Appendix 10-A

Murray River Coal Project: 2010 to 2012 Soils and Terrain Baseline Report

HD Mining International Ltd.

MURRAY RIVER COAL PROJECT
2010 to 2012 Soils and Terrain Baseline Report

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May 2013

MURRAY RIVER COAL PROJECT

2010 TO 2012 SOILS AND TERRAIN BASELINE REPORT

May 2013
Project #0791-007-40

Citation:

Rescan. 2013. *Murray River Coal Project: 2010 to 2012 Soils and Terrain Baseline Report*. Prepared for HD Mining International Ltd. by Rescan Environmental Services Ltd.: Vancouver, British Columbia.

Prepared for:

HD Mining International Ltd.

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Executive Summary

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Executive Summary

HD Mining International Ltd. (HD Mining) proposes to develop the Murray River Coal Project (the Project) as a 6 million tonne per annum (6 Mtpa) underground metallurgical coal mine. The property is located approximately 12.5 km south of Tumbler Ridge, British Columbia. The Project is located within the Peace River Coalfield (PRC), an area with a long history of metallurgical grade coal mining, mainly from open pit mining. HD Mining is proposing to access deeper zones of the coal field (600 to 1,000 m below surface) through underground mining techniques.

To support HD Mining's planning and development of the Project, and to fulfill the requirements of the environmental assessment process, environmental and socio-economic baseline studies were initiated by Rescan Environmental Services Ltd. (Rescan). Project-specific studies began in 2010 and have continued through 2012. As appropriate and available, historical data from government sources and neighbouring projects, as well as traditional use/knowledge information, have been compiled and incorporated into analysis.

This report presents a cumulative summary of all Terrain and Soils information compiled for the Project to date.

An understanding of the terrain and soils of the area is necessary in order to conduct a sound assessment of Project effects on the environment, as well as for the design and implementation of an appropriate management plan.

The main objectives of the Terrain and Soils baseline program were to:

- to map and characterize the terrain, surficial materials, and soils of the LSA;
- to identify terrain and soil features that could potentially affect the construction, operation, and decommissioning of Project facilities;
- to identify soils that may be suitable for salvage;
- to identify soils that may be sensitive to erosion; and
- to provide sufficient information for the development of the effects assessment, management and mitigation plans, and the reclamation and closure plan.

Terrain mapping was completed using PurVIEW software within ArcMap 9.3. Terrain maps were prepared at a 1:20,000 scale and included elevation data and stream networks. The final terrain attributes were adjusted according to the data collected during field inspections of terrain polygons.

Soil formation in the LSA is limited by the cold climate and in some cases by periodic deposition of new mineral material by gravity or water. Soils that developed on morainal deposits dominate the LSA. Colluvial, glaciofluvial, fluvial, and organic soils are also found throughout the LSA, but their proportion in relatively minor. In recent times, mining activity altered the characteristics of a considerable portion of the LSA, and thus, over 10% of the area is currently classified as anthropogenic terrain.

The proposed IIA is dominated by glaciofluvial deposits. Glaciofluvial veneers (20 to 70 cm thick), which dominate the upper and middle slopes, are characterized by loamy or sandy soils with a significantly lower coarse fragment content compared to glaciofluvial blankets, found on lower slopes. While most soils developed on glaciofluvial veneers are well-suited for reclamation and are relatively

easily accessible, the suitability of soils developed on blankets is highly dependent on coarse fragment content, which varies widely. Soils developed on fluvial deposits of the Murray River floodplain vary substantially in terms of texture and coarse fragment content. Sandy soils typically contain a high proportion of round or sub-rounded gravels and cobbles, which renders them unsuitable as capping material for reclamation. Finer soils, which often develop in periodically flooded areas, have much lower coarse material content and could potentially provide very good reclamation material, although metal contamination may occur. Similarly, the deep organic deposits could potentially provide a source of highly valuable reclamation material; however, it appears that due to their low landscape position, metal contamination may occur. Soils that developed on well-drained morainal deposits occur mainly in the northern section of the IIA. These are predominantly compacted silty clays containing 5 to 35% of gravels. These soils appear to resist erosion well and locally may provide a reasonably good reclamation material. The imperfectly to poorly drained morainal soils, often found on slopes associated with seepage, cover a small proportion of the IIA. Colluvial soils are expected to be of rather limited use, due to their peripheral location in the IIA and steep terrain.

The dominant mineral soils in the LSA are Orthic Regosols and Eluviated Eutric Brunisols, which are most typical of rapidly to moderately well-drained terrain. Rego Gleysols, Rego Humic Gleysols, Orthic Humic Gleysols, and Gleyed Regosols develop in imperfectly to poorly drained areas, and occasionally Cumulic Regosols develop in areas prone to flooding. Humo-Ferric Podzols and Brunisolic Gray Luvisols are rare. Organic soils that are found in very poorly drained seepage areas and depressions include Mesic Fibrisols, Typic Mesisols, and Humic Mesisols. These organic soils are very sensitive to disturbance.

Mineral soils in the LSA are slightly to very strongly acidic, have low levels of carbonates, and low organic carbon content. The metal concentrations in the top 50 cm of soil are generally low, with the exception of areas where metal accumulation is likely associated with human activity. Soil metal concentrations exceed the Canadian Soil Quality Guidelines for Protection of Environmental and Human Health (CCME 2007) at eight sites (12% of sampled sites) in the LSA. Four of these sites are located within the IIA. The common features of all the affected sites are their vicinity to industrialized areas and their low geomorphological position.

Acknowledgements

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Acknowledgements

This report was prepared for HD Mining International Ltd. by Rescan Environmental Services Ltd. The Terrain and Soils fieldwork was conducted and the report was written by Rescan scientist Dr. Tomasz Gradowski (P.Ag., R.P.Bio.). Don McQueen (P.Ag., B.Sc.) classified soils to mapping units. The work was managed by Jason Rempel (B.Sc., P.Geo.) and directed by Clem Pelletier (B.Sc.).

Table of Contents

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MURRAY RIVER COAL PROJECT
2010 TO 2012 SOILS AND TERRAIN BASELINE REPORT

Table of Contents

List of Figures

FIGURE **PAGE**

List of Tables

List of Plates

List of Appendices

Glossary

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Glossary

Terminology used in this document is defined where it is first used. The following list will assist readers who may choose to review only portions of the document.

Anion	An atom or molecule with a negative charge (contains more electrons than protons).
Calcareous	Refers to soils that contain calcium carbonate, often with magnesium carbonate.
Calcareous soil / horizon	A soil containing enough calcium (and/or magnesium) carbonate to visibly effervesce (fizz) when treated with 10% hydrochloric acid.
Calcite	The most stable mineral form of calcium carbonate.
Cation	An atom or molecule with a positive charge (contains more protons than electrons).
Edaphic	Features relating to soil, especially as the soil affects living organisms. Edaphic characteristics include factors such as moisture, acidity, aeration, and the availability of nutrients, rather than climatic factors.
Eluviation	The transportation of soil particles and minerals in a lateral or downward direction from the upper horizons of soil.
Fluvial	Refers to sediments deposited by streams or flowing water; it does not refer to deposition by waves or mass wasting processes such as mudflows.
Glaciofluvial	Deposits and landforms created by glacial rivers and streams.
Gleyed soil / horizon	A soil having one or more neutral grey horizons as a result of anoxic conditions associated with saturation. The term “gleyed” also designates gray horizons and horizons having sufficient yellow and grey mottles as a result of intermittent saturation.
Humus	The decomposition product of organic debris formed from plant and animal litter laid down at the surface and incorporated into soil mineral surficial horizons by soil organisms in the humification process.
Illuviation	Deposition of particles from one soil horizon to another, usually from an upper to a lower horizon, resulting in accumulations of clays, metals, and organic matter.
Lacustrine	Related to lakes; in soils, refers to deposits associated with lake level fluctuations, e.g., benches or terraces that mark former shorelines, or materials exposed by an uplifting of the land.
Loam	Soil composed of a well graded mixture of sand, silt, clay, and organic matter.
Moraine	An accumulation of earth, generally with stones, carried and deposited by glaciers.

Mud	A liquid or semi-liquid mixture of water and some combination of silt and clay.
Mudstone	A fine grained (grain diameter is < 0.0625 mm) sedimentary rock the original constituents of which were clays or muds.
Munsell colour system	A fine grained (grain diameter is < 0.0625 mm) sedimentary rock the original constituents of which were clays or muds.
Parent Material	The rock or deposit material that forms a soil.
Reclamation	A process of converting disturbed land into useful landscapes that meet a variety of goals (typically, creating productive ecosystems). It includes material placement and stabilization, capping with soil/overburden, re-grading, placing cover soils, re-vegetation, and maintenance.
Rhizosphere	The layer of soil that is immediately adjacent to and affected by plant roots, where plants, soil, microorganisms, nutrients and water interact.
Shale	A fine-grained, clastic sedimentary rock that originates from mud. It is a mix of clay and tiny fragments of other minerals, especially quartz and calcite. Unlike Mudstone, Shale is characterized by parallel fissures less than one centimeter in thickness, which results in flaky appearance of the mineral.
Soil reaction	An indicator of soil acidity or alkalinity measured on the pH scale. It affects the availability of nutrients and the reactivity of various substances in the soil.
Soil salvage	Conservation of topsoil by stripping it off the surface when the site is first disturbed (e.g., before excavation of overburden). Salvaged soils are either stockpiled for future use or they are immediately used for covering reclaimed surfaces in a different location.
Terrain Resource Inventory Mapping (TRIM)	TRIM is a digital dataset of geographic base mapping completed for the Province of BC in 1996 at a scale of 1:20,000. The dataset includes elevation data and stream networks.
Till (morainal material)	A heterogeneous and poorly sorted mixture of silt, sand, clay, and rock deposited by a glacier. Since till is the main component of glacial moraines, it is usually referred to as morainal material.

Acronyms and Abbreviations

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Acronyms and Abbreviations

AAFC	Agriculture and Agri-Food Canada
ALS	ALS Environmental
BAFA	Boreal Altai Fescue Alpine
BC	British Columbia
BC MELP	British Columbia Ministry of Environment, Lands, and Parks
BC MOF	British Columbia Ministry of Forests
BEC	Biogeoclimatic Ecosystem Classification
C	Carbon
Ca	Calcium
CCME	Canadian Council of Ministries of the Environment (Federal)
CCME-A	CCME (Canadian Soil Quality Guidelines for Protection of Environmental and Human Health), Agricultural Limits
CCME-I	CCME (Canadian Soil Quality Guidelines for Protection of Environmental and Human Health), Industrial Limits
CMA	Coastal Mountain-heather Alpine
CSR	Contaminated Sites Regulation (BC Reg. 375/96)
CSR-I	Contaminated Sites Regulation (BC Reg. 375/96), Industrial Criteria
CSR-L	Contaminated Sites Regulation (BC Reg. 375/96), Livestock Criteria
EA	Environmental Assessment
ha	Hectare
HD Mining	HD Mining International Ltd.
IIA	Infrastructure Investigation Area
m asl	Metres above sea level
Mg	Magnesium
N	Nitrogen
Na	Sodium
P	Phosphorus
SMU	Soil mapping unit
SMU-A	Anthropogenic soil mapping unit
SMU-C	Colluvial soil mapping unit
SMU-F	Fluvial soil mapping unit
SMU-GF	Glaciofluvial soil mapping unit

SMU-M	Morainal soil mapping unit
SMU-O	Organic soil mapping unit
TRIM	Terrain Resource Inventory Mapping
UTM	Universal Transverse Mercator

1. Introduction

1. Introduction

HD Mining International Ltd. (HD Mining) proposes to develop the Murray River Coal Project (the Project) as a 6 million tonne per annum (6 Mtpa) underground metallurgical coal mine. The property is located approximately 12.5 km south of Tumbler Ridge, British Columbia (Figure 1-1), and consists of 57 coal licences covering an area of 16,024 hectares. The Project is located within the Peace River Coalfield (PRC), an area with a long history of metallurgical grade coal mining, mainly from open pit mining. HD Mining is proposing to access deeper zones of the coal field (600 to 1,000 m below surface) through underground mining techniques.

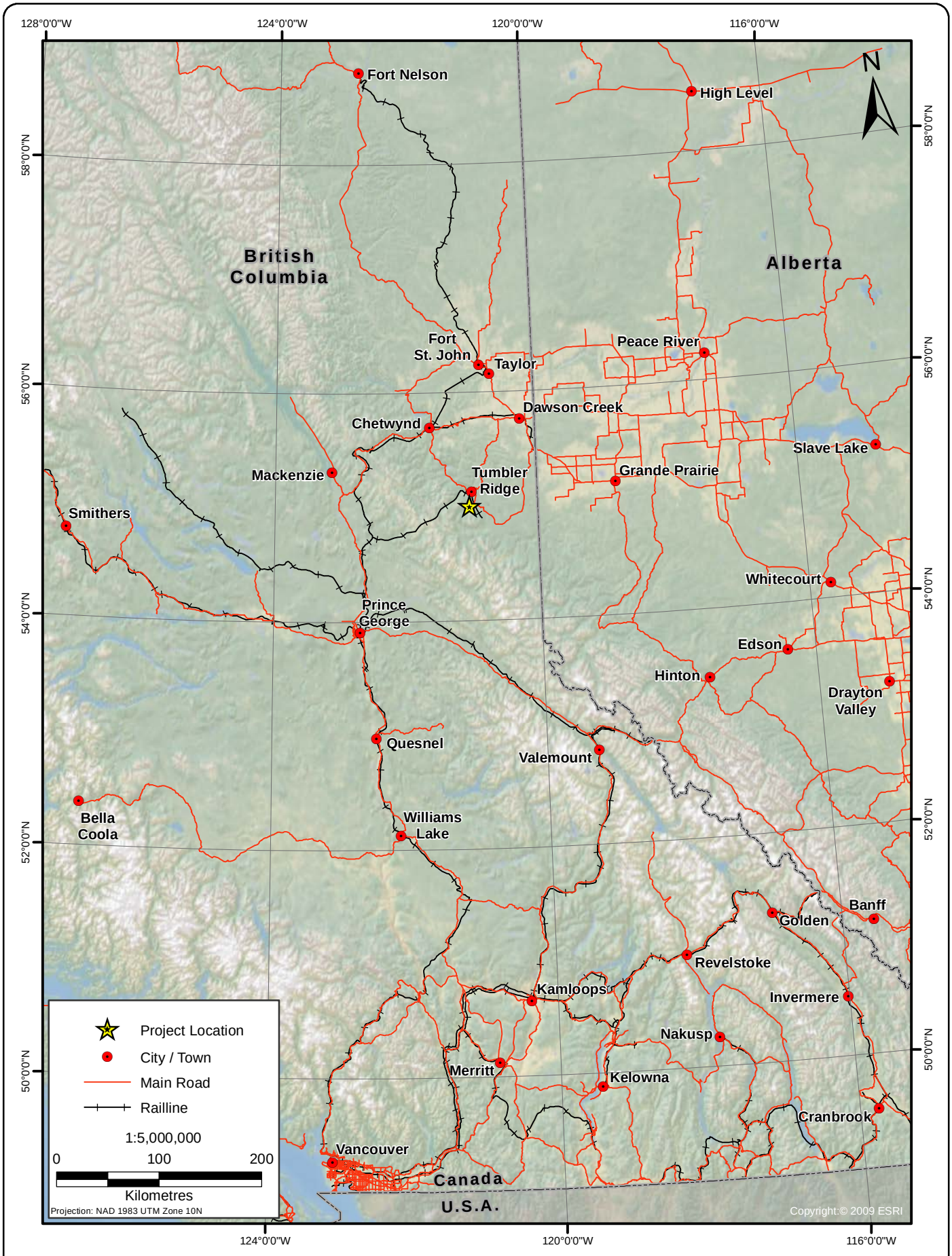
In October 2011, HD Mining submitted an application to the BC Ministry of Energy and Mines and Ministry of Environment seeking permission to complete a bulk sampling program as part of exploration of the property. In March 2012, HD Mining received approval to conduct a 100,000 tonne bulk sample for the purpose of conducting testing to assist in developing markets for the coal.

Beyond the bulk sample program, in order to develop a full mine at the proposed 6 Mtpa, the Project is subject to both the BC and Canadian environmental assessment processes. Development of any infrastructure for the full mine is not permitted before the requirements of these processes are met.

To support HD Mining's planning and development of the Project, and to contribute to the environmental assessment process, environmental and socio-economic baseline studies were initiated by Rescan Environmental Services Ltd. (Rescan). Project-specific studies began in 2010 and have continued through 2012. As appropriate and available, historical data from government sources and neighbouring projects, as well as traditional use/knowledge information, have been compiled and incorporated into analysis.

In order to help guide the scope of baseline studies, regional and local study areas (RSA and LSA, respectively) have been developed (Figures 1-2 and 1-3). The RSA is intended to encompass an area beyond which effects of the Project would not be expected. It is also intended to be ecologically relevant based on the home range of key wildlife species known to inhabit the region. The LSA encompasses an area surrounding the proposed Project infrastructure within which direct effects from the Project may be anticipated. Its boundary has also been developed following natural terrain and drainage boundaries in order to be ecologically relevant. For consistency, the same RSA and LSA are used for all environmental studies.

This report presents a cumulative summary of all Terrain and Soils information compiled for the Project to date. The goal of the Project's Terrain and Soils Baseline Program is to document current conditions and provide a means of determining and assessing future changes in terrain morphology, soil quantity, and soil quality related to the proposed development. The Terrain and Soils Baseline Program is also an integral component of the Terrestrial Ecosystem Mapping Program. An understanding of the terrain and soils of the area is necessary in order to conduct a sound assessment of Project effects on the environment, as well as for the design and implementation of an appropriate management plan.



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Project Location

Figure 1-1

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PROJECT # 0194106 GIS # MUR-15-058 VERSION # T0.10 April 10 2013

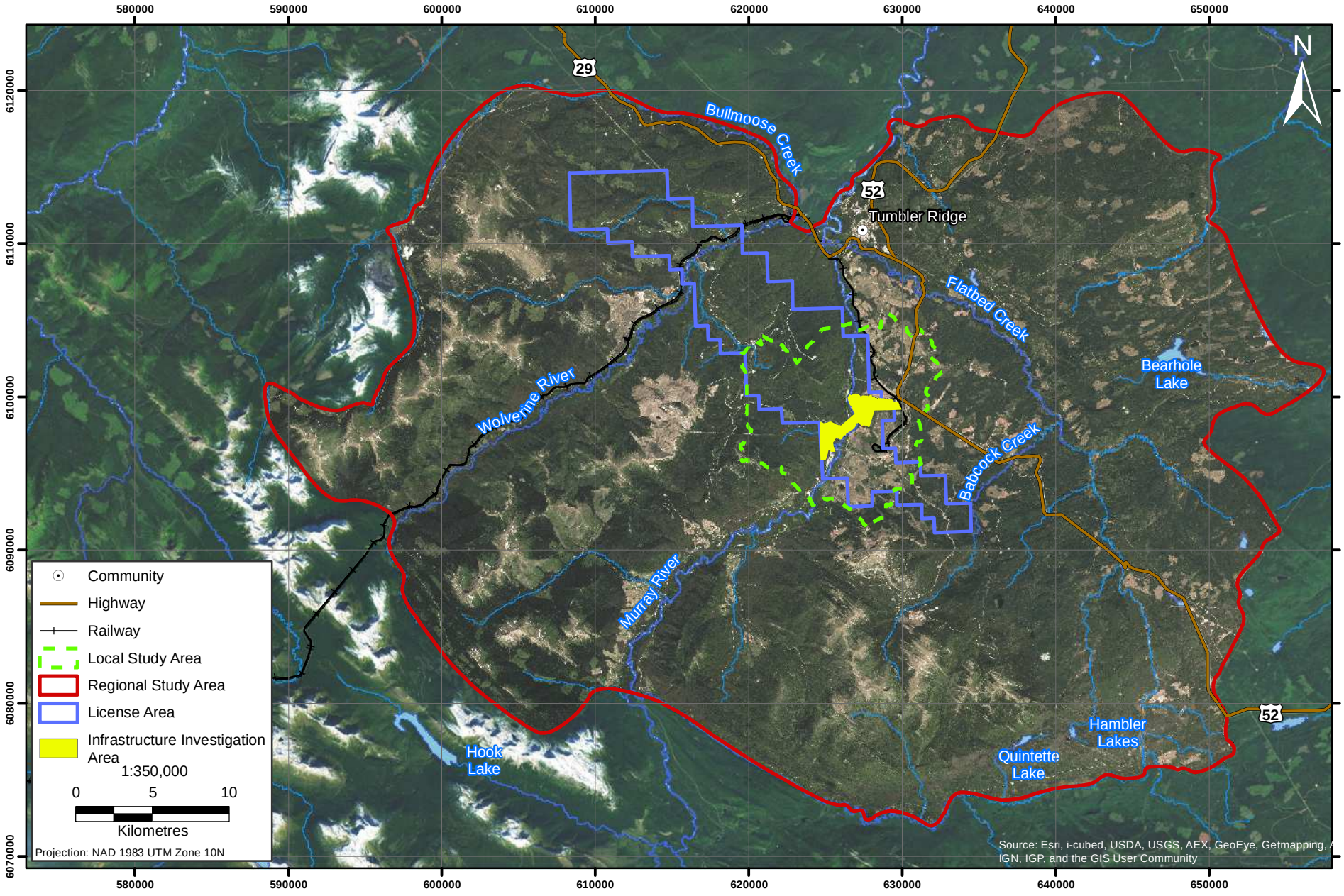

Figure 1-2

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MURRAY RIVER COAL PROJECT

Project Study Boundaries

Figure 1-2

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The main objectives of the Terrain and Soils baseline program were to:

- map and characterize the terrain, surficial materials, and soils of the LSA;
- identify terrain and soil features that could potentially affect the construction, operation, and decommissioning of Project facilities;
- identify soils that may be suitable for salvage;
- identify soils that may be sensitive to disturbances; and
- provide sufficient information to carry out effects assessment, develop the management and mitigation plans, and the reclamation and closure plan.

Data obtained from the program can also be used to support studies conducted by other disciplines.

The following chapters outline the available background information that supports the study (Chapter 2); describe the methods and rationale used to identify sites and collect Project-specific data (Chapter 3); discuss the results of data collection (Chapter 4); and provide a summary that synthesizes the key findings of the baseline program (Chapter 5).

PROJECT # 0791-007-01 *GIS #* MUR-15-071 *VERSION #* T0.10 February 18 2013

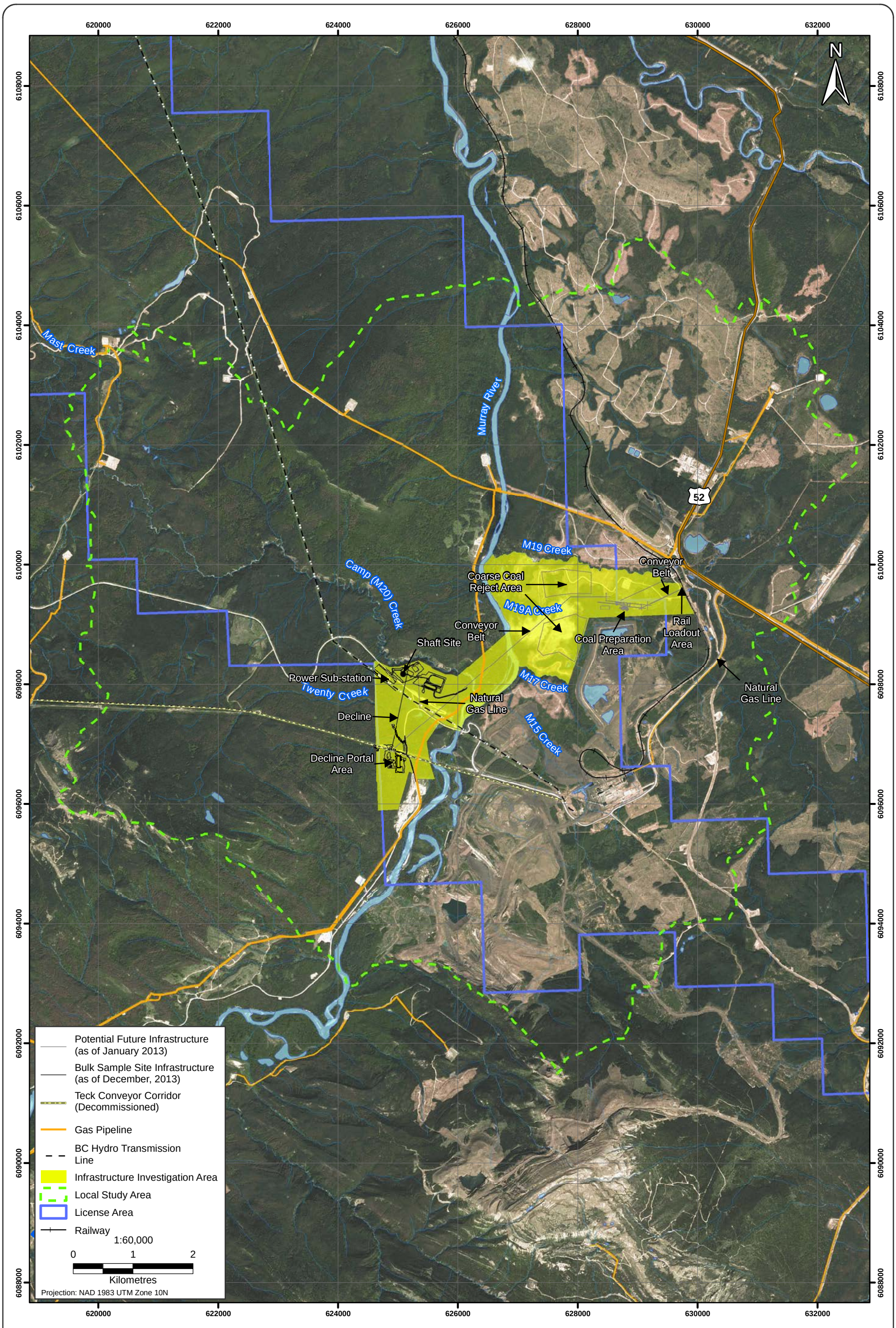

Figure 1-3

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Preliminary Site Layout

Figure 1-3

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2. Background

2. Background

2.1 APPLICABLE STANDARDS

The Fisheries Act (1985) provides the legal requirements designed to protect fish habitat and private property from flooding and potential loss of land due to stream erosion and instability. *The Fisheries Act* regulates access to the Fisheries Sensitive Zones. It also establishes rules guiding development within Fisheries Sensitive Zones and watercourses (Section 35). Section 36 of the *Fisheries Act* establishes erosion control guidelines related to land development activities, such as clearing land, grading slopes, road building, and excavation and stockpiling of soil materials. The Terrain and Soil Baseline Program identified terrain and soil features (e.g., texture and erodibility) that will help manage soil erosion during Project construction, operation, and decommissioning.

In addition to the federal *Fisheries Act*, the provincial *Fish Protection Act* (1997) and associated amendments to the provincial *Water Act* (1996) regulate provincial approvals of alterations and work in and around streams. The regulation focuses on the protection of riparian areas and waterways into which harmful debris (clay, silt, sand, rock, or any material, natural or otherwise) may potentially be introduced. Examples of industries affected by the regulation include resource extraction and land development. Terrain and soil information gathered during the baseline program can be used to design and guide Project development activities in vicinity of streams and rivers and to assess future changes in terrain associated with the Project development.

The *Canadian Environmental Protection Act* (1999) regulates the release of toxic substances into the environment, which includes potential contamination of soil by mining activities (Section 9). Similarly, the provincial *Environmental Management Act* (2003) provides procedural requirements for planning release of polluting substances to the environment, reporting spills, or conducting remediation of contaminated sites. Since coal mining can be potentially associated with contamination of soils with metals, one of the objectives of Terrain and Soil Baseline Program was to measure the baseline levels of metals within and outside of the LSA and to provide a means of assessing future changes in soil quality related to the proposed development.

The BC *Forest and Range Practices Act* (2002b) and its regulations govern the activities of forest and range licensees in BC. Since one of the objectives of the Forest Planning and Practices Regulation (BC Reg 14/2004) is "to conserve the productivity and the hydrologic function of soils," the *Act* sets the requirements for road building, logging, and regeneration of forested areas. Terrain and Soil Baseline Program provides detailed information about soil morphology, productivity, and current geomorphological conditions found in the LSA.

Under the provisions of the BC *Mines Act* (1996), applications for a mine permit should include a reclamation feasibility assessment and an outline of the proposed studies that will be undertaken in order to develop the reclamation program. The objectives of Terrain and Soil Baseline Program included gathering information about the physical, chemical and ecological characteristics of local soils, and the assessment of suitability of LSA soils for salvage and reclamation.

2.2 REGIONAL SETTING

2.2.1 Study Area

The Murray River property lies within the Municipal District of Tumbler Ridge, which is part of the Peace River Regional District in northeastern BC. Baseline studies were conducted within the regional and local study areas (RSA and LSA, respectively). For consistency, the same RSA and LSA were used for all environmental studies. While the RSA is intended to be ecologically relevant in relation to the home ranges of key wildlife species known to inhabit the region, the LSA outline follows natural terrain and drainage boundaries surrounding the proposed Project infrastructure, within which direct effects from the Project may be anticipated (Figure 1-2).

2.2.2 Climate Data

Climate data was derived from the closest Environment Canada climate station located at Chetwynd. During the winter (December to February) the mean daily temperatures in the LSA range between -14 and -1˚C. January is typically the coldest month, with an average temperature of-11.1˚C. During the summer (June to August), the mean daily temperatures range between 7 and 22˚C. July is typically the warmest month with an average temperature of 14.8˚C. Precipitation averages between 450 and 550 mm per year, and is generally evenly distributed throughout the year. The majority of precipitation between November and April occurs as snow, and average snow depth ranges between 12 and 25 cm (Environment Canada 2011). Short summer rainstorms generate high intensity rainfall events. Consequently, the annual stream discharge record is dominated by spring snowmelt, with secondary high-flows resulting from summer rainstorms.

2.2.3 Geology

The LSA is located in the eastern foothills (Inner Foothills Belt) of the Rocky Mountains in the Interior Platform Geological Province, near the eastern limits of the Cordilleran Orogen Geological Province. The bedrock is mostly composed of Mesozoic (65 to 225 million years old) sedimentary rock, such as shale and mudstone (Natural Resources Canada 2009a). Both types of rock weather rapidly and are easily eroded. Bedrock layers differ in resistance to erosion, which creates “plateau and escarpment” topography (Valentine et al. 1978). Valleys erode along belts of softer rock and are generally wide. The structural grain of the local bedrock results in elongated ridges oriented in the northwesterly direction (Holland 1976).

2.2.4 Surficial Geology

Periodic changes in the global climate of the Quaternary period (about 2 million to 8.5 thousand years ago) induced four major glaciations. Glacial erosion of bedrock produced rounded summits and ridge crests locally. Both erosion and deposition of eroded material formed undulating and rolling terrain in lower elevations (Valentine et al. 1978). The vast majority of the sedimentary bedrock in the LSA is covered by morainal deposits (Natural Resources Canada 2009b). Morainal material (often referred to as glacial till), deposited directly from the melting glacier, is a compact, unsorted, and non-stratified mineral material that contains a variable mixture of particle sizes. In this region, till typically covers level to moderately sloping surfaces located between colluvial slopes and areas affected by recent fluvial activity at the valley floor (Valentine et al. 1978).

Glacier retreat was associated with landslides and intense activity of streams and rivers, which resulted in significant redistribution of mineral material. Glaciofluvial materials, deposited by ice melt-water, are generally coarse, porous, and permeable. They form kames, terraces, or gravel plains at lower terrain elevations (Valentine et al. 1978). All these geomorphologic forms are widely represented in the LSA.

Post-glacier colluvial and fluvial deposits are also common in the LSA. Colluvial deposits are unconsolidated materials originating from the mass wastage of the original material. Consequently, their texture varies according to their source. Fluvial deposits are transported and deposited by existing streams and rivers. They consist of gravel, sand, silt, or clay and are generally well-sorted (Valentine et al. 1978).

2.2.5 Soil Development

Soil development is influenced by the interaction of local climate, hydrology, and characteristics of surficial deposits (parent material), from which they originate.

Climate influences soil formation because it affects soil activity, structure, root development, and vegetation abundance. The LSA is situated in the Cold Cryoboreal soil temperature class (Valentine et al. 1978). The soils in this class are characterized by mean annual temperature of 2 to 8˚C and a 120 to 180 day-long growing season (> 5˚C). Long winters and low soil temperatures restrict the rates of many processes that promote soil development.

Soil moisture classification is based on the availability of water in the rhizosphere (root zone) during the growing season. The LSA is situated in the unsaturated-humid soil moisture class, characterized by slight water deficit, which generally does not restrict soil development (Valentine et al. 1978).

In the LSA, upland soils developed predominantly on loamy morainal material (till), sandy glaciofluvial deposits, variable (but mostly sandy) colluvial material, and coarse to medium-textured fluvial sediments. Chemical characteristics of till usually reflect the chemistry of the rocks from which it originated. Depending on drainage conditions, Brunisols, Podzols, or Gleysols have formed on veneers (or blankets) of morainal till overlaying shale bedrock in the LSA (Natural Resources Canada 2009b). Glaciofluvial and colluvial deposits tend to be permeable, due to their generally coarse texture, and typically give rise to well-drained Brunisols. Fluvial deposits can be also coarse; however, due to their typical location at the bottom of valleys, they are often imperfectly or poorly drained. Consequently, Gleysols frequently develop on fluvial parent materials. In poorly drained areas, vegetation is often dominated by peatlands. The accumulation of organic matter in these ecosystems exceeds decomposition, which leads to the development of organic soils. Where the soils are saturated for only part of the year, organic soils typically grade into mineral Gleysols with only a thin organic veneer on top.

2.3 LITERATURE REVIEW – HISTORICAL BACKGROUND

The Murray River Project's License area is located within the Peace River Coalfield, known for producing metallurgical grade (hard coking) coal. In the 1950s and 1960s 15 significant coal deposits were discovered in this region. As coal prices rose after the 1973 Organization of Arab Petroleum Exporting Countries oil crisis, the Government of Canada examined the viability of accessing and transporting coal to the shore. In 1981 the governments of British Columbia and Canada, two Canadian mining companies, and a consortium of Japanese steel mills signed an agreement to develop the mining industry in the area. A new town (Tumbler Ridge), two coal mines (Quintette and Bullmoose), two highways (52 and 29) connecting the town with Highway 97, a power line from the W.A.C. Bennett Dam, and a rail line through the Rocky Mountains were built as a result of this agreement. Quintette mine and the Bullmoose mine started production in 1982. The Quintette mine was closed in August 2000. Oil and natural gas exploration and development are also active in the region, with gas wells and gas pipelines located within the LSA (Norwest Corporation 2010).

3. Methodology

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3. Methodology

3.1 REVIEW OF EXISTING INFORMATION

The initial stages of the Terrain and Soils Baseline Program involved a thorough review of climatic data, regional maps, scientific papers, and professional reports describing environmental conditions in the region. It provided general information about the local climate, geology, topography, and soil landscapes of the Project area. This information guided field program methodology development and allowed for the interpretation of field data in a local and regional context.

3.2 TERRAIN AND SOILS MAPPING

3.2.1 Terrain Mapping

Terrain mapping is the basis for the surficial material mapping for the LSA. Mapping was completed using PurVIEW software within ArcMap 9.3. PurVIEW enables users to view stereo pairs of digital air photos in three dimensions at variable scales. A digital elevation model, created from the provincial Terrain Resource Inventory Mapping (TRIM) data, was used to provide a control on the vertical plane (z-axis) to enable on-screen digitizing of polygons that are photogrammetricly accurate (Government of British Columbia 2011). Terrain polygons were delineated based upon observable characteristics such as surficial material, texture, surface expression, and geomorphological processes. Attributes were described using BC's Terrain System Classification (Howes and Kenk 1997) and recorded in a database linked to the ArcGIS terrain shape file. The terrain maps were prepared at a 1:20,000 scale on a 20-m contour TRIM base. TRIM is a digital dataset of geographic base mapping completed for the Province of BC in 1996. The dataset includes elevation data and stream networks. The final terrain attributes were adjusted according to the data collected during field inspections of terrain polygons (Section 3.2.3).

3.2.2 Slope Analysis

A slope gradient map was developed as part of the terrain assessment. The map was produced at a scale of 1:12,500 using digital information available from the provincial TRIM database (Government of British Columbia 2011). A geographic information system method using the Spatial Analyst extension in ArcGIS was used to generate a percent slope raster data set. This was based on the digital elevation model using a 20-m grid spacing for the TRIM-sourced data.

Slope classes were based on the Terrain Classification System for British Columbia (Howes and Kenk 1997). These classes were slightly modified to provide a better differentiation of relatively complex local slope conditions. In particular, the Howes and Kenk's (1997) "gentle" slope class, representing slopes between 5% and 26%, was divided into two classes: gentle (5% to 15%) and moderately gentle (15% to 26%). Slope classes were defined in Table 3.2-1.

Table 3.2-1. Slope Classification Used in the LSA

Slope Class		
Class 1	0% to 5%	level to very gently sloping
Class 2	6% to 15%	gently sloping
Class 3	16% to 26%	moderately gently sloping
Class 4	27% to 50%	moderately sloping
Class 5	51% to 70%	moderately steeply sloping
Class 6	> 70%	steeply sloping

3.2.3 Field Survey

The Terrain and Soils Field Program was carried out in the years 2010, 2011, and 2012 (between July and September). The field programs were typically carried out in conjunction with the Terrestrial Ecosystem Mapping field program by crews consisting of a soil scientist, a vegetation ecologist, and an assistant. One field program was focused on closure and reclamation planning and was carried by a soil scientist and an assistant. A total of 186 sites were surveyed during field inspections. The soil survey locations (inspection sites) are distributed throughout the LSA, with a special focus on areas located near the proposed Project facilities.

The field data were collected following the guidelines established in the *Field Manual for Describing Terrestrial Ecosystems* (BC MELP and BC MOF 1998). Detailed ground inspection forms were used for field data collection. Soil pits were excavated with a shovel and hand auger to a depth of approximately 100 cm or to the unaltered parent material. The following information was collected:

- location (UTM coordinates);
- terrain texture;
- surficial material;
- surface expression;
- geomorphic process;
- slope (gradient, aspect, and elevation);
- coarse fragment content;
- soil texture;
- soil drainage;
- soil color (Munsell);
- rooting depth;
- soil horizon designation and depth;
- water table depth; and
- soil classification.

The soils were classified according to the Canadian System of Soil Classification (Soil Classification Working Group 1998).

3.2.4 Soil Sampling and Analysis

Soil samples were collected from locations distributed throughout the LSA. During the 2010 field program 69 soil samples were collected 23 sites from three depths: 0 to 10 cm, 10 to 20 cm, and 30 to 50 cm. Additional sampling (one composite sample per site from the entire recommended soil salvage depth) was carried out at 28 sites during the field assessment of soil suitability for reclamation carried out in 2011 and 2012. Samples were placed in clean, plastic, labelled bags and submitted to ALS Environmental (ALS), Vancouver, BC, for laboratory analysis.

All samples were analyzed for soil reaction (pH), total organic carbon content and concentration of metals (listed in Table 3.2-2) according to standard procedures described in Appendix 5.

Table 3.2-2. List of Analyzed Metals

Metal	Symbol	Metal	Symbol
Aluminum	Al	Manganese	Mn
Antimony	Sb	Mercury	Hg
Arsenic	As	Molybdenum	Mo
Barium	Ba	Nickel	Ni
Beryllium	Be	Phosphorus	P
Bismuth	Bi	Potassium	K
Cadmium	Cd	Selenium	Se
Calcium	Ca	Silver	Ag
Chromium	Cr	Sodium	Na
Cobalt	Co	Strontium	Sr
Copper	Cu	Thallium	Tl
Iron	Fe	Tin	Sn
Lead	Pb	Titanium	Ti
Lithium	Li	Vanadium	V
Magnesium	Mg	Zinc	Zn

3.2.5 Soil Reaction and Organic Carbon

Soil reaction and organic carbon content were determined to help assess soil fertility and to guide soil salvage and reclamation planning.

3.2.6 Metals

Baseline soil analyses included testing for concentrations of 29 metals to determine the naturally occurring levels (i.e., background or baseline) of metals in the soils. The analyses were carried out using procedures from the CSR Analytical Method: "Strong Acid Leachable Metals (SALM) in Soil", BC Ministry of Environment, 26 June 2009, and procedures adapted from the EPA Method 200.2. This method is not a total digestion technique. It is a very strong acid digestion that is intended to dissolve those metals that may be environmentally available. By design, elements bound in silicate structures are not normally dissolved by this procedure as they are not usually mobile in the environment. Thus, the analytical method approximates metal environmental availability.

Baseline values provide a benchmark to gauge potential changes in soil chemistry during the Project life. The interpretation of baseline data included comparing analytical results to the industrial guidelines, provided for 19 of the metals by the Canadian Council of Ministers of the Environment (CCME 2007) and by the BC Contaminated Sites Regulation (BC CSR 2011).

3.2.7 Soil Mapping

Soils maps for the LSA were developed at a scale of 1:20,000. The maps will serve for future soil management planning. Texture, coarse fragments content, and soil drainage are considered critical parameters that determine the general behaviour of soils and their management. The information about these soil parameters was derived from the terrain maps verified by the field data collected at the inspection locations. These parameters were later used to classify soils into Soil Mapping Units (SMUs). Some materials found in the LSA did not fit the standard definition of soil, such as areas covered by bedrock, weathered bedrock and recent fluvial deposits.

4. Results

4. Results

4.1 INTRODUCTION

This chapter describes the analyses of data collected during the Terrain and Soils Field Program. The field program was conducted during three summer seasons between the years 2010 and 2012. This report is accompanied by five appendices containing maps, data summary tables, and methodologies.

4.2 TOPOGRAPHY

4.2.1 Landforms

The LSA is located in the eastern foothills of the Rocky Mountains. Topography consists of hills and low mountains accented by elongated ridges, characteristically oriented in the northwesterly direction. Valleys eroded along broad belts of soft rock and are generally wide; however, their bottoms and slopes are often deeply incised by rivers and streams (Plate 4.2-1). In general, smooth landscapes predominate in the LSA. Plains and gentle slopes cover approximately 60% of the land. Undulating landscapes, defined as a sequence of smooth, non-linear rises and hollows, occur over approximately 25% of the LSA. Rolling topography (similarly smooth, but linear sequences of elongated rises and valleys that repeat in a wave-like pattern across the landscape) compose 5% of the surveyed area. Only about 10% of the LSA consists of irregularly shaped, steeper landscapes such as ridges and hummocks.

Plate 4.2-1. The LSA topography consisting of hills and low mountains separated by broad valleys; long slopes are often deeply incised by streams.

4.2.2 Slope Analysis

While the mean slope values for terrain polygons range between 0% and 60%, the average slope in the LSA is 15.5%. The maximum difference in elevation between the highest (1,380 m asl) and the lowest (760 m asl) terrain positions is 620 m.

The LSA has been divided into six slope classes (Table 4.2-1). Approximately 22% of the LSA has been classified as level to very gentle slope (Class 1). Gentle slopes (Class 2) are the most common, representing 38% of the LSA, followed by the moderately gentle slopes (Class 3), representing another 22%. Consequently, the terrain generally considered accessible by heavy machinery (slopes below 26%) represents approximately 82% of the LSA. Moderate slopes (Class 4: 27% to 50%) have been recorded over approximately 15% of the LSA, while slopes exceeding 50% (Classes 5 and 6) have been found over only 3% of the LSA. Detailed slope information is provided in the Slope Map of the LSA (Appendix 1).

Table 4.2-1. Areal Extent of Slope Classes in the Local Study Area

Slope Class		Area (ha)	Proportion of LSA (%)
Class 1	0% to 5% - level to very gently sloping	2692.0	22.3
Class 2	6% to 15% - gently sloping	4543.7	37.6
Class 3	16% to 26% - moderately gently sloping	2671.1	22.1
Class 4	27% to 50% - moderately sloping	1824.8	15.1
Class 5	51% to 70% - moderately steeply sloping	282.6	2.3
Class 6	> 70% - steeply sloping	78.4	0.6
Total		**12092.6**	**100.0**

4.3 DETAILED TERRAIN AND SOILS MAPPING

4.3.1 Surficial Materials

The geomorphology of the LSA has been significantly influenced by glaciation. As indicated on the appended terrain maps (Appendix 2), morainal surficial materials dominate the LSA (Figure 4.3-1 and Table 4.3-1). Morainal till generally consists of well-compacted, non-stratified material composed of a mixture of sand, silt, and clay, and it contains a heterogeneous mixture of sub-rounded to angular coarse fragments of different sizes. More than half of the surficial materials (6,647 ha) are of the morainal origin.

Table 4.3-1. Surficial Material Distribution in the Local Study Area

Surficial Materials	Area (ha)	Proportion of LSA (%)
Anthropogenic	1252.5	10.4
Colluvial	1382.7	11.4
Fluvial	814.8	6.7
Glaciofluvial	1173.9	9.7
Morainal	6647.3	55.0
Organic	484.0	4.0
Bedrock	143.4	1.2
Water	194.2	1.6
Total LSA	**12092.7**	**100.0**

Glaciofluvial materials (recorded over 10% of the LSA) have been deposited as blankets or veneers on the slopes on both sides of the Murray River valley. They mainly consist of sandy and silty materials with a considerable component of rounded or sub-rounded coarse fragments and often display evidence of stratification.

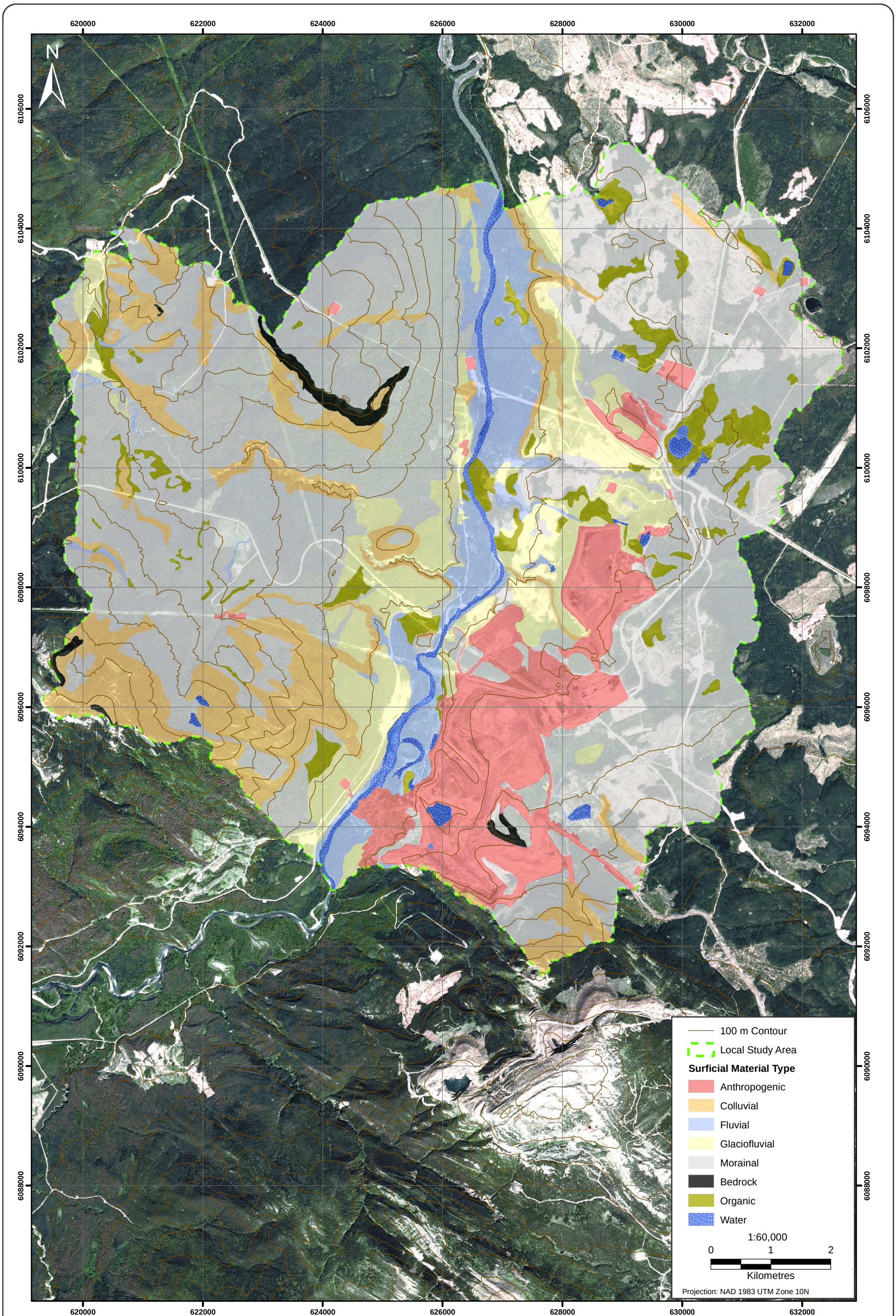

Figure 4.31

MURRAY RIVER COAL PROJECT

Distribution of Surficial Material Types in the Local Study Area

Figure 4.3-1

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Fluvial deposits dominate the relatively flat areas located at the bottom of the Murray River valley. These sediments generally contain a high proportion of gravel and sand; however, in the areas where, despite a short period of intense activity in the spring, streams are generally narrow and slow, fluvial materials contain a significant fraction of silt and clay. Fluvial deposits are generally well-sorted and display stratification. The gravels and cobbles are rounded. About 7% of the LSA consists of fluvial deposits.

Colluvial materials are the products of mass-wasting typically occurring on moderate to steep slopes. They are generally poorly sorted and contain a wide range of particle sizes. In the LSA, colluvial materials are commonly derived from unconsolidated Quaternary deposits. About 11% of the LSA has been mapped as colluvial terrain.

Organic materials are not common, occurring in less than 4% of the LSA. They result from accumulation of very slowly decomposing vegetation, typically in the wet lowlands and in areas of intense seepage. In the LSA organic deposits typically occur in the form of poorly or moderately decomposed peat layers more than 40 cm thick.

Due to considerable mining activity in the region, a relatively large proportion of the LSA represents the terrain that has been modified by people. Anthropogenic materials typically associated with mineral exploitation and waste rock disposal represent a wide range of physical properties (e.g., morphological form, structure, and texture) and cover over 10% of the LSA.

A consistent depositional sequence is commonly observed throughout the LSA, with glaciofluvial deposits overlying a mantle of morainal till, which in turn rests on the soft shale of mudstone rock (Plate 4.3-1).

Plate 4.3-1. The typical sequence of surficial materials in the LSA: glaciofluvial veneers overlie the morainal mantle, which rests over the shale rock.

4.3.2 Soil Mapping Units

The soil characteristics and stage of development is dependent on the topographic features of the terrain (e.g., slope, aspect), surficial materials, and other factors, such as, elevation, site drainage, and vegetative cover. In general, soil development is limited on top of rocky ridges, where soil

formation processes are limited by climatic conditions. Steep slopes also limit soil development through active mass wastage and limited water movement through the soil profile, which in turn limits the translocation of fines, nutrients, and organics into subsurface layers. Alternatively, soils tend to develop faster on the moist plains and on gentle slopes. The LSA has been divided into nine soil mapping units based on several factors, such as parent surficial material, texture, and drainage (Appendix 3). The area extent of the mapping units and the proportion of the LSA they occupy are presented in Table 4.3-2.

Table 4.3-2. Distribution of Soil Mapping Units in the Local Study Area

Soil Mapping Units	Area (ha)	Proportion of LSA (%)
SMU-A - Anthropogenic	1252.5	10.4
SMU-C - Colluvial	1382.7	11.4
SMU-F - Fluvial	814.8	6.7
SMU-GF1 - Glaciofluvial-1	565.8	4.7
SMU-GF2 - Glaciofluvial-2	608.1	5.0
SMU-M1 - Morainal-1	5918.6	49
SMU-M2 - Morainal-2	728.7	6.0
SMU-O - Organic	484.0	4.0
SMU-R - Bedrock	143.4	1.2
Water	194.2	1.6
Total LSA Area	**12092.7**	**100.0**

4.3.2.1 Anthropogenic Soil Mapping Units

A considerable proportion of the LSA has been modified by mining activity (Plate 4.3-2). Anthropogenic materials associated with excavation sites, tailing facilities, and waste rock disposal areas cover over 10% of the LSA (Figure 4.3-2). A significant portion of the terrain classified as anthropogenic is still actively modified.

Plate 4.3-2. The SMU-A is characterized by shallow soil depth and a combination of level and moderately sloping terrain.

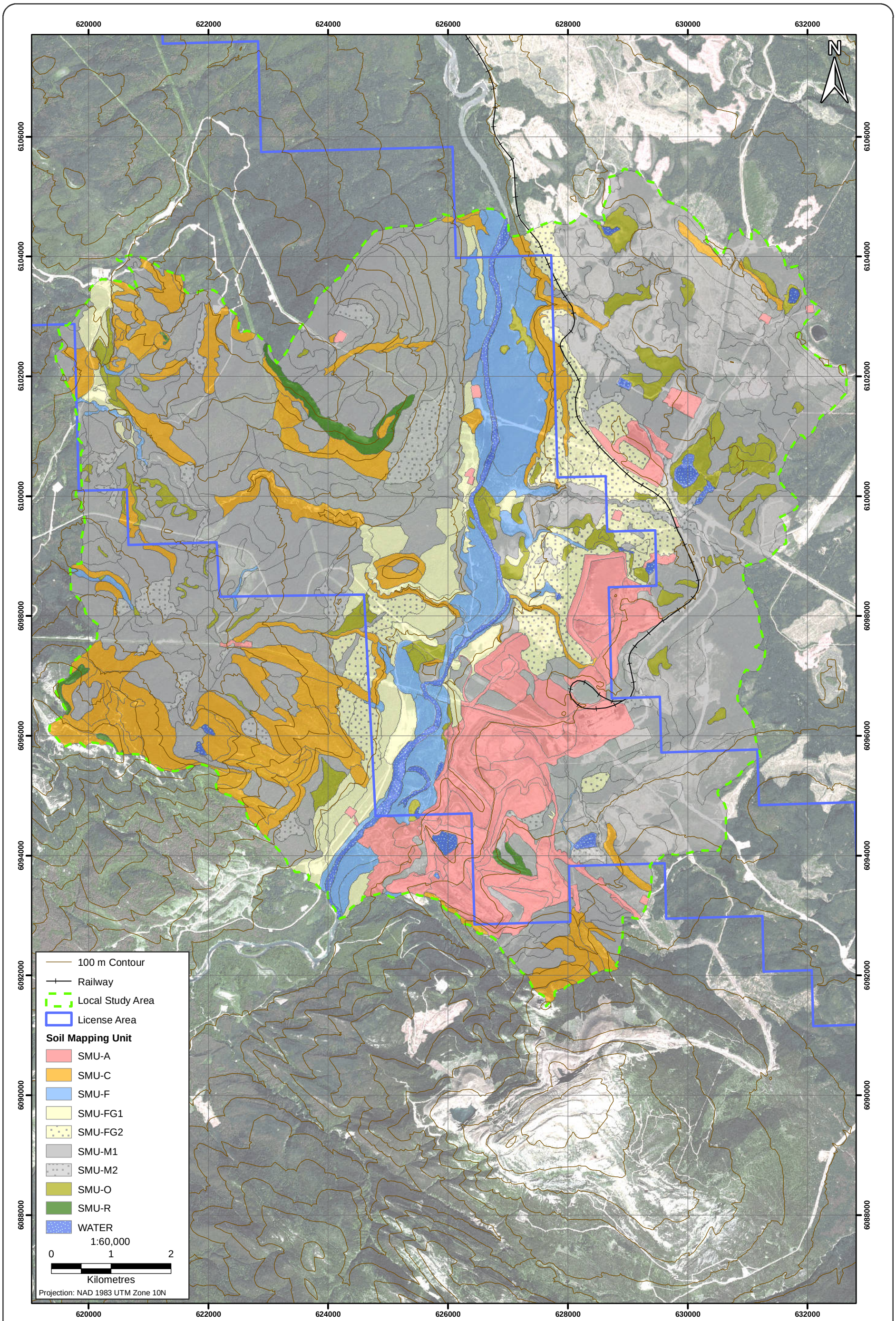

Figure 4.3-2

hdMining

MURRAY RIVER COAL PROJECT

Distribution of Soil Mapping Units in the Local Study Area

Figure 4.3-2

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The anthropogenic SMU (SMU-A) represents shallow soils: 30 to 35 cm on level surfaces and about 20 cm on moderate slopes. Soil textures vary between silt loams and clay loams, and the proportion of coarse fragments varies between 0 and 75%. Coarse fragments usually consist of gravels and cobbles, rounded (e.g., near gravel pits) or angular (e.g., near waste rock disposal sites). Typical soils include rapidly to well-drained Orthic Regosols (Plate 4.3-3). Rapid mass movement and the evidence of localized soil erosion were occasionally recorded on or near steeper slopes (Plate 4.3-4). Due to their shallow depth, high proportion of coarse fragments and potential contamination, anthropogenic soils are not suitable for salvage.

Plate 4.3-3. Well-drained shallow Orthic Regosols are common in the SMU-A.

Plate 4.3-4. Soil erosion was occasionally recorded on constructed slopes.

4.3.2.2 Colluvial Soil Mapping Units

Colluvial materials found in the LSA typically result from mass-wasting of the unconsolidated Quaternary deposits occurring on moderate to steep slopes (Plate 4.3-5). Consequently, the colluvial SMU (SMU-C), which accounts for 11.4% of the LSA, can be found in the north-western part of the LSA, along steep rocky ridges and canyons carved in the soft rock by streams (Figure 4.3-2). The SMU-C represents non-stratified, non-compacted colluvial veneers covering morainal or glaciofluvial materials deposited on moderate to steep slopes (average slope 41%) in higher elevations (average elevation 950 m asl). This unit is characterized by deep soils (typically over 100 cm), fine textures (predominantly clay loams and clays), and relatively high proportion of coarse fragments (10 to 85%). Coarse fragments consist mainly of sub-angular to angular gravels (1 to 60%) and up to 20% of cobbles. The typical soils include well- to imperfectly drained Eluviated Eutric Brunisols (Plate 4.3-6) and rapidly to imperfectly drained Orthic Regosols (Plate 4.3-7), which often contain a higher proportion coarse fragments and frequently display evidence of significant erosion (e.g., rapid mass movement or gullies). Due to high coarse fragment content and relatively difficult access for heavy machinery (steep slopes) most colluvial soils are not recommended for salvage.

Plate 4.3-5. Colluvial materials found in the LSA typically result from mass-wasting of the unconsolidated Quaternary deposits occurring on slopes.

Plate 4.3-6. Typical soils include well- to imperfectly drained Eluviated Eutric Brunisols.

Plate 4.3-7. Rapidly to imperfectly drained Orthic Regosols often contain high proportion coarse fragments.

4.3.2.3 Fluvial Soil Mapping Units

About 7% of the LSA consists of fluvial deposits (Plate 4.3-8), which form a wide strip along the bottom of the Murray River valley, stretched through the centre of the LSA from north to south (Figure 4.3-2). Thus, they are typically found on level terrain (average slope 1.6%) in the low elevations (average elevation 771 m asl). Some fluvial material can be also found on the bottom of canyons and ravines carved in the valley slopes, but these elongated and narrow features are usually dominated by colluvial or morainal deposits and were often mapped as such.

Plate 4.3-8. Fluvial materials are typically found on level terrain at low elevations.

The fluvial SMU (SMU-F) usually represents well-sorted, often stratified fluvial material deposited as veneers and blankets over the rock. These sediments generally contain a high proportion of coarse fragments (average 50%). On most fluvial sites, the proportion of round or sub-rounded gravels ranges from 30 to 90% (average 46%) with additional 2 to 10% of cobbles. In the southwestern section of the LSA, however, the round cobbles are often the dominant fraction of the parent material. This local phenomenon may be related to fluvial erosion of older glaciofluvial material deposited in that area. Due to high proportion of coarse fragments most fluvial soils are not recommended for salvage.

The soils are usually deep. The textures are often sandy or loamy; however, in the areas where, besides at freshet, streams are generally broad and slow, fluvial materials contain a significant fraction of silt and clay, often stratified with coarser materials. In some level floodplains, located at the bottom of the Murray River valley, the proportion of clay is also high. The typical soils include imperfectly drained Cumulic or Gleyed Regosols (Plates 4.3-9 and 4.3-10) and occasionally Rego Humic Gleysols.

Plate 4.3-9. The typical soils include imperfectly drained Cumulic Regosols.

Plate 4.3-10. The imperfectly drained Gleyed Regosols often contain a high proportion of coarse fragments.

4.3.2.4 Glaciofluvial Soil Mapping Units

Glaciofluvial materials cover almost 10% of the LSA (Table 4.3-1, Figure 4.3-1). They have been deposited as blankets or veneers over the predominantly morainal slopes on both sides of the Murray River valley (Figure 4.3-1). These well-sorted, often stratified, coarse materials have been subdivided into two soil management units (SMU-GF1 and SMU-GF2) based on deposit surficial expression and coarse fragment content.

Glaciofluvial SMU-GF1 represents glaciofluvial blankets. These sediments are found mostly on the western side of Murray River (Plate 4.3-11), in slightly higher elevations (average elevation 856 m asl) and on steeper slopes (average slope 16%) than SMU-GF2. SMU-GF1 also contains lower proportion of coarse fragments (average 25%) compared to SMU-GF2. At most sites, the proportion of round or sub-rounded gravels ranges from 10 to 50% (average 21%), with an additional 1 to 20% of cobbles (average 7%). The soils are deep and not compacted; textures are usually sandy or loamy. They are typically well-drained, although drainage may range from rapid to poor. Evidence of seepage, slow mass movement, and occasionally gullying has been recorded in these units. The typical soils include coarse, well-drained Eluviated Eutric Brunisols (Plate 4.3-12) or Orthic Regosols (Plate 4.3-13), with pockets of Orthic Humo-Ferric Podzols. SMU-GF1 soils generally provide good to fair salvage material. Coarse texture, high content of coarse fragments and steep slopes may lower the soil suitability as reclamation material in some sites.

Plate 4.3-11. Glaciofluvial blankets typical of SMU-GF1 are often found on the west side of Murray River.

Plate 4.3-12. The well- to imperfectly drained Eluviated Eutric Brunisols often contain significant proportion of coarse fragments.

Plate 4.3-13. Typical soils of the SMU-GF1 also include rapidly to well-drained Orthic Regosols.

SMU-GF2 represents glaciofluvial veneers and thin veneers deposited over gentle morainal slopes (average slope of 9% and average elevation of 814 m asl). These units are typically found on the eastern side of Murray River (Plate 4.3-14). They are characterized by relatively high coarse fragment content (average 48%), with a proportion of round or sub-rounded gravels ranging from 10 to 55%

(average 27%) with an additional 1 to 50% of cobbles (average 18%). The soils of this unit are shallower compared to SMU-GF1, and their profiles typically feature a clear boundary between the coarser (usually sandy or loamy) surficial horizons and the finer, more compacted, deeper morainal horizons (usually clay loams and clays; Plate 4.3-15). Soils are typically well-drained, although drainage may range from rapid to poor. Evidence of seepage has been recorded in these units. The typical soils include coarse, well- to moderately well-drained Eluviated Eutric Brunisols (Plate 4.3-16), Orthic Regosols, with pockets of imperfectly drained Gleyed Eutric Brunisols and Gleyed Regosols in seepage zones (Plate 4.3-17). 4 Most SMU-FG2 soils relatively easily accessible and are expected to provide good salvage material.

Plate 4.3-14. Glaciofluvial veneers typical of SMU-GF2 are often found on slopes on east side of Murray River.

Plate 4.3-15. The soil profiles of SMU-GF2 typically feature a clear boundary between the coarser surficial horizons and the finer, more compacted, deeper morainal horizons.

Plate 4.3-16. The well- to moderately well-drained Eluviated Eutric Brunisols are common in SMU-GF2.

Plate 4.3-17. Typical soils include well- to moderately well-drained Orthic Regosols.

4.3.2.5 Morainal Soil Mapping Units

Most soils in the LSA (55%) developed on morainal surficial materials (Table 4.3-1). Morainal deposits are typically found on gentle to moderate slopes on both sides of the Murray River valley (Plate 4.3-18) but are especially frequent in the western section of the valley (Figure 4.3-1). Two soil units have been differentiated within this group: Morainal SMU Nos. 1 and 2 (SMU-M1 and SMU-M2).

Almost 49% of the LSA has been mapped as SMU-M1 (Table 4.3-2). This unit represents non-stratified, compacted morainal mantles typically covering middle and upper slopes (Plate 4.3-18). Soils contain a considerable proportion of coarse fragments, which usually comprises 20 to 30% of sub-rounded to angular gravels (average 26%) and 10 to 15% of cobbles (average 13%). Soil textures vary widely (sandy to clayey), but most typically include clay loams and silty clay loams. While slow mass movement has been occasionally recorded, this soil unit typically does not display evidence of significant erosion. The typical soils are shallow (average soil depth is 75 cm) and include well- to moderately well-drained Eluviated Eutric Brunisols (Plate 4.3-19), usually found on gentle slopes (average slope 11%) in the middle elevations, and well-drained Orthic Regosols (Plate 4.3-20), often found at higher elevations and moderately gentle slopes (average slope 19%).

Plate 4.3-18. SMU-M1 is usually found on mid to upper sections of gentle to moderately gentle slopes.

Plate 4.3-19. Typical SMU-M1 soils include well- to moderately well-drained Eluviated Eutric Brunisols with high proportion of coarse fragments.

Plate 4.3-20. SMU-M1 soils also include well-drained Orthic Regosols.

SMU-M2 is found on gentle slopes (average slope 15%) often associated with seepage (Plate 4.3-21) and accounts for 6% of the LSA. It represents relatively small pockets of non-stratified, compacted blankets or mantles of glacial till, usually found at higher elevations (average elevation 1,070 m asl) throughout the LSA (Figure 4.3-2). These soils have a clay or clay loam texture and are slightly deeper than these found in SMU-M1. They contain 5 to 25% of sub-angular to angular gravels (average 16%) and 5 to 10% of cobbles (average 6%). The typical soils include imperfectly to poorly drained Rego Gleysols (Plate 4.3-22), Rego Humic Gleysols (Plate 4.3-23), and occasionally, Orthic Humic Gleysols. No evidence of significant erosion was recorded in this soil unit.

Plate 4.3-21. SMU-M2 is usually found at higher elevations, on gentle slopes, often associated with surficial seepage.

4.3.2.6 Organic Soil Mapping Units

Organic materials are relatively rare in the LSA (Table 4.3-1). They are typically associated with small streams and seepage areas distributed throughout the LSA (Figure 4.3-1). The organic soil mapping unit (SMU-O) represents organic veneers and blankets recorded in 4% of the LSA. They typically develop in the lower slopes or toe positions (Plate 4.3-24). This soil unit is characterized by level terrain, continuous (although sometimes very slow) water movement, and low coarse fragment content. The typical soils are deep and include very poorly drained Mesic Fibrisols (Plate 4.3-25), Typic Mesisols (Plate 4.3-26), and less frequently poorly to very poorly drained Humic Mesisols or Rego Humic Gleysols. This soil unit did not display evidence of significant erosion.

4.4 SOIL ANALYTICAL RESULTS

Soil samples collected from the LSA were analyzed for soil reaction (pH), total organic carbon, and metal concentration (Appendix 5). The summary of the analytical results is discussed below, however, a detailed discussion of metal concentration in the LSA is provided in a separate report titled: “Murray River Soil and Vegetation Tissue Metal Report - 2012” (Rescan 2013).

Plate 4.3-22. Typical SMU-M2 soils include Rego Gleysols.

Plate 4.3-23. Rego Humic Gleysols are also common in the SMU-M2.

Plate 4.3-24. The terrain of the SMU-O is typically associated with small streams and seepage areas distributed throughout the LSA.

Plate 4.3-25. Very poorly drained Mesic Fibrisol is one of the typical soil types in the SMU-O.

Plate 4.3-26. Very poorly drained Typic Mesisols are also commonly found in the SMU-O.

Soil pH, S, organic carbon content, and metal concentration are important parameters in the classification of soils and in assessment of their suitability for salvage and reclamation. Determining pre-disturbance metal levels also allows future assessment of potential changes in metal concentration during Project operation and after closure.

4.4.1 Soil Reaction (pH) and Total Organic Carbon

The median pH values of the soils collected from the LSA were 55.1 (0 to 10 cm samples), 5.6 (10 to 20 cm samples), and 66.2 (30 to 50 cm samples; Table 4.4-1). Soil pH variability within each sample group was low (coefficient of variation = 0.2). Majority of the soil samples were strongly acidic to very strongly acidic. This was especially true for the samples from the sampling depth of 0 to 10 cm. The data indicate that soil pH slightly increases with sampling depth. Well-drained soils in this region generally become less acidic with depth as a result of transfer of humic acids from organic layer into the surficial layers of mineral profile and ensuing eluviation of base cations to deeper horizons.

The above soil pH data were recorded at the ALS laboratory according to the 1:2 soil to water paste method. The uniformity of conditions during laboratory analyses provides a good base for sample comparison and, therefore, these results were presented first. The soil reaction, however, was also measured in the field using a portable soil pH kit. In most cases the measurement was taken using the soil from the B horizon. The results obtained that way suggest slightly less acidic soil conditions in the LSA. The mean soil reaction measured in the field was pH = 6.3. The variability of the pH data obtained in the field was similar to that obtained in the ALS laboratory. The field *in situ* pH measurements served as a basis for the classification of Brunisols. In this group, the mean soil reaction value measured in the Bm horizon was pH = 6.1 (SD = 0.7 pH units). Consequently, most Brunisols were classified as Eutric Brunisols.

Table 4.4-1. Summary of Soil Reaction (pH) and Total Organic Carbon

		Median	Mean	SD	Maximum	Minimum
Depth 0 to 10 cm	N = 23					
pH		5.1	5.6	1.2	7.9	4.3
Total Organic C (%)		1.4	3.9	8.2	39.0	0.3
Depth 10 to 20 cm	N = 23					
pH		5.6	6.0	1.1	8.1	4.5
Total Organic C (%)		1.0	3.0	7.4	36.3	0.4
Depth 30 to 50 cm	N = 23					
pH		6.2	6.4	1.1	8.4	5.1
Total Organic C (%)		0.9	2.7	6.5	32.2	0.4
Depth 0 to 30 cm	N = 97					
pH		5.8	6.0	1.2	8.1	4.2
Total Organic C (%)		1.0	3.2	7.3	39.0	0.3

Total organic carbon content ranged from 0.3% to 39% by weight (Table 4.4-1). The median organic carbon levels were 1.4% (0 to 10 cm samples), 1.0% (10 to 20 cm samples), and 0.9% (30 to 50 cm samples). The total organic carbon content of the surface samples (0 to 10 cm) was considerably higher than the subsurface samples, with only a few exceptions.

Organic carbon accumulates in soils primarily in result of addition of vegetation litter. Through microbial decomposition of organic debris, organic carbon is incorporated with mineral soil in the form of humus. Predominance of conifers in the forest canopy and generally cold climatic conditions slow down the organic matter turnover cycle and are the most likely reason for the low organic carbon content of some of the mineral soils occurring within the LSA.

4.4.2 Metal Analysis

Metal concentrations of soil samples in the LSA varied substantially between sampling locations (the coefficient of variation is 0.68). This is typical for natural soil datasets, especially when soils develop on a number of different surficial materials.

The concentrations of metals in the mineral soil have been compared to the BC Contaminated Sites Regulation Soil Criteria (BC Reg. 375/96) and to the Canadian Soil Quality Guidelines for Protection of Environmental and Human Health (CCME 2007). Elevated levels of arsenic, barium, cadmium, molybdenum, selenium, and tin, exceeding the CCME Agricultural Limits have been recorded in soil samples collected at 14 locations within the LSA (Table 4.4-2). Metal concentrations found in soil samples collected at 30 to 50 cm below surface were in general higher compared to surficial horizons, however, at sites where CCMA and/or BC CSR guidelines were exceeded, the highest concentrations were typically found in surficial horizons.

It appears that in most of the affected sites, the elevated metal concentrations are associated with industrial activities (such as mining, power transmission, or forest harvesting) and likely do not reflect any natural phenomena. For example, site 45 is located approximately 130 m west of the settling pond below the Quintette mine's rock waste dump; site 54 is located about 100 m down slope from the power transmission line; and site 328 is located between Mast Road and the transmission line, within an approximately 100 m distance from a laydown area. Inspection point 413 is located in the ravine that appears to be hydrologically connected with a large tailing pond located about 500 m to the east.

Flood waters might provide another pathway for metal deposition. Sites 16, 23, 40, 45, and 54 may have been affected by flooding, since they are located in the fluvial plains at the bottom of the valley. A detailed discussion of metal concentration in the LSA is provided in a separate report titled: "Murray River Soil and Vegetation Tissue Metal Report - 2012" (Rescan 2013).

Table 4.4-2. Sampling Sites within the LSA where Soil Metal Concentrations Exceeded Regulatory Guidelines

Metal	Percent of Inspected Sites	Number of Sites	Inspection point IDs	Guidelines Exceeded
Arsenic	2.7	2	NW-1, 413	CCME-A, CCME-I
Barium	9.5	7	NW-1, NW-3, W-2, 23, 34, 39, 54	CSR-L and I, CCME-A and I
Cadmium	10.8	8	NW-2, W-2, 16, 23, 45, 54, 88, 328	CCME-A
Molybdenum	1.4	1	54	CSR-L, CCME-A
Selenium	6.8	5	NW-1, 40, 45, 54, 328	CCME-A
Tin	1.4	1	88	CSR-L, CCME-A
Zink	1.4	1	23	CSR-L, CCME-A

Notes:
***CCME-A** = CCME Canadian Soil Quality Guidelines for Protection for Environmental and Human Health, Agricultural Limits.*
***CCME-I** = CCME Canadian Soil Quality Guidelines for Protection for Environmental and Human Health, Industrial Limits.*
***CSR-L** = Contaminated Site Regulation (BC Reg. 375/96), Livestock Criteria*
***CSR-I** = Contaminated Site Regulation (BC Reg. 375/96), Industrial Criteria*

The main goal of the soil sampling that was carried out for this baseline study was to provide data for a general description of physical and chemical properties of soils in the LSA and to contribute to determining soil suitability for reclamation. The sampling methodology was not applicable for a rigorous determination of soil contamination in any particular portion of the LSA.

4.5 TERRAIN AND SOIL FEATURES OF THE PROPOSED INFRASTRUCTURE INVESTIGATION AREA

The proposed Infrastructure Investigation Area (IIA) has been inspected more intensely than the rest of the LSA. The geomorphological features of the IIA have been photographed from the helicopter, and soils have been inspected at 30 sites (on average 7.8 ha per inspection point). Ten soil samples have been submitted for physical and chemical laboratory analyses.

4.5.1 Topography

The IIA consists of two topographically different sections located on the western and eastern sides of Murray River. The northern limits of the western section follow the edge of a steep ravine carved in the soft shale rock by one of Murray River's tributaries — Mast Creek (Plate 4.5-1). From its northern limits, the area gradually slopes to the south and east – towards the river. The eastern section is located immediately north and west of the Teck / Quintette Mine tailings facility (Plate 4.5-2) and gently slopes to the west, towards the river. This area is dissected by three parallel creek ravines. Considerable seepage has been recorded in this section of the IIA.

While the majority of slopes in the IIA are gentle, slightly above 13% of slopes are moderately to steeply inclined (Table 4.5-1). Apart from the ravine, the steepest section of the IIA extends between the Mast and the Murray roads and further south, along the river floodplain (Figure 4.5-1). Elevations in this area range from 768 to 858 m asl.

Plate 4.5-1. The northern limits of the mining area follow the edge of a steep ravine.

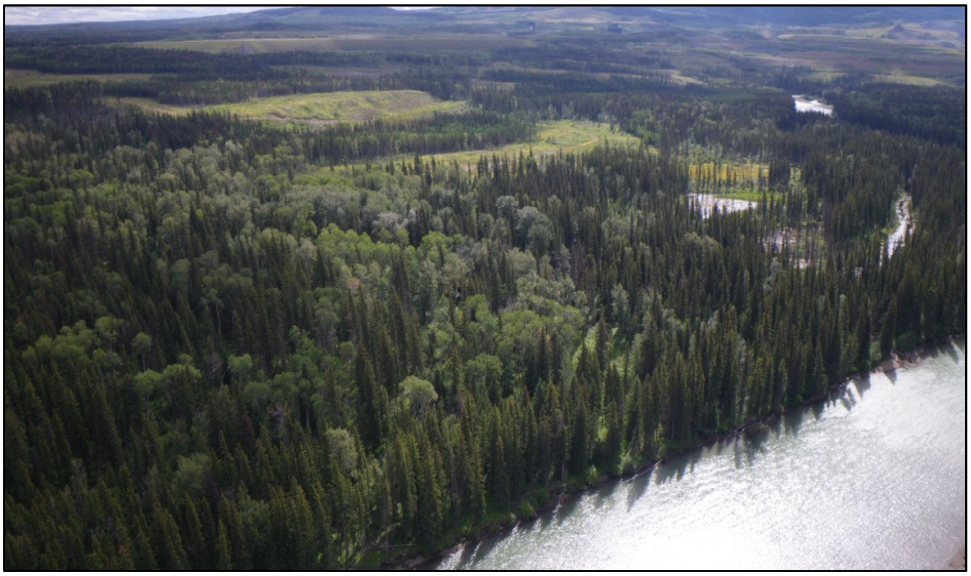

Plate 4.5-2. The Coarse Coal Reject Area is located on gentle slopes on the east side of Murray River.

Table 4.5-1. Comparative Proportion of Slope Classes within the Infrastructure Investigation Area

Slope Class		Area (ha)	Proportion of IIA (%)
Class 1	0% to 5% - level to very gently sloping	273.0	38.5
Class 2	6% to 15% - gently sloping	298.2	42.0
Class 3	16% to 26% - moderately gently sloping	83.4	11.8
Class 4	27% to 50% - moderately sloping	49.9	7.0
Class 5	51% to 70% - moderately steeply sloping	3.1	0.4
Class 6	> 70% - steeply sloping	1.9	0.3
Total		**709.4**	**100.0**

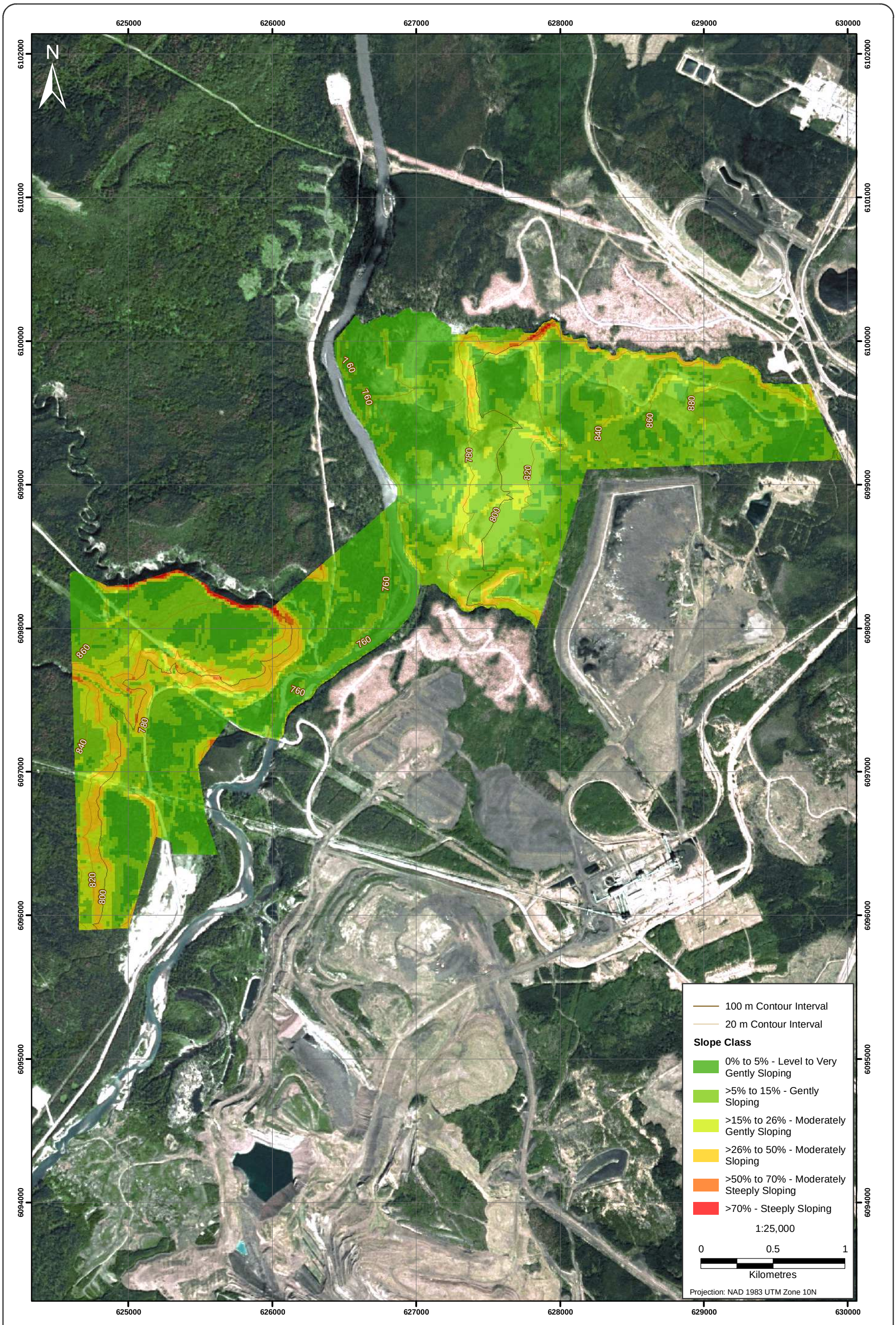

Figure 4.5-1

hd Mining

MURRAY RIVER COAL PROJECT

Distribution of Slope Classes in the Infrastructure Investigation Area

Figure 4.5-1

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4.5.2 Surficial Materials

Majority of the surficial materials found in the IIA consist of undulating terrain formed by coarse glaciofluvial deposits (Table 4.5-2; Figure 4.5-2) overlaying glacial till. Morainal deposits appear directly on the surface mainly in the northern portion of the IIA. The relatively level, central section of the area is dominated by fluvial materials often characterized by a high content of rounded gravels and cobbles. Organic materials developed in the several smaller areas located in lower landscape positions and in areas characterized by strong seepage.

Table 4.5-2. Comparative Proportion of Surficial Materials in the Infrastructure Investigation Area

Surficial Materials	Area (ha)	Proportion of IIA (%)
Anthropogenic	2.5	0.4
Colluvial	25.5	3.6
Fluvial	141.4	19.9
Glaciofluvial	319.1	45.0
Morainal	116.8	16.5
Organic	90.6	12.8
Bedrock	0.0	0.0
Water	13.5	1.9
Total LSA	**709.4**	**100.0**

The SMUs follow the distribution pattern of their respective surficial parent materials. Glaciofluvial veneers (SMU-GF2) are generally associated with the more elevated sections of the IIA, while the deeper blankets (SMU-GF1) developed in the valley, mainly in the southern section (Figure 4.5-3).

Glaciofluvial veneers, which cover over 31% of the IIA (Table 4.5-3), are characterized by loamy or sandy soils with a significantly lower coarse fragment content (average 6%) compared to glaciofluvial blankets (average 45%). The 20 to 70 cm thick veneers (average 43 cm) overlay finer and more compacted morainal deposits (usually silty clays or silty clay loams). Soils in the SMU-FG2 are typically well-drained, although drainage may range from rapid to poor depending on site landscape position. Most soils are relatively easily accessible for soil moving equipment, and are expected to provide good salvage material.

Table 4.5-3. Comparative Proportion of Soil Mapping Units in the Infrastructure Investigation Area

Soil Mapping Units	Area (ha)	Proportion of IIA (%)
SMU-A - Anthropogenic	2.5	0.4
SMU-C - Colluvial	25.5	3.6
SMU-F - Fluvial	141.4	19.9
SMU-GF1 - Glaciofluvial-1	97.4	13.7
SMU-GF2 - Glaciofluvial-2	221.7	31.3
SMU-M1 - Morainal-1	94.7	13.3
SMU-M2 - Morainal-2	22.1	3.1
SMU-O - Organic	90.6	12.8
SMU-R - Bedrock	0.0	0.0
Water	13.5	1.9
Total LSA Area	**709.4**	**100.0**

Glaciofluvial blankets (SMU-GF1) cover almost 14% of the IIA. These soil units appear to be more prone to mass movement and erosion compared to SMU-GF2. This may be the result of their association with slightly steeper slopes. In this mapping unit, soil suitability for reclamation is highly dependent on coarse fragment content, which varies between 2 and 70%.

On the bottom of the valley, within the Murray River floodplain, soils developed on predominantly fluvial deposits (SMU-F). This SMU represents about 20% of the IIA. Soil textures in this area vary substantially (from sands to clays). Sandy soils typically contain high proportion of round or sub-rounded gravels and cobbles (average 50%), which renders them unsuitable as capping material for reclamation. Finer soils (typically clay loams and clays), which often develop in periodically flooded areas, have much lower coarse material content and can sometimes provide very good quality reclamation material, although potential metal contamination may render them unsuitable.

Soils that developed on well-drained morainal deposits (SMU-M1) occur mainly in the northern section of the IIA, covering approximately 13% of it. These are predominantly compacted silty clays containing 5 to 35% of gravels (average 18%). These soils appear to resist erosion well and locally may provide a reasonably good reclamation material; however, the access of heavy machinery may be sometimes hindered by steep (above 26%) slopes. Similar but imperfectly to poorly drained morainal soils (SMU-M2), often found on slopes associated with seepage, cover a small proportion (3%) of the IIA.

Organic deposits developed in the eastern and western sections of the IIA (Figure 4.5-3). This SMU consists of blankets of poorly to very poorly drained, usually well-decomposed organic material (Typic or Humic Mesisols). Neutral soil reaction (pH ranges between 6.3 and 7.0), lack of coarse fragments, soil depth typically exceeding 1 m, and easy access, can potentially make these deposits the source of highly valuable reclamation material. It is possible however, that due to their low landscape position, organic sites might be contaminated with metals.

Soils that developed on colluvial deposits play a minimal role in the IIA. This mapping unit can be found only in 3.6% of the IIA at the northern limits of the area. Due to relatively high proportion of coarse fragments, colluvial soils rarely provide desirable reclamation material. Accessibility will likely be hindered by steep slopes.

4.5.3 Soil Chemistry

The results of soil chemical analysis suggest that majority of the mineral soils in the IIA have a moderately acidic to neutral reaction (pH 5 to 7, median pH 5.8), have low levels of carbonates, and contain below 1% of organic carbon (median 0.72%). In general, metal content of the sampled soils is low; however, the CCME industrial limits for barium and the agricultural limits for barium, cadmium, molybdenum, and selenium have been exceeded in two neighbouring sites (54 and 328) located at a low elevation, in the north western portion of the mining area. In addition, the concentration of barium near site 34, located in the Murray River floodplain (southeast section of the mining area), exceeded the CSR-L guideline. High levels of arsenic were recorded in the ravine located in the southern part of the IIA eastern section (Figure 4.5-4, inspection point 413). The ravine appears to be hydrologically connected with the large tailing pond located about 500 m to the east. Concentration of arsenic in the ravine soil exceeded Canadian Soil Quality Guidelines for Protection of Environmental and Human Health (Industrial Criteria) and barium exceeded BC Contaminated Sites Regulation Livestock Criteria for Toxicity to Soil Invertebrates and Plants.

The common feature of all the affected sites is their geomorphological position at the valley floor or at the slope toe, and all appear to have been subjected to periodic flooding. Soil located in the vicinity of these three inspection points is likely not suitable for reclamation. Furthermore, because several mineral soil samples collected along the river outside of the IIA (e.g., sites 16, 40, and 45) exceeded the BC CSR or CCME (2007) guidelines for metal concentration, there is a potential that other mineral and organic deposits associated with the Murray River floodplain may contain high levels of metals.

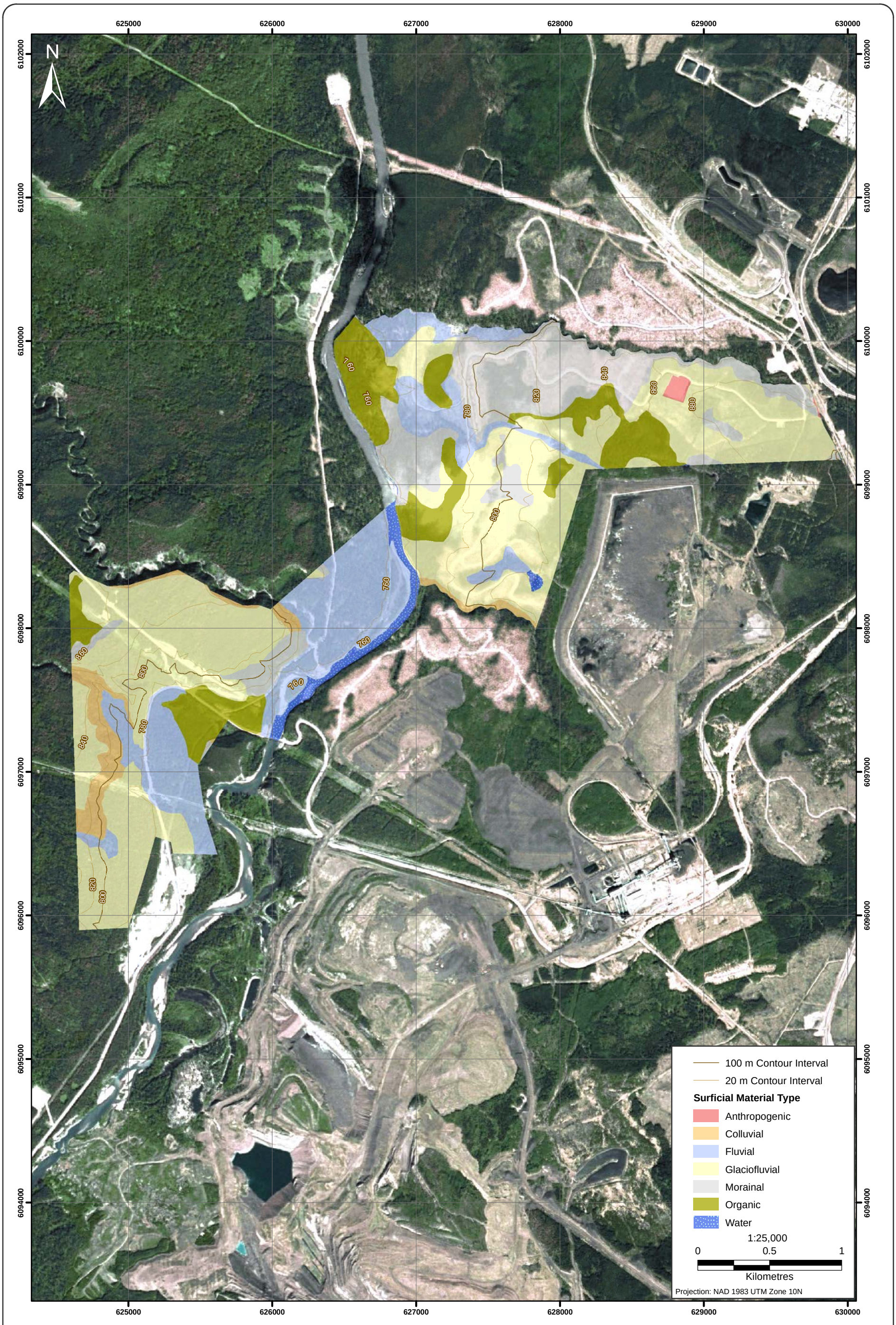

Figure 4.5-2

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Distribution of Surficial Materials in the Infrastructure Investigation Area

Figure 4.5-2

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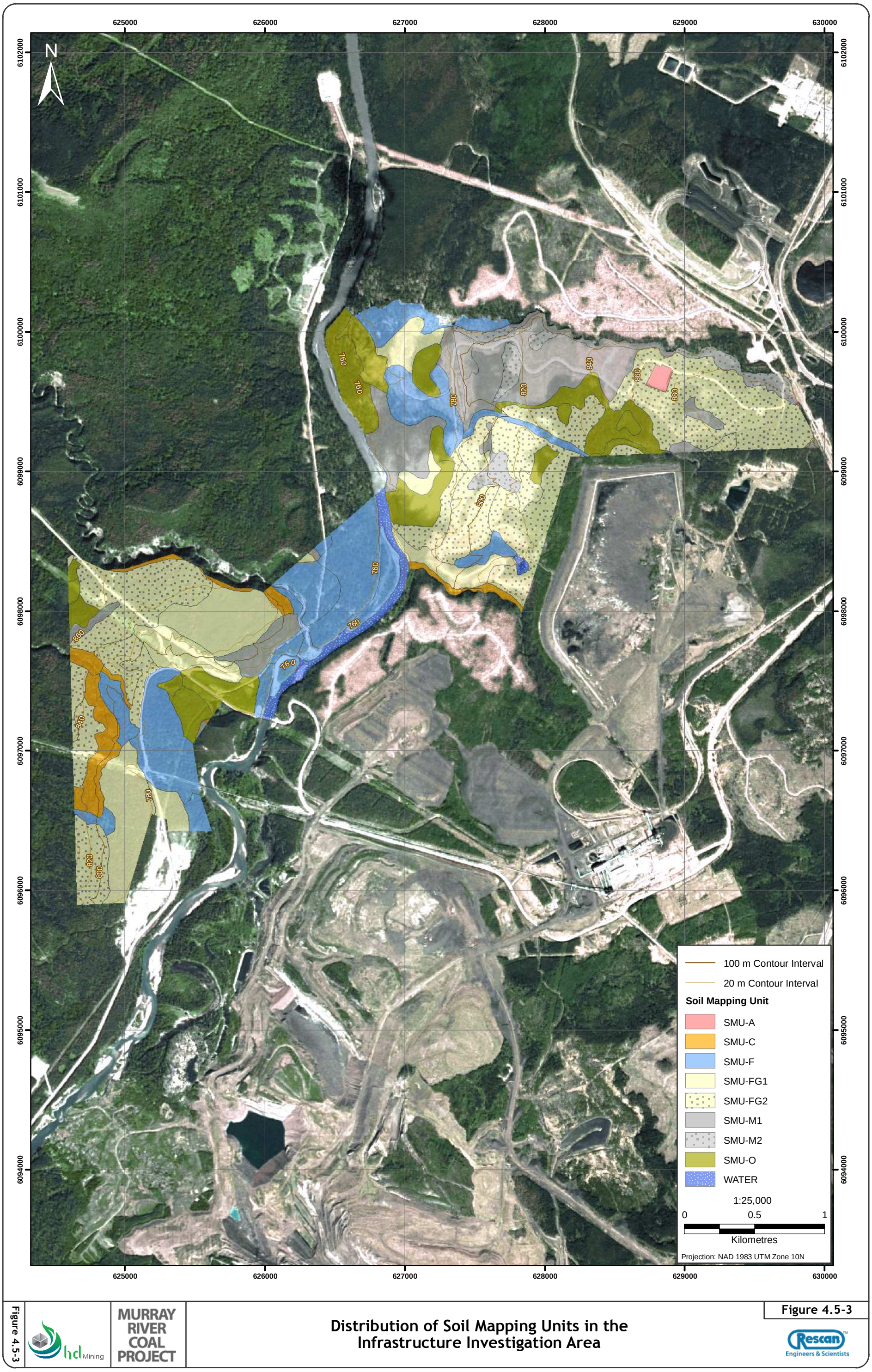

Figure 4.5-3

hd Mining

MURRAY RIVER COAL PROJECT

Distribution of Soil Mapping Units in the Infrastructure Investigation Area

Figure 4.5-3

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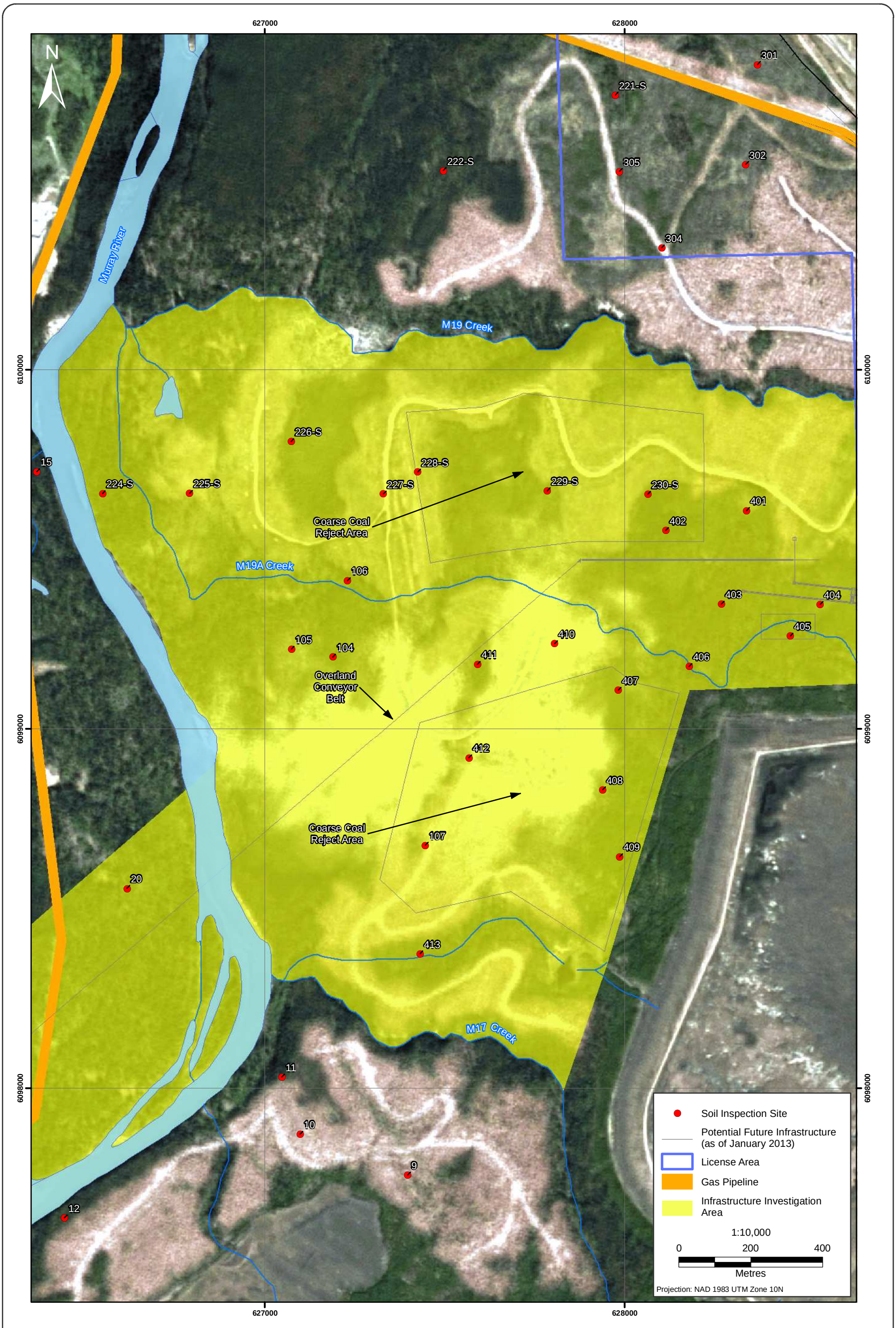

Figure 4.5-4

hdMining

MURRAY RIVER COAL PROJECT

Soil Inspection Sites Located in the Coarse Coal Reject Area on the East Side of Murray River

Figure 4.5-4

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5. Summary and Conclusions

5. Summary and Conclusions

Soil formation in the LSA is limited by the cold climate and in some cases by periodic deposition of new mineral material by gravity or water. Soils that developed on morainal (glacial till) and glaciofluvial deposits dominate the LSA. Colluvial, fluvial, and organic soils are also found throughout the LSA, but their proportion in relatively minor. In recent times, mining activity altered the characteristics of a considerable portion of the LSA, and thus, over 10 % of the LSA is currently classified as anthropogenic terrain.

The Infrastructure Investigation Area is dominated by glaciofluvial deposits. Glaciofluvial veneers (20 to 70 cm thick), typical of the eastern side of the river, are characterized by loamy or sandy soils with a significantly lower coarse fragment content compared to glaciofluvial blankets. While most soils developed on veneers are relatively easily accessible and are expected to provide good salvage material, the suitability of soils developed on blankets is highly dependent on coarse fragment content, which varies widely. Soils developed on fluvial deposits of the Murray River floodplain vary substantially in terms of texture and coarse fragment content. Sandy soils typically contain a high proportion of round or sub-rounded gravels and cobbles, which renders them unsuitable as a capping material for reclamation. Finer soils, which often develop in periodically flooded areas, have much lower coarse material content and could potentially provide a very good quality reclamation material, although metal contamination may occur. Similarly, the deep organic deposits developed in the eastern and western sections of the IIA could potentially provide a source of highly valuable reclamation material; however, it due to their low landscape position, metal contamination may occur. It appears that morainal and colluvial soils will be of rather limited use in the IIA, mainly due to their peripheral location.

Rapidly to moderately well-drained Orthic Regosols and Eluviated Eutric Brunisols are the dominant mineral soils in the LSA. Rego Gleysols, Rego Humic Gleysols, Orthic Humic Gleysols, and Gleyed Regosols develop in imperfectly to poorly drained areas, and occasionally Cumulic Regosols develop in areas prone to flooding. Humo-Ferric Podzols and Brunisolic Gray Luvisols are rare. Very poorly drained Mesic Fibrisols, Typic Mesisols, and Humic Mesisols are found in depressions and seepage areas. These organic soils are very sensitive to disturbance.

Most mineral soils in the LSA are slightly to very strongly acidic, have low levels of carbonates, and low organic carbon content. Consequently, their acid buffering capacity is expected to be low. The metal concentrations in the top 50 cm of soil are generally below the regulatory guidelines, with the exception of areas where metal accumulation is potentially associated with past human activity. Soil metal concentrations exceeded the Canadian Soil Quality Guidelines for Protection of Environmental and Human Health (CCME 2007) and/or BC Contaminated Sites Regulation Criteria for Toxicity to Soil Invertebrates and Plants (BC Reg. 375/96) at 14 sites (20% of sampled sites) in the LSA. Four of these sites are located within the IIA. The common features of all the affected sites are their vicinity to industrialized areas and their low geomorphological position, making them subject to periodic flooding.

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Definitions of the acronyms and abbreviations used in this reference list can be found in the Glossary and Abbreviations section.

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Appendix 1

Murray River Project Slope Map (including locations of soil inspections)

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Appendix 1
Slope Gradient Map - Local Study Area

- TEM Inspection Point
- Soil Salvage Inspection Point
- 20 m Contour
- 100 m Contour
- Stream / River
- Teck Conveyor Corridor
- Gas Pipeline
- BC Hydro Transmission Line
- Railway
- Wetland
- BEC polygon
- Gas Pipeline
- Infrastructure Investigation Area
- Local Study Area
- License Area
- Terrain Polygon

Slope Class

- < 2%
- 2 - 5%
- 5 - 15%
- 15 - 26%
- 26 - 50%
- 50 - 70%
- > 70%

1:17,000

0 1,000 2,000

Metres

Date: May 14, 2013
GIS no.: MUR-17-026
Projection: NAD 1983 UTM Zone 10N

SBSwk2
ESSFmv2
BWBSwk1
BWBSmw

Appendix 2

Murray River Project Terrain Maps – North and South (including locations of soil inspections)

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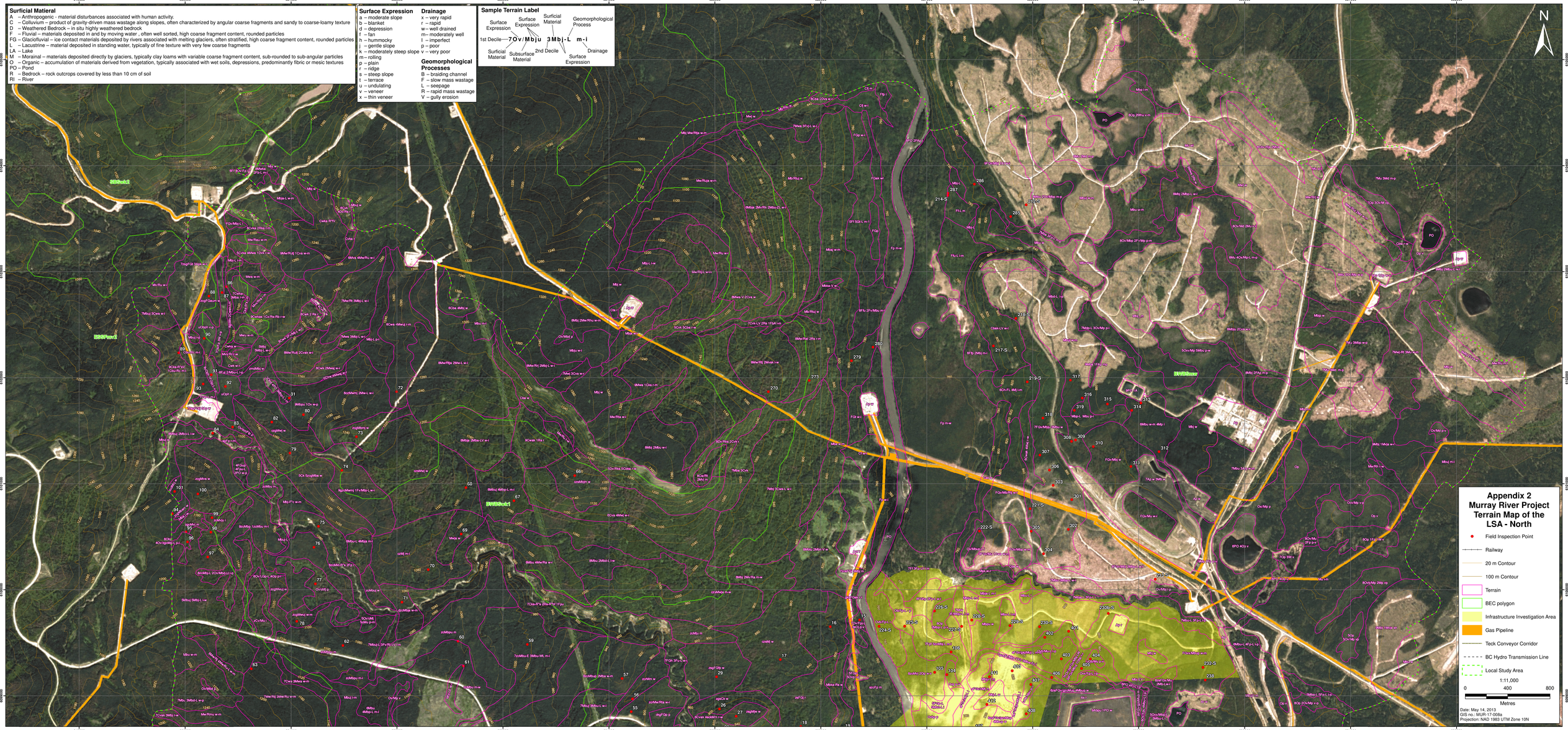
Surficial Matieral
A – Anthropogenic - material disturbances associated with human activity.
C – Colluvium – product of gravity-driven mass wastage along slopes, often characterized by angular coarse fragments and sandy to coarse-loamy texture
D – Weathered Bedrock – in situ highly weathered bedrock
F – Fluvial – materials deposited in and by moving water , often well sorted, high coarse fragment content, rounded particles
FG – Glaciofluvial – ice contact materials deposited by rivers associated with melting glaciers, often stratified, high coarse fragment content, rounded particles
L – Lacustrine – material deposited in standing water, typically of fine texture with very few coarse fragments
LA – Lake
M – Morainal – materials deposited directly by glaciers, typically clay loams with variable coarse fragment content, sub-rounded to sub-angular particles
O – Organic – accumulation of materials derived from vegetation, typically associated with wet soils, depressions, predominantly fibric or mesic textures
PO – Pond
R – Bedrock – rock outcrops covered by less than 10 cm of soil
RI – River
Surface Expression
a – moderate slope
b – blanket
d – depression
f – fan
h – hummocky
j – gentle slope
k – moderately steep slope
m – rolling
p – plain
r – ridge
s – steep slope
t – terrace
u – undulating
v – veneer
x – thin veneer
Drainage
x – very rapid
r – rapid
w – well drained
m – moderately well
i – imperfect
p – poor
v – very poor
Geomorphological Processes
B – braiding channel
F – slow mass wastage
L – seepage
R – rapid mass wastage
V – gully erosion
Sample Terrain Label
Surface Expression
Surface Expression
Surficial Material
Geomorphological Process
1st Decile—7Ov/Mbju 3Mbj-L m-i
Surficial Material
Subsurface Material
2nd Decile
Surface Expression
Drainage
N
Appendix 2
Murray River Project
Terrain Map of the
LSA - North
Field Inspection Point
Railway
20 m Contour
100 m Contour
Terrain
BEC polygon
Infrastructure Investigation Area
Gas Pipeline
Teck Conveyor Corridor
BC Hydro Transmission Line
Local Study Area
1:11,000
0
400
800
Metres
Date: May 14, 2013
GIS no.: MUR-17-008a
Projection: NAD 1983 UTM Zone 10N

Appendix 2
Murray River Project
Terrain Map of the LSA - South

- Field Inspection Points
- Teck Conveyor Corridor
- BC Hydro Transmission Line
- Railway
- 20 m Contour
- 100 m Contour
- Terrain
- BEC polygon
- Infrastructure Investigation Area
- Gas Pipeline
- Local Study Area

1:11,000

0 400 800

Metres

Date: May 14, 2013
GIS no.: MUR-17-008b
Projection: NAD 1983 UTM Zone 10N

Surficial Matieral
A – Anthropogenic - material disturbances associated with human activity.
C – Colluvium – product of gravity-driven mass wastage along slopes, often characterized by angular coarse fragments and sandy to coarse-loamy texture
D – Weathered Bedrock – in situ highly weathered bedrock
F – Fluvial – materials deposited in and by moving water , often well sorted, high coarse fragment content, rounded particles
FG – Glaciofluvial – ice contact materials deposited by rivers associated with melting glaciers, often stratified, high coarse fragment content, rounded particles
L – Lacustrine – material deposited in standing water, typically of fine texture with very few coarse fragments
LA – Lake
M – Morainal – materials deposited directly by glaciers, typically clay loams with variable coarse fragment content, sub-rounded to sub-angular particles
O – Organic – accumulation of materials derived from vegetation, typically associated with wet soils, depressions, predominantly fibric or mesic textures
PO – Pond
R – Bedrock – rock outcrops covered by less than 10 cm of soil
RI – River

Surface Expression
a – moderate slope
b – blanket
d – depression
f – fan
h – hummocky
j – gentle slope
k – moderately steep slope
m – rolling
p – plain
r – ridge
s – steep slope
t – terrace
u – undulating
v – veneer
x – thin veneer

Drainage
x – very rapid
r – rapid
w– well drained
m– moderately well
i – imperfect
p – poor
v – very poor

Geomorphological Processes
B – braiding channel
F – slow mass wastage
L – seepage
R – rapid mass wastage
V – gully erosion

Sample Terrain Label

1st Decile—7Ov/Mbju—3Mbj-L m-i—2nd Decile

Surficial Material / Subsurface Material / Surface Expression / Surficial Material / Surface Expression / Geomorphological Process / Drainage

Appendix 3

Distribution of Soil Mapping Units in the LSA (including locations of soil inspections)

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Appendix 3
Distribution of Soil Mapping Units in the LSA

- Field Inspection Point
- Teck Conveyor Corridor
- Gas Pipeline
- BC Hydro Transmission Line
- Railway
- 20 m Contour
- 100 m Contour
- Infrastructure Investigation Area
- Gas Pipeline
- Local Study Area
- License Area
- Terrain Polygon

Soil Mapping Units

- SMU-A
- SMU-C
- SMU-F
- SMU-FG1
- SMU-FG2
- SMU-M1
- SMU-M2
- SMU-O1
- SMU-O2
- Water

1:17,500

0 1,000 2,000

Metres

Date: May 14, 2013
GIS no.: MJR-17-009
Projection: UTM10, NAD83

hd Mining

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N

620000 621000 622000 623000 624000 625000 626000 627000 628000 629000 630000 631000 632000

6106000 6105000 6104000 6103000 6102000 6101000 6100000 6099000 6098000 6097000 6096000 6095000 6094000 6093000 6092000 6091000

Appendix 4

Summary of Terrain and Soil Inspection Data

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Appendix 4. Summary of Terrain and Soil Inspection Data

a) Site Data

Site ID	Landuse	Field Terrain Code	Slope	Aspect	Macro Slope Position	Meso Slope Position	Microtopography	Humus Order	SNR	SMR	Drainage	Geo Process	Water Table Depth	Root Restriction	Root Restriction Depth	Salvage Depth	Accessibility
001	Forest	FG/Mu	3	334	Plain	Middle	Slightly mounded	Moder	D	5	Imperfect	-	-	-	-	30	not assessed
002	Forest	FGv/Mu	4	328	Middle	Middle	Moderately Mounded	Moder	D	4	Rapid	-	-	Lithic	60	60	not assessed
003	Forest	Mu	8	355	Middle	Middle	Slightly mounded	Moder	E	4	Well Drained	-	-	-	-	-	not assessed
004	Other (Reclaimed Overburden)	A	6	105	Upper	Middle	Slightly mounded	None	C	3	Rapid	-	-	Claypan	18	-	not assessed
005	Other (Reclaimed tailings)	A	27	358	Upper	Upper	Moderately Mounded	None	C	3	Well Drained	-	-	Lithic	18	-	not assessed
006	Forest	Mj	6	242	Middle	Upper	Slightly mounded	Mor	B	2	Well Drained	F	-	Compaction	20	-	not assessed
007	Forest	Mu	22	550	Middle	Middle	Strongly Mounded	Mor	B	4	Well Drained	-	-	-	-	-	not assessed
008	Wetland	Ov/Fd	0	not assessed	Middle	Depression	Strongly Mounded	Peat	D	6	Very Poor	U	20	Excesive Moisture	20	-	not assessed
009	Forest	Fgu	7	330	Middle	Middle	Slightly mounded	Mor	C	5	Imperfect	-	-	Excesive Moisture	55	20	not assessed
010	Forest	Mu	12	265	Middle	Middle	Moderately Mounded	Mor	C	4	Moderately	-	-	-	-	-	not assessed
011	Forest	Mj	9	310	Lower	Toe	Strongly Mounded	Mor	D	4	Moderately	-	-	Claypan	50	30	not assessed
012	Forest	Fv/Mj	11	320	Lower	Middle	Slightly mounded	Mor	B	4	Well Drained	-	-	Lithic	30	-	not assessed
013	Forest	Mj	21	170	Lower	Middle	Slightly mounded	Mor	B	2	Well Drained	-	-	-	-	100	not assessed
014	Wetland	Ov	0	not assessed	Valley Floor	Depression	Level	Peat	B	7	Very Poor	-	-	Excesive Moisture	18	100	not assessed
015	Forest	Fbp	5	270	Valley Floor	Middle	Slightly mounded	None	E	5	Moderately	-	-	-	-	100	not assessed
016	Forest	FGb	12	80	Middle	Toe	Moderately Mounded	Mor	D	4	Moderately	-	-	-	-	25	not assessed
017	Forest	Mj	22	40	Middle	Upper	Slightly mounded	Mor	B	4	Well Drained	-	-	Lithic	40	-	not assessed
018	Forest	FGv/Mj	9	110	Middle	Middle	Slightly mounded	Mor	B	4	Rapid	-	-	-	-	-	not assessed
019	Forest	5Ck 5FGk-FR	56	84	Lower	Middle	Slightly mounded	Mor	C	3	Rapid	FR	-	-	-	-	not assessed
020	Forest	Ft	0	not assessed	Valley Floor	Level	Slightly mounded	Mor	C	5	Moderately	-	-	-	-	15	not assessed
021	Forest	Fp	2	80	Valley Floor	Lower	Slightly mounded	Mor	B	4	Well Drained	-	-	-	-	-	not assessed
022	Forest	Cv-F/FGk	65	130	Lower	Middle	Slightly mounded	Mor	C	4	Well Drained	-	-	-	-	-	not assessed
023	Forest	Fv/Mt	0	not assessed	Valley Floor	Lower	Slightly mounded	Mor	C	5	Moderately	-	-	-	-	15	not assessed
024	Other (Creek Bed)	Fp	0	not assessed	Valley Floor	Lower	Slightly mounded	None	B	4	Rapid	-	100	Lithic	80	-	not assessed
025	Forest	Ft	0	not assessed	Valley Floor	Level	Slightly mounded	Mor	D	4	Well Drained	-	-	-	-	-	not assessed
026	Forest	Ck	52	320	Middle	Middle	Slightly mounded	Moder	D	4	Well Drained	-	-	-	-	-	not assessed
027	Forest	Mj	4	40	Upper	Upper	Slightly mounded	Mor	B	3	Well Drained	-	-	-	-	-	not assessed
028	Forest	Cv/Ma	30	180	Upper	Upper	Slightly mounded	Mor	C	4	Well Drained	F	-	-	-	-	not assessed
029	Forest	FGp	2	185	Upper	Level	Slightly mounded	Mor	B	3	Well Drained	-	-	-	-	-	not assessed
030	Forest	FGp	2	85	Valley Floor	Level	Slightly mounded	Moder	C	5	Poor	-	-	-	-	-	not assessed
031	Forest	FGv/Mp	2	220	Middle	Level	Slightly mounded	Mor	C	4	Well Drained	-	-	-	-	-	not assessed
032	Forest	FGv/Mp	0	not assessed	Middle	Lower	Slightly mounded	Mull	B	3	Rapid	-	-	-	-	-	not assessed
033	Forest	FGb/Mr	50	140	Middle	Middle	Slightly mounded	Mor	C	3	Well Drained	F	-	-	-	-	not assessed
034	Forest	Fp	0	not assessed	Valley Floor	Level	Level	Moder	D	5	Well Drained	-	-	-	-	85	not assessed
035	Forest	Ob/Mp	0	not assessed	Valley Floor	Depression	Strongly Mounded	None	B	6	Poor	-	-	Excesive Moisture	56	-	not assessed
036	Wetland	Ox/FGp	0	not assessed	Valley Floor	Depression	Level	Peat	C	7	Very Poor	U	-	-	-	-	not assessed
037	Wetland	Op	0	not assessed	Valley Floor	Depression	Level	Peat	C	7	Very Poor	-	-	-	-	-	not assessed
038	Forest	Mj-F	9	210	Middle	Upper	Moderately Mounded	Mor	B	2	Well Drained	F	-	-	-	-	not assessed
039	Wetland	Cv-FR/Ms	85	350	Middle	Middle	Level	Mor	C	4	Well Drained	FR	-	-	-	-	not assessed
040	Forest	Fp	0	not assessed	Valley Floor	Level	Slightly mounded	Moder	E	5	Moderately	U	-	-	-	-	not assessed
041	Forest	FGp	2	230	Lower	Lower	Slightly mounded	Mor	B	3	Well Drained	-	-	-	-	-	not assessed
042	Forest	Cv/FGk	50	260	Middle	Middle	Moderately Mounded	Mor	C	4	Well Drained	F	-	-	-	-	not assessed
043	Forest	Fp	2	305	Valley Floor	Depression	Level	None	D	7	Very Poor	U	-	Claypan	30	-	not assessed
044a	Other (Reclaimed Road)	Au	0	not assessed	Valley Floor	Crest	Level	None	-	-	Well Drained	-	-	-	-	-	not assessed
044b	Other (Reclaimed Road)	Au	0	not assessed	Valley Floor	Depression	Level	None	-	-	Rapid	F	-	Excesive Moisture	40	-	not assessed
045	Wetland	Fp	0	not assessed	Valley Floor	Level	Slightly mounded	Mull	E	7	Very Poor	U	55	Excesive Moisture	55	-	not assessed
046	Other	Fm	0	not assessed	Valley Floor	Crest	Moderately Mounded	None	D	5	Well Drained	U	-	-	-	-	not assessed
047	Forest	FGj	12	310	Lower	Upper	Slightly mounded	Mor	B	3	Rapid	-	-	-	-	-	not assessed
048	Forest	FGj	22	160	Lower	Middle	Moderately Mounded	Mor	C	5	Moderately	F	-	-	-	-	not assessed
049	Forest	Ff	10	170	Lower	Lower	Strongly Mounded	None	D	3	Well Drained	U	-	-	-	-	not assessed

Geo-processes:

F *Slow mass movement*
L *Seepage*
R *Rrapid mass maovement*
U *Inundation*
V *Gully erosion*

Appendix 4. Summary of Terrain and Soil Inspection Data

a) Site Data

Site ID	Landuse	Field Terrain Code	Slope	Aspect	Macro Slope Position	Meso Slope Position	Microtopography	Humus Order	SNR	SMR	Drainage	Geo Process	Water Table Depth	Root Restriction	Root Restriction Depth	Salvage Depth	Accessibility
050a	Forest	Cs-FR	90	70	Lower	Lower	Severely Mounded	Mor	B	4	Well Drained	FR	-	-	-	-	not assessed
050b	Forest	R	12	90	Valley Floor	Lower	Slightly mounded	None	B	3	Very Rapid	V	-	-	-	-	not assessed
051	Forest	Mj	12	190	Lower	Middle	Slightly mounded	Mor	C	4	Well Drained	-	-	-	-	-	not assessed
052	Forest	FGv/Mr	15	160	Middle	Upper	Moderately Mounded	Mor	B	3	Well Drained	-	-	-	-	-	not assessed
053	Wetland	Op	2	130	Middle	Level	Moderately Mounded	Peat	B	7	Very Poor	-	-	-	-	-	not assessed
054	Forest	Ov/Mr/Ru	3	150	Middle	Level	Moderately Mounded	None	D	6	Very Poor	-	-	-	-	50	not assessed
055	Forest	Mv/Ru	8	30	Middle	Middle	Moderately Mounded	Mor	B	4	Well Drained	-	-	Lithic	60	20	not assessed
056	Forest	Mb/Rr	55	280	Middle	Lower	Moderately Mounded	Mor	B	4	Well Drained	F	-	-	-	-	not assessed
057	Forest	Mv/Ru	0	40	Middle	Crest	Moderately Mounded	Mor	B	2	Well Drained	-	-	-	-	-	not assessed
058	Forest	Mv/Ru	15	50	Middle	Upper	Strongly Mounded	Mor	C	4	Well Drained	-	-	-	-	-	not assessed
059	Forest	Mu	11	90	Middle	Middle	Strongly Mounded	Moder	C	5	Moderately	-	-	-	-	38	not assessed
060	Forest	Mv/Ru	0	not assessed	Middle	Upper	Moderately Mounded	Mor	B	4	Well Drained	-	-	-	-	-	not assessed
061	Forest	Ob/Ru	0	not assessed	Middle	Lower	Moderately Mounded	None	D	7	Very Poor	U	27	-	-	-	not assessed
062	Forest	Mbuj	12	355	Middle	Middle	Moderately Mounded	Mor	B	5	Moderately	-	-	Lithic	25	-	not assessed
063b	Forest	Muj	15	30	Middle	Upper	Moderately Mounded	Mor	D	6	Moderately	-	-	-	-	-	not assessed
064	Other (floodplain)	Ftp	2	150	Valley Floor	Level	Level	None	B	3	Very Rapid	-	-	-	-	-	not assessed
065	Forest	Ftp	3	90	Valley Floor	Upper	Slightly mounded	Mor	B	3	Rapid	-	-	Lithic	55	-	not assessed
066	Forest	Mw/Rmj	20	200	Middle	Middle	Slightly mounded	Moder	D	4	Well Drained	-	-	-	-	30	not assessed
067	Forest	Mmj	5	160	Middle	Lower	Slightly mounded	Moder	D	5	Imperfect	-	-	Compaction	18	50	not assessed
068	Forest	Mw/Rm	5	100	Middle	Middle	Slightly mounded	Mor	D	4	Well Drained	-	-	-	-	15	not assessed
069	Forest	M	10	110	Middle	Toe	Slightly mounded	Moder	D	6	Poor	L	-	Compaction	11	56	not assessed
070	Forest	Mw/Rj	12	130	Middle	Middle	Slightly mounded	Mor	C	4	Moderately	-	-	Lithic	75	20	not assessed
071	Forest	Mw/Rm	24	160	Middle	Middle	Slightly mounded	Mor	C	3	Well Drained	-	-	Lithic	65	10	not assessed
072	Forest	Mw/Rj	6	180	Upper	Middle	Moderately Mounded	Mor	C	4	Well Drained	-	-	-	-	20	not assessed
073	Forest	Mw/Rm-L	16	160	Upper	Upper	Slightly mounded	Mor	C	3	Well Drained	L	-	-	-	10	not assessed
074	Forest	Mw/Rm	0	not assessed	Upper	Crest	Slightly mounded	Mor	B	4	Moderately	-	-	Compaction	25	-	not assessed
075	Forest	Mw/Rma	27	200	Middle	Lower	Moderately Mounded	Mor	D	5	Imperfect	-	-	-	-	15	not assessed
076	Forest	Mw/Rm	3	140	Lower	Level	Slightly mounded	Mor	B	4	Moderately	-	-	Claypan	30	15	not assessed
077	Forest	Ov/Mj	6	120	Lower	Level	Slightly mounded	Peat	E	6	Poor	-	-	Claypan	35	35	not assessed
078	Forest	Au	0	not assessed	Middle	Crest	Strongly Mounded	Mor	C	4	Well Drained	-	-	-	-	15	not assessed
079	Forest	Cw/Rra	42	230	Middle	Middle	Moderately Mounded	Moder	C	4	Well Drained	-	-	-	-	25	not assessed
080	Wetland	Ob/Mu	0	not assessed	Middle	Depression	Slightly mounded	Peat	C	7	Very Poor	-	25	-	-	130	not assessed
081	Wetland	Ob/Mud	0	not assessed	Middle	Depression	Level	Peat	C	8	Very Poor	-	30	-	-	130	not assessed
082	Forest	Mw/Rmj	10	100	Middle	Middle	Slightly mounded	Mor	C	4	Well Drained	-	-	Compaction	20	15	not assessed
083	Wetland	Ov/Fp	0	not assessed	Lower	Level	Level	Peat	D	7	Poor	U	105	-	-	25	not assessed
084	Other (river terrace)	Ftp	0	not assessed	Valley Floor	Level	Level	None	D	5	Rapid	-	-	-	-	10	not assessed
085	Forest	Ftp	0	not assessed	Valley Floor	Level	Level	Mor	B	4	Well Drained	-	-	-	-	10	not assessed
086	Forest	Mv/Fp	8	250	Valley Floor	Middle	Slightly mounded	Moder	C	5	Imperfect	L	-	Compaction	20	25	not assessed
087	Wetland	Ob/Fp	0	not assessed	Valley Floor	Level	Level	Peat	D	8	Very Poor	-	-	-	-	105	not assessed
088	Forest	GFw/Ruj	25	310	Lower	Upper	Moderately Mounded	Mor	B	3	Well Drained	-	-	-	-	10	not assessed
089	Forest	Ca-FV	30	50	Lower	Lower	Strongly Mounded	Mor	C	4	Well Drained	FV	-	-	-	10	not assessed
090	Forest	Ob/FGp	0	not assessed	Valley Floor	Level	Moderately Mounded	Peat	B	7	Very Poor	-	-	-	-	100	not assessed
091	Wetland	Ob/FGp	0	not assessed	Valley Floor	Depression	Moderately Mounded	Peat	B	7	Very Poor	-	20	-	-	100	not assessed
092	Wetland	Op	0	not assessed	Valley Floor	Level	Strongly Mounded	Peat	B	7	Very Poor	-	-	-	-	100	not assessed
093	Forest	FGp	3	270	Lower	Upper	Slightly mounded	Mor	B	3	Well Drained	-	-	-	-	10	not assessed
094	Forest	Mw/Rmj	8	210	Middle	Upper	Slightly mounded	Mor	B	3	Well Drained	-	-	-	-	10	not assessed
095	Forest	Mbj	10	110	Lower	Lower	Slightly mounded	Moder	C	5	Moderately	F	-	-	-	20	not assessed
096	Forest	Ov/Mp	1	not assessed	Lower	Level	Slightly mounded	Peat	D	7	Poor	-	-	-	-	120	not assessed
097	Other (Clearcut)	Mu	13	20	Lower	Middle	Moderately Mounded	Mor	B	5	Imperfect	-	80	Claypan	40	15	not assessed

Geo-processes:

F *Slow mass movement*
L *Seepage*
R *Rrapid mass maovement*
U *Inundation*
V *Gully erosion*

Appendix 4. Summary of Terrain and Soil Inspection Data

a) Site Data

Site ID	Landuse	Field Terrain Code	Slope	Aspect	Macro Slope Position	Meso Slope Position	Microtopography	Humus Order	SNR	SMR	Drainage	Geo Process	Water Table Depth	Root Restriction	Root Restriction Depth	Salvage Depth	Accessibility
098	Forest	Mu	8	45	Lower	Middle	Moderately Mounded	Moder	D	5	Moderately	L	-	Claypan	25	25	not assessed
099	Forest	Mw/Ruj	10	70	Middle	Middle	Moderately Mounded	Mor	C	5	Imperfect	-	-	-	-	20	not assessed
100	Forest	Mw/Ruj	20	50	Middle	Middle	Moderately Mounded	Mor	C	4	Well Drained	-	-	-	-	10	not assessed
101	Forest	Mw/Rr	52	270	Lower	Upper	Slightly mounded	Mor	B	3	Well Drained	-	-	-	-	25	not assessed
102	Wetland	Lv/Fp	0	not assessed	Valley Floor	Depression	Level	Peat	D	8	Very Poor	-	-	-	-	-	not assessed
103	Wetland	Op	0	not assessed	Valley Floor	Depression	Moderately Mounded	Peat	C	8	Very Poor	-	-	-	-	100	not assessed
104	Forest	Ov/FGp	5	250	Lower	Lower	Moderately Mounded	Peat	B	7	Very Poor	-	-	-	-	100	not assessed
105	Forest	Fgw/Mu	0	not assessed	Valley Floor	Lower	Slightly mounded	Mor	C	4	Well Drained	-	-	-	-	25	not assessed
106	Wetland	Ob/Mu	3	260	Lower	Lower	Slightly mounded	Peat	D	6	Poor	L	85	-	-	65	not assessed
107	Other (clearcut)	FGv/Mj	20	280	Lower	Lower	Slightly mounded	Mor	D	5	Moderately	-	-	-	-	30	not assessed
212	Forest	zsFGv/gscMu	4	240	Lower	Upper	not assessed	Mor	C	4	Well Drained	-	-	-	-	50	not assessed
213	Forest	gzCv/gzcMk	70	280	Middle	Upper	not assessed	Mor	C	4	Well Drained	FV	-	-	-	-	not assessed
214	Forest	gsFp	0	not assessed	Lower	Level	not assessed	Mor	-	-	Imperfect	-	-	Excesive Moisture	48	-	not assessed
217	Forest	gzcC:FGx/zcMb	35	270	not assessed	Middle	not assessed	Mor	B	4	Well Drained	F	-	-	-	-	Good
218	Forest	kgsFGv/kgcMx	20	280	not assessed	Middle	not assessed	Mor	C	4	Well Drained	-	-	-	-	-	Good
219	Forest	zsC:FGv/cMv/Ru	20	260	Middle	Middle	not assessed	Mor	C	4	Well Drained	FV	-	-	-	35	not assessed
221	Forest	zsFGb	0	not assessed	not assessed	Middle	not assessed	Mull	C	3	Rapid	-	-	-	-	-	not assessed
222	Wetland	uhOb/gcMj	0	not assessed	not assessed	Level	not assessed	Peat	C	7	Very Poor	L	-	Excesive Moisture	40	-	Good
224	Forest	zcsFp	1	not assessed	not assessed	Level	not assessed	Mor	C	5	Well Drained	-	-	-	-	-	Good
225	Forest		0	not assessed	not assessed	Level	not assessed	Mull	C	7	Poor	-	-	-	-	-	Good
226	Wetland	euOv/zcLp	0	not assessed	not assessed	Level	not assessed	Peat	B	7	Very Poor	-	-	-	-	-	not assessed
227	Forest	FGv/Mu	15	270	not assessed	Middle	not assessed	Mor	B	4	Well Drained	-	-	-	-	-	not assessed
228	Forest	Mbu	0	not assessed	not assessed	Middle	not assessed	Mor	B	4	Well Drained	-	-	-	-	-	not assessed
229	Forest	Mbu	0	not assessed	not assessed	Middle	not assessed	Mor	C	4	Well Drained	-	-	-	-	-	not assessed
230	Forest	Mbu	0	not assessed	not assessed	Middle	not assessed	Mor	B	4	Well Drained	-	-	-	-	-	not assessed
232	Forest	zsFGx/Mu	10	170	not assessed	Middle	not assessed	Mull	B	3	Well Drained	-	-	Claypan	-	-	not assessed
233	Forest	FG/M	4	220	not assessed	Middle	not assessed	Mor	C	4	Well Drained	-	-	-	-	-	not assessed
238	Forest	zsFGx/zcMu	0	not assessed	not assessed	Middle	not assessed	Mull	B	3	Well Drained	-	-	-	-	-	not assessed
242	Forest	zcsFGbu	37	70	Valley Floor	Toe	not assessed	Mor	D	5	Moderately	LVF	-	-	-	-	not assessed
243	Forest	zcMbu	25	205	Upper	Upper	not assessed	Mor	B	4	Imperfect	-	-	Claypan	30	-	not assessed
244	Wetland	hOv/zcMp	1	not assessed	Valley Floor	Level	not assessed	Mor	D	7	Very Poor	-	-	Excesive Moisture	-	50	not assessed
254	Forest	szFAp	0	not assessed	not assessed	Level	not assessed	Mor	D	5	Moderately	-	-	-	-	-	not assessed
270	Forest	gzcMv/Rj	12	150	Middle	Upper	not assessed	Mor	C	4	Moderately	V	-	Compaction	-	-	not assessed
273	Forest	zgsMx/Rja	40	130	Middle	Middle	not assessed	Mor	C	3	Rapid	-	-	-	-	-	not assessed
279	Forest	gzcMv/Ra	23	110	Lower	Middle	not assessed	Mor	B	3	Well Drained	-	-	-	-	-	not assessed
282	Forest	gzcFp	8	330	Valley Floor	Lower	not assessed	Mor	C	4	Well Drained	-	-	-	-	-	not assessed
285	Forest	szgFGbj	6	260	not assessed	Middle	not assessed	Mor	C	4	Well Drained	-	-	-	-	-	Poor
301	Forest	FGb/Mw/Rj	9	230	not assessed	not assessed	not assessed	Humimor	-	-	Imperfect	L	-	not assessed	not assessed	25	Poor
302	Forest	FGv/Mw/Ru	6	220	not assessed	not assessed	not assessed	Hemimor	-	-	Imperfect	-	-	not assessed	not assessed	30	Good
303	Forest	Mw/Rj	70	190	not assessed	not assessed	not assessed	Lignomor	-	-	Well Drained	-	-	not assessed	not assessed	not suitable	Good
305	Forest	FGv/Mw/Rj	5	220	not assessed	not assessed	not assessed	Hemimor	-	-	Well Drained	-	-	not assessed	not assessed	50	Good
306	Forest	Mw/Rj	6	220	not assessed	not assessed	not assessed	Hemimor	-	-	Well Drained	-	-	not assessed	not assessed	not suitable	Good
307	Forest	Mw/Ru	12	230	not assessed	not assessed	not assessed	Hemimor	-	-	Well Drained	-	-	not assessed	not assessed	not suitable	Good
308	Forest	Mb	0	not assessed	not assessed	not assessed	not assessed	Humimor	-	-	Imperfect	-	70	not assessed	not assessed	30	Good
309	Wetland	Ov/FGp	0	not assessed	not assessed	not assessed	not assessed	Peat	-	-	Very Poor	-	-	not assessed	not assessed	45	Good
310	Forest	FGv/Mx/Rj	0	not assessed	not assessed	not assessed	not assessed	Hemimor	-	-	Rapid	-	-	not assessed	not assessed	50	Good
311	Forest	FGv/Mv/Ru	0	not assessed	not assessed	not assessed	not assessed	Lignomor	-	-	Well Drained	-	-	not assessed	not assessed	50	Good
312	Forest	FGv/Mv/Ru	3	210	not assessed	not assessed	not assessed	Hemimor	-	-	Well Drained	-	-	not assessed	not assessed	35	Good
314	Forest	Mv/Ru	1	not assessed	not assessed	not assessed	not assessed	Humimor	-	-	Well Drained	-	-	not assessed	not assessed	25	Good

Geo-processes:

F *Slow mass movement*
L *Seepage*
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a) Site Data

Site ID	Landuse	Field Terrain Code	Slope	Aspect	Macro Slope Position	Meso Slope Position	Microtopography	Humus Order	SNR	SMR	Drainage	Geo Process	Water Table Depth	Root Restriction	Root Restriction Depth	Salvage Depth	Accessibility
315	Forest	Mv/Rp	1	not assessed	not assessed	not assessed	not assessed	Hemimor	-	-	Well Drained	-	-	not assessed	not assessed	not suitable	Good
316	Forest	Mv/Rp	0	not assessed	not assessed	not assessed	not assessed	Hemimor	-	-	Moderately	-	-	not assessed	not assessed	30	Good
317	Forest	FGv/Mw/Rp	2	not assessed	not assessed	not assessed	not assessed	Hemimor	-	-	Well Drained	-	-	not assessed	not assessed	30	Good
318	Forest	FGv/Mw/Ru	12	280	not assessed	not assessed	not assessed	Hemimor	-	-	Well Drained	-	-	not assessed	not assessed	50	Good
320	Forest	FGv/Mw/Rp	0	not assessed	not assessed	not assessed	not assessed	Hemimor	-	-	Well Drained	-	-	not assessed	not assessed	50	Good
321	Forest	FGv/Mw/Rj	2	not assessed	not assessed	not assessed	not assessed	Hemimor	-	-	Well Drained	-	-	not assessed	not assessed	50	Good
322	Forest	FGx/Mw/Ru	0	not assessed	not assessed	not assessed	not assessed	Hemimor	-	-	Well Drained	-	-	not assessed	not assessed	not suitable	Good
323	Forest	FGv/Mw/Ru	0	not assessed	not assessed	not assessed	not assessed	Hemimor	-	-	Well Drained	-	-	not assessed	not assessed	50	Good
324	Forest	FGv/Mw/Rp	1	not assessed	not assessed	not assessed	not assessed	Hemimor	-	-	Well Drained	-	-	not assessed	not assessed	50	Good
326	Forest	FGv/Mw/Rp	2	not assessed	not assessed	not assessed	not assessed	Hemimor	-	-	Well Drained	-	-	not assessed	not assessed	35	Good
326	Forest	FGv/Mw/Rp	2	not assessed	not assessed	not assessed	not assessed	Hemimor	-	-	Well Drained	-	-	not assessed	not assessed	35	Good
327	Forest	FGv/Mw/Ru	16	150	not assessed	not assessed	not assessed	Hemimor	-	-	Well Drained	-	-	not assessed	not assessed	50	Good
328	Forest	Mw/Ru	0	not assessed	not assessed	not assessed	not assessed	Resimor	-	-	Well Drained	-	-	not assessed	not assessed	20	Good
329	Other	FGb/Mu	0	not assessed	not assessed	not assessed	not assessed	None	-	-	Very Rapid	-	-	not assessed	not assessed	not suitable	Fair
330	Forest	FGu	0	not assessed	not assessed	not assessed	not assessed	Hemimor	-	-	Rapid	-	-	not assessed	not assessed	not suitable	Fair
331	Forest	FGj	4	240	not assessed	not assessed	not assessed	Hemimor	-	-	Well Drained	-	-	not assessed	not assessed	25	Good
332	Forest	FGa	49	80	not assessed	not assessed	not assessed	Hemimor	-	-	Rapid	-	-	not assessed	not assessed	50	Poor
335	Forest	FGp	2	not assessed	not assessed	not assessed	not assessed	Hemimor	-	-	Well Drained	-	-	not assessed	not assessed	not suitable	Good
336	Forest	FGbj	10	90	not assessed	not assessed	not assessed	Hemimor	-	-	Well Drained	F	-	not assessed	not assessed	80	Fair
401	Forest	Obj	6	292	Middle	Middle	not assessed	Peat	B	6	Very Poor	-	> 100	-	-	>60	Good
402	Forest	Ov/FGv	6	245	Middle	Lower	not assessed	Peat	C	5	Imperfect	L	85	-	-	50	Good
403	Forest	FGv/Mj	10	262	Middle	Middle	not assessed	Mor	B	4	Well Drained	L	75	-	-	30	Good
404	Wetland	Obp	3	242	Middle	Level	not assessed	Peat	A	7	Very Poor	-	40	-	-	>60	Good
405	Forest	FGv/Mu	2	not assessed	Middle	Upper	not assessed	Mor	C	3	Well Drained	-	>100	-	-	25	Good
406	Forest	Fx/Mks	3	344	Valley Floor	Level	not assessed	Mull	D	6	Imperfect	V	50	Excesive Moisture	50	not suitable	Poor
407	Wetland	Obp	0	not assessed	Middle	Level	not assessed	Peat	A	7	Very Poor	-	>100	-	-	>60	Good
408	Forest	FGv/Mj	3	296	Middle	Middle	not assessed	Mor	C	4	Well Drained	-	>100	-	-	25	Good
409	Forest	FGv/Mu	6	230	Middle	Middle	not assessed	Mor	C	4	Well Drained	-	>100	-	-	25	Good
410	Forest	Muj	6	260	Middle	Middle	not assessed	Mor	C	4	Moderately	-	>100	-	-	25	Good
411	Forest	Mbj	2	276	Middle	Lower	not assessed	Mor	C	5	Moderately	-	>100	-	-	60	Good
412	Forest	Mbj	5	262	Middle	Middle	not assessed	Mor	D	4	Well Drained	-	>100	-	-	60	Good
413	Forest	Fv/Mbuj	8	340	Middle	Lower	not assessed	Mull	D	6	Poor	L	55	Claypan	50	50	Good

Geo-processes:

F *Slow mass movement*
L *Seepage*
R *Rrapid mass maovement*
U *Inundation*
V *Gully erosion*

Appendix 4. Summary of Terrain and Soil Inspection Data

b) Soil Data

Site ID	Horizon	Top Depth	Bottom Depth	Structure Grade	Structure Class	Structure Kind	Consistence	Soil Texture	% Gravel	% Cobbles	% Boulders	% Coarse Fr.	Coarse Fr. Shape	Soil pH	Mottles Abundance	Mottles Size	Mottle Colour	Root Abundance	Root Size	Carbonates
001	LFH	23	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	abundant	fine/medium	-
001	Ah	0	8	-	-	single grained	Friable	fine sand	-	10	-	10	angular	-	-	-	-	abundant	fine/medium	-
001	Bm	8	30	-	-	single grained	Friable	fine sand	-	-	-	-	-	-	common	medium	faint	few	coarse	-
001	C	30	41	-	-	massive	Firm	loam	90	-	-	90	angular	-	-	-	-	-	-	-
001	II C	41	100	-	-	massive	Firm	clay loam	3	1	-	4	angular	-	common	medium	distinct	-	-	-
002	LFH	11	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	abundant	fine	-
002	Ah	0	2	weak	coarse	granular	Friable	fine sand	-	1	-	1	round	-	-	-	-	abundant	fine	-
002	Ae	2	8	weak	coarse	platy	Friable	fine sand	-	1	-	1	round	-	-	-	-	plentiful	medium/coarse	-
002	Bf	8	23	moderate	medium	angular blocky	Friable	loamy sand	-	-	-	-	-	-	-	-	-	plentiful	medium	-
002	BC	23	38	-	-	massive	Friable	loamy sand	1	-	-	1	round	-	-	-	-	few	medium	-
002	C	38	60	-	-	massive	Friable	-	5	-	10	15	round	-	-	-	-	-	-	-
002	R	60+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
003	LFH	11	0	-	-	-	-	loamy sand	-	-	-	-	-	-	-	-	-	abundant	fine/medium	-
003	Ah	0	2	weak	medium	granular	Friable	loamy sand	2	-	-	2	round	-	-	-	-	abundant	fine/medium	-
003	Ae	2	12	moderate	medium	platy	Friable	loamy sand	2	-	-	2	round	-	-	-	-	abundant	fine/medium	-
003	Bt	12	27	moderate	medium	subangular blocky	Friable	sandy loam	2	5	-	7	round	-	-	-	-	few	fine/medium	-
003	BC	27	41	moderate	medium	subangular blocky	Friable	loam	2	-	-	2	round	-	-	-	-	few	fine	-
003	C	41	100	-	-	massive	Firm	loam	20	-	-	20	round	-	-	-	-	-	-	-
004	LFH	4	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
004	Ah	0	4	weak	fine	granular	Very firm	clay loam	50	-	-	50	angular	-	-	-	-	abundant	fine	-
004	C	4	35	-	-	massive	Very firm	clay loam	40	20	-	60	angular	-	-	-	-	abundant	fine	-
004	R	35+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
005	LFH	4	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	abundant	fine	-
005	Ah	0	3	moderate	fine	granular	Very firm	clay loam	50	-	-	50	angular	-	-	-	-	abundant	fine	-
005	C	3	18	-	-	massive	Very firm	clay loam	40	20	10	70	angular	-	-	-	-	-	-	-
005	R	18+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
006	LFH	6	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	plentiful	fine/medium	-
006	Ah	0	11	weak	fine	platy	Firm	loam	30	5	-	35	angular	-	-	-	-	plentiful	medium	-
006	C	11	55	-	-	massive	Firm	clay loam	30	10	-	40	angular	-	-	-	-	few	fine/medium/coarse	-
007	LFH	4	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	abundant	fine/medium/coarse	-
007	Ae	0	8	moderate	medium	platy	Friable	loam	5	-	-	5	angular	-	-	-	-	abundant	fine/medium	-
007	Btj	8	15	weak	medium	subangular blocky	Friable	loam	5	-	-	5	angular	-	-	-	-	plentiful	medium	-
007	Ae2	15	22	weak	fine	subangular blocky	Firm	sandy loam	5	-	-	5	angular	-	-	-	-	plentiful	medium	-
007	Bm	22	30	-	-	massive	Firm	sandy loam	5	-	-	5	angular	-	-	-	-	plentiful	medium	-
007	C	30	100	-	-	massive	Firm	sandy loam	10	5	5	20	angular	-	-	-	-	few	medium	-
008	Om	0	30	-	-	-	-	-	-	-	-	-	-	6.6	-	-	-	plentiful	fine/medium/coarse	-
008	Cg	30	100	-	-	massive	Slightly sticky	clay loam	-	-	-	-	-	-	few	coarse	distinct	-	-	-
009	LFH	14	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	abundant	fine/medium	-
009	Ah	0	5	weak	medium	platy	Slightly sticky	loam	-	-	-	-	-	-	-	-	-	abundant	fine/medium	-
009	Cg1	5	38	weak	coarse	platy	Slightly sticky	loamy sand	-	-	-	-	-	-	few	fine	prominent	-	-	-
009	Cg2	38	61	-	-	massive	-	loamy sand	-	-	-	-	-	-	common	medium	prominent	-	-	-
009	Cg3	61	100	-	-	massive	-	loamy sand	-	-	-	-	-	-	many	coarse	prominent	-	-	-
010	LFH	14	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	abundant	fine/medium	-
010	Ae	0	11	weak	medium	subangular blocky	Friable	loam	10	5	-	15	angular	-	-	-	-	few	medium	-
010	Bfj	11	17	strong	medium	subangular blocky	Firm	sandy loam	10	5	-	15	angular	-	-	-	-	few	medium	-
010	BCgj	17	41	-	-	massive	Firm	sandy clay loam	10	-	20	30	angular	-	few	medium	distinct	-	-	-
010	Cgj	41	100	-	-	massive	Firm	sandy clay loam	10	-	20	30	angular	-	few	medium	distinct	-	-	-
011	LFH	18	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
011	Ah	0	10	weak	fine	granular	Firm	loam	5	-	-	5	angular	-	-	-	-	-	-	-
011	C	10	50	-	-	massive	Firm	clay loam	5	-	-	5	angular	-	-	-	-	abundant	fine/medium/coarse	-
011	Cgj	50	100	-	-	massive	Very Firm	clay	-	-	-	-	-	-	common	medium	distinct	few	medium	-
012	LFH	12	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	abundant	fine/medium/coarse	-
012	Ae	0	12	weak	medium	platy	Friable	loam	2	-	-	2	angular	-	-	-	-	abundant	fine/medium/coarse	-
012	Bf	12	21	weak	very fine	subangular blocky	Friable	loam	2	-	-	2	angular	-	-	-	-	plentiful	medium	-
012	C	21	30	-	-	massive	Friable	loam	2	1	-	3	angular	-	-	-	-	few	medium	-
012	R	30+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
013	LFH	2	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	abundant	fine/medium	-

Appendix 4. Summary of Terrain and Soil Inspection Data

b) Soil Data

Site ID	Horizon	Top Depth	Bottom Depth	Structure Grade	Structure Class	Structure Kind	Consistence	Soil Texture	% Gravel	% Cobbles	% Boulders	% Coarse Fr.	Coarse Fr. Shape	Soil pH	Mottles Abundance	Mottles Size	Mottle Colour	Root Abundance	Root Size	Carbonates
013	Ah	0	6	-	-	massive	Loose	clay loam	50	10	-	60	angular	-	-	-	-	plentiful	fine/medium/coarse	-
013	C	6	50	-	-	massive	Loose	clay loam	50	10	-	60	angular	-	-	-	-	few	fine/medium	-
014	Om	0	10	-	-	-	-	-	-	-	-	-	-	6.6	-	-	-	abundant	fine/medium	-
014	Oh	10	100	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
015	Of	0	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	abundant	fine/medium/coarse	-
015	Oh	11	52	-	-	-	-	-	-	-	-	-	-	-	-	-	-	plentiful	fine/medium	-
015	Cgj	52	100	-	-	massive	Friable	sandy clay loam	-	-	-	-	-	-	few	coarse	faint	-	-	-
016	LFH	8	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	abundant	fine/medium	-
016	Ah	0	11	weak	fine	granular	Friable	clay loam	-	-	-	-	-	-	-	-	-	plentiful	fine/medium	-
016	Bm	11	22	moderate	medium	subangular blocky	Friable	clay loam	-	-	-	-	-	-	-	-	-	few	fine	-
016	C1	22	50	-	-	massive	Friable	loamy sand	-	-	-	-	-	-	few	medium	faint	few	fine	-
016	C2	50	70	-	-	massive	Firm	clay	-	-	-	-	-	-	-	-	-	-	-	-
016	C3	70	100	-	-	massive	Friable	loamy sand	-	-	-	-	-	-	-	-	-	-	-	-
017	LFH	5	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	abundant	fine/medium/coarse	-
017	Aej	0	11	weak	fine	granular	Friable	loam	50	5	-	55	angular	-	-	-	-	few	medium	-
017	C	11	40	-	-	massive	Friable	loam	50	5	-	55	angular	-	-	-	-	few	fine	-
017	R	40+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
018	LFH	8	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	abundant	fine/medium	-
018	Ae	0	8	weak	medium	platy	Friable	loamy sand	-	-	-	-	-	-	-	-	-	few	fine/medium	-
018	Bf	8	24	moderate	medium	angular blocky	Friable	loamy sand	-	-	-	-	-	-	-	-	-	few	fine/medium	-
018	BC	24	46	-	-	massive	Friable	loamy sand	-	-	-	-	-	-	-	-	-	few	fine	-
018	C1	46	63	-	-	massive	Friable	loamy sand	-	-	-	-	-	-	-	-	-	few	fine	-
018	C2	63	100	-	-	massive	Firm	sandy clay loam	15	-	-	15	angular	-	-	-	-	-	-	-
019	LFH	8	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
019	Ae	0	11	moderate	coarse	platy	Friable	loamy sand	-	-	-	-	-	-	-	-	-	abundant	fine/medium/coarse	-
019	Bm	11	19	moderate	medium	subangular blocky	Friable	loamy sand	-	-	-	-	-	-	-	-	-	plentiful	fine/medium/coarse	-
019	Ahb	19	23	moderate	medium	subangular blocky	Firm	sandy clay loam	3	-	-	3	round	-	-	-	-	plentiful	fine/medium	-
019	Bmb	23	30	-	-	massive	Firm	sandy clay loam	5	-	-	5	round	-	-	-	-	plentiful	fine/medium	-
019	C	30	100	-	-	massive	Firm	sand	5	-	-	5	round	-	-	-	-	few	fine/medium	-
020	LFH	9	0	-	-	-	Friable	-	-	-	-	-	-	-	-	-	-	abundant	fine/medium/coarse	-
019	C	30	100	-	-	massive	Firm	sand	5	-	-	5	round	-	-	-	-	few	fine/medium	-
020	LFH	9	0	-	-	-	Friable	-	-	-	-	-	-	-	-	-	-	abundant	fine/medium/coarse	-
020	Ah	0	5	moderate	medium	platy	Firm	clay loam	-	-	-	-	round	-	-	-	-	abundant	fine/medium/coarse	-
020	C1	5	25	moderate	medium	angular blocky	Firm	clay loam	-	-	-	-	round	6	few	fine	faint	plentiful	fine/medium	-
020	C2	25	36	-	-	single grained	Firm	sand	15	-	-	15	round	-	-	-	-	plentiful	fine	-
020	C3	36	44	-	-	massive	Firm	loam	-	-	-	-	round	-	-	-	-	few	fine	-
020	C4	44	100	-	-	granular	Firm	sand	40	-	-	40	round	-	-	-	-	-	-	-
021	LFH	8	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	abundant	fine/medium/coarse	-
021	Ae	0	3	weak	fine	platy	Friable	clay loam	-	-	-	-	-	-	-	-	-	plentiful	fine/medium	-
021	Bm	3	15	moderate	fine	subangular blocky	Firm	clay loam	2	-	-	2	angular	-	-	-	-	plentiful	fine	-
021	C	15	100	-	-	granular	Firm	sand	60	-	-	60	round	-	-	-	-	plentiful	fine	-
022	LFH	5	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	abundant	fine/medium/coarse	-
022	C	0	60	-	-	massive	Friable	clay loam	25	50	-	75	round	-	-	-	-	abundant	fine/medium/coarse	-
023	LFH	9	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	abundant	fine/medium/coarse	-
023	C1	0	6	weak	fine	platy	Friable	clay loam	-	-	-	-	-	-	-	-	-	plentiful	fine/medium/coarse	-
023	Ahb	6	9	weak	coarse	granular	Friable	clay loam	-	-	-	-	-	-	-	-	-	plentiful	fine/medium/coarse	-
023	C2	9	110	-	-	massive	Friable	clay loam	-	-	-	-	-	-	few	coarse	faint	plentiful	fine/medium	-
023	C3	110	130	-	-	massive	Firm	clay	30	-	-	30	round	-	-	-	-	-	-	-
024	C	0	80	-	-	granular	Firm	sand	10	-	-	10	subrounded	-	-	-	-	few	fine/medium	-
024	R	80+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
025	LFH	11	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	abundant	fine/medium	-
025	C1	0	95	-	-	massive	Friable	clay loam	-	-	-	-	-	-	-	-	-	plentiful	fine/medium/coarse	-
025	C2	95	100	-	-	granular	Friable	sand	30	-	-	30	angular	-	-	-	-	-	-	-
026	LFH	11	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	abundant	fine/medium/coarse	-
026	Ah	0	11	-	-	-	Friable	loam	2	-	-	2	angular	-	-	-	-	few	fine	-
026	Ae	11	34	-	-	-	Friable	silt loam	5	-	-	5	angular	-	-	-	-	-	-	-
026	Bm	34	48	-	-	-	Firm	clay loam	15	-	-	15	angular	-	-	-	-	-	-	-
026	C	48	100	-	-	-	Firm	clay loam	15	-	-	15	angular	-	-	-	-	-	-	-
027	LFH	4	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	abundant	fine/medium/coarse	-

Appendix 4. Summary of Terrain and Soil Inspection Data

b) Soil Data

Site ID	Horizon	Top Depth	Bottom Depth	Structure Grade	Structure Class	Structure Kind	Consistence	Soil Texture	% Gravel	% Cobbles	% Boulders	% Coarse Fr.	Coarse Fr. Shape	Soil pH	Mottles Abundance	Mottles Size	Mottle Colour	Root Abundance	Root Size	Carbonates
027	Ae	0	15	weak	fine	granular	Strong	silt loam	3	-	-	3	angular	-	-	-	-	plentiful	medium/coarse	-
027	Bm	15	33	weak	coarse	subangular blocky	Strong	clay loam	15	-	-	15	angular	6.5	-	-	-	plentiful	fine/medium	-
027	C	33	100	-	-	massive	Friable	clay loam	30	15	-	45	angular	-	-	-	-	-	-	-
028	LFH	6	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	abundant	fine/medium/coarse	-
028	Ae	0	15	weak	fine	platy	Friable	silt loam	10	10	30	50	angular	-	-	-	-	plentiful	fine/medium/coarse	-
028	Bf	15	29	weak	medium	subangular blocky	Friable	clay loam	5	5	-	10	angular	-	-	-	-	few	fine/medium	-
028	BC	29	40	weak	medium	subangular blocky	Friable	clay loam	5	5	-	10	angular	-	-	-	-	few	fine	-
028	C	40	100	-	-	massive	Firm	silty clay	30	-	-	30	angular	-	-	-	-	-	-	-
029	LFH	6	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	abundant	fine/medium	-
029	Ae	0	12	weak	medium	platy	Friable	silty clay loam	5	-	-	5	subrounded	-	-	-	-	plentiful	fine/medium	-
029	Bf	12	21	weak	fine	subangular blocky	Firm	clay loam	50	-	-	50	subrounded	-	-	-	-	plentiful	fine/medium	-
029	C	21	100	-	-	massive	Firm	silt loam	50	2	-	52	subrounded	-	-	-	-	few	fine	-
030	LFH	10	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	abundant	fine/medium/coarse	-
030	C1	0	15	weak	medium	subangular blocky	Firm	silty clay loam	30	20	-	50	round/angular	-	common	fine	prominent	few	fine	-
030	C2	15	70	-	-	massive	Firm	silty clay loam	40	20	-	60	round/angular	-	common	fine	prominent	-	-	-
031	LFH	5	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	abundant	fine/medium/coarse	-
031	Ae	0	11	moderate	coarse	platy	Very friable	sandy loam	-	-	-	-	-	-	-	-	-	few	fine/medium	-
031	Bf	11	24	moderate	medium	subangular blocky	Friable	loam	-	-	-	-	-	-	-	-	-	few	medium	-
031	BC	24	38	moderate	coarse	angular blocky	Friable	sandy loam	-	-	-	-	-	-	-	-	-	few	medium	-
031	C	38	75	-	-	massive	Firm	clay loam	25	-	-	25	round/angular	-	-	-	-	-	-	-
032	LFH	5	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	abundant	fine/medium/coarse	-
032	Ae	0	8	weak	medium	angular blocky	Very friable	loam	-	-	-	-	-	-	-	-	-	plentiful	fine/medium	-
032	Bm	8	28	moderate	coarse	subangular blocky	Friable	loamy sand	-	-	-	-	-	-	-	-	-	plentiful	fine/medium	-
032	C1	28	51	weak	coarse	angular blocky	Friable	loamy sand	-	-	-	-	-	-	-	-	-	few	fine	-
032	C2	51	100	-	-	massive	Firm	silty clay loam	30	5	-	35	round	-	-	-	-	few	fine	-
033	LFH	8	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	abundant	fine/medium/coarse	-
033	Bm	0	19	weak	medium	subangular blocky	Firm	sandy clay loam	-	-	-	-	-	-	-	-	-	plentiful	fine/medium/coarse	-
033	C1	19	62	-	-	massive	Friable	sandy loam	-	-	-	-	-	-	-	-	-	plentiful	fine/medium	-
033	C2	62	100	-	-	massive	Friable	sandy loam	40	-	-	40	round	-	-	-	-	-	-	-
034	LFH	10	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	abundant	fine/medium	-
034	Ah	0	85	weak	medium	granular	Friable	clay loam	-	-	-	-	-	-	-	-	-	plentiful	fine/medium/coarse	-
034	C1	84	85	-	medium	massive	Friable	silty clay	30	-	-	30	round/angular	-	-	-	-	few	fine	-
034	C2	95	100	-	-	massive	Firm	clay loam	-	-	-	-	-	-	-	-	-	-	-	-
035	Om	0	48	-	-	-	-	-	-	-	-	-	-	-	-	-	-	plentiful	fine/medium/coarse	-
035	Oh	48	110	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
035	Cg	110	130	-	-	massive	Slightly sticky	silty clay loam	-	-	-	-	-	6.8	-	-	-	-	-	-
036	Of	0	15	-	-	-	-	-	-	-	-	-	-	-	-	-	-	abundant	fine/medium	-
036	Ah	15	20	-	-	massive	Non sticky	loam	10	-	-	10	angular	-	-	-	-	few	medium	-
036	C1	20	35	-	-	massive	Sticky	sand	10	-	-	10	angular	-	-	-	-	-	-	-
036	C2	35	95	-	-	massive	Non sticky	sand	10	-	-	10	angular	-	-	-	-	-	-	-
037	Om	0	100	-	-	-	-	-	-	-	-	-	-	7	-	-	-	abundant	fine/medium/coarse	-
038	LFH	4	0	-	-	-	-	silt loam	-	-	-	-	-	-	-	-	-	plentiful	fine/medium/coarse	-
038	Ahj	0	9	weak	fine	granular	Friable	clay loam	25	-	-	25	angular	-	-	-	-	few	medium	-
038	C1	9	31	-	-	massive	Strong	clay loam	40	-	-	40	angular	-	-	-	-	few	medium	-
038	C2	31	70	-	-	massive	Strong		60	-	-	60	angular	-	-	-	-	-	-	-
039	LFH	12	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	abundant	fine/medium/coarse	-
039	C1	0	42	-	-	massive	Friable	silt loam	10	-	-	10	angular	-	-	-	-	plentiful	fine/medium	-
039	C2	42	100	-	-	massive	Friable	silt loam	50	-	-	50	angular	-	-	-	-	few	medium	-
040	LFH	5	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	abundant	fine/medium	-
040	Ah	0	48	moderate	medium	platy	Very friable	clay loam	-	-	-	-	-	-	-	-	-	plentiful	medium/coarse	-
040	C	48	100	-	-	massive	Very friable	clay loam	-	-	-	-	-	-	-	-	-	few	medium	-
041	LFH	6	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	abundant	fine/medium/coarse	-
041	Ae	0	10	weak	coarse	platy	Friable	silt loam	10	50	-	60	round	-	-	-	-	abundant	fine/medium	-
041	Bf	10	25	weak	medium	subangular blocky	Friable	silt loam	25	50	-	75	round	6.5	-	-	-	abundant	fine	-
041	BC	25	35	-	-	massive	Friable	loam	25	50	-	75	round	-	-	-	-	few	fine	-
041	C	35	70	-	-	massive	Friable	loam	25	50	-	75	round	-	-	-	-	-	-	-
042	LFH	7	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	plentiful	fine/medium/coarse	-

Appendix 4. Summary of Terrain and Soil Inspection Data

b) Soil Data

Site ID	Horizon	Top Depth	Bottom Depth	Structure Grade	Structure Class	Structure Kind	Consistence	Soil Texture	% Gravel	% Cobbles	% Boulders	% Coarse Fr.	Coarse Fr. Shape	Soil pH	Mottles Abundance	Mottles Size	Mottle Colour	Root Abundance	Root Size	Carbonates
042	Ae	0	10	weak	medium	platy	Friable	loam	20	10	-	30	round	-	-	-	-	few	medium	-
042	Bm	10	43	weak	medium	subangular blocky	Friable	loam	20	10	-	30	round	5.5	-	-	-	few	medium	-
042	C	43	100	-	-	massive	Friable	loam	20	20	-	40	round	-	-	-	-	few	medium	-
043	Om	0	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	plentiful	fine	-
043	C	6	100	-	-	massive	Sticky	silty clay	-	-	-	-	-	-	-	-	-	plentiful	fine	-
044a	Ap	0	30	-	-	massive	Very friable	silt loam	25	50	-	75	round	-	-	-	-	abundant	fine	-
044b	C	0	100	-	-	massive	Friable	sand	15	-	-	15	round	-	-	-	-	-	-	-
045	Ah	0	35	-	-	massive	Sticky	clay	-	-	-	-	-	-	-	-	-	-	-	-
045	Cg	35	100	-	-	massive	Sticky	clay	-	-	-	-	-	-	-	-	-	-	-	-
046	Ah	0	22	-	-	single grained	Loose	sandy loam	-	-	-	-	-	-	-	-	-	plentiful	fine/medium	-
046	C1	22	49	-	-	massive	Friable	sandy loam	-	-	-	-	-	-	-	-	-	plentiful	fine/medium	-
046	C2	49	100	-	-	massive	Friable	clay loam	-	-	-	-	-	-	-	-	-	few	medium	-
047	LFH	7	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	abundant	fine/medium/coarse	-
047	Ae	0	8	weak	medium	platy	Friable	sandy loam	5	20	-	25	round	-	-	-	-	plentiful	fine/medium	-
047	Bm	8	23	moderate	medium	subangular blocky	Firm	clay loam	20	20	-	40	round	-	-	-	-	abundant	fine/medium	-
047	C	23	60	-	-	massive	Firm	loamy sand	20	20	-	40	round	-	-	-	-	few	fine	-
048	LFH	11	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	abundant	fine/medium/coarse	-
048	Aej	0	8	moderate	coarse	platy	Friable	clay loam	-	-	-	-	-	6.5	-	-	-	plentiful	fine/medium	-
048	Bm	8	30	moderate	coarse	platy	Firm	loam	-	-	-	-	-	-	-	-	-	plentiful	fine/medium	-
048	BC	30	75	-	-	massive	Friable	sandy clay loam	-	-	-	-	-	-	-	-	-	plentiful	fine/medium	-
048	Cgj	75	100	-	-	-	Friable	silt loam	-	-	-	-	-	-	common	medium	distinct	-	-	-
049	C1	0	52	-	-	massive	Friable	loam	20	20	-	40	round	-	-	-	-	plentiful	fine/medium/coarse	-
049	C2	52	85	-	-	massive	Friable	sand	30	10	-	40	round	-	-	-	-	plentiful	fine/medium	-
049	C3	85	100	-	-	massive	Friable	sandy loam	10	-	-	10	round	-	-	-	-	few	medium	-
050a	LFH	0	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	abundant	fine/medium/coarse	-
050a	Ah	6	55	moderate	medium	granular	Friable	loam	15	-	-	15	angular	-	-	-	-	plentiful	fine/medium	-
050a	C	55	100	-	-	massive	Friable	loam	15	50	-	65	angular	-	-	-	-	plentiful	fine/medium	-
050b	R	0+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
051	LFH	10	0	-	-	-	-	clay loam	-	-	-	-	-	-	-	-	-	abundant	fine/medium/coarse	-
051	Ae	0	10	weak	coarse	platy	Friable	clay loam	3	-	-	3	angular	-	-	-	-	plentiful	fine/medium	-
051	Bm	10	29	moderate	medium	subangular blocky	Friable	clay loam	15	3	-	18	angular	6.5	-	-	-	few	medium/coarse	-
051	C	29	100	-	-	massive	Friable		15	3	-	18	angular	-	-	-	-	few	medium	-
052	LFH	6	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	abundant	fine/medium/coarse	-
052	Ae	0	9	weak	medium	platy	Very friable	loam	1	-	-	1	round	-	-	-	-	plentiful	fine/medium/coarse	-
052	Bm	9	41	weak	medium	subangular blocky	Strong	silt loam	20	10	-	30	round	6.5	-	-	-	plentiful	fine/medium	-
052	C	41	70	-	-	massive	Firm	silty clay	55	20	-	75	round/angular	-	-	-	-	few	fine	-
053	Of	0	27	-	-	-	-	-	-	-	-	-	-	6.3	-	-	-	plentiful	fine	-
053	Om	27	100	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
053	Oh	100	130	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
054	Of	0	20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	abundant	fine/medium/coarse	-
054	Cg	52	48	-	-	massive	Firm	clay	5	20	35	60	angular	-	few	medium	prominent	-	-	-
054	Oh	20	52	-	-	-	-	-	-	5	20	25	angular	-	-	-	-	plentiful	fine/medium/coarse	-
055	LFH	15	0	-	-	-	-	-	-	-	-	-	-	5	-	-	-	abundant	fine/medium/coarse	-
055	Ae	0	4	weak	medium	platy	Friable	silt loam	30	-	-	30	angular	-	-	-	-	plentiful	fine/medium/coarse	-
055	Bm	4	22	-	-	massive	Friable	clay loam	40	5	-	45	angular	-	-	-	-	plentiful	fine/medium	-
055	C	22	60	-	-	massive	Friable	clay loam	60	-	-	60	angular	-	-	-	-	-	-	-
055	R	60+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
056	LFH	8	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	abundant	fine/medium/coarse	-
056	Ae	0	4	weak	medium	platy	Friable	silt loam	40	-	-	40	angular	-	-	-	-	plentiful	fine/medium/coarse	-
056	Bm	4	25	weak	medium	subangular blocky	Friable	clay loam	40	5	20	65	angular	-	-	-	-	plentiful	fine/medium	-
056	BC	25	36	-	-	massive	Friable	clay loam	40	5	20	65	angular	-	-	-	-	few	medium	-
056	C	36	100	-	-	massive	Friable	loam	40	5	-	45	angular	-	-	-	-	few	medium	-
057	LFH	8	0	-	-	-	-	loam	-	-	-	-	-	-	-	-	-	abundant	fine/medium/coarse	-
057	Ae	0	9	weak	medium	platy	Friable	silt loam	5	10	-	15	angular	-	-	-	-	plentiful	fine/medium	-
057	Bf	9	21	moderate	medium	subangular blocky	Firm	sandy loam	20	10	-	30	angular	5	-	-	-	plentiful	fine/medium	-
057	BC	21	39	-	-	massive	Friable	sandy loam	25	10	-	35	angular	-	-	-	-	few	medium	-
057	C	39	75	-	-	massive	Friable		40	25	-	65	angular	-	-	-	-	few	-	-

Appendix 4. Summary of Terrain and Soil Inspection Data

b) Soil Data

Site ID	Horizon	Top Depth	Bottom Depth	Structure Grade	Structure Class	Structure Kind	Consistence	Soil Texture	% Gravel	% Cobbles	% Boulders	% Coarse Fr.	Coarse Fr. Shape	Soil pH	Mottles Abundance	Mottles Size	Mottle Colour	Root Abundance	Root Size	Carbonates
058	LFH	10	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	abundant	fine/medium/coarse	-
058	Ae	0	12	weak	coarse	granular	Friable	silt loam	30	10	-	40	angular	-	-	-	-	plentiful	fine/medium	-
058	Bm	12	30	weak	coarse	subangular blocky	Firm	clay loam	40	5	-	45	angular	5	-	-	-	few	fine	-
058	C	30	54	-	-	massive	Firm	clay loam	70	-	-	70	angular	-	-	-	-	-	-	-
059	LFH	18	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	abundant	fine/medium/coarse	-
059	Ah	0	20	moderate	medium	angular blocky	Friable	clay loam	10	5	-	15	angular	-	common	medium	faint	abundant	fine/medium/coarse	-
059	Btjgj	20	44	moderate	medium	angular blocky	Friable	clay	10	10	-	20	angular	5.5	common	medium	faint	few	fine/medium	-
059	Cgj	44	100	-	-	massive	Friable	clay	5	-	-	5	angular	-	-	-	-	-	-	-
060	LFH	12	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	abundant	fine/medium/coarse	-
060	Ah	0	3	moderate	medium	platy	Friable	loam	5	10	10	25	angular	-	-	-	-	abundant	fine/medium/coarse	-
060	Ae	3	11	moderate	medium	platy	Friable	loam	5	10	10	25	angular	-	-	-	-	plentiful	fine/medium	-
060	Bm	11	25	moderate	fine	subangular blocky	Firm	loam	50	10	10	70	angular	5	-	-	-	plentiful	fine/medium	-
060	C	25	48	-	-	massive	Firm	loam	50	10	20	80	angular	-	-	-	-	few	fine/medium	-
060	R	48+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
061	Om	0	100	-	-	-	-	-	-	-	-	-	-	-	-	-	-	abundant	fine/medium/coarse	-
062	LFH	14	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	abundant	fine/medium/coarse	-
062	Ae	0	7	moderate	medium	platy	Friable	clay loam	2	-	-	2	angular	-	-	-	-	plentiful	fine/medium	-
062	Bm	7	31	moderate	coarse	platy	Very Firm	sandy clay	2	-	-	2	angular	5	common	medium	faint	-	-	-
062	C	31	100	strong	coarse	platy	Very Firm	silty clay	-	-	-	-	-	-	common	medium	faint	-	-	-
063a	LFH	13	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	abundant	fine/medium/coarse	-
063a	Ae	0	11	moderate	medium	platy	Friable	silt loam	-	-	-	-	-	-	-	-	-	plentiful	fine/medium/coarse	-
063a	Ohb	11	16	-	-	-	-	-	-	-	-	-	-	-	-	-	-	plentiful	fine/medium/coarse	-
063a	Bm1	16	19	moderate	medium	subangular blocky	Friable	silt loam	-	-	-	-	-	-	-	-	-	plentiful	fine/medium/coarse	-
063a	Ohb2	19	22	-	-	-	-	-	-	-	-	-	-	-	-	-	-	plentiful	fine/medium/coarse	-
063a	Bm2	22	27	moderate	medium	subangular blocky	Friable	silt loam	-	-	-	-	-	-	-	-	-	few	fine	-
063a	Ohb3	27	30	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
063a	C1	30	100	-	-	massive	Friable	silty clay	10	-	-	10	angular	-	common	medium	prominent	-	-	-
063b	LFH	21	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	abundant	fine/medium/coarse	-
063b	Ae	0	6	moderate	medium	platy	Friable	loam	5	2	-	7	angular	-	-	-	-	plentiful	fine/medium/coarse	-
063b	Bm	6	35	weak	medium	subangular blocky	Friable	clay loam	5	2	-	7	angular	-	-	-	-	plentiful	fine/medium/coarse	-
063b	BC	35	50	moderate	medium	subangular blocky	Friable	clay loam	5	-	-	5	angular	-	-	-	-	few	fine/medium	-
063b	C	50	100	-	-	-	Friable	clay	5	-	-	5	angular	-	common	medium	faint	-	-	-
064	C	0	35	-	-	single grained	Loose	loamy sand	80	10	-	90	round	-	-	-	-	few	fine/medium	-
065	LFH	6	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	abundant	fine/medium/coarse	-
065	Ae	0	8	weak	fine	granular	Friable	loam	30	15	-	45	round	-	-	-	-	abundant	fine/medium/coarse	-
065	Bm	8	41	weak	medium	subangular blocky	Friable	sandy loam	30	15	-	45	round	6.5	-	-	-	abundant	fine/medium	-
065	C	41	55	-	-	massive	Friable	loamy sand	30	15	-	45	round	-	-	-	-	few	fine	-
065	R	55+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
066	LFH	12	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	abundant	fine/medium/coarse	-
066	Ah	0	17	moderate	medium	prismatic	Firm	clay loam	2	-	-	2	angular	-	-	-	-	plentiful	fine/medium/coarse	-
066	C	17	100	moderate	coarse	subangular blocky	Firm	clay loam	2	-	-	2	angular	-	-	-	-	few	medium	-
067	LFH	30	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	abundant	fine/medium/coarse	-
067	Ah	0	18	strong	medium	angular blocky	Firm	silty clay loam	3	15	-	18	angular	-	-	-	-	plentiful	fine/medium/coarse	Weak
067	Ckgj	18	100	strong	coarse	granular	Firm	clay loam	3	5	-	8	angular	-	common	medium	distinct	-	-	Weak
068	LFH	11	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	abundant	fine/medium/coarse	-
068	Ahe	0	14	moderate	medium	subangular blocky	Firm	clay loam	4	10	-	14	round	-	-	-	-	plentiful	medium/coarse	-
068	C	14	70	moderate	medium	subangular blocky	Firm	clay loam	4	10	-	14	round	-	-	-	-	few	medium	Weak
068	R	70+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
069	LFH	0	45	-	-	-	-	-	-	-	-	-	-	-	-	-	-	abundant	fine/medium/coarse	-
069	Ah	45	56	weak	medium	-	Friable	clay loam	-	-	-	-	-	-	common	fine	faint	few	medium	-
069	C1	56	80	-	-	massive	Firm	silty clay	10	15	-	25	subangular	-	common	fine	prominent	-	-	-
069	C2	80	95	-	-	massive	Firm		30	15	-	45	subangular	-	common	fine	prominent	-	-	-
070	LFH	20	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	abundant	fine/medium/coarse	-
070	Ae	0	7	moderate	fine	platy	Very friable	silty clay loam	-	-	-	-	-	-	-	-	-	plentiful	medium/coarse	-
070	Bm	7	18	moderate	coarse	platy	Friable	silty clay loam	1	-	-	1	angular	-	-	-	-	few	medium	-
070	BC	18	37	strong	fine	subangular blocky	Firm	silty clay	2	-	-	2	angular	-	-	-	-	-	-	-
070	C	37	75	-	-	massive	Very Firm	silty clay	2	-	-	2	angular	-	few	fine	faint	-	-	-

Appendix 4. Summary of Terrain and Soil Inspection Data

b) Soil Data

Site ID	Horizon	Top Depth	Bottom Depth	Structure Grade	Structure Class	Structure Kind	Consistence	Soil Texture	% Gravel	% Cobbles	% Boulders	% Coarse Fr.	Coarse Fr. Shape	Soil pH	Mottles Abundance	Mottles Size	Mottle Colour	Root Abundance	Root Size	Carbonates
070	R	75+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
071	LFH	10	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	abundant	fine/medium/coarse	-
071	Ae	0	14	moderate	coarse	platy	Friable	silty clay loam	1	-	-	1	subangular	-	-	-	-	plentiful	fine/medium/coarse	-
071	C	14	21	moderate	medium	subangular blocky	Firm	silt loam	5	20	-	25	subangular	-	-	-	-	plentiful	fine/medium	-
071	Ck	21	65	-	-	massive	Firm	silty clay loam	15	15	-	30	angular	-	-	-	-	few	fine	Weak
071	R	65+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
072	LFH	11	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	abundant	fine/medium/coarse	-
072	Ah	0	6	weak	medium	subangular blocky	Firm	silty clay loam	-	-	-	-	-	-	-	-	-	few	medium	-
072	Bm	6	15	moderate	coarse	angular blocky	Firm	silty clay loam	-	-	-	-	-	-	-	-	-	few	medium	-
072	C	15	100	weak	medium	subangular blocky	Friable	sandy clay loam	2	10	-	12	angular	-	few	fine	faint	-	-	-
073	LFH	8	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	abundant	fine/medium/coarse	-
073	Ah	0	4	weak	medium	platy	Friable	silty clay loam	3	-	-	3	subangular	-	-	-	-	plentiful	medium/coarse	-
073	Ae	4	23	weak	coarse	platy	Friable	silty clay loam	3	5	-	8	subangular	-	-	-	-	plentiful	medium/coarse	-
073	Bm	23	46	moderate	fine	angular blocky	Firm	clay loam	20	5	-	25	subangular	-	-	-	-	few	medium	-
073	C	46	70	-	-	massive	Firm	clay loam	30	10	-	40	subangular	-	-	-	-	few	medium	-
073	R	70+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
074	LFH	2	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	abundant	fine/medium/coarse	-
074	Ae	0	11	moderate	medium	platy	Friable	silty clay loam	3	-	-	3	angular	-	-	-	-	plentiful	fine/medium/coarse	-
074	Bf	11	23	moderate	fine	subangular blocky	Firm	silty clay loam	25	-	-	25	angular	-	-	-	-	plentiful	fine/medium/coarse	-
074	Cgj	23	80	strong	fine	angular blocky	Firm	silty clay	25	-	-	25	angular	-	many	fine	distinct	few	fine/medium	-
074	R	80+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
075	LFH	14	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	abundant	fine/medium/coarse	-
075	Cgj	0	100	moderate	coarse	angular blocky	Firm	sandy clay loam	10	5	-	15	subangular	-	common	coarse	distinct	few	fine/medium	Strong
075	Cg	100	120	-	-	massive	Firm	clay loam	5	-	-	5	subangular	-	common	fine	prominent	-	-	Strong
075	R	120+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
076	LFH	9	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	abundant	fine/medium/coarse	-
076	Ae	0	14	moderate	medium	angular blocky	Firm	clay loam	1	3	-	4	angular	-	-	-	-	few	fine/medium	-
076	C	14	90	strong	coarse	angular blocky	Firm	clay	1	3	-	4	angular	-	few	medium	faint	few	fine	-
076	R	90+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
077	Oh	34	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	plentiful	fine/medium	-
077	Cg	0	50	-	-	massive	Firm	clay	5	8	-	13	angular	-	common	fine	prominent	-	-	-
078	LFH	12	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	abundant	fine/medium/coarse	-
078	Ae	0	12	moderate	medium	angular blocky	Firm	silty clay loam	50	25	-	75	subangular	-	-	-	-	few	medium	-
078	Bm	12	32	-	-	-	Firm	silty clay loam	50	25	-	75	subangular	-	-	-	-	few	medium	-
078	R	32+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
079	LFH	25	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	abundant	fine/medium/coarse	-
079	C	0	100	moderate	very coarse	granular	Firm	silty clay loam	30	30	-	60	angular	-	-	-	-	few	medium	-
080	Of	0	130	-	-	-	-	-	-	-	-	-	-	-	-	-	-	abundant	medium	-
081	Oh	0	105	-	-	-	-	-	-	-	-	-	-	-	-	-	-	abundant	medium	-
081	Om	105	130	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
082	LFH	14	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	abundant	fine/medium/coarse	-
082	Ahe	0	15	weak	fine	angular blocky	Friable	clay loam	25	20	-	45	angular	-	-	-	-	abundant	fine/medium/coarse	-
082	C	15	40	-	-	massive	Firm	clay loam	25	20	-	45	angular	-	-	-	-	few	medium	-
082	R	40+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
083	Oh	25	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
083	Cgj	0	7	moderate	coarse	platy	Very friable	loam	-	-	-	-	-	-	many	medium	distinct	plentiful	fine/medium/coarse	-
083	Ahb	7	10	weak	medium	platy	Very friable	-	-	-	-	-	-	-	few	fine	prominent	-	-	-
083	Bmb	10	17	moderate	coarse	platy	Friable	clay loam	-	-	-	-	-	-	common	fine	distinct	-	-	-
083	Cg	17	80	-	-	massive	Friable	sandy clay	-	-	-	-	-	-	few	medium	prominent	-	-	-
084	LFH	10	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	abundant	fine/medium/coarse	-
084	C1	0	14	-	-	-	Very friable		80	5	-	85	round	-	-	-	-	plentiful	fine/medium	-
084	C2	14	25	-	-	single grained	Very friable	loamy sand	-	-	-	-	-	-	-	-	-	plentiful	fine/medium	-
084	C3	25	34	-	-	-	Very friable	sand	30	10	-	40	subrounded	-	-	-	-	plentiful	fine/medium	-
084	C4	34	44	-	-	single grained	Very friable	loam	-	-	-	-	-	-	-	-	-	plentiful	fine/medium	-
084	C5	44	80	-	-	massive	Friable	sandy loam	-	-	-	-	-	-	-	-	-	plentiful	fine/medium	-
085	LFH	7	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	abundant	fine/medium/coarse	-
085	Ae	0	9	weak	fine	platy	Friable	sandy clay loam	40	10	-	50	subrounded	-	-	-	-	plentiful	fine/medium/coarse	-

Appendix 4. Summary of Terrain and Soil Inspection Data

b) Soil Data

Site ID	Horizon	Top Depth	Bottom Depth	Structure Grade	Structure Class	Structure Kind	Consistence	Soil Texture	% Gravel	% Cobbles	% Boulders	% Coarse Fr.	Coarse Fr. Shape	Soil pH	Mottles Abundance	Mottles Size	Mottle Colour	Root Abundance	Root Size	Carbonates
085	Bm	9	30	strong	medium	subangular blocky	Firm	clay loam	40	10	-	50	subrounded	-	-	-	-	plentiful	fine/medium	-
085	C	30	53	-	-	single grained	Loose	sandy loam	40	10	-	50	subrounded	-	-	-	-	few	fine/medium	-
086	LFH	15	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	abundant	fine/medium/coarse	-
086	Ah	0	8	strong	medium	granular	Firm	clay loam	15	-	-	15	angular	-	-	-	-	abundant	fine/medium/coarse	-
086	C	8	55	strong	medium	angular blocky	Very Firm	silty clay loam	15	-	-	15	angular	-	-	-	-	few	medium	-
086	II Cg	55	105	-	-	massive	Friable	clay	-	-	-	-	-	-	common	medium	prominent	-	-	-
087	Of	0	30	-	-	-	-	-	-	-	-	-	-	-	-	-	-	abundant	fine/medium	-
087	Om	30	60	-	-	-	-	-	-	-	-	-	-	-	-	-	-	few	fine	-
087	Oh	60	105	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
087	Cg	105+		-	-	massive	-	silty clay	-	-	-	-	-	-	-	-	-	-	-	-
088	LFH	8	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	abundant	fine/medium/coarse	-
088	Ae	0	12	weak	medium	subangular blocky	Friable	silty clay loam	40	15	15	70	subangular	-	-	-	-	plentiful	fine/medium	-
088	Bm	12	32	weak	medium	subangular blocky	Friable	clay loam	40	30	-	70	subangular	-	-	-	-	plentiful	fine/medium	-
088	C	32	37	-	-	-	Friable	clay loam	40	50	-	90	subangular	-	-	-	-	few	medium	-
088	R	37+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
089	LFH	7	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	abundant	fine/medium/coarse	-
089	C	0	65	weak	fine	subangular blocky	Friable	clay loam	60	25	-	85	subangular	-	-	-	-	plentiful	fine/medium/coarse	-
090	Of	0	20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	abundant	fine/medium/coarse	-
090	Om	20	120	-	-	-	-	-	-	-	-	-	-	-	-	-	-	few	fine/medium	-
091	Om	20	12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	few	fine/medium	-
091	Of	0	20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	abundant	fine/medium	-
092	Of	0	20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	abundant	fine/medium	-
092	Om	20	120	-	-	-	-	-	-	-	-	-	-	-	-	-	-	few	fine/medium	-
093	LFH	8	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	abundant	fine/medium/coarse	-
093	Ae	0	10	weak	fine	platy	Friable	loam	50	20	-	70	subrounded	-	-	-	-	plentiful	fine/medium	-
093	Bm	10	21	weak	fine	subangular blocky	Friable	silt loam	50	20	-	70	subrounded	-	-	-	-	plentiful	fine/medium	-
093	C	21	52	-	-	single grained	Friable	loam	50	20	-	70	subrounded	-	-	-	-	few	fine	-
093	R	52+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
094	LFH	11	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	abundant	fine/medium/coarse	-
094	Ae	0	10	weak	fine	subangular blocky	Friable	clay loam	40	10	-	50	subangular	-	-	-	-	few	fine/medium	-
094	Bm	10	21	weak	medium	subangular blocky	Friable	clay loam	50	10	-	60	subangular	-	-	-	-	few	fine/medium	-
094	C	21	42	moderate	medium	angular blocky	Friable	clay loam	60	10	-	70	subangular	-	-	-	-	few	fine	-
094	R	42+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
095	LFH	11	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	abundant	fine/medium/coarse	-
095	Ah	0	7	weak	medium	granular	Friable	clay loam	25	10	-	35	subangular	-	-	-	-	plentiful	fine/medium/coarse	-
095	Ae	7	16	weak	medium	angular blocky	Firm	clay loam	25	10	-	35	subangular	-	-	-	-	few	fine/medium	-
095	Bm	16	40	moderate	fine	angular blocky	Firm	clay loam	25	10	-	35	subangular	-	-	-	-	few	fine/medium	-
095	C	40	70	-	-	massive	Firm	clay	15	5	-	20	subrounded	-	common	fine	faint	few	fine	Strong
096	Oh1	0	45	-	-	-	-	-	-	-	-	-	-	-	-	-	-	abundant	fine/medium/coarse	-
096	Cg1	45	60	-	-	massive	Friable	clay	-	-	-	-	-	-	-	-	-	-	-	-
096	Oh2	60	120	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
096	Cg2	120	130	-	-	massive	Friable	clay	1	-	-	1	round	-	-	-	-	-	-	-
097	LFH	12	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	abundant	fine/medium/coarse	-
097	Ae	0	21	moderate	coarse	platy	Firm	clay	25	10	-	35	subangular	-	-	-	-	few	coarse	-
097	Bmgj	21	46	moderate	medium	angular blocky	Friable	clay	25	10	-	35	subangular	-	common	medium	distinct	few	coarse	-
097	Cg	46	100	-	-	massive	Firm	clay	25	10	-	35	subangular	-	many	fine	prominent	-	-	-
098	LFH	12	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	plentiful	fine/medium/coarse	-
098	Ah	0	8	-	-	massive	Friable	silty clay loam	2	-	-	2	subangular	-	-	-	-	plentiful	medium/coarse	-
098	Ae	8	12	-	-	massive	Friable	silty clay loam	2	-	-	2	subangular	-	-	-	-	few	medium/coarse	-
098	Ahb	12	20	weak	medium	angular blocky	Friable	silty clay loam	2	5	-	7	subangular	-	-	-	-	few	medium	-
098	Aeb	20	28	moderate	medium	prismatic	Firm	silty clay loam	10	5	-	15	subangular	-	-	-	-	-	-	-
098	Bmb	28	39	moderate	medium	subangular blocky	Firm	silty clay loam	10	5	-	15	subangular	-	few	fine	faint	-	-	-
098	C	39+		-	-	massive	Firm	clay loam	10	5	-	15	subangular	-	-	-	-	-	-	-
099	LFH	10	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	abundant	fine/medium/coarse	-
099	Ah	0	8	moderate	medium	angular blocky	Firm	clay loam	5	2	-	7	subrounded	-	-	-	-	plentiful	fine/medium/coarse	-
099	C	8	40	moderate	coarse	angular blocky	Firm	clay loam	5	2	-	7	subrounded	-	common	fine	distinct	few	fine/medium/coarse	-
099	R	40+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Appendix 4. Summary of Terrain and Soil Inspection Data

b) Soil Data

Site ID	Horizon	Top Depth	Bottom Depth	Structure Grade	Structure Class	Structure Kind	Consistence	Soil Texture	% Gravel	% Cobbles	% Boulders	% Coarse Fr.	Coarse Fr. Shape	Soil pH	Mottles Abundance	Mottles Size	Mottle Colour	Root Abundance	Root Size	Carbonates
100	LFH	6	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	abundant	fine/medium/coarse	-
100	Ae	0	5	weak	coarse	prismatic	Friable	silty clay loam	30	15	-	45	subangular	-	-	-	-	plentiful	fine/medium/coarse	-
100	Bm	5	15	moderate	medium	subangular blocky	Friable	silty clay loam	30	15	-	45	subangular	-	-	-	-	plentiful	fine/medium/coarse	-
100	C	15	44	moderate	medium	subangular blocky	Firm	silty clay loam	50	15	-	65	subangular	-	-	-	-	few	coarse	Weak
100	R	44+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
101	LFH	6	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	abundant	fine/medium/coarse	-
101	Ae	0	10	weak	fine	subangular blocky	Friable	clay loam	30	15	-	45	angular	-	-	-	-	plentiful	fine/medium/coarse	-
101	Bm	10	25	moderate	medium	subangular blocky	Friable	clay loam	30	15	-	45	angular	-	-	-	-	plentiful	fine/medium	-
101	C	25	55	-	-	massive	Friable	clay loam	30	50	-	80	angular	-	-	-	-	-	-	-
102	Cg	0	80	-	-	massive	Slightly sticky	silty clay	-	-	-	-	-	8.3	-	-	-	plentiful	fine/medium	-
102	II Cg	80	120	-	-	massive	Slightly sticky	silt loam	40	-	-	40	subangular	-	-	-	-	-	-	-
103	Of	0	130	-	-	-	-	-	-	-	-	-	-	-	-	-	-	abundant	fine/medium	-
104	Of	0	30	-	-	-	-	-	-	-	-	-	-	6	-	-	-	plentiful	fine/medium/coarse	-
104	Om	30	75	-	-	-	-	-	-	-	-	-	-	-	-	-	-	plentiful	fine/medium/coarse	-
104	Oh	75	85	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
104	Cg	85	130	-	-	massive	Slightly sticky	silty clay	-	-	-	-	-	-	few	medium	prominent	-	-	-
105	LFH	6	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	abundant	fine/medium/coarse	-
105	Ae	0	6	moderate	medium	platy	Friable	silt loam	10	-	-	10	subrounded	-	-	-	-	plentiful	fine/medium	-
105	Bm	6	24	moderate	coarse	platy	Friable	clay loam	10	5	-	15	subrounded	-	-	-	-	few	fine/medium	-
105	C	24	33	-	-	-	Friable	clay loam	10	-	60	70	subrounded	-	-	-	-	few	fine	-
105	R	33+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
106	Ofb	130	14	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
106	Om	0	30	-	-	-	-	-	-	-	-	-	-	-	-	-	-	abundant	fine/medium/coarse	-
106	Oh	30	65	-	-	-	-	-	-	-	-	-	-	-	-	-	-	plentiful	fine/medium/coarse	-
106	Cg	65	105	-	-	massive	Slightly sticky	clay	-	-	-	-	-	-	-	-	-	-	-	-
106	Ohb	105	130	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
107	LFH	13	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	abundant	fine/medium/coarse	-
107	Ae	0	14	weak	coarse	angular blocky	Very friable	loamy sand	1	5	-	6	round	-	-	-	-	few	fine/medium	-
107	Bm	14	29	weak	coarse	angular blocky	Very friable	loamy sand	1	5	-	6	round	-	-	-	-	few	fine/medium	-
107	Cgj	29	120	-	-	massive	Firm	clay	10	5	-	15	angular	-	common	fine	faint	-	-	Moderate
212	LFH	5	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	plentiful	fine/medium/coarse	-
212	Ae	0	12	weak	coarse	platy	Friable	sandy loam	-	-	-	-	-	5.5	-	-	-	plentiful	fine/medium/coarse	-
212	Bm	12	24	weak	coarse	subangular blocky	Friable	sandy clay loam	-	-	-	-	-	6.5	-	-	-	few	fine/medium	-
212	C1	24	76	moderate	medium	angular blocky	Friable	sandy loam	-	-	-	-	-	-	-	-	-	few	fine	-
212	C2	76	100	weak	coarse	massive	Friable	sandy clay	15	-	-	15	subangular	-	few	medium	faint	-	-	-
213	LFH	8	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	plentiful	fine/medium/coarse	-
213	Ae	0	15	weak	medium	-	Friable	sandy clay loam	10	5	-	15	subrounded	-	-	-	-	plentiful	fine/medium/coarse	-
213	Bm	15	36	weak	fine	-	Friable	clay loam	5	5	-	10	round	6.5	-	-	-	plentiful	fine/medium/coarse	-
213	C	36	100	-	-	massive	Friable	clay loam	10	-	-	10	subangular	-	-	-	-	few	fine	Moderate
214	H	11	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	few	fine	-
214	LF	25	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	plentiful	fine/medium/coarse	-
214	Ah	0	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
214	C	0	50	-	-	single grained			60	2	-	62	subrounded	6.9	-	-	-	few	medium/coarse	-
217	LFH	8	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	plentiful	fine/medium/coarse	-
217	Ae	0	7	-	medium	subangular blocky		clay loam	5	-	-	5	subrounded	-	-	-	-	few	fine/medium	-
217	Bm	7	19	-	coarse	subangular blocky		clay loam	15	-	-	15	subrounded	6.5	-	-	-	few	medium	-
217	C	19	100	-	coarse	subangular blocky		silty clay	1	-	-	1	angular	-	-	-	-	few	medium	-
218	LFH	12	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	plentiful	fine/medium/coarse	-
218	Ae	0	12	-	-	-		sandy loam	15	50	-	65	subangular	-	-	-	-	plentiful	fine/medium/coarse	-
218	Bm	12	27	-	-	-		sandy clay loam	15	50	-	65	subangular	-	-	-	-	few	fine/medium	-
218	C	27	40	-	-	-		clay	15	50	-	65	subangular	-	-	-	-	few	medium	-
219	LFH	8	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	plentiful	fine/medium	-
219	Ae	0	10	-	-	single grained	Very friable	loam	10	15	1	26	subangular	-	-	-	-	few	medium	-
219	Bm	10	24	moderate	coarse	subangular blocky	Friable	loam	10	15	1	26	subangular	6.5	-	-	-	few	medium	-
219	C	24	60	moderate	coarse	subangular blocky	Firm	clay	25	10	1	36	subangular	-	-	-	-	few	medium	-
222	Om	25	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	plentiful	medium	-
222	Oh	25	120	-	-	-	-	-	-	-	-	-	-	-	-	-	-	few	medium	-

Appendix 4. Summary of Terrain and Soil Inspection Data

b) Soil Data

Site ID	Horizon	Top Depth	Bottom Depth	Structure Grade	Structure Class	Structure Kind	Consistence	Soil Texture	% Gravel	% Cobbles	% Boulders	% Coarse Fr.	Coarse Fr. Shape	Soil pH	Mottles Abundance	Mottles Size	Mottle Colour	Root Abundance	Root Size	Carbonates
222	Cgj	120		-	-	massive	-	clay	-	-	-	-	-	-	-	-	-	-	-	-
224	Of	12	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	plentiful	fine/medium/coarse	-
224	Ah1	0	6	-	coarse	platy	-	clay loam	-	-	-	-	-	7	-	-	-	few	fine/medium/coarse	-
224	Omb	6	14	-	-	-	-	-	-	-	-	-	-	-	-	-	-	plentiful	fine/medium/coarse	-
224	Ah2	14	75	-	coarse	subangular blocky	-	clay loam	-	-	-	-	-	7	-	-	-	few	fine/medium/coarse	-
224	C	75	110	-	-	massive	-	clay loam	-	-	-	-	-	8	-	-	-	-	-	-
225	Om	12	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	plentiful	fine/medium/coarse	-
225	Ah	0	15	-	-	-	-	silty clay	-	-	-	-	-	-	-	-	-	few	fine/medium	-
225	C	15	35	-	-	-	-	silty clay	-	-	-	-	-	-	-	-	-	few	fine/medium	-
225	Cgj	35	100	-	-	-	-	silty clay	-	-	-	-	-	7	-	-	-	-	-	-
226	Of	0	22	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
226	Om	22	45	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
226	Cgj	45	100	-	-	-	-	clay loam	-	-	-	-	-	-	-	-	-	-	-	-
232	LFH	10	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
232	Ah	0	25	moderate	coarse	platy	Friable	silty clay	-	-	-	-	-	-	-	-	-	abundant	fine/medium/coarse	-
232	C	25		-	-	massive	Friable	silty clay	-	-	-	-	-	-	-	-	-	few	fine/medium	-
242	LFH	25	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	abundant	fine/medium/coarse	-
242	Ah	0	7	moderate	medium	angular blocky	Friable	sandy clay loam	-	-	-	-	-	-	-	-	-	-	-	-
242	C1	7	58	moderate	coarse	subangular blocky	Friable	sandy clay loam	1	-	-	1	subangular	-	-	-	-	-	-	-
242	C2	58	100	-	-	massive	Non-sticky	sandy clay loam	-	-	-	-	-	-	-	-	-	-	-	-
243	LFH	8	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	abundant	fine/medium/coarse	-
243	Ae	0	23	strong	fine	subangular blocky	Firm	silty clay	20	-	-	20	subangular	-	-	-	-	plentiful	fine/medium/coarse	-
243	Cg	23	100	strong	fine	subangular blocky	Firm	silty clay	20	-	-	20	angular	5	many	medium	prominent	few	fine/medium	-
244	Oh	0	42	-	-	-	-	-	-	-	-	-	-	-	-	-	-	plentiful	fine/medium/coarse	-
244	Cg	42		-	-	massive	Non-sticky	silty clay	-	-	-	-	-	6.5	common	fine	distinct	-	-	-
270	LFH	6	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
270	Ahe	0	9	strong	coarse	platy	Friable	silty clay loam	15	-	-	15	angular	-	-	-	-	plentiful	fine/medium/coarse	-
270	Bm	9	28	strong	medium	subangular blocky	Friable	silty clay	15	10	-	25	angular	5	-	-	-	few	fine/medium	-
270	C	28	36	strong	medium	subangular blocky	Firm	silty clay	15	15	-	30	angular	-	-	-	-	-	-	-
273	LFH	7	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	plentiful	fine/medium/coarse	-
273	Ae	0	11	-	-	-	Friable	clay loam	20	-	30	50	angular	-	-	-	-	few	fine/medium/coarse	-
273	Bm	11	21	-	-	-	Firm	silty clay	20	20	-	40	angular	6.5	-	-	-	-	-	-
273	R	21+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
279	LFH	11	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	plentiful	fine/medium/coarse	-
279	C	0	20	strong	fine	subangular blocky	Firm	clay loam	40	10	-	50	angular	5.5	-	-	-	few	medium/coarse	-
279	R	20+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
282	LFH	12	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	abundant	fine/medium/coarse	-
282	Ae	0	7	weak	medium	platy	Friable	clay	15	10	-	25	subrounded	-	-	-	-	plentiful	fine/medium	-
282	Bm	7	24	moderate	medium	subangular blocky	Firm	clay	15	10	-	25	subrounded	5	-	-	-	few	medium	-
282	C	25	55+	-	-	-	Firm	loam	25	10	-	35	subrounded	-	-	-	-	few	medium	-
285	Hh	1	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
285	FM	8	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	abundant	-	-
285	L	16	8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
285	Ae	0	10	-	medium	granular	-	sand	-	-	-	-	-	-	-	-	-	abundant	fine/medium/coarse	-
285	Bf	10	12	-	medium	granular	-	loamy sand	-	-	-	-	-	-	-	-	-	plentiful	medium	-
285	Bm1	12	30	-	fine	-	-	loamy sand	-	-	-	-	-	-	-	-	-	plentiful	medium	-
285	Bm2	30	42	-	fine	-	-	loam	-	-	-	-	-	-	-	-	-	plentiful	medium	-
285	C1	42	70	-	-	-		sandy loam	15	20	-	35	-	-	-	-	-	few	fine	-
285	C2	70	80	-	-	-	-	sandy clay loam	-	-	-	-	-	-	-	-	-	-	-	-
301	LFH	10	0	-	-	-	Very friable	-	-	-	-	-	-	-	-	-	-	-	-	-
301	Ah	0	11	-	-	-	Very friable	sandy loam	-	-	-	-	-	-	-	-	-	-	-	-
301	BCg	11	90	-	-	-	Very friable	sandy loam	-	-	-	-	-	7.5	common	medium	distinct	-	-	-
301	Ck	90		-	-	-	Very friable	sandy clay loam	2	-	-	2	subrounded	7.5	-	-	-	-	-	Moderate
302	LFH	6	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
302	Ah	0	21	-	-	-	Very friable	loam	-	-	-	-	-	-	-	-	-	-	-	-
302	Bm	21	60	-	-	-	Very friable	loam	-	-	-	-	-	7.5	-	-	-	-	-	-
302	Ck1	60	80	-	-	-	Friable	sandy loam	5	2	-	7	angular	-	many	medium	distinct	-	-	Strong

Appendix 4. Summary of Terrain and Soil Inspection Data

b) Soil Data

Site ID	Horizon	Top Depth	Bottom Depth	Structure Grade	Structure Class	Structure Kind	Consistence	Soil Texture	% Gravel	% Cobbles	% Boulders	% Coarse Fr.	Coarse Fr. Shape	Soil pH	Mottles Abundance	Mottles Size	Mottle Colour	Root Abundance	Root Size	Carbonates
302	Ck2	80		-	-	-	Firm	sandy clay loam	40	10	20	70	angular	8	-	-	-	-	-	Strong
303	LFH	18	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
303	C	35		-	-	-	Firm	silty clay	15	5	-	20	angular	7	-	-	-	-	-	-
305	LFH	7	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
305	Ae	0	12	-	-	-	Friable	loam	-	-	-	-	-	-	-	-	-	-	-	-
305	Bm	12	27	-	-	-	Firm	loam	-	-	-	-	-	6.5	-	-	-	-	-	-
305	C1	27	60	-	-	-	Friable	sandy loam	2	-	-	2	round	7	-	-	-	-	-	-
305	Ck2	60	110	-	-	-	Friable	silty clay	3	2	-	5	subangular	-	-	-	-	-	-	Strong
306	LFH	9	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
306	C	0	40	-	-	-	Firm	silty clay	5	-	-	5	subangular	6.5	-	-	-	-	-	-
307	LFH	6	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
307	C	0	40	-	-	-	Firm	silty clay	15	-	-	15	subangular	6	-	-	-	-	-	-
308	LFH	9	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
308	Ah	0	8	-	-	-	Slightly sticky	silty clay	5	10	-	15	angular	7.5	-	-	-	-	-	-
308	Bm	8	25	-	-	-	Slightly sticky	silty clay	5	10	-	15	angular	7.5	common	coarse	faint	-	-	-
308	Cgj	25	80	-	-	-	Sticky	silty clay	5	10	-	15	angular	7.5	-	-	-	-	-	-
309	Of	0	42	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
309	Cgj	42	70	-	-	-	Non-sticky	sandy clay loam	-	-	-	-	-	-	few	medium	faint	-	-	-
309	Cg	70	100	-	-	-	Slightly sticky	sandy clay loam	-	-	-	-	-	6.8	-	-	-	-	-	-
310	LFH	4	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
310	Ae	0	9	-	-	-	Friable	loam	-	-	-	-	-	5.5	-	-	-	-	-	-
310	Bm	9	35	-	-	-	Friable	loamy sand	-	-	-	-	-	6.5	-	-	-	-	-	-
310	C1	35	75	-	-	-	Friable	loamy sand	-	-	-	-	-	6.8	-	-	-	-	-	-
310	C2	75	85	-	-	-	Firm	silty clay	5	-	-	5	angular	-	-	-	-	-	-	-
310	R	85+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
311	LFH	10	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
311	Ae	0	4	-	-	-	Friable	sandy loam	-	-	-	-	-	5	-	-	-	-	-	-
311	Bm	4	25	-	-	-	Friable	sandy loam	-	-	-	-	-	5.5	-	-	-	-	-	-
311	C1	25	90	-	-	-	Friable	sandy loam	-	-	-	-	-	-	-	-	-	-	-	-
311	C2	90		-	-	-	Friable	sandy clay loam	5	-	-	5	subangular	6.5	-	-	-	-	-	-
312	LFH	6	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
312	Ae	0	7	-	-	-	Friable	sandy loam	1	-	-	1	subrounded	5	-	-	-	-	-	-
312	Bf	7	16	-	-	-	Friable	sandy loam	1	-	-	1	subrounded	5.5	-	-	-	-	-	-
312	C1	16	65	-	-	-	Friable	loamy sand	5	15	-	20	subrounded	6.5	-	-	-	-	-	-
312	C2	65	75	-	-	-	Friable	sandy clay loam	10	15	-	25	angular	7.5	-	-	-	-	-	-
314	LFH	12	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
314	Bm	0	9	-	-	-	Friable	clay loam	2	-	-	2	angular	6.5	-	-	-	-	-	-
314	C	9	22	-	-	-	Friable	silty clay	10	15	-	25	angular	7	-	-	-	-	-	-
314	R	22+	-	-	-	-	Friable	-	5	10	80	95	subangular	-	-	-	-	-	-	-
315	LFH	8	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
315	C	30		-	-	-		clay loam	50	30	-	80	angular	6.5	-	-	-	-	-	-
316	LFH	9	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
316	C1	0	22	-	-	-	Friable	silty clay loam	10	5	-	15	subrounded	6.5	-	-	-	-	-	-
316	C2	22	32	-	-	-	Firm	silty clay	30	10	-	40	angular	7	-	-	-	-	-	-
316	R	32+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
317	LFH	6	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
317	Ae	0	13	-	-	-	Friable	loam	5	-	-	5	subangular	5.5	-	-	-	-	-	-
317	Bm	13	23	-	-	-	Friable	loam	5	-	-	5	subangular	6.5	-	-	-	-	-	-
317	C	23	40	-	-	-	Firm	clay loam	10	10	-	20	angular	6.8	-	-	-	-	-	-
318	LFH	5	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
318	Ae	0	6	-	-	-	Friable	sandy loam	-	-	-	-	-	5	-	-	-	-	-	-
318	Bm	6	31	-	-	-	Friable	sandy loam	-	-	-	-	-	5.5	-	-	-	-	-	-
318	C1	31	60	-	-	-	Friable	sandy loam	-	-	-	-	-	6.5	-	-	-	-	-	-
318	C2	60		-	-	-	Firm	clay loam	-	-	-	-	-	7	-	-	-	-	-	-
320	LFH	5	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
320	Ae	0	8	-	-	-	Friable	silt loam	1	-	-	1	subangular	-	-	-	-	-	-	-
320	Bm	8	20	-	-	-	Friable	silt loam	1	-	-	1	subangular	6.5	-	-	-	-	-	-

Appendix 4. Summary of Terrain and Soil Inspection Data

b) Soil Data

Site ID	Horizon	Top Depth	Bottom Depth	Structure Grade	Structure Class	Structure Kind	Consistence	Soil Texture	% Gravel	% Cobbles	% Boulders	% Coarse Fr.	Coarse Fr. Shape	Soil pH	Mottles Abundance	Mottles Size	Mottle Colour	Root Abundance	Root Size	Carbonates
320	C1	20	60	-	-	-	Firm	silty clay loam	1	-	-	1	subangular	-	-	-	-	-	-	-
320	C2	60		-	-	-	Firm	silty clay	5	-	-	5	angular	7.5	-	-	-	-	-	-
321	LFH	10	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
321	Ae	0	10	-	-	-	Very friable	silt loam	-	-	-	-	-	5	-	-	-	-	-	-
321	Bm	10	23	-	-	-	Friable	silt loam	-	-	-	-	-	6.5	-	-	-	-	-	-
321	C1	23	50	-	-	-	Friable	silty clay loam	2	2	-	4	subrounded	6.8	-	-	-	-	-	-
321	C2	50		-	-	-	Firm	silty clay	30	5	-	35	angular	6.8	-	-	-	-	-	-
322	LFH	8	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
322	Ae	0	10	-	-	-	Friable	silt loam	5	10	-	15	subrounded	-	-	-	-	-	-	-
322	Bm	10	24	-	-	-	Friable	silt loam	5	10	-	15	subrounded	-	-	-	-	-	-	-
322	C	24		-	-	-	Firm	silty clay	10	20	-	30	subangular	-	-	-	-	-	-	-
323	LFH	7	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
323	Ae	0	12	-	-	-	Very friable	silt loam	-	-	-	-	-	5.5	-	-	-	-	-	-
323	Bm	12	30	-	-	-	Friable	silt loam	-	-	-	-	-	6	-	-	-	-	-	-
323	C1	30	70	-	-	-	Friable	silt loam	-	-	-	-	-	6.5	-	-	-	-	-	-
323	C2	70	90	-	-	-	Firm	silty clay	5	-	-	5	angular	7	-	-	-	-	-	Strong
324	LFH	5	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
324	Ahe	0	25	-	-	-	Friable	silt loam	1	15	-	16	round	5.5	-	-	-	-	-	-
324	Bm	25	45	-	-	-	Friable	silt loam	1	15	-	16	round	6	-	-	-	-	-	-
324	C	45	65	-	-	-	Firm	silty clay	20	2	-	22	angular	7	-	-	-	-	-	-
326	LFH	5	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
326	Ae	0	5	-	-	-	Friable	silt loam	8	10	-	18	subrounded	5.5	-	-	-	-	-	-
326	Bm	5	22	-	-	-	Friable	silt loam	8	10	-	18	subrounded	7	-	-	-	-	-	-
326	C	22	50	-	-	-	Friable	sandy clay loam	5	10	-	15	subangular	7.5	-	-	-	-	-	-
327	LFH	6	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
327	Ae	0	9	-	-	-	Friable	sandy loam	-	-	-	-	-	5.5	-	-	-	-	-	-
327	Bm	9	33	-	-	-	Friable	sandy loam	-	-	-	-	-	6	-	-	-	-	-	-
327	C1	33	70	-	-	-	Friable	loamy sand	-	-	-	-	-	6.5	-	-	-	-	-	-
327	C2	70	80	-	-	-	Firm	clay	15	5	-	20	angular	7.5	-	-	-	-	-	-
328	LFH	15	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
328	C	0	20	-	-	-	Firm	silty clay	20	10	-	30	angular	7	-	-	-	-	-	-
329	C	0		-	-	-		sand	35	35	-	70	round	-	-	-	-	-	-	-
330	LFH	5	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
330	Ae	0	6	-	-	-	Friable	silt loam	35	35	-	70	round	-	-	-	-	-	-	-
330	Bm	6	23	-	-	-	Friable	-	-	-	-	-	-	-	-	-	-	-	-	-
331	LFH	6	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
331	Ae	0	7	-	-	-	Friable	clay loam	3	-	-	3	subrounded	5	-	-	-	-	-	-
331	Bm	7	16	-	-	-	Friable	clay loam	3	5	-	8	subrounded	5	-	-	-	-	-	-
331	C	16	40	-	-	-	Friable	clay loam	35	30	-	65	subrounded	5.5	-	-	-	-	-	-
332	LFH	9	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
332	Ae	0	8	-	-	-	Friable	loamy sand	1	-	-	1	subrounded	6.5	-	-	-	-	-	-
332	AB	8	37	-	-	-	Friable	loamy sand	1	-	-	1	subrounded	6.5	-	-	-	-	-	-
332	Bm	37	53	-	-	-	Friable	sandy loam	2	-	-	2	subrounded	6.5	-	-	-	-	-	-
332	C	53	90	-	-	-	Friable	sandy loam	-	-	-	-	-	7	-	-	-	-	-	-
335	LFH	8	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
335	Ae	0	9	-	-	-	Friable	silty clay loam	10	40	-	50	round	5	-	-	-	-	-	-
335	Bm	9	25	-	-	-	Firm	silty clay loam	10	40	-	50	round	5.5	-	-	-	-	-	-
335	C	25	35	-	-	-	Friable	clay loam	20	40	-	60	subangular	6.5	-	-	-	-	-	-
336	LFH	5	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
336	Ae	0	11	-	-	-	Friable	loam	1	1	-	2	round	5	-	-	-	-	-	-
336	Bm	11	43	-	-	-	Friable	sandy loam	1	1	-	2	round	5.5	-	-	-	-	-	-
336	C	43	100	-	-	-	Friable	silt loam	1	1	-	2	round	8	-	-	-	-	-	Moderate
401	visual	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
402	Of	0	8	weak		erect	-	-	-	-	-	-	-	-	-	-	-	plentiful	fine/medium/coarse	-
402	Oh	8	45	moderate		massive	-	-	-	-	-	-	-	-	-	-	-	plentiful	fine/medium	-
402	Ah	45	50	-	fine	platy	Friable	sandy clay loam	-	-	-	-	-	8	common	medium	faint	few	fine	-
402	I Cgi	50	120	-	-	single grained	Friable	loamy sand	-	-	-	-	-	8	common	medium	faint	-	-	-

Appendix 4. Summary of Terrain and Soil Inspection Data

b) Soil Data

Site ID	Horizon	Top Depth	Bottom Depth	Structure Grade	Structure Class	Structure Kind	Consistence	Soil Texture	% Gravel	% Cobbles	% Boulders	% Coarse Fr.	Coarse Fr. Shape	Soil pH	Mottles Abundance	Mottles Size	Mottle Colour	Root Abundance	Root Size	Carbonates
402	II Cgi	120	999	-	-	massive	Non-sticky	-	40	-	-	40	subangular	8	-	-	-	-	-	-
403	LFH	14	0	weak		non-matted	-	-	-	-	-	-	-	-	-	-	-	plentiful	fine/medium/coarse	-
403	Ae	0	22	-	medium	angular blocky	Friable	loamy sand	-	-	-	-	-	4.5	-	-	-	few	fine/medium	-
403	Bm	22	30	-	medium	angular blocky	Friable	sandy loam	-	-	-	-	-	5.3	-	-	-	-	-	-
403	I C	30	65	-	medium	subangular blocky	Friable	sandy loam	-	30	-	-	round	6	-	-	-	-	-	-
403	II C	65	85	-	-	massive	Firm	sandy clay loam	35	20	-	55	angular	6.8	-	-	-	-	-	-
404	Of	0	12	weak		erect	-	-	-	-	-	-	-	6	-	-	-	plentiful	fine/medium/coarse	-
404	Om	12	130	weak		massive	-	-	-	-	-	-	-	-	-	-	-	few	medium/coarse	-
405	visual	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
406	Hh	2	0	weak		massive	-	-	-	-	-	-	-	-	-	-	-	plentiful	fine/medium/coarse	-
406	Ah	0	14	-	-	massive	Slightly sticky	sandy loam	15	-	-	15	round	0	-	-	-	plentiful	fine/medium/coarse	-
406	C	14	80	-	-	massive	Slightly sticky	sandy loam	35	10	-	45	round	7.5	few	coarse	faint	few	fine/medium	-
407	Of	0	10	weak		erect	-	-	-	-	-	-	-	-	-	-	-	abundant	fine/medium/coarse	-
407	Om	10	120	moderate		massive	-	-	-	-	-	-	-	-	-	-	-	few	medium/coarse	-
408	LFH	12	0	weak		non-matted	-	-	-	-	-	-	-	-	-	-	-	abundant	fine/medium/coarse	-
408	Ae	0	9	-	coarse	platy	Friable	sandy loam	-	-	-	-	-	5.5	-	-	-	abundant	fine/medium/coarse	-
408	Bm	9	23	-	medium	subangular blocky	Friable	sandy loam	-	-	-	-	-	6.4	-	-	-	abundant	medium/coarse	-
408	I C	23	80	-	-	massive	Friable	sandy loam	-	-	-	-	-	0	-	-	-	plentiful	medium/coarse	-
408	II C	80	100	-	-	massive	Firm	clay	5	-	-	5	angular	7	-	-	-	-	-	-
409	LFH	13	0	moderate		non-matted	-	-	-	-	-	-	-	-	-	-	-	plentiful	fine/medium/coarse	-
409	Ae	0	8	-	medium	platy	Friable	sandy loam	-	-	-	-	-	5.5	-	-	-	plentiful	medium/coarse	-
409	Bm	8	20	-	medium	subangular blocky	Firm	sandy loam	-	-	-	-	-	6.5	-	-	-	plentiful	medium	-
409	I c	20	65	-	-	massive	Friable	sandy loam	-	-	-	-	-	7	-	-	-	-	-	-
409	II C	65	80	-	-	massive	Firm	sandy clay loam	5	-	-	5	angular	7	-	-	-	-	-	-
410	LFH	11	0	weak		non-matted	-	-	-	-	-	-	-	-	-	-	-	abundant	fine/medium	-
410	Ae	0	6	-	fine	subangular blocky	Friable	sandy clay loam	2	-	-	2	subangular	0	-	-	-	abundant	fine/medium	-
410	Bm	6	19	-	fine	subangular blocky	Firm	clay loam	5	-	-	5	subangular	6.8	-	-	-	abundant	fine/medium	-
410	C	19	75	-	-	massive	Firm	clay	5	5	-	10	subangular	0	common	medium	faint	plentiful	medium	-
411	Fr	21	10	moderate		granular	-	-	-	-	-	-	-	-	-	-	-	abundant	fine/medium/coarse	-
411	H	10	0	strong		massive	-	-	-	-	-	-	-	-	-	-	-	abundant	medium/coarse	-
411	Ah	0	7	-	medium	subangular blocky	Firm	sandy loam	2	-	-	2	subangular	0	-	-	-	plentiful	medium	-
411	Btj	7	26	-	medium	angular blocky	Firm	sandy loam	5	-	-	5	subangular	0	common	fine	faint	few	medium	-
411	Cgi	26	53	-	medium	angular blocky	Firm	sandy loam	5	15	-	20	subrounded	0	common	fine	faint	few	medium	-
411	C	53	70	-	-	massive	Very Firm	clay	2	-	-	2	subangular	0	-	-	-	-	-	-
412	Fr	24	11	moderate		non-matted	-	-	-	-	-	-	-	-	-	-	-	abundant	fine/medium/coarse	-
412	H	11	0	moderate		massive	-	-	-	-	-	-	-	-	-	-	-	abundant	fine/medium/coarse	-
412	Ahe	0	14	-	medium	platy	Firm	sandy loam	-	-	-	-	-	0	-	-	-	few	medium	-
412	Bm	14	36	-	medium	subangular blocky	Firm	sandy clay loam	-	-	-	-	-	7	-	-	-	few	medium	-
412	C	36	90	-	-	massive	Friable	sandy loam	-	-	-	-	-	0	-	-	-	-	-	-
413	L	25	20	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
413	Fv	20	11	-		massive	-	-	-	-	-	-	-	-	-	-	-	abundant	fine/medium/coarse	-
413	H	11	0	-		massive	-	-	-	-	-	-	-	-	-	-	-	abundant	fine/medium/coarse	-
413	Ah	0	36	-	-	massive	Slightly sticky	silt loam	-	-	-	-	-	0	-	-	-	plentiful	medium	-
413	I C	36	50	-	-	massive	Slightly sticky	silty clay loam	50	-	-	50	subrounded	0	-	-	-	-	-	-
413	II Cg	50	90	-	-	massive	Sticky	clay	-	-	-	-	-	0	common	fine	faint	-	-	-

Appendix 5

Results of Laboratory Soil Testing and a Summary of Analytical Procedures used by ALS Environmental Laboratories

Rescan™
Engineers and Scientists

ALS Laboratory Group
ANALYTICAL CHEMISTRY & TESTING SERVICES

Environmental Division

Certificate of Analysis

RESCAN ENVIRONMENTAL SERVICES
ATTN: TOMASZ GRADOWSKI

SIXTH FLOOR
1111 WEST HASTINGS STREET
VANCOUVER BC V6E 2J3

Report Date: 08-SEP-10 10:13 (MT)
Version: FINAL

Lab Work Order #: **L915119** **Date Received:** **30-JUL-10**

Project P.O. #: NOT SUBMITTED
Job Reference: 0791-002-08 MURRAY RIVER BASELINE
Legal Site Desc:
CofC Numbers: 10-041238

Other Information:

Comments:

Amber Springer
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A Campbell Brothers Limited Company

ALS LABORATORY GROUP ANALYTICAL REPORT

Sample ID	L915119-1	L915119-2	L915119-3	L915119-4	L915119-5
Description					
Sampled Date					
Sampled Time					
Client ID	MURRAY 007-1	MURRAY 007-2	MURRAY 007-3	MURRAY 012-1	MURRAY 012-2
Grouping / **Analyte**					
SOIL					
Physical Tests pH (pH)	4.70	5.13	5.13	4.33	4.67
Organic / Inorganic Carbon Total Organic Carbon (%)	1.27	0.46	0.50	0.71	0.62
Metals Antimony (Sb) (mg/kg)	<10	<10	<10	<10	<10
Arsenic (As) (mg/kg)	5.4	<5.0	5.0	<5.0	<5.0
Barium (Ba) (mg/kg)	89.6	68.0	95.0	37.1	111
Beryllium (Be) (mg/kg)	<0.50	<0.50	<0.50	<0.50	<0.50
Cadmium (Cd) (mg/kg)	<0.50	<0.50	<0.50	<0.50	<0.50
Chromium (Cr) (mg/kg)	13.3	7.6	13.8	3.5	13.0
Cobalt (Co) (mg/kg)	3.1	<2.0	4.0	<2.0	3.4
Copper (Cu) (mg/kg)	5.9	2.3	9.8	1.3	4.6
Lead (Pb) (mg/kg)	<30	<30	<30	<30	<30
Mercury (Hg) (mg/kg)	0.0220	0.0069	0.0145	0.0068	0.0099
Molybdenum (Mo) (mg/kg)	<4.0	<4.0	<4.0	<4.0	<4.0
Nickel (Ni) (mg/kg)	9.0	<5.0	16.2	<5.0	9.6
Selenium (Se) (mg/kg)	<0.50	<0.50	<0.50	<0.50	<0.50
Silver (Ag) (mg/kg)	<2.0	<2.0	<2.0	<2.0	<2.0
Thallium (Tl) (mg/kg)	<1.0	<1.0	<1.0	<1.0	<1.0
Tin (Sn) (mg/kg)	<5.0	<5.0	<5.0	<5.0	<5.0
Uranium (U) (mg/kg)	0.399	0.281	0.433	0.136	0.386
Vanadium (V) (mg/kg)	32.5	18.4	29.3	11.4	35.7
Zinc (Zn) (mg/kg)	45.8	23.1	57.6	7.1	40.8

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS LABORATORY GROUP ANALYTICAL REPORT

Grouping	Analyte	Sample ID: L915119-6 Description: MURRAY 012-3	L915119-7 MURRAY 016 -1	L915119-8 MURRAY 016 -2	L915119-9 MURRAY 016 -3	L915119-10 MURRAY 026-1
SOIL						
Physical Tests	pH (pH)	5.18	4.78	5.38	6.13	6.27
Organic / Inorganic Carbon	Total Organic Carbon (%)	0.50	1.65	0.97	1.23	1.67
Metals	Antimony (Sb) (mg/kg)	<10	<10	<10	<10	<10
	Arsenic (As) (mg/kg)	<5.0	<5.0	7.3	5.9	<5.0
	Barium (Ba) (mg/kg)	112	247	216	155	394
	Beryllium (Be) (mg/kg)	<0.50	<0.50	0.57	<0.50	<0.50
	Cadmium (Cd) (mg/kg)	<0.50	1.87	0.66	<0.50	<0.50
	Chromium (Cr) (mg/kg)	12.2	15.1	18.4	15.8	13.0
	Cobalt (Co) (mg/kg)	3.3	7.2	9.4	7.6	2.8
	Copper (Cu) (mg/kg)	3.7	12.5	11.0	11.6	11.6
	Lead (Pb) (mg/kg)	<30	<30	<30	<30	<30
	Mercury (Hg) (mg/kg)	0.0079	0.0157	0.0200	0.0373	0.0072
	Molybdenum (Mo) (mg/kg)	<4.0	<4.0	<4.0	<4.0	<4.0
	Nickel (Ni) (mg/kg)	8.6	13.6	20.1	19.1	9.8
	Selenium (Se) (mg/kg)	<0.50	<0.50	0.50	0.50	<0.50
	Silver (Ag) (mg/kg)	<2.0	<2.0	<2.0	<2.0	<2.0
	Thallium (Tl) (mg/kg)	<1.0	<1.0	<1.0	<1.0	<1.0
	Tin (Sn) (mg/kg)	<5.0	<5.0	<5.0	<5.0	<5.0
	Uranium (U) (mg/kg)	0.331	0.460	0.683	0.883	0.448
	Vanadium (V) (mg/kg)	33.3	38.4	35.1	31.7	26.4
	Zinc (Zn) (mg/kg)	38.4	82.5	67.6	55.0	66.5

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS LABORATORY GROUP ANALYTICAL REPORT

Sample ID	L915119-11	L915119-12	L915119-13	L915119-14	L915119-15
Description					
Sampled Date					
Sampled Time					
Client ID	MURRAY 026-2	MURRAY 026-3	MURRAY 029-1	MURRAY 029-2	MURRAY 029-3
Grouping / **Analyte**					
SOIL					
Physical Tests pH (pH)	6.04	5.71	4.47	5.10	5.10
Organic / Inorganic Carbon Total Organic Carbon (%)	1.54	1.13	0.64	0.57	0.66
Metals Antimony (Sb) (mg/kg)	<10	<10	<10	<10	<10
Arsenic (As) (mg/kg)	<5.0	6.4	5.1	9.0	7.9
Barium (Ba) (mg/kg)	395	339	84.3	128	143
Beryllium (Be) (mg/kg)	<0.50	<0.50	<0.50	0.61	0.63
Cadmium (Cd) (mg/kg)	<0.50	<0.50	<0.50	<0.50	<0.50
Chromium (Cr) (mg/kg)	11.2	15.2	6.7	14.8	15.4
Cobalt (Co) (mg/kg)	3.2	9.1	<2.0	4.2	4.8
Copper (Cu) (mg/kg)	9.3	13.8	5.7	12.3	14.5
Lead (Pb) (mg/kg)	<30	<30	<30	<30	<30
Mercury (Hg) (mg/kg)	0.0076	0.0090	0.0111	0.0208	0.0238
Molybdenum (Mo) (mg/kg)	<4.0	<4.0	<4.0	<4.0	<4.0
Nickel (Ni) (mg/kg)	10.1	16.4	6.7	18.4	22.2
Selenium (Se) (mg/kg)	<0.50	<0.50	<0.50	<0.50	<0.50
Silver (Ag) (mg/kg)	<2.0	<2.0	<2.0	<2.0	<2.0
Thallium (Tl) (mg/kg)	<1.0	<1.0	<1.0	<1.0	<1.0
Tin (Sn) (mg/kg)	<5.0	<5.0	<5.0	<5.0	<5.0
Uranium (U) (mg/kg)	0.389	0.550	0.233	0.432	0.431
Vanadium (V) (mg/kg)	21.5	30.3	23.9	32.1	29.8
Zinc (Zn) (mg/kg)	52.3	80.4	38.4	95.8	101

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS LABORATORY GROUP ANALYTICAL REPORT

Sample ID	L915119-16	L915119-17	L915119-18	L915119-19	L915119-20
Description					
Sampled Date					
Sampled Time					
Client ID	MURRAY 034-1	MURRAY 034-2	MURRAY 034-3	MURRAY 039-1	MURRAY 039-2
Grouping / **Analyte**					
SOIL					
Physical Tests pH (pH)	5.89	6.18	6.17	5.87	6.36
Organic / Inorganic Carbon Total Organic Carbon (%)	5.81	1.75	3.41	1.78	1.70
Metals Antimony (Sb) (mg/kg)	<10	<10	<10	<10	<10
Arsenic (As) (mg/kg)	7.1	7.9	6.6	8.5	8.1
Barium (Ba) (mg/kg)	453	245	462	419	466
Beryllium (Be) (mg/kg)	0.63	0.61	0.72	0.66	0.66
Cadmium (Cd) (mg/kg)	1.21	0.55	0.99	<0.50	<0.50
Chromium (Cr) (mg/kg)	14.6	12.2	16.8	12.2	13.3
Cobalt (Co) (mg/kg)	8.5	6.8	8.8	9.7	9.0
Copper (Cu) (mg/kg)	22.8	15.2	22.0	17.9	18.6
Lead (Pb) (mg/kg)	<30	<30	<30	<30	<30
Mercury (Hg) (mg/kg)	0.0737	0.0502	0.0878	0.0561	0.0653
Molybdenum (Mo) (mg/kg)	<4.0	<4.0	<4.0	<4.0	<4.0
Nickel (Ni) (mg/kg)	27.4	22.3	27.7	21.5	23.8
Selenium (Se) (mg/kg)	0.82	0.65	0.82	<0.50	<0.50
Silver (Ag) (mg/kg)	<2.0	<2.0	<2.0	<2.0	<2.0
Thallium (Tl) (mg/kg)	<1.0	<1.0	<1.0	<1.0	<1.0
Tin (Sn) (mg/kg)	<5.0	<5.0	<5.0	<5.0	<5.0
Uranium (U) (mg/kg)	0.870	0.735	1.06	0.884	0.823
Vanadium (V) (mg/kg)	30.0	25.6	32.2	23.1	25.0
Zinc (Zn) (mg/kg)	120	113	105	68.7	64.9

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS LABORATORY GROUP ANALYTICAL REPORT

Sample ID	L915119-21	L915119-22	L915119-23	L915119-24	L915119-25
Description					
Sampled Date					
Sampled Time					
Client ID	MURRAY 039-3	MURRAY 040-1	MURRAY 040-2	MURRAY 040-3	MURRAY 042-1
Grouping / **Analyte**					
SOIL					
Physical Tests pH (pH)	6.75	7.73	7.96	8.27	5.03
Organic / Inorganic Carbon Total Organic Carbon (%)	1.88	8.18	6.15	3.24	0.70
Metals Antimony (Sb) (mg/kg)	<10	<10	<10	<10	<10
Arsenic (As) (mg/kg)	8.1	<5.0	5.2	5.6	<5.0
Barium (Ba) (mg/kg)	476	191	329	156	55.0
Beryllium (Be) (mg/kg)	0.54	<0.50	<0.50	<0.50	<0.50
Cadmium (Cd) (mg/kg)	0.52	1.12	1.19	1.03	<0.50
Chromium (Cr) (mg/kg)	13.0	10.8	12.3	10.6	7.5
Cobalt (Co) (mg/kg)	7.5	5.6	6.4	5.9	2.5
Copper (Cu) (mg/kg)	16.8	17.3	19.0	16.4	2.4
Lead (Pb) (mg/kg)	<30	<30	<30	<30	<30
Mercury (Hg) (mg/kg)	0.0397	0.0999	0.118	0.0582	0.0083
Molybdenum (Mo) (mg/kg)	<4.0	<4.0	<4.0	<4.0	<4.0
Nickel (Ni) (mg/kg)	20.5	21.9	25.8	22.5	7.0
Selenium (Se) (mg/kg)	<0.50	0.67	1.11	0.76	<0.50
Silver (Ag) (mg/kg)	<2.0	<2.0	<2.0	<2.0	<2.0
Thallium (Tl) (mg/kg)	<1.0	<1.0	<1.0	<1.0	<1.0
Tin (Sn) (mg/kg)	<5.0	<5.0	<5.0	<5.0	<5.0
Uranium (U) (mg/kg)	0.609	0.776	0.779	0.791	0.210
Vanadium (V) (mg/kg)	26.3	23.5	25.9	25.6	23.3
Zinc (Zn) (mg/kg)	69.4	89.3	88.3	71.8	22.4

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS LABORATORY GROUP ANALYTICAL REPORT

Sample ID	L915119-26	L915119-27	L915119-28	L915119-29	L915119-30
Description					
Sampled Date					
Sampled Time					
Client ID	MURRAY 042-2	MURRAY 042-3	MURRAY 045-1	MURRAY 045-2	MURRAY 045-3
Grouping / **Analyte**					
SOIL					
Physical Tests pH (pH)	5.58	5.97	7.87	7.92	7.88
Organic / Inorganic Carbon Total Organic Carbon (%)	0.40	0.43	13.0	5.66	4.97
Metals Antimony (Sb) (mg/kg)	<10	<10	<10	<10	<10
Arsenic (As) (mg/kg)	<5.0	5.0	5.2	7.7	7.6
Barium (Ba) (mg/kg)	53.9	59.3	190	189	228
Beryllium (Be) (mg/kg)	<0.50	<0.50	<0.50	0.69	0.65
Cadmium (Cd) (mg/kg)	<0.50	<0.50	1.72	1.88	1.51
Chromium (Cr) (mg/kg)	9.0	11.6	11.8	16.6	16.3
Cobalt (Co) (mg/kg)	3.8	4.7	6.8	8.7	9.3
Copper (Cu) (mg/kg)	3.6	6.6	17.7	17.4	23.2
Lead (Pb) (mg/kg)	<30	<30	<30	<30	<30
Mercury (Hg) (mg/kg)	0.0054	0.0107	0.114	0.0831	0.0897
Molybdenum (Mo) (mg/kg)	<4.0	<4.0	<4.0	<4.0	<4.0
Nickel (Ni) (mg/kg)	11.0	17.0	24.2	30.3	36.7
Selenium (Se) (mg/kg)	<0.50	<0.50	1.31	1.43	1.11
Silver (Ag) (mg/kg)	<2.0	<2.0	<2.0	<2.0	<2.0
Thallium (Tl) (mg/kg)	<1.0	<1.0	<1.0	<1.0	<1.0
Tin (Sn) (mg/kg)	<5.0	<5.0	<5.0	<5.0	<5.0
Uranium (U) (mg/kg)	0.203	0.298	1.07	0.859	0.840
Vanadium (V) (mg/kg)	24.4	25.9	25.8	38.4	37.9
Zinc (Zn) (mg/kg)	30.5	42.6	94.9	104	100

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS LABORATORY GROUP ANALYTICAL REPORT

Sample ID	L915119-31	L915119-32	L915119-33	L915119-34	L915119-35
Description					
Sampled Date					
Sampled Time					
Client ID	MURRAY 048-1	MURRAY 048-2	MURRAY 048-3	MURRAY 054-1	MURRAY 054-2
Grouping / **Analyte**					
SOIL					
Physical Tests pH (pH)	5.10	5.48	8.38	5.32	7.28
Organic / Inorganic Carbon Total Organic Carbon (%)	0.68	0.43	0.79	39.0	36.3
Metals Antimony (Sb) (mg/kg)	<10	<10	<10	<10	<10
Arsenic (As) (mg/kg)	<5.0	6.2	<5.0	<5.0	<5.0
Barium (Ba) (mg/kg)	38.4	42.8	28.9	42.8	975
Beryllium (Be) (mg/kg)	<0.50	0.59	<0.50	<0.50	<0.50
Cadmium (Cd) (mg/kg)	<0.50	<0.50	<0.50	0.86	0.83
Chromium (Cr) (mg/kg)	14.8	17.4	6.5	<2.0	<2.0
Cobalt (Co) (mg/kg)	7.0	11.4	3.8	<2.0	<2.0
Copper (Cu) (mg/kg)	8.1	17.2	11.8	2.0	6.0
Lead (Pb) (mg/kg)	<30	<30	<30	<30	<30
Mercury (Hg) (mg/kg)	0.0142	0.0323	0.0284	0.0983	0.0750
Molybdenum (Mo) (mg/kg)	<4.0	<4.0	<4.0	<4.0	<4.0
Nickel (Ni) (mg/kg)	16.9	25.7	12.6	<5.0	6.7
Selenium (Se) (mg/kg)	<0.50	<0.50	<0.50	<0.50	0.66
Silver (Ag) (mg/kg)	<2.0	<2.0	<2.0	<2.0	<2.0
Thallium (Tl) (mg/kg)	<1.0	<1.0	<1.0	<1.0	<1.0
Tin (Sn) (mg/kg)	<5.0	<5.0	<5.0	<5.0	<5.0
Uranium (U) (mg/kg)	0.256	0.476	0.492	<0.050	0.997
Vanadium (V) (mg/kg)	24.3	27.4	14.3	<2.0	3.8
Zinc (Zn) (mg/kg)	35.8	51.2	32.0	7.6	13.1

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS LABORATORY GROUP ANALYTICAL REPORT

Grouping	Analyte	Sample ID: L915119-36 Description: MURRAY 054-3	L915119-37 MURRAY 020-1	L915119-38 MURRAY 020-2	L915119-39 MURRAY 020-3	L915119-40 MURRAY 023-1
SOIL						
Physical Tests	pH (pH)	7.34	5.05	5.46	5.70	7.38
Organic / Inorganic Carbon	Total Organic Carbon (%)	32.2	2.42	1.42	1.30	4.40
Metals	Antimony (Sb) (mg/kg)	<10	<10	<10	<10	<10
	Arsenic (As) (mg/kg)	<5.0	7.1	<5.0	7.2	6.3
	Barium (Ba) (mg/kg)	2710	309	320	218	510
	Beryllium (Be) (mg/kg)	<0.50	0.52	0.55	<0.50	<0.50
	Cadmium (Cd) (mg/kg)	2.53	1.25	1.20	0.76	0.54
	Chromium (Cr) (mg/kg)	3.7	12.6	13.1	9.4	10.3
	Cobalt (Co) (mg/kg)	8.0	7.7	8.8	6.9	7.8
	Copper (Cu) (mg/kg)	11.9	10.8	12.0	12.4	19.6
	Lead (Pb) (mg/kg)	<30	<30	<30	<30	<30
	Mercury (Hg) (mg/kg)	0.0836	0.0175	0.0167	0.0276	0.0822
	Molybdenum (Mo) (mg/kg)	8.7	<4.0	<4.0	<4.0	<4.0
	Nickel (Ni) (mg/kg)	19.9	14.7	18.3	16.6	25.3
	Selenium (Se) (mg/kg)	1.94	<0.50	<0.50	<0.50	0.52
	Silver (Ag) (mg/kg)	<2.0	<2.0	<2.0	<2.0	<2.0
	Thallium (Tl) (mg/kg)	<1.0	<1.0	<1.0	<1.0	<1.0
	Tin (Sn) (mg/kg)	<5.0	<5.0	<5.0	<5.0	<5.0
	Uranium (U) (mg/kg)	1.54	0.618	0.587	0.721	0.855
	Vanadium (V) (mg/kg)	9.2	33.8	25.2	16.8	19.1
	Zinc (Zn) (mg/kg)	40.4	91.5	108	97.1	91.3

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS LABORATORY GROUP ANALYTICAL REPORT

Sample ID	L915119-41	L915119-42	L915119-43	L915119-44	L915119-45
Description					
Sampled Date					
Sampled Time					
Client ID	MURRAY 023-2	MURRAY 023-3	MURRAY 031-1	MURRAY 031-2	MURRAY 031-3
Grouping / **Analyte**					
SOIL					
Physical Tests pH (pH)	7.42	7.45	5.04	5.58	5.79
Organic / Inorganic Carbon Total Organic Carbon (%)	3.62	1.56	0.47	0.84	0.69
Metals Antimony (Sb) (mg/kg)	<10	<10	<10	<10	<10
Arsenic (As) (mg/kg)	6.7	7.4	<5.0	6.5	6.5
Barium (Ba) (mg/kg)	761	335	32.2	41.5	45.4
Beryllium (Be) (mg/kg)	0.56	0.53	<0.50	0.50	<0.50
Cadmium (Cd) (mg/kg)	5.70	<0.50	<0.50	<0.50	<0.50
Chromium (Cr) (mg/kg)	13.6	11.9	5.6	16.8	18.1
Cobalt (Co) (mg/kg)	8.5	6.6	<2.0	5.6	9.1
Copper (Cu) (mg/kg)	20.6	11.8	1.9	7.4	11.0
Lead (Pb) (mg/kg)	<30	<30	<30	<30	<30
Mercury (Hg) (mg/kg)	0.0362	0.0562	0.0090	0.0121	0.0177
Molybdenum (Mo) (mg/kg)	<4.0	<4.0	<4.0	<4.0	<4.0
Nickel (Ni) (mg/kg)	21.4	21.4	<5.0	18.1	28.0
Selenium (Se) (mg/kg)	0.68	0.54	<0.50	<0.50	<0.50
Silver (Ag) (mg/kg)	<2.0	<2.0	<2.0	<2.0	<2.0
Thallium (Tl) (mg/kg)	<1.0	<1.0	<1.0	<1.0	<1.0
Tin (Sn) (mg/kg)	<5.0	<5.0	<5.0	<5.0	<5.0
Uranium (U) (mg/kg)	0.600	0.722	0.165	0.393	0.571
Vanadium (V) (mg/kg)	29.2	24.1	21.7	40.5	28.7
Zinc (Zn) (mg/kg)	329	60.6	25.9	88.7	63.0

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

Qualifiers for Sample Submission Listed:

Qualifier	Description
SR:COC	Sample Received, Not Listed on Submitted Chain of Custody / Analytical Request Form - samples # Maurray 020-1, 020-2, 020-3, 023-1, 023-2, 023-3, 031-1, 031-2, 031-3

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
C-INORG-ORG-SK	Soil	Inorganic and Organic Carbon	SSSA (1996) P455-456

When carbonates are decomposed with acid in an open system, carbon dioxide is released to the atmosphere. The decrease in sample weight resulting from CO2 loss is proportional to the carbonate content of the soil.

Reference:
Loeppert, R.H. and Suarez, D.L. 1996. Gravimetric Method for Loss of Carbon Dioxide. P. 455-456 In: J.M. Bartels et al. (ed.) Methods of soil analysis: Part 3 Chemical methods. (3rd ed.) ASA and SSSA, Madison, WI. Book series no. 5

C-TOT-LECO-SK	Soil	Total Carbon by combustion method	SSSA (1996) P. 973-974

The sample is introduced into a quartz tube where it undergoes combustion at 900 C in the presence of oxygen.
Combustion gases are first carried through a catalyst bed in the bottom of the combustion tube, where oxidation is completed and then carried through a reducing agent (copper), where the nitrogen oxides are reduced to elemental nitrogen.
This mixture of N2, CO2, and H2O is then passed through an absorber column containing magnesium perchlorate to remove water. N2 and CO2 gases are then separated in a gas chromatographic column and detected by thermal conductivity.

Reference:
Nelson, D.W. and Sommers, L.E. 1996. Total Carbon, organic carbon and organic matter. P. 973-974 In: J.M. Bartels et al. (ed.) Methods of soil analysis: Part 3 Chemical methods. (3rd ed.) ASA and SSSA, Madison, WI. Book series no. 5

HG-CCME-CVAFS-VA	Soil	CVAFS Hg in Soil (CCME)	BCMELP CSR SALM METHOD 8/EPA 245.7

This analysis is carried out using procedures from CSR Analytical Method 8 "Strong Acid Leachable Metals (SALM) in Soil", BC Ministry of Environment, Lands and Parks, 26 June 2001, and procedures adapted from "Test Methods for Evaluating Solid Waste", SW-846 Method 3050B United States Environmental Protection Agency (EPA). The sample is manually homogenized, dried at 60 degrees Celsius, sieved through a 2 mm (10 mesh) sieve, and a representative subsample of the dry material is weighed. The sample is then digested at 90 degrees Celsius for 2 hours by block digester using a 1:1 ratio of concentrated nitric and hydrochloric acids. Instrumental analysis is by atomic fluorescence spectrophotometry (EPA Method 7000 series).

Method Limitation: This method is not a total digestion technique. It is a very strong acid digestion that is intended to dissolve those metals that may be environmentally available. By design, elements bound in silicate structures are not normally dissolved by this procedure as they are not usually mobile in the environment.

MET-200.2-CCMS-VA	Soil	Metals in Soil by CRC ICPMS	EPA 200.2/6020A

This analysis is carried out using procedures from CSR Analytical Method: "Strong Acid Leachable Metals (SALM) in Soil", BC Ministry of Environment, 26 June 2009, and procedures adapted from EPA Method 200.2. The sample is manually homogenized, dried at 60 degrees Celsius, sieved through a 2 mm (10 mesh) sieve, and a representative subsample of the dry material is weighed. The sample is then digested at 95 degrees Celsius for 2 hours by block digester using concentrated nitric and hydrochloric acids. Instrumental analysis is by collision cell inductively coupled plasma - mass spectrometry (modifed from EPA Method 6020A).

Method Limitation: This method is not a total digestion technique. It is a very strong acid digestion that is intended to dissolve those metals that may be environmentally available. By design, elements bound in silicate structures are not normally dissolved by this procedure as they are not usually mobile in the environment.

MET-CSR-FULL-ICP-VA	Soil	Metals in Soil by ICPOES (CSR SALM)	BCMELP CSR SALM METHOD 8

This analysis is carried out using procedures from CSR Analytical Method 8 "Strong Acid Leachable Metals (SALM) in Soil", BC Ministry of Environment, Lands and Parks, 26 June 2001, and procedures adapted from "Test Methods for Evaluating Solid Waste", SW-846 Method 3050B United States Environmental Protection Agency (EPA). The sample is manually homogenized, dried at 60 degrees Celsius, sieved through a 2 mm (10 mesh) sieve, and a representative subsample of the dry material is weighed. The sample is then digested at 90 degrees Celsius for 2 hours by block digester using a 1:1 ratio of concentrated nitric and hydrochloric acids. Instrumental analysis is by inductively coupled plasma - optical emission spectrophotometry (EPA Method 6010B).

Method Limitation: This method is not a total digestion technique. It is a very strong acid digestion that is intended to dissolve those metals that may be environmentally available. By design, elements bound in silicate structures are not normally dissolved by this procedure as they are not usually mobile in the environment.

PH-1:2-VA	Soil	CSR pH by 1:2 Water Leach	BC WLAP METHOD: PH, ELECTROMETRIC, SOIL

This analysis is carried out in accordance with procedures described in the pH, Electrometric in Soil and Sediment method - Section B Physical/Inorganic and Misc. Constituents, BC Environmental Laboratory Manual 2007. The procedure involves mixing the dried (at <60 C) and sieved (No. 10 / 2mm) sample with deionized/distilled water at a 1:2 ratio of sediment to water. The pH of the solution is then measured using a standard pH probe.

TL-CSR-MS-VA	Soil	ICPMS Tl in Soil by CSR SALM	BCMELP CSR SALM Method 8

Reference Information

This analysis is carried out using procedures from CSR Analytical Method 8 "Strong Acid Leachable Metals (SALM) in Soil", BC Ministry of Environment, Lands and Parks, 26 June 2001, and procedures adapted from "Test Methods for Evaluating Solid Waste", SW-846 Method 3050B United States Environmental Protection Agency (EPA). The sample is manually homogenized, dried at 60 degrees Celsius, sieved through a 2 mm (10 mesh) sieve, and a representative subsample of the dry material is weighed. The sample is then digested at 90 degrees Celsius for 2 hours by either hotplate or block digester using a 1:1 ratio of concentrated nitric and hydrochloric acids. Instrumental analysis is by inductively coupled plasma - mass spectrometry (EPA Method 6020A).

Method Limitation: This method is not a total digestion technique. It is a very strong acid digestion that is intended to dissolve those metals that may be environmentally available. By design, elements bound in silicate structures are not normally dissolved by this procedure as they are not usually mobile in the environment.

U-200.2-MS-VA Soil Uranium in Soil by ICPMS EPA 200.2/6020A

This analysis is carried out using procedures from CSR Analytical Method: "Strong Acid Leachable Metals (SALM) in Soil", BC Ministry of Environment, 26 June 2009, and procedures adapted from EPA Method 200.2. The sample is manually homogenized, dried at 60 degrees Celsius, sieved through a 2 mm (10 mesh) sieve, and a representative subsample of the dry material is weighed. The sample is then digested at 95 degrees Celsius for 2 hours by block digester using concentrated nitric and hydrochloric acids. Instrumental analysis is by inductively coupled plasma - mass spectrometry (EPA Method 6020A).

Method Limitation: This method is not a total digestion technique. It is a very strong acid digestion that is intended to dissolve those metals that may be environmentally available. By design, elements bound in silicate structures are not normally dissolved by this procedure as they are not usually mobile in the environment.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
VA	ALS LABORATORY GROUP - VANCOUVER, BC, CANADA
SK	ALS LABORATORY GROUP - SASKATOON, SASKATCHEWAN, CANADA

Chain of Custody Numbers:

10-041238

GLOSSARY OF REPORT TERMS

Surrogate □ A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg □ milligrams per kilogram based on dry weight of sample.
mg/kg wwt □ milligrams per kilogram based on wet weight of sample.
mg/kg lwt □ milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L □ milligrams per litre.
< - Less than.
D.L. □ The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A □ Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as receieved by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

RESCAN ENVIRONMENTAL SERVICES
ATTN: TOMASZ GRADOWSKI
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Date Received: 22-FEB-11
Report Date: 08-MAR-11 17:29 (MT)
Version: FINAL

Certificate of Analysis

Lab Work Order #: L980265
Project P.O. #: NOT SUBMITTED
Job Reference: 791-002-03 MURRAY RIVER BASELINE
Legal Site Desc:
C of C Numbers: 1, 2

Amber Springer
Account Manager

ALS LABORATORY GROUP ANALYTICAL REPORT

Sample ID	L980265-1	L980265-2	L980265-3	L980265-4	L980265-5
Description					
Sampled Date					
Sampled Time					
Client ID	MURRAY 70 (0-10)	MURRAY 70 (10-20)	MURRAY 70 (30-50)	MURRAY 75 (0-10)	MURRAY 75 (10-20)
Grouping / **Analyte**					
SOIL					
Physical Tests pH (pH)	5.20	5.53	6.79	7.79	8.10
Organic / Inorganic Carbon Total Organic Carbon (%)	0.76	0.87	0.87	1.46	0.98
Metals Antimony (Sb) (mg/kg)	0.14	0.23	0.51	0.44	0.68
Arsenic (As) (mg/kg)	3.55	5.19	8.19	5.50	6.99
Barium (Ba) (mg/kg)	122	176	327	186	232
Beryllium (Be) (mg/kg)	<0.20	0.31	0.77	0.29	0.40
Cadmium (Cd) (mg/kg)	0.12	0.18	0.15	0.37	0.54
Chromium (Cr) (mg/kg)	11.3	15.1	24.1	7.33	9.54
Cobalt (Co) (mg/kg)	2.86	8.19	10.4	4.19	4.83
Copper (Cu) (mg/kg)	2.95	5.10	19.5	9.05	13.7
Lead (Pb) (mg/kg)	6.84	11.1	12.7	6.95	8.91
Mercury (Hg) (mg/kg)	0.0071	0.0120	0.0544	0.0539	0.0534
Molybdenum (Mo) (mg/kg)	0.69	1.03	1.24	1.08	1.80
Nickel (Ni) (mg/kg)	8.20	13.3	32.3	15.0	21.5
Selenium (Se) (mg/kg)	<0.20	<0.20	0.44	0.38	0.38
Silver (Ag) (mg/kg)	<0.10	<0.10	<0.10	0.16	0.18
Thallium (Tl) (mg/kg)	0.088	0.106	0.212	0.110	0.144
Tin (Sn) (mg/kg)	<2.0	<2.0	<2.0	<2.0	<2.0
Uranium (U) (mg/kg)	0.272	0.367	0.953	0.570	0.640
Vanadium (V) (mg/kg)	29.5	33.5	43.2	16.7	21.5
Zinc (Zn) (mg/kg)	34.5	43.9	70.0	59.6	80.3

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS LABORATORY GROUP ANALYTICAL REPORT

Sample ID	L980265-6	L980265-7	L980265-8	L980265-9	L980265-10
Description	MURRAY 75 (30-50)	MURRAY 85 (0-10)	MURRAY 85 (10-20)	MURRAY 85 (30-50)	MURRAY 88 (0-10)
Sampled Date					
Sampled Time					
Client ID					
Grouping / **Analyte**					
SOIL					
Physical Tests pH (pH)	8.28	4.39	4.46	5.27	4.75
Organic / Inorganic Carbon Total Organic Carbon (%)	0.96	1.19	1.03	0.73	0.76
Metals Antimony (Sb) (mg/kg)	0.46	0.27	0.53	0.68	<0.10
Arsenic (As) (mg/kg)	4.61	3.33	5.97	8.38	1.99
Barium (Ba) (mg/kg)	213	68.8	70.5	174	53.1
Beryllium (Be) (mg/kg)	0.31	<0.20	<0.20	0.63	<0.20
Cadmium (Cd) (mg/kg)	0.34	0.12	0.17	0.67	0.12
Chromium (Cr) (mg/kg)	8.61	5.88	7.74	13.6	5.75
Cobalt (Co) (mg/kg)	3.92	0.86	2.19	5.53	0.55
Copper (Cu) (mg/kg)	10.2	3.36	7.05	13.5	1.36
Lead (Pb) (mg/kg)	6.44	3.80	6.70	9.70	4.29
Mercury (Hg) (mg/kg)	0.0493	0.0135	0.0175	0.0287	0.0082
Molybdenum (Mo) (mg/kg)	0.96	1.19	1.52	1.56	<0.50
Nickel (Ni) (mg/kg)	14.9	4.08	9.86	21.0	1.88
Selenium (Se) (mg/kg)	0.28	<0.20	0.25	0.42	<0.20
Silver (Ag) (mg/kg)	0.13	0.17	<0.10	<0.10	<0.10
Thallium (Tl) (mg/kg)	0.105	0.103	0.099	0.101	0.093
Tin (Sn) (mg/kg)	<2.0	<2.0	<2.0	<2.0	6.1
Uranium (U) (mg/kg)	0.624	0.149	0.210	0.572	0.192
Vanadium (V) (mg/kg)	19.0	27.7	31.4	30.3	19.1
Zinc (Zn) (mg/kg)	52.6	22.8	52.0	102	13.2

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS LABORATORY GROUP ANALYTICAL REPORT

Sample ID	L980265-11	L980265-12	L980265-13	L980265-14	L980265-15
Description	MURRAY 88 (10-20)	MURRAY 88 (30-50)	MURRAY 89 (0-10)	MURRAY 89 (10-20)	MURRAY 89 (30-50)
Sampled Date					
Sampled Time					
Client ID					
Grouping / **Analyte**					
SOIL					
Physical Tests pH (pH)	5.25	6.38	6.01	6.23	6.23
Organic / Inorganic Carbon Total Organic Carbon (%)	0.91	0.65	1.42	1.39	1.54
Metals Antimony (Sb) (mg/kg)	0.15	0.38	0.65	0.63	0.68
Arsenic (As) (mg/kg)	4.37	5.96	6.09	6.57	7.38
Barium (Ba) (mg/kg)	143	134	239	280	323
Beryllium (Be) (mg/kg)	<0.20	0.27	0.43	0.53	0.57
Cadmium (Cd) (mg/kg)	0.23	0.30	0.73	0.77	0.60
Chromium (Cr) (mg/kg)	9.49	11.5	10.3	12.0	13.1
Cobalt (Co) (mg/kg)	1.70	2.84	6.30	6.84	6.43
Copper (Cu) (mg/kg)	2.60	5.82	12.0	13.6	15.1
Lead (Pb) (mg/kg)	9.01	8.30	9.29	10.3	10.4
Mercury (Hg) (mg/kg)	0.0131	0.0182	0.0314	0.0372	0.0656
Molybdenum (Mo) (mg/kg)	0.78	1.05	1.41	1.35	1.30
Nickel (Ni) (mg/kg)	4.26	10.6	18.1	19.7	22.4
Selenium (Se) (mg/kg)	<0.20	<0.20	0.29	0.36	0.38
Silver (Ag) (mg/kg)	0.12	0.10	0.16	0.19	0.42
Thallium (Tl) (mg/kg)	0.079	0.104	0.095	0.111	0.124
Tin (Sn) (mg/kg)	<2.0	<2.0	<2.0	<2.0	<2.0
Uranium (U) (mg/kg)	0.263	0.304	0.536	0.701	0.781
Vanadium (V) (mg/kg)	40.0	38.1	23.2	26.0	29.0
Zinc (Zn) (mg/kg)	37.1	65.5	78.5	88.2	81.0

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS LABORATORY GROUP ANALYTICAL REPORT

Sample ID	L980265-16	L980265-17	L980265-18	L980265-19	L980265-20
Description	MURRAY 93 (0-10)	MURRAY 93 (10-20)	MURRAY 93 (30-50)	MURRAY 100 (0-10)	MURRAY 100 (10-20)
Sampled Date					
Sampled Time					
Client ID					
Grouping / **Analyte**					
SOIL					
Physical Tests pH (pH)	4.29	4.97	5.19	4.67	5.12
Organic / Inorganic Carbon Total Organic Carbon (%)	0.85	0.99	0.66	1.35	0.83
Metals Antimony (Sb) (mg/kg)	0.16	0.48	0.69	0.26	0.36
Arsenic (As) (mg/kg)	3.34	7.79	8.96	4.13	5.38
Barium (Ba) (mg/kg)	40.7	92.7	100	61.4	82.0
Beryllium (Be) (mg/kg)	<0.20	0.40	0.64	<0.20	<0.20
Cadmium (Cd) (mg/kg)	<0.10	0.26	0.40	0.10	0.12
Chromium (Cr) (mg/kg)	7.07	19.7	13.5	8.29	6.80
Cobalt (Co) (mg/kg)	0.71	3.58	4.74	1.59	1.82
Copper (Cu) (mg/kg)	1.92	8.95	13.1	3.62	4.35
Lead (Pb) (mg/kg)	5.60	10.8	8.83	5.16	5.97
Mercury (Hg) (mg/kg)	0.0098	0.0293	0.0384	0.0200	0.0162
Molybdenum (Mo) (mg/kg)	0.61	1.51	1.74	0.77	1.15
Nickel (Ni) (mg/kg)	2.69	13.4	27.5	6.93	7.15
Selenium (Se) (mg/kg)	<0.20	0.28	0.41	<0.20	<0.20
Silver (Ag) (mg/kg)	<0.10	0.20	<0.10	<0.10	<0.10
Thallium (Tl) (mg/kg)	0.108	0.130	0.129	0.085	0.074
Tin (Sn) (mg/kg)	<2.0	<2.0	<2.0	<2.0	<2.0
Uranium (U) (mg/kg)	0.189	0.405	0.461	0.236	0.217
Vanadium (V) (mg/kg)	29.7	50.1	29.4	23.9	25.0
Zinc (Zn) (mg/kg)	15.6	76.1	108	31.3	32.5

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS LABORATORY GROUP ANALYTICAL REPORT

Grouping	Analyte	L980265-21 MURRAY 100 (30-50)	L980265-22 MURRAY 107 (0-10)	L980265-23 MURRAY 107 (10-20)	L980265-24 MURRAY 107 (30-50)
SOIL					
Physical Tests	pH (pH)	5.41	6.75	6.99	7.72
Organic / Inorganic Carbon	Total Organic Carbon (%)	0.61	0.34	0.38	0.69
Metals	Antimony (Sb) (mg/kg)	0.12	0.12	0.17	0.70
	Arsenic (As) (mg/kg)	2.65	2.59	4.26	9.81
	Barium (Ba) (mg/kg)	104	49.9	79.6	171
	Beryllium (Be) (mg/kg)	<0.20	<0.20	0.32	0.71
	Cadmium (Cd) (mg/kg)	<0.10	<0.10	0.12	0.30
	Chromium (Cr) (mg/kg)	5.31	8.77	13.2	23.4
	Cobalt (Co) (mg/kg)	0.72	3.21	4.77	9.91
	Copper (Cu) (mg/kg)	2.80	2.97	4.26	26.1
	Lead (Pb) (mg/kg)	4.19	5.06	7.26	12.3
	Mercury (Hg) (mg/kg)	0.0122	0.0090	0.0115	0.0764
	Molybdenum (Mo) (mg/kg)	<0.50	0.54	0.83	1.78
	Nickel (Ni) (mg/kg)	3.32	7.92	11.5	40.6
	Selenium (Se) (mg/kg)	<0.20	<0.20	0.22	0.45
	Silver (Ag) (mg/kg)	<0.10	<0.10	<0.10	<0.10
	Thallium (Tl) (mg/kg)	0.084	0.060	0.077	0.326
	Tin (Sn) (mg/kg)	<2.0	<2.0	<2.0	<2.0
	Uranium (U) (mg/kg)	0.219	0.357	0.565	0.626
	Vanadium (V) (mg/kg)	15.6	19.2	30.3	42.0
	Zinc (Zn) (mg/kg)	13.9	20.0	38.5	68.3

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

Qualifiers for Individual Parameters Listed:

Qualifier	Description
DLA	Detection Limit Adjusted For required dilution
DUP-H,J	Duplicate results outside ALS DQO, due to sample heterogeneity. Duplicate results and limits are expressed in terms of absolute difference.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
C-TOT-ORG-LECO-SK	Soil	Organic Carbon by combustion method	SSSA (1996) p. 973

Total Organic Carbon (C-TOT-ORG-LECO-SK, C-TOT-ORG-SK)

Total C and inorganic C are determined on separate samples. The total C is determined by combustion and thermal conductivity detection, while inorganic C is determined by weight lass after addition of hydrochloric acid. Organic C is calculated by the difference between these two determinations.

Reference for Total C:
Nelson, D.W. and Sommers, L.E. 1996. Total Carbon, organic carbon and organic matter. P. 961-1010 In: J.M. Bartels et al. (ed.) Methods of soil analysis: Part 3 Chemical methods. (3rd ed.) ASA and SSSA, Madison, WI. Book series no. 5

Reference for Inorganic C:
Loeppert, R.H. and Suarez, D.L. 1996. Gravimetric Method for Loss of Carbon Dioxide. P. 455-456 In: J.M. Bartels et al. (ed.) Methods of soil analysis: Part 3 Chemical methods. (3rd ed.) ASA and SSSA, Madison, WI. Book series no. 5

HG-200.2-CVAF-VA	Soil	Mercury in Soil by CVAFS	EPA 200.2/245.7

This analysis is carried out using procedures from CSR Analytical Method: "Strong Acid Leachable Metals (SALM) in Soil", BC Ministry of Environment, 26 June 2009, and procedures adapted from EPA Method 200.2. The sample is manually homogenized, dried at 60 degrees Celsius, sieved through a 2 mm (10 mesh) sieve (this sieve step is omitted for international soil samples), and a representative subsample of the dry material is weighed. The sample is then digested at 95 degrees Celsius for 2 hours by block digester using concentrated nitric and hydrochloric acids. Instrumental analysis is by atomic fluorescence spectrophotometry (EPA Method 245.7).

Method Limitation: This method is not a total digestion technique. It is a very strong acid digestion that is intended to dissolve those metals that may be environmentally available. By design, elements bound in silicate structures are not normally dissolved by this procedure as they are not usually mobile in the environment.

MET-200.2-CCMS-VA	Soil	Metals in Soil by CRC ICPMS	EPA 200.2/6020A

This analysis is carried out using procedures from CSR Analytical Method: "Strong Acid Leachable Metals (SALM) in Soil", BC Ministry of Environment, 26 June 2009, and procedures adapted from EPA Method 200.2. The sample is dried at 40 C, then ground to < 2 mm particle size using a stainless steel flail grinder. A representative portion is digested with concentrated nitric and hydrochloric acids for 2 hours in an open vessel digestor at 95 degrees. Instrumental analysis of the digested exttract is by collision cell inductively coupled plasma - mass spectrometry (modifed from EPA Method 6020A).

Method Limitation: This method is not a total digestion technique. It is a very strong acid digestion that is intended to dissolve those metals that may be environmentally available. By design, elements bound in silicate structures are not normally dissolved by this procedure as they are not usually mobile in the environment.

PH-1:2-VA	Soil	CSR pH by 1:2 Water Leach	BC WLAP METHOD: PH, ELECTROMETRIC, SOIL

This analysis is carried out in accordance with procedures described in the pH, Electrometric in Soil and Sediment method - Section B Physical/Inorganic and Misc. Constituents, BC Environmental Laboratory Manual 2007. The procedure involves mixing the dried (at <60□C) and sieved (No. 10 / 2mm) sample with deionized/distilled water at a 1:2 ratio of sediment to water. The pH of the solution is then measured using a standard pH probe.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
VA	ALS LABORATORY GROUP - VANCOUVER, BC, CANADA
SK	ALS LABORATORY GROUP - SASKATOON, SASKATCHEWAN, CANADA

Chain of Custody Numbers:

1 2

Reference Information

GLOSSARY OF REPORT TERMS

Surrogate □ A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg □ milligrams per kilogram based on dry weight of sample.
mg/kg wwt □ milligrams per kilogram based on wet weight of sample.
mg/kg lwt □ milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L □ milligrams per litre.
< - Less than.
D.L. □ The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A □ Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

RESCAN ENVIRONMENTAL SERVICES
ATTN: TOMASZ GRADOWSKI
SIXTH FLOOR
1111 WEST HASTINGS STREET
VANCOUVER BC V6E 2I3
Phone: 604-689-9460

Date Received: 22-FEB-11
Report Date: 08-MAR-11 17:29 (MT)
Version: FINAL

Certificate of Analysis

Lab Work Order #: L980265
Project P.O. #: NOT SUBMITTED
Job Reference: 791-002-03 MURRAY RIVER BASELINE
Legal Site Desc:
C of C Numbers: 1, 2

Amber Springer
Account Manager

ALS LABORATORY GROUP ANALYTICAL REPORT

Sample ID	L980265-1	L980265-2	L980265-3	L980265-4	L980265-5
Description					
Sampled Date					
Sampled Time					
Client ID	MURRAY 70 (0-10)	MURRAY 70 (10-20)	MURRAY 70 (30-50)	MURRAY 75 (0-10)	MURRAY 75 (10-20)
Grouping / **Analyte**					
SOIL					
Physical Tests pH (pH)	5.20	5.53	6.79	7.79	8.10
Organic / Inorganic Carbon Total Organic Carbon (%)	0.76	0.87	0.87	1.46	0.98
Metals Antimony (Sb) (mg/kg)	0.14	0.23	0.51	0.44	0.68
Arsenic (As) (mg/kg)	3.55	5.19	8.19	5.50	6.99
Barium (Ba) (mg/kg)	122	176	327	186	232
Beryllium (Be) (mg/kg)	<0.20	0.31	0.77	0.29	0.40
Cadmium (Cd) (mg/kg)	0.12	0.18	0.15	0.37	0.54
Chromium (Cr) (mg/kg)	11.3	15.1	24.1	7.33	9.54
Cobalt (Co) (mg/kg)	2.86	8.19	10.4	4.19	4.83
Copper (Cu) (mg/kg)	2.95	5.10	19.5	9.05	13.7
Lead (Pb) (mg/kg)	6.84	11.1	12.7	6.95	8.91
Mercury (Hg) (mg/kg)	0.0071	0.0120	0.0544	0.0539	0.0534
Molybdenum (Mo) (mg/kg)	0.69	1.03	1.24	1.08	1.80
Nickel (Ni) (mg/kg)	8.20	13.3	32.3	15.0	21.5
Selenium (Se) (mg/kg)	<0.20	<0.20	0.44	0.38	0.38
Silver (Ag) (mg/kg)	<0.10	<0.10	<0.10	0.16	0.18
Thallium (Tl) (mg/kg)	0.088	0.106	0.212	0.110	0.144
Tin (Sn) (mg/kg)	<2.0	<2.0	<2.0	<2.0	<2.0
Uranium (U) (mg/kg)	0.272	0.367	0.953	0.570	0.640
Vanadium (V) (mg/kg)	29.5	33.5	43.2	16.7	21.5
Zinc (Zn) (mg/kg)	34.5	43.9	70.0	59.6	80.3

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS LABORATORY GROUP ANALYTICAL REPORT

Sample ID	L980265-6	L980265-7	L980265-8	L980265-9	L980265-10
Description	MURRAY 75 (30-50)	MURRAY 85 (0-10)	MURRAY 85 (10-20)	MURRAY 85 (30-50)	MURRAY 88 (0-10)
Sampled Date					
Sampled Time					
Client ID					
Grouping / **Analyte**					
SOIL					
Physical Tests pH (pH)	8.28	4.39	4.46	5.27	4.75
Organic / Inorganic Carbon Total Organic Carbon (%)	0.96	1.19	1.03	0.73	0.76
Metals Antimony (Sb) (mg/kg)	0.46	0.27	0.53	0.68	<0.10
Arsenic (As) (mg/kg)	4.61	3.33	5.97	8.38	1.99
Barium (Ba) (mg/kg)	213	68.8	70.5	174	53.1
Beryllium (Be) (mg/kg)	0.31	<0.20	<0.20	0.63	<0.20
Cadmium (Cd) (mg/kg)	0.34	0.12	0.17	0.67	0.12
Chromium (Cr) (mg/kg)	8.61	5.88	7.74	13.6	5.75
Cobalt (Co) (mg/kg)	3.92	0.86	2.19	5.53	0.55
Copper (Cu) (mg/kg)	10.2	3.36	7.05	13.5	1.36
Lead (Pb) (mg/kg)	6.44	3.80	6.70	9.70	4.29
Mercury (Hg) (mg/kg)	0.0493	0.0135	0.0175	0.0287	0.0082
Molybdenum (Mo) (mg/kg)	0.96	1.19	1.52	1.56	<0.50
Nickel (Ni) (mg/kg)	14.9	4.08	9.86	21.0	1.88
Selenium (Se) (mg/kg)	0.28	<0.20	0.25	0.42	<0.20
Silver (Ag) (mg/kg)	0.13	0.17	<0.10	<0.10	<0.10
Thallium (Tl) (mg/kg)	0.105	0.103	0.099	0.101	0.093
Tin (Sn) (mg/kg)	<2.0	<2.0	<2.0	<2.0	6.1
Uranium (U) (mg/kg)	0.624	0.149	0.210	0.572	0.192
Vanadium (V) (mg/kg)	19.0	27.7	31.4	30.3	19.1
Zinc (Zn) (mg/kg)	52.6	22.8	52.0	102	13.2

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS LABORATORY GROUP ANALYTICAL REPORT

Sample ID	L980265-11	L980265-12	L980265-13	L980265-14	L980265-15
Description	MURRAY 88 (10-20)	MURRAY 88 (30-50)	MURRAY 89 (0-10)	MURRAY 89 (10-20)	MURRAY 89 (30-50)
Sampled Date					
Sampled Time					
Client ID					
Grouping / **Analyte**					
SOIL					
Physical Tests pH (pH)	5.25	6.38	6.01	6.23	6.23
Organic / Inorganic Carbon Total Organic Carbon (%)	0.91	0.65	1.42	1.39	1.54
Metals Antimony (Sb) (mg/kg)	0.15	0.38	0.65	0.63	0.68
Arsenic (As) (mg/kg)	4.37	5.96	6.09	6.57	7.38
Barium (Ba) (mg/kg)	143	134	239	280	323
Beryllium (Be) (mg/kg)	<0.20	0.27	0.43	0.53	0.57
Cadmium (Cd) (mg/kg)	0.23	0.30	0.73	0.77	0.60
Chromium (Cr) (mg/kg)	9.49	11.5	10.3	12.0	13.1
Cobalt (Co) (mg/kg)	1.70	2.84	6.30	6.84	6.43
Copper (Cu) (mg/kg)	2.60	5.82	12.0	13.6	15.1
Lead (Pb) (mg/kg)	9.01	8.30	9.29	10.3	10.4
Mercury (Hg) (mg/kg)	0.0131	0.0182	0.0314	0.0372	0.0656
Molybdenum (Mo) (mg/kg)	0.78	1.05	1.41	1.35	1.30
Nickel (Ni) (mg/kg)	4.26	10.6	18.1	19.7	22.4
Selenium (Se) (mg/kg)	<0.20	<0.20	0.29	0.36	0.38
Silver (Ag) (mg/kg)	0.12	0.10	0.16	0.19	0.42
Thallium (Tl) (mg/kg)	0.079	0.104	0.095	0.111	0.124
Tin (Sn) (mg/kg)	<2.0	<2.0	<2.0	<2.0	<2.0
Uranium (U) (mg/kg)	0.263	0.304	0.536	0.701	0.781
Vanadium (V) (mg/kg)	40.0	38.1	23.2	26.0	29.0
Zinc (Zn) (mg/kg)	37.1	65.5	78.5	88.2	81.0

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS LABORATORY GROUP ANALYTICAL REPORT

Sample ID	L980265-16	L980265-17	L980265-18	L980265-19	L980265-20
Description	MURRAY 93 (0-10)	MURRAY 93 (10-20)	MURRAY 93 (30-50)	MURRAY 100 (0-10)	MURRAY 100 (10-20)
Sampled Date					
Sampled Time					
Client ID					
Grouping / **Analyte**					
SOIL					
Physical Tests pH (pH)	4.29	4.97	5.19	4.67	5.12
Organic / Inorganic Carbon Total Organic Carbon (%)	0.85	0.99	0.66	1.35	0.83
Metals Antimony (Sb) (mg/kg)	0.16	0.48	0.69	0.26	0.36
Arsenic (As) (mg/kg)	3.34	7.79	8.96	4.13	5.38
Barium (Ba) (mg/kg)	40.7	92.7	100	61.4	82.0
Beryllium (Be) (mg/kg)	<0.20	0.40	0.64	<0.20	<0.20
Cadmium (Cd) (mg/kg)	<0.10	0.26	0.40	0.10	0.12
Chromium (Cr) (mg/kg)	7.07	19.7	13.5	8.29	6.80
Cobalt (Co) (mg/kg)	0.71	3.58	4.74	1.59	1.82
Copper (Cu) (mg/kg)	1.92	8.95	13.1	3.62	4.35
Lead (Pb) (mg/kg)	5.60	10.8	8.83	5.16	5.97
Mercury (Hg) (mg/kg)	0.0098	0.0293	0.0384	0.0200	0.0162
Molybdenum (Mo) (mg/kg)	0.61	1.51	1.74	0.77	1.15
Nickel (Ni) (mg/kg)	2.69	13.4	27.5	6.93	7.15
Selenium (Se) (mg/kg)	<0.20	0.28	0.41	<0.20	<0.20
Silver (Ag) (mg/kg)	<0.10	0.20	<0.10	<0.10	<0.10
Thallium (Tl) (mg/kg)	0.108	0.130	0.129	0.085	0.074
Tin (Sn) (mg/kg)	<2.0	<2.0	<2.0	<2.0	<2.0
Uranium (U) (mg/kg)	0.189	0.405	0.461	0.236	0.217
Vanadium (V) (mg/kg)	29.7	50.1	29.4	23.9	25.0
Zinc (Zn) (mg/kg)	15.6	76.1	108	31.3	32.5

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS LABORATORY GROUP ANALYTICAL REPORT

Grouping	Analyte	L980265-21 MURRAY 100 (30-50)	L980265-22 MURRAY 107 (0-10)	L980265-23 MURRAY 107 (10-20)	L980265-24 MURRAY 107 (30-50)
SOIL					
Physical Tests	pH (pH)	5.41	6.75	6.99	7.72
Organic / Inorganic Carbon	Total Organic Carbon (%)	0.61	0.34	0.38	0.69
Metals	Antimony (Sb) (mg/kg)	0.12	0.12	0.17	0.70
	Arsenic (As) (mg/kg)	2.65	2.59	4.26	9.81
	Barium (Ba) (mg/kg)	104	49.9	79.6	171
	Beryllium (Be) (mg/kg)	<0.20	<0.20	0.32	0.71
	Cadmium (Cd) (mg/kg)	<0.10	<0.10	0.12	0.30
	Chromium (Cr) (mg/kg)	5.31	8.77	13.2	23.4
	Cobalt (Co) (mg/kg)	0.72	3.21	4.77	9.91
	Copper (Cu) (mg/kg)	2.80	2.97	4.26	26.1
	Lead (Pb) (mg/kg)	4.19	5.06	7.26	12.3
	Mercury (Hg) (mg/kg)	0.0122	0.0090	0.0115	0.0764
	Molybdenum (Mo) (mg/kg)	<0.50	0.54	0.83	1.78
	Nickel (Ni) (mg/kg)	3.32	7.92	11.5	40.6
	Selenium (Se) (mg/kg)	<0.20	<0.20	0.22	0.45
	Silver (Ag) (mg/kg)	<0.10	<0.10	<0.10	<0.10
	Thallium (Tl) (mg/kg)	0.084	0.060	0.077	0.326
	Tin (Sn) (mg/kg)	<2.0	<2.0	<2.0	<2.0
	Uranium (U) (mg/kg)	0.219	0.357	0.565	0.626
	Vanadium (V) (mg/kg)	15.6	19.2	30.3	42.0
	Zinc (Zn) (mg/kg)	13.9	20.0	38.5	68.3

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

Qualifiers for Individual Parameters Listed:

Qualifier	Description
DLA	Detection Limit Adjusted For required dilution
DUP-H,J	Duplicate results outside ALS DQO, due to sample heterogeneity. Duplicate results and limits are expressed in terms of absolute difference.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
C-TOT-ORG-LECO-SK	Soil	Organic Carbon by combustion method	SSSA (1996) p. 973

Total Organic Carbon (C-TOT-ORG-LECO-SK, C-TOT-ORG-SK)

Total C and inorganic C are determined on separate samples. The total C is determined by combustion and thermal conductivity detection, while inorganic C is determined by weight lass after addition of hydrochloric acid. Organic C is calculated by the difference between these two determinations.

Reference for Total C:
Nelson, D.W. and Sommers, L.E. 1996. Total Carbon, organic carbon and organic matter. P. 961-1010 In: J.M. Bartels et al. (ed.) Methods of soil analysis: Part 3 Chemical methods. (3rd ed.) ASA and SSSA, Madison, WI. Book series no. 5

Reference for Inorganic C:
Loeppert, R.H. and Suarez, D.L. 1996. Gravimetric Method for Loss of Carbon Dioxide. P. 455-456 In: J.M. Bartels et al. (ed.) Methods of soil analysis: Part 3 Chemical methods. (3rd ed.) ASA and SSSA, Madison, WI. Book series no. 5

HG-200.2-CVAF-VA	Soil	Mercury in Soil by CVAFS	EPA 200.2/245.7

This analysis is carried out using procedures from CSR Analytical Method: "Strong Acid Leachable Metals (SALM) in Soil", BC Ministry of Environment, 26 June 2009, and procedures adapted from EPA Method 200.2. The sample is manually homogenized, dried at 60 degrees Celsius, sieved through a 2 mm (10 mesh) sieve (this sieve step is omitted for international soil samples), and a representative subsample of the dry material is weighed. The sample is then digested at 95 degrees Celsius for 2 hours by block digester using concentrated nitric and hydrochloric acids. Instrumental analysis is by atomic fluorescence spectrophotometry (EPA Method 245.7).

Method Limitation: This method is not a total digestion technique. It is a very strong acid digestion that is intended to dissolve those metals that may be environmentally available. By design, elements bound in silicate structures are not normally dissolved by this procedure as they are not usually mobile in the environment.

MET-200.2-CCMS-VA	Soil	Metals in Soil by CRC ICPMS	EPA 200.2/6020A

This analysis is carried out using procedures from CSR Analytical Method: "Strong Acid Leachable Metals (SALM) in Soil", BC Ministry of Environment, 26 June 2009, and procedures adapted from EPA Method 200.2. The sample is dried at 40 C, then ground to < 2 mm particle size using a stainless steel flail grinder. A representative portion is digested with concentrated nitric and hydrochloric acids for 2 hours in an open vessel digestor at 95 degrees. Instrumental analysis of the digested exttract is by collision cell inductively coupled plasma - mass spectrometry (modifed from EPA Method 6020A).

Method Limitation: This method is not a total digestion technique. It is a very strong acid digestion that is intended to dissolve those metals that may be environmentally available. By design, elements bound in silicate structures are not normally dissolved by this procedure as they are not usually mobile in the environment.

PH-1:2-VA	Soil	CSR pH by 1:2 Water Leach	BC WLAP METHOD: PH, ELECTROMETRIC, SOIL

This analysis is carried out in accordance with procedures described in the pH, Electrometric in Soil and Sediment method - Section B Physical/Inorganic and Misc. Constituents, BC Environmental Laboratory Manual 2007. The procedure involves mixing the dried (at <60□C) and sieved (No. 10 / 2mm) sample with deionized/distilled water at a 1:2 ratio of sediment to water. The pH of the solution is then measured using a standard pH probe.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
VA	ALS LABORATORY GROUP - VANCOUVER, BC, CANADA
SK	ALS LABORATORY GROUP - SASKATOON, SASKATCHEWAN, CANADA

Chain of Custody Numbers:

1 2

Reference Information

GLOSSARY OF REPORT TERMS

Surrogate □ A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg □ milligrams per kilogram based on dry weight of sample.
mg/kg wwt □ milligrams per kilogram based on wet weight of sample.
mg/kg lwt □ milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L □ milligrams per litre.
< - Less than.
D.L. □ The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A □ Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

RESCAN ENVIRONMENTAL SERVICES
ATTN: Tomasz Gradowski
Sixth Floor
1111 West Hastings Street
Vancouver BC V6E 2J3

Date Received: 28-SEP-11
Report Date: 11-OCT-11 11:07 (MT)
Version: FINAL

Client Phone: 604-689-9460

Certificate of Analysis

Lab Work Order #: L1064885

Project P.O. #: NOT SUBMITTED
Job Reference: 0791-002-03 MURRAY RIVER - SOIL SALVAGE
C of C Numbers: 1
Legal Site Desc:

Amber Springer
Account Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample ID	L1064885-1	L1064885-2	L1064885-3	L1064885-4	L1064885-5
Description	SOIL	SOIL	SOIL	SOIL	SOIL
Sampled Date	09-SEP-11	09-SEP-11	09-SEP-11	09-SEP-11	10-SEP-11
Sampled Time					
Client ID	301	302	303	305	306
Grouping / **Analyte**					
SOIL					
Physical Tests pH (1:2 soil:water) (pH)	7.28	7.47	7.09	4.81	6.65
Organic / Inorganic Carbon Total Organic Carbon (%)	1.43	1.77	1.78	0.47	1.65
Metals Aluminum (Al) (mg/kg)	6680	6450	8390	5660	7920
Antimony (Sb) (mg/kg)	<0.10	0.13	0.41	0.21	0.23
Arsenic (As) (mg/kg)	3.88	2.66	5.27	3.28	2.55
Barium (Ba) (mg/kg)	156	158	147	40.0	145
Beryllium (Be) (mg/kg)	0.21	0.23	0.43	<0.20	0.44
Bismuth (Bi) (mg/kg)	<0.20	<0.20	<0.20	<0.20	<0.20
Cadmium (Cd) (mg/kg)	0.273	0.254	0.309	0.068	0.287
Calcium (Ca) (mg/kg)	4500	8780	2250	584	2710
Chromium (Cr) (mg/kg)	14.9	13.6	16.9	10.6	13.5
Cobalt (Co) (mg/kg)	3.47	3.45	5.62	3.12	5.03
Copper (Cu) (mg/kg)	4.77	4.88	10.1	3.42	6.62
Iron (Fe) (mg/kg)	16200	13600	18600	12400	14100
Lead (Pb) (mg/kg)	6.29	5.80	10.3	5.48	8.40
Lithium (Li) (mg/kg)	7.7	9.5	10.7	7.6	6.1
Magnesium (Mg) (mg/kg)	2910	5540	2830	1440	1880
Manganese (Mn) (mg/kg)	133	104	194	77.7	371
Mercury (Hg) (mg/kg)	0.0173	0.0177	0.0327	0.0060	0.0248
Molybdenum (Mo) (mg/kg)	<0.50	<0.50	0.85	0.85	0.60
Nickel (Ni) (mg/kg)	10.4	10.7	19.3	7.45	14.1
Phosphorus (P) (mg/kg)	609	622	345	424	195
Potassium (K) (mg/kg)	620	520	910	410	680
Selenium (Se) (mg/kg)	0.46	0.36	0.43	<0.20	0.23
Silver (Ag) (mg/kg)	0.14	<0.10	0.20	<0.10	0.21
Sodium (Na) (mg/kg)	<100	<100	<100	<100	<100
Strontium (Sr) (mg/kg)	15.1	15.5	8.93	3.77	7.63
Thallium (Tl) (mg/kg)	0.064	0.059	0.122	0.071	0.103
Tin (Sn) (mg/kg)	<2.0	<2.0	<2.0	<2.0	<2.0
Titanium (Ti) (mg/kg)	157	142	87.6	122	36.8
Uranium (U) (mg/kg)	0.480	0.480	0.811	0.288	0.551
Vanadium (V) (mg/kg)	24.9	23.0	29.9	31.1	27.7
Zinc (Zn) (mg/kg)	36.3	32.0	61.2	24.7	61.8

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample ID	L1064885-6	L1064885-7	L1064885-8	L1064885-9	L1064885-10
Description	SOIL	SOIL	SOIL	SOIL	SOIL
Sampled Date	10-SEP-11	10-SEP-11	10-SEP-11	10-SEP-11	11-SEP-11
Sampled Time					
Client ID	308	310	311	312	314
Grouping / **Analyte**					
SOIL					
Physical Tests / pH (1:2 soil:water) (pH)	7.58	5.32	4.87	4.47	6.46
Organic / Inorganic Carbon / Total Organic Carbon (%)	2.18	0.53	0.62	0.68	0.83
Metals / Aluminum (Al) (mg/kg)	8270	6830	7500	5850	10100
Antimony (Sb) (mg/kg)	0.21	0.12	0.16	0.16	0.23
Arsenic (As) (mg/kg)	4.11	2.05	3.43	3.83	4.50
Barium (Ba) (mg/kg)	178	58.4	49.0	34.6	154
Beryllium (Be) (mg/kg)	0.37	0.22	0.22	<0.20	0.50
Bismuth (Bi) (mg/kg)	<0.20	<0.20	<0.20	<0.20	<0.20
Cadmium (Cd) (mg/kg)	0.418	0.122	0.067	0.073	0.194
Calcium (Ca) (mg/kg)	4950	556	986	493	2110
Chromium (Cr) (mg/kg)	16.0	12.0	13.3	9.76	17.3
Cobalt (Co) (mg/kg)	5.86	3.99	4.57	2.66	5.58
Copper (Cu) (mg/kg)	7.87	3.58	4.74	3.79	5.72
Iron (Fe) (mg/kg)	16600	10800	14400	11700	18500
Lead (Pb) (mg/kg)	7.97	4.59	5.62	5.44	9.49
Lithium (Li) (mg/kg)	11.2	4.9	9.6	6.6	9.1
Magnesium (Mg) (mg/kg)	3080	1160	2000	1290	2430
Manganese (Mn) (mg/kg)	429	126	165	63.3	210
Mercury (Hg) (mg/kg)	0.0394	0.0085	0.0160	0.0154	0.0190
Molybdenum (Mo) (mg/kg)	0.65	0.59	0.59	0.63	0.65
Nickel (Ni) (mg/kg)	16.0	8.80	11.2	6.89	16.5
Phosphorus (P) (mg/kg)	640	340	361	847	265
Potassium (K) (mg/kg)	650	390	460	370	550
Selenium (Se) (mg/kg)	0.49	<0.20	<0.20	<0.20	<0.20
Silver (Ag) (mg/kg)	0.30	<0.10	<0.10	<0.10	<0.10
Sodium (Na) (mg/kg)	<100	<100	<100	<100	<100
Strontium (Sr) (mg/kg)	13.4	3.56	6.16	3.96	6.64
Thallium (Tl) (mg/kg)	0.103	0.067	0.073	0.066	0.134
Tin (Sn) (mg/kg)	<2.0	<2.0	<2.0	<2.0	<2.0
Titanium (Ti) (mg/kg)	57.7	109	137	93.9	60.3
Uranium (U) (mg/kg)	0.776	0.283	0.362	0.309	0.523
Vanadium (V) (mg/kg)	32.0	24.2	25.4	26.9	40.5
Zinc (Zn) (mg/kg)	57.0	31.2	25.5	25.1	40.6

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample ID	L1064885-11	L1064885-12	L1064885-13	L1064885-14	L1064885-15
Description	SOIL	SOIL	SOIL	SOIL	SOIL
Sampled Date	11-SEP-11	11-SEP-11	11-SEP-11	11-SEP-11	11-SEP-11
Sampled Time					
Client ID	316	317	318	320	321
Grouping / **Analyte**					
SOIL					
Physical Tests pH (1:2 soil:water) (pH)	6.59	5.27	5.61	5.68	5.78
Organic / Inorganic Carbon Total Organic Carbon (%)	0.83	0.27	0.22	0.49	0.74
Metals Aluminum (Al) (mg/kg)	9720	8080	6290	8610	9430
Antimony (Sb) (mg/kg)	0.28	0.17	0.22	0.21	0.34
Arsenic (As) (mg/kg)	5.19	4.88	3.59	4.95	7.02
Barium (Ba) (mg/kg)	105	54.6	44.0	124	91.8
Beryllium (Be) (mg/kg)	0.45	0.24	<0.20	0.34	0.40
Bismuth (Bi) (mg/kg)	<0.20	<0.20	<0.20	<0.20	<0.20
Cadmium (Cd) (mg/kg)	0.226	0.073	0.067	0.108	0.108
Calcium (Ca) (mg/kg)	2190	881	980	1300	1490
Chromium (Cr) (mg/kg)	17.8	14.5	11.1	15.6	15.9
Cobalt (Co) (mg/kg)	6.44	3.98	3.85	7.64	8.04
Copper (Cu) (mg/kg)	8.14	4.31	4.58	7.27	8.21
Iron (Fe) (mg/kg)	19100	18000	12900	18800	22200
Lead (Pb) (mg/kg)	10.0	9.14	6.52	9.01	10.8
Lithium (Li) (mg/kg)	9.8	12.3	7.9	15.7	14.1
Magnesium (Mg) (mg/kg)	3120	2550	1620	2620	2360
Manganese (Mn) (mg/kg)	323	116	114	251	295
Mercury (Hg) (mg/kg)	0.0270	0.0070	0.0099	0.0160	0.0125
Molybdenum (Mo) (mg/kg)	0.73	0.65	0.64	0.77	1.90
Nickel (Ni) (mg/kg)	19.4	11.2	9.66	15.7	20.4
Phosphorus (P) (mg/kg)	356	380	434	750	882
Potassium (K) (mg/kg)	780	430	460	500	610
Selenium (Se) (mg/kg)	0.22	<0.20	<0.20	<0.20	0.25
Silver (Ag) (mg/kg)	0.11	<0.10	<0.10	<0.10	<0.10
Sodium (Na) (mg/kg)	<100	<100	<100	<100	<100
Strontium (Sr) (mg/kg)	7.45	4.92	5.00	8.76	8.35
Thallium (Tl) (mg/kg)	0.150	0.090	0.070	0.077	0.198
Tin (Sn) (mg/kg)	<2.0	<2.0	<2.0	<2.0	<2.0
Titanium (Ti) (mg/kg)	88.3	148	65.7	60.4	61.1
Uranium (U) (mg/kg)	0.518	0.345	0.309	0.395	0.551
Vanadium (V) (mg/kg)	39.9	34.7	27.2	27.7	33.6
Zinc (Zn) (mg/kg)	57.2	29.0	30.8	44.9	49.1

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample ID	L1064885-16	L1064885-17	L1064885-18	L1064885-19	L1064885-20
Description	SOIL	SOIL	SOIL	SOIL	SOIL
Sampled Date	11-SEP-11	11-SEP-11	12-SEP-11	12-SEP-11	12-SEP-11
Sampled Time					
Client ID	323	324	326	327	328
Grouping / **Analyte**					
SOIL					
Physical Tests pH (1:2 soil:water) (pH)	5.54	5.35	7.03	5.05	7.12
Organic / Inorganic Carbon Total Organic Carbon (%)	0.37	0.55	0.73	0.50	7.81
Metals Aluminum (Al) (mg/kg)	5710	4940	7710	5300	18800
Antimony (Sb) (mg/kg)	0.38	0.33	0.71	0.46	0.15
Arsenic (As) (mg/kg)	4.34	4.10	7.63	6.29	4.04
Barium (Ba) (mg/kg)	69.7	45.7	72.0	66.1	750
Beryllium (Be) (mg/kg)	0.26	0.20	0.49	0.23	1.04
Bismuth (Bi) (mg/kg)	<0.20	<0.20	<0.20	<0.20	<0.20
Cadmium (Cd) (mg/kg)	0.168	0.105	0.364	0.106	2.67
Calcium (Ca) (mg/kg)	1090	819	3720	775	12600
Chromium (Cr) (mg/kg)	10.5	8.72	14.6	10.3	29.1
Cobalt (Co) (mg/kg)	4.46	2.03	5.94	3.41	9.43
Copper (Cu) (mg/kg)	6.20	3.74	14.0	6.02	27.8
Iron (Fe) (mg/kg)	14300	11500	16900	16100	21800
Lead (Pb) (mg/kg)	6.08	6.97	8.73	8.25	10.7
Lithium (Li) (mg/kg)	8.5	6.1	8.5	7.6	40.9
Magnesium (Mg) (mg/kg)	1820	1120	3070	1470	4530
Manganese (Mn) (mg/kg)	105	55.6	193	84.6	532
Mercury (Hg) (mg/kg)	0.0084	0.0076	0.0250	0.0090	0.0373
Molybdenum (Mo) (mg/kg)	1.03	1.17	2.00	1.41	0.60
Nickel (Ni) (mg/kg)	11.9	7.09	25.2	10.2	36.6
Phosphorus (P) (mg/kg)	1230	703	596	1050	624
Potassium (K) (mg/kg)	590	540	800	640	1300
Selenium (Se) (mg/kg)	<0.20	<0.20	0.38	0.20	0.99
Silver (Ag) (mg/kg)	<0.10	<0.10	<0.10	<0.10	0.79
Sodium (Na) (mg/kg)	<100	<100	<100	<100	<100
Strontium (Sr) (mg/kg)	6.60	4.09	8.56	5.65	31.7
Thallium (Tl) (mg/kg)	0.109	0.120	0.256	0.111	0.186
Tin (Sn) (mg/kg)	<2.0	<2.0	<2.0	<2.0	<2.0
Titanium (Ti) (mg/kg)	46.4	57.1	25.4	58.5	30.0
Uranium (U) (mg/kg)	0.350	0.242	0.520	0.305	0.847
Vanadium (V) (mg/kg)	32.0	35.9	42.0	42.9	60.5
Zinc (Zn) (mg/kg)	56.6	27.9	60.6	44.4	90.7

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1064885-21	L1064885-22	L1064885-23		
	Description	SOIL	SOIL	SOIL		
	Sampled Date	12-SEP-11	12-SEP-11	13-SEP-11		
	Sampled Time					
	Client ID	331	332	336		
Grouping	**Analyte**					
SOIL						
Physical Tests	pH (1:2 soil:water) (pH)	4.43	6.45	5.22		
Organic / Inorganic Carbon	Total Organic Carbon (%)	0.72	0.50	0.38		
Metals	Aluminum (Al) (mg/kg)	4610	4850	6110		
	Antimony (Sb) (mg/kg)	0.23	0.53	0.41		
	Arsenic (As) (mg/kg)	2.35	5.60	5.70		
	Barium (Ba) (mg/kg)	35.8	34.7	44.8		
	Beryllium (Be) (mg/kg)	<0.20	0.29	0.24		
	Bismuth (Bi) (mg/kg)	<0.20	<0.20	<0.20		
	Cadmium (Cd) (mg/kg)	0.055	0.134	0.084		
	Calcium (Ca) (mg/kg)	413	1720	590		
	Chromium (Cr) (mg/kg)	6.87	9.09	9.53		
	Cobalt (Co) (mg/kg)	1.67	4.84	6.05		
	Copper (Cu) (mg/kg)	2.00	10.4	8.03		
	Iron (Fe) (mg/kg)	8600	12800	16000		
	Lead (Pb) (mg/kg)	5.95	6.57	7.78		
	Lithium (Li) (mg/kg)	5.1	6.8	10.3		
	Magnesium (Mg) (mg/kg)	1040	1950	2010		
	Manganese (Mn) (mg/kg)	61.5	192	151		
	Mercury (Hg) (mg/kg)	0.0055	0.0103	0.0077		
	Molybdenum (Mo) (mg/kg)	0.95	1.30	1.19		
	Nickel (Ni) (mg/kg)	4.96	14.9	11.2		
	Phosphorus (P) (mg/kg)	348	792	408		
	Potassium (K) (mg/kg)	410	770	450		
	Selenium (Se) (mg/kg)	<0.20	0.25	<0.20		
	Silver (Ag) (mg/kg)	<0.10	<0.10	<0.10		
	Sodium (Na) (mg/kg)	<100	<100	<100		
	Strontium (Sr) (mg/kg)	2.79	8.03	3.30		
	Thallium (Tl) (mg/kg)	0.113	0.165	0.113		
	Tin (Sn) (mg/kg)	<2.0	<2.0	<2.0		
	Titanium (Ti) (mg/kg)	69.5	30.9	39.3		
	Uranium (U) (mg/kg)	0.222	0.491	0.301		
	Vanadium (V) (mg/kg)	35.9	25.0	31.5		
	Zinc (Zn) (mg/kg)	21.6	45.6	36.7		

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Duplicate	Arsenic (As)	DUP-H,J	L1064885-1, -10, -11, -12, -13, -14, -15, -16, -17, -18, -19, -2, -20, -21, -22, -23, -3, -4, -5, -6, -7, -8, -9

Qualifiers for Individual Parameters Listed:

Qualifier	Description
DUP-H,J	Duplicate results outside ALS DQO, due to sample heterogeneity. Duplicate results and limits are expressed in terms of absolute difference.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
C-TOT-ORG-LECO-SK	Soil	Organic Carbon by combustion method	SSSA (1996) p. 973

Total Organic Carbon (C-TOT-ORG-LECO-SK, C-TOT-ORG-SK)

Total C and inorganic C are determined on separate samples. The total C is determined by combustion and thermal conductivity detection, while inorganic C is determined by weight lass after addition of hydrochloric acid. Organic C is calculated by the difference between these two determinations.

Reference for Total C:
Nelson, D.W. and Sommers, L.E. 1996. Total Carbon, organic carbon and organic matter. P. 961-1010 In: J.M. Bartels et al. (ed.) Methods of soil analysis: Part 3 Chemical methods. (3rd ed.) ASA and SSSA, Madison, WI. Book series no. 5

Reference for Inorganic C:
Loeppert, R.H. and Suarez, D.L. 1996. Gravimetric Method for Loss of Carbon Dioxide. P. 455-456 In: J.M. Bartels et al. (ed.) Methods of soil analysis: Part 3 Chemical methods. (3rd ed.) ASA and SSSA, Madison, WI. Book series no. 5

HG-200.2-CVAF-VA	Soil	Mercury in Soil by CVAFS	EPA 200.2/245.7

This analysis is carried out using procedures from CSR Analytical Method: "Strong Acid Leachable Metals (SALM) in Soil", BC Ministry of Environment, 26 June 2009, and procedures adapted from EPA Method 200.2. The sample is manually homogenized, dried at 60 degrees Celsius, sieved through a 2 mm (10 mesh) sieve (this sieve step is omitted for international soil samples), and a representative subsample of the dry material is weighed. The sample is then digested at 95 degrees Celsius for 2 hours by block digester using concentrated nitric and hydrochloric acids. Instrumental analysis is by atomic fluorescence spectrophotometry (EPA Method 245.7).

Method Limitation: This method is not a total digestion technique. It is a very strong acid digestion that is intended to dissolve those metals that may be environmentally available. By design, elements bound in silicate structures are not normally dissolved by this procedure as they are not usually mobile in the environment.

MET-200.2-CCMS-VA	Soil	Metals in Soil by CRC ICPMS	EPA 200.2/6020A

This analysis is carried out using procedures from CSR Analytical Method: "Strong Acid Leachable Metals (SALM) in Soil", BC Ministry of Environment, 26 June 2009, and procedures adapted from EPA Method 200.2. The sample is dried at 40 C, then ground to < 2 mm particle size using a stainless steel flail grinder. A representative portion is digested with concentrated nitric and hydrochloric acids for 2 hours in an open vessel digestor at 95 degrees. Instrumental analysis of the digested exttract is by collision cell inductively coupled plasma - mass spectrometry (modifed from EPA Method 6020A).

Method Limitation: This method is not a total digestion technique. It is a very strong acid digestion that is intended to dissolve those metals that may be environmentally available. By design, elements bound in silicate structures are not normally dissolved by this procedure as they are not usually mobile in the environment.

PH-1:2-VA	Soil	pH in Soil (1:2 Soil:Water Extraction)	BC WLAP METHOD: PH, ELECTROMETRIC, SOIL

This analysis is carried out in accordance with procedures described in the pH, Electrometric in Soil and Sediment method - Section B Physical/Inorganic and Misc. Constituents, BC Environmental Laboratory Manual 2007. The procedure involves mixing the dried (at <60□C) and sieved (No. 10 / 2mm) sample with deionized/distilled water at a 1:2 ratio of sediment to water. The pH of the solution is then measured using a standard pH probe.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
VA	ALS ENVIRONMENTAL - VANCOUVER, BC, CANADA
SK	ALS ENVIRONMENTAL - SASKATOON, SASKATCHEWAN, CANADA

Chain of Custody Numbers:

1

Reference Information

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

L10648885

CHAIN OF CUSTODY / ANALYTICAL REQUEST FORM

COC #

CANADA TOLL FREE 1-800-668-9878

www.alsenviro.com

REPORT TO:		REPORT FORMAT / DISTRIBUTION		SERVICE REQUEST	
COMPANY:	Rescan Environmental Services	HARDCOP	CROSSTAB	REGULAR SERVICE (DEFAULT)	X
CONTACT:	Tomasz Gradowski	ELECTRON	PDF and EXCEL	PRIORITY SERVICE (2-3 DAYS)	
ADDRESS:	6th Floor- 1111 West Hastings St	EMAIL 1:	tgradowski@rescan.com	EMERGENCY SERVICE (1-2 DAY / WEEKEND)	
CITY/ PROV	Vancouver, BC V6E 2J3	EMAIL 2:		OTHER (<1 DAY / WEEKEND) - CONTACT ALS	
PHONE:	604-689-9460 x 3419	fax: 604-687-4277		ANALYSIS REQUEST	
INVOICE TO:	SAME AS REPORT ? / NO			Filtered, Preserved or both (F, P, F/P)	
COMPANY:	Same as above	CLIENT / PROJECT INFORMATION:			
CONTACT:	Rescan Accounting	JOB #:	0791-002-03 Murray River - soil salvage		
ADDRESS:		PO /AFE:			
CITY/ PROV		Legal Site Description:			
PHONE:		QUOTE #:			
Order # (lab		ALS			

Sample #	SAMPLE IDENTIFICATION (This description will appear on the report)	DATE (dd-mmm-yy)	# of samples	SAMPLE TYPE	% organic carbon	CCME Metals (Cu, Ni)
	301	September 9, 2011	1	soil	x	x
	302	September 9, 2011	1	soil	x	x
	303	September 9, 2011	1	soil	x	x
	305	September 9, 2011	1	soil	x	x
	306	September 10, 2011	1	soil	x	x
	308	September 10, 2011	1	soil	x	x
	310	September 10, 2011	1	soil	x	x
	311	September 10, 2011	1	soil	x	x
	312	September 10, 2011	1	soil	x	x
	314	September 11, 2011	1	soil	x	x
	316	September 11, 2011	1	soil	x	x
	317	September 11, 2011	1	soil	x	x
	318	September 11, 2011	1	soil	x	x
	320	September 11, 2011	1	soil	x	x
	321	September 11, 2011	1	soil	x	x
	323	September 11, 2011	1	soil	x	x
	324	September 11, 2011	1	soil	x	x
	326	September 12, 2011	1	soil	x	x
	327	September 12, 2011	1	soil	x	x
	328	September 12, 2011	1	soil	x	x
	331	September 12, 2011	1	soil	x	x
	332	September 12, 2011	1	soil	x	x
	336	September 13, 2011	1	soil	x	x
	23 samples					

GUIDELINES / REGULATIONS	SPECIAL INSTRUCTIONS / HAZARDOUS DETAILS

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RELINQUISHED BY:	DATE & TIME:	RECEIVED BY:	DATE & TIME:	SAMPLE CONDITION (lab use only)	
Tomasz Gradowski	Sep 27th, 2011			TEMPERATURE	SAMPLES RECEIVED IN GOOD
RELINQUISHED BY:	DATE & TIME:	RECEIVED BY:	DATE & TIME:	14.4°C	
			28/9/11 12:05		If NO, Explain:

RESCAN ENVIRONMENTAL SERVICES
ATTN: Tomasz Gradowski
Sixth Floor
1111 West Hastings Street
Vancouver BC V6E 2J3

Date Received: 25-SEP-12
Report Date: 04-OCT-12 10:31 (MT)
Version: FINAL

Client Phone: 604-689-9460

Certificate of Analysis

Lab Work Order #: L1214351

Project P.O. #: NOT SUBMITTED
Job Reference: 0791-007-40 MURRAY RIVER 2012
C of C Numbers:
Legal Site Desc:

Amber Springer
Account Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample ID	L1214351-1	L1214351-2	L1214351-3	L1214351-4	L1214351-5
Description	Soil	Soil	Soil	Soil	Soil
Sampled Date	18-SEP-12	18-SEP-12	18-SEP-12	18-SEP-12	18-SEP-12
Sampled Time					
Client ID	E-1	E-2	E-3	E-3X	S-1
Grouping / **Analyte**					
SOIL					
Physical Tests pH (1:2 soil:water) (pH)	4.45	6.94	4.20	4.19	5.44
Metals Aluminum (Al) (mg/kg)	3590	6910	3820	4530	7030
Antimony (Sb) (mg/kg)	0.27	0.40	0.17	0.20	0.33
Arsenic (As) (mg/kg)	3.64	5.50	2.98	3.27	3.56
Barium (Ba) (mg/kg)	36.4	83.1	68.4	80.3	124
Beryllium (Be) (mg/kg)	<0.20	0.43	<0.20	0.21	0.22
Bismuth (Bi) (mg/kg)	<0.20	<0.20	<0.20	<0.20	<0.20
Cadmium (Cd) (mg/kg)	0.080	0.372	0.299	0.402	0.456
Calcium (Ca) (mg/kg)	308	3420	514	668	2700
Chromium (Cr) (mg/kg)	5.30	12.6	6.91	8.15	10.8
Cobalt (Co) (mg/kg)	1.54	5.53	1.38	1.52	6.54
Copper (Cu) (mg/kg)	3.86	11.9	3.99	5.37	6.20
Iron (Fe) (mg/kg)	8330	15800	9130	10300	14300
Lead (Pb) (mg/kg)	4.29	7.62	4.94	5.79	6.81
Lithium (Li) (mg/kg)	<5.0	8.3	<5.0	<5.0	8.8
Magnesium (Mg) (mg/kg)	591	2220	594	676	1890
Manganese (Mn) (mg/kg)	38.2	206	37.3	40.8	735
Mercury (Hg) (mg/kg)	0.0264	0.0316	0.0148	0.0146	0.0247
Molybdenum (Mo) (mg/kg)	1.09	1.01	0.59	0.70	0.91
Nickel (Ni) (mg/kg)	5.72	18.2	4.94	5.64	10.8
Phosphorus (P) (mg/kg)	209	510	351	362	379
Potassium (K) (mg/kg)	360	780	670	810	850
Selenium (Se) (mg/kg)	<0.20	0.21	<0.20	<0.20	<0.20
Silver (Ag) (mg/kg)	<0.10	0.12	<0.10	<0.10	<0.10
Sodium (Na) (mg/kg)	<100	<100	<100	<100	<100
Strontium (Sr) (mg/kg)	2.61	9.31	4.34	5.13	10.2
Thallium (Tl) (mg/kg)	0.076	0.131	0.073	0.082	0.105
Tin (Sn) (mg/kg)	<2.0	<2.0	<2.0	<2.0	<2.0
Titanium (Ti) (mg/kg)	26.9	54.6	36.5	30.9	48.7
Uranium (U) (mg/kg)	0.228	0.508	0.202	0.251	0.379
Vanadium (V) (mg/kg)	20.9	29.3	23.1	27.2	27.0
Zinc (Zn) (mg/kg)	21.3	48.1	30.4	37.6	41.4

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample ID	L1214351-6	L1214351-7	L1214351-8	L1214351-9	L1214351-10
Description	Soil	Soil	Soil	Soil	Soil
Sampled Date	18-SEP-12	18-SEP-12	18-SEP-12	18-SEP-12	18-SEP-12
Sampled Time					
Client ID	S-2	S-2X	S-3	W-1	W-2
Grouping / **Analyte**					
SOIL					
Physical Tests pH (1:2 soil:water) (pH)	7.59	7.64	5.91	6.50	6.71
Metals Aluminum (Al) (mg/kg)	8560	8610	6410	9930	6950
Antimony (Sb) (mg/kg)	0.82	0.86	0.52	0.24	0.18
Arsenic (As) (mg/kg)	7.17	7.28	3.11	5.09	1.55
Barium (Ba) (mg/kg)	186	190	65.3	323	1010
Beryllium (Be) (mg/kg)	0.60	0.60	0.27	0.44	0.33
Bismuth (Bi) (mg/kg)	<0.20	<0.20	<0.20	<0.20	<0.20
Cadmium (Cd) (mg/kg)	0.472	0.456	0.413	0.958	2.16
Calcium (Ca) (mg/kg)	12000	12000	2230	6880	14800
Chromium (Cr) (mg/kg)	15.4	15.0	10.5	15.7	13.4
Cobalt (Co) (mg/kg)	7.78	7.74	3.75	5.13	1.18
Copper (Cu) (mg/kg)	21.6	21.1	5.49	6.91	30.5
Iron (Fe) (mg/kg)	21000	21400	13500	17200	5780
Lead (Pb) (mg/kg)	11.6	12.0	8.01	9.29	6.56
Lithium (Li) (mg/kg)	11.1	12.3	8.7	12.4	<5.0
Magnesium (Mg) (mg/kg)	5610	6040	2420	2850	1490
Manganese (Mn) (mg/kg)	371	325	181	259	31.6
Mercury (Hg) (mg/kg)	0.0681	0.0763	0.0178	0.0570	0.0712
Molybdenum (Mo) (mg/kg)	1.42	1.50	1.67	0.80	0.52
Nickel (Ni) (mg/kg)	29.4	29.8	12.1	13.6	21.6
Phosphorus (P) (mg/kg)	707	711	384	546	299
Potassium (K) (mg/kg)	1340	1260	630	800	810
Selenium (Se) (mg/kg)	0.58	0.53	<0.20	0.28	0.38
Silver (Ag) (mg/kg)	0.21	0.25	<0.10	0.48	1.14
Sodium (Na) (mg/kg)	<100	<100	<100	<100	<100
Strontium (Sr) (mg/kg)	28.1	26.0	6.59	17.5	33.7
Thallium (Tl) (mg/kg)	0.152	0.163	0.144	0.115	0.134
Tin (Sn) (mg/kg)	<2.0	<2.0	<2.0	<2.0	<2.0
Titanium (Ti) (mg/kg)	58.8	32.6	59.3	28.6	17.0
Uranium (U) (mg/kg)	0.624	0.696	0.338	1.27	1.05
Vanadium (V) (mg/kg)	30.3	30.0	32.7	34.8	24.9
Zinc (Zn) (mg/kg)	81.4	80.1	65.9	55.3	28.1

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample ID	L1214351-11	L1214351-12	L1214351-13	L1214351-14	L1214351-15
Description	Soil	Soil	Soil	Soil	Soil
Sampled Date	18-SEP-12	18-SEP-12	18-SEP-12	18-SEP-12	18-SEP-12
Sampled Time					
Client ID	W-3	NE-1	NE-2	NE-3	NW-1
Grouping / **Analyte**					
SOIL					
Physical Tests pH (1:2 soil:water) (pH)	4.51	6.51	7.87	6.50	6.82
Metals Aluminum (Al) (mg/kg)	9370	10400	2200	8610	7200
Antimony (Sb) (mg/kg)	0.18	0.63	0.26	0.24	0.55
Arsenic (As) (mg/kg)	6.04	9.07	1.85	4.04	17.6
Barium (Ba) (mg/kg)	108	107	275	46.9	570
Beryllium (Be) (mg/kg)	0.24	0.61	<0.20	0.34	0.48
Bismuth (Bi) (mg/kg)	<0.20	<0.20	<0.20	<0.20	<0.20
Cadmium (Cd) (mg/kg)	0.289	0.164	0.497	0.071	1.30
Calcium (Ca) (mg/kg)	1060	2010	54700	1360	16200
Chromium (Cr) (mg/kg)	14.5	20.8	4.41	15.4	13.0
Cobalt (Co) (mg/kg)	4.03	6.96	2.51	7.15	7.23
Copper (Cu) (mg/kg)	4.38	18.5	4.83	5.93	16.8
Iron (Fe) (mg/kg)	17500	22200	6050	17100	36800
Lead (Pb) (mg/kg)	12.0	9.61	3.38	6.60	7.90
Lithium (Li) (mg/kg)	13.5	12.1	<5.0	10.8	10.1
Magnesium (Mg) (mg/kg)	1930	2600	13400	2250	2310
Manganese (Mn) (mg/kg)	162	234	271	256	779
Mercury (Hg) (mg/kg)	0.0336	0.0716	0.0302	0.0147	0.101
Molybdenum (Mo) (mg/kg)	0.84	1.23	<0.50	0.83	2.91
Nickel (Ni) (mg/kg)	9.49	30.2	7.28	15.1	23.7
Phosphorus (P) (mg/kg)	558	576	641	757	1190
Potassium (K) (mg/kg)	710	1260	350	700	1160
Selenium (Se) (mg/kg)	<0.20	0.35	0.84	<0.20	1.66
Silver (Ag) (mg/kg)	0.17	0.20	<0.10	<0.10	<0.45 RM-H
Sodium (Na) (mg/kg)	<100	<100	<100	<100	<100
Strontium (Sr) (mg/kg)	8.08	9.11	51.2	6.42	51.2
Thallium (Tl) (mg/kg)	0.134	0.225	<0.050	0.073	0.146
Tin (Sn) (mg/kg)	<2.0	<2.0	<2.0	<2.0	<2.0
Titanium (Ti) (mg/kg)	62.8	55.7	34.0	114	12.5
Uranium (U) (mg/kg)	0.429	0.703	0.612	0.427	1.35
Vanadium (V) (mg/kg)	46.8	42.3	12.3	29.1	30.7
Zinc (Zn) (mg/kg)	61.0	67.5	17.8	34.5	81.8

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample ID	L1214351-16	L1214351-17	L1214351-18	L1214351-19	L1214351-20
Description	Soil	Soil	Soil	Soil	Soil
Sampled Date	18-SEP-12	18-SEP-12	18-SEP-12	18-SEP-12	18-SEP-12
Sampled Time					
Client ID	NW-2	NW-3	RN-1	RN-2	RN-3
Grouping / **Analyte**					
SOIL					
Physical Tests pH (1:2 soil:water) (pH)	5.88	6.30	6.13	4.30	4.86
Metals Aluminum (Al) (mg/kg)	7510	11600	7040	6460	4450
Antimony (Sb) (mg/kg)	0.35	0.39	0.20	<0.10	0.31
Arsenic (As) (mg/kg)	4.12	5.53	3.78	2.65	4.50
Barium (Ba) (mg/kg)	381	871	155	54.1	105
Beryllium (Be) (mg/kg)	0.41	0.65	0.28	<0.20	<0.20
Bismuth (Bi) (mg/kg)	<0.20	<0.20	<0.20	<0.20	<0.20
Cadmium (Cd) (mg/kg)	1.88	1.33	0.253	0.115	0.236
Calcium (Ca) (mg/kg)	2600	6060	2010	607	1220
Chromium (Cr) (mg/kg)	13.5	19.0	12.3	9.29	8.65
Cobalt (Co) (mg/kg)	10.2	6.32	4.10	1.25	2.11
Copper (Cu) (mg/kg)	16.6	17.3	3.77	1.84	5.64
Iron (Fe) (mg/kg)	18000	19000	14000	7620	10700
Lead (Pb) (mg/kg)	13.4	12.4	6.96	6.34	4.39
Lithium (Li) (mg/kg)	7.9	13.4	10.0	5.9	<5.0
Magnesium (Mg) (mg/kg)	1320	2370	1800	850	888
Manganese (Mn) (mg/kg)	525	358	195	52.6	37.8
Mercury (Hg) (mg/kg)	0.0179	0.0563	0.0235	0.0222	0.0246
Molybdenum (Mo) (mg/kg)	1.08	0.77	0.52	<0.50	0.85
Nickel (Ni) (mg/kg)	19.4	32.7	10.5	2.98	7.15
Phosphorus (P) (mg/kg)	483	724	525	462	160
Potassium (K) (mg/kg)	1650	1490	1080	570	670
Selenium (Se) (mg/kg)	<0.20	0.52	<0.20	<0.20	<0.20
Silver (Ag) (mg/kg)	<0.60 RM-H	<0.80 RM-H	<0.10	<0.15 RM-H	<0.10
Sodium (Na) (mg/kg)	<100	<100	<100	<100	<100
Strontium (Sr) (mg/kg)	23.8	24.1	8.45	5.18	11.8
Thallium (Tl) (mg/kg)	0.133	0.172	0.062	0.062	<0.050
Tin (Sn) (mg/kg)	<2.0	<2.0	<2.0	<2.0	<2.0
Titanium (Ti) (mg/kg)	18.5	21.3	56.0	105	33.1
Uranium (U) (mg/kg)	0.409	1.01	0.413	0.303	0.268
Vanadium (V) (mg/kg)	37.3	42.1	25.7	24.0	24.7
Zinc (Zn) (mg/kg)	81.6	86.6	42.0	22.4	38.1

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample ID	L1214351-21	L1214351-22	L1214351-23	L1214351-24	L1214351-25
Description	Soil	Soil	Soil	Soil	Soil
Sampled Date	18-SEP-12	18-SEP-12	18-SEP-12	18-SEP-12	18-SEP-12
Sampled Time					
Client ID	RS-1	RS-2	RS-3	408-SAL	410-SAL
Grouping / **Analyte**					
SOIL					
Physical Tests pH (1:2 soil:water) (pH)	7.88	7.64	8.08	5.62	4.80
Metals Aluminum (Al) (mg/kg)	7620	7360	4090	6160	6880
Antimony (Sb) (mg/kg)	0.74	0.73	0.47	0.12	0.21
Arsenic (As) (mg/kg)	7.52	7.05	5.29	2.82	3.75
Barium (Ba) (mg/kg)	236	302	111	51.0	96.4
Beryllium (Be) (mg/kg)	0.56	0.56	0.34	0.22	0.22
Bismuth (Bi) (mg/kg)	<0.20	<0.20	<0.20	<0.20	<0.20
Cadmium (Cd) (mg/kg)	1.04	1.41	0.609	0.105	0.120
Calcium (Ca) (mg/kg)	49200	44500	63400	1540	1410
Chromium (Cr) (mg/kg)	19.1	17.3	9.85	11.4	14.0
Cobalt (Co) (mg/kg)	6.53	7.29	4.33	4.14	3.53
Copper (Cu) (mg/kg)	17.8	20.3	12.6	2.41	4.42
Iron (Fe) (mg/kg)	18000	18400	11500	13400	15500
Lead (Pb) (mg/kg)	10.7	10.7	6.94	6.38	8.12
Lithium (Li) (mg/kg)	9.7	9.6	5.5	11.0	11.1
Magnesium (Mg) (mg/kg)	17800	12200	16300	1800	1990
Manganese (Mn) (mg/kg)	150	346	195	225	93.8
Mercury (Hg) (mg/kg)	0.0784	0.111	0.0451	0.0081	0.0150
Molybdenum (Mo) (mg/kg)	2.63	2.92	2.23	<0.50	0.58
Nickel (Ni) (mg/kg)	29.4	32.3	19.8	7.37	10.7
Phosphorus (P) (mg/kg)	1380	1220	1240	508	1110
Potassium (K) (mg/kg)	1870	2090	1050	580	830
Selenium (Se) (mg/kg)	1.19	1.15	0.47	<0.20	<0.20
Silver (Ag) (mg/kg)	<0.25 RM-H	<0.25 RM-H	<0.15 RM-H	<0.10	<0.10
Sodium (Na) (mg/kg)	110	<100	<100	<100	<100
Strontium (Sr) (mg/kg)	65.2	68.8	79.3	7.63	8.06
Thallium (Tl) (mg/kg)	0.275	0.330	0.166	0.062	0.079
Tin (Sn) (mg/kg)	<2.0	<2.0	<2.0	<2.0	<2.0
Titanium (Ti) (mg/kg)	23.2	17.5	15.1	113	162
Uranium (U) (mg/kg)	1.30	1.14	1.20	0.412	0.363
Vanadium (V) (mg/kg)	42.9	38.6	26.8	25.8	33.7
Zinc (Zn) (mg/kg)	101	138	58.5	46.3	41.8

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1214351-26	L1214351-27	L1214351-28		
	Description	Soil	Soil	Soil		
	Sampled Date	18-SEP-12	18-SEP-12	18-SEP-12		
	Sampled Time					
	Client ID	411-SAL	412-SAL	413-SAL		
Grouping	**Analyte**					
SOIL						
Physical Tests	pH (1:2 soil:water) (pH)	7.70	6.85	7.76		
Metals	Aluminum (Al) (mg/kg)	7310	8740	5190		
	Antimony (Sb) (mg/kg)	0.19	0.15	0.14		
	Arsenic (As) (mg/kg)	4.55	3.80	21.0		
	Barium (Ba) (mg/kg)	79.9	94.5	562		
	Beryllium (Be) (mg/kg)	0.30	0.40	0.24		
	Bismuth (Bi) (mg/kg)	<0.20	<0.20	<0.20		
	Cadmium (Cd) (mg/kg)	0.127	0.114	0.498		
	Calcium (Ca) (mg/kg)	16500	2440	67100		
	Chromium (Cr) (mg/kg)	14.4	16.8	8.64		
	Cobalt (Co) (mg/kg)	3.91	5.76	5.35		
	Copper (Cu) (mg/kg)	5.91	6.42	6.78		
	Iron (Fe) (mg/kg)	14600	16400	32400		
	Lead (Pb) (mg/kg)	6.74	7.50	5.71		
	Lithium (Li) (mg/kg)	10.6	14.8	7.5		
	Magnesium (Mg) (mg/kg)	10400	3080	11900		
	Manganese (Mn) (mg/kg)	119	183	1480		
	Mercury (Hg) (mg/kg)	0.442	0.0239	0.0666		
	Molybdenum (Mo) (mg/kg)	0.71	<0.50	2.89		
	Nickel (Ni) (mg/kg)	12.4	18.0	11.8		
	Phosphorus (P) (mg/kg)	599	285	916		
	Potassium (K) (mg/kg)	950	850	660		
	Selenium (Se) (mg/kg)	<0.20	<0.20	0.84		
	Silver (Ag) (mg/kg)	<0.10	<0.10	<0.15 RM-H		
	Sodium (Na) (mg/kg)	<100	<100	<100		
	Strontium (Sr) (mg/kg)	17.4	10.3	78.6		
	Thallium (Tl) (mg/kg)	0.107	0.115	0.099		
	Tin (Sn) (mg/kg)	<2.0	<2.0	<2.0		
	Titanium (Ti) (mg/kg)	139	131	27.5		
	Uranium (U) (mg/kg)	0.519	0.383	0.712		
	Vanadium (V) (mg/kg)	31.6	33.4	19.0		
	Zinc (Zn) (mg/kg)	24.9	40.4	28.6		

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Duplicate	Silver (Ag)	RM-H	L1214351-15, -16, -17, -18, -19, -20, -21, -22, -23, -24, -25, -26, -27, -28
Certified Reference Material	Silver (Ag)	RM-H	L1214351-15, -16, -17, -18, -19, -20, -21, -22, -23, -24, -25, -26, -27, -28

Qualifiers for Individual Parameters Listed:

Qualifier	Description
RM-H	Reference Material recovery was above ALS DQO. Non-detected sample results are considered reliable. Other results, if reported, have been qualified.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
HG-200.2-CVAF-VA	Soil	Mercury in Soil by CVAFS	EPA 200.2/245.7

This analysis is carried out using procedures from CSR Analytical Method: "Strong Acid Leachable Metals (SALM) in Soil", BC Ministry of Environment, 26 June 2009, and procedures adapted from EPA Method 200.2. The sample is manually homogenized, dried at 60 degrees Celsius, sieved through a 2 mm (10 mesh) sieve (this sieve step is omitted for international soil samples), and a representative subsample of the dry material is weighed. The sample is then digested at 95 degrees Celsius for 2 hours by block digester using concentrated nitric and hydrochloric acids. Instrumental analysis is by atomic fluorescence spectrophotometry (EPA Method 245.7).

Method Limitation: This method is not a total digestion technique. It is a very strong acid digestion that is intended to dissolve those metals that may be environmentally available. By design, elements bound in silicate structures are not normally dissolved by this procedure as they are not usually mobile in the environment.

MET-200.2-CCMS-VA	Soil	Metals in Soil by CRC ICPMS	EPA 200.2/6020A

This analysis is carried out using procedures from CSR Analytical Method: "Strong Acid Leachable Metals (SALM) in Soil", BC Ministry of Environment, 26 June 2009, and procedures adapted from EPA Method 200.2. The sample is manually homogenized, dried at 60 degrees Celsius, sieved through a 2 mm (10 mesh) sieve (this sieve step is omitted for international soil samples), and a representative subsample of the dry material is weighed. The sample is then digested at 95 degrees Celsius for 2 hours by block digester using concentrated nitric and hydrochloric acids. Instrumental analysis of the digested extract is by collision cell inductively coupled plasma - mass spectrometry (modifed from EPA Method 6020A).

Method Limitation: This method is not a total digestion technique. It is a very strong acid digestion that is intended to dissolve those metals that may be environmentally available. By design, elements bound in silicate structures are not normally dissolved by this procedure as they are not usually mobile in the environment.

PH-1:2-VA	Soil	pH in Soil (1:2 Soil:Water Extraction)	BC WLAP METHOD: PH, ELECTROMETRIC, SOIL

This analysis is carried out in accordance with procedures described in the pH, Electrometric in Soil and Sediment method - Section B Physical/Inorganic and Misc. Constituents, BC Environmental Laboratory Manual 2007. The procedure involves mixing the dried (at <60°C) and sieved (No. 10 / 2mm) sample with deionized/distilled water at a 1:2 ratio of sediment to water. The pH of the solution is then measured using a standard pH probe.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

L1214351-COFC

TICAL REQUEST FORM COC #

800-668-9878

L1214351

REPORT TO:		REPORT FORMAT / DISTRIBUTION		SERVICE REQUEST
COMPANY:	Rescan Environmental Services	HARDCOPY:	CROSSTAB	REGULAR SERVICE (DE
CONTACT:	Tomasz Gradowski	ELECTRONIC	PDF and EXCEL	PRIORITY SERVICE (2-3
ADDRESS:	6th Floor- 1111 West Hastings St	EMAIL 1:	tgradowski@rescan.com	EMERGENCY SERVICE
CITY/ PROV	Vancouver, BC V6E 2J3	EMAIL 2:	dmcallister@rescan.com	OTHER (<1 DAY / WEEK
PHONE:	604-689-9460 x 3409	fax: 604-687-4277		
INVOICE TO:	SAME AS REPORT ? YES / NO			Please indicate below
COMPANY:	Same as above	CLIENT / PROJECT INFORMATION:		
CONTACT:	Rescan Accounting	JOB #:	0791-007-40 Murray River 2012	
ADDRESS:		PO /AFE:		
CITY/ PROV		Legal Site Description:		
PHONE:	FAX	QUOTE #:		
# (lab use only)		ALS		

Sample #	SAMPLE IDENTIFICATION (This description will appear on the report)	DATE (dd-mmm-yy)	# of samples	SAMPLE TYPE	MET-CCME+FULL-VA			
1	E-1	Sep 14-18, 2012	1	soil	x			
2	E-2	Sep 14-18, 2012	1	soil	x			
3	E-3	Sep 14-18, 2012	1	soil	x			
4	E-3x	Sep 14-18, 2012	1	soil	x			
5	S-1	Sep 14-18, 2012	1	soil	x			
6	S-2	Sep 14-18, 2012	1	soil	x			
7	S-2x	Sep 14-18, 2012	1	soil	x			
8	S-3	Sep 14-18, 2012	1	soil	x			
9	W-1	Sep 14-18, 2012	1	soil	x			
10	W-2	Sep 14-18, 2012	1	soil	x			
11	W-3	Sep 14-18, 2012	1	soil	x			
12	NE-1	Sep 14-18, 2012	1	soil	x			
13	NE-2	Sep 14-18, 2012	1	soil	x			
14	NE-3	Sep 14-18, 2012	1	soil	x			
15	NW-1	Sep 14-18, 2012	1	soil	x			
16	NW-2	Sep 14-18, 2012	1	soil	x			
17	NW-3	Sep 14-18, 2012	1	soil	x			
18	RN-1	Sep 14-18, 2012	1	soil	x			
19	RN-2	Sep 14-18, 2012	1	soil	x			
20	RN-3	Sep 14-18, 2012	1	soil	x			
21	RS-1	Sep 14-18, 2012	1	soil	x			
22	RS-2	Sep 14-18, 2012	1	soil	x			
23	RS-3	Sep 14-18, 2012	1	soil	x			
24	408-SAL	Sep 14-18, 2012	1	soil	x			
25	410-SAL	Sep 14-18, 2012	1	soil	x			
26	411-SAL	Sep 14-18, 2012	1	soil	x			
27	412-SAL	Sep 14-18, 2012	1	soil	x			
28	413-SAL	Sep 14-18, 2012	1	soil	x			
	28 samples							

ES / REGULATIONS

SPECIAL INSTRUCTIONS / HAZARD

JH Sept24/12 @11:05am

19.9°c