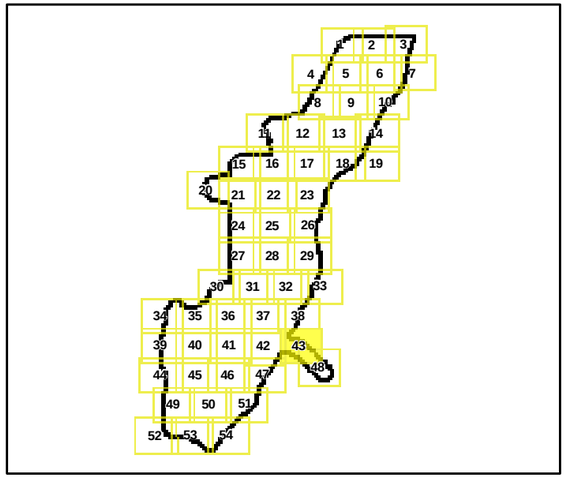


LEGEND

- PIERRE RIVER MINING AREA LOCAL STUDY AREA
- AVI POLYGON

DISTURBED

- EXISTING URBAN AND INDUSTRIAL DISTURBANCE



REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2005-2006), used under license.
Imagery (Orthophoto) obtained from Shell Canada (August 2005).
Projection: UTM Zone 12 Datum: NAD 83

300 0 300

SCALE 1:10,000 METRES

PROJECT

JACKPINE MINE EXPANSION &
PIERRE RIVER MINE PROJECT

TITLE

ALBERTA VEGETATION INVENTORY
POLYGON MAP: MAP 43 OF 54

Shell Canada Limited

PROJECT No. 05-1344-027.7600			SCALE AS SHOWN	REV. 0	
DESIGN	VR	18 Jan. 2007	FIGURE: P-43		
GIS	WZ	16 Nov. 2007			
CHECK	AA	15 Nov. 2007			
REVIEW	TC	16 Nov. 2007			

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457000
458000
459000
6373000
6372000
6371000
T98 R11
W4
N

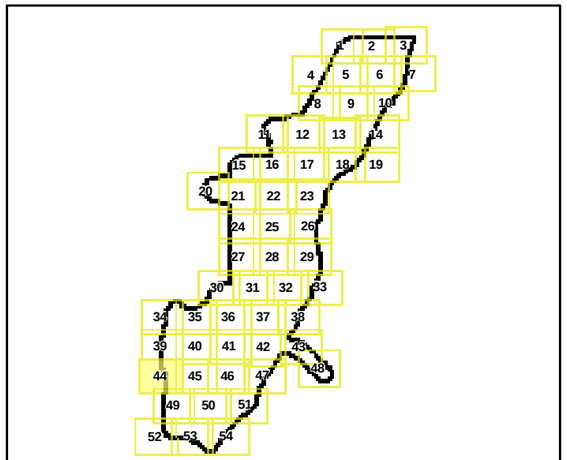
LEGEND

PIERRE RIVER MINING AREA LOCAL STUDY AREA

AVI POLYGON

DISTURBED

EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE



REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2005-2006), used under license.
Imagery (Orthophoto) obtained from Shell Canada (August 2005).
Projection: UTM Zone 12 Datum: NAD 83

300 0 300
SCALE 1:10,000 METRES

PROJECT
JACKPINE MINE EXPANSION &
PIERRE RIVER MINE PROJECT

TITLE
ALBERTA VEGETATION INVENTORY
POLYGON MAP: MAP 44 OF 54

Shell Canada Limited

PROJECT No. 05-1344-027.7600			SCALE AS SHOWN	REV. 0
DESIGN	VR	18 Jan. 2007	FIGURE: P-44	
GIS	WZ	16 Nov. 2007		
CHECK	AA	15 Nov. 2007		
REVIEW	TC	16 Nov. 2007		

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459000

460000

461000

T98 R11
W4

6372000

6371000

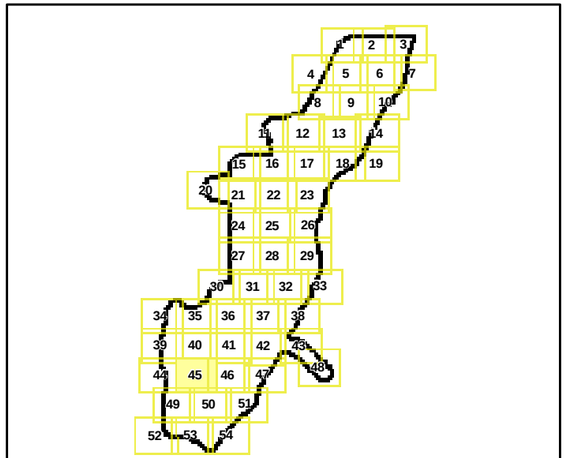
LEGEND

PIERRE RIVER MINING AREA LOCAL STUDY AREA

AVI POLYGON

DISTURBED

EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE



REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2005-2006), used under license.
Imagery (Orthophoto) obtained from Shell Canada (August 2005).
Projection: UTM Zone 12 Datum: NAD 83

300 0 300

SCALE 1:10,000 METRES

PROJECT

JACKPINE MINE EXPANSION &
PIERRE RIVER MINE PROJECT

TITLE

ALBERTA VEGETATION INVENTORY
POLYGON MAP: MAP 45 OF 54

Shell Canada Limited

PROJECT No. 05-1344-027.7600			SCALE AS SHOWN	REV. 0
DESIGN	VR	18 Jan. 2007	FIGURE: P-45	
GIS	WZ	16 Nov. 2007		
CHECK	AA	15 Nov. 2007		
REVIEW	TC	16 Nov. 2007		

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462000
463000
464000
6373000
6372000
6371000

T98 R11 W4
T98 R10 W4

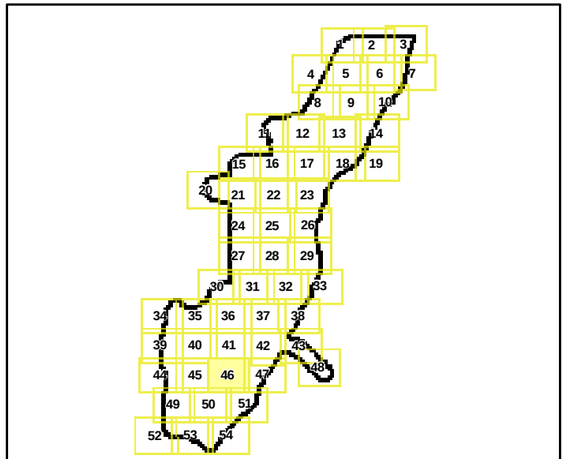
N

LEGEND

PIERRE RIVER MINING AREA LOCAL STUDY AREA
AVI POLYGON

DISTURBED

EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE



REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2005-2006), used under license.
Imagery (Orthophoto) obtained from Shell Canada (August 2005).
Projection: UTM Zone 12 Datum: NAD 83

300 0 300
SCALE 1:10,000 METRES

PROJECT
JACKPINE MINE EXPANSION &
PIERRE RIVER MINE PROJECT

TITLE
ALBERTA VEGETATION INVENTORY
POLYGON MAP: MAP 46 OF 54

Shell Canada Limited

PROJECT No. 05-1344-027.7600			SCALE AS SHOWN	REV. 0
DESIGN	VR	18 Jan. 2007	FIGURE: P-46	
GIS	WZ	16 Nov. 2007		
CHECK	AA	15 Nov. 2007		
REVIEW	TC	16 Nov. 2007		

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464000 465000 466000

6373000 6372000 6371000

T98 R10
W4

N

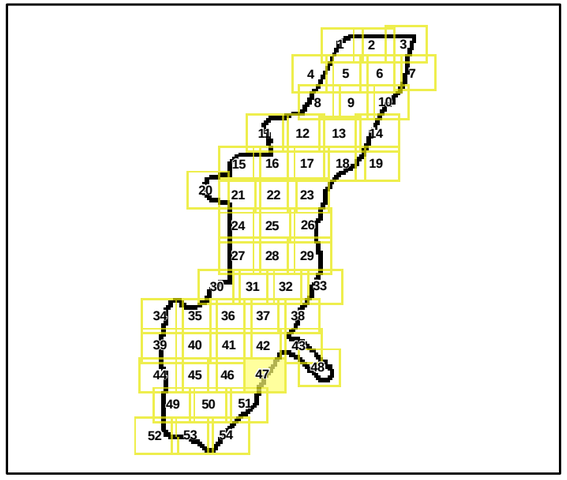
LEGEND

PIERRE RIVER MINING AREA LOCAL STUDY AREA

AVI POLYGON

DISTURBED

EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE



REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2005-2006), used under license.
Imagery (Orthophoto) obtained from Shell Canada (August 2005).
Projection: UTM Zone 12 Datum: NAD 83

300 0 300

SCALE 1:10,000 METRES

PROJECT

JACKPINE MINE EXPANSION &
PIERRE RIVER MINE PROJECT

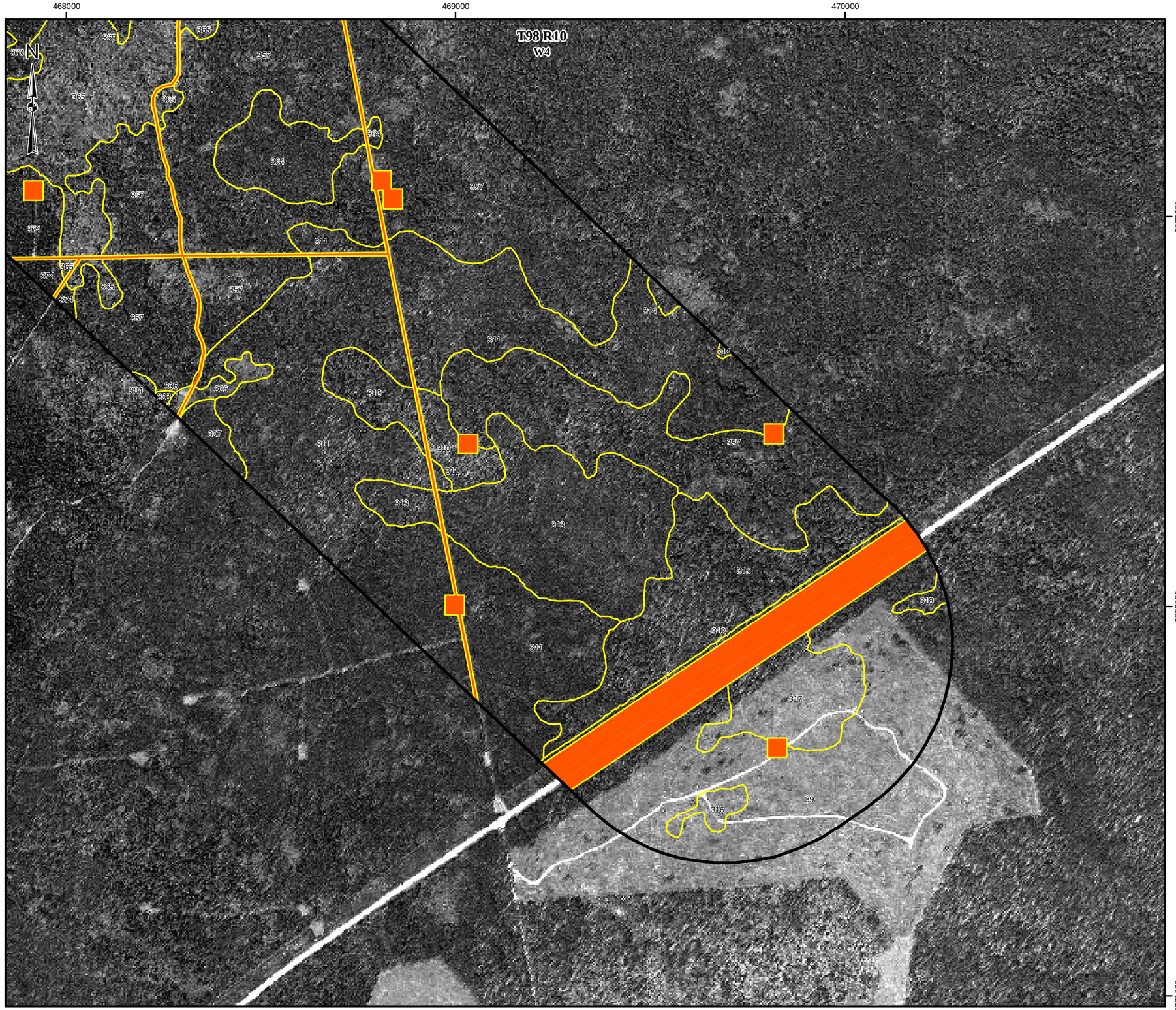
TITLE

ALBERTA VEGETATION INVENTORY
POLYGON MAP: MAP 47 OF 54

Shell Canada Limited

PROJECT No. 05-1344-027.7600			SCALE AS SHOWN	REV. 0
DESIGN	VR	18 Jan. 2007		
GIS	WZ	16 Nov. 2007		
CHECK	AA	15 Nov. 2007	FIGURE: P-47	
REVIEW	TC	16 Nov. 2007		

I:\CLIENTS\SHELL\05-1344-027\mapping\mxd\Forestry\DRAFT\pierreriver\PR_AVI_template_working_Map47.mxd

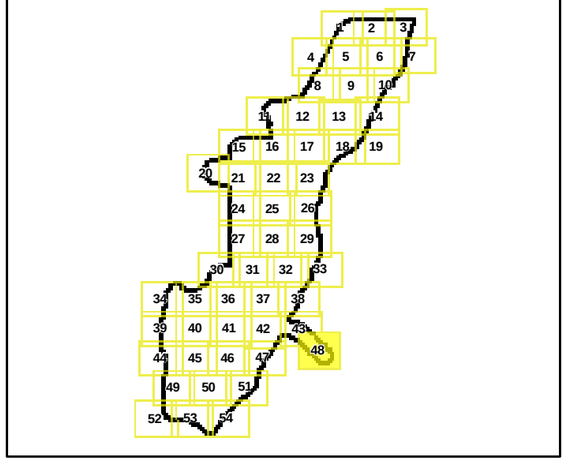


LEGEND

- PIERRE RIVER MINING AREA LOCAL STUDY AREA
- AVI POLYGON

DISTURBED

- EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE



REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2005-2006), used under license.
Imagery (Orthophoto) obtained from Shell Canada (August 2005).
Projection: UTM Zone 12 Datum: NAD 83

300 0 300
SCALE 1:10,000 METRES

PROJECT
JACKPINE MINE EXPANSION &
PIERRE RIVER MINE PROJECT

TITLE
ALBERTA VEGETATION INVENTORY
POLYGON MAP: MAP 48 OF 54

Shell Canada Limited

PROJECT No. 05-1344-027.7600			SCALE AS SHOWN	REV. 0
DESIGN	VR	18 Jan. 2007		
GIS	WZ	16 Nov. 2007		
CHECK	AA	15 Nov. 2007		
REVIEW	TC	16 Nov. 2007		

FIGURE: P-48

I:\CLIENTS\SHELL\05-1344-027\mapping\mxd\Forestry\DRAFT\pierreriver\PR_AVI_template_working_Map48.mxd

458000

459000

460000

6370000

6369000

T98 R11
W4

T97 R11
W4

N

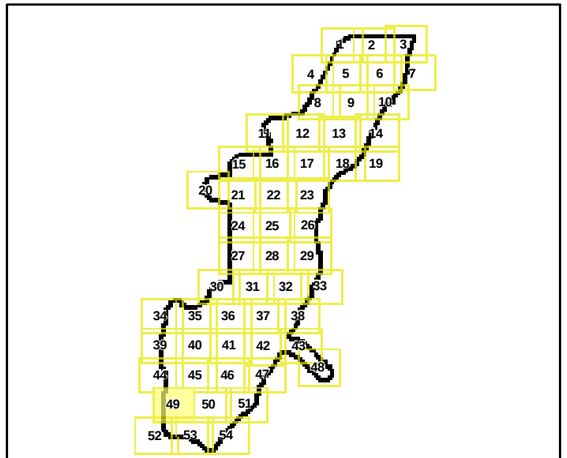
LEGEND

PIERRE RIVER MINING AREA LOCAL STUDY AREA

AVI POLYGON

DISTURBED

EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE



REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2005-2006), used under license.
Imagery (Orthophoto) obtained from Shell Canada (August 2005).
Projection: UTM Zone 12 Datum: NAD 83

300 0 300

SCALE 1:10,000 METRES

PROJECT

JACKPINE MINE EXPANSION &
PIERRE RIVER MINE PROJECT

TITLE

ALBERTA VEGETATION INVENTORY
POLYGON MAP: MAP 49 OF 54

Shell Canada Limited

PROJECT No. 05-1344-027.7600			SCALE AS SHOWN	REV. 0
DESIGN	VR	18 Jan. 2007	FIGURE: P-49	
GIS	WZ	16 Nov. 2007		
CHECK	AA	15 Nov. 2007		
REVIEW	TC	16 Nov. 2007		

I:\CLIENTS\SHELL\05-1344-027\mapping\mxd\Forestry\DRAFT\pierreriver\PR_AVI_template_working_Map49.mxd

460000

461000

462000

6370000

6369000

T98 R11
W4

T98 R10
W4

T97 R11
W4

T97 R10
W4

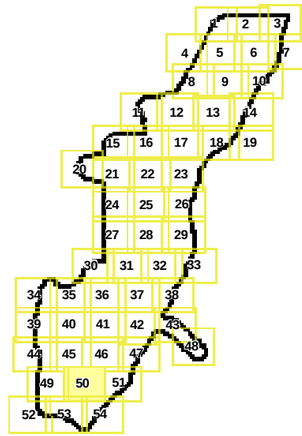
LEGEND

PIERRE RIVER MINING AREA LOCAL STUDY AREA

AVI POLYGON

DISTURBED

EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE



REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2005-2006), used under license.
Imagery (Orthophoto) obtained from Shell Canada (August 2005).
Projection: UTM Zone 12 Datum: NAD 83

300 0 300

SCALE 1:10,000 METRES

PROJECT

JACKPINE MINE EXPANSION &
PIERRE RIVER MINE PROJECT

TITLE

ALBERTA VEGETATION INVENTORY
POLYGON MAP: MAP 50 OF 54

Shell Canada Limited

PROJECT No. 05-1344-027.7600			SCALE AS SHOWN	REV. 0
DESIGN	VR	18 Jan. 2007	FIGURE: P-50	
GIS	WZ	16 Nov. 2007		
CHECK	AA	15 Nov. 2007		
REVIEW	TC	16 Nov. 2007		

I:\CLIENTS\SHELL\05-1344-027\mapping\mxd\Forestry\DRAFT\pierreriver\PR_AVI_template_working_Map50.mxd

463000

464000

465000

6370000

6369000

T98 R10
W4

T97 R10
W4

N

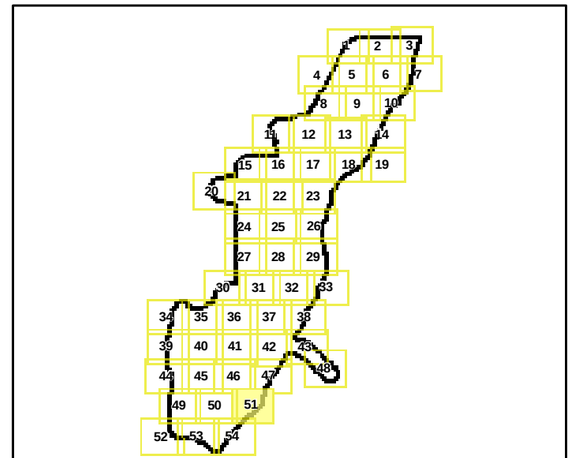
LEGEND

PIERRE RIVER MINING AREA LOCAL STUDY AREA

AVI POLYGON

DISTURBED

EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE



REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2005-2006), used under license.
Imagery (Orthophoto) obtained from Shell Canada (August 2005).
Projection: UTM Zone 12 Datum: NAD 83

300 0 300

SCALE 1:10,000 METRES

PROJECT

JACKPINE MINE EXPANSION &
PIERRE RIVER MINE PROJECT

TITLE

ALBERTA VEGETATION INVENTORY
POLYGON MAP: MAP 51 OF 54

Shell Canada Limited

PROJECT No. 05-1344-027.7600			SCALE AS SHOWN	REV. 0
DESIGN	VR	18 Jan. 2007		
GIS	WZ	16 Nov. 2007		
CHECK	AA	15 Nov. 2007		
REVIEW	TC	16 Nov. 2007		

FIGURE: P-51

I:\CLIENTS\SHELL\05-1344-027\mapping\mxd\Forestry\DRAFT\pierreriver\PR_AVI_template_working_Map51.mxd

457000

458000

459000

6368000

6367000

T97 R11
W4

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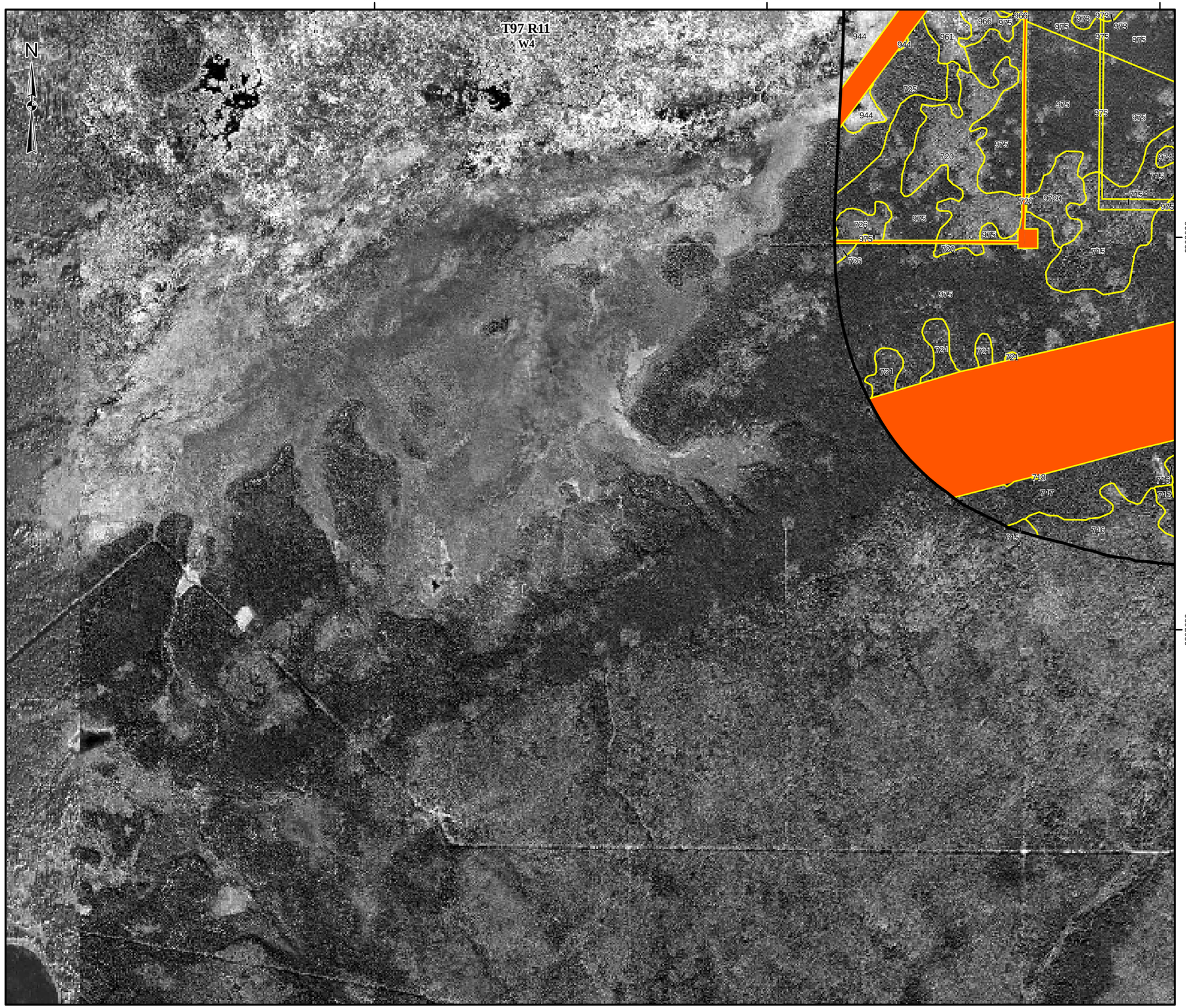

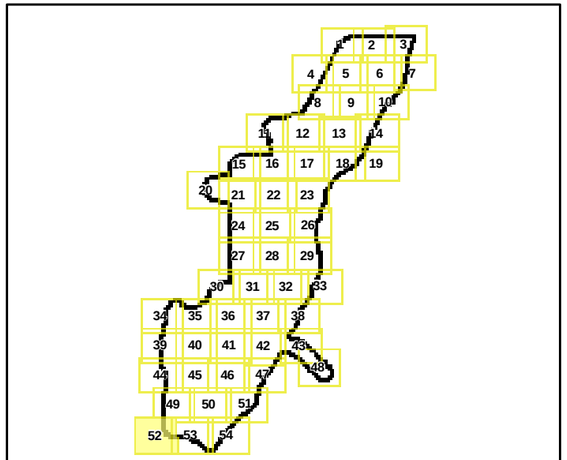

LEGEND

- PIERRE RIVER MINING AREA LOCAL STUDY AREA
- AVI POLYGON

DISTURBED

- EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE

REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2005-2006), used under license.
Imagery (Orthophoto) obtained from Shell Canada (August 2005).
Projection: UTM Zone 12 Datum: NAD 83

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SCALE 1:10,000 METRES

PROJECT

JACKPINE MINE EXPANSION &
PIERRE RIVER MINE PROJECT

TITLE

ALBERTA VEGETATION INVENTORY
POLYGON MAP: MAP 52 OF 54

Shell Canada Limited

PROJECT No. 05-1344-027.7600			SCALE AS SHOWN	REV. 0
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GIS	WZ	16 Nov. 2007		
CHECK	AA	15 Nov. 2007		
REVIEW	TC	16 Nov. 2007		

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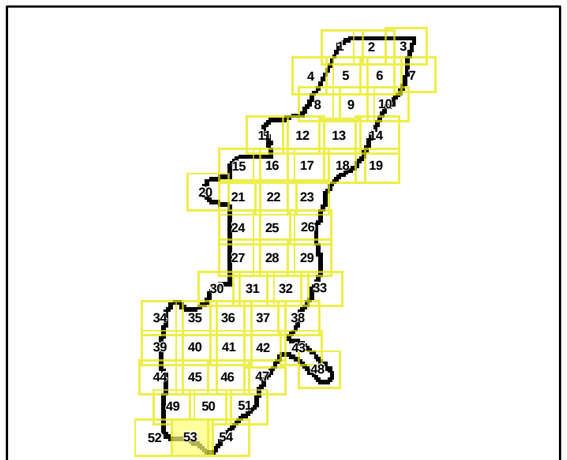
LEGEND

- PIERRE RIVER MINING AREA LOCAL STUDY AREA
- AVI POLYGON

DISTURBED

- EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE



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Projection: UTM Zone 12 Datum: NAD 83

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SCALE 1:10,000 METRES

PROJECT

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PIERRE RIVER MINE PROJECT

TITLE

ALBERTA VEGETATION INVENTORY
POLYGON MAP: MAP 53 OF 54

Shell Canada Limited

PROJECT No. 05-1344-027.7600			SCALE AS SHOWN	REV. 0
DESIGN	VR	18 Jan. 2007		
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FIGURE: P-53

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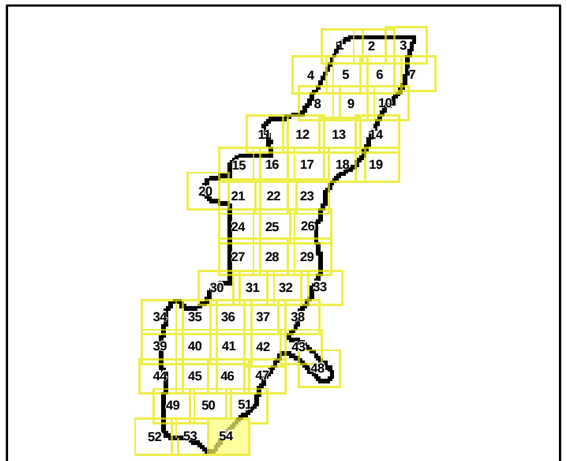
LEGEND

PIERRE RIVER MINING AREA LOCAL STUDY AREA

AVI POLYGON

DISTURBED

EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE



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Projection: UTM Zone 12 Datum: NAD 83

300 0 300

SCALE 1:10,000 METRES

PROJECT

JACKPINE MINE EXPANSION &
PIERRE RIVER MINE PROJECT

TITLE

ALBERTA VEGETATION INVENTORY
POLYGON MAP: MAP 54 OF 54

Shell Canada Limited

PROJECT No. 05-1344-027.7600			SCALE AS SHOWN	REV. 0
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APPENDIX Q

ALBERTA VEGETATION INVENTORY TIMBER VOLUME LOOK-UP TABLE

Submitted to:
Shell Canada Limited

Prepared by:
Golder Associates Ltd.

December 2007 **05-1344-027**

50 BEST EMPLOYERS IN CANADA 2007

CANADA'S 50 BEST MANAGED PRIVATE COMPANIES

OFFICES ACROSS NORTH AMERICA, SOUTH AMERICA, EUROPE, ASIA AND AUSTRALIA

LIST OF TABLES

Table Q-1 Alberta Vegetation Inventory Timber Volume Look-Up Table 1

Table Q-1 Alberta Vegetation Inventory Timber Volume Look-Up Table

Attributes		Coniferous (≥80%) [m^3]			Deciduous (≥80%) [m^3]			Mixedwood [m^3]					
								Coniferous Dominated			Deciduous Dominated		
Height [m]	Crown[a]	C[b]	D[c]	Total	C[b]	D[c]	Total	C[b]	D[c]	Total	C[b]	D[c]	Total
0	a	0	0	0	0	1	1	0	0	0	1	1	2
0	b	0	0	0	0	2	2	0	0	0	1	1	2
0	c	0	0	0	0	3	3	0	0	0	1	2	3
0	d	1	0	1	0	3	3	0	0	0	1	3	4
1	a	0	0	0	0	1	1	0	0	0	1	1	2
1	b	0	0	0	0	2	2	0	0	0	1	2	3
1	c	1	0	1	1	4	5	0	0	0	2	2	4
1	d	1	0	1	0	4	4	1	0	1	2	3	5
2	a	0	0	0	0	2	2	0	0	0	1	1	2
2	b	1	0	1	0	3	3	1	0	1	1	2	3
2	c	1	0	1	1	5	6	1	0	1	2	3	5
2	d	1	0	1	0	5	5	1	0	1	2	4	6
3	a	1	0	1	0	2	2	1	0	1	1	2	3
3	b	1	0	1	1	3	4	1	1	2	2	2	4
3	c	1	0	1	1	5	6	1	1	2	2	4	6
3	d	2	0	2	1	6	7	1	1	2	3	4	7
4	a	4	1	5	0	2	2	1	2	3	1	2	3
4	b	4	1	5	1	4	5	2	2	4	2	3	5
4	c	7	2	9	1	6	7	3	3	6	3	4	7
4	d	11	1	12	1	7	8	4	2	6	4	5	9
5	a	7	1	8	1	3	4	3	4	7	3	2	5
5	b	8	2	10	1	5	6	3	3	6	2	3	5
5	c	13	4	17	1	8	9	7	5	12	7	5	12
5	d	21	2	23	1	11	12	8	5	13	7	6	13
6	a	11	2	13	1	3	4	4	6	10	4	3	7
6	b	11	3	14	1	5	6	5	5	10	3	4	7
6	c	20	6	26	1	12	13	10	8	18	10	6	16
6	d	31	3	34	2	16	18	12	7	19	11	7	18
7	a	14	3	17	1	4	5	5	8	13	5	3	8
7	b	15	4	19	1	6	7	6	7	13	4	4	8
7	c	27	8	35	1	15	16	13	10	23	13	7	20
7	d	42	3	45	2	22	24	16	10	26	14	8	22
8	a	18	3	21	1	5	6	6	10	16	7	4	11
8	b	19	4	23	1	7	8	8	9	17	5	5	10
8	c	33	10	43	2	19	21	16	13	29	17	8	25
8	d	52	4	56	3	27	30	20	12	32	18	10	28
9	a	22	4	26	1	6	7	8	11	19	8	4	12
9	b	23	5	28	2	9	11	9	10	19	6	6	12
9	c	40	11	51	2	23	25	20	16	36	20	10	30
9	d	63	5	68	4	32	36	24	14	38	22	12	34
10	a	30	6	36	2	10	12	19	18	37	9	6	15
10	b	36	9	45	2	14	16	21	18	39	10	8	18
10	c	57	14	71	3	33	36	34	23	57	23	17	40
10	d	82	7	89	4	42	46	38	23	61	23	16	39
11	a	39	8	47	3	13	16	31	25	56	11	10	21
11	b	49	12	61	3	20	23	32	26	58	13	12	25

Table Q-1 Alberta Vegetation Inventory Timber Volume Look-Up Table (continued)

Attributes		Coniferous (≥80%) [m^3]			Deciduous (≥80%) [m^3]			Mixedwood [m^3]					
								Coniferous Dominated			Deciduous Dominated		
Height [m]	Crown[a]	C[b]	D[c]	Total	C[b]	D[c]	Total	C[b]	D[c]	Total	C[b]	D[c]	Total
11	c	74	17	91	5	43	48	48	31	79	26	24	50
11	d	102	9	111	5	52	57	52	31	83	25	24	49
12	a	47	9	56	4	17	21	42	32	74	12	13	25
12	b	62	15	77	4	26	30	43	34	77	16	16	32
12	c	91	20	111	6	53	59	63	39	102	30	31	61
12	d	122	10	132	6	62	68	67	39	106	27	32	59
13	a	56	11	67	4	21	25	54	39	93	14	16	30
13	b	75	18	93	5	31	36	55	42	97	19	20	39
13	c	108	22	130	7	63	70	77	47	124	33	38	71
13	d	141	12	153	7	72	79	81	48	129	29	40	69
14	a	64	13	77	5	24	29	65	46	111	16	19	35
14	b	88	21	109	6	37	43	66	50	116	22	24	46
14	c	125	25	150	9	74	83	91	55	146	36	45	81
14	d	161	14	175	7	81	88	96	56	152	31	48	79
15	a	73	14	87	6	28	34	77	53	130	17	22	39
15	b	100	25	125	7	42	49	77	58	135	25	28	53
15	c	142	28	170	10	84	94	105	63	168	39	52	91
15	d	180	16	196	8	91	99	110	64	174	32	56	88
16	a	79	21	100	7	33	40	82	57	139	20	27	47
16	b	111	28	139	8	53	61	86	64	150	29	35	64
16	c	155	31	186	12	95	107	117	72	189	44	60	104
16	d	192	21	213	9	105	114	124	74	198	40	70	110
17	a	86	27	113	8	39	47	87	61	148	23	33	56
17	b	122	31	153	10	64	74	95	70	165	33	42	75
17	c	168	35	203	14	107	121	128	82	210	49	69	118
17	d	203	27	230	11	119	130	138	83	221	48	84	132
18	a	92	34	126	9	44	53	93	65	158	26	38	64
18	b	132	34	166	12	74	86	104	76	180	38	50	88
18	c	181	39	220	16	119	135	140	92	232	54	77	131
18	d	215	32	247	12	132	144	152	93	245	56	98	154
19	a	98	40	138	9	50	59	98	70	168	28	43	71
19	b	143	37	180	14	85	99	113	82	195	42	57	99
19	c	193	42	235	18	130	148	151	102	253	58	86	144
19	d	226	37	263	13	146	159	166	102	268	63	112	175
20	a	105	46	151	10	55	65	103	74	177	31	48	79
20	b	154	40	194	15	95	110	122	88	210	46	65	111
20	c	206	46	252	20	142	162	163	111	274	63	95	158
20	d	238	43	281	14	160	174	179	112	291	71	126	197
21	a	111	53	164	11	60	71	109	78	187	34	54	88
21	b	164	43	207	17	106	123	131	93	224	50	72	122
21	c	219	49	268	22	154	176	174	121	295	68	103	171
21	d	249	48	297	15	174	189	193	122	315	79	140	219
22	a	115	54	169	12	61	73	108	76	184	35	51	86
22	b	167	44	211	18	105	123	133	91	224	51	73	124
22	c	222	50	272	25	155	180	174	123	297	69	104	173

Table Q-1 Alberta Vegetation Inventory Timber Volume Look-Up Table (continued)

Attributes		Coniferous (≥80%) [m^3]			Deciduous (≥80%) [m^3]			Mixedwood [m^3]					
								Coniferous Dominated			Deciduous Dominated		
Height [m]	Crown[a]	C[b]	D[c]	Total	C[b]	D[c]	Total	C[b]	D[c]	Total	C[b]	D[c]	Total
22	d	256	49	305	18	173	191	195	133	328	77	138	215
23	a	119	55	174	13	63	76	107	73	180	35	49	84
23	b	171	46	217	20	104	124	135	90	225	52	74	126
23	c	225	52	277	27	157	184	174	125	299	69	105	174
23	d	262	50	312	21	172	193	196	145	341	75	136	211
24	a	123	56	179	15	64	79	107	71	178	36	47	83
24	b	174	47	221	21	103	124	137	88	225	53	75	128
24	c	228	53	281	29	158	187	174	127	301	70	105	175
24	d	268	51	319	24	172	196	197	156	353	73	134	207
25	a	127	57	184	16	65	81	106	68	174	36	44	80
25	b	177	49	226	23	102	125	139	86	225	53	76	129
25	c	230	54	284	31	159	190	174	129	303	71	106	177
25	d	275	51	326	27	171	198	198	168	366	70	132	202
26	a	131	58	189	17	66	83	105	66	171	37	42	79
26	b	180	50	230	24	102	126	141	84	225	54	77	131
26	c	233	55	288	34	161	195	174	131	305	72	106	178
26	d	281	52	333	30	170	200	199	180	379	68	130	198
27	a	135	59	194	18	67	85	105	63	168	38	40	78
27	b	183	52	235	26	101	127	143	82	225	55	78	133
27	c	236	56	292	36	162	198	174	133	307	73	107	180
27	d	288	53	341	33	170	203	200	191	391	66	128	194
28	a	133	59	192	18	66	84	104	58	162	38	38	76
28	b	181	52	233	25	99	124	142	78	220	55	76	131
28	c	235	54	289	37	166	203	171	130	301	74	105	179
28	d	277	44	321	37	141	178	202	159	361	67	107	174
29	a	131	58	189	18	66	84	104	53	157	39	37	76
29	b	179	52	231	25	96	121	140	75	215	55	74	129
29	c	234	52	286	37	169	206	168	128	296	75	103	178
29	d	267	35	302	42	113	155	203	128	331	67	86	153
30	a	129	58	187	17	65	82	104	48	152	40	36	76
30	b	176	51	227	25	94	119	139	71	210	55	73	128
30	c	234	50	284	38	172	210	165	125	290	75	101	176
30	d	257	27	284	46	85	131	205	96	301	68	64	132
31	a	127	58	185	17	65	82	103	43	146	41	35	76
31	b	174	51	225	24	92	116	138	68	206	55	71	126
31	c	233	48	281	38	176	214	162	122	284	76	99	175
31	d	246	18	264	51	57	108	207	64	271	68	43	111
32	a	125	57	182	17	64	81	103	38	141	41	33	74
32	b	171	51	222	24	90	114	137	65	202	56	69	125
32	c	232	45	277	39	179	218	159	120	279	77	97	174
32	d	236	9	245	56	28	84	208	32	240	69	21	90
33	a	123	57	180	16	64	80	102	32	134	42	32	74
33	b	169	51	220	24	87	111	135	61	196	56	67	123
33	c	231	43	274	39	183	222	156	117	273	78	96	174
33	d	225	0	225	60	0	60	210	0	210	69	0	69

Table Q-1 Alberta Vegetation Inventory Timber Volume Look-Up Table (continued)

Attributes		Coniferous (≥80%) [m^3]			Deciduous (≥80%) [m^3]			Mixedwood [m^3]					
								Coniferous Dominated			Deciduous Dominated		
Height [m]	Crown[a]	C[b]	D[c]	Total	C[b]	D[c]	Total	C[b]	D[c]	Total	C[b]	D[c]	Total
34	a	0	0	0	0	0	0	0	0	0	0	0	0
34	b	0	0	0	0	0	0	0	0	0	0	0	0
34	c	0	0	0	0	0	0	0	0	0	0	0	0
34	d	0	0	0	0	0	0	0	0	0	0	0	0
35	a	0	0	0	0	0	0	0	0	0	0	0	0
35	b	0	0	0	0	0	0	0	0	0	0	0	0
35	c	0	0	0	0	0	0	0	0	0	0	0	0
35	d	0	0	0	0	0	0	0	0	0	0	0	0

[a] Crown closure classes: a = 6 to 30%; b = 31 to 50%; c = 51 to 70%; d = 71 to 100%.

[b] C = Coniferous.

[c] D = Deciduous.

Note: This Volume Look-Up table is supplied by Alberta Sustainable Resource Development for use in Timber Damage Assessments (ASRD 2007c, website).

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WILDLIFE AND WILDLIFE HABITAT ENVIRONMENTAL SETTING FOR THE JACKPINE MINE EXPANSION & PIERRE RIVER MINE PROJECT

Prepared for
Shell Canada Limited

Prepared by:
Golder Associates Ltd.

December 2007 **05-1344-027**

50 BEST EMPLOYERS IN CANADA 2007

CANADA'S 50 BEST MANAGED PRIVATE COMPANIES

OFFICES ACROSS NORTH AMERICA, SOUTH AMERICA, EUROPE, ASIA AND AUSTRALIA

TABLE OF CONTENTS

SECTION **PAGE**

5 WILDLIFE AND WILDLIFE HABITAT 1
5.1 INTRODUCTION 1
5.1.1 Study Objectives 1
5.1.2 Study Areas 2
5.2 METHODS 6
5.2.1 Environmental Setting Surveys 6
5.2.2 Field Methods and Data Analysis 25
5.2.3 Traditional Knowledge 36
5.2.4 Incidental Wildlife Sightings 36
5.2.5 Regional Data 37
5.2.6 Important Wildlife Habitat 37
5.2.7 Species of Concern 37
5.3 RESULTS – MAMMALS 39
5.3.1 Ungulates 39
5.3.2 Canids 55
5.3.3 Felids (Cats) 66
5.3.4 Bears 71
5.3.5 Terrestrial Mustelids (Weasel Family) 75
5.3.6 Semi-Aquatic Rodents 87
5.3.7 Bats 90
5.4 RESULTS – BIRDS 96
5.4.1 Marsh Birds 96
5.4.2 Waterfowl 99
5.4.3 Owls 104
5.4.4 Breeding Bird Communities 109
5.5 RESULTS – AMPHIBIANS AND REPTILES 131
5.5.1 Amphibians 131
5.5.2 Reptiles 139
5.6 RESULTS – IMPORTANT WILDLIFE HABITAT 139
5.6.1 Wildlife Species Diversity 139
5.6.2 Important Wildlife Areas 140
5.6.3 Wildlife Movement Corridors 141
5.7 REGIONAL INITIATIVES 146
5.8 SPECIES AND COMMUNITIES OF CONCERN 151
5.8.1 Wildlife Key Indicator Species 151
5.8.2 Species of Concern in and Adjacent to the Local Study Areas 151
5.9 SUMMARY 178

LIST OF TABLES

Table 5.2-1 Field Methods Information Sources 7
Table 5.2-2 Wildlife Surveys Conducted in the Local Study Areas 7
Table 5.2-3 Vegetation Types Sampled During the Winter Track Count Surveys on the Project Local Study Areas 29
Table 5.2-4 AnaBat Analysis Categories 36
Table 5.2-5 Cumulative Environmental Management Association Priority Indicators for Wildlife Environmental Setting Description 38

Table 5.2-6 Wildlife Key Indicator Resources Selected for the Wildlife Environmental Setting Description....39
Table 5.3-1 Moose Observations Recorded During the Aerial Survey by Vegetation Type....46
Table 5.3-2 Species-Specific Ecosite Phase and Wetlands Type Preferences and Avoidances as Determined During Winter Track Surveys in the Subregional Study Area, 1997 to 2007....47
Table 5.3-3 Survey Effort and Capture Success for Ecosite Phases and Wetlands Types Sampled During Bat Surveys in the Jackpine Expansion Mining Area Local Study Area....91
Table 5.3-4 Number of Plots in Which Bat Species Were Detected in the Jackpine Expansion Mining Area Local Study Area....91
Table 5.3-5 Number of Passes and Feeding Buzzes Produced by Small and Large Bat Species Groups in the Jackpine Expansion Mining Area Local Study Area....92
Table 5.3-6 Survey Effort and Capture Success for Ecosite Phases and Wetlands Types Sampled During Bat Surveys in the Pierre River Mining Area Local Study Area....93
Table 5.3-7 Number of Plots in Which Bat Species Were Detected in the Pierre River Mining Area Local Study Area....94
Table 5.3-8 Number of Passes and Feeding Buzzes Produced by Small and Large Bat Species Groups in the Pierre River Mining Area Local Study Area....95
Table 5.4-1 Marshbirds Detected by Ecosite Phases and Wetlands Types in the Jackpine Expansion and Pierre River Mining Areas Local Study Areas....98
Table 5.4-2 Waterfowl Density on Watercourses During Aerial Surveys in the Jackpine Expansion Mining Area Local Study Area....100
Table 5.4-3 Waterfowl Density on Waterbodies During Aerial Surveys in the Jackpine Expansion Mining Area Local Study Area....100
Table 5.4-4 Waterfowl and Waterbird Observations During Spring Aerial Surveys in the Jackpine Expansion Mining Area Local Study Area....101
Table 5.4-5 Waterfowl Density on Watercourses During Aerial Surveys in the Pierre River Mining Area Local Study Area....102
Table 5.4-6 Waterfowl Density on Waterbodies During Aerial Surveys in the Pierre River Mining Area Local Study Area....102
Table 5.4-7 Waterfowl and Waterbird Observations During Spring and Fall Aerial Surveys in the Pierre River Mining Area Local Study Area....103
Table 5.4-8 Owl Species Observed in the Jackpine Expansion and Pierre River Mining Areas Local Study Areas, 2006 and 2007....105
Table 5.4-9 Habitat Types of Owl Survey Locations in the Jackpine Expansion and Pierre River Mining Areas Local Study Areas....106
Table 5.4-10 Owls Recorded in the Local Study Areas by Habitat Type....106
Table 5.4-11 Habitat Types of Breeding Bird Point Counts in the in the Jackpine Expansion Mining Area Local Study Area....111
Table 5.4-12 Habitat Types of Breeding Bird Point Counts in the Pierre River Mining Area Local Study Area....111
Table 5.4-13 Breeding Bird Detections and Habitat Types in the Local Study Areas, 2006 to 2007....113
Table 5.4-14 Breeding Bird Species Richness and Diversity by Habitat Type in the Subregional Study Area....117
Table 5.4-15 Two-Way Indicator Species Analyses Grouping and Bird Abundance per 40 Hectares in Terrestrial Habitat Types in the Subregional Study Area....119
Table 5.4-16 Terrestrial Habitat Types Grouped by Two-Way Indicator Species Analysis....122

Table 5.4-17 Two-Way Indicator Species Analysis Grouping and Bird Abundance per 40 Hectares in Wetlands Habitat Types in the Subregional Study Area 125
Table 5.4-18 Wetlands Habitat Types Grouped by Two-Way Indicator Species Analysis 127
Table 5.5-1 Amphibian Detections in Each Survey Period in the Jackpine Expansion Mining Area Local Study Area 132
Table 5.5-2 Amphibian Detections in Each Survey Period in the Pierre River Mining Area Local Study Area 132
Table 5.5-3 Amphibian Chorus Detections by Ecosite Phases and Wetlands Types in the Jackpine Expansion Mining Area Local Study Area 133
Table 5.5-4 Amphibian Chorus Detections by Ecosite Phases and Wetlands Types in the Pierre River Mining Area Local Study Area 134
Table 5.5-5 Amphibian Chorus Detections by Waterbody Type in the Local Study Areas 134
Table 5.5-6 Amphibian Habitat Requirements 136
Table 5.5-7 Waterbody Type, Habitat Groups and Mean Abundance of Boreal Chorus Frogs in the Local Study Areas 137
Table 5.5-8 Waterbody Type, Habitat Groups and Mean Abundance of Wood Frogs in the Local Study Areas 138
Table 5.8-1 Species and Bird Communities of Special Concern Observed Within the Local Study Areas 152

LIST OF FIGURES

Figure 5.1-1 Terrestrial Resources Regional Study Area 3
Figure 5.1-2 Terrestrial Resources Local Study Areas 5
Figure 5.2-1 Photographic Station Locations in the Jackpine Expansion Mining Area Local Study Area 9
Figure 5.2-2 Photographic Station Locations in the Pierre River Mining Area Local Study Area 10
Figure 5.2-3 Winter Track Transect Locations in the Jackpine Expansion Mining Area Local Study Area 11
Figure 5.2-4 Winter Track Transect Locations in the Pierre River Mining Area Local Study Area 12
Figure 5.2-5 Amphibian and Marsh Bird Survey Locations in the Jackpine Expansion Mining Area Local Study Area 13
Figure 5.2-6 Amphibian and Marsh Bird Survey Locations in the Pierre River Mining Area Local Study Area 14
Figure 5.2-7 Breeding Bird Survey Plots in the Jackpine Expansion Mining Area Local Study Area 15
Figure 5.2-8 Breeding Bird Survey Plots in the Pierre River Mining Area Local Study Area 16
Figure 5.2-9 Bat Survey Locations and Capture Results in the Jackpine Expansion Mining Area Local Study Area 17
Figure 5.2-10 Bat Survey Locations and Capture Results in the Pierre River Mining Area Local Study Area 18
Figure 5.2-11 Aerial Survey Routes for Beaver/Muskrat and Waterfowl in the Jackpine Expansion Mining Area Local Study Area 19
Figure 5.2-12 Aerial Survey Routes for Beaver/Muskrat and Waterfowl in the Pierre River Mining Area Local Study Area 20
Figure 5.2-13 Ungulate Aerial Survey Coverage and Observations in the Jackpine Expansion Mining Area Local Study Area 21

Figure 5.2-14 Ungulate Aerial Survey Coverage and Observations in the Pierre River Mining Area Local Study Area 22
Figure 5.2-15 Owl Survey Locations in the Jackpine Expansion Mining Area Local Study Area 23
Figure 5.2-16 Owl Survey Locations in the Pierre River Mining Area Local Study Area 24
Figure 5.3-1 Ungulate Track Locations in the Jackpine Expansion Mining Area Local Study Area 41
Figure 5.3-2 Ungulate Photograph Locations Recorded in the Jackpine Expansion Mining Area Local Study Area 42
Figure 5.3-3 Ungulate Track Locations in the Pierre River Mining Area Local Study Area 44
Figure 5.3-4 Ungulate Photograph Locations Recorded in the Pierre River Mining Area Local Study Area....45
Figure 5.3-5 Canid Track Locations in the Jackpine Expansion Mining Area Local Study Area 58
Figure 5.3-6 Wolf and Lynx Photograph Locations Recorded in the Jackpine Expansion Mining Area Local Study Area 59
Figure 5.3-7 Canid Track Locations in the Pierre River Mining Area Local Study Area 60
Figure 5.3-8 Wolf and Lynx Photograph Locations Recorded in the Pierre River Mining Area Local Study Area....61
Figure 5.3-9 Lynx Track Locations in the Jackpine Expansion Mining Area Local Study Area 67
Figure 5.3-10 Lynx Track Locations in the Pierre River Mining Area Local Study Area....69
Figure 5.3-11 Black Bear Photograph Locations Recorded in the Jackpine Expansion Mining Area Local Study Area 73
Figure 5.3-12 Black Bear Photograph Locations Recorded in the Pierre River Mining Area Local Study Area....74
Figure 5.3-13 Fisher/Marten Track Locations in the Jackpine Expansion Mining Area Local Study Area....79
Figure 5.3-14 Fisher and Marten Photograph Locations Recorded in the Jackpine Expansion Mining Area Local Study Area 80
Figure 5.3-15 Fisher/Marten Track Locations in the Pierre River Mining Area Local Study Area 81
Figure 5.3-16 Fisher, Marten and Wolverine Photograph Locations Recorded in the Pierre River Mining Area Local Study Area....82
Figure 5.4-1 Detrended Correspondence Analysis Plot for Terrestrial Habitats in the Subregional Study Area....129
Figure 5.4-2 Detrended Correspondence Analysis Plot for Wetlands Habitats in the Subregional Study Area....130
Figure 5.6-1 Important Wildlife Areas In and Adjacent to the Local Study Areas....142
Figure 5.7-1 River Corridor Study Areas in the Mineable Oil Sands Area North of Fort McMurray, 2005 to 2007....149
Figure 5.7-2 Photographic Bait Station Study Areas in the Oil Sands Region, 2005 to 2006....150
Figure 5.8-1 Wildlife Species of Concern Observations in and Adjacent to the Terrestrial Local Study Areas – Birds....153
Figure 5.8-2 Wildlife Species of Concern Observations in and Adjacent to the Terrestrial Local Study Areas – Mammals and Canadian Toads....154

LIST OF APPENDICIES

Appendix R Common Names, Scientific Names and Status of Species Observed on the Jackpine Expansion and Pierre River Mining Area Project Local Study Areas
Appendix S Potential and Observed Species of Special Concern
Appendix T Incidental Wildlife Sightings
Appendix U Winter Track Count Results for the Project Local Study Areas
Appendix V Previous Wildlife Survey Results in the Oil Sands Region
Appendix W Photographic Bait Station Data

5 WILDLIFE AND WILDLIFE HABITAT

5.1 INTRODUCTION

This Wildlife and Wildlife Habitat Environmental Setting Report (ESR) complements and extends information collected for Muskeg River Mine (1999), Jackpine Mine – Phase 1 (2002) and Muskeg River Mine Expansion (2006). New data collected for the Shell Jackpine Mine Expansion & Pierre River Mine Project (the Project) combined with the existing information on Shell project areas, other regional information and the project design provide the data required to prepare the Environmental Impact Assessment (EIA) for the Project.

This Wildlife and Wildlife Habitat ESR provides information required to complete the EIA for the Project. Environmental setting information on wildlife, including mammals, birds, and amphibians, is required for the impact assessment, mitigation and monitoring program planning.

Common and scientific names for species mentioned in the text are listed in Appendix R. Potential and observed wildlife species of special concern within the Local Study Areas (LSAs) are listed in Appendix S. All incidental sightings of wildlife are reported in Appendix T. Species that are listed nationally by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC 2007), or provincially by Alberta Sustainable Resource Development (ASRD 2005a) are highlighted. Species of concern observed within the Project LSAs are discussed in detail in Section 5.8. Appendix U provides detailed results of the winter tracking data analysis for all species encountered during field surveys. Appendix V is a compendium of comparative results for all surveys from other field projects conducted in the Oil Sands Region. Appendix W provides detailed results from the photographic bait station and corridor monitoring field programs.

5.1.1 Study Objectives

5.1.1.1 Objectives

The objectives of the Wildlife and Wildlife Habitat ESR include:

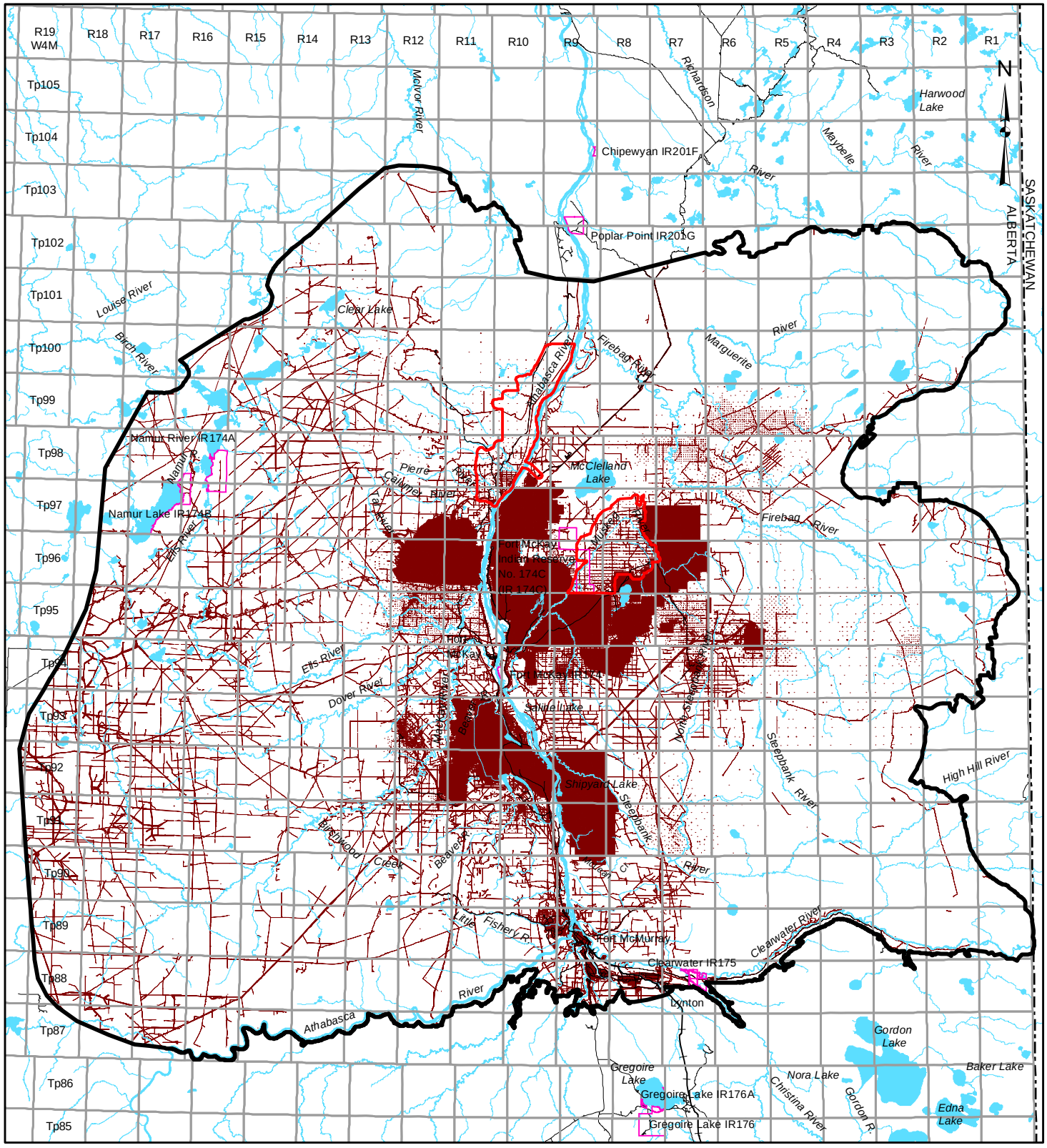
- assess wildlife abundance, distribution and habitat use within the Project LSAs;
- identify important wildlife habitat, including local and regional habitat, and if possible, seasonal use and movement corridors; and
- determine the presence of special status (e.g., nationally or provincially listed) wildlife species within the Project LSAs.

5.1.2 Study Areas

The Terrestrial LSAs and Regional Study Area (RSA) were developed with consideration of all terrestrial components (soil and terrain, terrestrial vegetation, wetlands and forest resources, wildlife and wildlife habitat and biodiversity). Therefore, the LSAs and RSA used for this report are also used for all Terrestrial Resources components. The use of the terms LSA and RSA in this report refer to the Terrestrial Resources LSAs or RSA.

The RSA was established to assess the the importance of the Project within a broad regional area (Figure 5.1-1). The RSA is in the Central Mixedwood and the Athabasca Plain Natural Subregions (Natural Regions Committee 2006). These subregions are in the Boreal Natural Region. The RSA covers an area of 2,277,376 ha. The RSA boundary was defined with consideration of the following terrestrial resources:

- ecodistrict boundaries;
- geographic or topographic boundaries such as the eastern shoulder of the Birch Mountains;
- defined woodland caribou habitat areas (e.g., Audet, Firebag and Steepbank caribou areas);
- average distance of two moose home ranges from oil sands developments (about 26 km);
- allowances for the major river systems (e.g., Athabasca and Clearwater rivers) that act as natural study boundaries; and
- inclusion of the community of Fort McMurray and other areas likely to expand in the future.



LEGEND

- TERRESTRIAL RESOURCES REGIONAL STUDY AREA
- LOCAL STUDY AREAS
- INDIAN RESERVE
- OPEN WATER
- PUBLIC ROADWAY
- RAILROAD

DISTURBED

- EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE
- EXISTING AND APPROVED URBAN AND INDUSTRIAL LINEAR DISTURBANCE

25 0 25

SCALE 1:1,000,000 KILOMETRES

REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2004), Pearson Timberline Ltd. (April 2004), LANDSAT 7 ETM Imagery (July 2006), and Alberta SRD, used under license.
Saskatchewan digital data obtained from Information Services Corp. (September 2004), used under license.
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 12.

PROJECT

JACKPINE MINE EXPANSION & PIERRE RIVER MINE PROJECT

TITLE

TERRESTRIAL RESOURCES REGIONAL STUDY AREA

Shell Canada Limited

PROJECT No. 05-1344-027.7700			SCALE AS SHOWN	REV. 0
DESIGN	VR	22 Jan. 2007	FIGURE: 5.1-1	
GIS	JH	14 Nov. 2007		
CHECK	MJ	16 Nov. 2007		
REVIEW	WES/TC	19 Nov. 2007		

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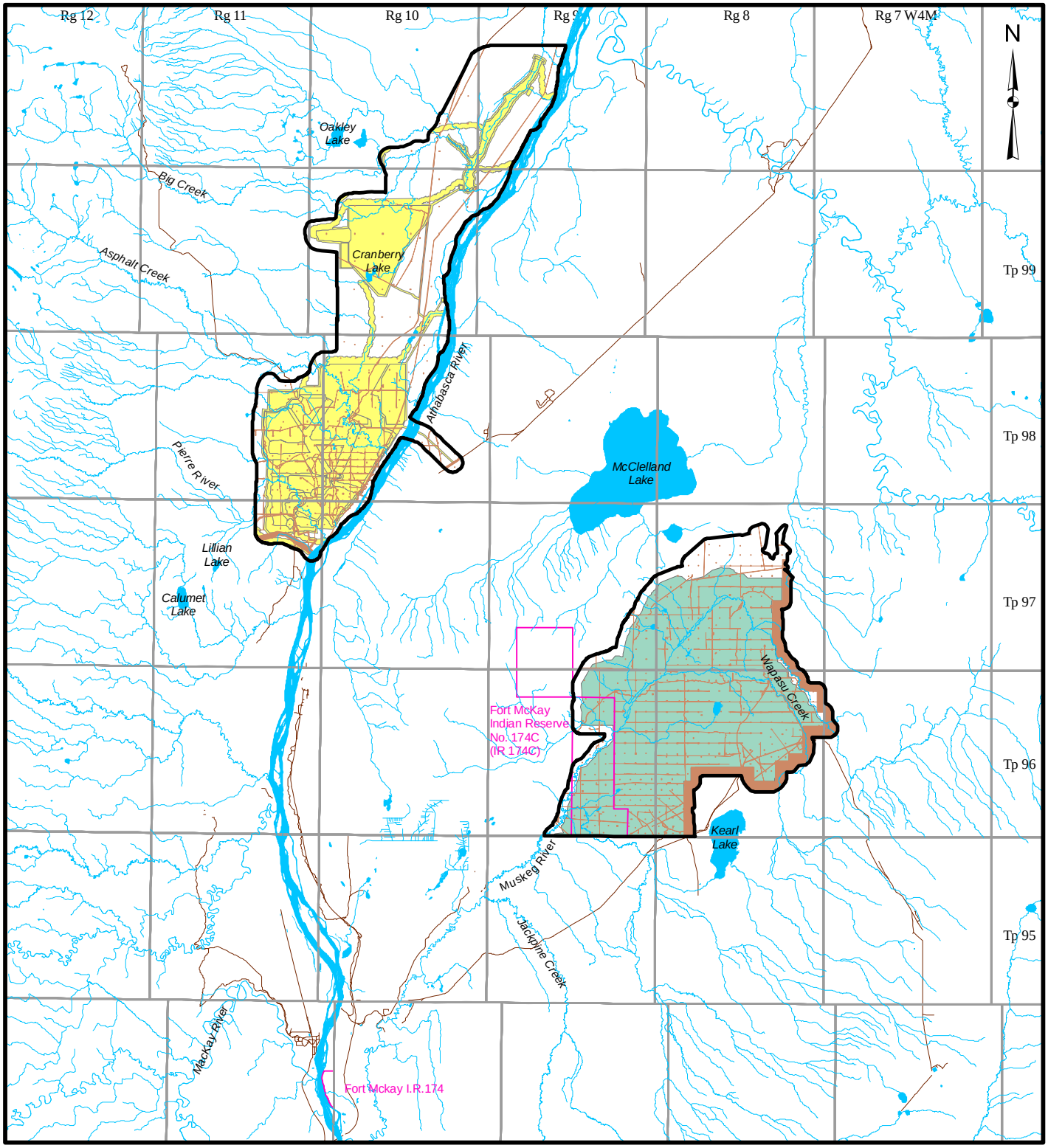
There are two LSAs for the Project (Figure 5.1-2). The Jackpine Expansion Mining Area (JEMA) LSA is located along the Muskeg River north and east of the approved Jackpine Mine – Phase 1 and covers an area of 18,348 ha. The Pierre River Mining Area (PRMA) LSA is located on the west side of the Athabasca River, north of the approved Canadian Natural Resources Limited (Canadian Natural) Horizon Project and covers an area of 21,136 ha.

The JEMA and PRMA LSAs are established to assess the effects of the Project at the local scale. They fall within the Central Mixedwood and Athabasca Plains Natural Subregions (Natural Regions Committee 2006) (Figure 5.1-2) and the following townships:

- Township 96, Ranges 8 and 9, W4M;
- Township 97, Ranges 8 and 11, W4M;
- Township 98, Ranges 10 and 11, W4M;
- Township 99, Range 9, W4M; and
- Township 100, Ranges 9 and 10, W4M.

The extent of the Project LSAs was defined on the basis of the project development area plus a buffer zone to account for indirect effects of the project. This buffer zone is based on a 500 m offset from the Project Development Area but varies in width depending on the configuration of the project footprint, as well as land uses and natural features in the surrounding area. To the east, the JEMA LSA is bounded by Imperial Oil Resources Ventures Limited (Imperial Oil) Kearl Lake Project. To the south, the JEMA LSA abuts the approved Shell Jackpine Mine – Phase 1 footprint. The PRMA LSA is bound by the Athabasca River to the east.



LEGEND

- TERRESTRIAL RESOURCES LOCAL STUDY AREAS
- PIERRE RIVER MINING AREA
- JACKPINE EXPANSION MINING AREA
- INDIAN RESERVE
- OPEN WATER
- PUBLIC ROADWAY

DISTURBED

- EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE
- EXISTING AND APPROVED URBAN AND INDUSTRIAL LINEAR DISTURBANCE

REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2004), and Alberta SRD, used under license.
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 12.

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SCALE 1:325,000 KILOMETRES

PROJECT
JACKPINE MINE EXPANSION & PIERRE RIVER MINE PROJECT

TITLE
TERRESTRIAL RESOURCES LOCAL STUDY AREAS

Shell Canada Limited

PROJECT No. 05-1344-027.7700			SCALE AS SHOWN	REV. 0
DESIGN	VR	03 Aug. 2007	FIGURE: 5.1-2	
GIS	JH	14 Nov. 2007		
CHECK	MJ	16 Nov. 2007		
REVIEW	WES/TC	19 Nov. 2007		

Project: I:\CLIENTS\SHELL\05-1344-027\mapping\mxd\wildlife\DRAFT\lsas_wildlife.mxd - Plot: I:\CLIENTS\SHELL\05-1344-027\mapping\pdf\wildlife\DRAFT\Figs.1-2_lsa_birds_jp_pr.pdf

5.2 METHODS

Information and methods used for the Project are consistent with those used in previous EIAs. Table 5.2-1 provides a cross-reference of this report to other Oil Sands Region EIAs which provide the specific details regarding methods, data analysis and descriptions. Any methods not included in past EIAs are outlined in Section 5.2.2.

Each species or species group is discussed in a distinct section of Section 5.3 (Results). Data used to discuss each species originate from several sources. Data collected in and around the LSAs between 2005 and 2007 are used in the "Population" section for each species or species group in the results section. These data reflect what was recorded currently on surveys specifically conducted in preparation for the Project EIA. Data collected for the JEMA and PRMA LSAs are reported separately.

Habitat associations reported in the "Habitat" sections for each species or species group are based on the cumulative dataset collected by Shell contractors in support of all EIAs and monitoring programs in what has been termed the "subregional study area" in this ESR. These include Muskeg River Mine, Jackpine Mine – Phase 1, Muskeg River Mine Expansion, the Jackpine Mine – Phase 1 Wildlife Monitoring Program and the current Project. In this case, the JEMA and PRMA LSA data are grouped with the rest of the data because habitat associations are not assumed to vary greatly between years.

Information contained in EIAs completed for other projects in the area surrounding the subregional study area described above is used to better determine conditions in the broader landscape around the Project LSAs. Data from these EIAs were collected in similar areas using similar methods, thus provide comparable data for this ESR. These projects include Canadian Natural Horizon Project (CNRL 2002), Deer Creek Energy Joslyn Project and its predecessors (Komex 2005), TrueNorth Fort Hills Project (TrueNorth Energy 2002), Syncrude Canada Ltd. (Syncrude) Aurora North and South (Syncrude 1996), Imperial Oil Kearl Lake Project (Imperial 2005), Husky Energy Inc. (Husky) Sunrise Project (Husky 2004) and the Synenco Energy Inc. (Synenco) Northern Lights Project (Synenco 2006).

5.2.1 Environmental Setting Surveys

Environmental setting surveys for wildlife were conducted within the LSAs to collect site-specific information on wildlife species (Table 5.2-2).

Table 5.2-1 Field Methods Information Sources

Jackpine Mine Expansion & Pierre River Mine Project	Suncor Voyageur Project (Suncor 2005)	Shell Jackpine Mine – Phase 1 Project (Shell 2002)	Canadian Natural Horizon Oil Sands Project (CNRL 2002)
winter track counts	Stand-Alone Report, Wildlife Environmental Setting, Section 2.1, Subsection 2.1.1, page 9	Stand-Alone Report, Wildlife Environmental Setting, Section 2.4, Subsection 2.4.1, page 10	Volume 6, Appendix C, Section C2.3, Subsection C2.3.1, page C2-5
ungulate aerial survey	–	Stand-Alone Report, Wildlife Environmental Setting, Section 2.4, Subsection 2.4.2, page 12	Volume 6, Appendix C, Section C2.3, Subsection C2.3.2, page C2-6
owl call-playback survey	–	Stand-Alone Report, Wildlife Environmental Setting, Section 2.5, Subsection 2.5.2, page 25	Volume 6, Appendix C, Section 2.4, Subsection 2.4.2, page C2-15
amphibian call survey	–	Stand-Alone Report, Wildlife Environmental Setting, Section 2.6, Subsection 2.6.1, page 33	Volume 6, Appendix 6, Section 2.5, Subsection 2.5.1, page C2-20
waterfowl and waterbird aerial survey	–	Stand-Alone Report, Wildlife Environmental Setting, Section 2.5, Subsection 2.5.1, page 23	Volume 6, Appendix C, Section 2.4, Subsection 2.4.1, page C2-14
breeding bird survey	–	Stand-Alone Report, Wildlife Environmental Setting, Section 2.5, Subsection 2.5.4, page 29	Volume 6, Appendix C, Section 2.4, Subsection 2.4.4, page C2-18
bat survey	–	Stand-Alone Report, Wildlife Environmental Setting, Section 2.4, Subsection 2.4.6, page 20	Volume 6, Appendix C, Section 2.3, Subsection 2.3.6, page C2-11
beaver/muskrat aerial survey	–	Stand-Alone Report, Wildlife Environmental Setting, Section 2.4, Subsection 2.4.4, page 16 Volume 6, Appendix C, Section C2.3, Subsection C2.3.4, page C2-9	Volume 6, Appendix C, Section C2.3, Subsection C2.3.4, page C2-9

– = Not applicable.

JPME R1 ERRATA

FOR BREEDING BIRDS SAMPLE LOCATIONS, SEE JPME R1 AENV SIR 517, FIG 517-1 AND

JPME R1 AENV SIR 517

Table 5.2-2 Wildlife Surveys Conducted in the Local Study Areas

Survey Type	Survey Date	Effort	Statistical Analysis	Survey Locations
photographic bait station	Nov. 15 to Dec. 5, 2005	12 cameras-21 days	n/a	Figures 5.2-1, 5.2-2
	Jan. 18 to Feb. 2, 2006	16 cameras-15 days		
	May 5 to 19, 2006	16 cameras-14 days		
	Jul. 18 to Aug. 4, 2006	16 cameras-17 days		
	Nov. 27 to Dec. 21, 2006	24 cameras-24 days		
	Jan. 23 to Feb. 7, 2007	24 cameras-15 days		
	Jun. 11 to 27, 2007	24 cameras-16 days		
	Jul. 25 to Aug. 10, 2007	24 cameras-16 days		

Table 5.2-2 Wildlife Surveys Conducted in the Local Study Areas (continued)

Survey Type	Survey Date	Effort	Statistical Analysis	Survey Locations
photographic corridor monitoring	Nov. 15 to Dec. 5, 2005 Jan. 18 to Feb. 2, 2006 Feb. 6 to 23, 2006 May 5 to 19, 2006 Sep. 29 to Oct. 14, 2006 May 21 to Jun. 2, 2006 Jun. 6 to 21, 2006 Jul. 18 to Aug. 4, 2006 Aug. 9 to 23, 2006 Aug. 24 to Sep. 12, 2006 Oct. 21 to Nov. 5, 2006 Jan. 23 to Feb. 7, 2007 Jun. 11 to 27, 2007 Jul. 25 to Aug. 10, 2007	8 cameras-15 days 8 cameras-21 days 8 cameras-16 days 8 cameras-15 days 8 cameras-15 days 8 cameras-12 days 8 cameras -15 days 8 cameras-17 days 8 cameras-14 days 8 cameras-18 days 24 cameras-15 days 24 cameras-15 days 24 cameras-16 days 24 cameras-16 days	n/a	Figures 5.2-1, 5.2-2
winter track triangle and corridor transects	Jan. 17 to 31, Mar 31, 2006 Dec. 2, 2006 to Mar. 31, 2007	201 km and 1,027 km-days	Chi-square Bonferroni	Figures 5.2-3, 5.2-4
amphibian	May 9 to 15, 2006 May 24 to 29 2006 May 23 to 26, 2007	151 plots 79 plots 35 plots	Analysis of Variance (ANOVA)	Figures 5.2-5, 5.2-6
marsh bird call playback	May 24 to 30, 2006 May 23 to 26, 2007	61 plots 35 plots	n/a	Figures 5.2-5, 5.2-6
breeding bird	Jun. 14 to 18, 2006 Jun. 5 to 7, 2007	165 point counts 67 point counts	Analysis of Variance (ANOVA) Kruskal-Wallis Two-Way Indicator Species Analysis (TWINSPAN) Detrended Correspondence Analysis (DCA)	Figures 5.2-7, 5.2-8
bats	Jul. 24 to 30, 2006 Jul. 13 to 19, 2007	10 mist-net plots, 48.4 mist-net hours; 58 detector plots, 20.9 hours monitoring 16 mist-net plots, 143.4 mist-net hours; 68 detector plots, 28.7 hour monitoring	n/a	Figures 5.2-9, 5.2-10
beaver and muskrat	Sep. 25, 2005 Oct. 14, 2006	191 ha of lakes and ponds, 19.1 km of watercourses	n/a	Figures 5.2-11, 5.2-12
spring and fall waterfowl	Sep. 25, 2005 May 18, Jun. 2, 2006	9,685.4 ha of lakes and ponds, 387.5 km of watercourses	n/a	Figures 5.2-11, 5.2-12
ungulate aerial	Dec. 8 to 9, 2005	118 km^2; 50% coverage	n/a	Figures 5.2-13, 5.2-14
owl call playback	May 4 to 9, 2006 May 13 to 18, 2007	139 plots	n/a	Figures 5.2-15, 5.2-16

n/a = Not applicable.

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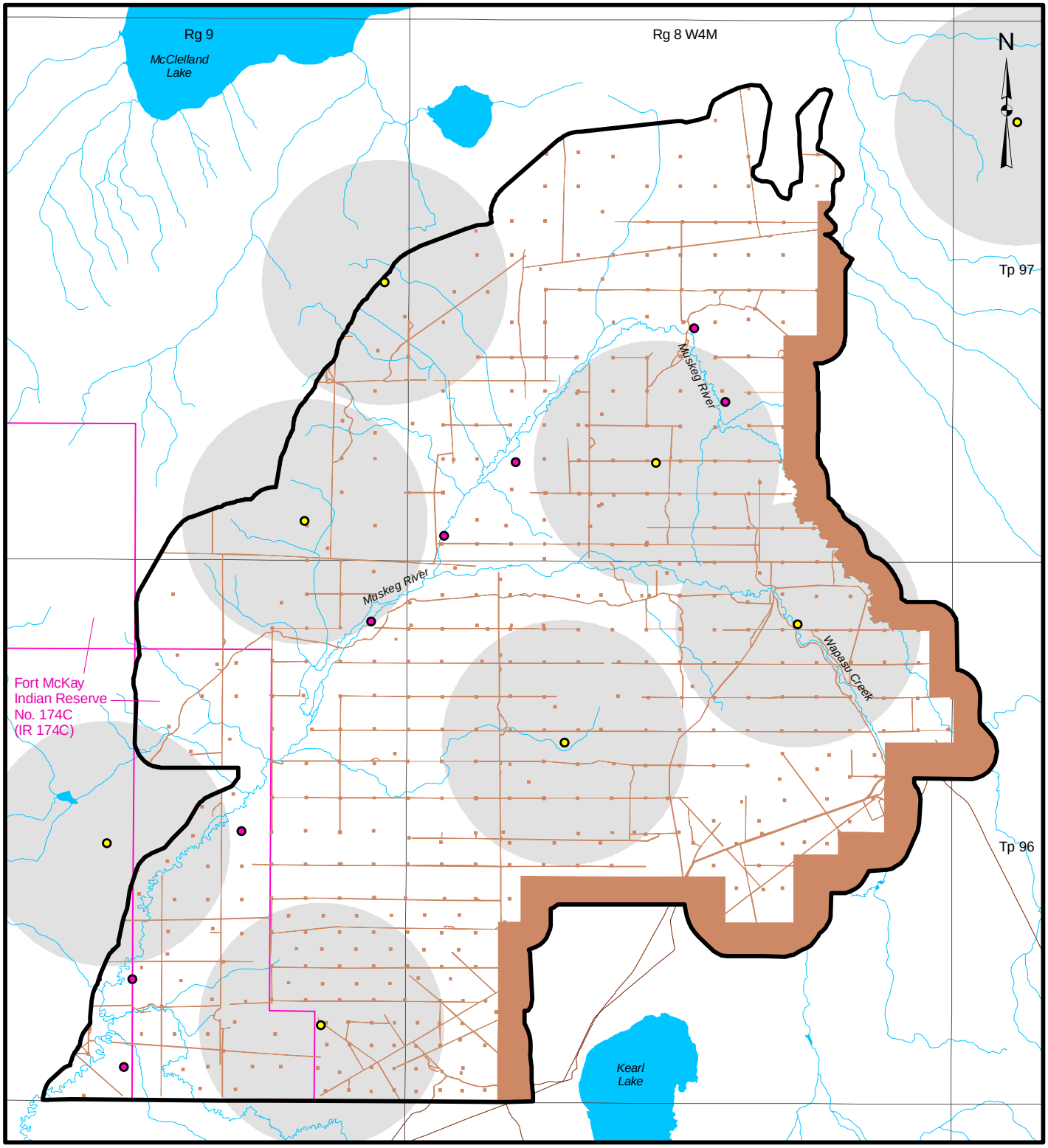

LEGEND

- JACKPINE EXPANSION MINING AREA LOCAL STUDY AREA
- INDIAN RESERVE
- OPEN WATER
- 2.2 KM BUFFER
- PUBLIC ROADWAY
- BAIT
- CORRIDOR

DISTURBED

- EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE
- EXISTING AND APPROVED URBAN AND INDUSTRIAL LINEAR DISTURBANCE

REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2004), and Alberta SRD, used under license.
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 12.

3 0 3
SCALE 1:100,000 KILOMETRES

PROJECT
JACKPINE MINE EXPANSION & PIERRE RIVER MINE PROJECT

TITLE
PHOTOGRAPHIC STATION LOCATIONS IN THE JACKPINE EXPANSION MINING AREA LOCAL STUDY AREA

Shell Canada Limited

PROJECT No. 05-1344-027.7700			SCALE AS SHOWN	REV. 0
DESIGN	VR	06 Jun. 2007	FIGURE: 5.2-1	
GIS	JH	14 Nov. 2007		
CHECK	MJ	16 Nov. 2007		
REVIEW	WES/TC	19 Nov. 2007		

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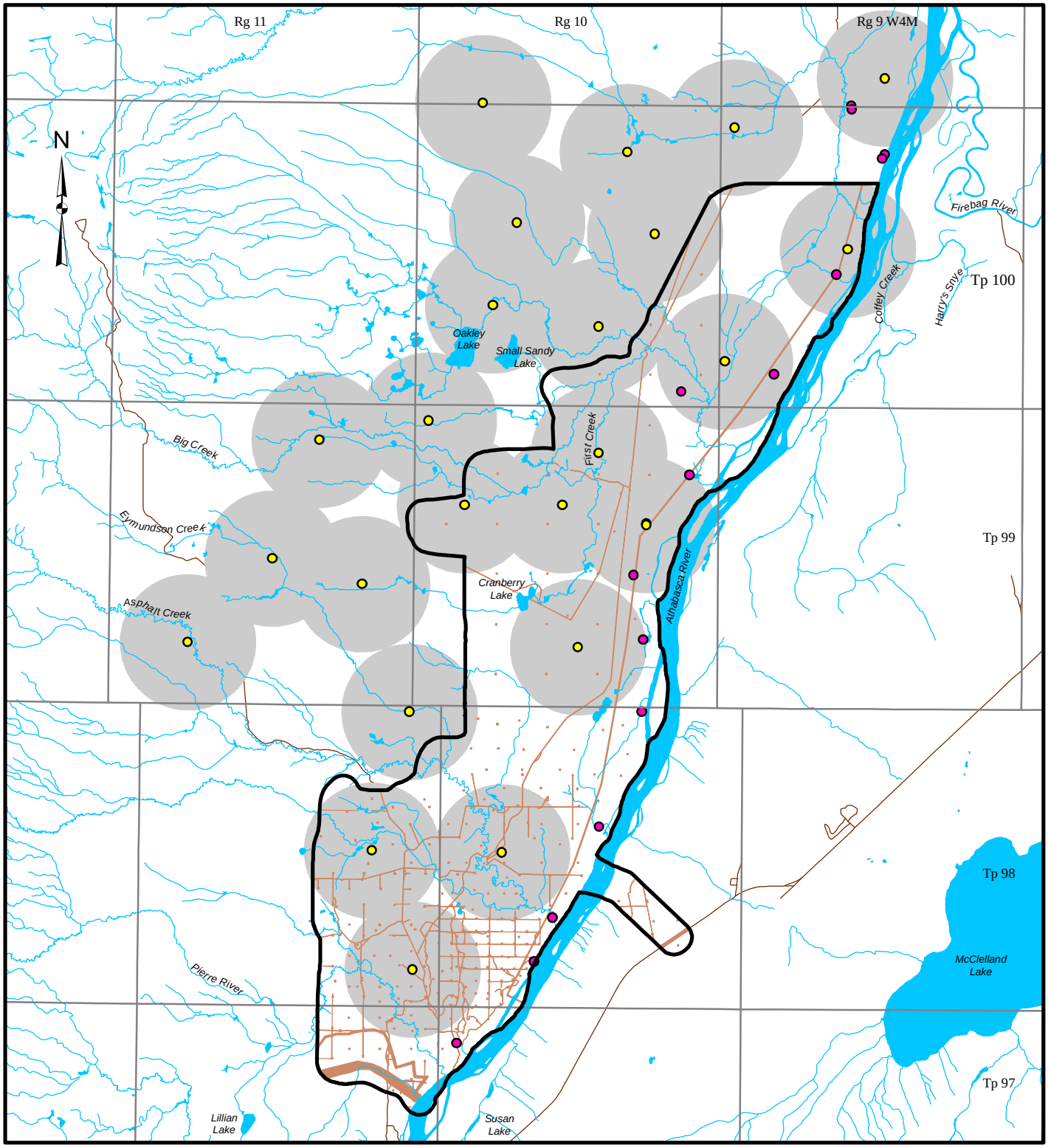

LEGEND

- PIERRE RIVER MINING AREA LOCAL STUDY AREA
- OPEN WATER
- 2.2 KM BUFFER
- ROAD
- BAIT
- CORRIDOR

DISTURBED

- EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE
- EXISTING AND APPROVED URBAN AND INDUSTRIAL LINEAR DISTURBANCE

REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2004), and Alberta SRD, used under license.
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 12.

6 0 6
SCALE 1:180,000 KILOMETRES

PROJECT
JACKPINE MINE EXPANSION &
PIERRE RIVER MINE PROJECT

TITLE
PHOTOGRAPHIC STATION LOCATIONS
IN THE PIERRE RIVER MINING AREA
LOCAL STUDY AREA

Shell Canada Limited

PROJECT No. 05-1344-027.7700			SCALE AS SHOWN	REV. 0
DESIGN	VR	10 Aug. 2007	FIGURE: 5.2-2	
GIS	JH	14 Nov. 2007		
CHECK	MJ	16 Nov. 2007		
REVIEW	WES/TC	19 Nov. 2007		

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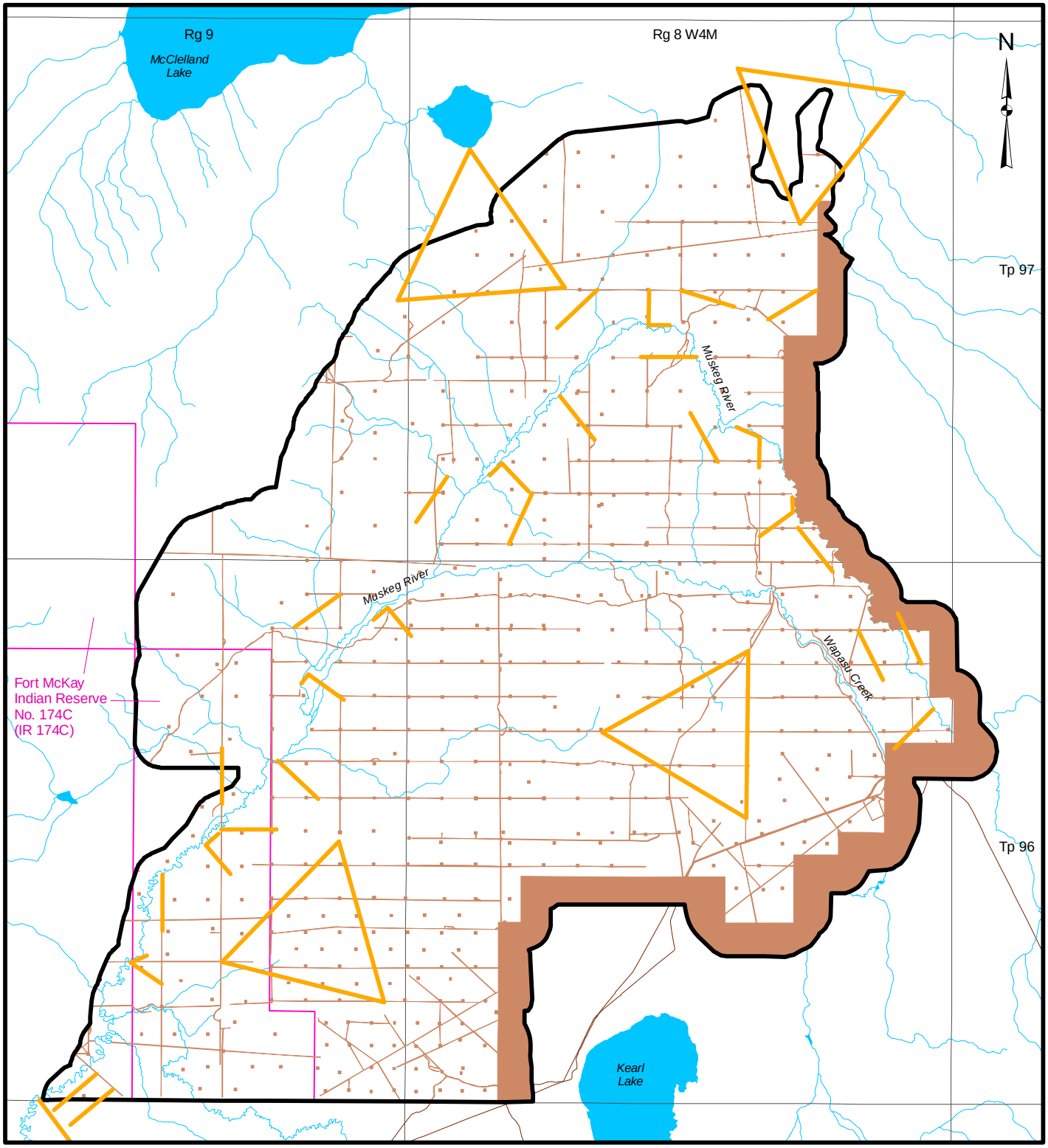


LEGEND

- JACKPINE EXPANSION MINING AREA LOCAL STUDY AREA
- INDIAN RESERVE
- OPEN WATER
- PUBLIC ROADWAY
- CORRIDOR AND TRIANGLE TRANSECT LOCATION

DISTURBED

- EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE
- EXISTING AND APPROVED URBAN AND INDUSTRIAL LINEAR DISTURBANCE

3 0 3

SCALE 1:100,000 KILOMETRES

REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2004), and Alberta SRD, used under license.
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 12.

PROJECT

JACKPINE MINE EXPANSION & PIERRE RIVER MINE PROJECT

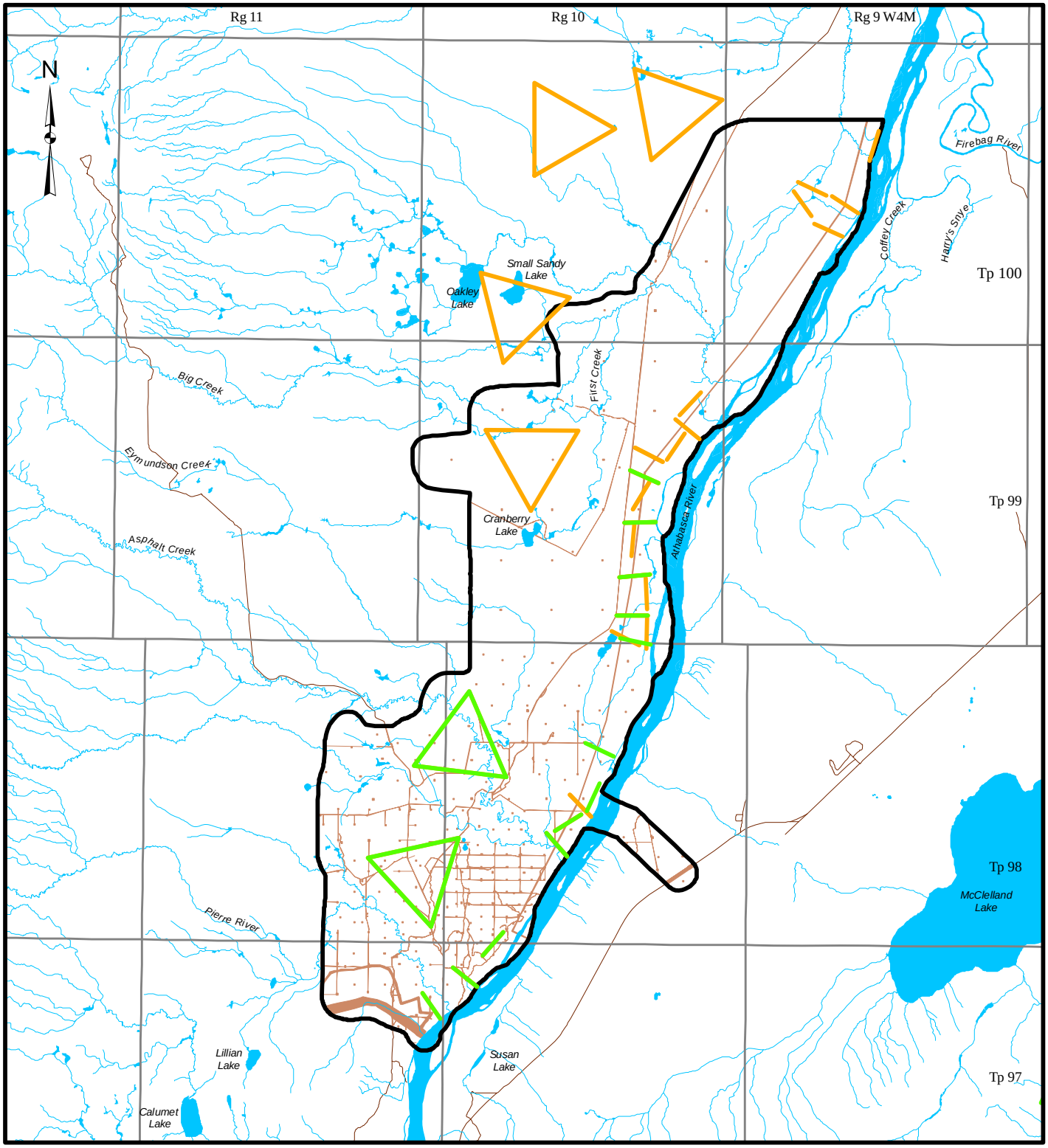
TITLE

WINTER TRACK TRANSECT LOCATIONS IN THE JACKPINE EXPANSION MINING AREA LOCAL STUDY AREA

Shell Canada Limited

PROJECT No. 05-1344-027.7700			SCALE AS SHOWN	REV. 0
DESIGN	VR	06 Jun. 2007	FIGURE: 5.2-3	
GIS	JH	14 Nov. 2007		
CHECK	MJ	16 Nov. 2007		
REVIEW	WES/TC	19 Nov. 2007		

Project: I:\CLIENTS\SHELL\05-1344-027\mapping\mxd\wildlife\DRAFT\jackpine\sa_corridor_triangle_trans_jp_esr.mxd - Plot: I:\CLIENTS\SHELL\05-1344-027\mapping\pdf\wildlife\DRAFT\jackpine\Fig5.2-3_lsa_corridor_triangle_trans_jp_esr.pdf



LEGEND

- PIERRE RIVER MINING AREA LOCAL STUDY AREA
- OPEN WATER
- ROAD
- CORRIDOR AND TRIANGLE TRANSECT LOCATION (2006)
- CORRIDOR AND TRIANGLE TRANSECT LOCATION (2007)

DISTURBED

- EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE
- EXISTING AND APPROVED URBAN AND INDUSTRIAL LINEAR DISTURBANCE

6 0 6

SCALE 1:180,000 KILOMETRES

REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2004), and Alberta SRD, used under license.
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 12.

PROJECT

JACKPINE MINE EXPANSION & PIERRE RIVER MINE PROJECT

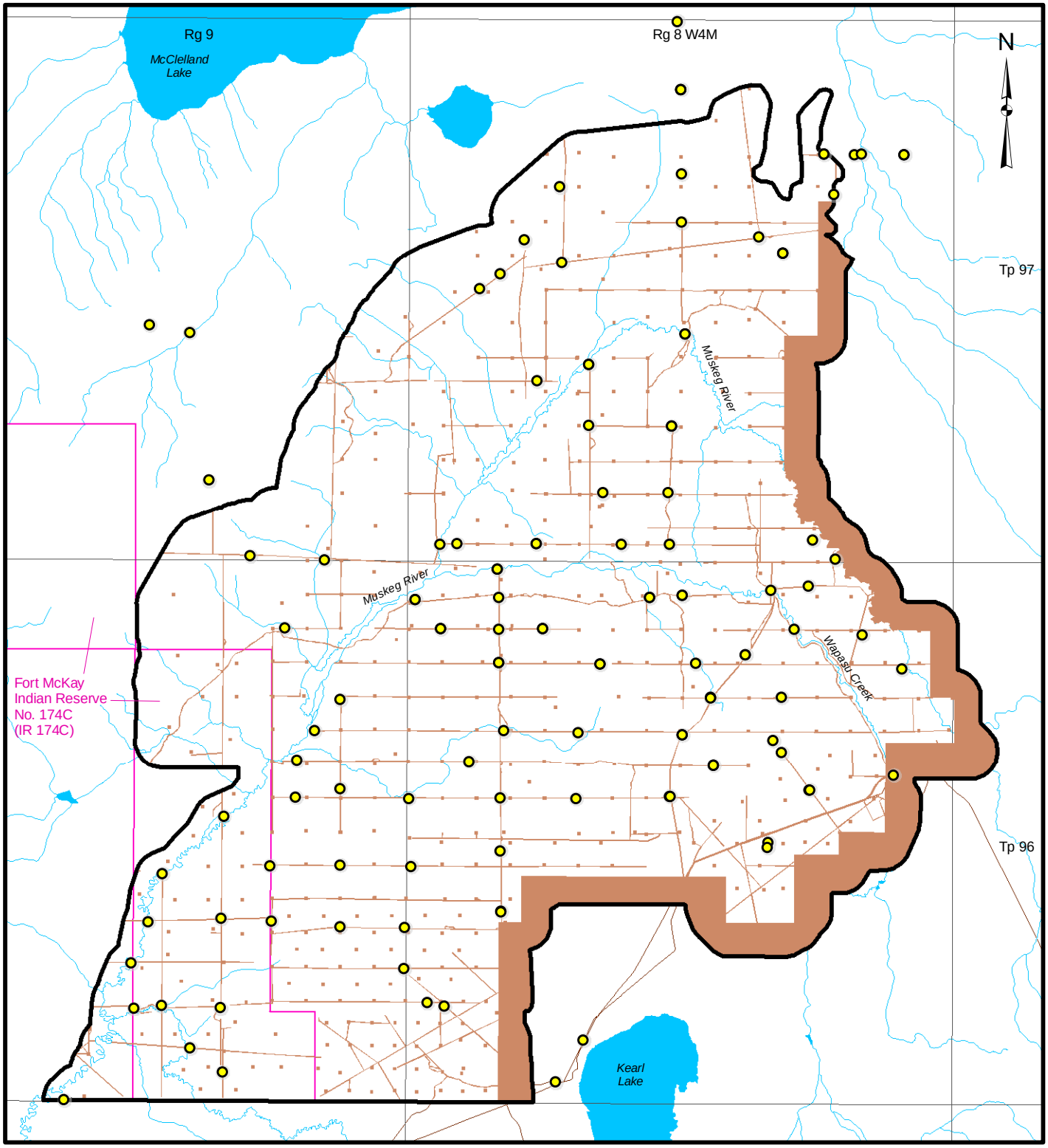
TITLE

WINTER TRACK TRANSECT LOCATIONS IN THE PIERRE RIVER MINING AREA LOCAL STUDY AREA

Shell Canada Limited

PROJECT No. 05-1344-027.7700			SCALE AS SHOWN	REV. 0
DESIGN	VR	10 Aug. 2007	FIGURE: 5.2-4	
GIS	JH	14 Nov. 2007		
CHECK	MJ	16 Nov. 2007		
REVIEW	WES/TC	19 Nov. 2007		

Project: I:\CLIENTS\SHELL\05-1344-027\mapping\mxd\wildlife\DRAFT\pierreriver\lsa_corridor_triangle_trans_pr.mxd Plot: ?J:\2005\GIS\ArcMapTemplates\templatesiv91\MyProject.pdf?



LEGEND

- JACKPINE EXPANSION MINING AREA LOCAL STUDY AREA
- INDIAN RESERVE
- OPEN WATER
- PUBLIC ROADWAY
- CORRIDOR AND TRIANGLE TRANSECT LOCATION

DISTURBED

- EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE
- EXISTING AND APPROVED URBAN AND INDUSTRIAL LINEAR DISTURBANCE

3 0 3

SCALE 1:100,000 KILOMETRES

REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2004), and Alberta SRD, used under license.
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 12.

PROJECT

JACKPINE MINE EXPANSION & PIERRE RIVER MINE PROJECT

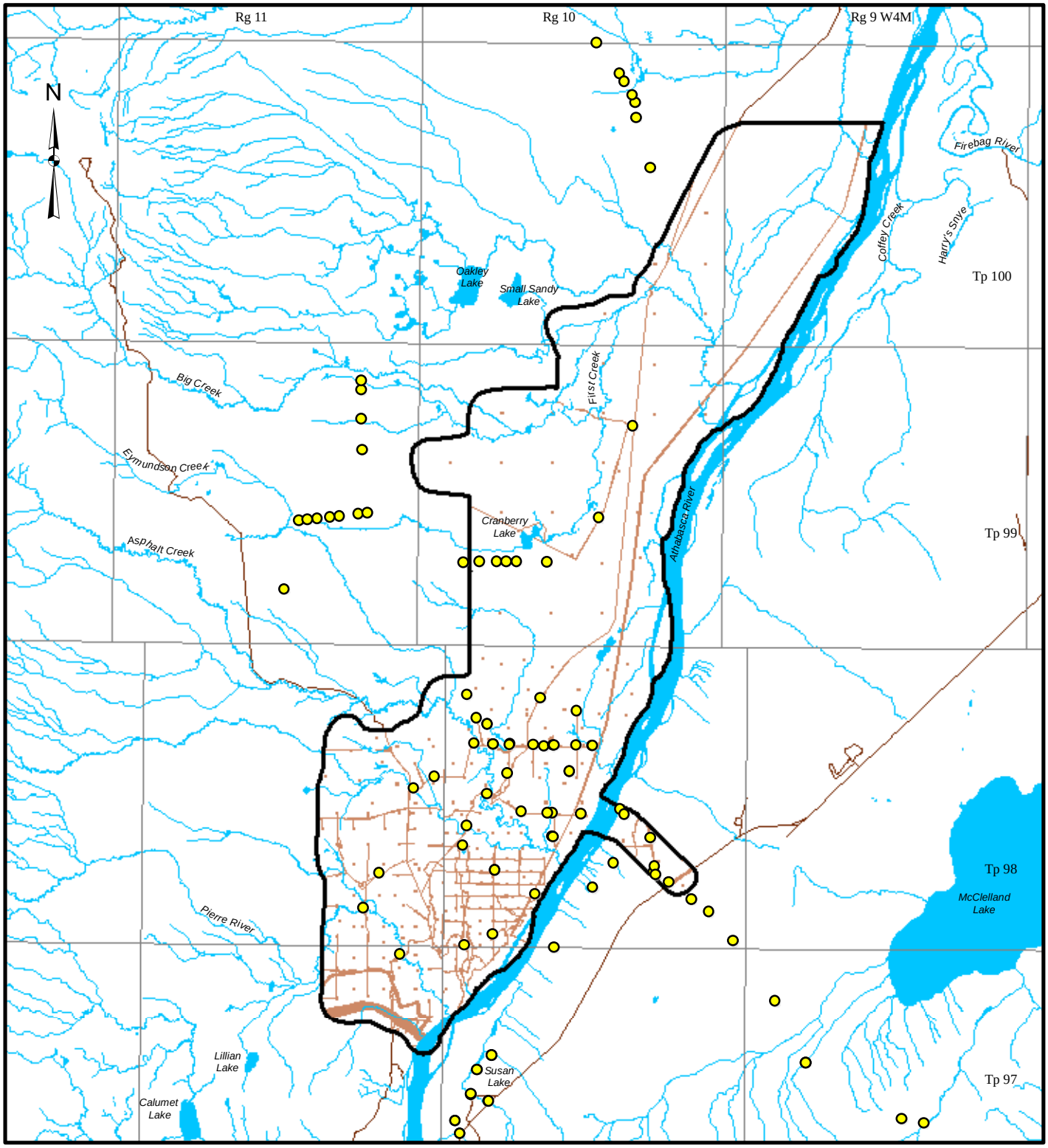
TITLE

AMPHIBIAN AND MARSH BIRD SURVEY LOCATIONS IN THE JACKPINE EXPANSION MINING AREA LOCAL STUDY AREA

Shell Canada Limited

PROJECT No. 05-1344-027.7700			SCALE AS SHOWN	REV. 0
DESIGN	VR	06 Jun. 2007	FIGURE: 5.2-5	
GIS	JH	14 Nov. 2007		
CHECK	MJ	16 Nov. 2007		
REVIEW	WES/TC	19 Nov. 2007		

Project: I:\CLIENTS\SHELL\05-1344-027\mapping\mxd\wildlife\DRAFT\jackpine\sa_amph_bird_jp_esr.mxd - Plot: I:\CLIENTS\SHELL\05-1344-027\mapping\pdf\wildlife\DRAFT\jackpine\Fig5.2-5_lsa_amph_bird_jp_esr.pdf



LEGEND

- PIERRE RIVER MINING AREA LOCAL STUDY AREA
- OPEN WATER
- ROAD
- SURVEY LOCATION INCLUDING 125M BUFFER

6 0 6

SCALE 1:180,000 KILOMETRES

DISTURBED

- EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE
- EXISTING AND APPROVED URBAN AND INDUSTRIAL LINEAR DISTURBANCE

REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2004), and Alberta SRD, used under license.
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 12.

PROJECT

JACKPINE MINE EXPANSION & PIERRE RIVER MINE PROJECT

TITLE

AMPHIBIAN AND MARSH BIRD SURVEY LOCATIONS IN THE PIERRE RIVER MINING AREA LOCAL STUDY AREA

Shell Canada Limited

PROJECT No. 05-1344-027.7700			SCALE AS SHOWN	REV. 0
DESIGN	VR	10 Aug. 2007	FIGURE: 5.2-6	
GIS	JH	14 Nov. 2007		
CHECK	MJ	16 Nov. 2007		
REVIEW	WES/TC	19 Nov. 2007		

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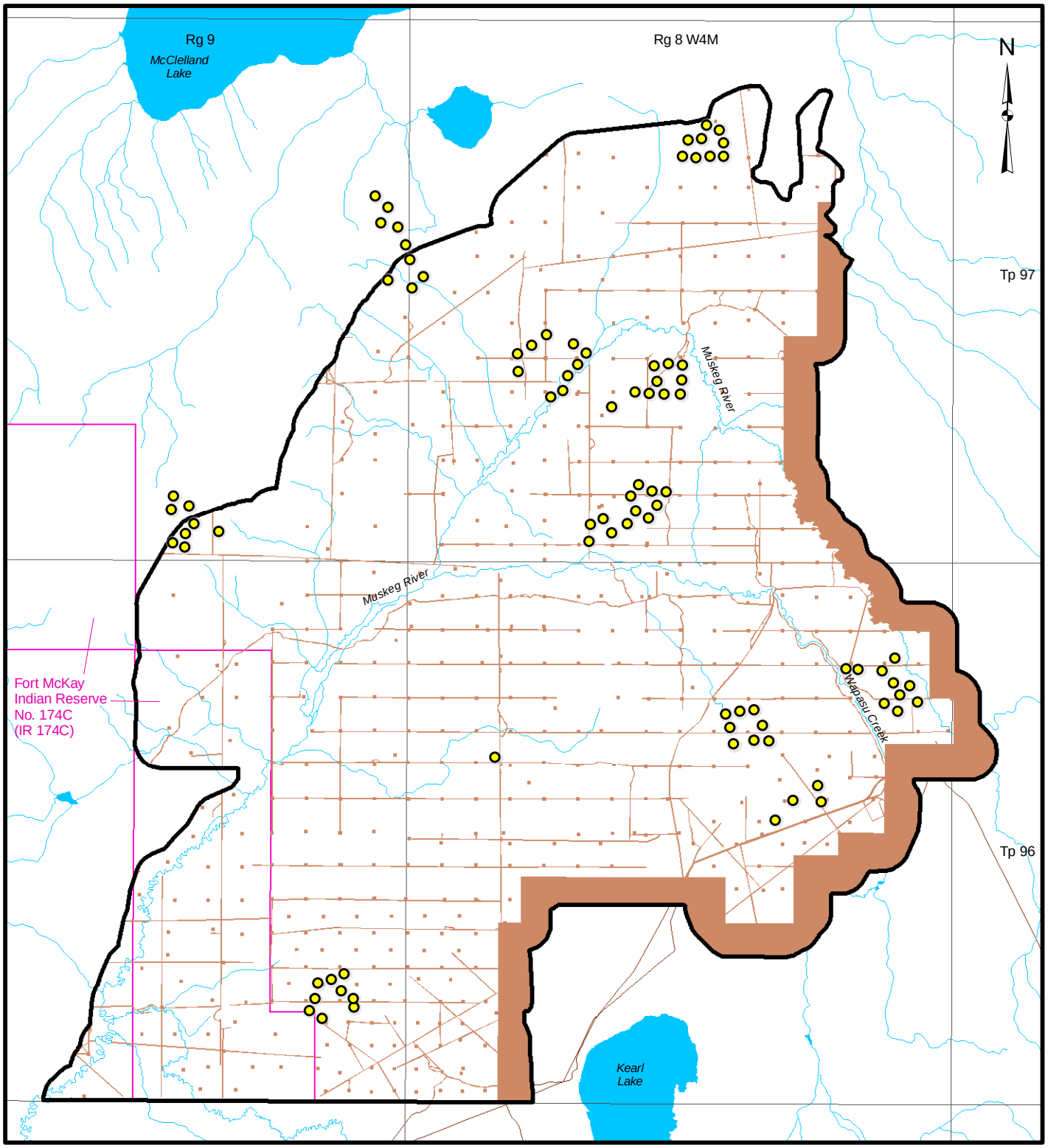


LEGEND

- JACKPINE EXPANSION MINING AREA LOCAL STUDY AREA
- INDIAN RESERVE
- OPEN WATER
- PUBLIC ROADWAY
- BREEDING BIRD SURVEY LOCATION INCLUDING 125 m BUFFER

DISTURBED

- EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE
- EXISTING AND APPROVED URBAN AND INDUSTRIAL LINEAR DISTURBANCE

3 0 3

SCALE 1:100,000 KILOMETRES

REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2004), and Alberta SRD, used under license.
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 12.

PROJECT

JACKPINE MINE EXPANSION & PIERRE RIVER MINE PROJECT

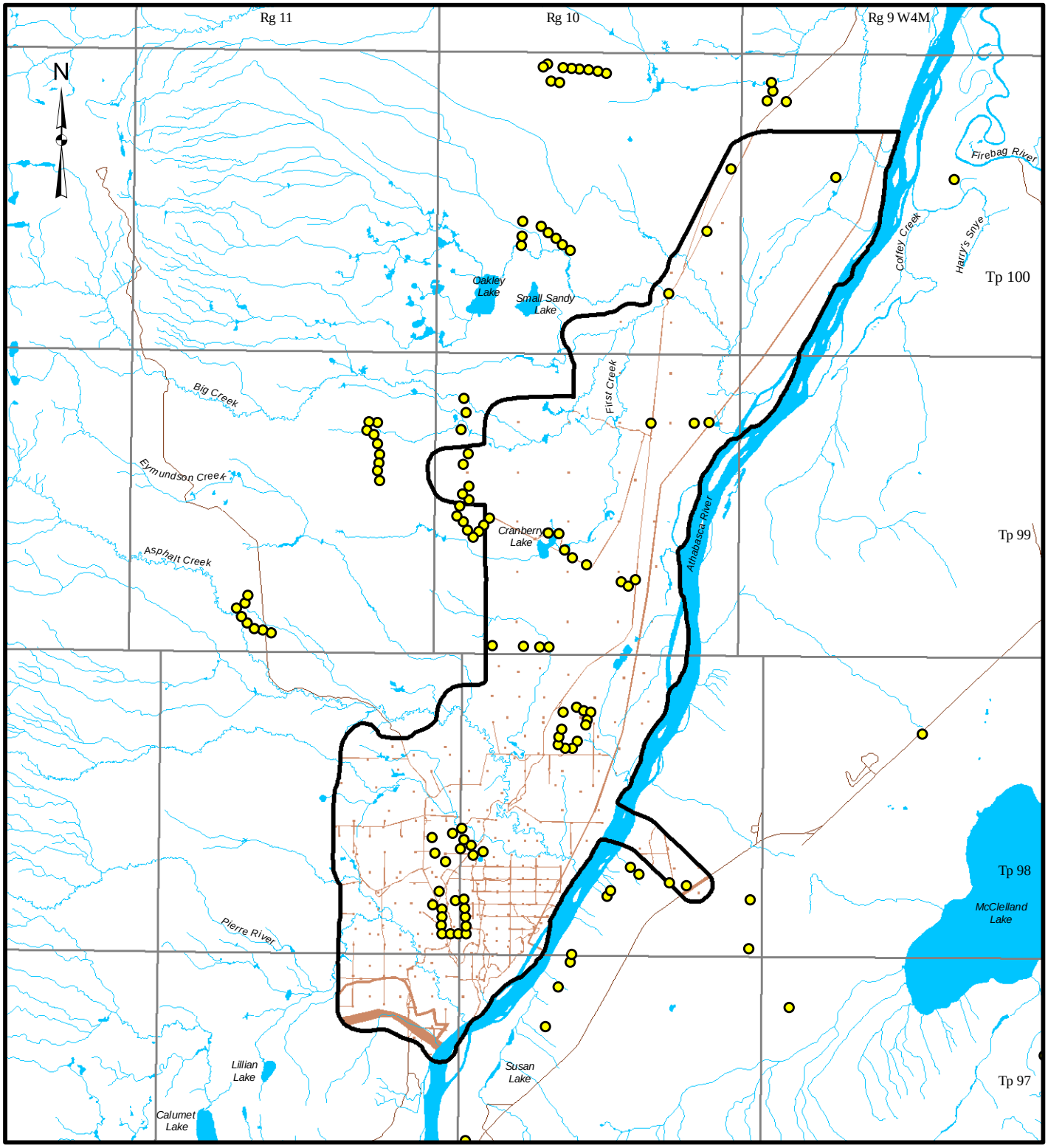
TITLE

BREEDING BIRD SURVEY PLOTS IN THE JACKPINE EXPANSION MINING AREA LOCAL STUDY AREA

Shell Canada Limited

PROJECT No. 05-1344-027.7700			SCALE AS SHOWN	REV. 0
DESIGN	VR	06 Jun. 2007	FIGURE: 5.2-7	
GIS	JH	14 Nov. 2007		
CHECK	MJ	16 Nov. 2007		
REVIEW	WES/TC	19 Nov. 2007		

Project: I:\CLIENTS\SHELL\05-1344-027\mapping\mxd\wildlife\DRAFT\jackpine\lsa_breeding_bird_jp_esr.mxd - Plot: I:\CLIENTS\SHELL\05-1344-027\mapping\pdf\wildlife\DRAFT\jackpine\Fig5.2-7_lsa_breeding_bird_jp_esr.pdf



LEGEND

- PIERRE RIVER MINING AREA LOCAL STUDY AREA
- OPEN WATER
- ROAD
- BREEDING BIRD SURVEY LOCATION INCLUDING 125 M BUFFER

6 0 6

SCALE 1:180,000 KILOMETRES

DISTURBED

- EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE
- EXISTING AND APPROVED URBAN AND INDUSTRIAL LINEAR DISTURBANCE

REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2004), and Alberta SRD, used under license.
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 12.

PROJECT

JACKPINE MINE EXPANSION & PIERRE RIVER MINE PROJECT

TITLE

BREEDING BIRD SURVEY PLOTS IN THE PIERRE RIVER MINING AREA LOCAL STUDY AREA

Shell Canada Limited

PROJECT No. 05-1344-027.7700			SCALE AS SHOWN	REV. 0
DESIGN	VR	10 Aug. 2007	FIGURE: 5.2-8	
GIS	JH	14 Nov. 2007		
CHECK	MJ	16 Nov. 2007		
REVIEW	WES/TC	19 Nov. 2007		

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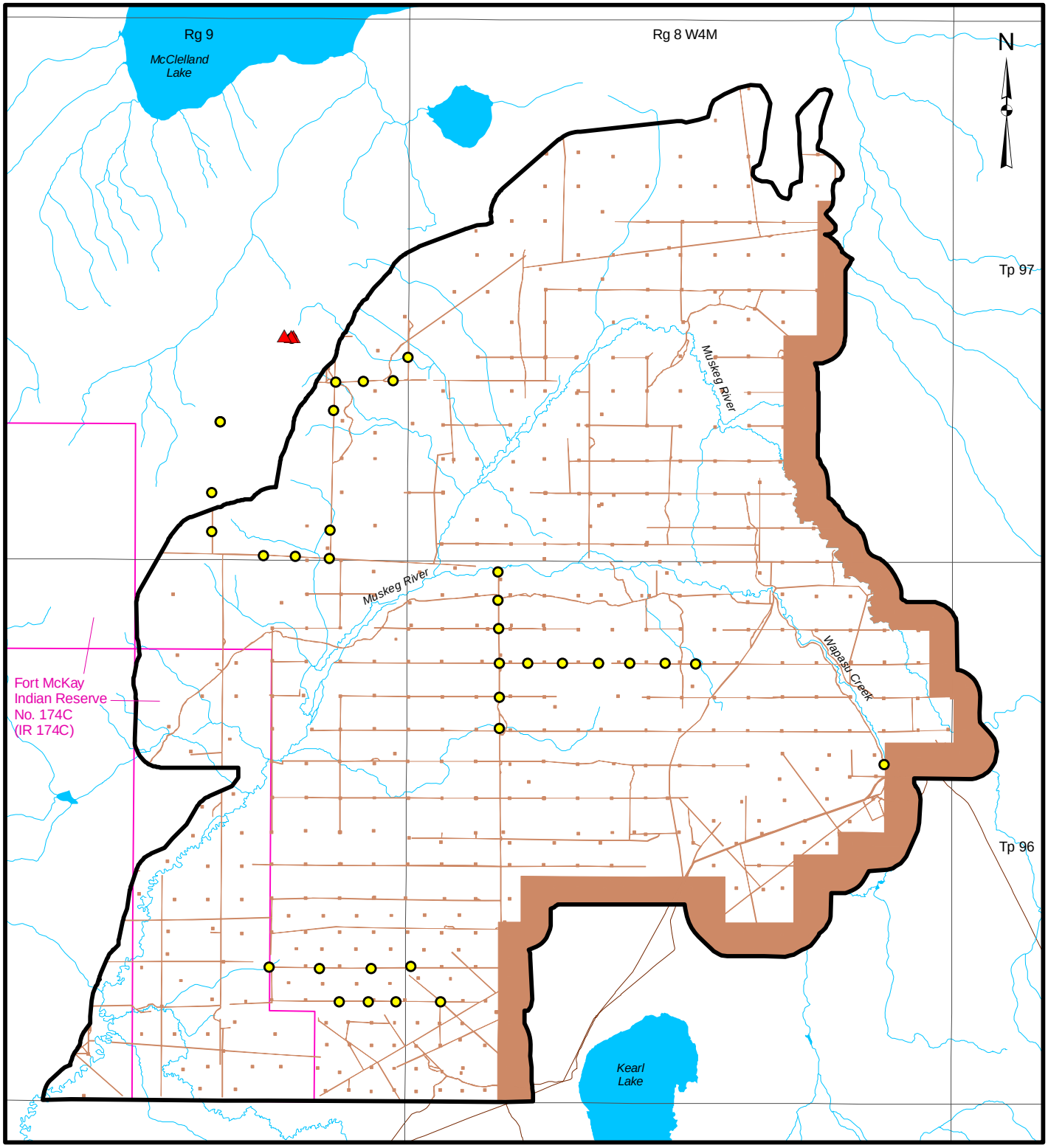

LEGEND

- JACKPINE EXPANSION MINING AREA LOCAL STUDY AREA
- INDIAN RESERVE
- OPEN WATER
- PUBLIC ROADWAY

BAT SURVEY LOCATIONS

- DETECTOR
- NETTING

DISTURBED

- EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE
- EXISTING AND APPROVED URBAN AND INDUSTRIAL LINEAR DISTURBANCE

3 0 3

SCALE 1:100,000 KILOMETRES

REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2004), and Alberta SRD, used under license.
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 12.

PROJECT

JACKPINE MINE EXPANSION & PIERRE RIVER MINE PROJECT

TITLE BAT SURVEY LOCATIONS AND CAPTURE RESULTS IN THE JACKPINE EXPANSION MINING AREA LOCAL STUDY AREA

Shell Canada Limited

PROJECT No. 05-1344-027.7700			SCALE AS SHOWN	REV. 0
DESIGN	VR	06 Jun. 2007	FIGURE: 5.2-9	
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REVIEW	WES/TC	19 Nov. 2007		

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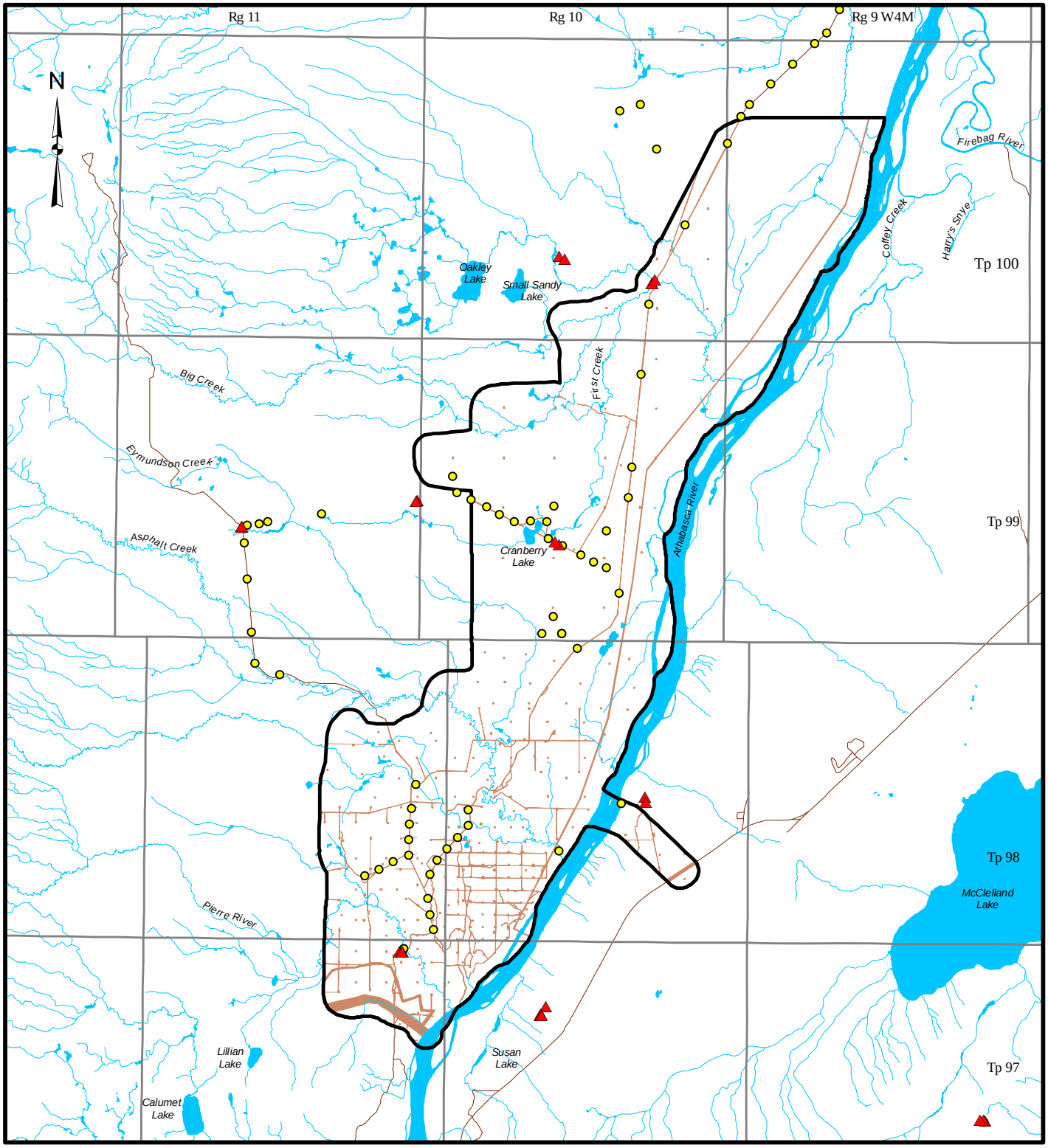

LEGEND

- PIERRE RIVER MINING AREA LOCAL STUDY AREA
- OPEN WATER
- ROAD

BAT SURVEY LOCATIONS

- DETECTOR
- NETTING

6 0 6

SCALE 1:180,000 KILOMETRES

DISTURBED

- EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE
- EXISTING AND APPROVED URBAN AND INDUSTRIAL LINEAR DISTURBANCE

REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2004), and Alberta SRD, used under license.
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 12.

PROJECT

JACKPINE MINE EXPANSION & PIERRE RIVER MINE PROJECT

TITLE

BAT SURVEY LOCATIONS AND CAPTURE RESULTS IN THE PIERRE RIVER MINING AREA LOCAL STUDY AREA

Shell Canada Limited

PROJECT No. 05-1344-027.7700			SCALE AS SHOWN	REV. 0
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REVIEW	WES/TC	19 Nov. 2007		

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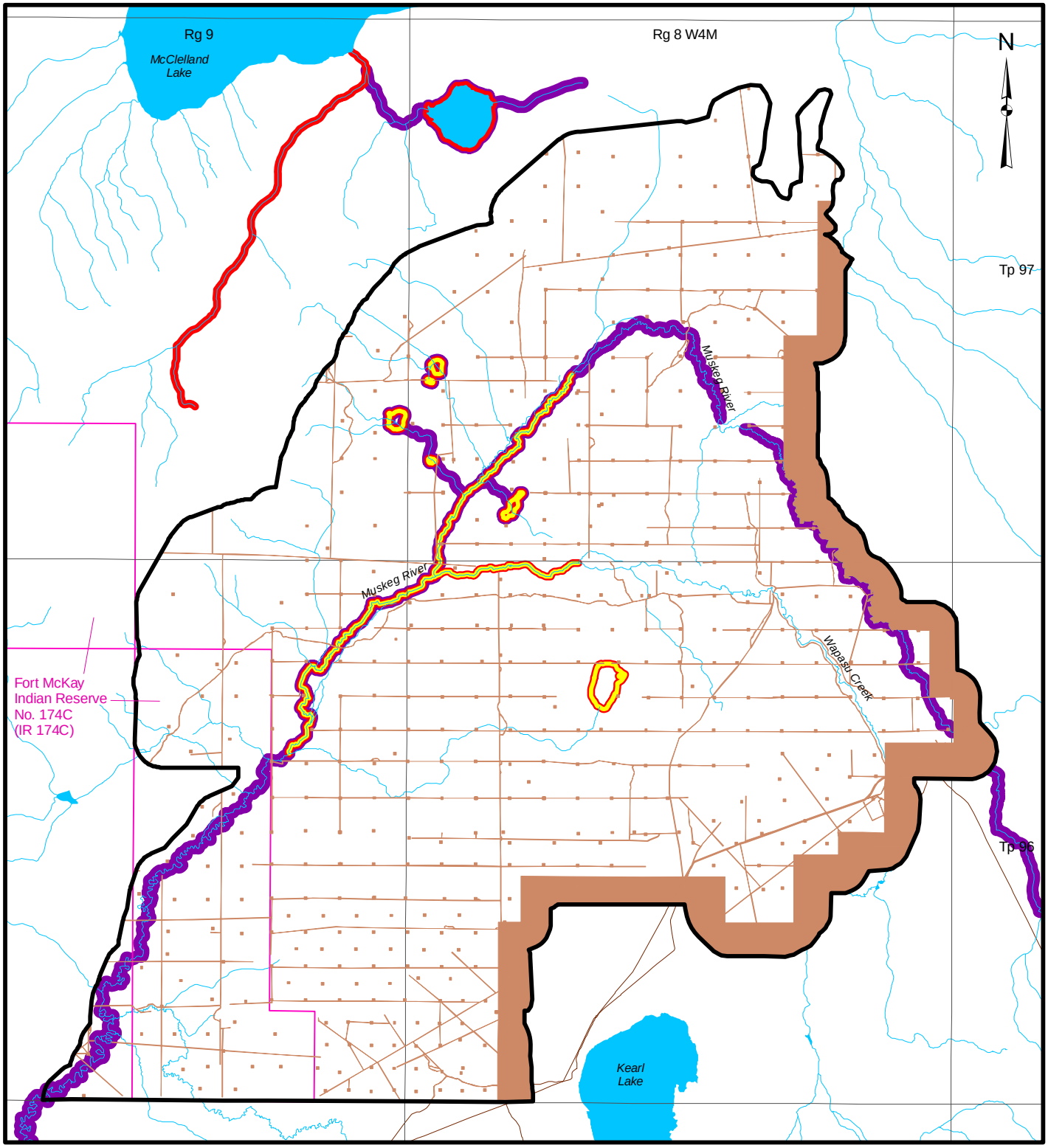

LEGEND

- JACKPINE EXPANSION MINING AREA LOCAL STUDY AREA
- INDIAN RESERVE
- OPEN WATER
- PUBLIC ROADWAY
- WATERFOWL AND BEAVER/MUSKRAT SURVEY (FALL 2005)
- WATERFOWL SURVEY (SPRING 2006)
- BEAVER/MUSKRAT SURVEY (FALL 2006)

DISTURBED

- EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE
- EXISTING AND APPROVED URBAN AND INDUSTRIAL LINEAR DISTURBANCE

REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2004), and Alberta SRD, used under license.
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 12.

3 0 3
SCALE 1:100,000 KILOMETRES

PROJECT
JACKPINE MINE EXPANSION & PIERRE RIVER MINE PROJECT

TITLE
AERIAL SURVEY ROUTES FOR BEAVER/MUSKRAT AND WATERFOWL IN THE JACKPINE EXPANSION MINING AREA LOCAL STUDY AREA

Shell Canada Limited

PROJECT No. 05-1344-027.7700			SCALE AS SHOWN	REV. 0
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GIS	JH	14 Nov. 2007		
CHECK	MJ	16 Nov. 2007		
REVIEW	WES/TC	19 Nov. 2007		

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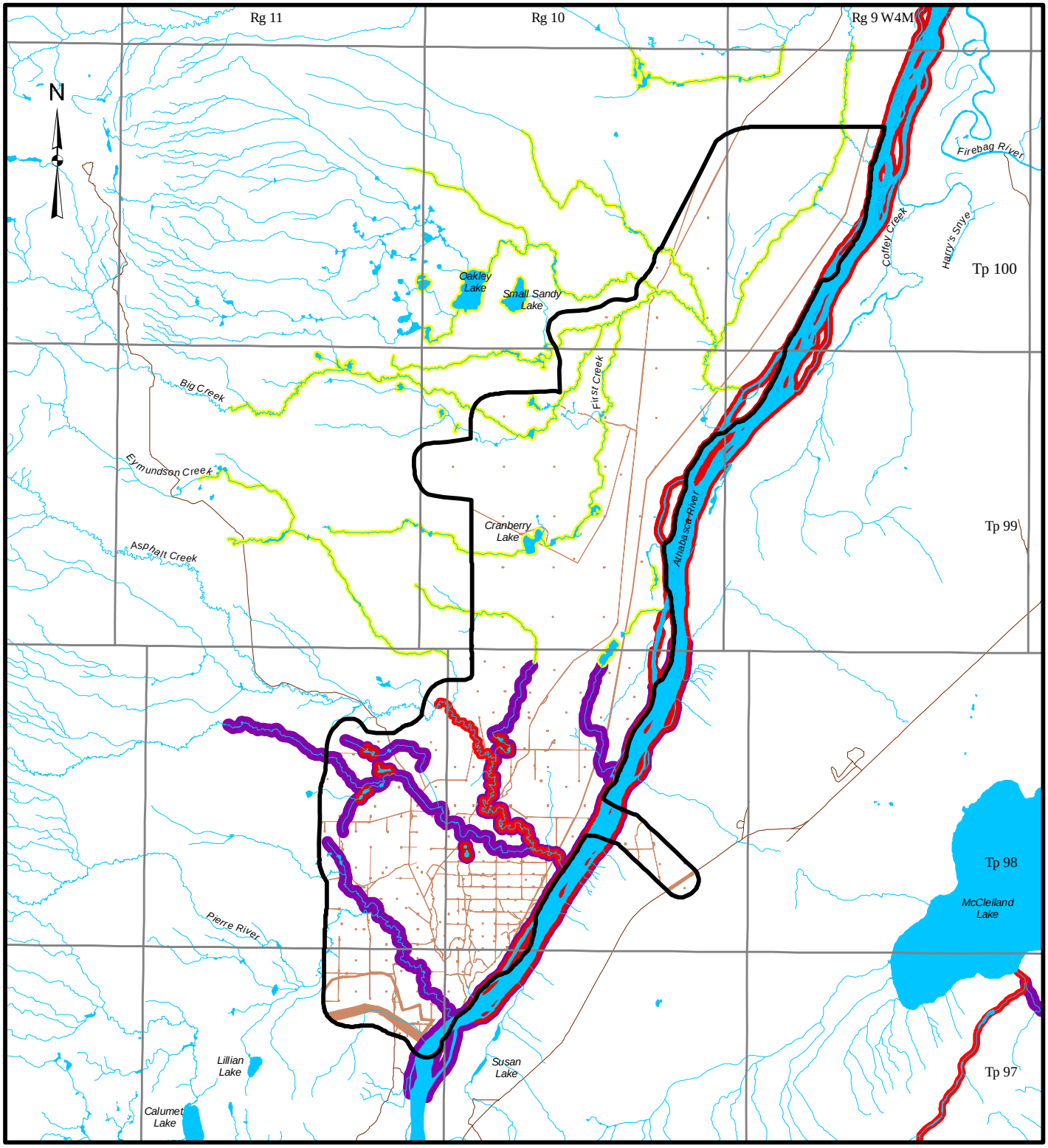

LEGEND

- PIERRE RIVER MINING AREA LOCAL STUDY AREA
- OPEN WATER
- ROAD
- WATERFOWL AND BEAVER-MUSKRAT SURVEY (FALL 2005)
- WATERFOWL SURVEY (SPRING 2006)
- BEAVER/MUSKRAT SURVEY (FALL 2006)

DISTURBED

- EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE
- EXISTING AND APPROVED URBAN AND INDUSTRIAL LINEAR DISTURBANCE

REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2004), and Alberta SRD, used under license.
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 12.

6 0 6
SCALE 1:180,000 KILOMETRES

PROJECT
JACKPINE MINE EXPANSION &
PIERRE RIVER MINE PROJECT

TITLE
AERIAL SURVEY ROUTES FOR
BEAVER/MUSKRAT AND WATERFOWL IN THE
PIERRE RIVER MINING AREA LOCAL STUDY AREA

Shell Canada Limited

PROJECT No. 05-1344-027.7700			SCALE AS SHOWN	REV. 0
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GIS	JH	14 Nov. 2007		
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REVIEW	WES/TC	19 Nov. 2007		

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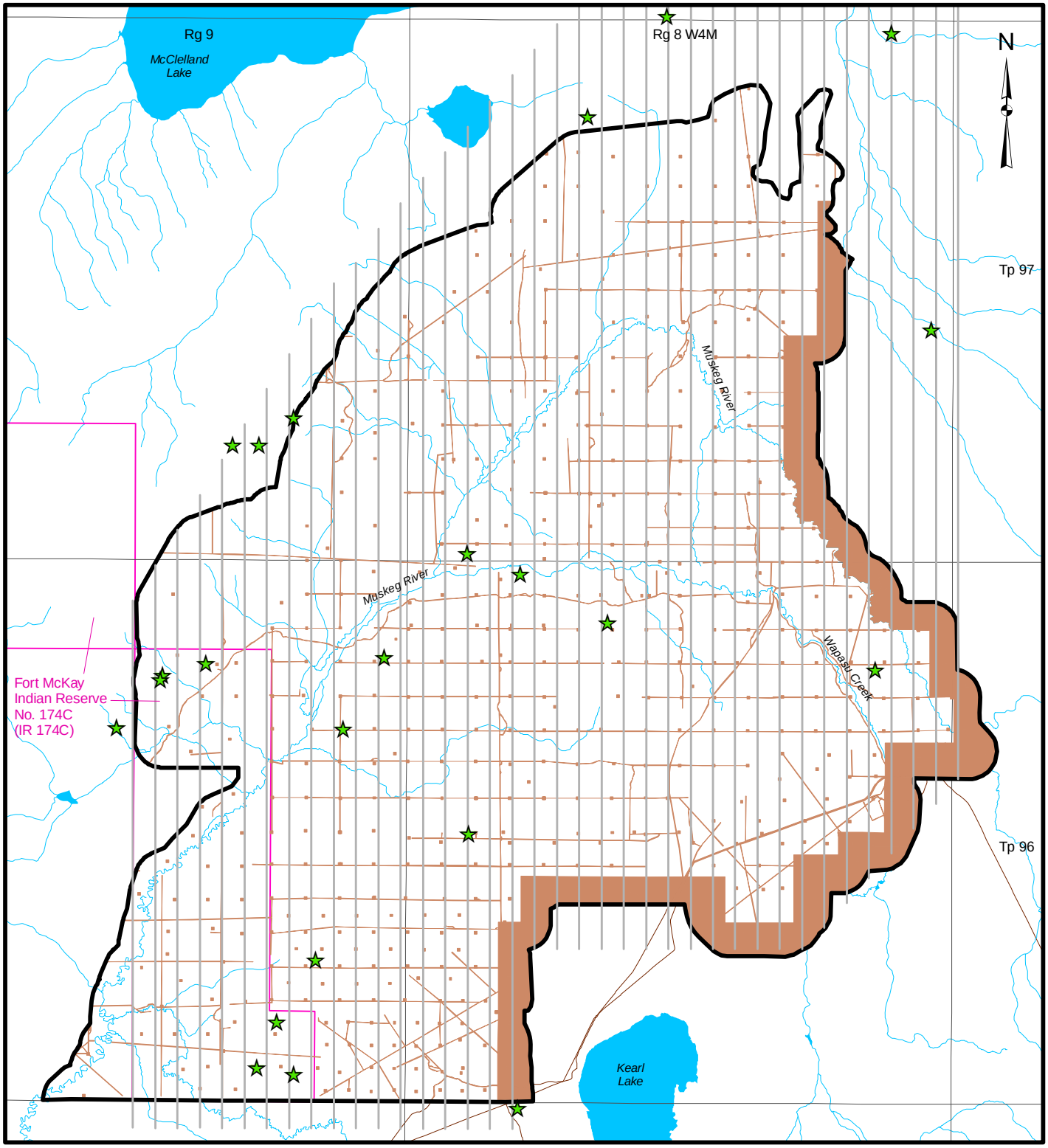

LEGEND

- JACKPINE EXPANSION MINING AREA LOCAL STUDY AREA
- INDIAN RESERVE
- OPEN WATER
- PUBLIC ROADWAY
- UNGULATE AERIAL TRANSECT
- MOOSE

DISTURBED

- EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE
- EXISTING AND APPROVED URBAN AND INDUSTRIAL LINEAR DISTURBANCE

REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2004), and Alberta SRD, used under license.
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 12.

3 0 3
SCALE 1:100,000 KILOMETRES

PROJECT
JACKPINE MINE EXPANSION & PIERRE RIVER MINE PROJECT

TITLE
UNGULATE AERIAL SURVEY COVERAGE AND OBSERVATIONS IN THE JACKPINE EXPANSION MINING AREA LOCAL STUDY AREA

Shell Canada Limited

PROJECT No. 05-1344-027.7700			SCALE AS SHOWN	REV. 0
DESIGN	VR	06 Jun. 2007	FIGURE: 5.2-13	
GIS	JH	14 Nov. 2007		
CHECK	MJ	16 Nov. 2007		
REVIEW	WES/TC	19 Nov. 2007		

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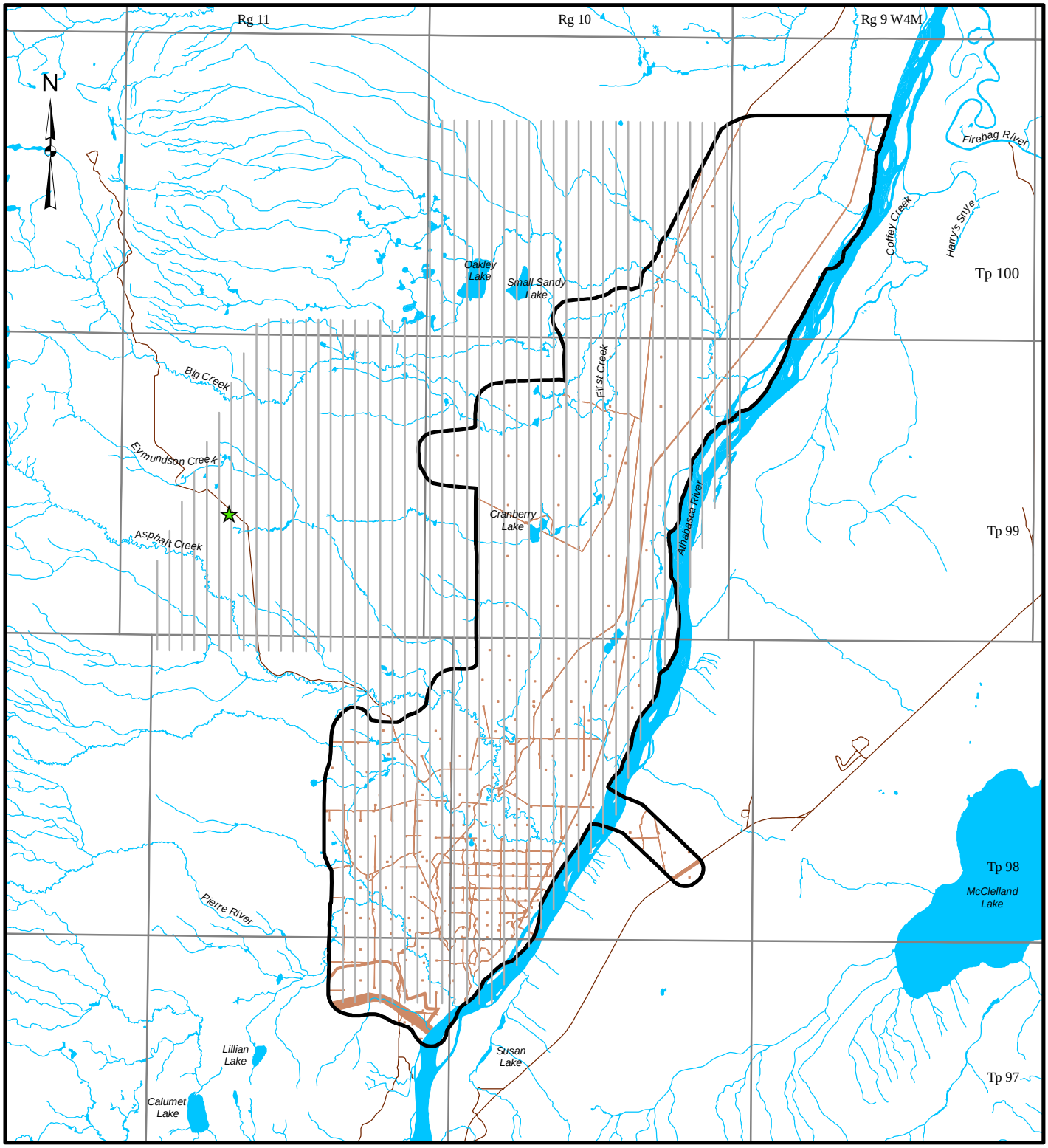

LEGEND

- PIERRE RIVER MINING AREA LOCAL STUDY AREA
- OPEN WATER
- ROAD
- UNGULATE AERIAL TRANSECT
- MOOSE

DISTURBED

- EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE
- EXISTING AND APPROVED URBAN AND INDUSTRIAL LINEAR DISTURBANCE

6 0 6

SCALE 1:180,000 KILOMETRES

REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2004), and Alberta SRD, used under license.
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 12.

PROJECT

JACKPINE MINE EXPANSION & PIERRE RIVER MINE PROJECT

TITLE

UNGULATE AERIAL SURVEY COVERAGE AND OBSERVATIONS IN THE PIERRE RIVER MINING AREA LOCAL STUDY AREA

Shell Canada Limited

PROJECT No. 05-1344-027.7700			SCALE AS SHOWN	REV. 0
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GIS	JH	14 Nov. 2007		
CHECK	MJ	16 Nov. 2007		
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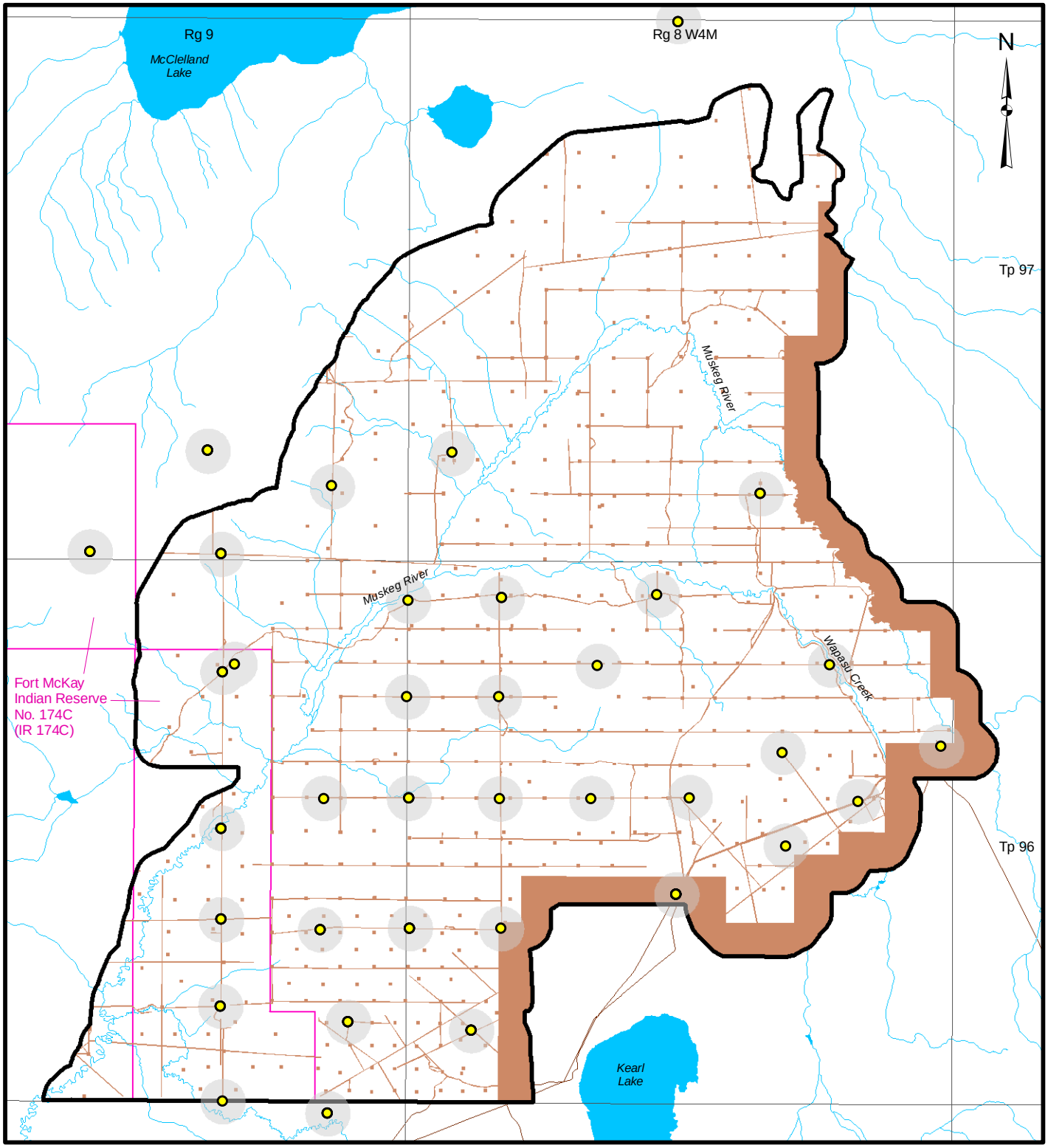

LEGEND

- JACKPINE EXPANSION MINING AREA LOCAL STUDY AREA
- INDIAN RESERVE
- OPEN WATER
- 400 m BUFFER
- PUBLIC ROADWAY
- OWL SURVEY LOCATION

DISTURBED

- EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE
- EXISTING AND APPROVED URBAN AND INDUSTRIAL LINEAR DISTURBANCE

REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2004), and Alberta SRD, used under license.
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 12.

3 0 3
SCALE 1:100,000 KILOMETRES

PROJECT
JACKPINE MINE EXPANSION &
PIERRE RIVER MINE PROJECT

TITLE
OWL SURVEY LOCATIONS IN THE JACKPINE EXPANSION MINING AREA LOCAL STUDY AREA

Shell Canada Limited

PROJECT No. 05-1344-027.7700			SCALE AS SHOWN	REV. 0
DESIGN	VR	06 Jun. 2007	FIGURE: 5.2-15	
GIS	JH	14 Nov. 2007		
CHECK	MJ	16 Nov. 2007		
REVIEW	WES/TC	19 Nov. 2007		

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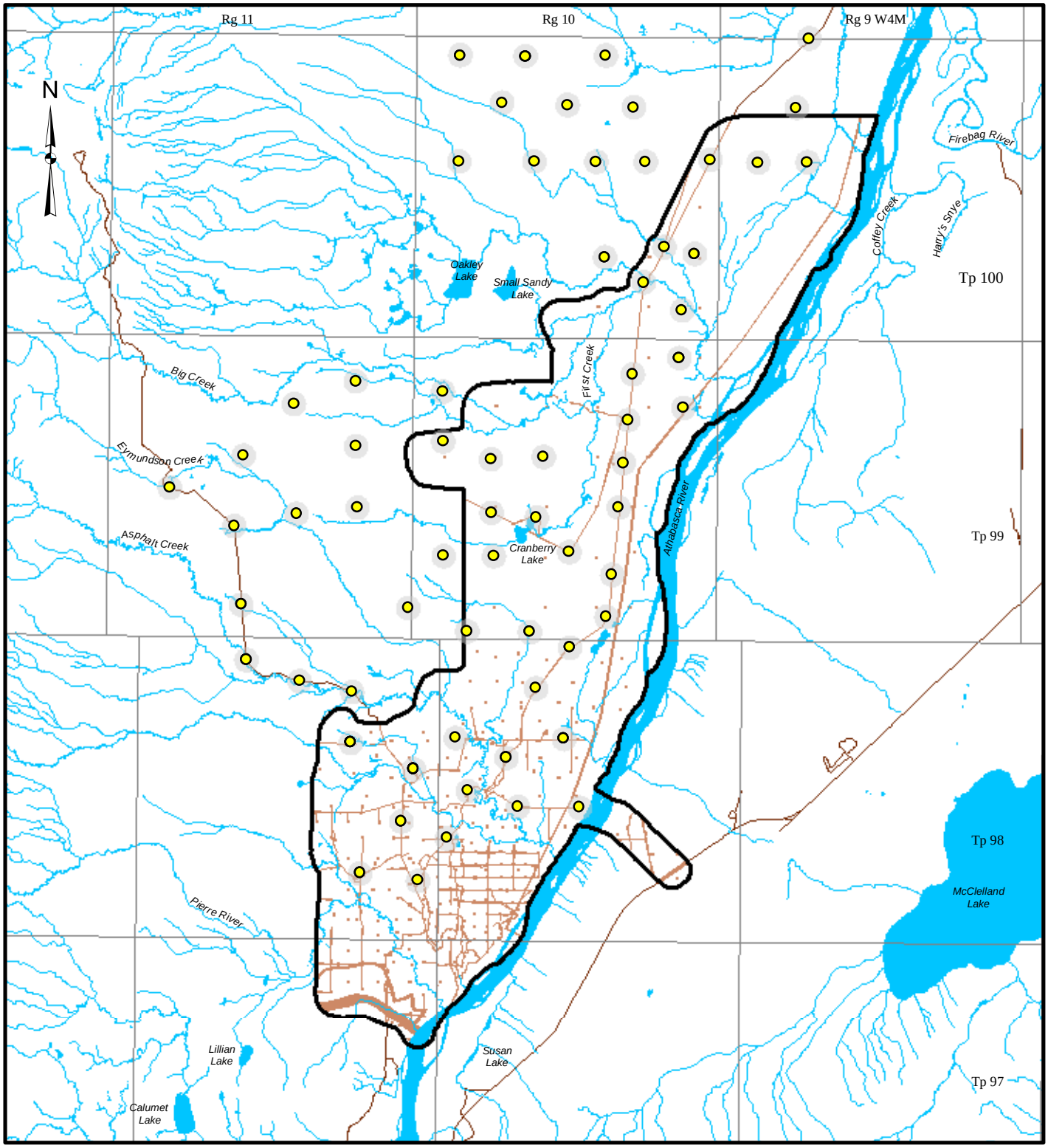

LEGEND

- PIERRE RIVER MINING AREA LOCAL STUDY AREA
- OPEN WATER
- 400 M BUFFER
- ROAD
- OWL SURVEY LOCATION

DISTURBED

- EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE
- EXISTING AND APPROVED URBAN AND INDUSTRIAL LINEAR DISTURBANCE

REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2004), and Alberta SRD, used under license.
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 12.

6 0 6
SCALE 1:180,000 KILOMETRES

PROJECT
JACKPINE MINE EXPANSION & PIERRE RIVER MINE PROJECT

TITLE
OWL SURVEY LOCATIONS IN THE PIERRE RIVER MINING AREA LOCAL STUDY AREA

Shell Canada Limited

PROJECT No. 05-1344-027.7700			SCALE AS SHOWN	REV. 0
DESIGN	VR	10 Aug. 2007	FIGURE: 5.2-16	
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REVIEW	WES/TC	19 Nov. 2007		

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5.2.2 Field Methods and Data Analysis

5.2.2.1 Photographic Bait Stations

JPME R1
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The objective of the photographic bait station survey was to determine presence and distribution of carnivores, including key species (e.g., the Cumulative Environmental Management Association [CEMA] listed carnivores such as black bears, fishers, lynx, river otters and Species at Risk Act [SARA] listed wolverine), wide-ranging species such as wolves and smaller furbearers including weasels and martens. Marten and fisher home ranges are likely in the 10 to 20 km² range (Fuller et al. 2001; Smith and Schaefer 2002). By placing photographic bait stations approximately 4.5 km apart in each study area (i.e., one per 15 km^2 on average, Figures 5.2-1 and 5.2-2), the sampling intensity was sufficient to detect most fishers and martens in each LSA and at the same time was adequate to detect wide-ranging carnivores in the LSAs within a two week sampling window.

The RECONYX® camera is a digital camera used to photograph wildlife. It has an infrared motion detector that senses heat and motion. The infrared illuminator allows the camera to take pictures at night without using a flash (RECONYX® 2004, website). All components of this camera are contained within a single housing unit. The camera uses a 512 kb Compact Flash memory card to store up to 10,000 images, a much greater storage capacity than typical 35 mm Trail Master cameras used previously in photographic bait station surveys. Programmable camera settings included a first picture delay set at two seconds, trigger sensitivity on high, with two pictures taken one second apart for each time the camera is triggered.

Skinned beaver carcasses purchased from local trappers were used as bait. The carcasses were cut into two pieces with each half placed in a closed bucket with small holes drilled on the side of the bucket to release the scent. Bait stations were set-up by suspending the bucket at least 3 m off the ground on a wire between two trees. Two large-diameter trees about 5 to 8 m apart were used to suspend the wire and bait bucket. Wildlife was unable to retrieve the bait bucket when it was suspended on a wire between two trees as described above.

The camera was fastened about 1 m from the ground onto a third tree facing the baited bucket using bungee cords and a lock. The camera was aimed at a height and angle to ensure that wildlife approaching the bucket was photographed. All objects that potentially obscured the photograph (i.e., grass or branches) were removed. A function test was performed on each camera before locking it.

Cameras were deployed for continuous two-week periods, once during each of four seasons. The camera and bucket with the beaver carcass were removed after each two-week session. However, because the same sites were used during all four seasons, the bait station wiring system was left in place between sessions. Table 5.2-2 indicates the scheduling of the photographic bait station sessions, while the locations are shown in Figures 5.2-1 and 5.2-2.

Data Analysis

Results were divided by season and species for each LSA. For each species photographed in each season, the photograph rate and the average number of days to first photograph was determined following the methods outlined by Moruzzi et al. (2002).

The photograph rate indicates the proportion of stations where a particular species was photographed. For example, if 10 stations were established and a species was only photographed at one of these, the rate will be 0.10. The number of days to first photograph indicates how long the camera was set up before a particular species was photographed. If more than one station had that species, the number of days to first photo was averaged between all station results and a range was also determined.

5.2.2.2 Photographic Corridor Monitoring

The purpose of the photographic corridor monitoring program was to collect comparable seasonal movement data on wide-ranging species within the Athabasca (within the PRMA LSA) and Muskeg River (within the JEMA LSA) corridors. Although the photographic monitoring was designed primarily to document the presence of key indicator species, the relative abundance for some species could be determined if their sample sizes were adequate.

RECONYX® cameras were deployed for continuous two-week periods, once during each of the four seasons (Table 5.2-2). Camera placement involved a variety of criteria applied at different scales. The general area for each camera was chosen to achieve an even distribution throughout the LSAs (Figures 5.2-1 and 5.2-2). Within these areas, cameras were located within defined corridors, preferably along game trails. Sites were chosen along the Athabasca and Muskeg rivers or along the top of the escarpment of the Athabasca River.

The camera was placed on a large-diameter tree about 1 m from the ground and oriented into the game trail or corridor such that an animal walking along the trail could be photographed for as long as possible. The camera functions and

exposure area were tested prior to locking the camera to the tree. Upon retrieval, the entire set-up was removed.

All incidental observations and signs of wildlife were recorded while conducting the surveys (Appendix T).

Data Analysis

Camera results were divided by season and species. For each species photographed in each season, the photograph rate and the average number of days to first photograph was determined following the methods used in other studies (Moruzzi et al 2002). The photograph rate indicates the proportion of stations where a particular species was photographed. For example, if 10 stations are established and a species was only photographed at one of these, the rate was 0.10. The number of days to first photograph indicates how long the camera was set up before a particular species was photographed. If more than one station has that species, the number of days to first photo was averaged between all station results and a range was also determined.

JPME R1 AENV SIR 481 AND JPME R1 AENV SIR 482

5.2.2.3 Winter Track Count Surveys

Objectives of the winter track count surveys were to determine the distribution, habitat use and relative abundance of ungulates and small and medium-sized carnivores. The winter track count surveys were designed to provide adequate coverage of the study area within representative vegetation types.

Two types of transects were used. Transects of about 1,000 m were placed along the Athabasca and Muskeg rivers (Figures 5.2-3 and 5.2-4). The other transects were modified Finnish triangles, 3 km long per side. The large size of triangle transects resulted in an unbiased sampling of habitat types. Triangle transects were placed throughout the LSAs (Figures 5.2-3 and 5.2-4). Track count surveys were conducted during December through April in 2005 to 2006 and 2006 to 2007.

The surveys were timed to occur after significant snowfall. Snow thickness and hardness measurements were recorded in the most common vegetation types to determine snow conditions at the time of the surveys. Vegetation communities encountered were classified and recorded according to Beckingham and Archibald (1996) for terrestrial communities and Vitt et al. (1997) for wetlands types.

Areas of anthropogenic (man-made) disturbance can be split into many categories depending on the nature of disturbance and vegetation succession.

Subdividing data reduces sample sizes and may obscure significant habitat preferences and avoidances. Some disturbances, such as roads and seismic lines, are linear, while others such as wellpads and clearcuts are non-linear. Wildlife may use linear and non-linear habitat differently. For example, some carnivores travel on linear disturbances to increase their search efficiency.

Anthropogenic disturbances were classified using the following criteria. All paved roads, gravel roads and winter roads were lumped together as active "roads". All disturbed cutlines and Rights-of-Way (ROW) were lumped together as ROW regardless of their vegetative cover. All non-linear disturbed areas, such as clearcuts with no identified successional vegetation, disturbed areas without identified successional vegetation or without vegetation were reported together as "disturbed". Ice, rivers, lakes and open water (WONN) habitats were reported together as "ice".

Experienced trackers recorded all individual animal tracks using an intercept method. A single transect intercept by a single species was recorded as one crossing. Where animals of the same species cross the transect in a "trail", an attempt is made to determine the number of individuals involved. If the number of individuals could not be determined, the observation was recorded as one "trail", which was considered three individual crossings for the purpose of statistical analysis. In situations where an area was heavily used, a "network" was recorded for a given 10-m segment of a transect, and was considered as seven individual crossings for the purpose of statistical analysis. All furbearer and ungulate tracks encountered along the linear transects were recorded in 10-m intervals, and a Global Positioning System (GPS) waypoint was recorded for each 10-m segment that contained tracks. Information on habitat type and structure was recorded for all transects, and all incidental observations of wildlife and wildlife sign were recorded.

In total, 117 km of transects in 41 vegetation communities representing 1,027 km-days were sampled in the Project LSAs (Table 5.2-3). Temperatures ranged from -15 to -20°C during the surveys and snow conditions ranged from poor to excellent. Fair and poor tracking conditions were encountered as a result of rapidly changing conditions, most frequently in the spring.

Table 5.2-3 Vegetation Types Sampled During the Winter Track Count Surveys on the Project Local Study Areas

Ecosite Phases/Wetlands Types[(a)]	Map Code	km-Days Sampled
lichen jack pine	a1	17.0
blueberry jack pine - aspen	b1	46.4
blueberry aspen / white birch	b2	4.3
blueberry aspen - white spruce	b3	24.3
blueberry white spruce - jack pine	b4	17.2
forested bog	BFNN	0.6
open bog	BONN	<0.1
shrubby bog	BONS	1.5
wooded bog	BTNN	70.6
Labrador tea mesic jack pine - black spruce	c1	11.4
low-bush cranberry aspen	d1	15.1
low-bush cranberry aspen - white spruce	d2	136.5
low-bush cranberry white spruce	d3	11.1
disturbed - burn	disturbed-burn	6.0
disturbed - clearcut	disturbed-clearcut	13.8
disturbed - cutline	disturbed-cutline	12.6
disturbed - graminoid	disturbed-Gram	6.7
disturbed - non-vegetated	disturbed-Non Veg	0.2
disturbed - road	disturbed-road	7.1
disturbed - right of way	disturbed-ROW	9.6
disturbed - shrub	disturbed-shrub	35.5
dogwood balsam poplar - aspen	e1	4.7
dogwood balsam poplar - white spruce	e2	11.7
dogwood white spruce	e3	7.1
horsetail balsam poplar - aspen	f1	0.6
horsetail balsam poplar - white spruce	f2	0.6
horsetail white spruce	f3	1.0
forested fen	FFNN	0.2
shrubby fen	FONS	58.5
open fen	FOPN	3.1
treed fen with internal lawns	FTNI	0.2
wooded fen	FTNN	275.2
Labrador tea - subhygric black spruce - jack pine	g1	17.8
Labrador tea / horsetail white spruce - black spruce	h1	21.1
ice	ice	2.0
riparian	Riparian	2.4
shrub	Shrub	0.9
graminoid marsh	MONG	19.4
shrubby swamp	SONS	126.5
wooded swamp	STNN	20.7
shallow open water	WONN	6.1
Total		**1,027**

(a) Beckingham and Archibald (1996) and Vitt et al. (1997).

Data Analysis

Proportions of transects in each of the ecosite phases and wetlands types was used to calculate expected values for statistical analysis. Data were analyzed in terms of the number of tracks per species per km-day which was calculated by dividing the number of tracks observed for each species in each vegetation type by the distance travelled times the number of days since last snowfall.

$$\text{Tracks per km-day} = \frac{\text{number of tracks observed}}{\text{distance [km]} * \text{time since last snowfall [days]}}$$

Data were analyzed using Chi-square tests and Bonferroni confidence intervals (Byers et al. 1984; Zar 1999) to determine if the abundance of each species differed significantly among habitat types. Where Chi-square tests were significant, Bonferroni confidence intervals were used to determine the relationship between a species and a habitat type (i.e., whether there was a significant difference between the expected use of a habitat and actual use as measured by winter tracking).

JPME R1
AENV SIR
483

5.2.2.4 Marsh Bird Surveys

Surveys specific for marsh birds were conducted to determine the distribution and habitat associations of sora, yellow rail, Virginia rail, American bittern and pied-billed grebe in the LSAs in conjunction with nocturnal amphibian call surveys. The marsh birds surveyed are primarily nocturnal and are hard to detect on traditional point counts due to their secretive and crepuscular nature (i.e., active at twilight or just before dawn), dense habitats and inconsistent vocalizations (Prescott et al. 2001; Priestley 2002).

To increase detection rates, Golder surveyed for these five marsh bird species by broadcasting recorded breeding calls to elicit responses following the Alberta Marsh Monitoring Program (MMP) protocol developed through Bird Studies Canada (Priestly 2002). Auditory surveys began 30 minutes after sunset. Surveys consisted of five minutes of passive listening followed by a single broadcast of the call playback recording. Individual species were identified by their distinctive calls. Information recorded at each survey point included ecosite phases and wetlands type, dominant emergent vegetation, location of survey point, weather data and moon phase, and visibility. Marsh birds respond to weather conditions; therefore, air and water temperatures, wind speed, cloud cover and precipitation were also recorded at each site. Surveys were discontinued if air or water temperatures, or wind conditions were judged to interfere with marsh bird calls or call perception. Weather was deemed unacceptable if the wind was more than 20 km/h or if precipitation was greater than a low drizzle.

Survey plots were predetermined using the vegetation classification to provide a representative sample of habitat types. Additional plots were selected during daylight hours if additional wetlands were found along the travel routes that were less than 250 m from another plot. Plots were placed at least 250 m apart (Figures 5.2-5 and 5.2-6) to avoid overlap because crews can detect and distinguish marsh bird species up to 125 m away. All incidental wildlife sightings (e.g., observations of individuals, nests, roosting sites, feeding sites) were recorded.

Surveys were conducted at 96 sites between May 24 and 30, 2006 and May 23 and 26, 2007, in conjunction with the nocturnal amphibian call survey. Survey effort was dispersed across the LSAs to the maximum extent possible given the wet and relative inaccessibility of much of the LSAs. Weather conditions were favourable during all call surveys.

Waterbody types sampled included cutlines/ditches, creeks, lakes/ponds, rivers and standing water. A total of 96 different plots were sampled across six different waterbody types, 12 ecosite phases and wetlands types and four different disturbed areas. Section 5.5 details ecosite phases and wetlands types visited.

5.2.2.5 Amphibian Surveys

Amphibian field surveys methods were as described in the Shell Jackpine Mine – Phase 1 Wildlife Environmental Setting Report (Table 5.2-1). A total of 210 amphibian survey plots were sampled during two surveys conducted in 2006 (149 surveys plots between May 9 to 15, 2006 and 61 survey plots between May 24 to 29, 2006). These plots are shown in Figures 5.2-5 and 5.2-6. An additional 35 plots were sampled on PRMA LSA between May 23 and 26, 2007. Habitat types included five disturbed areas, 12 ecosite phases/wetlands types and six different waterbody types.

Data Analysis

An estimate of breeding populations was determined from the field data by rating the chorus on the call index scale (i.e., a 1 to 4 scale used to estimate abundance). This scale was converted into an index of abundance to determine if abundance of amphibian species was different among vegetation communities and waterbodies (Stevens and Paszkowski 2004; Stevens 2006, pers. comm.). Analysis of Variance (ANOVA) was used to compare amphibian abundance among vegetation communities and waterbodies. Hypothesis testing was used to test for the effect of each factor in the ANOVA model. Analysis was conducted in Statistical Package for Social Sciences 14.0 (SPSS 2005). However, statistical

analysis was performed on wood frog and boreal chorus frog data only. The Canadian toad and boreal toad data sets were too small for statistically significant analyses.

Abundance data was transformed to meet assumptions of parametric tests (Zar 1999). Boreal chorus frog data is log transformed because the standard deviations are proportional to the mean. Wood frog data is square root transformed because the variance approximates the mean and data fit a Poisson distribution (Zar 1999).

5.2.2.6 Breeding Bird Surveys

Breeding birds were surveyed to describe species occurrence, relative abundance, habitat use and classification of birds within the various habitat types (i.e., ecosite phases and wetlands types) in the JEMA and PRMA LSAs using previously described standard point count methods consistent with that of the North American Breeding Bird Survey (Ralph 1993).

Birds recorded within a 50-m radius at each plot were included in the breeding bird descriptions and analyses. Species located beyond the 50-m radius, species flying through the plots, species flying over the plots and incidental observations made between plots are listed in Appendix T.

Breeding bird surveys were conducted within the JEMA LSA over a period of five days, from June 14 to 18, 2006. A total of 165 counts were conducted in 22 habitat types (Figure 5.2-7). Breeding bird surveys were conducted within the PRMA LSA over a period of three days, from June 5 to 7, 2007. A total of 67 counts were conducted in 20 habitat types (Figure 5.2-8).

Description of Bird Community Composition

Descriptors of bird community composition were calculated for each plot using the data collected. Descriptors included bird species abundance, richness (i.e., number of species) and diversity. Diversity was calculated using the Shannon-Weiner Index (Krebs 1989).

Species richness and diversity were tested statistically to determine whether they differed among habitat types in the RSA. Both richness and diversity values were not normally distributed count data; therefore, a non-parametric Kruskal-Wallis test was performed for each using SAS (SAS Systems 2002).

Classification of Bird Species and Habitat Types

Classification or grouping of bird species and habitat types was done to examine habitat use and reveal similarities between bird species and habitat types in the RSA. Bird observations were separated into terrestrial and wetlands habitats for analysis. Data from transition habitats (i.e., Labrador tea-subhygric black spruce-jack pine [g1] and Labrador tea/horsetail white spruce-black spruce [h1] ecosite phases) were included in the terrestrial habitat analysis.

The total number of detections for each species was calculated for each habitat type. The total number of detections in each habitat type was extrapolated to give bird abundances per 40 ha to compensate for unequal sampling of habitat types. To weigh common and uncommon species equally, data were then standardized by dividing the number of detections for a species in a given habitat type by the total number of detections for that species. Standardized values ranged from zero to one. The standardized values were then ranked according to the following categories:

- "0" = 0;
- "1" = 0.01 to 0.09;
- "2" = 0.10 to 0.19;
- "3" = 0.20 to 0.29;
- "4" = 0.30 to 0.39;
- "5" = 0.40 to 0.49; and
- "6" = 0.50 to 1.00.

Each species then received a rank based on its relative frequency of occurrence within each habitat type. These rank scores provided an index of relative species abundance among habitat types and were used to perform TWINSPAN to classify bird species and habitat types into groups.

Habitat assemblages are called "groups" and species assemblages are called "guilds". Birds within a guild are more similar to each other in habitat use than they are to birds outside their guild. Habitat types within a group are more similar to each other in bird species composition than they are to habitat types outside their group. Stand age was not included in the analyses.

Detrended Correspondence Analysis (DCA) was used to show the associations of birds and habitat types. Habitat types and bird species that are closer together on a DCA plot are considered to be more similar to each other than those points that

are further apart (ter Braak 1995). The DCA plot illustrates which species and habitat groupings are better classifications than others.

5.2.2.7 Bat Surveys

Bat surveys were conducted to describe species occurrence, relative activity and habitat preferences of bats within the various ecosite phases and wetlands types in the JEMA and PRMA LSAs. The presence of bats is documented by capture in mist nets and by recording echolocation calls.

Bat surveys were conducted from July 24 to 30, 2006 and July 13 to 19, 2007, when young-of-the-year were likely to be flying, but before their migration to hibernacula occurred. Survey data analysis for the PRMA LSA are limited to 2006 field surveys because data analysis for field surveys completed in July 2007 (Table 5.2-2) could not be completed prior to submission of the ESR.

JPME R1
AENV SIR 484

Capture

Mist nets were set according to recognized guidelines (Vonhof and Hobson 2001) in habitats where capture was likely (e.g., over small streams or channels, beaver ponds and dams, and roads or trails surrounded by dense vegetation). Mist nets were opened at sunset to prevent the capture of birds. The nets remained open for 2.5 to 3.5 hours depending on bat activity and weather conditions. Mist net hours were calculated based on the number of active hours per 6-m-wide net. For example, a single 6-m-wide net open for two hours equals two mist net hours, or a double-high 6-m-wide net open for two hours equals four mist net hours.

Nets were checked every 15 minutes to reduce the likelihood of injury to captured bats. Species, age, sex, forearm length, mass and reproductive condition were recorded for each bat captured. A wing punch was taken from captured northern long-eared bats for DNA analysis to confirm species designation.

Ultrasonic Detection

Bat activity was measured in ecosite phases and wetlands types using an AnabatII detector (Titley Electronics, Ballina, Australia). Survey locations were systematically established at least 500 m apart to minimize encountering the same bats twice. All-Terrain Vehicles (ATVs) were used to travel existing roads, trails and seismic lines throughout the LSAs to access survey locations. Each site was visited twice to capture variations in activity throughout the night.

Surveying started 30 minutes after sunset. Time, temperature and wind conditions were recorded at each survey location. During each five-minute sampling period the detector was slowly rotated 360 degrees while keeping the microphone pointed overhead. The position was varied as it rotated, but as soon as a bat was detected the microphone was held stationary to avoid recording the same bat twice. Ten seconds after the bat passed, rotation of the microphone resumed.

Call Analysis

When bats echolocate, they produce a series of vocalizations known as calls. A sequence of calls is a single pass. A single pass can be divided into three phases. As a bat explores a foraging area, the calls are longer in duration and the time between calls is longer, termed the "search phase". If a bat detects an object, the calls enter the "approach phase," where calls are produced quickly to provide the bat with more information about the object. If the object is suitable prey, a third phase occurs. The bat produces a "terminal feeding buzz," a rapid burst of echolocation calls to provide precise information about the insect.

The number of passes detected per unit time provides an index of relative bat activity for plot locations. The number of feeding buzzes detected is used as a relative measure of foraging activity at the plot locations (Griffin et al. 1960).

Echolocation call characteristics are believed to be species-specific (O'Farrell et al. 1999). To identify bat species, several variables of search phase calls are measured, including maximum frequency (i.e., the highest frequency of a call), minimum frequency (i.e., the lowest frequency of a call), duration and slope. From these parameters, simple slope is calculated as the difference between the minimum and maximum frequency divided by the duration. The characteristic slope of the call is also calculated, which is the slope of the flattest part or the body of the call.

Larger bat species, including hoary bats, silver-haired bats and big brown bats produce echolocation calls that have an upper limit of 25 kHz. Big brown and silver-haired bat calls are too similar to be distinguished from each other but can be distinguished from other species. These calls can be distinguished from smaller species, such as red bats and bats in the *Myotis* genus (i.e., little brown bat, northern long-eared bat) whose echolocation calls typically have an upper limit of around 35 to 40 kHz. Effort was made to distinguish *Myotis* species' calls although their calls have similar characteristics in the same frequency range and are therefore difficult to separate. Hoary and red bats each have unique call features that can be used to separate them from each other.

Table 5.2-4 presents the Anabat analysis categories used. When calls were not easily placed into a distinct category, other call characteristics were taken into consideration, such as shape of call, pattern of calls in the pass, immediately adjacent bat passes and time between calls. These decisions were made on a pass-by-pass case.

Other considerations during analysis included the number of bats recorded in a given pass, and which harmonic(s) were recorded. In the analysis, only search phase calls were analyzed; however, feeding buzzes were recognized and noted where clear. In northern long-eared passes, feeding buzzes were not always clearly recognizable and could therefore be underestimated.

Table 5.2-4 AnaBat Analysis Categories

Species Group	Species	Common Names
Eptesicus fuscus/ Lasionycteris noctivigans	*Eptesicus fuscus/ Lasionycteris noctivigans*	big brown/silver-haired
Myotis septentrionalis	*Myotis septentrionalis*	northern long-eared
Myotis lucifugus	*Myotis lucifugus*	little brown
high-frequency bats	*M. septentrionalis, M. lucifugius* and *Lasiurus borealis*	northern long-eared, western long-eared, little brown, red bat

Call characteristics were compared to reference calls from the literature (Adams 2003), from a pre-existing library of echolocation passes obtained from the Anabat System Manual (Corben and O'Farrell 1999) and a study conducted in similar habitat and at similar latitude (Patriquin 2001). The use of local reference calls, where possible, minimizes potential differences in calls due to geographic variation. A set of criteria established for discriminating between background noise and calls was used to ensure consistent, accurate measurement of call variables (Patriquin 2001) and species assignment.

5.2.3 Traditional Knowledge

Traditional wildlife knowledge and resource use data collected as part of the Traditional Knowledge and Resource Use ESRs were integrated into Sections 5.3 (Mammals), 5.4 (Birds), and 5.6 (Important Wildlife Habitat) of this ESR.

5.2.4 Incidental Wildlife Sightings

All incidental wildlife sightings including observations, calls, sign and/or scat were recorded during each wildlife survey. These observations are presented

where appropriate throughout the results and have been compiled together in Appendix T.

5.2.5 Regional Data

Conditions in the area surrounding the Project LSAs are described by wildlife data in recent EIAs. These projects include Albian Sands Muskeg River Mine, and Muskeg River Mine Expansion, Shell Jackpine Mine – Phase 1, Canadian Natural Horizon Project, Deer Creek Energy Joslyn Project and its predecessors, TrueNorth Fort Hills Project, Syncrude Aurora North and South, Imperial Oil Kearl Oil Sands Project, Husky Sunrise Project and the Synenco Northern Lights Project. Appendix V summarizes available wildlife data from the Oil Sands Region.

5.2.6 Important Wildlife Habitat

Important wildlife habitat is determined using the following sources:

- a literature review, including Environmentally Significant Areas (ESAs) (Westworth 1990) and ungulate zones in and around the LSAs;
- a review of data collected for this environmental setting report;
- an evaluation of important ecosite phases and wetlands types; and
- wildlife diversity indices used to determine important ecosite phases and wetlands types for terrestrial wildlife.

5.2.7 Species of Concern

Species of concern are defined as those species observed in the Project LSAs that are listed by provincial and federal government agencies or are Key Indicator Resources (KIRs) for this ESR. The status of wildlife in Alberta has been ranked nationally (COSEWIC 2007), provincially (ASRD 2005a) and regionally (Westworth 2002). At the provincial level, these species are designated as "Sensitive", "May Be At Risk" and "At Risk" (ASRD 2005a). At the federal level, these species are designated as "Endangered", "Threatened", or "Special Concern" (COSEWIC 2007).

The CEMA has identified 24 species and species groups based on three criteria: biological vulnerability, socio-economic importance and logistical criteria (Westworth 2002). Biological vulnerability criteria include population status, ecological role, sensitivity to development, regulatory importance and habitat specificity. Socio-economic criteria include traditional and cultural importance,

subsistence use, economic importance and consumptive recreational importance. Finally, logistical criteria include ease of monitoring and likelihood of detecting change. Based on these criteria, CEMA identified three priority levels for these species (Table 5.2-5).

Table 5.2-5 Cumulative Environmental Management Association Priority Indicators for Wildlife Environmental Setting Description

CEMA Priority 1 Species	CEMA Priority 2 Species	CEMA Priority 3 Species
Canadian toad	***black bear***	wood frog
moose	***beaver***	wolf
woodland caribou	river otter	bald eagle
muskrat	***ducks and geese***	common loon
fisher/redbacked vole	ruffed grouse	deciduous forest bird community
old growth forest bird community	***mixedwood forest bird community***	wetlands forest bird community
	pileated woodpecker	pine forest bird community
lynx/snowshoe hare	***boreal owl***	early succession forest bird community
		northern goshawk or broad-winged hawk

Note: ***Bold***, ***italicized font*** indicates those species chosen as Key Indicator Species for the Jackpine Mine Expansion & Pierre River Mine Project Wildlife Environmental Setting Report.

Source: Westworth 2002.

JPME R1
AENV SIR
485

Key Indicator Resources (KIRs) for this ESR are selected based on their CEMA priority levels, ecological significance, status both nationally and provincially and the availability of wildlife data from the LSAs (Table 5.2-6). All CEMA Priority 1 species expected to occur in the LSAs are selected. Five of eight species are selected from the CEMA Priority 2 list. Species excluded are river otter, pileated woodpecker and ruffed grouse; all species for which field data consist primarily of incidental sightings and, in the case of the two bird species, are part of bird communities that are KIRs themselves. In addition, marsh birds, a subset of the wetlands forest bird community, are included because they include the yellow rail, a SARA-listed species that is an indicator of riparian health. These species and communities are the focus of this report. Other species and communities are discussed where appropriate.

Table 5.2-6 Wildlife Key Indicator Resources Selected for the Wildlife Environmental Setting Description

Key Indicator Resource	Selection Rationale
Mammals	
moose	CEMA SEWG environmental indicator, CEMA Priority 1 indicator, economic importance, recreational importance, ecological importance (primary prey species) ease of monitoring, traditional importance, abundant information
Canada lynx	provincial status, ecological importance (carnivore, predator/prey relationships), traditional and economic importance, CEMA Priority 1 indicator
black bear	traditional importance, ecological importance (carnivore), CEMA SEWG environmental indicator, CEMA Priority 2 indicator
fisher	provincial status, ecological importance (carnivore, predator/prey relationships), traditional and economic importance, CEMA SEWG environmental indicator, CEMA Priority 1 indicator
muskrat	traditional and economic importance, CEMA Priority 1 indicator
beaver	traditional and economic importance, ecological importance (keystone species), CEMA Priority 2 indicator
Birds	
owls	ecological importance (predator/prey relationships), provincial status (barred owl, great grey owl, northern hawk owl, northern pygmy owl, short-eared owl), terrestrial old growth forest indicators, CEMA Priority 2 indicator (boreal owl)
ducks and geese	recreational and traditional importance, ecological importance (riparian health indicator), provincial status (lesser scaup, American green-winged teal, northern pintail)
marsh birds	ecological importance (riparian health indicator), SARA listed species (yellow rail), provincial status (American bittern, sora, great blue heron)
old growth forest bird community	indicator of ecosystem health, provincial status for many species (e.g., black-throated green warbler), CEMA SEWG environmental indicator, CEMA Priority 1 indicator, recreational importance
mixedwood forest bird community	indicator of ecosystem health, recreational importance, provincial status for selected species, CEMA Priority 2 indicator
Amphibians	
Canadian toad	provincial status, ecological importance (riparian health), CEMA Priority 1 indicator

5.3 RESULTS – MAMMALS

5.3.1 Ungulates

Ungulates in the Project LSAs may include woodland caribou, moose, white-tailed deer, mule deer and bison.

5.3.1.1 Moose

Moose is a KIR for the Project as one of five CEMA-SEWG wildlife indicators and a CEMA Priority 1 species (Westworth 2002).

Population

Jackpine Expansion Mining Area

Fourteen observations of a total of 25 moose were recorded during the aerial survey in the JEMA LSA (Figure 5.2-13). Of the 14 observations, four observations were of individuals, nine observations were of pairs, and one observation was three moose. Of the 25 moose counted, three were identified as bulls. Of the ten observations of more than one moose, one was a cow/calf pair, and another was a bull and cow; the remaining eight were not identified to sex and age. Moose density in the JEMA LSA was calculated at 0.22 moose/km^2, which is similar to the 0.21 moose/km^2 found in the Jackpine Mine – Phase 1 area in 2001 (Golder 2002a).

A moose track density of 4.27 tracks per km-day was recorded during winter track surveys on the JEMA LSA (Figure 5.3-1).

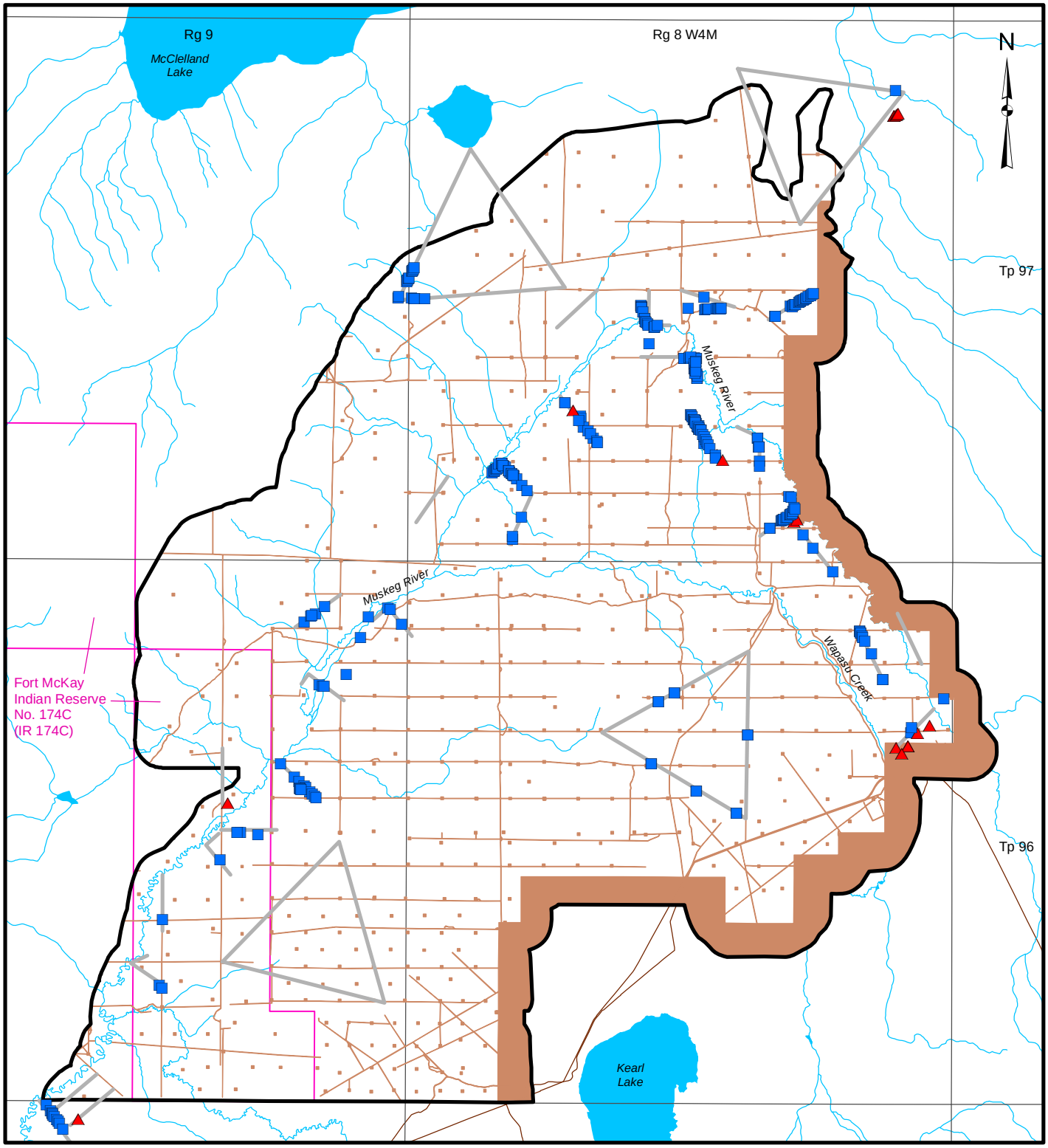
Eighteen moose photographs were taken during corridor monitoring throughout the year including six in the fall, one in the winter, nine in the spring and four in the summer in the JEMA LSA (Figure 5.3-2). The average number of days to first photo following camera set-up was 6.3 days in the fall, 11.2 in the winter, 4.9 in the spring and 11.5 in the summer. The photo rate was 0.12 in the fall, 0.08 in the winter, 0.21 in the spring and 0.18 in the summer. Photographic corridor monitoring results for all four seasons are listed in Appendix W (Tables W-9 to W-15).

Ten moose photographs were taken at bait stations throughout the year including six during the spring session and four during the summer in the JEMA LSA (Figure 5.3-2). The average number of days to first photo following camera set-up was 3.1 days in the spring and 8.5 in the summer.

The photo rate is 0.38 in both the spring and summer. Photographic bait station results for all four seasons are listed in Appendix W (Tables W-1 to W-7).

Pierre River Mining Area

One observation of a solitary moose was made during the aerial survey of the PRMA LSA (Figure 5.2-14). This was likely due to the heavily treed upland habitat throughout most of the PRMA LSA. Moose are also difficult to spot in dense stands of mature pine and spruce.



LEGEND

- JACKPINE EXPANSION MINING AREA LOCAL STUDY AREA
- INDIAN RESERVE
- OPEN WATER
- PUBLIC ROADWAY
- CORRIDOR AND TRIANGLE TRANSECT LOCATION
- DEER
- MOOSE

DISTURBED

- EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE
- EXISTING AND APPROVED URBAN AND INDUSTRIAL LINEAR DISTURBANCE

3 0 3

SCALE 1:100,000 KILOMETRES

REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2004), and Alberta SRD, used under license.
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 12.

PROJECT

JACKPINE MINE EXPANSION & PIERRE RIVER MINE PROJECT

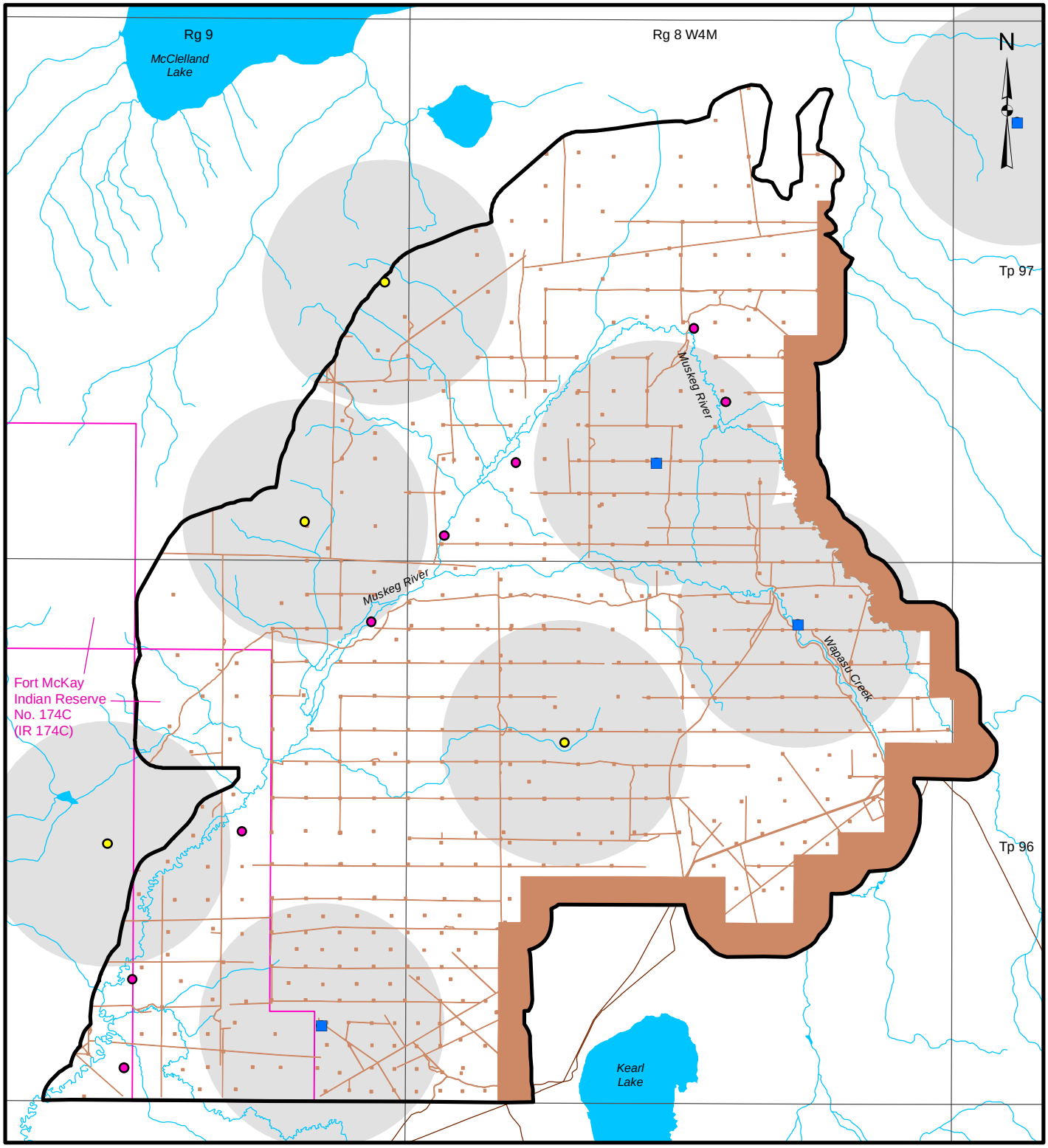
TITLE

UNGULATE TRACK LOCATIONS IN THE JACKPINE EXPANSION MINING AREA LOCAL STUDY AREA

Shell Canada Limited

PROJECT No. 05-1344-027.7700			SCALE AS SHOWN	REV. 0
DESIGN	VR	06 Jun. 2007	FIGURE: 5.3-1	
GIS	JH	14 Nov. 2007		
CHECK	MJ	16 Nov. 2007		
REVIEW	WES/TC	19 Nov. 2007		

Project: I:\CLIENTS\SHELL\05-1344-027\mapping\mxd\wildlife\DRAFT\jackpine\lsa_ungulate_wtr_jp_esr.mxd - Plot: ?:\2005\GIS\ArcMapTemplates\templates\v91\MyProject.pdf?



LEGEND

- JACKPINE EXPANSION MINING AREA LOCAL STUDY AREA
- INDIAN RESERVE
- OPEN WATER
- 2.2 KM BUFFER
- PUBLIC ROADWAY
- BAIT
- CORRIDOR
- DEER
- MOOSE

DISTURBED

- EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE
- EXISTING AND APPROVED URBAN AND INDUSTRIAL LINEAR DISTURBANCE

REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2004), and Alberta SRD, used under license.
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 12.

3 0 3
SCALE 1:100,000 KILOMETRES

PROJECT
JACKPINE MINE EXPANSION & PIERRE RIVER MINE PROJECT

TITLE
UNGULATE PHOTOGRAPH LOCATIONS RECORDED IN THE JACKPINE EXPANSION MINING AREA LOCAL STUDY AREA

Shell Canada Limited

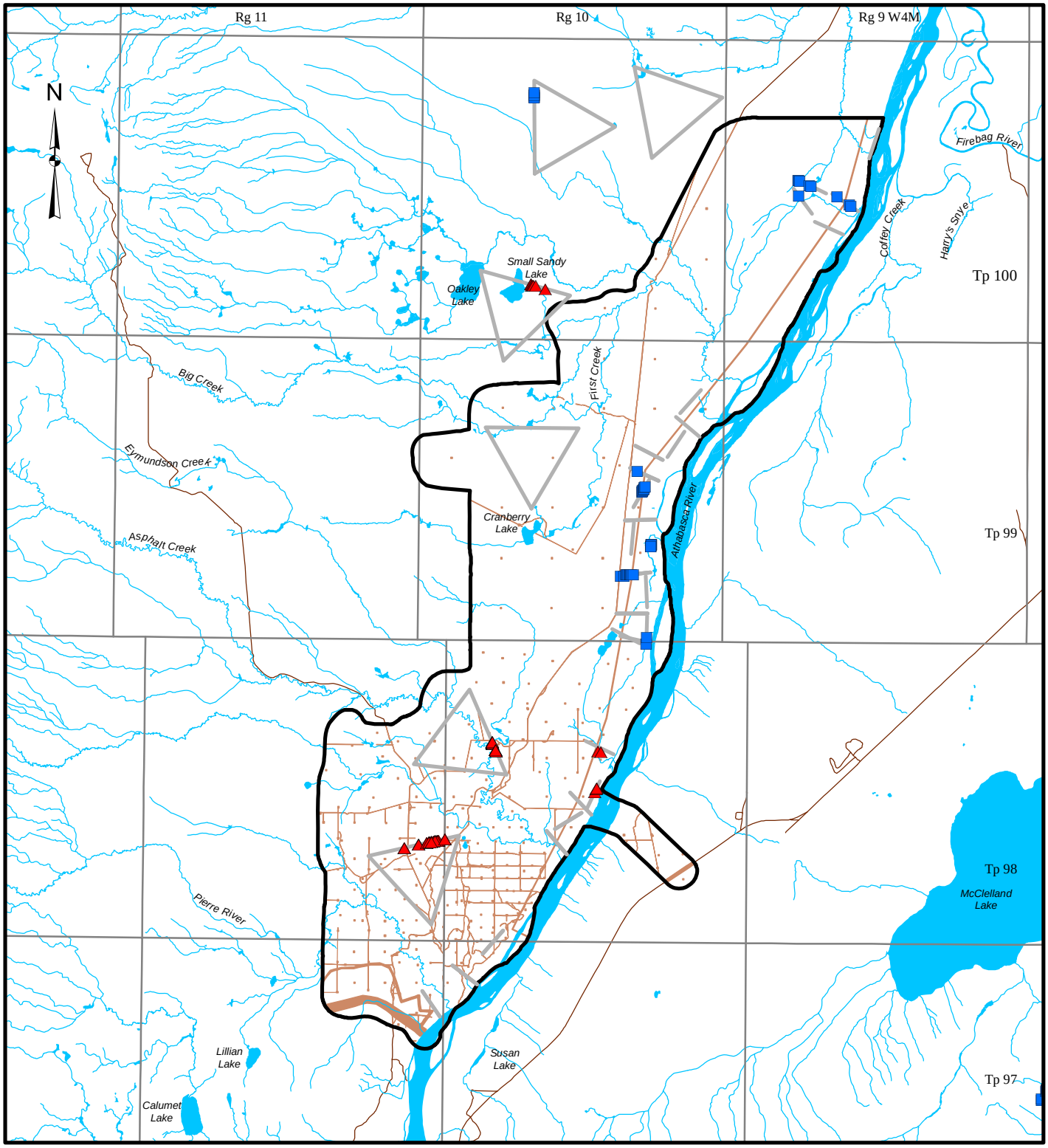
PROJECT No. 05-1344-027.7700			SCALE AS SHOWN	REV. 0
DESIGN	VR	06 Jun. 2007	FIGURE: 5.3-2	
GIS	JH	14 Nov. 2007		
CHECK	MJ	16 Nov. 2007		
REVIEW	WESTC	19 Nov. 2007		

Project: I:\CLIENTS\SHELL\05-1344-027\mapping\mxd\wildlife\DRAFT\jackpine\lsa_ungulate_jp_esr.mxd - Plot: ?:\J\2005\GIS\ArcMapTemplatestemplates\v91\MyProject.pdf?

A moose track density of 0.34 tracks per km-day was recorded during the winter track surveys in the PRMA LSA (Figure 5.3-3).

Nine moose photographs were taken during corridor monitoring throughout the year including one in the fall, five in the spring and three in the summer in the PRMA LSA (Figure 5.3-4). The average number of days to first photo following camera set-up was 4.1 days in the fall, 6.4 in the spring and 0.13 in the summer. The photo rate was 0.04 in the fall, 0.22 in the spring and 0.13 in the summer. Photographic corridor monitoring results for all four seasons are listed in Appendix W (Tables W-10 to W-16).

Nineteen moose photographs were taken at bait stations throughout the year including four during the fall session, six during the spring session and nine during the summer in the PRMA LSA (Figure 5.3-4). The average number of days to first photo following camera set-up was 3.3 days in the fall, 5.4 in the spring and 7.9 in the summer. The photo rate was 0.14 in the fall, 0.19 in the spring and 0.22 in the summer. Photographic bait station results for all four seasons are listed in Appendix W (Tables W-2 to W-8).



LEGEND

- PIERRE RIVER MINING AREA LOCAL STUDY AREA
- OPEN WATER
- ROAD
- CORRIDOR AND TRIANGLE TRANSECT LOCATION (2007)
- DEER
- MOOSE

DISTURBED

- EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE
- EXISTING AND APPROVED URBAN AND INDUSTRIAL LINEAR DISTURBANCE

6 0 6

SCALE 1:180,000 KILOMETRES

REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2004), and Alberta SRD, used under license.
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 12.

PROJECT

JACKPINE MINE EXPANSION & PIERRE RIVER MINE PROJECT

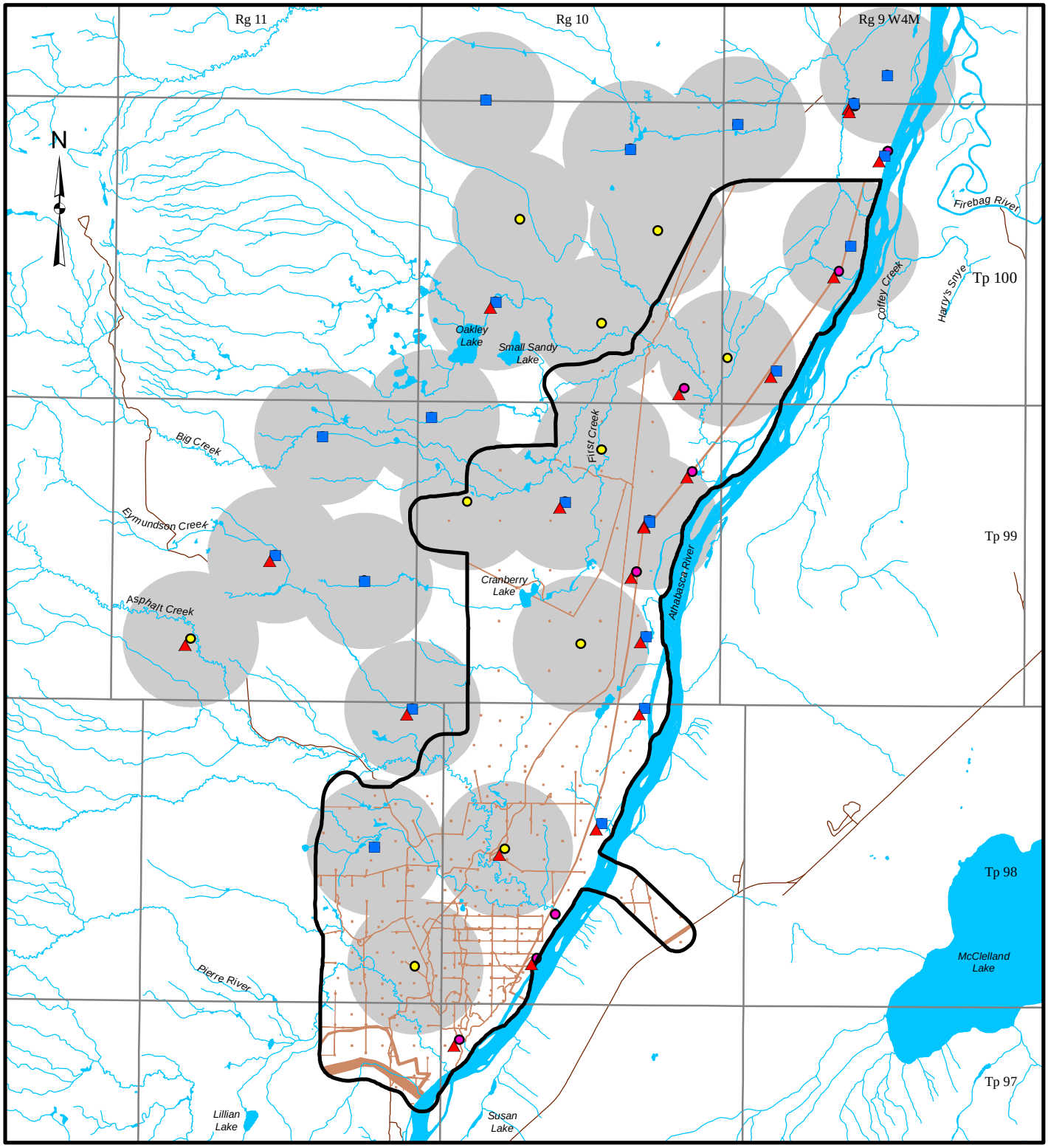
TITLE

UNGULATE TRACK LOCATIONS IN THE PIERRE RIVER MINING AREA LOCAL STUDY AREA

Shell Canada Limited

PROJECT No. 05-1344-027.7700			SCALE AS SHOWN	REV. 0
DESIGN	VR	10 Aug. 2007	FIGURE: 5.3-3	
GIS	JH	14 Nov. 2007		
CHECK	MJ	16 Nov. 2007		
REVIEW	WES/TC	19 Nov. 2007		

Project: I:\CLIENTS\SHELL\05-1344-027\mapping\mxd\wildlife\DRAFT\pierreriver\tsa_ungulate_wtr_pr.mxd Plot: 2J:\2005\GIS\ArcMapTemplates\templatesiv91\MyProject.pdf?



LEGEND

- PIERRE RIVER MINING AREA LOCAL STUDY AREA
- OPEN WATER
- 2.2 KM BUFFER
- ROAD
- BAIT
- CORRIDOR
- DEER
- MOOSE

DISTURBED

- EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE
- EXISTING AND APPROVED URBAN AND INDUSTRIAL LINEAR DISTURBANCE

REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2004), and Alberta SRD, used under license.
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 12.

6 0 6
SCALE 1:180,000 KILOMETRES

PROJECT
JACKPINE MINE EXPANSION &
PIERRE RIVER MINE PROJECT

TITLE
UNGULATE PHOTOGRAPH LOCATIONS
RECORDED IN THE PIERRE RIVER MINING
AREA LOCAL STUDY AREA

Shell Canada Limited

PROJECT No. 05-1344-027.7700			SCALE AS SHOWN	REV. 0
DESIGN	VR	10 Aug. 2007	FIGURE: 5.3-4	
GIS	JH	14 Nov. 2007		
CHECK	MJ	16 Nov. 2007		
REVIEW	WESTC	19 Nov. 2007		

Project: I:\CLIENTS\SHELL\05-1344-027\mapping\mxd\wildlife\DRAFT\pierreriver\lsa_ungulate_pr.mxd Plot: 2J:\2005\GIS\ArcMapTemplates\templatesIv91\MyProject.pdf?

Habitat

Results of this survey and others within the subregional study area show a broad range of habitat use by moose. During the aerial survey, moose were recorded most frequently in the wooded fen (FTNN), graminoid fen (FONG) and wooded bog (BTNN) wetlands types and in the low-bush cranberry aspen-white spruce (d2) ecosite phase (Table 5.3-1).

During winter track surveys, moose were recorded in 22 different terrestrial and wetland ecosites (Appendix U). Moose significantly preferred blueberry aspen - white spruce (b3), low-bush cranberry aspen (d1), dogwood balsam poplar - aspen (e1) and shrubby fen (FONS) communities. Moose used lichen jack pine (a1), blueberry jack pine - aspen (b1), dogwood white spruce (e3), Labrador tea - subhygric black spruce - jack pine (g1) ecosite phases and wooded bog (BTNN) and wooded fen (FTNN) wetlands communities less than expected (Table 5.3-2).

The prevalence of moose tracks in wetlands types and in shrubby terrestrial areas suggests that moose prefer habitats with high forage availability and that forage availability may be more important than cover habitat for moose in this region. All data indicate that moose are associated with habitats that contain high shrub cover.

Table 5.3-1 Moose Observations Recorded During the Aerial Survey by Vegetation Type

Ecosite Phases and Wetlands Types[(a)]		Number of Moose		
		Within LSA	Outside LSA	Total
burned uplands	BUu	2	0	**2**
wooded bog	BTNN	0	5	**5**
clearcut	CC	2	0	**2**
low-bush cranberry aspen	d1	2	0	**2**
low-bush cranberry aspen - white spruce	d2	3	2	**5**
wooded fen	FTNN	4	3	**7**
graminoid fen	FONG	0	3	**3**
Total		**13**	**13**	**26**

(a) Beckingham and Archibald (1996) and Vitt et al. (1997).

Table 5.3-2 Species-Specific Ecosite Phase and Wetlands Type Preferences and Avoidances as Determined During Winter Track Surveys in the Subregional Study Area, 1997 to 2007

Species	Ecosite Phases and Wetlands Types[(a)]		Chi Squared Value
	Preferred	Avoided	
moose	b3, d1, e1, FONS	FTNN, a1, b1, e3, g1, BTNN	χ^2=471.03; p<0.05
deer	d2, e3, g1, cutline	FTNN	χ^2=243.37; p<0.05
gray wolf	d1, d2	FTNN, g1	χ^2=99.81; p<0.05
coyote	d1	FTNN, h1	χ^2=58.18; p<0.05
Canada lynx	none	none	χ^2=0.17; p<0.05
fisher and marten	d1	FTNN	χ^2=291.36; p<0.05
weasels	FTNN, e3, g1	d2, b1, c1, d1, cutline, ROAD	χ^2=223.29; p<0.05
wolverine	none	none	n/a

(a) Beckingham and Archibald (1996) and Vitt et al. (1997).

Note: Only preferences and avoidances for species/habitat interactions where sample sizes met assumptions of chi-squared analysis are reported.

n/a = Not applicable.

Traditional Knowledge and Resource Use

Moose were described by Fort McKay participants in a CEMA-sponsored Wildlife Movement Traditional Environmental Knowledge (TEK) Workshop as moving with the seasons, but are generally found in places where there is food and water (FMA 2005). In winter, they move to higher ground or to larger swamps and rivers where there is less snow. In summer, they are found near large bodies of water where they can escape biting insects.

Hunting, particularly of moose, supplies a significant portion of the protein needs of the Fort McKay community. In fact, some people indicate that they eat moose every day. All trappers indicated there were moose on their Registered Fur Management Areas (RFMAs) and all hunted moose themselves. However, there were observations that the moose meat from the Fort McMurray area was of poorer quality than the moose meat procured from the Fort Chipewyan area (Golder 2002b).

The holder of RFMA #1275 says that moose can be found everywhere along his trapline. Conversely, although he hunts moose every year, the holder of RFMA #2939 did not find moose on his line last year. He indicated that more people access the area since the old McKay Road has been cleared and this has affected moose populations. In the JEMA LSA, the holder of RFMA #1714 finds moose primarily in poplar stands near muskeg. He indicated that moose are

still plentiful along the Firebag River, but the numbers get sparse near Muskeg River and Wapasu Creek. The holder of RFMA #2331 indicated that at one time McClelland Lake had the highest moose population in Alberta, but this is no longer true. The holder of RFMA #2137 also says the moose population has steadily dropped and believes it is likely because Alberta Pacific Forest Industries Inc. has removed all the poplar. However, the holder and junior partner indicate that moose are healthy. On RFMA #1716, the holder believes the animals are generally in good health except a few hunted moose that had white lumps in their stomachs. The holder suspects this is the result of a polluted environment, but the moose meat is still eaten. He believes that the additional people and hunters using existing roads have increased hunting pressure.

The Resource Use Survey (RUS) conducted for the Resource Use ESR (Golder 2007b) found that the four species of game hunted most often within the Project LSAs are in order, moose, deer, black bear and grouse. The results of the RUS indicate that most (64%) of the hunting respondents felt that their hunting success for all species was less in 2007 than it was five years earlier. The reason cited for the decrease in success was the ongoing development in the area that resulted in clearing of forests and increased access. It was felt that wildlife populations in the region were dropping. Birch Mountain Outfitters hunts actively in Wildlife Management Unit (WMU) 530 and 531, both in the JEMA and PRMA LSAs. They have historically had a 90% success rate for moose hunting, but in the 2006/2007 season they did not see a single moose. They view the increase in noise and loss of habitat from oil sands development as responsible for the reduced moose populations.

Incidentals

Moose and moose sign (i.e., tracks, browse) were seen frequently during all wildlife surveys on the Project LSAs (n=66). In addition to typical sightings of moose in the Project LSAs, a cow and calf moose were seen swimming to a large forested island in the Athabasca River during a flight to the PRMA LSA. Subsequent investigations of the island revealed plentiful moose sign including tracks, heavy browse and beds.

Regional Data

Moose density recorded during the aerial survey in the JEMA LSA (0.22 moose/km^2) is similar to those recorded in the Oil Sands Region historically. Moose densities in the PRMA LSA are substantively lower than those reported elsewhere, but the results of the survey were likely influenced by sightability in the predominantly forested LSA (Appendix V). On the Canadian Natural Horizon Project, a moose density of 0.15 moose/km^2 was recorded. Most observations were in low-bush cranberry aspen (d1), low-bush cranberry

aspen - white spruce (d2) and dogwood balsam poplar - aspen (e1) ecosite phases (CNRL 2002). During four aerial surveys conducted between 2003 and 2005 on the Imperial Kearl Oil Sands Project, the overall density of moose in the Kearl LSA was 0.28 moose/km^2 (Imperial Oil 2005). On the Suncor Voyageur South Project, a moose density of 0.25 moose/km^2 was recorded. Most observations were in low-bush cranberry aspen (d1), wooded fen (FTNN), cutblocks, wooded bog (BTNN) and shrubby fen (FONS) ecosite phases and wetlands types (Golder 2007a). Alberta Environmental Protection (AEP 1998) reported that the average moose density in Moose Management Area 8, which includes the JEMA LSA, is 0.13 moose/km^2. This average is based on nine surveys, which yielded densities between 0.08 and 0.31 moose/km^2.

Moose track densities recorded in the JEMA LSA (4.27 tracks per km-day) were very high relative to almost all those reported from other moose surveys in the Oil Sands Region, while on the PRMA LSA the density was similar to or lower than others reported previously (0.34 tracks per km-day), (Appendix V). On the Canadian Natural Horizon Project, a moose track density of 0.16 tracks per km-day was recorded. Tracks were observed in low-bush cranberry aspen - white spruce (d2), low-bush cranberry white spruce (d3), cutblock and burn, but a preference was observed for burn. Low-bush cranberry white spruce (d3) was used less than expected (CNRL 2002).

On the Suncor Voyageur South Project, a moose track density 0.66 tracks per km track day was recorded. A preference was demonstrated for blueberry aspen - white spruce (b3), dogwood balsam poplar - aspen (e1) and low-bush cranberry aspen (d1) ecosite phases (Golder 2007a). On the TrueNorth Fort Hills Project, a moose track density of 0.37 tracks per km-day was recorded (Golder 2000a). Ecosite phase dogwood balsam poplar - aspen (e1) was preferred. Low-bush cranberry aspen - white spruce (d2), Labrador tea - subhygric black spruce - jack pine (g1), wooded bog (BTNN) and wooded fen (FTNN) ecosite phases and wetlands types were used less than expected.

Moose track densities on the Imperial Kearl Oil Sands Project varied between 0.28 and 0.83 tracks per km-day during three surveys, with the highest densities recorded in midwinter (Imperial Oil 2005). On the Synenco Northern Lights Project (Synenco 2006), moose track occurrence was slightly higher than on the JEMA LSA (4.46 tracks per km track day) and appeared to prefer deciduous (31.90 tracks per km-day) and mixedwood forests.

5.3.1.2 Mule Deer and White-Tailed Deer

Deer are at the northern end of their range in the Oil Sands Region (Smith 1993). Mule deer are traditional residents of the western boreal forest at its southern

fringe and are most often associated with cleared or disturbed habitat. Populations in the Oil Sands Region are generally small and localized. At one time, white-tailed deer were not found in the Oil Sands Region. However, recent changes to access, creation of open habitat from human settlement, milder winter weather, the absence of ungulate competition and scarcity of predators have been hypothesized to have resulted in increased white-tailed deer observations within northern regions (Veitch 2001). First Nations and non-Aboriginal trappers who hunt deer concur with this observation. Most of the data collected during environmental setting surveys do not enable distinction between the two deer species; therefore, deer data were combined for the winter track analysis.

Population

Jackpine Expansion Mining Area

No deer were recorded during the ungulate aerial survey of the JEMA LSA. A deer track density of 0.14 tracks per km-day was recorded during winter tracking on the LSA (Figure 5.3-1).

Thirty-five white-tailed deer photographs were taken during corridor monitoring throughout the year including two during the fall, 17 during the spring and 16 during the summer in the JEMA LSA (Figure 5.3-4). The average number of days to first photo following camera set-up was 0.9 days in the fall, 2.9 in the spring and 6.0 in the summer. The photo rate was 0.06 in the fall, 0.38 in the spring and 0.23 in the summer. Photographic corridor monitoring results for all four seasons are listed in Appendix W (Tables W-9 to W-15).

Deer were not photographed during any of the bait stations sessions in the JEMA LSA.

Pierre River Mining Area

No deer were recorded during the ungulate aerial survey of the PRMA LSA. A deer track density of 0.31 tracks per km-day was recorded during winter tracking on the LSA (Figure 5.3-1).

A total of 49 white-tailed deer photographs were taken during corridor monitoring throughout the year including eight during the fall, one during the winter, 23 during the spring and 17 during the summer in the PRMA LSA (Figure 5.3-4). The average number of days to first photo following camera set-up was 2.9 days in the fall, 1.9 in the winter, 6.4 in the spring and 7.3 in the summer. The photo rate was 0.21 in the fall, 0.04 in the winter, 0.23 in the spring and 0.33 in the summer. Photographic corridor monitoring results for all four seasons are listed in Appendix W (Tables W-10 to W-16).

Photographs of 13 white-tailed deer were taken at the bait stations throughout the year including six during the fall, one during the winter, two during the spring and four during the summer in the PRMA LSA (Figure 5.3-4). No mule deer were photographed. The average number of days to first photo following camera set-up was 7.0 days in the fall, 12.0 in the winter, 8.5 in the spring and 6.3 in the summer. The photo rate was 0.14 in the fall, 0.03 in the winter, 0.06 in the spring and winter. Appendix W (Tables W-2 to W-8) presents the photographic bait station results for all four seasons.

Habitat

During the winter track surveys, deer tracks or sign were observed in 22 different terrestrial and wetland ecosites (Appendix T). Significantly preferred habitats are low-bush cranberry aspen - white spruce (d2), dogwood white spruce (e3), Labrador tea - subhygric black spruce - jack pine (g1) and cutline. Wooded fen (FTNN) is used significantly less than expected (Table 5.3-2).

In general, high-quality habitat for deer consists of spatially heterogeneous areas (Runge and Wobeser 1975) containing various forage species near areas that provide suitable cover from weather, predators and insects. Deer benefit from abundant browse and cover along watercourses and may use them as travel corridors during seasonal or dispersal movements (Brewster 1988). Deer prefer terrestrial forest, regenerating areas and riparian areas. Deer are limited by the availability of suitable habitat, winter conditions (i.e., snowfall and temperature) and predation (i.e., natural and human) (Stelfox 1993). Observations of deer tracks in the Oil Sands Region have been made in a wide variety of ecosite phases and wetlands types; however, most have been in aspen and mixedwood ecosite phases (Golder 2000a,b; Gulf 2001; OPTI 2000; URSUS and Komex 1997; Westworth, Brusnyk and Associates 1996).

Traditional Knowledge and Resource Use

Deer, principally white-tailed deer, are ubiquitous in the JEMA and PRMA LSAs. All trapline holders hunt deer. Deer supplies a portion of the protein needs of the Fort McKay community, although it is secondary to moose and hare. Opinions regarding the number of deer were mixed. According to the holder of RFMA #2939, animal numbers, including those of deer, are down due to hunting pressure associated with increased public access and outside hunters. Across the Athabasca River, the holder of RFMA #2137 felt that white-tailed deer were plentiful in the Fort Hills. Again, as was the case with moose, the deer population is said to be good near Firebag River, but there were fewer along the Muskeg River.

The RUS (Golder 2007b) found that, of the four species of game hunted most often within the Project LSAs, deer were the second most important after moose but before black bear and grouse.

Incidentals

Deer were often encountered during all wildlife field surveys (Appendix T). When deer were encountered during the surveys and could be identified, they were identified as white-tailed deer.

Regional Data

No deer were observed during aerial surveys in the Project LSAs. These results are similar to those of aerial surveys in surrounding areas. Deer were not observed during two aerial surveys on the TrueNorth Fort Hills Project (Golder 2000a), on the Rio Alto Kirby Project (Rio Alto 2002), the Albian Sands Jackpine Mine – Phase 1 Project (Golder 2002c) and the Suncor South Tailings Pond Project (Golder 2003). Deer were not recorded during late winter surveys on the Imperial Kearl Oil Sands Project and during early winter surveys the density was 0.14 deer/km^2 (Imperial Oil 2005). Generally, deer densities documented during aerial surveys in the Oil Sands Region have been low, possibly because sightability of the species is low in forested environments.

Deer track densities recorded in the Project LSAs were similar to those reported from other environmental setting surveys in the Oil Sands Region (Appendix V). On the Canadian Natural Horizon Project, a deer track density of 0.20 tracks per km-day was recorded. Deer showed a preference for low-bush cranberry aspen - white spruce (d2) and an avoidance of low-bush cranberry aspen (d1) (Canadian Natural 2002). The deer track density on the TrueNorth Fort Hills Project was 0.33 tracks per km-day (Golder 2000a); most tracks were in lichen jack pine (a1), blueberry jack pine - aspen (b1), low-bush cranberry aspen (d2), dogwood balsam poplar - aspen (e1) and dogwood balsam poplar - white spruce (e2) ecosite phases. On the Imperial Kearl Oil Sands Project the overall density was 0.11 tracks per km-day (Imperial Oil 2005). Husky (2004) reported similar winter track density for deer (0.12 tracks per km-day) in the Husky Sunrise Thermal Project adjacent to the Imperial Kearl Project LSA. On the Suncor Voyageur South Project, a deer track density 0.17 tracks per km-day was recorded; a preference was demonstrated for dogwood balsam poplar - aspen (e1) ecosite phase and ROW habitats (Golder 2007a). A deer track density of 0.17 tracks per km-day was also recorded on Deer Creek Energy's Joslyn lease (Komex 2005). Deer were not recorded during winter track surveys on the Synenco Northern Lights Project (Synenco 2006).

5.3.1.3 Wood Bison

The wood bison is listed federally as "Threatened" by COSEWIC (2007). In Alberta, the Wood Bison is considered "At Risk" (ASRD 2005a). Within a designated management area in the northwestern section of the province, bison are listed as "Endangered" under Alberta's Wildlife Act (Mitchell and Gates 2002). However, wood bison on provincial lands and are outside of the designated management area are not protected by legislation unless they are owned as livestock. The PRMA LSA is outside of the designated wildlife management area mentioned above.

Population

Jackpine Expansion Mining Area

Wood Bison were not seen during winter aerial surveys of JEMA LSA. No tracks were seen during winter track surveys and the species was not photographed at any of the photographic bait or corridor stations.

Pierre River Mining Area

Wood Bison were not seen during winter aerial surveys of PRMA LSA. No tracks were seen during winter track surveys and the species was not photographed at any of the photographic bait or corridor stations.

Habitat

Wetlands-associated meadows, open savanna-like shrublands and dry grasslands are the most important habitat types for Wood Bison in the boreal forest (Mitchell and Gates 2002). As obligate grazers, bison are associated with graminoid-dominated (i.e., grasses and sedges) plant communities (i.e., shrubby swamp (FONS), graminoid fen (FONG), shrubby swamp (SONS) wetlands types).

Traditional Knowledge

Trapline holders in the PRMA LSA (RFMA #s 1275 and 2939) reported that a small herd of buffalo moves around the area and may be seen more frequently in large swampy areas. They are occasionally shot for food.

The above-mentioned Redclay Creek bison herd is a resource concern (Sellin 2007, pers. comm.). This herd is an important species targeted by a small group of recreational hunters. This herd is not protected by the *Wildlife Act* Regulations and therefore, it provides some of the only bison hunting in the region (Sellin 2007, pers. comm.).

Incidentals

JPME R1
AENV SIR 449

Wood bison of the Redclay Creek herd were seen incidentally on several occasions in the PRMA LSA (Appendix T). Typically, the sightings were of individuals, likely bulls. However, a group of 10 to 12 was also recorded which would likely represent a cow group.

Regional Data

Historical surveys of the Redclay Creek bison herd have not been located.

5.3.1.4 Woodland Caribou

Woodland caribou is one of five CEMA-SEWG wildlife indicators and a CEMA Priority 1 species (Westworth 2002). Caribou are listed as "Threatened" by COSEWIC (2007) and as "At Risk" by ASRD (2005a).

Population

Jackpine Expansion Mining Area

Woodland caribou were not seen during winter aerial surveys of JEMA LSA and they were also not photographed at any of the photographic bait or corridor stations in the JEMA LSA. In addition, no tracks were seen during winter track surveys for the Project.

Pierre River Mining Area

Woodland caribou were not seen during winter aerial surveys of PRMA LSA and no tracks were seen during winter track surveys. Woodland caribou were also not photographed at any of the photographic bait or corridor stations in the PRMA LSA.

Habitat

Bradshaw et al. (1995) reported that caribou selected forest - open fen complexes and forested bogs and used upland areas and non-patterned fens less than expected in the winter. Black spruce muskegs (e.g., bogs, fens) are important to caribou year-round, while jack pine ridges are important in summer (Stelfox 1993). The caribou track recorded in the JEMA LSA was located in a graminoid fen (FONG) wetlands site.

Traditional Knowledge and Resource Use

Woodland caribou were described by Fort McKay participants in a CEMA-sponsored Wildlife Movement Traditional Environmental Knowledge Workshop

as, moving in circular cycles through jack pine, muskeg or "little spruce", eating caribou moss and not staying in any one place (FMA 2005). Fort Chipewyan participants described woodland caribou travelling in small groups of five or six to conserve an area's vegetation. Caribou south of Lake Athabasca travel in an east-west direction back and forth into Saskatchewan. Fort McKay participants indicated that in the vicinity of the Project, caribou were found east of the Muskeg River at Kearl Lake, around Namur and Gardiner Lakes in the Caribou Mountains and in the Birch Mountains to the north. One Fort McKay elder described that there were lots of woodland caribou on his trapline "a long time ago", but that there were far fewer now and this population decline began 20 years ago. He indicated that he didn't see any last year (2004).

Interviews with current RFMA holders indicate that caribou are present only sporadically, if at all. The holder of RFMA #1714 spotted a couple of caribou two years ago and while there are signs they still frequent the line, they have a tendency to move in and out of the area. According to the holder of RFMA #1716, there are no caribou in his area. However, woodland caribou are sometimes still hunted when they pass (e.g., RFMA #2137).

Incidentals

Woodland caribou were not seen during any other terrestrial surveys of the Project LSAs.

Regional Data

JPME R1
AENV SIR 486

One caribou track was observed during winter track surveys conducted for Shell's Muskeg River Mine Expansion in 2004 (AXYS 2005a). The Audet Caribou Zone is located 10 km northeast of the JEMA LSA, across the Firebag River. Most surveys in the areas around the JEMA LSA have not recorded caribou sign. However, caribou were recorded on the Suncor Firebag Project (Golder 2000c) and on the TrueNorth Fort Hills Project (AXYS 2001). The Synenco Northern Lights Project (Synenco 2006) and the Husky Sunrise Project (Husky 2004) fall within the Audet Caribou Zone. Woodland caribou and their sign were recorded during aerial surveys and winter tracking on the Synenco and Husky LSAs. The Birch Mountain Caribou Zone is about 50 km northwest of the PRMA LSA.

5.3.2 Canids

All three canids potentially present in the area, wolves, coyotes and red foxes, were recorded in the JEMA LSA.

5.3.2.1 Wolf

Wolves are a wide-ranging species. Pack territories may include areas larger than the LSAs. Movement corridors and habitat connectivity in the regional landscape are likely important to the species. The wolf is listed as a CEMA Priority 3 species and is provincially listed as "Secure".

Population

Jackpine Expansion Mining Area

A wolf track density of 0.07 tracks per km-day was recorded during winter track surveys in the JEMA LSA (Figure 5.3-5; Appendix U).

Five photographs of wolves were taken during corridor monitoring throughout the year including one during the fall and four during the spring session in the JEMA LSA (Figure 5.3-6). The average number of days to first photo following camera set-up is 12.9 days in the fall and 6.8 in the summer. The photo rate is 0.05 in the fall and 0.17 in the summer. Photographic corridor monitoring results for all four seasons are listed in Appendix W (Tables W-9 to W-15).

There were no wolves photographed during any bait station sessions in the JEMA LSA.

Pierre River Mining Area

A wolf track density of 0.21 tracks per km-day was recorded during winter track surveys in the PRMA LSA (Figure 5.3-7; Appendix U).

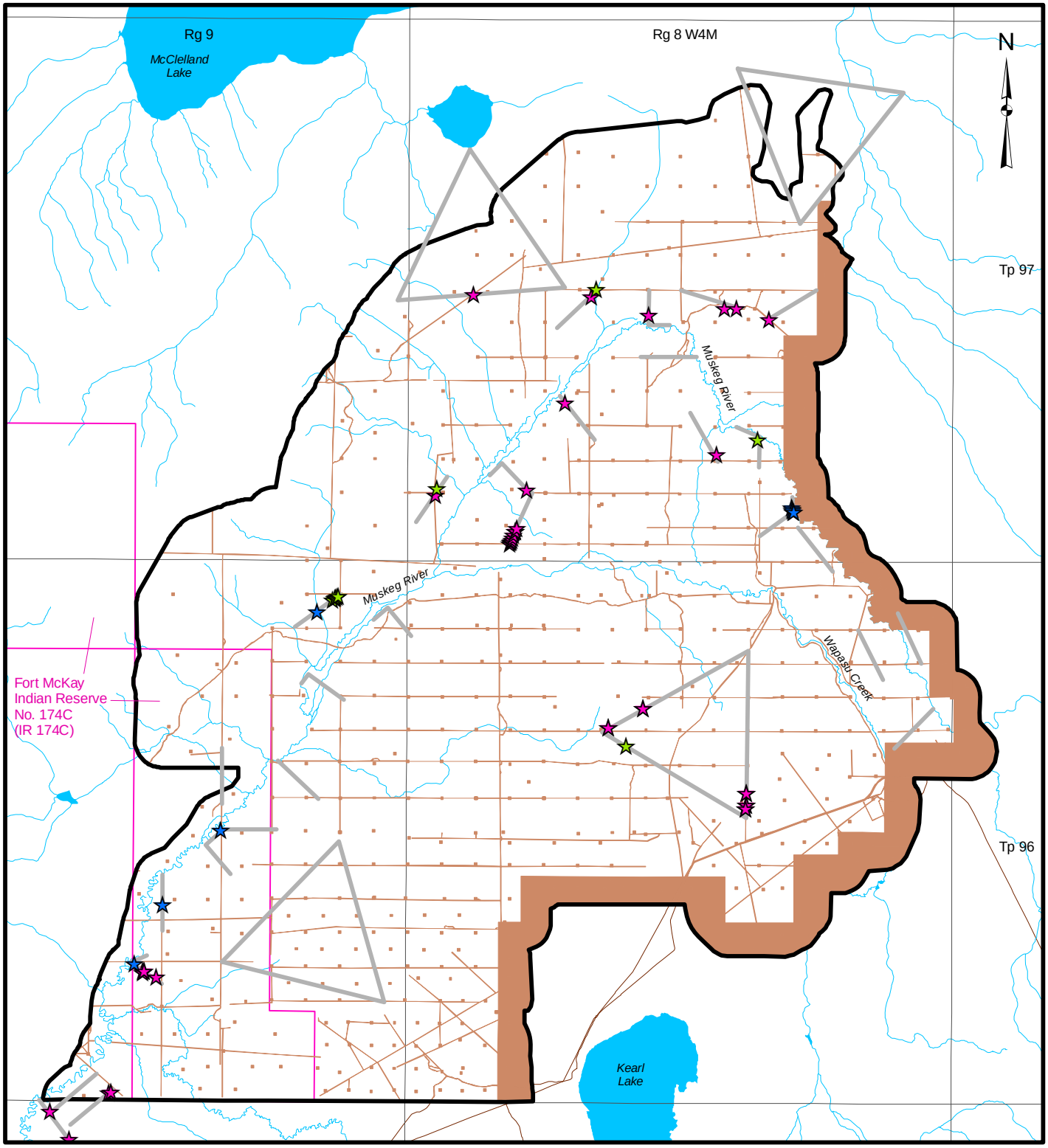
Eleven photographs of wolves were taken during corridor monitoring throughout the year including three during the fall, one during the winter, three during the spring and four during the summer in the PRMA LSA (Figure 5.3-8). The average number of days to first photo following camera set-up is 5.5 days in the fall, 2.0 in the winter, 6.0 in the spring and 7.7 in the summer. The photo rate is 0.13 in the fall, 0.04 in the winter, 0.09 in the spring and 0.17 in the summer. Photographic corridor monitoring results for all four seasons are listed in Appendix W (Tables W-10 to W-16).

Seven photographs of wolves were taken at the bait stations throughout the year including three during the fall, one during the winter and three during the summer in the PRMA LSA (Figure 5.3-8). The average number of days to first photo following camera set-up was 2.3 days in the fall, 10.5 in the winter and 5.6 in the summer. The photo rate was 0.04 in the fall, 0.03 in the winter and 0.06 in the summer. Appendix W (Tables W-2 to W-8) presents the photographic bait station results for all four seasons.

Habitat

During the winter track surveys, wolf tracks or sign were observed in 17 habitat types including cutlines and clearcuts (Appendix U). Significantly preferred habitats are low-bush cranberry aspen (d1) and low-bush cranberry aspen - white spruce (d2). Blueberry aspen - white spruce (b3), forested bog (BFNN), wooded fen (FTNN) and Labrador tea - subhygric black spruce - jack pine (g1) habitats are used significantly less than expected (Table 5.3-2).

Wolves tend to prefer open areas and avoid heavy coniferous cover in winter (Penner 1976). In studies where habitat preferences were determined, wolves were observed to prefer willow wetlands and riparian aspen (Westworth and Brusnyk 1982), black spruce/tamarack (Westworth, Brusnyk and Associates 1996) and terrestrial ecosite phases (Golder 1998a).



LEGEND

- JACKPINE EXPANSION MINING AREA LOCAL STUDY AREA
- INDIAN RESERVE
- OPEN WATER
- PUBLIC ROADWAY
- CORRIDOR AND TRIANGLE TRANSECT LOCATION
- COYOTE
- RED FOX
- WOLF

DISTURBED

- EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE
- EXISTING AND APPROVED URBAN AND INDUSTRIAL LINEAR DISTURBANCE

3 0 3

SCALE 1:100,000 KILOMETRES

REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2004), and Alberta SRD, used under license.
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 12.

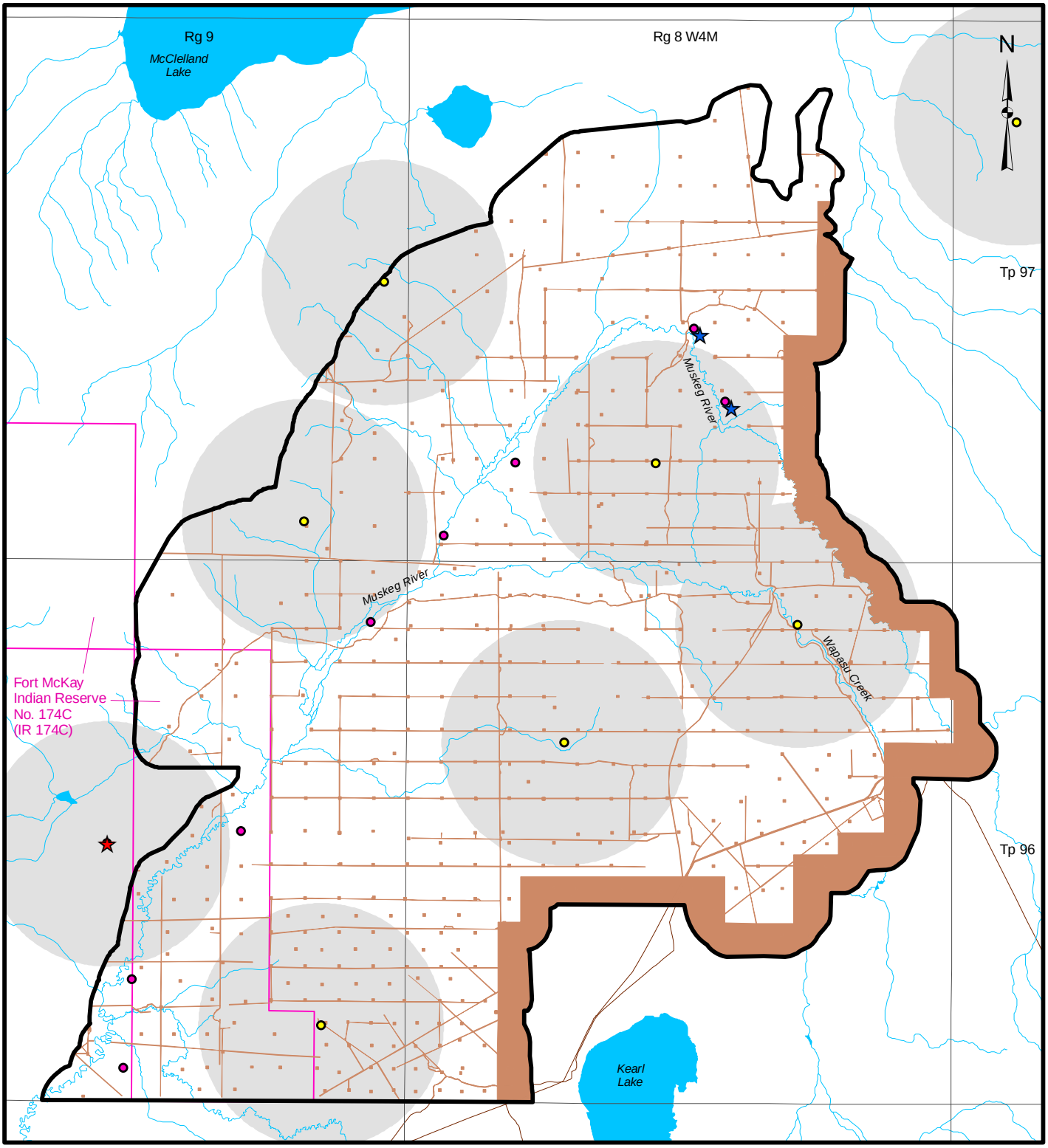
PROJECT
JACKPINE MINE EXPANSION & PIERRE RIVER MINE PROJECT

TITLE
CANID TRACK LOCATIONS IN THE JACKPINE EXPANSION MINING AREA LOCAL STUDY AREA

Shell Canada Limited

PROJECT No. 05-1344-027.7700			SCALE AS SHOWN	REV. 0
DESIGN	VR	06 Jun. 2007	FIGURE: 5.3-5	
GIS	JH	14 Nov. 2007		
CHECK	MJ	16 Nov. 2007		
REVIEW	WES/TC	19 Nov. 2007		

Project: I:\CLIENTS\SHELL\05-1344-027\mapping\mxd\wildlife\DRAFT\jackpine\lsa_canid_wtr_jp_esr.mxd - Plot: I:\CLIENTS\SHELL\05-1344-027\mapping\pdf\wildlife\DRAFT\jackpine\Fig5.3-5_lsa_canid_wtr_jp_esr.pdf



LEGEND

- JACKPINE EXPANSION MINING AREA LOCAL STUDY AREA
- INDIAN RESERVE
- OPEN WATER
- 2.2 KM BUFFER
- PUBLIC ROADWAY
- BAIT
- CORRIDOR
- LYNX
- WOLF

DISTURBED

- EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE
- EXISTING AND APPROVED URBAN AND INDUSTRIAL LINEAR DISTURBANCE

REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2004), and Alberta SRD, used under license.
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 12.

3 0 3
SCALE 1:100,000 KILOMETRES

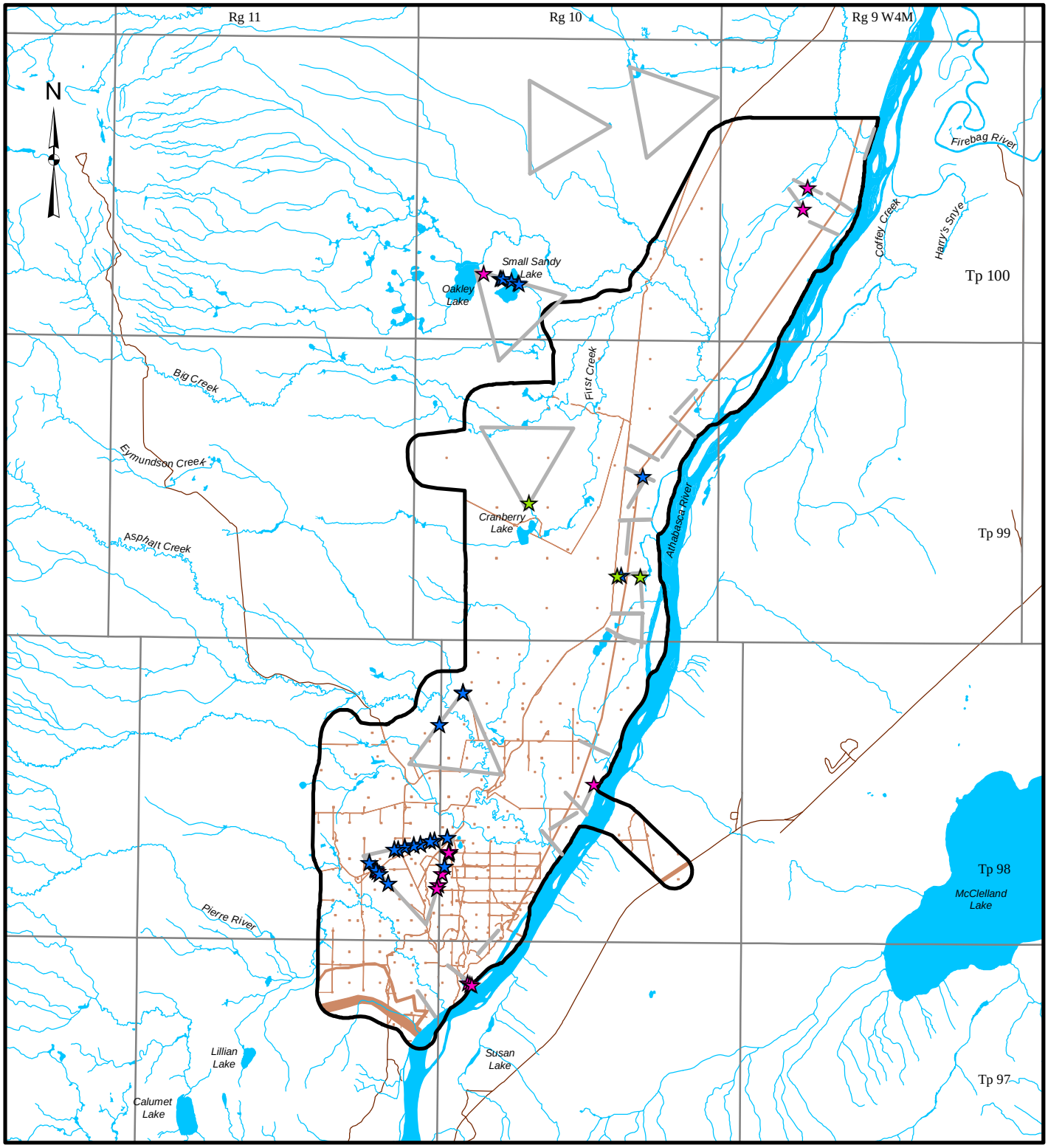
PROJECT
JACKPINE MINE EXPANSION & PIERRE RIVER MINE PROJECT

TITLE
WOLF AND LYNX PHOTOGRAPH LOCATIONS RECORDED IN THE JACKPINE EXPANSION MINING AREA LOCAL STUDY AREA

Shell Canada Limited

PROJECT No. 05-1344-027.7700			SCALE AS SHOWN	REV. 0
DESIGN	VR	06 Jun. 2007	FIGURE: 5.3-6	
GIS	JH	14 Nov. 2007		
CHECK	MJ	16 Nov. 2007		
REVIEW	WES/TC	19 Nov. 2007		

Project: I:\CLIENTS\SHELL\05-1344-027\mapping\mxd\wildlife\DRAFT\jackpine\lsa_lynx_wolf_jp_esr.mxd - Plot: I:\CLIENTS\SHELL\05-1344-027\mapping\pdf\wildlife\DRAFT\jackpine\Fig5.3-6_lsa_lynx_wolf_jp_esr.pdf



LEGEND

- PIERRE RIVER MINING AREA LOCAL STUDY AREA
- OPEN WATER
- ROAD
- CORRIDOR AND TRIANGLE TRANSECT LOCATION
- COYOTE
- RED FOX
- WOLF

DISTURBED

- EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE
- EXISTING AND APPROVED URBAN AND INDUSTRIAL LINEAR DISTURBANCE

6 0 6

SCALE 1:180,000 KILOMETRES

REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2004), and Alberta SRD, used under license.
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 12.

PROJECT

JACKPINE MINE EXPANSION & PIERRE RIVER MINE PROJECT

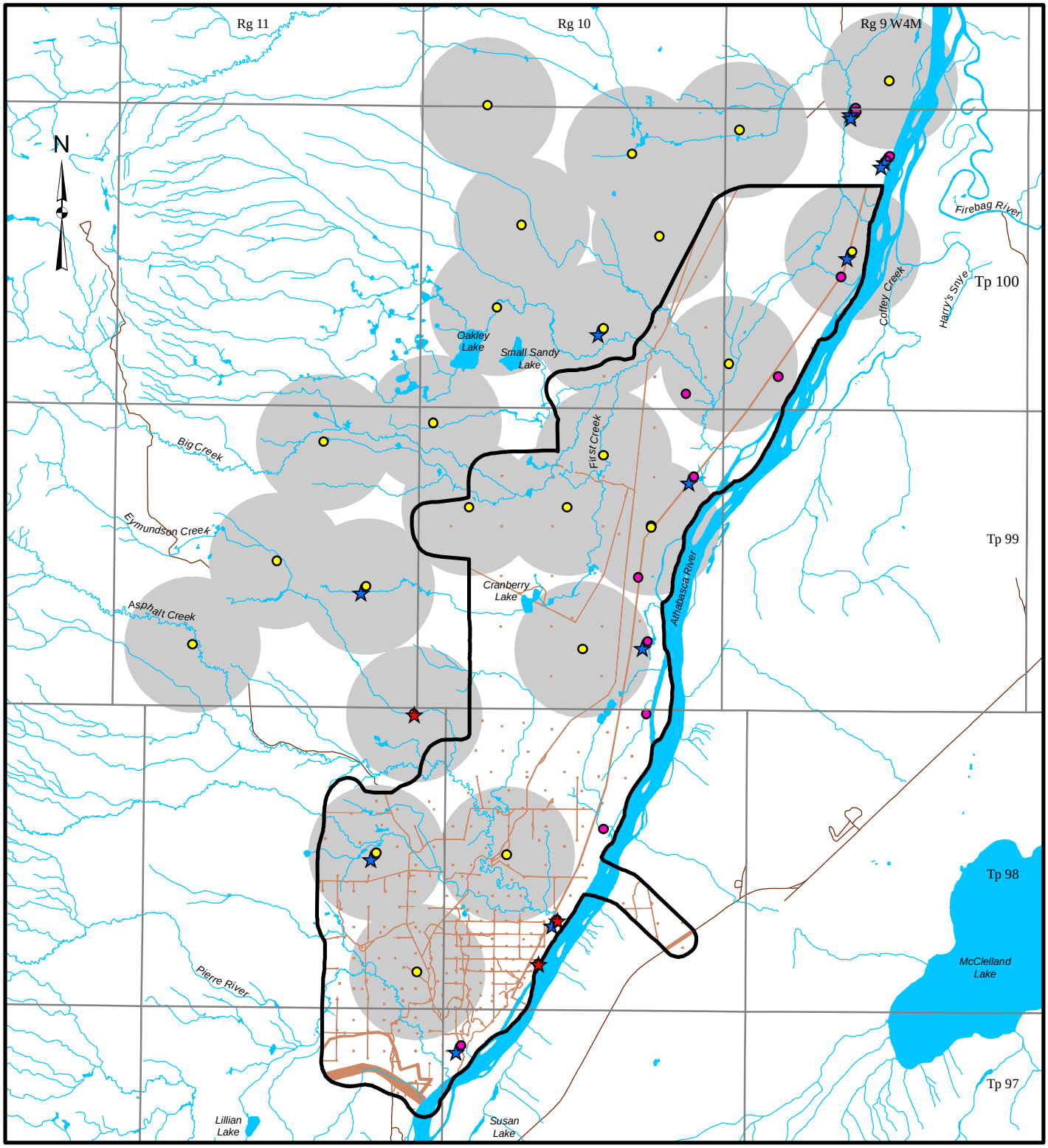
TITLE

CANID TRACK LOCATIONS IN THE PIERRE RIVER MINING AREA LOCAL STUDY AREA

Shell Canada Limited

PROJECT No. 05-1344-027.7700			SCALE AS SHOWN	REV. 0
DESIGN	VR	10 Aug. 2007	FIGURE: 5.3-7	
GIS	JH	14 Nov. 2007		
CHECK	MJ	16 Nov. 2007		
REVIEW	WES/TC	19 Nov. 2007		

Project: I:\CLIENTS\SHELL\05-1344-027\mapping\mxd\wildlife\DRAFT\pierreriver\sa_canid_wtr_pr.mxd Plot: 2J:\2005\GIS\ArcMapTemplates\templates\v91\MyProject.pdf?



LEGEND

- PIERRE RIVER MINING AREA LOCAL STUDY AREA
- OPEN WATER
- 2.2 KM BUFFER
- ROAD
- BAIT
- CORRIDOR
- LYNX
- WOLF

DISTURBED

- EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE
- EXISTING AND APPROVED URBAN AND INDUSTRIAL LINEAR DISTURBANCE

SCALE 1:180,000

6 0 6

KILOMETRES

REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2004), and Alberta SRD, used under license.
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 12.

PROJECT

JACKPINE MINE EXPANSION & PIERRE RIVER MINE PROJECT

TITLE

WOLF AND LYNX PHOTOGRAPH LOCATIONS RECORDED IN THE PIERRE RIVER MINING AREA LOCAL STUDY AREA

Shell Canada Limited

PROJECT No. 05-1344-027.7700			SCALE AS SHOWN	REV. 0
DESIGN	VR	10 Aug. 2007	FIGURE: 5.3-8	
GIS	JH	14 Nov. 2007		
CHECK	MJ	16 Nov. 2007		
REVIEW	WES/TC	19 Nov. 2007		

Project: I:\CLIENTS\SHELL\05-1344-027\mapping\mxd\wildlife\DRAFT\pierreriver\lsa_lynx_wolf_pr.mxd Plot: 7J\2005\GIS\ArcMapTemplates\templatesV91\MyProject.pdf?

Wolf habitat preference is likely dependent on the ecosite phases and wetlands types used by their prey and ease of travel. Wolves also use cutlines and other linear disturbances for ease of movement (e.g., James and Stuart-Smith 2000).

Traditional Knowledge and Resource Use

Wolves were described by Fort Chipewyan participants in a CEMA-sponsored Wildlife Movement Traditional Environmental Knowledge Workshop as travelling in packs, completing loops every four to five days and having ranges of 40 to 50 km (FMA 2005). Wolf packs follow the caribou and travel on older cutlines. According to Fort McKay participants in the workshop, the wolf population is currently declining from a general decline in the populations of small and medium-sized prey (i.e., hares, muskrat).

All RFMA holders indicated that wolves were present on their traplines and that they actively trapped wolves. The holder of RFMA #1275 who lives on his trapline in the PRMA LSA, said he trapped many wolves last winter and he felt that the population was "good" (i.e., wolves are numerous). He also hunts wolves in the spring. Conversely the holder of RFMA #2939 who also traps in the PRMA LSA was unsuccessful trapping wolves last year and felt that the population was lower than previous years. He didn't see many tracks. In the general area of JEMA LSA, the holder of RFMA #2331 usually catches about six or seven wolves each year. The holder of RFMA #1716 indicated that wildlife including wolves were more plentiful along the Firebag River, but there were fewer animals further south along the Muskeg River and Wapasu Creek. He also stated that tree planters came in six years ago and left their garbage behind which created wildlife problems including wolves that now feed off the local garbage which has affected trapping activity.

Incidentals

Wolves were seen or heard frequently during field work on the Project LSAs (n=56) (Appendix T).

Regional Data

Wolf track densities recorded in the Project LSAs were within the range of variation reported from other environmental setting surveys in the Oil Sands Region (Appendix V). On the Canadian Natural Horizon Project, a wolf track density of 0.08 tracks per km-day was recorded. Tracks were observed in blueberry jack pine - aspen (b1), low-bush cranberry aspen (d1), low-bush cranberry aspen - white spruce (d2), low-bush cranberry white spruce (d3), shrubby fen (FONS) and cutblock habitat types (CNRL 2002). On the Suncor Voyageur South Project, a wolf track density 0.17 tracks per km-day was

recorded; a preference was demonstrated for low-bush cranberry aspen (d1) and low-bush cranberry aspen - white spruce (d2) ecosite phases (Golder 2007a). A wolf track density of 0.06 tracks per km-day was recorded on Deer Creek Energy's Joslyn lease (Komex 2005). Wolf track densities in early winter on the Kearl Oil Sands Project LSA were higher and exclusively in low-bush cranberry white spruce (d3) and dogwood balsam poplar - white spruce (e2) ecosite phases (0.30 tracks per km-day), although in mid and late winter, track densities were much lower (0.03 and 0.05 tracks per km-day) (Imperial Oil 2005). Wolves were not recorded during winter track surveys on either the TrueNorth Fort Hills Project (Golder 2000a) or the Synenco Northern Lights Project (Synenco 2006), although wolf tracks were recorded incidentally on both projects.

5.3.2.2 Coyote

Population

Jackpine Expansion Mining Area

A coyote track density of 0.21 tracks per km-day was recorded during winter track surveys in the JEMA LSA (Figure 5.3-5; Appendix U).

Coyotes were photographed during the fall, winter, spring and summer during the corridor monitoring in the JEMA LSA, with three photographs occurring in the fall, two in the winter, seven in the spring and four in the summer. The average number of days to first photo is 17.0 days in the fall, 8.3 in the winter, 5.1 in the spring and 2.2 in the summer. The photo rate is 0.18 in the fall, 0.15 in the winter, 0.21 in the spring and 0.04 in the summer (Appendix W, TablesW-1 and W-15).

There were no coyotes photographed at any of the bait stations in the JEMA LSA.

Pierre River Mining Area

A coyote track density of 0.09 tracks per km-day was recorded during winter track surveys in the PRMA LSA (Figure 5.3-7; Appendix U).

Coyotes were photographed during the fall, spring and summer during the corridor monitoring in the PRMA LSA, with five photographs occurring in the fall, one in the spring and one in the summer. The average number of days to first photo was 8.6 days in the fall, 2.9 in the spring and 9.8 in the summer. The photo rate was 0.04 in all sessions (Appendix W, Tables W-10 and W-16).

There were no coyotes photographed at any of the bait stations in the PRMA LSA.

Habitat

During the winter track surveys, coyote tracks or sign were observed in 17 habitat types including cutlines and clearcuts. The only significantly preferred habitats was low-bush cranberry aspen (d1), while wooded fen (FTNN) and Labrador tea / horsetail white spruce - black spruce (h1) were used significantly less than expected (Table 5.3-2).

Coyotes are generalist predators that prefer cleared and agricultural fringe sites, while avoiding densely forested areas in agricultural landscapes (Boyd 1977). Increases in deer numbers in disturbed areas will often result in an increase in coyotes.

Traditional Knowledge and Resource Use

All RFMA holders indicated that they actively trapped coyotes. One to six coyotes have been trapped annually in the Project LSAs between the 2001/02 trapping season and the 2005/06 trapping season.

Incidentals

Coyotes and their sign were recorded occasionally during field surveys in the Project LSAs (n=10) (Appendix T).

Regional Data

Coyote track densities recorded in the Project LSAs were similar to those reported from other environmental setting surveys in the Oil Sands Region (Appendix V). On the Canadian Natural Horizon Project, a coyote track density of 0.20 tracks per km-day was recorded. Coyotes showed a preference for low-bush cranberry aspen - white spruce (d2) and an avoidance of low-bush cranberry aspen (d1) (CNRL 2002). The coyote track density on the TrueNorth Fort Hills Project was 0.02 tracks per km-day (Golder 2000a) and were located only in low-bush cranberry aspen - white spruce (d2), dogwood balsam poplar - aspen (e1), dogwood balsam poplar - white spruce (e2) and shrub habitats. On the Imperial Kearl Oil Sands Project the overall density varied between 0.05 and 0.23 tracks per km-day (Imperial Oil 2005) with mid-winter track counts being the highest. Husky (2004) reported similar winter track density for coyotes (0.12 tracks per km-day) in the Husky Sunrise Thermal Project adjacent to the JEMA LSA. On the Suncor Voyageur South Project, a coyote track density 0.17 tracks per km-day was recorded. A preference was demonstrated for dogwood balsam poplar -

aspen (e1) ecosite phase and ROW habitats (Golder 2007a). A coyote track density of 0.17 tracks per km day was recorded on Deer Creek Energy's Joslyn lease (Komex 2005). Coyotes were not recorded during winter track surveys on the Synenco Northern Lights Project (Synenco 2006).

5.3.2.3 Red Fox

Population

Jackpine Expansion Mining Area

A red fox track density of 0.02 tracks per km-day was recorded during winter track surveys in the JEMA LSA (Figure 5.3-5).

Red foxes were not photographed at any of the photographic stations in the JEMA LSA.

Pierre River Mining Area

A red fox track density of 0.02 tracks per km-day was recorded during winter track surveys in the PRMA LSA (Figure 5.3-7).

Red fox were not photographed at any of the photographic stations in the PRMA LSA.

Habitat

Red foxes, like wolves and coyotes, prefer semi-open country (Banfield 1987). During the winter track surveys, red fox tracks or sign were observed in wooded bog (BTNN), clearcut, cutline, low-bush cranberry aspen (d1), low-bush cranberry aspen - white spruce (d2), shrub and low-bush cranberry white spruce (d3) ecosite phases/wetlands types. No conclusions can be drawn about habitat preferences because of the small sample size.

Traditional Knowledge and Resource Use

The RFMA holders indicated that foxes were present in low numbers. Trappers on the Project LSAs have harvested 2 to 11 red fox each year between the 2001/02 trapping season and the 2005/06 trapping season.

Incidentals

Two red fox were recorded incidentally on the Project LSAs (Appendix T).

Regional Data

Red foxes are present but uncommon in the Oil Sands Region and may often be under-represented due to the difficulty in separating them from coyote tracks.

Red fox track densities recorded in the Project LSAs were similar to those reported from other environmental setting surveys in the Oil Sands Region (Appendix V). On the Canadian Natural Horizon Project, just one set of tracks was recorded in a shrubby swamp (SONS) wetlands type (CNRL 2002). The fox track density on the TrueNorth Fort Hills Project was 0.03 tracks per km-day and only in low-bush cranberry aspen - white spruce (d2), low-bush cranberry white spruce (d3) and shrub habitats (Golder 2000a), while on the Imperial Kearl Oil Sands Project red fox was recorded only as an incidental (Imperial Oil 2005). On the Suncor Voyageur South Project, a red fox track density of 0.03 tracks per km-day was recorded and only in low-bush cranberry aspen (d1), low-bush cranberry aspen - white spruce (d2) and ROW habitats (Golder 2007a). A track density of 0.01 tracks per km-day was recorded on Deer Creek Energy's Joslyn lease (Komex 2005). Red foxes were not recorded during winter track surveys on the Synenco Northern Lights Project (Synenco 2006).

5.3.3 Felids (Cats)

Felid species in the Project area include Canada lynx and cougar.

5.3.3.1 Canada Lynx

Canada lynx are listed as sensitive by ASRD (2005a) and are a CEMA Priority 1 indicator species (Westworth 2002).

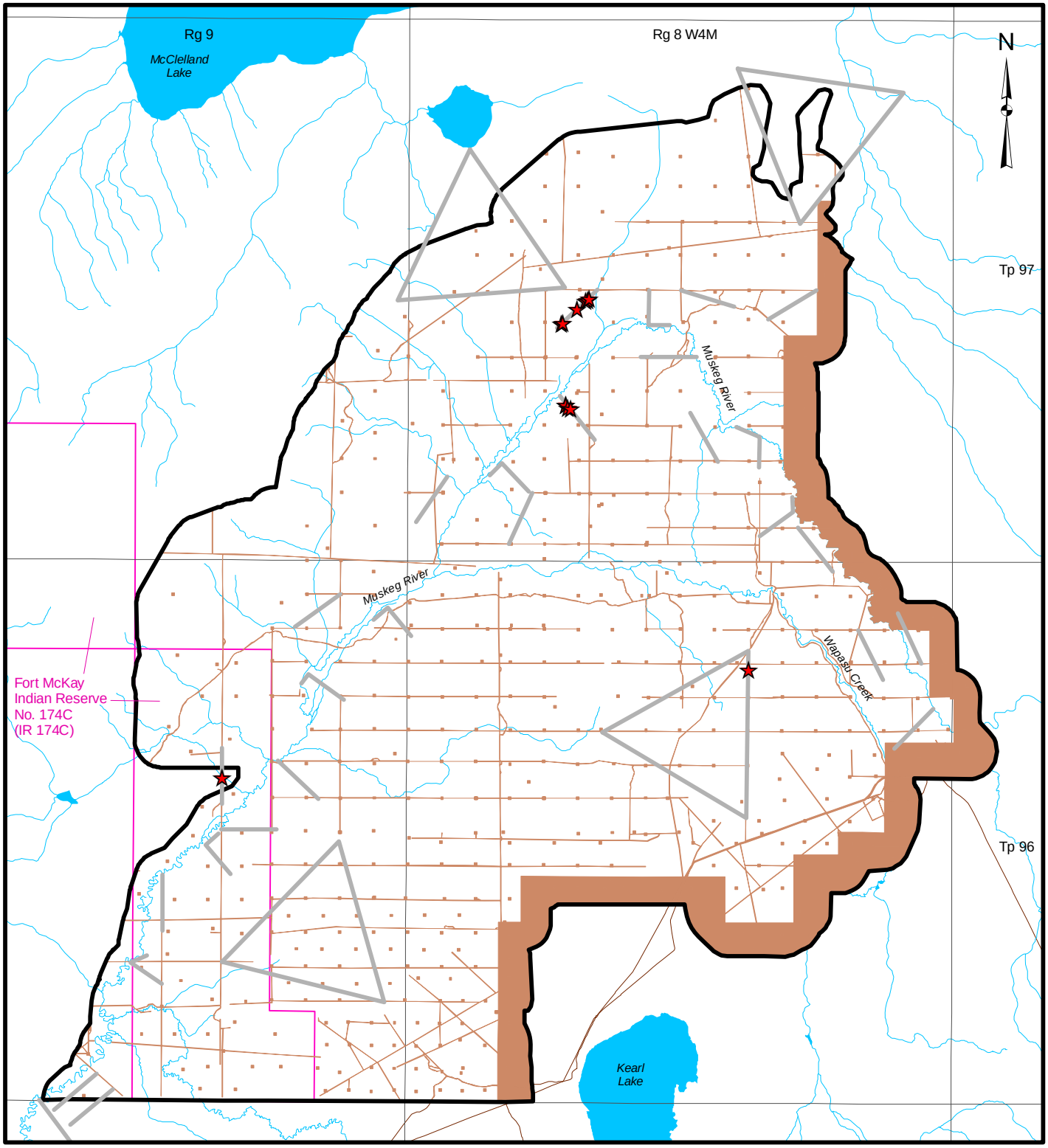
Population

Jackpine Expansion Mining Area

A Canada lynx track density of 0.07 tracks per km-day was recorded during winter track surveys in the JEMA LSA (Figure 5.3-9; Appendix U).

One photograph of a Canada lynx was taken at the bait stations in the JEMA LSA during the fall (Figure 5.3-6). The average number of days to first photo was 9.0 and the photo rate was 0.14. Appendix W (Tables W-1 to W-7) presents the photographic bait station results for all four seasons.

No photographs of Canada lynx were taken during corridor monitoring in the JEMA LSA.



LEGEND

- JACKPINE EXPANSION MINING AREA LOCAL STUDY AREA
- INDIAN RESERVE
- OPEN WATER
- PUBLIC ROADWAY
- CORRIDOR AND TRIANGLE TRANSECT LOCATION
- LYNX

DISTURBED

- EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE
- EXISTING AND APPROVED URBAN AND INDUSTRIAL LINEAR DISTURBANCE

3 0 3

SCALE 1:100,000 KILOMETRES

REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2004), and Alberta SRD, used under license.
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 12.

PROJECT

JACKPINE MINE EXPANSION & PIERRE RIVER MINE PROJECT

TITLE

LYNX TRACK LOCATIONS IN THE JACKPINE EXPANSION MINING AREA LOCAL STUDY AREA

Shell Canada Limited

PROJECT No. 05-1344-027.7700			SCALE AS SHOWN	REV. 0
DESIGN	VR	06 Jun. 2007	FIGURE: 5.3-9	
GIS	JH	14 Nov. 2007		
CHECK	MJ	16 Nov. 2007		
REVIEW	WES/TC	19 Nov. 2007		

Project: I:\CLIENTS\SHELL\05-1344-027\mapping\mxd\wildlife\DRAFT\jackpine\lsa_lynx_wtr_jp_esr.mxd - Plot: I:\CLIENTS\SHELL\05-1344-027\mapping\pdf\wildlife\DRAFT\jackpine\Fig5.3-9_lsa_lynx_wtr_jp_esr.pdf

Pierre River Mining Area

A Canada lynx track density of 0.11 tracks per km-day was recorded during winter track surveys in the PRMA LSA (Figure 5.3-10).

One photograph of a Canada lynx was taken at the bait stations in the PRMA LSA during the winter (Figure 5.3-8). The average number of days to first photo was 13.0 days and the photo rate was 0.03. Appendix W (Tables W-2 to W-8) presents the photographic bait station results for all four seasons.

One photograph of Canada lynx was taken during the corridor monitoring in the PRMA LSA during the summer (Figure 5.3-8). The average number of days to first photo was 7.1 days and the photo rate was 0.08. Appendix W (Tables W-2 to W-8) presents the corridor monitoring results for all four seasons.

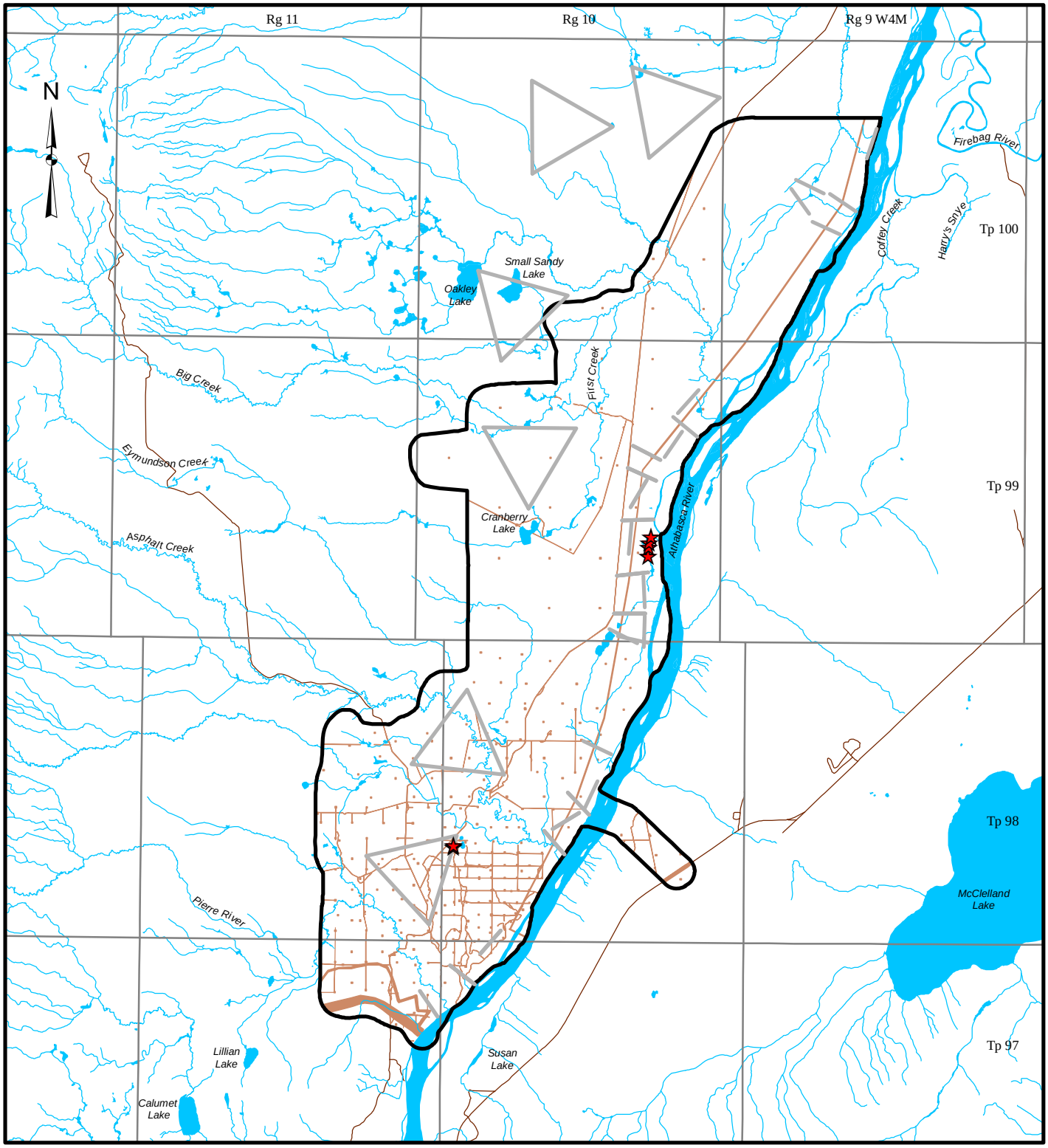
Habitat

During the winter track surveys, Canada lynx tracks or sign were observed in blueberry aspen - jack pine (b1), blueberry aspen - white spruce (b3), wooded bog (BTNN), low-bush cranberry aspen - white spruce (d2), low-bush cranberry white spruce (d3), shrubby fen (FONS), wooded fen (FTNN), Labrador tea - subhygric black spruce - jack pine (g1) and road habitat types. However, statistical inferences cannot be made as a result of the small sample size.

Lynx are thought to prefer dense climax boreal forest, although their distribution is tied to that of their most common food, the snowshoe hare (Skinner and Westworth 1981).

Traditional Knowledge and Resource Use

Lynx were described by Fort McKay participants in a CEMA-sponsored Wildlife Movement Traditional Environmental Knowledge Workshop as preferring areas near sloughs, little lakes and creeks (FMA 2005). The decline in rabbits is linked to the subsequent decline in the lynx population. As stated by Fort Chipewyan participants in the workshop, if there are no rabbits there will be no lynx.



LEGEND

- PIERRE RIVER MINING AREA LOCAL STUDY AREA
- OPEN WATER
- ROAD
- CORRIDOR AND TRIANGLE TRANSECT LOCATION
- LYNX

DISTURBED

- EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE
- EXISTING AND APPROVED URBAN AND INDUSTRIAL LINEAR DISTURBANCE

6 0 6

SCALE 1:180,000 KILOMETRES

REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2004), and Alberta SRD, used under license.
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 12.

PROJECT

JACKPINE MINE EXPANSION & PIERRE RIVER MINE PROJECT

TITLE

LYNX TRACK LOCATIONS IN THE PIERRE RIVER MINING AREA LOCAL STUDY AREA

Shell Canada Limited

PROJECT No. 05-1344-027.7700			SCALE AS SHOWN	REV. 0
DESIGN	VR	10 Aug. 2007	FIGURE: 5.3-10	
GIS	JH	14 Nov. 2007		
CHECK	MJ	16 Nov. 2007		
REVIEW	WES/TC	19 Nov. 2007		

Project: I:\CLIENTS\SHELL\05-1344-027\mapping\mxd\wildlife\DRAFT\pierreriver\lsa_lynx_wtr_pr.mxd Plot: 2J:\2005\GIS\ArcMapTemplates\templates\v91\MyProject.pdf?

Most other trappers indicated there were Canada lynx on their RFMAs and all RFMA holders said that they actively trapped lynx. The RFMA #1275 trapline holder, who lives on his trapline in the PRMA LSA felt that lynx population is very low because the rabbit cycle is down. Twenty-three lynx have been trapped on RFMAs in the Project LSAs in trapping seasons between the 2001/02 trapping season and the 2005/06 trapping season.

Incidentals

Two Canada lynx were recorded incidentally on the Project LSAs (Appendix T).

Regional Data

Canada lynx densities fluctuate in 10-year cycles in close association with snowshoe hares (Boutin et al. 1995). Thus, lynx densities can fluctuate dramatically depending on where they are in the cycle. Based on surveys conducted for this ESR and other regional data, lynx appear to be just past the low point in their cycle. Lynx typically have large home ranges (8.3 to 51.0 km^2, Koehler and Aubry 1994) making detection within the boundaries of a particular study area difficult and results can vary greatly.

Canada lynx track densities recorded in the Project LSAs were within the range of variation recorded on other environmental setting surveys in the Oil Sands Region (Appendix V). On the Canadian Natural Horizon Project, a track density of 0.84 tracks per km-day was recorded. They showed a preference for low-bush cranberry aspen (d1) and an avoidance of low-bush cranberry aspen - white spruce (d2), graminoid fen (FONG), shrubby swamp (SONS) and burns (CNRL 2002). The lynx track density on the TrueNorth Fort Hills Project was 0.01 (Golder 2000a) and tracks were located only in low-bush cranberry aspen - white spruce (d2) and dogwood balsam poplar - white spruce (e2) habitats, while on the Imperial Kearl Oil Sands Project the overall density varied between 0.08 and 0.20 tracks per km-day (Imperial Oil 2005) with early winter track counts being the highest. Husky (2004) reported higher winter track density for lynx (0.92 tracks per km-day) in the Husky Sunrise Thermal Project adjacent to the Imperial Kearl Project LSA. On the Suncor Voyageur South Project, a lynx track density of 0.02 tracks per km-day was recorded and no preferences were demonstrated for any habitats (Golder 2007a). A density of 0.16 tracks per km-day was recorded on Deer Creek Energy's Joslyn lease (Komex 2005). Canada lynx track densities on the Synenco Northern Lights Project varied between none to 0.80 tracks per km-day with tracks being most common in jack pine-dominated habitats (Synenco 2006).

5.3.4 Bears

Both black bears and grizzly bears have been recorded in the Oil Sands Region. Grizzly bears are listed as "May Be At Risk" in the province (ASRD 2005a) but are very rarely encountered. Black bears, on the other hand, are ubiquitous in the Oil Sands Region. They are one of five CEMA-SEWG wildlife indicators and are on the CEMA list of Priority 2 indicators (Westworth 2002).

5.3.4.1 Black Bear

Population

Jackpine Expansion Mining Area

A total of 19 photographs of black bears were taken during the bait station sessions in the JEMA LSA in the summer (Figure 5.3-11; Appendix W, Tables W-1 to W-7). None were photographed during the fall or winter sessions as expected likely because they were hibernating. The average number of days to first photo following camera set-up was 4.8 days and the photo rate was 0.75 in the spring.

A total of 22 photographs of black bears were taken during the corridor monitoring in the JEMA LSA including nine in the spring and 13 in the summer (Figure 5.3-11; Appendix W, Tables W-1 to W-7). None were photographed during the fall or winter. The average number of days to first photo following camera set-up was 7.3 days in the spring and 5.4 in the summer. The photo rate was 0.25 in the spring and 0.23 in the summer.

Pierre River Mining Area

A total of 205 photographs of black bears were taken during the bait station sessions in the PRMA LSA including 68 photographs in the spring and 137 in the summer (Figure 5.3-12; Appendix W, Tables W-1 to W-8). None were photographed during the fall or winter. The average number of days to first photo following camera set-up was 4.3 days in the spring and 4.0 in the summer. The photo rate was 0.69 in the spring and 0.90 in the summer.

A total of 67 black bear photographs were taken during the corridor monitoring in the PRMA LSA including 24 photographs during the spring and 43 during the summer (Figure 5.3-12; Appendix W, Tables W-10 to W-16). None were photographed during the fall or winter. The average number of days to first photo following camera set-up was 6.1 days in the spring and 5.9 in the summer. The photo rate was 0.52 in the spring and 0.71 in the summer.

Habitat

Black bears in the Oil Sands Region have been observed mostly in terrestrial habitats and occasionally in wetlands (Appendix V, Table V-10).

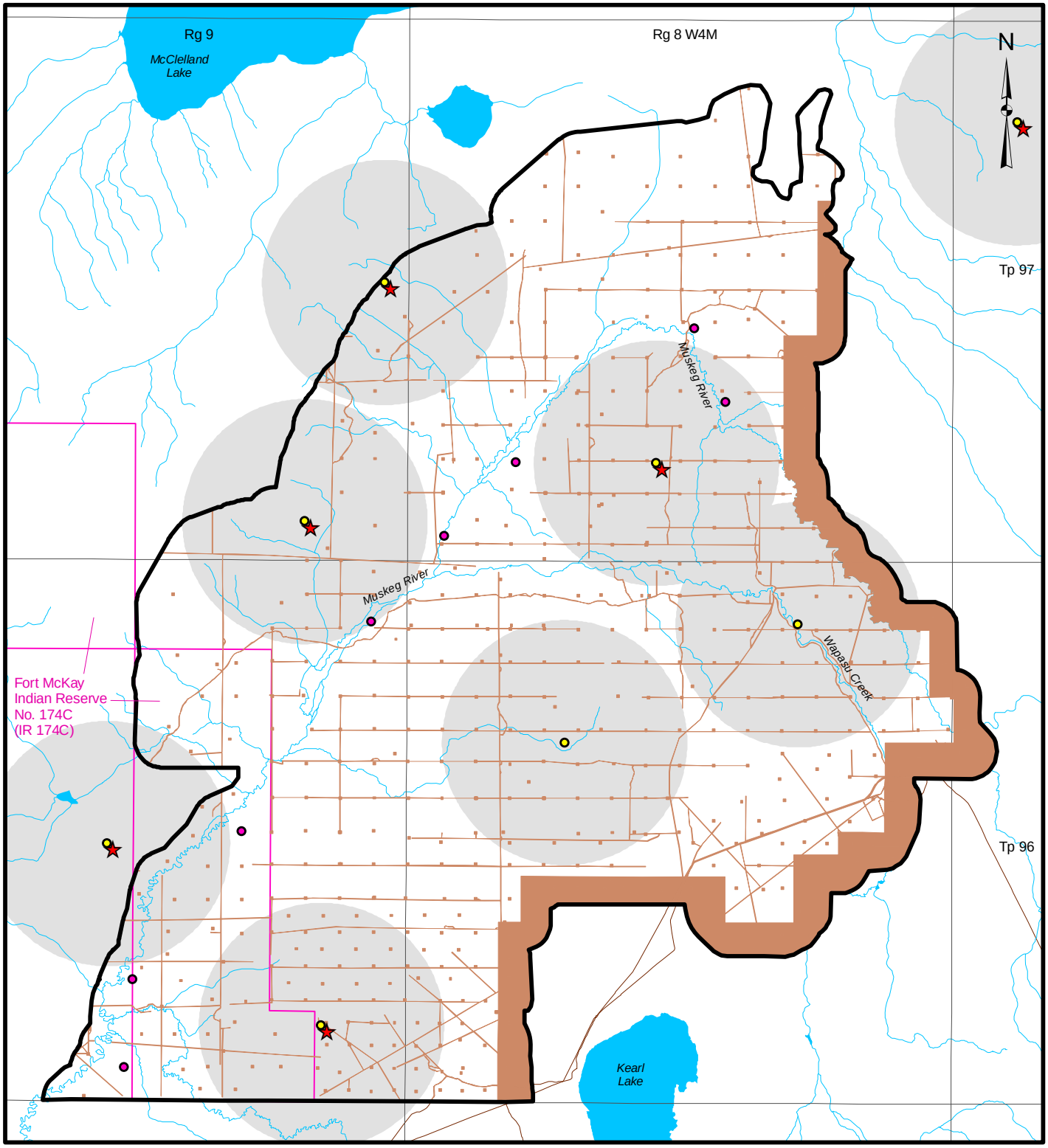
Forb and shrub diversity is generally higher in deciduous stands or recently disturbed areas. Westworth and Brusnyk (1982) observed black bears most often in balsam poplar, mixedwood and white spruce, and found that fen and willow wetlands were used less than expected.

Black bear were distributed across the PRMA LSA; most bait and corridor stations in the LSA were visited at least once (Figure 5.3-11). However, the distribution of black bears in the JEMA LSA was not nearly as uniform; none of the corridor stations and six of the eight bait stations were visited. Available habitat in the two LSAs is the probable reason for these differences. The JEMA LSA is primarily wetlands, while the PRMA LSA is predominantly terrestrial upland habitats.

Traditional Knowledge and Resource Use

Black bear move with the seasons as described by Fort Chipewyan participants in a CEMA-sponsored Wildlife Movement Traditional Environmental Knowledge Workshop (FMA 2005). In the summer they are along rivers and shorelines, in the late summer and fall they switch to berries, and after the berry season, they travel to fish spawning areas. Participants of the workshop believed that there had been a decline in bear numbers over the last 15 to 20 years, as a result of non-Aboriginal hunting using bait and a decrease in food resources.

Most other trappers indicated there were black bears on their RFMAs. Many trappers hunted black bears themselves, but not all. Two to nine black bears have been harvested annually by RFMA holders between the 2001/02 trapping season and the 2005/06 trapping season. One trapper stated that he will not hunt what he does not eat and that he did not enjoy bear meat. The RFMA #1716 trapline holder indicated that wildlife including black bears was more plentiful along the Firebag River, but there were fewer animals further south along the Muskeg River and Wapasu Creek. He also stated that tree planters came in six years ago and left their garbage behind which created wildlife problems including bears that now feed off the local garbage.



LEGEND

- JACKPINE EXPANSION MINING AREA LOCAL STUDY AREA
- INDIAN RESERVE
- OPEN WATER
- 2.2 KM BUFFER
- PUBLIC ROADWAY
- BAIT
- CORRIDOR
- BLACK BEAR

DISTURBED

- EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE
- EXISTING AND APPROVED URBAN AND INDUSTRIAL LINEAR DISTURBANCE

REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2004), and Alberta SRD, used under license.
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 12.

3 0 3
SCALE 1:100,000 KILOMETRES

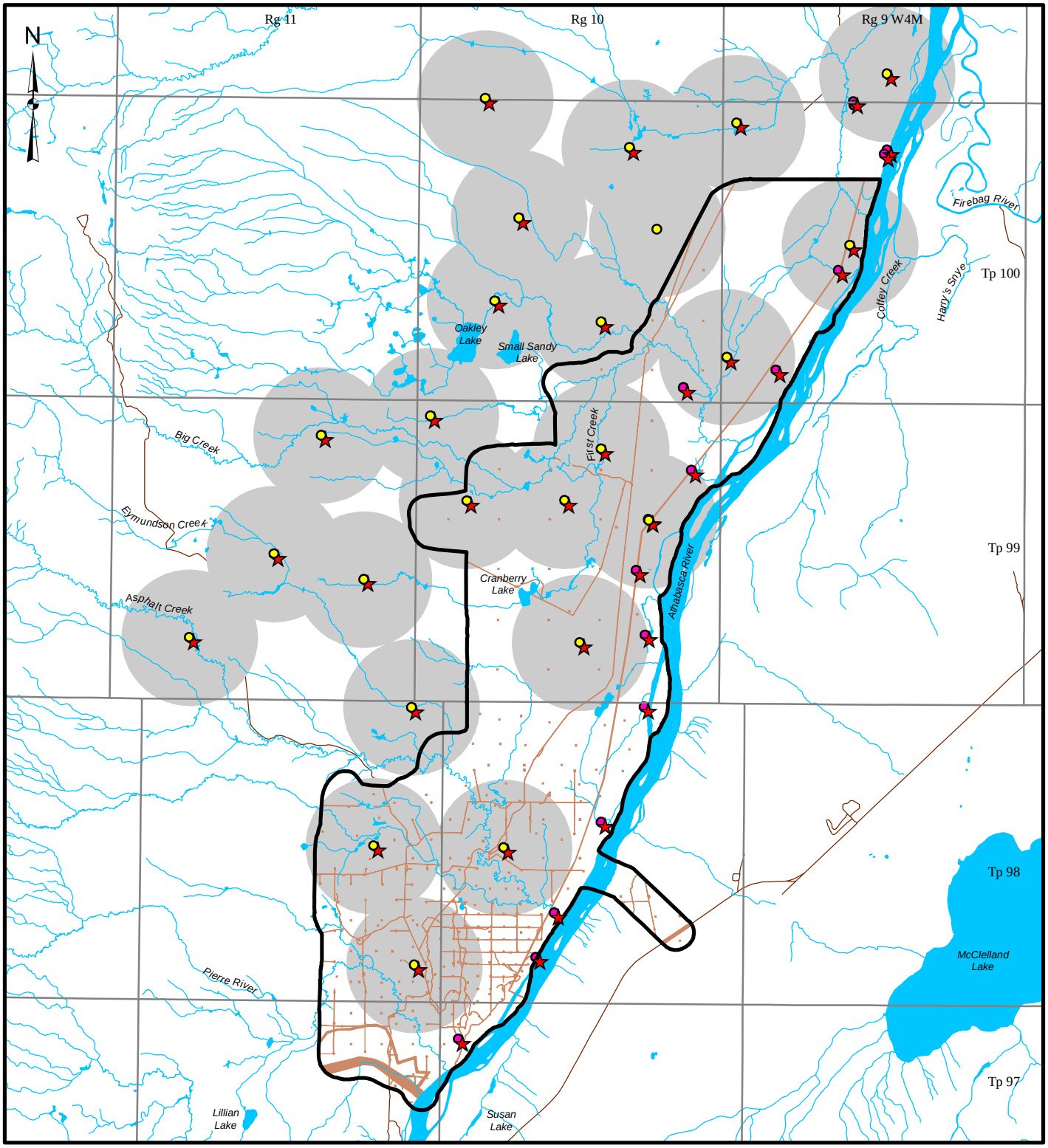
PROJECT
JACKPINE MINE EXPANSION & PIERRE RIVER MINE PROJECT

TITLE
BLACK BEAR PHOTOGRAPH LOCATIONS RECORDED IN THE JACKPINE EXPANSION MINING AREA LOCAL STUDY AREA

Shell Canada Limited

PROJECT No. 05-1344-027.7700			SCALE AS SHOWN	REV. 0
DESIGN	VR	06 Jun. 2007	FIGURE: 5.3-11	
GIS	JH	14 Nov. 2007		
CHECK	MJ	16 Nov. 2007		
REVIEW	WES/TC	19 Nov. 2007		

Project: I:\CLIENTS\SHELL\05-1344-027\mapping\mxd\wildlife\DRAFT\jackpine\sa_black_bear_jp_esr.mxd - Plot: I:\CLIENTS\SHELL\05-1344-027\mapping\pdf\wildlife\DRAFT\jackpine\Fig5.3-11_lsa_black_bear_jp_esr.pdf



LEGEND

- PIERRE RIVER MINING AREA LOCAL STUDY AREA
- OPEN WATER
- 2.2 KM BUFFER
- ROAD
- BAIT
- CORRIDOR
- BLACK BEAR

DISTURBED

- EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE
- EXISTING AND APPROVED URBAN AND INDUSTRIAL LINEAR DISTURBANCE

6 0 6

SCALE 1:180,000 KILOMETRES

REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2004), and Alberta SRD, used under license.
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 12.

PROJECT
JACKPINE MINE EXPANSION &
PIERRE RIVER MINE PROJECT

TITLE
BLACK BEAR PHOTOGRAPH LOCATIONS
RECORDED IN THE PIERRE RIVER
MINING AREA LOCAL STUDY AREA

Shell Canada Limited

PROJECT No. 05-1344-027.7700			SCALE AS SHOWN	REV. 0
DESIGN	VR	10 Aug. 2007	FIGURE: 5.3-12	
GIS	JH	14 Nov. 2007		
CHECK	MJ	16 Nov. 2007		
REVIEW	WES/TC	19 Nov. 2007		

Project: I:\CLIENTS\SHELL\05-1344-027\mapping\mxd\wildlife\DRAFT\pierreriver\sa_black_bear_pr.mxd Plot: 2J:\2005\GIS\ArcMapTemplates\templates\v91\MyProject.pdf?

A common thread among the interviews with RFMA holders was that black bear were heavily hunted by outfitters. The RFMA #1275 trapline holder indicated that the bear population is very poor due to the large number of hunters who bait traps and take too many of the animals. Similarly, another commented that the bear population has dwindled because outside hunters kill a lot of them during the fall hunt. Much of this increased bear hunting was blamed on increases in access. For example, the RFMA #2939 trapline holder stated that since the old McKay Road has been cleared, more people access the area and this has affected animal populations. One of the trappers commented negatively on some of the practices of trophy hunters, especially the use of bear bait and the abandonment of the carcass once a kill is made. These practices are considered objectionable.

The RUS (Golder 2007b) found that the four species of game hunted most often within the Project LSAs are moose, followed by deer, black bear and grouse.

Incidentals

Black bears and their sign were frequently recorded while conducting field work in the Project LSAs (n=26) (Appendix T).

Regional Data

The Suncor Voyageur South Project is the only other project for which black bear data have been collected to date (Suncor 2007). Although days to first photograph are similar between the Project LSAs and the Suncor Voyageur South Project, the proportion of stations visited was substantially lower on Suncor, suggesting that there may be more black bears on the JEMA and PRMA LSAs than on the Voyageur South Project.

5.3.4.2 Grizzly Bear

No grizzly bears or grizzly bear sign were observed during wildlife surveys within the LSAs. Grizzly bears were also not mentioned during interviews with RFMA trappers.

5.3.5 Terrestrial Mustelids (Weasel Family)

Terrestrial mustelids in the Oil Sands Region include weasels (i.e., least weasels and short-tailed weasel) and related family members (wolverines, fishers and martens).

5.3.5.1 Fisher and Marten

Fishers are listed provincially as "Sensitive" (ASRD 2005a) and are one of five CEMA-SEWG wildlife indicators, in addition to being a CEMA Priority 1 species. Martens are designated "Secure" in the Alberta.

Population

In good snow tracking conditions, male fishers can be differentiated from female martens based on track dimensions. However, track sizes of female and young-of-the-year fishers, and male martens overlap. Therefore, data collected as fisher, marten or fisher/marten were combined for the analysis of tracking data.

Jackpine Expansion Mining Area

A fisher/marten track density of 1.73 tracks per km-day was recorded during winter track surveys in the JEMA LSA (Figure 5.3-13).

Thirteen photographs of fishers were taken at the bait stations throughout the year including two during the fall and 11 during the summer in the JEMA LSA (Figure 5.3-14). The average number of days to first photo following camera set-up was 12.1 days in the fall and 5.1 in the summer. The photo rate was 0.14 in the fall and 0.13 in the summer. Appendix W (Tables W-1b to W-4b) presents the photographic bait station results for all four sessions.

No photographs of fishers were taken during the corridor monitoring in the JEMA LSA during all sessions.

Fifty-eight photographs of martens were taken at the bait stations throughout the year including 17 photographs during the fall, 18 during the winter, 16 during the spring and seven during the summer in the JEMA LSA (Figure 5.3-14). The average number of days to first photo following camera set-up was 3.5 days in the fall, 2.8 in the winter, 3.6 in the spring and 2.9 in the summer. The photo rate was 0.14 in the fall, 0.22 in the winter, 0.63 in the spring and summer sessions. Appendix W (Tables W-1b to W–4b) presents the photographic bait station results for all four seasons.

Twelve photographs of martens were taken during corridor monitoring throughout the year including three during the fall and nine during the summer session in the JEMA LSA (Figure 5.3-14). The average number of days to first photo following camera set-up was 3.9 days in the fall and 5.3 in the summer. The photo rate was 0.06 in the fall and 0.18 in the summer. Photographic

corridor monitoring results for all four seasons are listed in Appendix W (Tables W-5b to W-8b).

Pierre River Mining Area

A fisher/marten track density of 2.33 tracks per km-day was recorded during winter track surveys in the PRMA LSA (Figure 5.3-15; Appendix U).

Twenty-three photographs of fishers were taken at the bait stations throughout the year including 14 during the fall, two during the winter, four during the spring and three during the summer in the PRMA LSA (Figure 5.3-16). The average number of days to first photo following camera set-up was 10.8 days in the fall, 2.4 in the winter, 7.0 in the spring and 6.6 in the summer. The photo rate was 0.18 in the fall, 0.06 in the winter, 0.09 in the spring and summer sessions.

Appendix W (Tables W-1b to W–4b) presents the photographic bait station results for all four sessions.

Three photographs of fishers were taken during corridor monitoring throughout the year including one during the fall, winter and summer sessions in the PRMA LSA (Figure 5.3-14). The average number of days to first photo following camera set-up was 17.2 days in the fall, 5.8 in the winter and 7.3 in the summer. The photo rate was 0.04 in the all three sessions. Photographic corridor monitoring results for all four seasons are listed in Appendix W (Tables W-5b to W-8b).

Ninety-six photographs of martens were taken at the bait stations throughout the year including 51 photographs during the fall, 12 during the winter, 13 during the spring and 20 during the summer in the PRMA LSA (Figure 5.3-16). The average number of days to first photo following camera set-up was 5.6 days in the fall, 5.1 in the winter, 4.0 in the spring and 4.9 in the summer. The photo rate was 0.64 in the fall, 0.28 in the winter, 0.31 in the spring and 0.41 in the summer. Appendix W (Tables W-1b to W–4b) presents the photographic bait station results for all four sessions.

Fourteen photographs of martens were taken during corridor monitoring throughout the year including seven during the fall, one during the winter, four during the spring and two during the summer session in the PRMA LSA (Figure 5.3-16). The average number of days to first photo following camera set-up was 1.6 days in the fall, 11.0 in the winter, 9.1 in the spring and 7.3 in the summer. The photo rate was 0.12 in the fall, 0.04 in the winter, 0.13 in the spring and 0.08 in the summer. Photographic corridor monitoring results for all four sessions are listed in Appendix W (Tables W-5b to W-8b).

Results of the photographic bait and corridor station surveys indicate that marten are substantially more common than fisher in both LSAs.

Habitat

Combined fisher and marten tracks or sign were observed in 23 different habitats during the winter track surveys (Appendix U). Low-bush cranberry aspen (d1) is significantly preferred, while wooded fen (FTNN) is used significantly less than expected (Table 5.3-2).

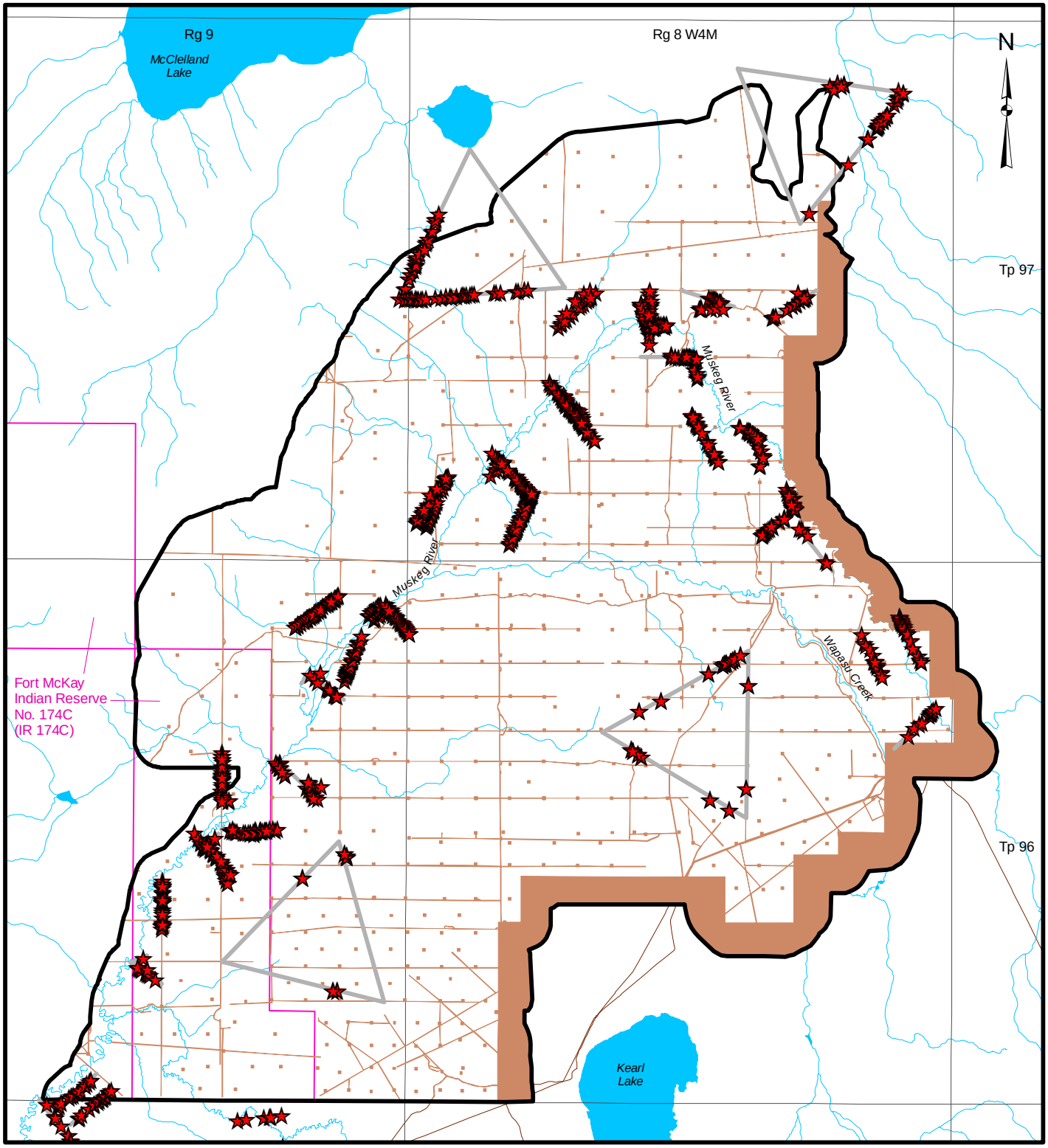
Fishers are usually found in middle to late stage coniferous forests (Buskirk and Ruggiero 1994; Powell and Zielinski 1994). In the Oil Sands Region, fishers were observed in mixedwood, coniferous and riparian areas (Golder 1997; 1998a; 1998b; 2000a) and in wetlands vegetation types (Golder 2000b; Suncor 2000; Ursus and Komex 1997; Westworth, Brusnyk and Associates 1996).

Martens are thought to prefer the same vegetation types as fishers (Buskirk and Ruggiero 1994; Powell and Zielinski 1994). In studies where a preference was observed, martens have been found to prefer mixed coniferous and riparian white spruce (Westworth, Brusnyk and Associates 1996), upland coniferous (Westworth, Brusnyk and Associates 1996), wooded fen (FTNN) (Suncor 2000), blueberry jack pine - aspen (b1) and wooded bog (BTNN) (Golder 2000b) ecosite phases and wetlands types.

Traditional Knowledge and Resource Use

Fisher were described by Fort Chipewyan participants in a CEMA-sponsored Wildlife Movement Traditional Environmental Knowledge Workshop as living in the same areas throughout the year, areas with lots of poplar and spruce where they eat rabbits, squirrels, mice and chickens (i.e., grouse) (FMA 2005). Marten have similar prey preferences and are found in heavy spruce timber, willows, and along river and lake shores. Marten have reinvaded several areas in northeastern Alberta where they have been absent for many years (e.g., Fort Chipewyan).

All RFMA holders indicate that there are at least some fishers and martens on their traplines and all trap both species. On RFMA #1275, the holder stated that the numbers of marten are down. Three years ago the population was good, but the population has since declined. However, he also said that there never were many marten in the area. There are few fisher but he indicated that this is typical for the area. On RFMA #1714, fisher and marten are trapped on the Athabasca River but the populations have dwindled over the past five years. The marten are doing well on RFMA #2331, but there are fewer fishers. Eighteen to 34 martens and 5 to 11 fishers have been trapped in the Project LSAs between the 2001/02 trapping season and the 2005/06 trapping season.



LEGEND

- JACKPINE EXPANSION MINING AREA LOCAL STUDY AREA
- INDIAN RESERVE
- OPEN WATER
- PUBLIC ROADWAY
- CORRIDOR AND TRIANGLE TRANSECT LOCATION
- FISHER/MARTEN

DISTURBED

- EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE
- EXISTING AND APPROVED URBAN AND INDUSTRIAL LINEAR DISTURBANCE

3 0 3

SCALE 1:100,000 KILOMETRES

REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2004), and Alberta SRD, used under license.
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 12.

PROJECT

JACKPINE MINE EXPANSION & PIERRE RIVER MINE PROJECT

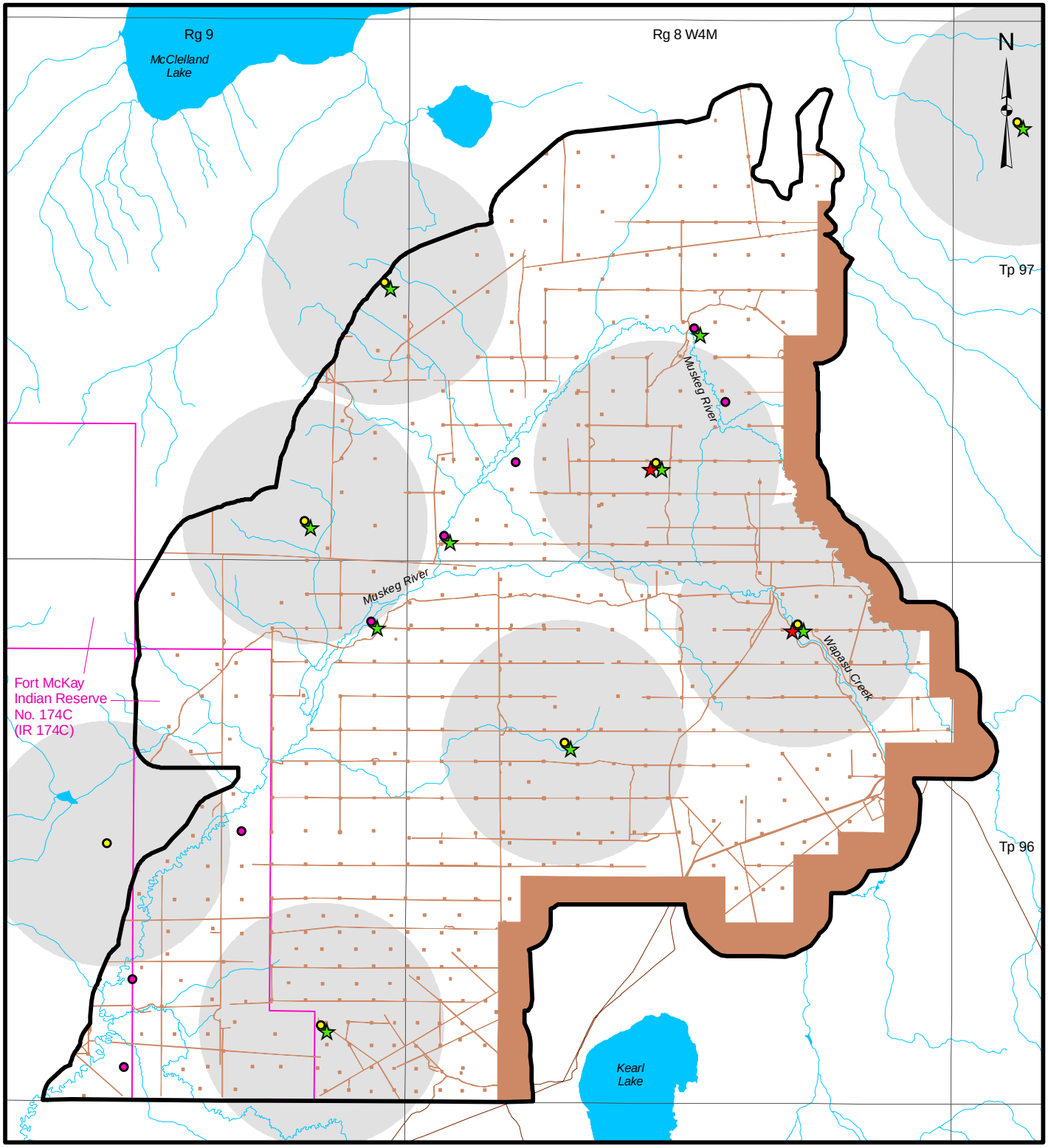
TITLE

FISHER/MARTEN TRACK LOCATIONS IN THE JACKPINE EXPANSION MINING AREA LOCAL STUDY AREA

Shell Canada Limited

PROJECT No. 05-1344-027.7700			SCALE AS SHOWN	REV. 0
DESIGN	VR	06 Jun. 2007	FIGURE: 5.3-13	
GIS	JH	14 Nov. 2007		
CHECK	MJ	16 Nov. 2007		
REVIEW	WES/TC	19 Nov. 2007		

Project: I:\CLIENTS\SHELL\05-1344-027\mapping\mxd\wildlife\DRAFT\jackpine\sa_fisher_marten_wtr_jp_esr.mxd - Plot: I:\CLIENTS\SHELL\05-1344-027\mapping\pdf\wildlife\DRAFT\jackpine\Fig5.3-13_lsa_fisher_marten_wtr_jp_esr.pdf



LEGEND

- JACKPINE EXPANSION MINING AREA LOCAL STUDY AREA
- INDIAN RESERVE
- OPEN WATER
- 2.2 KM BUFFER
- PUBLIC ROADWAY
- BAIT
- CORRIDOR
- FISHER
- MARTEN

DISTURBED

- EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE
- EXISTING AND APPROVED URBAN AND INDUSTRIAL LINEAR DISTURBANCE

REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2004), and Alberta SRD, used under license.
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 12.

3 0 3
SCALE 1:100,000 KILOMETRES

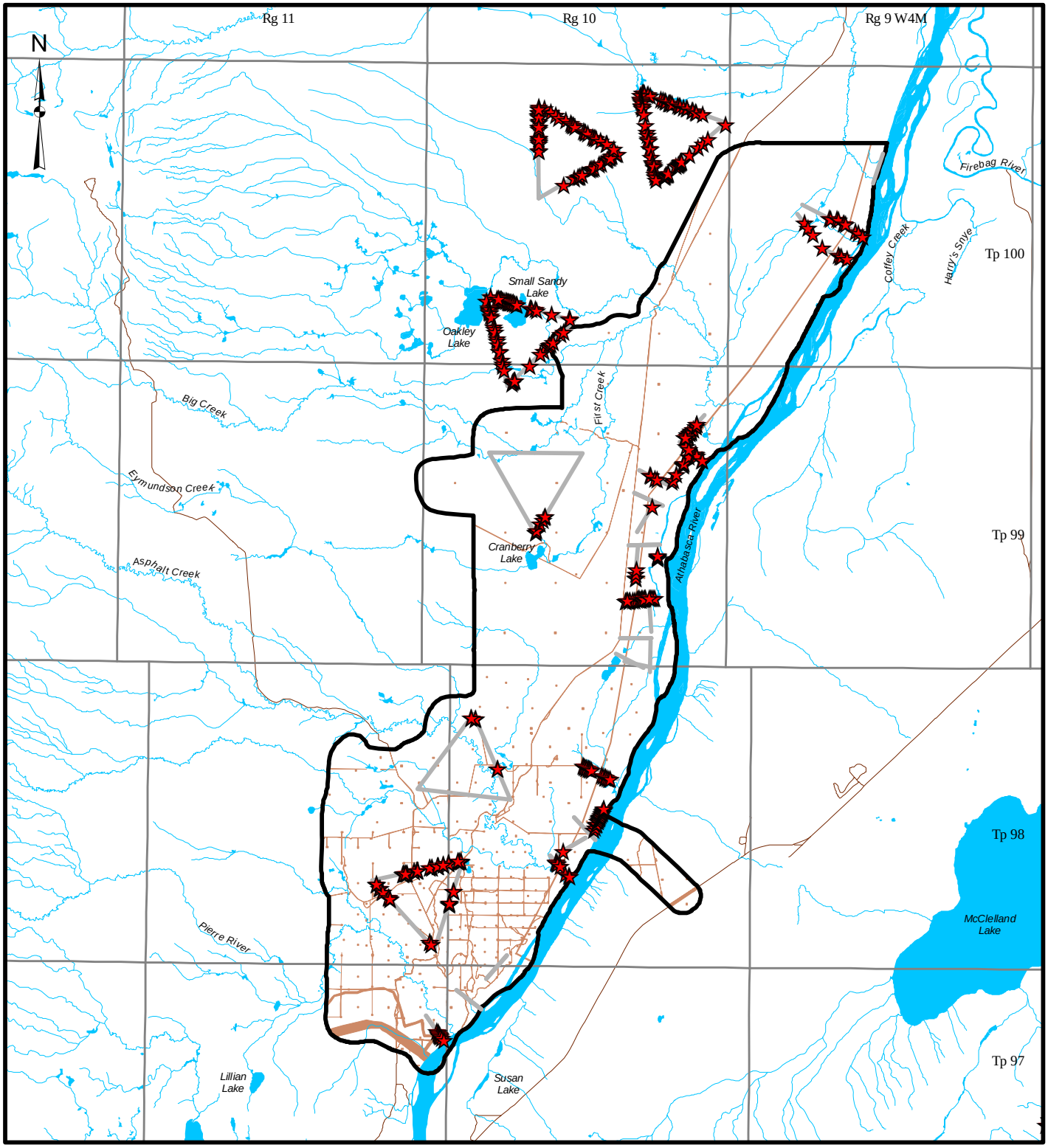
PROJECT
JACKPINE MINE EXPANSION & PIERRE RIVER MINE PROJECT

TITLE
FISHER AND MARTEN PHOTOGRAPH LOCATIONS RECORDED IN THE JACKPINE EXPANSION MINING AREA LOCAL STUDY AREA

Shell Canada Limited

PROJECT No. 05-1344-027.7700			SCALE AS SHOWN	REV. 0
DESIGN	VR	06 Jun. 2007	FIGURE: 5.3-14	
GIS	JH	14 Nov. 2007		
CHECK	MJ	16 Nov. 2007		
REVIEW	WES/TC	19 Nov. 2007		

Project: I:\CLIENTS\SHELL\05-1344-027\mapping\mxd\wildlife\DRAFT\jackpine\sa_fisher_marten_jp_esr.mxd - Plot: I:\CLIENTS\SHELL\05-1344-027\mapping\pdf\wildlife\DRAFT\jackpine\Fig5.3-14_lsa_fisher_marten_jp_esr.pdf



LEGEND

- PIERRE RIVER MINING AREA LOCAL STUDY AREA
- OPEN WATER
- ROAD
- CORRIDOR AND TRIANGLE TRANSECT LOCATION
- FISHER/MARTEN

DISTURBED

- EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE
- EXISTING AND APPROVED URBAN AND INDUSTRIAL LINEAR DISTURBANCE

6 0 6

SCALE 1:180,000 KILOMETRES

REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2004), and Alberta SRD, used under license.
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 12.

PROJECT

JACKPINE MINE EXPANSION &
PIERRE RIVER MINE PROJECT

TITLE

FISHER/MARTEN TRACK LOCATIONS
IN THE PIERRE RIVER
MINING AREA LOCAL STUDY AREA

Shell Canada Limited

PROJECT No. 05-1344-027.7700			SCALE AS SHOWN	REV. 0
DESIGN	VR	10 Aug. 2007	FIGURE: 5.3-15	
GIS	JH	14 Nov. 2007		
CHECK	MJ	16 Nov. 2007		
REVIEW	WES/TC	19 Nov. 2007		

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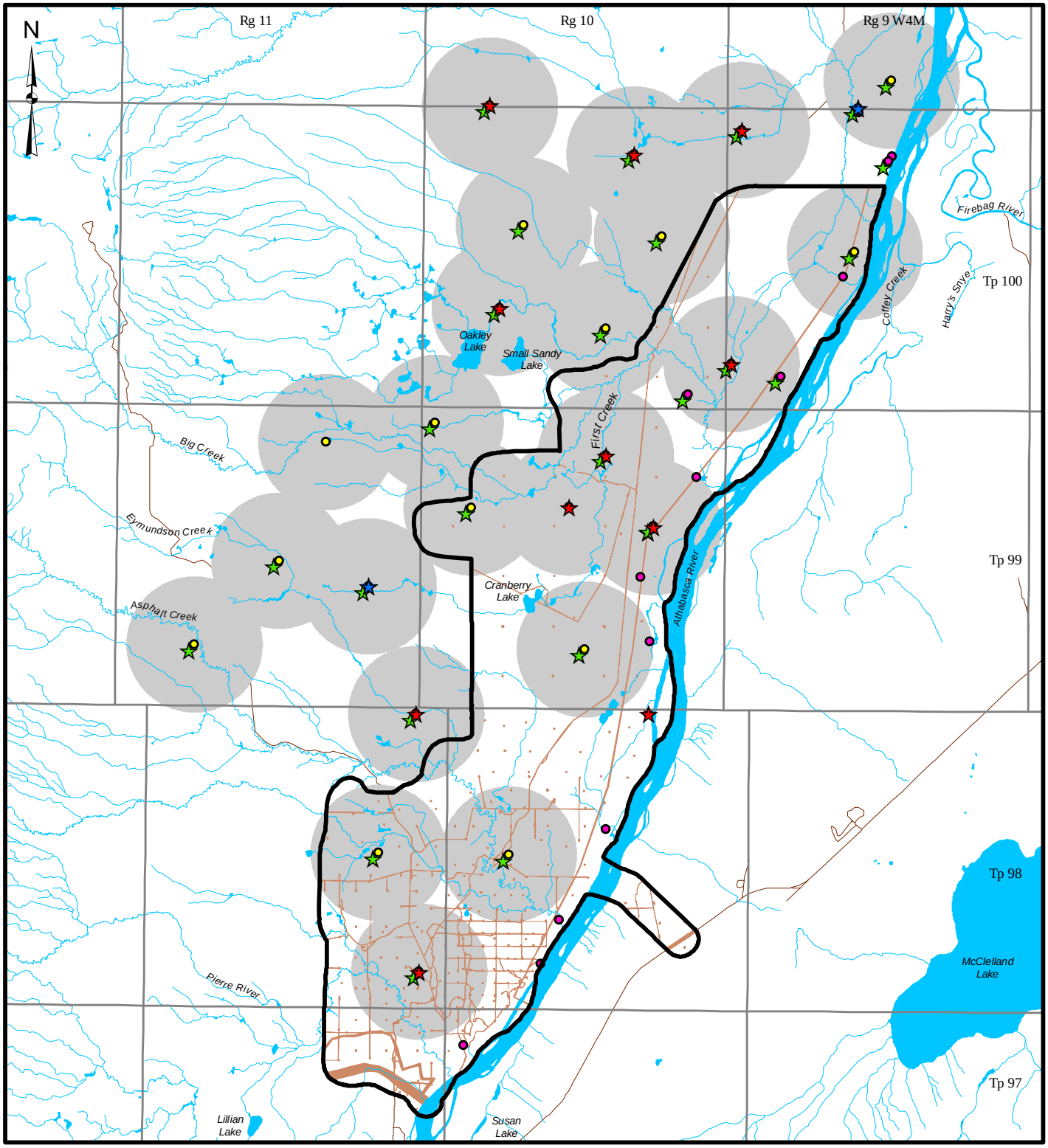

LEGEND

- PIERRE RIVER MINING AREA LOCAL STUDY AREA
- OPEN WATER
- 2.2 KM BUFFER
- ROAD
- BAIT
- CORRIDOR
- FISHER
- WOLVERINE
- MARTEN

DISTURBED

- EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE
- EXISTING AND APPROVED URBAN AND INDUSTRIAL LINEAR DISTURBANCE

6 0 6

SCALE 1:180,000 KILOMETRES

REFERENCE

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Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 12.

PROJECT

JACKPINE MINE EXPANSION & PIERRE RIVER MINE PROJECT

TITLE

FISHER, MARTEN AND WOLVERINE PHOTOGRAPH LOCATIONS IN THE PIERRE RIVER MINING AREA LOCAL STUDY AREA

Shell Canada Limited

PROJECT No. 05-1344-027.7700			SCALE AS SHOWN	REV. 0
DESIGN	VR	10 Aug. 2007	FIGURE: 5.3-16	
GIS	JH	14 Nov. 2007		
CHECK	MJ	16 Nov. 2007		
REVIEW	WES/TC	19 Nov. 2007		

Project: I:\CLIENTS\SHELL\05-1344-027\mapping\mxd\wildlife\DRAFT\pierreriver\sa_fisher_marten_pr.mxd Plot: I:\CLIENTS\SHELL\05-1344-027\mapping\pdf\wildlife\DRAFT\pierreriver\Fig5.3-16_lsa_fisher_marten_pr.pdf

Incidentals

Fisher sign, for example scat, was recorded five times, while marten sign was recorded 13 times on the Project LSAs. One marten was also observed (Appendix T) in the JEMA LSA while checking photographic stations.

Regional Data

Combined fisher and marten track densities recorded in the Project LSAs were high relative to those reported from other environmental setting surveys in the Oil Sands Region although reasons for the differences are not known (Appendix V). On the Canadian Natural Horizon Project, a track density of 0.97 tracks per km-day was recorded. The tracks were most often observed in low-bush cranberry aspen - white spruce (d2), dogwood white spruce (e3) and low-bush cranberry aspen (d1), but no significant preference for habitats was demonstrated (Canadian Natural 2002). For the Suncor Voyageur South Project, a track density 1.34 tracks per km-day was recorded and a preference for low-bush cranberry aspen (d1) was demonstrated (Golder 2007a). Fisher/marten track counts have averaged 1.22 tracks per km-day during winter tracking over all Suncor leases during the last decade (Suncor 2007). Comparisons with other projects could not be made as other projects reported fisher and marten track densities separately.

The Suncor Voyageur South Project is the only other project for which fisher and marten photographic bait station data have been collected to date (Suncor 2007). Based on the photographic bait station data, marten and fisher may be more common in the Project LSAs generally than on the Suncor Voyageur South Project LSA. Reasons for this are not currently known.

5.3.5.2 Wolverine

Wolverines are uncommon carnivores in the Oil Sands Region with large home ranges. The only studies of wolverine ecology in similar habitat are from lowland boreal forest habitat in northwestern Ontario where winter home ranges averaged 1,450 km^2 for males and 525 km^2 for females (Magoun et al. 2005). Movement corridors and habitat connectivity in the regional landscape are likely important to the species. The wolverine is federally listed as “Special Concern” (COSEWIC 2007) and as “May be at Risk” provincially (ASRD 2005a).

Population

Wolverines, due to their solitary nature and large home ranges, are considered to be an uncommon carnivore in the Oil Sands Region.

Jackpine Expansion Mining Area

Four wolverine tracks were recorded during winter track surveys resulting in a track density of 0.01 tracks per km-day.

Wolverines were not photographed during the photographic station surveys in the JEMA LSA.

Pierre River Mining Area

No wolverine tracks were recorded during winter tracking surveys in the PRMA LSA.

Nine photographs of wolverines were taken during the bait station session in the PRMA LSA during the fall session (Figure 5.3-16; Appendix W, Tables W-1b to W-4b). The average number of days to first photo following camera set-up was 1.8 days and the photo rate was 0.04 in the fall. This was the result of what appeared to be a single wolverine visiting the bait station over a period of several days.

One photograph of wolverines was taken during the corridor monitoring in the PRMA LSA during the fall session (Figure 5.3-16; Appendix W, Tables W-1b to W-4b). The average number of days to first photo following camera set-up was 8.9 days and the photo rate was 0.04 in the fall.

Habitat

Habitat studies have not been conducted in ecologically similar landscapes. However, in several research studies wolverines have used a wide range of habitat types within their large home ranges. Wolverines are thought to prefer undisturbed areas of coniferous forest (Pasitschniak-Arts and Larivière 1995). They are particularly sensitive to human disturbance and avoid disturbed areas (Banci 1994).

Traditional Knowledge and Resource Use

Wolverine was not raised as a species of particular interest during interviews with RFMA holders although many trap the species. The holder of RFMA #1716 mentioned that sometimes wolverines are spotted along Firebag River. Just one wolverine has been trapped in the Project LSAs between the 2001/02 trapping season and the 2005/06 trapping season.

Incidentals

Wolverines were not recorded incidentally in the Project LSAs.

Regional Data

Wolverine densities are likely very low in the Oil Sands Region. Wolverine track density was 0.02 tracks per km-day within the Suncor Voyageur South LSA, likely one animal, and 0.01 within Suncor's areas of operations over the last decade (Suncor 2007). Wolverines have been observed incidentally on two occasions within Suncor's reclamation sites (Golder 2004a). On the Kearl Oil Sands Project, wolverine tracks were not seen during the early and late-winter tracking surveys (Imperial Oil 2005). In mid-winter, the overall track frequency for wolverines was only 0.11 tracks per km-day. Wolverine tracks were seen only in a Labrador tea / horsetail white spruce - black spruce (h1) ecosite phase where there were 2.21 tracks per km-day. These tracks were observed on a single transect and likely from a single animal. Husky (2004) recorded an overall wolverine track density of 0.03 tracks per km-day, adjacent to the JEMA LSA. These tracks were recorded only in riparian–black spruce habitats. The Synenco Northern Lights Project recorded wolverine at track densities varying from 0.10 and 1.28 tracks per km-day, all in coniferous forests (Synenco 2006). One wolverine was killed by a vehicle on the road into the Northern Lights LSA.

No observations of the species were recorded in Syncrude Aurora North, TrueNorth Fort Hills Project, Deer Creek Energy Joslyn Project and Canadian Natural Horizon Project (Appendix V).

5.3.5.3 Weasels

Both short-tailed weasels and least weasels are considered "Secure" in Alberta (ASRD 2005a). The tracks of the two species are difficult to differentiate; winter track counts represent a combined count for the two weasel species. Based on the known distribution of the species in Alberta, the long-tailed weasel, listed as "May Be At Risk" is unlikely to range into the Oil Sands Region (Smith 1993).

Population

Jackpine Expansion Mining Area

A weasel track density of 0.61 tracks per km-day was recorded during winter track surveys in the JEMA LSA (Appendix U).

One photograph of a least weasel was taken during the fall bait station session in the JEMA LSA. The average number of days to first photo following camera

set-up was 17.1 days and the photo rate was 0.04 (Appendix W, Tables W-1b to W-4b). No photographs of weasels were taken during bait station sessions in the JEMA LSA.

Pierre River Mining Area

A weasel track density of 0.21 tracks per km-day was recorded during winter track surveys in the PRMA LSA (Appendix U).

No photographs of weasels were taken during bait station sessions or corridor monitoring in the PRMA LSA.

Habitat

During the winter track surveys, combined weasel species tracks or sign were observed in 24 habitat types. Significantly preferred habitats were dogwood white spruce (e3), wooded fen (FTNN) and Labrador tea - subhygric black spruce - jack pine (g1). Blueberry jack pine – aspen (b1), Labrador tea mesic jack pine - black spruce (c1), low-bush cranberry aspen (d1), low-bush cranberry aspen - white spruce (d2), cutlines and roads were used significantly less than expected (Table 5.3-2).

Weasels prefer riparian, deciduous and early successional vegetation types, due in part to the abundance of small mammalian prey usually found in those areas (Banfield 1987).

Traditional Knowledge and Resource Use

Weasels were not mentioned during interviews with trapline holders and therefore they are not considered to be an important part of the fur harvest in the Project LSAs. All trappers indicated that they trapped weasels on their RFMAs. However, during four of the five trapping seasons between the 2001/02 trapping season and the 2005/06 trapping season, no weasels were harvested, while five were taken in the 2003/04 trapping season.

Incidentals

Weasels were incidentally recorded 11 times during terrestrial field surveys in the Project LSAs (Appendix T).

Regional Data

Weasel track densities recorded in the Project LSAs were similar to those reported from other environmental setting surveys in the Oil Sands Region

(Appendix V). On the Canadian Natural Horizon Project, a track density of 0.65 tracks per km-day was recorded. They were observed in a wide variety of terrestrial and wetlands habitats (Canadian Natural 2002). The weasel track density on the TrueNorth Fort Hills Project was 0.31 tracks per km-day (Golder 2000a) and preferred wooded fen (FTNN) wetlands types. On the Imperial Kearl Oil Sands Project, the overall density varied between 0.08 and 0.20 tracks per km-day (Imperial Oil 2005) with early winter track counts being the highest. Husky (2004) reported higher winter track density for weasel (0.92 tracks per km-day) in the Husky Sunrise Thermal Project adjacent to the JEMA LSA. On the Suncor Voyageur South Project, a weasel track density 0.02 tracks per km-day was recorded and no preferences were demonstrated for any habitats (Golder 2007a). Densities of 0.08 and 0.32 tracks per km-day were recorded for least and short-tailed weasels, respectively on Deer Creek Energy's Joslyn lease (Komex 2005). Weasel track densities on the Synenco Northern Lights Project varied between 0.14 tracks per km-day in deciduous habitats to 3.48 tracks per km-day in fen wetlands (Synenco 2006).

5.3.6 Semi-Aquatic Rodents

Muskrat and beaver are CEMA Priority 1 and 2 listed species, respectively. Beaver/muskrat aerial surveys were conducted by helicopter on September 25, 2005 in conjunction with waterfowl aerial surveys, and on October 14, 2006. All sightings of active beaver lodges, beaver dams, food caches, muskrat pushups and wildlife sightings were recorded.

5.3.6.1 Beaver

Population

Jackpine Expansion Mining Area

A fall beaver-muskrat aerial survey was performed in the JEMA LSA on September 25, 2005, in conjunction with a waterfowl survey (Figure 5.2-11). Surveyed lake areas encompassed 113 ha and surveyed watercourses comprised 12.9 km.

A total of 54 observations of beaver activity were documented. Twenty-three lodges were observed, 10 of which appeared occupied based on food caches and recent maintenance. Thirty-one dams were observed in the JEMA LSA and 12 of these were recently maintained. The density for all beaver lodges was 0.06 lodges/ha in lakes and 1.63 lodges/km in watercourses. Active beaver lodge density was also 0.06 lodges/ha of lake, because all seven lodges were recently maintained. Active lodge density was 0.62 lodges/km of watercourse. No beavers were seen during the survey and no food caches were recorded.

Pierre River Mining Area

A fall aerial beaver-muskrat survey was performed in Leases 9 and 17 of the PRMA LSA on September 25, 2005 in conjunction with a waterfowl survey. A second more intensive fall aerial beaver-muskrat survey was performed in the PRMA LSA October 14, 2006. Aerial survey routes for the beaver-muskrat surveys are depicted in Figure 5.2-12. Lake areas surveyed in September 2005 included 78.0 ha in the PRMA LSA and surveyed watercourses comprised 6.2 km. Lake areas surveyed in October 2006 included 170.9 ha in the PRMA LSA and surveyed watercourses comprised 123.9 km.

A total of 31 observations of beaver activity were documented during the September 2005 aerial survey. Sixteen lodges were recorded, two of which were occupied. Six dams were observed across the PRMA LSA and two of these were recently maintained. Beaver lodge densities were 0.14 lodges/ha of lake and 0.64 lodges/km of watercourse. Active beaver lodge densities were 0.03/ha of lake but none of the beaver lodges on streams appeared occupied because no food caches were recorded. Nine beavers were seen during the survey.

A total of 652 observations of beaver activity were documented during the October 2006 PRMA LSA aerial survey. A total of 166 lodges were recorded, 70 of which were occupied. The number of dams observed totalled 396 dams across the PRMA LSA and 93 of these were recently maintained. Beaver lodge densities were 0.05 lodges/ha of lake and 1.28 lodges/km of watercourse. Active beaver lodge densities were 0.02 lodges/ha of lake and 0.53 lodges/km of watercourse. Two beavers were seen during the survey.

Habitat

Beavers are found throughout the boreal forest. The major habitat requirements of beavers are low gradient watercourses and waterbodies with an adjacent supply of deciduous woods or shrublands (Barnes and Mallik 1997). Colonies are most commonly associated with deciduous tree/shrub subclimax or edaphic climax plant communities (Curtis and Jensen 2004). Beavers are expected to occur along watercourses and in marshy areas near their preferred food items, including trembling aspen, birch and willow.

Traditional Knowledge and Resource Use

Beaver is a source of revenue from fur sales and protein for the Aboriginal community in Fort McKay and all RFMA holders indicated they trapped the species. Harvests are strongly correlated to their market value because they require more effort than other furs to prepare for sale. Between the 2001/02 and the 2005/06 trapping seasons, 34 to 69 beavers were harvested annually in the

Project LSAs. On RFMA #1714, the trapper does not bother with beaver because the pelts have little monetary value. The holder of RFMA #1275 felt that this year (2005) the beaver population is high because the market value for the pelts is poor. On RFMA #2137, the trapper indicated that there are no beaver left in the area because their habitat was removed (i.e., logging and industrial development). Further north on RFMA #2331, the trapper did not feel there was a change to the beaver population.

Incidentals

Incidental observations of beaver lodges and dams were recorded frequently in the Project LSAs (Appendix T).

Regional Data

Beaver lodge densities within the Project LSAs are within the ranges recorded in previous surveys in the Oil Sands Region (Appendix V). Beaver lodge density (i.e., active and inactive) on watercourses in the Shell Jackpine Mine - Phase 1 LSA on October 1, 2001 was 0.69 lodges/km in the tributaries, and the active beaver lodge density was 0.66 lodges/km (Golder 2002a). On Canadian Natural Horizon and Suncor Voyageur South LSAs, they were 1.27 lodges/km and 1.17 lodges/km (CNRL 2002), and 0.22 lodges/km and 0.16 lodges/km (Suncor 2007), respectively.

5.3.6.2 Muskrat

Population

No muskrats or evidence of muskrat were seen on the PRMA or the JEMA LSAs.

Habitat

Muskrats typically live in freshwater marshes, marshy areas of lakes, and slow-moving streams. The water must be deep enough so that it will not freeze to the bottom during the winter, but shallow enough to permit growth of aquatic vegetation—ideally between 1 and 2 m. Areas with good growths of bulrushes, cattails, pondweeds or sedges are preferred. Emergent plants are used by muskrats for food and lodge construction. The graminoid marsh (MONG) wetlands type best suits the forage and habitat requirements of muskrats. Muskrat activity can open up dense aquatic vegetation in wetlands, thereby enhancing plant diversity and waterfowl habitat (Messier and Virgil 1992).

Traditional Knowledge and Resource Use

Muskrats are an indicator species for Aboriginal communities; if muskrat populations increase so do the populations of many other animals. Up to 20 muskrats are harvested annually in the Project LSAs between the 2001/02 trapping season and the 2005/06 trapping season.

Incidentals

There were no incidental observations of muskrats or muskrat sign.

Regional Data

Muskrat survey data for the Oil Sands Region demonstrate that muskrat numbers are highly variable between lease areas (Appendix V). Many areas surveyed have no muskrat push ups because muskrat habitat is lacking. The results of the JEMA LSA survey is consistent with a previous study in the Jackpine Mine – Phase 1 area in October 2001 when no muskrats where observed (Golder 2002a).

5.3.7 Bats

5.3.7.1 Population

Jackpine Expansion Mining Area

Ten mist-netting plots were operated for a total of 48.4 mist-net hours during bat surveys within the JEMA LSA (Figure 5.2-9, Table 5.3-3). Thirty-one bats were captured, including two silver-haired bats, 24 northern long-eared bats and five little brown bats. The silver-haired bats consisted of one juvenile female and male. The northern long-eared bats consisted of 14 females, including 6 reproductively active adults and 10 males. The little brown bats consisted of two females and three males.

Fifty eight call detection stations were surveyed in 15 ecosite phases/wetlands types (Table 5.3-4, Figure 5.2-9). Seven species/species groups were identified based on call analysis: big brown/silver-haired, red bat, hoary bat, hoary/big brown/silver haired, little brown, northern long-eared, and high-frequency bats (Table 5.3-5).

During 21 hours of monitoring, there was a total 358.2 passes/hour and 12.3 buzzes/hour detected. Little brown bats were most frequently detected (155.0 passes/hour) followed by big brown/silver-haired bats (51.5 passes/hour) (Table 5.3-5). Foraging activity, as represented by feeding buzzes, was only detected for three species/species groups during the survey including hoary/big

brown/silver haired, little brown and northern long-eared bats. Little brown bats were most frequently detected (8.7 buzzes/hour), followed by northern long-eared bats (3.3 buzzes/hour) and hoary/big brown/silver haired bats (0.3 buzzes/hour).

Table 5.3-3 Survey Effort and Capture Success for Ecosite Phases and Wetlands Types Sampled During Bat Surveys in the Jackpine Expansion Mining Area Local Study Area

Ecosite Phases and Wetlands Types[a]		Survey Effort		Captures[b]		
		Mist-Net Plots	Mist-Net Hours	Silver-Haired Bat	Northern Long-Eared Bat	Little Brown Bat
blueberry jack pine - aspen cutline	b1	4	22.8	n/a	1 J, F 2 A, F, PL 2 A, F, NR 3 A, M 3 J, M	1 A, F, PL
blueberry aspen cutline	b2	3	9.0	1 J, F 1 J, M	1 J, F 1 A, F, Lact 2 A, F, PL 1 A, F, NR 2 A, M 1 J, M	2 A, M
dogwood balsam poplar - aspen	e1	2	11.1	n/a	1 A, F, PL	1 J, F
Labrador tea - subhygric black spruce - jack pine cutline	g1	1	5.5	n/a	2 J, F 1 A, F, NR 1 A, M	1 A, M
Total		**10**	**48.4**	**2**	**24**	**5**

[a] Beckingham and Archibald (1996); Halsey and Vitt (1996).

[b] A = adult, J = juvenile, M = male, F = female, Lact = lactating, PL = post-lactating, NR = non-reproductively active this season.

n/a = Not applicable.

Table 5.3-4 Number of Plots in Which Bat Species Were Detected in the Jackpine Expansion Mining Area Local Study Area

Species Group	Number of Plots	Ecosites
big brown/silver-haired bat	20	b2, b3, d1, d2, d3, burn, FTNN, FONS, FONG, WONN
red bat	3	b1, d3, FTNN
hoary bat	3	d2, d3, WONN
hoary/big brown/silver-haired bat	6	b1, d2, d3, FTNN, FONS, WONN
little brown	31	a1, b1, b2, d1, d3, burn, BTNN, FTNN, FONS, FONG, WONN
northern long-eared bat	23	b1, b2, d1, d2, h1, burn, BTNN, FTNN, FONS
high-frequency bat	8	b1, b2, d1, d3, BTNN, FTNN, WONN

Table 5.3-5 Number of Passes and Feeding Buzzes Produced by Small and Large Bat Species Groups in the Jackpine Expansion Mining Area Local Study Area

Ecosite[a]		Detector		Big-brown/silver-haired bats[b]		Red Bat		Hoary bat		Hoary/big brown/silver haired bats		Little brown		Northern long-eared bat		High-Frequency bats		All Bat Species	
		# of Plots	[hr]	[Passes/hr]	[Buzzes/hr]	[Passes/hr]	[Buzzes/hr]	[Passes/hr]	[Buzzes/hr]	[Passes/hr]	[Buzzes/hr]	[Passes/hr]	[Buzzes/hr]	[Passes/hr]	[Buzzes/hr]	[Passes/hr]	[Buzzes/hr]	[Passes/hr]	[Buzzes/hr]
lichen jack pine	a1	2	0.33	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	9.0	0.0	0.0	0.0	0.0	0.0	9.0	0.0
blueberry jack pine - aspen	b1	6	1.00	1.0	0.0	1.0	0.0	0.0	0.0	1.0	0.0	12.0	0.0	5.0	0.0	1.0	0.0	21.0	0.0
blueberry aspen	b2	2	4.17	3.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.6	0.0	12.7	0.0	1.4	0.0	20.3	0
blueberry aspen - white spruce	b3	1	0.17	6.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.0	0.0
low-bush cranberry aspen	d1	7	1.17	1.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	21.4	4.3	4.3	0.0	5.1	0.0	31.6	4.3
low-bush cranberry aspen - white spruce	d2	9	1.50	0.7	0.0	0.0	0.0	1.3	0.0	0.7	0.0	0.0	0.0	15.3	3.3	0.0	0.0	16.7	3.3
low-bush cranberry white spruce	d3	1	4.00	14.3	0.0	0.5	0.0	0.3	0.0	0.5	0.0	1.0	0.0	1.0	0.0	0.3	0.0	17.8	0.0
Labrador tea - subhygric black spruce - jack pine	g1	2	0.33	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Labrador tea / horsetail white spruce - black spruce	h1	1	0.17	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.0	0.0	0.0	0.0	6.0	0.0
wooded bog	BTNN	1	0.17	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	30.1	0.0	48.1	0.0	18.1	0.0	96.4	0.0
wooded fen	FTNN	10	1.67	13.3	0.0	3.0	0.0	0.0	0.0	0.6	0.0	20.5	0.0	3.0	0.0	0.6	0.0	41.0	0.0
shrubby fen	FONS	7	1.17	2.3	0.0	0.0	0.0	0.0	0.0	3.4	0.0	10.3	0.0	1.7	0.0	0.0	0.0	18.0	0.0
graminoid fen	FONG	4	0.67	1.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.6	0.0	0.0	0.0	0.0	0.0	9.1	0.0
open shallow water	WONN	2	3.75	1.1	0.0	0.0	0.0	1.1	0.0	6.1	0.3	32.5	2.4	0.0	0.0	0.5	0.0	41.3	2.7
disturbed –burn	burn	3	0.50	6.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	8.0	2.0	10.0	0.0	0.0	0.0	24.0	2.0
Total		**58**	**20.94**	**51.5**	**0.0**	**4.5**	**0.0**	**2.7**	**0.0**	**12.3**	**0.3**	**155.0**	**8.7**	**105.8**	**3.3**	**27.0**	**0.0**	**358.2**	**12.3**

(a) Beckingham and Archibald (1996); Halsey and Vitt (1996).

(b) Based on high similarity of call characteristics, big brown and silver-haired were not differentiated.

Pierre River Mining Area

Sixteen mist-netting plots were operated for a total of 143.4 mist-net hours within the PRMA LSA (Figure 5.2-10, Table 5.3-6). Thirty eight bats were captured, 26 northern long-eared bats and 12 little brown bats. The northern long-eared bats consisted of 15 females, including eight reproductively active adults, and 11 males. The little brown bats consisted of four females, including one reproductively active adult, and eight males.

Sixty eight call detection stations were surveyed in 16 ecosite phases/wetlands types. Seven species/species groups were identified based on call analysis: big brown/silver-haired, red bat, hoary bat, hoary/big brown/silver haired, little brown, northern long-eared, and high-frequency bats (Tables 5.3-7 and 5.3-8).

During 29 hours of monitoring, there was a total 190.0 passes/hour and 8.5 buzzes/hour detected. Northern long-eared bats were most frequently detected (68.8 passes/hour) followed by little brown bats (68.4 passes/hour) and big brown/silver-haired bats (44.0 passes/hour) (Table 5.3-8). Foraging activity, as represented by feeding buzzes, was only detected for two species during the survey, little brown and northern long-eared bats. Little brown bats were most frequently detected (6.0 buzzes.hour), followed by northern long-eared bats (2.5 buzzes/hour).

Table 5.3-6 Survey Effort and Capture Success for Ecosite Phases and Wetlands Types Sampled During Bat Surveys in the Pierre River Mining Area Local Study Area

Ecosite Phases and Wetlands Types[a]		Survey Effort		Captures[b]	
		Mist-Net Plots	Mist-Net Hours	Northern Long-Eared Bat	Little Brown Bat
blueberry jack pine - aspen cutline	b1	4	51.0	1 J, F 2 A, F, NR 3 A, F, Lact 4 A, M	1 A, M
low-bush cranberry aspen	d1	1	3.5	1 A, F, PL 1 A, M 1 J, M	0
low-bush cranberry aspen - white spruce	d2	6	67.3	1 J, F 1 A,F, NR 4 A, F, Lact 3 A, M	3 A, F, NR 1 A, F, Lact 1 J, M 6 A, M
dogwood balsam poplar - white spruce	e2	1	2.4	1 J, F	0
dogwood white spruce	e3	3	15.0	0	0
Labrador tea - subhygric black spruce - jack pine cutline	g1	1	4.2	1 J, F 2 A, M	0
Total		**16**	**143.4**	**26**	**12**

[a] Beckingham and Archibald (1996); Halsey and Vitt (1996).

[b] A = adult, J = juvenile, M = male, F = female, Lact = lactating, PL = post-lactating, NR = non-reproductively active this season.

n/a = Not applicable.

Table 5.3-7 Number of Plots in Which Bat Species Were Detected in the Pierre River Mining Area Local Study Area

Species Group	Number of Plots	Ecosites
big brown/silver-haired bat	18	b1, b3, d2, d3, e1, riparian, SONS
red bat	2	b1, d3
hoary bat	1	d3
hoary/big brown/silver-haired bat	4	b3, d2, d3
little brown bat	34	a1, b1, b3, d2, d3, e1, f1, f2, g1, riparian, SONS
northern long-eared bat	25	b1, b3, d2, d3, f1, f2, f3, SONS
high-frequency bat	7	b1, d2, d3, SONS

5.3.7.2 Habitat

The majority of the bats were captured in blueberry jack pine - aspen (b1), low-bush cranberry aspen - white spruce (d2) and blueberry aspen / white birch (b2) ecosite phases (22, 20, 12 bats, respectively) (Table 5.3-3 and 5.3-6). The majority of the little brown bats (11 of the 17) were captured in low-bush cranberry aspen - white spruce (d2) ecosite phases, while the majority of the northern long-eared bats were captured in blueberry jack pine - aspen (b1), blueberry aspen (b2) and low-bush cranberry aspen - white spruce (d2) ecosite phases (10, 9, 8 bats respectively) (Tables 5.3-3 and 5.3-6). Both silver-haired bats were captured in blueberry aspen / white birch (b2) ecosite phases.

Bats in the boreal forest generally prefer mature aspen and white spruce forests for both foraging and roosting habitat (Crampton and Barclay 1998). However, the highest bat activity was recorded in the wooded bog (BTNN), low-bush cranberry aspen - white spruce (d2) ecosite phase, and open shallow water (WONN) and wooded fen (FTNN) wetlands types (Tables 5.3-5 and 5.3-8). The wetlands habitats may be used as transit between foraging habitats as the highest foraging activity (buzzes) was recorded in Labrador tea - subhygric black spruce - jack pine (g1), low-bush cranberry aspen (d1) and low-bush cranberry aspen - white spruce (d2) ecosite phases. Big brown/silver-haired and little brown species groups of bats were detected in 14 and 19 ecosite phases/wetlands types, respectively, of 22 ecosite phases/wetlands types surveyed (Tables 5.3-5 and 5.3-8).

A previous study in the same region suggested northern long-eared bats preferred to forage in intact forest and avoided open habitat, while little brown bats preferred to forage along the edge of clear-cuts and silver-haired bats also preferred open habitat and avoided intact forest (Patriquin 2001). Bats may be limited by suitable roosting habitat at a landscape level, particularly old growth aspen mixedwood stands (Crampton and Barclay 1998) or coniferous (Banfield 1987; Pybus 1986).

Table 5.3-8 Number of Passes and Feeding Buzzes Produced by Small and Large Bat Species Groups in the Pierre River Mining Area Local Study Area

Ecosite[a]		Detector		Big-brown/silver-haired bats[b]		Red Bat		Hoary bat		Hoary/big brown/silver haired bats		Little brown/long-legged[b]		Northern long-eared bat		High-Frequency bats		All Bat Species	
		# of Plots	[hr]	[Passes/hr]	[Buzzes/hr]	[Passes/hr]	[Buzzes/hr]	[Passes/hr]	[Buzzes/hr]	[Passes/hr]	[Buzzes/hr]	[Passes/hr]	[Buzzes/hr]	[Passes/hr]	[Buzzes/hr]	[Passes/hr]	[Buzzes/hr]	[Passes/hr]	[Buzzes/hr]
lichen jack pine	a1	7	1.17	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.6	0.0	0.0	0.0	0.0	0.0	2.6	0.0
blueberry jack pine - aspen	b1	20	3.33	2.1	0.0	0.3	0.0	0.0	0.0	0.0	0.0	15.6	0.0	5.7	0.0	1.8	0.0	25.5	0.0
blueberry aspen / white birch	b2	2	0.33	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
blueberry aspen - white spruce	b3	10	1.67	1.8	0.0	0.0	0.0	0.0	0.0	0.6	0.0	0.6	0.0	3.0	0.0	0.0	0.0	6.0	0.0
low-bush cranberry aspen - white spruce	d2	12	2.00	2.0	0.0	0.0	0.0	0.0	0.0	2.5	0.0	16.5	0.0	22.5	2.5	0.5	0.0	44.0	2.5
low-bush cranberry white spruce	d3	2	7.25	8.0	0.0	0.3	0.0	0.1	0.0	0.3	0.0	1.0	0.0	0.6	0.0	0.1	0.0	10.5	0.0
dogwood balsam poplar - aspen	e1	1	5.25	3.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.1	0.0	0.0	0.0	0.0	0.0	4.7	0.0
horsetail balsam poplar - aspen	f1	4	0.67	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.0	0.0	6.0	0.0	0.0	0.0	9.0	0.0
horsetail balsam poplar - white spruce	f2	2	0.33	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.0	0.0	18.2	0.0	0.0	0.0	21.2	0.0
horsetail white spruce	f3	1	0.17	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	12.0	0.0	0.0	0.0	12.0	0.0
Labrador tea – subhygric black spruce – jack pine	g1	1	0.17	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.0	6.0	0.0	0.0	0.0	0.0	6.0	6.0
wooded fen	FTNN	1	0.17	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
graminoid fen	FONG	1	0.17	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
shrubby swamp	SONS	1	1.25	23.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	14.4	0.0	0.8	0.0	1.6	0.0	40.0	0.0
riparian	riparian	2	4.59	3.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.2	0.0	0.0	0.0	0.0	0.0	8.5	0.0
disturbed – clearcut	clearcut	1	0.17	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total		**68**	**28.69**	**44.0**	**0.0**	**0.6**	**0.0**	**0.1**	**0.0**	**3.4**	**0.0**	**68.4**	**6.0**	**68.8**	**2.5**	**4.0**	**0.0**	**190.0**	**8.5**

(a) Beckingham and Archibald (1996); Halsey and Vitt (1996).

(b) Based on high similarity of call characteristics, big brown and silver-haired bats were not differentiated.

5.3.7.3 Incidentals

Unidentified bats were seen on three occasions during breeding bird surveys in the Project LSAs.

5.3.7.4 Regional Data

Similar species have been captured during bat inventories for other projects in the Oil Sands Region. Little brown, silver-haired and northern long-eared bats were captured on the Canadian Natural Horizon Project (CNRL 2002). Little brown, silver-haired, northern long-eared, and red bats were captured on the Synenco Northern Lights Project (Synenco 2006). Bats were not inventoried on the Imperial Kearl Oil Sands Project (Imperial Oil 2005). Both capture success and bat activity were higher on the Project LSAs than on previous studies in the area (Appendix V, Table V-22). This may partly be attributed to improved methods and increased sample efforts for this study.

5.4 RESULTS – BIRDS

Bird groups occurring within the Oil Sands Region for which environmental setting surveys are conducted include marsh birds, waterfowl, owls and breeding birds. KIRs for the wildlife and wildlife habitat ESR include the old growth forest bird community which is a Priority 1 KIR for CEMA as well as a ratified CEMA-SEWG indicator. CEMA Priority 2 bird species and communities discussed in this report include boreal owls, ducks and geese, and the mixedwood forest bird community (Westworth 2002). Discussion of the two bird communities is limited to Section 5.8.2, Species of Concern.

Birds occurring within the Oil Sands Region that are listed provincially include the peregrine falcon and whooping crane, both listed as “At Risk” and the short-eared owl, which is listed as “May Be At Risk” (ASRD 2005a). Federally, whooping cranes are endangered, peregrine falcons are threatened and the short-eared owl and the yellow rail are of special concern (COSEWIC 2007). Additional species listed as “Sensitive” are discussed throughout Section 5.4 and are summarized in Section 5.8.

5.4.1 Marsh Birds

Marsh birds represent “indicator species” for assessing wetlands ecosystem quality (Conway 2004). Marsh birds consume a variety of aquatic invertebrates, and populations may be affected by accumulation of environmental contaminants in wetlands substrates. There are nine species of marsh birds in Alberta that are

listed provincially as "Sensitive" or "Status Undetermined". Many of these species rely on permanent to semi-permanent wetlands and may be susceptible to drainage, consolidation, cultivation of wetlands, drought and disturbance during the nesting period. Species listed provincially as "Sensitive" include the American bittern, great blue heron, black-crowned night heron, pied-billed grebe**,** horned grebe, western grebe, sandhill crane, American white pelican**,** black tern and sedge wren **(**ASRD 2005a). The yellow rail and Virginia rail are inconspicuous and apparently rare species in Alberta and very little is known of their distribution, populations or other traits in the province. Yellow and Virginia rails are "Status Undetermined" in Alberta (ASRD 2005a). The yellow rail is currently listed federally as "Special Concern" by COSEWIC (2007).

5.4.1.1 Population

Jackpine Expansion Mining Area

Sixteen sora were recorded during marsh bird surveys and nocturnal marsh bird/amphibian callback surveys on JEMA LSA (Table 5.4-1). No yellow rails were recorded during the marsh bird surveys.

Pierre River Mining Area

Six American bittern, 20 sora and two pie-billed grebes were recorded during the nocturnal marsh bird/amphibian callback surveys on PRMA LSA (Table 5.4-1). No yellow rails were recorded during the marsh bird surveys.

5.4.1.2 Habitat

The majority of sora observations were made within graminoid marsh (MONG; n=9) and shrubby swamp (SONS; n=6) wetlands types. They were also located in three graminoid fens (FONG) and three wooded fens (FTNN) wetlands, once in shallow open water (WONN) and once in a blueberry aspen/white birch ecosite (b2). American bitterns in the PRMA LSA were recorded in five ecosite phases and wetlands types, including horsetail balsam poplar - white spruce (f2), a graminoid fen (FONG), a wooded fen (FTNN), a graminoid marsh (MONG), and two locations in shrubby swamps (SONS) (Table 5.4-1). The 2 pie-billed grebes were both located in graminoid marshes (MONG).

Table 5.4-1 Marshbirds Detected by Ecosite Phases and Wetlands Types in the Jackpine Expansion and Pierre River Mining Areas Local Study Areas

Ecosite Phases and Wetlands Types		Detections (number)			
		American Bittern (PRMA LSA)	Pie-Billed Grebes (PRMA LSA)	Sora (PRMA LSA)	Sora (JEMA LSA)
blueberry aspen / white birch	b2	0	0	1	0
low-bush cranberry aspen	d1	0	0	0	1
horsetail balsam poplar - white spruce	f2	1	0	0	0
Labrador tea / horsetail white spruce - black spruce	h1	0	0	2	0
graminoid fen	FONG	1	0	1	2
wooded fen	FTNN	1	0	2	2
graminoid marsh	MONG	1	2	7	4
shrubby swamp	SONS	2	0	5	1
wooded swamp	STNN	0	0	1	0
shallow open water	WONN	0	0	0	1
disturbed - cutline		0	0	1	0
unknown		0	0	0	5
Total Number of Detections		**6**	**2**	**20**	**16**

American bitterns use tall, emergent vegetation. They are found in wetlands of all sizes but tend to be more abundant in larger versus smaller wetlands, and prefer impoundments and beaver-created wetlands to wetlands of glacial origin (Gibbs et al. 1992). Pie-billed grebes also prefer wetlands with dense, tall, emergent vegetation (Nudds 1982). Wetlands that are entirely open water (e.g., WONN) will generally be avoided (Faaborg 1976). Sora habitat is known to consist primarily of freshwater marshes dominated by emergent vegetation. They are often found in relatively shallow portions of wetlands where water level instability produces diverse mosaics of fine and robust emergent vegetation (Melvin and Gibbs 1996).

5.4.1.3 Incidentals

Three yellow rails were heard during bat surveys in late July on the JEMA LSA; habitats were Labrador tea / horsetail white spruce - black spruce (h1) ecosite and wooded fen (FTNN) wetlands type. Incidental observations of marsh birds included Baird's sandpiper, sandhill crane, great blue heron, solitary sandpiper, spotted sandpiper, Wilson's snipe, greater yellowlegs and lesser yellowlegs. A

great blue heron colony was recorded between the northern boundary of the JEMA LSA and McClelland Lake.

5.4.1.4 Regional Data

Yellow rails were recorded incidentally on leases adjacent to the JEMA LSA, during amphibian and breeding bird counts for the Muskeg River Mine Expansion Project (AXYS 2005a), during the TrueNorth Fort Hills wildlife environmental setting surveys (AXYS 2001), and on wildlife environmental setting surveys for the Imperial Kearl Oil Sands Project (Imperial Oil 2005).

Listed species recorded during wildlife surveys for the Imperial Kearl Oil Sands Project included American bittern, great blue heron, horned grebe, sandhill crane, American white pelican and black tern (Imperial Oil 2005). American bittern, great blue heron and sandhill cranes were each recorded during surveys on the Canadian Natural Horizon Project and the TrueNorth Fort Hills Project (Canadian Natural 2002; AXYS 2001). A great blue heron was also recorded on Syncrude Aurora nest surveys (AXYS 1995). Listed species recorded on surveys of wetlands on the Synenco Northern Lights Project included marsh birds listed above plus Virginia Rail (Synenco 2006).

Marsh bird surveys are a recent addition to survey protocols in the Oil Sands Region and comparisons to other projects in the area are limited. The sora is the most abundant and widely distributed rail in Canada.

5.4.2 Waterfowl

Ducks and geese are CEMA Priority 2 species and KIRs for the LSAs. The group includes American green-winged teal, lesser scaup and northern pintail, which are listed as “Sensitive” in Alberta (ASRD 2005a) and are discussed in Section 5.8.2, Species of Concern for the Project.

5.4.2.1 Population

Species observed during the spring waterfowl surveys are divided into two groups: waterfowl and waterbirds. Ducks, mergansers and geese are categorized as waterfowl, while loons, grebes, gulls and shorebirds are categorized as waterbirds. Ducks are further divided into dabblers or divers. Dabbling ducks generally feed on aquatic insects and plant material at the surface or within the first 20 to 30 cm of the water column. Diving ducks, in contrast, forage deeper in the water column, thus enabling them to exploit different food resources.

A fall aerial waterfowl survey was performed in the Project LSAs on September 25, 2005 and two spring aerial waterfowl surveys were conducted on May 18 and June 2, 2006. Aerial survey routes for the early (May 18, 2006) and late spring (June 2, 2006) and fall (September 25, 2005) waterfowl counts are depicted in Figures 5.2-11 and 5.2-12.

Jackpine Expansion Mining Area

Waterfowl density on streams was highest during the May survey (n=1.11/km) and lowest during the June survey (n=0.39/km) (Table 5.4-2). Waterfowl density on waterbodies in the JEMA LSA varied greatly across all three surveys; the lowest was the fall and highest in late spring (September n=0.26/ha, June n=2.06/ha) (Table 5.4-3).

Table 5.4-2 Waterfowl Density on Watercourses During Aerial Surveys in the Jackpine Expansion Mining Area Local Study Area

Survey Period		Length of Creeks and Rivers Surveyed [km]	Waterfowl Density in Streams [per km]
Fall	September 25, 2005	12.9	0.62
Early spring	May 18, 2006	83.0	1.11
Late spring	June 2, 2006	83.0	0.39

Table 5.4-3 Waterfowl Density on Waterbodies During Aerial Surveys in the Jackpine Expansion Mining Area Local Study Area

Survey Time		Area of Lakes Surveyed [ha]	Waterfowl Density in Lakes [per ha]
Fall	September 25, 2005	130.1	0.26
Early spring	May 18, 2006	143.4	0.68
Late spring	June 2, 2006	143.4	2.06

Diving ducks outnumbered dabbling ducks in all surveys (Table 5.4-4). The spring surveys identified 12 species of waterfowl, six were dabblers (i.e., American wigeon, blue-winged teal, redhead, American green-winged teal, mallard and northern shoveler), five species were diving ducks (i.e., bufflehead, common goldeneye, common merganser, lesser scaup and ring-necked duck) and Canada goose. The most abundant spring waterfowl were ring-necked ducks (May n=45, June n=23), buffleheads (May n=50, June n=11) and Canada geese (May n=8, June n=32). May 18, the earlier of the two spring surveys, had more waterfowl (n=260) than the June 2 survey (n=204). Bonaparte's gulls were commonly observed throughout the spring survey (May n=41, June n=23) and

were the most frequently recorded waterbird. Three great blue herons, a species listed as "Sensitive", were recorded during each of the spring surveys.

The September 2005 survey produced observations of 53 buffleheads, 20 lesser scaup, five unidentified dabbling ducks, 10 unidentified diving ducks and four unidentified ducks.

Table 5.4-4 Waterfowl and Waterbird Observations During Spring Aerial Surveys in the Jackpine Expansion Mining Area Local Study Area

Bird Types	Number Observed		
	September 25, 2005	May 18, 2006	June 2, 2006
Waterfowl			
American widgeon	0	1	3
American green-winged teal	0	2	0
blue-winged teal	0	17	4
bufflehead	53	50	11
Canada goose	0	8	32
common goldeneye	0	7	8
common merganser	0	4	0
lesser scaup	20	15	15
mallard	0	16	13
northern shoveler	0	5	0
redhead	0	1	0
ring-necked duck	0	45	23
unidentified dabbler species	5	0	0
unidentified divers	10	0	0
unidentified duck species	4	14	52
subtotal	*92*	*185*	*161*
Waterbird			
American coot	0	2	0
Bonaparte's gull	0	41	23
great blue heron	0	3	3
solitary sandpiper	0	7	17
spotted sandpiper	0	22	0
subtotal	*0*	*75*	*43*
Total	**92**	**260**	**204**

Pierre River Mining Area

Waterfowl density on waterbodies in the PRMA LSA was substantially higher during both spring surveys when compared to the fall survey (May n=4.91/ha, June n=2.28/ha, September n=0.46/ha) (Table 5.4-6). All waterfowl surveys

recorded more dabbling ducks than diving ducks, though numbers were comparable on the 18 May survey (n=66 dabblers, n=63 divers). Total lake area surveyed differed between the fall and the spring surveys (fall n=77.7 ha, spring n= 17.1 ha) because of changes to PRMA LSA boundaries. The small area covered in the spring surveys may inadequately reflect true waterfowl numbers (Table 5.4-6).

Table 5.4-5 Waterfowl Density on Watercourses During Aerial Surveys in the Pierre River Mining Area Local Study Area

Survey Period		Length of Creeks and Rivers Surveyed [km]	Waterfowl Density in Streams [per km]
Fall	September 25, 2005	23.4	1.54
Early spring	May 18, 2006	92.6	0.54
Late spring	June 2, 2006	92.6	0.53

Table 5.4-6 Waterfowl Density on Waterbodies During Aerial Surveys in the Pierre River Mining Area Local Study Area

Survey Time		Area of Lakes Surveyed [ha]	Waterfowl Density in Lakes [per ha]
Fall	September 25, 2005	77.7	0.46
Early spring	May 18, 2006	17.1	4.91
Late spring	June 2, 2006	17.1	2.28

Waterfowl density on streams was nearly identical for both spring surveys (May n=0.54/km, June n=0.53/km) and much lower than the fall survey (n=1.54/km) (Table 5.4-5).

The spring surveys identified 11 species of waterfowl (Table 5.4-7). Five species were diving ducks (i.e., bufflehead, common goldeneye, common merganser, lesser scaup and ring-necked duck), four were dabblers (i.e., American wigeon, blue-winged teal, American green-winged teal and mallard), as well as Canada goose and tundra swan. The most abundant spring waterfowl were buffleheads (May n=27, June n=19), Canada geese (May n=10, June n=24) and mallards (May n=27, June n=8). May 18, the earlier of the spring surveys, had many more waterfowl (n=204) than the June 2 survey (n=141). Solitary sandpipers were the most commonly observed shorebird.

The September 2005 survey produced observations of 33 tundra swans, one common merganser, 22 unidentified dabbling ducks, nine unidentified diving ducks and four unidentified ducks.

Table 5.4-7 Waterfowl and Waterbird Observations During Spring and Fall Aerial Surveys in the Pierre River Mining Area Local Study Area

Bird Types	Number Observed		
	September 25, 2005	May 18, 2006	June 2, 2006
Waterfowl			
American widgeon	0	11	7
American green-winged teal	0	10	0
blue-winged teal	0	8	14
bufflehead	0	27	19
Canada goose	0	10	24
common goldeneye	0	7	9
common merganser	1	1	4
lesser scaup	0	3	0
mallard	0	27	8
ring-necked duck	0	25	3
tundra swan	33	0	0
unidentified dabblers	22	0	0
unidentified divers	9	0	0
unidentified duck species	4	42	25
subtotal	*69*	*171*	*113*
Waterbird			
American coot	0	6	0
solitary sandpiper	0	11	28
spotted sandpiper	0	16	0
subtotal	*0*	*33*	*28*
Total	**69**	**204**	**141**

5.4.2.2 Habitat

Waterfowl density varied greatly seasonally and by location. Waterfowl density on lakes during both spring surveys on the PRMA LSA was high, substantially higher than those observed on the JEMA LSA. This may be attributable to the small sample size as the total surface area of surveyed waterbodies in the PRMA LSA was small, 17.1 ha. With the nature of the sample, data were also affected by events such as large flocks of geese or diving ducks.

5.4.2.3 Traditional Knowledge and Resource Use

Ducks, duck eggs and geese are the preferred avian resources harvested by Aboriginal communities in the Project LSAs. Participants in a CEMA-sponsored Wildlife Movement Traditional Environmental Knowledge Workshop felt that waterfowl, like large flocks of snow geese, used to get their “gravel” (i.e., grit for

their gizzards to digest plant material) from the Athabasca Delta, but they no longer stop there. There are also fewer ducks on the Athabasca River and no geese. Participants in the same workshop felt that muskeg in areas south of Fort McMurray used to be full of ducks and other waterfowl, and now there are decreasing amounts of water and fewer waterfowl.

5.4.2.4 Incidentals

Waterfowl heard or seen incidentally in the Project LSAs include common goldeneye, Canada goose, common loon and mallard ducks (Appendix T).

5.4.2.5 Regional Data

Staging waterfowl surveys have been conducted for the Imperial Kearl Oil Sands Project (Imperial Oil 2005), the Canadian Natural Horizon Project (Canadian Natural 2002) and the Deer Creek Energy Joslyn Project (Komex 2005). Surveys on the Canadian Natural Horizon Project had similar results to those reported here, while fewer species and overall numbers were recorded on the Joslyn Project LSA. Kearl Lake is well known as important habitat for waterfowl and waterbirds and results from the Kearl Lake waterfowl surveys indicate the lake's importance to waterfowl and waterbirds in the region (Imperial Oil 2005).

5.4.3 Owls

Owls as a group are a KIR for the wildlife and wildlife habitat ESR. Many species within the group are terrestrial old growth forest indicators and boreal owls are a CEMA Priority 2 indicator. Short-eared owls are listed provincially as "May be at Risk" while several other species are listed as "Sensitive" (i.e., barred owl, great gray owl, northern hawk owl, northern pygmy owl) (ASRD 2005a,b).

5.4.3.1 Population

Owls numbers observed within each LSA are presented in Table 5.4-8.

Surveys on the JEMA LSA were conducted in 2006, while surveys on the PRMA LSA were conducted in 2006 and 2007. The number of owls detected in 2006 (36) on the PRMA LSA was higher than the number detected in 2007 (28). Species diversity per plot was higher in 2006 (1.45 owls per plot) than it was in 2007 (1.13 owls per plot). The same species observed in 2006 were observed in 2007, except for the long-eared owl.

Jackpine Expansion Mining Area

Nocturnal owl surveys were conducted in the JEMA LSA on May 4 to May 9, 2006. Weather conditions during the surveys were excellent with cloud cover ranging from clear to overcast, with light wind and temperatures ranging from -5 to 9°C.

Owl calls were detected at 61% (31 of 51) of survey sites in the JEMA LSA. Owl density ranged from 0 to 1 owl per plot and averaged 0.80 owls per plot. Owl species richness ranged from 0 to 3 owl species per plot and averaged 1.21 owl species per plot. The boreal owl was the most abundant species recorded, followed by great horned owl, great gray owl and northern saw-whet owl.

Table 5.4-8 Owl Species Observed in the Jackpine Expansion and Pierre River Mining Areas Local Study Areas, 2006 and 2007

Local Study Area	Barred Owl	Boreal Owl	Great Gray Owl	Great horned Owl	Long-eared Owl	Northern Saw-whet Owl	Total
JEMA	0	29	2	8	0	2	**41**
PRMA	14	31	9	6	2	2	**64**

Pierre River Mining Area

Nocturnal owl surveys were conducted in the PRMA LSA on May 4 to May 9, 2006 and May 13 (Table 5.2-2), May 18, 2007. Weather conditions during the surveys were excellent with cloud cover ranging from clear to overcast, with light wind and temperatures ranging from -5 to 9°C.

Owl calls were detected at 48% (40 of 84) of sites and owl density ranged from 0 to 5 owls per plot and averaged 0.76 owls per plot. Owl species richness ranged from 0 to 4 owl species per plot and averaged 1.20 owl species per plot.

5.4.3.2 Habitat

A total of 131 owl plots were surveyed within 19 vegetation types (Table 5.4-9, Figures 5.2-15 and 5.2-16). Associated habitat types could be assigned to 99 of the 105 owl records (Table 5.4-10).

Table 5.4-9 Habitat Types of Owl Survey Locations in the Jackpine Expansion and Pierre River Mining Areas Local Study Areas

Vegetation Type[(a)]	Map Code	Number of Plots	
		PRMA	JEMA
Terrestrial			
lichen jack pine	a1	30	17
blueberry jack pine - aspen	b1	0	1
blueberry aspen / white birch	b2	1	0
blueberry aspen - white spruce	b3	1	0
Labrador tea mesic jack pine - black spruce	c1	1	0
low-bush cranberry aspen	d1	10	0
low-bush cranberry aspen - white spruce	d2	15	1
low-bush cranberry white spruce	d3	3	1
dogwood balsam poplar - white spruce	e2	2	0
dogwood white spruce	e3	1	0
horsetail balsam poplar - white spruce	f2	1	0
Labrador tea - subhygric black spruce - jack pine	g1	3	0
Wetlands			
wooded bog	BTNN	1	7
shrubby fen	FONS	0	3
wooded bog	FTNN	5	10
shrubby sons	SONS	3	1
Disturbed			
burn	Burn	–	6
road	Road	1	1
clearcut	Clearcut	2	3

(a) Beckingham and Archibald (1996); Vitt et al. (1997).

– = Not applicable.

Table 5.4-10 Owls Recorded in the Local Study Areas by Habitat Type

Species	Vegetation Type at Owls Estimated Location[(a)]	Map Code	Number of Observations
barred owl	lichen jack pine	a1	7
	low-bush cranberry aspen - white spruce	d2	3
	low-bush cranberry white spruce	d3	1
		sub-total	*11*
boreal owl	lichen jack pine	a1	16
	blueberry jack pine - aspen	b1	1
	blueberry aspen / white birch	b2	1
	blueberry aspen - white spruce	b3	1
	wooded bog	BTNN	3
	disturbed - burn	burn	2
	Labrador tea mesic jack pine - black spruce	c1	1
	low-bush cranberry aspen	d1	3
	low-bush cranberry aspen-white spruce	d2	11
	low-bush cranberry white spruce	d3	1
	disturbed - clearcut	Clearcut	3

Table 5.4-10 Owls Recorded in the Project Local Study Areas by Habitat Type (continued)

Species	Vegetation Type at Owls Estimated Location[(a)]	Map Code	Number of Observations
boreal owl (continued)	disturbed - road	Road	1
	dogwood balsam polar - white spruce	e2	1
	shrubby fen	FONS	1
	wooded fen	FTNN	8
	Labrador tea - subhygric black spruce - jack pine	g1	2
	shrubby swamp	SONS	1
		sub-total	*57*
great gray owl	lichen jack pine	a1	4
	low-bush cranberry aspen - white spruce	d2	2
	disturbed - clearcut	Clearcut	1
	dogwood balsam polar - white spruce	e2	1
	wooded fen	FTNN	2
	Labrador tea - subhygric black spruce - jack pine	g1	1
		sub-total	*11*
great horned owl	lichen jack pine	a1	10
	wooded bog	BTNN	1
	disturbed - burn	burn	1
	low-bush cranberry aspen - white spruce	d2	1
	wooded fen	FTNN	1
		sub-total	*14*
long-eared owl	lichen jack pine	a1	1
	wooded fen	FTNN	1
		sub-total	*2*
northern saw-whet owl	lichen jack pine	a1	2
	disturbed - clearcut	Clearcut	2
		sub-total	*4*
Total			**99**

(a) Beckingham and Archibald (1996); Vitt et al. (1997).

A total of 11 barred owls were observed during surveys in three different habitat types including lichen jack pine (a1), low-bush cranberry aspen - white spruce (d2) and low-bush cranberry white spruce (d3). These owls were likely using these habitat types for both breeding and foraging. The species generally uses mixed or mature deciduous forest during the breeding season (Mazur et. al. 1997). It selects older stands because preferred nesting sites (i.e., broken-topped, large-diameter aspen and balsam poplar trees) are most abundant in mature forest. The barred owl is currently listed in Alberta as a “Sensitive” species based on its preference of large, continuous blocks of mature forest habitat (ASRD 2005b).

The boreal owl was the most abundant owl observed and was recorded in 17 different habitat types. The 17 terrestrial and wetlands habitat types included lichen jack pine (a1), blueberry jack pine - aspen (b1), blueberry aspen / white birch (b2), blueberry aspen - white spruce (b3), wooded bog (BTNN), Labrador tea mesic jack pine - black spruce (c1), low-bush cranberry aspen (d1), low-bush cranberry aspen - white spruce (d2), low-bush cranberry white spruce (d3), dogwood balsam poplar - white spruce (e2), shrubby fen (FONS), wooded fen (FTNN), Labrador tea - subhygric black spruce - jack pine (g1), shrubby swamp (SONS) and disturbed habitat (Table 5.4-10). The boreal owl is known to breed in a variety of forest habitats (Bondrup-Nielsen 1978) and generally nests in the cavities of live or dead aspen trees (Hayward and Hayward 1993).

Great gray owls were observed in six different habitat types including both terrestrial and wetlands habitats. The six habitat types included lichen jack pine (a1), low-bush cranberry aspen - white spruce (d2), dogwood balsam poplar - white spruce (e2), wooded fen (FTNN), Labrador tea - subhygric black spruce - jack pine (g1) and disturbed habitat. The great gray owl typically breeds in wetlands habitats and nests atop snags or old raptor nests (Bull and Duncan 1993).

The great horned owl was observed over five habitat types: lichen jack pine (a1), wooded bog (BTNN), low-bush cranberry aspen - white spruce (d2), wooded fen (FTNN) and disturbed habitat.

The long-eared owl were observed in lichen jack pine (a1) and wooded fen (FTNN). The long-eared owl is associated with wooded habitats in close association with water and nests in abandoned stick nests (Semenchuk 1992).

The northern saw-whet owl was observed in two habitat types, lichen jack pine (a1) and a disturbed habitat, clearcut. This species was likely foraging in the clear cut because breeding habitat typically consists of mature, moist forest with woodpecker cavities (Semenchuk 1992).

Species that do not respond readily to call playbacks (e.g., short-eared owl) are under-represented in these survey data because visual searches are difficult for species that are most active after dark and systematic surveys for diurnal owls are not conducted.

5.4.3.3 Regional Data

Owl abundance and species diversity are quite variable in the Oil Sands Region. On leases closest to the Project LSAs, the Shell Muskeg River Mine Project, the

Muskeg River Mine Expansion and Jackpine Mine – Phase 1 had substantially fewer owls. Two boreal owls and one great horned owl were recorded during the Muskeg River Mine nocturnal owl surveys (Golder 1997). Two great horned owls were recorded during owl surveys for the Jackpine Mine – Phase 1 Project (Golder 2002a). Two owls, a boreal and a long-eared owl, were recorded in the Muskeg River Mine Expansion LSA in 2004 (AXYS 2005a). However, 21 owls, including 14 boreal owls and seven great horned owls, were recorded during owl surveys on the Imperial Kearl Project LSA in 2004 and an additional 5 great gray owls were recorded incidentally (Imperial Oil 2005). Field surveys for the Husky Sunrise Thermal Project and Syncrude Aurora South projects (Husky 2004) detected six owl species: boreal, great gray, great horned, long-eared, northern hawk and northern saw-whet owls. Barred owls were the most commonly detected species followed by boreal owls and great horned owls during surveys on the Synenco Northern Lights lease (Synenco 2006).

5.4.3.4 Incidentals

Northern hawk owl, barred owl, boreal owl, great gray owl and great horned owl were all recorded incidentally on the Project LSAs, primarily during breeding bird surveys (Appendix T).

5.4.4 Breeding Bird Communities

Old growth forest and mixedwood breeding bird communities are KIRs for the wildlife and wildlife habitat ESR. Breeding birds of special concern as a result of their provincial listing (ASRD 2005a) as “Sensitive” include:

- bay-breasted warbler;
- blackburnian warbler;
- black-throated green warbler;
- brown creeper;
- Canada warbler;
- Cape may warbler;
- common nighthawk;
- common yellowthroat;
- least flycatcher;
- rusty blackbird; and
- western tanager.

5.4.4.1 Population

Jackpine Expansion Mining Area

Breeding bird surveys were conducted within the JEMA LSA over a period of five days from June 14 to 18, 2006. A total of 165 counts were conducted (Table 5.4-11, Figure 5.2-7). Sixty-one different species and 586 individual birds were recorded within a 50 m radius during the surveys. Seven species comprised 50% of the bird observations. Chipping sparrow was the most abundant species detected, followed by Tennessee warbler, dark-eyed junco, alder flycatcher, ovenbird, white-throated sparrow and yellow-rumped warbler.

Nine "Sensitive" species were observed during the breeding bird surveys in the JEMA LSA. These include bay-breasted warbler, brown creeper, Canada warbler, Cape May warbler, common yellowthroat, great gray owl, least flycatcher, rusty blackbird and western tanager. The yellow-bellied flycatcher was the only species observed whose status is "Undetermined". No "May Be At Risk", or "At Risk" species (ASRD 2005a) were observed.

Pierre River Mining Area

Breeding bird surveys were conducted within the PRMA LSA over a period of three days from June 5 to 7, 2007. Sixty-seven counts were conducted (Table 5.4-12 and Figure 5.2-8). Forty-seven different species and 259 individual birds were recorded within a 50 m radius during the surveys. Nine species comprised 50% of the bird observations. White-throated sparrow was the most abundant species detected, followed by northern waterthrush, black-capped chickadee, chipping sparrow, Swainson's thrush, swamp sparrow, yellow-bellied sapsucker, boreal chickadee and dark-eyed junco.

Six "Sensitive" species were observed during the breeding bird surveys in the PRMA LSA. These include black tern, black-backed woodpecker, brown creeper, common yellowthroat, least flycatcher and western tanager. No "May Be At Risk", or "At Risk" species were observed (ASRD 2005a).

5.4.4.2 Habitat

A total of 232 sites in 24 ecosite phases and wetlands types were surveyed in the JEMA and PRMA LSAs (Figure 5.2-7 and 5.2-8).

Table 5.4-11 Habitat Types of Breeding Bird Point Counts in the in the Jackpine Expansion Mining Area Local Study Area

Map Code	Ecosite Phases and Wetlands Types[(a)]	Number of Plots
d2	low-bush cranberry aspen - white spruce	31
FTNN	wooded fen	25
BTNN	wooded bog	18
b1	blueberry jack pine - aspen	12
d1	low-bush cranberry aspen	11
b4	blueberry white spruce - jack pine	10
FONS	shrubby fen	10
b3	blueberry aspen - white spruce	9
SONS	shrubby swamp	8
a1	lichen jack pine	7
h1	Labrador tea / horsetail white spruce - black spruce	5
d3	low-bush cranberry white spruce	3
g1	Labrador tea – subhygric black spruce - jack pine	3
Burn	burn	2
c1	Labrador tea mesic jack pine - black spruce	2
FONG	graminoid fen	2
Shrub	shrub	2
b2	blueberry aspen / white birch	1
e2	dogwood balsam poplar - white spruce	1
e3	dogwood white spruce	1
f3	horsetail white spruce	1
STNN	wooded swamp	1
Total		**165**

[(a)] Beckingham and Archibald (1996); Vitt et al. (1997).

Table 5.4-12 Habitat Types of Breeding Bird Point Counts in the Pierre River Mining Area Local Study Area

Map Code	Ecosite Phases and Wetlands Types[(a)]	Number of Plots
d1	low-bush cranberry aspen	10
d2	low-bush cranberry aspen - white spruce	10
FONS	shrubby fen	6
a1	lichen jack pine	5
SONS	shrubby swamp	5
b2	blueberry aspen - white birch	3
b3	blueberry aspen - white spruce	3
BTNN	wooded bog	3
f2	horsetail balsam poplar - white spruce	3
FONG	graminoid fen	3
STNN	wooded swamp	3
b1	blueberry jack pine - aspen	2
d3	low-bush cranberry white spruce	2

Table 5.4-12 Habitat Types of Breeding Bird Point Counts in the Pierre River Mining Area Local Study Area (continued)

Map Code	Ecosite Phases and Wetlands Types[(a)]	Number of Plots
e2	dogwood balsam poplar - white spruce	2
FTNN	wooded fen	2
e3	dogwood white spruce	1
f3	horsetail white spruce	1
h1	Labrador tea / horsetail white spruce - black spruce	1
MONG	graminoid marsh	1
Shrub	shrub	1
Total		**67**

[(a)] Beckingham and Archibald (1996); Vitt et al. (1997).

Forty-six of the 73 species recorded occurred in more than three of the ecosite phases and wetlands types surveyed (Table 5.4-13). Twelve species occurred in two ecosite phases and wetlands types, while fifteen species occurred in only one ecosite phase or wetlands type. The Tennessee warbler and chipping sparrow were the most widespread species, as they were both observed in 18 of the 24 ecosite phases/wetlands types sampled (Table 5.4-13).

Eight of the 11 “Sensitive” species observed in the JEMA and PRMA LSAs were observed in terrestrial habitat. These include bay-breasted warbler, brown creeper, black-backed woodpecker, Canada warbler, Cape May warbler, common yellowthroat, least flycatcher and western tanager (Table 5.4-13).

Ten of the 11 “Sensitive” species observed in the JEMA and PRMA LSAs were observed in wetlands habitat. These include bay-breasted warbler, black tern, black-backed woodpecker, Canada warbler, Cape May warbler, common yellowthroat, great gray owl, least flycatcher, rusty blackbird and western tanager (Table 5.4-13). The only “Sensitive” species that was observed in the JEMA and PRMA LSAs that was not observed in wetlands habitat was the brown creeper.

Table 5.4-13 Breeding Bird Detections and Habitat Types in the Local Study Areas, 2006 to 2007

Species	Species Code (American Ornithologists' Union)	Ecosite Phase and Wetlands Type Map Codes[(a)]	Total Number of Observations	Provincial (ASRD 2005a) Status
chipping sparrow	CHSP	a1, FONS, d1, d2, d3, b1, burn, b3, c1, BTNN, h1, b4, g1, f3, STNN, FTNN, SONS, f2	92	Secure
Tennessee warbler	TEWA	a1, b3, b1, b2, b4, e3, h1, d1, g1, f3, FONG, d2, FONS, SONS, BTNN, FTNN, d3, e2	80	Secure
white-throated sparrow	WTSP	STNN, BTNN, g1, burn, FONS, SONS, FTNN, b2, c1, d2, d1, b4, f2, f3, h1, Shrub	50	Secure
ovenbird	OVEN	h1, b2, f3, a1, b3, d1, b1, d2, e3	48	Secure
dark-eyed junco	DEJU	BTNN, d1, FTNN, d2, b2, FONS, f3, a1	40	Secure
alder flycatcher	ALFL	a1, SONS, FTNN, FONS, STNN, BTNN, FONG, g1, c1, d1, d2, Shrub	33	Secure
Swainson's thrush	SWTH	FTNN, f2, e3, BTNN, d1, d3, d2, b1, FONS, FONG, b3, h1, SONS, b2, f3	33	Secure
yellow-rumped warbler	YRWA	SONS, a1, FTNN, BTNN, e2, h1, b1, FONS, burn, b3, d2	28	Secure
swamp sparrow	SWSP	STNN, FTNN, FONS, FONG, SONS, Shrub	27	Secure
gray jay	GRAJ	a1, e2, FONS, f2, b1, h1, BTNN, d2, FONG, e3, FTNN	26	Secure
palm warbler	PAWA	FTNN, Shrub, d2, STNN, b3, BTNN, FONG, FONS	27	Secure
common yellowthroat	COYE	FONS, Shrub, d2, SONS, STNN, FONG	21	Sensitive
least flycatcher	LEFL	SONS, STNN, f2, Shrub, BTNN, FONS, d2, d1	19	Sensitive
black-capped chickadee	BCCH	d1, FONS, BTNN, SONS, d3, d2	17	Secure
boreal chickadee	BOCH	d3, d2, FTNN, Shrub, b1, b3, BTNN, f3	17	Secure
western tanager	WETA	STNN, d1, e2, b3, b2, f3, d2, BTNN, b1	16	Sensitive
American redstart	AMRE	FONS, d2, FTNN, e2, FONG, d1, SONS	16	Secure
hermit thrush	HETH	b2, g1, b4, b1, FTNN, d2, BTNN, FONS	16	Secure
red-eyed vireo	REVI	d2, b3, FONG, SONS, f3, d1, d3	14	Secure
black-and-white warbler	BAWW	FONS, e2, d2, SONS, d3, b3	13	Secure
yellow-bellied sapsucker	YBSA	SONS, b4, b2, d1, a1, e3, d2	13	Secure
American robin	AMRO	SONS, FONG, c1, burn, b2, d1, d2	12	Secure
bay-breasted warbler	BBWA	b1, b3, h1, d2, f3	11	Sensitive
Cape May warbler	CMWA	b3, BTNN, h1, b1, d3, d2	10	Sensitive
hairy woodpecker	HAWO	BTNN, e2, b1, d2, d1, STNN	10	Secure
orange-crowned warbler	OCWA	SONS, Shrub, b1, d2, FONS	9	Secure
magnolia warbler	MAWA	d1, d2, b4, FONG, FONS	8	Secure
Wilson's warbler	WIWA	SONS, FTNN, b1, Shrub	8	Secure
greater yellowlegs	GRYE	FONS, FTNN, BTNN, burn	7	Secure
Le Conte's sparrow	LCSP	FONG, STNN, burn, FONS	6	Secure
Lincoln's sparrow	LISP	FTNN, FONS, burn	6	Secure
northern waterthrush	NOWA	FTNN, FONG, SONS, FONS	6	Secure
ruby-crowned kinglet	RCKI	FTNN, FONS, BTNN, b3	6	Secure
blue-headed vireo	BHVI	b4, d1, d2, a1	5	Secure
Philadelphia vireo	PHVI	FONS, SONS, d1	5	Secure
winter wren	WIWR	SONS, d2, d1	5	Secure
white-winged crossbill	WWCR	b1, d1, f3, e3	5	Secure

Table 5.4-13 Breeding Bird Detections and Habitat Types in the Project Local Study Areas, 2006 to 2007 (continued)

Species	Species Code (American Ornithologists' Union)	Ecosite Phase and Wetlands Type Map Codes[(a)]	Total Number of Observations	Provincial (ASRD 2005a) Status
yellow warbler	YWAR	f2, STNN, FONS	5	Secure
clay-coloured sparrow	CCSP	FONG, SONS, FONS	4	Secure
Connecticut warbler	CONW	STNN, FONS, d1, SONS	4	Secure
Wilson's snipe	WISN	burn, FTNN, FONG, SONS	4	Secure
lesser yellowlegs	LEYE	FONS	4	Secure
northern flicker	NOFL	d2, FTNN	4	Secure
red crossbill	RECR	b2, BTNN	4	Secure
tree swallow	TRES	FONS	4	Secure
downy woodpecker	DOWO	d1, d2	3	Secure
golden-crowned kinglet	GCKI	a1, d2, FTNN	3	Secure
mourning warbler	MOWA	FONS, g1, STNN	3	Secure
olive-sided flycatcher	OSFL	FONS, BTNN	3	Secure
red-winged blackbird	RWBL	FONG, MONG	3	Secure
American kestrel	MAKE	Shrub	2	Secure
black tern	BLTE	MONG	2	Sensitive
brown creeper	BRCR	d1, b2	2	Sensitive
Canada warbler	CAWA	b3, d2	2	Sensitive
cedar waxwing	CEDW	FONS	2	Secure
marsh wren	MAWR	MONG	2	Secure
rose-breasted grosbeak	RBGR	d3, d2	2	Secure
red-breasted nuthatch	RBNU	BTNN, e3	2	Secure
ruffed grouse	RUGR	FTNN, d2	2	Secure
western wood-pewee	WEWP	FTNN, FONG	2	Secure
yellow-bellied flycatcher	YBFL	SONS, FTNN	2	Undetermined
black-backed woodpecker	BBWO	a1	1	Sensitive
great gray owl	GGOW	FTNN	1	Sensitive
house wren	HOWR	d2	1	Secure
pine siskin	PISI	FONS	1	Secure
purple finch	PUFI	d2	1	Secure
rusty blackbird	RUBL	FONG	1	Sensitive
song sparrow	SOSP	BTNN	1	Secure
Nelson's sharp-tailed sparrow	NSTS	SONS	1	Secure
varied thrush	VATH	d2	1	Secure
vesper sparrow	VESP	BTNN	1	Secure
Total			**845**	

(a) Beckingham and Archibald (1996); Vitt et al. (1997).

Species Richness

Mean species richness is greatest in the shrubby swamp (SONS) wetlands type (Table 5.4-14). The horsetail white spruce (f3) and dogwood balsam poplar - aspen (e1) ecosite phases also have high mean richness values. Mean richness is lowest in the lichen jack pine (a1) ecosite phase. The Labrador tea mesic jack

pine - black spruce (c1) and blueberry jack pine - aspen (b1) ecosite phases also had low mean richness values.

Statistical analysis (Kruskal-Wallis test) of the richness data indicated that there is an overall significant difference in species richness among the sampled ecosite phases and wetlands types in the subregional study area ($F=6.26$, $p<0.0001$, $df=25$).

Species richness values in the shrubby swamp (SONS) wetlands type is significantly higher than those in many other ecosite phases and wetlands types including wooded fen (FTNN), Labrador tea - subhygric black spruce - jack pine (g1), low-bush cranberry aspen - white spruce (d2), wooded bog (BTNN), blueberry jack pine - aspen (b1), lichen jack pine (a1), blueberry aspen - white spruce (b3), low-bush cranberry aspen (d1), low-bush cranberry white spruce (d3), dogwood balsam poplar - white spruce (e2), dogwood white spruce (e3) and Labrador tea / horsetail white spruce - black spruce (h1).

Species richness values in the shrubby fen (FONS) wetlands type are significantly higher than those in the wooded fen (FTNN), Labrador tea - subhygric black spruce - jack pine (g1), low-bush cranberry aspen - white spruce (d2), wooded bog (BTNN), blueberry jack pine - aspen (b1), lichen jack pine (a1), blueberry aspen - white spruce (b3) and low-bush cranberry aspen (d1) ecosite phases and wetlands types.

Species richness values in the horsetail white spruce (f3), wooded swamp (STNN) and wooded fen (FTNN) ecosite phases and wetlands types are significantly higher than those in the lichen jack pine (a1) ecosite phase. The wooded swamp (STNN) wetlands type also had significantly higher richness values than the blueberry jack pine - aspen (b1) ecosite phase.

Species Diversity

Mean species diversity was greatest in the shrubby swamp (SONS) wetlands type (Table 5.4-14). The dogwood balsam poplar - aspen (e1) and blueberry white spruce - jack pine (b4) ecosite phases also have high mean diversity values. Mean species diversity was lowest in the lichen jack pine (a1) ecosite phase. The low-bush cranberry white spruce (d3) ecosite phase also has a low mean richness value.

Statistical analysis (Kruskal-Wallis test) of the diversity data indicated that there was an overall significant difference in species diversity among the sampled ecosite phases and wetlands types in the RSA ($F=5.76$, $p<0.0001$, $df=25$).

Species diversity values in the shrubby swamp (SONS) wetlands type are significantly higher than those in many other ecosite phases/wetlands types including wooded fen (FTNN), Labrador tea - subhygric black spruce - jack pine (g1), low-bush cranberry aspen - white spruce (d2), wooded bog (BTNN), blueberry jack pine - aspen (b1), lichen jack pine (a1), blueberry aspen - white spruce (b3), low-bush cranberry aspen (d1), low-bush cranberry white spruce (d3), dogwood balsam poplar - white spruce (e2), dogwood white spruce (e3), Labrador tea / horsetail white spruce - black spruce (h1), shrubby fen (FONS), blueberry aspen / white birch (b2), horsetail balsam poplar - aspen (f1) and horsetail balsam poplar - white spruce (f2).

Species diversity values in the wooded swamp (STNN) wetlands type are significantly higher than those in the Labrador tea - subhygric black spruce - jack pine (g1), low-bush cranberry aspen - white spruce (d2), blueberry jack pine - aspen (b1), lichen jack pine (a1), blueberry aspen - white spruce (b3), low-bush cranberry aspen (d1) and low-bush cranberry white spruce (d3) ecosite phases.

Species diversity values in the shrubby fen (FONS) wetlands type are significantly higher than those in the low-bush cranberry aspen - white spruce (d2), blueberry jack pine - aspen (b1), lichen jack pine (a1) and low-bush cranberry aspen (d1) ecosite phases.

Table 5.4-14 Breeding Bird Species Richness and Diversity by Habitat Type in the Subregional Study Area

Map Code	Ecosite Phases and Wetlands Types[a]	Number of Plots	Mean Richness (± SD)	Mean Diversity[b] (± SD)
d2	low-bush cranberry aspen - white spruce	84	2.5±1.5	1.1±1.3
FTNN	wooded fen	75	3.0±1.7	1.8±1.6
BTNN	wooded bog	50	3.0±1.7	1.7±1.5
d1	low-bush cranberry aspen	47	2.4±1.5	1.1±1.3
FONS	shrubby fen	42	4.6±2.1	2.4±2.3
b1	blueberry jack pine - aspen	33	2.1±1.4	0.8±1.0
g1	Labrador tea - subhygric black spruce - jack pine	22	2.3±1.2	0.9±1.1
b3	blueberry aspen - white spruce	21	2.2±1.3	1.0±1.0
h1	Labrador tea / horsetail white spruce - black spruce	17	2.9±1.2	1.5±1.2
SONS	shrubby swamp	16	5.8±1.8	4.7±2.1
a1	lichen jack pine	14	1.3±1.0	0.3±0.6
STNN	wooded swamp	11	4.5±2.5	3.2±2.9
d3	low-bush cranberry white spruce	10	2.9±2.0	0.7±2.0
FONG	graminoid fen	10	4.1±2.6	2.4±2.8
e2	dogwood balsam poplar - white spruce	9	2.9±1.4	1.5±1.2
e3	dogwood white spruce	7	2.9±1.2	1.4±1.0
b2	blueberry aspen - white birch	5	2.8±1.9	1.6±1.4
f3	horsetail white spruce	4	5.0±1.8	2.1±2.1
MONS	shrubby marsh	3	4.0±3.5	3.2±2.8
Shrub	shrub	3	3.7±2.1	2.3±2.2
Burn	burn	2	4.5±2.1	3.1±2.4
b4	blueberry white spruce - jack pine	2	4.5±3.5	3.3±3.8
c1	Labrador tea mesic jack pine - black spruce	2	2.0±1.4	0.8±1.1
e1	dogwood balsam poplar - aspen	2	5.0±1.4	3.6±1.7
f1	horsetail balsam poplar - aspen	2	3.5±0.7	2.0±0.8
f2	horsetail balsam poplar - white spruce	3	2.3±1.5	1.0±1.3
BONS	shrubby bog	1	3.0±0.0	1.5±0.0
MONG	graminoid marsh	1	3.0±0.0	1.4±0.0

[a] Beckingham and Archibald (1996); Vitt et al. (1997).

[b] Species diversity was calculated using the Shannon-Weiner Index (Krebs 1989).

Note: SD = Standard deviation.

Results from this survey suggest that the shrubby swamp (SONS), shrubby fen (FONS) and wooded swamp (STNN) wetlands types provide the most important habitats for breeding birds based on species richness and diversity. Although the dogwood balsam poplar - aspen (e1), blueberry white spruce - jack pine (b4) and horsetail white spruce (f3) ecosite phases had high richness and diversity values, too few plots were sampled in these ecosite phases to make statistical inferences about their richness and diversity.

TWINSPAN Classification in Terrestrial Habitats

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Fifty-eight bird species were observed in terrestrial habitats. Two-Way Indicator Species Analysis (TWINSPAN) classifies these 58 bird species into fifteen separate guilds (Table 5.4-15). The fifteen species guilds are associated with seven habitat groups comprised of nineteen terrestrial ecosite phases. The number values in Table 5.4-15 indicate species abundance per 40 ha. Terrestrial ecosite phase descriptions are presented in Table 5.4-16.

Table 5.4-15 Two-Way Indicator Species Analyses Grouping and Bird Abundance per 40 Hectares in Terrestrial Habitat Types in the Subregional Study Area

Species Guild	Species	Ecosite Phase[a]																		
		Au	Bu			Cu			Du					Eu		Fu		Gu		
		Shrub	f2	g1	h1	b3	d1	d2	b1	d3	e2	e3	f3	a1	b2	b4	e1	Burn	c1	f1
1u	AMKE	3	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	COYE	2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	SWSP	2	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–
	WIWA	2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
2u	OCWA	2	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–
3u	BOCH	3	–	–	1	–	–	–	1	1	–	–	1	–	–	–	–	–	–	–
4u	LEFL	2	2	–	–	–	1	–	–	–	1	–	–	–	–	–	–	–	–	–
	PAWA	2	–	1	1	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–
5u	NOWA	–	–	–	–	–	–	–	–	–	1	1	–	–	–	–	3	–	–	–
6u	HETH	–	–	1	–	–	–	–	–	–	–	–	–	–	1	3	–	–	–	–
	MAWA	–	–	1	1	–	–	–	–	–	–	–	–	–	–	3	3	–	–	–
	MOWA	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	3	–	–	–
	YBSA	–	–	–	–	–	–	–	–	–	–	1	–	–	2	3	–	–	–	–
7u	BAWW	–	–	–	–	–	–	1	–	1	2	1	–	–	–	–	3	–	–	–
	GRAJ	–	2	2	1	1	–	–	2	2	1	3	4	1	–	3	3	–	–	–
	WETA	–	–	–	–	1	–	–	–	1	1	1	1	–	3	–	3	–	–	–
8u	BBWO	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	BRCR	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–
	DEJU	–	–	–	–	–	–	–	–	–	–	–	1	1	2	–	–	–	–	–
	GCKI	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	OVEN	–	–	–	1	2	4	3	1	1	1	1	1	–	1	–	–	–	–	–
	RECR	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–
	SWTH	–	2	1	1	–	1	1	–	1	1	1	1	–	1	–	–	–	–	–

Table 5.4-15 Two-Way Indicator Species Analyses Grouping and Bird Abundance per 40 Hectares in Terrestrial Habitat Types in the Subregional Study Area (continued)

Species Guild	Species	Ecosite Phase[a]																		
		Au	Bu			Cu			Du					Eu		Fu		Gu		
		Shrub	f2	g1	h1	b3	d1	d2	b1	d3	e2	e3	f3	a1	b2	b4	e1	Burn	c1	f1
9u	RCKI	–	–	2	1	–	–	–	–	1	1	–	1	–	–	–	–	–	–	–
	YBFL	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	YWAR	–	2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
10u	AMRE	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–
	BBWA	–	–	–	1	–	–	–	1	–	–	–	1	–	–	–	–	–	–	–
	BCCH	–	–	–	–	–	–	–	–	1	1	–	–	–	–	–	–	–	–	–
	CMWA	–	–	–	1	–	–	–	–	2	1	2	–	–	–	–	–	–	–	–
	HAWO	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–
	PIWO	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–
	RBGR	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–
	RBNU	–	–	–	–	–	–	–	–	1	–	1	–	–	–	–	–	–	–	–
	RUGR	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–
	WIWR	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–
	WWCR	–	–	–	–	–	–	–	–	–	–	1	1	–	–	–	–	–	–	–
11u	CAWA	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	CEDW	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	CONW	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	DOWO	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	HOWR	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	NOFL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	PHVI	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	PUFI	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	REVI	–	–	–	–	–	1	1	–	1	–	–	1	–	–	–	–	–	–	–
	VATH	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Table 5.4-15 Two-Way Indicator Species Analyses Grouping and Bird Abundance per 40 Hectares in Terrestrial Habitat Types in the Subregional Study Area (continued)

Species Guild	Species	Ecosite Phase[a]																		
		Au	Bu			Cu			Du					Eu		Fu		Gu		
		Shrub	f2	g1	h1	b3	d1	d2	b1	d3	e2	e3	f3	a1	b2	b4	e1	Burn	c1	f1
12u	CHSP	–	2	1	2	1	1	1	2	3	1	–	8	2	–	3	3	5	3	–
	TEWA	–	–	1	3	2	2	3	2	6	3	2	4	–	1	3	3	–	–	5
13u	ALFL	5	–	1	–	–	1	–	–	–	–	1	1	–	–	–	8	–	5	–
	BHVI	–	–	–	–	–	–	–	–	–	–	–	1	1	–	3	–	–	–	5
	WTSP	2	3	1	–	–	1	–	–	–	–	1	1	–	1	3	–	5	3	3
	YRWA	–	–	2	3	–	–	1	1	1	1	–	–	–	–	3	–	3	–	5
14u	WISN	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	3	–	–
15u	AMRO	–	–	–	–	–	–	–	–	1	–	–	–	–	1	–	–	3	3	3
	GRYE	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	3	–	–
	LCSP	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	3	–	–
	LISP	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	3	–	–

[a] Beckingham and Archibald (1996); Vitt et al. (1997).

– = Not data.

Table 5.4-16 Terrestrial Habitat Types Grouped by Two-Way Indicator Species Analysis

Ecosite Phase[(a)]	Map Code	Habitat Group
shrub	Shrub	Au
horsetail balsam poplar - white spruce	f2	Bu
Labrador tea - subhygric black spruce - jack pine	g1	
Labrador tea / horsetail white spruce - black spruce	h1	
blueberry aspen - white spruce	b3	Cu
low-bush cranberry aspen	d1	
low-bush cranberry aspen - white spruce	d2	
blueberry jack pine-aspen	b1	Du
low-bush cranberry white spruce	d3	
dogwood balsam poplar – white spruce	e2	
dogwood white spruce	e3	
horsetail white spruce	f3	
lichen jack pine	a1	Eu
blueberry aspen / white birch	b2	
blueberry white spruce - jack pine	b4	Fu
dogwood balsam poplar - aspen	e1	
burn	Burn	Gu
Labrador tea mesic jack pine - black spruce	c1	
horsetail balsam poplar - aspen	f1	

(a) Beckingham and Archibald (1996); Vitt et al. (1997).

Species in guild 1u are associated almost solely with habitat group Au (shrub). These species include American kestrel, common yellowthroat, swamp sparrow, Wilson's warbler. The species in guilds 2u and 3u were most strongly associated with habitat group Au were orange-crowned warbler and boreal chickadee, respectively.

Species in guild 4u are most strongly associated with habitat groups Au (shrub) and Bu (horsetail balsam poplar - white spruce (f2), Labrador tea - subhygric black spruce - jack pine (g1) and Labrador tea / horsetail white spruce - black spruce (h1) ecosite phases). These species include least flycatcher and palm warbler.

Species in guild 5u and 6u are most strongly associated with habitat group Fu (blueberry white spruce - jack pine (b4) and dogwood balsam poplar - aspen (e1) ecosite phases). These species include northern waterthrush, hermit thrush, magnolia warbler, mourning warbler and yellow-bellied sapsucker.

Species in guild 10u are most strongly associated with habitat group Du (blueberry jack pine - aspen (b1), low-bush cranberry white spruce (d3), dogwood balsam poplar - white spruce (e2), dogwood white spruce (e3) and horsetail white spruce (f3) ecosite phases) but are also mildly associated with

habitat group Cu (blueberry aspen - white spruce (b3), low-bush cranberry aspen (d1) and low-bush cranberry aspen - white spruce (d2) ecosite phases). Species in guild 11u are almost solely associated with habitat group Cu. Species in guild 10u and 11u include American redstart, bay-breasted warbler, black-capped chickadee, Cape May warbler, hairy woodpecker, pileated woodpecker, rose-breasted grosbeak, red-breasted nuthatch, ruffed grouse, winter wren, white-winged crossbill, Canada warbler, cedar waxwing, Connecticut warbler, downy woodpecker, house wren, northern flicker, Philadelphia vireo, purple finch, red-eyed vireo and varied thrush.

Species in guilds 14u and 15u are most strongly associated with habitat group Gu (burn, Labrador tea-mesic jack pine - black spruce (c1) and horsetail balsam poplar - aspen (f1) ecosite phases). These species include Wilson's snipe, American robin, greater yellowlegs, Le Conte's sparrow and Lincoln's sparrow.

Species in guilds 7u, 8u, 9u, 12u and 13u are more general in their habitat associations. Guild 8u species were associated most strongly with habitat group Eu (lichen jack pine (a1) and blueberry aspen/white birch (b2) ecosite phases) but are also associated with other habitat groups. These species include black-backed woodpecker, brown creeper, dark-eyed junco, golden-crowned kinglet, ovenbird, red crossbill and Swainson's thrush. Guild 9u species are associated most strongly with habitat group Bu (horsetail balsam poplar - white spruce (f2), Labrador tea - subhygric black spruce - jack pine (g1) and Labrador tea / horsetail white spruce - black spruce (h1) ecosite phases) but are also associated with other habitat groups. These species include ruby-crowned kinglet, yellow-bellied flycatcher and yellow warbler. Guild 13u species are associated with all habitat groups. Guild 12u species are associated with all habitat groups except shrub while guild 7u species are associated with all habitat groups except Gu (burn, Labrador tea mesic jack pine - black spruce (c1) and horsetail balsam poplar - aspen (f1) ecosite phases). Species in guilds 7u, 12u and 13u include black-and-white warbler, gray jay, western tanager, chipping sparrow, Tennessee warbler, alder flycatcher, blue-headed vireo, white-throated sparrow and yellow-rumped warbler.

TWINSPAN Classification in Wetlands Habitats

Seventy-one bird species were observed in wetlands habitats. Two-Way Indicator Species Analysis (TWINSPAN) classifies these 71 bird species into fourteen separate guilds (Table 5.4-17). The fourteen species guilds are associated with five habitat groups comprised of nine wetlands types. The number values in Table 5.4-17 indicate species abundance per 40 ha. Wetlands types descriptions are presented in Table 5.4-18.

Species in guild 1w are associated solely with habitat group Bw (wooded bog (BTNN), shrubby fen (FONS) and wooded fen (FTNN) wetlands types). These species include American bittern, black-backed woodpecker, blue-headed vireo, cedar waxwing, common raven, evening grosbeak, golden-crowned kinglet, great gray owl, greater yellowlegs, lesser yellowlegs, Lincon's sparrow, northern flicker, pine siskin, red-breasted nuthatch, red crossbill, ruffed grouse, sora, song sparrow, three-toed woodpecker and vesper sparrow.

Species in guilds 2w and 3w are associated solely with habitat groups Bw (wooded bog (BTNN), shrubby fen (FONS) and wooded fen (FTNN) wetlands types) and Cw (shrubby swamp (SONS) and wooded swamp (STNN) wetlands types). These species include hermit thrush, yellow-bellied flycatcher, yellow-rumped warbler, black-capped chickadee, Nelson's sharp-tailed sparrow, olive-sided flycatcher and ovenbird.

Species in guilds 4w, 5w, 6w and 7w are most strongly associated with habitat group Cw (shrubby swamp (SONS) and wooded swamp (STNN) wetlands types) but are also mildly associated with habitat group Bw (wooded bog (BTNN), shrubby fen (FONS) and wooded fen (FTNN) wetlands types). These species include Cape May warbler, hairy woodpecker, least flycatcher, orange-crowned warbler, black-and-white warbler, bay-breasted warbler, boreal chickadee, mourning warbler, Philadelphia vireo, western tanager, winter wren, Canada warbler, Connecticut warbler, Swainson's thrush, yellow-bellied sapsucker, American redstart and northern waterthrush.

Species in guilds 9w, 11w and 12w are most strongly associated with habitat group Dw (graminoid fen (FONG) and shrubby marsh (MONS) wetlands types) but were also mildly associated with habitat groups Cw (shrubby swamp (SONS) and wooded swamp (STNN) wetlands types) and Bw (wooded bog (BTNN), shrubby fen (FONS) and wooded fen (FTNN) wetlands types). These species include alder flycatcher, clay-coloured sparrow, common yellowthroat, Le Conte's sparrow, magnolia warbler, red-eyed vireo, swamp sparrow, Tennessee warbler, Wilson's snipe, yellow warbler, American robin, killdeer, rusty blackbird, sandhill crane, western wood-pewee and Wilson's warbler.

Species in guild 13w are most strongly associated with habitat group Aw (shrubby bog (BONS) wetlands type). These species include blackburnian warbler, palm warbler and ruby-crowned kinglet.

Species in guild 14w are most strongly associated with habitat group Ew (graminoid marsh (MONG) wetlands type). These species include black tern, marsh wren and red-winged blackbird.

Species in guilds 8w and 10w are more general in their habitat associations. They are associated with all habitat groups except Aw (shrubby bog (BONS) wetlands type) and Ew (graminoid marsh (MONG) wetlands type). These species include chipping sparrow, dark-eyed junco, white-throated sparrow, gray jay and tree swallow.

Table 5.4-17 Two-Way Indicator Species Analysis Grouping and Bird Abundance per 40 Hectares in Wetlands Habitat Types in the Subregional Study Area

Species Guild	Species	Wetlands Type[a]								
		Aw	Bw			Cw		Dw		Ew
		BONS	BTNN	FONS	FTNN	SONS	STNN	FONG	MONS	MONG
1w	AMBI	–	–	–	–	–	–	–	–	–
	BBWO	–	–	–	–	–	–	–	–	–
	BHVI	–	–	–	–	–	–	–	–	–
	CEDW	–	–	–	–	–	–	–	–	–
	CORA	–	–	–	–	–	–	–	–	–
	EVGR	–	–	–	–	–	–	–	–	–
	GCKI	–	–	–	–	–	–	–	–	–
	GGOW	–	–	–	–	–	–	–	–	–
	GRYE	–	–	–	–	–	–	–	–	–
	LEYE	–	–	–	–	–	–	–	–	–
	LISP	–	–	1	–	–	–	–	–	–
	NOFL	–	–	–	–	–	–	–	–	–
	PISI	–	–	–	–	–	–	–	–	–
	RBNU	–	–	–	–	–	–	–	–	–
	RECR	–	–	–	–	–	–	–	–	–
	RUGR	–	–	–	–	–	–	–	–	–
	SORA	–	–	–	–	–	–	–	–	–
	SOSP	–	–	–	–	–	–	–	–	–
	TTWO	–	–	–	–	–	–	–	–	–
	VESP	–	–	–	–	–	–	–	–	–
2w	HETH	–	1	–	–	–	–	–	–	–
	YBFL	–	–	–	–	–	–	–	–	–
	YRWA	–	1	1	1	1	–	–	–	–
3w	BCCH	–	–	1	–	1	–	–	–	–
	NSTS	–	–	1	–	–	–	–	–	–
	OSFL	–	–	–	–	–	–	–	–	–
	OVEN	–	–	–	–	–	–	–	–	–
4w	CMWA	–	–	–	–	–	–	–	–	–
	HAWO	–	–	–	–	–	1	–	–	–
	LEFL	–	–	1	–	1	1	–	–	–
	OCWA	–	–	1	–	1	–	–	–	–
5w	BAWW	–	–	1	–	2	1	–	–	–
	BBWA	–	–	–	–	–	–	–	–	–
	BOCH	–	–	–	–	1	–	–	–	–
	MOWA	–	–	–	–	–	–	–	–	–
	PHVI	–	–	–	–	1	–	–	–	–
	WETA	–	–	–	–	–	–	–	–	–
	WIWR	–	–	–	–	1	–	–	–	–
6w	CAWA	–	–	–	–	–	–	–	–	–
	CONW	–	–	–	–	–	–	–	–	–
	SWTH	–	–	–	1	2	1	1	–	–
	YBSA	–	–	–	–	1	–	–	–	–
7w	AMRE	–	–	–	–	2	1	1	–	–
	NOWA	–	–	–	–	1	1	1	–	–

Table 5.4-17 Two-Way Indicator Species Analysis Grouping and Bird Abundance per 40 Hectares in Wetlands Habitat Types in the Subregional Study Area (continued)

Species Guild	Species	Wetlands Type[a]								
		Aw	Bw			Cw		Dw		Ew
		BONS	BTNN	FONS	FTNN	SONS	STNN	FONG	MONS	MONG
8w	CHSP	–	2	2	1	2	2	1	–	–
	DEJU	–	2	1	1	–	–	–	2	–
	WTSP	–	1	1	1	2	3	1	2	–
9w	ALFL	–	–	1	–	3	3	3	5	–
	CCSP	–	–	1	–	–	–	2	–	–
	COYE	–	–	2	–	3	2	2	2	–
	LCSP	–	–	–	–	–	1	1	–	–
	MAWA	–	–	1	–	1	–	2	–	–
	REVI	–	–	–	–	–	–	1	–	–
	SWSP	–	–	2	–	2	–	3	2	–
	TEWA	–	2	2	3	3	2	2	5	–
	WISN	–	–	–	–	–	–	2	–	–
	YWAR	–	–	–	–	–	1	1	3	–
10w	GRAJ	–	1	1	2	–	–	1	2	–
	TRES	–	–	1	–	–	–	1	–	–
11w	AMRO	–	–	–	–	–	–	2	–	–
12w	KILL	–	–	–	–	–	–	1	–	–
	RUBL	–	–	–	–	–	–	1	–	–
	SACR	–	–	–	–	–	–	1	–	–
	WEWP	–	–	–	–	–	–	1	2	–
	WIWA	–	–	1	–	1	–	1	3	–
13w	BLBW	5	–	–	–	–	–	–	–	–
	PAWA	5	1	2	2	–	2	1	–	–
	RCKI	10	2	1	1	–	–	–	–	–
14w	BLTE	–	–	–	–	–	–	–	–	10
	MAWR	–	–	–	–	–	–	–	–	10
	RWBL	–	–	–	–	–	–	1	–	10

[a] Beckingham and Archibald (1996); Vitt et al. (1997).

– = No data.

Table 5.4-18 Wetlands Habitat Types Grouped by Two-Way Indicator Species Analysis

Wetlands Types[(a)]	Map Code	Habitat Group
shrubby bog	BONS	Aw
wooded bog	BTNN	Bw
shrubby fen	FONS	
wooded fen	FTNN	
shrubby swamp	SONS	Cw
wooded swamp	STNN	
graminoid fen	FONG	Dw
shrubby marsh	MONS	
graminoid marsh	MONG	Ew

(a) Vitt et al. (1997).

Detrended Correspondence Analysis (DCA)

The TWINSPAN results show that some bird groupings are closely associated with one specific habitat group (i.e., guild 1w with one wetlands habitat group, Aw), while other bird groupings are more closely associated with a few or several habitat groups (i.e., guild 13u with all terrestrial habitat groups). These trends are also evident in the Detrended Correspondence Analysis (DCA) plots (Figure 5.4-1 and 5.4-2). Bird species that are grouped closely around one habitat type are more specialized in habitat use than those species that are not as closely grouped.

The DCA analysis generates three axes based on the associations of birds with various habitat attributes; two of the axes can be graphed. Axis 1 of the terrestrial DCA plot (Figure 5.4-1) explains 24% of the variation in the bird community structure, (r^2=0.24), Axis 2 explains 29% (r^2=0.29) and Axis 3 explains 10% (r^2=0.10). Axis 1 of the wetlands DCA plot (Figure 5.4-2) explains 55% of the variation in the bird community structure, (r^2=0.55), Axis 2 explains 5% (r^2 =0.05) and Axis 3 explains none (r^2=0.00). In this case, Axis 1 and 2 best present the data for both the terrestrial and wetlands plots.

5.4.4.3 Incidentals

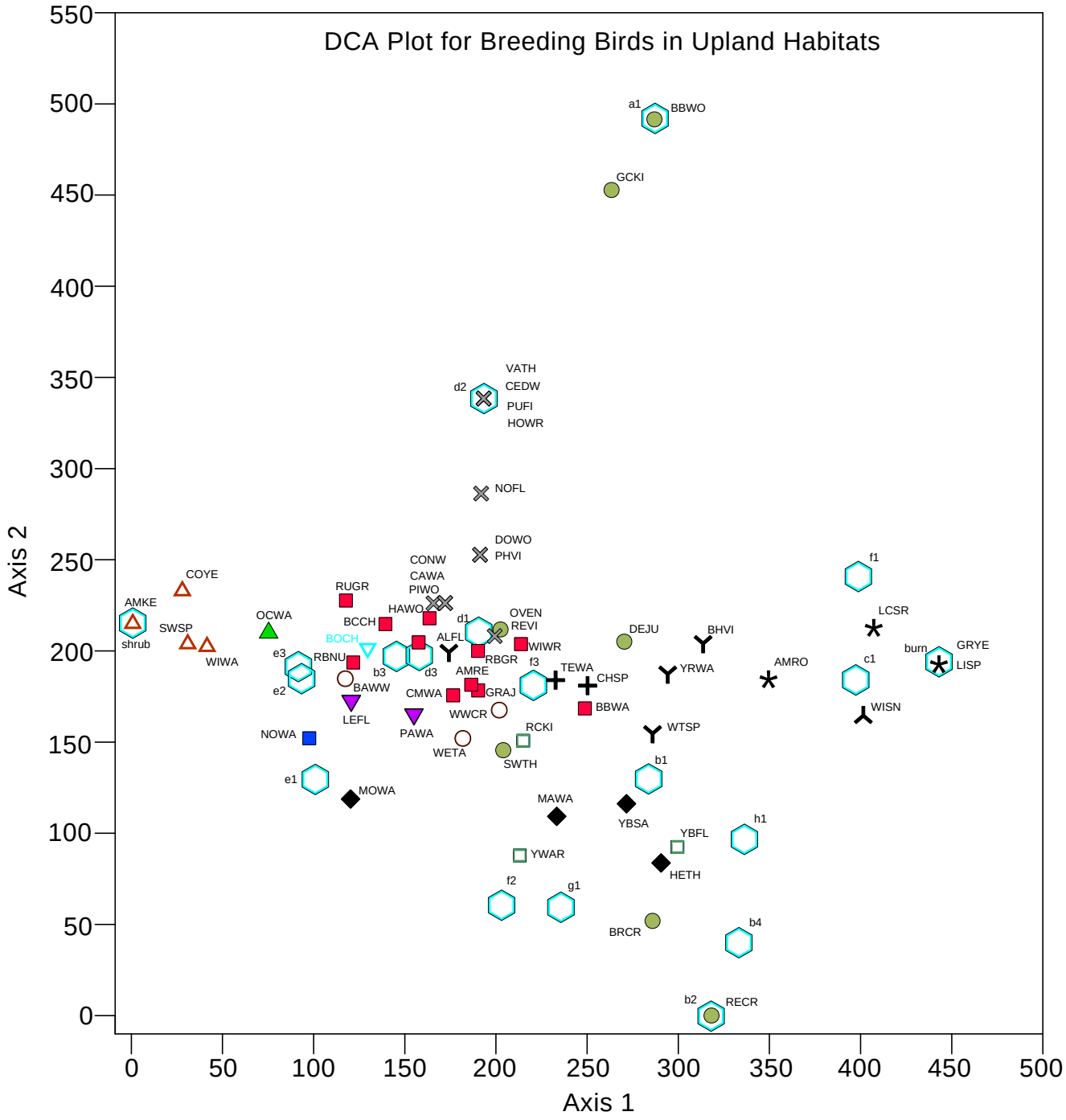
All birds recorded incidentally on the Project LSAs are listed in Appendix T. Included on that list are the following provincially listed species:

- bald eagle;
- bay-breasted warbler;
- black-throated green warbler;
- brown creeper;

- Canada warbler;
- Cape May warbler;
- common nighthawk;
- common yellowthroat;
- least flycatcher; and
- western tanager.

5.4.4.4 Regional Data

Breeding bird surveys in the immediate vicinity of the subregional study area provide comparable results in many cases. Recent surveys conducted by Golder in the Oil Sands Region found the horsetail white spruce (f3) and wooded swamp (STNN) ecosite phases and wetlands types provide the most important habitat for breeding birds (Golder, unpublished data). Other surveys in the Oil Sands Region have found richness and diversity to be highest in shrub and riparian habitats (Westworth, Brusnyk and Associates 1996) and in terrestrial hardwood and mixedwood ecosite phases (Schieck et al. 1995). Songbird surveys conducted for the Imperial Kearl Oil Sands Project identified low-bush cranberry aspen - white spruce (d2) and dogwood balsam poplar - aspen (e1) ecosite phases as those with the highest diversity index (Imperial Oil 2005). The greatest species richness on upland sites on the Synenco Northern Lights Project LSA was in low-bush cranberry aspen (d1) and low-bush cranberry aspen - white spruce (d2) ecosite phases (Synenco 2006).



LEGEND

ECOSITE PHASE

GROUPS

1		9	
2		10	
3		11	
4		12	
5		13	
6		14	
7		15	
8			

PROJECT

JACKPINE MINE EXPANSION &
PIERRE RIVER MINE PROJECT

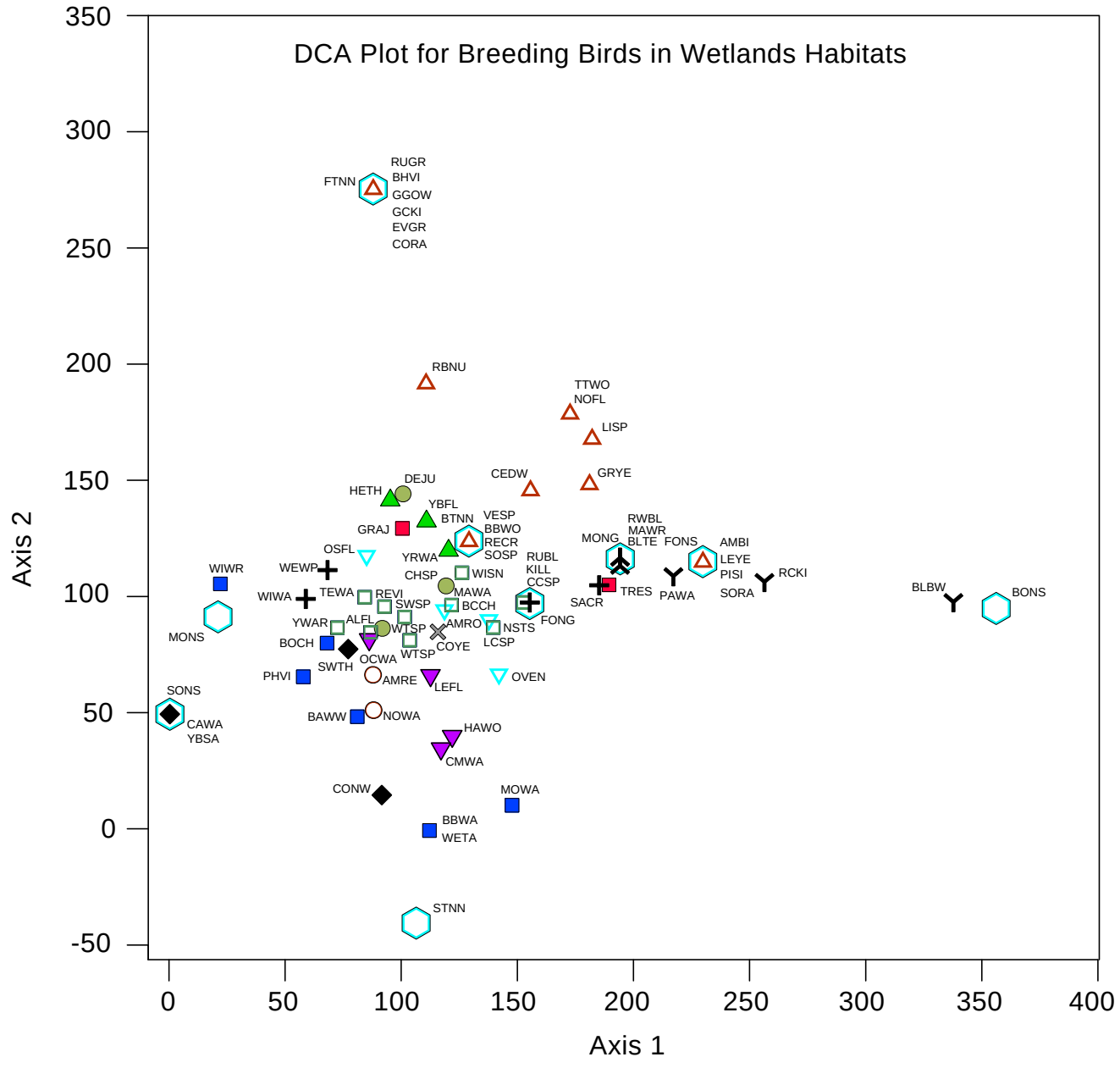
TITLE

DETRENDED CORRESPONDENCE ANALYSIS PLOT FOR TERRESTRIAL HABITATS IN THE PROJECT SUBREGIONAL STUDY AREA

Shell Canada Limited

PROJECT 05-1344-027.7790			FILE No. Terrestrial Habitats	
DESIGN	MJ	07/09/07	SCALE AS SHOWN	REV. 0
CADD	YW	07/09/07	**FIGURE: 5.4-1**	
CHECK	MJ	07/09/07		
REVIEW	TC	25/09/07		

L:\2005\1344-OIL SANDS\05-1344-027-Shell Omnibus\7700\7790\Fig 5.4-1 Detrended Correspondence Analysis Plot for Upland Habitats.dwg Nov 29, 2007 - 4:13pm



LEGEND

WETLANDS

GROUPS

1		8	
2		9	
3		10	
4		11	
5		12	
6		13	
7		14	

PROJECT

JACKPINE MINE EXPANSION &
PIERRE RIVER MINE PROJECT

TITLE

DETRENDED CORRESPONDENCE ANALYSIS PLOT FOR WETLANDS HABITATS IN THE PROJECT SUBREGIONAL STUDY AREA

Shell Canada Limited

PROJECT 05-1344-027.7790			FILE No.	Wetlands Habitats
DESIGN	MJ	07/09/07	SCALE AS SHOWN	REV. 0
CADD	YW	07/09/07		
CHECK	MJ	07/09/07		
REVIEW	TC	25/09/07		

FIGURE: 5.4-2

L:\2005\1344-OIL SANDS\05-1344-027-Shell Omnibus\7700\7790\Fig 5.4-2 Detrended Correspondence Analysis Plot for Wetlands Habitats.dwg Nov 29, 2007 - 4:13pm

5.5 RESULTS – AMPHIBIANS AND REPTILES

Amphibians and reptiles that may occur within the Project LSAs include wood frogs, boreal chorus frogs, northern leopard frogs, Canadian toads, boreal toads and red-sided garter snakes. Canadian toads are listed provincially as "May Be At Risk" (ASRD 2005a), are a CEMA Priority 1 indicator species (Westworth 2002) and are federally – listed as "Not at Risk" (COSEWIC 2007). Northern leopard frogs are listed provincially as "At Risk" (ASRD 2005a) and federally as "Special Concern". Wood frogs are a CEMA Priority 3 species listed as "Secure" in Alberta (ASRD 2005a).

5.5.1 Amphibians

A total of 210 and 35 amphibian survey plots were sampled during 2006 and 2007, respectively. There were two survey periods in 2006. One hundred and forty-nine plots were sampled in the first period and 61 plots were sampled in the second period. Habitat types included five disturbed areas and 19 ecosite phases and wetlands types. Boreal chorus frogs, wood frogs, boreal toads and Canadian toads were recorded during the nocturnal amphibian call surveys on May 9 to 15 and May 24 to 29, 2006 and May 23 to 26, 2007.

5.5.1.1 Population

Jackpine Expansion Mining Area

A total of 149 (Table 5.5-1) plots were sampled on JEMA LSA. Boreal chorus frogs were the most numerous, representing 91.3% (n=1,998) of all amphibians recorded on JEMA LSA, followed by wood frogs (n=162) and Canadian toads (n=24). Three boreal toads were detected on the JEMA LSA (Table 5.5-3).

A similar number of amphibians were recorded per plot during the early May (May 9 to 15, 2006), the late May (May 24 to 29, 2006) surveys and the late May (May 23 to 26) 2007 survey (Table 5.5-1). On the JEMA LSA, boreal chorus frogs were heard at 93 surveyed plots during the first survey and 43 during the second survey. Wood frogs were heard at 46 plots during the first survey and two plots during the second survey. Canadian toads were heard at 12 plots during the first survey and four plots during the second survey. Boreal toads were heard at three plots during the first survey and were not heard during the second survey (Table 5.5-1). Northern leopard frogs were not detected during amphibian surveys within the JEMA LSA.

Table 5.5-1 Amphibian Detections in Each Survey Period in the Jackpine Expansion Mining Area Local Study Area

Survey	Surveyed Plots	Boreal Chorus Frog	Wood Frog	Boreal Toad	Canadian Toad
May 9 to 15, 2006	128	93	46	3	12
May 24 to 29, 2006	65	43	2	0	4

Note: Surveyed plots do not add up to the total number of plots surveyed because many plots were surveyed during both survey periods. Plots may include one or all species. Amphibians were not recorded at all plots.

Evidence of reproductive effort was observed on two occasions in the JEMA LSA during the amphibian surveys. Frog eggs were observed in standing water in a graminoid fen (FONG) and in a lake/pond in graminoid marsh (MONG).

Pierre River Mining Area

A total of 61 (Table 5.5-2) plots were sampled on PRMA LSA. Boreal chorus frogs were the most numerous, representing 88.1% (n=528) of all amphibians recorded on the PRMA LSA, followed by wood frogs (n=42) then Canadian toads (n=29). There were no boreal toads detected on the PRMA LSA.

A similar number of amphibians were recorded per plot during the early May (May 9 to 15, 2006), the late May (May 24 to 29, 2006) survey and the 2007 (May 23 to 26, 2007) survey (Table 5.5-2). On the PRMA LSA, boreal chorus frogs were heard at 11 plots during the first survey and 12 plots during the second survey in 2006 and 18 plots in 2007. Wood frogs were detected at two plots during the first survey and one plot during the second survey in 2006 and 11 plots in 2007. Canadian toads were detected at five plots during the first survey and two plots during the second survey in 2006 and at one plot in 2007. Boreal toads and northern leopard frogs were not detected during amphibian surveys within the PRMA LSA.

Evidence of reproductive effort (e.g., egg clusters, egg strings and tadpoles) was observed on the PRMA LSA on two occasions. Two frog egg masses (species unknown) were found. One was found in a wooded fen (FTNN) on a cutline and the other was found in standing water in blueberry aspen (white birch) (b2).

Table 5.5-2 Amphibian Detections in Each Survey Period in the Pierre River Mining Area Local Study Area

Survey	Surveyed Plots	Boreal Chorus Frog	Wood Frog	Boreal Toad	Canadian Toad
May 9 to 15, 2006	16	11	2	0	5
May 24 to 29, 2006	23	12	1	0	2
May 23 to 26, 2007	35	18	11	0	1

Note: Surveyed plots do not add up to the total number of plots surveyed because many plots were surveyed during both survey periods in 2006. Plots may include one or all species. Amphibians were not recorded at all plots.

5.5.1.2 Habitat

Amphibians were recorded in all wetlands types. Boreal chorus frogs were found in every habitat type (Table 5.5-3 and 5.5-4) and every waterbody type (Table 5.5-5) sampled over both survey periods in the Project LSAs. Wood frogs were recorded in several habitat types surveyed, including blueberry jack pine - aspen (b1), wooded bog (BTNN), low-bush cranberry aspen - white spruce (d2), low-bush cranberry white spruce (d3), horsetail balsam poplar - white spruce (f2), graminoid fen (FONG), shrubby fen (FONS), wooded fen (FTNN), graminoid marsh (MONG), shrubby swamp (SONS), wooded swamp (STNN) and disturbed habitat. Canadian toads were detected in several habitats including blueberry jack pine - aspen (b1), blueberry aspen - white spruce (b3), wooded bog (BTNN), Labrador tea mesic jack pine - black spruce (c1), low-bush cranberry aspen (d1), low-bush cranberry aspen - white spruce (d2), shrubby fen (FONS), wooded fen (FTNN), Labrador tea/horsetail white spruce - black spruce (h1) and shrubby swamp (SONS) habitats. Boreal toads were rare in the Oil Sands Region and were recorded only in standing water in wooded bog (BTNN) and wooded fen (FTNN) habitats. Wood frogs were detected in all waterbody types sampled, except ditches (Table 5.55). Canadian toads were detected in all waterbody types with the exception of ditches and rivers.

The habitat requirements of amphibians recorded in the Oil Sands Region are outlined in Table 5.5-6.

Table 5.5-3 Amphibian Chorus Detections by Ecosite Phases and Wetlands Types in the Jackpine Expansion Mining Area Local Study Area

Ecosite Phases and Wetlands Types	Map Code	Number of detections[(a)]				
		Boreal Chorus Frog	Wood Frog	Boreal Toad	Canadian Toad	Total
blueberry jack pine - aspen	b1	1	2	0	2	**5**
shrubby bog	BONS	6	0	0		**6**
wooded bog	BTNN	53	4	1	2	**60**
low-bush cranberry aspen	d1	99	0	0	3	**102**
low-bush cranberry aspen - white spruce	d2	243	0	0	2	**245**
disturbed - clearcut	Clearcut	41	0	0	4	**45**
disturbed - cutline	Cutline	18	6	0	0	**24**
disturbed - road	Road	65	0	0	0	**65**
disturbed - vegetated	Vegetated	44	4	0	0	**48**
disturbed - wellpad	Wellpad	60	2	0	0	**62**
graminoid fen	FONG	171	34	0	0	**205**
shrubby fen	FONS	39	2	0	1	**41**
wooded fen	FTNN	346	54	2	8	**410**
graminoid marsh	MONG	147	24	0	0	**171**
shrubby swamp	SONS	264	12	0	2	**278**
wooded swamp	STNN	3	4	0	0	**7**
Labrador tea / horsetail white spruce - black spruce	WONN	42	0	0	0	**42**
unknown		356	14			**370**
Total Number of Detections		**1,998**	**162**	**3**	**24**	**2,187**

(a) Numbers for full chorus are based on an index of abundance and therefore the number of detections is an approximation.

Table 5.5-4 Amphibian Chorus Detections by Ecosite Phases and Wetlands Types in the Pierre River Mining Area Local Study Area

Ecosite Phases and Wetlands Types	Map Code	Number of detections[(a)]			
		Boreal Chorus Frog	Wood Frog	Canadian Toad	Total
lichen jack pine	a1	3	0	0	**3**
blueberry aspen / white birch	b2	12	0	0	**12**
blueberry aspen - white spruce	b3	6	0	1	**7**
wooded bog	BTNN	7	2	0	**9**
Labrador tea mesic jack pine - black spruce	c1		0	6	**6**
low-bush cranberry aspen	d1	30	0	0	**30**
low-bush cranberry aspen - white spruce	d2	39	4	3	**46**
low-bush cranberry white spruce	d3	30	2	0	**32**
disturbed - clearcut	Clearcut	30	0	0	**30**
disturbed - cutline	Cutline	63	0	2	**65**
horsetail balsam poplar - white spruce	f2	23	4	0	**27**
horsetail white spruce	f3	1	0	0	**1**
shrubby fen	FONS	56	4	0	**60**
wooded fen	FTNN	70	10	0	**80**
Labrador tea / horsetail white spruce - black spruce	h1	61	0	2	**63**
graminoid marsh	MONG	6	0	0	**6**
shrubby swamp	SONS	23	8	0	**31**
wooded swamp	STNN	18	8	0	**26**
unknown	Unknown	50	0	15	**65**
Total Number of Detections		**528**	**42**	**29**	**599**

(a) Numbers for full chorus are based on an index of abundance and therefore the number of detections is an approximation.

Table 5.5-5 Amphibian Chorus Detections by Waterbody Type in the Local Study Areas

Waterbody Type	Number of Detections[(a)]				
	Boreal Chorus Frog	Wood Frog	Boreal Toad	Canadian Toad	Total
JEMA					
creek (<5 m)	319	4	0	2	**325**
cutlline	159	36	0	1	**196**
ditch	78	0	0	0	**78**
none	3	0	0	2	**5**
lake/pond	234	10	0	2	**246**
river (>5 m)	97	12	0	0	**109**
standing water	765	98	3	15	**881**
unknown	343	2	0	2	**347**
Total Number of Detections	**1,998**	**162**	**3**	**24**	**2,187**

Table 5.5-5 Amphibian Chorus Detections by Waterbody Type in the Local Study Areas (continued)

Waterbody Type	Number of Detections[a]				
	Boreal Chorus Frog	Wood Frog	Boreal Toad	Canadian Toad	Total
PRMA					
creek (<5 m)	7	2	0	15	**24**
cutlline	207	34	0	7	**248**
none	63	0	0	2	**65**
lake/pond	106	0	0	2	**108**
river (>5 m)	0	0	0	0	**0**
standing water	85	2	0	0	**87**
unknown	60	4	0	3	**67**
Total Number of Detections	**528**	**42**	**0**	**29**	**599**

[a] Numbers for full chorus are based on an index of abundance and therefore the number of detections is an approximation.

Table 5.5-6 Amphibian Habitat Requirements

Species	Breeding	Summer	Hibernation
boreal chorus frog	favours temporary ponds will use more permanent sites under some conditions	near water margins; under leaf litter, prone to desiccation; establishes home range	under stumps, leaf litter; glycoprotectant; can survive temperatures as low as -6°C
wood frog	uses natural ponds, pits, stream back waters; will breed in bogs; early breeders, rapid metamorphosis; site fidelity	moist terrestrial community type; prefers canopy closure, wet litter; moves to lowland bogs after breeding; establishes home range; site fidelity	under stumps, leaf litter; glycoprotectant; can survive temperatures as low as -6°C
Canadian toad	wide range of breeding community types: lake margins, slow streams, ponds; site fidelity	waters edge (including lakes and streams); tends to avoid forests; most stay by breeding areas	burrows in loose earth, under frostline; communal areas; temperature threshold not available
boreal toad	use ponds, stream edges, shallow margins of lakes, ditches and road ruts; site fidelity	wetlands habitats, forested areas, wet shrublands, avalanche slopes and subalpine meadows	upland areas near seeps, stream banks and underground burrows; temperature threshold not available

Source: Russell and Bauer (2000).

GROUPING DATA

Ecosite phases and wetlands types are grouped for analysis to reduce the number of categorical variables. Grouping is based on ecological similarity as follows:

- Terrestrial sites are divided into three categories. The first category includes subxeric to submesic moisture regimes and poor to medium nutrient regimes (lichen, blueberry and Labdrador tea-mesic). The second category includes mesic moisture regimes and medium to rich nutrient regimes (low-bush cranberry, dogwood). The last category includes subhygric to hygric moisture regimes and medium to rich nutrient regimes (horsetail, Labrador tea-subhygric).
- Bogs include all bog types. Bogs are peatlands that have low surface water flow.
- Fens include all fen types. Fens differ from bogs in that they are characterized by water flow.
- Wetlands include all marshes, swamps and open shallow water wetlands types. These areas consist predominately of permanent standing water.
- Disturbed sites include all sites consisting of man-made disturbance, including cutlines, clearcuts, roads and vegetation.

Waterbodies are also grouped. Ditches and cutlines are grouped and defined as man-made waterbodies. Records that did not identify waterbodies or ecosite phases are excluded from analysis.

The ANOVA results suggest that mean abundance of boreal chorus frogs does not differ among habitat groups (F=1.78, P=0.10, df=6). There is no significant interaction between waterbody type and habitat groups (F= 0.79, P=0.67, df=15), but there is a significant difference between waterbody types (F= 4.48, P=0.01, df=5). Tukey's post hoc testing indicates a significant difference between cutline/ditch and lake/pond habitats (P=0.02), with significantly more boreal chorus frogs in lake/pond habitats than in cutline/ditch habitats. There are also significant differences between subxeric to submesic moisture regimes with a poor to medium nutrient regimes (i.e., lichen, blueberry and Labdrador tea-mesic ecosites) and disturbed habitats (P=0.03). Dry, nutrient poor habitats had very few boreal chorus frogs. However, boreal chorus frogs were found throughout the Project LSAs and their abundance was highly variable regardless of waterbody type or habitat group (Table 5.5-7).

Table 5.5-7 Waterbody Type, Habitat Groups and Mean Abundance of Boreal Chorus Frogs in the Local Study Areas

Waterbody Type	Abundance of Boreal Frogs (Mean ± SD)	Habitat Group	Abundance of Boreal Frogs (Mean ± SD)
lake/pond	13.08 ± 12.71	bog	4.71 ± 7.66
standing water	9.62 ± 11.24	fen	8.41 ± 10.91
cutline/ditch	5.72 ± 9.10	lichen, blueberry and Labrador tea-mesic	0.84 ± 1.99
creek (<5 m)	7.95 ± 11.99	wetlands	7.62 ± 10.78
river (>5 m)	6.47 ± 9.70	disturbed	10.35 ± 12.92
no water visible	6.00 ± 11.93	low-bush cranberry, dogwood	7.47 ± 11.63
		horsetail, Labrador tea-subhygric	7.08 ± 10.95

Note: SD = Standard deviation.

The ANOVA results suggest that mean abundance of wood frogs does not differ among waterbody types (F=1.43, P=0.22, df=5), but does differ between habitat groups (F=4.35, P=0.001, df=6). There is no significant interaction between waterbody type and habitat groups (F= 0.73, P=0.67, df=8). Tukey's post hoc testing indicates that bogs, subxeric to submesic moisture regimes with poor to medium nutrient regimes (e.g., lichen, blueberry and Labdrador tea-mesic) and the mesic moisture regimes with medium to rich nutrient regimes (e.g., low-bush cranberry, dogwood) are significantly different from fens and wetlands ($p<0.001$). Small numbers of wood frogs were found throughout the LSA except in terrestrial habitat (Table 5.5-8).

Table 5.5-8 Waterbody Type, Habitat Groups and Mean Abundance of Wood Frogs in the Local Study Areas

Waterbody Type	Abundance of Wood Frogs (Mean ± SD)	Habitat Groups	Abundance of Wood Frogs (Mean ± SD)
lake/pond	1.59 ± 0.50	bog	0
standing water	1.67 ± 0.51	fen	1.64 ± 0.45
cutline/ditch	1.37 ± 0.37	lichen, blueberry and Labdrador tea-mesic	1.06 ± 0.20
creek (<5 m)	1.31 ± 0.38	wetlands	1.72 ± 0.43
river (>5 m)	2.03 ± 0.50	disturbed	1.39 ± 0.51
no water visible	1.10 ± 0.28	low-bush cranberry, dogwood	1.00 ± 0.00
		horsetail, Labrador tea-subhygric	1.37 ± 0.42

Note: SD = Standard deviation.

Abundance data may be more reliable for wood frogs than boreal chorus frogs because boreal chorus frogs were much more common with many sites recorded as four on the Call Index Survey scale. It is impossible to tell whether large choruses are composed of 20 or 100-plus individuals resulting in a large margin of error in abundance estimates. The present study assumed a call index of four to equal 60 individuals (Stevens and Paszkowki 2004). Detections of wood frogs were either 0, 1 or 2 on the Call Index Survey and individual numbers were reliably counted in the field.

Amphibians use resources in both aquatic and terrestrial systems over the course of a lifetime. In addition, amphibians may migrate between different habitat resources over the course of a year (Sinsch 1990). A summary of amphibian habitat requirements is provided in Table 5.5-6. Suitable habitat within the Project LSAs appears to be available for most of the amphibians expected to occur in the area. In general, semi-permanent and permanent wetlands are widely distributed across the LSAs and may provide good habitat for boreal chorus frogs, wood frogs and Canadian toads.

5.5.1.3 Incidentals

Canadian toads were recorded twice incidentally on the Project LSAs (Appendix T). Boreal chorus and wood frogs were recorded incidentally numerous times in the Project LSAs.

5.5.1.4 Regional Data

Amphibian abundance in the Project LSAs appears to be similar to other surveys conducted within the Oil Sands Region. Golder (2005) showed that boreal chorus frogs, wood frogs and boreal toads occupy a wide variety of habitat types.

Results reported from Suncor's subregional study area were similar, with boreal chorus frogs and wood frogs occurring across a wide variety of habitat types (Golder 2005; 2007a). No boreal or Canadian toads were detected on the Suncor Voyageur Project, but Canadian toads were observed on the Suncor Reclamation Monitoring Project (Golder 2004a) and the Suncor Voyageur South Project (Golder 2007a). Canadian toads were also found on the Canadian Natural Primrose and Wolf Lake Project (CNRL 2000) and the Canadian Natural Horizon Project (CNRL 2002).

5.5.2 Reptiles

The only species likely to occur in the area are the red-sided garter snake and the western plains garter snake (Russell and Bauer 2000). No systematic surveys were conducted for snakes and snakes were not observed incidentally during field work in the LSAs.

5.6 RESULTS – IMPORTANT WILDLIFE HABITAT

5.6.1 Wildlife Species Diversity

JPME R1 ERRATA

SEE UPDATED WORDING IN JPME R1 AENV SIR 488 A & B

JPME R1 AENV SIR 488

Important ecosite phases and wetlands types for wildlife were identified within a regional biodiversity framework (Golder 2000d). Within the RSA, species richness indices indicated that the highest number of terrestrial vertebrate species (132) occurred in the shrubby swamp (SONS) and shrubland wetlands types including riparian areas. Upland ecosite phases, including blueberry aspen - white spruce (b3), low-bush cranberry aspen - white spruce (d2) and dogwood balsam poplar - white spruce (e2), supported 131 terrestrial vertebrate species.

In general, wetlands types, particularly wooded fens and swamps, are likely to contain more species than terrestrial ecosite phases. Most ecosite phases and wetlands types in the Oil Sands Region exhibit species overlap in habitat use, supporting several wildlife species (i.e., species that are considered habitat generalists). Only lakes and rivers had unique species with no species overlap within the RSA. All vegetation types supported listed species, with lakes and rivers supporting the most listed species (25), followed closely by wetlands types (shallow open water (WONN), wooded swamp (STNN), graminoid marsh (MONG) and fens) and ecosite phases (blueberry aspen - white spruce (b3), low-bush cranberry aspen - white spruce (d2), horsetail balsam poplar-white spruce (f2)). Ten ecosite phases and no wetlands types had old growth age classes in the JEMA LSA. In the PRMA LSA, 10 ecosite phases in the Central Mixedwood Ecoregion and 14 in the Athabasca Plain Ecoregion had old growth

age classes. Additionally, two wetlands types also contained old growth age classes.

Species-specific habitat requirements for KIRs were discussed in the preceding sections. Section 5.8 provides additional commentary on all listed species that were documented in the LSAs.

5.6.2 Important Wildlife Areas

5.6.2.1 Traditional Knowledge

The term "survival area" was coined during the Wildlife Movement Traditional Environmental Knowledge Workshop conducted by CEMA (FMA 2005) and refers to areas that needed to be protected from development if wildlife and the traditional ways of life were to survive. These areas are currently considered to be relatively untouched and if left undisturbed would be a place where wildlife could avoid disturbance. Fort McKay participants in the workshops felt the areas should be 1.6 km by 64 km and considered Poplar Point along the Athabasca River and portions of the Birch Mountains including Gardiner and Namur lakes to be survival areas. Fort Chipewyan participants considered the area north of the 27th Baseline (i.e., northern boundary of Township 104, the southern boundary of Wood Buffalo National Park), west to the boundary of Wood Buffalo National Park, east to the Saskatchewan border and north to the southern shore of Lake Athabasca as a survival area for their community.

5.6.2.2 Environmentally Significant Areas

Environmentally significant areas are not protected by legislation; however, they have been identified as areas that contain important and often sensitive features of the landscape, such as unique or representative landforms, rare or endangered vegetation, or significant or important wildlife habitat. Often ESAs contribute to biodiversity because they represent a unique combination of landscape features, vegetation communities, habitats, species populations and genetic resources that are otherwise uncommon in the region. The Resource Use ESR (Golder 2007b) provides additional details regarding levels of significance and background information for determining that level of significance.

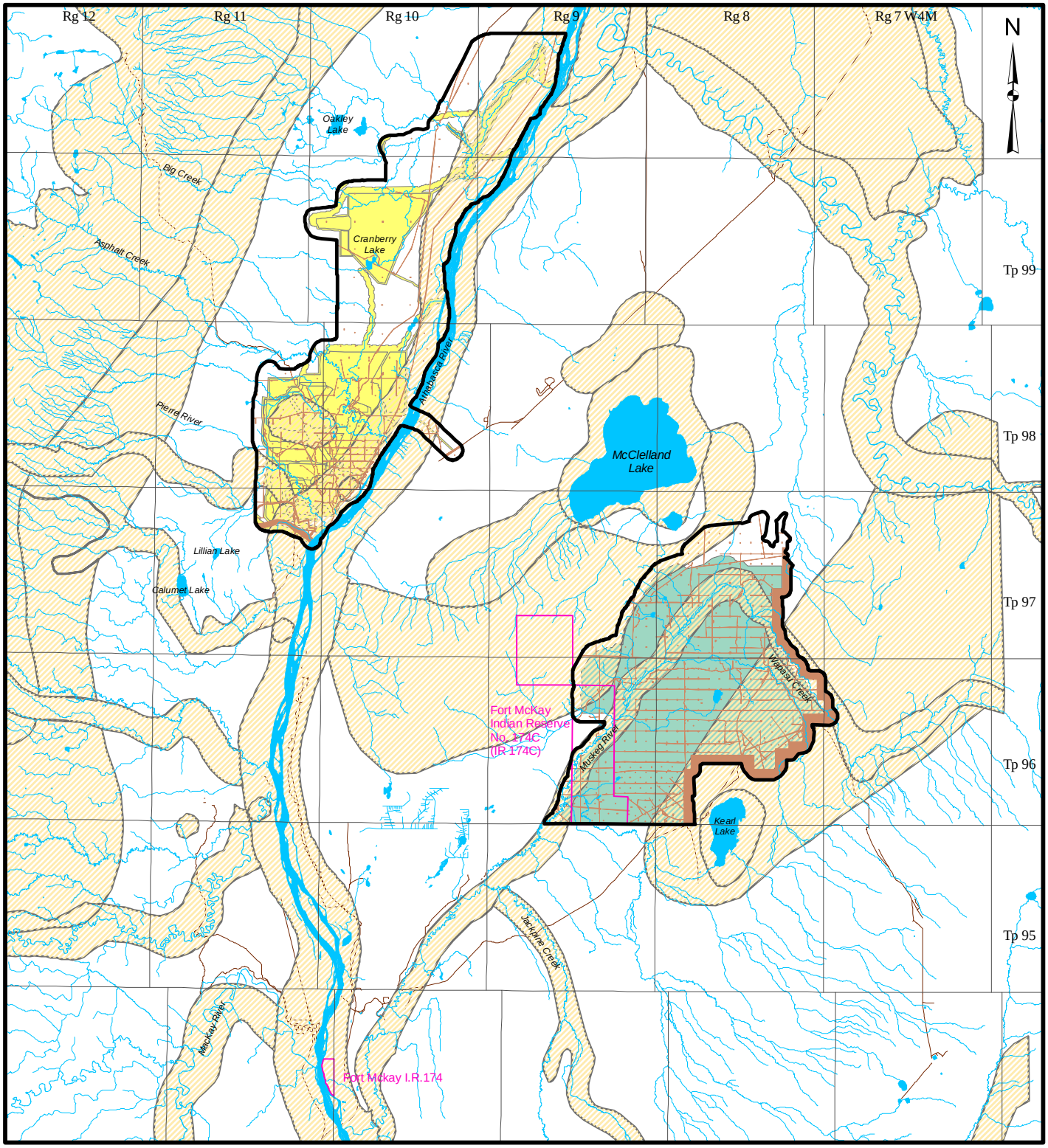
There are a total of eight Environmentally Significant Areas in the Project LSAs (Westworth and Associates 1990, Figure 5.6-1). Three regional ESAs overlap the JEMA LSA, including Fort Hills, Kearl Lake Moose Area and Muskeg River (North). The Fort Hills and Kearl Lake Moose Area are noted to provide important moose habitat. Both the Muskeg River and the Kearl Lake Moose Area are noted as important wildlife movement corridors. Additionally, one

provincially significant area, McClelland Lake, is located adjacent to the northern border of the JEMA LSA. McClelland Lake is noted as important waterfowl and bald eagle habitat.

Another five ESAs are located either entirely or partially within the PRMA LSA. The Athabasca River-Tar Sands Reach is nationally significant, the Eymundson Sinkholes are provincially significant and the Calumet Old Growth Forest, Firebag Marten Area and Pierre River are regionally significant. Athabasca River-Tar Sands Reach is noted as important as moose habitat and as a staging area for waterfowl in the spring and fall. It also has extensive stands of riparian old growth forest including the Calumet Old Growth Forest which are noted as important to a wide variety of wildlife both as habitat and as a movement corridor along the Athabasca River. Eymundson Sinkholes provide habitat similar to other small boreal lakes and as such are habitat for a variety of wildlife species including moose, black bears, beaver, marshbirds, ducks and geese, and a variety of migratory songbirds. The Firebag Marten Area and the Pierre River are both important furbearer habitat as well as general movement corridors for wildlife.

5.6.3 Wildlife Movement Corridors

Riparian zones are particular vegetation communities that exist generally within 100 m of streams and waterbodies. Riparian habitats have been identified as the most structurally diverse areas within the landscape, characterized by having high wildlife abundance and as supporting important biodiversity functions (Hannon et al. 2002). Riparian habitats have also been predicted to act as movement corridors for wildlife species (Westworth, Brusnyk and Associates 1996).



LEGEND

- TERRESTRIAL RESOURCES LOCAL STUDY AREAS
- PIERRE RIVER MINING AREA
- JACKPINE EXPANSION MINING AREA
- ENVIRONMENTALLY SIGNIFICANT AREA
- INDIAN RESERVE
- OPEN WATER
- PUBLIC ROADWAY

DISTURBED

- EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE
- EXISTING AND APPROVED URBAN AND INDUSTRIAL LINEAR DISTURBANCE

7.5 0 7.5

SCALE 1:325,000 KILOMETRES

REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2004), and Alberta SRD, used under license.
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 12.

PROJECT

JACKPINE MINE EXPANSION & PIERRE RIVER MINE PROJECT

TITLE

IMPORTANT WILDLIFE AREAS IN AND ADJACENT TO THE LOCAL STUDY AREA

Shell Canada Limited

PROJECT No. 05-1344-027.7700			SCALE AS SHOWN	REV. 0
DESIGN	VR	03 Aug. 2007		
GIS	VR	28 Sep. 2007		
CHECK	MJ	17 Nov. 2007		
REVIEW	WESTC	20 Nov. 2007		

FIGURE: 5.6-1

Project: I:\CLIENTS\SHELL\05-1344-027\mapping\mxd\wildlife\DRAFT\important_wildlife_jp_pr.mxd - Plot: I:\CLIENTS\SHELL\05-1344-027\mapping\pdf\wildlife\DRAFT\lsa_mammal_toad_jp_pr.pdf

The Athabasca River is the major river system in northeastern Alberta and was identified as a potentially important wildlife travel corridor ago (Golder 1998a). However, results from more recent multi-year winter monitoring surveys in the Oil Sands Region indicate that, in general, wildlife do not preferentially use riparian habitat corridors compared to upland habitats (Table 7-30, AXYS 2005a). From recent surveys along the Muskeg and Athabasca rivers in the vicinity of the Muskeg River Mine, no statistical preference was shown for either upland or riparian habitats by moose, deer, lynx, coyote and marten. Fishers were an exception in that they showed a significant preference for riparian forests compared to uplands. (Golder 2004b)

In the Project LSAs, the Athabasca and Muskeg rivers are potential movement corridors linking the landscape at a regional scale. The Athabasca River and the Muskeg River upstream of the Muskeg River Mine are very different water courses. The Athabasca River is much larger than the Muskeg River, up to 1 km in width with many large islands, some of which provide wildlife habitat to a wide variety of wildlife. Moose and black bears have been seen swimming to these islands. Sign of moose, wolves, deer, black bear has been recorded on the islands as well. The banks of the Athabasca River are high with varying amounts of lowland riparian habitat along its shores. In some reaches, the escarpment rises sharply from the waters edge while in others there are large wetlands and riparian forest between the river and the escarpment. Conversely, the Muskeg River is small, less than 10 m wide and flowing in a broad flat valley that is dominated by wetland habitats. Upland vegetation is limited to islands of higher ground.

The wildlife abundance and distribution data collected in the JEMA and PRMA LSAs provide insight into the use of the Athabasca River valley by wide-ranging mammals. The use of remote cameras along trails and cutlines, as well as winter-active wildlife tracking along the Athabasca River and associated drainages like Muskeg River, indicates that ungulates and carnivores make use of these areas as habitat and corridors for movement. Further data collection associated with the Jackpine Mine – Phase 1 Wildlife Corridor Monitoring Program will provide additional information regarding the role of habitat and disturbance in the use of movement corridors along these watercourses by wildlife.

In the Project LSAs, moose and deer were recorded in the Athabasca River and the Muskeg River valleys throughout the year (Figures 5.3-1 and 5.3-3). Moose were found along the Muskeg River in the JEMA LSA based on the winter track surveys (Figure 5.3-1), remote camera photos (Figure 5.3-2), and the aerial survey results (Figure 5.2-13). Winter tracking and remote camera data corroborated the aerial survey results in the PRMA LSA (Figures 5.2-14, 5.3-3

and 5.3-4); moose were encountered substantially less than in the JEMA LSA. Conversely, deer were recorded more frequently in the PRMA LSA than the JEMA LSA. The winter distribution of deer was concentrated in the southern portion of the PRMA LSA based on winter track surveys. However, corridor and bait station cameras recorded deer throughout that LSA during the spring, summer and fall. There was not a marked preference for either uplands or riparian habitats along the major water courses in the LSAs by moose or deer.

Among canids, wolves were recorded more frequently along the Athabasca River than at bait stations west of the river in the PRMA LSA (Figures 5.3-7 and 5.3-8). Although present throughout the JEMA LSA, wolves were recorded less frequently than in the PRMA LSA (Figures 5.3-5 and 5.3-6). Conversely, coyotes were recorded more frequently in the JEMA LSA and the southern half of the PRMA LSA than in the more remote northern leases in the PRMA LSA, based on the winter tracking and bait station and corridor camera data. Track densities reported for the JEMA LSA were double the density recorded in the PRMA LSA.

Fishers and martens were recorded frequently throughout both Project LSAs based on winter tracking and remote camera results (Figures 5.3-13, 5.3-14, 5.3-15 and 5.3-16). In the JEMA LSA, fisher and marten tracks are encountered on all transects along the Muskeg River. Similarly, the tracks of both species are commonly recorded on transects along the Athabasca River in the PRMA LSA and both species were photographed adjacent to the river as well.

Wolverines were photographed on two occasions in the northern portion of the PRMA LSA, while wolverine tracks were recorded five times in the JEMA LSA. Both wolverine photographs in the PRMA were taken along small drainages flowing into the Athabasca River, while the tracks in the JEMA LSA were located along the Muskeg River. Because wolverine home ranges are very large, they likely travel through both LSAs on an irregular basis and their travel routes are probably along game trails, which often follow drainages like the Muskeg and Athabasca rivers.

Black bears were found throughout the PRMA LSA. Bait station cameras both in the Athabasca River valley and in terrestrial habitats west of the river recorded numerous black bear visits and black bears were recorded along all corridor cameras along the river (Figure 5.3-12). In the JEMA LSA, bears were recorded less frequently and were not recorded on corridor cameras along the Muskeg River (Figure 5.3-11).

5.6.3.1 Jackpine Mine – Phase 1 Wildlife Corridor Monitoring

The Jackpine Mine – Phase 1 Wildlife Corridor Monitoring Program was designed to collect information on wildlife composition, abundance and distribution using winter track counts from January to March and remote cameras throughout the year along the Muskeg River, including the reach within the JEMA LSA, and along the Athabasca River corridor adjacent to Albian Sands Muskeg River Mine (Golder 2007c).

Species detected during the winter tracking sessions in 2006 included red fox, coyote, wolf, Canada lynx, fisher/marten, wolverine, river otter, mink, moose, deer species, snowshoe hare, red squirrel and weasel and grouse species. Coyote track densities were significantly higher ($p<0.05$) in the Athabasca River corridor than on the Muskeg River adjacent to the Muskeg River Mine Expansion (MRME) Project. Conversely, fisher/marten track densities were significantly higher in the JEMA LSA than on the Muskeg River adjacent to the MRME Project. Moose had statistically higher track densities in the JEMA LSA than in the Athabasca River corridor. Deer tracks were significantly more common in the Athabasca River corridor than anywhere along the Muskeg River.

The remote cameras were deployed for a continuous period of about two weeks, during each of the four seasons: winter, spring, summer and fall. During the winter and spring, seven species of wildlife were photographed, while in the summer eight species were photographed and in the fall nine species were detected. Significantly more photographs of coyote and red fox ($p<0.05$) were recorded in the Athabasca River corridor when compared to areas along the Muskeg River, either alongside the MRME Project or in the JEMA LSA further upstream. The number of photographs for white-tailed deer was also statistically higher ($p<0.05$) in the Athabasca River corridor compared to the Muskeg River.

These preliminary results suggest that genetic connectivity for most species of wildlife within the regional landscape is currently maintained by wildlife corridors along the Muskeg and Athabasca rivers, that is, at a minimum one to 10 migrants per generation of all wildlife species will pass through the wildlife corridors (Jinliang 2004; Mills and Allendorf 1996). Wide-ranging species including wolves, black bears, fishers and martens were each recorded within the experimental corridors at least once. The maintenance of genetic connectivity will minimize the loss of genetic diversity within the region.

The combined results of the photographic and winter active wildlife tracking appear reflective of the levels of disturbance that exist along the Athabasca River corridor and the Muskeg River alongside the MRME Project and further upstream in the JEMA LSA. White-tailed deer and coyotes, both species that are

well-adapted to human disturbance, were recorded most commonly in disturbed areas along the Muskeg River and along the Athabasca River corridor. Conversely, mesocarnivores, (i.e., marten, fisher, wolverine, lynx) were generally more common along the Muskeg River in the JEMA LSA than downstream along the Muskeg River and in the Athabasca River corridor. Both surveys indicated that moose and fisher/marten observations were highest in the JEMA LSA, while coyote and deer species were significantly more common in the Athabasca River corridor. The surveys also indicated that the Muskeg River adjacent to the MRME Project had the lowest species diversity compared to the two other areas.

5.6.3.2 Traditional Knowledge

A series of Wildlife Movement Traditional Environmental Knowledge Workshops were conducted with Aboriginal Stakeholder groups in the Oil Sands Region (FMA 2005). Results from these workshops as they pertain to the JEMA and PRMA LSAs are included in the species summaries in Sections 5.3 and 5.4 of this ESR.

Many moose use the Muskeg River watershed, including the JEMA LSA, during all seasons according to consultations with Athabasca Chipewyan First Nation Elders (AXYS 2005b). Moose move from the uplands east of the Muskeg River into the lowlands (e.g., Kearl Lake) in autumn. Overwintering areas include an area on the upper reaches of Jackpine Creek and the area around Hay Lake. Spring use of wetlands habitats along the upper reaches of the Muskeg River north of Kearl Lake was also documented.

5.7 REGIONAL INITIATIVES

Regional corridors have been a focus of regional wildlife planning since at least 2004. At that time, Alberta Environmental Protection and Enhancement Act (EPEA) approval conditions for three recently approved oil sands mining applications (i.e., Petro-Canada/UTS Fort Hills Project, Canadian Natural Horizon Project and Shell Jackpine Mine – Phase 1 Project) contained sections that required proponents to design and implement a research and monitoring program that would address the issue of wildlife habitat corridors and appropriate setback distances. Since then, two workshops and several meetings between industry, government and other stakeholders have taken place.

The first multi-stakeholder workshop, held in Edmonton on October 13, 2004, was sponsored by ASRD through Richard Chabaylo and was funded by industry. This workshop was designed to discuss, formulate and recommend a regional

research program to address wildlife corridors in the oil sands area north of Fort McMurray and was based on information and recommendations that were provided in a literature review report conducted for CEMA (Westworth 2002). Species with high potential as focal species for research included moose, fisher and possibly lynx. Traditional, ecological and logistical factors were considered in the species selection.

The objective of a regional study was to test the effectiveness of existing setbacks and movement corridors relative to natural control corridors, primarily along river valleys and to determine an appropriate design for corridor width. The study that was proposed consisted of a pair-wise design, having a control and treatment area on each river valley that currently has an adjacent oil sands mine. The treatment unit would be located between an adjacent oil sands mine and the given river, while the control unit would be along the same river but where there is no adjacent oil sands mine. Winter track counts and remote camera stations monitored over four seasons would be employed to measure the appropriate variables. Habitat types would be controlled through careful selection of control and treatment sites.

A second CEMA-sponsored workshop, also in Edmonton on March 14, 2006, was held to formulate a list of focal species and revisit methods to achieve EPEA approval conditions and the objectives of the first workshop. The three most prominent issues that needed to be addressed based on a poll of workshop attendees were in ranked order from highest to lowest were:

1) a system to ensure the design of effective movement corridors and connectivity;
2) consequences of the disruption of natural movement patterns and the anthropogenic barriers to movement; and
3) recolonization of reclaimed areas.

Moose, wolf, black bear, fisher and lynx were chosen as potential focal species. Applicable methods included aerial surveys, winter tracking, remote photography, radio telemetry, DNA hair snagging and landscape modelling.

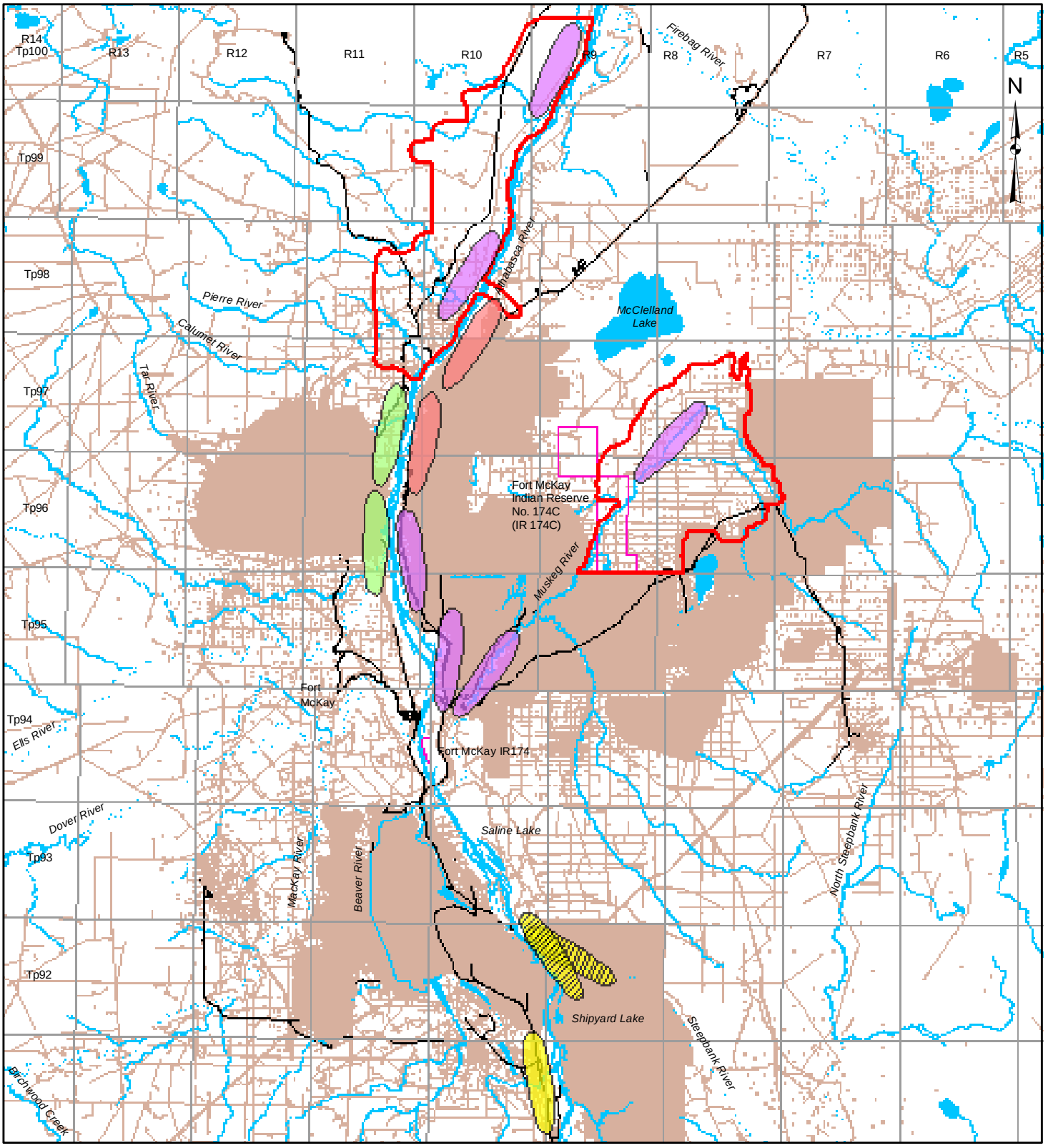
In addition to the multi-stakeholder workshops discussed above, CEMA and some individual oil sands mining operators have collected further information on wildlife use of river valleys from First Nations. Traditional Ecological Knowledge (TEK) was collected from First Nations peoples to enhance the understanding of the importance of river valleys to wildlife and First Nations.

There have been preliminary discussions regarding a regional research initiative to examine wildlife movement and the efficacy of corridors between industry, government and the University of Alberta. Shell has supported the concept of this regional initiative and has been actively involved in meetings between industry and with regulators. Wildlife information in this report was collected using methodologies consistent with those conducted for current monitoring programs. As such, should the regional initiative be implemented, information already collected on the Project LSAs can be used as part of a larger regional data set. As of September 2007, it appears that regional program which will examine the effectiveness of wildlife corridors and link wildlife corridor use with population demographics at the regional scale is expected to begin in winter 2007/08.

Early in the process to delineate wildlife populations and habitats on the LSAs, Golder, on behalf of Shell, entered into discussions with ASRD regarding wildlife environmental setting surveys required for upcoming EIAs. The application of new technologies to wildlife survey techniques provided new and innovative methods for collecting environmental setting wildlife data. For the purpose of this wildlife ESR, ASRD and Golder wildlife biologists agreed that raptor callback and ungulate browse pellet surveys were no longer required (Weclaw 2006, pers. comm). However, remote camera bait stations and corridor surveys were added to better fulfill the Terms of Reference requirements with respect to seasonal monitoring of wildlife, and in particular, wide-ranging species like fishers, moose and black bears year-round. In addition, winter tracking methodologies were changed to adhere to methods used in surveys designed to meet recent EPEA approval conditions.

These changes further the integration of data collection during environmental setting and monitoring surveys if and when projects are approved by using consistent methods during Base Case data collection and AEPEA approval condition monitoring field work. This linkage will provide additional data to the regional wildlife corridor monitoring program outlined above and will, in the longer term, provide a better understanding of the impacts of oil sands development on wildlife.

This approach has since been accepted by several other oil sands operators for environmental setting studies (e.g., Suncor 2007). As a result, oil sands mining operators have adopted a consistent study design for wildlife monitoring in the river valleys, which will aid the assembly of a *de facto* regional data set on wildlife use of the Athabasca River valley and associated drainages (Figures 5.7-1 and 5.7-2).



LEGEND

- TERRESTRIAL RESOURCES LOCAL STUDY AREAS
- INDIAN RESERVE
- OPEN WATER
- PUBLIC ROADWAY

DISTURBED

- EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE
- EXISTING AND APPROVED URBAN AND INDUSTRIAL LINEAR DISTURBANCE

RIVER CORRIDOR STUDY AREAS

- SUNCOR PROPOSED
- CANADIAN NATURAL RESOURCES LIMITED
- PETRO-CANADA
- SHELL CANADA ENERGY
- SUNCOR ENERGY INC.

10 0 10

SCALE 1:450,000 KILOMETRES

REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2004), Pearson Timberline Ltd. (April 2004), LANDSAT 7 ETM Imagery (July 2006), and Alberta SRD, used under license. Saskatchewan digital data obtained from Information Services Corp. (September 2004), used under license.
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 12.

PROJECT

JACKPINE MINE EXPANSION & PIERRE RIVER MINE PROJECT

TITLE

RIVER CORRIDOR STUDY AREAS IN THE MINEABLE OIL SANDS AREA NORTH OF FORT McMURRAY, 2005 TO 2007

Shell Canada Limited

PROJECT No. 05-1344-027.7700			SCALE AS SHOWN	REV. 0
DESIGN	VR	22 Jan. 2007		
GIS	VR	17 Nov. 2007		
CHECK	MJ	17 Nov. 2007		
REVIEW	WES/TC	20 Nov. 2007		

FIGURE: 5.7-1

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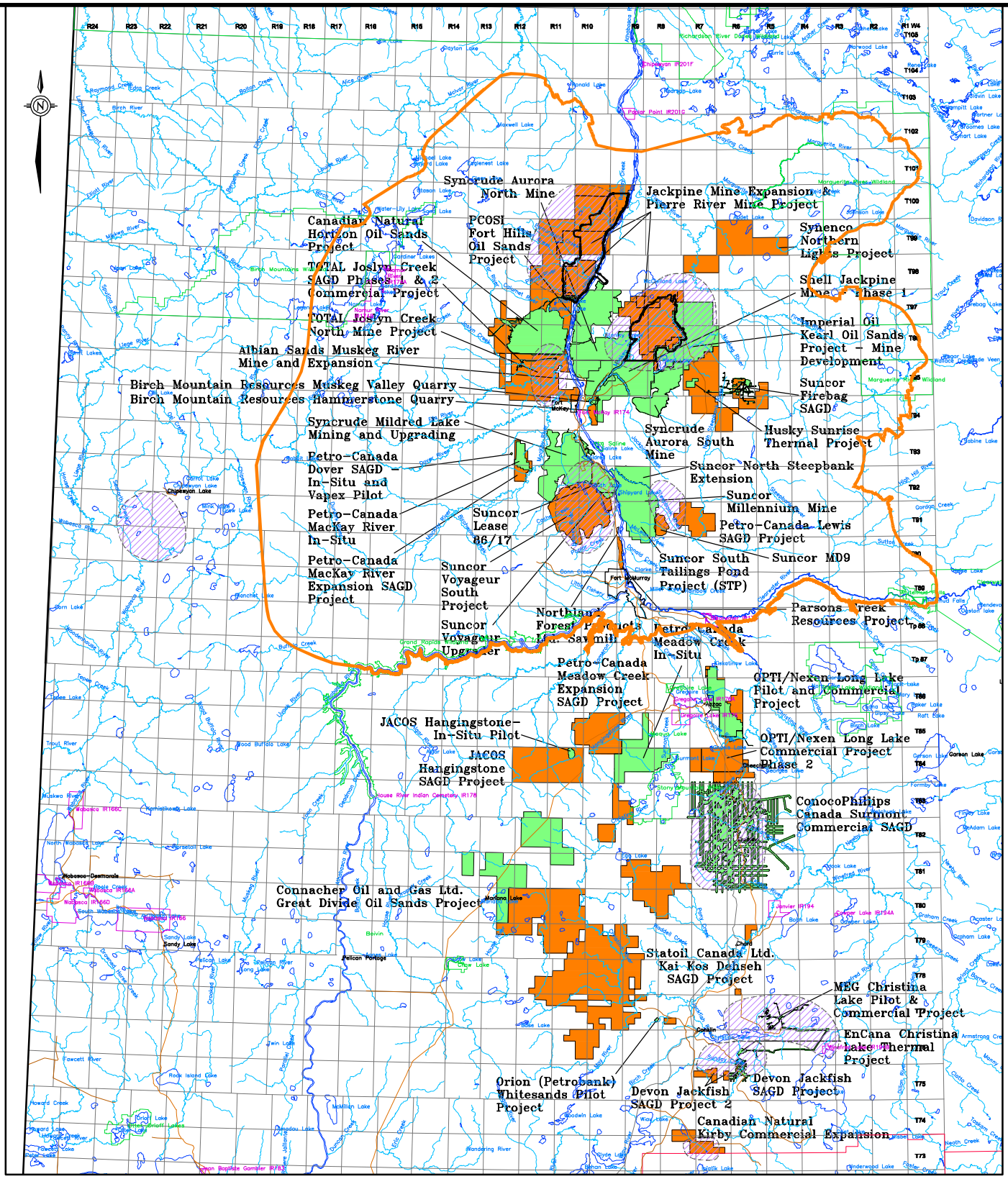

LEGEND

- EXISTING AND APPROVED DEVELOPMENTS
- PLANNED DEVELOPMENTS
- PHOTOGRAPHIC BAIT STATION STUDY AREA
- TERRESTRIAL LOCAL STUDY AREAS
- TERRESTRIAL RESOURCES REGIONAL STUDY AREA

30 0 30
SCALE METRES

REFERENCE

ALBERTA NTDB DIGITAL DATA OBTAINED FROM GEOMATICS CANADA, AUGUST 2001. SASKATCHEWAN NTDB DATA OBTAINED FROM ISC, AUGUST 2001. DATUM: NAD 83 PROJECTION: UTM ZONE 12

PROJECT

JACKPINE MINE EXPANSION & PIERRE RIVER MINE PROJECT

TITLE

PHOTOGRAPHIC BAIT STATION STUDY AREAS IN THE OIL SANDS REGION, 2005 TO 2007

Shell Canada Limited

PROJECT 05-1344-027.7790			FILE No. Photographic Areas	
DESIGN	MJ	07/09/07	SCALE AS SHOWN	REV. 0
CADD	PSR	29/11/07	FIGURE: 5.7-2	
CHECK	MJ	29/11/07		
REVIEW	WES/TC	29/11/07		

L:\2005\1344-OIL SANDS\05-1344-027-Shell Omnibus\7700\7790\Fig 5.7-2 Photographic Study Areas.dwg Nov 29, 2007 - 4:08pm

JPME R1
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490

5.8 SPECIES AND COMMUNITIES OF CONCERN

5.8.1 Wildlife Key Indicator Species

Key Indicator Resources for the Project were selected based on their CEMA priority levels, ecological significance and status both nationally and provincially, and the availability of wildlife data from the LSAs (Table 5.2-5). Fish and Wildlife Management Information System records for listed species are illustrated in Figure 5.8-1 and 5.8-2. Criteria used by CEMA to select wildlife KIRs included biological vulnerability, socio-economic importance and logistics. Biological vulnerability criteria included population status, ecological role, sensitivity to development, regulatory importance and habitat specificity. Socio-economic criteria included traditional and cultural importance, subsistence economic importance and consumptive recreational importance, as well as species of particular interest to First Nations people, such as moose. All CEMA Priority 1 species expected to occur in the LSAs were selected as KIRs. Five of eight species or species groups were selected from the CEMA Priority 2 list.

Additions and deletions to the lists of KIRs used in previous Oil Sands Region EIAs were the result of extensive discussions with regulators (Weclaw 2006, pers. comm.) with the aim to focus this report while ensuring that the effect of the Project on wildlife continues to be comprehensive. The KIRs from previous EIAs that were excluded were river otter, pileated woodpecker and ruffed grouse; all species for which field data consist primarily of incidental sightings and, in the case of the two bird species, are part of bird communities that are included. In addition, marsh birds, a subset of the wetlands forest bird community, were included because they include the yellow rail, a SARA listed species, and they are an indicator of riparian health.

5.8.2 Species of Concern in and Adjacent to the Local Study Areas

Species of concern include KIRs selected for the Project and all federally or provincially listed species that were recorded in the LSAs (Table 5.8-1). Of the special status species observed within the LSAs, the woodland caribou is listed nationally as threatened (COSEWIC 2006, website) and provincially as "At Risk" (ASRD 2005a). All of the other species are listed provincially as "Sensitive" or "May Be At Risk" by ASRD (2005a). "May Be At Risk" species have the potential to be at risk of extinction or extirpation and require a more detailed risk assessment (ASRD 2005a). Sensitive species are not considered to be at risk but may require special attention or protection (ASRD 2005a). Nine listed species observed within the Project LSAs are newly designated as "Sensitive" (ASRD 2005a). These include two mammals, the red and silver-haired bat, and seven birds, including the American green-winged teal,

brown creeper, common yellowthroat, least flycatcher, northern harrier, northern hawk owl and sora.

JPME R1 ERRATA

SEE JPME R1 ATTACH 488-1 FOR YELLOW RAIL INFO AND

JPME R1 AENV SIR 491

Table 5.8-1 Species and Bird Communities of Special Concern Observed Within the Local Study Areas

Species[a]	National Status[b]	Provincial Status[c]	CEMA Priority[d]
Mammals			
beaver	Not At Risk	Secure	Priority 2
black bear	Not At Risk	Secure	Priority 2
Canada lynx	Not At Risk	Sensitive	Priority 1
bison	Threatened	At Risk	-
fisher	–	Sensitive	Priority 2
moose	–	Secure	Priority 1
northern long–eared bat	–	May Be At Risk	–
hoary bat	–	Sensitive	–
red bat	–	Sensitive	–
silver–haired bat	–	Sensitive	–
wolverine	Special Concern	May Be At Risk	–
woodland caribou	Threatened	At Risk	Priority 1
Birds			
American bittern	–	Sensitive	–
American green–winged teal	–	Sensitive	–
bald eagle	–	Sensitive	–
barred owl	–	Sensitive	–
bay–breasted warbler	–	Sensitive	–
black-backed woodpecker	–	Sensitive	–
black tern	–	Sensitive	–
black throated green warbler	–	Sensitive	–
boreal owl	Not At Risk	Secure	Priority 2
brown creeper	–	Sensitive	–
Canada warbler	–	Sensitive	–
Cape May warbler	–	Sensitive	–
common yellowthroat	–	Sensitive	–
ducks and geese	–	–	Priority 2
great blue heron	–	Sensitive	–
great gray owl	Not At Risk	Sensitive	–
least flycatcher	–	Sensitive	–
lesser scaup	–	Sensitive	–
northern harrier	–	Sensitive	–
northern hawk owl	–	Sensitive	–
pileated woodpecker	–	Sensitive	Priority 2
rusty blackbird	Special Concern	Sensitive	–
sandhill crane	Not At Risk	Sensitive	–
sora		Sensitive	–
mixedwood forest bird community	–	–	Priority 2
old growth forest bird community	–	–	Priority 1
Amphibians			
Canadian toad	–	May Be At Risk	Priority 1
western (boreal) toad	Special Concern	Sensitive	–

(a) ***Bold, italicized*** entries are ratified CEMA SEWG wildlife indicators for long-term monitoring.

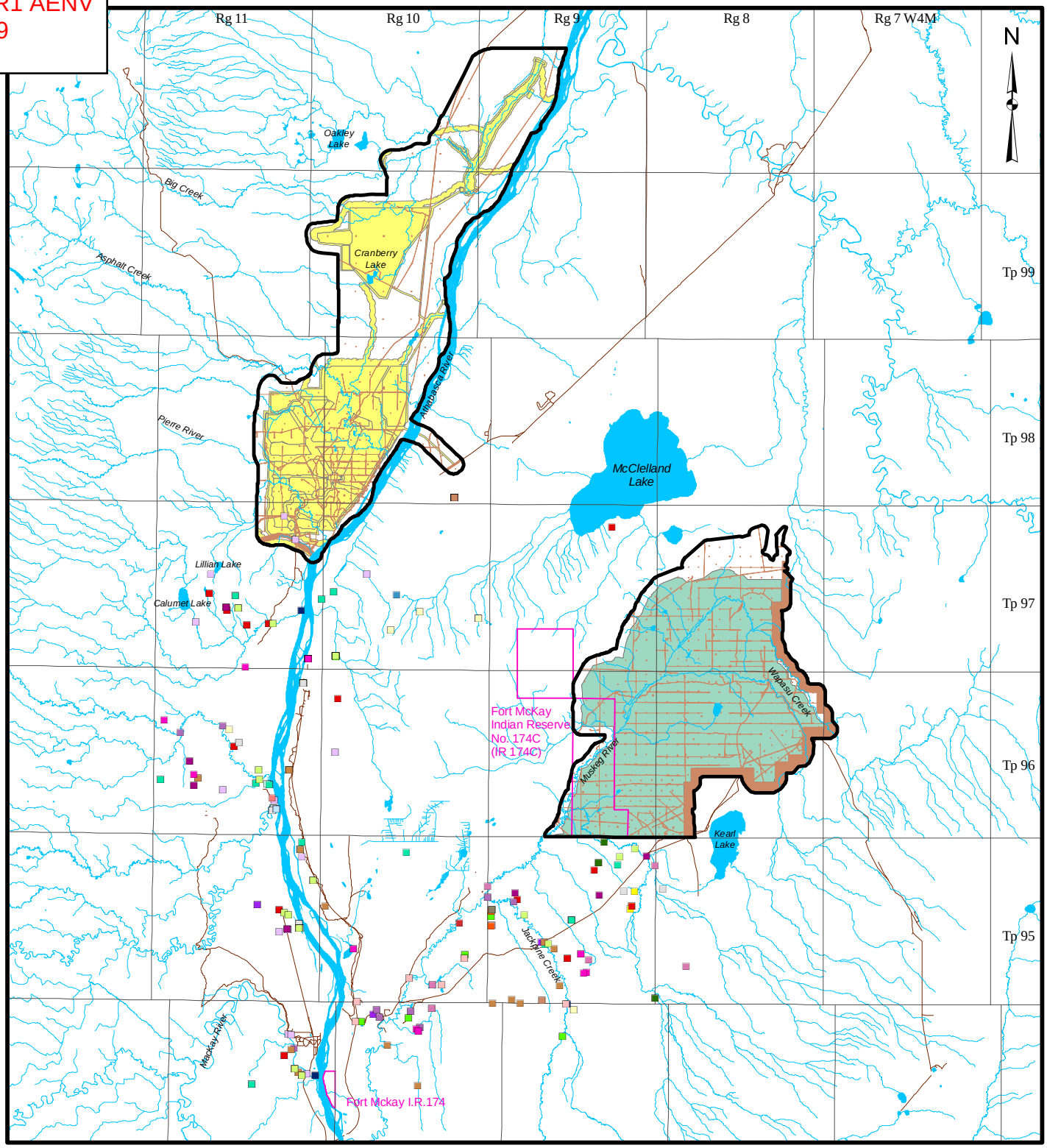
(b) COSEWIC (2007).

(c) ASRD (2005a,b).

(d) Westworth (2002).

– = No status.

JPME R1 AENV
SIR 489



LEGEND

- TERRESTRIAL RESOURCES LOCAL STUDY AREAS
- PIERRE RIVER MINING AREA
- JACKPINE EXPANSION MINING AREA
- INDIAN RESERVE
- OPEN WATER
- PUBLIC ROADWAY

DISTURBED

- EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE
- EXISTING AND APPROVED URBAN AND INDUSTRIAL LINEAR DISTURBANCE

SPECIES OBSERVED

- AMERICAN BITTERN
- BALD EAGLE
- BARN SWALLOW
- BARRED OWL
- BLACK-BACKED WOODPECKER
- BLACK-THROATED GREEN WARBLER
- BLACKBURNIAN WARBLER
- BLUE-WINGED TEAL
- BROAD-WINGED HAWK
- CANADA WARBLER
- CAPE MAY WARBLER
- COMMON NIGHTHAWK
- COMMON YELLOWTHROAT
- EASTERN PHOEBE
- GREAT BLUE HERON
- GREAT GRAY OWL
- HARLEQUIN DUCK
- LEAST FLYCATCHER
- LESSER SCAUP
- NORTHERN GOSHAWK
- NORTHERN HARRIER
- OSPREY
- PIED-BILLED GREBE
- PILEATED WOODECKER
- SANDHILL CRANE
- SHORT-EARED OWL
- SORA
- TRUMPETER SWAN
- WESTERN TANANGER

REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2004), and Alberta SRD, used under license.
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 12.

7.5 0 7.5
SCALE 1:325,000 KILOMETRES

PROJECT
JACKPINE MINE EXPANSION &
PIERRE RIVER MINE PROJECT

TITLE WILDLIFE SPECIES OF CONCERN OBSERVATIONS IN AND ADJACENT TO THE TERRESTRIAL LOCAL STUDY AREA - BIRDS

Shell Canada Limited

PROJECT No. 05-1344-027.7700			SCALE AS SHOWN	REV. 0
DESIGN	VR	03 Aug. 2007	FIGURE: 5.8-1	
GIS	VR	17 Nov. 2007		
CHECK	MJ	17 Nov. 2007		
REVIEW	WES/TC	20 Nov. 2007		

Project: I:\CLIENTS\SHELL\05-1344-027\mapping\mxd\wildlife\DRAFT\sa_birds_jp_pr.mxd - Plot: I:\CLIENTS\SHELL\05-1344-027\mapping\pdf\wildlife\DRAFT\sa_birds_jp_pr.pdf

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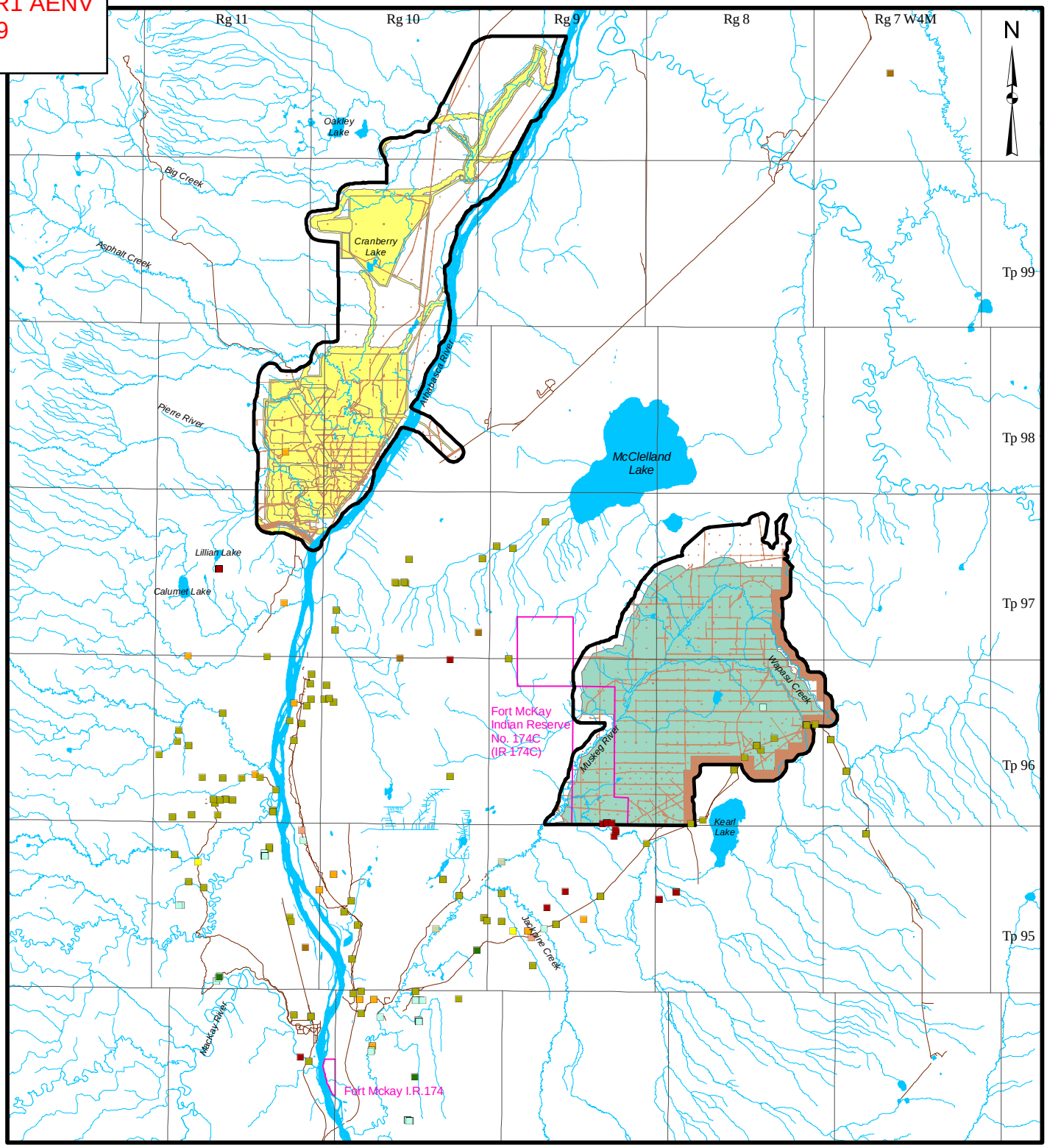

LEGEND

- TERRESTRIAL RESOURCES LOCAL STUDY AREAS
- PIERRE RIVER MINING AREA
- JACKPINE EXPANSION MINING AREA
- INDIAN RESERVE
- OPEN WATER
- PUBLIC ROADWAY

DISTURBED

- EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE
- EXISTING AND APPROVED URBAN AND INDUSTRIAL LINEAR DISTURBANCE

SPECIES OBSERVED

- CANADA LYNX
- CANADIAN TOAD
- FISHER
- HOARY BAT
- NORTHERN LONG-EARED BAT
- RED BAT
- SILVER-HAIRED BAT
- WOLVERINE
- WOODLAND CARIBOU

7.5 0 7.5
SCALE 1:325,000 KILOMETRES

REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2004), and Alberta SRD, used under license.
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 12.

PROJECT
JACKPINE MINE EXPANSION &
PIERRE RIVER MINE PROJECT

TITLE WILDLIFE SPECIES OF CONCERN OBSERVATIONS IN AND ADJACENT TO THE TERRESTRIAL LOCAL STUDY AREA - MAMMALS & CANADIAN TOADS

Shell Canada Limited

PROJECT No. 05-1344-027.7700			SCALE AS SHOWN	REV. 0
DESIGN	VR	03 Aug. 2007	FIGURE: 5.8-2	
GIS	VR	17 Nov. 2007		
CHECK	MJ	17 Nov. 2007		
REVIEW	WES/TC	20 Nov. 2007		

Project: I:\CLIENTS\SHELL\05-1344-027\mapping\mxd\wildlife\DRAFT\lsa_mammal_toad_jp_pr.mxd - Plot: I:\CLIENTS\SHELL\05-1344-027\mapping\pdf\wildlife\DRAFT\lsa_mammal_toad_jp_pr.pdf

5.8.2.1 "At Risk" Species

Bison

The wood bison is listed federally as "Threatened" by COSEWIC (2007). In Alberta, the Wood Bison is considered "At Risk" ASRD (2005a). Within a designated management area in the northwestern section of the province, bison are listed as "Endangered" under Alberta's Wildlife Act. However, wood bison on provincial lands that are not on ranches and are outside of the designated management area are not protected by legislation unless they are owned as livestock. The PRMA LSA is outside of the designated wildlife management area mentioned above and as such, the Redclay Creek bison herd are not protected by any legislation.

Wood bison were seen incidentally on several occasions in the PRMA LSA. The sightings were of individuals, likely bulls, although a group of 10 to 12 were recorded which would likely represent a cow group. Trappers also reported that a small herd lived in the general area. The herd is hunted and is a management concern to ASRD. These bison also likely provide a source of food for wolves as well as a source of food for other animals that scavenge on their carcasses.

Wetlands-associated meadows, open savanna-like shrublands and dry grasslands are the most important habitat types for wood bison in the boreal forest (Mitchell and Gates 2002). As obligate grazers, bison are associated with graminoid-(i.e., grasses and sedges) dominated plant communities (e.g., shrubby fen (FONS), graminoid fen (FONG) and shrubby swamp (SONS) wetlands types). Their diet is comprised of sedges and grasses; wet sedge meadows are particularly important during the winter when grasses have cured.

Woodland Caribou

Woodland caribou, a Project KIR, are listed federally as "Threatened" by COSEWIC (2007) and as "At Risk" in Alberta (ASRD 2005a). Woodland caribou sign (i.e., tracks) were observed once during winter track surveys on the JEMA LSA.

As woodland caribou's primary winter food source is lichen, caribou prefer mature to old forests (Dzus 2000). Woodland caribou primarily select peatland-dominated landscapes such as black spruce bogs and black spruce-tamarack fens, while typically avoiding terrestrial areas (Anderson 1999; Stuart-Smith et al. 1997). Caribou in northeastern Alberta also select upland jack pine ridges containing a high abundance of lichens (Schneider et al. 2000).

Caribou tend to move into areas of higher tree cover when snow depths increase, as movement and feeding are easier (Fuller and Keith 1981).

Caribou populations occur at low densities (0.03 to 0.12 caribou/km^2) and are sparsely distributed across available habitat in northeastern Alberta (Dzus 2000). Although the availability of quality habitat for forage and breeding health are not believed to be limiting for caribou in Alberta (BCC 2003), effects to caribou populations are believed to result from sensory disturbance of developments and fragmentation leading to habitat avoidance (Dyer 1999), barriers to movement (Dyer et al. 2001) and associated increases in predator mobility and caribou predation (CAPP 2004). In undisturbed landscapes, the major limiting factor for woodland caribou populations is predation, primarily by wolves (Dzus 2000). However other predators include bear, wolverine, coyote and lynx.

5.8.2.2 "May Be At Risk" Species

Wolverine

Wolverines are provincially recognized as a species that "May Be At Risk" (ASRD 2005a) and federally as a species of "Special Concern" (COSEWIC 2007); however, they are not a CEMA priority species. Evidence of their presence was seen within the Project LSAs during the winter track surveys, in photographic station data, traditionally by trappers using the area and during other oil sands surveys (e.g., CNRL 2002).

Wolverines are known to have a large home range encompassing a variety of habitat types (Petersen 1997). They have been found in habitats ranging from boreal forest to tundra and subalpine regions and the presence of wooded areas is considered important for predator avoidance. However, wolverines do not avoid natural openings and their density is thought to be more closely linked to food accessibility and proximity to humans than to habitat attributes (Petersen 1997).

Common food for the wolverine includes marmots, mice, voles and birds, as well as eggs and berries. In the winter months, wolverines become scavengers and rely on carrion for survival, although they will still catch live prey, such as grouse, to supplement their diet (Petersen 1997); an event that has been observed on Suncor's reclaimed site (Paquin 2004, pers. comm.).

Wolverines reach maturity in their second or third year, and mate during the spring and summer; however, implantation is delayed, and the kits, usually two to five, are not born until the following spring (Forsyth 1985). Reproductive success of wolverine females is determined by the combined effect of reproductive costs and winter food availability (Persson 2003).

Wolverines have low population densities and low reproductive potential, making them vulnerable to human activities (Weaver et al. 1996). Human causes are the major source of mortality for wolverines throughout their range. Humans impact wolverines directly through trapping and hunting; however, they are also susceptible to habitat loss and ungulate population decreases (Petersen 1997).

Canadian Toad

Canadian toads are provincially listed as "May Be At Risk" (ASRD 2005a) and are a CEMA Priority 1 species. Twenty-four and 29 Canadian toads were recorded during nocturnal amphibian callback surveys in the JEMA and PRMA LSAs, respectively. Canadian toad egg strings were observed in standing water in a shrubby swamp (SONS) on May 9, 2006. Recent surveys in the Oil Sands Region have shown that this species is very widespread with high local abundance (Golder 2006). Generally, breeding Canadian toads have been detected most often in fens, bogs and marshes.

Suitable over-wintering sites are believed to be the primary limiting factor for Canadian toad populations (Roberts 2003, pers. comm.). Their freeze-avoidance strategy for winter survival requires them to burrow into the soil profile, but their morphology prevents them from doing so in soils without a loose structure (Hamilton et al. 1998). Even when sandy soils are abundant, the root zone of forbs and grasses can act as a dense barrier preventing access to the underlying soil. Because suitable hibernacula are a limiting factor for Canadian toads, the disturbance of these sites, particularly communal sites that support high densities of toads, can adversely affect entire local populations of the species.

A further limiting factor on Canadian toad populations is the need for a combination of suitable breeding, foraging and over-wintering habitat within a limited spatial area. The maximum distance Canadian toads have been shown to travel is just over 2 km away from the breeding pond. Using this as a guideline for the maximum distance the toads will move in a season, the implication is that Canadian toad habitat must consist of a suitable over-wintering site (i.e., elevated topography or hill slope consisting of loose, sandy soils), a breeding waterbody, optimally having characteristics such as stable water levels, gradually emerging shores, mudflats and a *Typha*/*Scirpus* fringe, and foraging habitat supporting a sufficient food resource all within a 2 km radius.

Parasites and pathogens may be another limiting factor to Canadian toad populations. In one study, the majority of diagnosable Canadian toad mortalities were the result of mycotic dermatitis, an inflammation of the skin, caused by a fungal pathogen (Taylor et al. 1999a,b). Parasitic trematodes (i.e., flatworm/fluke) and nematodes (i.e., unsegmented roundworm) have also

been found to infect Canadian toads and have negative effects on their health (Bursey and Goldberg 1998).

Northern Long-Eared Bat

Although they are not a KIR for the Project, northern long-eared bats are listed as "May Be At Risk" in Alberta and are uncommon over their known range (ASRD 2005a). Twenty-four and 26 northern long-eared bats were captured during bat surveys on the JEMA and PRMA LSAs, respectively. Many adult females had been lactating earlier in the summer. The capture of post-lactating northern long-eared bat suggests that this species was reproducing in the Project LSAs. In addition, northern long-eared bat echolocation calls were identified during ultrasonic detection surveys.

Northern long-eared bats are found predominantly in mixedwood and coniferous forests during the spring, summer and fall (Smith 1993). These bats mate in the fall but fertilization is delayed until spring, with generally one young born (Pattie and Fisher 1999). During the winter months they hibernate in caves. The main limiting factor for northern long-eared bats in Alberta is the absence of suitable caves and the loss of old growth trees and roosting habitat. When the number of hibernacula, typically caves, is low, bat populations are clumped and the risk of impacts, such as predation, is increased (Caceres and Pybus 1997).

Prior to 2000, there were few data on the northern long-eared bat distribution in northern Alberta. There had been one historical record of the northern long-eared bat in the Fort McKay area in the summer of 1983 (Caceres and Pybus 1997), and the closest known hibernacula was identified in Wood Buffalo National Park (Schowalter 1979). However, since 2001, northern long-eared bats have been observed on nine oil sands leases, including the Project LSAs. Additionally, during provincial species at risk 2001 bat surveys in northeastern Alberta, three northern long-eared bats were captured along cutlines and trails, two at Kearl Lake in the Fort McKay area and one at Leismer in the Conklin area (Hubbs and Schowalter 2003; Schowalter 2001). Thus, it is likely that northern long-eared bats are much more widespread than originally postulated.

5.8.2.3 "Sensitive" Species

American Bittern

American bittern is listed as "Sensitive" in Alberta (ASRD 2005a). The Canadian Wildlife Service's *Northern Prairie and Parkland Waterbird Conservation Plan* lists the American bittern as a species of high concern (Priestley 2002). Six

American bitterns were recorded during the nocturnal marsh bird/amphibian callback surveys on the PRMA LSA.

The bittern breeds in suitable habitat throughout Alberta, although nowhere is it abundant (Semenchuck 1992). A solitary and secretive species, they breed in marshes, swamps, moist meadows, wet alder or willow thickets, always in areas with dense growth of emergent vegetation or tall grasses. In a Manitoba study, American bittern selected areas with higher proportions of tall shrubs at a fine spatial scale (Hays 2006). At a coarser scale (5-km scale), the species responded positively to the amount of wetlands. Nests are constructed on a matted platform of reeds, rushes and small sticks above the water table. The bittern's diet is carnivorous and includes frogs, small fish and crustaceans.

American bittern would benefit from the protection and/or restoration of wetlands complexes to ensure that remaining wetlands do not become smaller and increasingly isolated from one another (Hays 2006).

American Green-Winged Teal

Although not designated a KIR for the Project, green-winged teal fall within the "ducks and geese" grouping which is a Priority 2 KIR. They were recently designated as a "Sensitive" species (ASRD 2005a). Two American green-winged teal were seen during waterfowl surveys.

The American green-winged teal breeds in all natural regions of Alberta; highest breeding densities occur in the Peace-Athabasca Delta north of the Oil Sands Region (Semenchuck 1992). Beaver ponds are primary breeding habitat in the boreal forest, nesting in upland undergrowth close to water. During migration, both spring and fall, American green-winged teals tend to choose shallow inland wetlands with abundant floating and emergent vegetation. Pond weed, sedges and grasses are important parts of its diet, although it also eats aquatic insects and small mollusks.

The overall estimated population of green-winged teal in northwestern North America is above their long-term average, an estimated 56% of which breeds within the boreal forest of Canada and Alaska. However, increasing exploration and development in the boreal forest and its fringe may have a negative effect on this species and careful monitoring is required (USFWS 2006).

Bald Eagle

Bald eagles are listed as a CEMA Priority 3 species and designated "Sensitive" in Alberta because of low population levels and sensitivity to disturbance when

nesting (ASRD 2005a). One bald eagle was observed incidentally during waterfowl surveys in the Project LSAs.

The primary habitat requirement for bald eagles appears to be the presence of a large body of water (Brownell and Oldham 1985; Semenchuk 1992). Nest site preference appears to be associated with deciduous or mixedwood forests containing tall trees and limited crown cover (Brownell and Oldham 1985). Bald eagles are both scavengers and predators and their primary food source is fish, although both small birds and rodents can also be prey (ASRD 2005a).

Brownell and Oldham (1985) have identified several limiting factors for bald eagles; all are related to human activity and disturbance in some respect. These limiting factors include loss of nest sites through development, disturbance of nest sites during breeding, collisions with and electrocution on power lines, shooting and trapping.

Barred Owl

Although not designated a KIR for the Project, barred owl are considered a part of the old growth and mixedwood forest bird communities, which are Priority 1 and 2 KIRs, respectively. Eleven barred owls were heard during early spring owl surveys in the LSAs and another two were heard incidentally during breeding bird surveys.

The barred owl is distributed primarily in the southern boreal forest according to Semenchuck (1992) and records in the Oil Sands Region likely represent the northern limits of the species range in Alberta. The typical breeding habitat of this species is mature forest with nearby open country for foraging. Olsen et al. (2006) determined that barred owls nested primarily in balsam poplar snags more than 34 cm diameter at breast height (dbh) and nest trees were surrounded by large, more than 34 cm dbh, balsam poplar trees and snags. Nesting territories contained a variety of habitats including young (less than 80-year-old), deciduous-dominated stands, old deciduous and coniferous-dominated stands, wooded bogs and recent clear-cuts. Their diets consist of a wide variety of small mammals and birds.

Dr. Hubbs, ASRD wildlife biologist in Rocky Mountain House, developed an empirical resource selection function model for barred owl in northeastern Alberta. The probability of barred owl occurrence was positively correlated with the proportional area of old conifer stands and negatively with bog habitat. This indicates that at the landscape scale, barred owls are selecting breeding home range sites based on the relative amount of old conifer (positive correlation) and bog habitats (negative correlation) present.

Barred owls are a species of special management concern because of their dependency on mature or old growth forests and suspected declining population trends. The Minister of ASRD supported the Endangered Species Conservation Committee's recommendations to incorporate the habitat needs of barred owl in forest management plans. Despite selection of old forest for nesting, barred owls did not appear to completely avoid anthropogenic disturbance (Olsen et al. 2006).

Bay-Breasted Warbler

Bay-breasted warblers are listed as "Sensitive" (ASRD 2005a). Eleven bay-breasted warblers were observed during breeding bird surveys.

Bay-breasted warblers use a range of ecosite phases/wetlands types. The preferred vegetation type is extensive stands of spruce (Semenchuk 1992). They also use mixed stands of spruce, pine and tamarack (Kirk et al. 1996), but most nests are located in spruce trees. They feed on caterpillars, flies, beetles, moths and budworms (Norton 2001). Budworm outbreaks are known to affect the territorial behaviour of bay-breasted warblers as well as their clutch size.

Loss of habitat in their wintering ranges is a limiting factor for bay-breasted warblers. Their dependence on old growth forest for breeding is also a limiting factor (Norton 2001). Shorter forest-cutting cycles, which reduce the area of mature forests, will contribute to creating less attractive breeding habitat for this species.

Black-Backed Woodpecker

The black-backed woodpecker is listed as "Sensitive" in Alberta (ASRD 2005a). Black-backed woodpeckers were incidentally recorded four times in the LSAs, twice during winter track surveys and another two times during breeding bird surveys.

The species inhabits boreal and montane coniferous forests throughout its range, but tree-species composition varies geographically (Dixon and Saab 2000). In Manitoba, boreal forests comprised of black spruce, white spruce, tamarack, jack pine and trembling aspen were used (Villard 1994).

The black-backed woodpecker is confined mostly to burned-over coniferous forest sites. It is an irruptive species that forages opportunistically on outbreaks of wood-boring beetles in recently burned habitats. This restricted diet renders the species vulnerable to local and regional extinction as fire-suppression programs and postfire salvage logging programs increase (Dixon and Saab 2000).

Black Tern

The black tern is listed as "Sensitive" in Alberta (ASRD 2005a). A black tern was incidentally recorded in a graminoid fen (MONG) during the rare plant surveys in the LSAs.

The black tern nests semi-colonially amidst emergent vegetation in biologically rich wetlands including prairie sloughs, margins of lakes, and occasionally river or island edges (Dunn and Agro 1995). Nest marshes are found in open or forested country. In the north-central United States, the species prefers marshes or marsh complexes of 20+ ha; the smallest recorded to date is 5.3 ha. Main summer insect foods of black terns are damselflies and dragonflies, but may also consume mayflies, caddisflies, beetles, moths, dipterans, grasshoppers, crickets and locusts, water scorpions, spiders, grubs and larvae, amphipods, crayfish, and small mollusks (e.g., Chapman-Mosher 1986). Black terns may also eat small fish in summer where available.

Continental populations have been in continual decline since 1967 although less so in 1980s (Dunn and Agro 1995). Loss and/or degradation of wetlands are likely important factors in population decline. Black terns readily accept artificial wetlands such as restored wetlands and are tolerant of nearby human activity as long as colonies are not entered.

Black-Throated Green Warbler

The black-throated green warbler is listed as a "Sensitive" species in Alberta (ASRD 2005a). A black-throated green warbler was observed incidentally during the breeding bird surveys conducted in the PRMA LSA.

The black-throated green warbler inhabits boreal coniferous forest and the transitional area between coniferous and deciduous forests in northern Alberta (Morse and Poole 2005). It is commonly associated with conifers, but may also be found in mixed coniferous-deciduous forests or completely deciduous forests. Nests have been located in both deciduous (e.g., birch, balsam poplar) and white spruce trees. They feed entirely on insects during the summer, frequently a large volume of caterpillars.

Forest fragmentation as a result of anthropogenic change has an adverse impact on the presence and abundance of this species in the boreal forest of Alberta.

Brown Creeper

The brown creeper is listed as a "Sensitive" species in Alberta (ASRD 2005a). Two brown creepers were recorded during the breeding bird surveys conducted in the LSAs.

The brown creeper winters in Alberta and inhabits mature mixedwood and coniferous forests. Creepers commonly nest under the loose bark of a tree, feeding on insects, spiders and other small invertebrates and occasionally on seeds (Semenchuk 1992). Habitat loss is likely to be one of the main limiting factors for this species.

Canada Lynx

The Canada lynx is a CEMA Priority 1 KIR for the Project and is provincially listed as "Sensitive" (ASRD 2005a). Lynx and their tracks were recorded during both remote photographic and winter wildlife tracking surveys in the Project LSAs.

The Canada lynx is adapted to boreal forest ecosystems typical of northcentral Canada and Alaska, representing the majority of their geographic range. Lynx populations can reach high densities in these regions, but undergo dramatic nine to 11-year fluctuations in delayed synchrony with their primary prey, snowshoe hares (Stenseth et al. 1997). In the boreal forest, this translates to a 3- to 17-fold variation in lynx numbers throughout a hare cycle (Mowat et al. 1999). Overall, its current population is believed to be at the bottom of their cycle in the province (ASRD 2005a).

Lynx prefer open mature coniferous forests, late successional forest stages and black spruce bogs (Stardom 1989). However, habitat selection depends on the availability of its primary prey species, the snowshoe hare (Koehler and Aubry 1994; Krebs et al. 2001; Mowat et al. 2000). Lynx have high reproductive potential, but this is realized only during the increase the high phase of the hare cycle in the boreal forest; during other years, reproduction is close to nil (Mowat et al. 2000).

In Alberta, lynx populations are limited by fluctuations in snowshoe hare populations, habitat loss and overtrapping. Loss of either lynx or snowshoe hare habitat may have a detrimental effect on lynx populations. The lynx is considered a furbearing species in Alberta and is therefore subjected to trapping pressures. Overtrapping in times of high fur demand is detrimental to lynx populations. Concern has been expressed for the stability of lynx populations if

high fur prices coincide with a low period in the population cycle (Westworth 2002).

Canada Warbler

Canada warblers are recognized provincially as "Sensitive" (ASRD 2005a) and are a member of the old growth forest bird community. One was heard incidentally in a low-bush cranberry aspen-white spruce (d2) ecosite phase during the spring 2006 breeding bird surveys in the PRMA LSA.

Alberta represents the westernmost extension of the Canada warbler's range in North America (Semenchuk 1992). This species is more abundant in old rather than young aspen forests in Alberta (Schieck et al. 1995). They require older mixedwood stands that have a dense understorey and will breed in riparian thickets and shrubs along forest edges (Semenchuk 1992). They frequently nest near forest openings (Semenchuk 1992). Canada warblers feed in shrubs and lower branches on flying insects and caterpillars. They will also feed on the ground occasionally (Cooper et al. 1997).

Habitat loss within the Canada warbler's breeding range is likely to be the greatest limiting factor (Cooper et al. 1997). Its response to fragmentation is not well known; however, it is unlikely to be a large factor for this species as it frequents forest edge habitats. Another threat to the Canada warbler is the parasitism of its nests by cowbirds (Cooper et al. 1997). In general, the species probably responds favorably to habitat changes that increase density of understorey vegetation within forests, but negatively to changes that decrease forest understorey or severely reduce forest canopy. Overall, the Canada warbler's population status within the province is not known.

Cape May Warbler

Cape May warblers are listed as "Sensitive" in Alberta (ASRD 2005a) and their population status in Alberta is undetermined. Two were heard incidentally in a low-bush cranberry aspen - white spruce (d2) ecosite phase during the spring 2006 breeding bird surveys in the PRMA LSA.

Cape May warblers breed and nest in open stands of mature coniferous forest, particularly those dominated by white spruce (e.g., Kirk et al. 1996) and most nests are located in spruce trees well hidden near the trunk. They are primarily insectivores, but will also feed on tree sap, pollen and berries (Cooper et al. 1997).

Limiting factors for Cape May warblers include the loss of old growth coniferous forests for breeding (Cooper et al. 1997). Repeated fires and logging may limit this species by preventing development of the mature forests needed by both the warbler and its prey.

Common Yellowthroat

Common yellowthroat is listed as "Sensitive" in Alberta (ASRD 2005a) and 21 were observed during the breeding bird surveys in the Project LSAs.

The common yellowthroat generally breeds in open, damp and brushy areas (Semenchuck 1992) including dense willow shrubbery in open marshes, bogs, muskegs, wet meadows and around beaver ponds. Although typically associated with marshes, streamside thickets, wet meadows and other wetlands, common yellowthroats are also found in drier upland habitats as long as there is abundant and dense undergrowth for foraging and nesting. Common yellowthroats eat primarily insects gleaned from low vegetation or on the ground.

Cowbird parasitism is common for this species (Semenchuck 1992).

Fisher

Fishers are listed as "Sensitive" by ASRD (2005a), and as a CEMA Priority 1 KIR, and are a KIR for the Project. The CEMA SEWG selected fisher as a candidate for long-term monitoring during regional corridor monitoring workshops in 2006. Fisher/marten tracks were observed during winter track count surveys, and fishers were photographed at photographic stations in the Project LSAs.

Fishers occur most commonly in landscapes dominated by mature coniferous and mixedwood forest cover, with a preference for late seral-stage forests (Powell and Zielinski 1994; Smith 1993). Virtually all studies of fisher ecology have documented the need for overhead cover. Fishers have been reported by many researchers to select older seral stands with continuous canopy cover to provide security cover from predators (e.g., Arthur et al. 1989).

Fishers are opportunistic predators and make use of many species of prey ranging from insects to carrion. However, it appears that the most important food sources are snowshoe hares and other small mammals such as voles (Powell 1993). Food habitat is therefore closely associated with the cover habitats of the dominant prey.

Females are generally sexually mature at two years of age, bearing one to four young in each litter in March or April (Pattie and Fisher 1999). They are very selective when choosing a denning site and prefer to establish dens high in large-diameter deciduous tree cavities, although dens can also be located on the ground (Powell and Zielinski 1994; Weir 2003). Fishers are reported to use forested riparian zones frequently because these areas supply many habitat features that they require, such as large spruce trees and coarse woody debris for resting, and large-diameter deciduous trees for denning.

Human activity is the major limiting factor for fishers. Habitat loss as a result of development reduces the amount of suitable habitat within a region and results in a reduced capability of the land to support the resident population (Powell and Zielinski 1994). Fishers are also a furbearing species and as such are limited by trapping when prices for pelts are high (Powell and Zielinski 1994). Overtrapping has the potential to extirpate fishers from an area and this may be exacerbated by a natural cycle in fisher numbers based on the availability of snowshoe hares (Bowman et al. 2006).

Great Blue Heron

Great blue herons are a provincially listed as "Sensitive" species. Great blue herons were recorded incidentally during wildlife surveys. A great blue heron colony was recorded between the northern boundary of the JEMA LSA and McClelland Lake.

Great blue herons are found predominantly in areas with open shallow water, swamps and mudflats (Semenchuk 1992; Butler 1992). Nest sites are primarily located in areas close to foraging habitat and are selected to avoid predation (Butler 1992). Fish are the mainstay of the diet of great blue herons, but they will also eat insects, reptiles, small mammals and amphibians.

Both human disturbance and pesticide/herbicide contamination have been identified as limiting factors for great blue herons (Butler 1992). Repeated disturbance near nest sites can result in nest abandonment and reduction in breeding success. Activities such as logging and road building have been shown to have negative effects when within 500 m of nest sites (Werschkul et al. 1976). Contaminants such as polychlorinated biphenyls (PCBs), dioxins and dieldrin

have been shown to have various detrimental effects on great blue herons (Butler 1992). These effects include reduced eggshell thickness, reduced growth and development of young, reproductive failure and death.

Great Gray Owl

Great gray owls are listed as "Sensitive" (ASRD 2005a), although the status of the Alberta population is not known. Eleven great gray owls were heard in the Project LSAs.

Great gray owls are a circumpolar species in the boreal forest of North America and Eurasia. They prefer areas of coniferous, deciduous and mixedwood forests interspersed with bogs, fens and other open spaces (Nero 1979; Semenchuk 1992; Bull and Duncan 1993; Duncan 1994). In some areas, tamarack/black spruce communities appear to be the preferred nesting habitat. Suitable nesting habitat is probably limited by the availability of nest structures, generally nests of other raptors and prey. Small rodents are primary prey for the species.

Habitat loss is the primary limiting factor affecting the great gray owl population. Habitat loss associated with development affects this species through loss of suitable nest sites (Bull and Duncan 1993) and loss of prey items that can lead to starvation and death of great gray owls even if suitable nest sites are present (Bull and Duncan 1993; Duncan 1994). Other limiting factors for the great gray owl include collisions with vehicles, shooting, predation from other bird and mammalian species, accidental trapping and exposure to poisons used to control small mammal populations (Bull and Duncan 1993).

Hoary Bat

The hoary bat is listed as "Sensitive" in Alberta. This bat's listing has been upgraded recently as a result of concerns regarding the effects of wind energy on this species during migration. The hoary bat was not captured in the LSA, but the species was identified during call detection monitoring.

Hoary bats are one of America's largest bats and are among the most widespread of all bats in Canada, found throughout most of the country (Bat Conservation International 2007, website). They typically roost 3 to 4.5 m up in trees along forest borders. In the summer, hoary bats do not emerge to feed until after dark; they may make round trips of up to 39 km foraging from day roosts. Between late summer and early fall, they start migration south to subtropical and possibly even tropical areas to spend the winter. They are often found migrating with flocks of birds. For the rest of the year, hoary bats remain solitary.

Least Flycatcher

Least flycatchers are listed as "Sensitive" in Alberta (ASRD 2005a), although the status of the Alberta population is not known. The species was identified on 19 occasions during breeding bird surveys in the LSAs.

The least flycatcher breeds in semi-open, second-growth, and mature deciduous and mixedwoods in the boreal forest (Briskie 1994). Nests are built in a variety of trees, frequently deciduous varieties. The species feeds almost exclusively on insects. The species was located in shrubby fen (FONS), wooded fen (FTNN) and low-bush cranberry aspen (d1) in the LSAs.

Least flycatchers are considered to be an interior forest species and are adversely affected by logging and other anthropogenic disturbances that result in forest fragmentation.

Lesser Scaup

Although not designated a KIR for the Project, lesser scaup fall within the "ducks and geese" grouping which is a Priority 2 KIR for the Project. They were recently designated as a "Sensitive" species (ASRD 2005a). Lesser scaup were not specifically identified in the LSAs during field surveys, but numerous scaup were recorded during waterfowl surveys. Therefore, the LSAs have habitat used by scaups. Greater scaup are not commonly documented in the boreal forest of northern Alberta, while lesser scaup are one of the most abundant and widespread of North American ducks. Greater and lesser scaup cannot be differentiated in aerial surveys.

Breeding lesser scaup are typically associated with seasonal and semi-permanent wetlands and lakes with emergent vegetation where they frequently nest in wet meadow zones of wetlands. Aquatic invertebrates such as insects, crustaceans and mollusks are their primary food sources.

Populations are likely stable in the boreal forest because recruitment is affected by the availability of breeding wetlands. The number of wetlands in the boreal likely does not fluctuate greatly from year to year. Population declines have been documented during dry years in prairie-parklands.

Northern Harrier

Northern harriers are listed as "Sensitive" in Alberta (ASRD 2005a), although the status of the Alberta population is not known. The species was identified incidentally on six occasions during wildlife surveys in the Project LSAs.

The northern harrier occupies open wetlands, marshes, bogs and fens in the boreal forest (MacWhirter and Bildstein 1996). It preys on birds and mammals, primarily small rodents, passerines and small waterbirds. Nests are typically built on open ground in stands of dense, tall vegetation (e.g., cattails), most often near water.

Loss of nesting habitat, primarily wetlands, across North America has contributed to a decline in the species' continental population.

Northern Hawk Owl

Northern hawk owls are listed as "Sensitive" in Alberta (ASRD 2005a), although the status of the Alberta population is not known. The species was seen incidentally four times during wildlife surveys in the Project LSAs.

Breeding habitat in the boreal forest typically consists of moderately dense coniferous or mixed coniferous-deciduous forests bordering marshes or other open areas including areas cleared by fire or logging (Duncan and Duncan 1998). It nests in dead tree stubs or woodpecker holes, especially in open coniferous or mixed coniferous-deciduous forests, burned-over areas, or muskeg. In the summer, the northern hawk owl subsists primarily on small rodents. In the LSAs, the species was heard in wooded bog (BTNN), shrubby swamp (STNN), wooded fen (FTNN) and dogwood balsam poplar - aspen (e1).

Pileated Woodpecker

Pileated woodpeckers are listed as "Sensitive" in Alberta (ASRD 2005a) and are CEMA Priority 2 species in the Oil Sands Region. Although not designated a KIR for the Project, their primary habitat, old growth forest, is a vegetation KIR. Pileated woodpecker sign was common during field surveys in the LSAs.

Pileated woodpeckers are widely distributed residents of the boreal forest, most notable for being tree cavity excavators and for their use of bark/wood dwelling insects as their primary food source (Bonar 1995). Consequently, they are associated with mature forest types with high densities of large-diameter snags and downed wood (Westworth 2002). The preferred nesting sites are aspen or balsam poplar live trees; however, pileated woodpeckers are also known to excavate nests in dead snags and paper birch (Bonar 1995). Ants and beetle larvae are primary prey throughout the year.

While its population is stable in the province, its dependence on mature to old growth forests places this species at potential risk to timber harvest activities and other forest clearing activities. However, harvesting practices that retain clumps

of mature trees or leave snags for wildlife can be beneficial for pileated woodpeckers.

Red Bat

The red bat is listed as "Sensitive" in Alberta. This bat's listing has been upgraded recently as a result of concerns regarding the effects of wind energy development on this species during migration. Red bats were detected during echolocation monitoring surveys in the Project LSAs.

The red bat is North America's most abundant "tree bat." For the most part, red bats are solitary, coming together only to mate and to migrate (Bat Conservation International 2007, website). Unlike most bats, Eastern red bats often give birth to twins and can have litters of up to five young, though three young is average. In the summertime red bats are among the earliest evening fliers, typically feeding around forest edges, in clearings or around street-lights where they consume predominantly moths.

In September they begin their southward migration, usually to frost-free areas in the southern United States where they probably "hibernate" in hollow trees. They are known to survive body temperatures as low as -4°C. They begin their northward journey in April, reaching Canada in late May.

Rusty Blackbird

Rusty Blackbird is listed federally as "Special Concern" (COSEWIC 2006, website) and provincially as "Sensitive" (ASRD 2005a). Although not designated a KIR for the Project, their primary habitat, riparian wetlands, is a vegetation KIR. One rusty blackbird was recorded during breeding bird surveys in the Project LSAs.

The boreal wetlands of northern Canada are breeding habitat for rusty blackbirds. The species frequents fens, alder–willow bogs, muskegs, beaver ponds, and other openings in the forest such as swampy shores along lakes and streams (Semenchuk 1992). Breeding densities are typically low even in good habitat. An opportunistic feeder, it eats mostly invertebrates during the breeding season, generally taking them by probing in mud and vegetation along the edges of wetlands.

The rusty blackbird has shown steep population declines in recent decades in North America. The most recent Breeding Bird Survey (BBS) trend analyses (1966–2005, Sauer et al. 2005, website) show a 12.8% annual, statistically significant decline in Canada. However, Machtans et al. (2007, website) reported

that rusty blackbird occurrence does not appear to have changed significantly in the past 33 years in the Mackenzie Valley and concluded that declines in the southern parts of their range may be a large factor in the observed rates of population decline.

Sandhill Crane

Sandhill cranes are listed as "Sensitive" in Alberta, with an unknown population size (ASRD 2005a). Sandhill cranes were photographed at photographic corridor stations and they were also observed incidentally in the Project LSAs during other wildlife surveys.

Sandhill cranes are the most common and widespread crane in North America (Tacha et al. 1992). Cranes eat a wide variety of foods including insects, amphibians, small birds and mammals, seeds and berries (Tacha et al. 1992). They breed on large, open plains containing shallow water that are relatively free from human disturbance (Stephen 1979). Fens, bogs and large open shallow marshes in the RSA generally meet these conditions. Nests are generally built above water, attached to emergent vegetation and/or actually floating on the surface (Tacha et al. 1992).

The single, most important factor regulating sandhill crane populations is habitat availability. Nesting effort and success, as well as survival of young, correlate directly with the amount and quality of nesting habitat. Limiting factors for sandhill crane populations also include hunting and human disturbance (Sharp and Vogel 1992; Stephen 1979). As settlement and development increases, areas of suitable habitat have been abandoned as breeding and migratory stopping points. Additionally, the removal of wetlands through development has also been shown to be a limiting factor (Stephen 1979).

Silver-Haired Bat

The silver-haired bat is listed as "Sensitive" in Alberta (ASRD 2005a). This bat's listing has been upgraded recently as a result of concerns regarding the effects of wind energy development on this species during migration. Two juvenile silver-haired bats were captured in the LSAs and the species was also detected during call monitoring surveys.

Silver-haired bats are among the most common bats in forested areas of America, most closely associated with coniferous or mixed coniferous and deciduous forest types, especially in areas of old growth (Bat Conservation International 2007, website). They form maternity colonies almost exclusively in tree cavities or

small hollows. Silver-haired bats, like many forest-roosting bats, will switch roosts throughout the maternity season.

Silver-haired bats feed predominantly in disturbed areas, sometimes at tree-top level, but often in small clearings and along roadways or watercourses (Bat Conservation International 2007, website). Though their diets vary widely, these bats feed chiefly on small, soft-bodied insects. Silver-haired bats have been known to feed on flies, midges, leafhoppers, moths, mosquitoes, beetles, crane flies, lacewings, caddisflies, ants, crickets and occasional spiders.

Managing forests for diverse age structure and maintaining forested corridors are important to these bats because of their dependency on mature and old growth terrestrial habitats.

Sora

Sora rails are listed as "Sensitive" by ASRD (2005a). Soras were the most abundant marsh bird recorded during surveys in the LSAs in 2006. Thirty-six rails were recorded during marsh bird surveys in the Project LSAs.

The most abundant and widely distributed North American rail, the sora breeds primarily in marshes dominated by emergent vegetation. Soras were frequently documented in disturbed sites in the survey of the LSAs. Semenchuck (1992) stated that wherever ponds, meandering streams, marshes, sloughs or wet meadows were found, soras were likely also present. Preistley (2002) also found the sora to be most common rail detected during the Marsh Bird Monitoring Program Pilot. They feed primarily on seeds of wetlands plants and on invertebrates.

Preservation of emergent wetlands that provide breeding, migration and wintering habitats are important conservation measures for this wetlands-dependent species (Melvin and Gibbs 1996). Soras benefit from policies and management that eliminate or minimize effects of wetlands degradation and emphasize the restoration of or re-establishment of wetlands habitats.

Western Tanager

Western tanagers are listed as "Sensitive" (ASRD 2005a). They are a part of the old growth forest bird community and are widely distributed but uncommon throughout most of northern Alberta. Sixteen western tanagers were recorded during the spring breeding bird surveys and another 16 were observed incidentally in the LSAs.

Western tanagers prefer open mixedwood or pure coniferous forests, but are occasionally found in pure deciduous stands in Alberta (Semenchuk 1992). In aspen mixed-wood forest of central Alberta, the majority of the western tanagers were in old (more than 120 years) stands; the remainder were in mature stands (Schieck et al. 1995). In the western National Parks, tanagers are generally found in montane pine or aspen forests (Holroyd and Van Tighem 1983), preferring terrestrial ecosites phases rather than wetlands. Cover requirements include an open-canopied forest area with tall trees for nesting and conifers for cover. Tanagers will occupy pure deciduous stands in low abundance and only a few conifers are required in a stand to provide the needed thermal and concealment cover.

Western tanagers consume both insects and berries and prefer feeding within trees or bushes, although they will also catch insects aerially (Semenchuk 1992). Coniferous branches are preferred over deciduous ones as feeding sources due to the higher number of fine branches available for insects. Species with berry cover are also important for habitat selection because of the high energy provided by this food source.

Habitat loss is likely one of the main limiting factors for this species. However, western tanager is not particularly sensitive to selective harvesting and other logging practices, short of clear-cutting. In aspen mixedwood forest of central Alberta, western tanager abundance was related to two forest community attributes that can be retained during forest harvest operations: volume of down woody material more than 20 cm in diameter and conifer density (Schieck et al. 1995).

Western (Boreal) Toad

The western (boreal) toad is listed as "Sensitive" species in Alberta (ASRD 2005) and as a species of special concern federally (COSEWIC 2007). Most of the western toad populations in Alberta are documented to be well to the west and south of the LSAs (Russell and Bauer 2000). The trend in the western toad population in Alberta is unknown (ASRD 2005a). Three western toads were detected during the amphibian surveys in the Project LSAs.

The western toad prefers shallow water with a sandy bottom in either permanent or temporary waterbodies (usually pools or small ponds) for breeding habitat. Summer habitat for western toads includes areas around waterbodies and watercourses. However, it is largely a terrestrial species that may burrow into loose soil or seek shelter (as well as dig hibernacula) in pre-existing burrows of small rodents (Russell and Bauer 2000). Threats to western toads include pollution and pesticides (ASRD 2005a).

Yellow Rail

The yellow rail is listed as a species of "Special Concern" federally (COSEWIC 2007), although provincially its status is "Undetermined" (ASRD 2005a). No yellow rails were documented during spring marsh bird surveys in either LSA, but three were heard incidentally during bat surveys in the JEMA LSA.

Yellow rails are most likely to be found in seasonal wetlands containing sedges (Prescott et al. 2001). Although sedges often are the dominant plant species in yellow rail nesting habitat, yellow rails also nest in grasses, rushes (*Juncus* spp.) and bulrushes (*Schoenoplectus* and *Scirpus* spp.). The size of wetlands used by yellow rails can vary (Goldade et al. 2002). During the breeding season, yellow rails have been found in sedge meadows as small as 0.5 ha. In Minnesota, 16 wetlands used by yellow rails for nesting ranged from 24 to 1,000 ha and averaged 231.9 ha. Average male home ranges reported in the literature range from less than 5 to greater than 20 ha, and females use about less than 0.5 to 1.5 ha during the breeding season. The presence of yellow rails in wetlands is usually related to water depth. Water depths at nest sites ranged from 0 to 20 cm. Water depths in areas occupied by breeding yellow rails ranged from 0 to 46 cm. Small freshwater snails are the most important food followed by beetles, grasshoppers, spiders, ants, and fly larvae (Bookhout 1995).

Loss of wetlands to human activity is probably the most serious factor affecting yellow rail populations (Bookhout 1995). Drainage of marshes may explain why the southern boundary of the breeding area has moved northward in the twentieth century.

5.8.2.4 "Secure" Species

Beavers

Beavers are a CEMA Priority 2 KIR species for the Project and are listed as "Secure" in Alberta. Beavers, beaver lodges, dams and food caches were observed during the beaver/muskrat and waterfowl surveys in the Project LSAs.

Beavers are widespread and occur in most places where water is consistently deep enough to allow for food storage and access to the den under the winter ice (Novak et al. 1987). In the boreal forest, beavers prefer waterbodies located within aspen and willow habitats and they optimize this habitat by manipulating water levels to ensure suitable depths are maintained (Westworth 2002). In doing so, beavers create breeding habitat for the boreal forest amphibians like chorus frogs, wood frogs and Canadian toad (Stevens et al. 2006).

Beavers are generalists, eating a wide variety of woody and herbaceous species (Harper 1969). In northern regions, preference is given to the bark of trees and shrubs, particularly aspen and balsam poplar.

Beavers become sexually mature at two years of age when they disperse from their colonies (Pattie and Fisher 1999). Mating occurs around January or February (they occasionally have two litters in a season), with litters usually containing four kits (Pattie and Fisher 1999).

Factors that can limit beaver populations include over-trapping, habitat loss and predation (Westworth 2002). Federal and provincial governments have established conservation plans in co-operation with local trappers. Beavers have been reintroduced into many areas where early trappers had eradicated them. As a result of reintroductions and improved trapping laws, there has been a tremendous increase in the number of beavers in Canada (ASRD 2005a). Loss of habitat can occur when water is diverted or lands are deforested; however, the beaver is considered insensitive to human disturbance and can often use disturbed lands with great success, particularly if the disturbance allows for the growth of early-successional deciduous species (Westworth 2002).

Black Bears

Black bears are a CEMA Priority 2 KIR for the Project and are listed as "Secure" provincially. Black bears and black bear sign were observed both during the remote photographic stations and incidentally in the Project LSAs.

Although found in a variety of habitats, black bears prefer heavily wooded areas and dense bushland. In the Fort McMurray area, black bears have been reported to prefer habitats of aspen-jack pine and aspen-conifer mix, avoid muskeg and become attracted to dump sites (Fuller and Keith 1980; Tietje and Ruff 1980). They require large home ranges which may be a consequence of the scattered distribution of seasonal food resources (Westworth 2002). Black bears are omnivorous, eating vegetation such as berries and nuts, fish and small mammals. Breeding occurs in June or July, with usually two or three young born during the winter hibernation (Pattie and Fisher 1999). Black bear survival and fecundity rates are summarized in Golder (2002a).

Hunting, starvation and timber harvesting are the main factors influencing the occurrence of black bears in Alberta (Gunson 1993). As well, increased development can affect bear numbers through the associated increase in bear-human encounters, which can lead to extermination of problem bears (Gunson 1993). Black bear populations, however, are considered fairly high and stable throughout northeastern Alberta.

Boreal Owls

The boreal owl is listed as "Secure" in Alberta (ASRD 2005a) and is a CEMA Priority 2 KIR. Although the distribution and population size of this species is largely unknown, they were the most common owl recorded during owl surveys in the Project LSAs.

Habitats preferred by boreal owls are comprised of mature and old growth coniferous and mixedwood forests (Hayward and Verner 1994; Kirk 1995; Semenchuk 1992). They are also known to use open areas such as clearcuts as foraging grounds in early spring before vegetation growth becomes dense (Westworth 2002). This species nests and breeds in black spruce, white spruce, aspen, poplar, birch and balsam fir (Hayward and Verner 1994; Kirk 1995). Small mammals, such as voles, mice and squirrels, make up the majority of the boreal owl diet (Heinrich et al. 1999).

The main threats to boreal owl populations are habitat loss/fragmentation and prey availability (Westworth 2002). Because boreal owls require mature to old growth coniferous trees for nest cavities, the removal of suitable habitat has the potential to limit the boreal owl population within a region (Westworth 2002).

Ducks and Geese

Waterfowl (i.e., ducks and geese) are CEMA Priority 2 KIRs for the Project. Several species of ducks and geese were observed during the waterfowl surveys and incidentally. All waterfowl occurring in the area, with the exception of the green-winged teal, American pintail and lesser scaup, are listed as "Secure" (ASRD 2005a).

Ducks and geese live in a variety of aquatic habitats including marshes, lakes and rivers and seasonally frequent flooded grasslands, shrublands and forests. Diets are species-specific and varied with some species feeding solely on vegetation and others feeding on aquatic invertebrates and snails (Westworth 2002).

Ducks usually begin breeding at one or two years of age while geese usually breed at two to three years (Elphick et al. 2001). Ducks and geese generally have one brood per year with variable survival rates among populations (e.g., 65 to 80% of ducks may die in first year with survival higher thereafter) (Elphick et al. 2001). Because large numbers of waterfowl are known to move north to breed during prairie droughts, the waterbodies within the Oil Sands Region are considered important breeding grounds due to their stable water levels (Westworth 2002).

Moose

Moose are a CEMA Priority 1 KIR for the Project although they are listed as "Secure" provincially. Moose are an important indicator as they are highly sought after for both recreational hunting and sustenance by aboriginal groups. There were many several incidental observations of moose and their sign, in addition to observations of moose and moose sign in the LSAs during ungulate surveys as discussed in Section 5.3.1.1.

Optimal moose habitat consists of shrub and ground strata within deciduous, mixed and coniferous forests that offer edge or disturbed areas of early successional vegetation (Osko et al. 2004; Poole and Stuart-Smith 2003). Previous research in northeastern Alberta (Golder 1999, 2000b) has indicated that major river valleys act as important wintering areas for moose. Deciduous browse is the primary food source, varying from twigs and bark in the winter, to leaves in the spring and summer (URSUS and Komex 1997). They will also consume herbaceous and aquatic vegetation (Westworth 2002). Moose usually begin breeding at three years old, producing one to three (usually two) calves (Pattie and Fisher 1999). Moose survival and fecundity rates are summarized in Golder (2002a).

Moose are primarily threatened by direct and indirect habitat loss, altered predator/prey relationships and hunting. Their primary predators are wolves and bears, which most often kill calves, although adults can also become prey (Ballard and van Ballenberghe 1997).

5.8.2.5 Bird Communities of Concern

Mixedwood Forest Bird Community

The mixedwood forest bird community is a KIR for the Project. The mixedwood forest is characterized by a canopy of mature white spruce and aspen, but may also contain mature jack pine and other deciduous species. Typical species included in this community include western tanagers, blue-headed vireo, blue jay, brown creeper, magnolia warbler, Tennessee warblers, boreal owl, white-throated sparrows, black-capped chickadee, pileated woodpecker and red-breasted nuthatch (Westworth 2002). These bird species will also occur in other forest types.

Old Growth Forest Bird Community

The old growth forest bird community is a KIR for the Project. The old growth forest community is dominated by large mature white spruce, often with a component of large aspen, balsam poplar and sometimes balsam fir or black

spruce. Variable canopy closure, multiple layers and abundance of standing and fallen deadwood often characterize the old growth forest community. Typical bird species include the Cape May warbler, winter wren, red-breasted nuthatch, white-winged crossbill, black-throated green warbler and woodpeckers (Westworth 2002). Although these birds are commonly associated with old growth forests, they are also known to occur in other forest stand types such as mixedwood and, to a lesser extent, deciduous.

5.9 SUMMARY

Shell Canada Limited (Shell) is in the preliminary planning stages of the Jackpine Mine Expansion & Pierre River Mine Project (the Project). There are two Local Study Areas (LSAs) for the Project. The Jackpine Expansion Mining Area (JEMA) LSA is along the Muskeg River north and east of the approved Jackpine Mine – Phase 1 and covers an area of 18,348 ha. The Pierre River Mining Area (PRMA) LSA is located on the west side of the Athabasca River, north of the approved Canadian Natural Horizon Project and covers an area of 21,136 ha. Environmental setting surveys were conducted to support the Environmental Impact Assessment (EIA) for the Project.

The specific objectives of the Wildlife and Wildlife Habitat Environmental Setting Report (ESR) include:

- assess wildlife abundance, distribution and habitat use within the Project LSAs;
- identify important wildlife habitat, including local and regional habitat, and if possible, seasonal use and movement corridors; and
- determine the presence of special status (e.g., nationally or provincially listed) wildlife species within the Project LSAs.

Baseline wildlife surveys were conducted within the JEMA and PRMA LSAs from 2005 to 2007 and included:

- remote photographic bait stations;
- remote photographic corridor monitoring;
- winter track triangle and corridor transects;
- nocturnal amphibian call surveys;
- marshbird call surveys;
- breeding bird surveys;

- nocturnal bat surveys;
- beaver and muskrat aerial surveys;
- waterfowl aerial surveys;
- an ungulate aerial survey; and
- a nocturnal owl survey.

Incidental wildlife observations are reported and a particular note was made of special status species (i.e., species listed nationally or provincially and species listed as priority species by the Cumulative Environmental Management Association [CEMA]).

Key Indicator Resources (KIRs) for the wildlife and wildlife habitat environmental setting report were selected based on their CEMA priority levels, ecological significance, status both nationally and provincially, and the availability of baseline wildlife data from the LSAs. All CEMA Priority 1 species expected to occur in the LSAs are selected (i.e., muskrat, moose, Canada lynx, fisher, old growth forest birds, and Canadian toad). Five of eight species are selected from the CEMA Priority 2 list including black bear, beaver, ducks and geese, mixedwood forest birds and boreal owls. Species excluded are river otter, pileated woodpecker and ruffed grouse; all species for which field data consist primarily of incidental sightings and, in the case of the two bird species, are part of bird communities that are KIRs themselves. In addition, marsh birds, a subset of the wetlands forest bird community, are included because they include the yellow rail, a Species at Risk Act (SARA)-listed species that is an indicator of riparian health. These species and communities are the focus of this report.

The JEMA LSA is excellent moose habitat and surveys for moose and moose sign indicated that moose were plentiful relative to other areas in the Oil Sands Region north of Fort McMurray. Moose density in the JEMA LSA is calculated at 0.22 moose/km^2, which is similar to the 0.21 moose/km^2 found in the Jackpine Mine – Phase 1 area in 2001. A moose track density of 4.29 tracks per km-day was recorded during winter track surveys on the JEMA LSA. Eighteen moose photographs were taken during corridor monitoring along the Muskeg River throughout the year. Conversely, moose were less plentiful in the PRMA LSA. Only one observation of a solitary moose was made during the aerial survey of the PRMA LSA, although this is in part due to the heavily treed upland habitat throughout most of the PRMA LSA.

Moose density in the PRMA LSA could not be estimated due to the limited results of aerial surveys. Nine moose photographs were taken during corridor

monitoring throughout the year including one in the fall, five in the spring and three in the summer in the PRMA. A moose track density of 0.34 tracks per km-day was recorded during the winter track surveys in the PRMA LSA. Moose in the Project LSAs significantly preferred b3, low-bush cranberry aspen (d1), dogwood balsam poplar-aspen (e1), and shrubby fen (FONS) communities, and used a1, blueberry jackpine-aspen (b1), dogwood white spruce (e3), Labrador tea black spruce jackpine (g1) ecosite phases and wooded bog (BTNN) and wooded fen (FTNN) wetlands communities less than expected. The prevalence of moose tracks in wetlands types and in shrubby terrestrial areas suggests that moose prefer habitats with high forage availability and that forage availability may be more important than cover habitat for moose in this region.

Deer and their sign were not plentiful in either the JEMA or PRMA LSAs. No deer were recorded during the ungulate aerial survey of the JEMA or the PRMA LSAs. Thirty-five and 49 white-tailed deer photographs were taken during corridor monitoring throughout the year in the JEMA and PRMA LSAs, respectively. No mule deer were photographed. Deer track densities during winter tracking were low and typical for the region. Deer track densities of 0.14 and 0.31 tracks per km-day were recorded during winter tracking on the JEMA and PRMA LSAs, respectively. The higher track density in the PRMA LSA is likely a reflection of better deer habitat as a result of a greater amount of upland habitats relative to the JEMA LSA. Significantly preferred habitats for deer in the Project LSAs are low-bush cranberry aspen - white spruce (d2), dogwood white spruce (e3), Labrador tea - subhygric black spruce - jack pine (g1) and cutline, while wooded fen (FTNN) are used significantly less than expected based on winter tracking data.

Wood bison were not seen during winter aerial surveys of the Project LSAs. No tracks were seen during winter track surveys and the species was not photographed at any of the photographic bait or corridor stations. However, trapline holders in the PRMA LSA reported that the Redclay Creek bison herd moves around the area and may be seen more frequently in large swampy areas. Bison from this herd were seen incidentally a number of times during field surveys in the PRMA LSA. Although listed federally as “Threatened” and provincially “At Risk”, the bison in the PRMA are not legally protected by legislation because they are not privately owned and they occur outside of the management zone in northwestern Alberta and Wood Buffalo National Park.

Woodland caribou, also listed as “Threatened” federally and provincially “At Risk”, were not seen during winter aerial surveys of the Project LSAs. One caribou track was observed in a FONG wetland site during 2006 winter track surveys in the JEMA LSA. Interviews with current RFMA holders indicate that caribou are present sporadically, if at all. The Audet Caribou Zone is located

10 km northeast of the JEMA LSA, across the Firebag River while the Birch Mountain Caribou Zone is about 50 km northwest of the PRMA LSA.

Wolves were present in both Project LSAs although they were greater numbers in the PRMA LSA. Wolves were photographed more often in the PRMA and track densities during winter track surveys were higher. Wolf track densities were 0.21 and 0.07 tracks per km-day in the PRMA and JEMA LSA, respectively. Five photographs of wolves were taken during corridor monitoring throughout the year including one during the fall and four during the spring session in the JEMA LSA. A wolf track density of 0.07 tracks per km-day was recorded during winter track surveys in the JEMA LSA. Wolf track densities recorded in the Project LSAs were within the range of variation reported from other environmental setting surveys in the Oil Sands Region. Based on winter tracking data, wolves significantly preferred low-bush cranberry aspen (d1) and low-bush cranberry aspen - white spruce (d2) habitats, while blueberry aspen - white spruce (b3), forested bog (BFNN), wooded fen (FTNN) and Labrador tea - subhygric black spruce - jack pine (g1) were used significantly less than expected.

Coyotes were present in both Project LSAs although the JEMA LSA had greater numbers. The coyote track density was 0.21 tracks per km-day in the JEMA LSA, while the density in the PRMA LSA was 0.09 tracks per km-day. Again, coyote track densities recorded in the Project LSAs were similar to those reported from other environmental setting surveys in the Oil Sands Region. The only significantly preferred habitat was low-bush cranberry aspen (d1), while wooded fen (FTNN) and Labrador tea/horsetail white spruce - black spruce (h1) were used significantly less than expected.

Red foxes were not common in either Project LSA. A red fox track density of 0.02 tracks per km-day was recorded during winter track surveys in both LSAs. Red fox track densities recorded in the Project LSAs were similar to those reported from other environmental setting surveys in the Oil Sands Region.

Lynx numbers are low and their distribution is uneven in the Project LSAs as the population appears to be near the bottom of their 9 to 11 year cycle. The holder of RFMA #1275, who lives on his trapline in the PRMA, felt that lynx population is very low because the rabbit cycle is down. Canada lynx track densities of 0.11 and 0.07 tracks per km-day were recorded during winter track surveys in the PRMA and JEMA LSAs, respectively. Lynx were described by Fort McKay participants in a CEMA-sponsored Wildlife Movement Traditional Environmental Knowledge Workshop as preferring areas near sloughs, little lakes and creeks.

Black bears were ubiquitous in both Project LSAs as illustrated by the results of the photographic station surveys. However, based on fewer photographs of black bears in the JEMA LSA, bear numbers may be less in the JEMA LSA than across the Athabasca River in the PRMA LSA, where 205 photographs of black bears were taken during the spring and summer. The JEMA LSA is primarily wetlands, while the PRMA LSA is predominantly terrestrial upland habitats. Fort Chipewyan participants in a CEMA-sponsored Wildlife Movement Traditional Environmental Knowledge Workshop believed that there had been a decline in bear numbers over the last 15 to 20 years, as a result of non-Aboriginal hunting using bait and a decrease in food resources. A common thread among the interviews with RFMA holders was that black bear were heavily hunted by outfitters.

Fisher and marten are common in both Project LSAs. A fisher/marten track density of 1.73 and 2.33 tracks per km-day was recorded during winter track surveys in the JEMA and PRMA LSAs, respectively. As track sizes of female and young-of-the-year fishers and male martens overlap, data collected as fisher, marten or fisher/marten were combined for the analysis of tracking data. Low-bush cranberry aspen (d1) ecosite phases are significantly preferred, while wooded fen (FTNN) is used significantly less than expected. Combined fisher and marten track densities recorded in the Project LSAs were high relative to those reported from other environmental setting surveys in the Oil Sands Region although reasons for the differences are not known. Fishers and martens were also photographed regularly at both corridor and bait stations in both LSAs. Based on the photographic rates, marten were more plentiful than fisher in both LSAs and both mustelids were present in greater numbers in PRMA LSA, likely again the result of a greater number of preferred upland habitats.

Wolverines were recorded in both Project LSAs, although given their very large home ranges and therefore low densities, the species was recorded very infrequently as expected. Four wolverine tracks were recorded during winter track surveys within the JEMA LSA, resulting in a track density of 0.01 tracks per km-day. Nine photographs of a single wolverine were taken at a bait station and another wolverine was photographed walking along a trail in the PRMA LSA. These results are similar to those reported from other environmental setting surveys in the Oil Sands Region.

Beaver and muskrat aerial survey results within the Project LSAs are within the ranges recorded in previous surveys in the Oil Sands Region. The density for active beaver lodges was 0.06 lodges/ha in lakes and 0.62 lodges/km in watercourses in the JEMA LSA while active beaver lodge densities in the PRMA LSA were 0.02 lodges/ha in lakes and 0.53 lodges/km in watercourses. No muskrats or evidence of muskrat were seen on the PRMA or the JEMA LSAs.

Muskrat survey data for the Oil Sands Region demonstrate that muskrat numbers are highly variable between lease areas because muskrat habitat is lacking in many areas. The results of the JEMA LSA survey is consistent with a previous study in the Jackpine Mine – Phase 1 area in October 2001 when no muskrats where observed.

Bats were more common on the Project LSAs than on previous studies in the Oil Sands Region north of Fort McMurray based on both greater capture success and higher levels of bat activity on the Project LSAs. Northern long-eared bats, currently listed as "Sensitive" provincially, were caught most frequently (n=50) followed by little brown (n=17) and silver-haired bats (n=2). From results of call detection surveys in both Project LSAs, seven species/species groups were identified: big brown/silver-haired, red bat, hoary bat, hoary/big brown/silver haired, little brown, northern long-eared, and high-frequency bats. Little brown bats were most frequently detected, followed by northern long-eared bats, and hoary/big brown/silver haired bats.

The majority of the bats were captured in blueberry jack pine - aspen (b1), low-bush cranberry aspen - white spruce (d2) and blueberry aspen / white birch (b2) ecosite phases. However, the highest bat activity was recorded in the wooded bog (BTNN), low-bush cranberry aspen - white spruce (d2) ecosite phase, and open shallow water (WONN) and wooded fen (FTNN) wetlands types. The wetlands habitats may be used as transit between foraging habitats as the highest foraging activity (buzzes) was recorded in Labrador tea - subhygric black spruce - jack pine (g1), low-bush cranberry aspen (d1) and low-bush cranberry aspen - white spruce (d2) ecosite phases.

Thirty-six soras, six American bitterns and two pie-billed grebes were recorded during the nocturnal marsh bird callback surveys on PRMA and JEMA LSAs. No yellow rails were recorded during the marsh bird surveys in either LSA. However, three yellow rails were heard during bat surveys in late July on the JEMA LSA; habitats were Labrador tea / horsetail white spruce - black spruce (h1) ecosite and wooded fen (FTNN) wetlands type. The majority of sora observations were made within marshes (MONG) and shrubby swamp (SONS) wetlands types. All American bitterns were recorded in the PRMA LSA in five ecosite phases and wetlands types, including horsetail balsam poplar - white spruce (f2), a graminoid fen (FONG), a wooded fen (FTNN), a marsh (MONG), and two locations in shrubby swamps (SONS). The two pie-billed grebes were both located in graminoid marshes (MONG).

Waterfowl densities on streams and lakes within the JEMA and PRMA LSAs were similar to those reported from other environmental setting surveys in the Oil Sands Region. Densities were higher during spring aerial surveys than in the fall.

Diving ducks outnumbered dabbling ducks in all surveys. Identified species included American wigeon, blue-winged teal, redhead, American green-winged teal, mallard and northern shoveler, bufflehead, common goldeneye, common merganser, lesser scaup, mallard and ring-necked duck, tundra swan and Canada goose. Among the waterfowl, American green-winged teal and lesser scaup are listed provincially as "Sensitive". Three great blue herons, a species also listed as "Sensitive", were recorded during each of the spring surveys. Bonaparte's gulls and solitary sandpipers were commonly observed waterbirds.

A total of 131 owl plots were surveyed in both Project LSAs. Owl calls were detected at 61% and 48% of nocturnal owl survey sites in the JEMA and PRMA LSAs, respectively. Owl densities in both Project LSAs ranged from 0 to 5 owls per plot and averaged 0.8 owls per plot. Owl species richness ranged from 0 to 4 owl species per plot and averaged 1.2 owl species per plot. The boreal owl was the most abundant species recorded, followed by barred and great horned owls, great gray owl, northern saw-whet owl and long-eared owl.

Breeding bird surveys in the JEMA LSA recorded sixty-one different species and 586 individual birds were recorded within a 50-m radius during the surveys. Seven species comprised 50% of the bird observations. Chipping sparrow was the most abundant species detected, followed by Tennessee warbler, dark-eyed junco, alder flycatcher, ovenbird, white-throated sparrow and yellow-rumped warbler. Nine "Sensitive" species were observed during the breeding bird surveys in the JEMA LSA. These include bay-breasted warbler, brown creeper, Canada warbler, Cape May warbler, common yellowthroat, great gray owl, least flycatcher, rusty blackbird and western tanager. No "May Be At Risk", or "At Risk" species (ASRD 2005a) were observed.

In the PRMA LSA, 47 different species and 259 individual birds were recorded within a 50-m radius during the surveys. Nine species comprised 50% of the bird observations. White-throated sparrow was the most abundant species detected, followed by northern waterthrush, black-capped chickadee, chipping sparrow, Swainson's thrush, swamp sparrow, yellow-bellied sapsucker, boreal chickadee and dark-eyed junco. Six "Sensitive" species were observed during the breeding bird surveys in the PRMA LSA. These include black tern, black-backed woodpecker, brown creeper, common yellowthroat, least flycatcher and western tanager. No "May Be At Risk", or "At Risk" species were observed.

Breeding bird surveys were conducted in a total of 232 sites in 24 ecosite phases and wetlands types in the JEMA and PRMA LSAs. Forty-six of the 73 species recorded occurred in more than three of the ecosite phases and wetlands types surveyed. Twelve species occurred in two ecosite phases and wetlands types, while fifteen species occurred in only one ecosite phase or wetlands type. The

Tennessee warbler and chipping sparrow were the most widespread species, as they were both observed in eighteen of the 24 ecosite phases/wetlands types sampled. Eight of the 11 "Sensitive" species observed in the JEMA and PRMA LSAs were observed in terrestrial habitat. These include bay-breasted warbler, brown creeper, black-backed woodpecker, Canada warbler, Cape May warbler, common yellowthroat, least flycatcher and western tanager. Ten of the 11 "Sensitive" species observed in the JEMA and PRMA LSAs were observed in wetlands habitat. These include bay-breasted warbler, black tern, black-backed woodpecker, Canada warbler, Cape May warbler, common yellowthroat, great gray owl, least flycatcher, rusty blackbird and western tanager.

Amphibian surveys conducted on the JEMA and the PRMA LSAs found that boreal chorus frogs were the most numerous, followed by wood frogs and Canadian toads. Three boreal toads were detected on the JEMA LSA. Evidence of reproductive effort was observed in both Project LSAs during the amphibian surveys. Northern leopard frogs were not detected. Amphibians were recorded in all wetlands types. Amphibian abundance in the Project LSAs appears to be similar to other surveys conducted within the Oil Sands Region.

Thirty-three species of special concern (i.e., "Sensitive", "May Be At Risk", and "At Risk") (ASRD 2005a) were recorded in the two LSAs. These included bison, woodland caribou, wolverine, northern long-eared bat, hoary bat, red bat, silver-haired bat, Canada lynx, fisher, Canadian toad, western (boreal) toad and 24 bird species. Of the special status species observed, the bison and woodland caribou are listed nationally as "Threatened" and provincially as "At Risk". The wolverine, the northern long-eared bat and the Canadian toad are listed as "May Be At Risk" provincially. The western toad and rusty blackbird are listed provincially as "Sensitive", and along with the wolverine are listed federally as "Species of Special Concern". The remaining species are all listed as "Sensitive" provincially and are not listed federally.

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APPENDIX R

COMMON NAMES, SCIENTIFIC NAMES AND STATUS OF SPECIES OBSERVED ON THE JACKPINE MINE EXPANSION & PIERRE RIVER MINE PROJECT LOCAL STUDY AREAS

Submitted to:
Shell Canada Limited

Prepared by:
Golder Associates Ltd.

December 2007 **05-1344-027**

50 BEST EMPLOYERS IN CANADA 2007

CANADA'S 50 BEST MANAGED PRIVATE COMPANIES

OFFICES ACROSS NORTH AMERICA, SOUTH AMERICA, EUROPE, ASIA AND AUSTRALIA

LIST OF TABLES

Table R-1 Common Names, Scientific Names and Status of Wildlife Species Observed in the Local Study Areas 1

Table R-1 Common Names, Scientific Names and Status of Wildlife Species Observed in the Local Study Areas

Common Name	Scientific Name	National Status	Provincial Status[(a)]
Mammals			
bat spp.	*Myotis spp.*	–	–
beaver	*Castor canadensis*	–	Secure
big brown bat	*Eptesicus fuscus*	–	Secure
bison	*Bison bison*	Threatened	At Risk
black bear	*Ursus americanus*	Not At Risk	Secure
Canada lynx	*Lynx canadensis*	Not At Risk	Sensitive
coyote	*Canis latrans*	–	Secure
deer spp.	*Odocoileus spp.*	–	–
fisher	*Martes pennanti*	–	Sensitive
fisher/marten	*Martes spp.*	–	–
grey wolf	*Canis lupus*	Not At Risk	Secure
hoary bat	*Lasiurus cinereus*	–	Secure
little brown bat	*Myotis lucifugus*	–	Secure
marten	*Martes americana*	–	Secure
moose	*Alces alces*	–	Secure
muskrat	*Ondatra zibethicus*	–	Secure
northern long-eared bat	*Myotis septentrionalis*	–	May Be At Risk
red bat	*Lasiurus spp.*	–	Accidental/Vagrant
red squirrel	*Tamiasciurus hudsonicus*	–	Secure
silver-haired bat	*Lasionycteris noctivagans*	–	Secure
snowshoe hare	*Lepus americanus*	–	Secure
weasel spp.	*Mustela spp.*	–	–
white-tailed deer	*Odocoileus virginianus*	–	Secure
wolverine	*Gulo gulo*	–	–
woodland caribou	*Rangifer tarandus*	Threatened	At Risk
Amphibians/Reptiles			
boreal chorus frog	*Pseudacris triseriata*	–	Secure
western (boreal) toad	*Bufo boreas*	Special Concern	Sensitive
Canadian toad	*Bufo hemiophrys*	Not At Risk	May Be At Risk
wood frog	*Rana sylvatica*	–	Secure
Birds			
Alder flycatcher	*Empidonax alnorum*	–	Secure
American coot	*Fulica americana*	Not At Risk	Secure
American kestrel	*Falco sparverius*	–	Secure
American redstart	*Setophaga ruticilla*	–	Secure
American wigeon	*Anas americana*	–	Secure
bald eagle	*Haliaeetus leucocephalus*	–	Sensitive
barred owl	*Strix varia*	–	Sensitive
bay-breasted warbler	*Dendroica castanea*	–	Sensitive

Table R-1 Common Names, Scientific Names and Status of Wildlife Species Observed in the Local Study Areas (continued)

Common Name	Scientific Name	National Status	Provincial Status[(a)]
black-backed woodpecker	*Picoides arcticus*	–	Sensitive
black-capped chickadee	*Parus atricapillus*	–	Secure
American bittern	*Botaurus lentiginosus*	–	Sensitive
American green-winged teal	*Anas crecca*	–	Sensitive
black tern	*Chlidonias niger*	Not At Risk	Sensitive
black-throated green warbler	*Dendroica virens*	–	Sensitive
black and white warbler	*Mniotilta varia*	–	Secure
blue-headed vireo	*Vireo solitarius*	–	Secure
blue-winged teal	*Anas discors*	–	Secure
boreal chickadee	*Parus hudsonicus*	–	Secure
boreal owl	*Aegolius funereus*	Not At Risk	Secure
brown creeper	*Certhia americana*	–	Undetermined
bufflehead	*Bucephalus albeola*	–	Secure
Canada goose	*Branta canadensis*	–	Secure
Canada warbler	*Wilsonia canadensis*	–	Sensitive
Cape May warbler	*Dendroica tigrina*	–	Sensitive
cedar waxwing	*Bombycilla cedrorum*	–	Secure
chipping sparrow	*Spizella passerina*	–	Secure
clay-coloured sparrow	*Spizella pallida*	–	Secure
common goldeneye	*Bucephala clangula*	–	Secure
common loon	*Gavia immer*	Not At Risk	Secure
common merganser	*Mergus merganser*	–	Secure
common nighthawk	*Chordeiles minor*	–	Sensitive
common raven	*Corvus corax*	–	Secure
common yellowthroat	*Geothlypis trichas*	–	Secure
Connecticut warbler	*Oporornis agilis*	–	Secure
dark-eyed junco	*Junco hyemalis*	–	Secure
gray jay	*Perisoreus canadensis*	–	Secure
great blue heron	*Ardea herodias*	–	Sensitive
great gray owl	*Strix nebulosa*	Not At Risk	Sensitive
great horned owl	*Bubo virginianus*	–	Secure
greater yellowlegs	*Tringa melanoleuca*	–	Secure
grebe spp.	*Podiceps spp.*	–	–
hairy woodpecker	*Picoides villosus*	–	Secure
house wren	*Troglodytes aedon*	–	Secure
hermit thrush	*Catharus guttatus*	–	Secure
Le Conte's sparrow	*Ammodramus leconteii*	–	Secure
least flycatcher	*Empidonax minimus*	–	Secure
lesser scaup	*Aythya affinis*	–	Sensitive
lesser yellowlegs	*Tringa flavipes*	–	Secure

Table R-1 Common Names, Scientific Names and Status of Wildlife Species Observed in the Local Study Areas (continued)

Common Name	Scientific Name	National Status	Provincial Status[(a)]
Lincoln's sparrow	*Melospiza lincolnii*	–	Secure
magnolia warbler	*Dendroica magnolia*	–	Secure
mallard	*Anas platyrhynchos*	–	Secure
northern flicker	*Colaptes auratus*	–	Secure
marsh wren	*Cistothorus palustris*	–	Secure
mourning warbler	*Oporornis philadelphia*	–	Secure
Nelson's sharp-tailed sparrow	*Ammodramus nelsoni*	–	Secure
northern goshawk	*Accipiter gentilis*	Not At Risk	Sensitive
northern harrier	*Circus cyaneus*	Not At Risk	Secure
northern hawk owl	*Surnia ulula*	–	Sensitive
northern shoveler	*Anas clypeata*	–	Secure
northern waterthrush	*Seiurus noveboracensis*	–	Secure
olive-sided flycatcher	*Contopus cooperi*	–	Secure
orange-crowned warbler	*Vermivora celata*	–	Secure
ovenbird	*Seiurus aurocapillus*	–	Secure
palm warbler	*Dendroica palmarum*	–	Secure
Philadelphia vireo	*Vireo philadelphicus*	–	Secure
pileated woodpecker	*Dryocopus pileatus*	–	Sensitive
pine siskin	*Carduelis pinus*	–	Secure
purple finch	*Carpodacus purpureus*	–	Secure
red crossbill	*Loxia curvirostra*	–	Secure
red-breasted nuthatch	*Sitta canadensis*	–	Secure
red-eyed vireo	*Vireo olivaceus*	–	Secure
red-necked grebe	*Podiceps grisegena*	Not At Risk	Secure
ring-necked duck	*Aythya collaris*	–	Secure
red-winged blackbird	*Agelaius phoeniceus*	–	Secure
rose-breasted grosbeak	*Pheucticus ludovicianus*	–	Secure
red-breasted nuthatch	*Sitta canadensis*	–	Secure
ruby-crowned kinglet	*Regulus calendula*	–	Secure
ruffed grouse	*Bonasa umbellus*	–	Secure
sandhill crane	*Grus canadensis*	Not At Risk	Sensitive
rusty blackbird	*Euphagus carolinus*	Special Concern	Sensitive
solitary sandpiper	*Tringa solitaria*	–	Secure
song sparrow	*Melospiza melodia*	–	Secure
sora	*Porzana carolina*	–	Sensitive
spruce grouse	*Dendragapus canadensis*	–	Secure
Swainson's thrush	*Catharus ustulatus*	–	Secure
Tennessee warbler	*Vermivora peregrina*	–	Secure
swamp sparrow	*Melospiza georgiana*	–	Secure
tree swallow	*Tachycineta bicolor*	–	Secure

Table R-1 Common Names, Scientific Names and Status of Wildlife Species Observed in the Local Study Areas (continued)

Common Name	Scientific Name	National Status	Provincial Status[(a)]
varied thrush	*Ixoreus naevius*	–	Secure
white-throated sparrow	*Zonotrichia albicollis*	–	Secure
vesper sparrow	*Pooecetes gramineus*	–	Secure
western tanager	*Piranga ludoviciana*	–	Sensitive
white-winged crossbill	*Loxia leucoptera*	–	Secure
western wood peewee	*Contopus sordidulus*	–	Secure
Wilson's snipe	*Gallinago gallinago*	–	Secure
Wilson's warbler	*Wilsonia pusilla*	–	Secure
winter wren	*Troglodytes troglodytes*	–	Secure
yellow rail	*Coturnicops noveboracensis*	Special Concern	Undetermined
yellow warbler	*Dendroica petechia*	–	Secure
yellow-bellied flycatcher	*Empidonax flaviventris*	–	Undetermined
yellow-bellied sapsucker	*Sphyrapicus varius*	–	Secure
yellow-rumped warbler	*Dendroica coronata*	–	Secure

(a) Status definitions were presented in Section 5.8.

– = Indicates species that do not have official status (National or Provincial) and therefore are considered to be not at risk the purposes of this report.

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APPENDIX S

POTENTIAL AND OBSERVED SPECIES OF SPECIAL CONCERN

Submitted to:
Shell Canada Limited

Prepared by:
Golder Associates Ltd.

December 2007 **05-1344-027**

LIST OF TABLES

Table S-1 Potential and Observed Wildlife Species of Special Concern Within the Local Study Areas.....1

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491

Table S-1 Potential and Observed Wildlife Species of Special Concern Within the Local Study Areas

Species	Scientific Name	National Status [COSEWIC 2007]	Provincial Listing [AENV 2005]	CEMA Status [Westworth 2002]	Observed During Field Surveys	Habitat Requirements[(a)]
MAMMALS						
Chiroptera						
Northern long–eared bat	*Myotis septentrionalis*	–	May Be At Risk	–	yes	southern end of range; mixed and coniferous forests; hibernate in caves
hoary bat	*Lasiurus cinereus*	–	Sensitive	–	yes	found throughout most of the country, typically roost in trees along forest borders
red bat	*Lasiurus borealis*	–	Sensitive	–	yes	prefer forested environments, forage in a variety of habitats, mostly over land, along the edges of pastures, crop lands, or other openings dotted with large deciduous trees
silver–haired bat	*Lasionycteris Noctivagans*	–	Sensitive	–	yes	in forested areas of North America, most closely associated with coniferous or mixed coniferous and deciduous forest types, especially in areas of old growth
Castoridae						
beaver	*Castor canadensis*	–	Secure	Priority 2	yes	requires water; sloughs, rivers, creeks and lakes with trees within easy access
Carnivora						
black bear	*Ursus americanus*	–	Secure	Priority 2	yes	coniferous and mixed forests
fisher	*Martes pennanti*	–	Sensitive	Priority 1	yes	dense coniferous forest
wolverine	*Gulo gulo*	Special Concern	May Be At Risk	–	yes	dense forests
Canada lynx	*Lynx canadensis*	–	Sensitive	Priority 2	yes	coniferous and mixedwood forest
Artiodactyla						
moose	*Alces alces*	–	Secure	Priority 1	yes	mixedwood, around edges of lakes, bogs and streams
woodland caribou	*Rangifer tarandus*	Threatened	At Risk	Priority 1	yes	black spruce bogs and fens, upland jackpine forest
wood bison	*Bos bison athabascae*	–	At Risk	–	yes	boreal prairies

Table S-1 Potential and Observed Wildlife Species of Special Concern Within the Local Study Areas (continued)

Species	Scientific Name	National Status [COSEWIC 2007]	Provincial Listing [AENV 2005]	CEMA Status [Westworth 2002]	Observed During Field Surveys	Habitat Requirements[(a)]
AMPHIBIANS AND REPTILES						
Anura						
Canadian toad	*hemiophrys*	–	May Be At Risk	Priority 1	yes	margins of ponds, lakes and potholes
Northern leopard frog	*Rana pipiens*	Special Concern	At Risk	–	no	permanent ponds with emergent vegetation (cattails, bulrushes)
western (boreal) toad	*Bufo boreas*	Special Concern	Sensitive	–	yes	ponds, streams or lakes; breeding ponds tend to be shallow with cool water (less than 10°C) and sandy bottoms
wood frog	*Rana sylvatica*	–	Secure	Priority 3	yes	damp, shady woods; in winter, hibernates on land beneath leaf litter
red–sided garter snake	*ThamNophis sirtalis*	–	Sensitive	–	no	marshy areas; in winter, hibernates in crevices and caves
BIRDS						
Gaviformes						
common loon	*Gavia immer*	–	Secure	Priority 3	yes	clear open lake or large river with minimal shoreline development, little recreational activity and an abundance of small fish
Podicipediformes						
pied–billed grebe	*Podilymbus podiceps*	–	Sensitive	–	yes	pond, wetlands or prairie slough with shoreline or islands with dense with emergent growth
horned grebe	*Podiceps auritus*	–	Sensitive	–	no	open and forested areas, preferring ponds, sloughs and lakes with extensive marshy vegetation
red–necked grebe	*Podiceps grisegena*	–	Secure	–	no	small, shallow lakes 2 ha in size or in shallow protected bays of larger lakes
western grebe	*Aechmophorus occidentalis*	–	Sensitive	–	no	large lakes with large amounts of emergent and floating vegetation
Pelecaniformes						
American white pelican	*Pelecanus erythrorhynchos*	–	Sensitive	–	no	shallow, turbid lake remote from human activity with extensive shallow waters near shore and good rough fish populations

Table S-1 Potential and Observed Wildlife Species of Special Concern Within the Local Study Areas (continued)

Species	Scientific Name	National Status [COSEWIC 2007]	Provincial Listing [AENV 2005]	CEMA Status [Westworth 2002]	Observed During Field Surveys	Habitat Requirements[(a)]
Ciconiiformes						
American bittern	*Botaurus lentigiNosus*	–	Sensitive	–	yes	marshes, swamps, moist meadows, wet alder or willow thickets; occasionally in drier meadows, but always in areas with dense growth of vegetation
great blue heron	*Ardea herodias*	–	Sensitive	–	yes	areas with shallow, open water, swamps and mudflats
black–crowned night heron	*Nycticorax nycticorax*	–	Sensitive	–	no	swamps, streams, rivers, ponds, lakes and areas with dense emergent vegetation
Anseriformes						
trumpeter swan	*Cygnus buccinator*	Not At Risk	At Risk	–	no	small to medium size shallow lakes with well developed emergent and sub–emergent plant communities
white–winged scoter	*Melanitta fusca*	–	Sensitive	–	no	near ponds, lakes, oxbows and sluggish streams in treeless or open country, with dense and low ground cover associated; undisturbed islands in deep water lakes
Anatiformes						
American green–wing teal	*Anas crecca*	–	Sensitive	–	yes	wetlands, beaver ponds, lakes
lesser scaup	*Aythya affinis*	–	Sensitive	–	yes	wetlands, beaver ponds, lakes
Northern pintail	*Anas acuta*	–	Sensitive	–	no	wetlands, beaver ponds, lakes
Falconiformes						
osprey	*Pandion haliaetus*	–	Sensitive	–	yes	permanent lakes and rivers, where there is an adequate supply of fish
bald eagle	*Haliaeetus leucocephalus*	–	Sensitive	Priority 3	yes	proximity of a large body of water, usually an inland lake or river; breeding areas must have suitable tall trees near shore for nesting and roosting, good fish populations and relatively little human disturbance
Northern harrier	*Circus cyaneus*	–	Sensitive	–	yes	open country, including marshes, meadows and cultivated fields
Northern goshawk	*Accipiter gentilis*	–	Sensitive	Priority 3	yes	forested habitats, usually in mature forests that are dense; sometimes in areas interspersed with clearings

Table S-1 Potential and Observed Wildlife Species of Special Concern Within the Local Study Areas (continued)

Species	Scientific Name	National Status [COSEWIC 2007]	Provincial Listing [AENV 2005]	CEMA Status [Westworth 2002]	Observed During Field Surveys	Habitat Requirements[(a)]
broad–winged hawk	*Buteo platypterus*	–	Sensitive	Priority 3	no	in woodlands, generally near forest edge at clearings and wet areas
golden eagle	*Aquila chrysaetos*	–	Sensitive	–	no	rocky outcrops, sparsely wooded slopes and grassland habitats with coulees, steep river banks and canyons
peregrine falcon	*Falco peregrinus*	Threatened	At Risk	–	no	cliffs near water for nesting and open fields, swamps and marshes for hunting
Galliformes						
ruffed grouse	*Bonasa umbellus*	–	Secure	Priority 2	yes	aspen–dominated and mixed wood forests; small openings in a deciduous forest are preferred; heavy understorey needed for drumming sites
sharp–tailed grouse	*Tympanuchus phasianellus*	–	–	–	no	openings created by fire and man, and peatlands
Gruiformes						
yellow rail	*Coturnicops Noveboracensis*	Special Concern	Undetermined	–	yes	graminoid marshes and fens
sora	*Porzana caroline*	–	Sensitive	–	yes	wetlands and marshes
sandhill crane	*Grus canadensis*	–	Sensitive	–	yes	marshes, bogs adjacent to ponds and large marshes with some open water and tall grasses and rushes
whooping crane	*Grus americana*	Endangered	At Risk	–	no	large, relatively open, marshy areas
Charadriiformes						
upland sandpiper	*Bartramia longicauda*	–	Sensitive	–	no	open, grassy uplands, wet meadows, old fields with minimal tree or shrub growth
Caspian tern	*Sterna caspia*	–	Sensitive	–	no	large lakes rich with small fish
black tern	*Chlidonias niger*	–	Sensitive	–	yes	shallow lakes, marshes, sloughs, ponds and wet meadows, where there are extensive shallows and moderate amounts of emergent vegetation
Forster's tern	*Sterna forsteri*	Data Deficient	Sensitive	–	no	cattail marshes and back waters. small lakes with floating or emergent vegetation

Table S-1 Potential and Observed Wildlife Species of Special Concern Within the Local Study Areas (continued)

Species	Scientific Name	National Status [COSEWIC 2007]	Provincial Listing [AENV 2005]	CEMA Status [Westworth 2002]	Observed During Field Surveys	Habitat Requirements[(a)]
Strigiformes						
barred owl	*Strix varia*	–	Sensitive	–	yes	mixedwoods with large deciduous trees, particularly along lakeshores and stream valleys; breeding habitat must have densely foliaged trees for roosting and large trees with suitable cavities for nesting
great gray owl	*Strix nebulosa*	–	Sensitive	–	yes	coniferous, deciduous and mixedwood areas, usually near water sources such as peatlands, marshes and wet meadows
short–eared owl	*Asio flammeus*	Special Concern	May Be At Risk	–	no	open country, including grassland, grassy or brushy meadows, marshland, pastures and previously forested areas that have been cleared
boreal owl	*Aegolius funereus*	–	Secure	Priority 2	yes	coniferous and mixedwood forests
Caprimulgiformes						
common nighthawk	*Chordeiles miNor*	–	Sensitive	–	yes	open or semi–open habitats in a variety of areas; forest clearings, burnt–over areas, gravel pits, barren rock and beaches
Piciformes						
black–backed woodpecker	*Picoides arcticus*	–	Sensitive	–	yes	dense mixed or coniferous forests, often in openings such as bogs, swamps and lakeshores
pileated woodpecker	*Drycopus pileatus*	–	Sensitive	Priority 2	yes	older, mature dense–canopied forest, particularly mixed and deciduous woods with large dead and dying trees for nesting and downed woody material for feeding
Passeriformes						
great–crested flycatcher	*Myiarchus crinitus*	–	Sensitive	–	no	deciduous and mixedwood forests near clearings
sedge wren	*Cistothorus plantensis*	–	Sensitive	–	no	sedge meadows and grassy fields
Cape May warbler	*Dendroica tigrina*	–	Sensitive	–	yes	dense mature white spruce stands of coniferous and mixedwood forests
black–throated green warbler	*Dendroica virens*	–	Sensitive	–	yes	mature coniferous or mixedwood forest with large stands of white spruce
blackburnian warbler	*Dendroica fusca*	–	Sensitive	–	yes	mature coniferous or mixedwood forest containing coniferous trees (e.g., white spruce)

Table S-1 Potential and Observed Wildlife Species of Special Concern Within the Local Study Areas (continued)

Species	Scientific Name	National Status [COSEWIC 2007]	Provincial Listing [AENV 2005]	CEMA Status [Westworth 2002]	Observed During Field Surveys	Habitat Requirements[(a)]
bay–breasted warbler	*Dendroica castanea*	–	Sensitive	–	yes	extensive stands of spruce, also mixed stands of spruce, jack pine and tamarack
Canada warbler	*Wilsonia canadensis*	–	Sensitive	–	yes	thick stands of willow and alder along streams and dense shrubs and bushes in swamps near the forest edge
western tanager	*Piranga ludoviciana*	–	Sensitive	–	yes	open coniferous and mixedwood forests
common yellowthroat	*Geothlypis trichas*	–	Sensitive	–	yes	marshes, streamside thickets, wet meadows and other wetlands
eastern phoebe	*Sayornis phoebe*	–	Sensitive	–	yes	woodland and edge habitats near water
Bird Communities of Concern						
old growth bird community	n/a	n/a	n/a	Priority 1	n/a	–
ducks and geese	n/a	n/a	n/a	Priority 2	n/a	–
mixedwood forest bird community	n/a	n/a	n/a	Priority 2	n/a	–

(a) Source: Ehrlich et al. (1988); Godfrey (1986); Russell and Bauer (2001); Semenchuk (1992); Smith (1993).

n/a = Not applicable.

– = Indicates species that do not have official status (National or Provincial) and therefore are considered to be not at risk for the purposes of this report.

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APPENDIX T

INCIDENTAL WILDLIFE SIGHTINGS

Submitted to:
Shell Canada Limited

Prepared by:
Golder Associates Ltd.

December 2007 **05-1344-027**

LIST OF TABLES

Table T-1 Incidental Wildlife Sightings 1

Table T-1 Incidental Wildlife Sightings

Species	Observations				Alberta Status[b]	Federal Status[c]	CEMA Priority[d]	Habitat
	Visual	Audio	Other[a]	Total				
Birds								
blackbird – red–winged	0	3	0	3	Secure	Not At Risk	–	FONS, MONG, SONS
chickadee – black–capped	1	4	0	5	Secure	Not At Risk	–	d3, FONS, h1, c1
chickadee – boreal	0	11	0	11	Secure	Not At Risk	–	a1, b1, d2, e2, h1, g1
crane – sandhill	4	25	0	29	Sensitive	–	–	burn (old), FTNN, FONG, FONS, a1, STNN, FOPN, MONG, d2
creeper – brown	0	1	0	1	Sensitive	Not At Risk	–	d2
crossbill – red	0	7	0	7	Secure	Not At Risk	–	a1, BTNN
crossbill – white–winged	0	12	0	12	Sensitive	Not At Risk	–	a1, d1, FONG, g1
crow – American	0	1	0	1	Secure	Not At Risk	–	FTNN
eagle – bald	1	0	0	1	Sensitive	Not At Risk	3	b3
flicker – northern	0	5	0	5	Secure	–	–	e1, d1, d2
flycatcher – alder	0	1	0	1	Secure	–	–	a1
flycatcher – alder	0	17	0	17	Secure	Not At Risk	–	FONS, BONS, f3, a1, c1, d2, g1, FONG, FONS, SONS, burn
flycatcher – least	0	8	0	8	Sensitive	Not At Risk	–	c1, d1, shrub, SONS
goldeneye – common	0	2	0	2	Secure	Not At Risk	–	–
goose – Canada	0	4	0	4	Secure	Not At Risk	–	FONS
goshawk – northern	2	1	0	3	Sensitive	–	–	FTNN, BTNN, b2
grosbeak – rose–breasted	0	1	0	1	Secure	Not At Risk	–	SONS
grouse – ruffed	2	1	0	3	Secure	–	2	e3, d2
grouse – spruce	4	2	0	6	Secure	Not At Risk	–	g1
grouse – (species unknown)	0	2	2	4	Secure	Not At Risk	–	c1, f2, e2, BTNN, f3
grouse – (species unknown)	0	1	1	2	–	–	–	c1
gull – Bonaparte's	1	1	0	2	–	–	–	MONG
harrier – northern	2	2	0	4	Sensitive	Not At Risk	–	FTNN, FONS, FFNN, MONS
hawk – (species unknown)	1	0	0	1	–	–	–	g1
heron – great blue	0	23	0	1	Sensitive	–	–	c1, d2 – colony

Table T-1 Incidental Wildlife Sightings (continued)

Species	Observations				Alberta Status[b]	Federal Status[c]	CEMA Priority[d]	Habitat
	Visual	Audio	Other[a]	Total				
jay – gray	9	20	0	29	Secure	–	–	d2, a1, b1, c1, d2, a1, b1, c1, d2, b1, b2, BTNN, d1, d2, d3, f3, FONG, FTNN, SONS
junco – dark–eyed	1	33	0	34	Secure	Not At Risk	–	a1, b3, BTNN, d2, f2, FONG, FONS, FTNN, g1, h1
killdeer	0	1	0	1	–	–	–	FOPN
kinglet – ruby crowned	0	10	0	10	Secure	–	–	d2, BTNN, d2, FONS, FTNN, h1, SONS, d2, BTNN
loon – common	0	3	0	3	–	–	3	g1, FTNN
magpie – black–billed	0	1	0	1	Secure	Not At Risk	–	h1
mallard	0	2	0	2	Secure	Not At Risk	2	–
nighthawk – common	2	6	0	8	Sensitive	Threatened	–	a1, b1, disturbed – clearcut
nuthatch – red–breasted	0	5	0	5	Secure	Not At Risk	–	b3, d2, e2, FONG
nuthatch – spp	0	1	0	1	–	–	–	d2
ovenbird	0	51	0	51	–	–	–	a1, b1, b2, b3, d1, d2, d3, e3, FONS, STNN
owl – barred	0	3	0	3	Sensitive	–	–	BTNN, d2
owl – boreal	0	1	0	1	Secure	Not At Risk	2	disturbed – clearcut
owl – great gray	1	11	0	12	Sensitive	Not At Risk	–	BTNN, c1, d2, disturbed – cutline, FONS, STNN, FONG
owl – great horned	0	1	0	1	Secure	Not At Risk	–	disturbed – clearcut
owl – northern hawk	5	0	0	5	Sensitive	Not At Risk	3	burn, FTNN, FONG, FTNI, burn
owl – spp	1	1	0	2	–	–	–	FONS, d2
phoebe – eastern	0	2	0	2	Sensitive	Not At Risk	–	FTNN
ptarmigan – willow	0	3	0	3	Secure	Not At Risk	–	BTNN
rail – yellow	0	3	0	3	Undetermined	Special Concern	–	FTNN, h1
rail – sora	0	1	0	1	–	–	–	WONN
raven – common	0	1	0	1	Secure	Not At Risk	–	d1
redstart – American	0	5	0	5	Secure	Not At Risk	–	b1, b2, d1, FONG

Table T-1 Incidental Wildlife Sightings (continued)

Species	Observations				Alberta Status[b]	Federal Status[c]	CEMA Priority[d]	Habitat
	Visual	Audio	Other[a]	Total				
robin – American	0	10	0	10	Secure	Not At Risk	–	e1, BTNN, d1, d2, FONS, FTNN
sandpiper – Baird's	0	1	0	1	Secure	Not At Risk	–	–
sandpiper – solitary	0	1	0	1	Secure	Not At Risk	–	SONS
sandpiper – spotted	0	1	0	1	Secure	Not At Risk	–	SONS
sandpiper – upland	1	N	0	1	–	–	–	MONG
sapsucker – yellow–bellied	0	5	0	5	Secure	Not At Risk	–	d1, d2, e3, STNN
sapsucker – spp.	0	1	1	2	Secure	Not At Risk	–	d1, d2
shrike – northern	0	1	0	1	Secure	Not At Risk	–	d1
siskin – pine	0	3	0	3	Secure	Not At Risk	–	d3
snipe – common	0	88	0	88	Secure	–	–	BTNN, d2, e1 d2, e1 BTNN, FONG, FONS, FTNN, SONS, FTNN, FOPN FONS, BTNN, d2, e1
sparrow – American tree	0	21	0	21	Secure	Not At Risk	–	–
sparrow – chipping	0	35	0	35	Secure	Not At Risk	–	a1, b1, b2, b3, BTNN, c1, d1, d2, d3, FONG, FONS, FTNN, shrub, SONS
sparrow – clay coloured	0	1	0	1	Secure	Not At Risk	–	FONG
sparrow – Lincoln's	0	3	0	3	Secure	Not At Risk	–	FTNN, g1, SONS
sparrow – swamp	0	7	0	7	Secure	Not At Risk	–	FONS, FTNN, shrub, SONS
sparrow – white–throated	0	57	0	57	Secure	Not At Risk	–	b1, b2, b3, b4, BTNN, burn, c1, d1, d2, d3, e2, f2, f3, FONG, FONS, FTNN, h1, Shrub, SONS, STNN
swallow – tree	0	1	0	1	Secure	Not At Risk	–	b1
sparrow – chipping	0	1	0	1	Secure	–	–	g1
sparrow – white throated	0	1	0	1	Secure	–	–	b1
sparrow – clay–colored	0	unk	0	unk	–	–	–	FONS
sparrow – Le Conte's	0	2	0	2	–	–	–	FONS, FONG
tern – black	1	N	0	1	–	–	–	MONG
tanager – western	0	16	0	16	Sensitive	Not At Risk	–	a1, b3, BTNN, d1, d2, d3, e3, shrub, SONS

Table T-1 Incidental Wildlife Sightings (continued)

Species	Observations				Alberta Status[b]	Federal Status[c]	CEMA Priority[d]	Habitat
	Visual	Audio	Other[a]	Total				
thrush – hermit	0	30	0	30	Secure	Not At Risk	–	e1, a1, b1, b2, b3, b4, BTNN, d1, d2, e2, f3, FONG, FONS, FTNN, h1, SONS
thrush – Swainson's	0	54	0	54	Secure	Not At Risk	–	b1, b3, BTNN, d1, d2, d3, e2, f2, f3, FONG, FONS, FTNN, h1, SONS, STNN
vireo – blue–headed	0	1	0	1	Secure	Not At Risk	–	STNN
vireo – Philadelphia	0	3	0	3	Secure	Not At Risk	–	a1, FONS, STNN
vireo – red–eyed	0	15	0	15	Secure	Not At Risk	–	a1, b1, b2, b3, d1, f3, FONG, FONS, SONS, STNN
vireo – warbling	0	1	0	1	Secure	Not At Risk	–	d2
warbler – bay–breasted	0	1	0	1	Sensitive	Not At Risk	–	–
warbler – black–throated green	0	1	0	1	Sensitive	Not At Risk	–	d2
warbler – black and white	0	1	0	1	Secure	–	–	a1
warbler – Canada	0	1	0	1	Sensitive	Not At Risk	–	d2
warbler – Cape May	0	2	0	2	Sensitive	Not At Risk	–	d2
warbler – Connecticut	0	3	0	3	Sensitive	Not At Risk	–	d1, FONS
warbler – magnolia	0	5	0	5	Secure	Not At Risk	–	b2, b3, e2, FONS, FTNN
warbler – mourning	0	1	0	1	Secure	Not At Risk	–	d2
warbler – orange–crowned	0	1	0	1	Secure	Not At Risk	–	SONS
warbler – palm	0	10	0	10	Secure	Not At Risk	–	BTNN, FONG, FONS, FTNN, STNN
warbler – Tennessee	0	50	0	50	Secure	Not At Risk	–	b1, b2, b3, BTNN, c1, d1, d2, d3, e2, FONS, FTNN, g1, h1, SONS, STNN
warbler – Wilson's	0	6	0	6	Secure	Not At Risk	–	BTNN, d2, SONS, STNN
warbler – yellow	0	2	0	2	Secure	Not At Risk	–	b3, FONS
warbler – yellow–rumped	0	11	0	11	Secure	Not At Risk	–	a1, b1, BTNN, burn, c1, e2, FONS
waterthrush – northern	0	4	0	4	Secure	Not At Risk	–	FONG, SONS
waxwing – cedar	0	2	0	2	Secure	Not At Risk	–	a1
woodpecker – downy	2	1	0	3	Secure	–	–	e3, b2

Table T-1 Incidental Wildlife Sightings (continued)

Species	Observations				Alberta Status[b]	Federal Status[c]	CEMA Priority[d]	Habitat
	Visual	Audio	Other[a]	Total				
woodpecker – hairy	0	1	0	1	Secure	Not At Risk	–	d1
woodpecker – black–backed	1	2	0	3	Sensitive	Not At Risk	–	burn (old), FTNN, h1
woodpecker – pileated	1	0	0	1	–	–	–	FONS
woodpecker – (species unknown)	2	3	1	6	–	–	–	d2
wood–pewee – western	0	3	0	3	Secure	Not At Risk	–	a1, c1, d1
wren – winter	0	4	0	4	Secure	Not At Risk	–	d2, d3, FTNN, shrub
yellowlegs – greater	0	3	0	3	Secure	Not At Risk	–	FOPN, FTNN, SONS
yellowlegs – lesser	0	1	0	1	Secure	Not At Risk	–	BTNN
yellowlegs – spp.	0	4	0	4	–	–	–	FTPN a1, e1
yellowthroat – common	0	13	0	13	Sensitive	Not At Risk	–	d2, FONG, FONS, FTNN, SONS, STNN
Mammals								
badger – American	0	0	1	1	Sensitive	Not At Risk	–	–
bat – (species unknown)	1	0	3	1	–	–	–	b2, d3
bear – black	5	0	23	28	Secure	Not At Risk	1	b1, FONS, b1, d2, e3, a1, b1, d2, e3, g1, b1, d2, e3, a1, b1, d2, e3, g1
beaver	0	0	15	15	Secure	Not At Risk	1	SONS, MONG, FONS
bison – wood	0	0	2	2	At Risk	Threatened	–	a1, c1
chipmunk – least	1	N	0	1	–	–	–	f2
coyote	0	0	10	10	Secure	Not At Risk	–	b3m BTNN, c1, WONN
deer – (species unknown)	1	0	13	13	–	–	–	d3, disturbed – clearcut, a1, e1, e3, a1, b3, d1, d2, e1, e3
deer – white tailed	1	0	0	1	Secure	–	–	d3
deer – white tailed	1	0	0	1	Secure	–	–	d2
deer – white–tailed	0	0	1	1	Secure	Not At Risk	–	d3
fisher	0	0	6	6	Sensitive	–	1	a1, c1, d2, e1, g1
fisher/marten	0	0	20	20	–	–	–	a1, b1, d1, d2, e2, e3, SONS

Table T-1 Incidental Wildlife Sightings (continued)

Species	Observations				Alberta Status[b]	Federal Status[c]	CEMA Priority[d]	Habitat
	Visual	Audio	Other[a]	Total				
fox – red	0	N	3	3	Secure	–	–	b1, d2
hare – snowshoe	3	0	20	23	Secure	–	1	disturbed – cutline, c1, d1, d2, g1, b1, c1, d1, d2, g1
lynx – Canada	0	0	3	3	Sensitive	Not At Risk	1	g1, a1
marten – American pine	2	0	17	17	Secure	–	–	b1, c1, d2, e2, a1, b1, c1, d2, e2, f2
moose	0	0	10	10	Secure	Not At Risk	1	d2, e2, FTNN, g1
moose	15	0	41	56	Secure	–	1	d1, b1, d2, b1, BTNN, d1, d2, disturbed – cutline, e1, e2, e3 FTNN, g1, WONN, a1, b1, d1, d2, e1, e2, e3, g1, h1, WONN
mouse – deer	0	0	3	8	Secure	Not At Risk	–	b3, FTNN, SONS, e3, a1, e3
squirrel – red	1	1	5	7	Secure	Not At Risk	–	d2, g1, f3, STNN, c1, d1
vole – meadow	1	0	1	2	–	–	–	BFNN, FTPN
vole – red–backed	2	0	0	2	Secure	–	–	d2, c1
weasel – (species unknown)	0	0	11	11	–	–	–	b1, c1, d2, e2, f3
wolf – grey	0	6	50	56	Secure	Not At Risk	3	a1, b1, b3, d2, e1, f1, f2, g1, b1, d2, e1, g1, b2, d1, d2, disturbed – clearcut, b1, d2, e1, g1, a1, disturbed – cutline, FONS, g1
AMPHIBIANS								
frog – boreal chorus	0	36	0	36	Secure	Not At Risk	–	d2, FONS, BTNN
frog – wood	13	18	0	31	Secure	Not At Risk	3	a1, d2, e1, a1, e1, FONS, BTNN, FOPN, FONG
toad – Canadian	0	3	0	3	May Be At Risk	Not At Risk	1	f2

[a] "Other" refers to sign that includes (but is not restricted to); tracks, scat, markings, lodges, dams, feeding activity, bedding and nests, kill sites.

[b] AENV 2005.

[c] COSEWIC 2007.

[d] Westworth 2002.

– = Indicates species that do not have official status (National or Provincial) and therefore are considered to be not at risk for the purposes of this report.

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APPENDIX U

WINTER TRACK COUNT RESULTS FOR THE JACKPINE EXPANSION MINING AREA LOCAL STUDY AREA, THE PIERRE RIVER MINING AREA LOCAL STUDY AREA AND THE REGIONAL STUDY AREA

Submitted to:
Shell Canada Limited

Prepared by:
Golder Associates Ltd.

December 2007 **05-1344-027**

50 BEST EMPLOYERS IN CANADA 2007

CANADA'S 50 BEST MANAGED PRIVATE COMPANIES

OFFICES ACROSS NORTH AMERICA, SOUTH AMERICA, EUROPE, ASIA AND AUSTRALIA

LIST OF TABLES

Table U-1 Number of Tracks per km-day Observed for Each Wildlife Species by Ecosite Phase/Wetlands Type in the Jackpine Expansion Mining Area Local Study Area....1
Table U-2 Number of Tracks per km-day Observed for Each Wildlife Species by Ecosite Phase/Wetlands Type in the Pierre River Mining Area Local Study Area 3
Table U-3 Number of Tracks per km-day Observed for Each Wildlife Species by Ecosite Phase/Wetlands Type in the Regional Study Area....4

Table U-1 Number of Tracks per km-day Observed for Each Wildlife Species by Ecosite Phase/Wetlands Type in the Jackpine Expansion Mining Area Local Study Area

Ecosite Phase	Track Days [km]	Total Tracks	Caribou	Coyote	Deer	Fisher/Marten	Grouse	Lynx	Mice	Moose	Red Fox	Red Squirrel	Otter	Hare	Weasel	Wolf	Wolverine	Unknown
a1	9.77	143	0.00	0.51	1.02	2.46	1.84	0.72	1.33	0.51	0.00	3.89	0.00	0.72	0.72	0.51	0.41	0.00
b1	24.42	483	0.00	0.20	1.11	2.33	0.61	0.29	1.92	1.11	0.00	2.33	0.00	8.35	0.20	1.06	0.25	0.00
b2	2.38	51	0.00	4.20	2.10	0.42	0.00	0.00	0.00	0.00	0.00	5.04	0.00	7.56	0.00	2.10	0.00	0.00
b3	17.97	215	0.00	0.11	0.06	2.89	1.95	0.06	0.89	1.34	0.00	3.56	0.00	0.72	0.00	0.11	0.28	0.00
b4	9.48	925	0.00	0.21	0.42	0.21	0.21	0.32	0.00	0.21	0.00	5.70	0.00	89.99	0.00	0.11	0.21	0.00
BFNN	0.64	46	0.00	0.00	0.00	1.56	0.00	0.00	4.68	0.00	0.00	3.12	0.00	62.45	0.00	0.00	0.00	0.00
BONN	0.04	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
BONS	1.50	10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.67	0.00	0.00
BTNN	48.08	1019	0.00	0.21	0.02	2.08	0.69	0.42	0.62	0.62	0.06	1.16	0.00	14.31	0.00	1.00	0.00	0.00
c1	10.16	473	0.00	0.89	0.89	1.28	0.98	0.20	1.48	0.10	0.00	4.72	0.10	34.65	0.00	1.08	0.20	0.00
d1	10.91	195	0.00	0.18	0.64	1.65	0.82	0.46	2.29	1.83	0.00	0.82	0.00	7.97	0.00	1.10	0.09	0.00
d2	94.78	2049	0.00	0.40	0.39	1.88	2.02	0.21	0.73	0.33	0.02	2.54	0.01	12.11	0.03	0.81	0.09	0.04
d3	9.14	215	0.00	0.66	0.33	3.06	2.08	0.00	0.44	0.11	0.00	6.89	0.00	8.20	0.11	0.77	0.87	0.00
disturbance-clearcut	2.40	26	0.00	0.42	0.83	0.42	0.00	0.42	0.00	0.83	0.00	0.00	0.00	7.93	0.00	0.00	0.00	0.00
disturbance-cutline	3.01	61	0.00	0.00	0.00	3.33	2.00	0.00	0.33	1.00	0.00	0.33	0.00	8.98	0.00	4.32	0.00	0.00
disturbance-Gram	6.65	18	0.00	0.45	0.90	0.15	0.75	0.00	0.00	0.15	0.00	0.15	0.00	0.00	0.15	0.00	0.00	0.00
disturbance-no veg	0.15	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
disturbance-road	2.51	2	0.00	0.00	0.00	0.00	0.00	0.00	0.80	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
disturbance-ROW	9.22	69	0.00	0.43	1.84	2.71	0.11	0.00	0.33	0.33	0.00	0.54	0.00	0.33	0.00	0.87	0.00	0.00
disturbance-shrub	35.48	307	0.00	0.06	0.06	2.34	0.00	0.00	0.70	0.59	0.00	0.20	0.00	0.37	4.34	0.00	0.00	0.00
e1	4.34	88	0.00	0.00	0.00	7.14	0.46	0.00	1.38	0.00	0.00	8.06	0.00	2.07	0.00	1.15	0.00	0.00
e2	11.44	157	0.00	0.17	0.00	3.06	0.26	0.00	0.79	0.52	0.00	4.63	0.00	3.59	0.00	0.61	0.09	0.00
e3	3.90	97	0.00	0.00	3.59	4.88	1.80	0.00	0.00	0.00	0.00	2.05	0.00	11.81	0.00	0.00	0.77	0.00
f1	0.63	2	0.00	0.00	0.00	0.00	0.00	1.60	0.00	0.00	0.00	0.00	0.00	1.60	0.00	0.00	0.00	0.00
f2	0.61	5	0.00	3.31	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.96	0.00	0.00	0.00	0.00	0.00	0.00
f3	0.76	34	0.00	0.00	0.00	7.93	1.32	0.00	0.00	0.00	0.00	11.89	0.00	22.46	0.00	1.32	0.00	0.00
FONG	6.60	128	0.15	1.67	8.33	1.52	0.00	0.00	1.06	0.45	0.00	0.61	0.00	1.21	0.00	0.45	3.94	0.00
FONS	42.76	1060	0.00	0.16	0.02	1.22	0.19	0.02	0.58	0.47	0.00	0.00	0.00	20.63	0.00	1.50	0.00	0.00
FOPN	3.13	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FTNN	140.77	5022	0.00	0.20	0.08	3.05	0.09	0.11	0.86	0.26	0.02	1.26	0.02	28.09	0.01	1.61	0.02	0.00
g1	15.63	656	0.00	0.45	0.38	1.41	1.54	0.13	0.51	0.96	0.00	3.33	0.00	31.60	0.00	1.66	0.00	0.00
h1	8.24	412	0.00	0.24	0.00	1.82	0.49	0.00	0.61	0.97	0.00	2.06	0.00	42.58	0.00	1.21	0.00	0.00
ICE	0.32	1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.12	0.00	0.00
MONG	15.27	279	0.00	0.00	0.00	1.40	0.00	0.45	1.97	0.51	0.00	0.51	0.00	11.57	1.34	0.00	0.00	0.00
Riparian	2.44	68	0.00	2.87	0.41	1.64	0.00	0.00	4.11	3.70	0.00	0.41	1.23	11.91	1.23	0.00	0.41	0.00
Shrub	0.30	20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	67.00	0.00	0.00	0.00	0.00
SONS	64.04	831	0.00	0.09	0.02	3.75	1.16	0.09	0.56	1.81	0.02	0.59	0.06	3.14	0.00	1.69	0.00	0.00
STNN	13.29	1045	0.00	0.00	0.00	1.50	0.00	0.23	0.68	0.53	0.00	0.08	0.00	74.54	0.00	1.05	0.00	0.00
WONN	1.30	9	0.00	0.00	0.00	0.77	0.77	0.00	0.77	0.77	0.00	3.07	0.00	0.00	0.00	0.77	0.00	0.00

Table U-1 Number of Tracks per km-day Observed for Each Wildlife Species by Ecosite Phase/Wetlands Type in the Jackpine Expansion Mining Area Local Study Area (continued)

Ecosite Phase	Track Days [km]	Total Tracks	Caribou	Coyote	Deer	Fisher/Marten	Grouse	Lynx	Mice	Moose	Red Fox	Red Squirrel	Otter	Hare	Weasel	Wolf	Wolverine	Unknown
Tracks			1	171	220	1500	481	102.	521	400	9	1068	12	10785	18.00	862	78.	5.00
Total Track days [km]	634.46																	
Tracks/km day			0.00	0.27	0.35	2.36	0.76	0.16	0.82	0.63	0.01	1.68	0.02	17.00	0.03	1.36	0.12	0.01

Table U-2 Number of Tracks per km-day Observed for Each Wildlife Species by Ecosite Phase/Wetlands Type in the Pierre River Mining Area Local Study Area

Ecosite Phase	km-Track Days	Total Tracks	Coyote	Deer	Fisher/Marten	Grouse	Lynx	Mice	Moose	Red Fox	Red Squirrel	Otter	Hare	Weasel	Wolf
a1	7.23	43	0.00	0.14	5.40	0.00	0.00	0.00	0.00	0.00	0.14	0.00	0.00	0.28	0.00
b1	21.95	188	0.05	0.00	3.42	0.73	0.00	0.23	1.50	0.00	1.50	0.00	0.68	0.36	0.09
b2	1.90	8	0.00	0.00	2.63	0.53	0.00	0.53	0.00	0.00	0.00	0.00	0.53	0.00	0.00
b3	6.33	49	0.00	0.00	2.37	0.32	0.00	0.00	0.16	0.00	0.16	0.00	3.47	1.26	0.00
b4	7.73	94	0.00	0.00	5.44	0.78	0.00	0.26	0.91	0.00	1.29	0.00	2.59	0.91	0.00
BTNN	22.50	142	0.04	0.00	3.42	0.49	0.00	0.09	0.13	0.04	0.09	0.04	1.51	0.44	0.00
c1	1.25	25	0.00	0.00	6.38	0.80	0.00	0.00	0.00	0.00	0.00	0.00	11.16	1.59	0.00
d1	4.14	42	0.00	0.00	4.34	1.45	0.00	0.00	1.93	0.00	0.48	0.00	0.97	0.97	0.00
d2	41.75	466	0.02	0.26	3.66	1.48	0.05	0.31	1.15	0.05	0.38	0.00	1.82	1.65	0.31
d3	1.93	28	0.00	1.55	3.63	0.52	0.00	1.04	4.14	0.00	0.52	0.00	0.52	0.00	2.59
disturbance-burn	5.98	19	0.00	0.00	1.00	0.17	0.00	0.17	0.50	0.00	0.00	0.00	0.00	1.34	0.00
disturbance-clearcut	11.38	43	0.00	0.00	2.46	0.00	0.00	0.62	0.44	0.00	0.00	0.00	0.26	0.00	0.00
disturbance-cutline	9.61	2625	0.00	0.00	0.21	0.52	0.00	0.10	271.40	0.00	0.00	0.00	0.00	0.42	0.52
disturbance-road	4.85	21	1.65	0.00	0.00	0.00	0.00	0.00	0.41	0.00	0.00	0.00	1.44	0.82	0.00
disturbance-ROW	0.41	3	0.00	0.00	7.41	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
e1	0.36	2	2.77	0.00	0.00	0.00	0.00	2.77	0.00	0.00	0.00	0.00	0.00	0.00	0.00
e2	0.24	2	4.12	0.00	0.00	0.00	0.00	4.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00
e3	3.17	45	0.00	0.00	8.21	0.00	0.00	0.00	1.58	0.00	3.79	0.00	0.00	0.63	0.00
f3	0.22	8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	13.70	22.83	0.00
FFNN	0.21	1	0.00	0.00	4.76	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FONF	0.34	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FONG	22.30	29	0.00	0.00	0.27	0.00	0.00	0.00	0.49	0.04	0.00	0.00	0.00	0.49	0.00
FONS	15.75	82	0.00	0.32	0.95	0.32	0.00	0.32	1.40	0.13	0.00	0.00	0.25	1.52	0.00
FTNI	0.15	1	0.00	0.00	0.00	0.00	0.00	0.00	6.85	0.00	0.00	0.00	0.00	0.00	0.00
FTNN	134.41	12438	0.09	0.04	2.13	0.18	0.01	0.09	4.67	0.06	0.04	0.00	84.19	1.03	0.01
g1	2.21	17	0.00	0.00	2.27	0.00	0.00	0.00	0.00	0.00	0.91	0.00	4.08	0.45	0.00
h1	12.88	65	0.16	0.00	1.16	0.08	0.00	0.00	0.23	0.00	0.31	0.00	1.79	1.32	0.00
ICE	1.64	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MONG	3.70	25	0.54	0.00	1.62	0.00	0.00	0.00	3.79	0.00	0.00	0.00	0.00	0.81	0.00
Shrub	0.63	8	0.00	3.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	9.60	0.00
SONS	62.47	503	0.00	0.00	2.80	1.74	0.02	0.22	0.93	0.05	0.00	0.02	0.29	1.98	0.00
STNN	7.35	65	0.14	0.00	3.94	0.00	0.00	1.09	0.68	0.00	0.00	0.00	1.09	1.90	0.00
WONN	4.76	24	0.00	0.00	1.68	0.00	0.00	0.00	0.21	0.00	0.00	0.21	0.00	2.94	0.00
Tracks			30	28	1052	251	4	75	3474	17	89	3	11578	486	26
Total Track days [km]	421.73														
Tracks/km day			0.07	0.07	2.49	0.60	0.01	0.18	8.24	0.04	0.21	0.01	27.45	1.15	0.06

Table U-3 Number of Tracks per km-day Observed for Each Wildlife Species by Ecosite Phase/Wetlands Type in the Regional Study Area

Ecosite Phase	Track Days [km]	Total Tracks	Caribou	Coyote	Deer	Ermine	Fisher/ Martin	Grouse	Least Weasel	Lynx	Martin	Mice	Mink	Moose	Mule Deer	Porcupine	Red Fox	Red Squirrel	Otter	Hare	Weasel Species	Wolf	Wolverine	Unknown
a1	16.99	187	0.00	0.29	0.65	0.18	1.41	1.06	0.06	0.41	2.35	0.76	0.00	0.29	0.00	0.06	0.00	2.29	0.00	0.41	0.12	0.24	0.00	0.41
b1	46.38	671	0.00	0.13	0.56	0.15	1.25	0.67	0.02	0.15	1.62	1.12	0.00	1.29	0.02	0.00	0.00	1.94	0.00	4.72	0.54	0.17	0.00	0.11
b2	4.28	59	0.00	2.34	1.17	0.00	1.40	0.23	0.00	0.00	0.00	0.23	0.00	0.00	0.00	0.00	0.00	2.80	0.00	4.44	1.17	0.00	0.00	0.00
b3	24.31	264	0.00	0.08	0.04	0.00	1.19	1.52	0.00	0.04	1.60	0.66	0.00	1.03	0.00	0.00	0.00	2.67	0.00	1.44	0.37	0.21	0.00	0.00
b4	17.21	1019	0.00	0.12	0.23	0.12	2.27	0.46	0.00	0.17	0.29	0.12	0.00	0.52	0.00	0.00	0.00	3.72	0.00	50.74	0.35	0.12	0.00	0.00
BFNN	0.64	46	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.56	4.68	0.00	0.00	0.00	0.00	0.00	3.12	0.00	62.45	0.00	0.00	0.00	0.00
BONN	0.04	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
BONS	1.50	10	0.00	0.00	0.00	6.67	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
BTNN	70.57	1162	0.00	0.16	0.00	0.28	1.77	0.62	0.00	0.28	0.85	0.45	0.00	0.47	0.01	0.01	0.06	0.82	0.01	10.23	0.43	0.00	0.00	0.00
c1	11.41	498	0.00	0.79	0.18	0.44	1.14	0.96	0.00	0.18	0.88	1.31	0.18	0.09	0.61	0.00	0.00	4.21	0.09	32.07	0.35	0.18	0.00	0.00
d1	15.05	238	0.00	0.13	0.47	0.73	1.20	1.00	0.00	0.33	1.20	1.66	0.07	1.86	0.00	0.07	0.00	0.73	0.00	6.05	0.27	0.07	0.00	0.00
d2	136.53	2516	0.00	0.29	0.29	0.23	1.75	1.85	0.01	0.16	0.75	0.60	0.01	0.58	0.06	0.01	0.03	1.88	0.01	8.96	0.75	0.16	0.03	0.02
d3	11.07	243	0.00	0.54	0.45	0.18	1.63	1.81	0.00	0.00	1.54	0.54	0.00	0.81	0.09	0.00	0.00	5.78	0.00	6.86	0.45	1.17	0.00	0.09
d4	0.02	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
disturbed-burn	5.98	19	0.00	0.00	0.00	0.00	1.00	0.17	0.00	0.00	0.00	0.17	0.00	0.50	0.00	0.00	0.00	0.00	0.00	0.00	1.34	0.00	0.00	0.00
disturbed-clearcut	13.77	69	0.00	0.07	0.15	0.00	2.11	0.00	0.00	0.07	0.00	0.51	0.00	0.51	0.00	0.00	0.00	0.00	0.00	1.60	0.00	0.00	0.00	0.00
disturbed-cutline	12.62	2686	0.00	0.00	0.00	0.00	0.32	0.87	0.00	0.00	0.63	0.16	0.16	206.94	0.00	0.00	0.00	0.08	0.00	2.14	1.19	0.40	0.00	0.00
disturbed-Gram	6.65	18	0.00	0.45	0.90	0.00	0.15	0.75	0.00	0.00	0.00	0.00	0.00	0.15	0.00	0.00	0.00	0.15	0.00	0.00	0.15	0.00	0.00	0.00
disturbed-Non Veg	0.15	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
disturbed-road	7.10	23	0.00	1.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.28	0.00	0.28	0.00	0.00	0.00	0.00	0.00	0.99	0.56	0.00	0.00	0.00
disturbed-ROW	9.62	72	0.00	0.42	1.77	0.00	1.97	0.10	0.00	0.00	0.94	0.31	0.00	0.31	0.00	0.00	0.00	0.52	0.00	0.31	0.00	0.83	0.00	0.00
disturbed-shrub	35.48	307	0.00	0.06	0.06	2.59	2.31	0.00	0.00	0.00	0.03	0.70	0.03	0.59	0.00	0.00	0.00	0.20	0.00	0.37	1.72	0.00	0.00	0.00
e1	4.70	90	0.00	0.21	0.00	0.00	4.25	0.43	0.00	0.00	2.34	1.49	0.00	0.00	0.00	0.00	0.00	7.44	0.00	1.91	1.06	0.00	0.00	0.00
e2	11.68	159	0.00	0.26	0.00	0.09	1.80	0.26	0.00	0.00	1.20	0.86	0.34	0.51	0.00	0.00	0.00	4.54	0.00	3.51	0.17	0.09	0.00	0.00
e3	7.06	142	0.00	0.00	1.98	0.00	5.95	0.99	0.00	0.00	0.42	0.00	0.00	0.71	0.00	0.00	0.00	2.83	0.00	6.51	0.28	0.42	0.00	0.00
f1	0.63	2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.60	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.60	0.00	0.00	0.00	0.00
f2	0.61	5	0.00	3.31	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.96	0.00	0.00	0.00	0.00	0.00	0.00
f3	0.98	42	0.00	0.00	0.00	0.00	7.17	1.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	9.22	0.00	20.49	5.12	0.00	0.00	0.00
FFNN	0.21	1	0.00	0.00	0.00	0.00	4.76	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FONF	0.34	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FONS	58.51	1142	0.00	0.12	0.09	0.26	1.23	0.22	0.03	0.02	0.27	0.51	0.00	0.72	0.02	0.00	0.03	0.00	0.00	15.14	0.85	0.00	0.00	0.00
FOPN	3.13	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FTNI	0.15	1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.85	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FTNN	275.19	17462	0.00	0.15	0.06	0.26	2.35	0.13	0.01	0.06	0.78	0.48	0.00	2.41	0.00	0.01	0.04	0.66	0.01	55.49	0.53	0.01	0.00	0.01
g1	17.84	673	0.00	0.39	0.34	0.06	1.12	1.35	0.06	0.11	0.39	0.45	0.00	0.84	0.00	0.00	0.00	3.03	0.00	28.20	1.40	0.00	0.00	0.00
h1	21.12	477	0.00	0.19	0.00	0.00	1.33	0.24	0.00	0.00	0.38	0.24	0.00	0.52	0.00	0.00	0.00	0.99	0.00	17.71	0.99	0.00	0.00	0.00
ice	1.96	1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.51	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MONG	19.42	304	0.00	0.10	0.00	0.15	0.46	0.00	0.00	0.36	0.98	1.60	0.88	1.13	0.00	0.00	0.00	0.41	0.00	9.37	0.21	0.00	0.00	0.00
Riparian	2.44	68	0.00	2.87	0.41	1.23	1.23	0.00	0.00	0.00	0.41	4.11	0.00	3.70	0.00	0.00	0.00	0.41	1.23	11.91	0.00	0.00	0.41	0.00
Shrub	0.92	28	0.00	0.00	2.17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	21.66	6.50	0.00	0.00	0.00
SONS	126.51	1334	0.00	0.05	0.01	0.21	1.99	1.45	0.00	0.06	1.49	0.40	0.20	1.38	0.00	0.00	0.03	0.30	0.04	1.73	1.22	0.00	0.00	0.00
STNN	20.65	1110	0.00	0.05	0.00	0.00	2.76	0.00	0.00	0.15	0.10	0.82	0.05	0.58	0.00	0.00	0.00	0.05	0.00	48.38	0.82	0.00	0.00	0.00
WONN	6.07	33	0.00	0.00	0.00	0.16	1.48	0.16	0.00	0.00	0.16	0.16	0.66	0.33	0.00	0.00	0.00	0.66	0.16	0.00	1.48	0.00	0.00	0.00
Tracks			1	201	174	306	1928	732	8	106	871	596	59	3874	74	6	26	1157	15	22363	728	104	5	18
Total Track days [km]	1,027.49																							
Tracks/km day			0.00	0.20	0.17	0.30	1.88	0.71	0.01	0.10	0.85	0.58	0.06	3.77	0.07	0.01	0.03	1.13	0.01	21.76	0.71	0.10	0.00	0.02

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APPENDIX V

HISTORIC WILDLIFE SURVEY RESULTS IN THE OIL SANDS REGION

Submitted to:
Shell Canada Limited

Prepared by:
Golder Associates Ltd.

December 2007 **05-1344-027**

50 BEST EMPLOYERS IN CANADA 2007

CANADA'S 50 BEST MANAGED PRIVATE COMPANIES

OFFICES ACROSS NORTH AMERICA, SOUTH AMERICA, EUROPE, ASIA AND AUSTRALIA

LIST OF TABLES

Table V-1 Moose Aerial Survey Results Within the Oil Sands Region 1
Table V-2 Moose Productivity in the Oil Sands Region 4
Table V-3 Moose Track Count Survey Results Within the Oil Sands Region....5
Table V-4 Deer Aerial Survey Results Within the Oil Sands Region 7
Table V-5 Deer Track Count Survey Results Within the Oil Sands Region....9
Table V-6 Caribou Aerial Survey Results Within the Oil Sands Region 11
Table V-7 Caribou Track Count Survey Results Within the Oil Sands Region....13
Table V-8 Wolf Survey Results Within the Oil Sands Region 15
Table V-9 Coyote Survey Results Within the Oil Sands Region....17
Table V-10 Red Fox Survey Results Within the Oil Sands Region....19
Table V-11 Canada Lynx Survey Results Within the Oil Sands Region 21
Table V-12 Black Bear Survey Results Within the Oil Sands Region....23
Table V-13 Wolverine Survey Results Within the Oil Sands Region 24
Table V-14 Fisher and Marten Survey Results Within the Oil Sands Region....26
Table V-15 Weasel Survey Results Within the Oil Sands Region 30
Table V-16 Beaver Survey Results Within the Oil Sands Region....33
Table V-17 Muskrat Survey Results Within the Oil Sands Region....35
Table V-18 River Otter Track Survey Results Within the Oil Sands Region....36
Table V-19 Mink Track Survey Results Within the Oil Sands Region....38
Table V-20 Snowshoe Hare Survey Results Within the Oil Sands Region....40
Table V-21 Red Squirrel Survey Results Within the Oil Sands Region 42
Table V-22 Bat Survey Results Within the Boreal Mixedwood Forests of Alberta....44
Table V-23 Small Mammal Survey Results Within the Oil Sands Region 47
Table V-24 Owl Survey Results Within the Oil Sands Region 50
Table V-25 Raptor Survey Results Within the Oil Sands Region....54
Table V-26 Grouse Survey Results Within the Oil Sands Region....58
Table V-27 Breeding Bird Survey Results Within the Oil Sands Region 60
Table V-28 Amphibian Survey Results Within the Oil Sands Region 63

Table V-1 Moose Aerial Survey Results Within the Oil Sands Region

Year	Project	Results (individuals/km^2 unless otherwise noted)	Habitat	Reference
1969 to 1985	Alberta Environment	0.21 to 0.54	not reported	Gunderson and Rippin (1981) cited in BP Resources et al. (1985)
1973	Alberta Environment	0.50	not reported	Bibaud and Archer (1973)
1975 to 1976	Syncrude Lease 17	0.23	preferred tall shrub, deciduous and avoided mixedwood in early winter; preferred tall shrub and avoided coniferous in late winter	Penner (1976)
1977	AOSERP[(a)]	0.03 in Shell 0.23 in aspen 0.27 in river bottom	not reported	Cook and Jacobsen (1978)
1977 to 1978	AOSERP	0.26 in March 0.28 in December 0.19 in February	not reported	Hauge and Keith (1981) as reported in Conor Pacific (1998)
1978	Syncrude	0.10	not reported	Hauge and Keith (1981)
1978 to 1979	Esso	0.14 to 0.18	not reported	Esso (1979)
1978 to 1981	Alberta Environment	0.25 to 0.34	not reported	Gunderson and Rippin (1981) cited in BP Resources (1985)
1979 to 1980	Syncrude	0.13 in December 0.23 in February	December most in mixedwood, black spruce-Shell and shrub February most in deciduous and mixedwood	Westworth (1980)
1980	Canstar Project 80	0.10 in December	most in riparian shrub and black spruce-Shell	Skinner and Westworth (1981)
1981	Dome Petroleum Ltd	0.17	not reported	Roe (1984) cited in Suncor (1995)
1981 to 1982	Canstar Lease	0.33 in early winter 0.32 in late winter	most in mixedwood, aspen and willow wetlands in early winter most in willow wetlands, mixedwood, black spruce and aspen in late winter	Westworth and Brusnyk (1982)
1983	AOSTRA	0.18 in February	not reported	Green (1983) as reported in Conor Pacific (1998)
1985	Alberta Environment	0.52	not reported	Penner and Ealey, cited in Suncor (1995)
1986	OSLO[(b)]	0.11 in early winter 0.07 in late winter	not reported	Salter and Duncan (1986)
1991	Esso Resources Ltd.	0.14	not reported	Brusnyk et al. (1991) cited in Esso (1997)
1992 to 1993	Alberta Environment	0.10	not reported	AENV, Fish and Wildlife Division, cited in Esso (1997)
1995	Solv-Ex	0.01 in March	not reported	Bovar-Concord Environmental (1995)
1995	Syncrude Aurora North	0.10 in January	most in black spruce-tamarack	Westworth, Brusnyk and Associates (1996a)

Table V-1 Moose Aerial Survey Results Within the Oil Sands Region (continued)

Year	Project	Results (individuals/km^2 unless otherwise noted)	Habitat	Reference
1996	Suncor Mine, Lease 23 and Steepbank Mine	0.20 in February 0.32 in December	preferred closed deciduous, closed mixedwood and avoided closed jack pine, closed white spruce, mixed coniferous, black spruce, wetlands shrub complex and disturbed habitat in February; avoided closed jack pine, closed white spruce and mixed coniferous in December	Westworth, Brusnyk and Associates (1996b)
1996	Steepbank Study Area	0.24 in February 0.24 in December	preferred closed deciduous, closed mixedwood and avoided closed jack pine, closed white spruce, mixed coniferous, black spruce, wetlands shrub complex and disturbed habitat in February avoided closed jack pine, closed white spruce and mixed coniferous in December	Westworth, Brusnyk and Associates (1996b)
1998	Suncor Firebag Project	0.2 in February	most in FTNN	Suncor (2000)
1999	Mobil Lease 36	0.22 in February	most in FONS, FTNN and FT/STNN	Golder (1999a)
1999 to 2000	Petro-Canada MacKay River	0.37 in December 0.17 in February	found mostly in d1	AXYS (2000a)
2000	Canadian Natural PAW Project	0.07	not reported	Canadian Natural (2000)
2000	PanCanadian Christina Lake Thermal Project Study Area	0.04 in late winter	three in BTNN and two in FTNN	Golder (2000a)
2000	TrueNorth Fort Hills Oil Sands Project	0.22 in mid winter 0.25 in late winter	only in d1, b1 and disturbed in mid winter most in d1 and d2 in late winter	Golder (2000b)
2000	OPTI Long Lake Project	0.20 in January 0.28 in March	most observations in FTNN and BTNN	OPTI (2000)
2001	Rio Alto Kirby Project	0.08 in February	two moose observed in FTNN	Rio Alto (2002)
2001	Petro-Canada Meadow Creek Project	0.21 in February	most observations in FTNN, d2 and e1	Petro-Canada (2001)
2001	Shell Jackpine Mine – Phase 1	0.21	most observations in FTNN, h1, SONS and d2	Golder (2002a)
2001	Canadian Natural Horizon Project	0.15	most observations in d1, d2 and e1	Canadian Natural (2002)
2002	Petro-Canada Meadow Creek Aerial Ungulate Survey	0.10 in February	observed in BTNN, SONS, FTNN, d1, d2 and d3 ecosite phases/wetlands types.	Golder (2002b)
2003	Petro-Canada Meadow Creek Aerial Caribou Survey	0.13 in February	observed in d3, g1, BTNN, SONS, and WONN ecosite phase/wetlands types.	Golder (2003a)
2002	Suncor South Tailings Pond Project	0.1	observed in b3 and FTNN	Golder (2003b)
2002	Devon-Jackfish Project	0.16	most observations in closed aspen forest	Devon Canada (2004)
2003	EnCana-Christina Lake Thermal Project	0.09	observed in d2 and FONS	Golder (2004a)

Table V-1 Moose Aerial Survey Results Within the Oil Sands Region (continued)

Year	Project	Results (individuals/km^2 unless otherwise noted)	Habitat	Reference
2004	MEG Energy	0.07	observed within d1, d2, BTNN and FONS	MEG (2005)
2004	Suncor Voyageur	0.10 0.05	observed in b3 observed in FTNN	Golder (2005)
2004 to 2005	Primrose East Expansion	0.05	observed in d1, d2, BTNN, and FONS	Golder (2006)
2006	Devon – Jackfish 2 Project	0.16	observed in burn area, aspen forest, mixedwood forest, treed bog, treed fen, tall shrub, and open jack pine forest	Devon Canada (2006)
2006	Suncor Voyageur South	0.25	observed in d1, FTNN, cutblocks, BTNN, FONS	Suncor (2007)
2006	EnCana Christina Lake Expansion	0.06	observed in FTNN, FONS	unpublished data
2007	Canadian Natural Kirby	no observations	not reported	unpublished data
2007	Shell Jackpine Mine Expansion & Pierre River Mine	0.22	observed in BUu, BTNN, CC, d1, d2, FTNN, FONG	current project

(a) AOSERP = Alberta Oil Sands Environmental Research Program

(b) OSLO = Other Six Lease Owners

Table V-2 Moose Productivity in the Oil Sands Region

Year	Project	Cow:Calf Ratio	Reference
1975 to 1976	Syncrude Lease 17	10:5.6	Penner (1976)
1979 to 1980	Syncrude	10:6.2 in December 10:4.3 in February	Westworth (1980)
1980	Canstar Project 80	10:3 in December	Skinner and Westworth (1981)
1981 to 1982	Canstar Lease	10:3.0 in early winter 10:3.2 in late winter	Westworth and Brusnyk (1982)
1995	Syncrude Aurora North	10:7.1 in January	Westworth, Brusnyk and Associates (1996a)
1996	Suncor Mine, Lease 23 and Steepbank Mine	10:8.3 in February 10:6.4 in December	Westworth, Brusnyk and Associates (1996b)
1996	Steepbank Study Area	10:4.3 in February 10:3.5 in December	Westworth, Brusnyk and Associates (1996b)
1999	Mobil Lease 36	10:1.7	Golder (1999a)
1999 to 2000	Petro-Canada MacKay River	10:6.3 in December 10:7.8 in February	AXYS (2000a)
2000	TrueNorth Fort Hills Oil Sands Project	10:10	Golder (2000b)
2000	OPTI Long Lake Project	10:8	OPTI (2000)
2001	Petro-Canada Meadow Creek Project	10:5	Petro-Canada (2001)
2001	Shell Jackpine Mine – Phase 1	10:1.1	Golder (2002a)
2001	Canadian Natural Horizon Project	10:3.5	Canadian Natural (2002)
2002	Petro-Canada Meadow Creek Ungulate Aerial Survey	10:6.7	Golder (2002b)
2003	Petro-Canada Meadow Creek Caribou Aerial Survey	10:7.5	Golder (2003a)
2002	Suncor South Tailings Pond Project	10:5	Golder (2003b)
2002	Devon-Jackfish Project	10:6.4	Devon Canada (2004)
2003	EnCana-Christina Lake Thermal Project	10:2.5	Golder (2004a)
2004	MEG Energy	10:2.5	MEG (2005)
2004	Suncor Voyageur	not reported	Golder (2005)
2004 to 2005	Primrose East Expansion	10:5	Golder (2006)
2006	Devon – Jackfish 2 Project	10:4	Devon Canada (2006)
2006	Suncor Voyageur South	n/a	Suncor (2007)
2006	EnCana Christina Lake Expansion	1:1	Unpublished data
2007	Canadian Natural Kirby	not reported	Unpublished data
2007	Shell Jackpine Mine Expansion & Pierre River Mine	10:1	Present study

Table V-3 Moose Track Count Survey Results Within the Oil Sands Region

Year	Project	Results [tracks/km-track day]	Habitat Preference	Reference
1975 to 1976	Syncrude Lease 17	0.14	preferred tall shrub; avoided coniferous and disturbed areas	Penner (1976)
1980	Canstar Project 80	0.63	preferred riparian shrub; avoided jack pine and open Shell	Skinner and Westworth (1981)
1981 to 1982	Canstar Lease	0.33	preferred willow and riparian aspen; avoided jack pine, white spruce, black spruce and riparian white spruce	Westworth and Brusnyk (1982)
1995	Solv-Ex	no observations	n/a	Bovar-Concord Environmental (1995)
1995	Syncrude Aurora North	0.11	preferred cleared aspen; avoided mixedwood forest, willow wetlands riparian balsam poplar, riparian white spruce and riparian shrub	Westworth, Brusnyk and Associates (1996a)
1996	Suncor Mine, Lease 23 and Steepbank Mine	0.22 in February 0.65 in December	February: avoided jack pine, white spruce, mixed coniferous mixedwood, shorelines and fen December: avoided closed black spruce and open tamarack fen	Westworth, Brusnyk and Associates (1996b)
1997	Shell Muskeg River Mine	0.26	no preference most tracks observed in closed mixedwood-white spruce dominant	Golder (1997a,b)
1997	Suncor	0.29 in January 0.30 in February 0.19 in March	January: avoided upland February: preferred riparian, avoided escarpment March: no preference	Golder (1998a,b)
1997	Suncor	0.03 in January 0.0 in February	January: no preference February: no preference	Golder (1998a,b)
1997	Mobil Lease 36	0.32	most observations in black spruce –tamarack and tamarack black spruce bogs and fens	URSUS and Komex (1997)
1998	Suncor Firebag Project	0.41	preferred BTNN, BFNN, FONS and FTNN/FFNN avoided b4, c1, d3 and g1	Suncor (2000)
1998 to 1999	Suncor Wildlife Monitoring	0.0 in reclaimed 0.46 in riparian area beside disturbance	not reported	Golder (1999b)
2000	ATCO Pipeline	mean: 2.0	most common in cutblock, also common in FONS, d1 and d2	AXYS (2000b)
2000	TrueNorth Fort Hills Oil Sands Project	0.37	preferred e1; avoided d2, g1, BTNN and FTNN	Golder (2000b)
2000	Albian Sands Lease 13 West	0.56 in upland 0.60 in riparian	vegetation preferences not available due to lumping by landform	Golder (2000c)
2000	Suncor Wildlife Monitoring	0.0 in Lease 86/17 1.68 in Lease 25/97	only riparian corridors sampled	Golder (2000d)
2000	OPTI Long Lake Project	0.25	no preference most tracks observed in the d2 and FTNN ecosite phase/wetlands types	OPTI (2000)
2001	Gulf Surmont In-situ Oil Sands Project	no overall tracks/km-track day provided	highest track densities in e2; also observed in b2, c1, d1, d2, e3, f1, g1, BTNN, FTNN, FONS and FONG	Gulf (2001)

Table V-3 Moose Track Count Survey Results Within the Oil Sands Region (continued)

Year	Project	Results [tracks/km-track day]	Habitat Preference	Reference
1999 to 2001	Albian Sands Lease 13 West	mean densities: 0.56 in January 1999/2000 0.21 in January 2000/2001 0.16 in February 2000/2001	surveys conducted in riparian and upland habitat no evidence of use of riparian areas as movement corridors	Golder (2001a)
2001	Rio Alto Kirby Project	0.57 in February	No preference; most tracks observed in d2 and c1 ecosite/wetlands types, but also observed in b3 and cutlines	Rio Alto (2002)
2001	Petro-Canada Meadow Creek Project	0.52	tracks observed in c1, e1, BTNN, STNN; preference observed for BTNN, avoidance of FONS	Petro-Canada (2001)
2001	Shell Jackpine Mine – Phase 1	0.47	tracks observed in b4, FTNN, g1 and shrubland	Golder (2002a)
2001	Canadian Natural Horizon Project	0.16	tracks observed in d2, d3, cutblock and burn; preference observed for burn, avoidance of d3	Canadian Natural (2002)
2002	Suncor South Tailings Pond Project	0.72	tracks observed in FONS, FONG, and d2	Golder (2003b)
2002	Devon-Jackfish Project	0.26	highest track density in e1	Devon Canada (2004)
2003	EnCana-Christina Lake Thermal Project	no fresh tracks observed	old track observed in riparian creek area	Golder (2004a)
2004	MEG Energy	0.34	no preferences determined, tracks observed within MONS, d1, d2 and FTNN	MEG (2005)
2004	Suncor Monitoring Five Year Report	0.59	surveys conducted in natural sites	Golder (2004b)
2004	Suncor Voyageur	0.45 0.70	preference for deciduous forests observed in b3, d1, d2, d3, and BTNN	Golder (2005)
2004 to 2005	Primrose East Expansion	0.22	observed in d1, disturbed-cutline, FONS, FTNN, and STNN; most in d1	Canadian Natural (2006)
2005	Devon – Jackfish 2 Project	0.49	most trails observed in burn area and closed riparian shrubland	Devon Canada (2006)
2005 to 2006	Long Lake South Project	0.2	most observed in e3	OPTI/Nexen (2006)
2006	Suncor Voyageur South	0.66	preference for b3, e1, d1	Suncor (2007)
2006	EnCana Christina Lake Expansion	0.25	avoidance FTNN	Non-published data
2007	Shell Jackpine Mine Expansion & Pierre River Mine	4.27 0.34	preference for b3, d1, e1, and FONS communities used a1, b1, e3, g1 ecosite phases and BTNN and FTNN wetlands communities less than expected	Present study

n/a = Not applicable.

Table V-4 Deer Aerial Survey Results Within the Oil Sands Region

Year	Project	Species	Results (individuals/km^2 unless otherwise noted)	Habitat	Reference
1975 to 1976	Syncrude Lease 17	combined	one mule deer observed	Athabasca River	Penner (1976)
1978 to 1979	Esso	combined	0.14	not reported	Esso (1979) as reported in BP Resources et al. (1985)
1980	Canstar Project 80	combined	no observations	n/a	Skinner and Westworth (1981)
1978 to 1981	Alberta Environment	combined	0.28 in 1979 to 0.50 in 1981	not reported	Gunderson and Rippin (1985) as reported in BP Resources et al. (1985)
1981 to 1982	Canstar Lease	mule deer	no observations	n/a	Westworth and Brusnyk (1982)
1981 to 1982	Canstar Lease	white-tailed deer	0.01 in early winter no observations in late winter	in mixedwood, white spruce and aspen not available for late winter	Westworth and Brusnyk (1982)
1983 to 1985	Alberta Environment	combined	0.31 in 1984 to 0.44 in 1985.	not reported	Gunderson and Rippin (1985) as reported in BP Resources et al. (1985)
1984	Alberta Environment	combined	0.20	not reported	Gunderson (1984) as reported in Canadian Natural (2000)
1984	Alberta Environment	combined	0.44	not reported	Gunderson (1984) as reported in Canadian Natural (2000)
1993	Alberta Environment	combined	0.53	aspen, shrubland and shrubby fen	AENV (1993) as reported ESSO (1997)
1995	Solv-Ex	combined	no observations	n/a	Bovar-Concord Environmental (1995)
1995	Syncrude Aurora North	white-tailed deer	0.08	most in cleared peatland, riparian shrub and black spruce-tamarack	Westworth, Brusnyk & Associates (1996a)
1996	Suncor Mine, L23 and Steepbank Study Area	white-tailed deer	February: 2 individuals December: 5 individuals	both in deciduous forest 2 in mixedwood and 3 in deciduous forest	Westworth, Brusnyk & Associates (1996b)
1998	Suncor Firebag Project	combined	no observations	n/a	Suncor (2000)
1999	Mobil Lease 36	white-tailed deer mule deer	0.02 in February no observations	one d1 ecosite phase	Golder (1999a)
1999 to 2000	Petro-Canada MacKay River	white-tailed deer	0.15 in December 0.04 in February	most common in d1	AXYS (2000a)
2000	PanCanadian Christina Lake Thermal Project	white-tailed deer	0.02 in late winter	three in c1 ecosite phase	Golder (2000a)
2000	Canadian Natural PAW Project	combined	0.03	observed in b1 and d2 ecosite phase	Canadian Natural (2000)
2000	TrueNorth Fort Hills Oil Sands Project	mule deer	no observations	n/a	Golder (2000b)

Table V-4 Deer Aerial Survey Results Within the Oil Sands Region (continued)

Year	Project	Species	Results (individuals/km^2 unless otherwise noted)	Habitat	Reference
2000	TrueNorth Fort Hills Oil Sands Project	white-tailed deer	no observations in January 0.03 km^2 in March	only in b1 ecosite phase in March	Golder (2000b)
2000	OPTI Long Lake Project	combined	0.12 km^2 in January; and not observed in March	observations recorded in the d1, d2 and d3 ecosite phase/wetlands types	OPTI (2000)
2001	Rio Alto Kirby Project	n/a	no observations	n/a	Rio Alto (2002)
2001	Petro-Canada Meadow Creek Project	white-tailed deer	0.03	two individuals observed in the d2 ecosite phase/wetlands type	Petro-Canada (2001)
2001	Shell Jackpine Mine – Phase 1	combined	no observations	n/a	Golder (2002a)
2001	Canadian Natural Horizon Project	white-tailed deer mule deer	0.17 0.01	WTDE observed mostly in disturbed habitat, primarily cutblocks, also observed in d3, e1, and MONS mule deer observed in d1 and d2	Canadian Natural (2002)
2002	Petro-Canada Meadow Creek Ungulate Aerial Survey	white-tailed deer	0.06 in February	observations occurred within upland areas; majority in d2 and one observation in b3	Golder (2002b)
2003	Petro-Canada Meadow Creek Caribou Aerial Survey	white-tailed deer	0.04 in February	observations occurred within upland areas; d2 and d1 ecosites	Golder (2003a)
2002	Suncor South Tailings Pond Project	combined	no observations	n/a	Golder (2003b)
2002	Devon-Jackfish Project	white-tailed deer	0.12	most observations in upland habitats (mixed jack pine- aspen, aspen, mixed aspen- white spruce and jack pine)	Devon Canada (2004)
2003	EnCana-Christina Lake Thermal Project	white-tailed deer	0.17	observations in a1 and g1	Golder (2004a)
2004	MEG Energy	combined	no observations	n/a	MEG (2005)
2005 to 2006	Primrose East Expansion	combined	no observations	n/a	Golder (2007)
2006	Devon – Jackfish 2 Project	white-tailed deer	0.02	observed in upland habitats (aspen and mixed aspen-white spruce)	Devon Canada (2006)
2006	Suncor Voyageur South	deer	0.04	observed in d1, d2, FTNN	Suncor (2007)
2006	EnCana Christina Lake Expansion	combined	0.11	observed in FTNN	Unpublished data
2007	Canadian Natural Kirby	deer	no observations	n/a	Unpublished data
2007	Shell Jackpine Mine Expansion & Pierre River Mine	deer	no observations no observations	n/a	Present study

n/a = Not applicable.

Table V-5 Deer Track Count Survey Results Within the Oil Sands Region

Year	Project	Species	Results (tracks/km-track-day unless otherwise noted)	Habitat Preference	Reference
1975 to 1976	Syncrude Lease 17	combined	no observations	n/a	Penner (1976)
1980	Canstar Project 80	combined	one deer track observed	not reported	Skinner and Westworth (1981)
1981 to 1982	Canstar Lease	combined	one individual observed	only in mixedwood forest	Westworth and Brusnyk (1982)
1995	Solv-Ex	combined	no observations	n/a	Bovar-Concord Environmental (1995)
1995	Syncrude Aurora North	white-tailed deer	0.26	preferred aspen forest and cleared peatland; avoided jackpine, black spruce/ tamarack, fen wetlands, riparian balsam poplar, riparian white spruce and riparian shrub	Westworth, Brusnyk and Associates (1996a)
1996	Suncor Mine, Lease 23 and Steepbank Mine	white-tailed deer	0.09 in February 0.14 in December	preferred closed deciduous forest	Westworth, Brusnyk and Associates (1996b)
1997	Shell Muskeg River Mine	combined	no observations	n/a	Golder (1997a,b)
1997	Suncor Winter Wildlife	combined	no observations	n/a	Golder (1998a,b)
1997	Mobil Kearl Lake	combined	0.04	tracks observed in aspen, aspen-white spruce and jack-pine	URSUS and Komex (1997)
1998	Suncor Firebag Project	combined	no observations	n/a	Suncor (2000)
1998 to 1999	Suncor Wildlife Monitoring	combined	0.57 in reclaimed 0.0 in riparian area beside disturbance	not reported	Golder (1999b)
2000	ATCO Pipeline	combined	mean: 0.9	most common in d2 and e2	AXYS (2000b)
2000	TrueNorth Fort Hills Oil Sands Project	white-tailed deer	0.33	most in a1, b1, d2, e1 and e2	Golder (2000b)
2000	Albian Sands Lease 13 West	combined	0.08 in upland 0.02 in riparian	only in aspen dominated only in aspen dominated	Golder (2000c)
2000	Suncor Wildlife Monitoring	combined	0.37 in Lease 86/17 0.57 in Lease 25/97	only riparian corridors sampled	Golder (2000d)
2000	OPTI Long Lake Project	combined	0.75	preferred d2; avoided d1, FTNN	OPTI (2000)
2001	Gulf Surmont In-situ Oil Sands Project	combined	No overall tracks/km-track day provided	highest track densities in a1 and e2; also found in b1, b2,b3, d1, d2, d3, e1, e3, f1, h1, FONS and FTNN	Gulf (2001)
1999 to 2001	Albian Sands Lease 13 West	combined	mean densities: 0.08 in January 1999/2000 1.45 in January 2000/2001 0.39 in February 2000/2001	surveys conducted in riparian and upland habitat no evidence of use of riparian areas as movement corridors	Golder (2001a)
2001	Rio Alto Kirby Project	combined	0.2	one track observed in SONS	Rio Alto (2002)
2001	Petro-Canada Meadow Creek Project	combined	1.45	preferred b1 and d2; avoided g1, BTNN and FONS	Petro-Canada (2001)
2001	Canadian Natural Horizon Project	combined	0.07	tracks observed in d1, d2, d3 and BTNN	Canadian Natural (2002)

Table V-5 Deer Track Count Survey Results Within the Oil Sands Region (continued)

Year	Project	Species	Results (tracks/km-track-day unless otherwise noted)	Habitat Preference	Reference
2001	Shell Jackpine Mine – Phase 1	combined	no observations	n/a	Golder (2002a)
2002	Suncor South Tailings Pond Project	combined	no observations	n/a	Golder (2003b)
2002	Devon-Jackfish Project	combined	0.74	highest track density in f1	Devon Canada (2004)
2003	EnCana-Christina Lake Thermal Project	combined	4.66	preferred disturbed areas	Golder (2004a)
2004	MEG Energy	combined	0.41	no preferences; tracks observed within d1, d2, d3, e2, c1, a1, FTNN	MEG (2005)
2004	Suncor Monitoring Five Year Report	combined	0.34	surveys conducted in natural sites	Golder (2004b)
2004	Suncor Voyageur	combined	0.19 0.14	preference for white spruce forests and disturbed areas observed in b3 and BTNN	Golder (2005)
2004 to 2005	Primrose East Expansion	combined	0.83	occurred in a1, b3, BTNN, d1, d2, d3, FTNN, g1, and WONN; preferred WONN, avoided BTNN, c1, and g1	Canadian Natural (2006)
2005	Devon – Jackfish 2 Project	combined	1.29	most observed in i1, d3, and d1	Devon Canada (2006)
2005 to 2006	Long Lake South Project	combined	0.5	most observed in e2	OPTI/Nexen (2006)
2006	Suncor Voyageur South	combined	1.51	preference for d2, e3, g1, h1	Non-published data
2006	EnCana Christina Lake Expansion	combined	1.35	preference for b1, b3 avoidance of b4, BTNN, d2, clearcut, FONS, FTNN, g1, h1, ROW	Non-published data
2007	Shell Jackpine Mine Expansion & Pierre River Mine	combined	0.14 0.31	preference for d2, e3, g1 and cutline FTNN are used significantly less than expected	Present study

n/a = Not applicable.

Table V-6 Caribou Aerial Survey Results Within the Oil Sands Region

Year	Project	Results (individuals/km^2 unless otherwise noted)	Habitat	Reference
1975 to 1976	Syncrude Lease 17	no observations	n/a	Penner (1976)
1976 to 1978	AOSERP	4.17/100 km^2 in winter	black spruce occupied most heavily year round, while aspen or aspen conifer mixes were used very little	Fuller and Keith (1981)
1980	Canstar Project 80	no observations	n/a	Skinner and Westworth (1981)
1981 to 1982	Canstar Lease	no observations	n/a	Westworth and Brusnyk (1982)
1995	Solv-Ex	no observations	n/a	BOVAR-CONCORD (1995)
1995	Syncrude Aurora North	no observations	n/a	Westworth, Brusnyk and Associates (1996a)
1996	Suncor Mine, L23 and Steepbank Study Area	no observations	n/a	Westworth, Brusnyk and Associates (1996b)
1998	Firebag Project	no observations	n/a	Suncor (2000)
1999	Mobil Lease 36	no observations	n/a	Golder (1999a)
2000	PanCanadian Christina Lake Thermal Project	no observations	n/a	Golder (2000a)
2000	True North Fort Hills Oil Sands Project	no observations	n/a	Golder (2000b)
2000	Canadian Natural PAW Project	6 observations	observed in c1/g1	Canadian Natural (2000)
2000	Canadian Natural PAW Project	telemetry survey data	primarily observed in FTNN or FTNR, BTNN, BTNI, BTNR, BTXC, c1 or g1, and a1	Canadian Natural (2000)
2000	OPTI Long Lake Project	0.00/km^2 in January; 0.01/km^2 in March; and 11 incidental observations of caribou sign	deciduous, fen and pond[(a)]	OPTI (2000)
2001	Petro-Canada Meadow Creek Project	0.35 in February	wooded fen	Petro-Canada (2001)
2001	Rio Alto Kirby Project	no observations aerially; 26 incidental observations	c1 and g1, e1, BTNN, FONS, FTNN, MONS, and WONN	Rio Alto (2002)
2001	Shell Jackpine Mine – Phase 1	no observations	n/a	Golder (2002a)
2001	Canadian Natural Horizon Project	no observations	n/a	Canadian Natural (2002)
2002	Devon-Jackfish Project	no direct observations	forage sight and tracks observed in treed fen and shrubby bog	Devon Canada (2004)
2002	Petro-Canada Meadow Creek Project	0.03 in February	treed bog	Golder (2002b)
2003	Petro-Canada Meadow Creek Project	0.15 in February	BTNN, FONG, c1, FTNN, MONG, MONS and disturbance (wellpads, cutlines)	Golder (2003a)
2003	EnCana-Christina Lake Thermal Project	no observations	n/a	Golder (2004a)

Table V-6 Caribou Aerial Survey Results Within the Oil Sands Region (continued)

Year	Project	Results (individuals/km^2 unless otherwise noted)	Habitat	Reference
2004	MEG Energy	no observations	n/a	MEG (2005)
2004 to 2005	Primrose East Expansion	0.04	FTNN	Canadian Natural (2006)
2006	Devon – Jackfish 2 Project	0.05	shrubby/treed bog and treed fen	Devon Canada (2006)
2006	EnCana Christina Lake Expansion	no observations	n/a	Non-published data
2007	Canadian Natural Kirby	no observations	n/a	Non-published data
2007	Shell Jackpine Mine Expansion & Pierre River Mine	no observations no observations	n/a	Present study

n/a = Not applicable.

Table V-7 Caribou Track Count Survey Results Within the Oil Sands Region

Year	Project	Results (Tracks/km-track day unless otherwise noted)	Habitat Preference	Reference
1975 to 1976	Syncrude Lease 17	no observations	n/a	Penner (1976)
1981	Canstar Project 80	no observations	n/a	Skinner and Westworth (1981)
1982	Canstar Lease	0.01	only in mature mixedwood forest	Westworth and Brusnyk (1982)
1995	Solv-Ex	no observations	n/a	BOVAR-CONCORD (1995)
1995	Syncrude Aurora North	no observations	n/a	Westworth, Brusnyk and Associates (1996a)
1996	Suncor Mine, L23 and Steepbank Study Area	no observations	n/a	Westworth, Brusnyk and Associates (1996b)
1997	Shell Muskeg River mine	no observations	n/a	Golder (1997a,b)
1997	Suncor Wildlife Monitoring	no observations	n/a	Golder (1998b)
1998	Firebag Project	no observations	n/a	Suncor (2000)
1998 to 1999	Suncor Wildlife Monitoring	no observations	n/a	Golder (1999b)
2000	True North Fort Hills Oil Sands Project	no observations	n/a	Golder (2000b)
2000	Albian Sands Lease 13 West	no observations	n/a	Golder (2000c)
2000	Suncor Wildlife Monitoring	no observations	only riparian corridors sampled	Golder (2000d)
2000	OPTI Long Lake Project	11 incidental observations of caribou sign	deciduous, fen and pond	OPTI (2000)
2001	Gulf Surmont In-situ Oil Sands Project	incidental observations in g1, c1, BTNN and FONS	n/a	AXYS (2001)
2001	Petro-Canada Meadow Creek Project	2.1	tracks observed in d1, BTNN, FONS; a preference was observed for the d1 and avoidance of d2 and BTNN	Petro-Canada (2001)
2001	Rio Alto Kirby Project	no observations	n/a	Rio Alto (2002)
2001	Shell Jackpine Mine – Phase 1	no observations	n/a	Golder (2002a)
2001	Canadian Natural Horizon Project	no observations	n/a	Canadian Natural (2002)
2002	Devon-Jackfish Project	no observations	n/a	Devon Canada (2004)
2003	EnCana-Christina Lake Thermal Project	no observations	n/a	Golder (2004a)
2004	MEG Energy	0.51 (35 individual tracks)	preference for FTNN, avoidance of BTNN, also occurred within a1, c1, cutline, FONS, g1	MEG (2005)

Table V-7 Caribou Track Count Survey Results Within the Oil Sands Region (continued)

Year	Project	Results (Tracks/km-track day unless otherwise noted)	Habitat Preference	Reference
2004 to 2005	Primrose East Expansion	0.27	tracks observed in disturbed-cutline, c1, FONS, FTNN, and WONN; preferred FTNN, avoided d1, d2, g1, and BTNN	Canadian Natural (2006)
2005	Devon – Jackfish 2 Project	no observations	n/a	Devon Canada (2006)
2005 to 2006	Long Lake South Project	0.1	most observed in j2 and k1	OPTI/Nexen (2006)
2006	EnCana Christina Lake Expansion	no observations	n/a	Non-published data
2007	Shell Jackpine Mine Expansion & Pierre River Mine	one track observed no observations	observed in FONG n/a	Present study

n/a = not applicable

Table V-8 Wolf Survey Results Within the Oil Sands Region

Year	Project	Results (tracks/km-track day unless otherwise noted)	Habitat Preference	Reference
1970 to 1975	Traplines	0.14 animals/ 100 km^2 trapped	not reported	Boyd (1977)
1975 to 1976	Syncrude Lease 17	0.07	no preference	Penner (1976)
1975 to 1978	AOSERP	winter densities 1/92 km^2 to 1/198 km^2	not reported	Fuller and Keith (1980a)
1980	Canstar Project 80	0.01	only in jack pine and black spruce-Shell	Skinner and Westworth (1981)
1981 to 1982	Canstar Lease	0.04	preferred willow wetlands and riparian aspen; avoided balsam poplar, jack pine, white spruce and riparian white spruce	Westworth and Brusnyk (1982)
1995	Solv-Ex	no observations	n/a	Bovar-Concord Environmental (1995)
1995	Syncrude Aurora North	0.05	preferred black spruce/tamarack; avoided aspen forest and mixedwood forest	Westworth, Brusnyk and Associates (1996a)
1996	Suncor Mine, Lease 23 and Steepbank Mine	0.14 in December 0.09 in February	avoided closed mixedwood	Westworth, Brusnyk and Associates (1996b)
1997	Shell Muskeg River Mine	no observations	n/a	Golder (1997a,b)
1997	Suncor Winter Wildlife	0.31 in January 0.0 in February 0.0 in March	January: preferred upland, avoided escarpment	Golder (1998a,b)
1997	Suncor Winter Wildlife	no observations	n/a	Golder (1998a,b)
1997	Mobil Lease 36	0.38	most in lake shore emergent habitat and along main roads	URSUS and Komex (1997)
1998	Suncor Firebag Project	no observations	n/a	Suncor (2000)
1998 to 1999	Suncor Wildlife Monitoring	0.09 in reclaimed 0.08 in riparian area beside disturbance	not reported	Golder (1999b)
2000	ATCO Pipeline	mean: 0.5	most common in FONG, h1 and d1	AXYS (2000b)
2000	TrueNorth Fort Hills Oil Sands Project	no observations	n/a	Golder (2000b)
2000	Albian Sands Lease 13 West	0.01 in upland 0.04 in riparian	not reported	Golder (2000c)
2000	Suncor Wildlife Monitoring	0.0 in Lease 86/17 0.11 in Lease 25/97	only riparian corridors sampled	Golder (2000d)
2000	OPTI Long Lake Project	0.01	tracks observed in the d2 and h1 ecosite phase/wetlands types	OPTI (2000)
2001	Gulf Surmont In-situ Oil Sands Project	no overall tracks/km-track day provided	observed at low densities in d1, e1, e2, f1, FONS, FTNN and FONG	Gulf (2001)
1999 to 2001	Albian Sands Lease 13 West	mean densities: 0.03 in January 1999/2000 0.04 in January 2000/2001 0 in February 2000/2001	surveys conducted in riparian and upland habitat no evidence of use of riparian areas as movement corridors	Golder (2001a)

Table V-8 Wolf Survey Results Within the Oil Sands Region (continued)

Year	Project	Results (tracks/km-track day unless otherwise noted)	Habitat Preference	Reference
2001	Rio Alto Kirby Project	0.13	tracks observed in b2, d2 and FONS ecosite / wetlands types	Rio Alto (2002)
2001	Petro-Canada Meadow Creek Project	0.07	two sets of tracks observed in d2	Petro-Canada (2001)
2001	Shell Jackpine Mine – Phase 1	0.03	three sets of tracks in d2	Golder (2002a)
2001	Canadian Natural Horizon Project	0.08	tracks observed in b1, d1, d2, d3, FONS and cutblock	Canadian Natural (2002)
2002	Suncor South Tailings Pond Project	0.03	tracks observed in e2 ecosite phase; no habitat prefences determined	Golder (2003b)
2002	Devon-Jackfish Project	0.03	tracks observed in a1, d1, i2 and k2	Devon Canada (2004)
2003	EnCana-Christina Lake Thermal Project	no observations	n/a	Golder (2004a)
2004	MEG Energy	0.03	Tracks observed in c1, g1	MEG (2005)
2004	Suncor Monitoring Five Year Report	0.15	surveys conducted in natural sites	Golder (2004b)
2004	Suncor Voyageur	0.25 0.01	preference for mixedwood forests tracks observed in disturbed-cutline	Golder (2005)
2004 to 2005	Primrose East Expansion	no observations	n/a	Canadian Natural (2006)
2005	Devon – Jackfish 2 Project	0.32	not reported	Devon Canada (2006)
2005 to 2006	Long Lake South Project	0.1	most observed in b1	OPTI/Nexen (2006)
2006	Suncor Voyageur South	0.17	preference for d1, d2	Suncor (2007)
2006	EnCana Christina Lake Expansion	0.10	avoidance of FTNN	Non-published data
2007	Shell Jackpine Mine Expansion & Pierre River Mine	0.07 0.21	preference for d1, d2 b3, BFNN, FTNN and g1 were used significantly less than expected	Present study

n/a = Not applicable.

Table V-9 Coyote Survey Results Within the Oil Sands Region

Year	Project	Results (Tracks/km–track day unless otherwise noted)	Habitat Preference	Reference
1970 to 1975	traplines	0.44 animals/100 km^2	not reported	Boyd (1977)
1975 to 1976	Syncrude Lease 17	0.29	preferred disturbed habitat; avoided aspen, aspen-willow/alder and black spruce-willow	Penner (1976)
1978	Syncrude Alsands	0.29	n/a	Alsands (1978)
1979	Esso Cold Lake Production Project	0.35 individuals/km^2	not reported	Esso (1979)
1980	Canstar Project 80	0.10	preferred black spruce-Shell; avoided aspen, open Shell and riparian shrub	Skinner and Westworth (1981)
1981 to 1982	Canstar Lease	0.13	preferred balsam poplar and jack pine; avoided aspen, white spruce willow and fen	Westworth and Brusnyk (1982)
1995	Solv-Ex	0.72	most tracks in jack pine and black spruce	Bovar-Concord Environmental (1995)
1995	Syncrude Aurora North	0.09	avoided cleared aspen and willow wetlands	Westworth, Brusnyk and Associates (1996a)
1996	Suncor Mine, Lease 23 and Steepbank Mine	0.45 in December 0.13 in February	preferred closed deciduous; avoided closed jack pine/white spruce, open black spruce and shoreline	Westworth, Brusnyk and Associates (1996b)
1997	Shell Muskeg River Mine	0.10	most found in closed balsam poplar, closed mixedwood-white spruce dominant and closed white spruce	Golder (1997a,b)
1997	Suncor Winter Wildlife	0.24 in January 0.0 in February 0.0 in March	January: preferred upland	Golder (1998a,b)
1997	Suncor Winter Wildlife	0.06 in January 0.03 in February	January: no preference February: no preference	Golder (1998a,b)
1997	Mobil Lease 36	0.06	no preference	URSUS and Komex (1997)
1998	Suncor Firebag Project	0.03	no preference	Suncor (2000)
1998 to 1999	Suncor Wildlife Monitoring	2.23 in reclaimed 1.75 in riparian area beside disturbance	not reported	Golder (1999b)
2000	ATCO Pipeline	mean: 0.6	most common in d3	AXYS (2000b)
2000	TrueNorth Fort Hills Oil Sands Project	0.02	only in d2, e1, e2 and shrub	Golder (2000b)
2000	Albian Sands Lease 13 West	0.03 in upland 0.11 in riparian	not reported	Golder (2000c)
2000	Suncor Wildlife Monitoring	0.68 in Lease 86/17 0.89 in Lease 25/97	only riparian corridors sampled	Golder (2000d)
2000	OPTI Long Lake Project	0.26	no preference; however most tracks were recorded in the FTNN, SONS, d2, d1 and STNN ecosite phase/wetlands types	OPTI (2000)

Table V-9 Coyote Survey Results Within the Oil Sands Region (continued)

Year	Project	Results (Tracks/km–track day unless otherwise noted)	Habitat Preference	Reference
2001	Gulf Surmont In-situ Oil Sands Project	No overall tracks/km-track day provided	found in most ecosite phase/wetlands types (b1,b2, b3, c1, d1, d2, d3, e2, e3, f1, f2, h1, BTNN, FTNN, FONS and FONG)	Gulf (2001)
1999 to 2001	Albian Sands Lease 13 West	mean densities: 0.08 in January 1999/2000 0.74 in January 2000/2001 0.17 in February 2000/2001	surveys conducted in riparian and upland habitat no evidence of use of riparian areas as movement corridors	Golder (2001a)
2001	Rio Alto Kirby Project	0.13	no preferences; however, most tracks observed in the d2 and g1 ecosite phase/wetlands types	Rio Alto (2002)
2001	Petro-Canada Meadow Creek Project	0.57	almost all tracks observed in d2 ecosite phase/wetlands type, but three sets observed in BTNN; preferred d2, avoided BTNN and FONS	Petro-Canada (2001)
2001	Shell Jackpine Mine – Phase 1	0.01	one set of tracks in FTNN	Golder (2002a)
2001	Canadian Natural Horizon Project	0.20	tracks observed in b1, d2, d3, e3, g1, h1, FTNN, FONS and BTNN; preference for d2, avoidance of d1 (no observations)	Canadian Natural (2002)
2002	Suncor South Tailings Pond Project	0.60	tracks observed in d2 and FTNN ecosite phase/ wetlands types; no habitat prefences determined	Golder (2003b)
2002	Devon- Jackfish Project	1.29	highest densities in k3 and reclaimed industrial sites	Devon Canada (2004)
2003	EnCana-Christina Lake Thermal Project	0.50	most tracks observed along rights-of-way and in BTNN	Golder (2004a)
2004	MEG Energy	0.45	Highest density in e2, also occurred in a1, b4, c1, d2, d3, e2, FTNN, g1	MEG (2005)
2004	Suncor Monitoring Five Year Report	1.62	surveys conducted in natural sites	Golder (2004b)
2004	Suncor Voyageur	1.04 0.49	preference for disturbed areas observed in a1, b1, b3, b4, d2, d3, g1, BTNN, disturbed-cutline	Golder (2005)
2004 to 2005	Primrose East Expansion	0.12	observed in FONS, WONN, and SONS	Canadian Natural (2006)
2005	Devon – Jackfish 2 Project	0.61	most observed in i1 and h1	Devon Canada (2006)
2005 to 2006	Long Lake South Project	0.2	most observed in f1	OPTI/Nexen (2006)
2006	Suncor Voyageur South	0.17	preference for e1, ROW	Suncor (2007)
2006	EnCana Christina Lake Expansion	0.43	preference of BTNN avoidance of FTNN	Non-published data
2007	Shell Jackpine Mine Expansion & Pierre River Mine	0.21 0.09	preference for d1 FTNN and h1 were used significantly less than expected	Present study

n/a = Not applicable.

Table V-10 Red Fox Survey Results Within the Oil Sands Region

Year	Project	Results (tracks/km-track day unless otherwise noted)	Habitat Preference	Reference
1970 to 1975	traplines	0.59 animals/ 100 km^2 trapped	not reported	Boyd (1977)
1975 to 1976	Syncrude Lease 17	0.02	most found in disturbed habitat and forested black spruce	Penner (1976)
1980	Canstar Project 80	0.08	avoided aspen and open Shell	Skinner and Westworth (1981)
1981 to 1982	Canstar Lease	0.02	avoided aspen, white spruce, fen and willow wetlands	Westworth and Brusnyk (1982)
1995	Solv-Ex	0.95	most tracks in aspen and aspen-white spruce	Bovar-Concord Environmental (1995)
1995	Syncrude Aurora North	0.01	found in mixedwood forest, fen wetlands, cleared peatland, riparian white spruce and riparian shrub	Westworth, Brusnyk and Associates (1996a)
1996	Suncor Mine, Lease 23 and Steepbank Mine	0.02	only in closed deciduous, disturbed and mixed coniferous	Westworth, Brusnyk and Associates (1996b)
1997	Shell Muskeg River Mine	no observations	n/a	Golder (1997a,b)
1997	Suncor Winter Wildlife	0.05 in January 0.02 in February 0.0 in March	January: no preference February: no preference	Golder (1998a,b)
1997	Suncor Winter Wildlife	no observations	n/a	Golder (1998a,b)
1997	Mobil Lease 36	0.01	tracks recorded in closed black spruce and dwarf birch-willow shrubland	URSUS and Komex (1997)
1998	Suncor Firebag Project	0.01	only in c1, FONS and FTNN/FFNN	Suncor (2000)
1998 to 1999	Suncor Wildlife Monitoring	0.03 in reclaimed 0.23 in riparian area beside disturbance	not reported	Golder (1999b)
2000	ATCO Pipeline	mean: 0.1	observed in e2 and d1	AXYS (2000b)
2000	TrueNorth Fort Hills Oil Sands Project	0.03	found in d2, d3 and shrub	Golder (2000b)
2000	Albian Sands Lease 13 West	0.31 in upland 0.10 in riparian	not reported	Golder (2000c)
2000	Suncor Wildlife Monitoring	0.0 in Lease 86/17 0.39 in Lease 25/97	only riparian corridors sampled	Golder (2000d)
2000	OPTI Long Lake Project	0.19	most tracks observed in the h1 and d2 ecosite phase	OPTI (2000)
2001	Gulf Surmont In-situ Oil Sands Project	no overall tracks/km-track day provided	one observation in b2 ecosite phase	Gulf (2001)

Table V-10 Red Fox Survey Results Within the Oil Sands Region (continued)

Year	Project	Results (tracks/km-track day unless otherwise noted)	Habitat Preference	Reference
1999 to 2001	Albian Sands Lease 13 West	mean densities: 0.15 in January 1999/2000 0 in January 2000/2001 0.01 in February 2000/2001	surveys conducted in riparian and upland habitat no evidence of use of riparian areas as movement corridors	Golder (2001a)
2001	Rio Alto Kirby Project	no observations	n/a	Rio Alto (2002)
2001	Petro-Canada Meadow Creek Project	0.36	observed in b1, b3, c1, d2, e2 and BTNN	Petro-Canada (2001)
2001	Shell Jackpine Mine – Phase 1	0.03	observed in BTNN	Golder (2002a)
2001	Canadian Natural Horizon Project	one set of tracks observed	tracks observed in SONS	Canadian Natural (2002)
2002	Suncor South Tailings Pond Project	no observations	n/a	Golder (2003b)
2002	Devon-Jackfish Project	0.10	not able to determine preference	Devon Canada (2004)
2003	EnCana-Christina Lake Thermal Project	only 1 incidental observation	not reported	Golder (2004a)
2004	MEG Energy	0.01	unable to determine preference, observed in FTNN	MEG (2005)
2004	Suncor Voyageur	0.02 no observations	preference for open habitats with brushy shelter n/a	Golder (2005)
2004 to 2005	Primrose East Expansion	no observations	n/a	Canadian Natural (2006)
2005	Devon – Jackfish 2 Project	no observations	n/a	Devon Canada (2006)
2005 to 2006	Long Lake South Project	0.02	most observed in b4 and d1	OPTI/Nexen (2006)
2006	Suncor Voyageur South	0.03	observed in d1, d2, ROW, no demonstrated preference	Suncor (2007)
2006	EnCana Christina Lake Expansion	0.08	observed in b3, BTNN, e3, FTNN, g1	Non-published data
2007	Shell Jackpine Mine Expansion & Pierre River Mine	0.02 0.02	observed in BTNN, clearcut, cutline, d1,d2, d3	Present study

n/a = Not applicable.

Table V-11 Canada Lynx Survey Results Within the Oil Sands Region

Year	Project	Results (tracks/km-track day unless otherwise noted)	Habitat Preference	Reference
1970 to 1975	traplines	3.37 animals/100 km^2 trapped	not reported	Boyd (1977)
1975 to 1976	Syncrude Lease 17	0.002	only in black spruce	Penner (1976)
1980	Canstar Project 80	0.06	preferred black spruce-Shell; avoided aspen, mixedwood, open Shell, riparian shrub and riparian white spruce	Skinner and Westworth (1981)
1981 to 1982	Canstar Lease	0.13	preferred aspen and riparian aspen; avoided jack pine, white spruce, black spruce, fen and willow wetlands	Westworth and Brusnyk (1982)
1985	BP Resources (Wolf Lake)	0.1 individuals/km^2	not reported	BP Resources et al. (1985)
1995	Solv-Ex	0.24	only in black spruce	Bovar-Concord Environmental (1995)
1995	Syncrude Aurora North	no observations	n/a	Westworth, Brusnyk and Associates (1996a)
1996	Suncor Mine, Lease 23 and Steepbank Mine	no observations in December 0.01 in February	only in closed deciduous, mixed coniferous, black spruce-tamarack and disturbed	Westworth, Brusnyk and Associates (1996b)
1997	Shell Muskeg River Mine	no observations	n/a	Golder (1997a,b)
1997	Suncor Winter Wildlife	0.0 in January 0.02 in February 0.05 in March	February: no preference March: no preference	Golder (1998a,b)
1997	Suncor Winter Wildlife	no observations	n/a	Golder (1998a,b)
1997	Mobil Lease 36	no observations	n/a	URSUS and Komex (1997)
1998	Suncor Firebag Project	no observations	n/a	Suncor (2000)
1998 to 1999	Suncor Wildlife Monitoring	no observations	n/a	Golder (1999b)
1999	AEC Foster Creek SAGD Project	no overall tracks/km-track day provided	tracks found in coniferous forest (jack pine/black spruce, treed bogs and shrubby fens	AXYS (1999)
2000	ATCO Pipeline	mean: 3.2	most common in FONG, and FONS	AXYS (2000b)
2000	TrueNorth Fort Hills Oil Sands Project	0.01	found in d2 and e2	Golder (2000b)
2000	Albian Sands Lease 13 West	0.13 in upland 0.14 in riparian	not reported	Golder (2000c)
2000	Suncor Wildlife Monitoring	0.0 in Lease 86/17 0.04 in Lease 25/97	only riparian corridors sampled	Golder (2000d)
2000	OPTI Long Lake Project	0.50	most tracks were recorded in the d2, d1, FTNN and h1 ecosite phase/wetlands types	OPTI (2000)
2001	Gulf Surmont In-situ Oil Sands Project	no overall tracks/km-track day provided	found in most ecosite phase/wetlands types (a1, b1, b2, b3, c1, d1, d2, d3, e2, e3, g1, h1, BTNN, FTNN, FONS and FONG)	Gulf (2001)

Table V-11 Canada Lynx Survey Results Within the Oil Sands Region (continued)

Year	Project	Results (tracks/km-track day unless otherwise noted)	Habitat Preference	Reference
1999 to 2001	Albian Sands Lease 13 West	mean densities: 0.14 in January 1999/2000 0.21 in January 2000/2001 0.28 in February 2000/2001	surveys conducted in riparian and upland habitat no evidence of use of riparian areas as movement corridors	Golder (2001a)
2001	Rio Alto Kirby Project	0.25	no preference observed, tracks found in b3, g1, FONS, FTNN, STNN	Rio Alto (2002)
2001	Petro-Canada Meadow Creek Project	0.34	found most commonly in the BTNN and g1, but also observed in BFNN, c1, STNN	Petro-Canada (2001)
2001	Shell Jackpine Mine – Phase 1	0.54	preferred d2; avoided FONS	Golder (2002a)
2001	Canadian Natural Horizon Project	0.84	tracks observed in b3, d1, d2, d3, e3, g1, BTNN, FTNN, FONS, STNN, SONS and WONN; preference for d1, avoidance of d2, FONG, SONS and burn	Canadian Natural (2002)
2002	Suncor South Tailings Pond Project	0.41	tracks observed in d2 ecosite phase; with habitat prefence for d2 and avoidance of FONS determined	Golder (2003b)
2002	Devon-Jackfish Project	0.56	highest track densities in k1 and j1	Devon Canada (2004)
2003	EnCana-Christina Lake Thermal Project	no observations	n/a	Golder (2004a)
2004	Suncor Monitoring Five Year Report	0.08	surveys conducted in natural sites	Golder (2004b)
2004	MEG Energy CLRP	0.13	no preferences, highest densities in disturbed-cutline, BTNN	MEG (2005)
2004	Suncor Voyageur	0.06 0.04	no preference determined observed in MONS, FTNN and disturbed/road	Golder (2005)
2004 to 2005	Primrose East Expansion	0.04	observed in FTNN and g1	Canadian Natural (2006)
2005	Devon – Jackfish 2 Project	0.05	observed in a1, b1, c1, and g1	Devon Canada (2006)
2005 to 2006	Long Lake South Project	0.2	most observed in f2 and f3	OPTI/Nexen (2006)
2006	Suncor Voyageur South	0.02	observed in b1, b3, b4, BTNN, FONS, FTNN, g1, road habitats, no preference demonstrated	Suncor (2007)
2006	EnCana Christina Lake Expansion	0.09	avoidance of FTNN	Non-published data
2007	Shell Jackpine Mine Expansion & Pierre River Mine	0.11 0.07	observed in b1, b3, BTNN, d2, d3, FONS, FTNN, g1 and roads.	Present study

n/a = Not applicable.

Table V-12 Black Bear Survey Results Within the Oil Sands Region

Year	Project	Results	Reference
1976	Alberta Environment	0.38 bears/km^2	Ruff et al. (1976)
1977	AOSERP	1 bear/2 to 4 km^2	Fuller and Keith (1977)
1978	AOSERP	1bear/4 to 5.6km^2	Young (1978)
1980	AOSERP	25-50/100 km^2 (telemetry)	Fuller and Keith (1980b)
1981 to 1982	Canstar Lease	highest use in balsam poplar, mixedwood and white spruce; jack pine and black spruce habitats were low, while fen and willow wetlands were avoided	Westworth and Brusnyk (1982)
1982	Cold Lake	18-25/100 km^2 (telemetry)	Young and Ruff (1982)
1998	Suncor Firebag Project	12 incidental observations of individuals or sign	Suncor (2000)
2000	Canadian Natural PAW Project	incidental observations in black spruce/jack pine, jack pine/aspen, treed fen, shrubby fen, aspen/white spruce, poor fen/bog, shrubby swamp, jack pine and cutblocks	Canadian Natural (2000)
2000	OPTI Long Lake Project	7 incidental observations of individuals or sign	OPTI (2000)
2001	Gulf Surmont In-situ Oil Sands Project	12 incidental observations of individuals or sign in b2, d1, d2, e2, f1, d1 and FONS	Gulf (2001)
2001	Petro-Canada Meadow Creek Project	9 incidental observations of individuals or sign in b1, d1, d3, e1	Petro-Canada (2001)
2001	Rio Alto Kirby Project	8 incidental observations in b3, e2, and BTNN	Rio Alto (2002)
2001	Shell Jackpine Mine – Phase 1	5 incidental observations in MONS, d2 and d3	Golder (2002a)
2001	Canadian Natural Horizon Project	14 incidental observations in b1, d1, d2	Canadian Natural (2002)
2002	Suncor South Tailings Pond Project	7 incidental observations in d2 ecosite phase and cutblocks	Golder (2003b)
2002	Devon-Jackfish Project	no observations	Devon Canada (2004)
2003	EnCana-Christina Lake Thermal Project	4 observations of bear or evidence of bear	Golder (2004a)
2004	MEG Energy	8 incidental observations or evidence of bear within d2 and along cutlines	MEG (2005)
2004	Suncor Voyageur	3 incidental sightings in d2 1 incidental sighting in FTNN	Golder (2005)
2004 to 2005	Primrose East Expansion	36 observations of sign in SONS, g1, c1, d2i incidental observations of individuals in d2, h1, and STNN	Canadian Natural (2006)
2005	Devon – Jackfish 2 Project	no observations of sign	Devon Canada (2006)
2006	Suncor Voyageur South	no incidental sightings, see Appendix VI for remote camera results	Suncor (2007)
2006	EnCana Christina Lake Expansion	2 incidental sightings in c1, g1, see Appendix VI for remote camera results	Non-published data
2007	Canadian Natural Kirby	1 incidental den, see Appendix VI-G for remote camera results	Non-published data
2007	Shell Jackpine Mine Expansion & Pierre River Mine	26 incidental observations, see Appendix VI for remote camera results	Present study

Table V-13 Wolverine Survey Results Within the Oil Sands Region

Year	Project	Results (tracks/km-track day unless otherwise noted)	Habitat Preference	Reference
1970 to 1975	traplines	0.01 animals/ 100 km^2 trapped	not reported	Boyd (1977)
1975 to 1976	Syncrude Lease 17	0.01	only in aspen and mixedwood	Penner (1976)
1979	Syncrude Lease 17	estimated 0.08 individuals/100km^2	not reported	Westworth & Associates (1979)
1980	Canstar Project 80	0.005	only in black spruce-Shell	Skinner and Westworth (1981)
1981 to 1982	Canstar Lease	no observations	n/a	Westworth and Brusnyk (1982)
1995	Solv-Ex	no observations	n/a	Bovar-Concord Environmental (1995)
1995	Syncrude Aurora North	no observations	n/a	Westworth, Brusnyk and Associates (1996a)
1996	Suncor Mine, Lease 23 and Steepbank Mine	no observations	n/a	Westworth, Brusnyk and Associates (1996b)
1997	Shell Muskeg River Mine	no observations	n/a	Golder (1997a,b)
1997	Suncor Winter Wildlife	no observations	n/a	Golder (1998a,b)
1997	Mobil Lease 36	0.01	in a black spruce burn and along seismic line through white spruce-aspen mixedwood	URSUS and Komex (1997)
1998	Suncor Firebag Project	no observations	n/a	Suncor (2000)
1998 to 1999	Suncor Wildlife Monitoring	no observations	n/a	Golder (1999b)
2000	ATCO Pipeline	no observations	n/a	AXYS (2000b)
2000	TrueNorth Fort Hills Oil Sands Project	no observations	n/a	Golder (2000b)
2000	Albian Sands Lease 13 West	no observations	n/a	Golder (2000c)
2000	Suncor Wildlife Monitoring	no observations	n/a	Golder (2000d)
2000	OPTI Long Lake Project	no observations	n/a	OPTI (2000)
1999 to 2001	Albian Sands Lease 13 West	no observations	n/a	Golder (2001a)
2001	Rio Alto Kirby Project	no observations	n/a	Rio Alto (2002)
2001	Petro-Canada Meadow Creek Project	no observations	n/a	Petro-Canada (2001)
2001	Shell Jackpine Mine – Phase 1	no observations	n/a	Golder (2002a)
2001	Canadian Natural Horizon Project	no observations	n/a	Canadian Natural (2002)
2002	Suncor South Tailings Pond Project	no observations	n/a	Golder (2003b)
2002	Devon- Jackfish Project	no observations	n/a	Devon Canada (2004)
2003	EnCana-Christina Lake Thermal Project	no observations	n/a	Golder (2004a)
2004	MEG Energy	no observations	n/a	MEG (2005)
2004	Suncor Monitoring Five Year Report	0.004	surveys conducted in natural sites	Golder (2004b)
2004	La Loche Road Link Project	1 track	Christina River	Golder (2004c)

Table V-13 Wolverine Survey Results Within the Oil Sands Region (continued)

Year	Project	Results (tracks/km-track day unless otherwise noted)	Habitat Preference	Reference
2004	Suncor Voyageur	1 set of tracks no observations	observed in e3 n/a	Golder (2005)
2004 to 2005	Primrose East Expansion	no observations	n/a	Canadian Natural (2006)
2005	Devon – Jackfish 2 Project	no observations	n/a	Devon Canada (2006)
2005 to 2006	Long Lake South Project	no observations	n/a	OPTI/Nexen (2006)
2006	Suncor Voyageur South	0.02 no observations	observed in BTNN, 1 individual n/a	Suncor (2007)
2006	EnCana Christina Lake Expansion	no observations	n/a	Non-published data
2007	Shell Jackpine Mine Expansion & Pierre River Mine	0.01 n/a (see Appendix VI for remote camera results – 10 wolverine photos)	not reported	Present study

n/a = Not applicable.

Table V-14 Fisher and Marten Survey Results Within the Oil Sands Region

Year	Project	Species	Results (tracks/km-track day unless otherwise noted)	Habitat Preference	Reference
1970 to 1975	traplines	fisher	0.43 animals/ 100 km^2 trapped	not reported	Boyd (1977)
1975 to 1976	Syncrude Lease 17	fisher	0.06	no preference	Penner (1976)
1986	OSLO	fisher	No overall track count/km-track day provided	tracks were found in bogs, shrublands and fens	Duncan et al. (1986)
1995	Solv-Ex	fisher	1.52	most tracks in jack pine, white spruce and aspen-white spruce	Bovar-Concord Environmental (1995)
1995	Syncrude Aurora North	fisher	0.02 in January	most in riparian balsam poplar	Westworth, Brusnyk and Associates (1996a)
1996	Suncor Mine, Lease 23 and Steepbank Mine	fisher	0.21 in December 0.04 in February	preferred black spruce tamarack; avoided upland coniferous/ mixedwood	Westworth, Brusnyk and Associates (1996b)
1997	Suncor Winter Wildlife	fisher	0.0 in January 0.29 in February	February: no preference	Golder (1998a,b)
1997	Suncor Winter Wildlife	fisher	0.02 in January 0.59 in February 0.15 in March	January: no preference February: prefer upland, avoid riparian and escarpment March: no preference	Golder (1998a,b)
1997	Mobil Lease 36	fisher	0.09	most in treed fens and bogs	URSUS and Komex (1997)
1998	Suncor Firebag Project	fisher	0.61	avoided b1, b2, d2 and d3	Suncor (2000)
1998 to 1999	Suncor Wildlife Monitoring	fisher	0.03 in reclaimed 1.64 in riparian area beside disturbance	not reported	Golder (1999b)
2000	ATCO Pipeline	fisher	mean: 0.6	most common in b1, also common in FTNN and FONS	AXYS (2000b)
2000	TrueNorth Fort Hills Oil Sands Project	fisher	0.14	found in b1, d1, d2, BTNN and FTNN	Golder (2000b)
2000	Albian Sands Lease 13 West	fisher	0.81 in upland 1.16 in riparian	no landform preference	Golder (2000c)
2000	Suncor Wildlife Monitoring	fisher	0.0 in Lease 86/17 0.46 in Lease 25/97	only riparian corridors sampled	Golder (2000d)
2000	OPTI Long Lake Project	fisher	0.45	d2, h1	OPTI (2000)
1999 to 2001	Albian Sands Lease 13 West	fisher	mean densities: 1.02 in January 1999/2000 0.47 in January 2000/2001 0.77 in February 2000/2001	surveys conducted in riparian and upland habitat no evidence of use of riparian areas as movement corridors	Golder (2001a)
2001	Petro-Canada Meadow Creek Project	fisher	0.74	most often in d2 and e2 ecosite phase/wetlands types but also found in b1, e1, BTNN, STNN	Petro-Canada (2001)

Table V-14 Fisher and Marten Survey Results Within the Oil Sands Region (continued)

Year	Project	Species	Results (tracks/km-track day unless otherwise noted)	Habitat Preference	Reference
2001	Gulf Surmont In-situ Oil Sands Project	fisher	no overall tracks/km-track day provided	highest densities in a1, also found in b2, c1, d1, d2, d3, e2, e3, g1, h1, FTNN and FONS	Gulf (2001)
2001	Rio Alto Kirby Project	fisher	0.06	no preference but tracks observed in b3, c1, g1	Rio Alto (2002)
2001	Shell Jackpine Mine – Phase 1	fisher	1.00	most often in FTNN, FONS, STNN, BTNN; incidentally observed on four occasions in h1, STNN, FTNN and FONG ecosite phase/wetlands types	Golder (2002a)
2001	Canadian Natural Horizon Project	fisher	0.19	tracks observed most often in d2, also observed in d3, g1 and cutblock	Canadian Natural (2002)
2006	Long Lake South Project	fisher	0.06	most observed in b4	OPTI/Nexen (2006)
1970 to 1975	traplines	marten	animals/100 km^2 trapped	n/a	Boyd (1977)
1995	SolS-Ex	marten	0.08	only in black spruce	Bovar-Concord Environmental (1995)
1995	Syncrude Aurora North	marten	0.15 in January	preferred mixed coniferous and riparian white spruce; avoided black spruce- tamarack, open tamarack-bog birch, fen wetlands, willow wetlands, riparian balsam poplar, riparian shrub and cleared peatland	Westworth, Brusnyk and Associates (1996a)
1996	Suncor Mine, Lease 23 and Steepbank Mine	marten	0.04 in December 0.10 in February	preferred upland coniferous	Westworth, Brusnyk and Associates (1996b)
1997	Suncor Winter Wildlife	marten	0.38 in January 1.16 in February	January: avoided d1, d2, d3, shrub and WONN February: avoided a1 and d1	Golder (1998a,b)
1997	Suncor Winter Wildlife	marten	0.36 in January 0.35 in February 0.44 in March	January: avoided upland February: no preference march: preferred escarpment and avoid riparian	Golder (1998a,b)
1997	Mobil Lease 36	marten	1.03	most in riparian willow shrubland, white spruce – aspen mixedwood and white spruce	URSUS and Komex (1997)
1998	Suncor Firebag Project	marten	1.33	preferred FTNN/FFNN and avoided FONS	Suncor (2000)
1998 to 1999	Suncor Wildlife Monitoring	marten	0.03 in reclaimed 1.49 in riparian area beside disturbance	not reported	Golder (1999b)
2000	TrueNorth Fort Hills Oil Sands Project	marten	0.42	preferred b1 and BTNN avoided d1, d3, e1, g1, shrub and sons	Golder (2000b)

Table V-14 Fisher and Marten Survey Results Within the Oil Sands Region (continued)

Year	Project	Species	Results (tracks/km-track day unless otherwise noted)	Habitat Preference	Reference
2000	Albian Sands Lease 13 West	marten	0.28 in upland 0.50 in riparian	no landform preference	Golder (2000c)
2000	ATCO Pipeline	marten	mean: 1.8	most common in BTNN and shrubby bog, also common in d3 and h1	AXYS (2000b)
2000	Suncor Wildlife Monitoring	marten	0.0 in Lease 86/17 0.54 in Lease 25/97	only riparian corridors sampled	Golder (2000d)
2000	OPTI Long Lake Project	marten	0.02	tracks observed in the d2 and FTNN ecosite phase/wetlands types	OPTI (2000)
1999 to 2001	Albian Sands Lease 13 West	marten	mean densities: 0.41 in January 1999/2000 0.52 in January 2000/2001 1.02 in February 2000/2001	surveys conducted in riparian and upland habitat no evidence of use of riparian areas as movement corridors	Golder (2001a)
2001	Gulf Surmont In-situ Oil Sands Project	marten	no overall tracks/km-track day provided	highest densities of tracks found in e2 and g1, also found in b1, d1, d2, e3, f1, h1, BTNN, FONS and FTNN	Gulf (2001)
2001	Petro-Canada Meadow Creek Project	marten	0.57	most often observed in b3 and d2 but also observed in c1, g1, e1 and BTNN	Petro–Canada (2001)
2001	Shell Jackpine Mine – Phase 1	marten	0.46	most observed in FTNN, b1, BTNN and FONS	Golder (2002a)
2001	Canadian Natural Horizon Project	marten	0.42	most observed in d2, also observed in d1, d3, e3, g1, BTNN, FTNN, FONS and STNN	Canadian Natural (2002)
1997	Shell Muskeg River Mine	combined	1.26	preferred closed balsam poplar, closed mixedwood, open and closed aspen	Golder (1997a,b)
2005 to 2006	Long Lake South Project	marten	0.2	most observed in l1	OPTI/Nexen (2006)
1981	Canstar Project 80	combined	0.05	no preference	Skinner and Westworth (1981)
1982	Canstar Lease	combined	0.12	preferred mixedwood; avoided white spruce, black spruce, willow, fen and willow wetlands	Westworth and Brusnyk (1982)
1999	AEC Foster Creek SAGD Project	combined	tracks observed	not reported	AXYS (1999)
2000	OPTI Long Lake Project	combined	0.47	d2, h1	OPTI (2000)
2001	Rio Alto Kirby Project	combined	0.17	tracks observed in b3, c1, d2, g1	Rio Alto (2002)
2001	Petro-Canada Meadow Creek Project	combined	1.40	most often observed in d2, b3, e2 and BTNN; preferred d2 and avoided FONS	Petro-Canada (2001)

Table V-14 Fisher and Marten Survey Results Within the Oil Sands Region (continued)

Year	Project	Species	Results (tracks/km-track day unless otherwise noted)	Habitat Preference	Reference
2001	Shell Jackpine Mine – Phase 1	combined	1.75	most often observed in FTNN, FONS, BTNN and STNN; preferred FTNN, avoided d2 and h1	Golder (2002a)
2001	Canadian Natural Horizon Project	combined	0.97	most often observed in d2 (high effort), e3 and d1 but no significant preference or avoidance of habitat types	Canadian Natural (2002)
2002	Suncor South Tailings Pond Project	combined	0.85	most often observed in FONS wetlands type, also observed in BTNN, d2, and FTNN; preference for FONS and avoidance of d2 determined	Golder (2003b)
2002	Devon-Jackfish Project	combined	0.29	highest track densities in g1	Devon Canada (2004)
2003	EnCana-Christina Lake Thermal Project	combined	no observations	n/a	Golder (2004a)
2004	MEG Energy	combined	0.09	No preferences could be determined but recorded within g1, BTNN, FTNN	MEG (2005)
2004	Suncor Monitoring Five Year Report	combined	1.45	surveys conducted in natural sites	Golder (2004b)
2004	Suncor Voyageur	combined	1.00 1.37	preference for deciduous and white spruce forests preference for b3	Golder (2005)
2004 to 2005	Primrose East Expansion	combined	0.11	most in g1	Canadian Natural (2006)
2005	Devon – Jackfish 2 Project	combined (>90% fisher)	0.08	observed in sc, g1, burn area, and b1	Devon Canada (2006)
2006	Suncor Voyageur South	combined	1.34	preference for d1	Suncor (2007)
2006	EnCana Christina Lake Expansion	combined	0.26	avoidance of FTNN	Non-published data
2007	Shell Jackpine Mine Expansion & Pierre River Mine	combined	1.73 2.33	preference for d1 FTNN is used significantly less than expected	Present study

n/a = Not applicable.

Table V-15 Weasel Survey Results Within the Oil Sands Region

Year	Project	Results (tracks/km-track day unless otherwise noted)	Habitat Preference	Reference
1970 to 1975	traplines	1.92 animals/ 100 km^2 trapped	not reported	Boyd (1977)
1975 to 1976	Syncrude Lease 17	1.47	preferred aspen-willow/alder, treed black spruce and tall shrub; avoided black spruce-willow and disturbed	Penner (1976)
1980	Canstar Project 80	1.14	preferred black spruce Shell; avoided jack pine and open Shell	Skinner and Westworth (1981)
1981 to 1982	Canstar Lease	0.27	preferred willow; avoided balsam poplar, jack pine, white spruce and riparian white spruce	Westworth and Brusnyk (1982)
1985	OSLO	no overall track count/km-track day provided	low densities in forested and unforested habitats, high use of logged areas.	Duncan et al. (1986)
1995	Solv-Ex	1.75	most tracks in black spruce and jack pine	Bovar-Concord Environmental (1995)
1995	Syncrude Aurora North	1.22	preferred black spruce- tamarack, open tamarack bog birch and cleared peatland; avoided aspen forest, mixedwood forest, mixed coniferous, fen wetlands, willow wetlands and riparian white spruce	Westworth, Brusnyk and Associates (1996a)
1996	Suncor Mine, Lease 23 and Steepbank Mine	5.16 in December 0.83 in February	preferred black spruce-tamarack, open black spruce, open tamarack/fen and fen; avoided closed jack pine, closed mixedwood, wetlands shrub complex, disturbed and shoreline	Westworth, Brusnyk and Associates (1996b)
1997	Shell Muskeg River Mine	1.12	preferred closed mixedwood-white spruce dominant and closed mixedwood; avoided closed balsam poplar, open and closed aspen, closed mixed coniferous	Golder (1997a,b)
1997	Suncor Winter Wildlife	0.80 in January 0.78 in February	January: avoided Shrub, BTNN and WONN February: preferred BTNN; avoided a1, d1, d2, d3 and h1	Golder (1998a,b)
1997	Suncor Winter Wildlife	0.71 in January 0.48 in February 0.00 in March	January: prefer riparian avoid escarpment February: no preference	Golder (1998a,b)
1997	Mobil Lease 36	0.2	most in tamarack forest and riparian willow shrubland	URSUS and Komex (1997)
1998	Suncor Firebag Project	1.0	preferred FONS; avoided a1, b1, b2, d1, d2 and d3	Suncor (2000)
1998 to 1999	Suncor Wildlife Monitoring	0.16 in reclaimed 1.75 in riparian area beside disturbance	not reported	Golder (1999b)

Table V-15 Weasel Survey Results Within the Oil Sands Region (continued)

Year	Project	Results (tracks/km-track day unless otherwise noted)	Habitat Preference	Reference
2000	ATCO Pipeline	mean: 2.1	most common in h1	AXYS (2000b)
2000	TrueNorth Fort Hills Oil Sands Project	0.31	preferred FTNN; avoided a1, b1, d1, d3, e2 and BTNN	Golder (2000b)
2000	Albian Sands Lease 13 West	no observations	n/a	Golder (2000c)
2000	Suncor Wildlife Monitoring	0.40 in Lease 86/17 0.78 in Lease 25/97	only riparian corridors sampled	Golder (2000d)
2000	OPTI Long Lake Project	0.46	tracks mainly were observed in the FTNN, d2 and h1 ecosite phase/wetlands types	OPTI (2000)
1999 to 2001	Albian Sands Lease 13 West	no observations	n/a	Golder (2001a)
2001	Gulf Surmont In-situ Oil Sands Project	no overall tracks/km-track day provided	found in b1, b2, d2, e3, f1, f2, g1, h1 and FTNN	Gulf (2001)
2001	Rio Alto Kirby Project	0.38	no preference, most commonly observed in g1 and FTNN; one set of tracks each observed in STNN and disturbed	Rio Alto (2002)
2001	Petro-Canada Meadow Creek Project	0.48	observed in c1, g1 and BTNN ecosite phase/wetlands types	Petro-Canada (2001)
2001	Shell Jackpine Mine – Phase 1	0.67	observed in d2, FONS, FTNN, h1, SONS and STNN; preferred FTNN, avoided d2 and STNN	Golder (2002a)
2001	Canadian Natural Horizon Project	0.65	observed in b3, d1, d2, d3, e1, e3, g1, BTNN, FTNN, FONG, FONS, STNN, SONS, and cutblock; avoided e3	Canadian Natural (2002)
2002	Suncor South Tailings Pond Project	1.00	observed in FONS, FTNN, FONG and d2; preference for FONS and FTNN; avoided d2	Golder (2003b)
2002	Devon-Jackfish Project	0.9	highest track densities in k3	Devon Canada (2004)
2003	EnCana-Christina Lake Thermal Project	0.69	most observations in FTNN	Golder (2004a)
2004	MEG Energy	0.35	no preferences; most abundant in b4 and b2	MEG (2005)
2004	Suncor Monitoring Five Year Report	0.53	surveys conducted in natural sites	Golder (2004b)
2004	Suncor Voyageur	0.70 0.59	preference for treed wetlands most abundant in b3 and BTNN	Golder (2005)
2004 to 2005	Primrose East Expansion	0.52	most observations in c1, g1, and BTNN; preference for c1 and avoidance of WONN	Canadian Natural (2006)

Table V-15 Weasel Survey Results Within the Oil Sands Region (continued)

Year	Project	Results (tracks/km-track day unless otherwise noted)	Habitat Preference	Reference
2005	Devon – Jackfish 2 Project	0.06	observed in j1 and d1	Devon Canada (2006)
2005 to 2006	Long Lake South Project	0.1	most observed in f2	OPTI/Nexen (2006)
2006	Suncor Voyageur South	1.59	preference for ROW	Suncor (2007)
2006	EnCana Christina Lake Expansion	1.78	preference for FONS, FTNN avoidance b3, b4, burn, d2, g1	Non-published data
2007	Shell Jackpine Mine Expansion & Pierre River Mine	0.61 0.21	preference for e3, FTNN and g1 b1, c1, d1, d2, cutlines and roads were used significantly less than expected	Present study

n/a = Not applicable.

Table V-16 Beaver Survey Results Within the Oil Sands Region

Year	Project	Results	Reference
1970 to 1975	traplines	12.9 animals/ 100 km^2 trapped	Boyd (1977)
1975 to 1976	Syncrude Lease 17	0.14 to 1.0/km river or creek; 1.9/km^2	Penner (1976)
1978	AOSERP	0.32 active lodges/km of stream and 0.14 active lodges/km of lakeshore	Searing (1979)
1978	AOSERP	0.40 active lodges/km of stream	Gilbert et al. (1979) as reported in Conor Pacific (1998)
1978	Syncrude	0.32 food caches/km^2 0.26 active lodges/km^2	Westworth (1978) as reported in Conor Pacific (1998)
1979	Syncrude	0.29 food caches/km^2 0.23 active lodges/km^2	Westworth (1979) as reported in Conor Pacific (1998)
1980	Canstar Project 80	0.11 active lodges/km^2 or 0.16/km Shell River	Skinner and Westworth (1981)
1981	Canstar Lease	0.42 active lodges/km^2	Westworth and Brusnyk (1982)
1983	AOSERP	0.81 food caches/km^2 0.94 active lodges/km^2	Green (1983) as reported in Conor Pacific (1998)
1984	Syncrude	0.44 food caches/km^2	Pauls (1984) as reported in Conor Pacific (1998)
1985	OSLO	0.32 food caches/km^2	Salter and Duncan (1986)
1985	BP Resources	0.2 active lodges/km in wetlands	BP Resources et al. (1985)
1985	BP Resources	0.3 active lodges/km for shoreline 0.6 active lodges/km for creeks	Young and Bjornson (1985)
1986	Syncrude	0.52 food caches/km^2	Pauls and Arner (1987) as reported in Conor Pacific (1998)
1988	Syncrude	0.42 food caches/km^2	Pauls (1989) as reported in Conor Pacific (1998)
1991	Syncrude	0.46 food caches/km^2	Pauls (1991) as reported in Conor Pacific (1998)
1996	Aurora Mine	0.09 active lodge and food caches/km^2 and 0.57 active lodge and food caches /km^2 on the previous Alsands Site	Fort McKay Environmental Services (1996)
1998	Mobil Lease 36	0.37 active lodges/km^2	Golder (1999a)
1999	OPTI Long Lake Project	0.61 active lodges/km^2 or 1.6 active lodges/km	OPTI (2000)
2001	Rio Alto Kirby Project	0.02 active lodges/ha of lake 0.02 inactive lodges/ha of lake 0.00 active lodges/km of tributary 1.14 inactive lodges/km of tributary	Rio Alto (2002)
2001	Petro-Canada Meadow Creek Project	0.08 active lodges/ha of lake 0.20 active lodges/km of drainage	Petro-Canada (2001)
2001	Shell Jackpine Mine – Phase 1	0.69 active lodges/km of tributary 0.66 inactive lodges/km of tributary	Golder (2002a)

Table V-16 Beaver Survey Results Within the Oil Sands Region (continued)

Year	Project	Results	Reference
2001	Canadian Natural Horizon Project	0.05 active lodges/ha of lake 0.08 inactive lodges/ha of lake 1.17 active lodges/km of tributary 1.27 inactive lodges/km of tributary	Canadian Natural (2002)
2002	Suncor South Tailings Pond Project	0.78 active lodges/km of tributary 1.17 inactive lodges/km of tributary	Golder (2003b)
2003	EnCana-Christina Lake Thermal Project	3 incidental sightings during other surveys on the LSA	Golder (2004a)
2004	MEG Energy Christina Lake Regional Project	0.84 food caches/km^2 of lake (0.008/ha) 1.03 active lodges/km^2 of lake (0.010/ha) 0.21 food caches/km of stream 0.17 active lodges/km of stream	MEG (2005)
2004	Suncor Voyageur	0.34 active lodges/km of tributary 0.45 inactive lodges/km of tributary 1.4 active lodges/km of tributary 0.2 inactive lodges/km of tributary	Golder (2005)
2004 to 2005	Primrose East Expansion	3 incidental observations of individuals or sign during other surveys	Canadian Natural (2006)
2006	Suncor Voyageur South	0.16 active lodges/km of watercourse 0.22 inactive lodges/km of watercourse 0.02 active lodges/lake 0.01 inactive lodges/lake	Suncor (2007)
2006	EnCana Christina Lake Expansion	0.03 active lodges/km of stream 0.04 active lodges/lake	Non-published data
2007	Shell Jackpine Mine Expansion & Pierre River Mine	0.06 active lodges/ha of lake 0.62 active lodges lodges/km of watercourse 0.03 active lodges/ha of lake no active lodges/km of watercourse	Present study

Table V-17 Muskrat Survey Results Within the Oil Sands Region

Year	Project	Results	Reference
1970 to 1975	traplines	6.13 animals/ 100 km^2 trapped	Boyd (1977)
1975 to 1976	Syncrude Lease 17	estimate of 0.3n/a2.5 muskrats/ha	Penner (1976)
1980	Canstar Project 80	0.03 houses/km^2 (6 houses observed within the 176 km^2 study area)	Skinner and Westworth (1981)
1981 to 1982	Canstar Lease	0.02 houses/km^2 (6 houses in 387 km^2 study area)	Westworth and Brusnyk (1982)
1983	Syncrude	39 muskrat houses, common on Ruth Lake and Horseshoe Lake	Murray and Pauls (1983)
1984	Syncrude	48 muskrat houses recorded	Pauls (1984)
1986	Syncrude	25 muskrat lodges recorded, most on Horseshoe lake	Pauls and Arner (1987)
1989	Syncrude	64 houses recorded, most on Horseshoe lake	Pauls (1989)
1990	Syncrude	no observations	Pauls (1991)
1991	Syncrude	low number observed	Pauls (1991)
1996	Aurora Mine	no observations	Fort McKay Environmental Services Ltd (1996)
1997	Suncor Winter Wildlife	no observations	Golder (1998a,b)
1997	Mobil Lease 36	0.21 houses/km^2 and 0.84 feeding platforms/km^2	URSUS and Komex (1997)
2000	OPTI Long Lake Project	0.54 push ups/km^2	OPTI (2000)
2000	Canadian Natural PAW Project	muskrat houses were observed in shrubby fen and shallow open water with wetlands	Canadian Natural (2000)
2001	Rio Alto Kirby Project	0.01 push-ups/ha of lake 0.29 push-ups//km of tributary	Rio Alto (2002)
2001	Petro-Canada Meadow Creek Project	0.00 push-ups/km^2	Petro-Canada (2001)
2001	Shell Jackpine Mine – Phase 1	no observations	Golder (2002a)
2001	Canadian Natural Horizon Project	0.02 push-ups/ha of lake 0.07 push-ups//km of tributary	Canadian Natural (2002)
2002	Suncor South Tailings Pond Project	no observations	Golder (2003b)
2004	MEG Energy Christina Lake Regional Project	2.06 push-ups/km of tributary	MEG (2005)
2004	Suncor Voyageur	no observations	Golder (2005)
2004 to 2005	Primrose East Expansion	2 incidental observations of individuals during other surveys	Canadian Natural (2006)
2005	Devon – Jackfish 2 Project	no observations	Devon Canada (2006)
2005 to 2006	Long Lake South Project	0.01 tracks/km-track day; most observed in j2	OPTI/Nexen (2006)
2006	Suncor Voyageur South	1 lodge and 12 push-ups observed	Suncor (2007)
2006	EnCana Christina Lake Expansion	1 lodge and no push-ups observed	Non-published data
2007	Shell Jackpine Mine Expansion & Pierre River Mine	no observations	Present study

Table V-18 River Otter Track Survey Results Within the Oil Sands Region

Year	Project	Results (tracks/km-track day unless otherwise noted)	Habitat Preference	Reference
1970 to 1975	traplines	0.12 animals/ 100 km^2 trapped	not reported	Boyd (1977)
1975 to 1976	Syncrude Lease 17	0.0007	not reported	Penner (1976)
1980	Canstar Project 80	0.01(all) 0.06 (riparian)	only in riparian habitat	Skinner and Westworth (1981)
1981 to 1982	Canstar Lease	0.0005	not reported	Westworth and Brusnyk (1982)
1985	BP Resources	general observations	not reported	BP Resources et al. (1985)
1995	Solv-Ex	no observations	n/a	Bovar-Concord Environmental (1995)
1995	Syncrude Aurora North	0.02	only in riparian shrub, fen and willow wetlands	Westworth, Brusnyk and Associates (1996a)
1996	Suncor Mine, Lease 23 and Steepbank Mine	0.01	only in shoreline	Westworth, Brusnyk and Associates (1996b)
1997	Shell Muskeg River Mine	0.01	only in riparian shrub dominant	Golder (1997a,b)
1997	Suncor Winter Wildlife	no observations	n/a	Golder (1998a,b)
1998	Suncor Firebag Project	no observations	n/a	Suncor (2000)
1998 to 1999	Suncor Wildlife Monitoring	0.0 in reclaimed 0.04 in riparian area beside disturbance	not reported	Golder (1999b)
2000	ATCO Pipeline	mean: 0.6	most common in FONG	AXYS (2000b)
2000	Canadian Natural PAW Project	incidental observations	not reported	Canadian Natural (2000)
2000	TrueNorth Fort Hills Oil Sands Project	0.02	found in FTNN and SONS	Golder (2000b)
2000	Albian Sands Lease 13 West	0.0 in upland 0.11 in riparian	not reported	Golder (2000c)
2000	Suncor Wildlife Monitoring	0.0 in Lease 86/17 0.06 in Lease 25/97	only riparian corridors sampled	Golder (2000d)
2000	OPTI Long Lake Project	1 set of old tracks observed	mixedwood	OPTI (2000)
1999 to 2001	Albian Sands Lease 13 West	mean observations: 0.07 in January 1999/2000 0.10 in January 2000/2001 0.01 in February 2000/2001	surveys conducted in riparian and upland habitat no evidence of use of riparian areas as movement corridors, however, the animal's ecology sugegsts a preference for riparian areas	Golder (2001a)
2001	Rio Alto Kirby Project	0.02	one set of tracks observed in WONN	Rio Alto (2002)
2001	Gulf Surmont In-situ Oil Sands Project	no overall tracks/km-track day provided	found in F1 and FONG	Gulf (2001)

Table V-18 River Otter Track Survey Results Within the Oil Sands Region (continued)

Year	Project	Results (tracks/km-track day unless otherwise noted)	Habitat Preference	Reference
2001	Petro-Canada Meadow Creek Project	0.05	tracks observed in d2 and e1	Petro–Canada (2001)
2001	Shell Jackpine Mine – Phase 1	no observations	n/a	Golder (2002a)
2001	Canadian Natural Horizon Project	0.02	observed in SONS and WONN	Canadian Natural (2002)
2002	Suncor South Tailings Pond Project	no observations	n/a	Golder (2003b)
2002	Devon-Jackfish Project	1 observed track in g1	not reported	Devon Canada (2004)
2003	EnCana-Christina Lake Thermal Project	1 set of tracks observed incidentally	not reported	Golder (2004a)
2004	MEG Energy Christina Lake Regional Project	2 incidental observations	stream/MONS	MEG (2005)
2004	Suncor Voyageur	1 set of tracks observed no observations	not reported	Golder (2005)
2004 to 2005	Primrose East Expansion	no observations	n/a	Canadian Natural (2006)
2005	Devon – Jackfish 2 Project	no observations	n/a	Devon Canada (2006)
2005 to 2006	Long Lake South Project	0.01	most observed in e3	OPTI/Nexen (2006)
2006	Suncor Voyageur South	no observations	n/a	Suncor (2007)
2006	EnCana Christina Lake Expansion	no observations	n/a	Non-published data
2007	Shell Jackpine Mine Expansion & Pierre River Mine	0.02 0.01	observed in FTNN, riparian, SONS observed in BTNN, SONS, WONN	Present study

n/a = Not applicable.

Table V-19 Mink Track Survey Results Within the Oil Sands Region

Year	Project	Results (Tracks/km-track day unless otherwise noted)	Habitat Preference	Reference
1970 to 1975	traplines	2.26 animals/ 100 km^2 trapped	not reported	Boyd (1977)
1975 to 1976	Syncrude Lease 17	0.1	most in riparian, aspen-willow and deciduous dominated mixedwood[(a)]	Penner (1976)
1980	Canstar Project 80	0.10	preferred riparian shrub; avoided aspen, jack pine, black spruce Shell and open Shell	Skinner and Westworth (1981)
1981 to 1982	Canstar Lease	0.10	preferred willow wetlands; avoided aspen, balsam poplar, mixed wood, jack pine, white spruce and black spruce	Westworth and Brusnyk (1982)
1995	Solv-Ex	no observations	n/a	Bovar-Concord Environmental (1995)
1995	Syncrude Aurora North	0.22 in January	preferred riparian shrub; avoided aspen and mixedwood forest, jack pine, mixed coniferous, black spruce-tamarack, fen and willow wetlands, riparian balsam poplar and cleared peatland	Westworth, Brusnyk and Associates (1996a)
1996	Suncor Mine, Lease 23 and Steepbank Mine	0.02	most in wetlands shrub complex	Westworth, Brusnyk and Associates (1996b)
1997	Shell Muskeg River Mine	0.03	only in riparian shrub dominant	Golder (1997a,b)
1997	Suncor Winter Wildlife	0.59 in January no observations in February	January: avoided a1, d3, d1, d2, h1, FTNN, BTNN and WONN	Golder (1998a,b)
1997	Suncor Winter Wildlife	no observations	n/a	Golder (1998a,b)
1997	Mobil Lease 36	0.01	only in riparian willow shrubland	URSUS and Komex (1997)
1998	Suncor Firebag Project	0.01	only in FONS and FTNN/FFNN	Suncor (2000)
1998 to 1999	Suncor Wildlife Monitoring	0.13 in reclaimed 0.19 in riparian area beside disturbance	not reported	Golder (1999b)
2000	ATCO Pipeline	mean: 0.4	most common in FONG	AXYS (2000b)
2000	TrueNorth Fort Hills Oil Sands Project	no observations	n/a	Golder (2000b)
2000	Albian Sands Lease 13 West	0.00 in upland 0.07 in riparian	not reported	Golder (2000c)
2000	Suncor Wildlife Monitoring	0.0 in Lease 86/17 0.02 in Lease 25/97	only riparian corridors sampled	Golder (2000d)
2000	OPTI Long Lake Project	0.02	tracks observed in wooded fen (FTNN) wetlands type	OPTI (2000)

Table V-19 Mink Track Survey Results Within the Oil Sands Region (continued)

Year	Project	Results (Tracks/km-track day unless otherwise noted)	Habitat Preference	Reference
1999 to 2001	Albian Sands Lease 13 West	mean densities: 0.05 in January 1999/2000 0.00 in January 2000/2001 0.15 in February 2000/2001	surveys conducted in riparian and upland habitat no evidence of use of riparian areas as movement corridors, however, animal's ecology suggests a preference for riparian areas	Golder (2001a)
2001	Gulf Surmont In-situ Oil Sands Project	no overall tracks/km-track day provided	found in riparian communities (f1 andf2) and FONG	Gulf (2001)
2001	Rio Alto Kirby Project	no observations	n/a	Rio Alto (2002)
2001	Petro-Canada Meadow Creek Project	0.02	observed in e1	Petro-Canada (2001)
2001	Shell Jackpine Mine – Phase 1	no observations	n/a	Golder (2002a)
2001	Canadian Natural Horizon Project	one set of tracks observed	observed in e3	Canadian Natural (2002)
2002	Suncor South Tailings Pond Project	no observations	n/a	Golder (2003b)
2002	Devon-Jackfish Project	8 tracks observed	6 tracks occurred in k3 associated with lower order streams	Devon Canada (2004)
2003	EnCana-Christina Lake Thermal Project	no observations	n/a	Golder (2004a)
2004	MEG Energy Christina Lake Regional Project	no observations	n/a	MEG (2005)
2004	Suncor Voyageur Millennium Upgrader	no observations	n/a	Golder (2005)
2004	Suncor Millennium Mine	preference for shrubby wetlands	n/a	Golder (2005)
2004 to 2005	Primrose East Expansion	no observations	n/a	Canadian Natural (2006)
2005	Devon – Jackfish 2 Project	no observations	n/a	Devon Canada (2006)
2005 to 2006	Long Lake South Project	0.01	most observed in k2	OPTI/Nexen (2006)
2006	Suncor Voyageur South	no observations	n/a	Suncor (2007)
2006	EnCana Christina Lake Expansion	0.01	e2	Non-published data
2007	Shell Jackpine Mine Expansion & Pierre River Mine	no observations	n/a	Present study

(a) Not statistically significant.

n/a = Not applicable.

Table V-20 Snowshoe Hare Survey Results Within the Oil Sands Region

Year	Project	Results [tracks/km-track day]	Habitat Preference	Reference
1975 to 1976	Syncrude Lease 17	2.94	preferred aspen-willow/alder, mixedwood, forested black spruce and tall shrub; avoided aspen-balsam poplar, jack pine, treed black spruce, black spruce-willow, dwarf birch-tamarack, riparian and disturbed	Penner (1976)
1980	Canstar Project 80	21.15	preferred mixedwood, black spruce-Shell and riparian white spruce; avoided aspen, jack pine and open Shell	Skinner and Westworth (1981)
1981 to 1982	Canstar Lease	76.2	preferred aspen and balsam poplar; avoided mixedwood, white spruce, black spruce, willow, fen, willow wetlands and riparian aspen	Westworth and Brusnyk (1982)
1986	OSLO	no overall track count/km-track day provided	track densities were greatest in aspen-dominated, pine dominated mixed and spruce forests	Duncan et al. (1986)
1995	Solv-Ex	14.69	most tracks in aspen-white spruce and white spruce	Bovar-Concord Environmental (1995)
1995	Syncrude Aurora North	3.53 in January	preferred mixed coniferous and black spruce-tamarack; avoided cleared aspen, aspen and mixedwood forests, jack pine, open tamarack bog-birch, fen and willow wetlands, riparian balsam poplar and riparian shrub	Westworth, Brusnyk and Associates (1996a)
1996	Suncor Mine, Lease 23 and Steepbank Mine	4.14 in December 0.49 in February	preferred closed jack pine, closed mixedwood, closed mixed coniferous-black spruce dominant and open black spruce; avoided closed white spruce, closed deciduous, black spruce tamarack, open tamarack/fen, wetlands shrub complex, disturbed, shoreline and fen	Westworth, Brusnyk and Associates (1996b)
1997	Shell Muskeg River Mine	22.36	preferred closed jack pine, closed white spruce, closed balsam poplar, closed mixed conifer-black spruce dominant, closed mixedwood-white spruce dominant and closed black spruce bog; avoided wetlands shrub complex, open black spruce bog, riparian shrub dominant, open and closed aspen	Golder (1997a,b)
1997	Suncor Winter Wildlife	0.98 in January 5.80 in February	January: preferred d2; avoided a1, d3, d1, h1, Shrub, BTNN and WONN February: preferred d2; avoided d1, d3, FTNN and BTNN	Golder (1998a,b)
1997	Suncor Winter Wildlife	12.41 in January 15.98 in February 3.53 in March	January: preferred upland avoided riparian February: preferred upland avoided riparian and escarpment March: preferred upland avoided riparian	Golder (1998a,b)
1997	Mobil Lease 36	3.99	most in closed canopy black spruce, white spruce, black spruce-tamarack bog and white spruce-aspen mixedwood; avoided aspen stands	URSUS and Komex (1997)
1998	Suncor Firebag Project	8.96	preferred b4 and BTNN/BFNN; avoided a1, b2 and FONS	Suncor (2000)
1998 to 1999	Suncor Wildlife Monitoring	10.41 23.29	observed in reclaimed area observed in riparian area beside disturbance	Golder (1999b)
2000	ATCO Pipeline	mean: 204.7	most common in h1	AXYS (2000b)
2000	Canadian Natural PAW Project	incidental observations	found in aspen, jack pine/aspen, shrubby fen, treed fen, aspen/white spruce, black spruce/jack pine	Canadian Natural (2000)
2000	TrueNorth Fort Hills Oil Sands Project	10.13	preferred d2, g1 and FTNN; avoided b1, d1, e1 and SONS	Golder (2000b)

Table V-20 Snowshoe Hare Survey Results Within the Oil Sands Region (continued)

Year	Project	Results [tracks/km-track day]	Habitat Preference	Reference
2000	Suncor Wildlife Monitoring	10.85 in Lease 86/17 17.78 in Lease 25/97	only riparian corridors sampled	Golder (2000d)
2000	OPTI Long Lake Project	90.90	preferred d2, d3, SONS and STNN; avoided e1, FONS, h1 and shrub	OPTI (2000)
2001	Gulf Surmont In-situ Oil Sands Project	no overall track count/km-track day provided	found in all habitats except e1. Highest track counts were found in b3 and a1	Gulf (2001)
2001	Rio Alto Kirby Project	112.5	preferred b1, d3, e2, g1, STNN; avoided b3, d1, d2, FONS, MONG, MONS, WONN and disturbed	Rio Alto (2002)
2001	Petro-Canada Meadow Creek Project	48.77	preferred b3, c1, f1, g1, SONS; avoided b2, d1, d2, BTNN, FONS, FTNN, MONG, STNN and cutlines	Petro–Canada (2001)
2001	Shell Jackpine Mine – Phase 1	88.26	preferred b4, c1, FTNN, g1, h1, MONS and STNN	Golder (2002a)
2001	Canadian Natural Horizon Project	44.57	preferred b1, b3, d1, g1, h1, BTNN,FTNN, FONS, STNN, and seismic line; avoided b4, d2, e1, e3, FONG, MONG, cutblock and road	Canadian Natural (2002)
2002	Suncor South Tailings Pond Project	19.37	observed in d2, FTNN, e3, FONS, BTNN, h1, e2, and disturbed (cutblock); significant preference for d2 and e3; avoided e2, BTNN, FONG, FONS, cutline/disturbance	Golder (2003b)
2002	Devon-Jackfish Project	23.2	highest track densities in a1,c1,i2,k1,h1,g1 and j1	Devon Canada (2004)
2003	EnCana-Christina Lake Thermal Project	0.67	observed in BTNN,d2 and g1	Golder (2004a)
2004	MEG Energy Christina Lake Regional Project	13.3	Preference for a1, c1, d2, d3, g1; avoided b2, d1, FONS, FTNN, BTNN, MONS and WONN	MEG (2005)
2004	Suncor Monitoring Five Year Report	12.87	surveys conducted in natural sites	Golder (2004b)
2004	Suncor Voyageur	10.10 0.71	preference for treed wetlands and black and white spruce forests preference for d2 and BTNN	Golder (2005)
2004 to 2005	Primrose East Expansion	4.37	preferred c1, d2 , d3, and g1; avoided FONS, FTNN, BTNN, SONS, and WONN	Canadian Natural (2006)
2005	Devon – Jackfish 2 Project	2.2	observed in j1, c1, burn area, k2, and k3	Devon Canada (2006)
2005 to 2006	Long Lake South Project	8.4	most observed in e3	OPTI/Nexen (2006)
2006	Suncor Voyageur South	4.21	primarily observed in BTNN, d2, FTNN, g1, STNN	Suncor (2007)
2006	EnCana Christina Lake Expansion	5.76	primarily observed in BTNN, FTNN, FONS	Non-published data
2007	Shell Jackpine Mine Expansion & Pierre River Mine	16.99 27.45	primarily observed in b4, g2 and STNN primarily observed in b4, BFNN, g2, FTNN	Present study

n/a = Not applicable.

Table V-21 Red Squirrel Survey Results Within the Oil Sands Region

Year	Project	Results (tracks/km-track day unless otherwise noted)	Habitat Preference	Reference
1970 to 1975	traplines	49.6 animals/ 100 km^2 trapped	not reported	Boyd (1977)
1975 to 1976	Syncrude Lease 17	2.33; 1.19 squirrels/ha based on a midden study	preferred mixedwood, white spruce, jack pine and forested black spruce; avoided aspen, black spruce-willow, tall shrub, dwarf birch-tamarack, riparian and disturbed	Penner (1976)
1980	Canstar Project 80	2.08	preferred aspen, mixedwood, jack pine and riparian white spruce; avoided black spruce-Shell, open Shell and riparian shrub	Skinner and Westworth (1981)
1981 to 1982	Canstar Lease	1.59 in February	preferred mixedwood avoided aspen, balsam poplar, willow, fen, willow wetlands and riparian aspen	Westworth and Brusnyk (1982)
1986	OSLO	no overall track count/km-track day provided	track densities were greatest in pine, spruce and mixedwood forests and in bogs, no tracks were observed in aspen forest, shrubland and fens	Duncan et al. (1986)
1995	Solv-Ex	6.89	most in white spruce	Bovar-Concord Environmental (1995)
1995	Syncrude Aurora North	0.63 in January	preferred mixed coniferous and riparian white spruce; avoided cleared aspen, aspen forest, open tamarack-bog birch, fen and willow wetlands, riparian balsam poplar and shrub and cleared peatland	Westworth, Brusnyk and Associates (1996a)
1996	Suncor Mine, Lease 23 and Steepbank Mine	2.78 in December 0.42 in February	preferred closed jack pine and closed mixed coniferous-black spruce dominant; avoided black spruce-tamarack, open black spruce, open tamarack fen, wetlands shrub complex, disturbed, shoreline and fen	Westworth, Brusnyk and Associates (1996b)
1997	Shell Muskeg River Mine	5.65	preferred closed white spruce, closed mixedwood-white spruce dominant; avoided closed mixed wood, closed mixed coniferous-black spruce dominant, open and closed fen	Golder (1997a,b)
1997	Suncor Winter Wildlife	0.35 January 0.24 in February	January: preferred d2; avoided a1, h1, Shrub, FTNN, BTNN and WONN February: no preferences	Golder (1998a,b)
1997	Suncor Winter Wildlife	0.62 in January 3.18 in February 9.86 in March	January: preferred riparian; avoided upland February and March: preferred escarpment; avoided upland	Golder (1998a,b)
1997	Mobil Lease 36	2.62	most in white spruce-aspen mixedwood, jack pine, white spruce, black spruce-aspen and black spruce-tamarack	URSUS and Komex (1997)
1998	Suncor Firebag Project	1.00	preferred b4, c1 and BTNN/BFNN; avoided b2, g1, FONS and FTNN/FFNN	Suncor (2000)
1998 to 1999	Suncor Wildlife Monitoring	2.77 in reclaimed 15.64 in riparian area beside disturbance	not reported	Golder (1999b)
2000	ATCO Pipeline	mean: 13.8	most common in d3, also common in h1	AXYS (2000b)
2000	Canadian Natural PAW Project	incidental observations	found in poor fen/bog, treed fen, black spruce/jack pine, aspen/white spruce and white spruce/black spruce	Canadian Natural (2000)
2000	TrueNorth Fort Hills Oil Sands Project	0.31	preferred BTNN; avoided d1, e1, g1, Shrub and SONS	Golder (2000b)

Table V-21 Red Squirrel Survey Results Within the Oil Sands Region (continued)

Year	Project	Results (tracks/km-track day unless otherwise noted)	Habitat Preference	Reference
2000	Suncor Wildlife Monitoring	0.23 in Lease 86/17 0.30 in Lease 25/97	only riparian corridors sampled	Golder (2000d)
2000	OPTI Long Lake Project	1.25	preferred d3; avoided d1, FTNN and shrub	OPTI (2000)
2001	Rio Alto Kirby Project	3.70	preferred d2 and g1; avoided FONS and FTNN	Rio Alto (2002)
2001	Petro-Canada Meadow Creek Project	2.50	preferred d2; avoided BTNN and FONS	Petro-Canada (2001)
2001	Shell Jackpine Mine – Phase 1	0.47	observed in a1, b4, c1, d2, d3, FTNN, g1 and h1; observed incidentally in a1, b1, b3, c1, d1, d2 and FONS	Golder (2002a)
2001	Canadian Natural Horizon Project	2.31	observed in b1, b3, d1, d2, d3, e1, e2, e3, h1, BTNN,FTNN, STNN, burn and cutblock; avoided d1, g1, BTNN, FTNN, FONS, STNN, SONS, burn and cutblock	Canadian Natural (2002)
2002	Suncor South Tailings Pond Project	3.57	observed in d2, e3, FTNN, e2 and BTNN; preference for e3; avoided BTNN and FTNN	Golder (2003b)
2002	Devon-Jackfish Project	9.6	highest track densities in d3,e2 and h1	Devon Canada (2004)
2003	EnCana-Christina Lake Thermal Project	6 incidental observations during other surveys on the LSA	not reported	Golder (2004a)
2004	MEG Energy Christina Lake Regional Project	4.57	preferred d2, d3; avoided FTNN, FONS, MONS, WONN	MEG (2005)
2004	Suncor Voyageur	1.94 1.26	preference for mixedwood and white spruce forests observed in a1, b1, b3, c1, d2, g1, BTNN, FTNN, FONG, disturbed/vegetated	Golder (2005)
2004 to 2005	Primrose East Expansion	5.81	preferred c1, d2, and d3; avoided FTNN, BTNN, FONS, SONS, and WONN	Canadian Natural (2006)
2005	Devon – Jackfish 2 Project	1.0	observed in i1, h1, b4, d3, and b1	Devon Canada (2006)
2005 to 2006	Long Lake South Project	3.3	most observed in f3	OPTI/Nexen (2006)
2006	Suncor Voyageur South	1.65	observed primarily in d2, d3, g1, e2, h1	Suncor (2007)
2006	EnCana Christina Lake Expansion	4.63	observed primarily in BTNN, d1, FTNN, FONS	Non-published data
2007	Shell Jackpine Mine Expansion & Pierre River Mine	1.68 4.74	primarily observed in b1, b4, e3 primarily observed in c1, d3, e1, e2, f2, f3	Present study

n/a = Not applicable.

Table V-22 Bat Survey Results Within the Boreal Mixedwood Forests of Alberta

Year	Project	Activity Results	Bat Captures	Habitat Use	Reference
1993 to 1994	MSc Research (Lac La Biche, AB)	1933 passes (passes/hr n/a) *Myotis* spp.[(a)], silver-haired, big brown and hoary bats	99 bats (bat /net-night n/a) little brown (80), northern long-eared (1), silver-haired (17) and hoary (1) bats	captured and detected primarily in old and mature aspen mixedwood forest	Crampton and Barclay (1998)
1999 to 2000	MSc Research (near Peace River, AB)	2193 passes (1.6 passes/hr): little brown, northern long-eared and silver-haired bats	56 bats (0.31 /net-night): little brown (41), northern long-eared (13) and silver-haired (2) bats	captured in aspen dominant and white spruce dominant forest in cutlines, above puddles and ponds; detected in aspen dominant, white spruce dominant and mixedwood forests within open patches and closed canopies	Patriquin (2001)
2000	Gulf Surmont Supplemental Wildlife Surveys	161 passes (35 passes/hr): *Myotis* spp.[(a)] , hoary, big brown and silver-haired bats	30 bats (0.24 /net-hr): little brown (25), hoary (3) and silver-haired (2) bats;	n/a	Gulf (2001)
2000	Bat Surveys of Central and Northwestern AB (Caribou River)	11.4 passes/hr[(b)] (total n/a): detected *Myotis* spp.[(a)] and larger spp.[(c)]	0 bats	dry mixedwood subregion	Vonhof and Hobson (2001)
2000	Bat Surveys of Central and Northwestern AB (Rainbow Lake)	15 passes/hr[(b)] (total n/a): detected *Myotis* spp.[(a)] and larger spp.[(c)]	2 bats over 4 nights: northern long-eared bats	wet mixedwood subregion	Vonhof and Hobson (2001)
2000	Bat Surveys of Central and Northwestern AB (Sousa Creek)	39 passes/hr[(b)] (total n/a): *Myotis* spp.[(a)] and larger spp.[(c)]	11 bats over 6 nights: little brown (2), northern long-eared (6) and big brown (3) bats	wet mixedwood subregion	Vonhof and Hobson (2001)
2000	Bat Surveys of Central and Northwestern AB (Wabaska River)	19.8 passes/hr[(b)] (total n/a): *Myotis* spp.[(a)] and larger spp.[(c)]	10 bats over 7 nights: little brown (7), northern long-eared (2) and big brown (3) bats	central mixedwood subregion	Vonhof and Hobson (2001)
2001	Bat Surveys in Northeastern AB	approximately 270 passes (ca. 8.78 passes/hr): detected *Myotis* spp.[(a)], larger spp.[(c)] and hoary bats	36 bats (0.23 bat/net-hr): little brown (31), northern long-eared (3) and silver-haired (2) bats	little brown bats captured primarily above water, northern long-eared bats captured in cutlines and silver-haired bats captured above water; no habitat for echolocation calls provided	Schowalter (2001) Hubbs and Schowalter (2003)
2001	Rio Alto Kirby Project	380 passes (15.3 passes/hr): *Myotis* spp.[(a)], larger spp.[(c)] and little brown bats	4 bats (0.06 bat/net-hr): little brown bats	captured in e2 cutline; detected primarily in FONG and BTNN	Rio Alto (2002)
2001	Petro-Canada Wildlife Surveys	45 passes (2.2 passes/hr): *Myotis* spp.[(a)] and large spp.[(c)]	1 bat (0.01 bat/net-hr): silver-haired	captured above water in MONG; detected primarily in d2 as well as in MONS, MONG and BTNN.	Petro-Canada (2001)
2001	Shell Jackpine Mine – Phase 1 Wildlife Surveys	101 passes (3.9 passes/hr): *Myotis* spp.[(a)], larger spp.[(c)] and little brown bats	6 bats (0.13 bat/net-hr): northern long-eared (5) and little brown (1) bats	captured in b1, d1 and d2 cutlines; detected primarily in e2-cutline and SONS, as well as d1 forest, b1, d1 and d2 cutlines, FONS and STNN.	Golder (2002a)

Table V-22 Bat Survey Results Within the Boreal Mixedwood Forests of Alberta (continued)

Year	Project	Activity Results	Bat Captures	Habitat Use	Reference
2001	Canadian Natural Horizon Project	323 passes (15.3 passes/hr); *Myotis* spp.[(a)], larger spp.[(c)], little brown and northern long-eared bats	4 bats (0.08 bat/net-hr): little brown (1), northern long-eared (2) and silver-haired (1) bats	captured in a1-cutline and MONS; detected primarily in MONS, as well as in a1 and e1 forest and cutlines	Canadian Natural (2002)
2002	Suncor South Tailings Pond Project	28 passes and 2 feeding buzzes (1.88 passes/hr); *Myotis* spp.[(a)], larger spp.[(c)], little brown bats	7 captures; red (1), northern long-eared (4), little brown (2) bats	captured in d2 and h1 ecosites along cutlines; red bat captured in h1 disturbance and first red bat captured in northern Alberta	Golder (2003b)
2004	MEG Energy Christina Lake Regional Project	2.9 passes/hr, 0.5 buzzes per hour; *Myotis* spp.[(a)], big brown/silver haired, red and hoary bats	1 capture; little brown bat	captured in FTNN wetlands type along cutline; passes and feeding buzzes produced within c1, d2, FTNN and WONN	MEG (2005)
2004	Suncor Voyageur	n/a	3 captures; northern long-eared (2), little brown (1) bats 5 captures; northern long-eared (2), little brown (3) bats	captured in d2 in both LSAs	Golder (2005)
2004 to 2005	Primrose East Expansion	432 passes (3129 minutes) and 21 buzzes; *Myotis spp.*[(a)] 3.2 passes/hr, red 1.4 passes/hr, hoary 1.0 passes/hr	2 little brown bats	captured in c1 and SONS; most activity in c1, d2, and d1	Canadian Natural (2006)
2005	Devon – Jackfish 2 Project	n/a	2 captures; little brown bats	captured along road	Devon Canada (2006)
2006	Suncor Voyageur South	46 passes (11.5 passes/hr), 0 feeding buzzes, *Myotis lucifugus / Myotis volan* 30 passes, high freq bats 14 passes, *Myotis septentrionalis* 12 passes	2 red bats, 1 silver-haired bat, 14 northern long-eared bats, 9 little brown bats	captured in d2, h1	Suncor (2007)
2006	EnCana Christina Lake Expansion	24 passes (240 minutes), 0 buzzes, *Eptesicus fuscus/Lasionycteris noctivigans* 9 passes, *Myotis lucifugus / Myotis volans* 4 passes, *Lasiurus borealis* 1 pass, high frequency bats 1 pass	1 red bat, 2 silver-haired bats, 2 northern long-eared bats, 2 little brown bats	captured in d2	Non-published data

Table V-22 Bat Survey Results Within the Boreal Mixedwood Forests of Alberta (continued)

Year	Project	Activity Results	Bat Captures	Habitat Use	Reference
2007	Shell Jackpine Mine Expansion & Pierre River Mine	358.2 passes/hour and 12.2 buzzes/hour (21 hours), big brown/silver-haired, red bat, hoary bat, hoary/big brown/silver haired, little brown, northern long-eared, and high-frequency bats detected 190.0 passes/hour and 8.5 buzzes/hour detected (29 hours), big brown/silver-haired, red bat, hoary bat, hoary/big brown/silver haired, little brown, northern long-eared, and high-frequency bats detected	two silver-haired bat, 24 northern long-eared bats and five little brown bats 26 northern long-eared bats and 12 little brown bats	majority of the bats captured in b1, d2, b2	Present study

(a) *Myotis* species that were difficult to differentiate by echolocation calls were grouped as *Myotis* spp.

(b) Numbers were extrapolated from figures and represent approximate mean values.

(c) Larger bat species could not be differentiated by echolocation calls and were grouped as larger spp. This group may include silver-haired and big brown bats.

n/a = Not applicable.

Table V-23 Small Mammal Survey Results Within the Oil Sands Region

Small Mammal Species	Year	Project	Abundance (# captures/100 trap nights unless otherwise noted)	Habitat Association	Reference
masked shrew	1979	Syncrude	abundant	not reported	as reported in Westworth (1979)
	1979	Syncrude	present	not reported	Michielson and Radvanyi (1979)
	1997	Shell Muskeg River Mine Project	4 to 17	margins of moist fields, bogs, marshes and moist or dry woods, including mixedwood and upland coniferous	Golder (1997a)
	1980	AOSERP	common	aspen and willow habitats	as reported in Green (1980)
	1995	Alberta Environment Centre/Canadian Forest Service. Alberta Land and Forest Service	not reported	aspen mixedwood	Stelfox (1995)
	2000	Gulf Surmont In-Situ Oil Sands Project	3	b2,d1,d3	Gulf (2001)
dusky shrew	1995	Alberta Environment Centre/Canadian Forest Service Alberta Land and Forest Service	not reported	aspen mixedwood	Stelfox (1995)
	2000	Gulf Surmont In-Situ Oil Sands Project	2	e3 and h1	Gulf (2001)
water shrew	1979	Syncrude	common	wet margins of lakes, streams, and Shells	as reported in Westworth (1979)
arctic shrew	1979	Syncrude	scarce	not reported	as reported in Westworth (1979)
	1997	Shell Muskeg River Mine Project	not reported	bogs, marshes and grassy clearings	Golder (1997a)
	1995	Alberta Environment Centre/Canadian Forest Service Alberta Land and Forest Service	not reported	aspen mixedwood	Stelfox (1995)
	2000	Gulf Surmont In-Situ Oil Sands Project	1	FONS	Gulf (2001)
pygmy shrew	1979	Syncrude	common	not reported	as reported in Westworth (1979)
	1980	AEOSERP	common	aspen and willow habitats	as reported in Green (1980)
	1997	Shell Muskeg River Mine Project	uncommon	wooded areas (mixedwood), bogs, wet meadows and clearings within forests	Golder (1997a)
	2000	Gulf Surmont In-Situ Oil Sands Project	4	d1, FONS and FONG	Gulf (2001)

Table V-23 Small Mammal Survey Results Within the Oil Sands Region (continued)

Small Mammal Species	Year	Project	Abundance (# captures/100 trap nights unless otherwise noted)	Habitat Association	Reference
least chipmunk	1997	Shell Muskeg River Mine Project	not reported	clearings, forest edges and disturbed areas	Golder (1997a)
	1993	University of Alberta	not reported	aspen mixedwood	Moses and Boutin (2001)
	2004 to 2005	Primrose East Expansion	no observations	n/a	Canadian Natural (2006)
red-backed vole	1979	Syncrude	9.3 to 19.1	not reported	as reported in Westworth (1979)
	1980	AOSERP	abundant	forest and shrub-dominant habitats, balsam poplar, aspen and jack pine communities	as reported in Green (1980)
	1984	Syncrude Mildred Lake	not reported	prefer balsam poplar, mixedwood and tamarack forest	Syncrude (1984)
	1993	University of Alberta	not reported	aspen mixedwood	Moses and Boutin (2001)
	1997	Shell Muskeg River Mine Project	not reported	disturbed areas, mixedwood, riparian, upland coniferous forests and wetlands	Golder (1997a)
	2000	OPTI Long Lake Project	not reported	deciduous, upland coniferous, mixedwood forests, riparian areas and wetlands	OPTI (2000)
	2000	Gulf Surmont In-Situ Oil Sands Project	38	B2,b3,d1,d2,d3, e1, e3, h1, BTNN, FONS and FONG	Gulf (2001)
	2002	Suncor Reclamation Monitoring	1	e2	Golder (2003c)
	2004	Suncor Monitoring Five Year Report	1.3 / trap night	not reported	Golder (2004b)
	2004	Suncor Voyageur	no observations 5 captured total	n/a observed in b1, b3, d2, FTNN	Golder (2005)
heather vole	1993	University of Alberta	not reported	aspen mixedwood	Moses and Boutin (2001)
meadow vole	1979	Syncrude	common-abundant	not reported	as reported in Westworth (1979)
	1979	AOSERP	not reported	forest and shrub-dominant habitats. Moist habitats with dense grass or sedge cover	Green (1979)
	1984	Syncrude Midred Lake	not reported	prefers successional areas, willow shrub and tamerack forests	Syncrude (1984)
	1993	University of Alberta	not reported	aspen mixedwood	Moses and Boutin (2001)
	1997	Alsands Region	n/a	n/a	Fort McKay Environment Services Ltd (1997)

Table V-23 Small Mammal Survey Results Within the Oil Sands Region (continued)

Small Mammal Species	Year	Project	Abundance (# captures/100 trap nights unless otherwise noted)	Habitat Association	Reference
meadow vole (continued)	1997	Shell Muskeg River Mine Project	not reported	clearings, wet meadows with grass cover, disturbed areas, mixedwood, riparian, upland conifer forest and wetlands	Golder (1997a)
	2000	OPTI Long Lake Project	not reported	riparian	OPTI (2000)
	2000	Gulf Surmont In-Situ Oil Sands Project	5	b2, d1, h1 and FONS.	Gulf (2001)
	2002	Suncor Reclamation Monitoring	7	shrubby grassland	Golder (2003c)
	2004	Suncor Monitoring Five Year Report	2.5 / trap night	not reported	Golder (2004b)
deer mouse	1979	Syncrude	abundant	not reported	as reported in Westworth (1979)
	1979	Syncrude	abundant	not reported	Michielson and Radvanyi (1979)
	1979	AOSERP	not reported	grasslands and early successional habitats	Green (1979)
	1980	AEOSERP	not reported	forest and shrub-dominant habitats and recently disturbed areas (e.g. cutblocks)	Green (1980)
	1984	Syncrude Midred Lake	not reported	most abundant in aspen, balsam poplar or mixedwood forests	Syncrude (1984)
	1993	University of Alberta	not reported	aspen mixedwood	Moses and Boutin (2001)
	2000	OPTI Long Lake Project	not reported	deciduous, coniferous and mixedwood forests and riparian	OPTI (2000)
	2000	Gulf Surmont In-Situ Oil Sands Project	16	a1,b2, b3, d1 and d2	Gulf (2001)
	1993	University of Alberta	not reported	aspen mixedwood	Moses and Boutin (2001)
	2002	Suncor Reclamation Monitoring	38	e1, e2, deciduous-willow, deciduous misc., mixedwood grassland, mixedwood willow, shrubby grassland	Golder (2003c)
	2004	Suncor Monitoring Five Year Report	30 / trap night	not reported	Golder (2004b)
meadow jumping mouse	1997	Shell Muskeg River Mine Project	not reported	grasslands, riparian meadows,clearings, forest edges	Golder (1997a)
	2000	OPTI Long Lake Project	not reported	riparian	OPTI (2000)
northern bog lemming	1997	Shell Muskeg River Mine Project	not reported	wet forested areas, bogs, riparian and wetlands	Golder (1997a)
	2000	OPTI Long Lake Project	not reported	wetlands	OPTI (2000)
flying squirrel	2004 to 2005	Primrose East Expansion	no observations	n/a	Canadian Natural (2006)
mice and voles combined	2005	Devon – Jackfish 2 Project	not reported	observed in d3, i1, j2, c1, and b1	Devon Canada (2006)

n/a = Not applicable

Table V-24 Owl Survey Results Within the Oil Sands Region

Year	Project	Species (Abundance)	Habitat	Reference
1997	Shell Muskeg River Mine	boreal owl (7)	mixedwood, trembling aspen	Golder (1997b)
		great horned owl (1)	black spruce stand	
		Incidentals: great gray owl (4)	unknown	
1998	Steepbank River Valley, Shipyard Lake, & L25 and 29 Uplands	great gray owl (1)	STNN	Golder (1998b)
		Incidentals: great gray owl (1)	a1	
		northern hawk owl (1)	BTNN	
1998	Suncor Project Millennium	great gray owl (1)	STNN	Golder (1998a)
		Incidentals: great gray owl (2)	riparian area, a1	
2000	Firebag Project	great horned owl (7)	FONS, FTNN, d2, g1, h1	Golder (2000e)
		great gray owl (1)	FONS	
		boreal owl (5)	FTNN, g1	
		barred owl (4)	FTNN, d2, g1	
		Incidentals (1998):		
		great gray owl	e1	
		great horned owl	f2, BTNN	
		northern hawk owl	FTNN, c1	
		unknown owl	FTNN, BTNN, e1	
2000	Canadian Natural PAW Project	great-horned owl (10)	shrubby fen, poplar/aspen, aspen/white spruce, white spruce, poor fen/bog, treed fen	Canadian Natural (2000)
		northern-hawk owl (2)	aspen/white spruce, poplar/aspen	
		boreal owls (3)	aspen/white spruce, white spruce/jack pine	
		short-eared owl (1)	shrubby fen	
		northern saw-whet owl (1)	poplar/aspen	
		barred owl (1)	white spruce	
2000	OPTI Long Lake Project	great horned owl (16)	b3, d1, d2, g1, BTNN, SONS	OPTI (2000)
		great gray owl (4)	b2, b3, BTNN	
		boreal owl (10)	g1, BTNN	
		barred owl (15)	b2, b3, d1, d2	

Table V-24 Owl Survey Results Within the Oil Sands Region (continued)

Year	Project	Species (Abundance)	Habitat	Reference
2001	Gulf-Surmont In-Situ Oil Sands Project	barred owl (14)	b1, b2, d1, d2, h1, i1, j1	Gulf (2001)
		boreal owl (1)	i1	
		great horned owl (25)	b1, b2, d1, d2, e1, i1, j1	
		long-eared owl (1)	k3	
		Incidentals:		
		barred owl (27)	a1, b1, b2, c1, d1, e1, h1, i1, j1	
		boreal owl (6)	d2, i1, j1, k1	
		great gray owl (7)	d1, e1, i1, k2, k3	
		great horned owl (34)	b1, b2, d1, d2, e1, i1, j1	
		long-eared owl (2)	f1, k3	
		northern saw-whet owl (2)	c1, d1	
2001	Albian Sands Muskeg River Mine Project Wildlife Assessment	great horned owl (1)	b4	Westworth Associates (2001)
		Incidentals: great horned owl (5)	shrubland, d1, unknown	
		great gray owl (1)	j2	
2001	PanCanadian Christina Lake Thermal Project Wildlife Monitoring	great horned owl (5)	f3, FTNN	Golder (2000a)
		boreal owl (3)	e3, c1/g1, FTNN	
2001	Rio Alto Kirby Project	great horned owl (10)	b1, d2, g1, FTNN	Rio Alto (2002)
		boreal owl (2)	b1, d2	
2001	Petro-Canada Meadow Creek Project	great horned owl (4)	b1, g1, SONS	Petro-Canada (2001)
		great gray owl (1)	d2	
		boreal owl (2)	SONS, FONG	
		barred owl (5)	b3, c1, d2, g1, FTNN	
2001	Shell Jackpine Mine – Phase 1	great horned owl (5)	d2, BTNN, FTNN	Golder (2002a)
		great gray owl (1)	BTNN	
2001	Canadian Natural Horizon Project	great horned owl (24)	d2, d3, BTNN, FTNN, cutblock	Canadian Natural (2002)
		boreal owl (14)	a1, d2, BTNN, FTNN	
		barred owl (8)	b1, d2, e3	
2002	Suncor South Tailings Pond Project	boreal owl (11)	d1, d2, h1, FONS, FTNN, STNN	Golder (2003b)
		barred owl (2)	d3, SONS	
		great gray owl (1)	BTNN	
		great horned owl (1)	b3	
		northern saw-whet owl	STNN	
2002	Devon-Jackfish Project	boreal owl (19)	not reported	Devon Canada (2004)
		northern saw-whet owl (4)		
		great horned owl (4)		
		barred owl (1)		
		Incidentals:		
		great gray owl(1)		

Table V-24 Owl Survey Results Within the Oil Sands Region (continued)

Year	Project	Species (Abundance)	Habitat	Reference
2003	EnCana-Christina Lake Thermal Project	boreal owl (4) northern saw-whet owl (8) *Incidentals:* boreal owl (3) great gray owl (2) great-horned owl (3) northern saw-whet owl (4)	BTNN,b2 and g1 BTNN,FTNN,d2,e2 and g1	Golder (2004a)
2004	MEG Energy Christina Lake Regional Project	boreal owl (9)	c1, burn, b1, d1, FTNN, FONS, disturbed	MEG (2005)
		barred owl (5)	a1, burn, BTNN, d1, STNN	
		great gray owl (8)	BTNN, FONS, a1, c1, burn	
		great horned owl (3)	c1, d2, burn	
2004	Suncor Monitoring Five Year Report	boreal owl (13)	aspen-white spruce; black spruce; white spruce – aspen; black spruce- birch and black spruce-aspen	Golder (2004b)
		great gray owl (3)	black spruce and black sprucen/atamarack	
		barred owl (1)	cutblock area – aspen-white spruce	
2004	Suncor Voyageur	boreal owl (4)	aspen-white spruce	Golder (2005)
		great horned owl (1)	d1	
		no observations	n/a	
2004 to 2005	Primrose East Expansion	boreal owl (14)	a1, b1, FTNN, FONS/BTNN, MONG, h1	Canadian Natural (2006)
		great gray owl (4)	A1, FONG, FONS/BTNN	
		northern saw-whet owl (1)	h1	
2005	Devon – Jackfish 2 Project	*Incidentals:*	not reported	Devon Canada (2006)
		barred owl (2)		
		great grey owl (3)		
		short-eared owl (1)		
2006	Suncor Voyageur South	boreal owl (18)	d1, d2, BTNN, FTNN, SONS, STNN, industrial, cutblock	Suncor (2007)
		great gray owl (4)	d1, d2, FTNN, cutblock	
		barred owl (1)	d3	
2006	EnCana Christina Lake Expansion	boreal owl (75)	a1, b1, BTNN, d1, e1, FONS, FOPN, FTNN, g1, h1, MONG, road, STNN	Non-published data
		barred owl (5)	BTNN, FTNN, g1	
		great gray owl (18)	a1, BTNN, c1, FONS, FTNN, STNN	
		great horned owl (28)	a1, BTNN, c1, d1, FONS, FOPN, FTNN, g1, h1, MONG, SONS, STNN	
		long-eared owl (3)	a1, b1, MONG	
		northern saw-whet (4)	h1, FTNN	

Table V-24 Owl Survey Results Within the Oil Sands Region (continued)

Year	Project	Species (Abundance)	Habitat	Reference
2007	Shell Jackpine Mine Expansion & Pierre River Mine	boreal owl (29, 31)	a1, b2, b3, BTNN, c1, d1, d3, e2, FONS, FTNN, g1, SONS, dist	Present study
		barred owl (0, 14)	a1, d2, d3	
		great gray owl (2, 9)	a1, d2, e2, FTNN, g1, dist	
		great horned owl (8, 6)	a1, BTNN, d2, FTNN	
		long-eared owl (0, 2)	a1, FTNN	
		northern saw-whet (2, 2)	a1, dist	

n/a = Not applicable.

Table V-25 Raptor Survey Results Within the Oil Sands Region

Year	Project	Species (Abundance)	Habitat	Reference
1996	Suncor Steepbank Mine	broad-winged hawk (1)	riparian deciduous forest	Westworth, Brusnyk and Associates (1996c)
		northern goshawk (1)	over Athabasca river	
		northern harrier (1)	near Athabasca river	
		bald eagle (1)	east bank of Athabasca River	
		bald eagle nest (1)	aspen grove	
		unidentified accipiter (1)	near Beaver River	
		Incidentals:		
		red-tailed hawk (1)	open sb-Labrador tea	
		northern harrier (1)	closed shrub complex hab.	
		sharp-shinned hawk (2)	adjacent to aspen cutblock	
		American kestral (1)	adjacent to aspen cutblock	
		bald eagle (3)	near Athabasca River	
		sharp-shinned hawk (2)	east of wetlands 2	
		broad-winged hawk (1)	east side of Ruth Lake	
		northern harrier (1)	north end of reservoir	
1997	Shell Muskeg River Mine	*Incidentals:*		Golder (1997a)
		red-tailed hawk (undisclosed number)	unknown	
1998	Suncor Project Millennium	bald eagle (1)	unknown	Golder (1998a)
		red-tailed hawk (1)	lake area	
		Incidentals:		
		red-tailed hawk (undisclosed number)	unknown	
1998	Mobil Lease 36	*Incidentals:*		Golder (1999a)
		bald eagle (2)	unknown	
2000	Firebag Project	*Incidentals (1998):*		Golder (2000e)
		northern harrier (n/a)	FONS	
		rough-legged hawk (n/a)	BTNN	
		Incidentals (1999):		
		northern harrier (2)	BTNN; FONS	

Table V-25 Raptor Survey Results Within the Oil Sands Region (continued)

Year	Project	Species (Abundance)	Habitat	Reference
2000	Canadian Natural PAW Project	*Incidentals*:		Canadian Natural (2000)
		goshawks	marsh, treed fens	
		red-tailed hawk	jackpine/aspen, shrubby swamp	
		northern harrier	shrubby swamp, deep water	
		ospreys	near a pond	
2000	OPTI Long Lake Project	*Incidentals:*		OPTI (2000)
		broad-winged hawk (2)	mixedwood	
		Cooper's hawk (1)	mixedwood	
		northern goshawk (9)	mixedwood, ponds, Gregoire River, Sb bog, willow, deciduous	
		northern harrier (6)	fen, mixedwood, ponds	
		osprey (2)	Canoe Lake, Kiskatinaw Lake	
		red-tailed hawk (2)	Gregoire River, fen	
		sharp-shinned hawk (1)	Dogwood (e1)	
2001	Gulf-Surmont In-Situ Oil Sands Project	northern goshawk (10)	d2, e2, h1, e1, d1	Gulf (2001)
		Incidentals:		
		Cooper's hawk (1)	d1	
		Sharp-shinned hawk (2)	d1, k2	
2001	Albian Sands Muskeg River Mine Project Wildlife Assessment	northern harrier (3)	j2	Westworth Associates (2001)
		sharp-shinned hawk (9)	e2, d1, Lt-Sb	
		northern goshawk (3)	d1	
		broad-winged hawk (11)	d1, d2, f1	
		red-tailed hawk (15)	b4, d1, b1	
		American kestral (9)	k2	
		merlin (5)	b3	
2001	PanCanadian Christina Lake Thermal Project Wildlife Monitoring	broad-winged hawk (1)	FTNN	Golder (2000a)
		unknown species (1)	f3	
2001	Firebag Project Supplemental	northern harrier (3)	b3, j1, b4	Golder (2000e)
2001	Rio Alto Kirby Project	red-tailed hawk (3)	b1, FTNN	Rio Alto (2002)
		northern harrier (1)	FTNN	
		sharp-shinned hawk (1)	FTNN	
		Swainson's hawk (2)	c1	
		Unknown (1)	d1	

Table V-25 Raptor Survey Results Within the Oil Sands Region (continued)

Year	Project	Species (Abundance)	Habitat	Reference
2001	Petro-Canada Meadow Creek Project	northern goshawk (2)	g1, BTNN	Petro-Canada (2001)
		northern harrier (1)	c1	
		unknown (3)	BTNN, FTNN	
2001	Shell Jackpine Mine – Phase 1	northern goshawk (1)	STNN	Golder (2002a)
		American kestrel (1)	FONS	
2001	Canadian Natural Horizon Project	bald eagle (2)	MONG	Canadian Natural (2002)
		osprey (2)	MONG	
2002	Suncor South Tailings Pond Project	American kestrel (1)	clearcut	Golder (2003b)
		broad-winged hawk (1)	clearcut	
		northern harrier (1)	STNN	
2002	Suncor South Tailings Pond Project	American kestral (1)	clearcut	Golder (2003b)
		broad-winged hawk (1)	clearcut	
		northern harrier (1)	STNN	
2003	EnCana-Christina Lake Thermal Project	Cooper's hawk (1)	not reported	Golder (2004a)
		Incidentals:		
		northern harrier(1)	d2	
		red-tailed hawk(1)	not reported	
		sharp-shinned hawk(1)	not reported	
2004	MEG Energy Christina Lake Regional Project	sharp-shinned hawk (1)	BTNN d2 FTNN	MEG (2005)
		northern goshawk (1)		
		merlin (1)		
		Incidentals:		
		bald eagle (5)		
		northern harrier (2)		
		osprey (2)		
		American kestral (1)		
2004	Suncor Voyageur	American kestrel (1)	FTNN	Golder (2005)
		sharp-shinned hawk (2)	d2, BTNN	
		unknown (1)	FTNN	
		no observations	n/a	
2004 to 2005	Primrose East Expansion	northern goshawk (1)	d2	Canadian Natural (2006)
		Incidentals:		
		sharp-shinned hawks (2)	FTNN	
		northern harrier (1)	FONS	
		unknown (1)	not reported	

Table V-25 Raptor Survey Results Within the Oil Sands Region (continued)

Year	Project	Species (Abundance)	Habitat	Reference
2005	Devon – Jackfish 2 Project	Cooper's hawk (2)	not reported	Devon Canada (2006)
		northern goshawk (2)		
		sharp-shinned hawks (2)		
		red-tailed hawk (2)		
		broad-winged hawk (1)		
		peregrine falcon (1)		
		Incidentals:		
		northern goshawk (2)		
		broad-winged hawk (2)		

n/a = Not applicable.

Table V-26 Grouse Survey Results Within the Oil Sands Region

Year	Project	Results [Tracks/km-track day]	Habitat Preference	Reference
1995	Solv-Ex	3.04	most in aspen and aspen-white spruce[(a)]	Bovar-Concord Environmental (1995)
1997	Shell Muskeg River Mine	1.71	preferred wetlands shrub complex; avoided closed mixedwood, closed mixed coniferous and riparian shrub dominant	Golder (1997a,b)
1997	Suncor Winter Wildlife	0.36 January 0.99 in February	January: preferred FTNN; avoided d1, d3, h1, BTNN, shrub and WONN February: preferred FTNN; avoided a1, d3, d2, d1 and BTNN	Golder (1998a,b)
1997	Suncor Winter Wildlife	0.19 in January 0.30 in February 0.05 in March	did not show a landscape preference	Golder (1998a,b)
1997	Mobil Lease 36	0.36	most in white spruce-aspen and aspen-white spruce mixedwood forests[(a)]	URSUS and Komex (1997)
1998	Suncor Firebag Project	10.60	preferred FONS and FTNN/FFNN; avoided a1, b1, b2, b4, c1, d1, d2, d3 and g1	Suncor (2000)
1998 to 1999	Suncor Wildlife Monitoring	1.76 in reclaimed 2.06 in riparian area beside disturbance	not determined	Golder (1999b)
2000	ATCO Pipeline	mean: 3.1	most common in d3, also common in FTNN	AXYS (2000b)
2000	TrueNorth Fort Hills Oil Sands Project	0.07	preferred STNN and SONS; avoided a1, b1, d1, d2, d3, e1, e2, g1, Shrub and BTNN	Golder (2000b)
2000	Suncor Wildlife Monitoring	4.55 in Lease 86/17 0.63 in Lease 25/97	only riparian corridors sampled	Golder (2000d)
2000	OPTI Long Lake Project	0.14	most tracks observed in the d2 and h1 ecosite phase/wetlands types	OPTI (2000)
2001	Rio Alto Kirby Project	0.17	tracks observed in d2 and FTNN	Rio Alto (2002)
2001	Petro-Canada Meadow Creek Project	0.34	most tracks observed in the d2 and b1 ecosite phase/wetlands types	Petro-Canada (2001)
2001	Canadian Natural Horizon Project	0.33 (upland game birds)	observed mostly in d2, followed by d1, b3, d3, e3, STNN and burn	Canadian Natural (2002)
2001	Shell Jackpine Mine – Phase 1	0.19 (upland game birds)	observed in b3, d2, d3	Golder (2002a)
2002	Suncor South Tailings Pond	0.38 (upland game birds)	observed in d2, FONS, cutblock	Golder (2003b)

Table V-26 Grouse Survey Results Within the Oil Sands Region (continued)

Year	Project	Results [Tracks/km-track day]	Habitat Preference	Reference
2003	EnCana-Christina Lake Thermal Project	1 ruffed grouse and 4 spruce grouse observed incidentally	not reported	Golder (2004a)
2004	MEG Energy	0.60	observed in a1, b2, d1, d2, g1, FONS, FTNN	MEG (2005)
2004	Suncor Voyageur	0.46 0.14	preferences not established no habitat preference	Golder (2005)
2004 to 2005	Primrose East Expansion	0.46	preference for c1, avoidance of WONN	Canadian Natural (2006)
2005 to 2006	Long Lake South Project	0.2	most observed in f2	OPTI/Nexen (2006)
2006	Suncor Voyageur South	0.83	primarily observed in d2, h1, FONS	Suncor (2007)
2006	EnCana Christina Lake Expansion	0.39	primarily observed in FTNN, g1	Non-published data
2007	Shell Jackpine Mine Expansion & Pierre River Mine	0.76 1.68	primarily observed in a1, b3, d2, d3 primarily observed in d1, SONS	Present study

(a) Not statistically significant.

n/a = Not applicable.

Table V-27 Breeding Bird Survey Results Within the Oil Sands Region

Year	Project	Richness [range]	Diversity [range]	Listed Species [Observed Only]	Reference
1997	Shell Muskeg River Mine	6.30 to 16.0[a)]	1.50 to 2.50	blackburnian warbler Cape May warbler	Golder (1997a)
1998	Suncor Project Millennium	2.17 to 4.40	0.67 to 1.36	bay-breasted, blackburnian,black-throated green, Canada and Cape May warblers western tanager	Suncor (1998)
1998	Firebag Project	9.1 to 9.3	1.5 to 1.8	Blackburnian, Canada and Cape May warblers	Suncor (2000)
2000	OPTI Long Lake Project	1.56 to 3.13	0.35 to 0.97	bay-breasted warbler Cape May warbler western tanager	OPTI (2000)
2000	Canadian Natural PAW Project	1.60 to 2.80	0.30 to 0.90	bay-breasted warbler Cape May warbler	Canadian Natural (2000)
2000	TrueNorth Fort Hills Oil Sands Project	n/a	n/a	Cape May warbler bay-breasted warbler	TrueNorth (2001)
2001	Gulf Surmont In-situ Oil Sands Project	47 total richness	1.00 to 17.0	bay-breasted,black-throated green, Canada and Cape May warblers western tanager	Gulf (2001)
2001	Firebag Project Supplemental	1.00 to 4.50	0.90 to 3.05	no observations	Golder (2000e)
2001	Canadian Natural PAW Project Supplemental	2.70 to 4.60	1.30 to 3.30	bay-breasted, black-throated green, Canada and Cape May warblers	Canadian Natural (2000)
2001	Rio Alto Kirby Project	1.00 to 5.00	0.00 to 3.60	western tanager	Rio Alto (2002)
2001	Petro-Canada Meadow Creek Project	1.00 to 4.00	0.00 to 2.51	Cape May warbler western tanager	Petro-Canada (2001)
2001	Shell Jackpine Mine – Phase 1 Project	1.00 to 7.00	0.00 to 6.15	bay-breasted, Canada, and Cape May warblers western tanager	Golder (2002a)
2001	Canadian Natural Horizon Project	2.17 to 6.33	0.75 to 5.12	bay-breasted, black-throated green, Canada and Cape May warblers black-backed woodpecker pileated woodpecker western tanager	Canadian Natural (2002)
2002	Suncor 86/17 Wildlife Monitoring	6.33 to 7.57	5.72 to 7.42	black-throated green warbler horned grebe great blue heron sandhill crane western tanager	Golder (2003c)
2002	Suncor South Tailings Pond	2.14 to 2.72	0.89 to 1.41	bay-breasted warbler pileated woodpecker Cape May warbler western tanager	Golder (2003b)

Table V-27 Breeding Bird Survey Results Within the Oil Sands Region (continued)

Year	Project	Richness [range]	Diversity [range]	Listed Species [Observed Only]	Reference
2002	Devon-Jackfish Project	48 total richness	1.00 – 3.80	black tern pileated woodpecker Cape May warbler black-throated green warbler bay-breasted warbler Canada warbler western tanager	Devon Canada (2004)
2003	EnCana-Christina Lake Thermal Project	39 total richness	2.8-5.5 (mean diversities)	pileated wood-pecker short-billed dowitcher Cape May warbler	Golder (2004a)
2004	MEG Energy Christina Lake Regional Project	1.84 – 1.88 (mean richness)	0.65n/a0.93 (mean diversities)	not reported	MEG (2005)
2004	Suncor Monitoring Five Year Report	5.42 to 6.58 (2002) 4.14 to 5.08 (2003)	4.13 to 5.55 (2002) 2.89 to 3.95 (2003)	horned grebe great blue heron sandhill crane common nighthawk pileated woodpecker Canada warbler western tanager	Golder (2004b)
2004	Suncor Voyageur	1.31 to 2.05 1.65 to 2.83	2.38 to 3.12 3.07 to 4.25	western tanager pileated woodpecker Canada warbler Cape May warbler blackburnian warbler bay-breasted warbler	Golder (2005)
2004 to 2005	Primrose East Expansion	0.5 to 3.00	0.25 to 1.43	pileated woodpecker	Canadian Natural (2006)
2005	Devon – Jackfish 2 Project	64 total richness	2.6 to 4.3	pileated woodpecker black-backed woodpecker bay-breasted warbler Cape May warbler western tanager	Devon Canada (2006)

Table V-27 Breeding Bird Survey Results Within the Oil Sands Region (continued)

Year	Project	Richness [range]	Diversity [range]	Listed Species [Observed Only]	Reference
2005 to 2006	Long Lake South Project	71 total richness	4.8 to 18.4	black tern pileated woodpecker Cape May warbler bay-breasted warbler Canada warbler western tanager	OPTI/Nexen (2006)
2006	Suncor Voyageur South	1.5 to 8.0	0.3 to 7.3	Canada warbler bay-breasted warbler Cape May warbler common yellowthroat western tanager eastern phoebe	Suncor (2007)
2006	EnCana Christina Lake Expansion	0.5 to 8.0	0.0 to 7.7	bay-breasted warbler brown creeper common yellowthroat least flycatcher northern hawk-owl	Non-published data
2007	Shell Jackpine Mine Expansion & Pierre River Mine	1.3 to 5.8	0.3 to 4.7	bay-breasted warbler, brown creeper, Canada warbler, Cape May warbler, common yellowthroat, great gray owl, least flycatcher, rusty blackbird and western tanager, yellow-bellied flycatcher, black tern, black-backed woodpecker	Present study

(a) Methods used were different than from the present study.

n/a = Not applicable.

Table V-28 Amphibian Survey Results Within the Oil Sands Region

Year	Project	Species	Habitat	Reference
1995	Suncor Steepbank Mine	woodfrog (7)	unknown	Westworth, Brusnyk and Associates (1996d)
		boreal chorus frog (364+)	most within a sedge wetlands type with aspen/poplar	
1996	Shipyard Lake	striped chorus frog (n/a)	unknown	Golder (1996)
		wood frog (n/a)	unknown	
1998	PanCanadian Christina Lake Thermal Project Supplementals	boreal chorus frog (29)	e2, FTNN, FONS, WONS	Golder (2000a)
		boreal toad (17)	e2, FTNN, FONS	
		wood frog (2)	e2	
2000	Firebag Project	*Incidentals (1998):* boreal chorus frog (n/a)	d1, d2, FONS, FTNN, h1	Golder (2000e)
		wood frog (n/a)	d2, FONS, FTNN	
2000	Canadian Natural PAW Project	boreal chorus frog (116.5)	MONG, SONS, FONG, FTNN, clearing	Canadian Natural (2000)
		wood frog (40.34)	MONG, SONS, FONG, FTNN, clearing, FONS	
		Canadian toad (6)	MONG, FONG	
		western (boreal) toad (0.5)	MONG	
2000	PanCanadian Christina Lake Thermal Project	boreal chorus frog (34)	d2, FONS, FTNN, MONG, SONS	Golder (2000a)
		boreal toad (16)	a1, f1, FTNN, MONG, SONS	
		wood frog (19)	a1, e2, e3, FONS, FTNN, MONG, SONS	
2000	OPTI Long Lake Project	boreal frog (25)	b2, b3, d1, d2, d3, e3, g1, BTNN, FONS, FTNN, MONS, STNN	OPTI (2000)
		wood frog (16)	b3, d2, e3, BTNN, FONS, FTNN, MONS, STNN	
2001	PanCanadian Christina Lake Thermal Project Supplementals	boreal chorus frog (26)	f2, f3, g1, BTNN, FTNN, FONS, FONG, MONG, SONS, clearcut	Golder (2001b)
		wood frog (22)	f2, f3, g1, BTNN, FTNN, FONS, FONG, MONG, SONS, clearcut	
		boreal toad (19)	f3, g1, BTNN, FTNN, FONS, FONG, MONG, clearcut	
2001	Firebag Project Supplemental	boreal chorus frog (18)	ephemeral pond, permanent creek	Golder (2000e)
		wood frog (7)	ephemeral pond	
2001	Rio Alto Kirby Project	boreal chorus frog (154)	b1, b4, c1, d1, d2, g1, disturbed, BTNN, FONS, FTNN, MONG, MONS, SONS, STNN, WONN	Rio Alto (2002)
		wood frog (149)	b4, c1, d1, d2, g1, disturbed, BTNN, FONS, FTNN, MONG, MONS, SONS, STNN, WONN	
		boreal toad (81)	c1, d1, d2, g1, disturbed, BTNN, FONS, FTNN, MONG, MONS, SONS, STNN, WONN	
2001	Petro-Canada Meadow Creek Project	boreal chorus frog (41)	b3, c1, d2, BTNN, FONG, FONS, FTNN, MONG, MONS, shrubland, SONS, STNN	Petro-Canada (2001)
		wood frog (82)	b1, b3, c1, d2, g1, BTNN, FONG, FONS, FTNN, MONG, MONS, shrubland, SONS, STNN	

Table V-28 Amphibian Survey Results Within the Oil Sands Region (continued)

Year	Project	Species	Habitat	Reference
2001	Shell Jackpine Mine – Phase 1	boreal chorus frog (28)	b2, d2, FTNN, FONG, FONS,MONS, MONS/SONS, MONS/STNN, STNN, SONS, WONN	Golder (2002a)
		wooded frog (28)	b2, d2, FTNN, FONG, FONS,MONS, MONS/SONS, MONS/STNN, STNN, SONS, WONN	
2001	Canadian Natural Horizon Project	boreal chorus frog (56)	a1, b3, d1, d2, e1, e2, h1, BTNN, FONS, FTNN, MONG, MONS, SONS, STNN, cutblock, landfill	Canadian Natural (2002)
		wood frog (49)	b3, e1, e2, BTNN, FONS, FTNN, MONG, MONS, SONS, STNN, cutblock	
		Canadian toad (12)	a1, d2, BTNN, FTNN, MONS, SONS, STNN, landfill	
2002	Suncor Reclamation Monitoring	Canadian toad (24) wood frog (17) boreal chorus frog (236)	reclamation vegetation classes mixedwood willow and mixedwood grassland. WOFR and BCFR also observed in deciduous willow	Golder (2003c)
2002	Suncor South Tailings Pond	wood frog (15) boreal chorus frog (25)	d2, d3, FTNN, SONS, STNN	Golder (2003b)
2002	Devon-Jackfish Project	boreal chorus frog (many) wood frog (many) western toad (many)	not reported	Devon Canada (2004)
2003	EnCana-Christina Lake Thermal Project	boreal chorus frog (194) wood frog (41) boreal toad (119)	most observations in FTNN and FONS	Golder (2004a)
2004	MEG Energy Christina Lake Regional Project	western (boreal) toad (28) wood frog (39) boreal chorus frog (35) Canadian toad incidental	most observations within standing water along cutlines, followed by FTNN; also recorded in a1, b1, b3, BTNN, MONG, MONS, WONN	MEG (2005)
2004	Suncor Monitoring Five Year Report	wood frog (53) boreal chorus frog (636) Canadian toad (83)	reclaimed sites	Golder (2004b)
2004	Suncor Voyageur	wood frog (26) boreal chorus frog (32) wood frog (20) boreal chorus frog (24)	various	Golder (2005)
2004 to 2005	Primrose East Expansion	wood frog (33) boreal chorus frog (98) boreal toad (5) Canadian toad (6)	c1, d2, d3, FONS, FTNN c1, d2, d3, FONS, FTNN, disturbed FONS, FTNN d2, FONS, FTNN, disturbed	Canadian Natural (2006)

Table V-28 Amphibian Survey Results Within the Oil Sands Region (continued)

Year	Project	Species	Habitat	Reference
2005	Devon – Jackfish 2 Project	western (boreal) toad (many) wood frog (several) boreal chorus frog (many)	not reported	Devon Canada (2006)
2005 to 2006	Long Lake South Project	Canadian toad (46)	most observations in NWL and CC	OPTI/Nexen (2006)
2006	Suncor Voyageur South	wood frog (34) boreal chorus frog (272) Canadian toad (8)	disturbed (11), various others disturbed (116), various others disturbed (5), e2, FONS, riparian	Suncor (2007)
2006	EnCana Christina Lake Expansion	wood frog (31) boreal chorus frog (79) boreal toad (39) Canadian toad (2)	FTNN (18), various others FTNN (214), various others FTNN (27), various others FTNN, BTNN	Non-published data
2007	Shell Jackpine Mine Expansion & Pierre River Mine	wood frog (162, 42) boreal chorus frog (1998, 528) boreal toad (3, 0) Canadian toad (24, 29)	primarily d2, FTNN, SONS primarily FONG, FTNN, MONG BTNN, FTNN primarily c1, FTNN, dist	Present study

n/a = Not applicable.

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APPENDIX W

PHOTOGRAPHIC CORRIDOR AND BAIT STATION DATA

Submitted to:
Shell Canada Limited

Prepared by:
Golder Associates Ltd.

December 2007 **05-1344-027**

50 BEST EMPLOYERS IN CANADA 2007

CANADA'S 50 BEST MANAGED PRIVATE COMPANIES

OFFICES ACROSS NORTH AMERICA, SOUTH AMERICA, EUROPE, ASIA AND AUSTRALIA

LIST OF TABLES

Table W-1 Fall Photographic Bait Station Results in the Jackpine Expansion Mining Area 1
Table W-2 Fall Photographic Bait Station Results in the Pierre River Mining Area 1
Table W-3 Winter Photographic Bait Station Results in the Jackpine Expansion Mining Area 1
Table W-4 Winter Photographic Bait Station Results in the Pierre River Mining Area 2
Table W-5 Spring Photographic Bait Station Results in the Jackpine Expansion Mining Area 2
Table W-6 Spring Photographic Bait Station Results in the Pierre River Mining Area 2
Table W-7 Summer Photographic Bait Station Results in the Jackpine Expansion Mining Area 3
Table W-8 Summer Photographic Bait Station Results in the Pierre River Mining Area 3
Table W-9 Fall Photographic Corridor Station Results in the Jackpine Expansion Mining Area 3
Table W-10 Fall Photographic Corridor Station Results in the Pierre River Mining Area 4
Table W-11 Winter Photographic Corridor Station Results in the Jackpine Expansion Mining Area 4
Table W-12 Winter Photographic Corridor Station Results in the Pierre River Mining Area 4
Table W-13 Spring Photographic Corridor Station Results in the Jackpine Expansion Mining Area 5
Table W-14 Spring Photographic Corridor Station Results in the Pierre River Mining Area 5
Table W-15 Summer Photographic Corridor Station Results in the Jackpine Expansion Mining Area 5
Table W-16 Summer Photographic Corridor Station Results in the Pierre River Mining Area 6

Table W-1 Fall Photographic Bait Station Results in the Jackpine Expansion Mining Area

Species	Photos at Stations				Days to First Photo		
	Number of Photos	Stations With Photos	Total Stations	Rate	Mean	Min	Max
Canada lynx	1	1	7	0.14	9.0	n/a	n/a
fisher	2	1	7	0.14	12.1	n/a	n/a
marten	17	3	7	0.43	3.5	2	5.1
red squirrel	5	2	7	0.29	6.9	3.1	10.8

n/a = Not applicable.

Table W-2 Fall Photographic Bait Station Results in the Pierre River Mining Area

Species	Photos at Stations				Days to First Photo		
	Number of Photos	Stations With Photos	Total Stations	Rate	Mean	Min	Max
fisher	14	5	28	0.18	10.8	2.3	15.2
least weasel	1	1	28	0.04	17.1	n/a	n/a
marten	51	18	28	0.64	5.6	0.3	19.0
moose	4	4	28	0.14	3.3	0.4	7.0
white-tailed deer	6	4	28	0.14	7.0	0.7	18.9
wolf	3	1	28	0.04	2.3	n/a	n/a
wolverine	9	1	28	0.04	1.8	n/a	n/a

n/a = Not applicable.

Table W-3 Winter Photographic Bait Station Results in the Jackpine Expansion Mining Area

Species	Photos at Stations				Days to First Photo		
	Number of Photos	Stations With Photos	Total Stations	Rate	Mean	Min	Max
marten	18	2	9	0.22	2.8	0.3	5.3
red squirrel	10	1	9	0.11	0.8	n/a	n/a

n/a = Not applicable.

Table W-4 Winter Photographic Bait Station Results in the Pierre River Mining Area

Species	Photos at Stations				Days to First Photo		
	Number of Photos	Stations With Photos	Total Stations	Rate	Mean	Min	Max
Canada lynx	1	1	32	0.03	13.0	n/a	n/a
fisher	2	2	32	0.06	2.4	1.0	3.7
marten	12	10	32	0.28	5.1	0.8	10.0
white-tailed deer	1	1	32	0.03	12.0	n/a	n/a
wolf	1	1	32	0.03	10.5	n/a	n/a

n/a = Not applicable.

Table W-5 Spring Photographic Bait Station Results in the Jackpine Expansion Mining Area

Species	Photos at Stations				Days to First Photo		
	Number of Photos	Stations With Photos	Total Stations	Rate	Mean	Min	Max
marten	16	5	8	0.63	3.6	0.7	5.0
moose	6	3	8	0.38	3.1	0.4	7.1

Table W-6 Spring Photographic Bait Station Results in the Pierre River Mining Area

Species	Photos at Stations				Days to First Photo		
	Number of Photos	Stations With Photos	Total Stations	Rate	Mean	Min	Max
black bear	68	22	32	0.69	4.3	0.1	13.7
fisher	4	3	32	0.09	7.0	2.2	9.6
grouse species	1	1	32	0.03	5.1	n/a	n/a
marten	13	11	32	0.31	4.0	0.4	11.7
moose	6	6	32	0.19	5.4	0.4	10.8
red squirrel	3	2	32	0.07	6.1	3.8	8.4
sandhill crane	1	1	32	0.03	10.0	n/a	n/a
snowshoe hare	1	1	32	0.03	2.5	n/a	n/a
weasel species	1	1	32	0.03	8.8	n/a	n/a
white-tailed deer	2	2	32	0.06	8.5	4.1	12.8

n/a = Not applicable.

Table W-7 Summer Photographic Bait Station Results in the Jackpine Expansion Mining Area

Species	Photos at Stations				Days to First Photo		
	Number of Photos	Stations With Photos	Total Stations	Rate	Mean	Min	Max
black bear	19	6	8	0.75	4.8	0.0	9.0
fisher	11	1	8	0.13	5.1	n/a	n/a
grouse species	2	1	8	0.13	10.3	n/a	n/a
marten	7	5	8	0.63	2.9	0.4	6.5
moose	4	3	8	0.38	8.5	4.8	11.8

n/a = Not applicable.

Table W-8 Summer Photographic Bait Station Results in the Pierre River Mining Area

Species	Photos at Stations				Days to First Photo		
	Number of Photos	Stations With Photos	Total Stations	Rate	Mean	Min	Max
black bear	137	29	32	0.90	4.0	0.3	12.3
fisher	3	3	32	0.09	6.6	2.8	10.6
grouse species	1	1	32	0.03	9.0	n/a	n/a
marten	20	14	32	0.41	4.9	0.4	11.8
moose	9	7	32	0.22	7.9	5.3	11
red squirrel	5	3	32	0.09	11.3	4.9	15.0
snowshoe hare	3	2	32	0.06	2.7	2.6	2.7
white-tailed deer	4	2	32	0.06	6.3	5.6	6.9
wolf	3	2	32	0.06	5.6	4.5	6.8

n/a = Not applicable.

Table W-9 Fall Photographic Corridor Station Results in the Jackpine Expansion Mining Area

Species	Photos at Stations				Days to First Photo		
	Number of Photos	Stations With Photos	Total Stations	Rate	Mean	Min	Max
coyote	3	3	17	0.18	7.0	4.5	11.0
moose	6	2	17	0.12	6.3	3.3	9.2
marten	3	1	17	0.06	3.9	n/a	n/a
snowshoe hare	2	2	17	0.12	2.5	1.7	3.3
white-tailed deer	2	1	17	0.06	0.9	n/a	n/a
wolf	1	1	17	0.05	12.9	n/a	n/a

n/a = Not applicable.

Table W-10 Fall Photographic Corridor Station Results in the Pierre River Mining Area

Species	Photos at Stations				Days to First Photo		
	Number of Photos	Stations With Photos	Total Stations	Rate	Mean	Min	Max
coyote	5	2	24	0.04	8.6	n/a	n/a
fisher	1	1	24	0.04	17.2	n/a	n/a
marten	7	3	24	0.12	1.6	0.8	2.9
moose	1	1	24	0.04	4.1	n/a	n/a
pileated woodpecker	2	2	24	0.08	5.5	3.0	8.0
white-tailed deer	8	5	24	0.21	2.9	1.3	5.8
wolf	3	3	24	0.13	5.5	2.7	11.0
wolverine	1	1	24	0.04	8.9	n/a	n/a

n/a = Not applicable.

Table W-11 Winter Photographic Corridor Station Results in the Jackpine Expansion Mining Area

Species	Photos at Stations				Days to First Photo		
	Number of Photos	Stations With Photos	Total Stations	Rate	Mean	Min	Max
coyote	2	2	13	0.15	8.3	4.5	12.0
moose	1	1	13	0.08	11.2	n/a	n/a
river otter	1	1	13	0.08	2.3	n/a	n/a
snowshoe hare	1	1	13	0.08	10.4	n/a	n/a

n/a = Not applicable.

Table W-12 Winter Photographic Corridor Station Results in the Pierre River Mining Area

Species	Photos at Stations				Days to First Photo		
	Number of Photos	Stations With Photos	Total Stations	Rate	Mean	Min	Max
fisher	1	1	24	0.04	5.8	n/a	n/a
marten	1	1	24	0.04	11.0	n/a	n/a
white-tailed deer	1	1	24	0.04	1.9	n/a	n/a
wolf	1	1	24	0.04	2.0	n/a	n/a

n/a = Not applicable.

Table W-13 Spring Photographic Corridor Station Results in the Jackpine Expansion Mining Area

Species	Photos at Stations				Days to First Photo		
	Number of Photos	Stations With Photos	Total Stations	Rate	Mean	Min	Max
black bear	9	6	24	0.25	7.3	0.2	14.2
coyote	7	5	24	0.21	5.1	0.9	8.4
moose	9	5	24	0.21	4.9	0.7	9.3
sandhill crane	2	2	24	0.08	7.5	7.2	7.9
snowshoe hare	21	6	24	0.25	2.6	0.2	10.4
white-tailed deer	17	9	24	0.38	2.9	0.5	6.9
wolf	4	4	24	0.17	6.8	2.4	11.4

Table W-14 Spring Photographic Corridor Station Results in the Pierre River Mining Area

Species	Photos at Stations				Days to First Photo		
	Number of Photos	Stations With Photos	Total Stations	Rate	Mean	Min	Max
black bear	24	14	23	0.52	6.1	0.0	11.0
coyote	1	1	23	0.04	2.9	n/a	n/a
marten	4	3	23	0.13	9.1	7.5	10.3
moose	5	5	23	0.22	6.4	1.5	11.4
snowshoe hare	1	1	23	0.04	6.5	n/a	n/a
white-tailed deer	23	10	23	0.43	6.4	0.6	11.0
wolf	3	2	23	0.09	6.0	0.7	11.3

n/a = Not applicable.

Table W-15 Summer Photographic Corridor Station Results in the Jackpine Expansion Mining Area

Species	Photos at Stations				Days to First Photo		
	Number of Photos	Stations With Photos	Total Stations	Rate	Mean	Min	Max
black bear	13	7	22	0.23	5.4	0.1	15.2
coyote	4	1	22	0.04	2.2	n/a	n/a
grouse species	2	2	22	0.09	11.5	7.1	15.8
marten	9	4	22	0.18	5.3	0.8	14.9
meadow vole	14	1	22	0.05	5.3	n/a	n/a
moose	4	4	22	0.18	11.5	4.4	15.6
snowshoe hare	7	4	22	0.18	3.0	0.5	7.3
white-tailed deer	16	6	22	0.23	6.0	1.9	8.9

n/a = Not applicable.

Table W-16 Summer Photographic Corridor Station Results in the Pierre River Mining Area

Species	Photos at Stations				Days to First Photo		
	Number of Photos	Stations With Photos	Total Stations	Rate	Mean	Min	Max
black bear	43	17	24	0.71	5.9	0.2	13.9
Canada lynx	2	2	24	0.08	7.1	1.7	12.6
coyote	1	1	24	0.04	9.8	n/a	n/a
fisher	1	1	24	0.04	7.3	n/a	n/a
marten	2	2	24	0.08	7.3	4	10.6
moose	3	3	24	0.13	2.5	0.0	4.7
sandhill crane	2	1	24	0.04	5.2	n/a	n/a
snowshoe hare	2	2	24	0.08	11.6	10.7	12.5
white-tailed deer	17	8	24	0.33	7.3	1.3	15.7
wolf	4	4	24	0.17	7.7	4.8	11.6

n/a = Not applicable.

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BIODIVERSITY ENVIRONMENTAL SETTING FOR THE JACKPINE MINE EXPANSION & PIERRE RIVER MINE PROJECT

Submitted to:
Shell Canada Limited

Prepared by:
Golder Associates Ltd.

December 2007 **05-1344-027**

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TABLE OF CONTENTS

SECTION **PAGE**

6 BIODIVERSITY 1
6.1 INTRODUCTION 1
6.2 STUDY OBJECTIVES 2
6.3 METHODS 3
6.3.1 Ecosystem-Level Biodiversity Ranking 3
6.4 RESULTS AND DISCUSSION 8
6.4.1 Species-Level Biodiversity 9
6.4.2 Ecosystem-Level Biodiversity 11
6.4.3 Landscape-Level Biodiversity 22
6.5 SUMMARY 25

LIST OF TABLES

Table 6.3-1 Summary of Biodiversity Indicators According to Biological Level 4
Table 6.3-2 Ecosystem-Level Biodiversity Indices Assessed 6
Table 6.4-1 Biodiversity Potential of Ecodistricts Within the Regional Study Area 11
Table 6.4-2 Biodiversity Potential of Regional Land Cover Classes Within the Regional Study Area 14
Table 6.4-3 Biodiversity Potential in the Jackpine Expansion Mining Area Local Study Area 16
Table 6.4-4 Biodiversity Potential in the Pierre River Mining Area Local Study Area 18

LIST OF FIGURES

Figure 6.4-1 Biodiversity Potential in the Regional Study Area 13
Figure 6.4-2 Biodiversity Potential in the Jackpine Expansion Mining Area Local Study Area 15
Figure 6.4-3 Biodiversity Potential in the Pierre River Mining Area Local Study Area 20

LIST OF APPENDICES

Appendix X Biodiversity Ranking Protocol and Results for the Oil Sands Region

6 BIODIVERSITY

6.1 INTRODUCTION

The Canadian Biodiversity Strategy (Environment Canada 1995) emphasizes the need for ecological management, increased understanding of ecosystems, conservation of biodiversity and use of biological resources in a sustainable manner. The mandate of the Sustainable Ecosystems Working Group (SEWG), is to develop a framework to manage the cumulative effects of development and resource use on landscapes and ecosystems, including biodiversity.

Biological organization ranges from small things such as genes, through individual organisms, species, populations, communities, ecosystems and landscapes. Biodiversity encompasses the variety of life at these levels of organization and all the ecological and biological processes through which they are connected. There are four levels at which biodiversity is commonly considered: genes, species, ecosystems and landscapes (Noss and Cooperrider 1994).

Genetic diversity measures the variety of genetic subtypes within a species. This issue is important because it is ultimately the amount of genetic variation that determines the expressed phenotypic (observable) variation in a population. Genetic diversity is maintained through the interbreeding of different populations within a species and increases the probability that a species can persist under changing environmental conditions. Genetic variation is also important in the maintenance of rare species. Little information exists concerning genetic diversity of species in the Oil Sands Region; therefore, it is not addressed in this biodiversity environmental setting report. The Oil Sands Region is defined as the area which includes the Athabasca Oil Sands Subregional Integrated Resource Plan (IRP), the Lakeland Subregional IRP and the Cold Lake – Beaver River Subregional IRP.

Species are the basic compositional features within communities. Species may be defined as groups of morphologically similar organisms that have descended from a common ancestor and which produce fertile offspring only among themselves. There are several indicator variables at the species level of organization, including: species presence/absence, abundance, biomass, habitat specificity, demographics and population structure (e.g., sex ratios, age ratio) of individual species (Noss 1990). The fish and fish habitat, vegetation and wildlife components (Section 5 of the Aquatics ESR [Golder 2007] and Sections 3 and 5 in this report, respectively) examine species-level biodiversity indices such as abundance and distribution of plant and animal species. This section provides a

general overview of biodiversity at the species-level of biological organization, with more detailed, species-specific summaries found in the sections indicated above.

Ecosystems are a dynamic complex of plants, animals, micro-organisms and their non-living environment interacting as a functional unit (Environment Canada 1995). Ecosystems can be large-scale, describing the entire biosphere, or small-scale, referring to a single drop of water (Environment Canada 1995). In this report the term "ecosystem" has been used preferentially over the term "community". Communities are similar groupings of plants and animals that exist within individual landscapes, but do not include the non-living environment. Since ecosite phases and wetlands types are the primary objects of study in the Oil Sands Region, the use of the term "ecosystem" is preferred, because ecosite phases and wetlands types are highly linked with the moisture and nutrient regimes that are responsible for their development.

This section focuses on the ecosystem-level and evaluates the biodiversity potential for all ecodistricts and regional land cover classes in the Regional Study Area (RSA) and all ecosite phases, wetlands types and disturbed areas in the two Local Study Areas (LSAs). The ranking system combines several indices that reflect biodiversity values and can be quantified from available vegetation and wildlife information for the Oil Sands Region.

A landscape is a land area with groups of plant communities or ecosystems forming an ecological unit with distinguishable structure, function, geomorphology and disturbance regimes (Gaines et al. 1999). Landscape types are primarily defined by physical features. The relationship between landscape structure/pattern to biodiversity has been well established in the scientific literature (e.g., Forman and Gordon 1986). Landscape features such as patch size and shape, heterogeneity and proximity of similar patches have major implications on species composition, distribution and viability (Noss and Harris 1986). In most instances, biodiversity at the landscape-level refers to the pattern of vegetation and wildlife species communities distributed across the landscape (Noss and Cooperrider 1994). Landscape-level analyses (i.e., fragmentation and heterogeneity) were used in previous sections of this report (Section 3 and 5) and are summarized in terms of biodiversity in this section.

6.2 STUDY OBJECTIVES

The main objective of this component is to summarize biodiversity at the species, ecosystem and landscape levels. Analyses from the other aquatic and terrestrial

components are discussed within the context of biodiversity at the species and landscape-levels of biological organization. An emphasis is placed on examining biodiversity at the ecosystem-level using a regional biodiversity ranking approach developed for the Oil Sands Region in 2000 (Golder 2000a) and periodically updated. This approach identifies areas of high, moderate and low biodiversity potential in the RSA and two LSAs. Areas are ranked based on an integration of five ecosystem-level biodiversity indices, as recommended by SEWG (CEMA 2006). These indices consider the composition, structure and function of ecosystems and were chosen because they can be quantified from available vegetation and wildlife information for the Oil Sands Region. Ecosystem-level biodiversity indices include:

- rare vegetation types;
- total species richness;
- species overlap;
- rare species potential; and
- structural complexity.

6.3 METHODS

Methods to assess existing biodiversity in the study areas for three levels of biological organization (species, ecosystem and landscape) are discussed throughout this report, as well as Golder 2007 (as referenced in Table 6.3-1). This section only provides methods with respect to ecosystem-level biodiversity.

6.3.1 Ecosystem-Level Biodiversity Ranking

Information and methods used for this Project are consistent with methods, data analysis and descriptions used in previous Oil Sands Region Environmental Impact Assessments (EIAs) and environmental setting reports (e.g., CNRL 2002, 2006, 2007; Golder 2000a; MEG 2005; Shell 2002, 2005; Suncor 2005, 2007). The following sections summarize the data sources, mapping, biodiversity indices and scoring and ranking process used in the biodiversity ranking. A detailed description of the methods for the ecosystem-level biodiversity ranking, based on the approach originally developed by Golder (2000a), can be found in Appendix X.

Table 6.3-1 Summary of Biodiversity Indicators According to Biological Level

Level of Biological Organization	Biodiversity Indicator Variables	Reference Section [s#]
genetics	allelic diversity	n/a[(a)]
	presence of rare alleles	n/a[(a)]
species	abundance and distribution	Fish and Fish Habitat (s5 in Golder 2007); Vegetation, Wildlife and Wildlife Habitat, Biodiversity (s3, s5 and s6, respectively, in this report)
	habitat specificity	Fish and Fish Habitat (s5 in Golder 2007); Wildlife and Wildlife Habitat, Biodiversity (s5 and s6, in this report)
ecosystem	rare vegetation types	Vegetation, Biodiversity with Appendix X (s3 and s6, in this report)
	total species richness	Fish and Fish Habitat (s5 in Golder 2007); Vegetation, Wildlife and Wildlife Habitat, Biodiversity with Appendix X (s3, s5 and s6, respectively, in this report)
	species overlap	Fish and Fish Habitat (s5 in Golder 2007); Vegetation, Wildlife and Wildlife Habitat, Biodiversity with Appendix X (s3, s5 and s6, respectively, in this report)
	rare species potential	Fish and Fish Habitat (s5 in Golder 2007); Vegetation, Biodiversity with Appendix X (s3 and s6, in this report)
	structural complexity	Vegetation, Forestry, Biodiversity with Appendix X (s3, s4 and s6, respectively, in this report)
	old growth	Vegetation, Forestry, Wildlife and Wildlife Habitat (s3, s4 and s5, respectively, in this report)
	riparian	Vegetation, Wildlife and Wildlife Habitat (s3 and; s5, in this report)
landscape	heterogeneity	Vegetation with Appendix J, Biodiversity (s3 and s6, in this report)
	fragmentation	Vegetation with Appendix J, Wildlife and Wildlife Habitat, Biodiversity (s3, s5 and s6, respectively, in this report)
	core area	Vegetation with Appendix J, Wildlife and Wildlife Habitat, Biodiversity (s3, s5 and s6, respectively, in this report)
	habitat isolation	Biodiversity (s6 in this report)
	edge effects	Vegetation, Wildlife and Wildlife Habitat, Biodiversity (s3, s5 and s6, respectively, in this report)
	non-native/invasive species	Vegetation, Wildlife and Wildlife Habitat, Biodiversity (s3, s5 and s6, respectively, in this report)

(a) The genetic-level of biological organization is not addressed in this report.

n/a = Not applicable.

6.3.1.1 Data Sources

The data used to develop the scoring values to rank biodiversity potential are derived from existing project data, literature and regional research programs in the Oil Sands Region encompassing areas north and south of Fort McMurray. A complete list of the projects and data sources used is found in Appendix X.

6.3.1.2 Mapping

Separate spatial representations of the landscape are analyzed for the RSA and LSAs using ecosystem-level biodiversity indicators. Ecodistrict classes are developed using the ecodistrict descriptions obtained from the National Ecological Framework (Marshall and Schut 1999). Ecodistricts, originally delineated by Strong (1992), are modified based on the regional land cover classes derived from satellite imagery, as well as surficial geology maps (Bayrock 1973; Bayrock and Reimchen 1974), 1:250,000 National Topographic Survey (NTS) maps and soils inventory/Ecological Land Classification (ELC) mapping (Turchenek and Lindsay 1982).

The regional land cover classes in the RSA are analyzed using the reflectance value classes of satellite imagery. The ecosite phases/wetlands types in the LSAs are analyzed using Alberta Vegetation Inventory (AVI) (Beckingham and Archibald 1996), Alberta Wetlands Inventory (AWI) (Halsey et al. 2003) and vegetation composition field data. A more detailed description of the mapping process can be found in Section 3.3.2 of this report.

As discussed in Sections 3.2.2 and 3.2.3, the Jackpine Expansion Mining Area (JEMA) LSA is located entirely within the Central Mixedwood Natural Subregion, whereas the Pierre River Mining Area (PRMA) LSA is located in two natural subregions, the Central Mixedwood (21% of the LSA) and Athabasca Plain (79% of the LSA). There are different ecosite phases in each natural subregion, so data are presented for both natural subregions in the PRMA LSA. The wetlands types and disturbance (i.e., urban, industrial and agricultural developments) categories are the same for both natural subregions.

6.3.1.3 Biodiversity Indices

Each ecosite phase and wetlands type is evaluated for five ecosystem-level biodiversity indices summarized in Table 6.3-2, including rare vegetation types, total species richness, species overlap, rare species potential and structural complexity. Data on riparian and old growth communities are not sufficient to include these indices in the ranking system. The five indices are chosen because they consider the composition, structure and function of ecosystems, and can be quantified from available vegetation and wildlife information for the Oil Sands Region. Each index is briefly described and discussed within the ecological context of the Oil Sands Region in the following paragraphs. Additional details on the biodiversity indices and how these indices are ranked in the Oil Sands Region can be found in Appendix X.

Table 6.3-2 Ecosystem-Level Biodiversity Indices Assessed

Biodiversity Index	Description	Maximum Score[(a)]
rare vegetation type	measure of relative abundance of pre-disturbance vegetation types	6
total species richness	number of native and non-native vascular plant species estimates of species richness for bryophytes and lichen	4
	number of aquatic and terrestrial wildlife species	4
rare species potential	number of special status plant species (ANHIC 2006)	4
	number of special status wildlife species (AENV 2005)	4
species overlap	measurement of the proportion of plant species also occurring in other vegetation types	4
	measurement of the proportion of wildlife species also occurring in other vegetation types	4
structural complexity	based on the presence of different vegetation layers (forb and/or shrub layers) and the tree stand (single- or multi-storey stands)	4

(a) Refer to Appendix X for a detailed description of the scoring process.

Rarity of Vegetation Type

Rarity of vegetation type is a measure of the relative abundance of ecosite phases and wetlands types within the Oil Sands Region. In many cases, rare ecosite phases and wetlands types also support rare species and therefore, any loss or disturbance to rare vegetation types will have a negative impact on local plant and animal populations. For example, open patterned fen (FOPN) is a rare wetlands type in the Oil Sands Region that supports many rare plant species, which influences its high biodiversity potential ranking (Appendix X).

Species Richness

Total species richness measures the number of species in a sampling unit (Magurran 1988). This measure is important to biodiversity because loss of habitat with high species richness will negatively impact a greater number of species. Wooded fens (FTNN), for example, typically support a much greater number of plant and wildlife species than do lichen jack pine stands (a1). In the Oil Sands Region, wooded fens are ranked high for biodiversity potential, whereas a1 is ranked low (Appendix X).

Species Overlap

Species overlap is a measure of the proportion of species in an ecosite phase or wetlands type also found in other vegetation types. It indicates whether vegetation types contain proportionately more species that are habitat specialists versus habitat generalists. Disturbance to ecosite phases and wetlands types that support unique species (i.e., habitat specialists) can negatively affect biodiversity

if the disturbance results in the loss of those species that are not found in any other habitats. In the Oil Sands Region, plant species overlap is typically common among ecosite phases, with very few occurrences of species not found in any other habitat. Unique plant species are more commonly found in wetlands types, with wooded fens (FTNN) having the highest number (Appendix X).

Wildlife species overlap is even more common than plant species overlap due to the mobility of wildlife and their tendency to use more than one vegetation type on a daily basis. Unique wildlife species have not been recorded in any ecosite phases in the Oil Sands Region. Among wetlands types, shrubby swamps (SONS) contain the most unique wildlife species and, are thus are ranked as having high biodiversity potential (Appendix X).

Rare Species Potential

Rare species potential measures the abundance of special status plant (ANHIC 2006) and wildlife (AENV 2005) species relative to the habitat in which they would be expected to occur. Rare plant and wildlife species often require specific ecological conditions and as such are particularly vulnerable to habitat alteration. Thus, identifying ecosystems that support rare species is an important consideration in preserving the biodiversity of a region. In the Oil Sands Region, fens typically have the highest rare plant potential, while fens and swamps typically have the highest potential to support rare wildlife species. Fens and swamps are ranked as having either high or moderate biodiversity potential (Appendix X).

Some ecosite phases and wetlands types may be ranked as having moderate or low rare species potential, yet still possess compositional characteristics important for special status plants and wildlife. For example, the relatively high number of lichens found in a1 [Section 3.5.2.1] are an important food source for woodland caribou [Section 5.8.2.1]).

Structural Complexity

Structural complexity measures the vertical stratification (number of vegetation layers) in a habitat. An increase in complexity of vertical stratification naturally leads to an increase in plant diversity and has also been correlated with the diversity of wildlife species that occur within an ecosystem (Morse 1989). Therefore, structural complexity is considered to be a valuable index for overall biodiversity. Disturbances that reduce structural complexity within a habitat and/or eliminate habitats with high structural complexity will negatively impact local populations and ultimately reduce biodiversity.

Among ecosite phases in the Oil Sands Region, blueberry aspen–white birch (b2) and Labrador tea–subhygric black spruce–jack pine (g1) are the most structurally complex (Appendix X). Blueberry aspen–white birch (b1) is ranked as having moderate biodiversity potential while g1 is ranked as low. Generally, the wooded fens and swamps have the highest structural complexity among wetlands types.

6.3.1.4 Scoring and Ranking Process

All ecosite phases, wetlands types, water and other classes are collectively referred to as "vegetation types" and are scored based on their combined total score for all biodiversity indices (Table 6.3-2), for a maximum possible score of 34 (i.e., the sum of the maximum score of each index; Appendix X). To standardize the scoring so that all vegetation types could be compared directly, the total raw score was indexed relative to the vegetation type with the highest score (i.e., on a scale of 0 to 1). The relative biodiversity potential was then categorized into biodiversity ranks of low, moderate and high, so that ecosite phases and wetlands types with similar biodiversity potential could be grouped. The threshold value for each category was based on natural breaks in the data (i.e., low = ≤0.70; moderate = 0.71 to 0.84; and high = ≥0.85).

The biodiversity ranking system is based on Central Mixedwood ecosite phases because most of the Oil Sands Region falls within that Natural Subregion. The ecosite phases in the Athabasca Plain were correlated with those in the Central Mixedwood (Table 3.6-12; Section 3) and the same biodiversity potential was assigned to correlated ecosite phases. The biodiversity potential for each regional land cover class was then derived based on the proportional scores of its contributing ecosite phases and wetlands types. Field experience, professional judgment and literature sources (e.g., Haeussler and Bergeron 2004; Malcolm et al. 2004; Strong 2004) were used to assign a rank if there was not enough information to complete the scoring process for a vegetation type or disturbance category. Refer to Appendix X for a thorough explanation of the scoring and ranking process.

6.4 RESULTS AND DISCUSSION

The following sections aim to create an overall understanding of the factors influencing biodiversity at the species, ecosystem and landscape levels of biological organization. Biodiversity was assessed using indices that characterize the composition, structure and function of ecosystems and their components at different levels of biological organization, with an emphasis placed on ecosystem and landscape levels. Although the larger scales are the primary consideration in this section, all levels of biological organization are interrelated and impacts at

one level will have a cascading effect on all other levels. The ecosystem-level assessment centres on the biodiversity potential ranking of vegetation types and regional land cover classes based on the integration of five biodiversity indices The landscape-level assessments describe the size, shape and configuration of the landscape, which can then be used to assess fragmentation of the landscape. Core area, habitat isolation, edge effects and non-native/invasive species are also considered in relation to biodiversity.

6.4.1 Species-Level Biodiversity

At the species level of organization, species abundance, distribution and habitat specificity are the indicator variables addressed in the various areas of this ESR (Table 6.3-1). Information on these variables was collected for fish through backpack and boat electrofishing, gill netting, baited minnow trapping and underwater video monitoring (Golder 2007). For vegetation, these data were gathered through vegetation mapping aerial surveys and detailed ground vegetation inventories (Section 3.3.1). Remote camera monitoring (mammals), winter tracking (mammals), call playback surveys (marsh birds and owls), nocturnal surveys (amphibians and bats), point count surveys (breeding birds) and aerial surveys (beaver/muskrat, waterfowl and ungulates) were used to collect information on these variables for wildlife (Section 5.2.1). Other potential species-level variables were not considered for this assessment because this information is historically not collected in support of the regulatory process. These other variables include demographic and population structure (e.g., sex ratios and age ratio) as well as life history variables (e.g., number of offspring and life cycle).

Overall fish and fish habitat diversity was rated moderate to very low in the waterbodies and watercourses surveyed in the LSAs, with the exception of the Muskeg River, which was rated high (Golder 2007). Distribution of plant communities indicated that the JEMA and PRMA had high (51%) and low (19%) rare plant potential, respectively, compared to the RSA (23%) (Section 3). In total, plant species richness (including lichens) was slightly higher in the PRMA (564 species in 396 plots) than in the JEMA (539 species in 485 plots). In general, wildlife abundance in the LSAs was similar to that reported for the RSA. However, lower deer densities and higher densities of moose, fisher/marten and bats were reported in the LSAs relative to the RSA (Section 5).

Species Abundance and Distribution

Species abundance is simply the number of individuals in a population. It is important in terms of biodiversity because populations with few individuals are more vulnerable to natural and anthropogenic (human) disturbances and are at

greater risk of extinction. The Fish and Fish Habitat, Vegetation and Wildlife sections (Golder 2007, Section 3 and Section 5, respectively) summarize species abundance and distribution for key indicator resources and species of concern. Woodland caribou provide a good example of a species whose abundance and distribution is closely monitored by resource management agencies to maintain population numbers above a certain threshold that will allow the population to persist over time (Westworth and Associates 2002) (Section 5 in this report). Many plant species are monitored for abundance and distribution on the landscape in the interest of maintaining these populations for Aboriginal people's traditional food, medicine or spiritual use (Section 3, Appendix K).

Habitat Specificity

Habitat specificity is the degree to which species are reliant on certain habitats to fulfil their ecological requirements (i.e., they are habitat specialists). It differs from species overlap in that it concerns a species rather than a vegetation type. Habitat specificity measures the number of different habitats utilized by a given species, whereas, species overlap represents the number of different species found in a given habitat. Habitat specificity is important in terms of plant biodiversity because loss of ecosite phases and wetlands types that contain plant species not found in other ecosite phases or wetlands types negatively impacts local populations to a greater degree than the loss of ecosite phases and wetlands types with more widespread plant species.

Habitat specificity also refers to the range of habitats that wildlife species are expected to occupy. Some wildlife species may not be rare, but may only use a narrow range of habitat types (e.g., beavers). In addition, some wildlife species may use a variety of habitats for different activities (e.g., foraging, breeding). For example, the Canadian toad migrates to breeding ponds in the spring, but uses terrestrial habitats during other times of the year. This means that ecosite phases and wetlands types are not necessarily interchangeable with respect to function and all habitats required by a species must be maintained. Wildlife species that rely on a narrow range of habitats to meet their requirements (i.e., high specificity) are more likely to be vulnerable to disturbance because they are not able to meet their reproductive/survival needs in alternative habitats. Vegetation and wildlife habitat association data from field programs in the Oil Sands Region have been incorporated into the biodiversity potential ranking process through the species overlap index.

6.4.2 Ecosystem-Level Biodiversity

6.4.2.1 Regional Study Area Results

The biodiversity potential ranking results at the RSA level are summarized in the following sections according to ecodistricts and regional land cover classes. The biodiversity potential of ecodistricts is required to meet the terms of reference.

Biodiversity Potential of Ecodistricts

Nine ecodistricts occur in the RSA (Table 6.4-1). Overall, the RSA consists of 22% high (513,982 ha), 40% moderate (894,340 ha) and 38% low (869,055 ha) biodiversity potential areas (Table 6.4-1). The Organic Plain ecodistrict covers the largest area within the RSA (742,056 ha; 33%) with 29% of this area ranked high, 47% ranked moderate and 25% ranked low for biodiversity potential. Among the nine ecodistricts, this constitutes the smallest proportion of area ranked low for biodiversity potential. The Hummocky Moraine covers the smallest area of the RSA (less than 1%), but has the highest proportion (39%) of area ranked high for biodiversity potential. The Escarpment ecodistrict has the smallest proportion of area ranked high for biodiversity potential (7%) and the largest proportion of area ranked low (51%).

Table 6.4-1 Biodiversity Potential of Ecodistricts Within the Regional Study Area

Ecodistrict	Biodiversity Potential							
	High		Moderate		Low		RSA	
	[ha]	[%]	[ha]	[%]	[ha]	[%]	[ha]	[%]
Escarpment	16,653	7	95,615	42	114,648	51	226,916	10
Glaciolacustrine/ Glaciofluvial Plain	84,052	26	105,136	32	134,887	42	324,075	14
Hummocky Moraine	904	39	711	31	699	30	2,314	<1
Incised Valley	13,988	13	45,185	43	46,298	44	105,471	5
Moraine Plain	54,533	23	78,475	34	100,275	43	233,283	10
Organic Plain	213,202	29	345,787	47	183,066	25	742,056	33
Outwash Plain	56,338	26	64,756	30	93,185	43	214,280	9
Peat Plateau	54,885	16	131,585	38	155,853	46	342,323	15
Precambrian Shield	19,425	22	27,090	31	40,143	46	86,659	4
Total RSA	**513,982**	**22**	**894,340**	**40**	**869,055**	**38**	**2,277,376**	**100**

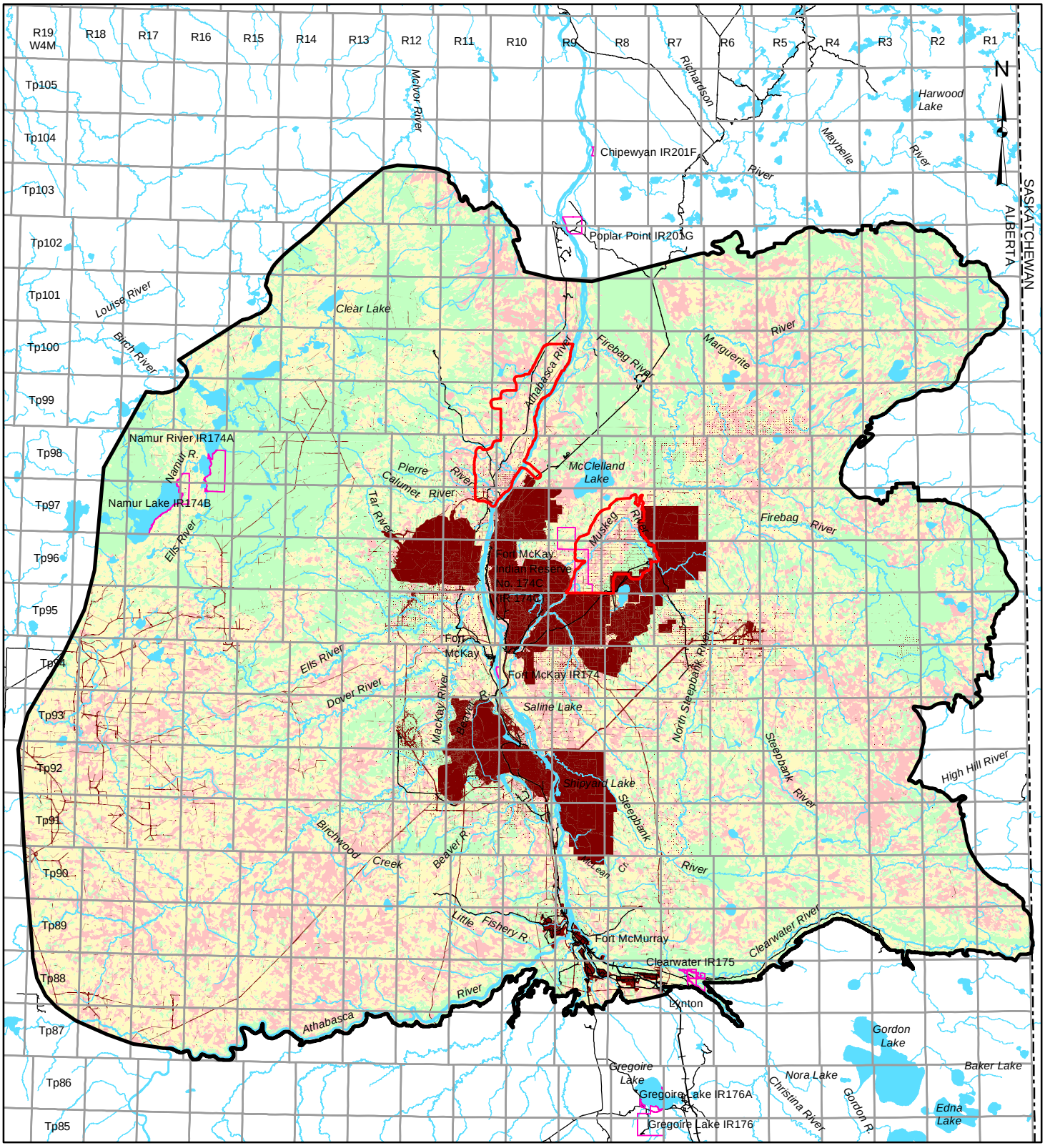
Note: Some numbers are rounded for presentation purposes. Therefore, it may appear that the totals do not equal the sum of the individual values.

Ecodistricts found within the LSAs include the Moraine Plain, the Organic Plain and the Outwash Plain in the JEMA, and the Glaciolacustrine/Glaciofluvial Plain, the Incised Valley and the Outwash Plain in the PRMA. The Organic Plain has proportionately more high and moderate biodiversity potential areas, while the Incised Plain has proportionately less high biodiversity potential areas than the RSA overall.

Biodiversity Potential of Regional Land Cover Classes

The biodiversity potential ranking results for the regional land cover classes in the RSA are presented in Table 6.4-2 and Figure 6.4-1 and a summary is provided below:

- Of the 13 regional land cover classes, two are ranked high, five are ranked moderate and six are ranked low for biodiversity potential. In regard to land area, 22% of the RSA has high biodiversity potential, 40% has moderate and 38% has low biodiversity potential.
- Regional land cover classes ranked as having high biodiversity potential include treed fens and non-treed wetlands, with ranking index scores of 1.00 and 0.97, respectively. Treed fens cover 12% (283,815 ha) of the RSA and non-treed wetlands cover 10% (230,167 ha; Table 6.4-2). High biodiversity rankings are attributed to these classes because they have relatively high species richness, as well as high rare plant and wildlife potential.
- Regional land cover classes ranked as having moderate biodiversity potential include water, mixedwood aspen–jack pine, poor wooded fen/wooded bog, coniferous white spruce and mixedwood aspen–white spruce, with ranking index scores ranging from 0.86 to 0.76. The poor wooded fen/wooded bog class covers the largest area of the RSA (525,347 ha; 23%) and is also the largest moderately-ranked class. Water (48,736 ha; 2%), coniferous white spruce (58,199 ha; 3%) and mixedwood aspen–jack pine (61,535 ha; 3%) are the smallest classes ranked moderate in the RSA. Some of the indices for these classes are ranked high, while others are moderate to low, resulting in the overall moderate ranking.
- Coniferous jack pine, coniferous jack pine–black spruce and deciduous aspen–balsam poplar classes are ranked as having low biodiversity potential because they have relatively low species richness, as well as low rare plant and wildife potential. The ranking index scores for these classes are 0.73, 0.69 and 0.69, respectively. The coniferous jack pine and deciduous aspen–balsam poplar classes both cover about 9% of the RSA (215,255 ha and 203,653 ha, respectively) and coniferous jack pine–black spruce covers 3% (61,737 ha).
- Data for individual indices were not available for the burn, cutblock and disturbance classes, so they are ranked as having a low biodiversity potential based on a combination of field experience, professional judgement and literature sources (e.g., Haeussler and Bergeron 2004; Malcolm et al. 2004; Strong 2004). The burn class covers 9% of the RSA (207,257 ha), disturbance covers 8% (170,314 ha) and cutblocks cover less than 1% (10,839 ha) of the RSA.



LEGEND

- TERRESTRIAL RESOURCES REGIONAL STUDY AREA
- LOCAL STUDY AREAS
- INDIAN RESERVE
- OPEN WATER
- PUBLIC ROADWAY
- RAILROAD

BIODIVERSITY POTENTIAL

- HIGH
- MODERATE
- LOW

DISTURBED

- EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE
- EXISTING AND APPROVED URBAN AND INDUSTRIAL LINEAR DISTURBANCE

25 0 25

SCALE 1:1,000,000 KILOMETRES

REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2004), Pearson Timberline Ltd. (April 2004), LANDSAT 7 ETM Imagery (July 2006), and Alberta SRD, used under license.
Saskatchewan digital data obtained from Information Services Corp. (September 2004), used under license.
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 12.

PROJECT

JACKPINE MINE EXPANSION & PIERRE RIVER MINE PROJECT

TITLE

BIODIVERSITY POTENTIAL IN THE REGIONAL STUDY AREA

Shell Canada Limited

PROJECT No. 05-1344-027.7600			SCALE AS SHOWN	REV. 0
DESIGN	VR	22 Jan. 2007		
GIS	VR	17 Nov. 2007		
CHECK	AA	17 Nov. 2007		
REVIEW	WES/TC	20 Nov. 2007		

FIGURE:6.4-1

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Table 6.4-2 Biodiversity Potential of Regional Land Cover Classes Within the Regional Study Area

Regional Land Cover Class[a]	Area		Total Score	Ranking Index[b]
	[ha]	% of RSA		
High Biodiversity Potential[c]				
treed fen	283,815	12	23.2	1.00
non-treed wetlands	230,167	10	22.6	0.97
subtotal	*513,982*	*22*		
Moderate Biodiversity Potential[c]				
water	48,736	2	20.0	0.86
mixedwood aspen–jack pine	61,535	3	18.5	0.80
poor wooded fen/wooded bog	525,347	23	18.2	0.78
mixedwood aspen–white spruce	200,523	9	17.7	0.76
coniferous white spruce	58,199	3	17.6	0.76
subtotal	*894,340*	*40*		
Low Biodiversity Potential[c]				
coniferous jack pine	215,255	9	17.0	0.73
coniferous jack pine–black spruce	61,737	3	16.1	0.69
deciduous aspen–balsam poplar	203,653	9	15.9	0.69
burn	207,257	9	n/a	n/a
cutblock	10,839	<1	n/a	n/a
disturbance	170,314	8	n/a	n/a
subtotal	*869,055*	*38*		
Total	**2,277,376**	**100**		

(a) Refer to Table 3.3-2 in Section 3.3.3 for the correlation between regional land cover classes and ecosite phases and wetlands types.

(b) Ranking index standardized relative to regional land cover class with highest total score.

(c) Biodiversity Potential: Low = ≤0.75; Moderate = 0.76 to 0.89; High = ≥0.90.

Note: Some numbers are rounded for presentation purposes. Therefore, it may appear that the totals do not equal the sum of the individual values.

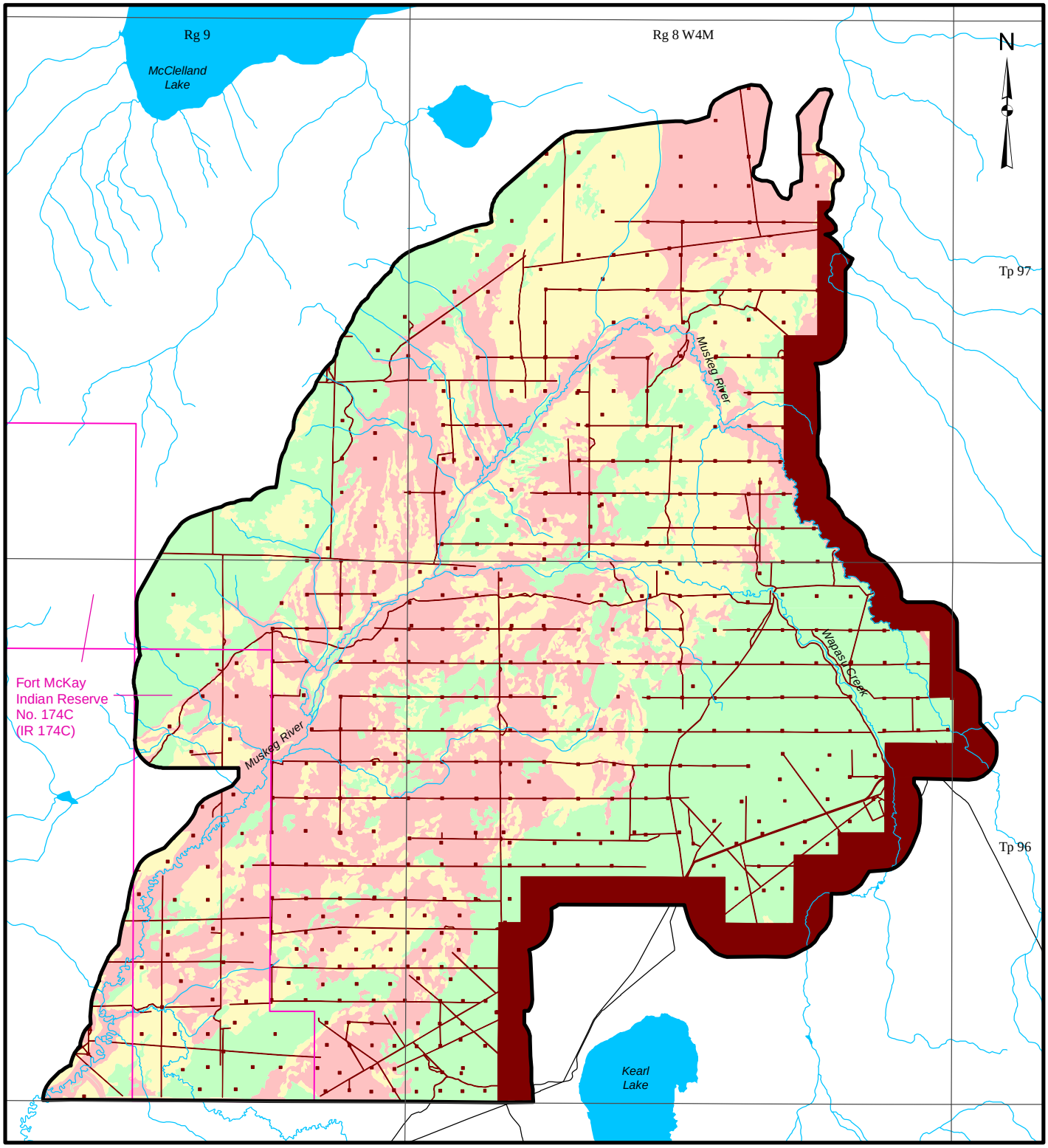
n/a = Not applicable.

6.4.2.2 Jackpine Expansion Mining Area Local Study Area Results

The biodiversity potential ranking for the JEMA LSA is summarized in the following sections according to ecosite phases, wetlands types and disturbed areas in the Central Mixedwood Natural Subregion.

Biodiversity Potential of Ecosite Phases, Wetlands Types and Disturbed Areas

The biodiversity potentials for the JEMA LSA are presented in Table 6.4-3 and Figure 6.4-2 and a summary is provided below:



LEGEND

- JACKPINE EXPANSION MINING AREA LOCAL STUDY AREA
- INDIAN RESERVE
- OPEN WATER
- PUBLIC ROADWAY

BIODIVERSITY POTENTIAL

- HIGH
- MODERATE
- LOW

DISTURBED

- EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE
- EXISTING AND APPROVED URBAN AND INDUSTRIAL LINEAR DISTURBANCE

3 0 3

SCALE 1:100,000 KILOMETRES

REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2004), and Alberta SRD, used under license.
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 12.

PROJECT

JACKPINE MINE EXPANSION & PIERRE RIVER MINE PROJECT

TITLE

BIODIVERSITY POTENTIAL IN THE JACKPINE EXPANSION MINING AREA LOCAL STUDY AREA

Shell Canada Limited

PROJECT No. 05-1344-027.7600			SCALE AS SHOWN	REV. 0
DESIGN	VR	03 Aug. 2007	FIGURE: 6.4-2	
GIS	VR	17 Nov. 2007		
CHECK	AA	17 Nov. 2007		
REVIEW	WES/TC	20 Nov. 2007		

Project: I:\CLIENTS\SHELL\05-1344-027\mapping\mxd\biodiversity\DRAFT\sa_biopot_jp.mxd - Plot: I:\CLIENTS\SHELL\05-1344-027\mapping\pdf\biodiversity\DRAFT\sa_biopot_jp.pdf

Table 6.4-3 Biodiversity Potential in the Jackpine Expansion Mining Area Local Study Area

Code	Description	Area		Total Score	Ranking Index[a]
		ha	% of LSA		
High Biodiversity Potential[b]					
FTNI	wooded fen with internal lawns	409	2	26.5	1.00
FFNN	forested fen	2	<1	26	0.98
FTPN	wooded patterned fen	415	2	26	0.98
SONS	shrubby swamp	752	4	25	0.94
FOPN	open patterned fen	792	4	24	0.91
FTNN	wooded fen	3,452	19	23.5	0.89
	subtotal	*5,822*	*32*		
Moderate Biodiversity Potential[b]					
FONG	graminoid fen	878	5	22	0.83
WONN	shallow open water	2	<1	21.5	0.81
BONN	open bog	61	<1	21	0.79
FONS	shrubby fen	2,505	14	21	0.79
lake	lake	59	<1	21	0.79
f3	horsetail white spruce	16	<1	20	0.75
BFNN	forested bog	<1	<1	20	0.75
BTNI	wooded bog with internal lawns	714	4	20	0.75
BTXC	wooded permaforst bog with collapse scar	89	<1	20	0.75
STNN	wooded swamp	164	1	20	0.75
e3	dogwood white spruce	4	<1	19.5	0.74
b2	blueberry aspen (white birch)	201	1	19	0.72
	subtotal	*4,693*	*26*		
Low Biodiversity Potential[b]					
b1	blueberry jack pine–aspen	518	3	18.5	0.70
b3	blueberry aspen–white spruce	230	1	18.5	0.70
BTNN	wooded bog	632	3	18	0.68
BTNR	wooded bog with internal lawns and islands of forested peat plateau	17	<1	18	0.68
e1	dogwood balsam poplar–aspen	7	<1	18	0.68
e2	dogwood balsam poplar–white spruce	5	<1	18	0.68
h1	Labrador tea/horsetail white spruce–black spruce	167	1	18	0.68
river	river	<1	<1	18	0.68
d2	low-bush cranberry aspen–white spruce	239	1	17.5	0.66
a1	lichen jack pine	164	1	17	0.64
b4	blueberry white spruce–jack pine	89	<1	16.5	0.62
d3	low-bush cranberry white spruce	93	1	16.5	0.62
c1	Labrador tea–mesic jack pine–black spruce	59	<1	16	0.60
g1	Labrador tea–subhygric black spruce–jack pine	72	<1	16	0.60
PJ–Lt Comp	jack pine–tamarack complex[c]	14	<1	16	0.60
Sh	shrubland	5	<1	16	0.60
d1	low-bush cranberry aspen	484	3	15.5	0.58
BUu	burn upland	1,124	6	n/a	n/a
BUw	burn wetlands	1,902	10	n/a	n/a
BDis	disturbance	1,893	10	n/a	n/a
CC	cutblock	120	1	n/a	n/a
	subtotal	*7,834*	*43*		
Total		**18,348**	**100**		

[a] Ranking index standardized relative to ecosite phase or wetlands type with the highest total score.

[b] Biodiversity Potential: Low = ≤0.70; Moderate = 0.71 to 0.84; High = ≥0.85.

[c] Biodiversity potential for jackpine–tamarack complex (Pj–Lt Comp) was assigned the same total score as the Labrador tea–subhygric black spruce–jack pine (g1) ecosite phase based on professional judgement and field experience in the Oil Sands Region because data for biodiversity indices for this complex were not available.

Note: Some numbers are rounded for presentation purposes. Therefore, it may appear that the totals do not equal the sum of the individual values.

n/a = Not applicable.

- There are 39 ecosite phases, wetlands types and disturbed areas in the JEMA LSA: six are ranked high for biodiversity, 12 are ranked moderate and 21 are ranked low (Figure 6.4-2). In regard to land area, 32% of the JEMA LSA has high biodiversity potential, 26% has moderate and 43% has low (Table 6.4-3).

- Only wetlands types were ranked as having high biodiversity potential. Forested fen (FFNN), open patterned fen (FOPN), wooded fens with internal lawns (FTNI), wooded fen (FTNN), wooded patterned fen (FTPN) and shrubby swamp (SONS) ranked high for biodiversity. Ranking index values for the high biodiversity potential category range between 0.89 and 1. Of the high-ranked wetlands types, wooded fens cover the largest area of the JEMA LSA (3,452 ha; 19%) and the other high-ranked wetlands types each occupy less than 5% of the JEMA LSA. High biodiversity rankings are attributed to these classes because they have relatively high species richness, rare plant and wildlife potential and are generally rare wetlands types.

- Moderate biodiversity potential vegetation types included ecosite phases and wetland types. Ranking index values for this category ranged between 0.72 and 0.83. Of these, shrubby fen (FONS) covers the largest area of the JEMA LSA (2,505 ha; 14%), with the remaining moderately ranked ecosite phases and wetlands types each covering 5% or less of the JEMA LSA. Results from the pooled indices are variable for this category, but broadly indicate that at least one or two indices are ranked high, with others ranked moderate or low.

- The low biodiversity potential category is dominated by ecosite phases, but also contains two wooded bog types, shrubland and river. Ranking index values for ecosite phases and wetlands types with low biodiversity potential range between 0.58 and 0.70. Blueberry jack pine–aspen (b1), low-bush cranberry aspen (d1) and wooded bog (BTNN) each occupy about 3% of the JEMA LSA. The remaining low-ranked ecosite phases and wetlands types occupy 1% or less of the JEMA LSA.

- Data for biodiversity indices (Table 6.3-2) were not available for the disturbance, burn and cutblock classes, so they are ranked as having low biodiversity potential based on a combination of field experience, professional judgment and literature sources (e.g., Haeussler and Bergeron 2004; Malcolm et al. 2004; Strong 2004). Burned, disturbed and cutblock areas occupy a large portion (5,039 ha; 27%) of the JEMA LSA.

6.4.2.3 Pierre River Mining Area Local Study Area Results

The biodiversity potential ranking for the PRMA LSA is summarized in the following sections according to ecosite phases, wetlands types and disturbed areas in the Central Mixedwood and Athabasca Plain Natural Subregions.

Biodiversity Potential of Ecosite Phases, Wetlands Types and Disturbed Areas

The ranking results for the PRMA LSA are presented in Table 6.4-4 and Figure 6.4-3 and a summary is provided below:

Table 6.4-4 Biodiversity Potential in the Pierre River Mining Area Local Study Area

Natural Subregion	Code	Description	Area		Total Score	Ranking Index[a]
			[ha]	% of LSA		
High Biodiversity Potential[b]						
AP/CM	MONG	marsh	146	1	25.0	0.94
AP/CM	SONS	shrubby swamp	372	2	25.0	0.94
AP/CM	FOPN	open patterned fen	69	<1	24.0	0.91
AP/CM	FTNN	wooded fen	1,580	7	23.5	0.89
		subtotal	*2,168*	*10*		
Moderate Biodiversity Potential[b]						
AP/CM	FONG	graminoid fen	702	3	22.0	0.83
AP/CM	STNN	wooded swamp	517	2	21.5	0.81
AP/CM	BONS	shrubby bog	1	<1	21.0	0.79
CM	f2	horsetail balsam poplar-white spruce	4	<1	21.0	0.79
AP/CM	FONS	shrubby fen	905	4	21.0	0.79
AP/CM	WONN	shallow open water	57	<1	21.0	0.79
AP/CM	BFNN	forested bog	73	<1	20.0	0.75
CM	f1	horsetail balsam poplar–aspen	4	<1	20.0	0.75
CM	f3	horsetail white spruce	7	<1	20.0	0.75
AP/CM	lake	lake	84	<1	20.0	0.75
AP	e3	willow/horsetail–white spruce–black spruce	307	1	19.5	0.74
CM	e3	dogwood white spruce	45	<1	19.5	0.74
CM	b2	blueberry aspen (white birch)	43	<1	19.0	0.72
		subtotal	*2,747*	*13*		
Low Biodiversity Potential[b]						
CM	b1	blueberry jack pine–aspen	242	1	18.5	0.70
CM	b3	blueberry aspen–white spruce	104	<1	18.5	0.70
AP/CM	BTNN	wooded bog	1,186	6	18.0	0.68
AP	e1	willow/horsetail aspen–white birch–balsam poplar	325	2	18.0	0.68
CM	e1	dogwood balsam poplar–aspen	6	<1	18.0	0.68
AP	e2	willow/horsetail aspen–white spruce–black spruce	404	2	18.0	0.68
CM	e2	dogwood balsam poplar–white spruce	121	1	18.0	0.68
CM	h1	Labrador tea/horsetail white spruce–black spruce	118	1	18.0	0.68
AP/CM	river	river	263	1	18.0	0.68
AP	b3	Canada buffalo-berry–green alder aspen–white spruce–black spruce	1,728	8	17.5	0.66
CM	d2	low-bush cranberry aspen–white spruce	478	2	17.5	0.66
AP	a1	bearberry jack pine	2,740	13	17.0	0.64
CM	a1	lichen jack pine	16	<1	17.0	0.64
AP	b1	Canada buffalo-berry–green alder jack pine–aspen–white birch	2,922	14	17.0	0.64
AP	b4	Canada buffalo-berry–green alder – white spruce–black spruce–jack pine	927	4	16.5	0.62

Table 6.4-4 Biodiversity Potential in the Pierre River Mining Area Local Study Area (continued)

Natural Subregion	Code	Description	Area		Total Score	Ranking Index[a]
			[ha]	% of LSA		
CM	b4	blueberry white spruce–jack pine	173	1	16.5	0.62
CM	d3	low-bush cranberry white spruce	250	1	16.5	0.62
AP	c1	Labrador tea–mesic jack pine–black spruce	60	<1	16.0	0.60
CM	c1	Labrador tea–mesic jack pine–black spruce	19	<1	16.0	0.60
AP	d1	Labrador tea–subhygric black spruce–jack pine	130	1	16.0	0.60
CM	g1	Labrador tea–subhygric black spruce–jack pine	12	<1	16.0	0.60
AP	Pj–Lt Comp	jack pine–tamarack complex[c]	3	<1	16.0	0.60
AP/CM	Sh	shrubland	87	<1	16.0	0.60
AP	b2	Canada buffalo-berry–green alder aspen	2,151	10	15.5	0.58
CM	d1	low-bush cranberry aspen	734	3	15.5	0.58
AP/CM	BDis	disturbance	439	2	n/a	n/a
AP/CM	CC	cutblock	535	3	n/a	n/a
AP/CM	Me	meadow	7	<1	n/a	n/a
AP/CM	sand	sand	41	<1	n/a	n/a
		subtotal	*16,221*	*77*		
Total			**21,136**	**100**		

[a] Ranking index standardized relative to the ecosite phase or wetlands type with the highest total score.

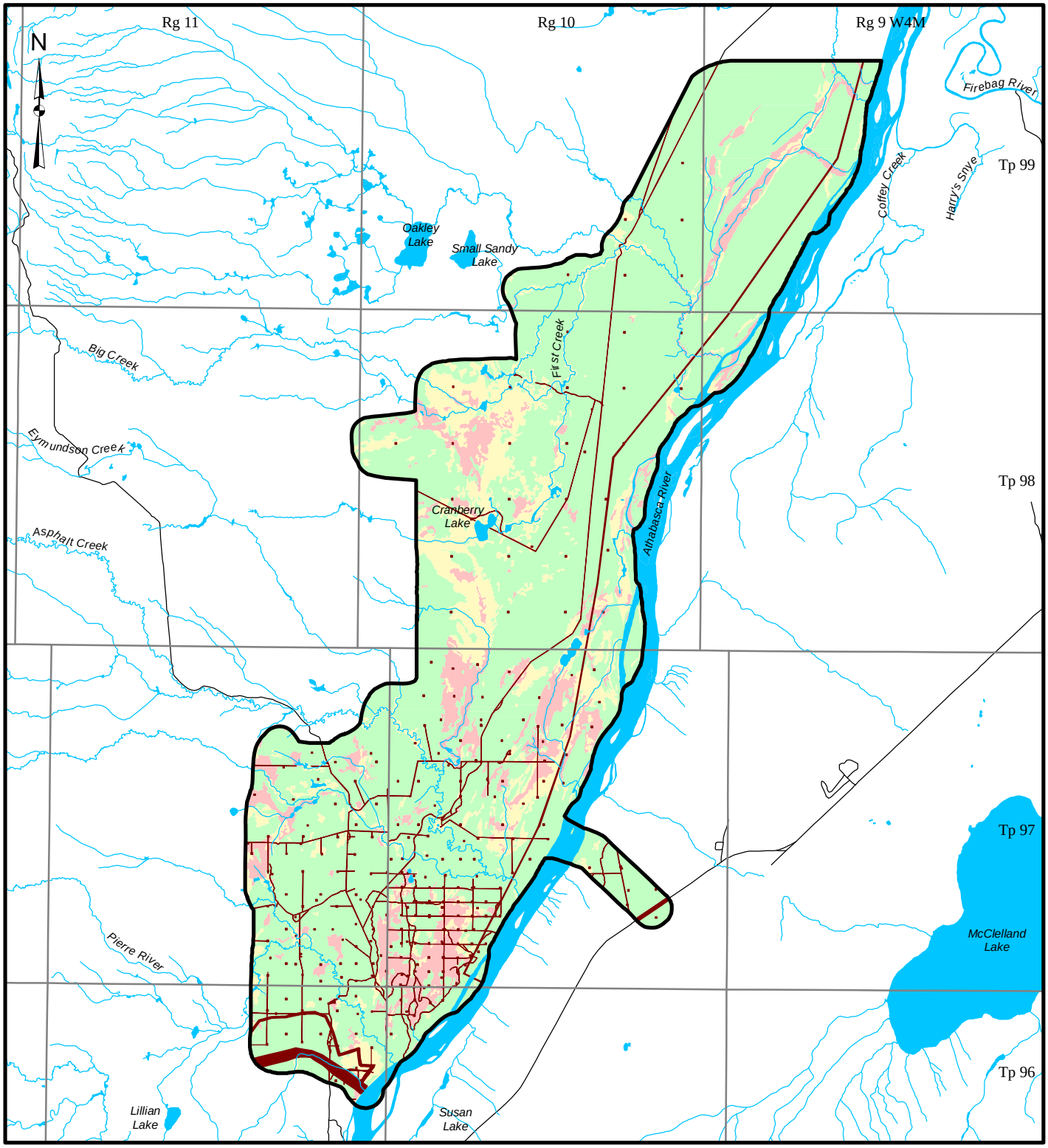
[b] Biodiversity Potential: Low = ≤0.70; Moderate = 0.71 to 0.84; High = ≥0.85.

[c] Biodiversity potential for jackpine–tamarack complex (Pj–Lt Comp) was assigned the same total score as the Labrador tea–subhygric black spruce–jack pine (g1) ecosite phase based on professional judgement and field experience in the Oil Sands Region because data for biodiversity indices for this complex were not available.

AP = Athabasca Plain Natural Subregion; CM = Central Mixedwood Natural Subregion.

Note: Some numbers are rounded for presentation purposes. Therefore, it may appear that the totals do not equal the sum of the individual values.

n/a = Not applicable.



LEGEND

- PIERRE RIVER MINING AREA
- LOCAL STUDY AREA
- OPEN WATER
- ACCESS ROAD

BIODIVERSITY POTENTIAL

- HIGH
- MODERATE
- LOW

DISTURBED

- EXISTING AND APPROVED URBAN AND INDUSTRIAL DISTURBANCE
- EXISTING AND APPROVED URBAN AND INDUSTRIAL LINEAR DISTURBANCE

4 0 4

SCALE 1:160,000 KILOMETRES

REFERENCE

Alberta digital data obtained from AltaLIS Ltd. (September 2004), IHS Energy Ltd. (August 2006), Alberta Pacific Ltd. (April 2004), and Alberta SRD, used under license.
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 12.

PROJECT

JACKPINE MINE EXPANSION & PIERRE RIVER MINE PROJECT

TITLE

BIODIVERSITY POTENTIAL IN THE PIERRE RIVER MINING AREA LOCAL STUDY AREA

Shell Canada Limited

PROJECT No. 05-1344-027.7600			SCALE AS SHOWN	REV. 0
DESIGN	VR	10 Aug. 2007	FIGURE: 6.4-3	
GIS	VR	17 Nov. 2007		
CHECK	AA	17 Nov. 2007		
REVIEW	WES/TC	20 Nov. 2007		

Project: I:\CLIENTS\SHELL\05-1344-027\mapping\mxd\biodiversity\DRAFT\sa_biopot_pr.mxd Plot: I:\CLIENTS\SHELL\05-1344-027\mapping\pdf\biodiversity\DRAFT\sa_biopot_pr.pdf

- There are 46 ecosite phases, wetlands types and disturbed areas in the PRMA LSA: four are ranked high for biodiversity, 13 are ranked moderate and 29 are ranked low (Figure 6.4-3). In regard to land area, 10% of the PRMA LSA has high biodiversity potential, 13% has moderate and 77% has low (Table 6.4-4).

- Only wetlands types were ranked as having high biodiversity potential. Open patterned fen (FOPN), FTNN, marsh (MONG) and SONS are ranked high for biodiversity. Ranking index values for the high biodiversity potential category range between 0.89 and 0.94. Of the high-ranked wetlands types, wooded fens cover the largest area of the PRMA LSA (1,580 ha; 7%) and the other high biodiversity ranked wetlands types each occupy 2% or less of the PRMA LSA. High biodiversity rankings are attributed to these classes because they have relatively high species richness, rare plant and wildlife potential and are generally rare wetlands types.

- Both ecosite phases and wetlands types were ranked as having moderate biodiversity potential. Ranking index values for this category ranged between 0.72 and 0.83. Of these, FONS is the largest moderately ranked vegetation type in the PRMA LSA, covering 905 ha (4%). The remaining moderately ranked ecosite phases and wetlands types each cover 3% or less of the PRMA LSA. Results from the pooled indices are variable for this category, but broadly indicate that at least one or two indices are ranked high, with others ranked moderate or low.

- The low biodiversity potential category is dominated by ecosite phases, as well as BTNN, shrubland and river. Ranking index values for the low biodiversity potential category range between 0.58 and 0.70. Canada buffalo-berry–green alder jack pine–aspen–white birch (b1 in the Athabasca Plain) and bearberry jackpine (a1 in the Athabasca Plain) occupy the largest portion of the PRMA LSA (14% and 13%, respectively). Canada buffalo-berry–green alder aspen (b2 in the Athabasca Plain), Canada buffalo-berry–green alder aspen–white spruce–black spruce (b3 in the Athabasca Plain) and BTNN are also well-represented in the PRMA LSA (10%, 8% and 6%, respectively). Ten low-ranked vegetation and disturbance types each occupy less than 1% of the PRMA LSA (Table 6.4-4).

- Data for biodiversity indices (Table 6.3-2) were not available for the disturbance, burn and cutblock, meadow and sand classes, so they are ranked as having a low biodiversity potential based on a combination of field experience, professional judgement and literature sources (e.g., Haeussler and Bergeron 2004; Malcolm et al. 2004; Strong 2004).

- Impacts due to PRMA differ between the RSA (Table 6.4-2) and the LSA (Table 6.4-4) because of the difference in scale used at each level of analysis (Section 6.3.1.2). Ranking of regional land cover classes (RSA) is less accurate and more conservative than the ranking of vegetation types (LSA). For example, graminoid fens (FONG) and

FONS are relatively abundant wetlands types in the PRMA LSA and are ranked moderate for biodiversity potential at the LSA scale. However, because they cannot be distinguished from other non-treed wetlands at the RSA scale, they are conservatively placed in the non-treed wetlands regional land cover class, which is ranked high for biodiversity potential. Thus, comparisons of biodiversity potential focus on changes between baseline and closure within the RSA and LSAs, rather than between the two scales.

6.4.3 Landscape-Level Biodiversity

Landscape is defined as a heterogeneous land area composed of a cluster of interacting ecosystems that is repeated in similar form throughout (Forman and Gordon 1986). There is no absolute size for a landscape; it could range from an area smaller than a single forest stand to an entire ecodistrict (McGarigal and Marks 1995). For the purpose of this report, landscape should be thought of as an area of land containing a mosaic of habitat patches.

Landscape features such as patch size, shape and number were used as the basis for estimating more biologically relevant parameters such as patch evenness within the landscape, the amount of core area, the distance between similar patch types and the total edge between natural and human disturbed areas (Sections 3.4.2, 3.5.2 and 3.6.2). Disturbances affecting patch size, shape and number will affect the overall landscape, which can have major implications on species composition, distribution and viability (Noss and Harris 1986). A summary of the current distribution, composition and fragmentation of habitat patches at the RSA and LSA levels described in Section 3 are discussed here in relation to biodiversity.

Heterogeneity

Heterogeneity refers to the diversity and distribution of habitat patches within a landscape. Quantification of landscape heterogeneity has assumed a prominent role in landscape ecology because biodiversity is thought to be greater in more diverse and spatially heterogeneous landscapes (McGarigal and Marks 1995). At the RSA level, there are 13 well-distributed regional land cover classes indicating that the overall landscape is generally a diverse and heterogeneous mosaic of habitats with only treed bogs/poor fens occupying a disproportionately larger area (Section 3.4.2).

The JEMA LSA has high habitat richness (39 patch types), but the landscape is somewhat dominated by wetlands types (e.g., FTNN; Section 3.5.2). The PRMA LSA has higher habitat richness than the JEMA LSA (46 patch types), and the

variety of habitat patches is slightly more evenly distributed within the landscape (Section 3.6.2). In contrast to the JEMA LSA, the PRMA LSA tends to be dominated by upland habitat (e.g., jack pine dominant forest). Upland habitats are generally ranked low for biodiversity potential; however, even low-ranked habitats are important for a wide range of plant and wildlife species.

Fragmentation

Fragmentation refers to the breaking up of contiguous habitat patches into smaller and more disjoint or isolated patches (Morrison et al. 1998). Quantification of landscape fragmentation is an important consideration in landscape ecology because biodiversity is compromised in landscapes that are highly fragmented by unsuitable habitat. The suitability of a habitat patch varies depending on the habitat requirements of a particular organism.

To capture the variety of needs of different organisms, fragmentation was examined from several different perspectives including fragmentation of all natural areas by human disturbance, fragmentation of forested and non-forested areas, as well as fragmentation of riparian and old growth areas (Sections 3.4.2.2, 3.5.2.2 and 3.6.2.2). Fragmentation will negatively impact biodiversity if it leads to a reduction in the area of the remaining patches (e.g., decreased core area); increased isolation of the patches from each other; increased disturbance from the surroundings (e.g., edge effects) or increased opportunity for invasive and non-native species (Haila 1999). The following subsections will address each of these factors with specific reference to the Project.

Core Area

Many species require suitable habitat patches of a minimum size and are sometimes more closely associated with patch interiors (Robbins et al. 1989; Temple 1986). For patch-interior specialists, core area has been found to be a much better predictor of habitat quality than patch area (Temple 1986). Unlike patch area, core area is affected by patch shape such that more complex shapes contain less core area. Thus, while a patch may be large enough to support a given species, it still may not contain enough suitable core area to support the species. Maintenance of large, simple-shaped patches of habitat increases core area and is a key consideration in the preservation of biodiversity (Haila 1999).

At the RSA level, natural habitat patches are primarily (87%) composed of core area, and forested and non-forested patches are 73% and 54% core area, respectively. This is comparable to previous research in Alberta that identified thresholds for core grizzly bear and caribou habitat (i.e., area of forested landscape within the RSA that is secure from human disturbance) as 60% (Salmo Consulting Inc. et al. 2003). Core area is not applicable to riparian

habitats due to the complex landscape pattern typical of water systems, and it could not be computed for old growth forest at the RSA level. At the LSA level, natural patches in the JEMA and PRMA LSAs have on average 58 and 74% core area, respectively. Within this range, forested and non-forested patches have significantly less core area, and old growth forest patches have negligible amounts of core area, in both LSAs (Sections 3.5.2.2 and 3.6.2.2).

Habitat Isolation

As habitat is lost and fragmented, residual habitat patches become more isolated from each other in space and time (McGarigal and Marks 1995). If movement among habitat patches is significantly impeded or prevented, then individuals (and local populations) in remnant habitat patches may become functionally isolated. Less agile species with very restrictive habitat requirements and limited gap-crossing ability (e.g., Canadian toad) will likely be most sensitive to isolation effects. Furthermore, the probability of a population persisting in a patch may be related to patch isolation because remnant habitat patches are typically small and support fewer individuals (McGarigal and Marks 1995). Small populations are more vulnerable to natural and anthropogenic disturbances and are at greater risk of extinction.

Forested patches were less isolated than non-forested patches in the RSA (Section 3.4.2.2). In the JEMA LSA, forested patches were on average, relatively close together as were non-forested patches. In the PRMA LSA, forested patches were, on average, less isolated than non-forested patches (Section 3.5.2.2 and 3.6.2.2). Old growth forest tended to be more isolated, while riparian habitat patches were well connected. In the JEMA LSA and PRMA LSA, riparian communities are potential corridors linking the adjoining landscapes at the regional scale. Wildlife studies along the Athabasca River and major drainages like Muskeg River indicate that ungulates and carnivores make use of theses areas as habitat and corridors for movement (Section 5.6.3).

Edge Effects

Total amount of edge in a landscape is important to many ecological phenomena. Edge effects result from a combination of biotic and abiotic factors that alter environmental conditions along patch edges compared to patch interiors. For example, differences in wind and light intensity and quality reaching a forest patch will alter the microclimate and disturbance rates (Ranney et al. 1981). These changes, in combination with changes in seed dispersal and herbivory, can influence vegetation composition and structure (Ranney et al. 1981). As with other landscape measurements, edge effects must be viewed from an organism-centred perspective because edge effects influence organisms differently; some species have an affinity for edges (e.g., deer and other grazers), some may be unaffected, and others may be adversely affected (e.g., wolverine).

The total amount of edge created by human disturbance in the RSA is 35,128 km. In the JEMA LSA and PRMA LSA human disturbance has resulted in 771 km and 600 km of edge habitat, respectively. In general, habitat fragmentation and the resulting edge effects can significantly reduce native biodiversity by increasing colonization opportunity for non-native and invasive species (Goforth et al. 2002).

Non-Native/Invasive Species

Invasion by non-native species into pristine habitats can have drastic consequences on the natural balance of the ecosystem. When non-native plants or wildlife are introduced to an area, they may out-compete or prey on native species. In most instances, the communities with fewer species are easier to invade. Thus, natural or human disturbances create smaller patches containing fewer species, which are generally much easier to invade than "old" communities (Pimm 1994; Robins et al. 1989). Despite similar amounts of edge habitat (Sections 3.5.2.2 and 3.6.2.2) and plant species richness (Sections 3.5.1.6 and 3.6.1.6), the PRMA LSA had more non-native/invasive plant species than the JEMA LSA (Sections 3.5.1.7 and 3.6.1.7). This is likely due to many of the observed invasive/non-native plant species being associated with upland habitat, which was much more prevalent in the PRMA LSA.

The presence of non-native wildlife species is often associated with altered or disturbed landscapes and many of these species succeed because they also survive well in association with human activity. The European house sparrow, European starling and brown-headed cowbird are three such species (Ehrlich et al. 1992; Terborgh 1989). Not only are these species adaptable to human-altered landscapes, they directly compete with native species for nest sites and food, and may depredate or parasitize the nests of native birds. For example, the common yellowthroat is a native passerine present in both the JEMA and PRMA LSAs and it is particularly susceptible to brood parasitism by the brown-headed cowbird (Section 5.4.4.1).

6.5 SUMMARY

Species-level biodiversity was addressed in the various sections of this Environmental Setting Report using abundance, distribution and habitat specificity as indicator variables. Overall fish and fish habitat diversity was rated moderate to very low in the waterbodies and watercourses surveyed in the LSAs, with the exception of the Muskeg River, which was rated high (Golder 2007). Distribution of plant communities indicated that the JEMA and PRMA LSAs had high (51%) and low (19%) rare plant potential, respectively, compared to the RSA (23%) (Section 3). In total, plant species richness (including lichens) was slightly higher in the PRMA LSA (564 species in 396 plots) than in the JEMA

LSA (539 species in 485 plots). In general, wildlife abundance in the LSAs was similar to that reported for the RSA. However, lower deer densities and higher densities of moose, fisher/marten and bats were reported in the LSAs relative to the RSA (Section 5).

Ecosystem-level biodiversity potential was assessed for regional land cover classes at the RSA level, and for ecosite phases, wetlands types and disturbed areas at the LSA level. The JEMA LSA contains a greater proportion of high (32%) and low (43%) ecosystem-level biodiversity potential area compared to the RSA (22% and 38%, respectively). The RSA contains more moderate-ranked biodiversity potential area (40%) than the JEMA LSA (26%). The PRMA LSA contains a lower proportion of high (10%) and moderate (13%) biodiversity potential area compared to the RSA (22% and 40%, respectively). The RSA contains significantly less low-ranked biodiversity potential area (38%) than the PRMA LSA (77%).

Landscape-level biodiversity potential was addressed in the vegetation component of this report (Section 3). Heterogeneity and fragmentation analyses are used to assess the composition and distribution of habitat patches in the RSA and LSAs. Overall, the JEMA LSA consists of more wetlands (60%), less terrestrial (13%) and more disturbed areas (27%) than the RSA. In contrast, the PRMA LSA consists of less wetlands (28%), more terrestrial (67%) and less disturbed areas (5%) than the RSA. The RSA consists of 47% wetlands, 36% terrestrial and 17% disturbed areas (Sections 3.4.2, 3.5.2 and 3.6.2).

Median patch size of natural areas is similar between the PRMA LSA (2.4 ha) and the RSA (1.2 ha), but it is larger in the JEMA LSA (18.2 ha). Median patch size of human disturbed areas is the same in the LSAs and the RSA (0.2 ha). Forested areas in the PRMA LSA have similar proportions of core area (48%) compared to the RSA (51%); however, the JEMA LSA has less forested core area (14%). In contrast, non-forested areas in the JEMA LSA have similar proportions of core area (13%) compared to the RSA (11%); and the PRMA LSA has less non-forested core area (2%). Riparian areas occupy similar proportions of the JEMA LSA (9%), PRMA LSA (8%) and RSA (9%), but are less isolated in the JEMA LSA (8.9 m) than in the PRMA LSA (18.9 m). More old growth remains in the PRMA LSA (2,088 ha) than in the JEMA LSA (840 ha).

Evaluation of biodiversity potential characterizes the environmental setting conditions to which future landscapes in the Oil Sands Region can be compared. The similarity between the pre- and post-Project landscapes can be measured using this information for directing conservation and reclamation, monitoring and adaptive management plans. These analyses provide a benchmark to compare impact values and assist in future reclamation planning.

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APPENDIX X

BIODIVERSITY RANKING PROTOCOL AND RESULTS FOR THE OIL SANDS REGION

Submitted to:
Shell Canada Limited

Prepared by:
Golder Associates Ltd.

December 2007 **05-1344-027**

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TABLE OF CONTENTS

SECTION **PAGE**

1 INTRODUCTION....1

2 METHODS....2
2.1 VEGETATION CLASSIFICATION....2
2.1.1 Regional Land Cover Classes....2
2.1.2 Ecosite Phases and Wetlands Types/Water....3
2.1.3 Other Classes....5
2.2 DATA SOURCES....5
2.3 SCORING OF INDICES....7
2.3.1 Landscape Composition....9
2.3.2 Ecosystem Composition....10
2.3.3 Ecosystem Structure....13
2.4 SCORING PROCESS....14

3 RESULTS AND DISCUSSION....17
3.1 RARE VEGETATION TYPE....17
3.2 TOTAL SPECIES RICHNESS....18
3.3 SPECIES OVERLAP....22
3.4 RARE SPECIES POTENTIAL....26
3.4.1 Rare Plants....26
3.4.2 Special Status Wildlife Species....27
3.5 STRUCTURAL COMPLEXITY....29

4 RANKING OF VEGETATION TYPES....31

5 RANKING OF REGIONAL LAND COVER CLASSES....36

6 SUMMARY....39

LIST OF TABLES

Table X-1 Ecological Classification Hierarchy....3
Table X-2 Scoring of the Biodiversity Ranking Indices....8
Table X-3 Correlation of Regional Land Cover Classes With Vegetation Types in the Oil Sands Region....15
Table X-4 Rarity of Vegetation Types in Ecosite Phases and Wetlands Types/Water in the Oil Sands Region....17
Table X-5 Total and Relative Plant Species Richness by Vegetation Type in the Oil Sands Region....20
Table X-6 Total and Relative Wildlife Species Richness by Vegetation Type....22
Table X-7 Overlap of Plant Species for Ecosite Phases....23
Table X-8 Overlap of Plant Species for Wetlands Types and Water....24
Table X-9 Overlap of Wildlife Species for Ecosite Phases....25
Table X-10 Overlap of Wildlife Species for Wetlands Types and Water....25
Table X-11 Rare Plant Potential in Ecosite Phases and Wetlands Types/Water in the Oil Sands Region....26
Table X-12 Potential for Special Status Wildlife Species by Vegetation Type....28
Table X-13 Structural Complexity Indices by Vegetation Type....29

Table X-14 Biodiversity Potential for Vegetation Types in the Oil Sands Region 32
Table X-15 Biodiversity Ranking Assessment for Regional Land Cover Classes in the Oil Sands Region 37

1 INTRODUCTION

A process for relating ecosystem-level biodiversity values to vegetation types (i.e., ecosite phases, wetlands types, water and disturbance types) and regional land cover classes was developed. This process was initially developed (Golder 2000a) for the Oil Sands Region, which includes the Fort McMurray – Athabasca Oil Sands Subregional Integrated Resource Plan (IRP), the Lakeland Subregional IRP and the Cold Lake – Beaver River Subregional IRP. In this process, vegetation types are ranked for their relative contribution to overall biodiversity based on the combined scores of several plant and wildlife indices that reflect biodiversity values. The indices represent compositional and structural characteristics of vegetation types that are quantified from available information for the Oil Sands Region. These indices have been updated with revised species status and additional data collected since the original report was produced (Golder 2000a). Biodiversity potential maps are then made based on the relative biodiversity potential for each vegetation type.

This appendix has the following specific objectives:

- to describe the methods of vegetation classification;
- to provide a comprehensive list of data sources used in the biodiversity assessment;
- to describe the biodiversity ranking approach;
- to define the scoring indices;
- to evaluate vegetation types for each of the chosen biodiversity indices and derive a ranking index;
- to derive biodiversity potential for vegetation types at the Local Study Area (LSA) scale using plant species, and aquatic and terrestrial vertebrate species data from the Oil Sands Region; and
- to derive biodiversity potential for regional land cover classes at the Regional Study Area (RSA) scale from corresponding vegetation types.

2 METHODS

2.1 VEGETATION CLASSIFICATION

2.1.1 Regional Land Cover Classes

A regional land cover classification map was developed using satellite imagery and a Geographic Information System (GIS) to provide information on the relative abundance of vegetation types within the RSA. Image classification is a method of automatically categorizing all pixels in an image. The image classification for the RSA satellite imagery is at a coarser scale than completed for the LSA (which uses finer scale Alberta Vegetation Inventory [AVI] data) resulting in a more broadly defined vegetation classification. However, classification of satellite imagery at the RSA level is a generally accepted standard practice for regional vegetation resource mapping.

Land cover classes easily identifiable from the satellite imagery and Alberta Vegetation Inventory (AVI) data (Nesby 1997) from the region were used in selecting classification "training sites". These training sites are selected to capture the range of variation in the reflectance values or "spectral signature" of the vegetation classes. Based on the signatures, the remote sensing software assigns the best-fit classification to all pixels in the image. The process of selecting training sites and image classification is an iterative process balancing the objectives of having as many meaningful vegetation classes as possible with a reasonable level of accuracy. Once the classification is complete, AVI polygons other than those used as training sites, are compared against the classification for validation purposes.

The classification resulted in the identification of 13 regional land cover classes within the RSA. These classes fell within one of the following four broad groups:

- terrestrial vegetation;
- wetlands;
- water; and
- miscellaneous cover types.

Terrestrial vegetation is generally defined as land where the soils are not saturated for extended periods of the year. All terrestrial land cover classes were forested. The National Wetlands Working Group (NWWG 1988) defines wetlands as: "…land that is saturated with water long enough to promote

wetlands or aquatic processes as indicated by poorly drained soils, hydrophytic vegetation and various kinds of biological activity which are adapted to a wet environment". Wetlands in the RSA consist of marshes, fens, bogs and swamps. Water includes all open water (e.g., lakes and rivers and shallow open water [WONN]). Miscellaneous land cover types include recently burned areas, grassland, meadow, sand, channels, cutbanks, cutblocks and other disturbances (i.e., urban, industrial and agricultural development).

2.1.2 Ecosite Phases and Wetlands Types/Water

Terrestrial vegetation is classified to ecosite phase as defined in the Field Guide to Ecosites of Northern Alberta (Beckingham and Archibald 1996) and used as a basis to map and describe the terrestrial resources within an LSA. This classification is based on the principles of Ecological Land Classification (ELC). The system uses a mixture of biotic and abiotic variables to create a hierarchical, or nested ecological classification structure.

At the highest level in the ecological classification hierarchy (Table X-1), ecological areas and natural subregions are defined on the basis of broad eco-climatic factors. Ecological areas of northern Alberta include Boreal Mixedwood, Boreal Highlands, Subarctic and Canadian Shield. Natural subregions are found within each ecological area; for example, Boreal Mixedwood consists of Central Mixedwood, Dry Mixedwood, Wetlands Mixedwood and Peace River Lowlands natural subregions (Beckingham and Archibald 1996).

Table X-1 Ecological Classification Hierarchy

Ecological Area	Natural Subregions	Natural Region
Boreal Mixedwood (BM)	Central Mixedwood Dry Mixedwood Wetlands Mixedwood Peace River Lowlands	Boreal Forest
Boreal Highlands (BH)	Boreal Highlands	Boreal Forest
Subarctic (SB)	Subarctic	Boreal Forest
Canadian Shield (CS)	Athabasca Plain Kazan Uplands	Canadian Shield

Note: Adapted from Beckingham and Archibald 1996.

At the site level, ecosites are ecological units that develop under similar environmental influences, broadly defined on the basis of climate, soil nutrients and soil moisture regime (Beckingham and Archibald 1996). There are eight distinct ecosites relevant to our work, that are derived from the Boreal

Mixedwood Ecological Area, found within the Boreal Forest Natural Region. Each ecosite is designated with a small letter.

Ecosites are subdivided into ecosite phases according to the dominant species in the tree canopy. Ecosite phases within the same ecosite share the same range in moisture and nutrient regime conditions but vary in canopy composition. Ecosite phases are identified by small letter, name and number. The terrestrial component of LSAs is mapped to the ecosite phase level of this classification system. All references to specific ecosite phases in this report refer to the Boreal Mixedwood classification as it is the most dominant ecological area in the Oil Sands Region.

There are further subdivisions of classifications (e.g., plant community types, a subdivision of the ecosite phase based on understorey species composition and abundance), but they are not practical for the scale of mapping in an LSA.

Wetlands within LSAs are described and mapped using Alberta Wetlands Inventory (AWI) Standards (Halsey et al. 2003). In the AWI system, there are five primary wetlands types: bog (B), fen (F), marsh (M), swamp (S) and shallow open-water (W).

These wetlands types are defined in terms of inter-relationships among the hydrologic, chemical and biotic processes that control wetlands structure and function. Vegetation and landform modifiers are used to subdivide the primary wetlands types. The modifiers have been defined in such a way that the subdivided wetlands classes can readily be discriminated on airphotos.

Wetlands types are subdivided into three subclasses on the basis of vegetation and landform criteria: forested (F), wooded (T) and open (O). Not all five classes can be placed in these subdivisions; by definition, marshes and shallow open water may only be open.

The next subdivision of wetlands classes is a wetlands complex landform modifier that recognizes the presence of patterning and permafrost: permafrost present (X), patterning present (P) and permafrost or patterning is not present (N). In Alberta, patterning is restricted to fens, and regional permafrost is almost exclusively restricted to bogs (Halsey et al. 2003). Therefore, bogs will never be P, and fens will never be X.

The next subdivision is a local wetlands element landform or vegetation modifier: collapse scar (C), internal lawn with islands of forested peat plateau (R), internal lawns (I), no internal lawns present (N), shrub cover more than 25%

when tree cover less than 6% (S) and graminoid dominated with shrub cover less than 25% and tree cover less than 6% (G).

The shrubland category includes both wetlands and terrestrial shrubland types because the distinction between the two types is difficult based on remote sensing. In addition, wetlands shrublands persist over time, whereas terrestrial shrublands are typically ephemeral (e.g., regenerating cleared areas). Therefore, shrublands have been included in the wetlands category, while recognizing the category can be comprised of both types within a particular study area.

Rivers and lakes are not included in this classification system as they do not fit the definition of wetlands types (Section 2.1.1). Instead they fall within the water category. Rivers refers to open, moving bodies of water and lakes comprise open water that is greater than 2 m deep.

2.1.3 Other Classes

Other classification units are used to describe areas that do not fit into the ecosite phase, wetlands type classifications or water category. Burns are natural disturbances and represent upland and wetlands areas that have been recently burned by wildfire. Channels are natural or man-made streams with specific characteristics of water depth, velocity and vegetative cover. Cutbanks are the outside edge of an alluvial river meander that grows by caving. The cutblock cover type is represented by harvested stands at various stages of regrowth. Disturbances are human caused and include all urban, industrial or agricultural development). Grasslands are areas dominated by grasses and grass-like plants such as sedges and rushes. The meadow category consists of non-forested, open grassy areas found next to rivers and streams. The sand category includes open sandy soils that can be found along lakeshores and the Athabasca River, and sand dunes located in the Oil Sands Region.

Other classification units are included in the integrated system so that all areas within the LSAs are mapped to an appropriate class. Ecosite phases, wetlands types, water and other classes are collectively referred to as “vegetation types” within this report.

2.2 DATA SOURCES

Reports and data sets used for the biodiversity ranking are from various projects or regional monitoring programs within the Oil Sands Region since 1997 and include the following:

- Albian Sands Energy Inc. (Albian Sands) Muskeg River Mine (Golder 1997);
- Suncor Energy Inc. (Suncor) Lease 86/17 and Fee Lot 2, (Golder 1998a);
- Suncor Project Millennium (Golder 1998b,c);
- Suncor Steepbank Mine (Golder 1998d);
- Canadian Natural Resources Limited (Canadian Natural) Kirby Pilot Project (Golder 2000b);
- Suncor Firebag In-Situ Oil Sands Project (Firebag Project) (Golder 2001a);
- Canadian Natural Kirby Lake Experimental Thermal Pilot Project (Golder 2001b);
- Suncor Firebag ETS and Compliance Monitoring Program (Golder 2001c);
- Canadian Natural Primrose and Wolf Lake In-Situ Project (Golder 2001d);
- Canadian Natural Horizon Oil Sands Project (Golder 2002a);
- Canadian Natural Kirby In-Situ Oil Sands Project (Golder 2002b);
- Suncor Firebag Project Seismic Line Reclamation Study (Golder 2002c);
- Shell Canada Limited (Shell) Jackpine Mine – Phase 1 Project (Golder 2002d);
- OPTI Canada Inc./Nexen Canada Ltd. (OPTI/Nexen) Long Lake Pilot and Commercial Project (Golder 2003a);
- Suncor South Tailings Pond (Golder 2003b);
- Petro-Canada Meadow Creek Expansion SAGD Project (Golder 2003c);
- EnCana Corporation (EnCana) Christina Lake Thermal Project (Golder 2004a);
- Shell Lease 13 West Project (Golder 2004b);
- Imperial Oil Resources Ventures Limited (Imperial Oil) Kearl Oil Sands Project (Imperial Oil 2005);
- Albian Sands Muskeg River Mine Expansion Project (Golder 2005a);
- Suncor Voyageur Project (Golder 2005b);
- MEG Energy Corp. (MEG) Christina Lake Regional Project – Pilot and Commercial (Golder 2005c);
- Suncor Fisheries Act Approvals (Golder 2006a);

- Canadian Natural Primrose East In-Situ Oil Sands Project (Golder 2006b);
- Suncor Voyageur South Project (Golder 2007); and
- data collected in support of the Jackpine Mine Expansion & Pierre River Mine Project (the Project).

Scoring values are used to determine overall biodiversity potential for vegetation types. The data used to create the scoring values are derived from the following sources:

- vegetation data collected for Oil Sands Region Environmental Impact Assessments (EIAs) and monitoring programs, as maintained in Golder's vegetation databases;
- wildlife species data collected for Oil Sands Region EIAs and monitoring programs, as maintained in Golder's wildlife databases;
- wildlife habitat associations reported in the literature; and
- aquatic vertebrate species data collected during Oil Sands Region EIAs and monitoring programs.

2.3 SCORING OF INDICES

Each "vegetation type" was ranked based on a combined score against five ecosystem-level biodiversity indices quantifying components of biodiversity, including rarity of vegetation type, rare plant and wildlife species potential, total plant and wildlife species richness, species overlap (i.e., proportion of species shared with other vegetation types) and structural complexity. Table X-2 summarizes the scoring of the biodiversity indices. A discussion of the process to score the indices follows.

Table X-2 Scoring of the Biodiversity Ranking Indices

Level	Index	Parameter	Location of Data	Scoring
landscape composition	rarity of vegetation type	vegetation	Table X-4	0 = vegetation type highly abundant and of no concern; >10% of combined local study areas representing the Oil Sands Region 2 = vegetation type moderately abundant and of no concern; 3 to 10% of combined local study areas representing the Oil Sands Region 4 = vegetation type uncommon, low abundance but not threatened; 0.25 to 3% of combined local study areas representing the Oil Sands Region 6 = vegetation type rare or at extreme end of range; <0.25% of combined local study areas representing the Oil Sands Region
ecosystem composition	total species richness	vascular and non-vascular plants	Table X-5	1 = low (<25% total species) 2 = moderate (25 to 49.9% total species) 3 = moderate-high (50 to 74.9% total species) 4 = high (≥75% total species)
		terrestrial and aquatic vertebrates	Table X-6	1 = low (<30% total potential species) 2 = moderate (30 to 59.9% total potential species) 3 = moderate-high (60 to 89.9% total potential species) 4 = high (≥90% total potential species)
	species overlap	vascular and non-vascular plants	Tables X-7 and X-8	0 = 100% species shared with >4 other habitats 1 = 90 to 99.9% species shared with >4 other habitats 2 = 75 to 89.9% species shared with >4 other habitats 3 = 50 to 74.9% species shared with >4 other habitats 4 = <50% species shared with >4 other habitats
		terrestrial and aquatic vertebrates	Tables X-9 and X-10	0 = 100% species shared with >10 other habitats 1 = 75 to 99.9% species shared with >10 other habitats 2 = 50 to 74.9% species shared with >10 other habitats 3 = <50% species shared with >10 other habitats 4 = contains unique[(a)] species
	rare species potential	rare plants	Table X-11	1 = low rare plant potential 2 = moderate rare plant potential 4 = high rare plant potential
		special status wildlife species	Table X-12	0 = does not support listed species 1 = <50% of highest possible score for rare species potential 2 = 50 to 64.9% of highest possible score for rare species potential 3 = 65 to 79.9% of highest possible score for rare species potential 4 = ≥80% of highest possible score for rare species potential
ecosystem structure	structural complexity	vascular plants	Table X-13	Number of layers: 1 = herbaceous 2 = shrub/herbaceous 3 = single-storey stand 3.5 = even distribution of single and multi-storey stands 4 = multi-storey stand

[(a)] Unique species are species not found in other vegetation types.

A landscape is a land area with groups of plant communities or ecosystems forming an ecological unit with distinguishable structure, function, geomorphology and disturbance regimes (Gaines et al. 1999). Landscape

composition is the variety and abundance of patch types within a landscape (McGarigal and Marks 1995), where a patch is a spatial unit of potential habitat. The measure of landscape composition used in the ranking process is the rarity of vegetation types based on the relative abundance of ecosite phases and wetlands types in the RSA.

Ecosystem composition focuses on the variety and abundance of species within an ecosystem. Measures of ecosystem composition are total species richness, species overlap and the potential for rare species occurrence.

Ecosystem structure refers to the physical characteristics of ecosystems. The measure of ecosystem structure is structural complexity, specifically the number of layers of vegetation present. For example, forested ecosystems have a tree, shrub and herbaceous layer, while grassland ecosystems typically have an herbaceous and/or shrub layer.

2.3.1 Landscape Composition

2.3.1.1 Rarity of Vegetation Type

Rarity is used as a measure of relative abundance of vegetation types within the Oil Sands Region. The rarity of a vegetation type is based on vegetation mapping of LSAs for which data was available. This data is used to act as a surrogate for the Oil Sands Region. Rarity scores are based on a total coverage of more than 225,000 ha and more than 1,500 plots. The LSAs of the following projects were used to determine the rarity scores:

- Albian Sands Muskeg River Mine (Golder 1997);
- Suncor Project Millennium (Golder 1998b,c);
- Suncor Firebag Project (Golder 2001a);
- Canadian Natural Primrose and Wolf Lake In-Situ Project (Golder 2001d);
- Canadian Natural Horizon Oil Sands Project (Horizon) (Golder 2002a);
- Canadian Natural Kirby In-Situ Oil Sands Project (Golder 2002b);
- Shell Jackpine Mine – Phase 1 Project (Golder 2002d);
- OPTI/Nexen Long Lake Pilot and Commercial Project (Golder 2003a);
- Suncor South Tailings Pond Project (Golder 2003b);
- Petro-Canada Meadow Creek Expansion SAGD Project (Golder 2003c);
- Imperial Oil Kearl Oil Sands Project (Imperial Oil 2005);
- Albian Sands Muskeg River Mine Expansion Project (Golder 2005a)
- Suncor Voyageur Project (Golder 2005b); and
- Suncor Voyageur South Project (Golder 2007).

The sum of the area for each vegetation type covered within the 15 LSAs is calculated and the relative proportion of each vegetation type is determined. The scoring class breaks (Table X-2) for the rare vegetation type rankings are determined based on natural breaks in the data from the combined LSAs. The scoring values for rarity of vegetation type are higher compared to the other parameters used in the ranking process to accentuate the importance of vegetation rarity to regional biodiversity. This weighting is based on professional judgment.

The relative abundance of vegetation types is not equivalent across the Oil Sands Region. For example, the lichen jack pine (a1) ecosite phase in the Boreal Mixedwood is more abundant in the northeast portion of the region (i.e., closer to the Athabasca Delta). These spatial considerations will be addressed in the landscape-level analysis at the assessment stage, as applicable.

2.3.2 Ecosystem Composition

2.3.2.1 Total Species Richness

Species richness indices are essentially measures of the number of species in a sampling unit (Magurran 1988). Species richness is calculated using different approaches for vegetation and wildlife, vegetation richness is based on plot data and wildlife richness is based on potential and observed terrestrial vertebrate species.

Vegetation

Total species richness for vegetation is calculated using plot data from surveys in vegetation types conducted in the Oil Sands Region and is maintained in Golder's vegetation databases. Vegetation species richness values are updated as more data are collected. Total species richness for each vegetation type combines all layers (i.e., tree, shrub, herb, graminoid, lichen and moss) to derive the total score. A richness index is calculated on a scale of 0 to 1 to permit comparison of the relative richness of potential plant species among vegetation types. All vegetation types are evaluated against the vegetation type(s) with the highest species total. Vegetation types are scored according to the proportion of total species richness (Table X-2).

Limited plot data have been collected for vegetation types that are uncommon in the Oil Sands Region, such as wooded permafrost bog (BTXN), areas associated with lakes and rivers, and forested swamp (SFNN). Plant species richness values are inferred from the most similar vegetation type where no plant species richness values exist.

Vegetation types were not sampled equally and did not have the same number of sample sites because certain vegetation types are uncommon on the landscape and consequently difficult to locate or access (e.g., wooded swamp [STNN] and blueberry white spruce-jack pine [b4]). Because the number of species per vegetation type is correlated with the number of sites sampled, the total richness values for less-sampled vegetation types are conservative estimates.

Wildlife

Total species richness for wildlife is estimated for potential and observed terrestrial and aquatic vertebrate species (i.e., mammals, birds, amphibians, reptiles and fish) in the Oil Sands Region. The species habitat associations and species ranges are derived from monitoring programs and field surveys conducted in the Oil Sands Region, professional judgment and literature sources, particularly RL&L (1982, 1989), Russell and Bauer (2001), Semenchuk (1992), Smith (1993) and Syncrude (1975). In cases where information is lacking or insufficient, species habitat associations are inferred from the most similar species and habitats.

Species richness is determined for mammals, birds, amphibians, reptiles and fish separately and combined for a total species richness score that represents overall wildlife biodiversity for each vegetation type. A richness index is calculated on a scale of 0 to 1 to permit comparison of the relative richness of potential vertebrate species among vegetation types. All vegetation types are evaluated against the vegetation type(s) with the highest species total. Vegetation types are scored according to the proportion of total species richness (Table X-2).

2.3.2.2 Species Overlap

Species overlap is calculated using the proportion of species in a vegetation type that are also found in other vegetation types. This score indicates whether vegetation types contain proportionately more species that are habitat specialists or habitat generalists. A vegetation type that contains a high proportion of species that are not found in other ecosystems (habitat specialists) would have a higher score than a vegetation type that contains a high proportion of species that are also found in other vegetation types (habitat generalists).

Species overlap is determined by performing data queries on Golder's vegetation and biodiversity databases of species occurrence for each vegetation type. Using detailed vegetation data available on species occurrence in the RSA, species overlap is such that most species occur in more than four habitats or vegetation types. For wildlife species, criteria are refined to differentiate between overlap classes through locating class breaks in the data set as follows: 1 habitat (contains

species not found in other vegetation types), 2 to 10 habitats shared and more than 10 habitats shared (Table X-2).

2.3.2.3 Rare Species Potential

Rare Plants

Rare Plant Potential

A rare plant is considered to be "any native vascular or non-vascular (mosses, hornworts, liverworts) plant that, because of biological characteristics or for some other reason, exists in low numbers or in very restricted areas in Alberta" (Alberta Native Plant Council [ANPC 2006]). The provincial status of plant species are outlined in the *Tracking and Watch Lists Vascular Plants, Mosses, Liverworts and Hornworts* distributed by Alberta Natural Heritage Information Centre (ANHIC 2006). The ANHIC tracking and watch lists were updated in 2006, resulting in the change in status of plant species. Corresponding rare plant potentials are adjusted to account for these changes.

A rare plant potential is assigned to each vegetation type using vegetation and rare plant data from the Golder vegetation database for the Oil Sands Region. This database is queried for plants *occurring* on the ANHIC watch list (ANHIC 2006). Over 3,000 vegetation plots from the Oil Sands Region were used in making a preliminary assessment of rare plant potential by vegetation type. The number of rare plant occurrences was tallied along with the total number of sites visited within each vegetation type. Within this information, rare plant frequency of occurrence was calculated for each vegetation type. These frequency values were sorted to determine if there were any natural breaks in the data that could be used to distinguish between low, moderate and high ranks. Information on rare species habitats within the region was also evaluated. The results were used to adjust the rankings accordingly, especially in cases where there was a limited sample size of a particular vegetation type. A score of one is given for low rare plant potential, a score of two for moderate rare plant potential and a score of four for high rare plant potential to emphasize its importance in the landscape (Table X-2). Refer to Section 3, Volume 3 for a more detailed description of the methods.

Wildlife Species of Concern

The rating for wildlife species of concern is based on the provincial status evaluation system outlined in *The General Status of Alberta Wild Species* (AENV 2005). Special status species are species whose populations are considered "At Risk", "May Be At Risk" or "Sensitive". Species may be listed due to habitat loss, restriction of distribution or because the species is naturally

rare, geographically localized or associated with habitats (e.g., old growth forest) or habitat features (e.g., wildlife trees) that are rare or in decline (AENV 2005).

The potential to provide suitable habitat for "At Risk", "May Be At Risk" and "Sensitive" listed wildlife species is based on the habitat associations used to derive the species richness values for each vegetation type.

Listed species occurrence is weighted according to the level of risk to a species (i.e., "At Risk" species are endangered compared to "May Be At Risk" species that are threatened [AENV 2005]). The scoring system emphasizes the differences between the categories where "At Risk" species are assigned a multiplier of five, "May Be At Risk" species are assigned a multiplier of three and "Sensitive" species are assigned a value of one (Table X-2). The total score for each vegetation type is calculated by summing the weighted values for all listed species expected to occur in that vegetation type. The score for each type is divided by the vegetation type with the highest score to provide an index value. The four rare wildlife species scoring categories are determined based on class breaks in the distribution of the plotted index values (Table X-2).

2.3.3 Ecosystem Structure

2.3.3.1 Structural Complexity

In some instances, an increase in the diversity and abundance of species is directly related to structural complexity. More specifically, the vertical stratification of plant species (number of vegetation layers) in a site affects plant diversity. The complexity of vertical stratification has also been correlated with the diversity of wildlife species that occur within an ecosystem (MacArthur 1958; Morse 1989). Therefore, structural complexity is considered to be a valuable index for overall biodiversity. The structural complexity for each vegetation type pertains to the mature vegetation type successional stage.

Structural complexity is scored (Table X-2) based on the presence of the following:

- a herbaceous layer;
- a shrub and herbaceous layer;
- a single-storey stand; or
- a multi-storey stand (Golder 1999).

The presence of an herb or shrub layer is determined using the *Field Guide to Ecosites of Northern Alberta* (Beckingham and Archibald 1996) and field experience in the region. The proportion of single- and multi-storey stands within each vegetation type is determined using the AVI database (ASRD 2005).

2.4 SCORING PROCESS

All vegetation types are evaluated for each of the five vegetation and wildlife biodiversity indices, for a maximum possible score of 34 (i.e., the sum of the maximum score of each index). To standardize the scoring so that all vegetation types can be directly compared, the total raw score is indexed relative to the vegetation type with the highest score (i.e., on a scale of 0 to 1). The relative biodiversity potential is then categorized into biodiversity ranks of low, moderate and high, so that vegetation types with similar biodiversity potential can be grouped. The threshold value for each category was based on natural breaks in the data (i.e., low = less than or equal to 0.75; moderate = 0.76 to 0.89; and high = more than or equal to 0.90). Refer to Table X-2 for the scoring categories for each of the ranking indices used in the scoring process.

The ranking procedure is also performed using regional land cover classes in the Oil Sands Region to address regional biodiversity. Alberta Vegetation Inventory data from which vegetation types are determined are not available for the entire RSA and classification of satellite imagery results in more broadly defined vegetation classification (regional land cover classes) for the RSA. Each vegetation type is assigned to a regional land cover class (Table X-3) and its relative contribution to that regional land cover class is calculated based on its relative proportion in the Oil Sands Region. This proportion was estimated based on the aerial extent of each vegetation type from Geographic Information System (GIS) mapping for the projects listed in Section 2.2. The biodiversity potential for each regional land cover class is then derived from the weighted average of the scores of all contributing vegetation types.

Table X-3 Correlation of Regional Land Cover Classes With Vegetation Types in the Oil Sands Region

Regional Land Cover Class[a]	Boreal Mixedwood Ecosite Phases[b]	Boreal Highlands Ecosite Phases[b]	Athabasca Plain Ecosite Phases[b]	Wetlands Types[c]
coniferous jack pine dominant	lichen jack pine (a1)	bearberry/lichen (a1)	bearberry jack pine (a1)	n/a
mixedwood jack pine – aspen	blueberry jack pine–aspen (b1)	blueberry jack pine–aspen (b1)	Canada buffalo-berry – green alder –jack pine – aspen – white birch (b1)	n/a
deciduous aspen – balsam poplar	blueberry aspen (b2) low-bush cranberry aspen (d1) dogwood balsam poplar–aspen (e1) horsetail balsam poplar–aspen (f1)	blueberry aspen (b2) low-bush cranberry aspen (d1)	Canada buffalo-berry–green alder–aspen (b2) willow/horsetail–aspen – white birch–balsam poplar (e1)	n/a
mixedwood aspen –white spruce	blueberry aspen–white spruce (b3) low-bush cranberry aspen–white spruce (d2) dogwood balsam poplar–white spruce (e2) horsetail balsam poplar–white spruce (f2)	low-bush cranberry aspen–white spruce–black spruce (d2)	Canada buffalo-berry – green alder–aspen–white spruce–black spruce (b3) willow/horsetail –aspen – white spruce–black spruce (e2)	n/a
coniferous white spruce	low-bush cranberry white spruce (d3) dogwood white spruce (e3) horsetail white spruce (f3) Labrador tea/horsetail white spruce–black spruce (h1)	blueberry white spruce–jack pine (b3) low-bush cranberry white spruce (d3) fern white spruce (e1) horsetail white spruce (f1)	willow/horsetail white spruce–black spruce (e3)	n/a
coniferous jack pine–black spruce	blueberry white spruce–jack pine (b4) Labrador tea–mesic jack pine–black spruce (c1) Labrador tea–subhygric black spruce–jack pine (g1)	Labrador tea–mesic jack pine–black spruce (c1) Labrador tea–subhygric black spruce–jack pine (g1)	Labrador tea–mesic jack pine–black spruce (c1) Labrador tea–subhygric black spruce–jack pine (d1)	n/a
treed fen	n/a	n/a	n/a	wooded fen (FFNN, FTNI, FTNN, FTNR, FTPN) forested swamp (SFNN) wooded swamp (STNN)
non-treed wetlands	n/a	n/a	n/a	open bog (BONN) shrubby fen (FONS, FOPN) graminoid fen (FONG) graminoid marsh (MONG) shrubby swamp (SONS) shrubland
poor wooded fen/wooded bog	n/a	n/a	n/a	forested bog (BFNN) wooded bog (BTNI, BTNN, BTNR, BTXC,BTXN)

Table X-3 Correlation of Regional Land Cover Classes With Vegetation Types in the Oil Sands Region (continued)

Regional Land Cover Class[a]	Boreal Mixedwood Ecosite Phases[b]	Boreal Highlands Ecosite Phases[b]	Athabasca Plain Ecosite Phases[b]	Wetlands Types[c]
water	n/a	n/a	n/a	lakes and ponds river shallow open water (WONN)[d]
other (burn, channel, cutbank, cutblock, disturbance, grassland, meadow, sand)	n/a	n/a	n/a	n/a

[a] Regional land cover classes developed by Golder using satellite imagery, Geographic Information System and Alberta Vegetation Inventory information.

[b] Beckingham and Archibald (1996). The Boreal Mixedwood category includes the Central Mixedwood subregion (Natural Regions Committee 2006).

[c] Halsey et al. (2003).

[d] Distinction of WONN from lakes is difficult based on remote sensing at the RSA scale and therefore it is included in the water class.

n/a = Not applicable.

3 RESULTS AND DISCUSSION

Data in this section are complied from the projects listed in Section 2.2 and include data collected in support of the Project.

3.1 RARE VEGETATION TYPE

The rarity values for each vegetation type are presented in Table X-4 and are based on the projects listed in Section 2.3.1.1.

Table X-4 Rarity of Vegetation Types in Ecosite Phases and Wetlands Types/Water in the Oil Sands Region

Ecosite Phase	Rarity Score
a1	4
b1	2
b2	4
b3	4
b4	4
c1	2
d1	0
d2	2
d3	4
e1	4
e2	4
e3	6
f1	6
f2	6
f3	6
g1	2
h1	4
Wetlands Type/Water	**Rarity Score**
BFNN	6
BONN	6
BTNI	6
BTNN	2
BTNR	4
BTXC	6
BTXN	6
FFNN	6
FONG	4
FONS	2
FOPN	6

Table X-4 Rarity of Vegetation Types in Ecosite Phases and Wetlands Types/Water in the Oil Sands Region (continued)

Wetlands Type/Water	Rarity Score
FTNI	4
FTNN	0
FTNR	4
FTPN	6
MONG	4
SFNN	6
SONS	2
STNN	2
WONN	4
lake	2[(a)]
river	2[(a)]
shrubland	4

[(a)] Lakes and rivers were assigned a rarity score based on overall regional distribution because LSAs are generally designed to avoid these types.

The rarest ecosite phases in the Oil Sands Region are dogwood white spruce (e3), horsetail balsam poplar–aspen (f1), horsetail balsam poplar–white spruce (f2) and horsetail white spruce (f3).

The rarest wetlands types in the Oil Sands Region are the forested bogs (BFNN), open bogs (BONN), wooded bogs with internal lawns (BTNI), wooded permafrost bogs with collapse scars (BTXC), wooded permafrost bogs (BTXN), forested fens (FFNN), patterned fens (FOPN and FTPN) and forested swamps (SFNN). The BTXC wetlands type is at the extreme edge of its range.

The remaining vegetation types are more common, but vary in their distribution within the Oil Sands Region. At higher elevations (e.g., the Boreal Highlands), the distribution of vegetation types is somewhat different than in the Boreal Mixedwood, with the Labrador tea–mesic jack pine-black spruce (c1) vegetation type being more common than in the Boreal Mixedwood.

3.2 TOTAL SPECIES RICHNESS

Vegetation

Overall, the wetlands types have higher vegetation species richness values than the terrestrial ecosite phases (Table X-5). The wooded fen (FTNN) and shrubby fen (FONS) have the highest plant species richness values, 291 and 235 species, respectively. The species richness for wetlands types sampled with five or more

plots ranges from a low of 36 in rivers to a high of 291 in the wooded fen (FTNN) wetlands type. The species richness for ecosite phases sampled with five or more plots ranges from a low of 80 in the horsetail balsam poplar–aspen (f1) ecosite phase to a high of 193 in the Labrador tea–subhygric black spruce–jack pine (g1) ecosite phase. Fens and forested swamp have the highest scores for species richness (4). Six ecosite phases have the next highest score of three.

In the Oil Sands Region, the greatest number (15) of tree and shrub species in the tree layer occurs in wooded swamps (STNN) and low-bush cranberry aspen-white spruce (d2). The greatest number of shrub species (46), forb species (87) and graminoid species (54) occur in the wooded fen wetlands type (FTNN).

Wildlife

A total of 286 vertebrate species are expected to occur in the Oil Sands Region, based on species range maps. Species habitat associations are derived from regional field surveys where possible. Field survey data are not comprehensive for all species in all habitats and therefore, professional judgment and the literature, particularly Semenchuk (1992), Smith (1993) and Russel and Bauer (2001) are also used to determine species habitat associations.

The habitat preferences for each species are categorized according to regional land cover classes. As each regional land cover class is comprised of one or more vegetation types (Table X-3), all vegetation types within a regional vegetation class are considered equivalent in the ranking system.

The species richness for wetlands types ranges from a low of 64 in forested bog (BFNN) to a high of 152 in the shrubby swamp (SONS) wetlands type (Table X-6). The species richness for ecosite phases ranges from a low of 71 in the lichen jack pine (a1) ecosite phase to a high of 137 in the horsetail balsam poplar-white spruce (f2) ecosite phase. Wooded fens, shrubby swamp and f2 have the highest index scores for species richness (4).

Table X-5 Total and Relative Plant Species Richness by Vegetation Type in the Oil Sands Region

Vegetation Type	Number of Plots	Richness							Richness Index[a]	% of Total Species Present	Ranking Score
		Tree/Shrub	Shrub	Forb	Graminoid	Lichen	Moss	Species Total			
a1	53	10	16	27	6	21	13	93	0.32	32	2
b1	93	15	28	59	14	26	19	161	0.55	55	3
b2	30	10	19	39	11	11	13	103	0.35	35	2
b3	43	12	25	53	9	8	10	117	0.40	40	2
b4	32	11	23	42	8	9	7	100	0.34	34	2
c1	137	13	33	51	11	36	21	165	0.57	57	3
d1	171	14	35	75	18	24	19	185	0.64	64	3
d2	186	15	36	76	14	12	17	170	0.58	58	3
d3	47	10	28	56	6	10	12	122	0.42	42	2
e1	26	11	22	40	4	0	4	81	0.28	28	2
e2	25	11	27	50	5	6	10	109	0.37	37	2
e3	15	11	25	62	15	2	7	122	0.42	42	2
f1	13	7	18	30	5	4	16	80	0.27	27	2
f2	13	9	18	33	5	6	14	85	0.29	29	2
f3	15	12	26	46	13	6	11	114	0.39	39	2
g1	147	14	38	56	24	34	27	193	0.66	66	3
h1	53	13	39	50	23	23	26	174	0.60	60	3
BFNN	2	2	6	6	0	2	0	16	0.05	5	3[b]
BONN	3	1	3	2	3	0	3	12	0.04	4	3[b]
BTNI	4	1	6	2	1	3	5	18	0.06	6	3[b]
BTNN	163	9	33	35	23	37	30	167	0.57	57	3
BTNR	1	1	3	2	0	1	4	11	0.04	4	3[b]
BTXC	1	2	6	8	1	0	0	17	0.06	6	3[b]
BTXN	0	n/d	n/d	n/d	n/d	n/d	n/d	n/d	n/d	n/d	3[b]
FFNN	7	4	18	22	7	1	7	59	0.20	20	3[b]
FONG	67	6	20	57	34	19	26	162	0.56	56	3
FONS	176	13	35	80	45	22	40	235	0.81	81	4
FOPN	4	1	2	0	0	0	1	4	0.01	1	4[b]
FTNI	4	2	5	8	3	0	5	23	0.08	8	4[b]
FTNN	351	14	46	87	54	37	53	291	1.00	100	4
FTNR	1	2	4	3	2	0	2	13	0.04	4	4[b]
FTPN	2	0	0	2	0	0	0	0	0.00	0	4[b]

Table X-5 Total and Relative Plant Species Richness by Vegetation Type in the Oil Sands Region (continued)

Vegetation Type	Number of Plots	Richness							Richness Index[a]	% of Total Species Present	Ranking Score
		Tree/Shrub	Shrub	Forb	Graminoid	Lichen	Moss	Species Total			
MONG	59	7	12	66	27	0	4	116	0.40	40	2
SFNN	0	n/d	n/d	n/d	n/d	n/d	n/d	n/d	n/d	n/d	4[b]
SONS	90	13	36	86	29	16	36	216	0.74	74	3
STNN	107	15	41	85	35	22	35	233	0.80	80	4
WONN	12	0	0	36	3	0	3	42	0.14	14	1
lake	4	0	0	32	1	0	0	33	0.11	11	1
river	6	2	8	15	1	3	7	36	0.12	12	1
shrubland	12	8	17	19	4	0	1	49	0.17	17	1

[a] Richness ranking index standardized relative to vegetation type with the highest species richness.

[b] Richness index and ranking score for wetlands with low plot sampling intensity (BFNN, BONN, BTNI, BTNR, BTXC, BTXN, FFNN, FOPN, FTNI, FTNR, FTPN, SFNN) were assigned a ranking based on the expected species richness using ranking scores for well-sampled similar wetlands types (BTNN, FTNN, FONS, STNN).

n/d = No data.

Table X-6 Total and Relative Wildlife Species Richness by Vegetation Type

Vegetation Type	Species Total	Richness Index[(a)]	% of Total Species Present	Ranking Score
a1	71	0.47	47	2
b1	126	0.83	83	3
b2	116	0.76	76	3
b3	112	0.74	74	3
b4	87	0.57	57	2
c1	79	0.52	52	2
d1	123	0.81	81	3
d2	135	0.89	89	3
d3	89	0.59	59	2
e1	109	0.72	72	3
e2	136	0.89	89	3
e3	92	0.61	61	3
f1	107	0.70	70	3
f2	137	0.90	90	4
f3	97	0.64	64	3
g1	82	0.54	54	2
h1	80	0.53	53	2
BFNN	64	0.42	42	2
BONN	76	0.50	50	2
BTNI/BTNR	73	0.48	48	2
BTNN	109	0.72	72	3
BTXC/BTXN	72	0.47	47	2
FFNN	118	0.78	78	3
FONG	95	0.63	63	3
FONS	120	0.79	79	3
FOPN	72	0.47	47	2
FTNI/FTNR/FTPN	124	0.82	82	3
FTNN	139	0.91	91	4
MONG	119	0.78	78	3
SFNN	126	0.83	83	3
SONS	152	1.00	100	4
STNN	132	0.87	87	3
WONN	77	0.51	51	2
lake	93	0.61	61	3
river	96	0.63	63	3
shrubland	78	0.51	51	2

[(a)] Richness ranking index standardized relative to vegetation type with highest species richness.

3.3 SPECIES OVERLAP

Vegetation

Vegetation overlap of plant species among ecosite phases is common in the Oil Sands Region (Table X-7). In general, most plant species occur in many vegetation types with only a few species being restricted to a small number of vegetation types. There are three ecosite phases that have unique species (i.e., species not found in other vegetation types): Labrador tea–mesic jack pine–black

spruce (c1), low-bush cranberry aspen (d1) and low-bush cranberry white spruce (d3).

In the Central Mixedwood Natural Subregion of the Oil Sands Region, all 17 ecosite phases have at least 80% of their vascular plant species occurring in greater than four other vegetation types (Table X-7). The low-bush cranberry aspen (d1) ecosite phase has the lowest proportion (80%) of species in greater than four habitats.

Table X-7 Overlap of Plant Species for Ecosite Phases

Ecosite Phase	Proportion [%] and Number of Species Shared with Other Vegetation Types					Number of Unique Species[(a)]	Total Species Richness	Ranking
	2 to 4 Habitats Shared [%]	Number of Species	>4 Habitats Shared [%]	Number of Species	Number of Shared Species			
a1	11.8	11	88.2	82	93	0	93	2
b1	12.4	20	87.6	141	161	0	161	2
b2	6.8	7	93.2	96	103	0	103	1
b3	6.8	8	93.2	109	117	0	117	1
b4	7.0	7	93.0	93	100	0	100	1
c1	10.3	17	89.1	147	164	1	165	2
d1	19.5	36	80.0	148	184	1	185	2
d2	11.8	20	88.2	150	170	0	170	2
d3	10.7	13	88.5	108	121	1	122	2
e1	4.9	4	95.1	77	81	0	81	1
e2	11.0	12	89.0	97	109	0	109	2
e3	12.3	15	87.7	107	122	0	122	2
f1	7.5	6	92.5	74	80	0	80	1
f2	5.9	5	94.1	80	85	0	85	1
f3	12.3	14	87.7	100	114	0	114	2
g1	14.0	27	86.0	166	193	0	193	2
h1	10.9	19	89.1	155	174	0	174	2

[(a)] Unique species are species not found in other vegetation types.

Wetlands types exhibit lower species overlap compared to ecosite phases (Table X-7). Most notably, graminoid fens (FONG), shrubby fens (FONS), wooded fens (FTNN), graminoid marshes (MONG) and open bog (BONN) wetlands types all have less than 75% of their plant species occurring in greater than four other vegetation types (Table X-8). Shallow open water (WONN) and lakes have the lowest species overlap because there are only a few water types and some plant species, particularly aquatic species, only occur in the wetlands types with open water.

Table X-8 Overlap of Plant Species for Wetlands Types and Water

Wetlands Types/Water	Proportion [%] and Number of Species Shared With Other Vegetation Types					Number of Unique Species[a]	Total Species Richness	Ranking
	1 to 4 Habitats Shared [%]	Number of Species	>4 Habitats Shared [%]	Number of Species	Number of Shared Species			
BFNN	6.3	1	93.8	15	16	0	16	2[b]
BONN	25.0	3	75.0	9	12	0	12	2[b]
BTNI	0	0	100.0	18	18	0	18	2[b]
BTNN	12.0	20	88.0	147	167	0	167	2
BTNR	0	0	100.0	11	11	0	11	2[b]
BTXC	0	0	94.1	16	16	1	17	2[b]
BTXN	n/d	n/d	n/d	n/d	n/d	n/d	0	2[b]
FFNN	1.7	1	98.3	58	59	0	59	3[b]
FONG	25.9	42	72.4	117	159	3	163	3
FONS	25.5	60	73.2	172	232	3	235	3
FOPN	0	0	100.0	4	4	0	4	3[b]
FTNI	0	0	100.0	23	23	0	23	3[b]
FTNN	24.7	72	73.2	213	285	6	291	3
FTNR	0	0	100.0	13	13	0	13	3[b]
FTPN	n/d	n/d	n/d	n/d	n/d	n/d	n/d	3[b]
MONG	33.3	39	63.2	74	113	4	117	3
SFNN	n/d	n/d	n/d	n/d	n/d	n/d	n/d	2[b]
SONS	23.5	51	75.6	164	215	2	21	2
STNN	16.3	38	83.7	195	233	0	233	2
WONN	67.4	29	30.2	13	42	1	43	4
lake	76.5	26	20.6	7	33	1	34	4
river	19.2	5	80.8	21	26	0	26	2
shrubland	6.1	3	93.9	46	49	0	49	1

[a] Unique species are species not found in other vegetation types.

[b] Species overlap and ranking score for wetlands with low plot sampling intensity were assigned a ranking based on the expected species overlap using ranking scores for well-sampled similar wetlands types (BTNN, FTNN, FONS, STNN).

n/d = No data.

In addition, wetlands also have more unique species (i.e., not found in other vegetation types) than terrestrial ecosite phases. For example, graminoid fens (FONG), shrubby fens (FONS), wooded fens (FTNN) and graminoid marshes (MONG) all have three or more unique species. Tables X-7 and X-8 provide the number of vegetation types in which the plant species were observed, but do not capture the frequency or abundance of these species in the vegetation types.

Some plant species may not have been observed in vegetation types where only a few plots were surveyed. Conversely, vegetation types that were abundantly sampled may be overemphasized in species lists. For example, a species may be uncommon in a particular vegetation type; however, because the vegetation type was well-sampled, the species was detected. Uncommon vegetation types will be sampled less frequently; therefore, not all species that occur within the vegetation type may be detected.

Wildlife

Most of the vegetation types in the Oil Sands Region share wildlife species with more than ten other vegetation types (Tables X-9 and X-10). Some of the overlap can be explained by the fact that wildlife are mobile and often use more than one vegetation type on a daily (e.g., roosting and foraging) or seasonal (e.g., breeding and non-breeding) basis. Lakes, rivers, graminoid marshes (MONG) and shrubby swamps (SONS) had species that do not occur in any other vegetation type (Table X-10).

Table X-9 Overlap of Wildlife Species for Ecosite Phases

Ecosite Phase	Proportion [%] and Number of Species Shared With Other Vegetation Types					Number of Unique Species[(a)]	Total Species Richness	Ranking
	1 to 10 Habitats Shared [%]	Number of Species	>10 Habitats Shared [%]	Number of Species	Number of Shared Species			
a1	3.3	2	96.7	58	60	0	60	1
b1	20.5	24	79.5	93	117	0	117	1
b2	20.7	24	79.3	92	116	0	116	1
b3	10.4	11	89.6	95	106	0	106	1
b4	7.1	6	92.9	78	84	0	84	1
c1	3.1	2	96.9	63	65	0	65	1
d1	21.1	24	78.9	90	114	0	114	1
d2	19.7	26	80.3	106	132	0	132	1
d3	7.1	6	92.9	79	85	0	85	1
e1	9.8	10	90.2	92	102	0	102	1
e2	20.3	27	79.7	106	133	0	133	1
e3	6.9	6	93.1	81	87	0	87	1
f1	9.6	10	90.4	94	104	0	104	1
f2	20.1	27	79.9	107	134	0	134	1
f3	6.7	6	93.3	83	89	0	89	1
g1	2.9	2	97.1	66	68	0	68	1
h1	3.0	2	97.0	65	67	0	67	1

[(a)] Unique species are species not found in other vegetation types.

Table X-10 Overlap of Wildlife Species for Wetlands Types and Water

Wetlands Type/Water	Proportion [%] and Number of Species Shared With Other Vegetation Types					Number of Unique Species[(a)]	Total Species Richness	Ranking
	2 to 10 Habitats Shared [%]	Number of Species	>10 Habitats Shared [%]	Number of Species	Number of Shared Species			
BFNN	11.3	7	88.7	55	62	0	62	1
BONN	17.6	13	82.4	61	74	0	74	1
BTNI	9.6	7	90.4	66	73	0	73	1
BTNN	9.6	7	90.4	66	73	0	73	1
BTNR	9.6	7	90.4	66	73	0	73	1
BTXC	9.7	7	90.3	65	72	0	72	1
BTXN	9.7	7	90.3	65	72	0	72	1
FFNN	5.9	7	94.1	111	118	0	118	1
FONG	12.8	10	87.2	68	78	0	78	1
FONS	15.1	13	84.9	73	86	0	86	1

Table X-10 Overlap of Wildlife Species for Wetlands Types and Water (continued)

Wetlands Type/Water	Proportion [%] and Number of Species Shared With Other Vegetation Types					Number of Unique Species[a]	Total Species Richness	Ranking
	2 to 10 Habitats Shared [%]	Number of Species	>10 Habitats Shared [%]	Number of Species	Number of Shared Species			
FOPN	11.1	8	88.9	64	72	0	72	1
FTNI	5.6	7	94.4	117	124	0	124	1
FTNN	5.6	7	94.4	117	124	0	124	1
FTNR	5.6	7	94.4	117	124	0	124	1
FTPN	5.6	7	94.4	117	124	0	124	1
MONG	26.1	29	72.0	81	110	1	111	4
SFNN	5.6	7	94.4	119	126	0	126	1
SONS	25.6	34	73.0	97	131	2	133	4
STNN	5.5	7	94.5	121	128	0	128	1
WONN	33.8	25	66.2	49	74	0	74	2
lake	48.4	45	50.5	47	92	1	93	4
river	46.9	45	49.0	47	92	4	96	4
shrubland	25.0	17	75.0	51	68	0	68	1

[a] Unique species are species not found in other vegetation types.

3.4 RARE SPECIES POTENTIAL

3.4.1 Rare Plants

Rare plants have been recorded in 40 vegetation types in the Oil Sands Region based on 3,339 vegetation plots surveyed by Golder. Thirteen vegetation types are considered to have a high rare plant potential (ranking score of 4), 10 have moderate potential (ranking score of 2) and 17 have low potential (ranking score of 1) (Table X-11).

Table X-11 Rare Plant Potential in Ecosite Phases and Wetlands Types/Water in the Oil Sands Region

Ecosite Phase	Rare Plant Potential
a1	2
b1	2
b2	2
b3	2
b4	2
c1	2
d1	1
d2	1
d3	1
e1	2
e2	1
e3	1
f1	2
f2	1
f3	1
g1	1
h1	1

Table X-11 Rare Plant Potential in Ecosite Phases and Wetlands Types/Water in the Oil Sands Region (continued)

Wetlands Type/Water	Rare Plant Potential
BFNN	1
BONN	4
BTNI	1
BTNN	1
BTNR	1
BTXC	1
BTXN	1
FFNN	4
FONG	4
FONS	4
FOPN	4
FTNI	4
FTNN	4
FTNR	4
FTPN	4
MONG	4
SFNN	2
SONS	4
STNN	2
WONN	4
lake	1
river	1
shrubland	4

3.4.2 Special Status Wildlife Species

There are 125 special status wildlife species in Alberta (AENV 2005): 18 “At Risk”, 19 “May Be At Risk” and 88 “Sensitive” species. All vegetation types support listed species (Table X-12). Wooded swamps (STNN) and wooded fens (FTNN) support the most listed species (37 and 36, respectively), followed closely by the other wooded fens (FTNR and FTNI), patterned fens (FTPN) and forested swamps (SFNN) (Table X-12). The shrublands ecosite phase supports the fewest listed species (10), followed by lichen jack pine (a1) with 15.

The highest weighted score occurs in the graminoid marsh (MONG) wetlands type, because this wetlands type supports the most species that have high status (i.e., the most “At Risk” species).

Table X-12 Potential for Special Status Wildlife Species by Vegetation Type

Vegetation Type	At Risk	May Be At Risk	Sensitive	Total Listed Species	Weighted Score	Index	Ranking Score
a1	2	2	11	15	27	0.44	1
b1	1	3	25	29	39	0.63	2
b2	1	3	21	25	35	0.56	2
b3	0	3	22	25	31	0.50	2
b4	1	2	14	17	25	0.40	1
c1	1	2	13	16	24	0.39	1
d1	1	2	23	26	34	0.55	2
d2	1	2	25	28	36	0.58	2
d3	0	2	16	18	22	0.35	1
e1	1	3	18	22	32	0.52	2
e2	1	3	26	30	40	0.65	2
e3	1	2	17	20	28	0.45	1
f1	2	3	17	22	36	0.58	2
f2	2	3	25	30	44	0.71	3
f3	2	2	17	21	33	0.53	2
g1	2	2	13	17	29	0.47	1
h1	3	2	14	19	35	0.56	2
BFNN	3	1	13	17	31	0.50	2
BONN	2	2	13	17	29	0.47	1
BTNI	3	2	16	21	37	0.60	2
BTNN	3	2	21	26	42	0.68	3
BTNR	3	2	16	21	37	0.60	2
BTXC	3	2	16	21	37	0.60	2
BTXN	3	2	15	20	36	0.58	2
FFNN	3	1	28	32	46	0.74	3
FONG	4	2	17	23	43	0.69	3
FONS	2	3	21	26	40	0.65	2
FOPN	3	1	15	19	33	0.53	2
FTNI	3	2	30	35	51	0.82	4
FTNN	3	2	31	36	52	0.84	4
FTNR	3	2	30	35	51	0.82	4
FTPN	3	2	30	35	51	0.82	4
MONG	6	3	23	32	62	1.00	4
SFNN	3	2	30	35	51	0.82	4
SONS	5	1	25	31	53	0.85	4
STNN	3	2	32	37	53	0.85	4
WONN	4	2	20	26	46	0.74	3
lake	4	3	22	29	51	0.82	4
river	4	3	22	29	51	0.82	4
shrubland	1	1	8	10	16	0.26	1

Note: Based on AENV (2005).

Four wetlands types, including graminoid marshes (MONG), swamps (STNN, SFNN, SONS), fens (FTNI, FTNN, FTNR and FTPN) and water (lakes and rivers) have the highest number of listed species (ranking score of 4). These vegetation types provide potential breeding and non-breeding habitat for the Canadian toad and northern leopard frog, foraging habitat for the peregrine falcon and migratory stopping grounds for the whooping crane. There are four wetlands types (wooded bogs [BTNN], fens [FONG, FFNN] and shallow open

water [WONN]) and one ecosite phase (horsetail balsam poplar–white spruce [f2]) with a ranking score of 3. The lowest scoring vegetation types generally provide potential habitat for the fewest number of listed species in the Oil Sands Region. Although there are fewer special status wildlife species in the terrestrial vegetation types, most of these habitats support some "At Risk" and "May Be At Risk" species.

3.5 STRUCTURAL COMPLEXITY

Of the 30 vegetation types with established tree canopies 17 are generally comprised of single-storey stands (ranking score of 3), 11 are comprised of multi-storey stands (ranking score of 3.5) and two have an even distribution of single and multi-storey stands (ranking score of 4) within the Oil Sands Region (Table X-13). The ranking score for each vegetation type directly reflects the number of structural layers attributed to that vegetation type and also implies a corresponding measure of wildlife diversity.

Table X-13 Structural Complexity Indices by Vegetation Type

Vegetation Type	Number of Vegetation Layers	Ranking Score
a1	3	3
b1	3.5	3.5
b2	4	4
b3	3.5	3.5
b4	3.5	3.5
c1	3	3
d1	3.5	3.5
d2	3.5	3.5
d3	3.5	3.5
e1	3	3
e2	3	3
e3	3.5	3.5
f1	3	3
f2	3	3
f3	3	3
g1	4	4
h1	3	3
BFNN	3	3
BONN	2	2
BTNI	3	3
BTNN	3	3
BTNR	3	3
BTXC	3	3
BTXN	3	3
FFNN	3	3
FONG	1	1
FONS	2	2
FOPN	2	2

Table X-13 Structural Complexity Indices by Vegetation Type (continued)

Vegetation Type	Number of Vegetation Layers	Ranking Score
FTNI	3.5	3.5
FTNN	3.5	3.5
FTNR	3	3
FTPN	3	3
MONG	1	1
SFNN	3.5	3.5
SONS	2	2
STNN	3.5	3.5
WONN	1	1
lake	1	1
river	1	1
shrubland	2	2

Note: Number of vegetation layers for wetlands types is derived from field experience and professional expertise.

4 RANKING OF VEGETATION TYPES

Biodiversity within the Oil Sands Region is determined to a large extent by the rarity of each vegetation type. All of the indices presented in Table X-14 are influenced in some manner by the distribution of vegetation types. For example, a vegetation type that is at the extreme end of its distribution in the region and has high total species richness, low species overlap, high rare species potential and greater structural complexity may not contribute as much to regional biodiversity as a vegetation type that is more common, but moderate in terms of the other indices. A good example of a vegetation type that falls into this category is the patterned open fen (FOPN).

Wetlands types scored higher on average than ecosite phases. Wetlands types are typically rarer, have higher plant species richness and support more plant habitat specialists than ecosite phases. Wildlife species richness scores were generally similar for ecosite phases and wetlands types although the wildlife species overlap was generally lower for wetlands types (i.e., contained more unique species).

Wetlands types also typically support more rare plants and special status wildlife species than ecosite phases. These results reflect the occurrence of rare plant species in several wetlands types and the higher use of wetlands types by wildlife species at risk (e.g., woodland caribou and Canadian toad [Golder 2000a]).

The structural complexity was generally higher for terrestrial vegetation types than wetlands, indicative of the higher occurrence of multi-storey stands among terrestrial vegetation types.

Nine of the wetlands types are rated as having high biodiversity potential (Table X-14). The highest potential for biodiversity occurs in the wooded fens, particularly those that are non-patterned with internal lawns (FTNI). Some of the non-treed wetlands (FOPN, MONG and SONS) also have high biodiversity potential. All of the ecosite phases are rated as having either moderate or low biodiversity potential; none are ranked high.

Data were not available for all indices for eight of the categories (burn, channel, cutbank, cutblock, disturbance, grassland, meadow and sand). The low biodiversity potential assigned to these categories is based on a combination of field experience, professional judgement and available literature. Literature sources indicate that recently burned areas and regenerating cutblocks are typically less biodiverse in the earlier years of regeneration due to reduced presence of specialized epiphytic and non-vascular species (Haeussler and Bergeron 2004), temporary loss of micro-habitats, reduced habitat suitability (Malcolm et al. 2004) and constraints to understorey vegetation development due to shading caused by dense regenerating trees and shrubs (Strong 2004).

Table X-14 Biodiversity Potential for Vegetation Types in the Oil Sands Region

Regional Land Cover Class	Vegetation Type/Other	Indices Scores							Structural Complexity	Total Score	Ranking Index[a]	Biodiversity Potential[b]
		Rare Vegetation Type	Total Species Richness		Species Overlap		Rare Species Potential					
			Vegetation	Wildlife	Vegetation	Wildlife	Vegetation	Wildlife				
coniferous jack pine dominant	a1	4	2	2	2	1	2	1	3	17	0.64	L
mixedwood jack pine – aspen dominant	b1	2	3	3	2	1	2	2	3.5	18.5	0.69	L
deciduous aspen/aspen – balsam poplar dominant	b2	4	2	3	1	1	2	2	4	19	0.72	M
mixedwood aspen –white spruce dominant	b3	4	2	3	1	1	2	2	3.5	18.5	0.69	L
coniferous jack pine – black spruce dominant	b4	4	2	2	1	1	2	1	3.5	16.5	0.62	L
coniferous jack pine – black spruce dominant	c1	2	3	2	2	1	2	1	3	16	0.60	L
deciduous aspen/aspen – balsam poplar dominant	d1	0	3	3	2	1	1	2	3.5	15.5	0.58	L
mixedwood–aspen – white spruce dominant	d2	2	3	3	2	1	1	2	3.5	17.5	0.66	L
coniferous white spruce dominant	d3	4	2	2	2	1	1	1	3.5	16.5	0.62	L
deciduous aspen/aspen – balsam poplar dominant	e1	4	2	3	1	1	2	2	3	18	0.68	L
mixedwood aspen – white spruce dominant	e2	4	2	3	2	1	1	2	3	18	0.68	L
coniferous white spruce dominant	e3	6	2	3	2	1	1	1	3.5	19.5	0.74	M

Table X-14 Biodiversity Potential for Vegetation Types in the Oil Sands Region (continued)

Regional Land Cover Class	Vegetation Type/Other	Indices Scores							Structural Complexity	Total Score	Ranking Index[a]	Biodiversity Potential[b]
		Rare Vegetation Type	Total Species Richness		Species Overlap		Rare Species Potential					
			Vegetation	Wildlife	Vegetation	Wildlife	Vegetation	Wildlife				
deciduous aspen/aspen – balsam poplar dominant	f1	6	2	3	1	1	2	2	3	20	0.75	M
mixedwood aspen –white spruce dominant	f2	6	2	4	1	1	1	3	3	21	0.79	M
coniferous white spruce dominant	f3	6	2	3	2	1	1	2	3	20	0.75	M
coniferous jack pine – black spruce dominant	g1	2	3	2	2	1	1	1	4	16	0.60	L
coniferous white spruce dominant	h1	4	3	2	2	1	1	2	3	18	0.68	L
poor wooded fen/wooded bog	BFNN	6	3	2	2	1	1	2	3	20	0.75	M
non - treed wetlands	BONN	6	3	2	2	1	4	1	2	21	0.79	M
poor wooded fen/wooded bog	BTNI	6	3	2	2	1	1	2	3	20	0.75	M
poor wooded fen/wooded bog	BTNN	2	3	3	2	1	1	3	3	18	0.68	L
poor wooded fen/wooded bog	BTNR	4	3	2	2	1	1	2	3	18	0.68	L
poor wooded fen/wooded bog	BTXC	6	3	2	2	1	1	2	3	20	0.75	M
poor wooded fen/wooded bog	BTXN	6	3	1	2	1	1	2	3	20	0.75	M
treed fen	FFNN	6	3	3	3	1	4	3	3	26	0.98	H
non-treed wetlands	FONG	4	3	3	3	1	4	3	1	22	0.83	M
non - treed wetlands	FONS	2	4	3	3	1	4	2	2	21	0.79	M
non - treed wetlands	FOPN	6	4	2	3	1	4	2	2	24	0.91	H
treed fen	FTNI	4	4	3	3	1	4	4	3.5	26.5	1.00	H

Table X-14 Biodiversity Potential for Vegetation Types in the Oil Sands Region (continued)

Regional Land Cover Class	Vegetation Type/Other	Indices Scores							Structural Complexity	Total Score	Ranking Index[a]	Biodiversity Potential[b]
		Rare Vegetation Type	Total Species Richness		Species Overlap		Rare Species Potential					
			Vegetation	Wildlife	Vegetation	Wildlife	Vegetation	Wildlife				
treed fen	FTNN	0	4	4	3	1	4	4	3.5	23.5	0.89	H
treed fen	FTNR	4	4	3	3	1	4	4	3	26	0.98	H
treed fen	FTPN	4	4	3	3	1	4	4	3	26	0.98	H
Non - treed wetlands	MONG	4	2	3	3	4	4	4	1	25	0.94	H
treed fen	SFNN	6	4	3	2	1	2	4	3.5	25.5	0.96	H
Non - treed wetlands	SONS	2	3	4	2	4	4	4	2	25	0.94	H
treed fen	STNN	2	4	3	2	1	2	4	3.5	21.5	0.81	M
water	WONN	4	1	2	4	2	4	3	1	21	0.79	M
water	lake	2	1	3	4	4	1	4	1	20	0.75	M
water	river	2	1	3	2	4	1	4	1	18	0.68	L
non-treed wetlands	shrubland	4	1	2	1	1	4	1	2	16	0.60	L
other[c]	burn	4	n/d	n/d	n/d	n/d	2	n/d	n/d	6	n/a	L[c]
	channel	6	n/d	n/d	n/d	n/d	n/d	n/d	n/d	6	n/a	L[c]
	cutbank	6	n/d	n/d	n/d	n/d	1	n/d	n/d	7	n/a	L[c]
	cutblock	4	n/d	n/d	n/d	n/d	2	n/d	n/d	6	n/a	L[c]
	disturbance[d]	2	n/d	n/d	n/d	n/d	1	n/d	1	4	n/a	L[c]
	grassland	6	n/d	n/d	n/d	n/d	n/d	n/d	n/d	6	n/a	L[c]
	meadow	6	n/d	n/d	n/d	n/d	4	n/d	1	11	n/a	L[c]
	sand	6	n/d	n/d	n/d	n/d	n/d	n/d	n/d	6	n/a	L[c]

[a] Ranking index standardized relative to vegetation type with highest total score.

[b] Biodiversity Potential: Low (L) = ≤0.70; Moderate (M) = 0.71 to 0.84; High (H) = ≥0.85.

[c] The biodiversity potential for these categories was determined based on professional judgment, field experience and available literature in the Oil Sands Region because data for individual indices was not available.

[d] Disturbances include all urban, industrial and agricultural development.

n/d = No data.

Assigning a single biodiversity value to each vegetation type may highlight the importance of particular types; however, it is also important to consider which indices contributed to the assigned rank. As discussed above, the factors that influence biodiversity differ for each vegetation type.

While the biodiversity ranking system is a quantitative assessment of relative biodiversity potential of vegetation types in an LSA, ecosystems are connected systems, involving complex relationships among vegetation types and individual species. Therefore, vegetation types ranked low for biodiversity potential are important because they provide niche habitats and contribute to species life cycles and overall ecological processes. For example, ecosite phases ranked as having low biodiversity potential are linked across the landscape, providing connectivity for plants and wildlife, contain old growth forest and provide habitat opportunities for a variety of species.

5 RANKING OF REGIONAL LAND COVER CLASSES

Regional land cover classes in the Oil Sands Region are ranked based on the weighted contribution of their constituent vegetation types (Table X-15) because information required for the indices is not collected at this scale. Previous environmental impact assessment projects dating back to 1997 (refer to Section 2.2) were used to determine the relative proportion of ecosite phases, wetlands types and other vegetation types in the Oil Sands Region.

Improved land classification methods have been developed to classify regional land cover classes since the previous version of the biodiversity ranking document (Golder 2000a). To incorporate these improved methods, the Oil Sands Region has been reclassified using the most recent imagery, which also includes current disturbances as of 2006. This has resulted in modified classes based on revised vegetation type groupings that more effectively reflect regional land cover classes. The new groupings result in new biodiversity rankings for the regional land cover classes in some instances.

The results indicate that treed fen and non-treed wetlands regional land cover classes have the highest biodiversity potential in the Oil Sands Region. Mixedwood jack pine–aspen, mixedwood aspen–white spruce, coniferous white spruce, poor wooded fen/wooded bog and water regional land cover classes are ranked as moderate. All other regional land cover classes have low biodiversity potential.

Table X-15 Biodiversity Ranking Assessment for Regional Land Cover Classes in the Oil Sands Region

Regional Land Cover Class	Vegetation Type/Other	Biodiversity Score	Weighted Contribution to Regional Vegetation Type[a]	Weighted Score	Total Score	Ranking Index[b]	Biodiversity Potential[c]
coniferous jack pine	a1	17.0	1.00	16.00	17.0	0.73	L
mixedwood jack pine–aspen	b1	18.5	1.00	18.50	18.5	0.80	M
deciduous aspen/aspen–balsam poplar	b2	19.0	0.08	0.19	15.9	0.69	L
	d1	15.5	0.87	14.88			
	e1	18.0	0.05	0.57			
	f1	20.0	0.002	0.02			
mixedwood aspen–white spruce	b3	18.5	0.13	0.74	17.7	0.76	M
	d2	17.5	0.79	13.86			
	e2	18.0	0.08	2.40			
	f2	21.0	0.01	0.08			
coniferous white spruce	d3	16.5	0.41	10.44	17.6	0.76	M
	e3	19.5	0.05	1.49			
	f3	20.0	0.05	0.76			
	h1	18.0	0.49	6.00			
coniferous jack pine–black spruce	b4	16.5	0.14	1.81	16.1	0.69	L
	c1	16.0	0.33	3.91			
	g1	16.0	0.54	7.20			
treed fen	FFNN	26.0	0.001	0.02	23.2	1.00	H
	FTNI	26.5	0.01	0.28			
	FTNN	23.5	0.71	17.86			
	FTNR	26.0	0.01	1.08			
	FTPN	26.0	0.04	0.00			
	SFNN	25.5	0.01	0.03			
	STNN	21.5	0.23	4.66			

Table X-15 Biodiversity Ranking Assessment for Regional Land Cover Classes in the Oil Sands Region (continued)

Regional Land Cover Class	Vegetation Type/Other	Biodiversity Score	Weighted Contribution to Regional Vegetation Type[a]	Weighted Score	Total Score	Ranking Index[b]	Biodiversity Potential[c]
non-treed wetlands	BONN	21.0	0.002	0.03	22.6	0.97	H
	FONG	22.0	0.12	2.56			
	FONS	21.0	0.44	9.34			
	FOPN	24.0	0.02	0.39			
	MONG	25.0	0.07	1.72			
	SONS	25.0	0.32	8.05			
	shrubland	16.0	0.03	0.48			
poor wooded fen/wooded bog	BFNN	20.0	0.02	0.40	18.2	0.78	M
	BTNI	20.0	0.04	0.73			
	BTNN	18.0	0.84	15.08			
	BTNR	18.0	0.07	1.27			
	BTXC	20.0	0.03	0.70			
	BTXN	20.0	0.0003	0.01			
water	NWL	20.0	0.79	15.75	20.0	0.86	M
	NWR	18.0	0.07	1.31			
	WONN[d]	21.0	0.14	2.94			
other[d]	burn, channel, cutbank, cutblock, disturbance[e], grassland, meadow, sand	n/a	n/a	n/a	n/a	n/a	L[e]

[a] Weighted contribution was derived from ecosite phases, wetlands types and other vegetation types mapped for projects listed in Section 2.2.

[b] Ranking index standardized relative to regional land cover class with highest total score.

[c] Biodiversity Potential: Low (L) = ≤0.75; Moderate (M) = 0.76 to 0.89; High (H) = ≥0.90.

[d] The biodiversity potential for these categories was determined based on professional judgment, field experience and available literature in the Oil Sands Region because data for individual indices was not available.

[e] Disturbances include all urban, industrial and agricultural development.

n/a = Not applicable.

6 SUMMARY

This biodiversity ranking approach provides a relative biodiversity rank for vegetation types based on indices that combine vascular and non-vascular plant species, and terrestrial and aquatic vertebrates. By understanding the relative biodiversity potential for each vegetation type, it is easier to use vegetation maps to determine areas of high biodiversity that might be impacted by a development.

Based on the ranking system, the wooded fens (FTNI, FTNN, FTNR and FTPN), as well as forested fens (FFNN), forested swamps (SFNN), shrubby swamps (SONS), graminoid marshes (MONG) and open patterned fens with no internal lawns (FOPN) have the highest biodiversity potential ratings of vegetation types in the Oil Sands Region. None of the ecosite phases are ranked as having high biodiversity potential. Regional land cover classes ranked high for biodiversity are treed fens and non-treed wetlands. This result is due to the high proportion of rare species and low species overlap among these regional land cover classes. Mixedwood jack pine–aspen, mixedwood aspen–white spruce, coniferous white spruce, poor wooded fen/wooded bog and water regional land cover classes are ranked as moderate and all other regional land cover classes are ranked as having low biodiversity potential.

The biodiversity values described in this report characterize the environmental setting conditions to which future landscapes in the Oil Sands Region can be compared. The similarity between the pre- and post-development landscapes can be measured using these indices as a means to direct conservation and reclamation, monitoring and management plans.

7 GLOSSARY AND ABBREVIATIONS

7.1 GLOSSARY OF TERMS

Abiotic Non-living factors that influence an ecosystem, such as climate, geology and soil characteristics.

Abscission The separation of part of a plant from the main plant body – most commonly, the falling of leaves or the dropping of fruit.

Accidental/Vagrant Any species occurring infrequently and unpredictably in Alberta, (i.e., outside its usual range). These species may be in Alberta due to unusual weather occurrences, an accident during migration or unusual breeding behaviour by a small number of individuals. If a species appears in Alberta with increasing predictability and more frequently, it may eventually be given a different rank. Changes in "Accidental/Vagrant" species may be a good indicator of general ecosystem or climatic changes.

Acidification The decrease of acid neutralizing capacity in water, or base saturation in soil, caused by natural or anthropogenic processes. Acidification is exhibited as the lowering of pH, a process that can adversely affect aquatic life.

Acute Exposure Chemical exposures that are very short in duration, single exposure event that occurs as a result of an accident, or exposures that do not typically occur on a regular basis. Health Canada defines an acute exposure as one that occurs over a period of no longer than 14 days. The term can also be applied to the effects that are associated with short duration exposures (i.e., acute effects), or generally used to describe the adverse effects resulting from these exposures (i.e., acute toxicity).

Additivity Each substance contributes to the same toxic effect in the same organ by the same mechanism, with the observed toxicity equal to that expected by adding the toxicities of the individual agents.

Adiabatic Clockwise winds blowing off the retreating Laurentide ice sheet.

Admixing The dilution of topsoil with subsoil, spoil or waste material, with the result that topsoil quality is reduced. Admixing can result in adverse changes in topsoil texture, poor soil aggregation and structure, loss of organic matter and decrease in friability.

Adsorption The surface retention of solid, liquid or gas particles by a solid or a liquid.

Adverse Effect An undesirable or harmful effect to an organism (human, animal or plant), indicated by some result such as mortality, growth inhibition, reproductive abnormalities, altered food consumption, altered body and organ weights, altered enzyme concentrations, visible pathological changes or carcinogenic effects.

Aeolian Sedimentary deposits arranged by wind, such as sand and other loose substrates in dunes.

Aesthetic Objective (AO) Aesthetic objective for drinking water (includes parameters such as odour, taste and turbidity).

Afforestation The process of establishing a forest by planting trees or their seeds on land that is not a forest, or has not been a forest for an extended period.

Age-to-Maturity The age at which more than 50% of the individuals of a particular sex within a population reach sexual maturity. Age-to-maturity of individuals within the same population can vary considerably from the population median value. In fish species, males often reach sexual maturity at a younger age than females.

Agglomeration A technique that combines small particles to form larger particles.

Agitation Tank A vessel in which slurry material is maintained in suspension by using an impeller or by recirculating the material with pumps.

Agronomic Species Plant species typically grown as agricultural crops.

Ah Horizon In soils, an A horizon of organic matter accumulation containing less than 17 percent carbon.

Air Cooler A device that lowers temperature using atmospheric air as the coolant.

Airshed The geographic area requiring unified management to achieve air pollution control.

Albedo The ratio of reflected solar radiation to the total incoming solar radiation received at the surface.

Alberta Ambient Air Quality Objective (AAAQO)

Alberta Ambient Air Quality Objective levels are established for several air compounds under Section 14 of the *Environmental Protection and Enhancement Act* (EPEA). The AAAQOs form an integral part of the management of air quality in the province, and are used for reporting the state of the environment, establishing approval conditions, evaluating proposed facilities with air emissions, assessing compliance near major air emission sources and guiding monitoring programs.

Alberta Energy and Utilities Board (EUB)

An independent, quasi-judicial agency of the Government of Alberta, the EUB was created in February 1995 by the amalgamation of the Energy Resources Conservation Board and the Public Utilities Board. The purpose of the EUB is to ensure that the discovery, development, and delivery of Alberta's resources take place in a manner that is fair, responsible and in the public interest.

Alberta Environment (AENV)

Provincial ministry that looks after the following: establishes policies, legislation, plans, guidelines and standards for environmental management and protection; allocates resources through approvals, dispositions and licenses, and enforces those decisions; ensure water infrastructure and equipment are maintained and operated effectively; and prevents, reduces and mitigates floods, droughts, emergency spills and other pollution-related incidents.

Alberta Surface Water Quality Guidelines (ASWQG)

Numerical concentrations or narrative statements established to support and protect the designated uses of water. These are minimum levels of quality, developed for Alberta watersheds, below which no waterbody is permitted to deteriorate. These guidelines were established as minimum levels that would allow for the most sensitive use. These concentrations represent a goal to be achieved or surpassed.

Alberta Sustainable Resource Development (ASRD)

Alberta Sustainable Resource Development (ASRD) is one of the Alberta Ministries whose mission is to encourage balanced and responsible use of Alberta's natural resources through the application of leading practices in management, science and stewardship. ASRD works with Albertans across the province to ensure a balance between the economic, environmental and social values of our province. They fight forest fires, manage fish and wildlife, oversee the development of Alberta's forests, and manage the use of public lands.

Aldehyde	Hydrocarbon chain compound associated with a –C-H=O single carbon bond to other chain-like hydrocarbons (e.g., ldehyde H-CHO).
Alevin	A newly-hatched fish in the larval stage, dependent upon a yolk sac for nutrients while their digestive system develops.
Alkalinity	A measure of water's capacity to neutralize an acid. It indicates the presence of carbonates, bicarbonates and hydroxides, and less significantly, borates, silicates, phosphates and organic substances. Alkalinity is expressed as an equivalent of calcium carbonate. Its composition is affected by pH, mineral composition, temperature and ionic strength. However, alkalinity is normally interpreted as a function of carbonates, bicarbonates and hydroxides. The sum of these three components is called total alkalinity.
Alkane	Hydrocarbon chain compound with fully saturated carbon-to-carbon bonds (e.g., methane, ethane).
Alkene	Hydrocarbon chain compound with unsaturated (double) carbon-to-carbon bonds (e.g., ethylene).
Alleles/Allelic Diversity	One member of a pair or series of genes that occupy a specific position on a specific chromosome/the variety, distribution and abundance of different alleles within a population.
Alluvial	Soil or earth material which has been deposited by running water, as in a riverbed, floodplain, or delta.
Alluvial Deposit	Eroded soil deposited by flowing water.
Alluvium	Sediment deposited by flowing water, especially soil formed in river valleys and deltas from material washed down by the river.
Ambient	The conditions surrounding an organism or area.
Ambient Air	The air in the surrounding atmosphere.
Ambient Noise	The pre-existing sound environment of a location, before the introduction of, or in absence of, noise from a specific source which also affects the sound environment of that location.
Amine	One of a class of organic compounds that can be derived from ammonia by replacing one or more hydrogens with organic radicals.

Amine Regeneration Unit	Equipment that removes absorbed acid gases from amine to reusable condition for acid gas absorption.
Amine Unit	A processing unit that removes certain contaminants, primarily hydrogen sulphide and carbon dioxide, from gas or liquid hydrocarbon streams through an amine-based chemical reaction.
Ammonia	A pungent, colourless, gaseous, alkaline compound of nitrogen and hydrogen that is soluble in water, lighter than air, and can easily be condensed to a liquid by cold and pressure.
Ammonite	An extinct group of marine animals having spiral shells.
Amphibian	Any of the class of cold-blooded vertebrates such as frogs, toads, and salamanders intermediate between fishes and reptiles; they have gilled aquatic larva and air-breathing adults.
Anaerobic	Living or growing where there is no free oxygen. Anaerobic bacteria obtain oxygen by decomposing compounds containing oxygen.
Anion	A negatively charged ion.
Annulus	The space around a pipe in a wellbore, the outer wall of which might be the wall of either the borehole or the casing.
Anoxia	Little to no dissolved oxygen in the water sample. Waters with <2 mg/L of dissolved oxygen experience anoxia.
Antagonism	Two substances interact such that the effect of one substance is counteracted by the other. For example, antidotes are antagonistic to the poisons they are used to treat.
Anthropogenic	Pertaining to the influence of human activities.
Antiscalant	An additive that prevents the buildup of scale, such as from calcium or iron.
Application Case	The Environmental Impact Assessment (EIA) case including the project that is the subject of the application, existing environmental conditions, and existing and approved projects or activities.
Aquatics Study Area (ASA)	Defines the spatial extent directly or indirectly affected by the project.

Aquiclude An impermeable stratum or material that acts as a barrier to the flow of groundwater.

Aquifer A body of rock or soil that contains sufficient amounts of saturated permeable material to yield economic quantities of water to wells or springs.
Any water-saturated body of geological material from which enough water can be drawn at a reasonable cost for the purpose required. An aquifer in an arid prairie area required to supply water to a single farm may be adequate if it can supply 1 m^3/d. This would not be considered an aquifer by any industry looking for cooling water in volumes of 10,000 m^3/d. A common usage of the term aquifer is to indicate the water-bearing material in any area from which water is most easily extracted.

Aquifer Depressurization The process of reducing the natural hydrostatic pressure in an aquifer.

Aquifer Test A method of obtaining quantitative information on the hydraulic characteristics of an aquifer by removing water from the aquifer in a controlled manner and measuring the groundwater surface or piezometric response. Often referred to as a "pumping test" or "drawdown test".

Aquitard A material of low permeability between aquifers. An aquitard allows some measure of leakage between the aquifers it separates.

Arboreal Living on trees, as in arboreal lichens such as old man's beard.

Archaeology The scientific study of the unwritten portion of man's historic and prehistoric past.

ARCINFO Is one of ESRI's integrated collection of Geographic Information System (GIS) software products used for spatial analysis, data manipulations and cartography. It can be used for data building, modelling, analysis and map display.

Argillaceous Applied to rocks or substances composed of clay minerals, or having a notable proportion of clay in their composition.

Argos Amphibious all-terrain vehicles, typically capable of moving across dry land, wetlands and water.

Armoured Habitat Cobble and boulder habitat.

Armouring	Protecting a channel from erosion by covering with protective material.
Aromatic	Organic compounds containing a ring structure composed of six carbon atoms. Benzene is the simplest of these molecules, which are composed of a single ring with no branch chains.
Artifact	Any portable object modified or manufactured by man.
Artifact Find	A site with five or fewer artifacts.
Artifact Scatter	A site with six or more artifacts.
Artificial Lift System	Any method used to raise oil to the surface through a well after the reservoir pressure has declined to the point at which the well no longer produces by means of natural energy.
Aspect	Aspect is the orientation of a slope by compass points and indicates if a slope is exposed to the north, south, east or west or any point between.
Asphaltene	Any of the dark, solid constituents of crude oils or other bitumens that are soluble in carbon disulphide but insoluble in paraffin naphthas. They hold most of the organic constituents of bitumens.
Assay	A qualitative or quantitative determination of the components of a material such as ore.
Assemblage	A collection of cultural materials from a sampling area or unit such as a site, pit or level.
Association	Archaeological materials are said to be associated when they are found in close proximity in an undisturbed context.
At Risk	Any species known to be "At Risk" after formal detailed status assessment and designation as "Endangered" or "Threatened" in Alberta.
Atlatl	A hand-held wooden implement in which a spear shaft is placed. The resultant extension of the arm increases the velocity and accuracy of the spear itself.

Atmospheric Distillation	Distillation conducted at atmospheric pressure. Distillation is the process of producing a gas or vapour from a liquid by heating the liquid in a vessel and collecting and condensing the vapours into liquids.
Attenuation	The process by which a compound is reduced in concentration over time, through adsorption, degradation, dilution and/or transformation.
Attenuation (Noise)	A reduction in sound level that occurs with sound propagation over distance by means of physical dissipation or absorption mechanisms, or a reduction in sound level that occurs by means of noise control measures applied to a sound source.
Atterberg Limits	A geometric and decimal grade scale for classifying particles in sediments based on the unit value of 2 mm and involving a fixed ration of 10 for each successive grade. Subdivisions are geometric means of the limits of each grade.
Auxiliary Utilities	Supplementary utilities, such as diesel fuel, nitrogen, plant air and steam.
Available Drawdown	The vertical distance that the equipotential surface of an aquifer can be lowered; in confined aquifers, this is to the top of the aquifer; in unconfined aquifers, this is to the bottom of the aquifer.
Average Depth	Average depth of pools, riffles and runs, based on measurements taken across one to three transects within the surveyed stream section.
Average Wetted Wet Width	Average width of the water surface based on measurements taken across three to six transects.
Avulsion Events	The sudden removal of soil by change in a watercourse or by a flood.
Awl	A pointed tool for making holes as in wood or leather.
Background	An area not influenced by chemicals released from the site under evaluation.
Background Concentration (Environmental)	The concentration of a chemical in a defined control area during a fixed period before, during or after data gathering.

Backwater	Discrete, localized area exhibiting reverse flow direction and, generally lower stream velocity than main current. Substrate similar to adjacent channel with more fines.
BADT (Best Available Demonstrated Technology)	Best Available Demonstrated Technology has been defined as "emission control technology based on the maximum degree of emission reduction that has been shown to be practicably and economically achievable for a given source and type."
Bail	A loop of heavy wire snap-fitted around two or more parts of a connector or other device to hold the parts together.
Bailer	A long, cylindrical vessel fitted with a bail at the upper end and a flap or tongue valve at the lower extremity.
Bankfull Depth	The maximum depth of a channel within a rifle segment when flowing at a bank-full discharge.
Bankfull Discharge	The flow rate that fills the channel of an undisturbed stream with a wide floodplain up to the top of its banks prior to flooding.
Bankfull Width	The width of the stream, measured at the water surface elevation corresponding to the bankfull discharge. For undisturbed streams with a wide floodplain, this is equivalent to channel width.
Barb (Tang)	A sharp projection on the lateral margins of an artifact, near the base. Commonly used in describing the shoulder of a projectile point.
Barrels Per Day (bbl/d)	A unit of measure for oil production and processing operations.
Barrels Per Stream Day (bpsd)	A unit of measure for oil production and processing operations.
Basal Aquifer	A water-bearing strata located at the lowest portion of a stratigraphic unit.
Basal Date	A radiocarbon date obtained at the bottom of a lake core where organic sediments first started to accumulate. This date indicates when vegetation first became established in the surrounding area after the ice melted at the end of the last Ice Age.

Basal Thinning The intentional removal of small longitudinal flakes from the base of a chipped stone projectile point or knife to facilitate hafting (fitting to a shaft or handle).

Basal Water Sands A water-saturated sand unit occurring within the McMurray Formation in the Voyageur South area. The McMurray Formation underlies the entire Local Study Area outside of the Athabasca River Valley and locally has thicknesses ranging up to about 60 m. At some locations, all of the sands within the McMurray Formation may be bitumen-saturated; at other locations there are "water sands" near the base of the formation, which contain little bitumen.

Basalt A dark igneous rock with variable textures.

Base Cation An alkali or alkaline earth metal cation (Ca^{2+}, Mg^{2+}, K^{+}, Na^{+}).

Base Saturation The extent to which the adsorption complex of a soil is saturated with exchangeable cations other than hydrogen and aluminum. It is expressed as a percentage of the total cation exchange capacity.

Baseline A surveyed or predicted condition that serves as a reference point to which later surveys are coordinated or correlated.

Baseline Case The EIA assessment case that includes existing environmental conditions as well as existing and approved projects or activities.

Baseline Data (also Environmental Setting Data) A quantitative level or value from which other data and observations of a comparable nature are referenced. Information accumulated concerning the state of a system, process or activity before the initiation of actions that may result in changes.

Basic Sound Level The allowable sound level at a residential location, as defined by the current EUB Directive, with the inclusion of industrial presence based upon dwelling unit density and proximity to transportation noise sources.

Basin A geographic area drained by a single major stream; consists of a drainage system comprised of streams and often natural or man-made lakes.

Bathymetry Measurement of the depth of an ocean or large waterbody.

Beaver River Sandstone A light grey, medium to fine-grained quartz sandstone cemented in a silica matrix.

Bed Slope	The inclination of the river channel bottom.
Bedrock	The body of rock that underlies gravel, soil or other surficial material.
Benthic Invertebrates	Invertebrate organisms living at, in or in association with the bottom (benthic) substrate of lakes, ponds and streams. Examples of benthic invertebrates include some aquatic insect species (such as caddisfly larvae) that spend at least part of their lifestages dwelling on bottom sediments in the waterbody. These organisms play several important roles in the aquatic community. They are involved in the mineralization and recycling of organic matter produced in the water above, or brought in from external sources, and they are important second and third links in the trophic sequence of aquatic communities. Many benthic invertebrates are major food sources for fish.
Benzene	A colourless, liquid, flammable, aromatic hydrocarbon that boils at 80.1ºC and freezes at 5.4 to 5.5ºC. It is used to manufacture styrene and phenol.
Berm	A mound or wall of earth.
Biface	A stone artifact flaked on both surfaces.
Bifurcated	To fork or divide into two branches.
Bile	An alkaline secretion of the vertebrate liver. Bile, which is temporarily stored in the gall bladder, is composed of organic salts, excretion products and bile pigments. It primarily functions to emulsify fats in the small intestine.
Bioaccumulation	When an organism stores within its body a higher concentration of a substance than is found in the environment. This is not necessarily harmful. For example, freshwater fish must bioaccumulate salt to survive in intertidal waters. Many toxicants, such as arsenic, are not included among the dangerous bioaccumulative substances because they can be handled and excreted by aquatic organisms.
Bioavailability/ Bioavailable	The amount of chemical that enters the general circulation of the body following administration or exposure.

Biochemical Oxygen Demand (BOD)	An empirical test in which standardized laboratory procedures are used to determine the relative oxygen requirements of wastewaters, effluents and polluted waters.
Bioconcentration	A process where there is a net accumulation of a chemical directly from an exposure medium into an organism.
Biodegrade	Capable of being decomposed by biological agents.
Biodiversity	The variety of plant and animal life in a particular habitat (e.g., plant community or a country). It includes all levels of organization, from genes to landscapes, and the ecological processes through which these levels are connected.
Biodiversity Ranking	The relative contribution of an ecosite phase/wetlands type to the overall biological diversity of an area..
Biogenic	Essential to the maintenance of life.
Biogenic Emission	Emissions resulting from biological activity.
Biological Indicators	Any biological parameter used to indicate the response of individuals, populations or ecosystems to environmental stress. For example, growth is a biological indicator.
Biomarker	A chemical, physiological or pathological measurement of exposure or effect in an individual organism from the laboratory or the field. Examples include contaminants in liver enzymes, bile and sex steroids.
Biome	A major community of plants and animals such as the boreal forest or tundra biome.
Bioremediation	The process of applying corrective action to unbalanced biological systems.
Biotic	The living organisms in an ecosystem.
Biotic Gradient	The scale or continuum moving from having little living material to a very productive site.
Biox Treatment	The use of biological processes to digest carbonaceous and nitrogenous contaminants by oxidation.

Bi-Polar	The technique of resting a core, or lithic implement on an anvil and striking the core with a percussor. Contrary to popular belief, bulbs of force are not present on both ends of bi-polar flakes or blades. This technique causes the cone of force to be shattered or severed.
Bitumen	A highly viscous, tarry, black hydrocarbon material having an API gravity of about 9 (specific gravity about 1.0). It is a complex mixture of organic compounds. Carbon accounts for 80 to 85% of the elemental composition of bitumen, hydrogen 10%, sulphur 5%, and nitrogen, oxygen and trace elements form the remainder.
Bitumen Froth	Air-entrained bitumen with a froth-like appearance that is the product of the primary extraction step in the warm or hot water extraction process.
Bitumen Grade	The amount of bitumen in oil sands usually expressed as a percentage.
Blade (lamellar flake)	A flake with parallel edges and a length which is equal to or twice the width. The blade classification includes prismatic blades, microblades and ridge flakes.
Blank	An advanced preliminary stage in the manufacture of an artifact.
Blanket	A mantle of unconsolidated material that is thick enough to mask minor irregularities on the underlying unit but still conforms to the general underlying topography.
Blowdown	The act of emptying or depressurizing material in a vessel.
Bog	Ombrotrophic, acidic, peat-forming wetlands that receives its surface moisture from precipitation. Characterized by a level, raised or sloping peat surface with hollows and hummocks.
Boiler Feed Water	Water that meets required purity specifications and is used in the heat recovery steam generator to produce steam.
Bonferroni Confidence Intervals	A simple statistical method that adjusts for multiple comparisons while assuring that an overall confidence coefficient is maintained.
Borden Block	Map units of 10' latitude by 10' longitude used to facilitate site designation.

Borden System A grid system based on National Topographic Series maps, which form a grid covering the whole of Canada. Each square on the grid is numbered with a code such as DgRn. The number following the code (23:) denotes the number of the archeological site in the area. Artifacts recovered at the dig are then sequentially numbered after the colon. This enables archaeologist to identify the origin of an artifact by just looking at its number.

Boreal Forest The northern hemisphere, circumpolar, tundra forest type consisting primarily of black spruce and white spruce with balsam fir, birch and aspen.

Borehole A hole advanced into the ground by means of a drilling rig.

Borrow Pit A bank or pit from which earth is taken for use in filling or embanking. Often used in the construction of roads.

Bottom Sediments Substrates that lie at the bottom of a body of water. For example, the soft mud, silt, sand, gravel, rock and organic litter that make up a river bottom.

Bottom-Feeding Fish Fish that feed on the substrates and/or organisms associated with the river bottom.

Bottoms The substance left after distilling off all but the heaviest components from crude oil in petroleum refinery operations. Also known as residue.

Boundary Condition A specified value of hydraulic head (specified head cell), specified groundwater inflow or outflow (zero hydraulic gradient, groundwater recharge or well), or a specified relationship between hydraulic head and groundwater flow (general head boundary, recharge-seepage face or river). Boundary conditions are required at the boundaries of the model domain.

Bowen Ratio The ratio of sensible heat flux to latent heat flux.

B.P. (Before Present) 1,000 B.P. = 1,000 years before 1950 AD, or approximately 1000 AD.

Brackish Water Water with total dissolved solids concentration ranging from 1,000 to 10,000 g/m^3.

Brine Water with total dissolved solids concentration exceeding 100,000 g/m^3.

Broadcast Seeding A method of sowing seed using a machine with a rotating fan-like distributor.

Brown Water Water with a total dissolved solids concentration ranging from 1,000 to 10,000 g/m^3.

Brunisolic Soil An order of soils whose horizons are developed sufficiently to exclude the soils from the Regosolic order, but that lack the degrees or kinds of horizon development specified for soils of the other orders. These soils, which occur under a wide variety of climatic and vegetative conditions, all have Bm or Btj horizons.

Bryophyte Non-vascular plants from the phylum Bryophyta. Include species within this phylum mosses, liverworts and hornworts.

Buffer Zone A transition zone between areas managed for different objectives.

Burin A stone chisel-like tool, used mainly for grooving bone and also wood working.

Bush Economy Representing some of the value of a traditional life, considering hunting, trapping, berry collection and other activities.

Butane An alkane of which there are two isomers, n- and iso-butane. It occurs in natural gas, petroleum and is also produced by cracking heavier petroleum fractions.

Cairn Stones intentionally piled by humans.

Calcareous Soil A soil containing enough calcium carbonate (commonly combined with magnesium carbonate) to effervesce visibly when treated with cold, dilute hydrochloric acid.

Calendar day Stream day multiplied by a service factor for planned and unplanned downtime.

CALGRID An Eulerian photochemical transport and dispersion model that includes modules for horizontal and vertical advection/diffusion, dry deposition and a detailed photochemical mechanism.

CALMET	A meteorological model that includes a diagnostic wind field generator containing objective analysis and parameterized treatments of slope flow, kinematic terrain effects, terrain blocking effects with a divergence minimization procedure, and a micrometeorological model for overland and overwater boundary layers.
CALPUFF	A non-steady Lagrangian Gaussian Puff Model containing modules for complex terrain effects, overwater transport interaction effects, building downwash, wet and dry removal, and simple chemical transformation.
Canadian Water Quality Guidelines (CWQG)	Numerical concentrations or narrative statements recommended to support and maintain a designated water use in Canada. The guidelines contain recommendations for chemical, physical, radiological and biological parameters necessary to protect and enhance designated uses of water.
Cancer	A disease characterized by the rapid and uncontrolled growth of aberrant cells into malignant tumours.
Canid	Any animal of the family *Canidae*, a family of mammals including dogs, jackals, wolves and foxes, typically having a bushy tail, erect ears and a long muzzle: order *Carnivora* (carnivores).
Canopy	An overhanging cover, shelter or shade. The tallest layer of vegetation in an area.
Cap Rock	A relatively impervious rock overlying an oil- or gas-bearing formation.
Carbon to Nitrogen Ratio	The ratio of the weight of organic carbon to the weight of total nitrogen in a soil or in soil organic matter.
Carcinogen	An agent that is reactive or toxic enough to act directly to cause cancer.
Cardinal Directions	North, south, east and west.
Carnivore	Any of an order of mammals that feed chiefly on flesh or other animal matter rather than plants.
Carrying Capacity	The maximum population size that can be supported by the available resources.

Catalyst A substance that reduces the peak activation energy required for a chemical reaction, such as by allowing the reaction to occur at a lower temperature.

Catalytic Cracking The conversion of high-boiling hydrocarbons into lower-boiling types by a catalyst.

Catchment Area The area of land from which water finds its way into a particular watercourse, lake or reservoir (Also termed "river basin" or "watershed."

Cation A positively charged ion.

Cation Exchange Capacity The sum total of exchangeable cations that a soil can adsorb. It is usually expressed in milliequivalents per 100 grams of soil.

Centre Reject A non-bituminous baring material found within a central zone of the oil sands ore body.

Ceramics Clay artifacts, such as vessels, that have been intentionally fired.

Cervid Of the family Cervidae, which includes elk, deer, moose and caribou.

CFA (Consolidated Frequency Analysis) A computer program for deriving flood flow frequencies.

Chalcedony A cryptocrystalline variety of quartz composed predominantly of silica and having the near lustre of paraffin wax. May be transparent or translucent and of various tints.

Channel The bed of a stream or river.

Channel Cover The vegetation that projects over the channel width of a stream and material that is in the stream. It is recorded as the percent of the channel width covered within a 50 m section of the stream at each site. Channel cover is arbitrarily divided into three levels:

Crown: vegetation >1 m above the water surface;

Overhanging: vegetation <1 m above the water surface; and

Instream: material (debris, stumps, fallen trees) in the stream that can provide cover for fish.

Channel Invert The lowest point in the cross-section of a natural or man-made channel.

Channel Regime The morphological characteristics, including cross-section, longitudal slope and sinuosity, of a watercourse that is in long-term equilibrium.

Channel Unit Distinct channel sections with specific characteristics of water depth, velocity and cover for fish.

Channel Width The horizontal distance along a transect line from stream bank to stream bank (rooted vegetation to rooted vegetation) at the normal high water marks measured at right angles to the direction of flow.

Chert A fine-grained siliceous rock. Impure variety of chalcedony that is generally light-coloured.

Chi Thos A large, crudely manufactured scraper made from sandstone. It is typically bifacially worked along a blunted convex edge.

Chironomids A taxonomic family of invertebrates consisting of flies referred to as non-biting midges. The larval stage is aquatic and is included in the benthic invertebrate community.

Chi-Square Analysis A statistical test to determine if the patterns exhibited by data could have been produced by chance.

Chlorophyll *a* One of the green pigments in plants. It is a photo-sensitive pigment that is essential for the conversion of inorganic carbon (e.g., carbon dioxide) and water into organic carbon (e.g., sugar). The concentration of chlorophyll a in water is an indicator of algal concentration.

Chlorosis A yellowing of leaf tissue due to a lack of chlorophyll. Possible causes of chlorosis include poor drainage, damaged roots, compacted roots, high alkalinity, and nutrient deficiencies in the plant.

Chopper A natural pebble or cobble with a crude, steep cutting edge formed by unifacial percussion flaking.

Chronic The development of adverse effects after extended exposure to a given substance. In chronic toxicity tests, the measurement of a chronic effect can be reduced growth, reduced reproduction or other non-lethal effects, in addition to lethality. Chronic should be considered a relative term depending on the life span of the organism.

Chronic Exposure Exposures occurring over a relatively long duration of time (Health Canada considers periods of human exposure greater than three months to be chronic while the U.S. EPA only considers human exposures greater than seven years to be chronic).

Chronic Toxicity The development of adverse effects after an extended exposure to relatively small quantities of a chemical.

Chronic Toxicity Unit (TU_c) Measurement of long-duration toxicity that produces an adverse effect on organisms.

Class Area (CA) The total area of each patch type, or of the total undisturbed landscape area (in hectares). This provides a direct summary of area for comparison of losses due to disturbances, that either decreases the total amount of undisturbed land, or which changes patch types from one type to another.

Clearcut Modifier An AVI stand condition modifier presents additional information about the condition of the stand. A clearcut modifier (CC) indicates a result from timber harvesting, either clear or selective harvesting, depending on extent (AEP 1991).

Climax The culminating stage in plant succession for a given site where the vegetation has reached a stable condition.

Climax Community The culminating stage in plant succession for a given site where the vegetation has reached a stable condition.

Climax Forest A community of plants that will eventually grow and remain dominant in an area.

Cline A gradual change in a feature across the distributional range of a species or population.

Closed Canopy Dense cover in the topmost vegetation layer in a community, usually limiting the light availability to the forest floor.

Closure The point after shutdown of operations when regulatory certification is received and the area is returned to the Crown.

Club Lichen An unbranched or sparsely branched lichen, typically with an upright and cylindrical form.

Coarse Fragment Rock fragments >2.0 mm in diameter and include: gravel 0.2 to 7.5 cm and cobbles 7.5 to 25.0 cm.

Coarse Textured Soil The texture exhibited by sands, loamy sands and sandy loams but not including very fine sandy loam. A soil containing large quantities of these textural classes.

Coefficient of Variation (CV) Standardized index of the variability of a value relative to the mean value.

Cofferdam A temporary dam-like structure constructed around an excavation to exclude water.

Collapse Scar Areas where permafrost has melted, causing the ground above to slump below the surrounding area, often with "ripped" edges.

Colluvial A heterogeneous mixture of material that as a result of gravitational action has moved down a slope and settled at its base.

Commercial Forest Land characterized by:

(i) forest stands stocked with trees to meet the standards of a commercial forest as defined in the Alberta Timber Harvest Planning and Operating Groundrules, 2000, as amended;

(ii) forest stands stocked with native tree species as defined by the Timber Management Regulations AR 60-73 (144.2), 2000, as amended, that may include white spruce, black spruce, jack pine, aspen poplar, balsam poplar, balsam fir, white birch and larch;

(iii) forest stands not limited by operating restrictions such as slopes steeper than 45%, with the exception of tailing sand structures with slopes over 20%; stream buffers; potential recreational lakes; stand size; arrangement or accessibility as identified in the Alberta Al-Pac Timber Harvest Planning and Operating Groundrules, 2000 as amended; and

(iv) other characteristics specified in writing by the Director.

Community Plant or animal species living in close association or interacting as a unit.

Compaction The process of pore space reduction in soil or sediments from heavier overlying material weighing the soil down.

Compensation (Fisheries)	The replacement of natural habitat, increase in the productivity of existing habitat or maintenance of fish production by artificial means in circumstances dictated by social and economic conditions, where mitigation techniques and other measures are not adequate to maintain habitat for Canada's fisheries resources.
Complex	A consistently recurring assemblage of artifacts or traits which may be indicative of a specific set of activities, or a common cultural tradition.
Complex Structure	A stand of trees with a high variation in heights but with no distinct tree layers.
Composite Tailings (CT) (See Consolidated Tailings)	A non-segregating mixture made by Syncrude Canada Ltd. of oil sands extraction tailings that consolidates relatively quickly in deposits. Composed of sand tailings, mature fine tailings and a chemical stabilizer (e.g., $CaSO_4$).
Concentration	Quantifiable amount of a chemical in environmental media.
Concentration Ratio (CR)	A method of risk characterization that is used for locally acting chemicals. The CR is the mathematical relationship between a chemical air concentration and the respective reference concentration. Concentration ratios are named as such, because the potential for adverse effects is dependent on the concentration of the chemical present in ambient air, rather than on total internal dose received by the receptor (as is the case when assessing exposure ratios).
Conceptual Model	A model developed at an early stage of the risk assessment process that describes a series of working hypotheses of how the chemicals of concern may affect potentially exposed populations. The model identifies the populations potentially at risk along with the relevant exposure pathways and scenarios.
Condition Factor	A measure of the relative "fitness" of an individual or population of fishes by examining the mathematical relationship between growth in length relative to growth in weight. In populations where increases in length are matched by increases in weight, the growth is said to be isometric. Allometric growth, the most common situation in wild populations, occurs when increases in either length or weight are disproportionate.

Conditioning Drums	Large, inclined cylindrical tumblers that rotate slowly, used for preparing (conditioning) oil sands for primary extraction by mixing it with hot water and steam.
Conductivity	A measure of the capacity of water to conduct an electrical current. It is the reciprocal of resistance. This measurement provides an estimate of the total concentration of dissolved ions in the water.
Cone of Depression	An inverted cone depression in groundwater surface surrounding a pumped well or dewatered/depressurized excavation.
Configuration	The location and arrangement of landscape elements.
Confined Aquifer	A body of groundwater surrounded by impermeable strata. In confined aquifers the pressure of the water is usually higher than that of the atmosphere and the water in well stands above the top of the aquifer. The water in a confined aquifer is called confined or artesian water.
Conifer	Trees in the division Pinophyta of the plant kingdom. These are cone-bearing trees with no true flower (e.g., white spruce, black spruce, balsam fir, jack pine and tamarack).
Connate Water	Water entrapped in the interstices of a sedimentary rock at the time the rock was deposited.
Connectivity	A measure of how connected or spatially continuous a corridor or matrix is.
Conservative Approach	Approach taken to incorporate protective assumptions to ensure that risk will not be underestimated.
Consolidated Tailings (CT)	Consolidated tailings are prepared by combining mature fine tails with cycloned fresh sand tailings to form a deposit that consolidates relatively quickly in tailings deposits. This mixture is chemically stabilized (to prevent segregation of fine and coarse mineral solids) using gypsum ($CaSO_4$). Also known as composite tailings.
Consolidated Tailings Release Water	Water expelled from consolidated tailings mixtures during consolidation.
Consolidation	The gradual reduction in volume of a soil or semi-solid mass.
Contaminant Body Burdens	The total concentration of a contaminant found in either whole-body or individual tissue samples.

Contaminants	Any chemical compound added to a receiving environment in excess of natural concentrations. Contaminants include chemicals or effects not generally regarded as "toxic," such as nutrients, colour and salts.
Control	A toxicity test that duplicates all the conditions of exposure treatments but contains no test material. The control is used to determine basic test conditions in the absence of toxicity (e.g., health of test organisms, quality of dilution water).
Convective Meteorological Conditions	A condition where turbulence is enhanced due to strong solar heating (e.g., such as during a hot summer afternoon).
Convergence Tolerance	The permissible difference between computed hydraulic heads for successive computer calculations when calculating the hydraulic heads using a numerical groundwater flow model. The convergence tolerance is set to a small value to give an acceptable mass balance error.
Core	A blocky nucleus of stone from which flakes or blades have been removed.
Core Reduction / Rejuvenation (trimming flakes)	Intentional flake wastage in the process of further flake removal. Flakes exhibit the remnants of past platforms and are removed by percussion or pressure techniques. They can be further separated into transverse or lateral trimming flakes depending on their point of impact.
Corridor	A travel route allowing animals to migrate from one faunal region to another.
Corrosion	Any of a variety of complex chemical or electrochemical processes by which metal is destroyed through reaction with its environment.
Corrosion Scale Inhibitors	Substances that prevent the buildup of metal oxides produced by corrosion.
Cortex	Fresh surface of a nodule that has been altered by weathering.
Coversoil	Any peat-mineral mix, organic horizon or upland surface soil.
Cratering	The act of creating depressions, or craters in the snow when foraging for food. Usually done by elk or other ungulates.

Craton	A portion of a continent that has not been subjected to major deformation for a prolonged time, typically since Precambrian or early Paleozic time.
Creek	A branch or small tributary of a river.
Critical Load	A quantitative estimate of an exposure to one or more pollutants below which significant harmful effects on specified sensitive elements of the environment do not occur according to present knowledge. For waterbody acidification, the critical load represents an estimate of the amount of acidic deposition below which significant adverse changes are not expected to occur in a lake's ecosystem.
Crop Tree Regeneration	The renewal of a forest or stand of trees by natural or artificial means, usually white spruce, jack pine or aspen.
Crown Closure	The ground cover area covered by a vertical projection of the tree crowns onto the ground for each identified storey.
Crust Lichen	Lichen with a hard upper surface and attached closely to the substrate.
Cryosol	Cryosolic soils are mineral or organic soils that have perennially frozen material within 1 m of the surface in some part of the soil body, or pedon.
Cubic metres per day (m^3/d)	A measure of oil production or processing rate.
Cubic metres per second (m^3/s)	The standard measure of water flow in rivers (i.e., the volume of water in cubic metres that passes a given point in one second).
Culture	The sum of man's non-biological behavioural traits: learned, patterned and adaptive.
Cumulative Effects Assessment (CEA)	The assessment of the effects of one project with consideration of current conditions, other existing projects, other approved projects and typically, other planned projects.
Cumulative Environmental Management Association (CEMA)	An association of oil sands industry, other industry, regional community representatives, regulatory agencies and other stakeholders designed to develop systems to manage cumulative effects associated with developments in the Oil Sands Region.

Cutblock	Previously forested area that has been harvested for timber and is presently regenerating at various stages of regrowth.
Cutblock Modifier	An AVI stand condition modifier presents additional information about the condition of the stand. A cutblock modifier (CC) indicates a result from timber harvesting, either clear or selective harvesting, depending on extent (AEP 1991).
Cyclo-	Hydrocarbon ring or cyclic compound of saturated or unsaturated carbon-to-carbon bonds (e.g., cyclohexane, C_6H_{12}).
Cyclofeeder	A vertical, open-topped cylindrical vessel with a conical bottom. Cyclofeeders are used to mix oil sands with warm water, forming a slurry that can be pumped via a pipeline to Extraction. Warm water is introduced through horizontal ports at the bottom of the vessel's vertical portion to produce a vortex inside the vessel, into which incoming oil sands falls. The energy imparted to the oil sands forms a slurry that is withdrawn at the bottom of the cone.
Darcy's Law	A law describing the rate of flow of water through porous media. (Named for Henry Darcy of Paris who formulated it in 1856 from extensive work on the flow of water through sand filter beds).
dBA	A decibel value which has been A-weighted, or filtered to match the response of the human ear.
Deaerator	A device in which oxygen, carbon dioxide and other non-condensable gases are removed from boiler feed water, steam condensate or a process stream.
Debitage	Waste by-products from tool manufacture.
Deciduous	Tree species that lose their leaves at the end of the growing season.
Demineralizer	Equipment in which mineral constituents are removed from water.
Dendritic Drainage Pattern	A stream system that branches irregularly in all directions with the tributaries joining with the main stream at all angles.
Deoiling	The process where oil is removed from produced water.

Department of Fisheries and Oceans (DFO) (now Fisheries and Oceans Canada)	Responsible for policies and programs in support of Canada's economic, ecological and scientific interests in oceans and inland waters; for the conservation and sustainable utilization of Canada's fisheries resources in marine and inland waters; for leading and facilitating federal policies and program on oceans; and for safe effective and environmentally sound marine services responsive to the needs of Canadians in a global economy.
Deposit	Material left in a new position by a natural transporting agent such as water, wind, ice or gravity, or by the activity of man.
Depositional	Gentle slope with fines.
Depressurization	The process of reducing the pressure in an aquifer, by withdrawing water from it.
Depuration	Loss of accumulated chemical residues from an organism placed in clean water or clean solution.
Desulphurization	A process in which sulphur compounds are removed from a gas or liquid hydrocarbon stream. See also “Flue Gas Desulphurization”.
Detection Limit (DL)	The lowest concentration at which individual measurement results for a specific analyte are statistically different from a blank (that may be zero) with a specified confidence level for a given method and representative matrix.
Deterministic	Risk approach using a single number from each parameter set in the risk calculation and producing a single value of risk.
Detoxification	To decrease the toxicity of a compound. Bacteria decrease the toxicity of resin and fatty acids in mill effluent by metabolizing or breaking down these compounds; enzymes like the EROD or P4501A proteins begin the process of breaking down and metabolizing many “oily” compounds by adding an oxygen atom.
Detrended Correspondence Analysis (DCA)	An ordination technique used to visually determine species and site relationships.
Development Area	Any area altered to an unnatural state. This represents all land and water areas included within activities associated with the development of oil sands leases.

Devonian	A period of the Paleozoic era thought to have covered the span of time between 400 and 345 million years ago; also, the corresponding system of rocks.
Dewatering	Removal of groundwater from a geological formation using wells or drainage ditch systems.
Diagenesis	Process involving physical and chemical changes in groundwater (e.g., includes solution of soluble minerals, cation exchange between groundwater and rock, ions diffusion).
Diameter at Breast Height (DBH)	The diameter of a tree 1.37 m above the ground surface.
Diamicton Rip-Up Clasts	Geological debris ripped up from the ground by an outburst flood.
Diatom	The common name for algae composing the class Bacillariophyceae. It is noted for the symmetry and sculpturing of the siliceous cell walls.
Diatomaceous Earth	A yellow, white or light grey, siliceous, porous deposit made of the opaline shells of diatoms. It is used as a filter aid, paint filler, adsorbent, abrasive and thermal insulator.
Digital Elevation Model (DEM)	A three-dimensional grid representing the height of a landscape above a given datum.
Diluent	A light liquid hydrocarbon added to bitumen to lower viscosity and density. The thinning agent is used by the oil sands to make heavy oil more fluid so it can be transported.
Diluent Stripping	The process where the diluent that is added to the bitumen in the upstream processing units is recovered.
Discharge	In a stream or river, the volume of water that flows past a given point in a unit of time (e.g., m^3/s).
Disclimax	A type of climax community that is maintained by either continuous or intermittent disturbance to a severity that the natural climax vegetation is altered.
Dispersal Routes	The travel route of an animal from its birth site or breeding site.
Dissolved Organic Carbon (DOC)	The dissolved portion of organic carbon water; made up of humic substances and partly degraded plant and animal materials.

Dissolved Oxygen (DO)	Measurement of the concentration of dissolved (gaseous) oxygen in the water, usually expressed in milligrams per litre (mg/L).
Distillation	The process of producing a gas or vapour from a liquid by heating the liquid in a vessel and collecting and condensing the vapours into liquids.
Disturbance	An event that causes a sudden change from the existing pattern, structure and/or composition in an ecological system or habitat.
Disturbance (Historic)	A cultural deposit is said to be disturbed when the original sequence of deposition has been altered. Examples of agents of disturbance include erosion, plant or animal activity, cultivation and excavation.
Disturbance (Terrestrial)	A force that causes significant change in structure and/or composition of a habitat.
Disturbance Area (DA)	The area of disturbance (hectares) in a fragmentation and heterogeneity analysis.
Disturbance Coefficient	The effectiveness of the habitat within the disturbance zone of influence in fulfilling the requirements of a species.
Disturbance Zone of Influence	The maximum distance to which a disturbance (e.g., traffic noise) is felt by a species.
Diversity	The variety, distribution and abundance of different plant and animal communities and species within an area.
Dose	A measure of integral exposure. Examples include: (1) the amount of chemical ingested; (2) the amount of a chemical taken up; and (3) the product of ambient exposure concentration and the duration of exposure.
Dose Rate	Dose per unit time, for example in mg/day, sometimes also called dosage. Dose rates are often expressed on a per-unit-body-weight basis, yielding units such as mg/kg body weight/day expressed as averages over some period, for example a lifetime.
Dose Response	The quantitative relationship between exposure of an organism to a chemical and the extent of the adverse effect resulting from that exposure.

Dose Response Principle	The fundamental principle in toxicology, based on the assumption that the response of a specific organism to a chemical is directly related to the amount of chemical that is received by the organism.
Drainage Basin	A region of land that eventually contributes water to a river or lake.
Drake	A male duck.
Drawdown	Lowering of water level caused by pumping. It is measured for a given quantity of water pumped during a specified period, or after the pumping level has become constant.
Drawdown Cone	A conical groundwater surface created in an unconfined aquifer due to pumping, or an imaginary conical surface indicating pressure relief in a confined aquifer due to pumping.
Drift Density	The number of organisms per m^3 of stream water.
Drift Deposits	Any sediment laid down by, or in association with, the activity of glaciers and ice sheets.
Drill / Perforator	A pointed, edge-retouched tool that is rotated on the long axis for the purpose of drilling usually into wood or bone.
Drill Stem Tester (DST)	A device used in a borehole to measure hydraulic properties of a tested interval and/or to collect fluid samples.
Dry Landscape Reclamation	A reclamation approach that involves dewatering or incorporation of fine tailings into a solid deposit capable of being reclaimed as a land surface or a wetlands.
Dyke	An embankment built to hold semi-solids or fluids.
Echolocation	High frequency sounds (25 to 120 kHz) produced by bats that are beyond the range of human hearing (20 Hz to 25 kHz). These sounds are produced with great intensity. Echoes resulting from sound returning from objects in the bat's environment provide information to the bat.
Ecodistrict	A broad subdivision of the landscape based on differences in landscape pattern, topography and dominant soils.
Ecofact	Nonartifactual evidence from the past that has cultural relevance; e.g., pollen.

Ecological Area	As part of the hierarchical classification system outlined in the Field Guide to Ecosites of Northern Alberta, a broad climatic region within the green zone of Alberta. Within northeastern Alberta, the Boreal Mixedwood ecological area includes the Central Mixedwood, Dry Mixedwood, Wetlands Mixedwood and Peace River Lowlands natural subregions.
Ecological Land Classification (ELC)	A means of classifying landscapes by integrating landforms, soils and vegetation components in a hierarchical manner.
Ecoregion	Ecological regions that have broad similarities with respect to soil, terrain and dominant vegetation.
Ecosection	Clearly recognizable landforms such as river valleys and wetlands at a broad level of generalization.
Ecosite	Ecological units that develop under similar environmental influences (climate, moisture and nutrient regime). Ecosites are groups of one or more ecosite phases that occur within the same portion of the moisture/nutrient grid. Ecosite is a functional unit defined by the moisture and nutrient regime. It is not tied to specific landforms or plant communities, but is based on the combined interaction of biophysical factors that together dictate the availability of moisture and nutrients for plant growth.
Ecosite Phase	A subdivision of the ecosite based on the dominant tree species in the canopy. On some sites where the tree canopy is lacking, the tallest structural vegetation layer determines the ecosite phase.
Ecosystem	An integrated and stable association of living and non-living resources functioning within a defined physical location. A community of organisms and its environment functioning as an ecological unit. For the purposes of assessment, the ecosystem must be defined according to a particular unit and scale.
Ecotone	The transition of physical and biological characteristics, from one community to the next.
Edaphic	Referring to the soil. The influence of the soil on plant growth is referred to as an edaphic factor.
Edatope	Soil moisture/nutrient grid that displays the potential ranges of combinations of moisture (very dry to wet or xeric to hydric moisture regimes) and nutrient (very poor to very rich) conditions.

Edge	Where different plant communities meet in space on a landscape; and where plant communities meet a disturbance. An outer band of a patch that usually has an environment significantly different from the interior of the patch.
Edge Effect	An ecological effect associated with patch edges. An outer band of a plant community that usually has an environment significantly different from the interior of the plant community.
Edge Species	A species found only or primarily near the perimeter of a patch.
Effective Porosity	The percentage of the total volume of a given mass of soil or rock that consists of interconnected voids.
Effects Assessment	The process of determining the amount (concentration or dose) of a chemical to which a receptor may be exposed without the development of adverse effects.
Effluent	Stream of water discharging from a source.
Ekman Grab	Cube-shaped mechanical device with a spring-loaded opening that is lowered to the bottom of a waterbody and triggered to close as to collect a sample of the bottom substrate.
Electrical Conductivity	The capability of a solution to transmit an electrical current. A capability closely related to the concentration of salts in soils.
Electrofishing	A 'live' fish capture technique in which negative (anode) and positive (cathode) electrodes are placed in the water and an electrical current is passed between the electrodes. Fish are attracted (galvano-taxis) to the anode and become stunned (galvano-narcosis) by the current, allowing fish to be collected, measured and released.
Elevation	Measurement of the height of the land above sea level.
Eluvial	An eluvial horizon is a soil horizon that has been formed by the process of eluviation. Eluviation is the transport of soil materials from the upper layers of soil to lower layers by downward precipitation of water across soil horizons.
End Pit Lake	A man-made lake, used to fill a mine pit area into which the remaining fine tailings at the end of mine like may be discharged and stored under a water cap. See Pit Lake.

Endangered	A species facing immediate extinction or extirpation.
Endogamy	Marriage within one's own tribe or similar unit.
Entrenchment Ratio	The ratio of the width of the flood-prone area to the surface width of the bankfull channel which is used to describe the degree of vertical containment of a river channel.
Environmental Impact Assessment (EIA)	A review of the effects that a proposed development will have on the local and regional environment.
Environmental Media	One of the major categories of material found in the physical environment that surrounds or contacts organisms (e.g., surface water, groundwater, soil, food or air) and through which chemicals can move and reach the organism.
Environmental Protection and Enhancement Act **(EPEA) (Alberta)**	The purpose of the act is to support and promote the protection, enhancement and wise use of the environment.
Environmental Setting	A quantitative level or value from which other data and observations of a comparable nature are referenced. Information accumulated concerning the state of a system, process or activity before the initiation of actions that may result in changes.
Eolian	A designation of rocks and soils whose constituents have been carried and laid down by atmospheric currents.
Ephemeral	A phenomenon or feature that lasts only a short time (e.g., an ephemeral stream is only present for short periods during the year).
Epilimnion	A freshwater zone of relatively warm water in which mixing occurs as a result of wind action and convection currents.
Epilyxic	A plant that typically grows on decaying wood.
Epiphyseal Plate	The area where the metacarpal and phalange meet in an animal's foot.
Epiphyte	A plant that grows upon another plant, but is neither parasitic on it nor rooted in the ground.

Episodic Acidification	Also referred to as a spring acid pulse, this natural phenomena occurs commonly in surface waters and is usually a response to snowmelt or rainfall. Industrial sources can contribute to this depression of pH and increase the recovery period.
EROD (7-ethoxyresorufin- 0-deethylase)	Used to measure fish exposure to chemicals, particularly polycyclic aromatic hydrocarbons (PAHs). It is a biomarker that measures the activity of an enzyme that metabolizes PAHs.
Erosion	The process by which material, such as rock or soil, is worn away or removed by wind or water.
Ericaceous	Plant species belonging to the heath family (Ericaceae) and typically prefer acid soil.
Escarpment	A cliff or steep slope at the edge of an upland area. The steep face of a river valley.
Eskers	Long, narrow bodies of sand and gravel deposited by a subglacial stream running between ice walls or in an ice tunnel, left behind after melting of the ice of a retreating glacier.
Estuarine	Formed or deposited in an estuary; *estuarine muds*: or growing in, inhabiting, or found in an estuary; *an estuarine fauna*.
Eutrophic	The nutrient-rich status (amount of nitrogen, phosphorus and potassium) of an ecosystem.
Evaporation	The process by which water is changed from a liquid to a vapour.
Evaporation, Lake	Evaporation that occurs from a lake surface.
Evaporation, Potential	The maximum quantity of water capable of being evaporated from the soil and transpired from the vegetation of a specified region on a given time interval under existing climatic conditions and without limiting available surface moisture.
Evaporite	A sediment that is deposited from aqueous solution as a result of extensive or total evaporation.
Evapotranspiration	A measure of the capability of the atmosphere to remove water from a location through the processes of evaporation and water loss from plants (transpiration).

Evapotranspiration, Areal	Evapotranspiration that occurs over a given area.
Evapotranspiration, Potential	The maximum quantity of water capable of being evaporated from the soil and transpired from the vegetation of a specified region in a given time interval under existing climatic conditions.
Evenness	The relative abundance of species; measured using the Shannon Weiner Index.
Exotic/Alien	Any species that has been introduced as a result of human activities.
Exposure	The contact reaction between a chemical and a biological system, or organism. Estimated dose of chemical that is received by a particular receptor via a specific exposure pathway (e.g., ingestion, inhalation); expressed as the amount of chemical received, per body weight, per unit time (i.e., mg/kg/day).
Exposure Assessment	The process of estimating the amount (concentration or dose) of a chemical that is taken up by a receptor from the environment.
Exposure Concentration	The concentration of a chemical in its transport or carrier medium at the point of contact.
Exposure Limit or Toxicity Reference Value	For a non-carcinogenic chemical, the maximum acceptable dose (per unit body weight and unit of time) of a chemical that a specified receptor can be exposed to, without the development of adverse effects. For a carcinogenic chemical, the maximum acceptable dose of a chemical to which a receptor can be exposed to, assuming a specified risk (e.g., 1 in 100,000). May be expressed as a Reference Dose (RfD) for non-carcinogenic (threshold-response) chemicals or as a Risk Specific Dose (RsD) for carcinogenic (non-threshold response) chemicals. Also referred to as a toxicity reference value.
Exposure Pathway or Route	The route by which a receptor comes into contact with a chemical or physical agent. Examples of exposure pathways include: the ingestion of water, food and soil; the inhalation of air and dust; and dermal absorption.
Exposure Ratio (ER) or Hazard Quotient (HQ)	A comparison between total exposure from all predicted routes of exposure and the exposure limits for chemicals of concern. This comparison is calculated by dividing the predicted exposure by the exposure limit. Also referred to as hazard quotient (HQ).

Exposure Scenario	A set of facts, assumptions and inferences about how exposure takes place, which helps the risk assessor evaluate, estimate and quantify exposures.
Extinct	A species that no longer exists.
Extirpated	A species no longer existing in the wild in Canada, but exists elsewhere in the world.
Fan	A large, fan-shaped deposit of materials that are built of stratified alluvium carried by water, and formed at a location where a stream emerges from a steeper, narrower valley onto a wider, flatter area.
Fate	In the context of the study of contaminants, fate refers to the chemical form of a contaminant when it enters the environment and the compartment of the ecosystem in which that chemical is primarily concentrated (e.g., water or sediments). Fate also includes transport of the chemical within the ecosystem (via water, air or mobile biota) and the potential for food chain accumulation.
Fate Transport Parameters	The mechanism by which pollutants move through and are ultimately deposited within media such as air, water or soil.
Fauna	An association of animals living in a particular place or at a particular time.
Faunal Remains	Bones and other animal parts found in archaeological sites.
Feature	A non-portable product of human workmanship (e.g., includes hearths, structural remains, clusters of associated objects).
Fecundity	The most common measure of reproductive potential in fishes. It is the number of eggs in the ovary of a female fish. It is most commonly measured in gravid (pregnant) fish. Fecundity increases with the size of the female.
Female Composite Receptor	Used for assessing and characterizing the risk to carcinogenic chemicals. For carcinogens, since it is the incremental lifetime cancer risk that is important, all lifestages are considered. Thus, the risk to the female composite receptor represents the sum total of the risk at each individual lifestage. The lifestages assessed included: the infant (zero to <six months), toddler (six months to five years), child (five to <12 years), adolescent (12 to <20 years) and adult (20 to <70 years) receptors.

Fen Sedge peat materials derived primarily from sedges with inclusions of partially decayed stems of shrubs formed in a eutrophic environment due to the close association of the material with mineral rich waters. Minerotropic peat-forming wetlands that receive surface moisture from precipitation and groundwater. Fens are less acidic than bogs, deriving most of their water from groundwater rich in calcium and magnesium.

Fetch An area of a waterbody where waves are generated by a wind having a constant direction and speed (also called Generating Area).

Filterable Residue Materials in water that pass through a standard-size filter (often 0.45 μm). This is a measure of the "total dissolved solids" (TDS), i.e., chemicals that are dissolved in the water or that are in a particulate form smaller than the filter size. These chemicals are usually salts, such as sodium ions and potassium ions.

Filter-Feeders Organisms that feed by straining small organisms or organic particles from the water column.

Fine Tailings A suspension of fine silts, clays, residual bitumen and water that forms in the course of bitumen extraction from oil sands using the hot water extraction process. This material segregates from coarse sand tailings during placement in tailings ponds and accumulates in a layer, referred to as fine tailings, that dewaters very slowly. The top of the fine tailings deposit is typically about 85% water, 13% fine minerals and 2% bitumen by weight.

Fine Textured Soil consisting of or containing large quantities of the fine earth fractions, particularly of silt and clay. It includes the textural classes: clay loam, sandy clay loam, silty clay loam, sandy clay, silty clay and clay. Sometimes it is subdivided into clayey texture and moderately fine texture.

Fines Silt and clay particles.

Fire-Cracked Rock Heat-fractured stone that result from rapid or alternate heating and cooling as in stone boiling or in campfires.

Fish Health Parameters Parameters used to indicate the health of an individual fish. May include, for example, short-term response indicators such as changes in liver mixed function oxidase activity and the levels of plasma glucose, protein and lactic acid. Longer-term indicators include internal and external examination of exposed fish, changes in organ characteristics, hematocrit and hemoglobin levels. May also include challenge tests such as disease resistance and swimming stamina.

Fish Tainting Abnormal odour and/or flavour detected in the edible fish tissue.

Fisheries Act Federal legislation that protects fish habitat from being altered, disrupted or destroyed by chemical, physical or biological means. Destruction of the habitat could potentially undermine the economic, employment and other benefits that flow from Canada's fisheries resources. Department of Fisheries and Oceans (DFO). 1986. The Department of Fisheries and Oceans Policy for the Management of Fish Habitat. Presented to Parliament by the Minister of Fisheries and Oceans. October 7, 1986.

Flake A fragment removed from a core of cryptocrystalline or fine-grained rock by percussion or pressure. The flake may be used as a tool itself if suitable for a particular task or may be formed into a specific tool by further flaking. A typical flake will display a platform or striking surface, bulb of percussion and rings of force radiating from the platform.

Flarks Wet, elongate, depressions in patterned peatlands that develop perpendicular to the direction of dominant water flow.

Flint A microcrystalline silicate rock similar to chert.

Flocculant A reagent added to a dispersion of solids in a liquid to bring together the fine particles to form flocs.

Flocs Small masses formed in a fluid through coagulation, agglomeration or biochemical reaction of fine suspended particles.

Floodplain The portion of the river valley, adjacent to the river channel, which is built of sediments during the present regimen of the stream and which is covered with water when the river overflows its banks at flood stages.

Floodplain Fringe	The portion of the floodplain outside the floodway which is covered by floodwaters during the 100-year recurrence interval flood. It is generally associated with shallow, standing or slowly moving water rather than deep, rapidly flowing water.
Flue Gas Desulphurization (FGD)	A process involving removal of a substantial portion of sulphur dioxide from the combustion gas (flue gas) formed from burning petroleum coke. Desulphurization is accomplished by contacting the combustion gases with a solution of limestone. Gypsum ($CaSO_4$) is formed as a by-product of this process.
Fluid Catalytic Cracking	An oil refining process in which the gas-oil is cracked by a catalyst bed fluidized by steam and the oil vapours produced by cracking.
Fluvial	Relating to a stream or river.
Fluvial Processes	Natural processes involving the formation and evolution of stream and river channels and their floodplains.
Foliose	Having a leaf-like thallus loosely attached to a surface, as certain lichens.
Food Chain Transfer	A process by which materials accumulate in the tissues of lower trophic level organisms and are passed on to higher trophic level organisms by dietary uptake.
Footprint	The proposed development area that directly affects the soil and vegetation components of the landscape.
Forage Area	The area used by animals for hunting or gathering food.
Forage Fish	Small fish that provide food for larger fish (e.g., longnose sucker, fathead minnow).
Forb	A broad-leaved herb, that is not a grass.
Forest	A growth of trees and underbrush covering a tract of land.
Forest Cover Type	Primary stand groupings based on the percent composition of coniferous or deciduous species. Forest cover type can be deciduous, coniferous or mixedwood. Also, regenerating stands are included as a forest cover type.

Forest Ecosystem	The sum of the plants, animals, environmental influences, and their interactions within a plant community predominantly of trees and other woody vegetation, growing more or less closely together.
Forest Fragmentation	The change in the forest landscape, from extensive and continuous forests.
Forest Landscape	Forested or formerly forested land not currently developed for non-forest use.
Forest Productivity	A measure of forest growth based on the volume of wood fibre added to the landbase annually (i.e., mean annual increment) or the rate at which trees grow in height over a given period of time as defined by a timber productivity rating or site index value.
Forest Succession	The orderly process of change in a forest as one plant community or stand condition is replaced by another, evolving toward the climax type of vegetation.
Forested	Closed canopy with greater than 20% tree coverage.
Fork Length	The length of a fish measured from the most anterior portion of the head to the tip of the shortest rays in the caudal fin (i.e., to the fork in the tail).
Formation	A geologic unit of distinct rock types that is large enough in scale to allow its mapping over a region.
Fossil	Mineralized or otherwise preserved remains of animals, plants and other organisms.
Fossiliferous	Rock formation or sedimentary layer containing fossils.
Fragmentation	The process of breaking into pieces or sections. For example, dividing contiguous tracts of land into smaller and less connected sections through site clearing (e.g., for roads).
Fragmentation Analysis	Evaluation of the level or degree of fragmentation in the landscape to assess current or future habitat condition.
FRAGSTATS	A spatial pattern analysis software program used to quantify the areal extent and spatial configuration of patches within a landscape. The analysis is done using categorical spatial data (e.g., plant communities).

Frazil Ice Small, needle-like or thin, flat ice crystals suspended in water and formed when sub-freezing air cools the surface of the water to below the freezing point (supercooling). In rivers with turbulent flow, the supercooled water mixes into a thicker layer and frazil ice forms, suspended in the supercooled layer.

Freeboard The distance between the water level and the top of a containing structure such as a dyke crest or channel top of bank.

Freeze-Out An increase in the concentrations of dissolved substances in surface waters during ice formation in the winter.

French Drains A gravel or rock filled ditch used to direct surface and/or groundwater away from an area..

Frequency Analysis A statistical procedure involved in interpreting the past record of a hydrological event to occurrences of that event in the future.

Fresh Water Water with total dissolved solids concentration below 1,000 mg/L.

Friable Soil material that is easily crushed under gentle to moderate pressure on its mass.

Froth Air-entrained bitumen with a froth-like appearance that is the product of the primary extraction step in the hot water extraction process.

FRQ (Frequency) A computer program for deriving low flow frequencies

Fugitive Emissions Substances emitted from any source except those from stacks and vents. Typical sources include gaseous leakage from valves, flanges, drains, volatilization from ponds and lagoons, and open doors and windows. Typical particulate sources include bulk storage areas, open conveyors, construction areas or plant roads.

Furbearer Mammals that have traditionally been trapped or hunted for their fur.

Gasification A process whereby upgrader by-products are converted in a partial oxidization process to produce synthetic gas “syngas” for use as an alternate fuel to natural gas by other components of the project.

Gasifier The process equipment used in gasification.

General Head Boundary	A boundary condition used to define a relationship between groundwater flow into/out of the model domain and the hydraulic head in a grid cell.
Generalist	Organism which can survive under a wide variety of conditions, and does not specialize to live under any particular set of circumstances.
Genetic Diversity	The range of possible genetic characteristics found within a species and amongst different species (e.g., variations in hair colour, eye colour and height in humans).
Genotoxic	Adverse effects that occur at the molecular level, when a chemical interacts directly with genetic material such as DNA.
Geographic Information System (GIS)	Computer software designed to develop, manage, analyze and display spatially referenced data.
Geomorphic	The natural evolution of surface soils and landscape over long periods.
Geomorphical Processes	The origin and distribution of landforms, with the emphasis on the nature of erosional processes.
Geomorphology	The science of surface landforms and their interpretation on the basis of geology and climate. That branch of science that deals with the form of the earth, the general configurations of its surface and the changes that take place in the evolution of landforms.
Georeference	The process of scaling, rotating, translating and correcting an image to match a particular size and position.
Glacial Till	Unsorted and unstratified glacial drift (generally unconsolidated) deposited directly by a glacier without subsequent reworking by water from the glacier. Consisting of a heterogeneous mixture of clay, silt, sand, gravel and boulders (i.e., drift) varying widely in size and shape.
Glaciofluvial (or Glacio-Fluvial)	Sediments or landforms produced by melt waters originating from glaciers or ice sheets. Glaciofluvial deposits commonly contain rounded cobbles arranged in bedded layers.
Glaciolacustrine	Relating to the lakes that formed at the edge of glaciers as the glaciers receded. Glaciolacustrine sediments are commonly laminar deposits of fine sand, silt and clay.

Glauconitic Containing glauconite, a blue-green or yellow-green mineral, typically found in shallow marine sedimentary rocks.

Gleyed/Gleying A soil condition resulting from prolonged soil saturation which results in the development of drab colors (bluish or greenish) due to reduction of iron or the depletion of iron under anaerobic conditions. The development of accumulations of secondary iron oxide in splotches within the soil matrix may also occur. These splotches are referred to as mottles (reddish and orange coloured deposits).

Gleysolic Soil A great group of soils in the Gleysolic order. A Gleysol either has a thin (less than 8 cm) Ah horizon underlain by mottled grey or brownish grey material, or it has no Ah horizon.

Global Positioning System (GPS) A system of satellites, computers and receivers that is able to determine the latitude and longitude of a receiver on Earth by calculating the time difference for signals from different satellites to reach the receiver.

Glycoprotectant Blood antifreeze (in frogs).

Gonads Organs responsible for producing haploid reproductive cells in multi-cellular cells in multi-cellular animals. In the male, these are the testes and in the female, the ovaries.

Gonad-Somatic Index (GSI) The proportion of reproductive tissue in the body of a fish. It is calculated by dividing the total gonad weight by the total body weight and multiplying the result by 100. It is used as an index of the proportion of growth allocated to reproductive tissues in relation to somatic growth.

Graminoid Grasses and grass-like plants such as sedges and rushes.

Gran Alkalinity Alkalinity in a water sample measured by the gran method which does not rely on the presence of inflection points in the titration curve; therefore, it is particularly useful for waters with low alkalinity.

Granivore/granivorous Animals that feed on seeds or grains.

Gravelly An accumulation of rounded particles ranging in size from pebbles to boulders.

Graver A small pointed or chisel-like stone tool used for incising or engraving. Generally made by pressure flaking.

Grid Cell (Cell)	A small, regular-shaped subregion of a numerical groundwater flow model domain within which groundwater flow and hydraulic head are represented by simple mathematical equations. The mathematical equations for all grid cells in a model domain are solved at once using a computer to calculate the hydraulic heads and groundwater flows for the entire model domain.
Ground-Level Concentration (GLC)	The ambient concentration (mass per unit volume of air) of a substance predicted to occur at the ground surface. These concentrations are predicted using dispersion models, and are typically reported in micrograms per cubic metre [$\mu g/m^3$].
Groundtruth or Groundtruthing	Visiting locations in the field to confirm or correct information produced from remote sources such as interpreted aerial photographs or classified satellite imagery.
Groundwater	That part of the subsurface water that occurs beneath the water table, in soils and geologic formations that are fully saturated.
Groundwater Flow Model	A simplified representation of one or more groundwater flow systems. Numerical groundwater flow models are used to represent the groundwater flow systems in the Regional Study Area.
Groundwater Level	The level below which the rock and subsoil, to unknown depths, are saturated.
Groundwater Mounding	An area of a groundwater system featuring an increased groundwater surface elevation above the baseline condition for that area.
Groundwater Regime	Water below the land surface in a zone of saturation.
Groundwater Velocity	The speed at which groundwater advances through the ground; the average linear velocity of the groundwater.
Guild	A set of co-existing species that share a common resource.
Gullied	A modification to consolidated or unconsolidated surfaces, usually by running water, that results in the formation of parallel and sub-parallel long narrow ravines.
Habitat	The place or environment where a plant or animal naturally or normally lives or occurs.

Habitat Alienation	The loss of habitat effectiveness as a result of sensory disturbances from human activities at disturbed sites.
Habitat Effectiveness	The physical characteristics associated with the suitability of a habitat and, the capability of a habitat to be used by wildlife. The effectiveness of a habitat can be decreased through visual, auditory, or olfactory disturbance even though the physical characteristics of the habitat remain unchanged.
Habitat Fragmentation	Occurs when extensive, continuous tracts of habitat are reduced by habitat loss to dispersed and usually smaller patches of habitat. Generally reduces the total amount of available habitat and reduces remaining habitat into smaller, more isolated patches.
Habitat Generalist	Wildlife species that can survive and reproduce in a variety of habitat types (e.g., red-backed vole).
Habitat Patches	Isolated patches of habitat.
Habitat Specialist	Wildlife species that is dependent on a few habitat types for survival and reproduction (e.g., Cape May warbler).
Habitat Suitability Index (HSI) Model	Analytical tools for determining the relative potential of an area to support individuals or populations of a wildlife species. They are frequently used to quantify potential habitat losses and gains for wildlife as a result of various land use activities.
Habitat Unit (HU)	Generally, used in Habitat Suitability Index models. A habitat is ranked in regards to its suitability for a particular wildlife species. This ranking is then multiplied by the area (ha) of the particular habitat type to give the number of habitat units (HU) available to the wildlife species in question.
Hafted Biface	A biface that shows evidence of having been hafted or fitted to a shaft, but which is not the correct shape for a projectile.
Hair Lichen	An intricately branched lichen, often with hanging filaments.
Hammerstone	A rounded stone used for hammering as evidenced by a battered or crushed striking surface.

Hardness Calculated mainly from the calcium and magnesium concentrations in water; originally developed as a measure of the capacity of water to precipitate soap. The hardness of water is environmentally important since it is inversely related to the toxicity of some metals (e.g., copper, nickel, lead, cadmium, chromium, silver and zinc).

Hazard A condition with the potential for causing an undesirable consequence.

Head The energy, either kinetic or potential, possessed by each unit weight of a liquid; expressed as the vertical height through which a unit weight would have to fall to release the average energy possessed. It is used in various compound terms such as pressure head, velocity head and loss of head.

Headwater(s) The source and upper reaches of a stream; also the upper reaches of a reservoir. The water upstream from a structure or point on a stream. The small streams that come together to form a river. Also may be thought of as any and all parts of a river basin except the mainstem river and main tributaries.

Health Effect Endpoint A measurable biological response which may compromise the health of a human receptor, which is used as a point of reference for assessing exposure to a particular chemical.

Heart Cut Diluent Blend of narrow boiling point range naphtha. Contains lower concentrations of benzene.

Hearth A fireplace.

Hectare (ha) A metric unit of area equal to 10,000 square metres.

Hepatotoxicity The quality or condition of being toxic or destructive to the liver.

Herb Tender plant, lacking woody stems, usually small or low; it may be annual or perennial, broadleaf (forb) or graminoid (grass).

Herbivory A mode of feeding in which an organism known as a herbivore, consumes only autotrophs such as plants, algae and photosynthesizing bacteria.

Heterogeneity Consisting of parts that are unlike each other. For example, the variety and abundance of ecological units (e.g., ecosite phases and wetlands types) comprising a landscape mosaic.

Hexane	A water-insoluble, toxic, flammable, colourless liquid with a faint aroma. Forms include n-hexane, a straight-chain compound used as a solvent, paint diluent, alcohol denaturant and polymerization-reaction medium; isohexane, a mixture of hexame isomers used as a solvent and freezing-point depressant; and neohexane.
Hibernacula	A protective care, covering, or structure, such as a plant bed, in which an organism remains dormant for the winter.
Histology/Histological	The microscopic study of tissues.
Historical/Heritage Resources	Works of nature or of man, valued for their palaeontological, archaeological, prehistoric, historic, cultural, natural, scientific or aesthetic interest.
Historical Resources Impact Assessment (HRIA)	A review of the effects that a proposed development will have on the local and regional historic and prehistoric heritage of an area.
Home Range	The area within which an animal normally lives, and traverses as part of its annual travel patterns.
Horizontal Stand	Structure of a forest inventory polygon where two unique stands occur adjacent to each other but with one unit being too small to map separately due to minimum polygon size standards.
Human Health Risk Assessment	The process of defining and quantifying risks and determining the acceptability of those risks to human life.
Hummocky	A very complex sequence of slopes extending from somewhat rounded depression or kettles or various sizes to irregular to conical knolls or knobs. There is a general lack of concordance between knolls and depressions.
Hydraulic Conductivity	The permeability of soil or rock to water. A coefficient “k” depends on the physical properties of formation and fluid. It describes the “ease” with which a fluid will flow through a porous material. “k” is the rate of flow per unit cross-sectional area under the influence of a unit gradient, and has the dimension of: $Length^3/Length^2$ x Time or Length/Time (e.g., m/s), but should not be confused with velocity.

Hydraulic Gradient A measure of the force of moving groundwater through soil or rock. It is measured as the rate of change in total head per unit distance of flow in a given direction. Hydraulic gradient is commonly shown as being dimensionless, since its units are metres/metre.

Hydraulic Head The elevation, with respect to a specified reference level, at which water stands in a piezometer (a pipe in the ground used to measure water elevations/or a small diameter observation well) connected to the point in question in the soil. Its definition can be extended to soil above the water table if the piezometer is replaced by a tensiometer (instrument used to measure moisture content of soil). The hydraulic head in systems under atmospheric pressure may be identified with a potential expressed in terms of the height of a water column. More specifically, it can be identified with the sum of gravitational and capillary potentials, and may be termed the hydraulic potential.

Hydraulic Structure Any structure designed to handle water in any way. This includes retention, conveyance, control, regulation and dissipation of the energy of water.

Hydric Soil moisture conditions where water is removed so slowly that the water table is at or near the soil surface all year; has organic and gleyed mineral soils.

Hydrochemical Type The definition of a chemical composition of groundwater based on cation and anion concentrations.

Hydrocracking A catalytic, high-pressure petroleum refinery process that is flexible enough to produce either high-octane gasoline or aviation jet fuel. The two main reactions are adding hydrogen to petroleum-derived molecules too massive and complex for gasoline, and then cracking them to the required fuels. The catalyst is an acidic solid with a hydrogenating metallic component.

Hydrocyclone A device for separating out sand from extraction tailings slurry by imparting a rotating (cyclone) action to the slurry. Water, fine tailings and residual bitumen report to the overflow of the device. Sand flows out the bottom of the device in a dense slurry.

Hydrogen A colourless, odourless, tasteless gas, composed of diatomic molecules, used to manufacture ammonia and methanol, for hydrofining, for desulphurization of petroleum products, and to reduce metallic oxide ores.

Hydrogeological Window	The erosional, sedimentional or structural break in geological strata, which allows hydraulic connection between different aquifers.
Hydrogeology	The study of the factors that deal with subsurface water (groundwater) and the related geologic aspects of surface water. Groundwater as used here includes all water in the zone of saturation beneath the earth's surface, except water chemically combined in minerals.
Hydrograph	A graph showing water surface elevations or flow versus time.
Hydrolic Gradient	The scale from very dry to very wet. Exists along a shoreline from water to upland.
Hydrologic Simulation Program – Fortran (HSPF)	The Hydrologic Simulation Program – Fortran (HSPF) model is a comprehensive, conceptual, continuous watershed simulation model designed to simulate the water quantity and water quality processes that occur in a watershed. The model can reproduce spatial variability by dividing the basin in hydrologically homogeneous land segments and simulating runoff for each land segment independently, using segment-specific meteorological input data and watershed parameters.
Hydrology	The science of waters of the earth, their occurrence, distribution, and circulation; their physical and chemical properties; and their reaction with the environment, including living beings.
Hydrometric Station	A station where measurement of hydrological parameters is performed.
Hydrophytic Vegetation	Plants that are adapted to saturated soil conditions or aquatic ecosystems.
Hydrostratigraphic Unit	A formation, part of a formation, or group of formations in which there are similar hydrologic characteristics allowing for grouping into aquifers or confining layers.
Hydrotransport	The transport of granular materials (e.g., oil sands ore or extraction tailings) by means of a water-based slurry in a pipeline.
Hydrotreating	A process in which a crude or synthetic oil or oil product is treated under pressure with the addition of hydrogen in the presence of a catalyst to reduce the sulphur and nitrogen content of the oil and otherwise improve the quality of the oil.

Hygric Soil moisture conditions where water is removed slowly enough to keep the soil wet for most of the growing season. Permanent seepage and mottling are present and possibly weak gleying.

Hyper-Eutrophic Trophic state classification for lakes characterized by high primary productivity and high nutrient inputs (particularly total phosphorus). Hyper-eutrophic lakes are characterized by abundant plant growth, algal blooms and oxygen depletion.

Hypsithermal A warm period during roughly the interval 9,000 to 5,00 B.P. This event is also known by other names, including the Holocene Climate Optimum, Altithermal, Climatic Optimum and Holocene Optimum. This warm period was followed by a gradual decline until about 2,000 years ago.

Hypolimnion The deep, cold layer of a lake lying below the metalimnion (thermocline) during the time a lake is normally stratified.

Hypsometer A device using trigonomic principles to measure height of trees or slope of land. Often called a clinometer or Suunto™.

IC25 25% Inhibition Concentration. The sample concentration percentage at which test organisms exhibit a 25% reduction in a biological function, such as reproduction or growth.

IC50 50% Inhibition Concentration. The sample concentration percentage at which test organisms exhibit a 50% reduction in a biological function, such as reproduction or growth.

Ice-Rafted Pebbles Pebbles carried onto post glacial lakes by small icebergs.

Illuvial A soil layer or horizon in which material carried from an overlying layer has been precipitated from solution or deposited from suspension. This layer of accumulation contains illuvial deposits of clays, oxides, and organics accumulated in a soil horizon classified as “B horizons”.

Inclined A sloping, unidirectional surface with a generally constant slope not broken by marked irregularities. The form of inclined slopes is not related to the initial mode of origin of the underlying material.

Incremental Lifetime Cancer Risk The risk associated with daily exposure to a carcinogenic chemical that is separate from the risk associated with assumed background exposures.

Indeterminate	A species for which there is sufficient scientific information to support states designation.
Index	A numerical scale used to compare values with one another, relative to some specified value.
Induction	Response to a biologically active compound — involves new or increased gene expression resulting in enhanced synthesis of a protein. Such induction is commonly determined by measuring increases in protein levels and/or increases in the corresponding enzyme activity. For example, induction of EROD (7-ethoxyresorufin-0-deethylase) would be determined by measuring increases in cytochrome P4501A protein levels and/or increases in EROD activity.
Inductively Coupled Plasma (Atomic Emission Spectroscopy) (ICP) (Metals)	This analytical method is an U.S. EPA designated method (Method 6010). The method determines elements within samples of groundwater, aqueous samples, leachates, industrial wastes, soils, sludges, sediments and other solid wastes. Samples require chemical digestion before analysis.
Industrial Water	Water that has been in contact with oil sands and is contained on site to minimize effects on the water quality of receiving streams.
Infiltration	The movement of groundwater or hydrothermal water into rock or soil through joints and pores. Infiltration is the main factor in recharge of groundwater reserves.
Influent	An inflow, especially a tributary.
Infrastructure	Basic facilities, such as transportation, communications, power supplies and buildings, which enable an organization, project or community to function.
Inorganics	Chemical compounds that do not contain carbon.
In-Situ	Also known as “in place”. Refers to methods of extracting deep deposits of oil sands without removing the groundcover. The in-situ technology in oil sands uses underground wells to recover the resources with less impact to the land, air and water than for oil sands mining.
Insolation Patterns	The amount of solar radiation received by the earth.

Instream Flow Needs Amount of water needed in a watercourse for sustaining instream values (such as fisheries or related riverine resources) at an acceptable level based on appropriate study.

Integrated Light Intensity Summation of solar radiation since sunrise to the clock hour.

Integrated Resource Management (IRM) A coordinated approach to land and resource management that encourages multiple-use practices.

Interburden Material within a valid ore zone that is at least 3 m thick and has a bitumen content of less than 7 wt%.

Interim Maximum Acceptable Concentration (IMAC) Interim maximum acceptable concentration of contaminants for drinking water quality.

Interior Species A species located only or primarily away from the perimeter of a landscape element.

Internal Lawn Wet depressional area within bog or fen wetlands types that are absent of trees and contain species adapted to wetter conditions than the surrounding wooded habitat. In bogs, internal lawns contain wet *Sphagnum* species and sedges and represent previous areas of permafrost that have degraded in the past. In fens, internal lawns contain wetter species of *Sphagnum* or brown moss.

Interspersion The percentage of map units containing categories different from the map unit surrounding it.

Interspersion and Juxtaposition Index (IJI) A measure of the dispersion and interspersion of patches in the landscape. It is a true landscape-level index that is computed based on the probabilities of a patch belonging to a class and its neighbours belonging to another.

Intra-Orebody Aquifers Isolated water-saturated sand bodies, typically a few metres thick and up to a few tens of metres long, occurring within the oil sands.

Invasive Species A species that has moved into an ecosystem and reproduced so successfully that it has displaced the original structure of the community.

Inversion A reversal of normal atmospheric conditions, when temperatures increase rather than decrease with height above the ground. During inversion conditions the vertical mixing of emissions are restricted.

Invertebrate Drift Collectively, stream invertebrates (almost wholly the aquatic larval stages of insects) that voluntarily or accidentally leave the substrate to move or float with the current, as well as terrestrial invertebrates that drop into the stream. Also, any detrital material transported in the water current.

Ionic Load The total mass of charged molecules (ions) dissolved in a volume of water.

Irritant Chemicals Chemicals which cause irritation at the site of contact (e.g., skin, nasal). These chemicals produce local adverse effects, and do not produce effects in areas away from the site of contact. Examples of irritant chemicals include carbon disulphide, carbon monoxide, nitrogen dioxide, sulphur dioxide and carbonyl sulphide.

Isolated Find The occurrence of a single artifact with no associated artifacts or features.

Isopach Map A geological map of subsurface strata showing the various thicknesses of a given formation underlying an area.

Isopleth A line on a map connecting places sharing the same feature (e.g., ground-level concentrations).

Isostatic Rebound A slow lifting of the land after the heavy weight of glacial ice has been removed from it.

Isotherm A zone or portion of a waterbody with the same water temperature.

ISQG (Interim Sediment Quality Guideline) Recommended maximum concentration of a chemical in sediment, intended to be protective of aquatic organisms.

Kames Ice contact deposits associated with the concurrent processes of melting ice and flowing meltwater.

Karst A topography formed over limestone, dolomite or gypsum and characterized by sinkholes, caves and underground drainage.

Ketone Hydrocarbon chain compound associated with the > C=O two single carbon bonds to other chain-like hydrocarbons (e.g., acetone, CH_3-CO-CH_3).

Kettle A small hollow or depression formed in glacial deposits when outwash was deposited around a residual block or ice that later melted.

Key Indicator Resources (KIRs)	Environmental attributes or components identified as a result of a social scoping exercise as having legal, scientific, cultural, economic or aesthetic value.
Keystone Species	A species that is of particular importance to community integrity and function, without which significant changes to the community would occur.
Kick Sampling	Sampling of the streambed using a small mesh net with a long handle. The net is placed against the streambed and the substrate is disturbed (kicked) upstream of the net to dislodge fish eggs which float down into the net.
Kjeldahl Method	A quantitative analysis of organic compounds to determine nitrogen content by interaction with concentrated sulphuric acid. Ammonia is distilled from the NH_4SO_4 formed.
Knife River Flint	A dark-coloured chert commonly used for tools on the northern plains.
Labile	Susceptible to alteration or destruction.
Lacustrine	Relating to a lake.
Laminar Flow	Fluid flowing in parallel layers, with no mixing or disruption between the layers.
Lanceolate Knives	Lance-shaped stone knives.
Land Capability Class	A land capability class assigned to an area according to the criteria outlined in Land Capability Classification System for Forest Ecosystems in the Oil Sands, 3rd Edition, as amended.
Land Cover Class	A vegetated or non-vegetated map unit defined at the regional study area level and classified from LANDSAT 5 satellite imagery.
Land Reclamation	The stabilization, contouring, maintenance, conditioning, reconstruction, and revegetation of the surface of the land to a state that permanently returns the plant to a land capability equivalent to its pre disturbed state.
Land Status Automated System (LSAS)	An online government database containing Alberta Surface Public Land and Crown Mineral dispositions and activities. Includes information about land restrictions and reservations.

Land System A subdivision of an ecodistrict that recognizes different land surface forms, surficial materials, soils and wetlands.

Landform One of the multitudinous features that taken together make up the surface of the earth. It includes all broad features, such as plain, plateau, and mountain, and also all the minor mountain, and also all the minor features, such as hill, valley, slope, canyon, arroyo and alluvial fan.

LANDSAT 5 A specific satellite or series of satellites used for earth resource remote sensing. Satellite data can be converted to visual images for resource analysis and planning.

Landscape A heterogeneous land area with interacting ecosystems that are repeated in similar form throughout. From a wildlife perspective, a landscape is an area of land containing a mosaic of habitat patches within which a particular "focal" or "target" habitat patch is embedded.

Landscape Composition All the types of stands or patches present across a given area of land.

Landscape Connectivity A measure of the probability that individuals are capable of moving across a landscape and colonizing suitable habitat patches within their dispersal range.

Landscape Diversity The size, shape and connectivity of different ecosystems across a large area.

Landscape Ecology The study of the structure, function and change in a heterogeneous land area composed of interacting ecosystems.

Landscape Structure The spatial relations among a landscape's component parts including composition; the presence and amount of each patch type without being spatially explicit; and landscape configuration, the physical distribution or spatial character of patches within a landscape.

Landslide A slope or mass movement where a shear failure occurs along a specific surface.

Leaching The removal, by water, of soluble matter from any solid material lying on top of bedrock (e.g., soil, alluvium or bedrock).

Leaf Lichen A leafy form lichen, usually with rhizines and a hard lower surface.

Leakage The flow of water from one hydrogeological unit to another. It may be natural or anthropogenic.

Leakance A property of a leaky layer. Expressed as K' divided by b', where K' refers to the hydraulic conductivity of the leaky layer confirming an aquifer in units of length/time and b' refers to the thickness of the leaky layer in units of length.

Lean Oil Sands Oil bearing sands that do not have a high enough saturation of oil to make extraction of them economically feasible.

Leave Area An area of standing timber retained among areas of logging activity to satisfy management objectives, such as seed source, wildlife habitat or landscape management constraints.

Lesions Pathological change in a body tissue.

Lethal Causing death by direct action.

Levee A natural or artificial slope or wall, usually earthen, often parallel with a watercourse, used to prevent flooding of adjoining lands.

Level A flat or very gently sloping, unidirectional surface with a generally constant slope and is not broken by marked elevations and depressions.

Lignin A complex polymer occurring in plant cell walls making the plant rigid.

Limestone A bedded sedimentary deposit consisting chiefly of calcium carbonate ($CaCO_3$) which yields lime when burned. Limestone is the most important and widely distributed of the carbonate rocks and is the consolidated equivalent of limy mud, calcareous sand, or shell fragments.

Linear Corridor Roads, seismic lines, pipelines and electrical transmission lines, or other long, narrow disturbances.

Lipid One of a large variety of organic fats or fat-like compounds, including waxes, steroids, phospholipids and carotenes. Refers to substances that can be extracted from living matter using hydrocarbon solvents. They serve several functions in the body, such as energy storage and transport, cell membrane structure and chemical messengers.

Lithic	Consolidated bedrock (r) within the control section below a depth of 10 cm. The upper surface of a lithic layer is a lithic contact.
Lithic Scatter	A small concentration of lithic (stone) artifacts on the surface. This term is usually used when there is insufficient information present to identify the function of the site.
Lithics	Of or pertaining to stone.
Lithology	The systematic description of sediment and rocks, in terms of composition and texture.
Litter, Fibric and Humic (LFH)	Organic layers developed primarily from leaves, twigs and wood materials with minor components of mosses. The forest floor that accumulates on the mineral soil surface under forest vegetation, and which includes dead vegetation and organic matter, including litter and unincorporated humus.
Littoral Zone	The zone in a lake that is closest to the shore. It includes the part of the lake bottom, and its overlying water, between the highest water level and the depth where there is enough light (about 1% of the surface light) for rooted aquatic plants and algae to colonize the bottom sediments.
Liver Somatic Index (LSI)	Ratio of liver versus total body weight. Expressed as a percentage of total body weight.
Loading Rates	The amount of deposition, determined by technical analysis, above which there is a specific deleterious ecological effect on a receptor.
Loam	Soil comprised of sand, silt, and clay in relatively even concentration (about 40-40-20% concentration, respectively).
Lobate	Having or resembling lobes.
Local Study Area (LSA)	Defines the spatial extent directly or indirectly affected by the Project.
Lognormal	Of, relating to, or being a logarithmic function with a normal distribution.
Long Range Sustained Yield Average (LRSYA)	The sum of Mean Annual Increments (MAI) for all forest cover types in a study area. The LRSYA is an estimate for the sustained yield or expected annual growth of the coniferous and deciduous fibre in a study area.

Lower Subsoil	Generally considered to be BC and C horizons of all pedons. In most interpretive rating systems, the lower subsoil extends from 50 to 100 cm below the mineral surface.
Lowest Observed Adverse Effect Level (LOAEL)	In toxicity testing, it is the lowest concentration at which adverse effects on the measurement end point are observed.
Lowest Observed Effect Concentration (LOEC)	The lowest concentration in a medium that causes an effect that is a statistically significant difference in effect compared to controls.
Lowest Observed Effect Level (LOEL)	In toxicity testing, it is the lowest concentration at which effects on the measurement end point are observed.
Lowland Areas	Areas with ground slopes of less than 0.5% and typically poorly drained.
Luvisol	An order of soils that have eluvial (Ae) horizons, and illuvial (Bt) horizons in which silicate clay is the main accumulation product. The soils developed under forest or forest-grassland transition in a moderate to cool climate.
Macrophytes	Plants large enough to be seen by the unaided eye. Aquatic macrophytes are plants that live in or in close proximity to water.
Macroterrain	A large area of the landscape.
Main Canopy	A well-defined, uppermost layer of trees within a forest.
Mainstem	The main portion of a watercourse extending continuously upstream from its mouth, but not including any tributary watercourses.
Make-Up Water	The process water required to replace that lost by evaporation or leakage in a closed-circuit, recycle operation.
Marine	Of, relating to, or occurring in a sea or ocean.
Marsh	A non-peat-forming, nutrient-rich wetlands characterized by frequent flooding and fluctuating water levels.
Mass Balance Error	The difference between the groundwater flows into and out of a model domain. For a numerical groundwater flow model with a perfect solution, the mass balance error is zero (i.e., inflows equal outflows). In practice, small mass balance errors are acceptable.

Mass Loading	The rate of atmospheric deposition (including wet and dry deposition) of a compound over a given area for a set time. Typically expressed in units of kilograms per hectare per year (kg/ha/yr).
Mass Movement	Mass movement is a descriptive name for the downward and outward movement of slope forming materials. Mass movements have been classified in categories based largely on type of movement. Mass movement categories can include debris slides, debris flows, debris avalanches, earth flows, slumps, topples, lateral spreads, rock falls, rock slides and rotational slides.
Matrix	The most extensive and most connected landscape element type present, which plays the dominant role in landscape functioning.
Mature Fine Tailings (MFT)	Fine tailings that have dewatered to a level of about 30% solids over a period of about three years after deposition. The rate of consolidation beyond this point is substantially reduced. Mature fine tailings behave like a viscous fluid.
Mature Forest	A forest greater than rotation age with moderate to high canopy closure; a multilayered, multispecies canopy dominated by large overstorey trees; some with broken tops and other decay; numerous large snags and accumulations of downed woody debris.
Mature Stand	A stand of trees for which the annual net rate of growth has peaked.
Maximum Acceptable Concentration (MAC)	Maximum acceptable concentration of contaminants for drinking water quality.
Maximum Allowable Daily Dose	The upper limit of the amount of chemical that can be received by a particular receptor, every day for an entire lifetime, without experiencing adverse health effects.
Maximum Depth	The maximum depth of the surveyed section of the stream recorded for each pool, riffle and run.
May Be At Risk	Any species that “May Be At Risk” of extinction or extirpation and is therefore a candidate for detailed risk assessment.
Mean (MN)	Centroid value of a data population when viewing its probability distribution function (or histogram) as a mass distribution.

Mean Annual Increment (MAI)	The measure of cubic metres of fibre that accumulates per year from each hectare of forest. Calculated MAI for each stand is summed by forest cover type, and multiplied by its area to derive expected fibre accumulation for that forest cover type.
Mean Nearest Neighbour (ENN_MN)	The mean of the shortest distance, in metres, between each patch and each adjacent patch of the same type.
Mean Patch Fractal Dimension (FRAC_MN)	A measure of the complexity of a patch's shape. It also determines the amount of core area contained in the class.
Mean Patch Size (AREA_MN)	The area of an ecosystem type divided by the number of patches of that type. For total undisturbed areas, it is the mean size of the undisturbed patches.
Meander	A randomized search pattern used in rare plant surveys to cover the range in micro-habitat variation within a larger ecosystem unit.
Media	The physical form of the environmental sample under study (e.g., soil, water, air).
Median (MD)	Fifty percent of the data population values are greater than, and 50% are less than, the median value.
Medium Textured	Intermediate between fine-textured and coarse-textured soils. It includes the following textural classes: very fine sandy loam, loam, silt loam and silt.
Mercaptan	A group of organosulphur compounds that are derivatives of hydrogen sulphide in the same way that alcohols are derivatives of water. These compounds have a characteristically disagreeable odour, are found with other sulphur compounds in crude petroleum, and are added to odourless fuel gases to give them a distinctive odour for safety purposes.
Merchantable Forest	A forest area with potential to be harvested for production of lumber/timber or wood pulp. Forests with a timber productivity rating of moderate to good.
Mesic	A moderate soil moisture regime value whereby water is removed somewhat slowly in relation to supply; neither wet nor dry. Available soil water reflects climatic inputs.
Mesocarnivore	Mid-sized carnivore species (e.g., fisher, lynx, marten).

Mesohabitat	General habitat characteristics of a watercourses or waterbody, as assessed on a large scale.
Mesotrophic	Trophic state classification for lakes characterized by moderate productivity and nutrient inputs (particularly total phosphorus).
Metabolism	The total of all enzymatic reactions occurring in the cell; a highly coordinated activity of interrelated enzyme systems exchanging matter and energy between the cell and the environment. Metabolism involves both the synthesis and breakdown (catabolism) of individual compounds.
Metabolites	Organisms alter or change compounds in various ways, such as removing parts of the original or parent compound, or in other cases adding new parts. Then, the parent compound has been metabolized and the newly converted compound is called a metabolite.
Metacarpal	The digits in an animal's foot consist of many bone segments. The longest segment in a digit is the metacarpal.
Metastable	A state of being in equilibrium (oscillating around a central position) but susceptible to being diverted to another equilibrium.
Meteoric Water	That which occurs in or is derived from the atmosphere.
Method Detection Limit (DL)	The lowest concentration at which individual measurement results for a specific analyte are statistically different from a blank (that may be zero) with a specified confidence level for a given method and representative matrix.
Metric	A standard of measurement.
Microbiological Control	The science of keeping micro organisms within acceptable limits, such as by adding chlorine or other process chemicals to water to eliminate or control algae, fungi and bacteria.
Microclimate	The temperature, precipitation and wind velocity in a restricted or localized area, site or habitat.
Micro-Habitat	A small-scale surface in the landscape that has its own unique surface properties different from surrounding surfaces. The characteristics of surface promote the development of a unique assemblage of plant species relative to the surrounding vegetation (e.g., Sphagnum hummock or hollow, downed and decayed log, wetlands pool).

Microtine	Small mammal species (voles) with the genus name Microtus.
Microtopographic	The fine-scale topography of a site.
Microtox®	A toxicity test that includes an assay of light production by a strain of luminescent bacteria (*Photobacterium phosphoreum*).
Mineral Soil	Soils containing low levels of organic matter. Soils that have evolved on fluvial, glaciofluvial, lacustrine and morainal parent material.
Mineralization of Groundwater	Synonym of total dissolved solid concentration.
Minerotrophic	Receiving mineral-rich water from groundwater sources, e.g., fens are minerotrophic.
Mixed Function Oxidase (MFO)	A term for reactions catalyzed by the Cytochrome P450 family of enzymes, occurring primarily in the liver. These reactions transform organic chemicals, often altering toxicity of the chemicals.
Mixedwood	A terrestrial forest type that is an assemblage of both deciduous and coniferous tree species.
Mixing Height	The depth of surface layer in which atmospheric mixing of emissions occurs.
Model Calibration	The trial-and-error process of matching the hydraulic heads and groundwater flows in a numerical groundwater flow model with observed values. An acceptable model calibration depends on the intended use of the numerical model.
Model Domain	The region of interest for a numerical groundwater flow model.
Modelling	A simplified representation of a relationship or system of relationships. Modelling involves calculation techniques used to make quantitative estimates of an output parameter based on its relationship to input parameters. The input parameters influence the value of the output parameters.
Moisture Regime	The relative moisture supply at a site available for plant growth.

Mole An amount of substance of a system which contains as many elementary units as there are atoms of carbon in 0.012 kilograms of the pure nuclide carbon-12. The elementary unit must be specified and may be an atom, molecule, ion, electron, photon, or a specified group of such units. Abbreviated by mol.

Montane One of three Natural Subregions in the Rocky Mountains Ecoregion in Alberta. The montane landscape is characterized by a pattern of open forests and grasslands. Characteristic tree species include Douglas fir, limber pine and white spruce. Ridgetop, open forests dominated by Douglas fir and limber pine are among the driest forest communities and are species-rich due to the great habitat diversity. Limber pine forests are generally open and occur on the most exposed rock outcrops and eroding morainal or colluvial slopes.

Grasslands are typically dominated by bluebunch wheatgrass, fescue grasses and oatgrasses with a large diversity of forbs. Lodgepole pine forests occur on upland sites. White spruce forests occur on more mesic sites especially along streams on fluvial terraces. Aspen forests occur characteristically on fluvial fans and terraces.

Moraine Sediment generally consisting of well compacted material that is nonstratified and contains a heterogeneous mixture of particle sizes, often in a mixture of sand, silt, and clay that has been transported beneath, beside, on, within and in front of a glacier and not modified by any intermediate agent.

Morphological Process Process leading to a change in shape. In a stream, these processes may cause changes in channel cross-section and longitudinal slope.

Movement Corridor Travel way used by wildlife for daily, seasonal, annual and/or dispersal movements from one area or habitat to another.

Multi-Directional Core A core bearing scars that show that flakes or blades were removed in more than two directions.

Multilayered Forest stands where two or three storeys exist and each storey is significant, clearly observable and evenly distributed.

Multilayered Canopy Forest stands with two or more distinct tree layers in the canopy; also called multistoreyed stands.

Multistorey	Forest stands where two or three storeys exist and each storey is significant, clearly observable and evenly distributed.
Muskeg	A soil type comprised primarily of organic matter. Also known as bog peat.
Mycorrhizal	Fungi that form symbiotic relationships with plants, resulting in improved nutrient uptake by the plant.
N to P Ratio	Total nitrogen to total phosphorus ratio.
Naphthenic Acids	Generic name used for all the organic acids present in crude oils.
Narcosis	A state of unconsciousness caused by a chemical compound or lack of oxygen.
Native Plant	Plant species that naturally occur in a given area.
Native Species	Species that are known to be historically present in a given area.
Natural Region	The highest level in Alberta's ecological classification hierarchy; defined broadly on the basis of climate, topography, landforms and soil.
Natural Subregion	A division of the natural regions of Alberta. Areas within a natural subregion have a similar climate regime, which is characterized by modal vegetation distinct for that subregion.
Nearest Neighbour Coefficient of Variation (ENN_CV)	A percentage measurement of the variability of mean nearest neighbour (MNN) distance to the actual MNN distance. The number of patches and patch density are required to provide a complete understanding of NNCV.
Nearest Neighbour Standard Deviation (ENN_SD)	A measurement of patch dispersion. A uniform or regular distribution of vegetation units will have a low standard deviation. Clustered or dispersed patches will have a large standard deviation compared to the mean.
Necrosis	Death of cells or plant parts, usually resulting in the tissue turning brown or black due to oxidation of phenolics.
Nitrogen Oxides (NO_x)	A measure of the oxides of nitrogen comprised of nitric oxide (NO) and nitrogen dioxide (NO_2).

Nival Flow Regimes A flow regime that is dominated by spring and summer snowmelt, and is consequently characterized by spring or early summer high flows, and lower late summer and fall flows.

No Net Loss Plan A working principle which strives to balance unavoidable habitat losses with habitat replacement on a project by project basis so that reductions to fisheries resources due to habitat loss or damage may be prevented

No Observed Adverse Effect Level (NOAEL) In toxicity testing, it is the highest concentration at which no adverse effects on the measurement end point are observed.

No Observed Effect Concentration (NOEC) The highest concentration in a medium that does not cause a statistically significant difference in effect as compared to controls.

No Observed Effect Level (NOEL) In toxicity testing, it is the highest concentration at which no effects on the measurement end point are observed.

Node Location along a river channel, lake inlet or lake outlet where flows, sediment yield and water quality have been quantified.

Non-Benzene Aromatic Aromatic benzene ring type hydrocarbon other than benzene itself (e.g., toluene $C_6H_5CH_3$).

Non-Carcinogen A chemical that does not cause cancer and has a threshold concentration, below which adverse effects are unlikely.

Non-Commercial Forest Any area of forested land that does not meet the criteria of commercial forest.

Non-Filterable Residue Material in a water sample that does not pass through a standard size filter (often 0.45 mm). This is considered to represent "total suspended solids" (TSS), i.e., particulate matter suspended in the water column.

Non-Methane Hydrocarbons (NMHC) A measure of the airborne hydrocarbons, less methane.

Non-Native Plant A plant that has been brought over from another country by man and has established itself within its new environment. Because non-native plants have not evolved within the current environment, they may become invasive and detrimental to native plant communities.

Non-Segregating Tailings (NST)	Tailings formed from a mixture of cycloned sand tailings and thickened fine tailings in a non-segregating stream. These consolidate relatively rapidly upon placement in tailings disposal areas to form a trafficable surface. Consolidated tailings is one type of NST.
Non-Threshold Chemicals	A chemical which does not act via a threshold mechanism of action. That is, a specific chemical concentration does not need to be reached for adverse effects to occur, since any exposure could potentially cause adverse effects. The only dose level associated with no potential for adverse effects to occur is zero. Most non-threshold chemicals are genotoxic chemicals.
Non-Vascular Plant	Plants that do not possess conductive tissues (e.g., veins) for the transport of water and food.
Not at Risk	A species that has been evaluated and found to be not at risk.
Numerical Groundwater Flow Model	A computer-based representation of one or more groundwater flow systems. The numerical model calculates the distribution of hydraulic head and the resulting groundwater flow by subdividing a region of interest (the model domain) into many grid cells, defining the mathematical representations for each cell and solving the resulting set of equations with the computer using specialized techniques. Numerical groundwater flow models are typically used for groundwater flow systems with complex boundary conditions, geometry, or hydrostratigraphy.
Nutrients	Environmental substances (elements or compounds) such as nitrogen or phosphorus, which are necessary for the growth and development of plants and animals.
Nutrient Regime	The relative supply of nutrients available for plant growth at a given site.
Observation Well	A constructed controlled point of access to an aquifer that allows groundwater observations. Small-diameter observation wells are often called piezometers.
Obsidian	Volcanic glass which is easily worked into tools and attains a very sharp edge.
Ochre	Iron oxide or hematite. The colour is generally reddish-brown to yellow. Used as a natural pigment.

Odourant Material, usually a compound containing sulphur or mercaptan that is added to odourless fuel gases to give them a distinctive odour for safety purposes.

Ogee Weir A particular shape of weir often used for dam spillways.

Oil Sands A sand deposit containing a heavy hydrocarbon (bitumen) in the intergranular pore space of sands and fine grained particles. Typical oil sands comprise approximately 10 wt% bitumen, 85% coarse sand (more than 44 μm) and a fines (less than 44 μm) fraction, consisting of silts and clays.

Oil Sands Region The Oil Sands Region includes the Fort McMurray – Athabasca Oil Sands Subregional Integrated Resource Plan (IRP), the Lakeland Subregional IRP and the Cold Lake – Beaver River Subregional IRP.

Old Growth Forest An ecosystem distinguished by old trees and related structural attributes. Old growth encompasses the later stages of stand development that typically differ from earlier stages in a variety of characteristics which may include tree size, accumulations of large dead woody material, number of canopy layers, species, composition, and ecosystem function. Old growth forests are those forested areas where the annual growth equals annual losses, or where the mean annual increment of timber volume equals zero. They can be defined as those stands that are self-regenerating (i.e., having a specific structure that is maintained).

Olfactory Relating to the sense of smell.

Oligotrophic Trophic state classification for lakes characterized by low productivity and low nutrient inputs (particularly total phosphorus).

Ombrogenous Bog A mineral-poor, acid, peat-forming plant community that derives all its water, and dissolved nutrients, from rainfall

Ombrotrophic Wetlands which receive all water and nutrients from direct precipitation.

Omnivorous Carnivore A fish species with a diet that consists primarily of other fish, with no particular selectivity for a specific prey item.

Open Canopy Less than 6% tree cover.

Organic, Forest Litter	L, F, and H horizons, commonly combined as LF or LFH and occurring on the mineral soil surface.
Organic Horizon	The surface soil horizon in Organic soils containing more than 17% organic carbon by weight.
Organic, Peat	Unconsolidated soil material consisting largely of organic matter. Peaty organic horizons labelled as Of, Om and Oh.
Organic Soil	A soil order that have developed primarily on organic deposits. Soils containing high percentages of organic matter (fibric and humic inclusions).
Organics	Chemical compounds, naturally occurring or otherwise, which contain carbon, with the exception of carbon dioxide (CO_2) and carbonates (e.g., $CaCO_3$).
Orthophoto	A digital image of an aerial photograph.
Outcrop	An outcrop is a geologic unit that is exposed at the earth's surface.
Outlier	A data point that falls outside of the statistical distribution defined by the mean and standard deviation.
Outwash	A glaciofluvial sediment that is deposited by meltwater streams emanating from a glacier.
Overburden	Material below the soil profile and above the bituminous sand.
Overstorey	Those trees that form the upper canopy in a multi-layered forest.
Overwintering Habitat	Habitat used during the winter as a refuge and for feeding.
Oxidants	Chemical compounds that are capable of oxidizing other atmospheric compounds.
Oxidation Reduction	The electric potential to transfer electrons from one compound or element (the oxidant) to another compound or element (the reductant); used as a qualitative measure of the state of oxidation in water treatment systems.

Ozone (O_3) Ozone is a gas that occurs both in the Earth's upper atmosphere and at ground level. Ozone in the upper atmosphere protects living organisms by preventing damaging ultraviolet light from reaching the Earth's surface. Ground-level ozone is an air pollutant with harmful effects on the respiratory systems of animals.

Palaeontological Sites that include evidence of multicellular invertebrate and vertebrate faunal remains and plant materials that have been fossilized or otherwise preserved.

Palaeontology The study of the forms of life existing in prehistoric or geologic times, as represented by the fossils of plants, animals and other organisms.

Paleosol A paleosol is a soil that was formed in the past. Paleosols are usually buried beneath a layer of sediments and are thus no longer being actively created by soil formation processes like organic decay.

Paleotopography An ancient (in geologic time) landscape surface that has been buried by more recent deposits.

Paleo-Valleys A valley of the geologic past, frequently buried under younger sediments.

Paleozoic An era of geologic time, from the end of the Precambrian to the beginning of the Mesozoic, or from about 570 to about 225 million years ago. Also, the rocks deposited during the Paleozoic.

Palsa Bog A mound of perennially frozen peat and mineral soil, up to 5 m high, with a maximum diameter of 100 m. The surface is convex in shape, highly uneven and at least 1 m higher than its edge or surrounding fen.

Paludification When sphagnum moss blankets dry land and prevents water from leaving the surface leading to bog formation.

Palynology The study of living and fossil pollen grains and plant spores.

Paraconformity An uncertain or obscure unconformity in which no erosion surface is discernible or in which the contact is a simple bedding plane and in which the beds above and below the break are parallel.

Parasitism	The relation between two different kinds of organisms in which one receives benefits from the other by causing damage to it (usually not fatal damage).
Passerine	Perching birds, mostly small and living near the ground with feet having four toes arranged to allow for gripping the perch; most are songbirds.
Patch	An area that is different from the area around it (e.g., vegetation types, non-forested areas). This term is used to recognize that most ecosystems are not homogeneous, but rather exist as a group of patches or ecological islands that are recognizably different from the parts of the ecosystem that surround them but nevertheless interact with them.
Patch Richness (PR)	A measure of the number of different patch types that occur within a study area or landscape unit within a study area. The patch types used here are vegetation units.
Patch Size Coefficient of Variation (AREA_CV)	The patch size coefficient builds off the mean patch size (MPS) as the variability of patch size relative to the mean. The PSCV is calculated as the standard deviation of patch size divided by the MPS and is thus a relative measure.
Patterned Fen	Peatlands that display a distinctive pattern due to alterations between open wet areas (flarks) and drier shrubby to wooded areas (strings).
Pathology	The science that deals with the cause and nature of disease or diseased tissues.
Peat	A material composed almost entirely of organic matter from the partial decomposition of plants growing in wet conditions.
PeatMineral Mix	A mixture of an organic horizon and the underlying mineral soil, or an organic horizon and mineral soil from another source, where the mineral soil in both cases is rated good, fair or poor according to Table 8, Page 27 of the Soil Quality Criteria Relative to Disturbance and Reclamation,1987, as amended.
Peatland	Areas where there is an accumulation of peat material at least 40 cm thick. These are represented by bog and fen wetlands types.

Peatland Complex Within a given area, a mixture of bog and fen wetlands types have formed usually as a result of variation in groundwater flow regimes.

Pebble Core So termed because of its size. These miniature objective pieces will display the full range of reduction processes such as bi-polar and multidirectional flake removal often associated with larger core artifacts.

Pelagial Zone Deep-water zone(s) of a waterbody where aquatic plants do not grow due to lack of sufficient light penetration.

Pelagic Inhabiting open water, typically well off the bottom. Sometimes used synonymously with limnetic to describe the open water zone (e.g., large lake environments).

Percentile (e.g., 95%) in Context of Exposure Ratios (ERs) The 95th percentile is the reference level used when a stochastic analysis is conducted. The stochastic analysis can calculate Exposure Ratios (Ers) at various percentile levels of distribution. Stochastic analysis uses a range of values (e.g., body weights, consumption rates, inhalation rates) in an attempt to adequately depict the assessed population. Exposure model results are presented as a range of values. The 95th percentile represents a level of risk that 95% of the population should never experience. In other words, the ER value at the 95th percentile indicates that 95% of the population will experience an ER equal to or less than the value at the 95th percentile. Thus, only 5% of the population would experience ER values greater than the value at the 95th.

Perched Basin A tributary area or sub-watershed that is elevated above the main watershed.

Perched Water Tables An aquifer that occurs above the main water table because of an impermeable layer above the main aquifer but below the surface. Water percolating down to the main aquifer gets trapped above this second impermeable rock layer.

Performance Assessment Prediction of a reclaimed lease's future performance, identifying potential adverse effects with respect to geotechnical, geomorphic and ecosystem sustainability.

Periglacial Lakes A periglacial lake is one formed where the natural drainage of the topography is obstructed by an ice sheet, ice cap or glacier.

Permafrost Permanently frozen ground (subsoil). Permafrost areas are divided into more northern areas in which permafrost is continuous, and those more southern areas in which patches of permafrost alternate with unfrozen ground.

Permeability The capacity of porous rock, sediment, soil or a medium for transmitting a fluid. Has dimensions Length^2. When measured in cm^2, the value of permeability is very small, therefore more practical units are commonly used (i.e., Darcy [D] or millidarcy [mD].

Permissible Sound Level (PSL) The allowable overall A-weighted sound level of noise from energy industry sources, as specified by the EUB Noise Control Directive, which may contribute to the sound environment of a residential location.

Permit Holder The director of a Historical Resource Impact Assessment. Responsible for the satisfactory completion of all field and laboratory work and author of the technical report.

Petrified Wood Agatized wood used for the manufacture of stone artifacts.

pH The degree of acidity (or alkalinity) of soil or solution. The pH scale is generally presented from 1 (most acidic) to 14 (most alkaline). A difference of one pH unit represents a ten-fold change in hydrogen ion concentration.

pH Value The degree of acidity (or alkalinity) of soil or solution. The pH scale is generally presented from 1 (most acidic) to 14 (most alkaline). A difference of one pH unit represents a ten-fold change in hydrogen ion concentration.

Pharmacodynamics The interactions of a chemical with biological systems of an organism, including the mechanism of action, and associated effects. The dose-response relationship of a chemical is included as a part of the quantitative aspect of pharmocodynamics.

Phenology The study of flowering time in relation to climate.

Phosphorus The key nutrient influencing plant growth in lakes; total phosphorus includes the amount of phosphorus in solution (reactive) and in particulate form.

Photosynthetic Activity Processes where plant cells make sugar from carbon dioxide and water in the presence of chlorophyll and light.

Phreatic Surface	Synonym of unconfined groundwater surface. The planar surface between the zone of saturation and the zone of aeration. Also known as the water table.
Physiography	Synonym of geomorphology.
Physiological	Related to function in cells, organs or entire organisms, in accordance with natural processes of life.
Phytoremediation	A process that uses plants to remove, transfer, stabilize or destroy contaminants in soil, sediment and groundwater.
Phtyotoxic	Toxic or poisonous to plants or plant tissue.
Phytotoxic Metals	Metals in concentrations toxic to plants.
Pictograph	Designs painted by Aboriginal peoples on natural rock surfaces. Red ochre is the most frequently used pigment.
Pièces Esquillées	A tool which is generally rectangular in outline and presumably used as a wedge. It is manufactured using bi-polar flaking resulting in primary and secondary striking platforms.
Piezometer	A pipe in the ground in which the elevation of water levels can be measured, or a small diameter observation well.
Piezometric Surface	If water level elevations in wells completed in an aquifer are plotted on a map and contoured, the resulting surface described by the contours is known as a potentiometric or piezometric surface.
Pin Lichen	Lichens that look like tiny pins sticking up from their substrate (mainly old bark and wood) with a stalk and a distinct head on top. They range in size from a couple of millimetres to tenths of millimetres. Dense colonies may look a little like stubble.
Piping	Small leaks in dam or dyke walls that carry away the finer materials, weakening the holding walls and ultimately resulting in failure.
Piscivorous Diet	Feeding on fish.
Pit Cell	As an open-pit mine progresses, individual excavated areas or pit cells are created, contained by walls or dykes created either by leaving native material in place or by back-filling.

Pit Lake	A man-made lake used to fill a mine pit area into which tailings may be discharged. Pit Lakes are typically filled with waters pumped from adjacent rivers, or from runoff waters from reclamation areas.
Pixel	The basic unit of digital image data. Shortened from "picture element". The intensity of each pixel corresponds to the average "brightness" measured electronically by the sensor.
Planned Development Case (PDC)	The Planned Development Case includes the Application Case components and planned developments that have been publicly disclosed at least six months prior to submission of the Environmental Impact Assessment.
Plant Community	A group of interacting plant species that exist within a defined space and time.
Plant Community Type	As part of the hierarchical classification system outlined in the Field Guide to Ecosites of Northern Alberta, this ecological unit represents the lowest level taxonomic unit of the ecosite classification system. These units are subdivisions of an ecosite phase based on differences in understorey species composition.
Platy	A soil structure consisting of soil aggregates that are developed predominantly along the horizontal axes and generally bounded by relatively flat horizontal surfaces; laminated; flaky.
PM_{10}	Airborne particulate matter with a mean diameter less than 10 μm (microns) in diameter. This represents the fraction of airborne particles that can be inhaled into the upper respiratory tract.
$PM_{2.5}$	Airborne particulate matter with a mean diameter less than 2.5 μm (microns) in diameter. This represents the fraction of airborne particles that can be inhaled deeply into the pulmonary tissue.
Pneumatic Piezometer	A device used to measure hydrostatic and/or pore pressure in a borehole or engineered structure.
Point Bars	Floodplain deposits of alluvium found on the inside bank of a meandering stream.

Point Estimate A single numerical value used to describe a particular exposure parameter in the deterministic analysis of a risk assessment. As opposed to the use of a 95th percentile in the stochastic analysis, the point estimate does not use a range of values. For example, when considering body weights, only one value is chosen to represent the population. Single values are chosen for all exposure parameters, resulting in one level of risk that "roughly" represents the exposed population. Most times, the point estimate is deliberately chosen to represent a conservative, worst-case scenario.

Polishing Pond Pond where final sedimentation takes place before discharge.

Polyacrylamide A white polyamide related to acrylic acid used in geleiectrophoresis.

Polycyclic Aromatic Hydrocarbon (PAH) A chemical by-product of petroleum-related industry. Aromatics are considered to be highly toxic components of petroleum products. PAHs, many of which are potential carcinogens, are composed of at least two fused benzene rings. Toxicity increases along with molecular size and degree of alkylation of the aromatic nucleus.

Polygon The spatial area delineated on a map to define one feature unit (e.g., one type of ecosite phase).

Pool: Run: Riffle Ratio The ratio of pool: run: riffle based on the percentage of each stream type in the surveyed section of the stream. These habitat types are described as:

- Pool: a deep area of low current velocity;
- Run: a moderately deep area within the main current; and
- Riffle: a shallow area where the water surface is broken into waves by bed material.

Population A collection of individuals of the same species that potentially interbreed.

Population Viability Analysis (PVA) A modelling process that uses estimates of landscape changes, demographic rates and environmental variation to calculate the probability of species extinction within a given period of time and space.

Porewater Water between the grains of a soil or rock.

Porosity	The percentage of the bulk volume of a rock or soil that is occupied by interstices (minute openings or crevices), whether isolated or connected.
Potable Water	Water that is suitable for drinking.
Potential (Hydrology and Hydraulics) **Potential (Water Quality)**	Any of several scalar variables, each involving energy as a function of position or condition; of relevance here is the fluid potential of groundwater. A water quality issue or problem identified by a river authority as being a potential problem, or a problem without current supporting data.
Potential Acid Input (PAI)	A composite measure of acidification determined from the relative quantities of deposition from background and industrial emissions of sulphur, nitrogen and base cations.
Potentiation	An interaction that may be considered a special type of synergism. Potentiation occurs when a substance that is not toxic by itself increases the toxic potency of another substance.
Potentiometric	Synonym to piezometric.
Primary Decortication Flake	First series of flakes removed from a nodule. The dorsal surface of such flakes is covered by cortex and lack any real arris or flake scars on the dorsal side. Removed by percussion or pressure technique.
Primary Flakes	The first series of flakes removed from a core or nucleus in the process of tool manufacture.
Probable Effects Level	Concentration of a chemical in sediment above which adverse effects on an aquatic organism are likely.
Probable Maximum Flood (PMF)	The most severe flood that may be expected from a combination of the most critical meteorological and hydrological conditions that is reasonably possible in the drainage basin. It is used in designing high-risk flood protection works and siting of structures and facilities that must be subject to almost no risk of flooding. The probable maximum flood is much larger than the 100-year flood.
Probable Maximum Precipitation (PMP)	The maximum amount of precipitation for a given period that can reasonably be expected to occur in a specific drainage basin.
Problem Formulation	The initial step in a risk assessment that focuses the assessment on the chemicals, receptors and exposure pathways of greatest concern.

Productive Forest	Forests on lands with a capability rating of equal to or greater than three, and stocked with enough trees to meet the standards of a merchantable forest.
Projectile Point	An inclusive term for arrow, spear or dart points. Characterized by a symmetrical point, a relatively thin cross-section and some element to allow attachment to the projectile shaft. Flaked stone projectile points are usually classified by their outline form.
Propagules	Root fragments, seeds, and other plant materials that can develop into a plant under the right conditions.
Provenance	Point of origination or derivation.
Provenience	The horizontal and/or vertical position of an artifact in relation to known coordinates.
Quality Assurance/Quality Control (QA/QC)	A set of practices that ensure the quality of a product or a result. For example, "Good Laboratory Practice" is part of QA/QC in analytical laboratories and involves such things as proper instrument calibration, meticulous glassware cleaning and an accurate sample information system.
Quarternary	The most recent geologic time period, encompassing the last two million years.
Quartz Crystal	Pure silicate rock crystal. Usually perfectly clear.
Quartzite	A granular metamorphic rock consisting essentially of quartz.
Quota Holder	A company or person(s) with rights to a portion of the Annual Allowable Cut in a Forest Management Agreement area, under direction of the Forest Management Agreement Holder.
Raptor	A carnivorous (meat-eating) bird; includes eagles, hawks, falcons and owls.
Rare Plants	A native plant species found in restricted areas, at the edge of its range or in low numbers within a province, state, territory or country.
Rare Plant Community	Plant communities that are described as unusual, uncommon, of limited extent or encountered infrequently.

Rare Plant Potential A ranking system used to determine and map the likelihood of finding rare plants or the relative abundance of rare plant species among different vegetation types or land cover classes within the landscape.

Raster A graphic structure where the data is divided into cells on a grid. An example would be a computer screen where an image is represented by horizontal lines of coloured pixels. Shapes are represented by cells of the same colour or content adjacent to each other.

Rating Curve A curve showing the relation between the discharge of a gauge, meter or other hydraulic structure or instrument and the pertinent hydraulic conditions affecting the discharge, such as pressure, hydrostatic head and velocity of approach. In hydrology, typically refers to a curve showing the relation between the discharge of a river or stream and the water level in the stream.

Reach A comparatively short length of river, stream channel or shore. The length of the reach is defined by the purpose of the study.

Reach Break Analysis Longitudinal division of a watercourse into different segments based on differences in fish habitat characteristics from morphological differences in parameters such as chemical pattern, flow regime, gradient and substrate.

Rearing Habitat Habitat used by young fish for feeding and/or as a refuge from predators.

Receptor The person or organism subjected to exposure to chemicals or physical agents.

Recharge / Discharge Area Areas that either contribute (recharge) or take away (discharge) to/from the overall volume of groundwater in an aquifer.

Recharge-Seepage Face A boundary condition used to define a relationship between groundwater flow into or out of the model domain and the hydraulic head in a grid cell. It differs from the general head boundary in that the maximum groundwater inflow rate and the maximum hydraulic head are both specified for the recharge-seepage face boundary.

Reclamation The restoration of disturbed land or wasteland to a state of useful capability. Reclamation is the initiation of the process that leads to a sustainable landscape (see definition), including the construction of stable landforms, drainage systems, wetlands, soil reconstruction, addition of nutrients and revegetation. This provides the basis for natural succession to mature ecosystems suitable for a variety of end uses.

Reclamation Certificate A certificate issued by an Alberta Environment signifying that the terms and conditions of a conservation and reclamation approval have been complied with.

Reclamation Unit A unique combination of reclamation conditions, namely surface shape, sub-base material, cover material and initial vegetation.

Recovery Test A method of obtaining quantitative information on the hydraulic characteristics of an aquifer, routinely used following a pump test. After pumping has been terminated, the water level will stop dropping and will begin to rise towards its original position. The rise of the water level can be measured as residual drawdowns (i.e., as the difference between the original water level before pumping and the actual water level measured at a given time after pumping is stopped).

Reference Concentration (RfC) For a specific chemical that is conceptually equivalent to an air quality objective, and is expressed in $\mu g/m^3$. It is an exposure limit that is established for chemicals which are locally acting (e.g., irritant chemicals), whose toxicity is dependent solely on the air concentration and not on the total internal dose received via multiple exposure pathways.

Reference Value The maximum acceptable dose (per unit body weight and unit of time) of a chemical to which a specified receptor can be exposed to, assuming a specified risk (e.g., one in one hundred thousand). May be expressed as a Reference Dose (RfD) for threshold-response chemicals or as a Risk Specific Dose (RsD) for non-threshold response chemicals.

Refractory Materials or compounds able to retain strength and structure at high temperatures.

Refugia Areas of natural ecosystems within, or next to, a development area from which plants or animals may move back into the development area, or to which animals may move from the development area.

Regeneration	The natural or artificial process of establishing young trees.
Regional Aquatics Monitoring Program (RAMP)	RAMP was established to determine, evaluate and communicate the state of the aquatic environment in the Athabasca Oil Sands Region.
Regional Issues Working Group (RIWG)	A group that works to promote the responsible, sustainable development of resources within the Regional Municipality of Wood Buffalo.
Regional Study Area (RSA)	Defines the spatial extent related to the cumulative effects resulting from the Project and other regional developments.
Regional Sustainable Development Strategy (RSDS)	A regulatory framework for balancing development of Alberta's oil sands resources with protection of the environment.
Regolith	The unconsolidated mantle of weathered heterogeneous material covering solid rock.
Regosol	The only great group in the Regosolic order. The soils in the group have insufficient horizon development to meet the requirements of the other orders.
Rejects	Hard clusters of clays or lean oil sands that do not pass sizing screens in the extraction process and are rejected. Rejects contain residual bitumen and account for a portion of extraction recovery loss.
Relative Abundance	The proportional representation of a species in a sample or a community.
Relative Humidity	The ratio of the amount of water vapour in the atmosphere to the amount necessary for saturation at the same temperature. Relative humidity is expressed in terms of percent and measures the percentage of saturation.
Release Water	Water that is not in contact with oil sands and thus is normally returned to receiving streams. This minimizes hydrologic effects on receiving streams and avoids excessive waster inventory at the mine site.
Relict	Developed under geomorphic or climatic conditions perhaps thousands of years ago.

Relief	The variation in height of a land surface.
Remote Sensing	Measurement of some property of an object or surface by means other than direct contact; usually refers to the gathering of scientific information about the earth's surface from great heights and over broad areas, using instruments mounted on aircraft or satellites.
Replicate	Duplicate analyses of an individual sample. Replicate analyses are used for measuring precision in quality control.
Reproductive Success	The production of healthy offspring which live to reproduce themselves.
Resource Use Questionnaire (RUQ)	Completed as part of the Golder 2001 Athabasca Oil Sands Regional Resource Use Baseline to obtain information on the public's perception and patterns of resource use.
Retouch / Resharpening Flakes	Varying in size from large to microscopic, these flakes are driven off the lateral edges of a flake by pressure to form a sharp edge (retouch) or to maintain the sharp edge of an existing tool (resharpening).
Reverse Osmosis	A technique used to remove dissolved solids from water, such as in desalination, wastewater treatment, or preparation of boiler feedwater. Pressure is applied to the surface of a saline or waste solution, forcing pure water to pass from the solution through a membrane (hollow fibres of cellulose acetate or nylon) that will not pass the ions of dissolved solids.
RfD (Reference Dose)	The maximum recommended daily exposure for a non-carcinogenic chemical exhibiting a threshold (highly nonlinear) dose-response based on the No Observed Adverse Effect Level (NOAEL) determined for the chemical from human and/or animals studies and the use of an appropriate uncertainty factor.
Richness	The number of species in a biological community (e.g., habitat).
Riffle	A reach of stream that is characterized by shallow, fast-moving water broken by the presence of rocks and boulders.
Riffle Habitat	Shallow rapids where the water flows swiftly over completely or partially submerged materials to produce surface agitation.

Riffle-Run-Pool A mixture of flows and depth and providing a variety of habitats. Pools are deep with slow water. Riffles are shallow with fast, turbulent water running over rocks. Runs are deep with fast water and little or no turbulence.

Rinsate Samples Samples collected during rinsing of collection equipment or bottles. These samples are often examined as part of Quality Assurance and Quality Control (QA/QC) procedures to ensure the monitoring data meets the quality objectives.

Riparian Refers to terrain, vegetation or simply a position next to or associated with a stream, floodplain or standing waterbody.

Riparian Area A geographic area containing an aquatic ecosystem and adjacent upland areas that directly affects it.

Riparian Community Vegetation assemblages adjacent to streams and waterbodies and whose structure and function are influenced by, or dependent upon this aquatic association.

Riparian Zones A geographic area containing interdependent aquatic and terrestrial/wetlands ecosystems. Riparian zones are viewed as supporting important biodiversity functions as they provide unique habitat for vegetation and wildlife as well as providing a buffer for lakes and streams by absorbing excess water runoff, breaking down pollutants and holding sediments.

Riprap Large rocks used for erosion control.

Risk The likelihood or probability that the toxic effects associated with a chemical or physical agent will be produced in populations of individuals under their actual conditions of exposure. Risk is usually expressed as the probability of occurrence of an adverse effect, i.e., the expected ratio between the number of individuals that would experience an adverse effect at a given time and the total number of individuals exposed to the factor. Risk is expressed as a fraction without units and takes values from 0 (absolute certainty that there is no risk, which can never be shown) to 1.0, where there is absolute certainty that a risk will occur.

Risk Analysis Quantification of predictions of magnitudes and probabilities of potential impacts on the health of people, wildlife and/or aquatic biota that might arise from exposure to chemicals originating from a study area.

Risk Assessment	Process that evaluates the probability of adverse effects that may occur, or are occurring on target organism(s) as a result of exposure to one or more stressors.
Risk Characterization	The process of evaluating the potential risk to a receptor based on comparison of the estimated exposure to the toxicity reference value.
Risk Management	The managerial, decision-making and active hazard control process used to deal with those environmental agents for which risk evaluation has indicated the risk is too high.
Risk Specific Dose (RsD)	The exposure limit determined for chemicals assumed to act as genotoxic, non-threshold carcinogens. A RsD is a function of carcinogenic potency (q_1*) and defined acceptable risk (i.e., q_1* target level of risk); for example, the RsD for a lifetime cancer risk of one-in-one-million would equal q_1*, 1 x 10^{-6}.
Risk-Based Concentration (RBC)	Concentration in environmental media below which health risks are not expected to occur.
Robust Landscape	Landscape with either a capability to self-correct after extreme events or one with hazard triggers reducing with time.
Rock Alignment	Any artificial arrangement of rocks or boulders into rows or other patterns.
Rolling	A very regular sequence of moderate slopes extending from rounded, sometimes confined, concave depressions to broad, rounded convexities producing a wave-like pattern of moderate relief.
Rough Broken	An area having steep slopes and many intermittent drainage channels, but usually covered with vegetation.
Rough Broken Land	An area having steep slopes and many intermittent drainage channels, but usually covered with vegetation
Run Habitat	Areas of swiftly flowing water, without surface waves, that approximate uniform flow and in which the slope of water surface is roughly parallel to the overall gradient of the stream reach.

Runoff	The portion of water from rain and snow that flows over land to streams, ponds or other surface waterbodies. It is the portion of water from precipitation that does not infiltrate into the ground, or evaporate.
Run-On	Essentially the same as runoff, but referring to water that flows onto a property, or any piece of land of interest. Includes only those waters that have not been in contact with exposed oil sands, or with oil sands operational areas.
Saline Water	Water with total dissolved solids concentration ranging from 10,000 to 100,000 g/m^3.
Sand Lens	A body of sand that is thick in the middle and thin at the edges.
Sanitary Can	Specific design of metal can also known as an open topped can. Typically consists of a lapped or locked side seam and rolled or crimped lip. Invented in 1896.
Saturation Percent	The moisture content that a soil becomes saturated, with free water.
Scale	Level of spatial resolution.
Scavenging	Removal of a pollutant from the air through chemical or physical processes such as dry deposition or washout by precipitation.
Scraper	A tool presumably used in scraping, scouring or planing functions. Most frequently refers to flaked stone artifacts with one or more steep unifacially retouched edge(s).
Screening	The process of filtering and removal of implausible or unlikely exposure pathways, chemicals or substances, or populations from the risk assessment process to focus the analysis on the chemicals, pathways and populations of greatest concern.
Secondary Canopy	A well-defined layer of trees beneath the main canopy within a forest.
Secondary Decortication Flake	Second series of flakes removed from a nodule by percussion or pressure techniques. Are partially covered by cortex and most commonly exhibit an arris.
Secondary Extraction	In this step, bitumen froth from the primary extraction step is diluted with light hydrocarbon, and water and fine solids are removed by centrifuges in two stages.

Secondary Flake	Lithic fragment intentionally removed from a core by percussion or pressure techniques. They vary in size and shape with core types and core preparation. All exhibit platforms and/or other definitive removal characteristics.
Secure	A species that is not "At Risk", "May Be At Risk" or "Sensitive".
Sedge	Any plant of the genus *Carex*, perennial herbs, often growing in dense tufts in marshy places. They have triangular jointless stems, a spiked inflorescence and long grass-like leaves which are usually rough on the margins and midrib. There are several hundred species.
Sediment	Solid material that is transported by, suspended in, or deposited from water. It originates mostly from disintegrated rocks; it also includes chemical and biochemical precipitates and decomposed organic material, such as humus. The quantity, characteristics and cause of the occurrence of sediment in streams are influenced by environmental factors. Some major factors are degree of slope, length of slope soil characteristics, land usage and quantity and intensity of precipitation.
Sediment Load	(1) The soil particles transported through a channel by stream flow. (2) The total sediment, including bedload plus suspended sediment load, is the sediment being moved by flowing water in a stream at a specified cross-section.
Sediment Load, Total	Also referred to as the total load, a term that refers to the total sediment (bed load plus suspended-sediment load) that is in transport. The term needs to be qualified, however, such as "annual suspended-sediment load" or "sand-size suspended-sediment load," and so on. It is not synonymous with total sediment discharge.
Sediment Sampling	A field procedure relating to a method for determining the configuration of sediments.
Sediment Transport	Transport rate of soil particles through a channel by stream flow.
Sediment Yield	The amount of sediment transported by a stream system that may be measurable at a particular location. Usually expressed in volume or weight per unit of time.

Sedimentation	The process of subsidence and deposition of suspended matter carried by water, wastewater or other liquids, by gravity. It is usually accomplished by reducing the velocity of the liquid below the point at which it can transport the suspended material.
Seepage	Slow water movement in subsurface. Flow of water from man-made retaining structures. A spot or zone, where water oozes from the ground, often forming the source of a small spring.
Semi-Quantitative Assessment	The weight of evidence approach used in assessing risks to particulate matter. It is only semi-quantitative because a numerical value cannot be calculated and used to calculate risk.
Sensitive	Any species that is not at risk of extinction or extirpation but may require special attention or protection to prevent it from becoming at risk.
Sensory Disturbance	Visual, auditory, or olfactory stimulus that creates a negative response in wildlife species.
Sentinel Species	Species that can be used as an indicator of environmental conditions.
Separation Cells	Large, cylindrical open-top vessels which are used as the primary extraction device in the hot water extraction process. Bitumen is recovered from the top of the vessel (as well as from a sidestream in a secondary circuit). Tailings are removed from the bottom.
Seral Community	One of a sequence of communities in the development stages towards a climax community.
Seral Stage	In an ecological succession, the series of biotic communities that follow one another on the way to the stable stage, or climax community.
Seven-Day 10-Year Low Flow (7Q10)	The lowest average stream flow during a 7-day interval that is expected to occur once every 10 years on average.
"Shadow" Population	The people who live in work camps, campgrounds or hotels near Fort McMurray.
Shannon's Evenness Index (SHEI)	Distribution of area among or within patch types in the landscape.

Shannon-Wiener Index A diversity measure based on information theory, a measure of order (or disorder) within a particular system. The Shannon-Wiener index provides a measure of the degree of complexity in a system from low (0) to high (5).

Shovel Test A subsurface test approximately 40 to 50 cm on a side excavated by hand to determine the presence/absence of buried cultural materials.

Shrub Lichen A lichen that has many cylindrical branch stems and is often tufted.

Sign Wildlife tracks, pellets or other indications that they have been in an area.

Silviculture The science and practice of controlling the establishment, composition and growth of the vegetation in forest stands. It includes the control or production of stand structures such as snags and down logs, in addition to live vegetation.

Sinuosity The ratio of the thalweg length (i.e., the line connecting the deepest points along a stream) to valley length, for a specific reach of a river or stream system. This is, in essence, a ratio of the stream's actual "running" length to its down-gradient length.

Site [Historic] Any location with detectable evidence of past human activity.

Site [Human Health] The area determined to be significantly impacted after the iterative (repetitious/frequent) evaluations of the risk assessment. Can also be applied to political or legal boundaries.

Site Index The average height of undamaged, dominant and co-dominant trees in a stand at a standard (reference) age that have been free-growing since reaching breast height.

Slope Ravel The movement of individual particles resulting from wetting and drying, freezing and thawing, or mechanical disturbance.

Slumps Small, shallow slope failure involving relocation of surficial soil on a slope without risk to the overall stability of the facility.

Slump Area Slopes subject to regular mass-wasting events characterized by movement (slow or rapid) of a mass of soil and/or rock.

Slurry At Face (SAF)

Slurry at Face (SAF) is a technology that has mobile ore preparation units that crush and slurry ore for hydrotransport to the Primary Extraction Plant for primary bitumen extraction. The introduction of SAF ore preparation technology will eliminate most of the mine haul fleet for transporting ore and will result in a significant reduction in fuel cost, fleet capital and maintenance cost, road maintenance cost and mine fleet emissions, in particular oxides of nitrogen (NO_x).

The entire system comprises the following components:

- shovel;
- mobile sizer with receiving hopper, apron feeder and discharge conveyor;
- mobile mining conveyor hopper feeding onto a mobile mining conveyor;
- transfer conveyor feeding the slurry plant;
- slurry plant with a hopper, roller screen, oversize sizer, slurry pumpbox;
- a hydrotransport pumphouse and pipeline; and
- utilities including a water supply system and electric power.

The SAF system uses components that are similar to a conventional ore preparation plant and therefore produces similar ore slurry given similar ore feed. The major differences are that SAF is direct-fed by a shovel and is designed to be mobile.

Snag

A naturally occurring, standing dead or dying tree often missing a top or most of the smaller branches. It plays an important role in providing habitat for a variety of forest-dwelling wildlife species as well as epiphytic lichens.

Snag Density

The density level of snags (i.e., stems/ha) provides an index for biodiversity in a forested environment.

Snye

A side channel of a river on non-flowing water connected to a flowing river channel only at its downstream end, generally formed in a side channel of a river or behind a peninsula (bar).

Sodium Adsorption Ratio (SAR) The comparative concentrations of sodium, calcium and magnesium in the soil solution, where $[Na^{+}]$, $[Ca^{2+}]$ and $[Mg^{2+}]$ are the concentrations in mmol of charge per litre of solution. The SAR of a soil extract takes into consideration that the adverse effect of sodium is moderated by the presence of calcium and magnesium ions. SAR values of 7 and higher cause dispersion of soils.

Soil The naturally occurring, unconsolidated mineral or organic material at least 10 cm thick that occurs at the earth's surface and is capable of supporting plant growth.

Soil Aggregates The arrangement of individual soil particles into compound particles which are separated from adjoining compound particles (aggregates) by planes of weakness through processes of soil development.

Soil Amendment An alteration of the properties of a soil and, thereby, of the soil, by adding substances, such as lime, gypsum and sawdust, to make the soil more suitable for growth of plants. Fertilizers constitute a special group of soil amendments.

Soil Consistence Soil consistence is the property of soil materials that relates to the degree and kind of cohesion and adhesion or resistance to deformation and rupture. Soil consistency can be expressed as wet, moist, or dry consistence.

Soil Drainage Class Refers to the frequency and duration of periods of saturation or partial saturation during soil formation. There are seven drainage classes ranging from very rapid to very poorly drained.

Soil Horizon A layer of mineral or organic soil material approximately parallel to the land surface that has characteristics altered by processes of soil formation. A soil mineral horizon is a horizon with 17% or less total organic carbon by weight. A soil organic horizon is a horizon with more than 17% organic carbon by weight.

Soil Moisture Regime The available moisture supply for plant growth on a relative scale ranging from very dry (xeric) to very wet (hydric) classes.

Soil Nutrient A chemical element or compound found in the soil that is essential for plant growth.

Soil Nutrient Regime Amount of essential nutrients that are available for plant growth on a relative scale ranging from very poor to very rich.

Soil Parent Material The unconsolidated and more or less chemically weathered mineral or organic matter from which the solum of soils is developed by pedogenic processes.

Soil Pedon A real unit of soil; the smallest homogenous, three-dimensional unit that can be considered a soil.

Soil Salvage The process of physically removing soil from the pre-disturbance landscape for use in reclamation activities.

Soil Structure The combination or arrangement of individual soil particles into definable aggregates or peds that are characterized on the basis of size, shape and degree of distinctness.

Solar Radiation The principal portion of the solar spectrum that spans from approximately 300 nanometres (nm) to 4,000 nm in the electromagnetic spectrum. It is measured in W/m^2, which is radiation energy per second per unit area.

Solonetzic Soils An order of soils developed mainly under grass or grass-forest vegetative cover in semiarid to subhumid climates. The soils have a stained brownish solonetzic B (Bnt or Bn) horizon and a saline C horizon. The surface may be one or more of Ap, Ah, or Ae horizons.

Songbird Perching birds (e.g., warblers, sparrows, swallows, chickadees, thrushes, kinglets).

Sour Water Water that has been in contact with oil in a processing operation. Sour water may contain traces of hydrocarbons, hydrogen sulphide, ammonia and other compounds.

Spall A large flake driven off of a cobble. One hundred percent of its dorsal surface covered with cortex. Thick mid-section with a pronounced outward curve.

Spatial Relates to definition and consideration of space in the EIA. The spatial boundaries define the area considered in the assessment.

Spawning Habitat A particular type of area where a fish species chooses to reproduce. Preferred habitat (substrate, water flow, temperature) varies from species to species.

Special Concern (Vulnerable) A species of special concern because of characteristics that make it particularly sensitive to human activities or natural events.

Special Plant Community	Communities that are suspected to be rare or unique but are differentiated from known rare plant communities in that there is less information known about them, and currently are not included on Alberta Natural Heritage Information Centre's Preliminary Ecological Community Tracking and Watch List.
Species	A group of organisms that actually or potentially interbreed and are reproductively isolated from all other such groups; a taxonomic grouping of genetically and morphologically similar individuals; the category below genus.
Species Abundance	The number of individuals of a particular species within a biological community (e.g., habitat).
Species Composition	The number and abundance of species found within a biological community.
Species Distribution	Where the various species in an ecosystem are found at any given time. Species distribution varies with season.
Species Diversity	A description of a biological community that includes both the number of different species and their relative abundance. Provides a measure of the variation in number of species in a region.
Species Evenness	A measure of equitability calculated to incorporate the sum of the proportional contributions of an individual species to the total population of a community.
Species Richness	The number of different species occupying a given area.
Specified Head Cell	A grid cell with a specified value of hydraulic head.
Spectral Signature	The unique characteristics in a solar reflectance of a particular land classification unit based upon multi-spectral satellite imagery.
Spent Lime	The waste material from the Steam Assisted Gravity Drainage boiler feedwater treating process.
Sport/Game Fish	Large fish caught for food or sport (e.g., northern pike, Arctic grayling).
Spring	A place where water flows from rock or soil upon the land or into a body of surface water.

Stability	A measure of the atmosphere's capability to disperse emissions. Stable atmospheric conditions create poorer dispersion of plumes and increased concentrations. Unstable conditions promote dispersion and result in lower concentrations.
Staging Area	Area located next to a highway that allows marshalling of oversized loads.
Staging Birds / Areas	Refers to key locations, often wetlands, along their migratory routes where birds concentrate in huge numbers to replenish the body fat and energy reserves needed for their migration.
Stagnation Air Flow Condition	A meteorological condition characterized by low wind speeds that tend to be disorganized.
Stand	A group of trees occupying a specific area and sufficiently uniform in composition, age, arrangement and condition so that it is distinguishable from trees in adjoining areas.
Stand Age	The number of years since a forest has been affected by a stand-replacing disturbance event (e.g., fire or logging) and has since been regenerating.
Stand Density	The number and size of trees on a forest site.
Stand Structure	The various horizontal and vertical physical elements of the forest. The physical appearance of canopy and subcanopy trees and snags, shrub and herbaceous layers and downed woody material.
Standard Deviation (SD)	A measure of the variability or spread of the measurements about the mean. It is calculated as the positive square root of the variance.
Standpipe	A device consisting of a perforated/slotted pipe, often used in the past to measure depth to groundwater surface at shallow depths.
Steam Assisted Gravity Drainage (SAGD)	An in-situ oil sands recovery technique that involves the use of two horizontal wells, one to inject steam and a second to produce the bitumen.
Stem	The base of a particularly old style of projectile point. These spear points do not have notches but, instead, have a tongue-like base that fits into a hole or slot at the end of a spear shaft. The stem may or may not be narrower than the blade of the projectile point.

Stilling Basin

A basin, usually lined with erosion resistant material such as concrete or riprap, that is located below a fast-flowing waterway such as a dam spillway. The basin serves to dissipate the energy of the fast-flowing water and thereby minimize downstream channel erosion.

Stochastic

A risk assessment approach that is typically the second phase in the risk assessment process. Also referred to as a probabilistic approach, it involves assessing risk using probability distributions to describe exposure parameters. Thus, rather than using a single point estimate value for exposure parameters, a range of values is used.

Stomatal Closure

The movement of stomata guard cells to slow or prevent gas exchange between the plant and its environment.

Stomate (plural, stomata)

A plant pore or aperture, surrounded by two guard cells, which allows gaseous exchange. These microscopic pores are found on the under sides of leaves.

Stone Circle

A circle of rocks used to hold down the edges of a conical tent.

Storage Coefficient

The storage coefficient and the specific yield are both defined as the volume of water released or stored per unit surface area of the aquifer per unit change in the component of head normal to that surface. Both are designated by the symbol S and are dimensionless.

The storage coefficient refers only to the confined parts of an aquifer and depends on the elasticity of the aquifer material and the fluid. It typically has an order of magnitude of 10-4 to 10-6.

The specific yield refers to the unconfined parts of an aquifer. In practice, it may be considered to equal the effective porosity or drainable pore space because in unconfined aquifers the effects of the elasticity of aquifer material and fluid are generally negligible.

It should be kept in mind that small pores do not contribute to the effective pore space because in small pores the retention forces are greater than the weight of the water. For sands the specific yield may be in the order of 0.1 to 0.2.

In American Literature the terms storage coefficient and specific yield are often used synonymously.

Storativity The volume of water an aquifer releases from or takes into storage due to pressure change.

Stratify Layering of lakes into two or more non-mixing layers; in summer, typically a layer of warmer, less dense water lies on a cooler, denser layer; in winter, typically a layer of very cold (<4°C), less dense water overlies warmer, denser water (approximately 4°C).

Stratigraphy (Historical) The depositional layers within a site.

Stratosphere Atmospheric strata zone between approximately 15 to 45 km above the earth.

Stream Day Maximum daily rate (design capacity for equipment).

Stream Diversion A change or alteration in the natural course of a watercourse or stream either by removal/redirection of the waterflow or physical alteration to the stream channel.

Stream Flow The movement of surface water in a stream channel, usually measured in cubic metres per second (m^3/s). It describes the flow at a specific location along the watercourse. Runoff contributed by the entire land area to the stream can be used to describe flow.

Strings Dry, elongated ridges in patterned peatlands that develop perpendicular to the direction of dominant water flow.

Strip Mining Mining method in which overburden is first removed from a sedimentary ore such as oil sands, allowing ore to be removed.

Strong Acids Acids with a high tendency to donate protons or to completely dissociate in natural waters (e.g., H_2SO_4, HNO_3, HCl).

Structure (Stand Structure) The various horizontal and vertical physical elements of the forest. The physical appearance of canopy and subcanopy trees and snags, shrub and herbaceous layers and downed woody material.

Subchronic Toxicity Adverse effects occurring as a result of the repeated daily exposure to a chemical for a short time. In Canada, human exposures lasting between two weeks and three months may be termed subchronic; while in the US, human exposures lasting between two weeks and seven years may be termed subchronic.

Subcrop A geologic unit that is exposed beneath an overlying geologic layer, usually at an unconformity.

Subhydric Soil moisture conditions where water is removed slowly enough to keep the water table at or near the surface for most of the year; organic and gleyed mineral soils are present as well as permanent seepage less than 30 cm below the surface.

Subhygric Soil moisture conditions where water is removed slowly enough to keep the soil wet for a significant part of the growing season. There is some temporary seepage and possible mottling below 20 cm.

Submesic Soil moisture conditions where water is removed readily in relation to supply. Water is available for moderately short periods following precipitation.

Subsoil A stratum that includes one or more of the following:

(i) that portion of the B horizon left after salvage of upland surface soil;

(ii) the C horizon of an upland soil;

(iii) underlying parent material at an upland location that is rated good, fair or poor as described in Table 9, Page 28 of the Soil Quality Criteria Relative to Disturbance and Reclamation,1987, as amended; and

(iv) mineral material below an organic layer at a location other than upland, that is rated good, fair or poor as described in Table 9, Page 28 of the Soil Quality Criteria Relative to Disturbance and Reclamation,1987, as amended.

Substrate Material in the stream bed. The assemblage of material sizes include:

- Organic/Silt: organic material and/or fine material <0.006 mm diameter;
- Sand: material 0.06 to 2.0 mm diameter;
- Small Gravel: material 2 to 8 mm diameter;
- Large Gravel: material 8 to 32 mm diameter;
- Pebble: material 32 to 64 mm diameter;
- Cobble: material 64 to 256 mm diameter; and
- Boulder: material >256 mm diameter.

Subxeric	Soil moisture conditions where water is removed rapidly in relation to supply. Soil is moist for short periods following precipitation.
Succession	A series of dynamic changes by which one group of organisms succeeds another through stages leading to a climax community.
Successional Stage	A particular phase of the forest succession continuum with its own characteristic of age, structure and composition of species. Stages may include the following: pioneer, young seral, maturing seral, old seral, young edaphic, mature edaphic, young climatic, mature climatic and disclimax.
Supervised Classification	The image analyst assigns the pixel categories by specifying the various land cover types present in a scene.
Surber Sampler	A sampler used to collect benthic invertebrate samples from a streambed. It consists of a fine-mesh sample bag with a square frame attached that provides quantitative sampling of a defined area.
Surface Substrate	The components of the ground surface which may be composed of materials such as mineral soil, cobbles and stones, organic matter, downed woody material and water.
Surficial Aquifer	A surficial (at or near the surface of the earth) deposit containing water considered an aquifer.
Surficial Bed Material	The top 3 to 6 cm of the bed material that is sampled using US Series Bed-Material Samplers.
Surficial Deposit	A geologic deposit (clay, silt or sand) that has been placed above bedrock. (See also "Overburden").
Surrogate	Refers to the chemical selected to represent a group of related chemicals.
Suspended Sediments	Particles of matter suspended in the water. Measured as the oven dry weight of the solids, in mg/L, after filtration through a standard filter paper. Less than 25 mg/L would be considered clean water, while an extremely muddy river might have 200 mg/L of suspended sediments.
Sustainability	The process of managing biological resources (e.g., timber or fish) to ensure replacement by regrowth or reproduction of the part harvested before another harvest occurs.

Sustainable Development	Development that meets the needs of the present without compromising the ability of future generations to meet their own needs.
Sustainable Landscape	Capability of landscape (including landforms, drainage, waterbodies and vegetation) to survive extreme events and natural cycles of change, without causing accelerated erosion and environmental impacts much more severe than that of the natural environment.
Swale	A natural depression or wide shallow ditch used to convey runoff.
Swamp	Land having soils that are saturated with water for at least part of the year and which usually occur next to waterbodies or in areas in association with fluctuating water levels such as along peatland margins.
Synergism	Two or more toxic substances interact such that the toxicity of the mixture is greater than would be expected if the substances were acting additively or independently. For example, people who use both tobacco and alcohol have a much higher risk of some cancers than would be expected if these two products were acting additively.
Syngas	A manufactured gas fuel such as would be produced through gasification.
Synthetic Crude Oil	A mixture of hydrocarbons, similar to crude oil, derived from upgrading bitumen from oil sands.
Systemic	Refers to the fact that chemicals need to be absorbed and transported to their site of action (i.e., target organ) to produce adverse effects. This is in contrast to locally acting chemicals that produce effects at the site of contact.
Tail Gas Treatment Unit (TGTU)	The final stage of the sulphur recovery process, which removes the final recoverable sulphur. Any of the sulphur compounds that are not removed from the gas stream are converted to SO_2 in a high temperature incinerator. The SO_2 from the incinerator is released to the atmosphere.
Tailings	A by-product of oil sands extraction typically comprised of water, sands and clays, with minor amounts of residual bitumen.

Tailings Ponds Man-made impoundment structures required to contain tailings. Tailings ponds are enclosed dykes made with tailings and/or overburden materials to stringent geotechnical standards.

Tailings Porewater The water stored in voids within mine tailings. A portion of this water is mobile, and may drain from the tailings during tailings consolidation.

Tailings Release Water Water is expelled from consolidated tailings or non-segregated tails during the course of consolidation. The water is referred to as tailings release water.

Tailings Settling Pond An artificial impoundment structure to contain tailings. Tailings settling ponds are enclosed by dykes made with tailings and overburden materials to stringent geotechnical standards.

Tainting Potential Hypothetical parameter that is modelled by converting the tainting threshold release water concentrations from percent release water to tainting potential units (TPUs) using the formula, TPU = 100/TC, where TC equals the threshold concentration for tainting as a percentage diluted in river water.

Taxa A group of organisms of any taxonomic rank (e.g., family, genus, or species).

Telemetry Study Study conducted to monitor fish movements through the use of a remote tracking device, such as a radio transmitter, attached to the fish.

Temporal Relating to the consideration of time in the EIA. The temporal boundaries define the time during which something is assessed.

Terminal Moraine A sinuous ridge of unsorted glacial till deposited by a glacier at the line of its farthest advance.

Terraced Scarp face and the horizontal or gently inclined surface (tread) above it.

Terrestrial Vegetation Forested or non-forested areas of the landscape with non-saturated and non-peat-forming soils. Excludes bogs, fens, swamps and marshes.

Terricolous Living in or on the ground.

Thallus	A simple vegetative body undifferentiated into true leaves, stem and root, ranging from an aggregation of filaments to a complex plant-like form.
Thalweg	A line extending longitudinally along a watercourse following the deepest portion of the channel.
Thermograph	A type of thermometer that produces a continuous record of fluctuating temperature.
Thermokarst	Pock-marked topography in northern regions caused by the collapse of permafrost features.
Thickened Fine Tailings (TT)	Thickened fine tailings are produced by increasing the solids content of fine tailings from the Bitumen Cleaning process to 35 to 45% in a large vessel called a thickener by removing water. Thickened tailings are combined with cycloned sand tailings from the Bitumen Recovery process to produce non-segregated tailings (NST).
Thinning Flake	Removed by pressure to rejuvenate the lateral edge of an existing flake. They are characteristically longer than they are wide with a pronounced inward curve to them.
Threatened	A species likely to become endangered if limiting factors are not reversed.
Threshold Chemicals	Chemicals that act via a threshold mechanism of action require a minimal concentration level to produce adverse effects. Below this specific threshold level, there is no potential for adverse effects to occur.
Threshold Limit Value (TLV)	The air concentration of a chemical below which workers may be repeatedly exposed day after day, without any occurrence of health effects. TLVs are recommended occupational exposure limits designed to control potential adverse effects associated with workplace exposure.
Tidal	Of or relating to tides.
Till	Sediments laid down by glacial ice.
Timber Productivity Rating (TPR)	The potential timber productivity of a stand based on height and age of dominant and co-dominant trees of the leading species.

Tipi Ring/ Stone Circle A circle of rocks used to hold down the edges of a conical tent.

Toe Ditches A ditch constructed adjacent to the base of a structure (typically a waste dump or storage dyke) that collects surface runoff and possible seepage water from the structure.

Tolerable Daily Intake Also referred to as a reference concentration (see RfC); indicates the maximum allowable daily dose of a chemical that a receptor can receive over its entire lifetime that is not associated with adverse health effects.

Topsoil Ae, Ah, Ahe, Ahj and gleyed and weakly gleyed versions of these horizons were usually considered to be part of the topsoil.

Total Alkalinity A measure of the ability of water to resist changes in pH caused by the addition of acids or bases and therefore, the main indicator of susceptibility to acid rain; in natural waters it is due primarily to the presence of bicarbonates, carbonates and to a much lesser extent occasionally borates, silicates and phosphates; it is expressed in units of milligrams per litre (mg/L) of $CaCO_3$ (calcium carbonate). Alkalinity is determined from a discernable inflection point in the measured titration curve.

Total Core Area Index (TCA) A core area is an interior of a patch type that is within a given distance from the patch edge. This is the distance from a disturbance edge used to represent isolation from disturbance. It is used to represent the central portion of the natural area that is not part of the ecotone.

Total Daily Drift Represents the total number of drifting organisms during one day at a site in the entire stream.

Total Dissolved Solids (TDS) The total concentration of all dissolved compounds solids found in a water sample. See filterable residue.

Total Edge (TE) A measure of the total length of all patch boundaries. Total edge differs from the total perimeter of a patch because each edge represents the boundary of two patches, whereas perimeter refers to only one patch.

Total Hydrocarbons (THC) Total hydrocarbons include all airborne compounds containing only carbon and hydrogen.

Total Organic Carbon (TOC)	Total organic carbon is composed of both dissolved and particulate forms. Total organic carbon is often calculated as the difference between total carbon (TC) and total inorganic carbon (TIC). Total organic carbon has a direct relationship with both biochemical and chemical oxygen demands, and varies with the composition of organic matter present in the water. Organic matter in soils, aquatic vegetation and aquatic organisms are major sources of organic carbon.
Total Recoverable Hydrocarbons	A term that refers to groups of petroleum hydrocarbons recovered using a solvent-specific extraction procedure. Hydrocarbons may include a wide range of fuels, oils and greases.
Total Reduced Sulphur (TRS)	A term used to collectively describe hydrogen sulphide and mercaptans.
Total Suspended Particulate (TSP)	A measure of the total particulate matter suspended in the air. This represents all airborne particles with a mean diameter less than 30 µm (microns) in diameter.
Total Suspended Solids (TSS)	The amount of suspended substances in a water sample. Solids, found in wastewater or in a stream, which can be removed by filtration. The origin of suspended matter may be artificial or anthropogenic wastes or natural sources such as silt.
Toxic	A substance, dose or concentration that is harmful to a living organism.
Toxic Potency Factor (TPF)	When assessing groups of chemicals, each chemical within the group is assigned a numerical value, which indicates the toxic potency of that chemical, relative to the surrogate. The TPF is applied to chemical concentrations such that they are adjusted to represent surrogate-equivalent concentrations.
Toxic Threshold	Almost all compounds (except genotoxic carcinogens) become toxic at some level with no evident harm or adverse effect below that level. Scientists refer to the level or concentration where they can first see evidence for an adverse effect on an organism as the toxic threshold. Genotoxic carcinogens exhibit some toxic potential at any level.
Toxicity	The inherent potential or capacity of a material to cause adverse effects in a living organism.

Toxicity Assessment	The process of determining the amount (concentration or dose) of a chemical to which a receptor may be exposed without the development of adverse effects.
Toxicity Reference Value (TRV)	For a non-carcinogenic chemical, the maximum acceptable dose (per unit body weight and unit of time) of a chemical to which a specified receptor can be exposed, without the development of adverse effects. For a carcinogenic chemical, the maximum acceptable dose of a chemical to which a receptor can be exposed, assuming a specified risk (e.g., 1 in 100,000). May be expressed as a Reference Dose (RfD) for non-carcinogenic (threshold-response) chemicals or as a Risk Specific Dose (RsD) for carcinogenic (non-threshold response) chemicals. Also referred to as exposure limit.
Traditional Environmental (or Ecological) Knowledge (TEK)	Knowledge and understanding of traditional resource and land use, harvesting and special places.
Traditional Land Use (TLU)	Activities involving the harvest of traditional resources such as hunting and trapping, fishing, gathering medicinal plants and travelling to engage in these activities. Land use maps document locations where the activities occur or are occurring.
Traditional Plant Potential	A ranking system used to determine and map the relative abundance of traditional use plant species among different vegetation types or land cover classes within the landscape.
Traditional Resources	Plants, animals and mineral resources that are traditionally used by indigenous populations.
Traditional Use Plants	Plants used by aboriginal people of a region as part of their traditional lifestyle for food, ceremonial, medicinal and other purposes.
Tragus (pertains to bats)	A small membranous projection in front of the ear.
Training Areas	A representative sample site of known cover type used to compile an interpretation key for image analysis. This can be groundtruthed field data.
Training Site	A group of selected satellite imagery pixels used to define the spectral signature of a particular map unit for land classification purposes.

Transmissivity	The product of the average coefficient of hydraulic conductivity (or permeability) and the thickness of the aquifer. Consequently, transmissivity is the rate of flow under a hydraulic gradient equal to unity through a cross-section of unit width over the whole thickness of the aquifer. It is designated by the symbol T. It has the dimension of: $Length^3/Time$ x Length or $Length^2/Time$ (e.g., m^2/day).
Transpiration	Transpiration is the process by which water is transferred from soil and plant surfaces to the atmosphere.
Tree Throws	Dirt-filled root system of a tree that is ripped up when the tree falls.
Trophic	Pertaining to part of a food chain, for example, the primary producers are a trophic level just as tertiary consumers are another trophic level.
Trophic State	Eutrophication is the process by which lakes are enriched with nutrients, increasing the production of rooted aquatic plants and algae. The extent to which this process has occurred is reflected in a lake's trophic classification or state: oligotrophic (nutrient poor), mesotrophic (moderately productive) and eutrophic (very productive and fertile).
Truck and Shovel Operation	The process of using large trucks and shovels to obtain ore from the ground.
Turbidity	An indirect measure of suspended particles, such as silt, clay, organic matter, plankton and microscopic organisms, in water.
TWINSPAN	Two-Way Indicator Species Analysis. A technique used to classify bird species and vegetation communities.
Typology	The classification of artifacts according to analytical criteria, to determine and define significant trends or variations in time and space.
Uncertainty	Imperfect knowledge concerning the present or future state of the system under consideration; a component of risk resulting from imperfect knowledge of the degree of hazard or of its spatial and temporal distribution.

Uncertainty Factor A unitless numerical value that is applied to a reference toxicological value (i.e., No Observed Adverse Effect Level [NOAEL]). It accounts for uncertainties in the experimental data used to derive the toxicological value (e.g., short testing period, lack of species diversity, small test group) as well as to increase the confidence in the safety of the exposure dose as it applies to species other than the test species (e.g., sensitive individuals in the human population). RfD equals the NOAEL divided by the uncertainty factor.

Unconfined Aquifer A permeable bed only partly filled with water and overlying a relatively impervious layer. Its upper boundary is formed by a free water table under atmospheric pressure. Water in a well penetrating an unconfined aquifer does not, in general, rise above the water surface, except when there is vertical flow.

Underburden Waste located below the bottom-most ore block in a mine.

Understorey Trees or other vegetation in a forest that exist below the main canopy level.

Undetermined Any species for which insufficient information, knowledge or data is available to reliably evaluate its general status.

Undulating A very regular sequence of gentle slopes that extend from rounded, sometimes confined concavities to broad, rounded convexities producing a wavelike pattern of low local relief. Slope length is generally less than 0.8 km and the dominant gradient of slopes is 2 to 5%.

Ungulate Belonging to the former order Ungulata, now divided into the orders Perissodactyla and Artiodactyla, and composed of the hoofed mammals such as horses, cattle, deer, swine and elephants.

Uniface A stone artifact flaked only on one surface.

United States Environmental Protection Agency (U.S. EPA)

The U.S. EPA is responsible for implementing the federal laws designed to protect the environment. The U.S. EPA endeavours to accomplish its mission systematically by proper integration of a variety of research, monitoring, standard-setting and enforcement activities. As a complement to its other activities, the U.S. EPA coordinates and supports research and anti-pollution activities of state and local governments, private and public groups, individuals and educational institutions. The U.S. EPA also monitors the operations of other federal agencies with respect to their impact on the environment.

Universal Transverse Mercator (UTM)

The UTM system applies the Transverse Mercator projection to mapping the world, using 60 pre-defined standard zones to supply parameters. UTM zones are six degrees wide. Each zone exists in a north and south variant. The northern hemisphere projections for the UTM system consist of 120 zones (60 different zones with north and south variants of each). Originally developed for military use and now widely used in civil mapping.

Upgraded Product (Upgraded Crude Oil)

Often referred to as synthetic oil, upgraded product is bitumen that has undergone alteration to improve its hydrogen-carbon balance to a lighter specific gravity product. Upgraded crude oil products may include:

- Oil Sands A, a blend of low sulphur (hydrotreated) naphtha, kerosene and gas oil;
- Oil Sands Diesel, hydrotreated kerosene;
- Oil Sands E, a sour (higher sulphur) blend of coker distillate; and
- Oil Sands Virgin, an uncracked vacuum tower product.

Upgrader

A facility for processing heavy oil or bitumen to reduce the density and viscosity of oil, and otherwise improve the value of the oil.

Uplands

Areas where the soil is not saturated for extended periods as indicated by vegetation and soils.

Upland Soil

Mineral soils developed under forest in locations with imperfect drainage or drier, typically including LFH and A, B and C horizons.

Upland Surface Soil

A stratum salvaged from an upland soil that includes the LFH, A horizon and in some cases part or all of the B horizon.

Upper Subsoil	All types of B horizons (Bm, Bt, Bg, Bnt), plus gleyed (g) and juvenile (j) versions of them were considered to be part of the upper subsoil for depth calculations. The BA horizons were also included if they were transitional to an underlying B horizon.
Uptake	The process by which a chemical crosses an absorption barrier and is absorbed into the body.
Utilized Flake	A stone flake used for a tool without deliberate retouch, but exhibiting use-wear.
Vacuum Tower	A vessel used in the petroleum upgrading process that separates the light high-value petroleum products from the heavy lower-value products. In upgrading facilities such as oil sands, vacuum towers are often used in combination with coking and cracking units.
Valley Slope	An area of land that is lower than the land on either side of it. An elongated depression cut by stream erosion and associated water erosion on its sideslopes (stream valley).
Valued Ecosystem Component (VEC)	Components of an ecosystem (either plant, animal or abiotic feature) considered valuable by various sectors of the public.
Varved	A layer or series of sediment deposited in over time.
Vascular Plant	Plants possessing conductive tissues (e.g., veins) for the transport of water and food.
Vector	A graphic structure where the data is partitioned into polygons. Shapes are created by drawing a line around data of the same content.
Vegetation Community	See “Plant Community”.
Vegetation Type	A broad term used to describe the collection of vegetation units defined within different classification systems. It includes those units defined as ecosite phases, wetlands types and miscellaneous vegetation types.
Veneer	Unconsolidated materials too thin to mask the minor irregularities of the underlying unit surface. A veneer ranges from 10 cm to 1 m in thickness and possesses no form typical of the materials’ genesis.
Visual Aesthetics	The study of the psychological responses to appearances.

Volatile Organic Compounds (VOC)	Volatile Organic Compounds include aldehydes and all of the hydrocarbons except for ethane and methane. VOCs represent the airborne organic compounds likely to undergo or have a role in the chemical transformation of pollutants in the atmosphere.
Vulnerable	A species of special concern because of characteristics that make it particularly sensitive to human activities or natural events.
Waste Area	The area where overburden materials are placed that are surplus to the need of the mine. Also referred to as a "waste dump".
Water Equivalent	As relating to snow; the depth of water that would result from melting.
Water Sands	A water-saturated sand unit occurring within the McMurray formation in the Voyageur South area.
Water Table	The shallowest saturated ground below ground level - technically, that surface of a body of unconfined groundwater in which the pressure is equal to atmospheric pressure.
Water Yield	Runoff, including groundwater outflow that appears in the stream, plus groundwater outflow that leaves the basin underground. Water yield is the precipitation minus the evapotranspiration.
Water-Bearing	Containing water within the void spaces.
Waterfowl Staging Area	Waterbodies used by waterfowl to gather, rest and feed before or during migration.
Watershed	The entire surface drainage area that contributes water to a lake or river.
Wedge	A piece of rock, wood or metal tapered for insertion in a narrow crevice and used for splitting, tightening, severing or levering.
Weeds	Plants that are defined as controlled weeds, nuisance weeds, or noxious weeds by the *Weed Control Act*, as amended.
Weighted Score	A number assigned to an item to express its relative importance in a frequency distribution.

Wellpad	1. The platform from which a hole or shaft is excavated, drilled, bored or cut into the earth so as to tap a supply of some material (e.g., water, oil, gas). 2. An area associated with Steam Assisted Gravity Drainage operations on which pairs of wells are drilled. The pairs of wells include a steam injection well and a production well.
Wetlands	A wetlands is land where the water table is at, near or above the surface or which is saturated for a long enough period to promote such features as wet-altered soils and water tolerant vegetation. Wetlands include organic wetlands or "peatlands," and mineral wetlands or mineral soil areas that are influenced by excess water but produce little or no peat.
Wetted Width	The width of the water surface measured at right angles to the direction of flow. Multiple channel widths are summed to obtain total wetted width.
Whole Effluent Toxicity Testing	A water sediment or soil sample is delivered to a laboratory, wherein live organisms are placed into the sample. The ability of the test organisms to survive, grow and reproduce is tracked to evaluate the toxicity of the sample.
Whole Mixture Model (WMM)	A model used to assess the carcinogenic potency of and the exposure to, mixtures of polycyclic aromatic hydrocarbons (PAHs). The WMM is based on the assumptions that the PAH profile and the potency of PAH fractions are reasonably similar between different PAH mixtures from various sources (e.g., coke oven emissions, coal tar).
Windrose	Graphic pie-type representation of frequencies of wind directions and speeds over a period of time (e.g., one year) for a meteorological station.
Wind Shear	A difference in wind speed and/or direction over a relatively short distance in the atmosphere.
Wood Buffalo Environmental Association (WBEA)	The mission of the Wood Buffalo Environmental Association is to monitor and provide accurate, credible, transparent and understandable information on air quality and air related environmental impacts in the Regional Municipality of Wood Buffalo.
Wooded	Open canopy; from 6 to 70% tree coverage.

Worst-Case	A semi-quantitative term referring to the maximum possible exposure, dose or risk that can conceivably occur, whether or not this exposure, dose, or risk actually occurs or is observed in a specific population. It should refer to a hypothetical situation in which everything that can plausibly happen to maximize exposure, dose, or risk does happen. The worst-case may occur in a given population, but since it is usually a very unlikely set of circumstances in most cases, a worst-case estimate will be somewhat higher than what occurs in a specific population.
Xeric	Soil moisture conditions where water is removed very rapidly in relation to supply. Soil is only moist for a very short time following precipitation.
Young of the Year (YOY)	Fish at age 0, within the first year after hatching.
Zooplankton	Small (often microscopic) aquatic animals suspended or weakly swimming in water.

7.2 LIST OF ABBREVIATIONS

%	Percent
% OM	Percent Organic Matter
<	Less than
≤	Less than or equal to
>	More than
≥	More than or equal to
±	Plus or minus
AENV	Alberta Environment
AEP	Alberta Environmental Protection
AGRASID	Agricultural Region of Alberta Soil Inventory Database
Al	Aluminum
Al-Pac	Alberta-Pacific Forest Industries Inc.
ANHIC	Alberta Natural Heritage Information Centre
ANOVA	Analysis of Variance
AOSERP	Alberta Oil Sands Environmental Research Program
AREA_CV	Patch Size Coefficient of Variation
AREA_MD	Patch Size Median
AREA_MN	Patch Size Mean
AREA_SD	Patch Size Standard Deviation
ASRD	Alberta Sustainable Resource Development
ATV	All-terrain vehicle
AVI	Alberta Vegetation Inventory
Aw	Trembling aspen (Populus tremuloides)
AWI	Alberta Wetlands Inventory
B	Bog
BC/Al	Base cation to aluminum ratio
BC/H	Base cation to hydrogen ratio

Bs	Shallow bog
Bw	White birch (Betula papyrifera)
Ca	Calcium
$CaCO_3$	Calcium carbonate
CanSIS	Canadian Soil Information System
C	Coniferous
CA	Class Area
CAI_AM	Core Area Index Area Weighted Mean
CC	Clear cut modifier
C,C&R	Closure, Conservation and Reclamation
CEC	Cation Exchange Capacity
CEMA	Cumulative Environmental Management Association
cm	Centimetre
CNRL	Canadian Natural Resources Limited
COSEWIC	Committee on the Status of Endangered Wildlife in Canada
D	Deciduous
DCA	Detrended Correspondence Analysis
dis	Disturbed
e.g.	For example
E	Eolian
EC	Electrical Conductivity
EIA	Environmental Impact Assessment
ELC	Ecological Land Classification
ENN_MD	Euclidean Nearest Neighbour Coefficient of Variation
ENN_MN	Euclidean Nearest Neighbour Mean
EOR	Element Occurrence Record
EPEA	Alberta *Environmental Protection and Enhancement Act*
ESA	Environmentally Significant Area

ESR	Environmental Setting Report
et al.	Group of authors
F	Fluvial
Fg	Glaciofluvial
FMA	Forest Management Agreement
FMU	Forestry Management Unit
FTNN	Wooded Fens
GIS	Geographic Information System
Golder	Golder Associates Ltd.
GPS	Global Positioning System
H^+	Hydrogen
ha	Hectare
i.e.,	That is
IRP	Integrated Resource Plan
JEMA	Jackpine Expansion Mining Area
K	Potassium
keq/ha/yr	Kiloequivalent per hectares per year
KIR	Key Indicator Resource
km	Kilometre
km^2	Square kilometre
LFg/M	Glaciofluvial and glaciolacustrine over moraine
Lg	Glaciolacustrine
LRSYA	Long Run Sustained Yield Average
LSA	Local Study Area
Lt	Tamarack (Larix laricina)
m	Metre
m^3	Cubic metres
m^3/ha	Cubic metres per hectare

m^3/ha/yr	Cubic metres per hectare per year
m^3/yr	Cubic metres per year
M	Moraine
MAI	Mean Annual Increment
M1	Morainal - fine textured
M2	Morainal - coarse textured
Mg	Magnesium
N	Nitrogen
Na	Sodium
Ns	Shallow fen
n/a	Not applicable
n/d	No data collected
NO_X	Oxides of nitrogen (NO, NO_2) (gas), or all nitrogen species (e.g., NO_X, N_2O, N_3O)
NP	Number of Patches
P	Phosphorus
PAI	Potential Acid Input
Pb	Balsam Poplar (Populus balsamifera)
Pers. comm.	Personal Communication
Pj	Jack pine (Pinus banksiana)
PRMA	Pierre River Mining Area
QA/QC	Quality Assurance/Quality Control
RFMA	Registered Fur Management Areas
ROW	Rights-of-way
RSA	Regional Study Area
RUS	Resource Use Survey
S	Sulphur
SAR	Sodium adsorption ratio
SARA	*Species at Risk Act*

Sb	Black spruce (Picea mariana)
SEWG	Sustainable Ecosystems Working Group of CEMA
Shell	Shell Canada Limited
SO_X	Sulphur oxides
SONS	Shrubby Swamps
STP	South Tailings Pond
Sw	White spruce (Picea glauca)
TE	Total Edge
TEK	Traditional Ecological Knowledge
TKN	Total Kjeldahl Nitrogen
TP	Total Phosphorus
TPR	Timber Productivity Rating
TWINSPAN	Two-Way-Indicator Analyses
UTM	Universal Transverse Mercator
W4M	West of the Fourth Meridian
WONN	Lakes and open water
yr	Year

8 REFERENCES

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