

Appendix 13-B

Wetland Ecosystem Baseline Report



NWP COAL CANADA LTD

Wetland Ecosystem Baseline Report

Crown Mountain Coking Coal Project



Table of Contents

Acronyms

Executive Summary

1.0	Introduction	1
1.1	Project Overview	1
1.2	Objectives	3
1.3	Wetland Definitions.....	4
1.3.1	Wetland Classification	4
1.4	Applicable Wetland Legislation.....	6
2.0	Project Setting and Study Areas	8
3.0	Methods	11
3.1	Wetland Ecosystem Surveys	11
3.2	Wetland Catchment Delineation.....	14
3.3	Wetland Classification	14
3.4	Wetland Conservation Ranking.....	15
4.0	Results	16
4.1	Wetland Ecosystem Surveys	16
4.2	Wetland Catchment Delineation.....	18
4.3	Wetland Classification	21
4.3.1	Bog Wetlands	36
4.3.2	Fen Wetlands	38
4.3.3	Marsh Wetlands	40
4.3.4	Swamp Wetlands.....	43
4.3.5	Shallow Water Wetlands	47
4.3.6	Transitional Wetland Associations	50
4.3.7	Ephemeral Wetlands	54
4.3.8	Flood Associations.....	56
4.4	Invasive Plants.....	57

4.5	Wetland Conservation Ranking.....	58
5.0	The Summary	62
6.0	References	64
Figures		
	Figure 1. Project Location	2
	Figure 2. Terrestrial Local Study Area	10
	Figure 3. Surveyed Wetland Ecosystems.....	17
	Figure 4. Frequency of Wetland Sizes Observed within the LSA	18
	Figure 5. Estimated Catchment Areas for Surveyed Wetland Ecosystems	20
	Figure 6a: Wetland Classification of Surveyed Wetland Ecosystems	26
	Figure 6b: Wetland Classification of Surveyed Wetland Ecosystems	27
	Figure 6c: Wetland Classification of Surveyed Wetland Ecosystems.....	28
	Figure 6d: Wetland Classification of Surveyed Wetland Ecosystems	29
	Figure 6e: Wetland Classification of Surveyed Wetland Ecosystems	30
	Figure 6f: Wetland Classification of Surveyed Wetland Ecosystems	31
	Figure 6g: Wetland Classification of Surveyed Wetland Ecosystems.....	32
	Figure 6h: Wetland Classification of Surveyed Wetland Ecosystems	33
	Figure 6i: Wetland Classification of Surveyed Wetland Ecosystems	34
	Figure 7. Composition of Wetland Classes and Non-wetland Groups Surveyed in the LSA.....	35
	Figure 8. Composition of Wetland Classes Surveyed in the LSA.....	35
	Figure 9. Surveyed Wetlands with Site Associations of the Three Major B.C. Conservation Ranks (Note Ga02\$ and Ga03\$, Red-listed wetland-associated terrestrial site associations, are excluded)	60
Tables		
	Table 1. Estimated Catchment Area for Wetland Ecosystems Surveyed in the LSA	19
	Table 2. Wetland Ecosystem Classification of Wetlands Surveyed in the LSA	23
	Table 3. Area, Occurrence, and Conservation Status of Bog Site Associations in the LSA	36
	Table 4. Area, Occurrence, and Conservation Status of Fen Site Associations in the LSA	39
	Table 5. Area, Occurrence, and Conservation Status of Marsh Site Associations in the LSA	41
	Table 6. Area, Occurrence, and Conservation Status of Swamp Site Associations in the LSA	44
	Table 7. Area, Occurrence, and Conservation Status of Shallow Waters in the LSA	48
	Table 8. Area, Occurrence, and Conservation Status of Transitional Associations in the LSA	52
	Table 9. Area, Occurrence, and Conservation Status of Floodplain Associations in the LSA	56
	Table 10. Non-native (Introduced) Plants Observed at Wetlands	58
	Table 11. Wetland Site Associations of Conservation Concern	59
	Table 12. Uncommon Wetland Site Associations in East Kootenay (MacKillop et al., 2018)	60

Photos

Photo 1. Wb15 along edge of site WL5.1a (July 8, 2019)	37
Photo 2. Bog (Wb15) around base of stunted spruce in site WL3 (July 9, 2019)	37
Photo 3. Wf01 at site WL2 (July 29, 2018)	39
Photo 4. Wf02 at site WL3 (July 9, 2019)	40
Photo 5. Wm01 at site WL4 (September 13, 2019)	42
Photo 6. Wm05 near the north end of site WL11.2 (July 4, 2019)	43
Photo 7. Ws07.1 at site WL2a (July 9, 2019)	46
Photo 8. Ws04 at site WL5.4 (September 12, 2019)	46
Photo 9. Ww Muskgrass and peripheral marsh of site WL4 (September 13, 2019)	49
Photo 10. Ww at site WL11.1 with marl-encrusted moss (<i>Drepanocladus longifolius</i>) (September 10, 2019)	49
Photo 11. <i>Nuttall's alkaligrass – Foxtail barley</i> (seral) alkaline/saline meadow wetland at site WL14, early season (May 4, 2018)	52
Photo 12. <i>Ga02\$ Nuttall's alkaligrass – Foxtail barley</i> (seral) alkaline/saline meadow at site WL14, late season (September 11, 2019)	53
Photo 13. <i>Ga03\$ Field sedge</i> (seral) alkaline/saline meadow at site WL14, late season (September 11, 2019)	53
Photo 14. Ephemeral Wm16 at site WL8.1 (July 26, 2018)	55
Photo 15. Ephemeral Wm01 at site WL19, in forest (September 11, 2019)	55
Photo 16. FI05 along a beaver dam and channels at site WL21 (September 13, 2019)	57

Appendices

A	Conservation Status Definitions
B	Wetland Location, Size, and Elevation
C	Wetland Profiles
D	Additional Photographs

Acronyms

AIR	Application Information Requirements
B.C. CDC	British Columbia Conservation Data Centre
B.C. EAA	British Columbia Environmental Assessment Act
B.C. MECCS	B.C. Ministry of Environment and Climate Change Strategy
B.C. MOE	B.C. Ministry of Environment
BEC	Biogeoclimatic Ecosystem Classification
CDEM	Canadian Digital Elevation Model
CEAA	<i>Canadian Environmental Assessment Act</i>
COSEWIC	Committee on the Status of Endangered Wildlife in Canada
CWCS	Canadian Wetland Classification System
DEM	Digital Elevation Model
EIS	Environmental Impact Statement
ESSF	Engelmann Spruce-Subalpine Fir
ESSFdk1	Elk Dry Cool Engelmann Spruce – Subalpine Fir (the BEC subzone variant that occurs above the MSdw)
ESSFdkw	Dry Cool Woodland Engelmann Spruce – Subalpine Fir (the BEC subzone variant that occurs above the ESSFdk1)
LSA	Local Study Area
M ROMt	Million Run-of-Mine Tonnes
MS	Montane Spruce
MSdw	Dry Warm Montane Spruce (BEC subzone that characterizes most of the LSA)
RSA	Regional Study Area
SARA	<i>Species at Risk Act</i>
TEM	Terrestrial Ecosystem Mapping
tpd	Tonnes per day
WSA	<i>Water Sustainability Act</i>
WSI	Wetland shape index

Executive Summary

NWP Coal Canada Ltd (NWP) is proposing to develop the Crown Mountain Coking Coal Project (the Project), an open pit metallurgical coal mine in the Elk Valley coal field of southeastern British Columbia. The proposed Project is situated adjacent to existing metallurgical coal mines, including Elkview (Teck Resources Limited) located 8 km southwest and Line Creek located 12 km to the north. The mine is expected to produce approximately 10,150 tonnes per day (tpd) and up to 4.0 million run-of-mine tonnes (M ROMt) per year for 15 years. The proposed Project footprint covers approximately 1,300 ha.

The Project is reviewable under both the federal Canadian Environmental Assessment Act (2012) and the provincial *Environmental Assessment Act* (2002). As part of planning processes and the development of an Environmental Assessment Application to both the federal and provincial agencies, a wetland ecosystem baseline assessment was completed between 2017 and 2019. The assessment focused on determining the number, extent, and class of wetlands within the Local Study Area (LSA) as well as ecological function. The wetland ecosystem baseline report captures important information intended to provide an accurate evaluation of current conditions to guide project development; identify, avoid and protect important elements; assess project impacts; assess long term environmental effects; and inform mitigation, compensation and offsetting arrangements. Information gathered as part of this assessment will be applied to the environmental assessment process to determine potential impacts to wetlands as a result of the proposed Project.

The key objectives of the wetland ecosystem baseline assessment are to:

- Document the location of wetlands within the Local Study Area;
- Determine wetland size, orientation, and landscape position (i.e., the geomorphic setting as noted by Laubhan et al., 2012);
- Determine the physical and ecological characteristics of the wetlands¹;
- Assign a wetland classification in accordance with The Canadian Wetland Classification System (CWCS; Warner and Rubec, 1997) and vegetation associations presented in MacKenzie and Moran (2004) and MacKillop et al. (2018); and
- Determine the conservation status rank based on the provincial classification;
- Document invasive plant species within and surrounding wetland ecosystems;
- Determine abundance and distribution of wetland classes in the LSA; and
- Identify any unique, under-represented or rare, endangered or threatened plant or animal species².

¹ Soil characteristics, water quality, plant and animal species, physical, structural and floristic characteristics that define portions of the wetland complex.

² An attempt was not made to determine all plant species at wetlands. Dillon focused on species common to, or representative of, specific wetlands. All birds, amphibians and mammals observed were recorded during or outside formal surveys.

Two spatial boundaries have been developed to guide the completion of the wetland ecosystem assessment, the Project footprint and the Local Study Area (LSA). The Project footprint covers approximately 1,300 ha and includes all anticipated Project components, such as the active mining area, waste rock management area piles, and associated infrastructure following the Grave Creek Forest Service Road west to the Elk River. The LSA, which covers approximately 24,100 ha, includes the area surrounding the Project footprint that may experience changes at an ecosystem level, both indirectly and directly.

Thirty-six wetland ecosystems were identified in the baseline assessment within the LSA. Wetlands identified in this study range from 0.02 ha to 8.84 ha. Six wetland classes were including bog, fen, marsh, swamp, shallow water, and a transitional/successional marsh-fen. Two non-wetland groups, two transition mineral association and three flood association, were also observed in the LSA. Marsh constitutes the largest area of all wetlands and non-wetland groups surveyed at 15.91 ha (38.90%), followed by swamp at 13.32 ha (32.58%), transitional marsh-fen at 4.15 ha (10.14%), shallow water at 3.74 ha (9.14%), fen at 2.76 ha (6.75%), transitional mineral association at 0.38 ha (0.94%), and bog at 0.04 ha (0.09%). Flood associations surveyed comprise 0.60 ha (1.47%) of the LSA. The non-wetland groups are presented as part of the wetland ecosystem baseline assessment as these areas are periodically and occasionally inundated and often influence or interact with wetland groups such that they can be difficult to distinguish and delineate.

Most wetlands observed as part of the wetland ecosystem baseline assessment were wetland complexes or mosaics of multiple wetland types. Twenty-six wetland types (i.e., wetland site associations) were identified across the 36 wetlands surveyed. Among the wetland types observed, seven are provincially Blue-listed and two are provincially Red-listed site associations. Some wetland site associations observed in the LSA currently have no assigned conservation status ranks, including all shallow water wetlands, bogs, and swamps. Flood associations, which are not wetlands, are also not ranked. Uncommon species and plant species at risk in wetlands, such as the moss *Scorpidium cossinii* observed at wetland survey site WL3, contribute to wetland value given that the wetland may be the only one, or one of few in the area, in which this species of moss is found. Many wetlands within the LSA have been influenced, altered, and even created by human modification. Consequentially, some wetlands may be deteriorating, stable, developing as expected without interference, or developing along new ecological trajectories.

Wetlands provide water recharge, flood control, shoreline erosion (along Grave Creek), filtration, carbon storage, and refuge for plants and animals, including species at risk. Based on the composition of wetlands in the LSA, led by marsh and swamp, primary functional contributions of wetlands assessed include carbon sequestration and water quality treatment (biochemical); shoreline erosion control (e.g., southern shore of Grave Lake) and water flow moderation (hydrological); and biological productivity and biodiversity (habitat).

1.0 Introduction

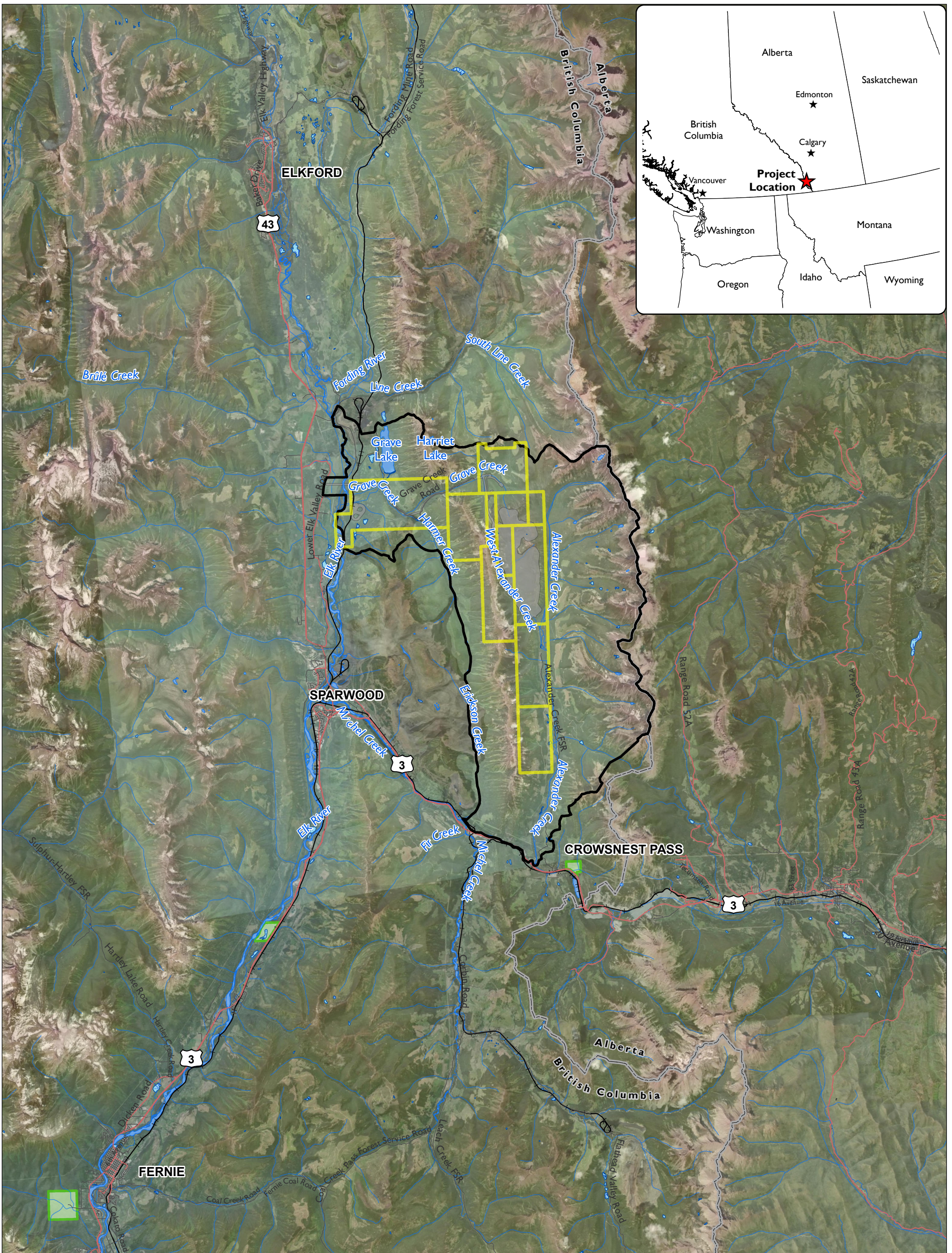
1.1 Project Overview

NWP Coal Canada Ltd (NWP) is proposing to develop the Crown Mountain Coking Coal Project (the Project) which is intended as an open pit metallurgical coal mine located within the Elk Valley coal field in the East Kootenay Regional District of southeastern British Columbia (B.C.; **Figure 1**). NWP is jointly owned by Jameson Resources Limited and Bathurst Resources Limited (Canada). The Project comprises 10 coal licenses and is located between several existing metallurgical coal mines in the Elk Valley and Crowsnest coal fields, with Teck Coal Limited's (Teck) Elkview mine located approximately 8 kilometres (km) southwest of the Project area and their Line Creek mine located approximately 12 km north of the Project area.

The mine is expected to produce approximately 10,150 tonnes per day (tpd) and up to 4.0 million run-of-mine tonnes (M ROMt) per year for 15 years. The proposed Project footprint covers approximately 1,300 ha. Key components of the proposed Project include, but are not limited to:

- Surface extraction areas (3 pits – north pit, east pit, and south pit);
- Waste rock management areas;
- Plant area (includes raw coal stockpile area, a processing plant, and site support facilities);
- Clean coal transportation route (via an overland conveyor and haul road);
- Rail load-out facility and rail siding (includes various auxiliary facilities);
- Power supply;
- Natural gas supply;
- Explosives storage;
- Fuel storage;
- Sewage treatment; and
- Water supply.

The Project is subject to both the *Canadian Environmental Assessment Act (CEAA) 2012* and the *British Columbia Environmental Assessment Act (BC EAA) 2002*. Provincially, the Project is considered a Reviewable Project given that the production capacity of the mine will be greater than 250,000 tonnes per year of clean coal and will result in a disturbance greater than 750 hectares (ha) that was not previously permitted for disturbance (*BC EAA, 2002*). Federally, the Project is considered a Designated Project under the *CEAA 2012 Regulations Designating Physical Projects* as the mine will have a production capacity of more than 3,000 tonnes per day. Project-specific terms of reference were developed for the provincial EA process (Application Information Requirements [AIR], 2018) and the federal EA process (Environmental Impact Statement [EIS] Guidelines, 2015).



Crown Mountain Coking Coal Project

FIGURE 1
Project Location

- LEGEND**
- Terrestrial Local Study Area
 - Project Footprint
 - Coal Licences
 - Highways
 - Arterial Roads
 - Local/Resource Roads
 - Railway (Canadian Pacific)
 - Watercourse
 - Waterbody
 - Wetland
 - Provincial Park
 - BC/Alberta Border

0 1 2 3 4 Kilometers

SCALE 1:200,000

Map Drawing Information: Data Provided by Province of British Columbia, NWP Coal Canada Ltd., Dillon Consulting Limited

Map Created By: JFC/RBB
Map Checked By: LKD
Map Projection: NAD 1983 UTM Zone 11N

PROJECT: 12-6231
STATUS: FINAL
DATE: 2021-08-23

Wetlands provide a variety of ecosystem services including water recharge, flood control, shoreline erosion, filtration, carbon storage, and refuge for plants and animals. These ecosystems may be small but are important components of the landscape and can be affected by and vulnerable to proximate and remote natural events (e.g., flooding, avalanches) and human activities. Wetlands are repositories for climatic, ecological, and cultural information and can be used to help determine and gauge effects of local and regional activities.

As outlined in the AIR and the EIS Guidelines, information specific to wetland ecosystems is required for presentation in the Environmental Assessment Application, including: ecosystem abundance; Red- and Blue-listed communities; delineation of wetlands; and, wetland classification, location, size, and function. This report outlines the findings of the wetland ecosystem baseline assessment as well as other relevant wetland ecosystem information compiled to date.

1.2 Objectives

The key objectives of the wetland ecosystem baseline assessment are to:

- Document the location of wetlands within the Local Study Area;
- Determine wetland size, orientation, and landscape position (i.e., the geomorphic setting as noted by Laubhan et al., 2012);
- Determine the physical and ecological characteristics of the wetlands³;
- Assign a wetland classification in accordance with The Canadian Wetland Classification System (CWCS; Warner and Rubec, 1997); and vegetation associations presented in MacKenzie and Moran (2004) and MacKillop et al. (2018); and
- Determine the conservation status rank based on the provincial classification;
- Document invasive plant species within and surrounding wetland ecosystems;
- Determine abundance and distribution of wetland classes in the LSA; and
- Identify any unique, under-represented or rare, endangered or threatened plant or animal species⁴.

Information gathered as part of the wetland ecosystem baseline assessment will serve as the basis for assessing potential direct and indirect impacts of the proposed Project on wetland ecosystems within the LSA. An understanding of potential effects is important for predicting and managing potential Project-related impacts, developing appropriate mitigation measures, and determining impact significance (Noble, 2010). Additional context for the importance of studying and understanding wetland ecosystems is provided in **Sections 1.3 to 1.5**.

³ Soil characteristics, water quality, plant and animal species, physical, structural, and floristic characteristics that define portions of the wetland complex.

⁴ An attempt was not made to determine all plant species at wetlands. Dillon focused on species common to, or representative of, specific wetlands. All birds, amphibian, and mammals observed were recorded during or outside formal surveys.

1.3 Wetland Definitions

Several wetlands definitions were used to guide the completion of the wetland ecosystem baseline assessment:

- The Canadian Wetland Classification System defines a wetland “...land that is saturated with water long enough to promote wetland or aquatic processes as indicated by poorly drained soils, hydrophytic vegetation and various kinds of biological activity which are adapted to a wet environment” (Warner and Rubec, 1997, p. 1).
- MacKenzie and Moran (2004) defines wetlands as “...areas where soils are water-saturated for a sufficient length of time such that excess water and resulting low soil oxygen levels are principal determinants of vegetation and soil development. Wetlands will have a relative abundance of hydrophytes⁵ in the vegetation community and/or soils featuring “hydric” characters” (p. 6).
- Keddy (2010) note a wetland is “... an ecosystem that arises when inundation by water produces soils dominated by anaerobic processes, which, in turn, forces the biota, particularly rooted plants, to adapt to flooding” (p. 2).

A common theme in the above definitions is the prolonged presence of water causing saturated soils in a low oxygen environment which encourages plants adapted to these conditions. Ecologically, a wetland can be determined by the presence of hydrophytes or hydric soils and delineated by changes in vegetation structure, and the presence, abundance and characteristics of hydrophytes and hydric soils (MacKenzie and Moran, 2004).

MacKillop et al. (2018) present the following characteristics of a wetland:

- Organic soil (peat) > 40 centimetres (cm);
- Gleying (blue-grey colouration) of fine mineral soils within 30 cm of the surface;
- Distinctive mottling of coarse (sandy) soils within 30 cm of the surface;
- Smell of rotten eggs from hydrogen sulphide, within 30 cm of the surface; and
- Hydrophytic vegetation.

1.3.1 Wetland Classification

Wetlands can be placed in two broad categories based on the accumulation of organic material – organic wetlands and mineral wetlands. Organic wetlands or peatlands develop where organic material (peat) accumulates and forms the substrate that creates characteristic hydrological, chemical, and vegetation (structural and floristic) conditions. Mineral wetlands develop where water and physical or climatic conditions prevent the accumulation of organic matter. Mineral soils form the substrate that creates characteristic hydrological, chemical and vegetation (structural and floristic) conditions.

⁵ hydrophytes: plants adapted to grow in water-saturated soils low in oxygen (MacKenzie and Moran, 2004)

Traditionally, wetland classification recognizes five wetland types: bog; fen; marsh; swamp; and shallow water (Warner and Rubec, 1997). Flood associations are recognized MacKenzie and Moran (2004) as non-wetland riparian ecosystems that are regularly flooded and have coarse-textured soils that drain quickly. Alkaline/saline meadows are recognized as transition associations and included in MacKenzie and Moran (2004) because of their close association with marsh wetlands. Both flood and transition associations have been included in the wetland ecosystems baseline assessment because of their association with wetlands (MacKenzie and Moran, 2004; MacKillop et al., 2018).

Key wetland classifications used in the wetland ecosystems baseline assessment, as per MacKenzie and Moran (2004) and Keddy (2010) are as follows:

Peat (mesic to fibric)	<p>Bog Wetland Class (Wb) “Bogs are shrubby or treed, nutrient-poor peatlands with distinctive communities of ericaceous shrubs and hummock-forming <i>Sphagnum</i> species adapted to highly acid and oxygen-poor soil conditions” (MacKenzie and Moran, 2004, p. 30). Bogs have vegetation rooted in deep peat and have a pH <5 (Keddy, 2010).</p>
	<p>Fen Wetland Class (Wf) “Fens are peatlands where groundwater inflow maintains relatively high mineral content within the rooting zone. These sites are characterized by non-ericaceous shrubs, sedges, grasses, reeds, and brown mosses” (MacKenzie and Moran, 2004, p. 30). Fens have vegetation rooted in shallow peat and a pH >6 (Keddy, 2010).</p>
Mineral (or humic peat)	<p>Marsh Wetland Class (Wm) “A marsh is a shallowly flooded mineral wetland dominated by emergent grass-like vegetation. A fluctuating watertable is typical in marshes, with early-season high watertables dropping through the growing season. Exposure of the substrate in late season or during dry years is common. The substrate is usually mineral, but may have a well-decomposed organic veneer derived primarily from marsh emergents. Nutrient availability is high (eutrophic to hyper-eutrophic) due to circumneutral pH, water movement, and aeration of the substrate” (MacKenzie and Moran, 2004, p. 33).</p>
	<p>Swamp Wetland Class (Ws) “A swamp is a forested, treed, or tall-shrub, mineral wetland dominated by trees and broadleaf shrubs on sites with a flowing or fluctuating, semi-permanent, near-surface water table. Tall-shrub swamps are dense thickets, while forested swamps have large trees occurring on elevated microsites and lower cover of tall deciduous shrubs. Both types of swamps have abundant available nutrients from groundwater and often have surface standing water. Swamps may be underlain with peat but this is well decomposed, woody, and dark” (MacKenzie and Moran, 2004, p. 33).</p>
Mineral	<p>Shallow-water Wetland Class (Ww) “Aquatic wetlands are shallow waters dominated by rooted, submerged and floating aquatic plants. These communities are always associated with permanent still or slow-moving waterbodies such as shallow potholes or deeper ponds and lakes. Shallow-water sites are usually permanently flooded and rarely become exposed during extreme drought years. Shallow-water communities most commonly occur where standing water is less than 2 m deep in midsummer. Aquatic plants may root in mineral soils or in well-humified sedimentary peat” (MacKenzie and Moran, 2004, p. 33).</p>

Non-Wetland	<p>Alkaline/Saline Meadow Class (Ga) (Note this is referred to as Saline meadow Transition Class [Gs] in MacKenzie and Moran [2004]) “Saline meadows are grass-, rush-, or halophyte-dominated sites that occur on periodically saturated and occasionally inundated sites, where water table decline is caused mainly by evaporation and where salts accumulate. These conditions occur only in dry climates. After a brief period of inundation, the watertable drops below the rooting zone during most of the growing season, resulting in a well-aerated rooting medium. These ecosystems are part of a Grassland Group of terrestrial ecosystems” (MacKenzie and Moran, 2004, pp. 33-34). They are included here because of their close association with wetlands.</p>
	<p>Low bench Flood Class (Fl) “Low bench ecosystems occur on sites that are flooded for moderate periods (< 40 days) of the growing season, conditions that limit the canopy to tall shrubs, especially willows and alders. Annual erosion and deposition of sediment generally limit understorey and humus development” (MacKenzie and Moran, 2004, p. 34).</p>

1.4 Applicable Wetland Legislation

No specific legislation in Canada directly covers wetlands, although some statutes indirectly cover wetlands through other legislated objectives (i.e., the supply of water for domestic, industrial, and emergency use). At the federal level, legislation such as the *Species at Risk Act (SARA; 2002)* and the *Migratory Birds Convention Act (1994)* may provide indirect protection for wetlands at certain times of the year as a result of the protection of birds and federally listed wildlife⁶ and their critical habitat. SARA (2002) provides legislation covering wetlands by protecting plant and animal species at risk that depend on wetlands (i.e., listed species that occur on federal lands and in areas designated as critical habitat; [SARA 2002, s. 58(1)].

The legislative authority over wetlands is primarily at the provincial level (Lynch-Stewart et al., 1999). The B.C. *Water Sustainability Act (WSA; 2014)* includes wetlands within the definition of streams as “a natural source of water supply” and notes wetlands include “swamp, marsh, fen or prescribed feature”. Most provisions in the WSA pertain to flowing systems, including sensitive streams, a designation related to fish presence. The WSA is intended to conserve water in B.C. for residents now and in the future. Relevance to the wetland ecosystem baseline assessment and the Project include consideration of water flow needs for the environment (the conservation of important wetlands), preventing the dumping of deleterious materials into wetlands to protect aquatic ecosystems, and the provision for temporary restrictions on the use of surface and groundwater to protect flows critical to the environment, which includes wetlands.

⁶ Federally listed wildlife are species listed as extirpated, endangered or threatened by the Committee on the Status of Wildlife in Canada (COSEWIC). Protection of species only applies to federal crown land, except under special order (SARA 2002).

In 2009, the Government of B.C. and partners developed and published online an interim series of guidelines for wetland protection and conservation in B.C. called *Wetland Ways* (Cox and Cullington, 2009). The guideline presents provincial legislation relating to mining that potentially cover wetlands:

- *Mines Act* (1996) includes permitting, reclamation, and protection of and mitigation for damages to watercourses. The *Mines Act* is current to January 22, 2020.
- *Coal Act* (2004) provides licensees the right to engage in exploration and extraction on land. The *Coal Act* is current to January 22, 2020.

The Government of B.C. is in the early stages of developing a species at risk legislation with the aim to protect species and ecosystems at risk, provide recognition of and support for federal programs that protect native species at risk, and promote the protection of species at risk on municipal, regional and private lands (B.C. Ministry of Environment and Climate Change Strategy [B.C. MECCS], 2018). Wetlands or wetland features deemed critical to the survival of a species at risk (i.e., considered critical habitat) may, under special circumstances and a ministerial order, be protected.

The British Columbia Riparian Areas Protection Regulation (RAPR) protects riparian areas of wetlands connected by surface flow to a watercourse or body of water that provide fish habitat or contribute nutrients to fish in connected downstream waters.

Project Setting and Study Areas

The Project is located approximately 30 km by road from Sparwood, B.C (**Figure 1**). Project is situated in an area of steep topography of the Front Ranges Rocky Mountains of B.C. and accessed by several Forest Service Roads, including Grave Creek Forest Service Road from the west and Alexander Creek Road from the south. The Project is in the Elk River, Grave Creek, Harmer Creek, and Alexander Creek watersheds. Alexander Creek flows south from the Project area and subsequently joins Michel Creek (**Figure 2**). Michel Creek eventually discharges to the Elk River which flows generally southwest and discharges to Lake Kocanusa, a reservoir which partially occurs in the State of Montana. Grave Creek flows in a westerly direction from the upper extent of the Project area and discharges to the Elk River. Harmer Creek, a tributary to Grave Creek, flows from the south to the north and joins Grave Creek east of the Elk River.

Three spatial boundaries have been developed to guide the completion of the wetland ecosystem assessment, the Project footprint and the Local Study Area (LSA). The spatial boundaries include the Project footprint, the Local Study Area (LSA), and the Regional Study Area (RSA). Project-specific surveys conducted at the LSA scale are presented in this report, while the evaluation of wetlands at the RSA level is presented in a separate technical report.

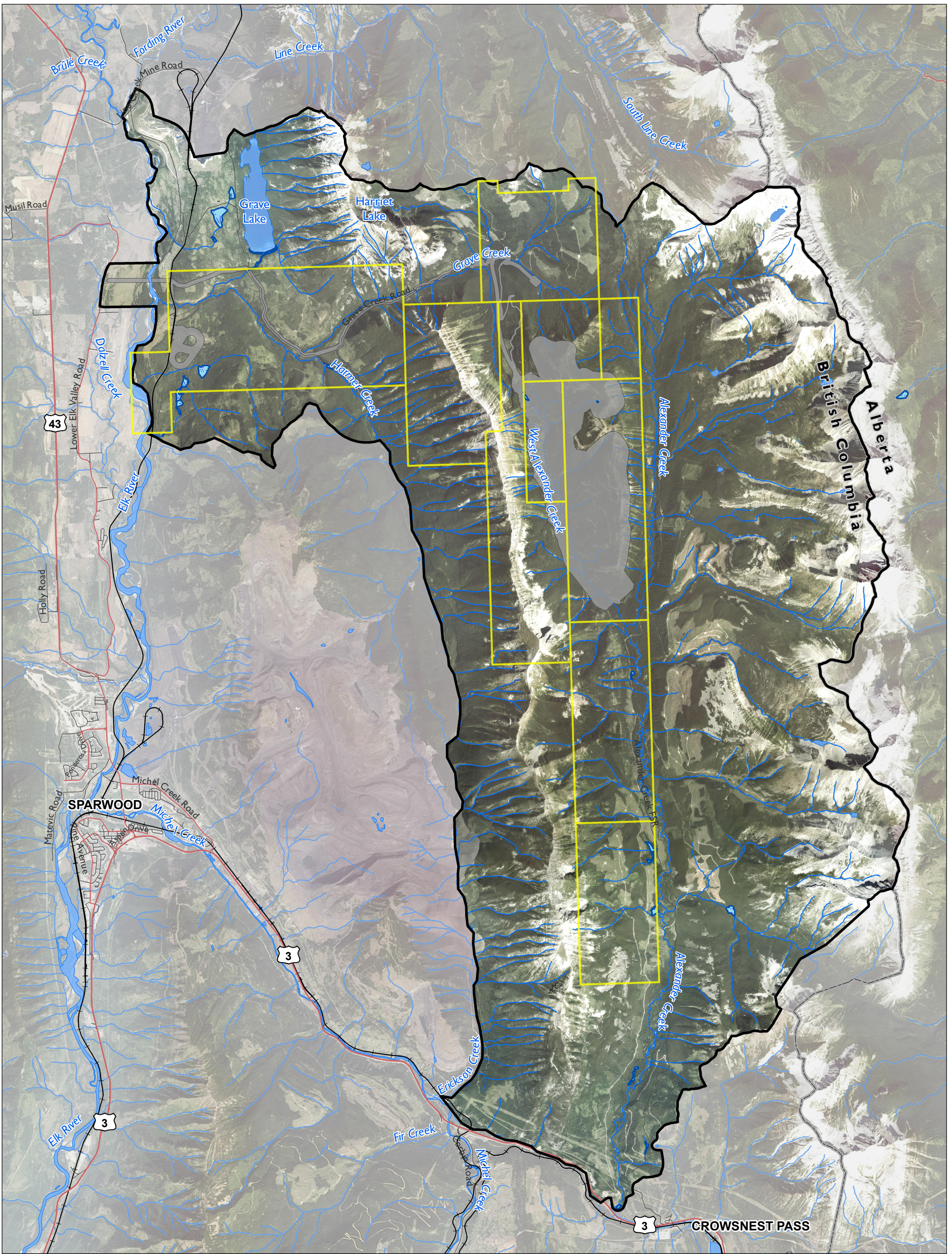
The Project footprint covers approximately 1,300 ha (**Figure 2**) and includes all anticipated Project components, such as the active mining area, waste rock management area piles, and associated infrastructure following the Grave Creek Forest Service Road west to the Elk River.

The terrestrial LSA (**Figure 2**), which covers approximately 24,100 ha, was used for other Project-specific terrestrial baseline studies. The LSA includes the area surrounding the Project footprint that may experience changes at an ecosystem level, both indirectly and directly. The LSA includes watercourses that influence wetland development and persistence, including Grave Creek, West Alexander Creek, and Alexander Creek. The LSA includes watersheds of Alexander Creek, West Alexander Creek, Grave Creek, Harmer Creek, and the Elk River. Erikson Creek was not included in the LSA for the wetland ecosystem surveys as it is outside the potential project area of influence.

The LSA consists of the Montane Spruce (MS) and Engelmann Spruce-Subalpine Fir (ESSF) Biogeoclimatic Ecosystem Classification zones. MS is represented solely by the Dry Warm Montane Spruce (MSdw) subzone at elevations below 1,600 m. The MSdw is characterized by dry, cool winters and dry, warm summers and falls and a predominance of hybrid spruce (Engelmann x white [*Picea engelmannii* x *glauca*] and Douglas-fir (*Pseudotsuga menziesii*) (MacKillop et al., 2018). The majority of the wetlands in the LSA are located in the MSdw subzone (Keefer Ecological Services Limited, 2020). The higher elevation ESSF BEC zone makes up the rest of the study area. The ESSF zone is characterized by cold, moist winters and cool, moist summers and dominated by Engelmann spruce (*Picea engelmannii*) and

subalpine fir (*Abies lasiocarpa*) (British Columbia Ministry of Forests, 1991; MacKillop et al., 2018) and has three units that occur in the LSA:

- The Elk Dry Cool Engelmann Spruce Subalpine Fir Elk Dry (ESSFdk1) variant, which occurs adjacent to and above the MSdw to about 1900 m;
- The Dry Cool Woodland Engelmann Spruce Subalpine Fir (ESSFdkw) variant, which occurs above the ESSdk1; and
- The Dry Cool Parkland Engelmann Spruce Subalpine Fir (ESSFdkp) variant, which occurs at elevations greater than 2,100 m.



Crown Mountain Coking Coal Project

FIGURE 2
Terrestrial Local Study Area

LEGEND

- Terrestrial Local Study Area
- Project Footprint
- Coal Tenure Licenses
- Highways
- Arterial Roads
- Local/Resource Roads
- Railway (Canadian Pacific)
- Watercourse
- Waterbody
- Wetland
- BC/Alberta Border



SCALE 1:82,000

Map Drawing Information: Data Provided by Province of British Columbia, NWP Coal Canada Ltd., Dillon Consulting Limited

Map Created By: JFC/RBB
Map Checked By: LKD
Map Projection: NAD 1983 UTM Zone 11N



PROJECT: 12-6231
STATUS: FINAL
DATE: 2021-08-23

3.0 Methods

3.1 Wetland Ecosystem Surveys

Wetland baseline ecosystem surveys were conducted in 2017, 2018, and 2019 to obtain information on wetland presence within the LSA and to determine wetland classification and conservation ranking. Some wetlands within the LSA were initially visited in 2014 as part of general information gathering and directed studies for birds and amphibians. Wetlands surveyed were situated across several watersheds in the LSA, including Alexander Creek, West Alexander Creek, Grave Creek, Harmer Creek, and the Elk River.

A desktop review was conducted prior to the field surveys to guide the assessment of wetland ecosystems with the LSA. As part of the desktop evaluation, data from previously-conducted baseline programs (e.g., bird community, amphibians, and Terrestrial Ecosystem Mapping) was used to indicate the location of wetlands in the LSA, in conjunction with available aerial imagery (ESRI, 2019). Wetlands identified for assessment in the LSA included all wetlands discernable on aerial photographs and additional areas encountered as part of other Project baseline surveys. Wetlands encountered as part of the wetland field surveys but not visible on aerial imagery during preliminary desktop review were recorded as part of the wetland surveys. Desktop reviews of aerial photographs revealed the potential presence of wetlands along the floodplains, some of which were investigated as part of the field surveys; however, an extensive survey of all potential floodplain areas was not completed as part of the wetland ecosystem surveys.

Given the size of the LSA and access constraints, not all wetlands within the LSA were documented as part of the field surveys. The extensive field coverage for the baseline assessment suggests few or no wetland types or classes were excluded.

Methods employed for the wetland ecosystem surveys were based on information gathered from the following publications:

- *Describing and Identifying Site Units* (MacKenzie and Moran, 2004);
- *Field Manual for Describing Terrestrial Ecosystems* (B.C. Ministry of Forests and Range [B.C. MFR], 2010);
- *Sampling Rare and Elusive Species* (Poon and Margules, 2004);
- *Predicting Occurrences of Geographically Restricted Rare Floral Elements with Qualitative Habitat Data* (MacDougall and Loo, 2002);
- *Sampling Rare Populations* (McDonald, 2004); and
- *Wetland Ecology: Principles and Conservation* (Keddy, 2010).

Plot sampling for vegetation, vegetation identification (onsite and from collected specimens), and soil sampling were conducted at each wetland ecosystem surveyed. Information on other characteristics such as zonation, transition, and wetland boundaries was also collected. Photographs were taken of plot sites and general wetland characteristics. Wetland ecosystem surveys followed publications outlined above and involved “walk-through surveys” and meanders to determine general and specific vegetative and physical characteristics, gather information on the occurrence (distribution and abundance) of common and characteristic plant species, and to document uncommon and rare plant species.

Plots for vegetation cover estimates were established based on wetland size and vegetation characteristics. In wetland complexes with segregated units of distinct vegetation, plots were established in each unit to record characteristics of each. In wetlands with indistinct, heterogeneous assemblages of species, multiple plots adjusted to wetland size were used to infer characteristics of the wetland. Wetland edges were avoided, when possible, unless features appeared unusual or noteworthy. In small wetlands, where edges could not be avoided, plot sizes were adjusted and information from edges “filtered out” where they did not represent characteristic wetland attributes; that is, they were common or expected expressions of a narrow zone transitional to upland. At all wetlands surveyed, plots were circular with an 11.3 m radius or were square and 20 m x 20 m. In wetlands that could not accommodate plots of these dimensions, a small plot was used to survey the whole wetland or multiple small plots were used to characterize distinct features. Photographs were taken and detailed notes were made to further characterize features.

Soil samples were taken within plots using an Edelman soil auger to a maximum depth of approximately 80 cm. Most soil cores were extracted until a mineral layer was encountered. Following examination of the soil cores, holes were plugged with some of the extracted soil and the remaining surface cores were broken apart and scattered under foot. Organic soils (peat) were characterized using classifications of humic, mesic, and fibric, and the van Post scale of decomposition. The wetland ecosystem surveys focussed on vegetation species common to, or representative of, specific wetlands. Plant species infrequently encountered in the LSA were also noted, whether they were representative or not of wetland ecosystems.

Information recorded for each wetland surveyed included:

- Wetland number and name;
- Surveyors and relevant Project tracking information;
- Date and time;
- Weather;
- Photographs to record general and specific features;
- Location and elevation using a hand-held GPS (Garmin Map64st) and UTM's (NAD83);
- Aspect, slope, shape, and orientation;
- Total area;

- Composition of plant species (percent cover), including invasive and unusual plant species, with a focus on plants characteristic/representative of the wetland;
- Biogeoclimatic ecosystem classification zone and subzone;
- General distribution and extent of wetland types⁷;
- Soil characteristics, including presence and characteristics of peat (composition, texture, firmness, moisture, etc.) and depth of mineral layer;
- General hydrological characteristics, including presence of open water, depth of water, and flow of water (Flow as per Moran and MacKenzie [2004]);
- Hydroperiod as permanent, seasonal, ephemeral;
- Geomorphic setting/landscape context; and
- Wildlife observations.

The wetland shape index (WSI) was determined for each sampled wetland. The WSI represents a value derived from wetland area and perimeter to represent general shape (elongate versus circular or square) (Minke et al., 2010). A WSI value of 1.0 = circle; 1.1 = square; and >2 = long rectangle (i.e., long and narrow). Wetland delineation was based on field observations⁸, vegetation structure and floristics, and aerial imagery. Due to wetland complexity, size, and indistinct termination in transitional zones, accuracy of the WSI is considered to be somewhat imprecise and variable between wetlands.

Plant specimens that could not be identified in the field were collected for identification in the herbarium. Bryophytes and vascular plants were dried, and vascular plants pressed, for later examination using microscopy and technical references. Technical references included, among others: *The Flora of North America* (Flora of North America Editorial Committee, 1993+: various volumes for vascular plants and bryophytes); *Illustrated Flora of British Columbia* (Douglas et al., 1998; Douglas et al., 1999-2001), and *Flora of the Pacific Northwest* (Hitchcock and Cronquist, 2018). Specimens will be deposited at the UBC Herbarium at the Beaty Biodiversity Museum. Prior to wetland ecosystem surveys, field tools and clothing were cleaned with a bleach solution as per *Standard Operating Procedures: Hygiene Protocols for Aquatic Field Research* (B.C. Ministry of Environment [MOE], 2008) and *Decontamination Protocol for Field Work with Amphibians and Reptiles in Canada* (CHHWG, 2017).

The suspected or evidential origin of the wetland was also recorded at each of the wetlands surveyed. Origin was noted to be either anthropogenic or non-anthropogenic (natural) with qualifiers such as “beaver” noted where appropriate. As part of the surveys, “non-anthropogenic” was used to describe isolated wetlands with no obvious sign of human modification. Non-anthropogenic is assumed based on conditions observed during field surveys but the wetland’s actual history may be different. In some instances, both anthropogenic and non-anthropogenic were used to describe wetlands that present

⁷ Most wetlands in the study area are complexes of two or more wetland types, differentiated by physical features, soils, vegetation structure, and floristics.

⁸ The confidence with which surveyors could make assertions regarding wetland characteristics diminishes beyond the area surveyed on foot. The interpretation of wetland areas and characteristics reflect this.

evidence of both; that is, portions of the wetland appear to have developed naturally and other portions through human modification.

Wetlands were mapped in ArcGIS using information gathered in the field, 2016 ortho-imagery (Province of B.C. and GeoBC, 2016), and Terrestrial Ecosystem Mapping (TEM; Keefer Ecological Services Ltd., 2020). Wildlife observations and signs of wildlife activity were recorded during wetland surveys. Breeding and migratory bird surveys were conducted at wetlands to document potential migratory birds. Information on water quality at wetlands surveyed was also gathered to inform the Project human health and ecological risk assessment and is not presented in this report. *In-situ* water quality was gathered at selected wetlands through use of a multi-meter probe in open water, water amongst graminoids and other plants, or in isolated pools in small depressions when surface water was scarce. *In-situ* information was gathered to support the completion of a wetland function assessment for the Project and is not presented in this report. *In-situ* data collected included water clarity, temperature, specific conductivity, conductivity, total dissolved solids, salinity, dissolved oxygen, pH, and turbidity and was collected to inform the wetland function assessment.

3.2 Wetland Catchment Delineation

Surface catchment areas for surveyed wetlands were estimated using an available LiDAR 2 m Digital Elevation Model (DEM) which was merged with the 20 m Canadian Digital Elevation Model (CDEM) for areas in which the 2 m DEM was not available. Catchment areas were determined to support an understanding of surface water contributions to surveyed wetland ecosystems and to inform the completion of a wetland ecosystem function assessment.

3.3 Wetland Classification

Wetland classification completed for the wetland ecosystem baseline assessment followed MacKenzie and Moran (2004) and MacKillop et al. (2018), and was aligned with the provincial standard for ecological classification, the Biogeoclimatic Ecosystem Classification (BEC), which is based on three levels of classification, climatic, vegetation and site (Pojar et al., 1991). Wetlands in MacKenzie and Moran (2004) are named based on three levels of classification: the realm; the class; and, the site association (e.g., Wb15 indicates the wetland realm (W); bog class (b); spruce – Labrador tea – peat moss site association (15). Additional wetland site associations, specific to the East Kootenay, are presented in MacKillop et al. (2018) and were used as part of the wetland classification. Wetlands were also classified using the Canadian Wetland Classification System (CWCS; Warner and Rubec, 1997). The CWCS provides a broader scale classification of wetlands that focuses on landform, hydrology, and general vegetation groups. The CWCS provides landscape context not provided in provincial the classification guideline.

The provincial and global status, as well as the provincial conservation status, if applicable, was determined for each wetland site association documented, if applicable. The provincial status is based

on conservation status identified by the BC Conservation Data Centre (B.C. CDC; 2019), while the global status is based on NatureServe (2020). The provincial conservation status is based on BC Conservation Data Centre (2019) information (see **Section 3.4** for additional information on the conservation status of wetlands).

Typically, wetlands are complexes or mosaics of distinct types of wetlands that grade into one another across transitional areas that share characteristics of each. The complexity and uniqueness of a wetland reflects the complexity and uniqueness of the combinations of features that influence their formation. No two wetlands are the same and as such, additional information is provided when necessary to further characterize the wetlands and site. Discrete wetland types within the complexes were determined by visual examination, vegetation plot sampling to determine plants species assemblages and structure, and soil sampling. For the purposes of this baseline assessment, wetland complexes were described from the wetland types that could be distinguished. To simplify classification for some complex wetlands observed, for example if the wetland comprised a series of beaver ponds and connecting channels over an extended area, the subunits of the wetland were considered together.

Generally, when considering wetlands we are referring to natural wetlands, those wetlands that have developed without direct influence by human activity; however, it may be difficult to determine whether a wetland is “natural” or whether it resulted from human activity. Human-created wetlands can become naturally functioning wetland systems that can be classified accordingly (Warner and Rubec, 1997), and they were for this study.

3.4 Wetland Conservation Ranking

The B.C. CDC assigns conservation ranks to wetland classes and specific site associations. The conservation rank indicates the commonness, rarity, and vulnerability of the wetland site association. The rank confers “value” and may indicate the presence of plant species uncommon or rare in the project area, region, or province. For the wetland ecosystem baseline assessment and wetlands observed within the LSA, the conservation status for wetland site associations was determined using available B.C. CDC data as well as information specific to wetlands in the East Kootenay region, such as their relative frequency of occurrence based on descriptors such as “uncommon” or “rare” (i.e., MacKillop et al. [2018]).

Additional information on the definitions of conservation rankings referenced as part of the wetland ecosystem baseline assessment is provided in **Appendix A**.

4.0 Results

Information in **Section 4.0** is presented to describe the results of the wetland ecosystem surveys, the delineation and classification of wetlands and wetland complexes surveyed in the LSA, the landscape and ecological context of wetlands observed, common invasive plants documented at wetland ecosystems, and wetland conservation status ranking.

4.1 Wetland Ecosystem Surveys

Thirty-six wetland (36) ecosystems within the LSA were surveyed in 2017, 2018, and 2019 (**Figure 3**). Many of the wetlands observed within the LSA form wetland complexes of two or more distinct wetland associations; of the 36 wetland ecosystems classified, 23 form wetland complexes comprising two or more distinct wetland site associations. Thirteen wetlands were found to have a single site association. Wetlands surveyed varied in size, with some variation attributable to wetland delineation and composition. Adjoining wetland site associations that differed markedly in structure and species composition, such as a graminoid fen and treed swamp, were considered separately, as were those separated by markedly different features and those with distinctive physical or topographical features. Most wetlands surveyed ranged from 0.01 to 0.25 ha (n=11) and 0.51 to 0.75 ha in size (n=10) (**Figure 4**). Of the wetlands surveyed, 31 occur in the Dry Warm Montane Spruce (MSdw), four in the Elk Dry Cool Engelmann Spruce – Subalpine Fir (ESSFdkw), and one in the Dry Cool Woodland Engelmann Spruce – Subalpine Fir (ESSFdk1). Additional information on the location of wetlands, including their size and elevation, is provided in **Appendix B**.

American Beaver (*Castor canadensis*) have played and continue to play a major role in the creation of wetlands in the LSA. Many of the wetlands are present along creeks that have been dammed by beaver, creating a complex of ponds and channels of varied depths, flows and sizes, all of which contribute to a diverse assemblage of plants and plant communities. At the time of the wetland ecosystem surveys, at least 12 wetland ecosystems were influenced by beaver activity (i.e., WL1, WL4, WL5.1, WL5.2, WL5.3, WL5.4, WL6, WL6.1, WL6.2, WL9, WL11.2, and WL17). Flooding is a major force in wetland creation, especially along creeks. High water levels in the spring slowly decrease over the growing season, influencing wetland vegetation. The wetlands in the LSA have also been influenced by both human activities and natural processes. Roads and culverts have helped to create or shape wetlands. Earthen berms, fences, and other human artifacts are evident in some wetlands.

FIGURE 3
Surveyed Wetland Ecosystems



LEGEND

- Surveyed Wetland Ecosystem
- Terrestrial Local Study Area
- Project Footprint
- Highways
- Arterial Roads
- Local/Resource Roads
- Railway (Canadian Pacific)
- Watercourse
- Waterbody
- BC/Alberta Border

Wetland Site ID	Estimated Wetland Area (ha)	Wetland Site ID	Estimated Wetland Area (ha)
WL1	0.55	WL10	0.03
WL2	0.51	WL11.1	0.21
WL2a	0.59	WL11.2	0.88
WL3	0.76	WL11.3	0.78
WL4	2.12	WL11.3a	1.14
WL5.1	0.41	WL11.3b	0.72
WL5.1a	0.03	WL12	2.44
WL5.2	0.59	WL13	8.84
WL5.3	0.14	WL14	4.79
WL5.4	1.92	WL15	2.59
WL6	0.45	WL16	2.44
WL6.1	0.16	WL16a	1.63
WL6.2	0.02	WL17	0.67
WL7	0.08	WL18	0.10
WL8.1	0.04	WL19	0.02
WL8.2	0.55	WL20	0.61
WL8.3	0.03	WL21	2.82
WL9	0.57	WL22	0.69

0 1 2 3 4 Kilometers
SCALE 1:175,000



Map Drawing Information: Data Provided by Province of British Columbia, NWP Coal Canada Ltd., Dillon Consulting Limited

Map Created By: JFC/LMM
Map Checked By: LKD
Map Projection: NAD 1983 UTM Zone 11N



PROJECT: 12-6231
STATUS: FINAL
DATE: 2021-08-26

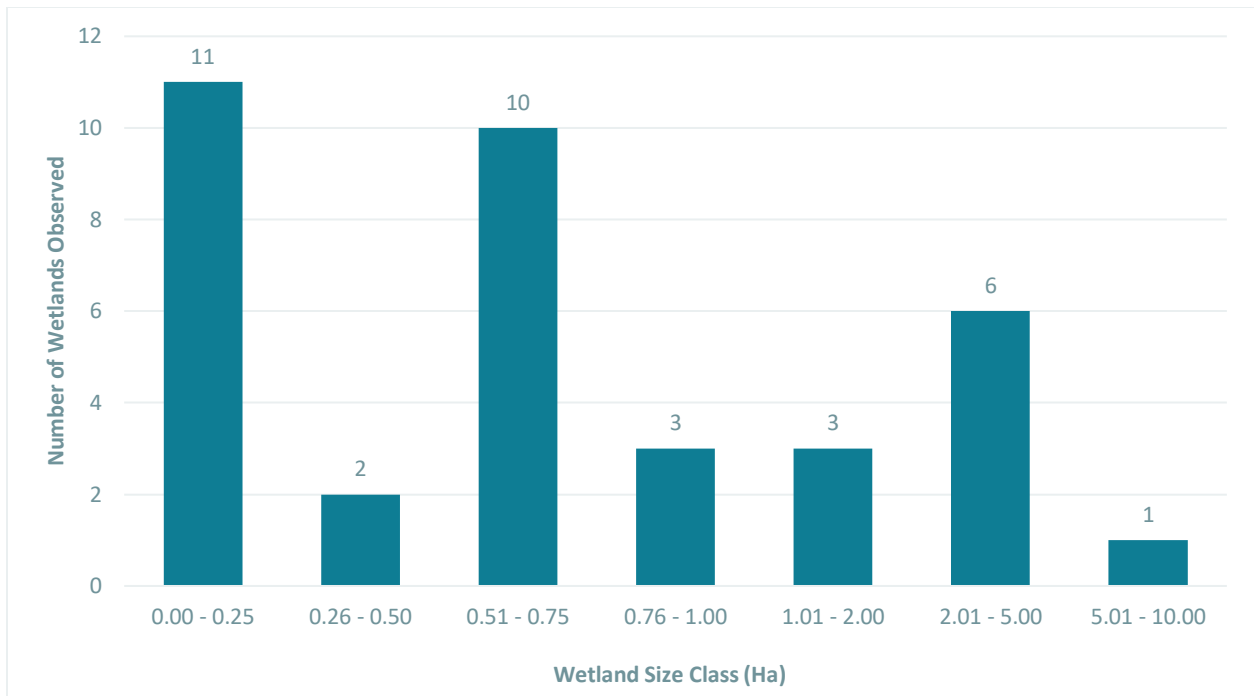


Figure 4. Frequency of Wetland Sizes Observed within the LSA

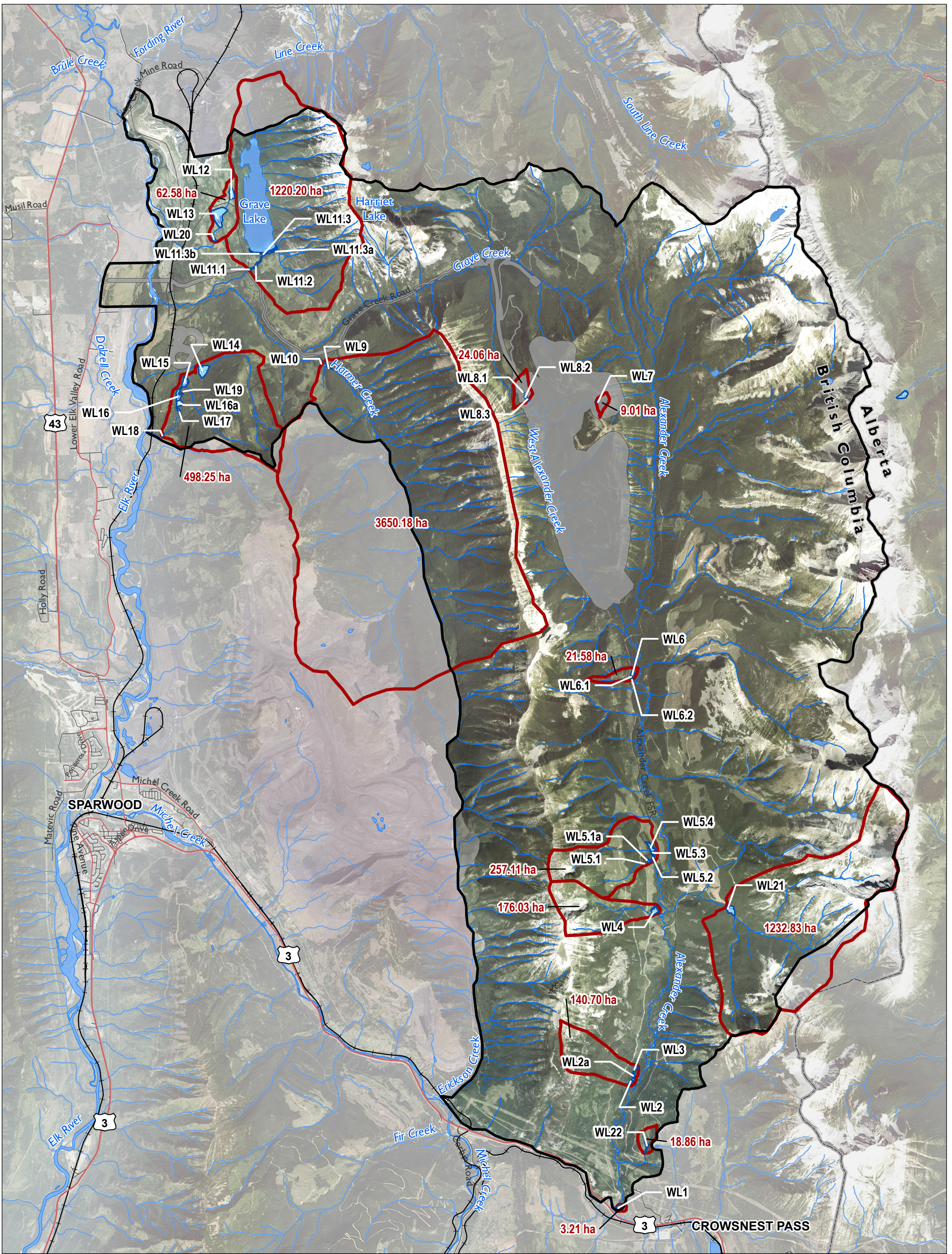
4.2 Wetland Catchment Delineation

Generally, wetlands were found to be restricted to flat areas, valleys, and bowls with many wetlands observed to be formed in basins, depressions, and through obstructions along drainage ways (e.g., presence of beaver dams). Many wetlands have developed in basins along creeks or drainage channels adjacent to forested slopes. Basin wetlands are fed by creeks, surface drainage and drainage from the adjacent slope. Layers of peat of various depths, composition and stages of decomposition develop in these basins and effectively store water to sustain marsh and fen communities.

Wetland catchment areas are the upslope areas that drain water into a wetland. They are drainage subunits of, and occur within, the greater drainage areas identified as the Alexander Creek, Elk River, Grave Creek and Harmer Creek watersheds. Wetland catchment areas range in size across the LSA and occurred across small, lower elevation areas (e.g., site WL1) to larger areas at mid-elevation (3,650.2 ha, WL9 and WL10; **Table 1, Figure 5**). Small wetland catchments were considered those less than 100 ha, medium catchments as ranging from 100 ha to 500 ha, and large catchments greater than 500 ha. Those wetlands that are in close proximity, connected, and are influenced by the inflow and outflow of one another were grouped together to determine the catchment area. The Alexander Creek watershed contained the highest number of wetlands surveyed (n=19), followed by the Elk River watershed (n=10), Grave Creek watershed (n=5), and the Harmer Creek watershed (n=2).

Table 1. Estimated Catchment Area for Wetland Ecosystems Surveyed in the LSA

Wetland Survey Site ID	Wetland Area (ha)	Estimated Catchment Area (ha)	Watershed	Catchment Description
WL1	0.55	3.21	Alexander Creek Watershed	Small catchment at low elevation (1,355 – 1,320 m)
WL2	0.51	140.70	Alexander Creek Watershed	Mid-sized catchment at high-low elevation (2,250 – 1,355 m)
WL2a	0.59			
WL3	0.76			
WL4	2.12	176.03	Alexander Creek Watershed	Mid-sized catchment at mid-elevation (2,370 – 1,450 m)
WL5.1	0.41	257.11	Alexander Creek Watershed	Mid-sized catchment at high-low elevation (2,370 – 1,450 m)
WL5.1a	0.03			
WL5.2	0.59			
WL5.3	0.14			
WL5.4	1.92			
WL6	0.45	21.58	Alexander Creek Watershed	Small catchment at mid-elevation (1,975 – 1,500 m)
WL6.1	0.16			
WL6.2	0.02			
WL7	0.08	9.01	Alexander Creek Watershed	Small catchment at high elevation (2,220 – 2,060 m)
WL8.1	0.04	24.06	Alexander Creek Watershed	Small catchment at mid-elevation (1,995 – 1,875 m)
WL8.2	0.55			
WL8.3	0.03			
WL9	0.57	3,650.18	Harmer Creek Watershed	Large catchment at high-mid elevation (2,200 – 1,325 m)
WL10	0.03			
WL11.1	0.21	1,220.20	Grave Creek Watershed	Large catchment at high-low elevation (2,515 – 1,260 m)
WL11.2	0.88			
WL11.3	0.78			
WL11.3a	1.14			
WL11.3b	0.72			
WL12	2.44	62.58	Elk River Watershed	Small catchment at low elevation (1,310 – 1,280 m)
WL13	8.84			
WL20	0.61			
WL14	4.64	498.25	Elk River Watershed	Mid-sized catchment at mid-elevation (1,800 – 1,190 m)
WL15	2.59			
WL16	2.44			
WL16a	1.63			
WL17	0.67			
WL18	0.10			
WL19	0.02			
WL21	2.82	1,232.83	Alexander Creek Watershed	Large catchment at high-low elevation (2,500 – 1,520 m)
WL22	0.69	18.86	Alexander Creek Watershed	Small catchment at low elevation (1,390 – 1,440 m)



Crown Mountain Coking Coal Project

FIGURE 5
Estimated Catchment Areas for
Surveyed Wetland Ecosystems

LEGEND

- Estimated Wetland Catchment
- BC/Alberta Border
- Wetland
- Terrestrial Local Study Area
- Project Footprint
- Highways
- Arterial Roads
- Local/Resource Roads
- Railway (Canadian Pacific)
- Watercourse
- Waterbody



Map Drawing Information: Data Provided by
Province of British Columbia, NWP Coal Canada Ltd.,
Dillon Consulting Limited

Map Created By: JFC/LMM
Map Checked By: LKD
Map Projection: NAD 1983 UTM Zone 11N



PROJECT: 12-6231
STATUS: FINAL
DATE: 2021-08-23

4.3 Wetland Classification

Wetlands were classified across the 36 wetland survey sites (**Table 2; Figures 6a to 6i**). Six wetland classes were represented in the wetlands surveyed in the LSA and include bog, fen, marsh, swamp, shallow water, and a transitional/successional marsh-fen. Two non-wetland groups, a transition mineral association and flood association, were also observed in the LSA. Of the wetlands surveyed, marsh constitutes the largest area of all wetlands and non-wetland groups surveyed at 13.88 ha (34.06%), followed by swamp at 13.43 ha (32.96%), transitional marsh-fen at 5.39 ha (13.22%), shallow water at 3.74 ha (6.77%), fen at 2.76 ha (6.77%), transitional mineral association at 0.92 ha (2.26%), and bog at 0.04 ha (0.09%) (**Figure 7 and Figure 8**). Flood associations surveyed make up 0.60 ha (1.47%) of the LSA. Wetland profiles for each wetland ecosystem surveyed, including detailed classification information, are included **Appendix C**. Additional photos are provided in **Appendix D**.

The wetland classes and non-wetland groups were further broken down into associations based on information gathered as part of the wetland ecosystem surveys (**Section 4.3**). Twenty-three distinct wetland site associations were identified amongst the wetlands surveyed (**Table 2**) and include seven marsh, six shallow water, five swamp, two fen, one bog, and one transitional/successional marsh-fen. Three flood associations were also observed and two transitional mineral wetland associations were recorded. Site associations were based largely on the presence of characteristic assemblages of plants. Most wetlands observed and discussed in **Section 4.3** are presented in *Wetlands of B.C.* (MacKenzie and Moran, 2004) with information on additional units being based on *A Field Guide to Ecosystem Classification and Identification for Southeast British Columbia* (MacKillop et al., 2018). This approach provides a means to classify and group similar wetland ecosystems; however, due to the complexity and diversity of wetlands, no system of wetland classification can cover all the varieties of wetlands and ecological details.

The most common type of wetland observed across the LSA was marsh. Of the marsh site associations documented, the *Wm01 Beaked sedge – Water sedge* marsh was the most common site association observed across wetlands assessed and constituting 10.82 ha of wetland area surveyed in the LSA. Notably, marsh was observed alongside 15 of 18 shallow water wetlands surveyed. Bogs and fens occur in basins and adjacent to shallow water in the LSA while marshes and swamps are present in basins, beside large bodies of water (lakes and reservoirs), shallow water, and along drainage channels. The transitional/successional wetland association *Wm01-Wf01* represents wetlands in which marsh (*Wm01*) and fen (*Wf02*) were found together, suggesting a community where marsh is succeeding to fen as organic matter (sedge peat) gradually accumulates. The transitional mineral associations *Ga02\$* and *Ga03\$*, represent disturbed seral alkaline meadow communities that experience early season inundation and late season drying which concentrates salts (MacKillop et al., 2018). The disturbance modifiers *B.d.* and *B.w.* are assigned to each to indicate biotic disturbance through grazing, browsing and trampling by domestic animals (*B.d.*) and wildlife (*B.w.*): *Ga02\$[B.d][B.w]* and *Ga03\$[B.d][B.w.]*. In the following text, they are simply referred to as *Ga02\$* and *Ga03\$*.

Sixty-four percent of the wetland ecosystems surveyed (23 of 36) are wetland complexes of more than one distinct wetland site association. The location, extent and shape of the different wetland types within wetland complexes are influenced by underlying topography, wetland age, surrounding features (floristic and geologic), water entering the wetland⁹, and water leaving the wetland¹⁰. Given the complexity of wetlands within the LSA, it is difficult to classify them based on one wetland site association, because two or more site associations might constitute near-equal portions of a wetland area and individual components of each wetland complex can be ecologically inextricable. As such, wetlands were broken into complex components (e.g., primary, secondary, tertiary, etc.) to identify the proportion of wetland types present at each wetland complex observed.

Sections 4.3.1 to 4.3.8 summarize wetland classification for each of the wetland and non-wetland groups observed within the LSA. A discussion on ephemeral wetlands observed within the LSA over the course of the wetland ecosystem surveys is presented in **Section 4.3.8**.

⁹ Broad category encompassing quality (chemical, sediment) and quantity with various aspects of flow considered: rate, volume, duration, periodicity, and seasonality.

¹⁰ Includes flow and evaporation.

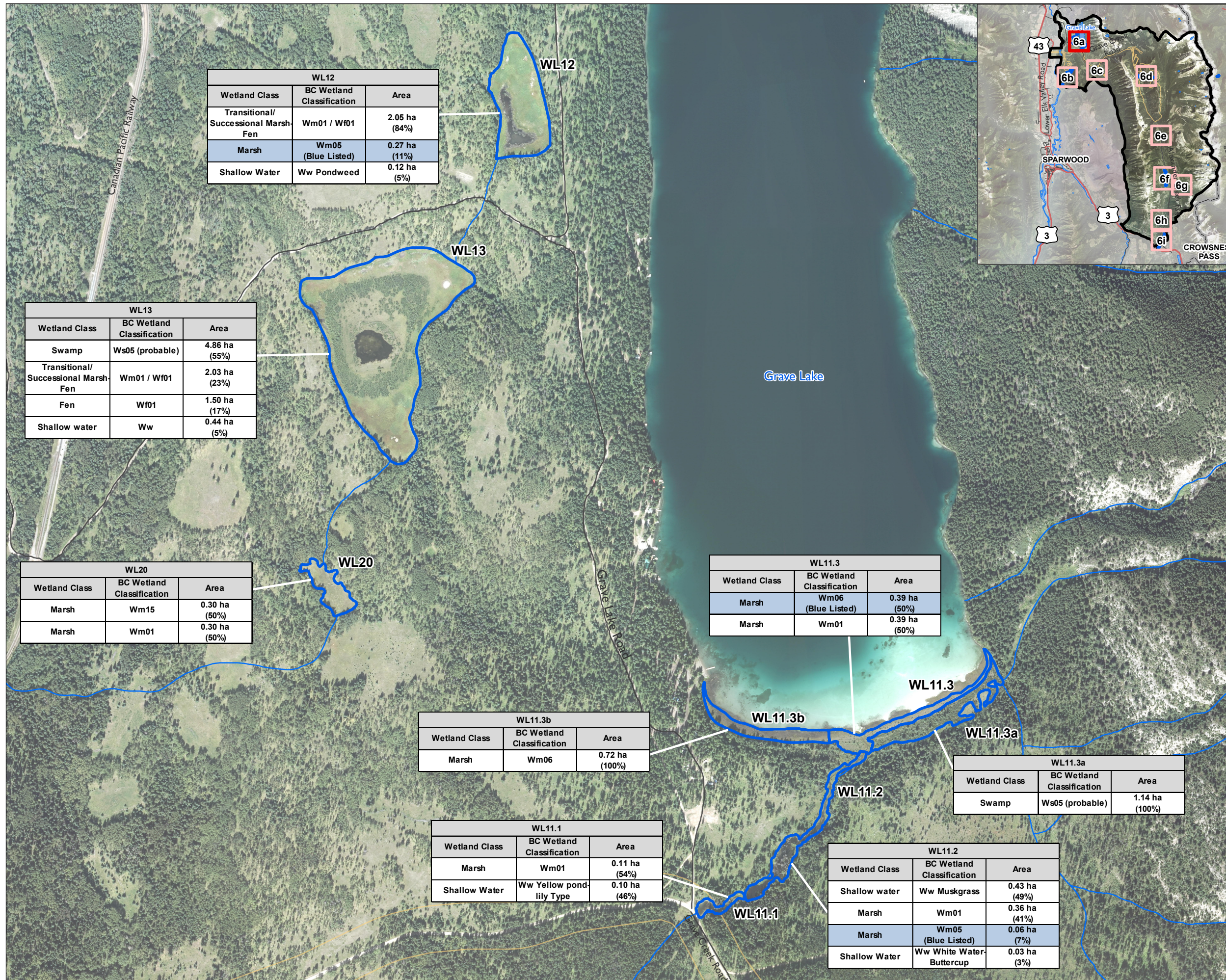
Table 2. Wetland Ecosystem Classification of Wetlands Surveyed in the LSA

Wetland Site ID	Estimated Wetland Area (ha)	Complex Component	Wetland Class	Wetland Complex Component Area (ha)	Estimated Area of Wetland Complex (% Total)	BC Wetland Classification	English Name	Scientific Name	Biogeoclimatic Zone
1	0.55	Primary	Marsh	0.30	54	Wm01	Beaked sedge - Water sedge marsh	<i>Carex utriculata</i> - <i>Carex aquatilis</i> marsh	MSdw
		Secondary	Shallow water	0.25	46	Ww Muskgrass	Muskgrass shallow water	<i>Chara</i> sp. Shallow water	
2	0.51	Primary	Fen	0.51	100	Wf01	Water sedge - Beaked sedge fen	<i>Carex aquatilis</i> - <i>Carex utriculata</i> fen	MSdw
2a	0.59	Primary	Swamp	0.59	100	Ws07.1	Spruce - Horsetail - Leafy moss (Hybrid white spruce - Horsetails - Leafy mosses) swamp	<i>Picea engelmannii</i> x <i>glauca</i> - <i>Equisetum</i> spp. - <i>Mnium</i> spp. (Mniaceae) swamp	MSdw
3	0.76	Primary	Fen	0.59	78	Wf02	Scrub birch - Water sedge fen	<i>Betula nana</i> - <i>Carex aquatilis</i> fen	MSdw
		Secondary	Fen	0.16	21	Wf01	Water sedge - Beaked sedge fen	<i>Carex aquatilis</i> - <i>Carex utriculata</i> fen	
		Tertiary	Bog	0.01	1	Wb15	Labrador tea – Peat moss bog	<i>Rhododendron groenlandicum</i> – <i>Sphagnum</i> spp. bog	
4	2.12	Primary	Marsh	1.44	68	Wm01	Water sedge - Beaked sedge marsh	<i>Carex aquatilis</i> - <i>Carex utriculata</i> marsh	MSdw
		Secondary	Swamp	0.47	22	Ws04 (probable)	Drummond's willow – Beaked sedge swamp	<i>Salix drummondiana</i> - <i>Carex utriculata</i> swamp	
		Tertiary	Shallow water	0.21	10	Ww Muskgrass	Muskgrass shallow water	<i>Chara</i> sp. shallow water	
5.1	0.41	Primary	Marsh	0.31	77	Wm01	Beaked sedge - Water sedge marsh	<i>Carex utriculata</i> - <i>Carex aquatilis</i> marsh	MSdw
		Secondary	Shallow water	0.09	23	Ww Muskgrass	Muskgrass shallow water	<i>Chara</i> sp. shallow water	
5.1a	0.03	Primary	Bog	0.03	100	Wb15	Spruce - Labrador tea - Peat moss bog	<i>Picea engelmannii</i> - <i>Rhododendron groenlandicum</i> - <i>Sphagnum</i> spp. bog	MSdw
5.2	0.59	Primary	Marsh	0.49	83	Wm01	Beaked sedge - Water sedge marsh	<i>Carex utriculata</i> - <i>Carex aquatilis</i> marsh	MSdw
		Secondary	Shallow water	0.10	17	Ww Muskgrass	Muskgrass shallow water	<i>Chara</i> sp. shallow water	
5.3	0.14	Primary	Marsh	0.09	60	Wm01	Beaked sedge - Water sedge marsh	<i>Carex utriculata</i> - <i>Carex aquatilis</i> marsh	MSdw
		Secondary	Shallow water	0.06	40	Ww Muskgrass	Muskgrass shallow water	<i>Chara</i> sp. shallow water	
5.4	1.92	Primary	Swamp	1.54	80	Ws04 (probable)	Drummond's willow – Beaked sedge swamp	<i>Salix drummondiana</i> - <i>Carex utriculata</i> swamp	MSdw
		Secondary	Marsh	0.38	20	Wm01	Beaked sedge - Water sedge marsh	<i>Carex utriculata</i> - <i>Carex aquatilis</i> marsh	
6	0.45	Primary	Marsh	0.27	60	Wm01	Beaked sedge - Water sedge marsh	<i>Carex utriculata</i> - <i>Carex aquatilis</i> marsh	MSdw
		Secondary	Shallow water	0.18	40	Ww	Shallow water	Association undetermined - no aquatic plants observed	
6.1	0.16	Primary	Marsh	0.16	100	Wm01	Beaked sedge - Water sedge marsh	<i>Carex utriculata</i> - <i>Carex aquatilis</i> marsh	MSdw
6.2	0.02	Primary	Shallow water	0.02	100	Ww	Shallow water	Association undetermined - no aquatic plants observed	MSdw
7	0.08	Primary	Marsh	0.08	100	Wm01	Beaked sedge - Water sedge marsh	<i>Carex utriculata</i> - <i>Carex aquatilis</i> marsh	ESSFdkw
8.1	0.04	Primary	Marsh	0.04	100	Wm16	Bluejoint - Arrow-leaved groundsel marsh	<i>Calamagrostis canadensis</i> - <i>Senecio triangularis</i> marsh	ESSFdk1
8.2	0.55	Primary	Shallow water	0.43	78	Ww	Shallow water	Association undetermined - possibly pondweed	ESSFdk1
		Secondary	Marsh	0.12	22	Wm01	Beaked sedge - Water sedge marsh	<i>Carex utriculata</i> - <i>Carex aquatilis</i> marsh	
8.3	0.03	Primary	Marsh	0.03	100	Wm01	Beaked sedge - Water sedge marsh	<i>Carex utriculata</i> - <i>Carex aquatilis</i> marsh	ESSFdk1

Wetland Site ID	Estimated Wetland Area (ha)	Complex Component	Wetland Class	Wetland Complex Component Area (ha)	Estimated Area of Wetland Complex (% Total)	BC Wetland Classification	English Name	Scientific Name	Biogeoclimatic Zone
9	0.57	Primary	Floodplain	0.20	35	FI01	Mountain alder – Common horsetail Flood Association	<i>Alnus incana</i> - <i>Equisetum</i> spp. Flood Association	MSdw
		Secondary	Floodplain	0.20	35	FI04	Sitka willow – Red-osier dogwood – Horsetail Flood Association	<i>Salix sitchensis</i> - <i>Cornus stolonifera</i> - <i>Equisetum</i> spp. Flood Association	
		Tertiary	Shallow water	0.17	30	Ww	Shallow water - beaver pond	Shallow water association undetermined - no aquatic plants observed	
10	0.03	Primary	Marsh	0.03	100	Wm01	Beaked sedge - Water sedge marsh	<i>Carex utriculata</i> - <i>Carex aquatilis</i> marsh	MSdw
11.1	0.21	Primary	Marsh	0.11	54	Wm01	Beaked sedge - Water sedge marsh	<i>Carex utriculata</i> - <i>Carex aquatilis</i> marsh	MSdw
		Secondary	Shallow water	0.10	46	Ww Yellow pond-lily Type	Yellow pond-lily - Bladderwort shallow water	Ww <i>Nuphar lutea</i> - <i>Utricularia macrorhiza</i> shallow water	
11.2	0.88	Primary	Shallow water	0.43	49	Ww Muskgrass	Muskgrass	<i>Chara</i> sp. shallow water	MSdw
		Secondary	Marsh	0.36	41	Wm01	Beaked sedge - Water sedge marsh	<i>Carex utriculata</i> - <i>Carex aquatilis</i> marsh	
		Tertiary	Marsh	0.06	7	Wm05	Cattail marsh	<i>Typha latifolia</i> marsh marsh	
		Quaternary	Shallow water	0.03	3	Ww White Water-Buttercup	White water-buttercup shallow water	<i>Ranunculus aquatilis</i> shallow water	
11.3	0.78	Primary	Marsh	0.39	50	Wm06	Great bulrush marsh	<i>Schoenoplectus acutus</i> marsh	MSdw
		Secondary	Marsh	0.39	50	Wm01	Beaked sedge - Water sedge marsh	<i>Carex utriculata</i> - <i>Carex aquatilis</i> marsh	
11.3a	1.14	Primary	Swamp	1.14	100	Ws05 (probable)	MacCalla's willow – Serviceberry willow - Beaked sedge swamp	<i>Salix maccalliana</i> – <i>Salix pseudomonticola</i> - <i>Carex utriculata</i> swamp	MSdw
11.3b	0.72	Primary	Marsh	0.72	100	Wm06	Great bulrush marsh	<i>Schoenoplectus acutus</i> marsh	MSdw
12	2.44	Primary	Transitional/Successional Marsh-Fen	2.05	84	Wm01-Wf01	Successional Beaked sedge - Water sedge marsh / Water sedge - Beaked sedge fen	Successional <i>Carex utriculata</i> - <i>Carex aquatilis</i> marsh / <i>Carex aquatilis</i> - <i>Carex utriculata</i> fen	MSdw
		Secondary	Marsh	0.27	11	Wm05	Common cattail marsh	<i>Typha latifolia</i> marsh	
		Tertiary	Shallow water	0.12	5	Ww Pondweed	Pondweed shallow water	<i>Potamogeton</i> shallow water	
13	8.84	Primary	Swamp	4.86	55	Ws05 (probable)	MacCalla's willow – Serviceberry willow - Beaked sedge swamp	<i>Salix maccalliana</i> – <i>Salix pseudomonticola</i> - <i>Carex utriculata</i> swamp	MSdw
		Secondary	Transitional/Successional Marsh-Fen	2.03	23	Wm01-Wf01	Successional Beaked sedge - Water sedge marsh / Water sedge - Beaked sedge fen	Successional <i>Carex utriculata</i> - <i>Carex aquatilis</i> marsh / <i>Carex aquatilis</i> - <i>Carex utriculata</i> fen	
		Tertiary	Fen	1.50	17	Wf01	Water sedge - Beaked sedge fen	<i>Carex aquatilis</i> - <i>Carex utriculata</i> fen	
		Quaternary	Shallow water	0.44	5	Ww	Yellow Pond-Lily or Pondweed (probable) shallow water	<i>Nuphar lutea</i> type or <i>Potamogeton</i> shallow water	
14	4.79	Primary	Swamp (treed)	1.83	39	Ws07.2 (Wm01)	Spruce – Horsetail – Soft-leaved sedge – Leafy moss swamp	<i>Picea engelmannii</i> x <i>glauca</i> - <i>Equisetum</i> spp. - <i>Mnium</i> spp. (<i>Mniaceae</i>) swamp	MSdw
		Secondary	Transitional/Successional Marsh-Fen	1.24	27	Wm01-Wf01	Successional Beaked sedge - Water sedge marsh / Water sedge - Beaked sedge fen	<i>Carex utriculata</i> - <i>Carex aquatilis</i> marsh / <i>Carex aquatilis</i> - <i>Carex utriculata</i> fen	
		Tertiary	Marsh	0.55	12	Wm07	Baltic rush marsh	<i>Juncus balticus</i> marsh	
		Quaternary	Alkaline/Saline meadow (transitional mineral)	0.54	12	Ga03\$	Field sedge (seral) Alkaline/saline meadow	<i>Carex praegracilis</i> (seral) Alkaline/saline meadow	

Wetland Site ID	Estimated Wetland Area (ha)	Complex Component	Wetland Class	Wetland Complex Component Area (ha)	Estimated Area of Wetland Complex (% Total)	BC Wetland Classification	English Name	Scientific Name	Biogeoclimatic Zone
		Quinary	Alkaline/Saline meadow (transitional mineral)	0.38	8	Ga02\$ (probable)	Nuttall's alkaligrass – foxtail barley (seral) Alkaline/saline meadow	<i>Puccinellia nuttalliana</i> - <i>Hordeum jubatum</i> (seral) Alkaline/saline meadow	
		Senary	Marsh	0.10	2	Wm15 (probable)	Bluejoint - Beaked sedge marsh	<i>Calamagrostis canadensis</i> - <i>Carex utriculata</i> marsh	
15	2.59	Primary	Marsh	2.56	99	Wm01	Beaked sedge - Water sedge marsh	<i>Carex utriculata</i> - <i>Carex aquatilis</i> marsh	MSdw
		Secondary	Shallow water	0.03	1	Ww	Ww site association undetermined; very small portion of open water in flooded marsh	Ww site association undetermined	
16	2.44	Primary	Marsh	1.78	73	Wm01	Beaked sedge - Water sedge marsh	<i>Carex utriculata</i> - <i>Carex aquatilis</i> marsh	MSdw
		Secondary	Marsh	0.56	23	Wm06	Great bulrush deep marsh	<i>Schoenoplectus acutus</i> marsh	
		Tertiary	Marsh	0.05	2	Wm05	Common cattail marsh	<i>Typha latifolia</i> marsh	
		Quaternary	Shallow water	0.05	2	Ww Muskgrass	Muskgrass shallow water	<i>Chara</i> sp. shallow water	
16a	1.63	Primary	Swamp (treed)	1.63	100	Ws07.2	Spruce - Horsetail - Leafy moss (Hybrid white spruce - Horsetails - Soft-leaved sedge - Leafy mosses)	<i>Picea engelmannii</i> / <i>glauca</i> - <i>Equisetum</i> spp. - <i>Carex disperma</i> - <i>Mnium</i> spp. (Mniaceae)	MSdw
17	0.67	Primary	Marsh	0.63	95	Wm01	Beaked sedge - Water sedge marsh	<i>Carex utriculata</i> - <i>Carex aquatilis</i> marsh	MSdw
		Secondary	Shallow water	0.03	4	Ww Muskgrass	Muskgrass shallow water	<i>Chara</i> sp. shallow water	
		Tertiary	Marsh	0.01	1	Wm04	Common spike-rush herbaceous vegetation marsh	<i>Eleocharis palustris</i> herbaceous vegetation marsh	
18	0.10	Primary	Shallow water	0.07	69	Ww anthropogenic	Shallow water (anthropogenic)	Unknown	MSdw
		Secondary	Marsh	0.02	20	Wm01	Beaked sedge - Water sedge marsh	<i>Carex utriculata</i> - <i>Carex aquatilis</i> marsh	
		Tertiary	Marsh	0.01	11	Wm05	Common cattail marsh	<i>Typha latifolia</i> marsh	
19	0.02	Primary	Marsh	0.02	100	Wm01	Beaked sedge – Water sedge marsh	<i>Carex utriculata</i> – <i>Carex aquatilis</i> marsh	MSdw
20	0.61	Primary	Marsh	0.30	50	Wm15	Bluejoint - Beaked sedge marsh	<i>Calamagrostis canadensis</i> - <i>Carex utriculata</i> marsh	MSdw
		Secondary	Marsh	0.30	50	Wm01	Beaked sedge - Water sedge marsh	<i>Carex utriculata</i> - <i>Carex aquatilis</i> marsh	
21	2.82	Primary	Marsh	0.93	33	Wm01	Beaked sedge - Water sedge marsh	<i>Carex utriculata</i> - <i>Carex aquatilis</i> marsh	ESSFdk1
		Secondary	Shallow water	0.93	33	Ww	Undetermined - recent beaver dam pond; no aquatic vegetation	Undetermined - recent beaver dam pond	
		Tertiary	Swamp (treed)	0.56	20	Ws07.1	Spruce - Horsetail - Leafy moss treed swamp	<i>Picea engelmannii</i> x <i>glauca</i> - <i>Equisetum</i> spp. - <i>Mnium</i> spp. (Mniaceae) swamp	
		Quaternary	Swamp	0.20	7	Ws04 (probable)	Drummond's willow – beaked sedge swamp	<i>Salix drummondiana</i> – <i>Carex utriculata</i> swamp	
		Quinary	Floodplain	0.20	7	F105 (probable)	Drummond's willow – bluejoint reedgrass Flood Association	<i>Salix drummondiana</i> - <i>Calamagrostis canadensis</i> Flood Association	
22	0.69	Primary	Swamp	0.62	90	Ws03	Bebb's willow – Bluejoint swamp	<i>Salix bebbiana</i> - <i>Calamagrostis Canadensis</i> swamp	MSdw
		Secondary	Transitional/Successional Marsh-Fen	0.07	10	Wm01-Wf01	Successional Beaked sedge - Water sedge marsh / Water sedge - Beaked sedge fen	<i>Carex utriculata</i> - <i>Carex aquatilis</i> marsh / <i>Carex aquatilis</i> - <i>Carex utriculata</i> fen	

FIGURE 6a
Wetland Classification of Surveyed Wetland Ecosystems



WL12		
Wetland Class	BC Wetland Classification	Area
Transitional/Successional Marsh-Fen	Wm01 / Wf01	2.05 ha (84%)
Marsh	Wm05 (Blue Listed)	0.27 ha (11%)
Shallow Water	Ww Pondweed	0.12 ha (5%)

WL13		
Wetland Class	BC Wetland Classification	Area
Swamp	Ws05 (probable)	4.86 ha (55%)
Transitional/Successional Marsh-Fen	Wm01 / Wf01	2.03 ha (23%)
Fen	Wf01	1.50 ha (17%)
Shallow water	Ww	0.44 ha (5%)

WL20		
Wetland Class	BC Wetland Classification	Area
Marsh	Wm15	0.30 ha (50%)
Marsh	Wm01	0.30 ha (50%)

WL11.3		
Wetland Class	BC Wetland Classification	Area
Marsh	Wm06 (Blue Listed)	0.39 ha (50%)
Marsh	Wm01	0.39 ha (50%)

WL11.3b		
Wetland Class	BC Wetland Classification	Area
Marsh	Wm06	0.72 ha (100%)

WL11.3a		
Wetland Class	BC Wetland Classification	Area
Swamp	Ws05 (probable)	1.14 ha (100%)

WL11.1		
Wetland Class	BC Wetland Classification	Area
Marsh	Wm01	0.11 ha (54%)
Shallow Water	Ww Yellow pond-lily Type	0.10 ha (46%)

WL11.2		
Wetland Class	BC Wetland Classification	Area
Shallow water	Ww Muskgrass	0.43 ha (49%)
Marsh	Wm01	0.36 ha (41%)
Marsh	Wm05 (Blue Listed)	0.06 ha (7%)
Shallow Water	Ww White Water-Buttercup	0.03 ha (3%)

LEGEND

- Surveyed Wetland Ecosystem
- Blue-Listed Site Association
- Terrestrial Local Study Area
- Project Footprint
- Local/Resource Roads
- Watercourse



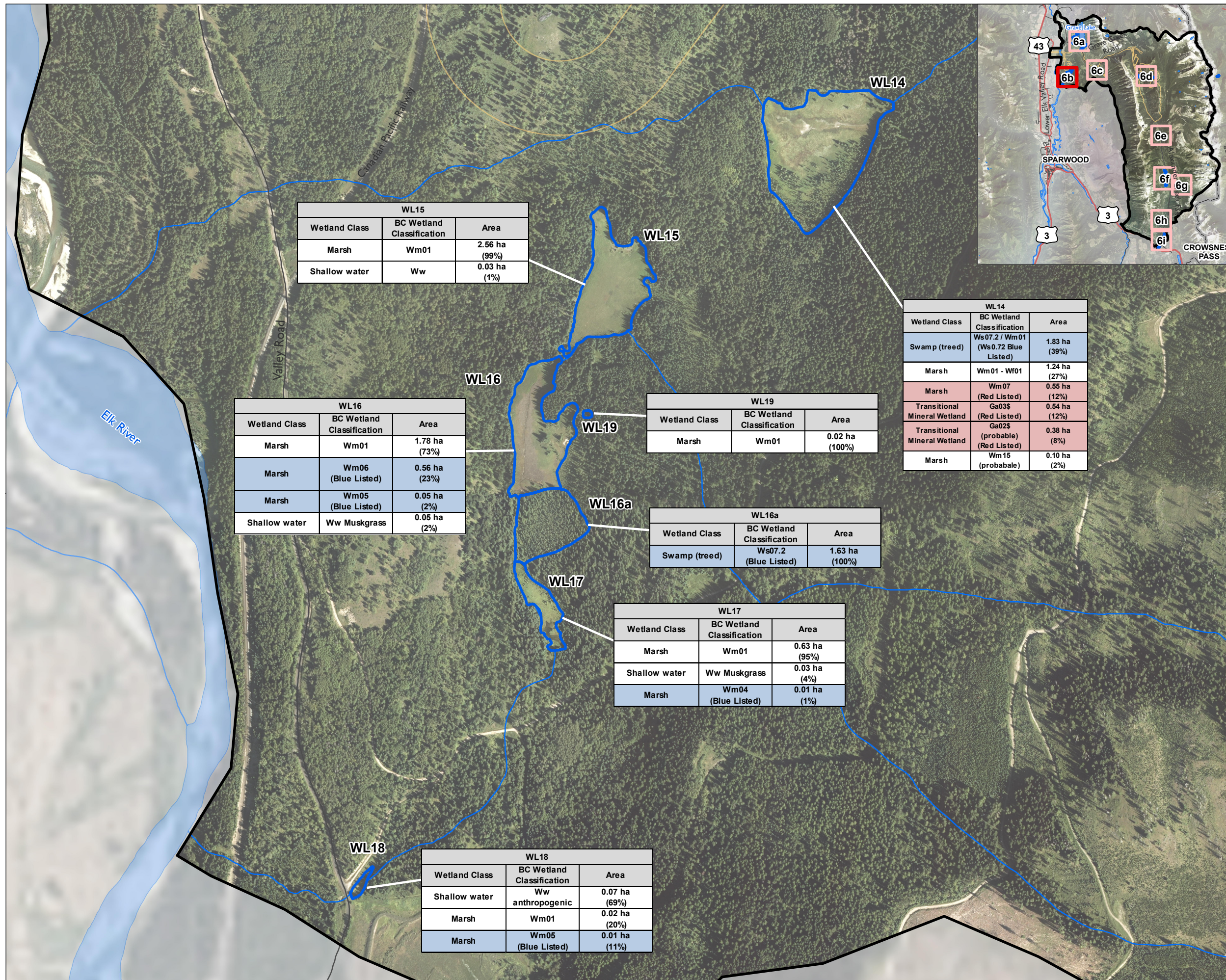
Map Drawing Information: Data Provided by Province of British Columbia, NWP Coal Canada Ltd., Dillon Consulting Limited

Map Created By: JFC/LMM
Map Checked By: LKD
Map Projection: NAD 1983 UTM Zone 11N



PROJECT: 12-6231
STATUS: FINAL
DATE: 2021-08-24

FIGURE 6b
Wetland Classification of Surveyed Wetland Ecosystems



WL15		
Wetland Class	BC Wetland Classification	Area
Marsh	Wm01	2.56 ha (99%)
Shallow water	Ww	0.03 ha (1%)

WL14		
Wetland Class	BC Wetland Classification	Area
Swamp (treed)	Ws07.2 / Wm01 (Ws07.2 Blue Listed)	1.83 ha (39%)
Marsh	Wm01 - Wf01	1.24 ha (27%)
Marsh	Wm07 (Red Listed)	0.55 ha (12%)
Transitional Mineral Wetland	Ga03\$ (Red Listed)	0.54 ha (12%)
Transitional Mineral Wetland	Ga02\$ (probable) (Red Listed)	0.38 ha (8%)
Marsh	Wm15 (probabale)	0.10 ha (2%)

WL16		
Wetland Class	BC Wetland Classification	Area
Marsh	Wm01	1.78 ha (73%)
Marsh	Wm06 (Blue Listed)	0.56 ha (23%)
Marsh	Wm05 (Blue Listed)	0.05 ha (2%)
Shallow water	Ww Muskgrass	0.05 ha (2%)

WL19		
Wetland Class	BC Wetland Classification	Area
Marsh	Wm01	0.02 ha (100%)

WL16a		
Wetland Class	BC Wetland Classification	Area
Swamp (treed)	Ws07.2 (Blue Listed)	1.63 ha (100%)

WL17		
Wetland Class	BC Wetland Classification	Area
Marsh	Wm01	0.63 ha (95%)
Shallow water	Ww Muskgrass	0.03 ha (4%)
Marsh	Wm04 (Blue Listed)	0.01 ha (1%)

WL18		
Wetland Class	BC Wetland Classification	Area
Shallow water	Ww anthropogenic	0.07 ha (69%)
Marsh	Wm01	0.02 ha (20%)
Marsh	Wm05 (Blue Listed)	0.01 ha (11%)

LEGEND

- Surveyed Wetland Ecosystem
- Blue-Listed Site Association
- Red-Listed Site Association
- Terrestrial Local Study Area
- Project Footprint
- Local/Resource Roads
- Watercourse
- Waterbody



Map Drawing Information: Data Provided by Province of British Columbia, NWP Coal Canada Ltd., Dillon Consulting Limited

Map Created By: JFC/LMM
Map Checked By: LKD
Map Projection: NAD 1983 UTM Zone 11N

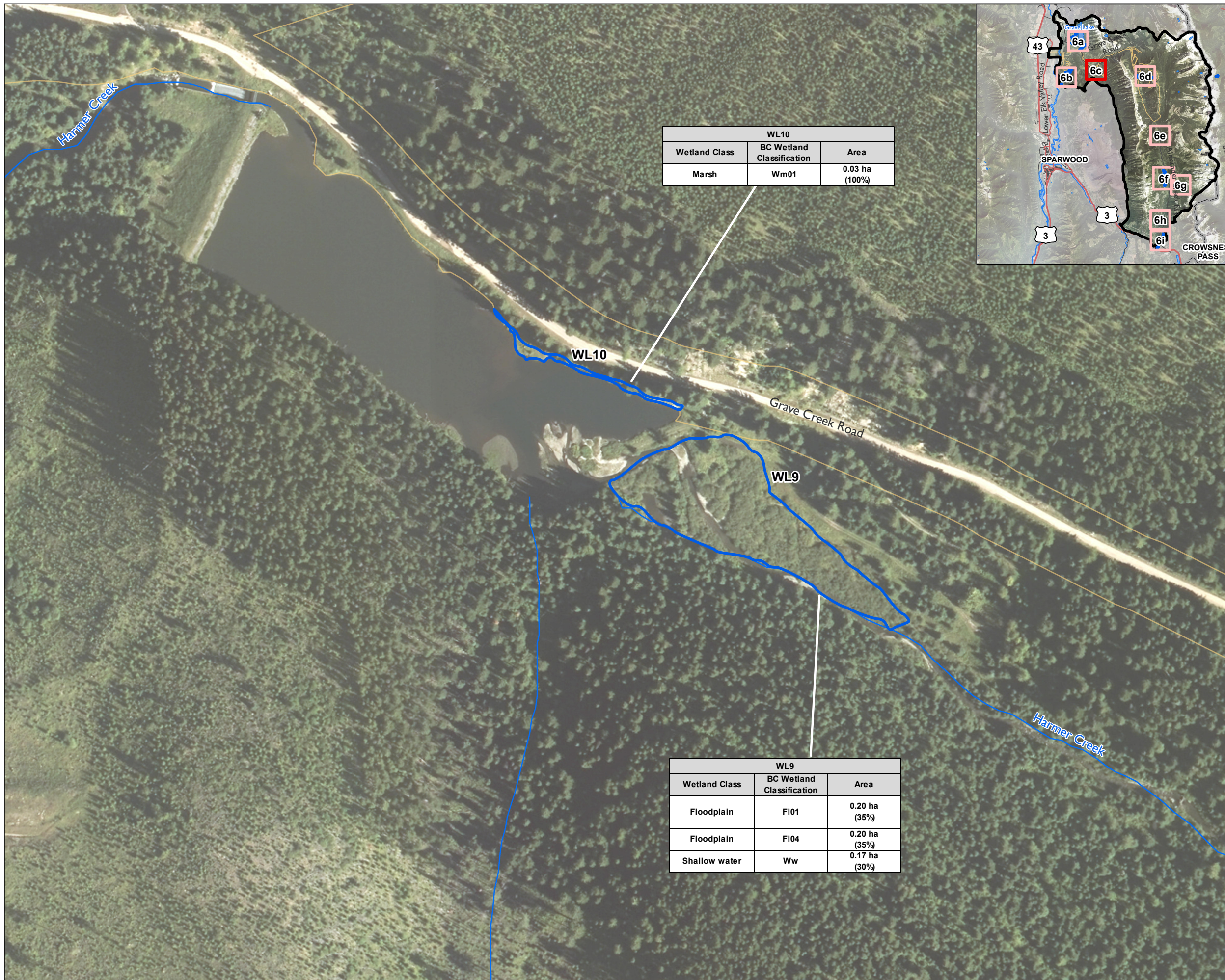


PROJECT: 12-6231
STATUS: FINAL
DATE: 2021-08-23

FIGURE 6c
Wetland Classification of Surveyed Wetland Ecosystems

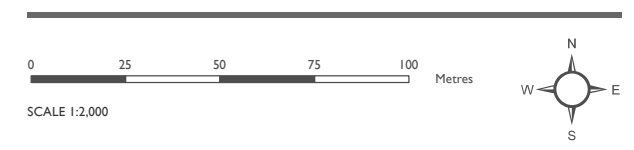
LEGEND

-  Surveyed Wetland Ecosystem
-  Terrestrial Local Study Area
-  Project Footprint
-  Watercourse



WL10		
Wetland Class	BC Wetland Classification	Area
Marsh	Wm01	0.03 ha (100%)

WL9		
Wetland Class	BC Wetland Classification	Area
Floodplain	FI01	0.20 ha (35%)
Floodplain	FI04	0.20 ha (35%)
Shallow water	Ww	0.17 ha (30%)



Map Drawing Information: Data Provided by Province of British Columbia, NWP Coal Canada Ltd., Dillon Consulting Limited





Map Created By: JFC/LMM
Map Checked By: LKD
Map Projection: NAD 1983 UTM Zone 11N

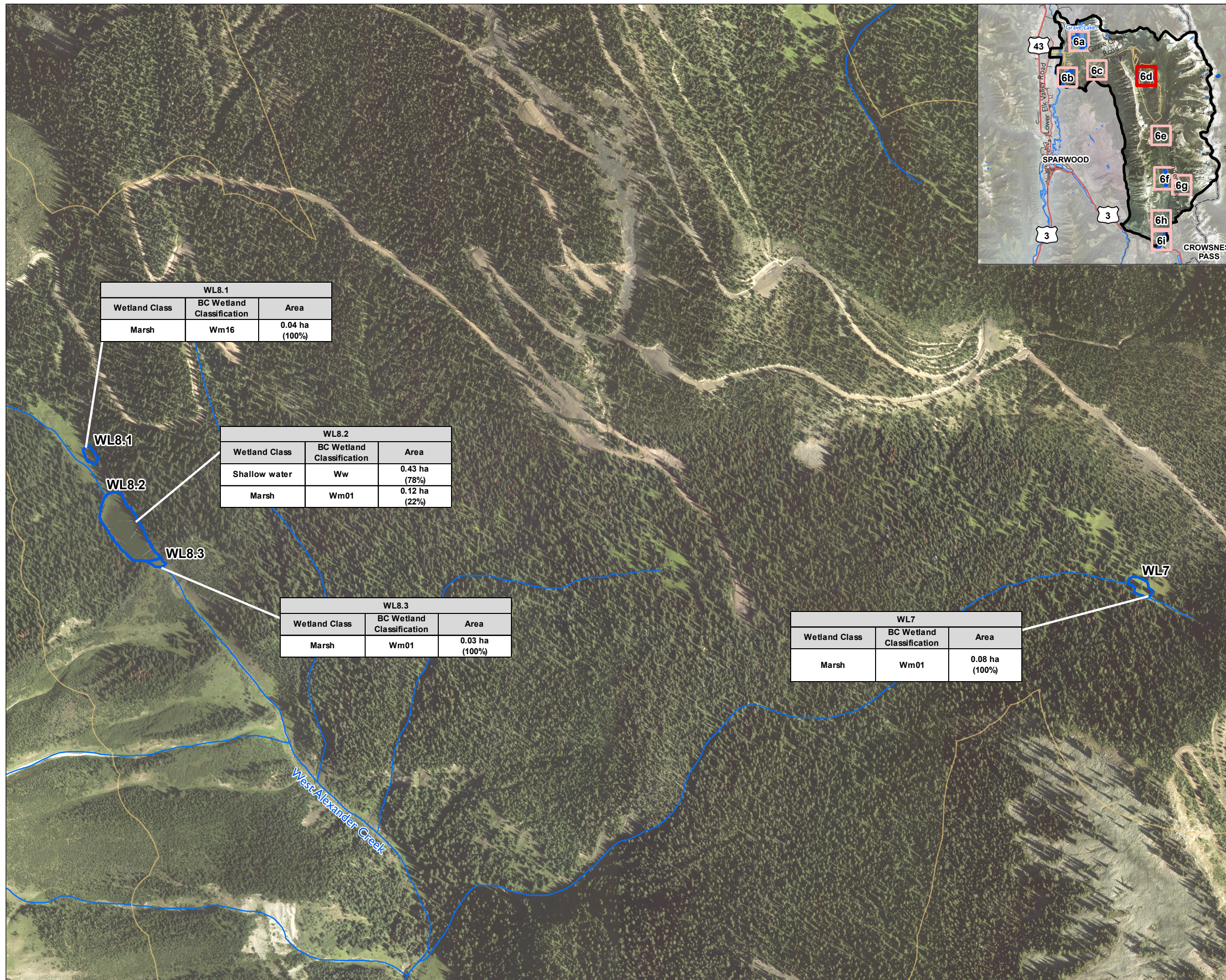


PROJECT: 12-6231
STATUS: FINAL
DATE: 2021-08-23

FIGURE 6d
Wetland Classification of Surveyed Wetland Ecosystems

LEGEND

-  Surveyed Wetland Ecosystem
-  Terrestrial Local Study Area
-  Project Footprint
-  Watercourse



WL8.1		
Wetland Class	BC Wetland Classification	Area
Marsh	Wm16	0.04 ha (100%)

WL8.2		
Wetland Class	BC Wetland Classification	Area
Shallow water	Ww	0.43 ha (78%)
Marsh	Wm01	0.12 ha (22%)

WL8.3		
Wetland Class	BC Wetland Classification	Area
Marsh	Wm01	0.03 ha (100%)

WL7		
Wetland Class	BC Wetland Classification	Area
Marsh	Wm01	0.08 ha (100%)



SCALE 1:6,000



Map Drawing Information: Data Provided by Province of British Columbia, NWP Coal Canada Ltd., Dillon Consulting Limited

Map Created By: JFC/LMM
Map Checked By: LKD
Map Projection: NAD 1983 UTM Zone 11N

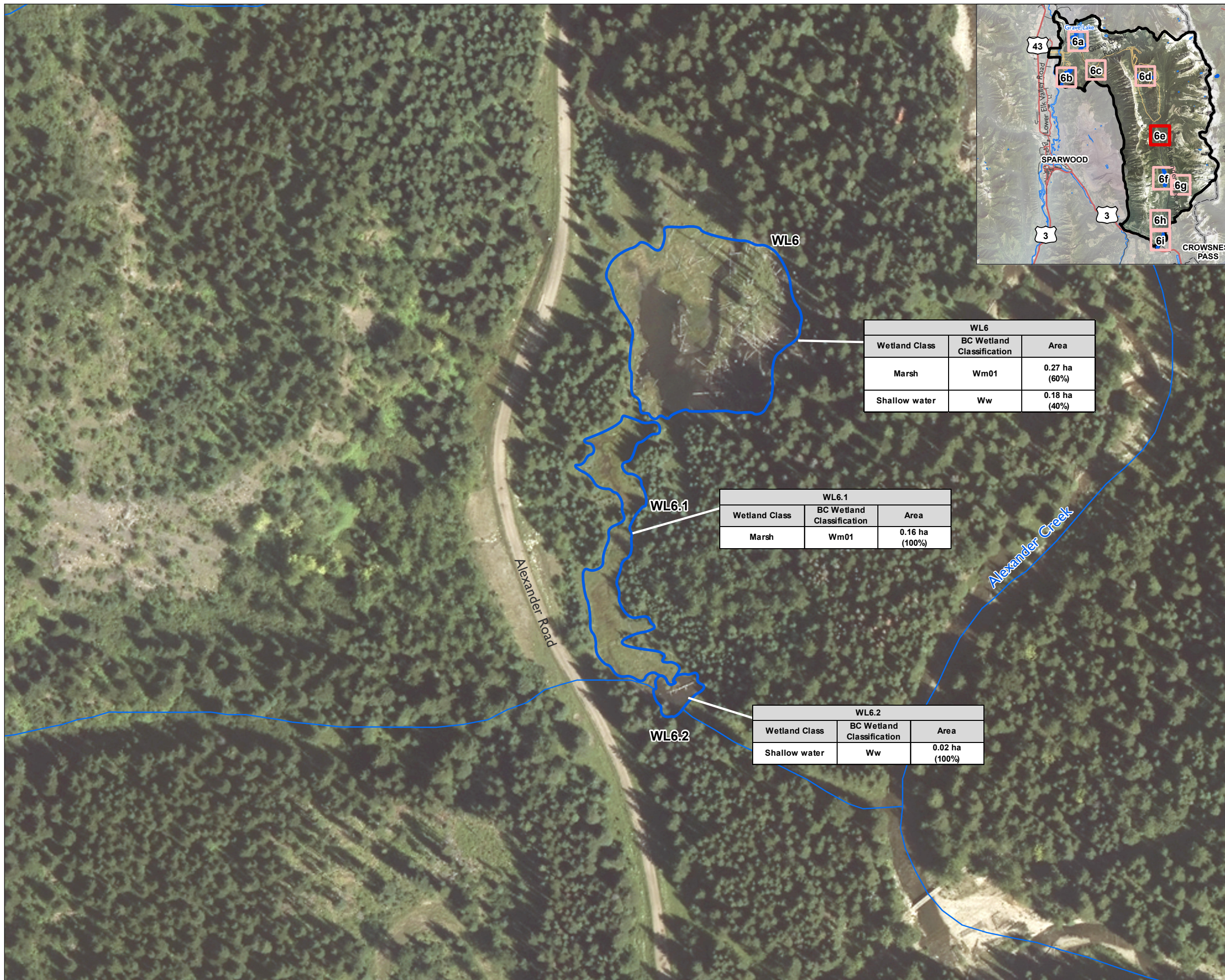


PROJECT: 12-6231
STATUS: FINAL
DATE: 2021-08-23

FIGURE 6e
Wetland Classification of Surveyed Wetland Ecosystems

LEGEND

- Surveyed Wetland Ecosystem
- Terrestrial Local Study Area
- Project Footprint
- Watercourse



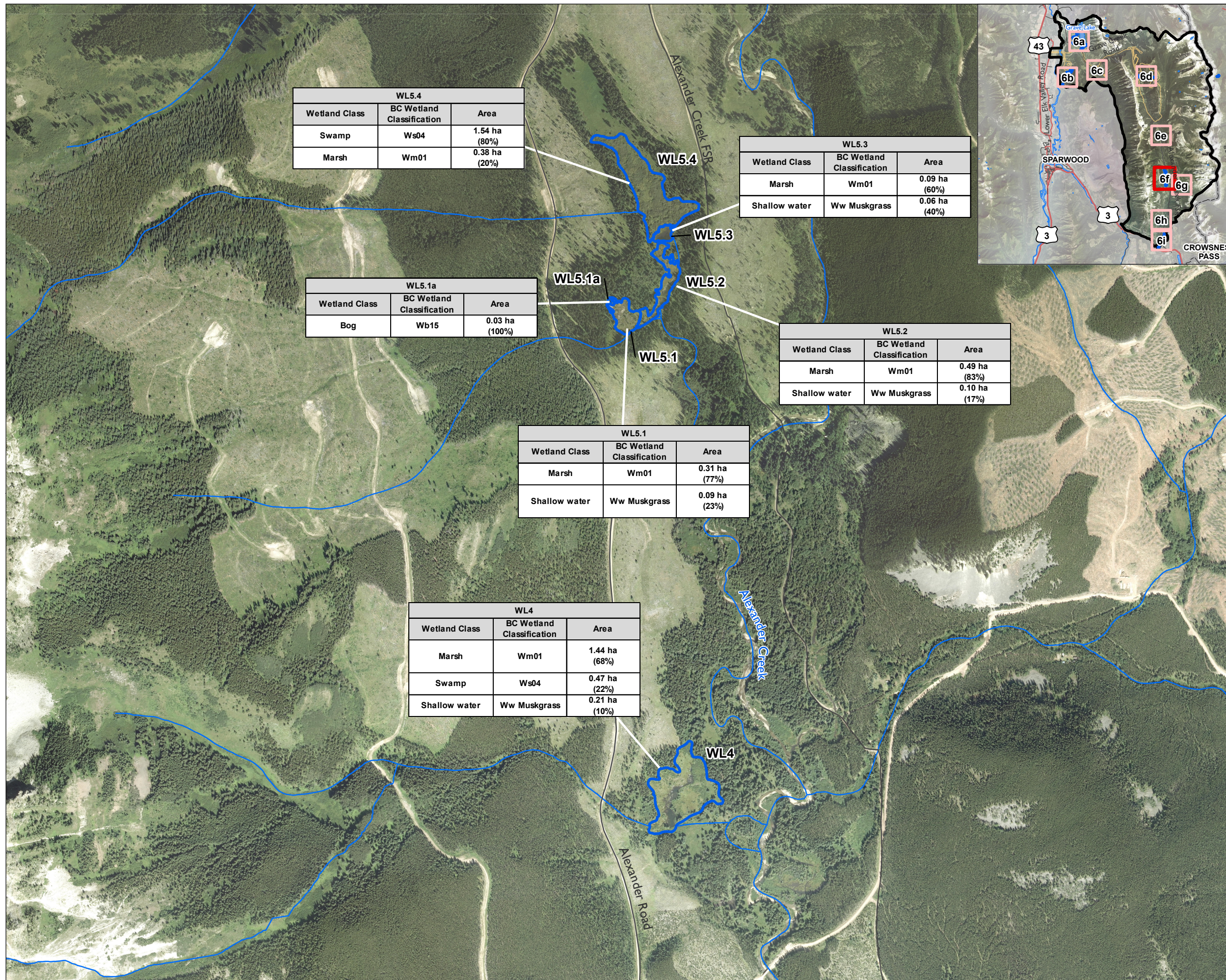
Map Drawing Information: Data Provided by Province of British Columbia, NWP Coal Canada Ltd., Dillon Consulting Limited

Map Created By: JFC/LMM
Map Checked By: LKD
Map Projection: NAD 1983 UTM Zone 11N



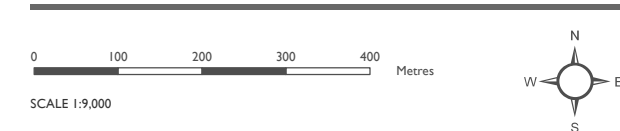
PROJECT: 12-6231
STATUS: FINAL
DATE: 2021-08-23

FIGURE 6f
Wetland Classification of Surveyed Wetland Ecosystems



LEGEND

- Surveyed Wetland Ecosystem
- Terrestrial Local Study Area
- Project Footprint
- Local/Resource Roads
- Watercourse



Map Drawing Information: Data Provided by Province of British Columbia, NWP Coal Canada Ltd., Dillon Consulting Limited







Map Created By: JFC/LMM
Map Checked By: LKD
Map Projection: NAD 1983 UTM Zone 11N

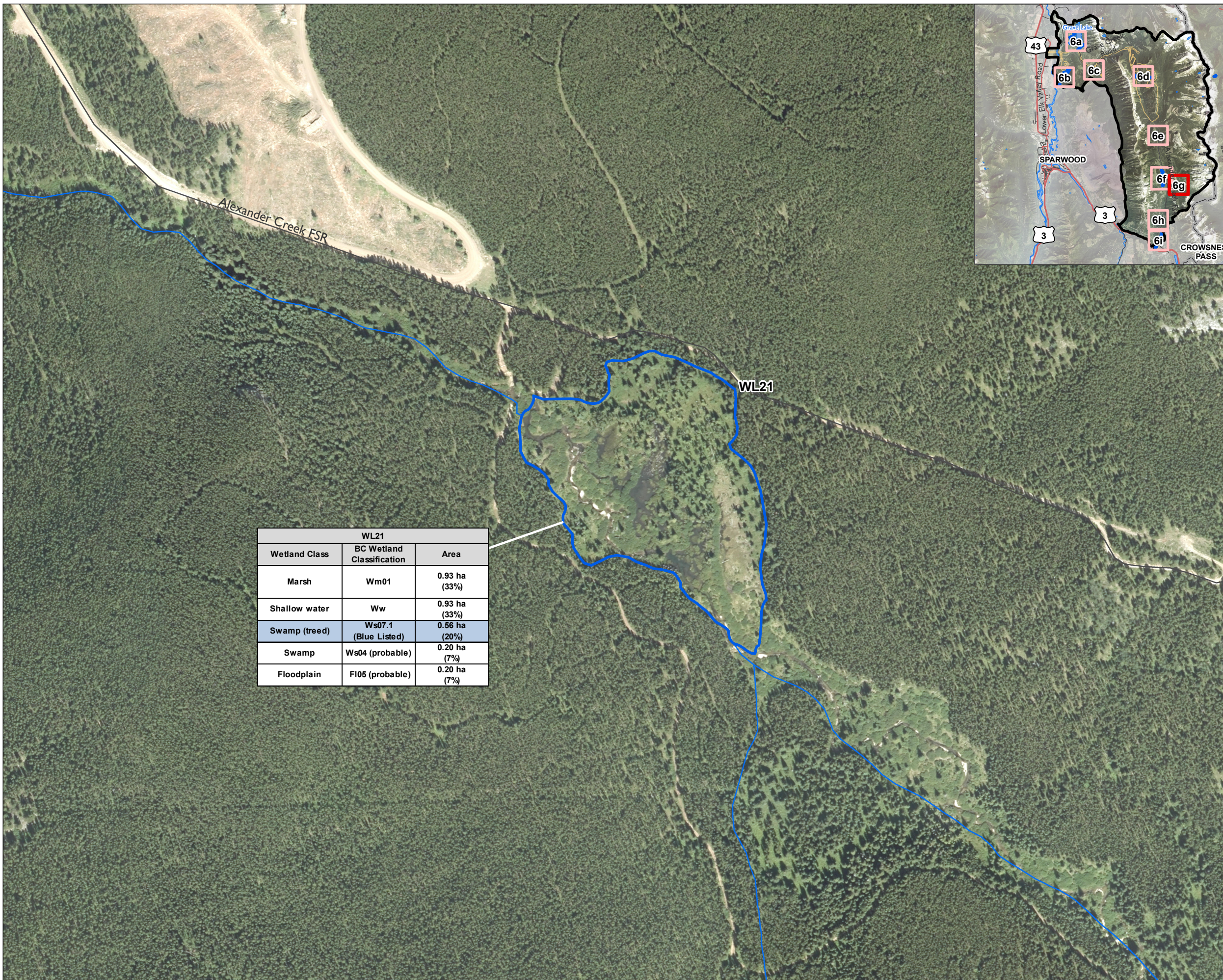


PROJECT: 12-6231
STATUS: FINAL
DATE: 2021-08-23

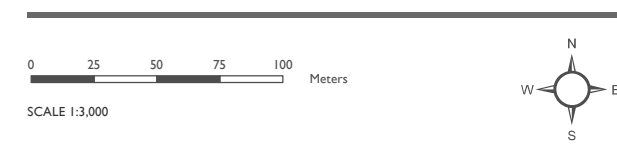
FIGURE 6g
Wetland Classification of Surveyed Wetland Ecosystems

LEGEND

-  Surveyed Wetland Ecosystem
-  Blue-Listed Site Association
-  Terrestrial Local Study Area
-  Project Footprint
-  Local/Resource Roads
-  Watercourse



WL21		
Wetland Class	BC Wetland Classification	Area
Marsh	Wm01	0.93 ha (33%)
Shallow water	Ww	0.93 ha (33%)
Swamp (treed)	Ws07.1 (Blue Listed)	0.56 ha (20%)
Swamp	Ws04 (probable)	0.20 ha (7%)
Floodplain	FI05 (probable)	0.20 ha (7%)



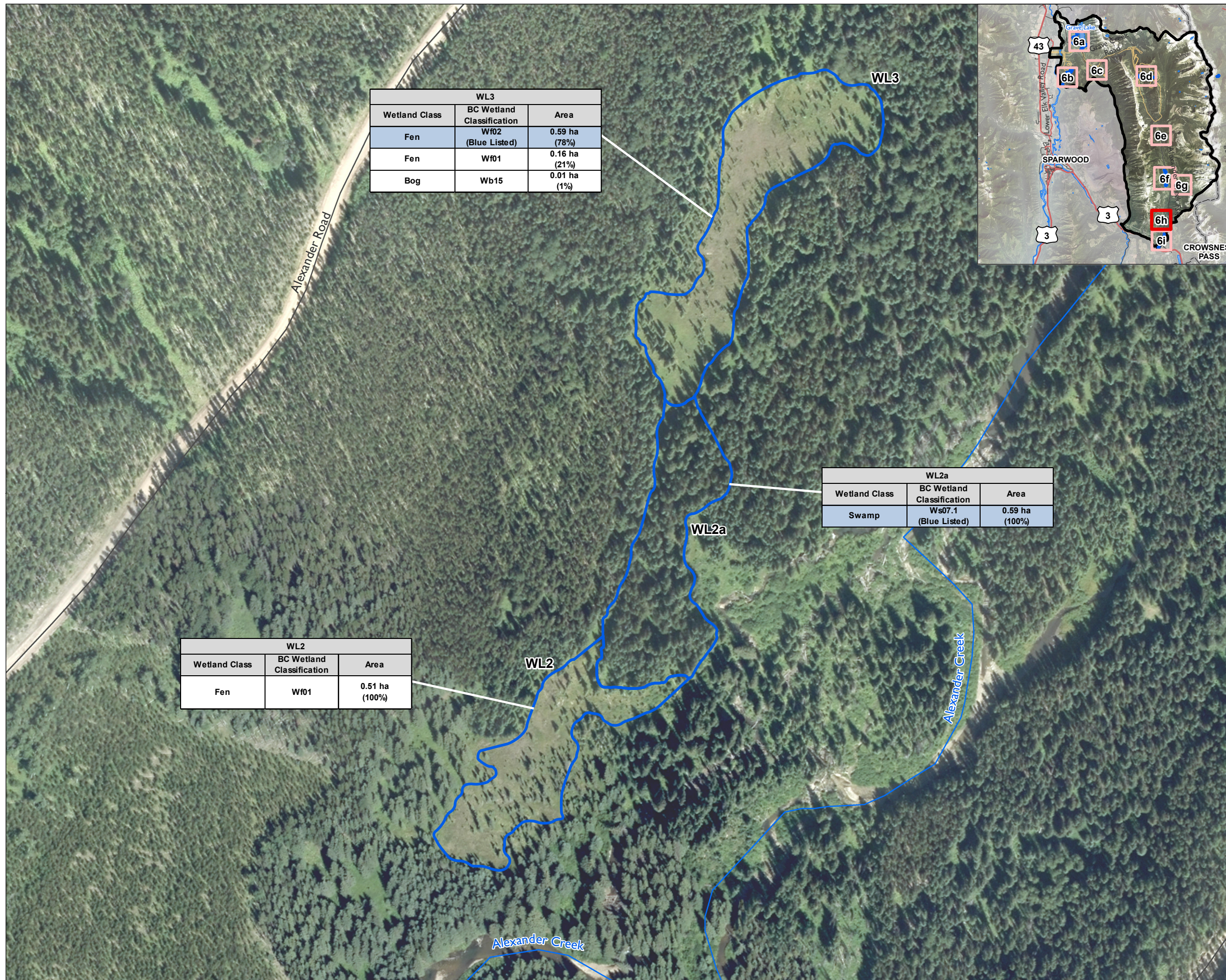
Map Drawing Information: Data Provided by Province of British Columbia, NWP Coal Canada Ltd., Dillon Consulting Limited

Map Created By: JFC/LMM
Map Checked By: LKD
Map Projection: NAD 1983 UTM Zone 11N



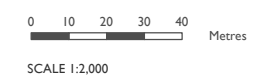
PROJECT: 12-6231
STATUS: FINAL
DATE: 2021-08-23

FIGURE 6h
Wetland Classification of Surveyed Wetland Ecosystems



LEGEND

- Surveyed Wetland Ecosystem
- Blue-Listed Site Association
- Terrestrial Local Study Area
- Project Footprint
- Local/Resource Roads
- Watercourse



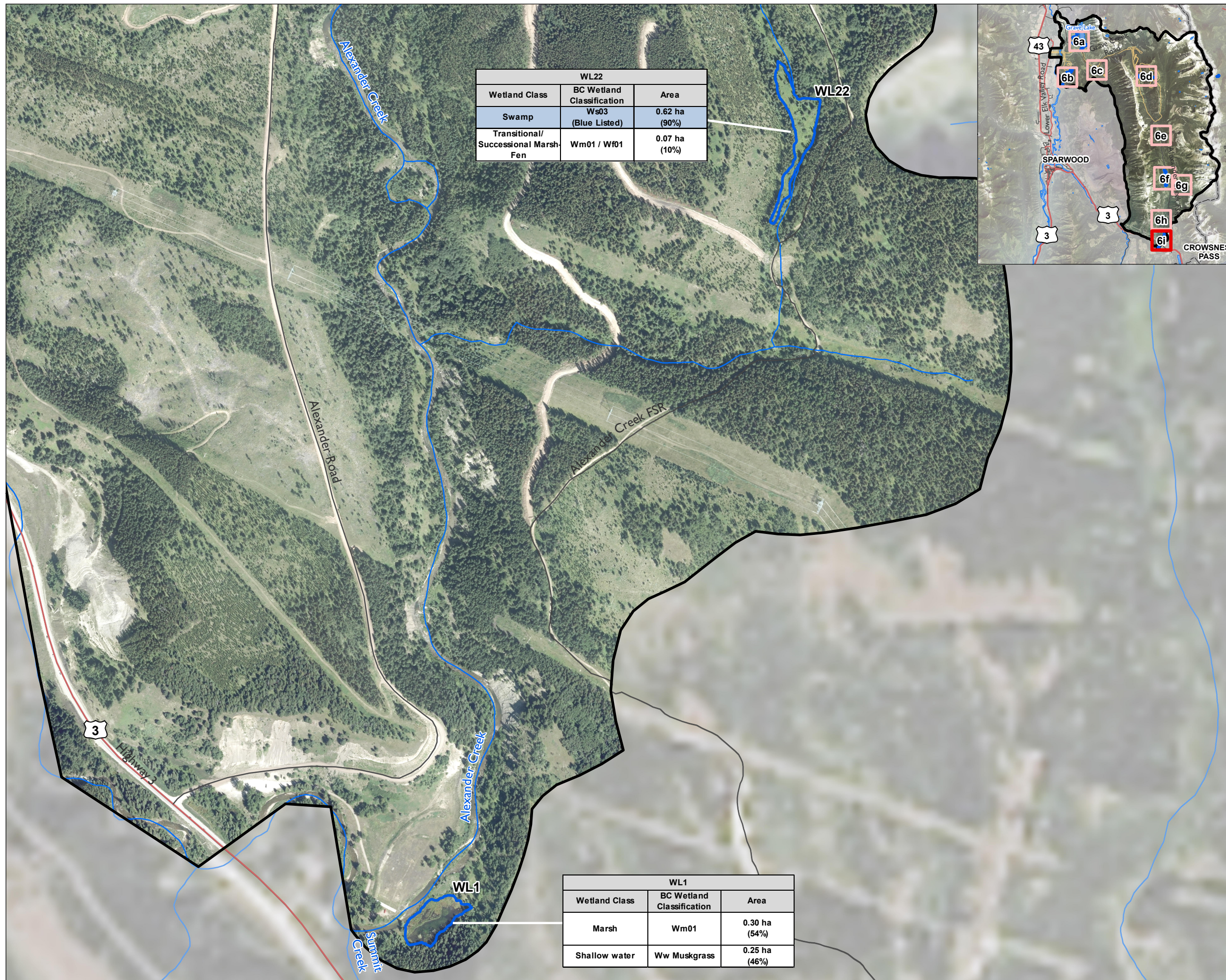
Map Drawing Information: Data Provided by Province of British Columbia, NWP Coal Canada Ltd., Dillon Consulting Limited

Map Created By: JFC/LMM
Map Checked By: LKD
Map Projection: NAD 1983 UTM Zone 11N



PROJECT: 12-6231
STATUS: FINAL
DATE: 2021-08-23

FIGURE 6i
Wetland Classification of Surveyed Wetland Ecosystems



WL22		
Wetland Class	BC Wetland Classification	Area
Swamp	Ws03 (Blue Listed)	0.62 ha (90%)
Transitional/ Successional Marsh- Fen	Wm01 / Wf01	0.07 ha (10%)

WL1		
Wetland Class	BC Wetland Classification	Area
Marsh	Wm01	0.30 ha (54%)
Shallow water	Ww Muskgrass	0.25 ha (46%)

LEGEND

- Surveyed Wetland Ecosystem
- Blue-Listed Site Association
- Terrestrial Local Study Area
- Project Footprint
- Highways
- Local/Resource Roads
- Watercourse

0 50 100 150 200 Metres

SCALE 1:6,500



Map Drawing Information: Data Provided by
Province of British Columbia, NWP Coal Canada Ltd.,
Dillon Consulting Limited

Map Created By: JFC/LMM
Map Checked By: LKD
Map Projection: NAD 1983 UTM Zone 11N



PROJECT: 12-6231
STATUS: FINAL
DATE: 2021-08-24

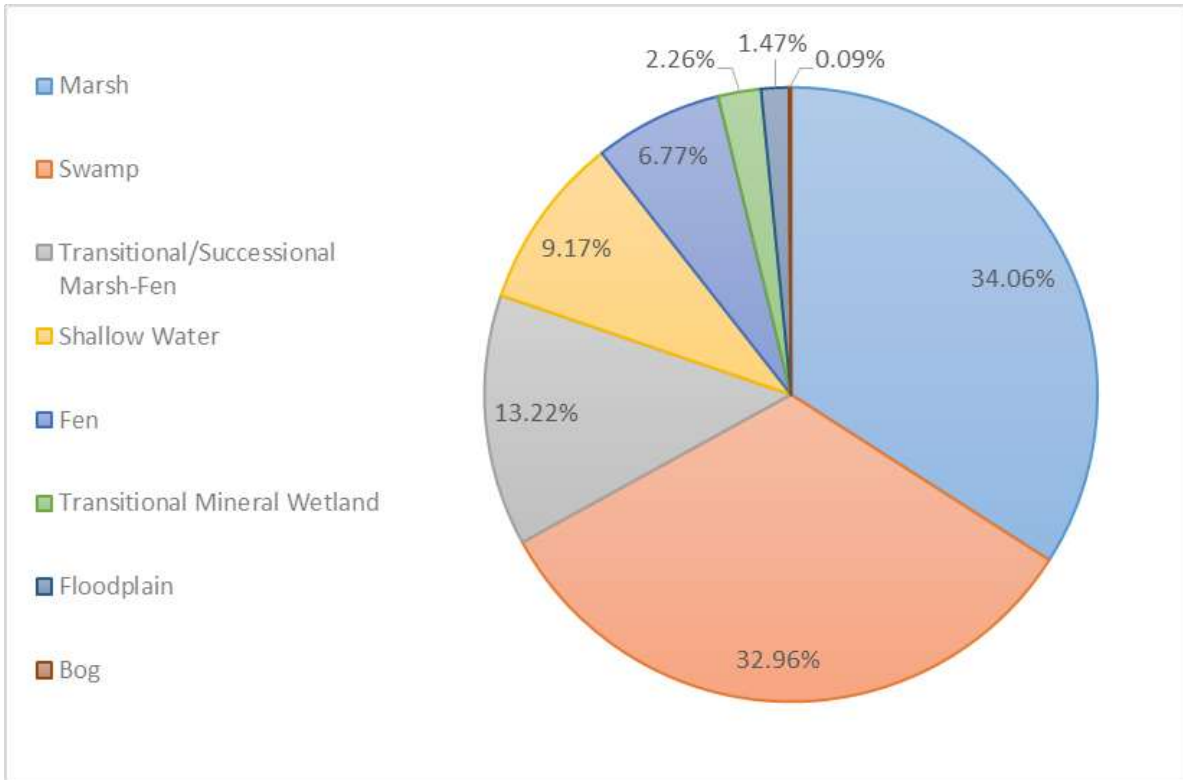


Figure 7. Composition of Wetland Classes and Non-wetland Groups Surveyed in the LSA

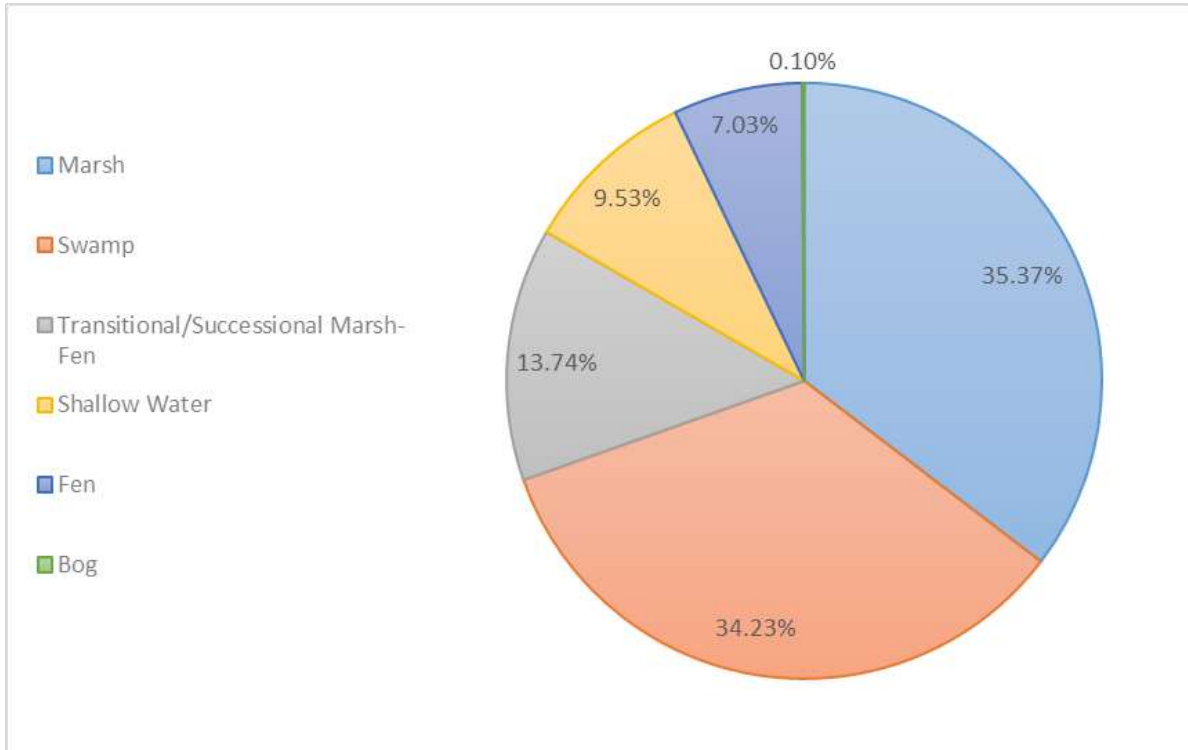


Figure 8. Composition of Wetland Classes Surveyed in the LSA

4.3.1 Bog Wetlands

A bog is a wetland of organic soils (peat) that receives no nutrients from groundwater and supports *Sphagnum* moss as its dominant vegetation (MacKenzie and Moran, 2004). Bogs typically have a pH less than five (Keddy, 2010). *Sphagnum* moss is usually associated with acidic and low nutrient conditions. Some species have a greater tolerance for a broad range of conditions while others are narrowly suited to specific conditions and as such, different species occupy different locations in fens and bogs and are useful in wetland characterization. *Sphagnum* may also develop in hummocks, effectively isolating it from alkaline groundwater and creating a microhabitat that primarily receives water from rainfall. In one wetland (WL3) small hummocks of *Sphagnum* formed around stunted spruce (SxW) in a fen (pH 7.52) dominated by a calcicolous wetland moss.

Vegetation in bogs grows very slowly and lacks diversity because of high acidity, prolonged saturation, and low temperature. Bogs of the LSA provide negligible forage for large mammals and limited opportunities for birds; however, they may support small mammals and probably support unique assemblages of arthropods (MacKenzie and Moran, 2004) infrequent or rare in the landscape.

Bogs occupy the smallest area of all the major wetland classes observed in the LSA (0.04 ha or 0.09%) (Table 3) and were observed in only two of 36 wetlands surveyed (sites WL3 and WL5.1a) (Photo 1 and Photo 2). They occurred as small “islands” at the base of small spruce at site WL3 (Figure 6h) and along the west and northwest edges of site WL5.1 (Figure 6f). Site WL3 is in a broad drainage basin at the base of a slope on the upper bench of and far removed from, Alexander Creek while site WL5.1a is located at the toe of a slope adjacent to site WL5. Despite differences in plant species (bryophytes and vascular plants) and landscape position, the bogs of both sites WL3 and WL5a were given the same wetland site association, *Wb15 Spruce – Labrador tea – Peat moss* (MacKillop et al., 2018). The fens of site WL3 may eventually succeed to bog as peat deepens and isolates mineral-rich groundwater. Although this represents the most common pathway of succession, some fens will persist in the right conditions (MacKenzie and Moran, 2004).

Table 3. Area, Occurrence, and Conservation Status of Bog Site Associations in the LSA

Bog Site Association	Total Wetland Area (ha)	Occurrence of Bog Wetlands within LSA	Conservation Status (B.C. List)
Wb15 Spruce – Labrador tea – Peat-moss	0.04	WL3 WL5.1a	Not ranked



Photo 1. Wb15 along edge of site WL5.1a (July 8, 2019)



Photo 2. Bog (Wb15) around base of stunted spruce in site WL3 (July 9, 2019)

4.3.2 Fen Wetlands

A fen is a wetland of permanently saturated organic soils (peat) that receives nutrients from groundwater and supports sedges, grasses, and brown mosses as its dominant vegetation (MacKenzie and Moran, 2004; Keddy, 2010). Fens have a pH greater than six (Keddy, 2010). Brown mosses common in fen wetlands includes species of *Scorpidium*, *Drepanocladus*, *Warnstorfia*, and *Tomentypnum nitens* (MacKenzie and Moran, 2004; Keddy, 2010). Floristically, the graminoid fens within the LSA are, in most cases, very similar to the marshes observed since beaked sedge and water sedge are the main plants of each. In fens, water sedge is typically more abundant than beaked sedge, and in marshes, beaked sedge is more abundant although this, as a rule, does not always hold. Soils in fens consist of mesic to fibric peat greater than 40 cm while the peat in marshes is finer (humic to mesic) and usually less than 40 cm. The presence of *Scorpidium cossonii*, a “brown moss” and typical fen species, with water sedge and beaked sedge in WL3, further supported its determination as fen.

Fens were confirmed at three of 36 wetlands surveyed in the LSA (2.76 ha or 6.77%). Two types of fens were observed in the LSA, the *Wf01 Water sedge – Beaked sedge* and the *Wf02 Scrub birch – Water sedge* (**Table 4**). It should be noted here that these refer to wetlands where Wf01 occurred as the sole or dominant graminoid site association. Wf01 also occurred with *Wm01 Beaked sedge – Water sedge* marsh in three other wetlands in such a manner that it was impossible to delineate the boundaries of each without extensive study. These Wm01-Wf01 wetlands are discussed in **Section 4.3.6**. Wf01 was the most common fen association and was found in all three of the wetlands with fens (sites WL2, WL3, and WL13) and found in basins along broad drainage channels (**Figure 6h** and **Figure 6a**). Wf01 is the most common and widespread fen site association in B.C. (MacKenzie and Moran, 2004). The Wf01 association may develop from the marsh association, *Wm01 Beaked sedge – Water sedge*. Wf01 may succeed to a bog association (MacKenzie and Moran, 2004). Wf02 was less common in the LSA and only found in the southern portion of site WL3 in an area of transition to the adjacent treed swamp at WL2a (**Figure 6h**). Wf02 is Blue-listed provincially and was only observed at site WL3.

Fens are generally known to occur across a wide variety of hydrologic conditions. Those dominated by sedges, which include the two site associations found in the LSA, are most tolerant of hydrological changes and are the most common associations in B.C. (MacKenzie and Moran, 2004); however, prolonged or permanent changes to water levels, such as from draining or impoundment, will result in the replacement of an existing wetland site associations by another (MacKenzie and Moran, 2004). The fens of WL2 and WL3 support unique assemblages of species and wetland site associations, including the Blue-listed moss *Scorpidium cossonii* at WL2 (**Photo 3**), and the Blue-listed fen association, Wf02 at WL3 (**Photo 4**). The fens of WL2 and WL3 are likely sensitive to change as they also support a unique assemblage of species, such as the Blue-listed Wf02 at WL3.

The value of fens to wildlife is generally moderate but varies considerably between groups of taxa. Wildlife use of fens varies considerably. Fens may not be important to a great variety of wildlife, but they may be important to some wildlife that are not widely distributed. MacKenzie and Moran (2004)

consider fens moderate producers of forage for ungulate and poor producers for bear. Fens are frequented by small mammals, including shrew and voles, and fens with extensive moss cover, such as sites WL2 and WL3, may support unique arthropod communities (MacKenzie and Moran, 2004). Wilson's snipes, recorded in the LSA, may nest, forage and take shelter in the graminoid fens. Bats, flycatchers, and swallows may benefit from the openings and abundant flying insects, especially in those fens with open water¹¹.

Table 4. Area, Occurrence, and Conservation Status of Fen Site Associations in the LSA

Fen Site Associations	Total Wetland Area (ha)	Occurrence of Fen Wetlands within LSA	Conservation Status (B.C. List)
Wf01 Water sedge – Beaked sedge	2.17	WL2, WL3, WL13	Yellow
Wf02 Scrub birch – Water sedge	0.59	WL3	Blue
Total	2.76		



Photo 3. Wf01 at site WL2 (July 29, 2018)

¹¹ In the LSA, fens with open water were found in the large transitional Wm01-Wf01 wetland complexes such as WL12 and WL13. The production of flying insects in fens with open water is presumed to be higher than that of fens without (MacKenzie and Moran, 2004).



Photo 4. Wf02 at site WL3 (July 9, 2019)

4.3.3 Marsh Wetlands

A marsh is a mineral wetland of emergent grass-like plants (sedges, rushes, and grasses) that is seasonally or permanently flooded (MacKenzie and Moran, 2004). Typically, plant communities in marsh wetlands have low diversity and are dominated by one or two plant species (MacKenzie and Moran, 2004). Marshes flood early each season and can remain flooded year-round; although many marshes can experience significant drawdown by mid- to late- summer, exposing wetland bottom substrates (MacKenzie and Moran, 2004). According to MacKenzie and Moran (2004), wildlife heavily use marsh wetlands given the presence of palatable vegetation, plankton, and aquatic invertebrates. As well, waterfowl and amphibians favour the cover, open water, and food sources that marsh wetlands provide.

Marshes make up the greatest area of all major wetland types recorded in the LSA (13.88 ha or 34.06%) and were found in the greatest number of wetlands surveyed (26 of 36). Marshes surveyed in the LSA included seven site associations (Table 5), the most common of which was *Wm01 Beaked sedge – Water sedge*, found in 22 of the 36 wetlands. *Wm01* constituted 10.82 ha or 77.95% of all marsh site associations observed and was typically present on the periphery of shallow water wetlands between open water and upland (e.g., sites WL5.3, WL8.2, and WL17; Photo 5). It is the most common and widespread marsh site association in British Columbia (MacKenzie and Moran, 2004). *Wm01* occurred in 14 of 18 wetlands with *Ww Shallow water* and is very common along sluggish channels of low-grade streams connecting abandoned beaver ponds (e.g., WL4, WL5.2, and WL11.2).

Table 5. Area, Occurrence, and Conservation Status of Marsh Site Associations in the LSA

Marsh Site Associations	Total Wetland Area (ha)	Occurrence of Marsh Wetlands within LSA	Conservation Status (B.C. List)
Wm01 Beaked sedge - Water sedge	10.82	WL1, WL4, WL5.1, WL5.2, WL5.3, WL5.4, WL6, WL6.1, WL7, WL8.2, WL8.3, WL10, WL11.1, WL11.2, WL11.3, WL15, WL16, WL17, WL18, WL19, WL20, WL21	Yellow
Wm04 Common Spike-rush herbaceous vegetation	0.01	WL17	Blue
Wm05 Common cattail	0.39	WL11.2, WL12, WL16, WL18,	Blue
Wm06 Great bulrush Deep Marsh	1.67	WL11.3, WL11.3b, WL16	Blue
Wm07 Baltic rush	0.55	WL14	Red
Wm15 Bluejoint reedgrass – Beaked sedge	0.40	WL14, WL20	Not ranked
Wm16 Bluejoint reedgrass - Arrow-leaved groundsel	0.04	WL8.1	Not ranked
Total	13.88		

In three of the 25 wetlands Wm01 occurred, it was observed in close association with the Wf01. In this report, this marsh-fen mixture is identified as a transitional association, Wm01-Wf01, although it may be more aptly described as successional since Wf01 usually develops from Wm01 (**Section 4.3.6**; MacKenzie and Moran, 2004). At site WL11.2, Wm01 was found in close association with *Wm05 Common cattail*, with Wm01 occupying 41% and Wm05 7% of the total area of this wetland (**Photo 6**).

Wm06 Great bulrush Deep Marsh, a provincially Blue-listed association, was observed at three wetland sites, sites WL11.3, WL11.3b, and WL16 and covered 1.67 ha or 12.03% of all marsh site associations observed in the LSA (**Figure 6a**). Soil cores at site WL16 revealed the presence of deep, coarsely mesic peat in the central area of hard-stemmed bulrush (*Schoenoplectus acutus*), suggesting that portions of this marsh might be fen (see **Section 4.3.6** for additional information; **Figure 6b**). The *Wm07 Baltic rush* marsh site association, a Red-listed association, occupied the third largest area of the marsh site associations, which constitutes only 0.55 or 3.96% of the area occupied by marsh, and occurred in only one wetland, site WL14 (**Figure 6b**).

Wm15 Bluejoint reedgrass – Beaked sedge marsh, which constitutes 0.40 ha in the LSA at sites WL14 and WL20, was observed in areas that appeared slightly drier than the nearby Wm01 (**Figure 6b**). The total area covered by *Wm05 Common cattail*, present in four wetlands, sites WL11.2, WL12, WL 16 and WL18, is an estimated 0.39 ha (**Figure 6a** and **Figure 6b**). Wm05 of sites WL11.2 and WL18 occur in channels, one of which (i.e., site WL18) was formed when water was impounded by a road and culvert. The other two Wm05 sites (e.g., sites WL12 and WL16) occur as small areas in large graminoid wetland complexes.

In site WL12, the Wm05 rings a small shallow water wetland while in site WL16, it forms a distinctive patch at the edge of the wetland complex. Wm05 is a Blue-listed association in B.C.

Two remaining site associations – *Wm04 Common spike-rush herbaceous vegetation* and *Wm16 Bluejoint reedgrass - Arrow-leaved groundsel* – were found at one wetland each, WL17 (0.01 ha) and WL8.1 (0.04 ha), respectively. Common spike-rush occurs in wet portions of other wetlands as scattered plants and small patches, too small to be considered Wm04 marsh site associations, but possibly indicative of developing Wm04 marshes. Wm16 is a drier site association often found between wetter portions of wetlands and upland coniferous forests (MacKillop et al., 2018), a condition that characterized site WL8.1, a small depression that is periodically and temporarily wetted by rainfall.

Of the marsh site associations documented in the LSA, four are currently listed as communities of conservation concern in British Columbia. Wm07 is Red-listed, and Wm04, Wm05 and Wm06 are Blue-listed. Wm15 and Wm16 have not been assigned conservation rankings (see **Section 4.5** for additional information).



Photo 5. Wm01 at site WL4 (September 13, 2019)



Photo 6. Wm05 near the north end of site WL11.2 (July 4, 2019)

4.3.4 Swamp Wetlands

A swamp is a wetland dominated by shrubs or trees rooted in mineral hydric soils (Keddy, 2010). Swamps are nutrient-medium to nutrient-rich with a well-developed herb-layer reflective of nutrient levels. Sedges are characteristic of nutrient-medium swamps, and ferns and forbs are characteristic of nutrient-rich swamps (MacKenzie and Moran, 2004). Swamps have high water tables and a varied microtopography of mounds supporting shrubs and trees unable to grow in the low areas of permanently or semi-permanently saturated soils.

Swamps occupy the second largest area of all wetland classes at 13.43 ha or 32.96% of the total wetland area observed in the LSA. Despite this large area, swamps were only found in nine of the 36 wetlands surveyed. Small areas of tall shrub on the edges of some wetlands were not included because of their small size and narrow configuration. Seven swamp site associations were observed across the wetlands surveyed in the LSA (see **Table 6**). The swamp association *Ws05 MacCalla's willow – Beaked sedge* occurred in two wetlands (i.e., WL11.3a and WL13) and occupied the largest area of all swamp wetland associations, totalling 6.00 ha or 51.72% of swamp surveyed. *Ws04 Drummond's willow – Beaked sedge* formed 2.20 ha 18.97% of all swamp wetland and was found at three sites, WL4, WL5.4, and WL21 (see **Figure 6f** and **Figure 6g**). *Ws03 Bebb's willow – Bluejoint*, a provincially Blue-listed wetland site association was found at only one wetland in the LSA and occupied 0.62 ha or 5.34% of all swamp surveyed.

Table 6. Area, Occurrence, and Conservation Status of Swamp Site Associations in the LSA

Swamp Site Associations	Total Wetland Area (ha)	Occurrence of Swamp Wetlands within LSA	Conservation Status (B.C. List)
Ws03 Bebb's Willow – Bluejoint	0.62	WL22	Blue
Ws04 Drummond's Willow – Beaked Sedge	2.20	WL4, WL5.4, and WL21	Not ranked
Ws05 MacCalla's Willow – Beaked Sedge	6.00	WL11.3a and WL13	Not ranked
Ws07.1 Spruce – Horsetail – Leafy Moss	1.15	WL2a and WL21	Blue
Ws07.2 Spruce – Horsetail – Soft-leaved sedge – Leafy moss	1.63	WL16a	Blue
Ws07.2 – Spruce – Horsetail – Leafy Moss - Spruce – Horsetail – Soft-leaved sedge – Leafy moss (Wm01 Beaked sedge – Water sedge Marsh)	1.83	WL14	Blue
Total	13.43		

Two site associations, Ws04 at WL21 and Ws05 at sites WL13 and WL11.3a, are considered probable classifications. At WL21, WL13, and WL11.3a, Ws04 and Ws05 associations assigned represent the closest site association match possible to the floristic assemblages presented in MacKenzie and Moran (2004) and MacKillop et al. (2018). Minor discrepancies are not uncommon for classifications intended to group wetlands that occur over a wide area and which are influenced by a varying set of climatic, site, hydrological, and edaphic features.

Two variations of the Blue-listed treed swamp site association *Ws07 Spruce – Horsetail – Leafy moss*, Ws07.1 and Ws07.2, together occupy the second largest area of swamp in the LSA and were found in four wetlands. *Ws07.1 Spruce – Horsetail – Leafy moss* was observed at sites WL2a (**Figure 6h; Photo 7**) and WL21 while *Ws07.2 Spruce – Horsetail – Soft-leaved sedge – Leafy moss* was observed at WL16a and WL14 (**Figure 6b**). Each variant was represented by shrubby swamp within a larger wetland complex and by a singular treed swamp, large and distinct from surrounding wetland site associations. The north portion of the treed swamp in WL14 is occupied by open canopy spruce with an understory predominantly of beaked sedge. The Ws07.2 community of WL14 is annotated with “(Wm01)” to indicate this distinction. These treed swamp site associations, Ws07.1 and Ws07.2, occupied the largest areas, 1.16 ha and 3.46 ha respectively, of any singular, non-complex wetland in the LSA. These associations are the only non-complex swamps of the nine observed.

Shrub-dominated swamps were found to occur in basins in the LSA (e.g., site WL5.4), and adjacent to lakes (Grave Lake; e.g., site WL11.3a), graminoid wetlands (site WL14), shallow waters (e.g., site WL4), and old floodplain back channels (site WL21). Two large, treed swamps occur between graminoid-

dominated wetlands along drainage ways (e.g., sites WL2a and WL16a). Spruce (SxW¹²) is the dominant tree of these swamps within the LSA. Lateral water flow, characteristic of many swamps (MacKenzie and Moran, 2004), was evident in the treed swamps within the LSA as small channels connecting the various wetlands along these broad drainage ways.

Swamps often have a shallow surface layer of woody peat (MacKenzie and Moran, 2004), as was observed at site WL5.4 in which the peat layer was variable but less than 20 cm and in the treed swamp of site WL2 for which the peat layer was 15 cm (**Photo 8**). Deep peat occasionally occurs in swamps (MacKenzie and Moran, 2004), and was present in the shrubby swamp of the large basin wetland at site WL13, where fibric peat was greater than 40 cm, and in the treed swamp of site WL16a where mesic peat was greater than 40 cm. Conditions at site WL13 are probably indicative of peatland subjected to hydrological change, while that of site WL16a suggests the input of oxygenated water (MacKenzie and Moran, 2004).

Swamps provide productive wildlife habitat for a wide range of organisms (MacKenzie and Moran, 2004). They provide food and shelter for birds, including migratory and breeding passerines and sapsuckers. Red-naped sapsucker drill-wells were a common sight on willows in swamps of the LSA. They provide herbaceous forage for bears, and shrubs for ungulates to forage on. WL13 and other wetlands with swamps showed heavy browsing on willow and red-osier dogwood by moose and elk.

Swamps often occur as smaller components of larger wetland classes (MacKenzie and Moran, 2004), which was apparent at four of the nine wetlands in the LSA which had swamps (i.e., WL5.4, WL13, WL21, and WL22). Note that WL11.3a was grouped with WL11.3 and WL11.3b since the three wetlands, and three composite wetland classes (two marshes and one swamp), constitute large portions of one contiguous wetland complex. The two treed swamps (WL2a and WL16a) are considered distinct wetlands, wetland entities rather than complexes.

¹² SxW = Engelmann spruce x white spruce hybrid (*Picea engelmannii* x *Picea glauca*)



Photo 7. Ws07.1 at site WL2a (July 9, 2019)



Photo 8. Ws04 at site WL5.4 (September 12, 2019)

4.3.5 Shallow Water Wetlands

Shallow water wetlands are permanently flooded wetlands supporting submerged or floating aquatic plants and may have grass-like plants with less than 10% cover (MacKenzie and Moran, 2004; MacKillop et al., 2018). These wetlands are often present at the edges of lakes. Water in these wetlands is still or slow-moving and ranges from 0.25 m to 5 m deep, although they are usually between 0.5 m to 2 m (MacKenzie and Moran, 2004; Keddy, 2010). Shallow water wetlands usually support simple plant communities with aquatic plant presence being closely tied to available light which is influenced by water clarity and depth (MacKenzie and Moran, 2004).

In the LSA, most shallow water wetlands are surrounded by sedge-dominated marshes, fens, and willow-dominated tall shrub swamps (e.g., sites WL4, WL12 and WL21; **Photo 9**). Many shallow water wetlands of the LSA are created by beaver and characteristics of each vary greatly with wetland age, whether beaver were still active and, if not, the length of time since beaver abandonment. Many beaver-created shallow waters are rimmed by marsh along the edges away from the dam (e.g., sites WL5.3 and WL11.2). Along the dam, the water is deep and soils are thin, marsh plants (i.e., graminoids) establish when the dam is further degraded.

Shallow water wetlands were observed at 18 of 36 wetland ecosystems surveyed. Shallow water cover 3.74 ha or 9.17% of the wetlands surveyed in the LSA and six shallow water site association were observed (**Table 7**). *Ww Muskgrass* shallow water wetland, observed in eight wetlands in the LSA, was the most abundant class of shallow water wetlands, occupying a total area of 1.22 ha or 32.62% of shallow water wetlands observed. The unclassified *Ww* shallow water category was observed at seven wetlands and occupied the largest area of shallow water at 2.20 ha or 58.82% of shallow water wetlands observed in the LSA. The other identified shallow water wetlands were found at only one wetland each in the LSA. *Ww White Water-Buttercup* was observed at WL11.2 covering just 0.03 ha along the series of beaver ponds and channels at site WL11.2. *Ww Yellow Pond-Lily* occupies a small area of 0.10 ha at site WL11.1 while *Ww Potamogeton* at 0.12 ha at site WL12 (**Figure 6a**; **Photo 10**). The *Ww Yellow Pond-Lily* shallow water describes a wetland (site WL11.1) where yellow pond-lily (*Nuphar variegata*) was not observed, but greater bladderwort (*Utricularia macrorhiza*), the other community constituent (MacKenzie and Moran, 2004), was abundant. WL18 was formed along a creek whose flow was impeded by a road crossing and culvert. Small marshes of common cattail and beaked rush have formed at the edges of the shallow water (**Figure 6a**).

Table 7. Area, Occurrence, and Conservation Status of Shallow Waters in the LSA

Shallow Water Site Associations	Total Wetland Area (ha)	Occurrence of Shallow Water Wetlands within LSA	Conservation Status (B.C. List)
Ww Muskgrass	1.22	WL1, WL4, WL5.1, WL5.2, WL5.3, WL11.2, WL16, and WL17	Not ranked
Ww Yellow Pond-Lily	0.10	WL11.1	Not ranked
Ww White Water-Buttercup	0.03	WL11.2	Not ranked
Ww Pondweed	0.12	WL12	Not ranked
Ww	2.20	WL6, WL6.2, WL8.2, WL9, WL13, WL15, and WL21	Not ranked
Ww anthropogenic	0.07	WL18	Not ranked
Total	3.74		

The macroalga or charophyte muskgrass (*Chara* sp.) of *Ww Muskgrass* grows in many shallow water wetlands of the LSA. This plant species is typical of sluggish waters with moderate to high alkalinity. The average pH of six muskgrass shallow water wetlands across the LSA was 7.8. Muskgrass uses bicarbonate for photosynthesis (MacKenzie and Moran, 2004) which produces calcium carbonate precipitate or marl. The presence and relative abundance of muskgrass algae and aquatic plants guided the naming of shallow water wetlands for the LSA. Provisional classifications are provided for wetlands whose shallow water portions could not be examined closely and those in which no aquatic plant dominated. These wetlands are simply referred to as shallow water or Ww, without a botanical descriptor.

MacKillop et al. (2018) recognize two shallow water class subgroups for East Kootenay, *Yellow pond-lily* and *Pondweed*, but no site associations. MacKenzie and Moran (2004) recognize some site associations under *Yellow pond-lily* and *Pondweed* types and recognize a separate *Muskgrass* shallow water ecosystem type. The B.C. CDC (2019) does not rank shallow water wetlands. Shallow water wetland are highly productive features that can sustain a great variety of animals, from invertebrates through fish, waterfowl, aerial insectivores (birds and bats), moose, beaver and muskrat (MacKenzie and Moran, 2004).



Photo 9. Ww Muskgrass and peripheral marsh of site WL4 (September 13, 2019)



Photo 10. Ww at site WL11.1 with marl-encrusted moss (*Drepanocladus longifolius*) (September 10, 2019)

4.3.6 Transitional Wetland Associations

As discussed previously, wetlands are usually a complex of a different wetland features or classes that are separate and occupy distinct areas. Between each wetland, however, are areas of transition. Some transitional areas are narrow and abrupt, but often they occur over an area in which characteristics of each is blended gradually so there is no distinct boundary. It is important to understand these transition areas for restoration when plant prescriptions should reflect the differences that may favour species more tolerant, or intolerant, of certain conditions such as shade, temperature, and drainage. Occasionally, distinct communities develop and persist between two very different communities such as the alkaline/saline meadows that develop between wetlands and uplands under specific conditions contributed by both.

Saline meadows occur in transition zones between wetlands and uplands and are usually inundated for brief periods after which the water level drops below the rooting zone, the soils dry, salts concentrate, and alkaline conditions develop (MacKillop et al., 2018). Plants characteristic of these sites – usually grasses, sedges and rushes – are tolerant of flooding, salt and alkali (MacKenzie and Moran, 2004). Alkaline/saline meadows provide good forage and are heavily used by livestock (MacKenzie and Moran, 2004).

Two transitional mineral wetland site associations, classed as alkaline/saline meadows in east Kootenay, were observed within the LSA: Ga02\$ *Nuttall's alkaligrass – Foxtail barley (seral) Alkaline/Saline Meadow* site association and Ga03\$ *Field sedge (seral) Alkaline/Saline Meadow*. Ga02 and Ga03 often occur next to wetlands (in this case, Wm07) and are considered transitional sites between wetland and terrestrial units.

Ga02\$ occurs over 0.38 ha at wetland site WL14 (**Figure 6a; Photo 11**). Ga02\$ occurs in an elevated linear feature along a broad, shallow drainage channel at the north end of the wetland complex and is the only known occurrence of this site association in the LSA. It is not known from the MSdw biogeoclimatic subzone but listed by MacKillop et al. (2018) as only occurring in the IDF biogeoclimatic zone. At site WL14, this transitional mineral association showed heavy grazing and trampling by ungulates, presumably elk, cattle or both (**Photo 12**). Ga02 is Red-listed in B.C. and considered very uncommon in the East Kootenay (MacKillop et al., 2018) and Ga02\$ retains this conservation status rank (Emily Cameron, pers. comm.). WL14 ecology is likely influenced by fluctuations in moisture conditions, with snow melt early in the season, followed by seasonal precipitation events and eventual evaporation due to the wetland's expose to sun and wind.

Only one of the two graminoids that characterize Ga02 in other areas of the province was observed in the Ga02\$. Foxtail barley was present; however, Nuttall's alkaligrass (*Puccinellia nuttalliana*) was not observed. Kentucky bluegrass was present.

Ga03\$ occurs along a very gentle slope between Ga02\$ and Wm07 to the south. It is drier and supports a greater abundance (cover) and diversity of native and introduced species than the Ga02\$. The sparse vegetation of Ga02\$ yields to increasing cover of Baltic rush which eventually grades into Wm07 which is dominated by Baltic rush with common silverweed (*Potentilla anserina* ssp. *anserina*). Like the Ga02\$, which lacked the characteristic grass of Ga02 communities elsewhere, no field sedge (*Carex praegracilis*), the defining species of this Ga03 elsewhere in the province, was observed in WL14. Another alkali-tolerant sedge, Sartwell's sedge (*Carex sartwellii*) was recorded and possibly replaces field sedge in this region of the province.

Another site association considered transitional represents a presumed successional, temporal transition from one wetland class to another rather than a transitional class representing the spatial zone of gradation between two distinct units. This wetland is found in areas where *Wm01 Beaked sedge – Water sedge* marshes co-occur with *Wf01 Water sedge – Beaked sedge* fens. These units may represent ecologically successional sites where *Wm01 Beaked sedge – Water sedge marshes* is changing to *Wf01 Water sedge – Beaked sedge* (Wm01-Wf01) as sedge peat accumulates. Therefore, this report refers to them as Wm01-Wf01, which reflects the likely process, the transitioning or succeeding of one site association to another (**Table 8**). The co-occurrence of these units may also represent disturbance patterns which may have resulted from mineral soil deposition or the removal of organic soils or moisture through changes in hydrology.

The Wm01-Wf01 successional site associations usually occur separately in different wetlands of the LSA; however, there were some instances (e.g., sites WL12 and WL13) where the transitional Wm01-Wf01 occurred together in the same graminoid wetland and were virtually indistinguishable but for differing soil characteristics (**Figure 6a**). The co-occurrence of Wm01-Wf01 could represent two separate wetland site associations that will persist and remain superficially indistinct, or it may represent a successional wetland in which the Wm01 is succeeding to Wf01 fen. Beaked sedge-water sedge marshes (Wm01) usually develop into water sedge-beaked sedge fens (Wf01) (MacKenzie and Moran, 2004) and as such, this transition has been documented as a transitional/successional association. Wm01-Wf01 covers 5.39 ha of the wetlands surveyed in the LSA. Like its component wetlands (i.e., Wm01 and Wf01), the Wm01-Wf01 transition is of low floristic and structural diversity but it provides forage and cover for many animals, and a productive source of insects for birds and bats.

The process by which Wm01-Wf01 are developing or have developed is unknown; however, the following observations were made:

- Marsh (Wm01) tends to occur on the periphery of the wetlands where the depression or basin – and peat depth – is shallower;
- Marsh (Wm01) and fen (Wf01) occur intermixed in some central portions of the wetlands and may reflect topographical variation, succession, or both; and

- Sampling in WL14 suggests graminoid marsh (Wm01) is the dominant feature and fen (Wf01) is a minor component; however, we have chosen to classify this as Wm01-Wf01 based on the presence of fen.

Table 8. Area, Occurrence, and Conservation Status of Transitional Associations in the LSA

Transitional Site Associations	Total Wetland Area (ha)	Occurrence of Transitional Associations within LSA	Conservation Status (B.C. List)
Ga02\$ Nuttall's alkaligrass – Foxtail barley (seral) Alkaline/Saline Meadow	0.38	WL14	Red
Ga03\$ Field sedge (seral) Alkaline/Saline Meadow	0.54	WL14	Red
Wm01-Wf01 – Beaked sedge-Water sedge – Water sedge-Beaked sedge	5.39	WL12, WL13, WL14, and WL22	Yellow
Total	6.31		



Photo 11. Nuttall's alkaligrass – Foxtail barley (seral) alkaline/saline meadow wetland at site WL14, early season (May 4, 2018)



Photo 12. *Ga02* Nuttall's alkaligrass – Foxtail barley (seral) alkaline/saline meadow at site WL14, late season (September 11, 2019).



Photo 13. *Ga03* Field sedge (seral) alkaline/saline meadow at site WL14, late season (September 11, 2019).

4.3.7 Ephemeral Wetlands

Ephemeral wetlands are wetlands in depressions or impoundments that receive and retain water periodically and temporarily before drying out. Most wetlands of the LSA are large enough to experience drawdown and drying. Water drawdown usually occurs on the wetland's periphery, while other portions, usually more central, can remain wet because they lie in the deeper part of a basin, a depression, or have areas of deeper peat. The normal drawdown of marshes as the season progresses could be result in a marsh being mistaken for an ephemeral marsh (Mitsch and Gosselink, 2007).

Two of the smallest wetlands surveyed in the LSA, sites WL8.1 and WL19, were observed to dry out in the summer and fall. Both are marshes that differed markedly in soils, plants, and landscape position. Site WL8.1 is the uppermost wetland in a broad open valley in the higher reaches of West Alexander Creek (**Figure 6d**). It has a very thin veneer of peat and supports a rather sparse cover of grass (approximately 15%). It is the only *Wm16 Bluejoint-Arrow-leaved groundsel* marsh observed in the LSA. WL8.1 has an estimated area of 0.04 ha which is only 0.003 % of total surveyed marsh (**Photo 14**).

WL19 is very small, depressional Wm01 marsh of approximately 0.02 ha in the forest east of WL16 (**Figure 6a; Photo 15**). It is an isolated basin marsh (CWCS, 1997) with no inflow or outflow channels. Beaked sedge is the characteristic plant, with creeping buttercup and lousewort (*Pedicularis* sp.) also present within the ephemeral area. Both sites WL8.1 and WL19 are included in the general discussion of marsh wetlands (**Section 4.3.3**). Marshes may be a common form of ephemeral wetlands in the LSA because of their thin layer of fine-textured peat.

Ephemeral wetlands are valuable to amphibians that use them in early season for breeding and move into terrestrial environments after metamorphosis from larvae to juveniles. A calling Wilson's snipe led to the discovery of WL19. The small size of ephemeral wetlands, their undistinguished features, and isolation from other watercourses and waterbodies can contribute to a presumed lack of detection during surveys.



Photo 14. Ephemeral Wm16 at site WL8.1 (July 26, 2018)



Photo 15. Ephemeral Wm01 at site WL19, in forest (September 11, 2019)

4.3.8 Flood Associations

Although considered a site association by MacKenzie and Moran (2004), flood associations are not wetlands, they are riparian ecosystems along creeks and adjacent to waterbodies that flood regularly. Flood associations occur on coarse, well-drained soils of fluvial materials such as sand, gravel and silt (MacKenzie and Moran, 2004). The vegetation that defines them reflects their topographic position, so shrub-dominated floodplains (willow and dogwood) occur in low positions (low bench), deciduous forests (black cottonwood) occur on higher sites (middle bench), and coniferous forests (spruce) occur on the highest sites (high bench). Within the LSA, it was observed that beavers play an important role in the floodplains where they alter floodplain features and create wetlands along low-volume and high-volume watercourses.

Floodplain ecosystems were identified at two wetland complexes in LSA, specifically along high-volume watercourses at site WL9 and site WL21 (**Table 9**). Site WL9 supports flood associations along a series of braided channels and beaver dams southeast of WL10 and the reservoir along Harmer Creek (**Figure 6c**). At site WL21, floodplain associations are similarly distributed along channels and beaver ponds where a creek (adjacent to Deadman Pass) expands over a broad portion of the otherwise narrow valley (**Figure 6g**).

Table 9. Area, Occurrence, and Conservation Status of Floodplain Associations in the LSA

Floodplain Associations	Total Floodplain Area (ha)	Occurrence of Associations within LSA	Conservation Status (B.C. List)
FI01 Mountain alder – Common horsetail low bench flood ecosystem	0.20	WL9	not ranked
FI04 Sitka willow – Red-osier dogwood – Horsetail low bench flood ecosystem	0.20	WL9	not ranked
FI05 Drummond’s willow – Bluejoint low bench flood ecosystem	0.20	WL21	not ranked
Total	0.60		

At site WL9, two flood associations, *FI01 Mountain alder – Common horsetail* and *FI04 Sitka willow – Red-osier dogwood – Horsetail*, cover approximately 0.40 ha of 0.57 ha, 70% of the wetland complex (**Photo 16**). At WL21, the *FI05 Drummond’s willow – bluejoint reedgrass Flood Association* was estimated to be 0.20 ha, approximately 7% of the wetland complex. The ecosystems with floodplain associations at WL9 and WL21 are anticipated to change frequently due to shifting channel morphology and beaver activity, and may contribute to or succeed to swamp associations where channels and ponds become isolated from major flows and associated scouring and mineral deposition.

Floodplains have great vertical and horizontal structural heterogeneity that provide habitat for a variety of animals (MacKenzie and Moran, 2004). Changing channels and variable flows create conditions beneficial to plants and animals. The flood associations create productive habitat for aerial insectivores

such as flycatchers and swallows. The ever-changing conditions create pockets of degradation and rejuvenation. A juvenile Northern Goshawk was observed flying across and perching in the middle of site WL21 in September 2019.



Photo 16. F105 along a beaver dam and channels at site WL21 (September 13, 2019)

4.4 Invasive Plants

All invasive species discussed are non-native (introduced or exotic) plants with the exception of foxtail barley (*Hordeum jubatum*) which is an important component of a grassland transitional terrestrial site association (Ga02%) found at site WL14. Throughout the wetland ecosystem surveys, invasive plant species were observed along roads and in clearings. As well, invasive, non-native plants were common around wetlands that occur near roads and clearings. Invasives were also present within and around wetlands isolated from roads and clearings and likely transported by wildlife and wind.

At all wetlands, invasive species were restricted to mineral soils not inundated for prolonged periods (**Table 10**). For most wetlands, invasive plants occupied peripheral areas transitional to surrounding uplands. The distribution and abundance of invasive plant species suggested populations were maintained by periodic or frequent soil disturbance by animals such as beaver, deer, elk, and cattle. The unusual occurrence of an open mineral grassland association at site WL14 suited English plantain (*Plantago major*) and foxtail barley, neither of which were common in other wetlands. Canada thistle (*Cirsium arvense*) and perennial sow-thistle (*Sonchus arvensis*) were dominant on beaver dams and in small clearings beside wetlands near roads.

Table 10. Non-native (Introduced) Plants Observed at Wetlands

Wetland	Documented Non-native Species	Characteristics of Invasive Species
WL4	Canada thistle, perennial sow-thistle, hemp-nettle, common dandelion	Invasives abundant along southwest edge and adjacent field
WL5.2	Canada thistle	Observed on small patch of mineral soil
WL9	timothy, oxeye daisy, common dandelion	Invasives restricted to shoreline
WL10	Canada thistle	Invasives restricted to shoreline
WL14	English plantain, foxtail barley	Invasives restricted to a terrestrial mineral grassland association adjacent to wetland
WL15	Canada thistle, perennial sow-thistle	Invasives observed at north end of wetland in drier area
WL17	Canada thistle, perennial sow-thistle	Invasives very abundant on some beaver dams and small clearings

In most wetlands, invasive species were restricted to peripheral areas where they had no apparent adverse effects on wetland ecology. The distribution of invasive plants could change if the volume of water received and the frequency and duration of flooding changes. No invasive, introduced aquatic plants were observed during the wetland ecosystem surveys. Canada thistle, observed at sites WL4, WL5.2, WL10, WL15, and WL 17 is considered noxious provincially. Perennial sow-thistle, observed at sites WL4, WL15, and WL17 is also provincially noxious (Ralph et al., 2014). Noxious weeds are non-native species considered “highly destructive, competitive and difficult to control” (Ralph et al., 2014).

Special coding has been developed to classify wetlands that are predominantly composed of invasive species (MacKillop et al., 2018); however, none of the major species for which the codes are developed were found in the LSA and none of the invasive non-native species observed in the wetlands occurred in greater abundance than native species. The non-native invasive species found in the LSA were not strictly aquatic plants; that is, they were not species that occur only or primarily in wetland conditions.

4.5 Wetland Conservation Ranking

Ten wetland site associations documented in the LSA have assigned conservation ranks (**Table 11**). Seven of the nine wetland site associations with a conservation ranking are provincially Blue-listed while three are provincially Red-listed. Yellow-listed site associations are not discussed given that they are not of conservation concern. The Blue-listed site associations include three marshes (Wm04, Wm05 and Wm06), one fen (Wf02), two treed swamps (Ws07.1 and Ws07.2), and one shrubby swamp (Ws03). The Red-listed site associations include a marsh (Wm07) and two alkaline/saline meadows (Ga02\$ and Ga03\$). Ga02\$ and Ga03\$ are terrestrial or wetland transition associations closely associated with wetlands. Currently, the B.C. CDC does not assign conservation ranks to shallow water wetlands.

Table 11. Wetland Site Associations of Conservation Concern

Site Association	English Name	Scientific Name	BC Conservation Ranking	Location
Ga02\$	Nuttall's alkaligrass – foxtail barley (seral) Alkaline/Saline Meadow	<i>Puccinellia nuttalliana</i> - <i>Hordeum jubatum</i> (seral) Alkaline/Saline Meadow	Red	WL14
Ga03\$	Field sedge (seral) Alkaline/Saline Meadow	<i>Carex praegracilis</i> (seral) Alkaline/Saline Meadow	Red	WL14
Wm07	Baltic rush Marsh	<i>Juncus balticus</i> Marsh	Red	WL14
Wf02	Scrub birch - Water sedge Fen	<i>Betula nana</i> - <i>Carex aquatilis</i> Fen	Blue	WL3
Wm04	Common spike-rush Herbaceous Vegetation Marsh	<i>Eleocharis palustris</i> Herbaceous Vegetation Marsh	Blue	WL17
Wm05	Common cattail Marsh	<i>Typha latifolia</i> Marsh	Blue	WL11.2, WL12, WL16, WL18
Wm06	Great bulrush Deep Marsh	<i>Schoenoplectus acutus</i> Deep Marsh	Blue	WL11.3, WL16
Ws03	Bebb's willow - Bluejoint reedgrass Swamp	<i>Salix bebbiana</i> - <i>Calamagrostis canadensis</i> Swamp	Blue	WL22
Ws07.1	Hybrid white spruce - Horsetails - Leafy moss) Swamp	<i>Picea engelmannii</i> x <i>glauca</i> - <i>Equisetum</i> spp. - <i>Mnium</i> spp. (Mniaceae) Swamp	Blue	WL2a; WL21
Ws07.2	hybrid white spruce - horsetails - (soft-leaved sedge) - leafy mosses Swamp	<i>Picea engelmannii</i> x <i>glauca</i> - <i>Equisetum</i> spp. - (<i>Carex disperma</i>) - <i>Mnium</i> spp. (Mniaceae) Swamp	Blue	WL14, WL16a

Provincially-listed site associations were observed at 12 wetlands surveyed in the LSA (**Figure 9**). Several wetlands in the northwestern portion of the LSA were found to contain site associations currently ranked by the B.C. CDC, many of which are marshes. The three documented Red-listed site associations as well as one Blue-listed association were observed at site WL14, upland and east of the Elk River (**Figure 6a**). Wm07, provincially Red-listed, forms a portion of the wetland ecosystem at site WL14 while Ga03\$, also Red-listed, occurs in a transitional area of WL14, adjacent to Wm07 and Ga02\$ occurs beside it. The Blue-listed Ws07.2 also occurs at site WL14. In the East Kootenay region, both Ga02\$ and Ws07.2 associations are considered uncommon (**Table 12**; MacKillop et al., 2018). Ga03\$ is considered common in the east Kootenay MacKillop et al., 2018.

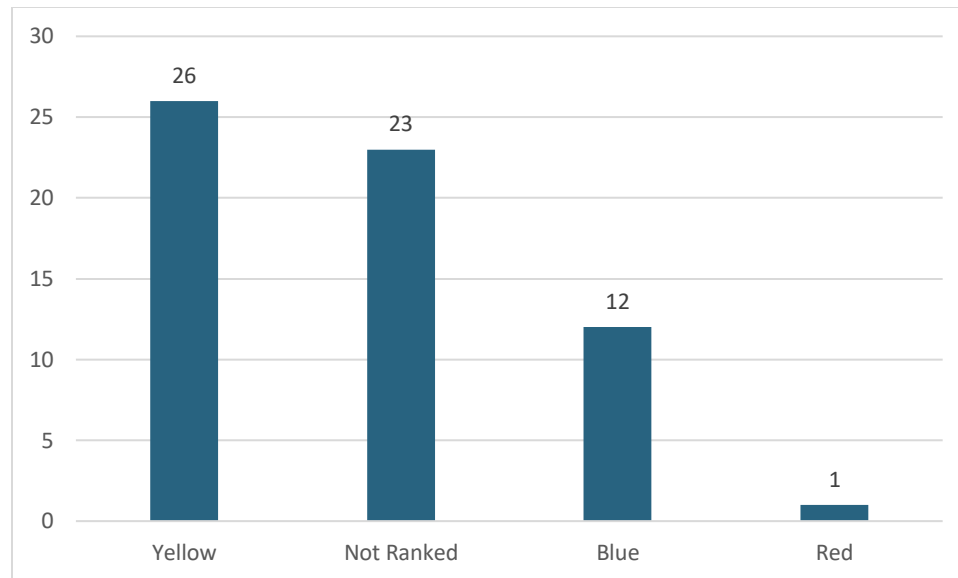


Figure 9. Surveyed Wetlands with Site Associations of the Three Major B.C. Conservation Ranks (Note Ga02\$ and Ga03\$, Red-listed wetland-associated terrestrial site associations, are excluded)

Table 12. Uncommon Wetland Site Associations in East Kootenay (MacKillop et al., 2018)

Site Association	English Name	Scientific Name	Location
Wb15*	Spruce – Labrador tea – Peat-moss Bog	<i>Rhododendron groenlandicum</i> – <i>Sphagnum</i> spp. Bog	WL3 WL5.1a
Wm04	Common spike-rush Marsh	<i>Eleocharis palustris</i> herbaceous vegetation Marsh	WL17
Wm06	Great bulrush Marsh	<i>Schoenoplectus acutus</i> Marsh	WL11.3, WL16
Wm07	Baltic rush Marsh	<i>Juncus balticus</i> Marsh	WL14
Ws03	Bebb’s willow – Bluejoint Swamp	<i>Salix bebbiana</i> - <i>Calamagrostis canadensis</i> Swamp	WL22
Ws04*	Drummond’s willow – Beaked sedge Swamp	<i>Salix drummondiana</i> - <i>Carex utriculata</i> Swamp	WL4, WL5.4, WL21
Ws07.1	Spruce – Horsetail – Leafy moss Swamp	<i>Picea engelmannii</i> x <i>glauca</i> - <i>Equisetum</i> spp. - <i>Mnium</i> spp. (Mniaceae) Swamp	WL2a; WL21
Ws07.2	Spruce – Horsetail – Soft-leaved sedge – Leafy moss Swamp	<i>Picea engelmannii</i> x <i>glauca</i> - <i>Equisetum</i> spp. - (<i>Carex disperma</i>) - <i>Mnium</i> spp. (Mniaceae) Swamp	WL14, WL16a

* Not currently ranked by the B.C. CDC.

At site WL16, approximately 600 m southwest of WL14, two Blue-listed marsh site associations were observed, Wm05 and Wm06 (**Figure 6a**). Site WL16a, which occurs immediately south of WL16, was found to contain the Blue-listed treed swamp site association Ws07.2 which was also observed at WL14 and considered uncommon in the region. At site WL17, immediately south of WL16, the Blue-listed Wm04 marsh was observed, a site association considered uncommon in the region. Approximately 800 m southwest of site WL16, the Blue-listed Wm05 marsh was documented at site WL18. Along the series of wetlands that occur in the southern Grave Lake drainage, two Blue-listed marshes were observed. Wm05 was found at site WL11.2 while Wm06 was observed at WL11.3, a site association that is regionally uncommon (**Figure 6a**; MacKillop et al., 2018).

Several site associations observed in the LSA are identified by MacKillop et al. (2018) as uncommon in the East Kootenay region (**Table 12**). Many of the uncommon site associations are ranked by the B.C. CDC except Wb15 and Ws04. The small areas of Wb15 were recorded along Alexander Creek at sites WL5.1a and WL3 (**Figure 6f** and **Figure 6h**, respectively). Ws04 was observed at site WL17, along a chain of wetlands with documented Red- and Blue-listed site associations (**Figure 6a**). As mentioned previously, no shallow water wetlands have been ranked by the B.C. CDC and only two general categories (Yellow Pond-Lily and Pondweed) have been identified by MacKillop et al. (2018).

The Summary

Thirty-six wetland ecosystems were identified across 23 wetland survey sites within the LSA. Many of the wetland ecosystems observed form wetland complexes comprising two or more distinct wetland associations. Six wetland classes were observed in the LSA and included seven marsh wetlands, six shallow water wetlands, five swamp (three shrub and two tree) wetlands, two fen wetlands, one bog wetland, and one transitional/successional marsh-fen wetland. Three non-wetland flood associations were also documented in the LSA as well as two transitional mineral wetlands. Twenty-three wetland site associations were identified amongst the wetlands surveyed with marshes making up the greatest area of all major wetland types recorded in the LSA (13.88 ha), followed by swamp wetlands (13.43 ha). Most wetland site associations surveyed ranged from 0.01 to 0.25 ha and 0.51 to 0.75 ha in size. The wetlands and wetland complexes which constituted these site associations, ranged from 0.02 to 8.84 ha. The wetland ecosystem baseline study distinguished adjoining or proximate wetlands and wetland complexes from one another based on differences between each site's physical characteristics (e.g., distinct topographical differences; distinct hydrology or hydrological connections) and marked differences in vegetation structure and floristics. The estimated catchment size for wetlands surveyed within the LSA varies based on terrain, elevation, and proximity to watercourses and obstructions along drainage ways (e.g., beaver dams).

Generally, wetlands were found to be restricted to flat areas, valleys, and bowls with many wetlands observed to be formed in basins, depressions, and through obstructions along drainage ways (e.g., presence of beaver dams). Many wetlands have developed in basins along creeks or drainage channels adjacent to forested slopes. The floodplain of Alexander Creek may support additional wetlands that were not observed as part of the extensive wetland field surveys. Observations during the wetland field surveys, as well as other baseline surveys completed for the project, noted that the floodplains of major creeks within the LSA (e.g., Alexander, West Alexander, Harmer and Grave) are dynamic, with periodic, high energy flows and debris dams that contribute to flood associations and young seral stage ecosystems on shifting deposits of sand, gravel, cobble and boulders; conditions that may not be conducive to wetland development. Wetlands were noted on elevated benches along creeks beyond the active floodplain (e.g., WL2 and WL3). Basin wetlands are fed by creeks, surface drainage, and drainage from the adjacent slope. Layers of peat of various depths, composition and stages of decomposition develop in these basins and effectively store water to sustain marsh and fen communities.

Of the wetlands evaluated, sites WL14 and WL21 were found to contain five distinct wetland associations each. Notable site associations at site WL14 included Ga02\$ and Ga03\$, transitional site associations and Red-listed communities, Red-listed Wm07, as well as the Blue-listed Ws07.2. Although each component wetland site association at WL14 may not support a large number of different plant species (although Ws07.2 was one of the most highly biodiverse wetland site association), these distinct ecological communities represent a considerable array of species when considered together in one

wetland complex. Site WL21 is a dynamic wetland of changing assemblages of ecological communities and includes marsh, shallow water, swamp, and floodplain associations. The two willow swamp communities occur along the channelized portion and are impossible to delineate precisely. The shallow water portions change as beavers dam new sections of the Alexander Creek, isolating and slowing water within the ponds (shallow waters) and along their landward edges where marshes develop. The treed swamp portion has developed away from influence of the constantly changing channels, along the complex edge where water levels has remained relatively stable over a long period.

Several other site associations ranked as Blue or Red by the B.C. CDC were also documented in the LSA, including marsh associations Wm07 (Red) and Wm04, Wm05, and Wm06 (Blue). These associations occurred in the chain of wetlands east of the Elk River and wetlands along the drainage from Grave Lake to Grave Creek.

Invasive plants were commonly observed around wetlands that occur near roads and clearings (Canada thistle and perennial sow-thistle at site WL4). In areas where invasive plants were also present within and around wetlands isolated from roads and clearings, their occurrence in these areas is likely attributed to wildlife and wind movement. In most wetlands, invasive species were restricted to peripheral areas where they had no apparent adverse effects on wetland ecology. Provincially-listed as Noxious Weeds, Canada thistle and perennial sow-thistle were the most common invasive plants observed near wetlands surveyed.

Wetlands provide important functions and ecological and cultural values. Wetlands contribute to the biodiversity and species richness of the LSA. The wetland site associations and the plants that compose them, contribute to the biodiversity and species richness of the area. Wetlands are often characterized by few species (Keddy, 2010), as was observed in the wetlands of the LSA where a few species were observed to dominate great portions of wetlands such as beaked sedge and hard-stemmed bulrush at site WL16. The number and type of species differed between wetlands, but each contribute to biodiversity and species richness in the LSA. The ecological contribution of wetlands is not restricted to the LSA; organisms and processes associated with the wetlands are important to areas outside the LSA, within the region and adjacent political jurisdictions (Raiter et al., 2014).

Based on the observations and results of the wetland ecosystem baseline assessment, it is anticipated that key wetland functions in the LSA include carbon sequestration and water quality treatment for biochemical functions, shoreline erosion control and water flow moderation for hydrological functions, and biological productivity and biodiversity for habitat functions. A detailed wetland functions assessment will be completed Project and will confirm wetland function of the LSA.

6.0

References

- Bond, W. K., Cox, K. W., Heberlein, T., Manning, E. W., Witty, D. R., & Young, D. A. (1992). *Wetland evaluation guide. Final report of the wetlands are not wastelands project* (Issues Paper No. 1992-1). North American Wetlands Conservation Council (Canada). http://www.env.gov.bc.ca/wld/documents/WEG_Oct2002_s.pdf
- British Columbia Conservation Data Centre [B.C. CDC]. (2019). *B.C. Species and Ecosystems Explorer*. Province of British Columbia. <http://a100.gov.bc.ca/pub/eswp/>
- British Columbia Ministry of Environment [MOE]. (2008). *Standard operating procedures: Hygiene protocols for aquatic field research*. <http://www.env.gov.bc.ca/bcparks/partnerships/Item/docs/protocols/wetland/BC-DisinfectionProtocol-AquaticFieldResearchers-2008.pdf?v=1487548800040>
- British Columbia Ministry of Environment and Climate Change Strategy [B.C. MECCS]. (2018). *Protecting species at risk: A primer to support a conversation with British Columbians*. https://engage.gov.bc.ca/app/uploads/sites/376/2018/05/Protecting-Species-at-Risk_A-Primer-Apr16_rev.pdf
- British Columbia Ministry of Forests and Range [B.C. MFR]. (2010). *Field manual for describing terrestrial ecosystems* (2nd ed.).
- British Columbia Water Sustainability Act*, R.S.B.C. c. 15 (2014), Retrieved from <http://www.bclaws.ca/civix/document/id/complete/statreg/14015#section1> [Accessed October 09, 2019]
- Canadian Herpetofauna Health Working Group [CHHWG]. (2017). *Decontamination protocol for field work with amphibians and reptiles in Canada*. <http://www.cwhc-rscf.ca/docs/HHWG%20Decontamination%20Protocol%202017-05-30.pdf>
- Coal Act*, R.S.B.C. c. 15. (2004), Retrieved from http://www.bclaws.ca/civix/document/id/complete/statreg/00_04015_01 [Accessed January 22, 2020]
- Cox, R. K., & Cullington, J. (2009). *Wetland ways: Interim guidelines for wetland protection and conservation in British Columbia. Chapter 6: Mining*. Wetland Stewardship Partnership. <https://www2.gov.bc.ca/gov/content/environment/air-land-water/water/water-planning-strategies/wetlands-in-bc>
- Douglas, G. W., Straley, G. B., Meidinger, D., & Pojar, J. (Eds.). (1998). *Illustrated flora of British Columbia, Volume 1: Gymnosperms and Dicotyledons (Aceraceae through Asteraceae)*. British Columbia

- Ministry of Environment, Lands and Parks and Ministry of Forests.
<https://www.for.gov.bc.ca/hfd/pubs/docs/Mr/Mr100.pdf>
- Douglas, G. W., Meidinger, D., & Pojar, J. (Eds.). (1999a). *Illustrated flora of British Columbia, Volume 3: Dicotyledons (Diapensiaceae through Onagraceae)*. British Columbia Ministry of Environment, Lands and Parks and Ministry of Forests. <https://www.for.gov.bc.ca/hfd/pubs/docs/Mr/Mr102.pdf>
- Douglas, G. W., Meidinger, D., & Pojar, J. (Eds.). (1999b). *Illustrated flora of British Columbia, Volume 4: Dicotyledons (Orobanchaceae through Rubiaceae)*. British Columbia Ministry of Environment, Lands and Parks and Ministry of Forests. <https://www.for.gov.bc.ca/hfd/pubs/docs/Mr/Mr103.pdf>
- Douglas, G. W., Meidinger, D., & Pojar, J. (Eds.). (2000). *Illustrated flora of British Columbia, Volume 5: Dicotyledons (Salicaceae through Zygophyllaceae; Pteridophytes)*. British Columbia Ministry of Environment, Lands and Parks and Ministry of Forests.
<https://www.for.gov.bc.ca/hfd/pubs/docs/Mr/Mr104.pdf>
- Douglas, G. W., Meidinger, D., & Pojar, J. (Eds.). (2001a). *Illustrated flora of British Columbia, Volume 6: Monocotyledons (Acoraceae through Najadaceae)*. British Columbia Ministry of Environment, Lands and Parks and Ministry of Forests. <https://www.for.gov.bc.ca/hfd/pubs/docs/Mr/Mr105.pdf>
- Douglas, G. W., Meidinger, D., & Pojar, J. (Eds.). (2001b). *Illustrated Flora of British Columbia, Volume 7: Monocotyledons (Orchidaceae through Zosteraceae)*. British Columbia Ministry of Environment, Lands and Parks and Ministry of Forests. <https://www.for.gov.bc.ca/hfd/pubs/docs/Mr/Mr106.pdf>
- ESRI. (2019). ESRI Base Imagery. Sources: ESRI, Digital Globe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community.
- Flora of North America Editorial Committee (Eds.). (1993+). *Flora of North America North of Mexico, 19+ volumes*. http://www.efloras.org/flora_page.aspx?flora_id=1
- Hitchcock, C. L., & Cronquist, A. C. (2018). *Flora of the pacific northwest: An illustrated manual* (2nd ed.). University of Washington Press.
- Keefer Ecological Services Ltd. (2020). *Terrestrial Ecosystem Mapping Report – Crown Mountain Coking Coal Project*.
- Keddy, P. A. (2010). *Wetland ecology. Principles and conservation* (2nd ed.). Cambridge University Press.
- Laubhan, M. K., King, S. L., & Fredrickson, L. H. (2012). Managing inland wetlands for wildlife. In N. J., Silvy (Ed.), *The wildlife techniques manual: Management* (7th ed., volume 2). The Johns Hopkins University Press.
- Lynch-Stewart, P., Kessel-Taylor, I., & Rubec, C. (1999). *Wetlands and government: Policy and legislation for wetland conservation in Canada* (Sustaining wetlands issues paper No. 1999-1). Environment Canada. <http://nawcc.wetlandnetwork.ca/1999-1%20Wetlands%20and%20Government.pdf>

- MacDougall, A. S., & Loo, J. A. (2002). Predicting occurrences of geographically restricted rare floral elements with qualitative habitat data. *Environ. Rev.*, *10*, 167-190.
- MacKenzie, W. H., & Moran, J. R. (2004). *Wetlands of British Columbia: A guide to identification* (Land Management Handbook No. 52). British Columbia Ministry of Forests Forest Science Program. <https://www.for.gov.bc.ca/hfd/pubs/Docs/Lmh/Lmh52.pdf>
- MacKillop, D. J., Ehman, A. J., Iverson, K. E., & McKenzie, E. B. (2018). *A field guide to site classification and identification for southeast British Columbia: The East Kootenay* (Land Management Handbook No. 71). Province of British Columbia. <https://www.for.gov.bc.ca/hfd/pubs/docs/lmh/LMH71.pdf>
- McDonald, L. L. (2004). Sampling rare populations. In W.L. Thompson (Ed.), *Sampling rare or elusive species: Concepts, designs, and techniques for estimating population parameters* (pp. 11 - 40). Island Press.
- Mines Act*, R.S.B.C. c. 293 (1996), Retrieved from http://www.bclaws.ca/civix/document/id/complete/statreg/00_96293_01 [Accessed January 22, 2020]
- Minke, A. G, Westbrook, C. J., & Van der Kamp, G. (2010). Simplified volume-area-depth method for estimating water storage of prairie potholes. *Wetlands*, *30*(3): 541-551.
- Mitsch, W. J., & Gosselink, J. G. (2007). *Wetlands* (4th ed.). John Wiley & Sons Inc.
- NatureServe. (2020). *Statuses | NatureServe Explorer 2.0*. NatureServe Explorer. <https://explorer.natureserve.org/AboutTheData/Statuses>
- Noble, B. (2010). *Introduction to environmental impact assessment: A guide to principles and practice*. Oxford University Press.
- Pojar, J., Meidinger, D., & Klinka, K. (1991). *Ecosystems of British Columbia Chapter 2: Concepts* (Special Report Series 6). B.C. Ministry of Forests. <https://www.for.gov.bc.ca/hfd/pubs/Docs/Srs/Srs06.pdf>
- Poon, E. L., & Margules, C. R. (2004). Searching for new populations of rare plants in remote locations. In W.L. Thompson (Ed.), *Sampling rare and elusive species: Concepts, designs, and techniques for estimating population parameters* (pp. 189-207). Island Press.
- Province of B.C. and GeoBC. (2016). Ortho Imagery. 0.5m Spatial Resolution. 1:20,000. 082g066, 082g076, 082g086, 082g087, 082g067, 082g077, 082g087, 082g097.
- Raiter, K. G., Possingham, H. P., Prober, S. M., & Hobbs, R. J. (2014). Under the radar: Mitigating enigmatic ecological impacts. *Trends Ecol. Evol.*, *29*(11): 635–644. doi:10.1016/j.tree.2014.09.003. PMID:25269749.

Ralph, D., Miller, V., Hougren, C., & Leekie, J. (2014). *Field guide to noxious and other selected invasive plants of British Columbia*. Invasive Species Council of British Columbia and British Columbia Inter-Ministry Invasive Species Working Group.

Species at Risk Act, S.C. c. 29 (2002), Retrieved from <https://laws-lois.justice.gc.ca/eng/acts/s-15.3/page-1.html> [Accessed October 10, 2019]

Warner, B. G., & Rubec, C. D. A. (Eds.). (1997). *The Canadian Wetland Classification System* (2nd ed.). National Wetlands Working Group, Wetlands Research Centre, University of Waterloo.

Appendix A

Conservation Status Definitions

Conservation Status Definitions

Provincial Conservation Status

Provincial Status applies to a species' or ecological community's conservation status in British Columbia. The status ranks have the following meaning:

- X = presumed extirpated
- H = historical (species)/possibly extirpated (communities)
- 1 = critically imperiled
- 2 = imperiled
- 3 = special concern, vulnerable to extirpation or extinction
- 4 = apparently secure
- 5 = demonstrably widespread, abundant, and secure.
- NA = not applicable
- NR = unranked
- U = unrankable

B.C. List Status

Species are assigned to provincial lists depending on their Provincial Conservation Status (see table below). The lists are as follows:

Extinct:

Species that no longer exist. This status is only assigned if the Global Conservation Status rank is GX.

Red:

Includes any native species or subspecies that have, or are candidates for, Extirpated, Endangered, or Threatened status in British Columbia. Extirpated taxa no longer exist in the wild in British Columbia but do occur elsewhere. Endangered taxa are facing imminent extirpation or extinction. Threatened taxa are likely to become endangered if limiting factors are not reversed. Not all Red-listed taxa will necessarily become formally designated. Placing taxa on these lists flags them as being at risk and requiring investigation.

Blue:

Includes any native species or subspecies considered to be of Special Concern (formerly Vulnerable) in British Columbia. Taxa of Special Concern have characteristics that make them particularly sensitive or vulnerable to human activities or natural events. Blue-listed taxa are at risk, but are not Extirpated, Endangered or Threatened.

Yellow:

Includes species that are apparently secure and not at risk of extinction. Yellow-listed species may have red- or blue-listed subspecies.

Exotic:

Species that have been moved beyond their natural range as a result of human activity. Exotic species are also known as alien species, foreign species, introduced species, non-indigenous species and non-native species. Exotic species are excluded from the Red, Blue and Yellow Lists as a Provincial Conservation Status Rank is not applicable (i.e. SNA)

Accidental:

Species occurring infrequently and unpredictably, outside their usual range. Accidental species are excluded from the Red, Blue and Yellow Lists as a Provincial Conservation Status Rank is not applicable (i.e., SNA)

Unknown:

Includes species or subspecies for which the Provincial Conservation Status is unknown due to extreme uncertainty (e.g., S1S4). It will also be 'Unknown' if it is uncertain whether the entity is native (Red, Blue or Yellow), introduced (Exotic) or accidental in B.C. This designation highlights species where more inventory and/or data gathering is needed.

No Status:

Includes species that have not been ranked (i.e., Provincial Conservation Status Rank is SNR). No Status is also assigned to an animal when all subspecies or populations of a species are assigned to either the Red List or the Blue List. For example, there are two populations of Western Painted Turtle in B.C.; one population is on the Red List, the other is on the Blue List. The species record for Western Painted Turtle is therefore not assigned to a list.

Global Conservation Status

A Global Rank applies to a species/ecological community across its entire range. The number in parenthesis is the year the rank was last reviewed. The ranks have the following meaning:

- X = presumed extinct (species)/eliminated (community)
- H = possibly extinct (species)/presumed eliminated (comm.)
- 1 = critically imperiled
- 2 = imperiled
- 3 = vulnerable to extirpation or extinction
- 4 = apparently secure
- 5 = demonstrably widespread, abundant, and secure.
- NA = not applicable

NR = unranked - Global Rank not yet assessed.

U = unrankable

Source:

B.C. Conservation Data Centre (B.C. CDC). (2019). BC Species and Ecosystems Explorer. B.C. Ministry of Environment. Victoria, B.C. Available: <http://a100.gov.bc.ca/pub/eswp/> (accessed Sep 4, 2019).

Appendix B

Wetland Location, Size, and Elevation

Wetland	UTM (NAD 83)	Size (m2)	Size (ha.)	Elev. (m)
WL1	11 U 663941 5502585	5498	0.55	1305
WL2	11 U 664229 5505500	5066	0.51	1348
WL2a	11 U 664285 5505628	5896	0.59	1352
WL3	11 U 664310 5505768	7581	0.76	1355
WL4	11 U 664742 5509372	21207	2.12	1422
WL5.1	11 U 664626 5510566	4067	0.41	1444
WL5.1a	11 U 664603 5510589	301	0.03	1445
WL5.2	11 U 664736 5510647	5874	0.59	1441
WL5.3	11 U 664733 5510766	1445	0.14	1443
WL5.4	11 U 664688 5510880	19205	1.92	1444
WL6	11 U 664264 5514861	4518	0.45	1494
WL6.1	11 U 664237 5514806	1609	0.16	1492
WL6.2	11 U 664262 5514742	226	0.02	1490
WL7	11 U 663476 5521127	768	0.08	2089
WL8.1	11 U 661756 5521351	429	0.04	1873
WL8.2	11 U 661807 5521243	5482	0.55	1873
WL8.3	11 U 661860 5521194	252	0.03	1873
WL9	11 U 657290 5521906	5742	0.57	1325
WL10	11 U 657123 5522007	302	0.03	1322
WL11.1	11 U 655465 5524177	2095	0.21	1263
WL11.2	11 U 655622 5524247	8759	0.88	1265
WL11.3	11 U 655927 5524606	7775	0.78	1269
WL11.3a	11 U 655942 5524580	11377	1.14	1269
WL11.3b	11 U 655658 5524558	7199	0.72	1269
WL12	11 U 655054 5525819	24365	2.44	1298
WL13	11 U 654738 5525349	88406	8.84	1285
WL14	11 U 654394 5521844	46400	4.64	1217
WL15	11 U 653981 5521570	25888	2.59	1216
WL16	11 U 653822 5521252	24411	2.44	1215
WL16a	11 U 653844 5521111	16268	1.63	1215
WL17	11 U 653864 5520896	6668	0.67	1214
WL18	11 U 653471 5520358	999	0.10	1188
WL19	11 U 653943 5521327	233	0.02	1227
WL20	11 U 654626 5524896	6099	0.61	1279
WL21	11 U 666530 5509502	28249	2.82	1509
WL22	11 U 664593 5503968	6879	0.69	1431

Appendix C

Wetland Profiles

Wetland Profile Definitions

Key definitions and abbreviations used in the wetland profiles (Section 2.0 of Appendix D) are provided below.

Table 1. Definitions of wetland characteristics recorded for each wetland/wetland complex

Characteristic	Definition/Explanation
Elevation (m)	Elevation expressed as metres above sea level. Taken from a representative point in the wetland feature.
BEC	Biogeoclimatic Zone as per MacKillop et al. (2018) reflects the typical patterns of vegetation, soil, and climate over a given area.
Total Estimated Area (ha)	Total estimated area of the wetland or wetland complex.
WSI (wetland shape index)	Represents the general shape of the feature. A value of 1.0 = circle; 1.1 = square; >2 = long rectangular (i.e. long and narrow).
Orientation (general)	General orientation of wetland when one axis is longer than the other.
Flow (St, Sl, Mo, Dy, VD)	General description of rate of water flow. St = stagnant; Sl = sluggish; Mo = mobile; Dy = dynamic, and VD = very dynamic
Hydroperiod (P, S, E)	The period in which the soil is saturated or the "the length of time and portion of the year the wetland holds water" (Tarr and Babbitt, n.d.). P = permanent; S = seasonal, and E = ephemeral
Origin	Non-anthropogenic (natural) or anthropogenic (human-created). This is based on field observations and may not reflect historical human disturbances that have been obscured by natural processes.

Table 2. Definitions of wetland classification information

Wetland Classification Information	Definition/Explanation
Soil (depth to mineral; cm)	Depth of mineral soil from surface in centimetres.
Soil (humic, mesic, fibric; van Post)	Measures of organic soil (peat) decomposition. Key features are size of plant fibres/materials, composition, consistency, and water-holding capacity. Most decomposed to least decomposed: humic - mesic - fibric. The van Post scale of decomposition ranks peat from undecomposed (1) to completely decomposed (10).
Wetland Class	General wetland class.
Wetland Complex Component Area (ha)	Estimated area of the wetland or wetland complex
Estimated Area of Wetland Complex (% of total)	Proportion that this wetland component constitutes of the whole wetland complex. It provides a relative estimate of the ecological contribution of the component to the wetland complex.
B.C. Wetland	Standard provincial wetland classification of the wetland component based on MacKenzie and Moran (2004), MacKillop et al. (2018) and BCCDC (2019). This classification includes characteristic plant species.
English Name	The English name of the above classification.
Scientific Name	The scientific name of the above classification.

Wetland Classification Information	Definition/Explanation
CWCS	Standard federal wetland classification based on the Canadian Wetland Classification System (CWCS 1997). This classification includes geomorphological context.
Provincial Status	Conservation status rank of the B.C. Wetland classification. S1 = critically imperiled; S2 = imperiled; S3=special concern; S4 = apparently secure; S5 = secure; SNR = not ranked
B.C. List	Conservation status listing for B.C. Wetland classification. Red = extirpated, endangered or threatened; Blue = special concern; Yellow = apparently secure.
Global Status	Conservation status rank of the B.C. Wetland classification throughout its entire range (irrespective of national jurisdiction). G1 = critically imperiled; G2 = imperiled; G3=special concern; G4 = apparently secure; G5 = secure; GNR = not ranked (NatureServe, 2020)

2.0

Wetland Profiles

2.1

Wetland WL1

The shallow water wetland component of WL1 is an active beaver pond with an extensive dam along its south and west sides. The east side abuts the bottom of a steep slope. Sedge marsh is present among small pools and channels on a gently sloping surface between the beaver dam and Alexander Creek.

Table 3. Main characteristics of WL1

Characteristic	WL1
Elevation (m)	1305
BEC	MSdw
Total Estimated Area (ha)	0.55
WSI (wetland shape index)	1.2
Orientation (general)	SW-NE
Flow (St, Sl, Mo, Dy, VD)	Dy
Hydroperiod (P, S, E)	P
Origin	Non-anthropogenic (Natural). Beaver

Table 4. WL1 classification information

Wetland Classification Information	Primary Component	Secondary Component
Soil (depth to mineral; cm)	<40	n/a
Soil (humic, mesic, fibric, van Post)	-	n/a
Wetland Class	Marsh	Shallow water
Wetland Complex Component Area (ha)	0.30	0.25
Estimated Area of Wetland Complex (% of total)	54	46
B.C. Wetland	Wm01	Ww Muskgrass
English Name	Beaked sedge - Water sedge	Muskgrass shallow water
Scientific Name	<i>Carex utriculata</i> - <i>Carex aquatilis</i>	<i>Chara</i> sp.
CWCS	Spring Marsh	Linked Basin Water
Provincial Status	S4	not ranked
B.C. List	Yellow	not ranked
Global Status	G4	unknown

Description

This elevated wetland complex along the east side of Alexander Creek consists of shallow water and marsh. The large shallow water wetland (beaver pond) is fed by clear, calcium-rich springs at its northeast end. Beavers actively maintain a dam which stretches approximately 150 m along the west edge, retaining water in the shallow water wetland and allowing point and non-point (diffuse) discharge into the marsh below. The marsh is dominated by beaked sedge (*Carex utriculata*) growing among a

series of small, shallow channels and pools with marl (calcium carbonate) deposits. The east side of the pond abuts the toe of a steep forested slope. The macroalga muskgrass (*Chara* sp.) is the shallow water wetland's defining biological feature.

Landscape Context

Much of the area around WL1 has been cleared for recreation, industry and transportation. The wetland cannot be considered insular, although it is unlikely many people venture into it since there are no clear trails or roads.

Conservation

The Wm01 marsh is provincially Yellow-listed and not of conservation concern. It is common throughout the study area and the province (MacKillop et al. 2018). However, the predominance of beaked sedge in the marsh and its presence amongst channels and pools over a broad slope with marl deposits is atypical of Wm01 marshes in the study area. The marsh at WL5.1 is the most similar.

The Ww Muskgrass shallow water community is not listed by the BCCDC but it is a common shallow water wetland association in the project area. This muskgrass shallow water wetland appears to have a high renewal or turnover rate and, consequently, few aquatic macrophytes.

2.2 Wetland WL2

WL2 is a graminoid fen on a bench west of Alexander Creek, 2.8 km north of Highway 3. It is isolated from Alexander Creek Forest Road and appears to have received little direct human interference.

Table 5. Main characteristics of WL2

Characteristic	WL2
Elevation (m)	1348
BEC	MSdw
Total Estimated Area (ha)	0.51
WSI (wetland shape index)	1.5
Orientation	N-S
Flow (St, SI, Mo, Dy, VD)	SI
Hydroperiod (P, S, E)	-
Origin	Non-anthropogenic (Natural)

Table 6. WL2 classification information

Wetland Classification Information	Primary Component
Soil (depth to mineral; cm)	>40
Soil (humic, mesic, fibric, van Post)	mesic; 5
Wetland Class	fen (graminoid)
Wetland Complex Component Area (ha)	0.51
Estimated Area of Wetland Complex (% of total)	100
B.C. Wetland	Wf01
English Name	Water sedge - Beaked sedge
Scientific Name	<i>Carex aquatilis</i> - <i>Carex utriculata</i>
CWCS	Horizontal Fen
Provincial Status	S4
B.C. List	Yellow
Global Status	G4

Description

This graminoid fen is located at the base of a steep slope on a bench 50 to 100 m west of Alexander Creek. It is approximately 115 m by 40 m, and aligned north-south, parallel to the creek. Spruce (*Picea engelmannii* X *glauca*) are scattered throughout the wetland but more abundant on the wetland's periphery, especially on the east side. The open graminoid fen covers approximately 70 m by 30 m. Beaked sedge and water sedge are the most common graminoids and occur in near equal abundance. Arctic rush (*Juncus arcticus* ssp. *alaskanus*) (syn. Baltic rush) is slightly less abundant than either sedge. Water Sedge is more abundant and forms monotypic stands peripherally. Beaked Sedge occurs more centrally and co-occurs with Arctic rush which also occurs in small monotypic patches. Common mosses include *Plagiomnium* sp. and *Aulacomnium palustre*. No *Sphagnum* was observed.

Landscape Context

WL2's location at the bottom of a forested slope next to Alexander Creek affords it some isolation and protection from human activities and, possibly, natural stochastic perturbations such as fire, wind, drought and excessive precipitation or meltwater floods. A large clearcut 60 m to the southwest may alter the effects of weather on this wetland.

Conservation

This small wetland and WL3 have developed in isolation from human disturbance for a long time and are highly susceptible to changes in water levels and water quality. Thus, changes to the surrounding landscape that influence the amount and quality of water flowing into and through these wetlands will affect them. They are fed by the same creek, as is the swamp forest (WL2a) between them. Although Wf01 is common to both wetlands, the specific attributes of each is unique; that is, despite their similarities these two wetlands are distinctive and found nowhere else in the LSA.

Although the BCCDC does not list the Wf01 as a wetland of conservation concern, it is worth noting that fens occur infrequently in the East Kootenay (MacKillop et al. 2018). This is supported by field investigations and observations for this study. The specific attributes of the wetland are not found elsewhere in the LSA.

2.3 Wetland WL2a

WL2a is a treed swamp of large spruce with an understory of water-associated shrubs and herb-layer plants.

Table 7. Main characteristics of WL2a

Characteristic	WL2a
Elevation (m)	1352
BEC	MSdw
Total Estimated Area (ha)	0.59
WSI (wetland shape index)	1.4
Orientation	N-S
Flow (St, Sl, Mo, Dy, VD)	Mo
Hydroperiod (P, S, E)	P
Origin	Non-anthropogenic (Natural)

Table 8. WL2a classification information

Wetland 2a	Primary Component
Soil (depth to mineral; cm)	15
Soil (humic, mesic, fibric, van Post)	-
Wetland Class	Swamp
Wetland Complex Component Area (ha)	0.59
Estimated Area of Wetland Complex (% of total)	100
B.C. Wetland	Ws07.1 (Ws07 is equivalent to the BEC MSdw/111b)
English Name	Spruce - Horsetail - Leafy moss (Hybrid white spruce - Horsetails - Leafy mosses)
Scientific Name	<i>Picea engelmannii</i> x <i>glauca</i> - <i>Equisetum</i> spp. - <i>Mnium</i> spp. (Mniaceae)
CWCS	Drainageway Swamp
Provincial Status	S3
B.C. List	Blue
Global Status	GNR

Description

This is a forest of large spruce with a low understory of small shrubs, predominantly skunk currant (*Ribes glandulosum*), willow (*Salix* sp.), alder-leaved buckthorn (*Rhamnus alnifolia*) and a dense herb layer of common horsetail (*Equisetum arvense*), with sweet coltsfoot (*Petasites frigidus* var. *palmatus*) and common mitrewort (*Mitella nuda*). Common mosses include *Plagiomnium* sp., *Pleurozium schreberi* and

Tomenthypnum nitens. A small channel flows through the swamp and there are many small pools and areas of shallow surface water.

Landscape Context

This treed swamp lies between wetlands WL2 and WL3 along a wide drainage surface. See WL2.

Conservation

Treed swamps (Ws07) are considered uncommon in East Kootenay (MacKillop et al. 2018) and are uncommon in the study area. Two variants of Ws07 are recognized by MacKillop et al. (2018). This is variant Ws07.1. Both were found in the LSA (see WL16a).

The BCCDC lists the Ws07 as a wetland community of conservation concern (Blue-listed), without distinguishing the two variants.

2.4 Wetland WL3

WL3 is a fen, similar to WL2 in landscape position, size and shape, but floristically and structurally dissimilar.

Table 9. Main characteristics of WL3

Characteristic	WL3
Elevation (m)	1355
BEC	MSdw
Total Estimated Area (ha)	0.76
WSI (wetland shape index)	1.6
Orientation	N-S
Flow (St, Sl, Mo, Dy, VD)	Sl
Hydroperiod (P, S, E)	-
Origin	Non-anthropogenic (Natural)

Table 10. WL3 classification information

Wetland Classification Information	Primary Component	Secondary Component	Tertiary Component
Soil (depth to mineral; cm)	>40	>40	>40
Soil (humic, mesic, fibric, van Post)	fibric	fibric	fibric
Wetland Class	Fen	Fen	Bog
Wetland Complex Component Area (ha)	0.59	0.16	0.01
Estimated Area of Wetland Complex (% of total)	78	21	1
B.C. Wetland	Wf02	Wf01	Wb15
English Name	Scrub birch - Water sedge	Water sedge - Beaked sedge	Labrador tea - Peat moss

Wetland Classification Information	Primary Component	Secondary Component	Tertiary Component
Scientific Name	<i>Betula nana</i> - <i>Carex aquatilis</i>	<i>Carex aquatilis</i> - <i>Carex utriculata</i>	<i>Rhododendron</i> <i>groenlandicum</i> – <i>Sphagnum</i> spp.
CWCS	Horizontal Fen	Horizontal Fen	Mound Bog
Provincial Status	S3	S4	not ranked*
B.C. List	Blue	Yellow	not ranked*
Global Status	G4	G4	unknown

* the BCCDC lists another site association with Labrador Tea and *Sphagnum* spp. that is provincially S3, Blue-listed and globally G3 (BCCDC 2019).

Description

Deep, fibric peat supports this structurally and floristically varied plant community. Water sedge and beaked sedge define some areas, while in areas of lesser sedge cover, the provincially Blue-listed moss *Scorpidium cossonii* is characteristic. Species of the genus *Scorpidium* are commonly found in mineral rich wetlands and *Scorpidium cossonii*, in calcium rich fens (Hedenas 2014). Yellow bog sedge (*Carex gynocrates*) and bristle-stalked sedge (*Carex leptalea* ssp. *leptalea*) are present. Scrub birch (*Betula nana* ssp. *exilis*) and willow (*Salix* spp.) are scattered throughout, and peat mosses (*Sphagnum* spp.) and other bog-associated plants form distinctive hummocks at the base of scattered, stunted spruce (*Picea engelmannii* X *glauca*). These small mound bogs comprise Labrador tea, dwarf red raspberry (*Rubus pubescens*), twinflower (*Linnaea borealis* ssp. *longiflora*), scrub birch, common mitrewort and the mosses *Sphagnum fuscum*, *Sphagnum* sp., *Polytrichum strictum* and *Pleurozium schreberi*. Sage willow (*Salix candida*) was present in a shrub-dominated transition area at the wetland's southern edge.

See Photo 12, Appendix E.

Landscape Context

This is the northernmost of three adjoining wetlands along a broad linear drainage. A treed swamp (WL2a) and fen (WL2) lie to the south. All occur along the base of an east-facing slope on a bench extending west from Alexander Creek.

Conservation

These fens and the adjoining swamp have developed in isolation from recent human activity. A stable supply of alkaline water ensures yearly net positive moisture levels and high pH critical to the diverse and specialized plant community. Changes in water quantity and quality flowing into this wetland will alter species composition. Landscape changes such as forest clearing of the adjacent slope will adversely affect this wetland through increased evaporation and changes in the amount and type of water draining from the slope. The small hummocks of bog species, forming small mounded bogs at the base of spruce, supported a diverse assemblage of vascular plants and bryophytes characteristic of bogs.

Fens occur infrequently in the East Kootenay (MacKillop et al. 2018) and in the LSA. WL3 represents a community of plant species found nowhere else in the project area. It is presumed to be rare outside the project area and across the province since the moss *Scorpidium cossinii* is the most abundant bryophyte and characteristic of this community. *Moercki flotoviana*, a small thallose liverwort known only from a few records in British Columbia, was found and is expected to be scarce. It has not been ranked provincially or globally (BCCDC 2019).

Bogs are uncommon in the East Kootenay (MacKillop et al. 2018) and very uncommon in the project area. The only other bog noted during field studies was a small, perched bog beside WL5.1 although small patches of *Sphagnum* were noted in other wetlands, notably WL4 and WL21. The bogs of WL3 and WL5.1a developed differently, occupy different landscape positions and differ in species composition. There are no additional site associations within Wb15 to distinguish them (MacKillop et al. 2018).

See also the discussion of *Conservation* under WL2.

2.5 Wetland WL4

Wetland 4.1 is a large, broadly channelized wetland of shallow open water and sedge marsh with pockets of swamp on its periphery.

Table 11. Main characteristics of WL4

Characteristic	WL4
Elevation (m)	1422
BEC	MSdw
Total Estimated Area (ha)	2.12
WSI (wetland shape index)	1.2
Orientation	N-S
Flow (St, Sl, Mo, Dy, VD)	Mo
Hydroperiod (P, S, E)	P
Origin	Non-anthropogenic (Natural)

Table 12. WL4 classification information

Wetland Classification Information	Primary Component	Secondary Component	Tertiary Component
Soil (depth to mineral; cm)	<40	-	n/a
Soil (humic, mesic, fibric, van Post)	mesic	-	n/a
Wetland Class	Marsh	Swamp	Shallow water
Wetland Complex Component Area (ha)	1.44	0.47	0.21
Estimated Area of Wetland Complex (% of total)	68	22	10
B.C. Wetland	Wm01	Ws04	Ww Muskgrass
English Name	Water sedge - Beaked sedge	Drummond's willow - Beaked sedge	Muskgrass shallow water

Wetland Classification Information	Primary Component	Secondary Component	Tertiary Component
Scientific Name	<i>Carex aquatilis</i> - <i>Carex utriculata</i>	<i>Salix drummondiana</i> - <i>Carex utriculata</i>	<i>Chara</i> sp.
CWCS	Riparian Stream Marsh		Linked Basin Water
Provincial Status	S4	SNR	none
B.C. List	Yellow	not ranked	none
Global Status	G4	unknown	none

Description

The largest marsh of this wetland complex lies adjacent to and west of the channel and shallow water wetland. Shrubby and treed swamps are mostly confined to the periphery of the marsh and shallow water in patches and bands. The marsh comprises beaked sedge and water sedge. Arrow-leaved Coltsfoot (*Petasites frigidus* var. *sagittatus*) is scattered among beaked sedge, mainly in shallower portions of the marsh and at the marsh edge. Yellow bog sedge (*Carex gynocrates*) and a small patch of *Sphagnum* were present at the southwest edge of the wetland which may indicate a fen or a marsh/fen transitional area. The submerged macroalga Muskgrass is very abundant in the shallow water wetland, an inactive beaver pond. Small spruce are minor components of the willow swamp.

Landscape Context

WL4 lies at the foot of an east facing slope below Alexander Creek Forest Service Road. It is fed by a creek to the north and the west.

Conservation

The small swamp patches, which may belong to a provincially Blue-listed community, are common across the project area in many of the beaver-created wetlands. They are presumably common in the landscape beyond the LSA.

The Muskgrass shallow water wetland is not listed by the BCCDC. The Wm01 marsh is the most widespread marsh community in the province (MacKenzie and Moran 2004).

2.6 Wetlands WL5.1 to WL5.4

Wetlands WL5.1 to 5.4 wetlands have formed along a drainageway and include marsh and shallow water (beaver ponds), swamp and sections of slow flowing channels. Flow in the creek is supplemented by slope drainage and small channels of calcium-rich water. A small bog is present alongside one wetland. The wetlands are presented beginning with those located farthest downstream at the south end of the complex.

2.6.1

Wetland WL5.1

WL5.1 includes pockets of Wm01 marsh of beaked sedge and water sedge between and among shallow channels and pools of marl deposits.

Table 13. Main characteristics of WL5.1

Characteristic	WL5.1
Elevation (m)	1444
BEC	MSdw
Total Estimated Area (ha)	0.41
WSI (wetland shape index)	1.6
Orientation	N-S
Flow (St, SI, Mo, Dy, VD)	Dy
Hydroperiod (P, S, E)	P
Origin	Non-anthropogenic (natural). Beaver.

Table 14. WL5.1 classification information

Wetland Classification Information	Primary Component	Secondary Component
Soil (depth to mineral; cm)	<40	n/a
Soil (humic, mesic, fibric, van Post)	-	n/a
Wetland Class	Marsh	Shallow water
Wetland Complex Component Area (ha)	0.31	0.09
Estimated Area of Wetland Complex (% of total)	77	23
B.C. Wetland	Wm01	Ww Muskgrass
English Name	Beaked sedge - Water sedge	Muskgrass shallow water
Scientific Name	<i>Carex utriculata</i> - <i>Carex aquatilis</i>	<i>Chara</i> sp.
CWCS	Slope Marsh / Riparian Stream Marsh	Basin Water: Linked Basin Water
Provincial Status	S4	not ranked
B.C. List	Yellow	not ranked
Global Status	G4	unknown

Description

WL5.1 is characterized by channels of calcium-rich water, small pools of shallow water and areas prone to flooding that support marshes of sparsely growing sedges and non-graminoids among rock fines, gravel and marl. Clumps of sedge (*Carex* sp.) give much of the area a hummocky appearance. Marsh plants become dense at the edges of the open channels. The amount of water turnover through most of the complex limits *Chara* sp. to sluggish, lower pools.

Landscape Context

WL5.1 is located at the base of an east facing slope below the Alexander Creek Forest Service Road. It is fed by a small creek to the north.

Conservation

The marsh is common and widespread in the project area and the province. Muskgrass shallow water wetlands have been assigned no status by the BCCDC. They are common in the project area: the predominant wetland class of shallow water wetlands of beaver-created wetlands.

There are no communities of conservation concern, but this combination of expansive shallow water, sparsely and variously populated by sedges and herbs, and marl is uncommon in the project area (see WL1).

2.6.2 Wetland WL5.1a

WL5.1a is a semi-forested bog with abundant Labrador tea at the toe of the slope along the west and northwest edges of WL5.1.

Table 15. Main characteristics of WL5.1a

Characteristic	WL5.1a
Elevation (m)	1445
BEC	MSdw
Total Estimated Area (ha)	0.03
WSI (wetland shape index)	1.9
Orientation	N-S
Flow (St, SI, Mo, Dy, VD)	St
Hydroperiod (P, S, E)	-
Origin	Non-anthropogenic (Natural).

Table 16. WL5.1a classification information

Wetland Classification Information	Primary Component
Soil (depth to mineral; cm)	45
Soil (humic, mesic, fibric, van Post)	fibric
Wetland Class	Bog
Wetland Complex Component Area (ha)	0.03
Estimated Area of Wetland Complex (% of total)	100
B.C. Wetland	Wb15
English Name	Spruce - Labrador tea - Peat moss
Scientific Name	<i>Picea engelmannii</i> - <i>Rhododendron groenlandicum</i> - <i>Sphagnum</i> spp.
CWCS	Shore Bog
Provincial Status	not ranked
B.C. List	not ranked
Global Status	unknown

Description

WL5.1a is a very small bog characterized by dense Labrador tea perched 0.5 to 1 m above WL5.1. It is located at the toe of the adjacent east-facing slope and extends around the north side of WL5.1. Shore

bog is of the riparian bog class and distinguished by a flat surface and its presence at the edge of open water wetlands and streams (CWCS 1997). Labrador tea makes up about 75% of vegetative cover. Common juniper (*Juniperus communis*), shrubby cinquefoil (*Dasiphora fruticosa*), and a few small willows (*Salix* sp.) are present. Sweet coltsfoot (*Petasites frigidus* var. *palmatius*) was noted in the herb layer with fireweed (*Chamaenerion angustifolium*), common horsetail, yellow bog sedge and hairlike sedge (*Carex capillaris*). *Aulacomnium palustre* and *Sphagnum* spp. formed the moss layer.

See Photo 11, Appendix E.

Landscape Context

WL5.1a is located at the toe of the slope below the Alexander Creek Forest Service Road, along the west edge of WL5.1.

Conservation

Bogs are uncommon in East Kootenay and Wb15 occurs only occasionally (MacKillop et al. 2018). WL5.1 is a much different bog than those found in the open fen of WL3. Species composition was much different between the two, but each contained key floristic elements of bogs: *Sphagnum* and Labrador tea.

2.6.3 Wetland WL5.2

WL5.2 is a series of beaver-created shallow water wetlands and low gradient channels lined by sedge marsh.

Table 17. Main characteristics of WL5.2

Characteristic	WL5.2
Elevation (m)	1441
BEC	MSdw
Total Estimated Area (ha)	0.59
WSI (wetland shape index)	1.4
Orientation	E-W
Flow (St, Sl, Mo, Dy, VD)	Mo
Hydroperiod (P, S, E)	P
Origin	Non-anthropogenic (Natural). Beaver.

Table 18. WL5.2 classification information

Wetland Classification Information	Primary Component	Secondary Component
Soil (depth to mineral; cm)	<20	n/a
Soil (humic, mesic, fibric, van Post)	-	n/a
Wetland Class	Marsh	Shallow water
Wetland Complex Component Area (ha)	0.49	0.10
Estimated Area of Wetland Complex (% of total)	83	17

Wetland Classification Information	Primary Component	Secondary Component
B.C. Wetland	Wm01	Ww Muskgrass
English Name	Beaked sedge - Water sedge	Muskgrass shallow water
Scientific Name	<i>Carex utriculata</i> - <i>Carex aquatilis</i>	<i>Chara</i> sp.
CWCS	Riparian Stream Marsh	Basin Water: Linked Basin Water
Provincial Status	S4	not ranked
B.C. List	Yellow	not ranked
Global Status	G4	unknown

Description

WL5.2 is a series of Muskgrass shallow water wetlands, low gradient channels and beaked sedge and water sedge marsh.

See Photos 1 and 2, Appendix E.

Landscape Context

W5.2 occupies a broad drainage channel between WL5.1 and the large beaver pond that is WL5.3.

Conservation

The marsh and shallow water wetlands are common in the project area and not considered of conservation concern (BCCDC 2019).

2.6.4

Wetland WL5.3

WL5.3 is a large beaver-created shallow water wetland with a small sedge marsh along the north side, adjacent to an extensive swamp (WL5.4). WL5.2 lies to the south.

Table 19. Main characteristics of WL5.3

Characteristic	WL5.3
Elevation (m)	1443
BEC	MSdw
Total Estimated Area (ha)	0.14
WSI (wetland shape index)	1.4
Orientation	E-W
Flow (St, SI, Mo, Dy, VD)	Mo
Hydroperiod (P, S, E)	P
Origin	Non-anthropogenic (Natural). Beaver.

Table 20. WL5.3 classification information

Wetland Classification Information	Primary Component	Secondary Component
Soil (depth to mineral; cm)	<20	n/a
Soil (humic, mesic, fibric, van Post)	-	n/a
Wetland Class	Marsh	Shallow water
Wetland Complex Component Area (ha)	0.09	0.06
Estimated Area of Wetland Complex (% of total)	60	40
B.C. Wetland	Wm01	Ww Muskgrass
English Name	Beaked sedge - Water sedge	Muskgrass shallow water
Scientific Name	<i>Carex utriculata</i> - <i>Carex aquatilis</i>	<i>Chara</i> sp.
CWCS	Riparian Stream Marsh	Basin Water: Linked Basin Water
Provincial Status	S4	not ranked
B.C. List	Yellow	not ranked
Global Status	G4	unknown

Description

WL5.3 is a distinctive complex of Muskgrass shallow water wetland with beaked sedge and water sedge marsh. Its north boundary is defined by the abrupt edge of an extensive willow swamp (WL5.4). A creek running through the swamp enters the northeast corner of the WL5.3. Muskgrass is the defining feature of the shallow water wetland. The marsh is the ubiquitous Wm01 which, typically, included more beaked sedge than water sedge.

See Photo 9, Appendix E.

Landscape Context

This wetland is the most northerly wetland feature in this beaver-created complex of shallow water, low gradient channels and marsh. It is formed in a drainage channel that runs along the base of the slope below the Alexander Creek Forest Service Road

Conservation

This wetland, being the first of the shallow water wetlands along this drainage, appears to have a high rate of turnover than some of the associated downstream shallow water wetlands.

Muskgrass shallow water wetlands are not given conservation ranks by the BCCDC and the marsh, Wm01, is not of conservation concern.

2.6.5 Wetland WL5.4

WL5.4 is a large complex of willow swamp and small pockets of sedge marsh sustained by a meandering channel that feeds the downstream wetlands WL5.3 and WL5.2.

Table 21. Main characteristics of WL5.4

Characteristic	WL5.4
Elevation (m)	1444
BEC	MSdw
Total Estimated Area (ha)	1.92
WSI (wetland shape index)	1.6
Orientation	N-S
Flow (St, Sl, Mo, Dy, VD)	Mo
Hydroperiod (P, S, E)	P
Origin	Non-anthropogenic (Natural). Beaver (partially).

Table 22. WL5.4 classification information

Wetland Classification Information	Primary Component	Secondary Component
Soil (depth to mineral; cm)	<20 (but variable)	<40
Soil (humic, mesic, fibric, van Post)	-	-
Wetland Class	Swamp	Marsh
Wetland Complex Component Area (ha)	1.54	0.38
Estimated Area of Wetland Complex (% of total)	80	20
B.C. Wetland	Ws04	Wm01
English Name	Drummond's willow - Beaked sedge Swamp	Beaked sedge - Water sedge
Scientific Name	<i>Salix drummondiana</i> - <i>Carex utriculata</i> Swamp	<i>Carex utriculata</i> - <i>Carex aquatilis</i>
CWCS	Flat Swamp: Basin Swamp	Riparian Stream Marsh
Provincial Status	not ranked	S4
B.C. List	not ranked	Yellow
Global Status	unknown	G4

Description

WL5.4 is an extensive tall shrub (willow) swamp interspersed with sedge marsh. A small channel runs through it, draining into WL5.3. Ws04 Drummond's willow – beaked sedge Swamp forms the dominant overstory. Beaked sedge and water sedge form small patches along with sweet coltsfoot (*P. f. var. sagittatus*), common horsetail and herbs.

See Photo 9, Appendix E.

Landscape Context

WL5.4 is the most northerly wetland in the series of wetlands labelled as WL5. It is fed by small creek that runs along the west side of a wet meadow of creeping buttercup (*Ranunculus repens*) frequented by cattle.

Conservation

The dense growth of willow appears to discourage cattle. Changes to drainage, particularly the flow characteristics of the feeder creek, will affect the swamp and downstream wetlands WL5.2 and 5.3. Changes to flow characteristics of the feeder creek will result in floristic and structural changes that may not be apparent for some time.

The swamp (Ws04) is not ranked by the BCCDC (2019).

2.7 Wetlands WL6, WL6.1 and WL6.2

Wetland WL6 is shallow water wetland that drains through a channel to the east. WL6.1 is a wet channel extending from the southwest edge of WL6 below the beaver dam. It appears to be the former drainage channel that now supports marsh over much of its length. It is supplemented by a small creek that drains from a culvert under the road to the west. The channel drains into a small shallow water wetland, WL6.1.

2.7.1 Wetland WL6

WL6 is a shallow water wetland with a peripheral marsh along the shallow north portion that transitions to upland.

Table 23. Main characteristics of WL6

Characteristic	WL6
Elevation (m)	1494
BEC	MSdw
Total Estimated Area (ha)	0.45
WSI (wetland shape index)	1.6
Orientation	N-S
Flow (St, Sl, Mo, Dy, VD)	Mo
Hydroperiod (P, S, E)	P
Origin	Non-anthropogenic (Natural). Beaver. Anthropogenic (partly: culvert and roadside clearing).

Table 24. WL6 classification information

Wetland Classification Information	Primary Component	Secondary Component
Soil (depth to mineral; cm)	<40	n/a
Soil (humic, mesic, fibric, van Post)	-	n/a
Wetland Class	Marsh	Shallow water
Wetland Complex Component Area (ha)	0.27	0.18
Estimated Area of Wetland Complex (% of total)	60	40
B.C. Wetland	Wm01	Ww
English Name	Beaked sedge - Water sedge	Shallow water

Wetland Classification Information	Primary Component	Secondary Component
Scientific Name	<i>Carex utriculata</i> - <i>Carex aquatilis</i>	Association undetermined - no aquatic plants observed
CWCS Classification	Riparian Stream Marsh	Basin Water: Linked Basin Water
Provincial Status	S4	not ranked
B.C. List	Yellow	not ranked
Global Status	G4	not ranked

Description

This shallow water wetland and peripheral marsh located beside the road in the north portion of the south access area. It developed from a beaver dam in a small creek channel. Clearing around the culvert beneath Alexander Creek Forest Service Road suggests the wetland was at least partially influenced by human activity. In addition to this creek, another small creek flows into the pond from the northeast. It drains through a channel at the southwest end of the wetland. Beaked sedge, Arctic (Baltic) rush (*Juncus balticus*), sweet coltsfoot (*Petasites frigidus* var. *frigidus*), meadow-foxtail (*Alopecurus* sp.) and common horsetail grow along the edges of the shallow water wetland in what is probably best classified as a depauperate beaked sedge – water sedge marsh (Wm01). No floating aquatic vegetation was observed but masses of gelatinous algae are present in isolated, stagnant, shallow peripheral portions of the wetland.

Landscape Context

WL6 is a beaver dam wetland along a creek beside the Alexander Creek Forest Service Road.

Conservation

Shallow water wetlands are not listed by the BCCDC and the marsh, Wm01, is not of conservation concern.

2.7.2 Wetland WL6.1

WL6.1 is a linear marsh along a shallow channel.

Table 25. Main characteristics of WL6.1

Characteristic	WL6
Elevation (m)	1492
BEC	MSdw
Total Estimated Area (ha)	0.16
WSI (wetland shape index)	2.3
Orientation	N-S
Flow (St, SI, Mo, Dy, VD)	Mo

Characteristic	WL6
Hydroperiod (P, S, E)	P
Origin	Non-anthropogenic (Natural). Beaver. Anthropogenic (partly: culvert and roadside clearing).

Table 26. WL6.1 classification information

Wetland Classification Information	Primary Component
Soil (depth to mineral; cm)	<40
Soil (humic, mesic, fibric, van Post)	-
Wetland Class	Marsh
Wetland Complex Component Area (ha)	0.16
Estimated Area of Wetland Complex (% of total)	100
B.C. Wetland	Wm01
English Name	Beaked sedge - Water sedge
Scientific Name	<i>Carex utriculata</i> - <i>Carex aquatilis</i>
CWCS Classification	Riparian Stream Marsh
Provincial Status	S4
B.C. List	Yellow
Global Status	G4

Description

This marsh extends along the edge of a narrow channel, varying in shape and size.

Landscape Context

This appears to be an old outflow channel from WL6, no longer receiving above ground water from WL6. A creek crossing the forest service road joins the channel about half way along its length.

Conservation

The marsh is not of conservation concern.

2.7.3

Wetland WL6.2

WL6.2 is a shallow water wetland formed by a beaver dam.

Table 27. Main characteristics of WL6.2

Characteristic	WL6.2
Elevation (m)	1490
BEC	MSdw
Total Estimated Area (ha)	0.02
WSI (wetland shape index)	1.3

Characteristic	WL6.2
Orientation	N-S
Flow (St, Sl, Mo, Dy, VD)	Mo
Hydroperiod (P, S, E)	P
Origin	Non-anthropogenic (Natural). Beaver. Anthropogenic (partly: culvert and roadside clearing).

Table 28. WL6.2 classification information

Wetland Classification Information	Primary Component
Soil (depth to mineral; cm)	n/a
Soil (humic, mesic, fibric, van Post)	n/a
Wetland Class	Shallow water
Wetland Complex Component Area (ha)	0.02
Estimated Area of Wetland Complex (% of total)	100
B.C. Wetland	Ww
English Name	Shallow water
Scientific Name	Association undetermined - no aquatic plants observed
CWCS Classification	Basin Water: Linked Basin Water
Provincial Status	not ranked
B.C. List	not ranked
Global Status	unknown

Description

This shallow water is the last of the series of wetlands relating to WL6. It receives water from a creek crossing the forest service road and flowing into WL6.1. No aquatic plants were noted so the shallow water wetland association was undetermined.

Landscape Context

WL6.1 is the last wetland feature in a channel beginning at WL6.

Conservation

Shallow water wetlands are not listed by the BCCDC.

2.8

Wetland WL7

WL7 comprises small marshes among extensive wet herbaceous meadows at the toe of a steep slope.

Table 29. Main characteristics of WL7

Characteristic	WL7
Elevation (m)	2089
BEC	ESSFdkw
Total Estimated Area (ha)	0.08
WSI (wetland shape index)	2.0
Orientation	N-S
Flow (St, Sl, Mo, Dy, VD)	Sl
Hydroperiod (P, S, E)	-
Origin	Non-anthropogenic.

Table 30. WL7 classification information

Wetland Classification Information	Primary Component
Soil (depth to mineral; cm)	>40
Soil (humic, mesic, fibric, van Post)	humic; 7-8
Wetland Class	marshes (scattered, small)
Wetland Complex Component Area (ha)	0.08
Estimated Area of Wetland Complex (% of total)	100
B.C. Wetland	Wm01
English Name	Beaked sedge - Water sedge
Scientific Name	<i>Carex utriculata</i> - <i>Carex aquatilis</i>
CWCS	Slope Marsh
Provincial Status	S4
B.C. List	Yellow
Global Status	G4

Description

WL7 comprised small marshes on deep peat amongst sloping wet meadows of globeflower (*Trollius albiflorus*), valerian (*Valeriana* sp.), meadowrue (*Thalictrum* sp.), green false-hellebore (*Veratrum viride* var. *eschscholziaenum*), arrow-leaved groundsel (*Senecio triangularis*) and common horsetail. The wet meadow best fits ESSFdkw/110. The small marshes¹ were considered Wm01 and thought to be predominantly or solely water sedge, although the plants were very young at the time of the site visit (July 4, 2018). The site was visited only once. Rock fall from road construction above this area after the first visit made a subsequent visit hazardous. Avalanche and rock fall are threats to these site associations.

Landscape Context

WL7 spans the lower portion of a steep, west-facing slope of a high elevation valley.

¹ Although fens are more common at these elevations, the peat of these wetlands was highly decomposed (humic) and as such, the wetland is considered a marsh.

Conservation

The terrestrial, wet meadows, ESSFdw/110, are not listed by the BCCDC but have sensitive soils and hydrology for which timber harvesting is not recommended (MacKillop et al. 2018). The small creeks, wet meadows and small Wm01 marshes are sensitive to changes in water flows. Water flow could be interrupted by timber harvesting above the site. Avalanches threaten these communities.

2.9 Wetlands WL8.1, WL8.2, and WL8.3

Wetlands WL8.1, 8.2, and 8.3 are aligned along a drainage channel in a small valley. A small, ephemeral marsh (WL8.1) lies in a bowl above the large shallow water wetland (WL8.2) that drains into the headwaters of West Alexander Creek through a small marsh (WL8.3) at its south end.

2.9.1 Wetland WL8.1

WL8.1 is a small, ephemeral marsh in a large meadow in a “bowl” at the top of the valley.

Table 31. Main characteristics of WL8.1

Characteristic	WL8.1
Elevation (m)	1873
BEC	ESSFdk1
Total Estimated Area (ha)	0.04
WSI (wetland shape index)	1.2
Orientation	N-S
Flow (St, SI, Mo, Dy, VD)	SI
Hydroperiod (P, S, E)	S, E
Origin	Uncertain. Probably non-anthropogenic.

Table 32. WL8.1 classification information

Wetland Classification Information	Primary Component
Soil (depth to mineral; cm)	0 – surface
Soil (humic, mesic, fibric, van Post)	-
Wetland Class	Marsh
Wetland Complex Component Area (ha)	0.04
Estimated Area of Wetland Complex (% of total)	100
B.C. Wetland	Wm16
English Name	Bluejoint - Arrow-leaved groundsel
Scientific Name	<i>Calamagrostis canadensis</i> - <i>Senecio triangularis</i>
CWCS	Riparian Meltwater Channel Marsh ("situated in broad spillway valleys, and alluvial and outwash plains." CWCS 1997; p. 49)
Provincial Status	not ranked
B.C. List	not ranked
Global Status	not ranked

Description

WL8.1 is a small marsh or ephemeral pool. A low cover of grass (~15%) forms later in the season.

Landscape Context

WL8.1 is located on the lower slope of a large meadow that drains into the shallow water wetland (WL8.2).

Conservation

WL8.1 lies in a large meadow with small channels, and depressions in which water accumulates early in the season. It is very small example of Wm16, which is not listed by the BCCDC.

2.9.2**WL8.2**

WL8.2 is a large shallow water wetland at the base of steep, forested slopes to the east and west.

Table 33. Main characteristics of WL8.2

Characteristic	WL8.2
Elevation (m)	1873
BEC	ESSFdk1
Total Estimated Area (ha)	0.55
WSI (wetland shape index)	1.2
Orientation	N-S
Flow (St, Sl, Mo, Dy, VD)	St
Hydroperiod (P, S, E)	P
Origin	Non-anthropogenic (Natural).

Table 34. WL8.2 classification information

Wetland Classification Information	Primary Component	Secondary Component
Soil (depth to mineral; cm)	n/a	<40
Soil (humic, mesic, fibric, van Post)	n/a	-
Wetland Class	Shallow water	Marsh
Wetland Complex Component Area (ha)	0.43	0.12
Estimated Area of Wetland Complex (% of total)	78	22
B.C. Wetland	Ww	Wm01
English Name	Shallow water	Beaked sedge - Water sedge
Scientific Name	Association undetermined - possibly pondweed	<i>Carex utriculata</i> - <i>Carex aquatilis</i>
CWCS	Linked Basin Water	Lacustrine Shore Marsh
Provincial Status	not ranked	S4
B.C. List	not ranked	Yellow
Global Status	unknown	G4

Description

WL8.2 is a large shallow water wetland in a basin at the headwaters of West Alexander Creek. Water exits the wetland through a small marsh (WL8.3) at its south end and drains into a narrow valley. Wm01 beaked sedge – water sedge marsh occupies the inflow of the creek at the northeast end of the shallow water wetland and forms a narrow band (1-2 m wide) along the east edge. This wetland was assigned Ww (Pondweed) because it bears resemblance to pondweed shallow waters, but no pondweed was observed to confirm it.

Landscape Context

WL 8.2 lies in a depression at the top West Alexander Creek valley.

Conservation

The Ww (Pondweed) is a tentative shallow water wetland site association. No shallow water wetland association is listed by the BCCDC. Wm01 is not of conservation concern.

2.9.3

WL8.3

WL8.3 is a small sedge marsh at the outflow and south end of WL8.2.

Table 35. Main characteristics of WL8.3

Characteristic	WL8.3
Elevation (m)	1873
BEC	ESSFdk1
Total Estimated Area (ha)	0.03
WSI (wetland shape index)	1.2
Orientation	N-S
Flow	SI
Hydroperiod	S
Origin	Non-anthropogenic (Natural).

Table 36. WL8.3 classification information

Wetland Classification Information	Primary Component
Soil (depth to mineral; cm)	20
Soil (humic, mesic, fibric, van Post)	-
Wetland Class	Marsh
Wetland Complex Component Area (ha)	0.03
Estimated Area of Wetland Complex (% of total)	100
B.C. Wetland	Wm01
English Name	Beaked sedge - Water sedge
Scientific Name	<i>Carex utriculata</i> - <i>Carex aquatilis</i>
CWCS	Lacustrine Shore Marsh
Provincial Status	S4

Wetland Classification Information	Primary Component
B.C. List	Yellow
Global Status	G4

Description

WL8.3 is a small Wm01 marsh at the south end of a large shallow water wetland (WL8.2). It is connected to the linear shoreline marsh of WL8.2 and represents a more expansive and defined version of that with a greater abundance of beaked sedge.

See Photo 10, Appendix E.

Landscape Context

WL8.3 is situated at the headwaters of West Alexander Creek. The marsh is an extension of the shallow water wetland.

Conservation

This marsh is dependent on water levels in WL8.2. See the discussion under WL8.2.

2.10

Wetland WL9

WL9 is a channel and floodplain complex along Grave Creek where it broadens at the inflow to Harmer Lake reservoir (WL10).

Table 37. Main characteristics of WL9

Characteristic	WL9
Elevation (m)	1325
BEC	MSdw
Total Estimated Area (ha)	0.57
WSI (wetland shape index)	1.7
Orientation	NW-SE
Flow (St, Sl, Mo, Dy, VD)	Dy
Hydroperiod (P, S, E)	P
Origin	Non-anthropogenic (Natural). Beaver / Anthropogenic.

Table 38. WL9 classification information

Wetland Classification Information	Primary Component	Secondary Component	Tertiary Component
Soil (depth to mineral; cm)	-		n/a
Soil (humic, mesic, fibric, van Post)	-		n/a
Wetland Class	Floodplain	Floodplain	Shallow water
Wetland Complex Component Area (ha)	0.20	0.20	0.17

Wetland Classification Information	Primary Component	Secondary Component	Tertiary Component
Estimated Area of Wetland Complex (% of total)	35	35	30
B.C. Wetland	F101	F104	Ww
English Name	Mountain alder – Common horsetail Flood Association	Sitka willow – Red-osier dogwood – Horsetail Flood Association	Shallow water - beaver pond
Scientific Name	<i>Alnus incana</i> - <i>Equisetum</i> spp. Flood Association	<i>Salix sitchensis</i> - <i>Cornus stolonifera</i> - <i>Equisetum</i> spp. Flood Association	Shallow water association undetermined - no plants observed
CWCS	Riverine Swamp	Riverine Swamp	Linked Basin Water
Provincial Status	not ranked	not ranked	not ranked
B.C. List	not ranked	not ranked	not ranked
Global Status	unknown	unknown	unknown

Description

WL9 is a low bench floodplain complex along Grave Creek. It consists of the main creek channel and smaller side channels inundated during freshet, and a large, terminal shallow water wetland created by a beaver dam. Portions of the beaver dam are new, so the shallow water wetlands are young and poorly developed, ecologically. No distinct aquatic plants were noted in new or older ponds to confirm a shallow wetland site association. Increased deposition of fine sediment, sand and gravel in new areas is expected. Willow and red-osier dogwood along old channels will likely die out as new stands are formed on the periphery in areas of shallower water and temporary flooding. The flood association is a low bench, meaning it occurs in a low topographic position with frequent and prolonged inundation, similar, and adjacent to areas of swamp.

See Photo 3, Appendix E.

Landscape Context

WL9 has formed in a broadened section of Harmer Creek where water flows into the reservoir along Harmer Creek at WL10.

Conservation

This floodplain is a dynamic system that maintains large areas of early succession vegetation (shrubs). This constant change and relative successional stasis define its ecological value.

Wetland WL10

WL10 is narrow band of marsh along the north edge of a large human-created reservoir formed by damming Harmer Creek. The reservoir sustains the wetland located at WL10.

Table 39. Main characteristics of WL10

Characteristic	WL10
Elevation (m)	1322
BEC	MSdw
Total Estimated Area (ha)	0.03
WSI (wetland shape index)	1.6
Orientation	NW-SE
Flow (St, Sl, Mo, Dy, VD)	Mo
Hydroperiod (P, S, E)	P
Origin	Anthropogenic

Table 40. WL10 classification information

Wetland Classification Information	Primary Component
Soil (depth to mineral; cm)	<40
Soil (humic, mesic, fibric, van Post)	-
Wetland Class	Marsh
Wetland Complex Component Area (ha)	0.03
Estimated Area of Wetland Complex (% of total)	100
B.C. Wetland	Wm01
English Name	Beaked sedge - Water sedge
Scientific Name	<i>Carex utriculata</i> - <i>Carex aquatilis</i>
CWCS	Shoreline Marsh
Provincial Status	S4
B.C. List	Yellow
Global Status	G4

Description

This small marsh forms the shoreline of the large reservoir at the base of the road bank.

Landscape Context

The shoreline marsh forms a linear band along the north side of this large reservoir, at the bottom of the road embankment.

Conservation

This small beaked sedge – water sedge marsh (Wm01) is not of conservation concern in British Columbia.

2.12 Wetlands WL11.1, WL11.2, WL11.3, WL11.3a, and WL11.3b

WL11 is broken into five wetlands – WL11.1, 11.2, 11.3, 11.3a, and WL11.3b. WL11.1 is a shallow water wetland at a road intersection and culvert at the south end of WL11.2 which is a series of shallow water wetlands and channels along the creek draining Grave Lake. WL11.3 and WL11.3b are shoreline marshes along the south edge of Grave Lake. WL11.3a is a linear swamp between WL11.3 and the adjacent upland.

2.12.1 Wetland WL11.1

WL11.1 is a partly channelized shallow water wetland extending north from the culvert through which it drains beneath Harmer Road.

Table 41. Main characteristics of WL11.1

Characteristic	WL11.1
Elevation (m)	1263
BEC	MSdw
Total Estimated Area (ha)	0.21
WSI (wetland shape index)	1.8
Orientation	E-W
Flow (St, Sl, Mo, Dy, VD)	Mo
Hydroperiod (P, S, E)	P
Origin	Anthropogenic

Table 42. WL11.1 classification information

Wetland Classification Information	Secondary Component	Primary Component
Soil (depth to mineral; cm)	<20	-
Soil (humic, mesic, fibric, van Post)	-	-
Wetland Class	Marsh	Shallow water
Wetland Complex Component Area (ha)	0.11	0.10
Estimated Area of Wetland Complex (% of total)	54	46
B.C. Wetland	Wm01	Ww Yellow pond-lily Type
English Name	Beaked sedge - Water sedge	Yellow pond-lily - Bladderwort shallow water
Scientific Name	<i>Carex utriculata</i> - <i>Carex aquatilis</i>	Ww <i>Nuphar lutea</i> - <i>Utricularia macrorhiza</i>
CWCS	Artificial Wetland	Artificial Wetland
Provincial Status	S4	not ranked
B.C. List	Yellow	not ranked
Global Status	G4	unknown

Description

WL11.1 extends north and east from the outflow culvert at Harmer Road. The northern portion is at the bottom of a flooded channel that forms part of the linear WL11.2. A narrow band of Beaked sedge – water sedge marsh lines the steep edge of the wetland near Harmer Road and both sides of the flooded channel that extends northward. No yellow pond-lily (*Nuphar lutea*) was observed but greater bladderwort (*Utricularia macrorhiza*) is abundant. The marsh is Wm01 beaked sedge – water sedge, the common marsh wetland site association in the project area. The wetland moss, *Drepanocladus longifolius*, is very abundant on the water's surface and areas of shallow shoreline.

The shoreline is variably steep and gradual. Gradual sections support sedges, common horsetail and wetland mosses.

Landscape Context

WL11.1 is the bottom portion of the creek draining Grave Lake. The intersection of two roads forms a barrier that created this wetland.

Conservation

The Ww Yellow pond-lily - Bladderwort shallow water shallow water site association is uncommon in the project area but not listed by the BCCDC. The wetland moss *Drepanocladus longifolius* is especially abundant at this wetland. It is Yellow-listed in British Columbia, but few collections have been made.

2.12.2

Wetland WL11.2

WL11.2 is a series of beaver-created shallow water wetlands and channels along the creek that drains Grave Lake. Sedge marsh occupies the edges of the shallow waters and slow-moving channels. Cattail marsh in small pockets in the north section along the channel and in drained beaver ponds.

Table 43. Main characteristics of WL11.2

Characteristic	WL11.2
Elevation (m)	1265
BEC	MSdw
Total Estimated Area (ha)	0.88
WSI (wetland shape index)	2.6
Orientation	NE-SW
Flow (St, Sl, Mo, Dy, VD)	Mo
Hydroperiod (P, S, E)	P, S
Origin	Non-anthropogenic (Natural); Beaver.

Table 44. WL11.2 classification information

Wetland Classification Information	Primary Component	Secondary Component	Tertiary Component	Quaternary Component
Soil (depth to mineral; cm)	n/a	<40	<40	n/a
Soil (humic, mesic, fibric, van Post)	n/a	-	-	n/a
Wetland Class	Shallow water	Marsh	Marsh	Shallow water
Wetland Complex Component Area (ha)	0.43	0.36	0.06	0.03
Estimated Area of Wetland Complex (% of total)	49	41	7	3
B.C. Wetland	Ww Muskgrass	Wm01	Wm05	WW White Water-Buttercup
English Name	Muskgrass	Beaked sedge - Water sedge	Cattail marsh	White water-buttercup
Scientific Name	<i>Chara</i> sp.	<i>Carex utriculata</i> - <i>Carex aquatilis</i>	<i>Typha latifolia</i> marsh	<i>Ranunculus aquatilis</i>
CWCS	Linked Basin Water	Riparian Stream Marsh	Riparian Stream Marsh	Linked Basin Water
Provincial Status	not ranked	S4 /S3	S3	not ranked
B.C. List	not ranked	Yellow / Blue	Blue	not ranked
Global Status	unknown	G4 / G5	G5	unknown

Description

W11.2 is a series of small beaver dam wetlands and connecting channels along the creek draining Grave Lake. The ponds become smaller and more degraded, and the channels narrower, towards the north. The presence of muskgrass in most of the shallow water wetlands suggests they are Muskgrass shallow water wetlands (Ww Muskgrass) but some differences, such as the presence of white water-buttercup (*Ranunculus aquatilis*), suggest other associations such as Ww white water-buttercup (MacKenzie and Moran 2004). The marsh wetland site association Wm01 beaked sedge – water sedge, occurs in varying widths along the length of the creek. Small patches of cattail (*Typha latifolia*) marsh (Wm05) are present in the north half along the channel and in drained beaver ponds.

These shallow water wetlands have more large organic debris in the water than most other wetlands examined. Felled trees and other woody debris are abundant. Aquatic vegetation (mosses, vascular plants and algae) appears more abundant and diverse than most other shallow water wetlands.

Landscape Context

WL11.2 comprises shallow water wetlands and marsh along the creek draining Grave Lake.

Conservation

The few wetland site associations used to define this drainage channel belie its physical and structural complexity and floristic diversity. The Wm05 cattail marsh is Blue-listed in British Columbia. Wm01 beaked sedge – water sedge is common in the project area and throughout British Columbia. The BCCDC gives no conservation status rankings for Ww Muskgrass or Ww White Water-Buttercup.

2.12.3

Wetland WL11.3

WL11.3 is a shoreline marsh along the south shore of Grave Lake.

Table 45. Main characteristics of WL11.3

Wetland	WL11.3
Elevation (m)	1269
BEC	MSdw
Total Estimated Area (ha)	0.78
WSI (wetland shape index)	2.4
Orientation	E-W
Flow (St, Sl, Mo, Dy, VD)	Mo (wave)
Hydroperiod (P, S, E)	P, S
Origin	Non-anthropogenic (Natural).

Table 46. WL11.3 classification information

Wetland Classification Information	Primary Component	Secondary Component
Soil (depth to mineral; cm)	<40	<40
Soil (humic, mesic, fibric, van Post)	CaCO ₃ (shells)	-
Wetland Complex Component Area (ha)	Marsh	Marsh
Estimated Area of Wetland Complex (% of total)	0.39	0.39
% of Total	50	50
B.C. Wetland	Wm06	Wm01
English Name	Great bulrush marsh	Beaked sedge - Water sedge marsh
Scientific Name	<i>Schoenoplectus acutus</i>	<i>Carex utriculata</i> - <i>Carex aquatilis</i>
CWCS	Lacustrine Shore Marsh	Lacustrine Shore Marsh
Provincial Status	S3	S4
B.C. List	Blue	Yellow
Global Status	G5	G4

Description

WL11.3 is a lacustrine shore marsh along the south shore of Grave Lake. It consists of two adjoining, parallel bands of distinctive marsh wetland site associations, one along the open water and one inland. A dense, monotypic stand of hard-stemmed bulrush (*Schoenoplectus acutus*) forms the Wm06 Bulrush Marsh along the water's edge while the band of Wm01 beaked sedge – water sedge marsh occurs more inland.

Landscape Context

WL11.3 forms a large, flat marsh stretching along the south edge of Grave Lake adjacent to a willow swamp /marsh transitional to the nearby upland.

Conservation

WL11.3 is a product of its location at the south end of a large open body of water. Wind, waves, and fluctuating water levels are forces that have and continue to influence the nature of these wetlands. This marsh filters debris entering WLS 11.2 and 11.1 and absorbs wave energy. The Great bulrush marsh component is provincially Blue-listed.

2.12.4

Wetland WL11.3a

WL11.3a is a willow swamp located landward from the shoreline marsh along the south shore of Grave Lake.

Table 47. Main characteristics of WL11.3a

Characteristic	WL11.3a
Elevation (m)	1269
BEC	MSdw
Total Estimated Area (ha)	1.14
WSI (wetland shape index)	2.4
Orientation	E-W
Flow (St, Sl, Mo, Dy, VD)	St
Hydroperiod (P, S, E)	S
Origin	Non-anthropogenic (Natural).

Table 48. WL11.3a classification information

Wetland Classification Information	Primary Component
Soil (depth to mineral; cm)	-
Soil (humic, mesic, fibric, van Post)	-
Wetland Class	Swamp
Wetland Complex Component Area (ha)	1.14
Estimated Area of Wetland Complex (% of total)	100
B.C. Wetland	Ws05 (probable)
English Name	MacCalla's willow - Serviceberry willow - Beaked sedge
Scientific Name	<i>Salix maccalliana</i> – <i>Salix pseudomonticola</i> - <i>Carex utriculata</i>
CWCS	Lacustrine Swamp
Provincial Status	not ranked
B.C. List	not ranked
Global Status	unknown

Description

WL11.3a is a lacustrine swamp located landward from the lacustrine shore marsh along the south shore of Grave Lake. It comprises scattered and clumped MacCalla's (*Salix macalliana*) and serviceberry (*Salix pseudomonticola*) willows. It best fits the Ws05 swamp site association.

Landscape Context

WL11.3a is a lacustrine swamp located landward from the lacustrine shore marsh along the south shore of Grave Lake.

Conservation

There is no known site association to define this assemblage of willows which is rare in the LSA. The only other known occurrence is in WL13.

2.12.5**Wetland WL11.3b**

WL11.3b is a westward continuation of the great bulrush marsh of 11.3 that lies adjacent to the open water of Grave Lake. It lacks an extensive sedge marsh and swamp between the wetland and the upland.

Table 49. Main characteristics of WL11.3b

Characteristic	WL11.3b
Elevation (m)	1269
BEC	MSdw
Total Estimated Area (ha)	0.72
WSI (wetland shape index)	2.6
Orientation	E-W
Flow (St, Sl, Mo, Dy, VD)	Mo (wave)
Hydroperiod (P, S, E)	P, S
Origin	Non-anthropogenic (Natural).

Table 50. WL11.3b classification information

Wetland Classification Information	Primary Component
Soil (depth to mineral; cm)	<40
Soil (humic, mesic, fibric, van Post)	CaCO ₃ (shells)
Wetland Class	Marsh
Wetland Complex Component Area (ha)	0.72
Estimated Area of Wetland Complex (% of total)	100
B.C. Wetland	Wm06
English Name	Great bulrush marsh
Scientific Name	<i>Schoenoplectus acutus</i> marsh
CWCS	Lacustrine Shore Marsh
Provincial Status	S3

Wetland Classification Information	Primary Component
B.C. List	Blue
Global Status	G5

Description

WL11.3b is a lacustrine shore marsh of hard-stemmed bulrush, extending westward from 11.3 along the shoreline of Grave Lake.

Landscape Context

WL11.3b extends along the south shoreline of Grave Lake between the open water to the north and upland forest to the south.

Conservation

This shoreline marsh absorbs waver energy from the lake. The Great bulrush marsh or hard-stemmed bulrush is provincially Blue-listed.

2.13 Wetland WL12

WL12 is a large wetland complex with sedge fen, small shallow water wetlands and associated marsh.

Table 51. Main characteristics of WL12

Characteristic	WL12
Elevation (m)	1298
BEC	MSdw
Total Estimated Area (ha)	2.44
WSI (wetland shape index)	1.3
Orientation	N-S
Flow (St, Sl, Mo, Dy, VD)	St
Hydroperiod (P, S, E)	S
Origin	Non-anthropogenic (Natural); Anthropogenic (possibly, partly).

Table 52. WL12 classification information

Wetland Classification Information	Primary Component	Secondary Component	Tertiary Component
Soil (depth to mineral; cm)	40 – 45	-	n/a
Soil (humic, mesic, fibric, van Post)	mesic/humic; 6-7	-	n/a
Wetland Class	Transitional/Succ essional Marsh- Fen	Marsh	Shallow water
Wetland Complex Component Area (ha)	2.05	0.27	0.12
Estimated Area of Wetland Complex (% of total)	84	11	5

Wetland Classification Information	Primary Component	Secondary Component	Tertiary Component
B.C. Wetland	Wm01 / Wf01	Wm05	Ww Pondweed
English Name	Beaked sedge - Water sedge marsh / Water sedge - Beaked sedge fen	Common cattail Marsh	Pondweed shallow water
Scientific Name	<i>Carex utriculata</i> - <i>Carex aquatilis</i> marsh / <i>Carex aquatilis</i> - <i>Carex utriculata</i> fen /	<i>Typha latifolia</i> marsh	<i>Potamogeton</i> shallow water
CWCS	Linked Basin Marsh / Horizontal Fen	Linked Basin Marsh	Linked Basin Water
Provincial Status	S4 / S4 / (S3)	S3	not ranked
B.C. List	Yellow / Yellow / (Blue)	Blue	not ranked
Global Status	G4 / G4 / (G5)	G5	unknown

Description

Graminoid fen (Wf01 water sedge – beaked sedge) constitutes most of this wetland complex but the presence of Wm01 marsh within the area suggests it is transitioning from marsh (Wm01) to graminoid fen (Wf01). Wm05 (common cattail marsh) is restricted to the periphery of the shallow water wetland, and marsh (Wm01) is confined to the wetland edge. The abundance of beaked sedge and water sedge varies between locations. A thick layer of mesic peat overlays humic peat but this varies between location indicating the presence of both marsh and fen. Siberian water-milfoil (*Myriophyllum sibiricum*) is abundant in portions of the shallow water. Pondweed (*Potamogeton* sp.) was also recorded.

Landscape Context

WL12 is the most northerly wetland examined. It is located north of WL13 in shallow basin along a small drainage channel. A road runs along its east side.

Conservation

This wetland, though predominantly fen, had no strong fen-associated plants or distinguishing floristic characteristics. It was indistinguishable from marsh (Wm01) outside of the thick layer of mesic peat. Although fens are uncommon in the study area and the East Kootenay, this fen does not possess features of ecological significance or distinctiveness that might separate it from a conservation perspective, from its marsh counterpart, Wm01. It may be a good example of Wm01 succeeding to Wf01. Common cattail marsh (Wm05) is a blue-listed wetland site association. It provides important habitat for red-winged blackbirds and other wetland associated birds.

Wetland WL13

WL13 is a very large complex of distinctive marsh/fen, swamp and shallow water arranged concentrically. It appears at least in part to have been created, or modified, by humans.

Table 53. Main characteristics of WL13

Characteristic	WL13
Elevation (m)	1285
BEC	MSdw
Total Estimated Area (ha)	8.84
WSI (wetland shape index)	1.3
Orientation	N-S
Flow (St, SI, Mo, Dy, VD)	SI
Hydroperiod (P, S, E)	P, S
Origin	Uncertain. Possibly anthropogenic and non-anthropogenic.

Table 54. WL13 classification information

Wetland Classification Information	Primary Component	Secondary Component	Tertiary Component	Quaternary Component
Soil (depth to mineral; cm)	>40	40-45	-	n/a
Soil (humic, mesic, fibric, van Post)	fibric; 4	mesic; 6-7	-	n/a
Wetland Class	Swamp	Transitional/Successional Marsh-Fen	Fen	Shallow water
Wetland Complex Component Area (ha)	4.86	2.03	1.50	0.44
Estimated Area of Wetland Complex (% of total)	55	23	17	5
B.C. Wetland	Ws05 (probable)	Wm01 / Wf01	Wf01	Ww
English Name	MacCalla's willow – Serviceberry willow - Beaked sedge	Beaked sedge - Water sedge marsh / Water sedge - Beaked sedge fen	Water sedge - Beaked sedge	Yellow pond-lily or Pondweed (probable)
Scientific Name	<i>Salix maccalliana</i> – <i>Salix pseudomonticola</i> - <i>Carex utriculata</i>	<i>Carex utriculata</i> - <i>Carex aquatilis</i> marsh / <i>Carex aquatilis</i> - <i>Carex utriculata</i> fen	<i>Carex aquatilis</i> - <i>Carex utriculata</i>	<i>Nuphar lutea</i> type or <i>Potamogeton</i>
CWCS	Lacustrine Swamp	Basin Fen / Lacustrine Lagoon Marsh	Shore Fen	Isolated Basin Water

Wetland Classification Information	Primary Component	Secondary Component	Tertiary Component	Quaternary Component
Provincial Status	not ranked	S4 / S4	S4	not ranked
B.C. List	not ranked	Yellow / Yellow	Yellow	not ranked
Global Status	unknown	G4 / G4	G4	none

Description

This is a large wetland complex with shallow water (possibly Ww yellow pond lily or Ww pondweed) at its centre and fen (presumed Wf01), swamp (probably Ws05) and marsh (Wm01) arranged concentrically outwards to the surrounding upland. An old, tall wire and post fence surrounds the inner graminoid fen/marsh and shallow water wetland. The width of the peripheral sedge marsh and fen (Wm01 and Wf01) varies considerably and, for the most part, changes abruptly into willow swamp, which most closely fits Ws05, at its inner edge. The outer marsh on the north and west edge of the wetland has areas of open water in spring and early summer. Peat depth is greater away from the wetland edge, but its consistency varies, indicating both graminoid fen and marsh in the south. Marsh is present near the wetland edge, adjacent to the upland. The inner and outer graminoid marsh/fen areas are presumed to be similar, with the suspicion, based on soil cores in the swamp, that the inner portion is fen rather than marsh. Water avens (*Geum rivale*) and marsh cinquefoil (*Comarum palustre*) are present among the beaked sedge in the marsh and swamp.

The central shallow water wetland (Ww) could not be examined closely but it is assumed to be either Yellow Pond Lily or Pondweed types based on information that could be acquired. Like many other wetlands, it may support Muskgrass (*Chara* sp.), an algae indicative of calcium and alkaline conditions. Greater Bladderwort (*Utricularia macrorhiza*) is present in pockets of the peripheral graminoid wetland (marsh/fen) which suggests that it may also occur in the shallow water portion of the wetland complex. The shallow water wetland may therefore closely resemble the Yellow Pond Lily – Bladderwort (*Nuphar lutea* – *Utricularia macrorhiza*) wetland site association although the presence of Yellow Pond Lily at this location was not determined.

Landscape Context

The wetland lies in a large basin fed by a small creek at the northwest corner and water draining from the surrounding slopes. During periods of high water such as from snow melt in early spring or prolonged rain, water can exit the wetland through a low, wet forest of Black Cottonwood (*Populus trichocarpa*) at the southwest. WL13 is the second-most northerly wetland examined during field investigations.

Conservation

This is the largest wetland in the study area² with each representative wetland type (marsh/fen, swamp and shallow water) present as large, contiguous units.

The large surface area of the wetland and surrounding drainage suggests that increases in airborne particulates could result in accumulation of these elements in the wetland with possible deleterious effects.

The presence of MacCalla's willow and serviceberry willow suggests Ws05 MacCalla's willow – serviceberry willow - beaked sedge wetland site association, plants also characteristic of WL11.3a.

2.15

Wetland WL14

This is a large wetland complex of marsh, swamp, mineral wetland and wet meadow.

Table 55. Main characteristics of WL14

Characteristic	WL14
Elevation (m)	1217
BEC	MSdw
Total Estimated Area (ha)	4.64
WSI (wetland shape index)	1.2
Orientation	N-S
Flow (St, Sl, Mo, Dy, VD)	Mo
Hydroperiod (P, S, E)	S, E
Origin	Non-anthropogenic (Natural).

² Although the WL10 is classed as wetland, only a small portion of it is wetland (Wm01). The rest is a human-made lake.

Table 56. WL14 classification information

Wetland Classification Information	Primary Component	Secondary Component	Tertiary Component	Quaternary Component	Quinary Component	Senary Component
Soil (depth to mineral; cm)	>40	<40	<40	<40	<40	<40
Soil (humic, mesic, fibric, van Post)	-	-	-	-	-	-
Wetland Class	Swamp (treed)	Transitional/Successional Marsh-Fen	Marsh	Transitional Mineral Wetland	Transitional Mineral Wetland	Marsh
Wetland Complex Component Area (ha)	1.83	1.24	0.55	0.54	0.38	0.10
Estimated Area of Wetland Complex (% of total)	39	27	12	12	8	2
B.C. Wetland	Ws07.2 (Wm01)	Wm01 - Wf01	Wm07	Ga03\$	Ga02\$ (probable)	Wm15 (probable)
English Name	Spruce – horsetail – soft-leaved sedge – leafy moss Swamp / (mixed beaked sedge - water sedge Marsh peripherally)	Successional Beaked sedge - Water sedge marsh / Water sedge - Beaked sedge fen	Baltic Rush Marsh	Field Sedge (Seral) Alkaline/saline meadow	Nuttall's alkaligrass – Foxtail barley (seral) Alkaline/saline meadow (probable)	Bluejoint - Beaked sedge (probable)
Scientific Name	<i>Picea engelmannii</i> x <i>glauca</i> - <i>Equisetum</i> spp. - <i>Mnium</i> spp. (Mniaceae) Swamp / (mixed <i>Carex utriculata</i> - <i>Carex aquatilis</i> Marsh peripherally)	<i>Carex utriculata</i> - <i>Carex aquatilis</i> marsh / <i>Carex aquatilis</i> - <i>Carex utriculata</i> fen	<i>Juncus balticus</i>	<i>Carex praegracilis</i> (Seral) Alkaline/saline meadow	<i>Puccinellia nuttalliana</i> - <i>Hordeum jubatum</i> (seral) Alkaline/saline meadow	<i>Calamagrostis canadensis</i> - <i>Carex utriculata</i>
CWCS	Basin Swamp (in Flat Swamp)	Linked Basin Marsh (Horizontal Fen)	Linked Basin Marsh	Non-wetland	Non-wetland-	Linked Basin Marsh
Provincial Status	S3 /Blue	S4 (S4)	S2	S1S2	S2	not ranked
B.C. List	Blue/Yellow	Yellow (Yellow)	Yellow	Red	Red	not ranked
Global Status	GNR/G4	G4 (G4)	GNR	G3G4	G3 (probable)	unknown

Description

WL14 supports a complex and diverse assemblage of wetland and wetland-associated transitional terrestrial ecosystems. The ecological classifications (BEC site associations), their size and distribution should be considered estimates, with some degree of uncertainty. Disturbance by ungulates influences site ecology along the broad wetted portion of an ephemeral creek and the adjacent vegetation of alkaline/saline meadow grassland site associations (Ga) in the northern portion of WL14. The history of human interference at WL14 is unknown.

The alkaline/saline meadow site associations Ga02 (Nuttall's alkaligrass – foxtail barley) and Ga03 (field sedge) are considered drier Wm07 (Baltic rush) sites (MacKenzie and Moran, 2004) and may occur upslope and adjacent to Wm07 (MacKillop et al., 2018). These three site associations occur in saline conditions and comprise some of the same species although they are defined by a predominance of a few: Nuttall's alkaligrass (*Puccinellia nuttalliana*) and foxtail barley (*Hordeum jubatum*) for Ga02; field sedge (*Carex praegracilis*) for Ga03; and Baltic rush (*Juncus balticus*) for Wm07 (MacKenzie and Moran, 2004; Coupé and Iverson, 2014; and MacKillop et al., 2018). In the east Kootenay, undisturbed examples of Ga03 with its defining characteristic, field sedge, have not been found. As a result, the disturbed, poor expression of Ga03 found in the East Kootenay area and lacking field sedge has been assigned the name Ga03\$ (MacKillop et al., 2018). Following this classification, the area denoted Ga02 has been assigned the name Ga02\$ to reflect its disturbed, seral state.

In Wm07, Baltic rush is always dominant while in Ga03 it represents a minor component and in Ga02 even less (MacKenzie and Moran, 2004; Coupé and Iverson, 2014; and MacKillop et al., 2018). Wm07 supports a less diverse assemblage of species than the Ga, with common silverweed (*Potentilla anserina* ssp. *anserina*) frequently present (Coupé and Iverson, 2014). As part of field surveys of WL14, Nuttall's alkali grass, a co-characteristic species of Ga02, and field sedge, the characteristic species of Ga03, were not confirmed; however, foxtail barley, the other characteristic species of Ga02 was present in patches within and adjacent to the broad, ungulate trampled wet area along the ephemeral creek.

The relatively sparse vegetation cover and presence of foxtail barley around the broad mineral channel at the north end of WL14 suggests Ga02, although the other defining species, Nuttall's alkaligrass was not confirmed. Therefore, this feature is considered probably, rather than definitively, Ga02 and is assigned the name Ga02\$. An area south of and adjacent to this wetted area, with greater vegetation cover and diversity, including a greater abundance of Baltic rush, closely matches Ga03\$. Southward, Baltic rush, with a minor component of common silverweed, becomes dominant and is indicative of Wm07. Eventually, moving south, the Wm07 yields to an increasing abundance of beaked sedge (*Carex utriculata*) and water sedge (*Carex aquatilis*) defining areas of graminoid marsh (Wm01), with patches of graminoid fen (Wf01) that transitions into the Ws07.2 spruce – horsetail – soft-leaved sedge – leafy moss. This treed swamp carries on through portions of the forest between WL14 and WL15.

Another saline tolerant sedge, Sartwell's sedge (*Carex sartwellii*), also found in wet meadows (Douglas et al., 2001a), was present south of the wetted ephemeral creek area in the Ga03\$ and Wm07 marsh.

The designation of a small area in the northeast as Wm15 (bluejoint – beaked sedge marsh) is based on an abundance of Canada bluejoint (*Calamagrostis canadensis*) in an area slightly wetter than the Ga03\$ meadow to the north. Defining an area of occupancy is difficult since Canada bluejoint is known to occur in the Wm07 in other areas of the province (MacKenzie and Moran, 2004), but not for Wm15 in the east Kootenay, nor for Ga03\$ (MacKillop et al., 2018). Some degree of variation within and among units is expected.

The relative contribution of a potential Ga02\$ was considered the area within and immediately surrounding the broad, ungulate-trampled ephemeral channel in the north. The relative contribution of Ga03\$ is considered the area adjacent to this area, an area slightly drier, with greater vegetation cover and species diversity. Southward, this grades into the Wm07 marsh which is distinguished by the dominant cover of Baltic Rush with some common silverweed (*Potentilla anserina*) growing beneath it. Areas occupied by each site association are difficult to determine and estimates are based on field observations and aerial imagery.

Landscape Context

WL14 is the most northerly wetland complex in a series of large graminoid wetlands (WL15, WL16, and WL 17) that fill depressions in a broad, flat valley. A small, ephemeral creek flows west across the north half and drains to the north at the northwest corner.

Conservation

WL14 contains a great mix of wetland site associations. The mineral area running along the small creek, adjacent to the Wm07, appears to be Ga02 (Nuttall's alkaligrass – foxtail barley), a Red-listed terrestrial alkaline/saline meadow (MacKillop et al., 2018) or transitional wetland (Gs02 in MacKenzie and Moran, 2004) unique among site associations encountered in the LSA. It typically occurs next to wetlands and is here present next to Ga03\$ Field Sedge (seral), another alkaline/saline meadow site association, which transitions to Wm07 (Baltic Rush), a Red-listed community. The grass-sedge marsh (Wm15 bluejoint - beaked sedge) occupies a small area and grades into the other types. It is not ranked by the BCCDC. Wm01 is not considered at risk. The south end of the wetland is a mix of marsh and swamp. The swamp is the Blue-listed Ws07.2 spruce – horsetail – soft-leaved sedge – leafy moss Swamp.

See Photos 13 and 14, Appendix E.

Wetland WL15

WL15 is a large, uniform marsh.

Table 57. Main characteristics of WL15

Characteristic Wetland	WL15
Elevation (m)	1216
BEC	MSdw
Total Estimated Area (ha)	2.59
WSI (wetland shape index)	1.6
Orientation	N-S
Flow (St, Sl, Mo, Dy, VD)	Sl
Hydroperiod (P, S, E)	P, S
Origin	Non-anthropogenic (Natural).

Table 58. WL15 classification information

Wetland Classification Information	Primary Component	Secondary Component
Soil (depth to mineral; cm)	30; 15; >40	n/a
Soil (humic, mesic, fibric, van Post)	-	n/a
Wetland Class	Marsh	Shallow water
Wetland Complex Component Area (ha)	2.56	0.03
Estimated Area of Wetland Complex (% of total)	99	1
B.C. Wetland	Wm01	Ww
English Name	Beaked sedge - Water sedge marsh	Ww site association undetermined; very small portion of open water in flooded marsh
Scientific Name	<i>Carex utriculata</i> - <i>Carex aquatilis</i>	Ww site association undetermined
CWCS	Linked Basin Marsh	Linked Basin Water
Provincial Status	S4	not ranked
B.C. List	Yellow	not ranked
Global Status	G4	unknown

Description

WL15 is a large wetland, uniformly covered by Wm01 beaked sedge – water sedge marsh. A small Ww shallow water wetland present at the south end has no distinctive characteristics. It is included here as a shallow water wetland because open water was always present though occupied a small area surrounded by a flooded marsh.

Landscape Context

WL15 is the middle of three large graminoid wetlands along a broad, flat drainage area. The wetland narrows at the south end where the shallow water wetland drains into the north end of WL16.

Conservation

No wetland site association is listed by the BCCDC as a wetland of conservation concern.

2.17

Wetland WL16

WL16 is the southernmost of the large graminoid wetlands that occupy the same, broad drainage area.

Table 59. Main characteristics of WL16

Characteristic	WL16
Elevation (m)	1215
BEC	MSdw
Total Estimated Area (ha)	2.44
WSI (wetland shape index)	1.5
Orientation	N-S
Flow (St, SI, Mo, Dy, VD)	SI
Hydroperiod (P, S, E)	P
Origin	Non-anthropogenic (Natural).

Table 60. WL16 classification information

Wetland Classification Information	Primary Component	Secondary Component	Tertiary Component	Quaternary Component
Soil (depth to mineral; cm)	15	30; >40	-	n/a
Soil (humic, mesic, fibric, van Post)	-	mesic	-	n/a
Wetland Class	Marsh	Marsh	Marsh	Shallow water
Wetland Complex Component Area (ha)	1.78	0.56	0.05	0.05
Estimated Area of Wetland Complex (% of total)	73	23	2	2
B.C. Wetland	Wm01	Wm06	Wm05	Ww Muskgrass
English Name	Beaked sedge - Water sedge marsh	Great bulrush deep marsh and fen	Common cattail marsh	Muskgrass shallow water
Scientific Name	<i>Carex utriculata</i> - <i>Carex aquatilis</i>	<i>Schoenoplectus acutus</i>	<i>Typha latifolia</i>	<i>Chara</i> sp.
CWCS	Linked Basin Marsh	Linked Basin Marsh / Horizontal Fen	Linked Basin Marsh	Linked Basin Water
Provincial Status	S4	S3	S3	not ranked
B.C. List	Yellow	Blue	Blue	not ranked
Global Status	G4	G5	G5	none

Description

Peat depth and texture suggest that marsh defines most of the site except for small pockets within the middle portion of hard-stemmed Bulrush³ near the drainage channel for which peat cores suggest areas of both marsh (Wm06 Great bulrush marsh) and fen adjacent to the narrow channel. The presence of mesic peat at some sites suggested fen. In general, peat is less decomposed amongst the hard-stemmed bulrush than in the surrounding Wm01 marsh, but some samples suggest medium to high levels of decomposition (Drzymulska 2016) (mesic to humic peat in MacKenzie (1999)).

A small cattail marsh (Wm05) is present at the east side of WL16, close to WL19. A series of small Ww Muskgrass shallow water wetlands are present at the south edge of the wetland. Additionally, muskgrass grew in small water-filled depressions in the marsh that dried up later in the season. In peripheral areas of shallow water bluejoint reedgrass (*Calamagrostis canadensis*), field mint (*Mentha arvensis*), arrow-leaved coltsfoot (*Petasites frigidus* var. *sagittatus*) and a violet (probably *Viola nephrophylla* or *V. palustris*) were observed. Canada thistle (*Cirsium arvense*) and prickly lettuce (*Lactuca serriola*), two exotic species, were also noted in small numbers in these peripheral areas.

The periphery of the wetland is Wm01 in which beaked sedge is more abundant than water sedge. The wetland moss *Drepanocladus longifolius* was the only moss observed. It grew at the base of the plants among decaying sedge stalks on the peat surface. Peat depth (surface to mineral soil) was 32 cm and peat was highly decomposed based on microscopic examination of collected peat (Drzymulska 2016).

See Photo 5, Appendix E.

Landscape Context

This is the southern-most of the three large graminoid wetlands. It has developed in a large depression that stretches across a broad valley.

Conservation

The assemblage of Wm01, Wm06 and Wm05, in addition to Muskgrass shallow water wetlands make this wetland complex unique in the project area. The large size and distinctiveness of each wetland type add to its ecological value. Wm06 and Wm05 are provincially Blue-listed.

³ Hard-stemmed bulrush (*Schoenoplectus acutus*) and soft-stemmed bulrush (*Schoenoplectus tabernaemontani*) may occur in the project area. The two species are difficult to distinguish since the distinguishing features are not always distinct and the species may hybridize, producing intermediates (Voss and Reznicek 2012). Specimens collected at this site matched hard-stemmed bulrush for 10 of 15 attributes from Voss and Reznicek (2012) and Smith (2017); they are therefore considered Hard-stemmed Bulrush. Specimens from other wetlands also keyed to hard-stemmed bulrush.

Wetland WL16a

WL16a is a large treed swamp located between wetlands WL16 and WL17.

Table 61. Main characteristics of WL16a

Characteristic	WL16a
Elevation (m)	1215
BEC	MSdw
Total Estimated Area (ha)	1.63
WSI (wetland shape index)	1.1
Orientation	-
Flow (St, Sl, Mo, Dy, VD)	Sl
Hydroperiod (P, S, E)	P
Origin	Non-anthropogenic (Natural).

Table 62. WL16a classification information

Wetland Classification Information	Primary Component
Soil (depth to mineral; cm)	>40
Soil (humic, mesic, fibric, van Post)	mesic
Wetland Class	Swamp (treed)
Wetland Complex Component Area (ha)	1.63
Estimated Area of Wetland Complex (% of total)	100
B.C. Wetland	Ws07.2
English Name	Spruce - Horsetail - Leafy moss (Hybrid white spruce - Horsetails – Soft-leaved sedge - Leafy mosses)
Scientific Name	<i>Picea engelmannii</i> / <i>glauca</i> - <i>Equisetum</i> spp. - <i>Carex disperma</i> - <i>Mnium</i> spp. (Mniaceae)
CWCS	Drainageway Swamp
Provincial Status	S3
B.C. List	Blue
Global Status	GNR

Description

WL16a is an extensive swamp (Ws07.2 Spruce -Horsetail-Soft-leaved sedge -Leafy moss) of large spruce with red-osier dogwood (*Cornus stolonifera*), mountain alder (*Alnus incana*), horsetail, sweet coltsfoot (*P.f. sagittatus*), inland sedge (*Carex interior*), common mitrewort, and the moss *Plagiothecium* sp. A channel runs through the west side of the forest from WL16 to WL17.

Although the name of this swamp site association includes soft-leaved sedge (*Carex disperma*), indicating it is a characteristic component, no soft-leaved sedge was observed in WL16a. Instead, inland sedge, another delicate species, was very abundant. It seems to replace soft-leaved sedge for this site.

See Photo 7, Appendix E.

Landscape Context

This treed swamp is located between WL16 and W117 and is confined by slopes to the west and east.

Conservation

Treed swamps are considered uncommon in the East Kootenay and were uncommon in the LSA. Ws07.2 is considered the most common of the two treed swamp wetland site associations, but the presence of inland sedge instead of the characteristic soft-leaved sedge suggests WL16a is a less common representation.

2.19 Wetland WL17

WL17 is the southern-most and smallest of the wetlands in the drainageway that includes WL14 to WL17.

Table 63. Main characteristics of WL17

Characteristic	WL17
Elevation (m)	1214
BEC	MSdw
Total Estimated Area (ha)	0.67
WSI (wetland shape index)	1.5
Orientation	N-S
Flow (St, Sl, Mo, Dy, VD)	St; Sl
Hydroperiod (P, S, E)	P
Origin	Non-anthropogenic (Natural). Beaver.

Table 64. WL17 classification information

Wetland Classification Information	Primary Component	Secondary Component	Tertiary Component
Soil (depth to mineral; cm)	>40 / <40	n/a	-
Soil (humic, mesic, fibric, van Post)	humic; 7-8 / humic; 8	n/a	-
Wetland Class	Marsh	Shallow water	Marsh
Wetland Complex Component Area (ha)	0.63	0.03	0.01
Estimated Area of Wetland Complex (% of total)	95	4	1
B.C. Wetland	Wm01	Ww Muskgrass	Wm04
English Name	Beaked sedge - Water sedge marsh	Muskgrass shallow water	Common spike- rush herbaceous vegetation marsh
Scientific Name	<i>Carex utriculata</i> - <i>Carex aquatilis</i>	<i>Chara</i> sp.	<i>Eleocharis palustris</i> herbaceous vegetation marsh

Wetland Classification Information	Primary Component	Secondary Component	Tertiary Component
CWCS	Linked Basin Marsh	Linked Basin Water	Linked Basin Marsh
Provincial Status	S4	not ranked	S3
B.C. List	Yellow	not ranked	Blue
Global Status	G4	unknown	GNR

Description

WL17 is the last and most southerly of the wetlands along this drainage channel. It is much smaller than the others and confined to a narrower depression. It comprises a large, beaver-created muskgrass shallow water wetland and marsh (Wm01) that extends north to WL16a. A narrow, sharply incised channel cuts through the graminoid marsh from WL16a to the shallow water. In addition to the muskgrass, which is present in the south portion of the shallow water near the beaver dam, small yellow water-buttercup (*Ranunculus gmelinii*) and pondweed (*Potamogeton* sp.) are present in the north portion, but Muskgrass was considered the dominant aquatic. The marsh has a thick layer of humic peat. Canada thistle (*Cirsium arvense*) is abundant on the old beaver dam.

The marsh along the south outflow channel below the beaver dam is small and yields to shrubby riparian vegetation along the channel in a narrower section of the draw. A small area of common spike-rush is present in the shallows of the shallow water wetland.

See Photo 6, Appendix E.

Landscape Context

This wetland is sustained by a beaver dam at its south end. It is the last and smallest of a series of graminoid fens found along this drainage basin.

Conservation

The beaver dam is critical to maintaining the shallow water wetland and the extensive marsh to the north. There was no sign of beaver activity which suggests the dam degrade and the wetland diminish. The common spike-rush community is blue-listed. See WL14 for further discussion of threats.

2.20

Wetland WL18

WL18 is a small human-created wetland at the intersection of two roads. It exits a through a culvert beneath Valley Forest Service Road.

Table 65. Main characteristics of WL18

Characteristic	WL18
Elevation (m)	1188
BEC	MSdw
Total Estimated Area (ha)	0.10
WSI (wetland shape index)	1.8
Orientation	E-W
Flow (St, Sl, Mo, Dy, VD)	Mo
Hydroperiod (P, S, E)	P, S
Origin	Anthropogenic.

Table 66. WL18 classification information

Wetland Classification Information	Primary Component	Secondary Component	Tertiary Component
Soil (depth to mineral; cm)	n/a	<40; surface	-
Soil (humic, mesic, fibric, van Post)	n/a	-	-
Wetland Class	Shallow water	Marsh	Marsh
Wetland Complex Component Area (ha)	0.07	0.02	0.01
Estimated Area of Wetland Complex (% of total)	69	20	11
B.C. Wetland	Ww anthropogenic	Wm01	Wm05
English Name	Shallow water (anthropogenic)	Beaked sedge - Water sedge marsh	Common cattail marsh
Scientific Name	Unknown	<i>Carex utriculata</i> - <i>Carex aquatilis</i>	<i>Typha latifolia</i> marsh
CWCS	Artificial Wetland	Artificial Wetland	Artificial Wetland
Provincial Status	not ranked	S4	S3
B.C. List	not ranked	Yellow	Blue
Global Status	unknown	G4	G5

Description

WL18 was created by the obstruction of a small creek that passes through a culvert beneath a Valley Forest Service Road. It consists of a small anthropogenic shallow water wetland at the base of the culvert and marsh where the water becomes shallower upstream. In the shallows beside the culvert a small area of cattail has established. The upstream marsh is anthropogenic version of Wm01 beaked sedge - water sedge. Common mare's-tail is abundant in the shallow water beside this marsh. Accumulated sediment at the inflow of the wetland (farthest from the culvert) and periodic high flows most likely inhibit the ability of some aquatic species to establish.

Landscape Context

ML18 is located at the base of intersecting roads where it passes through a culvert south of Grave Prairie beneath Valley Forest Service Road.

Conservation

ML18 is small anthropogenic, constructed wetland that has developed wetland features that emulate natural wetlands of the area, including a small, blue-listed common cattail Marsh.

2.21 Wetland WL19

WL19 is a very small, isolated, ephemeral basin wetland in the forest east of WL16.

Table 67. Main characteristics of WL19

Characteristic	WL19
Elevation (m)	1227
BEC	MSdw
Total Estimated Area (ha)	0.02
WSI (wetland shape index)	1.2
Orientation	NW-SM
Flow (St, SI, Mo, Dy, VD)	St
Hydroperiod (P, S, E)	-
Origin	Non-anthropogenic (Natural).

Table 68. WL19 classification information

Wetland Classification Information	Primary Component
Soil (depth to mineral; cm)	35
Soil (humic, mesic, fibric, van Post)	humic
Wetland Class	Marsh
Wetland Complex Component Area (ha)	0.02
Estimated Area of Wetland Complex (% of total)	100
B.C. Wetland	Wm01
English Name	Beaked sedge – Water sedge
Scientific Name	<i>Carex utriculata</i> – <i>Carex aquatilis</i>
CWCS	Isolated Basin Marsh
Provincial Status	S4
B.C. List	Yellow
Global Status	G4

Description

WL19 is a very small, isolated, ephemeral basin wetland in the forest east of WL16. It supports low densities of beaked sedge, creeping buttercup, lousewort (*Pedicularis* sp.), and a wetland moss (Amblystegiaceae or Calliergonaceae).

Landscape Context

WL19 is a very small, isolated, ephemeral basin wetland in the forest east of WL16.

Conservation

WL19 is a very small wetland with general features common in the study area. Similar wetlands likely occur elsewhere in the area. These wetlands are not considered of conservation concern, but the deep humic peat suggests it has developed in isolation over a long period.

2.22

Wetland WL20

WL20 is a “poor” marsh in a shallow depression in an open forest of trembling aspen (*Populus tremuloides*).

Table 69. Main characteristics of WL20

Characteristic	WL20
Elevation (m)	1279
BEC	MSdw
Total Estimated Area (ha)	0.61
WSI (wetland shape index)	1.5
Orientation	N-S
Flow (St, Sl, Mo, Dy, VD)	St
Hydroperiod (P, S, E)	S,E
Origin	Uncertain. Non-anthropogenic (Natural). Anthropogenic.

Table 70. WL20 classification information

Wetland Classification Information	Primary Component	Secondary Component
Soil (depth to mineral; cm)	<40	<40
Soil (humic, mesic, fibric, van Post)	-	-
Wetland Class	Marsh	Marsh
Wetland Complex Component Area (ha)	0.30	0.30
Estimated Area of Wetland Complex (% of total)	50	50

Wetland Classification Information	Primary Component	Secondary Component
B.C. Wetland	Wm15	Wm01
English Name	Bluejoint - Beaked sedge	Beaked sedge - Water sedge marsh
Scientific Name	<i>Calamagrostis canadensis</i> - <i>Carex utriculata</i>	<i>Carex utriculata</i> - <i>Carex aquatilis</i> marsh
CWCS	Isolated Basin Marsh	Isolated Basin Marsh
Provincial Status	not ranked	S4
B.C. List	not ranked	Yellow
Global Status	unknown	G4

Description

WL20 supports marsh (*Wm01 Beaked sedge – Water sedge*) in shallow depressions, and wet meadow (possibly *Wm15 Bluejoint – Beaked sedge*) in slightly elevated areas. Patches of Baltic (Arctic) rush suggest an additional marsh wetland site association such as *Wm07 Baltic rush*, but the low density of Baltic rush also suggests the possibility of the alkaline/saline meadow site association, Ga03\$. These small patches do not appear to form distinct communities and are therefore not presented in Table 70. The indistinct areas of Ga03\$ suggest successional features that will present distinctive characteristics over time. Northern clustered sedge (*Carex arcta*) and small-winged sedge (*Carex microptera*) are present on elevated portions and may suggest a succession of WL20 towards drier, terrestrial associations.

Landscape Context

WL20 is present in shallow depressions in a gently undulating opening amongst trembling aspen.

Conservation

No other similar wetland complexes were found in the uplands of the LSA. *Wm07 Baltic rush* marsh is considered uncommon in East Kootenay (MacKillop). Baltic rush was also present in WL2 but only considered to form *Wm07* marsh community in WL14. It is Red-listed by the BCCDC (2019). *Wm15* is not ranked by the BCCDC and MacKillop et al. (2018) indicate it is widespread in East Kootenay.

2.23

Wetland WL21

WL21 is a large floodplain wetland complex comprising shallow water wetland, marsh and treed swamp.

Table 71. Main characteristics of WL21

Characteristic	WL21
Elevation (m)	1509
BEC	ESSFdk1
Total Estimated Area (ha)	2.82
WSI (wetland shape index)	1.3
Orientation	E-W
Flow (St, Sl, Mo, Dy, VD)	Dy
Hydroperiod (P, S, E)	P
Origin	Non-anthropogenic (Natural). Beaver. Anthropogenic. Adjacent historical road and building. Human influence may be greater than is evident based on the presence of historical mining artifacts upstream.

Table 72. WL21 classification information

Wetland Classification Information	Primary Component	Secondary Component	Tertiary Component	Quaternary Component	Quinary Component
Soil (depth to mineral; cm)	<20	n/a	>40	-	-
Soil (humic, mesic, fibric, van Post)	-	n/a	mesic	-	-
Wetland Class	Marsh	Shallow water	Swamp (treed)	Swamp	Floodplain
Wetland Complex Component Area (ha)	0.93	0.93	0.56	0.20	0.20
Estimated Area of Wetland Complex (% of total)	33	33	20	7	7
B.C. Wetland	Wm01	Ww	Ws07.1	Ws04 (probable)	F105 (probable)
English Name	Beaked sedge - Water sedge marsh	Undetermined - recent beaver dam pond; no aquatic vegetation	Spruce - Horsetail - Leafy moss	Drummond's willow - Beaked sedge swamp	Drummond's willow - Bluejoint reedgrass Flood Association
Scientific Name	<i>Carex utriculata</i> - <i>Carex aquatilis</i> marsh	Undetermined - recent beaver dam pond	<i>Picea engelmannii</i> x <i>glauca</i> - <i>Equisetum</i> spp. - <i>Mnium</i> spp. (Mniaceae)	<i>Salix drummondiana</i> - <i>Carex utriculata</i>	<i>Salix drummondiana</i> - <i>Calamagrostis canadensis</i> Flood Association

Wetland Classification Information	Primary Component	Secondary Component	Tertiary Component	Quaternary Component	Quinary Component
CWCS	Riparian Stream Marsh / Riparian Floodplain Marsh	Linked Basin Water	Floodplain Swamp	Riverine Swamp	Riverine Swamp
Provincial Status	S4	not ranked	S3	S2S3	not ranked / S2S3
B.C. List	Yellow	not ranked	Blue	Blue	not ranked / Blue
Global Status	G4	unknown	GNR	G3	unknown / G3

Description

A large creek expands over a broad floodplain before resuming its course along a confined channel. Many of the shallow water wetlands are recent. The central portion of the wetland complex likely forms and re-forms frequently with flooding and channel changes. The configuration of swamp and marsh will change as channels shift and areas are flooded with the construction of beaver dams. Peripheral marshes and swamps are less dynamic and older, as evidenced by peat depth which was 20 cm in the marsh and over 40 cm in the treed swamp. The shrubby areas are split (50% each) between a flood and swamp association; the precise area of each is difficult to discern.

Beaked sedge is more abundant (80 percent) than water sedge (20 percent) in the peripheral marsh. Yellow sedge (*Carex flava*) and bristle-stalked sedge were also present in the peripheral marsh. Portions of the treed swamp supported plants more indicative of fens such as *Sphagnum* spp., *Aulacomnium palustre* (moss), grass of parnassus (*Parnassia* sp.), bunchberry (*Cornus canadensis*) and common miterwort. The presence of yellow sedge (*Carex flava*), bristle-stalked sedge (*Carex leptalea*), the mosses *Tomentypnum nitens* and *Plagiomnium* sp. suggest fen-like characteristics and a fluctuating water table (Schofield 1992; Wilson et al. 2008; Leighton 2012; MacKillop et al. 2018).

See Photos 4 (flood association) and 8 (treed swamp), Appendix E.

Landscape Context

WL21 is a broadened portion of an otherwise channelized creek. At this point, however, the creek valley is less confined by steep slopes than it is upstream. Upstream of the wetland there is much evidence of historical mining activity. This broad, flat wetland area may be a consequence of that activity.

Conservation

This is a dynamic wetland complex that challenges classification. The isolated, peripheral treed swamp was the only wetland site association at risk noted for WL21. The status of the swamp and flood

associations are unknown. There is inherent ecological value in an ever-changing system that maintains early successional plant communities and provides opportunities for plants and communities that may depend on ephemeral conditions uncommon in the landscape. The treed swamp Wm07.1 was found at only one other location in the LSA (WL2a). It is a community of special concern (Blue-listed) in British Columbia.

2.24 Wetland WL22

A large, linear swamp and graminoid marsh/fen in a drainage basin beside a forestry road in a forest recently cleared. The wetland has thick organic soils and supports a diverse assemblage of plants.

Table 73. Main characteristics of WL22

Characteristic	WL22
Elevation (m)	1431
BEC	MSdw
Total Estimated Area (ha)	0.69
WSI (wetland shape index)	1.9
Orientation	N-S
Flow (St, SI, Mo, Dy, VD)	SI
Hydroperiod (P, S, E)	S
Origin	Non-anthropogenic. Anthropogenic.

Table 74. WL22 classification information

Wetland Classification Information	Primary Component	Secondary Component
Soil (depth to mineral; cm)	45; 60	<40; >40
Soil (humic, mesic, fibric, van Post)	mesic	mesic
Wetland Class	Swamp	Transitional/Successional Marsh-Fen
Wetland Complex Component Area (ha)	0.62	0.07
Estimated Area of Wetland Complex (% of total)	90	10
B.C. Wetland	Ws03	Wm01/Wf01
English Name	Bebb's willow - Bluejoint	Beaked sedge - Water sedge / Water sedge - Beaked sedge
Scientific Name	<i>Salix bebbiana</i> - <i>Calamagrostis canadensis</i>	<i>Carex utriculata</i> - <i>Carex aquatilis</i> / <i>Carex aquatilis</i> - <i>Carex utriculata</i>
CWCS	Drainageway Swamp	Riparian Stream Marsh
Provincial Status	S3	S4/S4
B.C. List	Blue	Yellow/Yellow
Global Status	G3	G4/G4

Description

Like many wetlands in the project area, WL22 has developed in a depression along a drainage channel. However, its vegetative structure and composition are distinctive. WL22 is unlike any other wetland in its assemblage of plant species which consists of graminoids (beaked sedge, water sedge and bluejoint reedgrass), large and small shrubs including Bebb's willow and skunk currant (*Ribes glandulosum*), and herbaceous species such as arrow-leaved coltsfoot (*Petasites frigida* var. *sagitata*), water avens (*Geum rivale*), American speedwell (*Veronica beccabunga* var. *americana*), willowherb (*Epilobium* sp.) and common horsetail (*Equisetum arvense*). *Plagiomnium ellipticum* and *Amblystegium serpens*, two mosses found in swamps and other wetlands (McIntosh and Newmaster 2014; Vanderpoorten 2014), were common. The peculiar assemblage of graminoids and herbaceous species may represent changing conditions brought about by construction of the adjacent road and extensive forest clearing. The thick humic and mesic peat suggests elements of fen as well as marsh.

Landscape Context

This is a depressional wetland along a drainage channel. Much of the surrounding area has been logged and a forest service road runs along its east edge.

Conservation

ML22 is an old, well established wetland whose current condition may not reflect its state before trees were cleared in the surrounding area. Current conditions suggest the intrusion of plants more suited to greater insolation and drier conditions than those which occurred previously.

It is unclear whether the current plant assemblage reflects new conditions resulting from the clearing of the surrounding forest and road construction and how these human-created modifications will affect the ecological community's persistence and successional trajectory. The Ws03 swamp site association is recognized as being of special concern in British Columbia and Canada.

References

- British Columbia Conservation Data Centre [B.C. CDC]. (2019). *B.C. Species and Ecosystems Explorer*. Province of British Columbia. <http://a100.gov.bc.ca/pub/eswp/>
- Coupé, R.A, and K.E. Iverson. (2014). Supplement to Steen O.A. Coupé, R.A. (1997) A Field Guide to Forest Site Identification and Interpretation for the Cariboo Forest Region. Supplement 3 (2014) – BGxh3 (6-3), BGxw2 (6-4), and IDfxm (6-23) nonforested site series classification (6-12).
- Drzymulska, D. (2016). Peat decomposition - Shaping factors, significance in environmental studies and methods of determination; a literature review. *Geologos*, 22, 1.
- Hedenas L. (2014). Calliergonaceae Vanderpoorten. In L. Hedenas, C. J. Cox, & A. J. Shaw (Eds.), *Flora of North America north of Mexico, volume 28*. Flora of North America Editorial Committee.
- Leighton, A. L. (2012). *Sedges (Carex) of Saskatchewan, flora of Saskatchewan fascicle 3*. Flora of Saskatchewan Association.
- MacKenzie, W. (1999). *Draft Field description of wetlands and related ecosystems in British Columbia* (FRBC Project #SB97170). Ministry of Forests Research Program.
- MacKenzie, W. H., & Moran, J. R. (2004). *Wetlands of British Columbia: A guide to identification* (Land Management Handbook No. 52). British Columbia Ministry of Forests Forest Science Program. <https://www.for.gov.bc.ca/hfd/pubs/Docs/Lmh/Lmh52.pdf>
- MacKillop, D. J., Ehman, A. J., Iverson, K. E., & McKenzie, E. B. (2018). *A field guide to site classification and identification for southeast British Columbia: The East Kootenay* (Land Management Handbook No. 71). Province of British Columbia. <https://www.for.gov.bc.ca/hfd/pubs/docs/lmh/LMH71.pdf>
- NatureServe. (2020). *Statuses | NatureServe Explorer 2.0*. NatureServe Explorer. <https://explorer.natureserve.org/AboutTheData/Statuses>
- Schofield, W. B. (1992). *Some Common Mosses of British Columbia*. Royal British Columbia Museum,
- Wilson, B. L., Brainerd, D., Lytjen, D., Newhouse, B., & Otting, N. (2008). *Field Guide to the Sedges of the Pacific Northwest*. Oregon State University Press.

Appendix D

Additional Photographs



Photo 1. Shallow water wetland (Ww Muskgrass) at WL5.2 with beaked sedge-water sedge marsh (Wm01; July 8, 2019).



Photo 2. Muskgrass shallow water wetland (Ww Muskgrass) at WL5.2. Note the dense growth of submerged muskgrass (September 12, 2019).



Photo 3. Floodplain complex at WL9 with beaver dam wetland and channels at creek inflow at reservoir along Harmer Creek (July 4, 2019).



Photo 4. Shallow water wetland and flood complex at WL21 (September 13, 2019).



Photo 5. Great bulrush Deep Marsh (Wm06) and peripheral beaked sedge-water sedge marsh (Wm01) at WL16 (July 5, 2019).



Photo 6. Beaked sedge – water sedge Marsh (Wm01) and shallow water wetland (Ww Muskgrass/Pondweed) at WL17. Note the common mare's tail in the shallow water (September 10, 2019).



Photo 7. Hybrid white spruce - horsetails - (soft-leaved sedge) - leafy mosses Treed swamp (Ws07.2) at WL16a (July 5, 2019).



Photo 8. Spruce - horsetail - leafy moss (hybrid white spruce - horsetails - leafy moss Swamp (Ws07.1) at WL21 (July 9, 2019).



Photo 9. Beaked sedge – water sedge Marsh (Wm01) surrounding muskgrass shallow water (Ww Muskgrass) at WL5.3 with Drummond’s willow – beaked sedge Swamp (Wm04) of WL5.4 in the background (September 12, 2019).



Photo 10. Small beaked sedge - water sedge Marsh (Wm01) at WL8.3, immediately south of WL8.2 (July 11, 2019).



Photo 11. Plants of the Spruce - Labrador tea - peat moss Bog (Wb15) at WL5.1a (September 12, 2019).



Photo 12. Spruce - Labrador tea - peat moss Bog (Wb15) surrounding stunted spruce in a graminoid fen (Wf01) at WL3 (July 9, 2019).



Photo 13. Baltic rush Marsh (Wm07) in WL14 (September 11, 2019).



Photo 14. Baltic rush Marsh (Wm07) in WL14 (September 11, 2019).