APPENDIX 31

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Pacific Booker Minerals Inc.

Morrison Copper/Gold Project

British Columbia, Canada

Morrison Copper/Gold Project Wetland Baseline Studies Report

Prepared by:

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February 2009

Executive Summary

This report presents the wetland baseline study for Pacific Booker Minerals Inc (PBM).

PBM's proposed Morrison Copper/Gold Project (the Project) is \65 km northeast of Smithers and 35 km north of the village of Granisle in north-central British Columbia. The Project is on the east side of Morrison Lake on Crown land and falls within the traditional territory of the Lake Babine Nation. Access to the Project site is by road with barge access across Babine Lake, which is 50 km south of the site. The Project is approximately 35 km north of the former Bell and Granisle copper/gold mines.

The Morrison mine will be a 30,000 tpd open pit operation with ore processed in a conventional milling plant and the copper/gold concentrate transported to the Port of Stewart for shipment to offshore smelters. Molybdenum concentrate will be shipped to a location to be determined for processing. The mine will produce approximately 224 Mt of tailings and 170 Mt of waste rock.

The information contained in this baseline is intended to support a full environmental and socio-economic impact assessment of the Project. The objective of this study was to identify the number and types of wetlands and the functions of these wetlands within the study area so that the effects of the Project can be later be evaluated.

In the summer of 2007, two representative wetland sites (Pond X and Pond Y) were selected for hydrological monitoring and water level logging. Shallow wells were installed at these two sites. Hydrological monitoring was conducted on July 22, 2007, and again on August 15, 2007. In the summer months of 2006 and 2007, the aquatic resources of four ponds (Ore, X, Y, Z) and one small lake (Booker Lake) were sampled. Aquatic resource, water, and sediment samples were collected from these sites to identify the biological and chemical properties of the wetlands. These sample results were assessed together with ecosystem survey results to identify wetland function. The ecosystem survey followed provincial methodologies, which incorporate provincially relevant ecosystem description methodologies and the federal descriptions of wetland class from the Canadian Wetland Classification System. The ecosystem survey data were also used to map the location and size of wetlands in the study area.

A total of 17 wetland ecosystems were mapped using ecosystem survey and Terrain Resource Information Management Geographic Information System (TRIM GIS) data. All five federally recognized wetland classes (bog, fen, marsh, swamp, and shallow open water) encompassing eight provincial wetland ecosystem associations and covering a total of 66.75 ha were mapped in the study area. Bogs covered the greatest amount of area (33.15 ha) within the study area, although swamps were the most commonly occurring wetland class. The most commonly occurring wetland ecosystem association was Wm01 (beaked sedge – water sedge), a marsh ecosystem. The wetland ecosystem association covering the greatest amount of area (31.1 ha) was a provincially blue-listed ecosystem, Wb01 (spruce – creeping-snowberry – peat moss). One Committee on the Status of Endangered Wildlife In Canada listed species of concern (western toad, *Bufo boreas*) was found in the study area. These ecosystem data were combined with the hydrological and aquatic biological survey data to support descriptions of wetland function in the study area.

Acknowledgements

This report was prepared for Pacific Booker Minerals Inc. by Rescan Environmental Services Ltd. (Rescan). Rolf Schmitt (M.Sc., P.Geo) was the Project Manager for the Environmental Assessment (EA) Application and Baseline Studies. The wetland study was coordinated by Wade Brunham (B.Sc.) and the report was written by Lisa DeSandoli (B.ASc., B.Sc) Wade Brunham, Carolyn Duckham (B.Sc.), and Steven Guenther (M.Sc.).

Field work was conducted by the following Rescan scientists: Wade Brunham (B.Sc.), Sarah Lawrie (M.Sc.), Allyson Longmuir (M.Sc.) and Mike Stamford. Field assistants were provided by: Lake Babine Nation. Report production was coordinated by Silvia Hausmann (M.A.).

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Morrison Copper/Gold Project Wetland Baseline Studies Report

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Acronyms and Abbreviations

BC MELP	British Columbia Ministry of Environment, Lands and Parks
BC MOE	British Columbia Ministry of Environment
CCME	Canadian Council of Ministers of the Environment
CSSC	Canadian System of Soil Classification
COSEWIC	Committee on the Status of Endangered Wildlife In Canada
EC	Environment Canada
GIFs	Ground Inspection Forms
GIS	Geographic Information System
GPS	Global Positioning System
masl	Metres above sea level
PBM	Pacific Booker Minerals Inc.
the Project	Morrison Copper/Gold Project
Rescan	Rescan Environmental Services Ltd.
TRIM	Terrestrial Resource Information Management
UTM	Universal Transverse Mercator

1. Introduction

1.1 Morrison Copper/Gold Project Summary

This report provides wetland interpretations based on field work completed for the Morrison Copper/Gold Project (the Project) proposed by Pacific Booker Minerals Inc. (PBM). PBM is in the advanced stage of a feasibility study to evaluate the Morrison Property, which is a porphyry copper/gold/molybdenum deposit. PBM is proposing an open pit mining and milling operation for the production of copper/gold/molybdenum concentrate from the Morrison deposit.

The Morrison Property is on Crown land, 65 km northeast of Smithers and 35 km north of the village of Granisle, within the traditional territory of the Lake Babine Nation. The Project is within the forest management area of Canadian Forest Products Ltd. This area is currently used for forestry activities and has been extensively logged and replanted. Coordinates of the property are Lat 55°11′24″ N and Long 126°19′7″ W. The National Topographic System map sheet that covers the area is 93M01/W. The property elevation ranges from 737 metres above sea level (masl) at Morrison Lake to 890 masl at the top of the ridge southeast of the deposit. Topography in the area includes undulating and rolling plateaus rising steeply to the east toward a ridge of 1,350 m.

The property is on the east side of the southern end of Morrison Lake (Figure 1.1-1). It is accessed from the highway that turns north off Highway 16 at Topley to Michelle Bay, then by an all-season barge across Babine Lake from which a main haulage logging road network extends to the Morrison deposit (Figure 1.2-1). The area has a road network established by forestry companies operating in the area. PBM will use these roads and establish additional roads to access the mine infrastructure and mining operations.

1.2 Wetland Ecosystem Study

As part of the baseline studies conducted for the Project, a survey of wetland ecosystems was initiated in September of 2007. Wetland hydrological data were collected during 2007 and a comprehensive wetland survey was completed in both 2007 and 2008. The wetland survey incorporated provincially recognized ecosystem description methodology, water quality sampling, and aquatic biology surveys and sampling. Wetlands within or proximate (within 80 m) to the proposed mine infrastructure and transmission line were mapped and classified.

1.2.1 Objectives

The objectives of the wetland baseline studies program were to determine the hydrological physical; chemical and biological characteristics of wetlands; and to identify the quantity, size and location of wetlands within the study area. Once the wetland classification was complete, an assessment of wetland function was conducted.

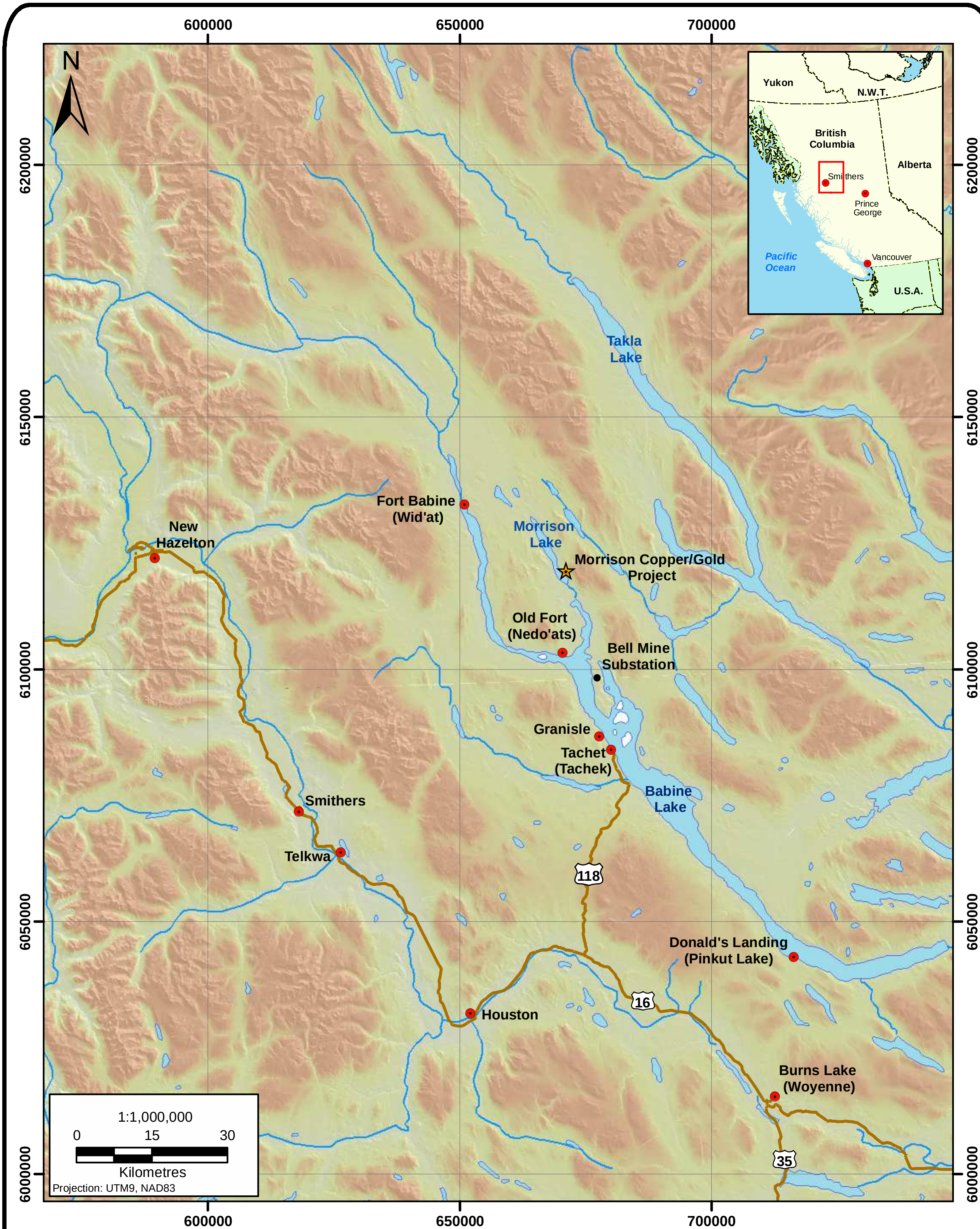

FIGURE 1.1-1

Morrison Copper/Gold Project
Location Map

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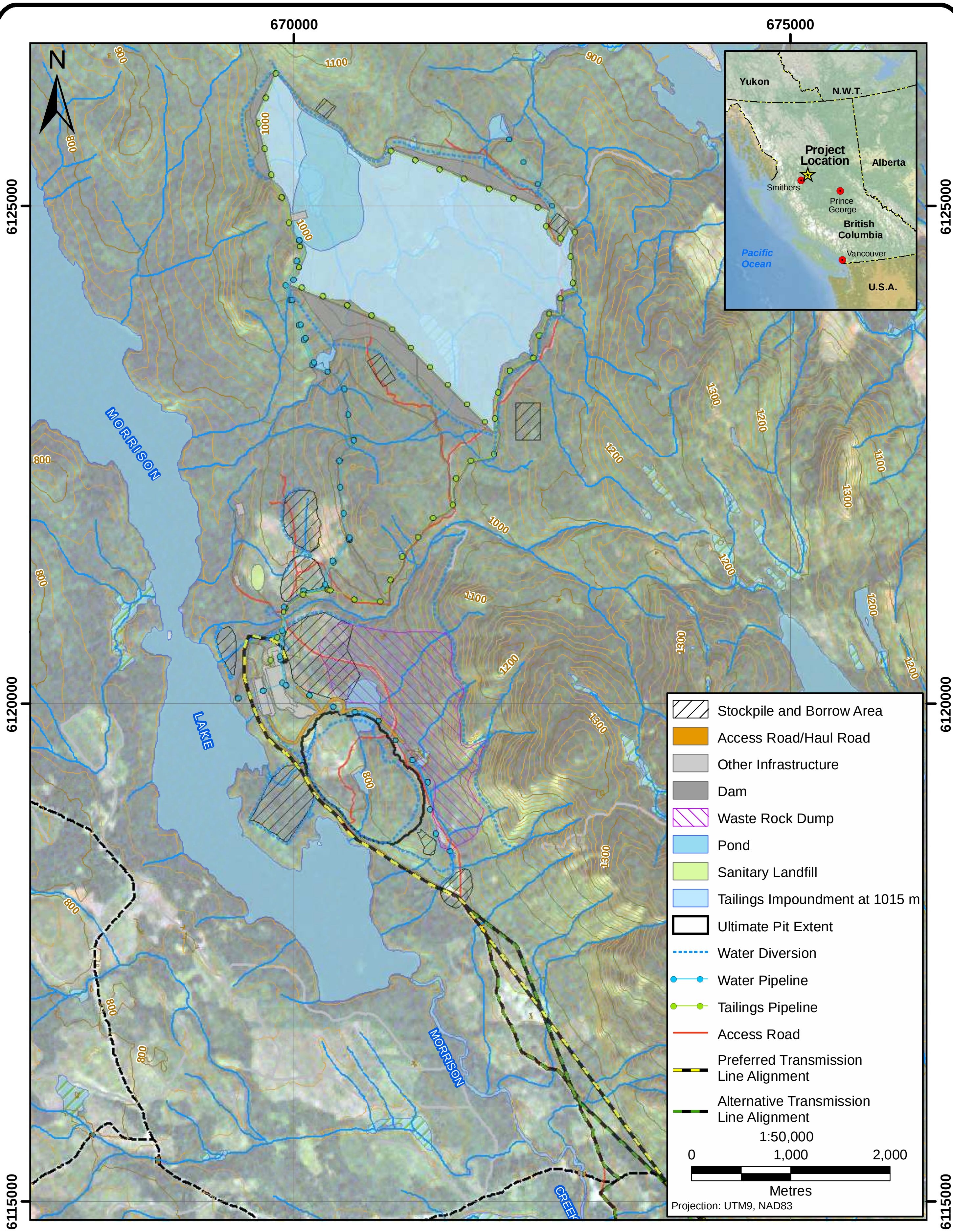

FIGURE 1.2-1

Morrison Copper/Gold Project Infrastructure

2. Study Design

2.1 Study Area

The study area for the Project's wetland baseline study includes all areas at or near proposed development features. Wetlands were surveyed, identified, or mapped if they were within any of the proposed development feature, or within 80 m of the three proposed transmission line alignments.

2.2 Wetland Hydrology

Wetland hydrology studies were conducted during the summer field season of 2007 at two representative wetlands (Pond X and Pond Y) in the Project area (Figure 2.2-1). Hydrological surveys were not conducted at other ponds (Pond Z and Ore Pond) because of their similarity to other shallow open water wetlands in the study area. The wetland hydrology study was conducted using static surveys of the wetland water table in monitoring wells.

Locations of the wetland hydrological monitoring sites are presented in Figure 2.2-1. Details of the monitoring sites are summarized in Table 2.2-1. The monitoring sites were selected to provide hydrological data characteristic of the area that could be used to infer the hydrology of wetlands throughout the baseline studies period.

Table 2.2-1
Details of Wetland Hydrological Monitoring Sites

Wetland Name / Well	Location (Northing, Easting)	Number of Wells	Wetland Class
Pond X	671273, 6119271	7	Bog
Pond Y	670050, 6125300	4	Marsh

***All coordinates in Universal Transverse Mercator (UTM).**

2.2.1 Shallow Groundwater Well Installation

Shallow (< 1.0 m below ground surface) groundwater wells were installed at Pond X and Pond Y study wetlands. Wells consisted of 1 inch PVC pipes with a drive point. They were installed using a hand auger and a sledge hammer. The configuration of the wells at each wetland was slightly different. At Pond X the wells were installed in a "T" shape with five wells running laterally beside the lake on an approximate west-east transect; two additional wells were located at a perpendicular angle to the centre well away from the lake edge. At Pond Y a single lateral transect of four wells is along the pond on the northwest side.

The wells were installed on 22 July, 2007, and an additional water depth measurement was made on 15 August, 2007, in each well. A builder's level (transit) was used to determine distance and relative elevation of the ground surface and well height for all of the groundwater wells. Because of the relatively unstable conditions of the wetland surfaces, surveyed elevations are assumed to have an error of ± 0.01m.

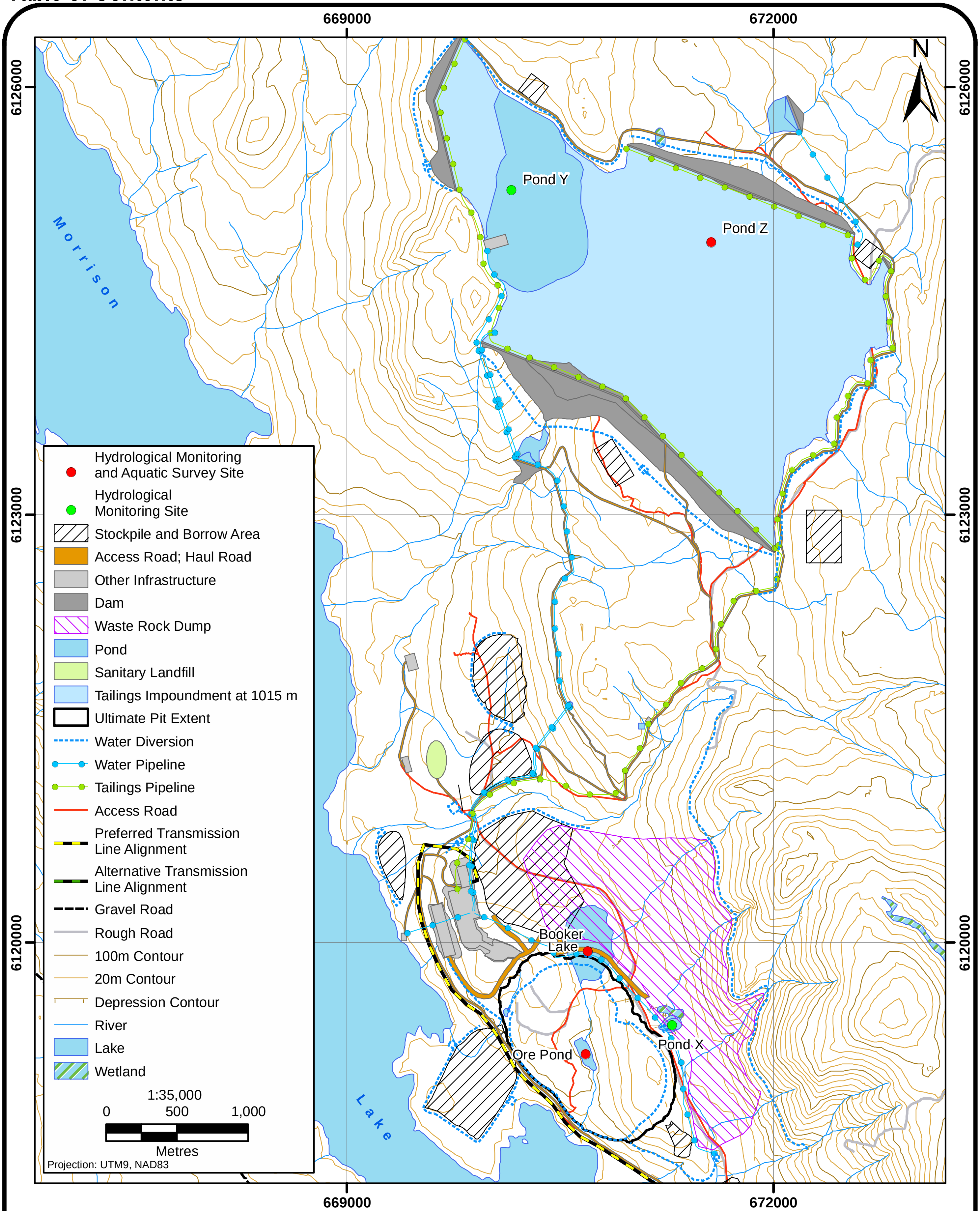

FIGURE 2.2-1

Morrison Copper/Gold Project Wetland Hydrological Monitoring and Aquatic Survey Sites

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2.3 Aquatic Resources

A component of the aquatics baseline studies for the Project is a characterization of aquatic resources in small lakes and ponds in the receiving environment. Characterization of aquatic resources included assessing water and sediment quality, primary producer (phytoplankton) communities, and benthic invertebrate communities. Assessment objectives include determining baseline conditions of these aquatic components within the Project area.

Aquatic resources were assessed at a small lake (Booker Lake), the two ponds at which hydrological surveys were conducted (ponds X and Y), and two additional ponds (Ore Pond and Pond Z; Figure 2.2-1). Water and sediment quality samples were collected once in July in 2006 and 2007. Primary and secondary producers were sampled in the summer months of 2006 and 2007. Detailed methods regarding field sampling, and sample and data analyses can be found in the section 2 of the *Morrison Copper/Gold Project Aquatics Baseline Report*, *2006/2007* (Rescan 2009a). All of these wetlands were also assessed to determine fish presence.

2.4 Wetland Classification and Mapping

2.4.1 Field Studies

Field studies were conducted to classify the wetlands identified within the study area. Ground-based classification surveys are required to provide detailed descriptions of the wetlands types and characteristics. Terrain Resource Information Management (TRIM) data includes some wetland classification, but at a broad level of organization.

The TRIM data are useful for identifying the locations of wetlands and their size. However, it is insufficient to provide detailed ecosystem information. The wetlands in TRIM are defined into two classes: marsh and swamp. These two wetland classes are recognized as two of the five federal wetland classes (Warner and Rubec 1997). Bogs, fens, and shallow open water wetlands (the remaining three federal wetland classes) are not differentiated by TRIM and are either included in the two TRIM classes or not mapped as wetlands altogether. The definitions for marsh and swamp supplied by TRIM (BC MELP 1991) are:

- Marsh: A water-saturated, poorly drained, treeless area intermittently or permanently water covered, having cattail, rushes, or grass-like vegetation.
- Swamp: A water-saturated area, intermittently or permanently covered with water, having shrubs.

It is likely that some shallow open water, fens, and tree-less bogs are included in the TRIM marsh class. The TRIM swamp class does not include treed swamps; treed swamp associations can represent a major percentage of wetlands in northwest British Columbia and high elevation biogeoclimatic zones (MacKenzie and Moran 2004). Bogs and shallow open water are not included in either TRIM class; however, shallow open water wetlands may appear as small lakes.

The field studies are intended to qualify the wetlands within the study area as they relate to the federal descriptions of class (Warner and Rubec 1997) and the provincial description of ecosystem association (MacKenzie and Moran 2004). Wetlands were surveyed according to methods outlined in *Field Description of Wetland and Related Ecosystems in the Field*, (MacKenzie 1999) and *Wetlands of British Columbia: A Guide to Identification*, (MacKenzie and Moran 2004). Wetland sample locations are displayed in Figure 2.4-1.

Thirteen wetlands, MW01 to MW13, were surveyed between September 11 and 13, 2007. Four wetlands, WL001, WL002 (A and B), and WL003, were surveyed between September 8 and 11, 2008. Plots were established in the centre of large (>20 m x 20 m) uniform wetlands, on the boundaries between different wetland associations in the same complex or at the ecosystem edge in amorphous and small (<20 m x 20 m) wetlands. At the centre of the plot, a soil pit was dug and a global positions system (GPS) coordinate was taken. Photographs were taken in each cardinal direction of the soil pit, soil surface, a representative soil sample, and other significant features such as landforms, unique vegetation, and wildlife.

Ground Inspection Forms (GIFs) were used to record field notes. Information recorded on the field form included:

- Plot Number
- Project ID
- Surveyor
- Date
- Photograph Numbers
- GPS coordinates in Universal Transverse Mercator (UTM)
- Aspect (slope direction)
- Meso Slope Position (site position in the overall landscape)
- Soil Moisture Regime (hydrodynamic index)
- Soil Nutrient Regime (nutrient content; poor to rich)
- Drainage Mineral Soils (drainage of all soils)
- Moisture Subclasses: Organic Soils (location and types of water features)
- Mineral Soil Texture
- Organic Soil Texture (notes on decomposition)
- Surface Organic Horizon Thickness
- Humus Form (decomposition of surface layer)
- Root Restricting Layer
- Coarse Fragment Content
- List of Vegetation (dominant/indicator plant species and percent cover)
- Site Diagram on waterproof paper

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FIGURE 2.4-1

Morrison Copper/Gold Project Wetland Survey Locations

The soil survey methodologies for wetland ecosystem classification principally follow *The Canadian System of Soil Classification* (CSSC 1987), *Towards a Taxonomic Classification of Humus Forms* (Greene, Trowbridge, and Klinka 1993), *Describing Ecosystems in the Field* (Luttmerding et al. 1990), and *Field Description of Wetland and Related Ecosystems in the Field* (MacKenzie 1999). These methods require soil identification to a depth of 160 cm or lithic contact. Often super-saturated soils and shallow alpine soils made deep sampling impossible.

2.4.2 Wetland Classification

Wetland classification was completed, where possible, in the field and followed *The Canadian Wetland Classification System* (Warner and Rubec 1997) for "class" level classification and *Wetlands of British Columbia: A Guide to Identification* (MacKenzie and Moran 2004) for "site association" level classification. Wetland class describes associations with similar basic underlying environmental characteristics that support similar species guilds at climax (MacKenzie and Moran 2004). There are five federal wetland classes: bog, fen, marsh, swamp, and shallow open water. Site association defines all sites capable of supporting a similar plant association at climax (MacKenzie and Moran 2004). There are a number of site associations in each wetland class.

Occasionally, classification was not possible in the field because of time constraints or unidentified vegetation; in these cases a post-field classification was done. The botanical name of all vegetation species identified in the field and office were entered into a database to aid in post-field classification of wetlands to provincial site association (MacKenzie and Moran 2004; Appendix 1). Wetlands were classified to the lowest level, typically site association, and that information along with the field data were entered into a database (Appendix 2).

2.4.3 Wetland Mapping

Digital wetland TRIM data were acquired and used to identify wetlands in the Project area. Wetlands were delineated in the field using a Wide Area Augmentation System-enabled GPS; wetland positions were recorded on field maps. The TRIM wetlands were re-digitized based on field observations using high resolution digital aerial photographs. ArcView 9.2 was used to digitize wetland areas and build a geographic information system (GIS) of wetlands in the study area.

3. Results

3.1 Wetland Hydrology

3.1.1 Pond X

The Pond X Wetland is along the access road east of the proposed open pit (Figure 2.2-1). The wetland transects are orientated approximately east-west and north-south on the south end of Pond X (Figure 3.1-1).

The two transects in Pond X illustrate that generally the water table was below the surface during both sampling times (Figure 3.1-1). The exception to this occurred at one well that is farthest away from the lake along the north-south transect, where the water remained above the surface for both the July and August sampling times.

Generally the data showed that the water table was above the surface in the low-lying areas and below the surface in areas that were elevated. Temporally the water table varied between 5 and 25 cm between samplings, with the greater variation generally occurring in wells on higher elevation ground. The water table was lower during the second sampling (August). This was likely caused by a reduction of water input to the Pond and wetland from both precipitation and runoff.

3.1.2 Pond Y

The Pond Y Wetland is in the northwestern portion of the proposed tailings management facility (Figure 2.2-1). The well transect is oriented approximately north-south on the northwest side of Pond Y (Figure 3.1-2).

The water table profiles in Pond Y indicate that the water table increases relative to the ground surface with closer proximity to the lake (Figure 3.1-2). A picture of Well 4 is shown in Plate 3.1-1, illustrating the water table above the ground surface. The data showed that the water table was above the surface in the low-lying areas and below the surface in areas that were elevated. Temporally the water table varied little. All locations along the transect declined approximately 5 cm from July to August. The consistent change in water table between the two sampling periods suggests that the Pond Y wetland water table is influenced by the surface water level fluctuations in the pond.

3.1.3 Summary

The two monitored wetlands are considered to be typical wetlands in the Morrison Project area. Data collected as part of the wetland hydrology monitoring program can be used to infer the hydrology of wetlands throughout the Project area.

By definition, wetlands have shallow water tables. Observed water levels of the monitored wetlands ranged from approximately 0.21 m below the ground surface to 0.17 m above the ground surface.

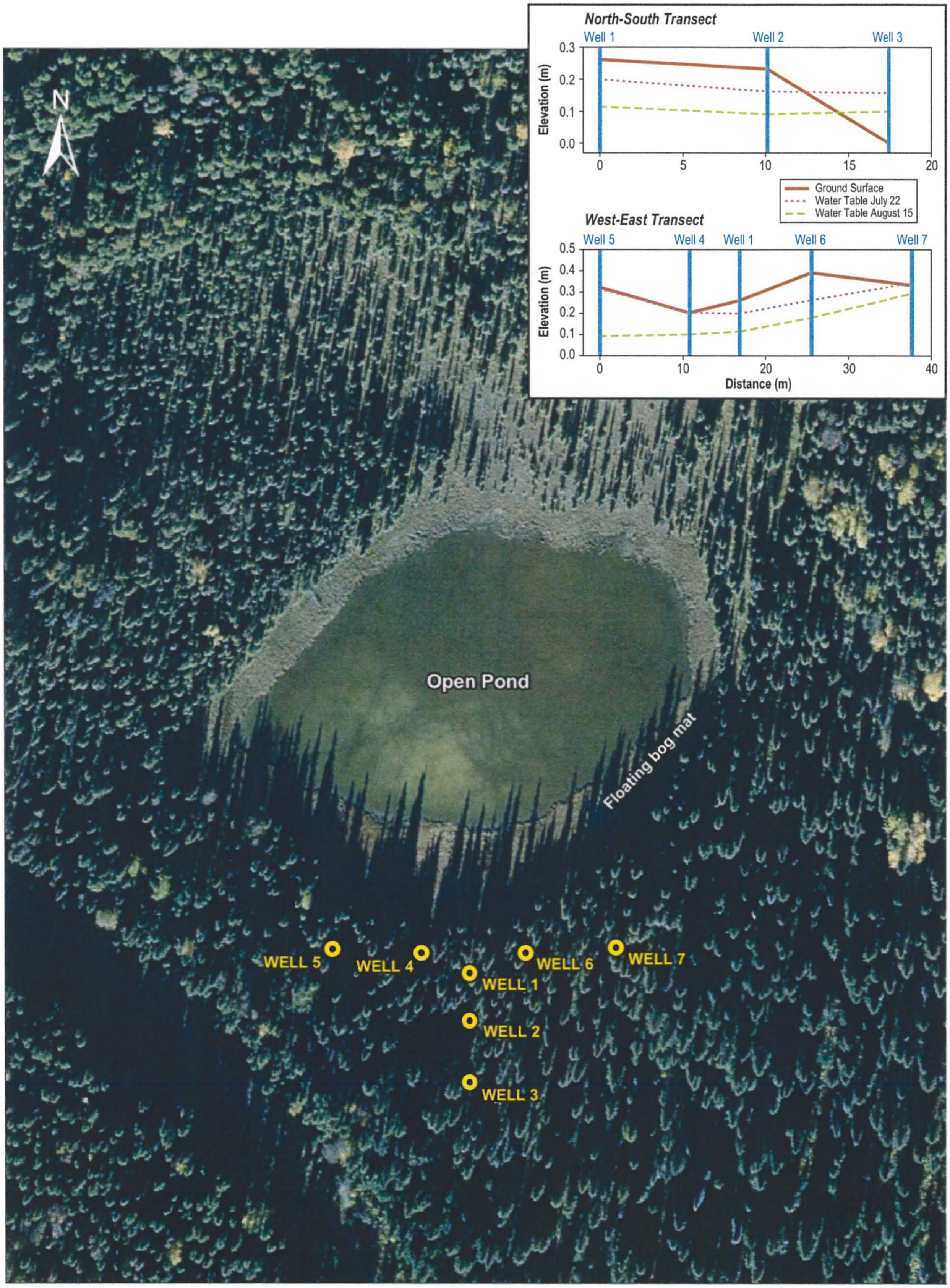
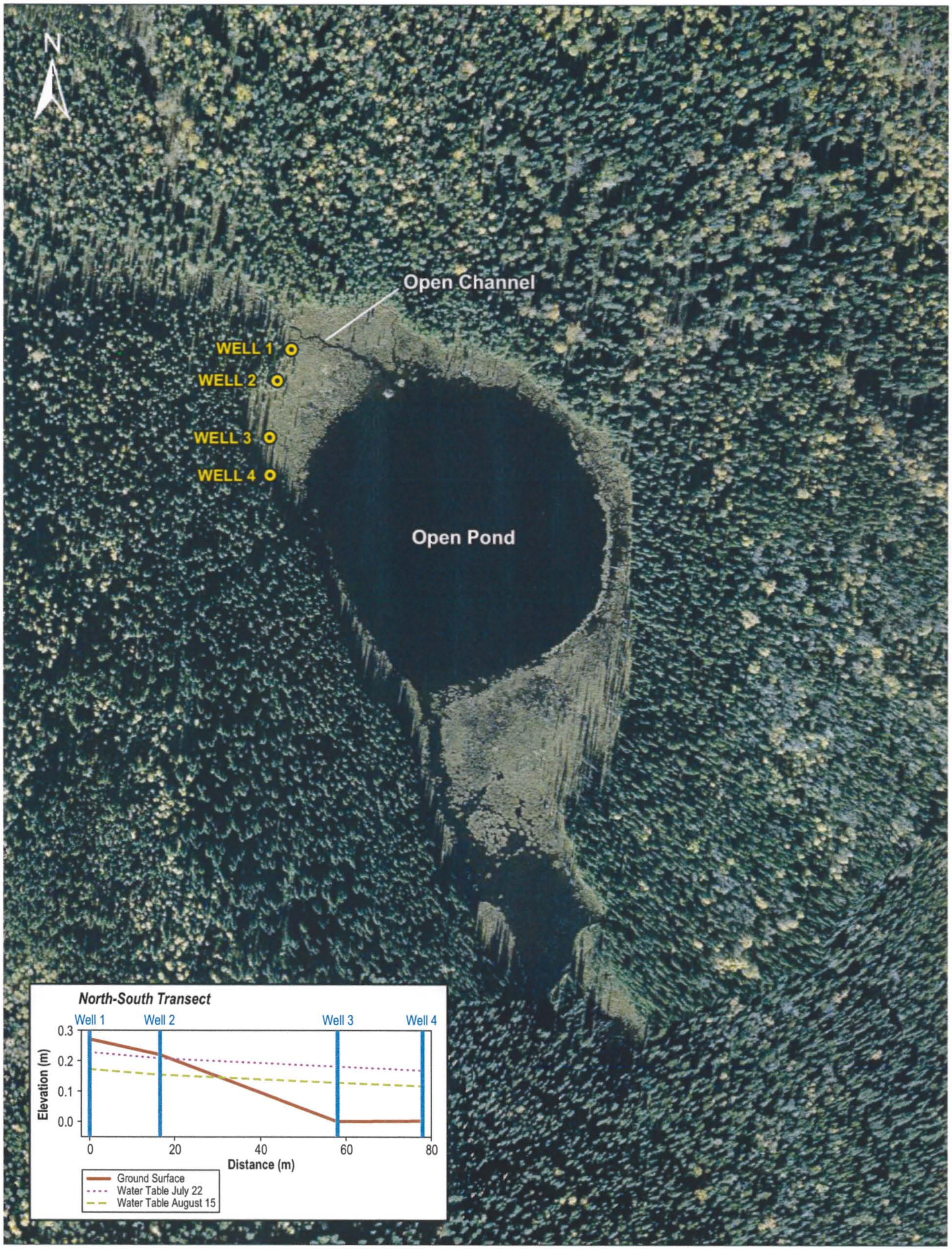


FIGURE 3.1-1

Morrison Copper/Gold Project
Pond X Wetland Transects and Water Table Elevations



Morrison Copper/Gold Project
Pond Y Wetland Transects and Water Table Elevations

FIGURE 3.1-2

The water table in each wetland was observed to decrease from July to August in response to hydrological inputs, such as rainfall and pond water elevation. Wetland water table levels are expected to be highest after the spring snow melt period, which generally occurs in May and results in substantial areas of open water. High water levels may also be expected in September and October, which are normally the months with highest precipitation. Lowest annual water table levels are expected to occur in the late summer, after snow pack from the previous winter has been depleted and prior to the commencement of the wet fall period.

Plate 3.1-1. Pond Y Well at 78 metres along the transect (22 July 2008).

3.2 Aquatic Resources

Hardness levels were relatively high in Pond X, Booker Lake, and Ore Pond (90 to 183 mg/L) and low in Pond Y and Z (31 to 46 mg/L). Spatial trends for total dissolved solids, sulphate, and conductivity mirrored hardness, meaning their concentrations were generally twice as high in Booker Lake, Ore Pond, and Pond X than in ponds Y and Z. This is likely caused by the proximity of these waterbodies to each other (at the southeastern end of Morrison Lake), where more substantial groundwater input is likely, while ponds Y and Z are farther north of the mine area in a higher elevation area. Concentrations of these four variables (hardness, total dissolved solids, conductivity, and sulphate) did not vary much between 2006 and 2007 except at Pond X where 2006 samples of conductivity and sulphate were considerably higher than in 2007. Sulphate concentrations were well below the British Columbia Ministry of Environment (BC MOE) ambient water quality guideline for freshwater aquatic life of 100 mg/L. All lakes and ponds had low conductivity (54.6 to 362.0 μS/cm), were slightly alkaline (7.32 to 8.16 pH), and fairly clear (turbidity: 0.39 to 1.89 nephelometric turbidity units). Total cyanide, total organic carbon, and nutrients (total nitrogen and total phosphate) did not vary widely between sites and years. Total organic carbon ranged from 10.3 to 19.0 mg/L. Total nitrogen concentrations ranged from 0.31 to 0.84 mg/L for all samples except Pond X (2006), which had a concentration of 2.86 mg/L (Figure 3.2-1). Total phosphate concentrations were also low ranging from 0.0077 to 0.0268 mg/L, with the highest concentration at Ore Pond (2006; Figure 3.2-1). Total cyanide concentrations exceeded the federal and provincial guideline of 0.005 mg/L at least once at all lake and pond sites. In 2007 surface waters of ponds X and Y were roughly double the cyanide guideline (Figure 3.2-2).

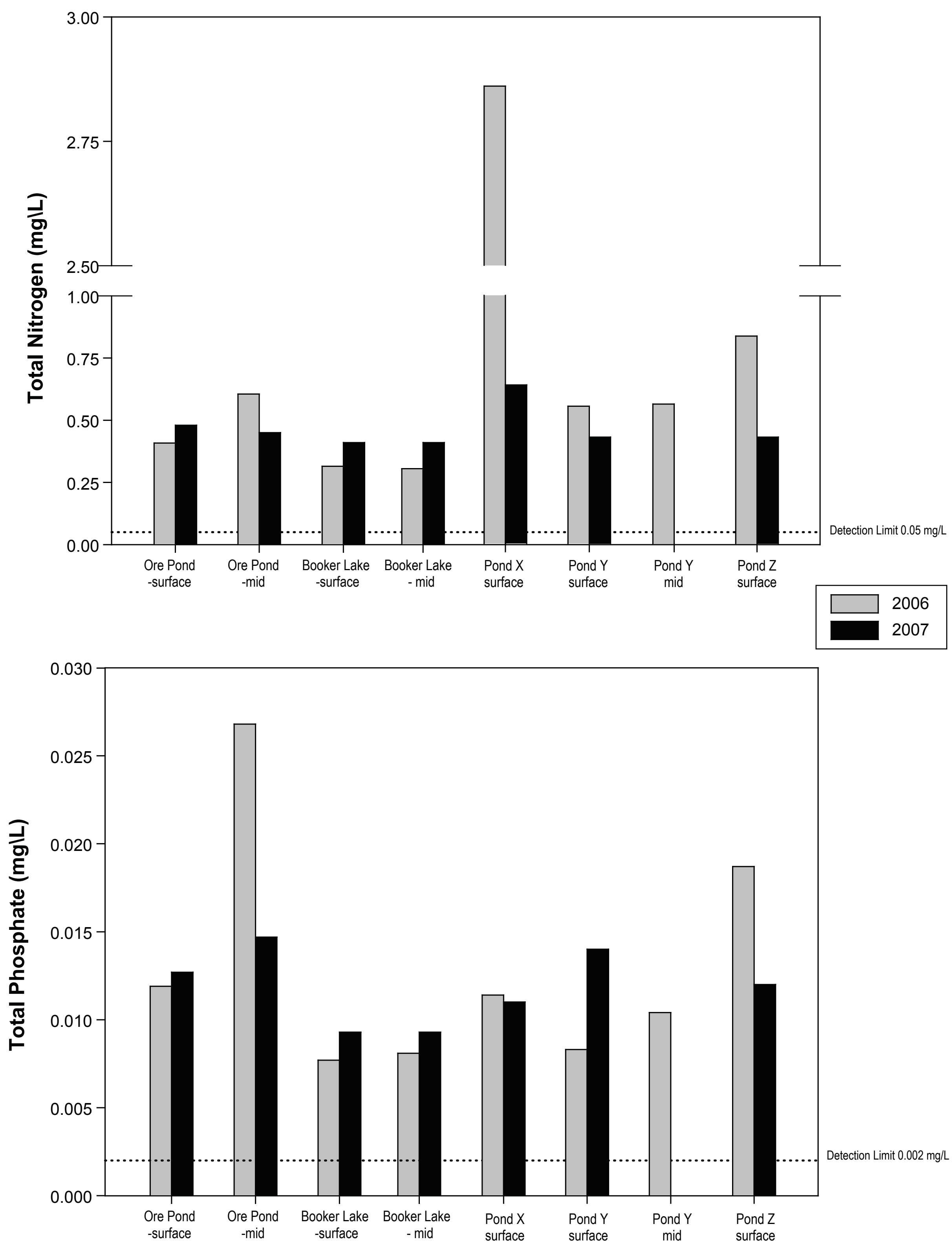
Most metal concentrations were low throughout the lake and pond sites with barium, beryllium, cadmium, mercury, nickel, silver, and titanium having more than 80% of concentrations below the detection limit. Concentrations for arsenic, copper, iron, lead, manganese, molybdenum, selenium, and zinc were generally above the detection limits though concentrations were low, not exceeding guidelines. The only metal to exceed guidelines was total and dissolved aluminum. The total aluminum Canadian Council of Ministers of the Environment (CCME) guideline of 0.10 mg/L was exceeded once by the surface waters of Pond Y (2007) with 0.12 mg/L (Figure 3.2-2). Dissolved aluminum concentrations exceeded the BC MOE 30-day mean guideline for freshwater aquatic life of 0.050 mg/L in 2007 at the surface waters of ponds Y and Z (0.0726 and 0.0555 mg/L, respectively; Figure 3.2-2). All other total and dissolved aluminum concentrations were at least half the guideline values. Ore Pond generally had the highest metal concentrations (arsenic, copper, lead, manganese, molybdenum, and zinc) than all other lake or pond sites. Ore Pond directly overlies the Morrison deposit. No other temporal or spatial patterns were observed for metal concentrations between the lakes and ponds.

3.2.1 Sediment Quality

In 2006 sediment was primarily composed of clay and silt, while in 2007 sediment was dominated by silt and sand. Nitrogen values were low across all sites in both years ranging from 1.6 to 2.4%. Total phosphorous ranged from 686 to 1,983 mg/kg. Total organic carbon concentrations were moderate and similar across years and sites, ranging from 21 to 32%. Total cyanide concentrations were below detectable limits at all sites except Ore Pond, which contained an average concentration of 55.2 mg/kg.

Of the metals analyzed antimony, beryllium, bismuth, lead, molybdenum, silver, selenium, thallium, and tin were not detected in more than 80% of samples. Of the metals with guidelines, Ore Pond and Booker Lake often had the highest concentrations.

Ore Pond and Booker Lake had relatively high concentrations of copper and cadmium compared to the other sites. Of the nine metals with guidelines eight were exceeded; lead was not exceeded at any site. Chromium, iron, and zinc were not exceeded at ponds Y and Z. Chromium was only exceeded at Booker Lake in 2007. In both years high copper concentrations were found at Ore Pond. Guidelines were exceeded at three to five sites in 2006 and one to five sites in 2007.



Notes: No CCME or BC aquatic life guidelines exist
Dotted lines indicate analytical detection limits

Total Nitrogen and Phosphates in the Morrison Copper/Gold Project Lakes and Ponds, 2006-2007

FIGURE 3.2-1

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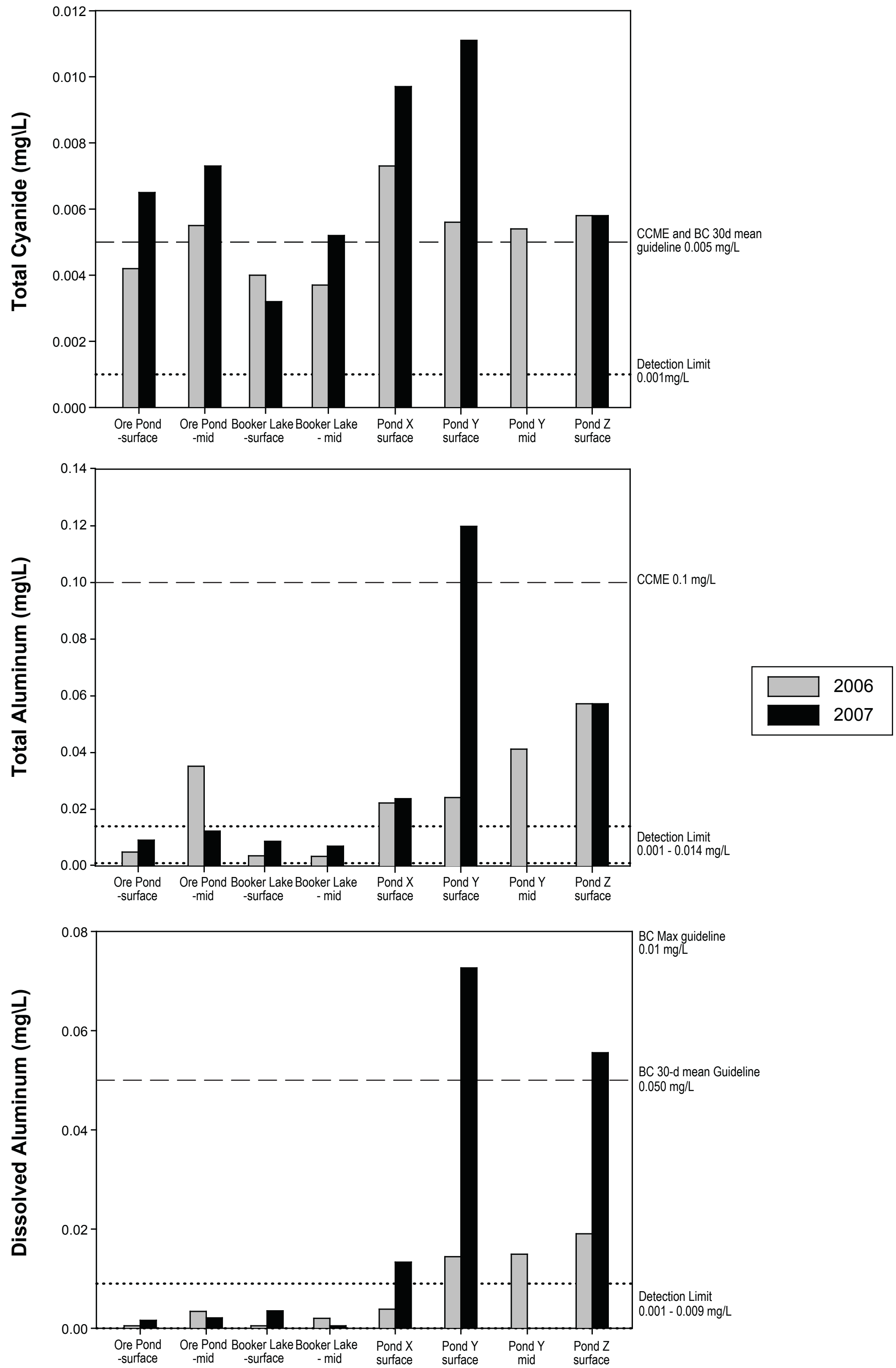


Notes: No CCME or BC aquatic life guidelines exist
Dotted lines indicate analytical detection limits

Total Cyanide and Total and Dissolved Aluminum in the Morrison Copper/Gold Project Lakes and Ponds, 2006-2007

FIGURE 3.2-2

3.2.2 Primary Producers

Phytoplankton density and biomass varied greatly between the lake and four ponds, with considerable variation observed between the years. Biomass and density did not always increase and decrease in relation to one another. While density increased from 2006 to 2007 at Booker Lake and ponds X and Y, biomass decreased. At Ore Pond an increase in density and biomass were observed between 2006 and 2007, while a decrease in both variables occurred at Pond Z. Phytoplankton biomass ranged from 0.87 to 7.61 µg/L (Figure 3.2-3), while densities ranged from 150 to 1,002 cells x 10^3/L (Figure 3.2-4).

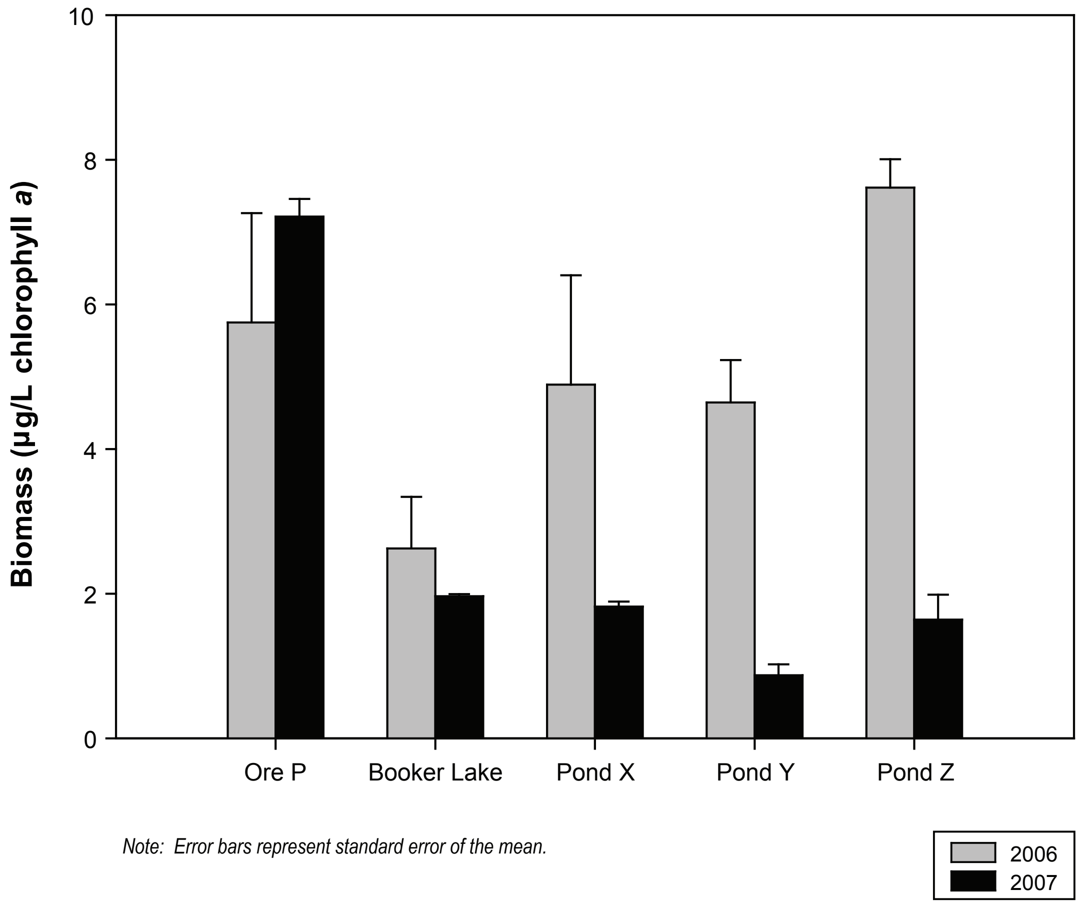
A total of 49 genera were identified in 2006, and 38 identified in 2007. Genus richness ranged from 8 to 20 taxa (Figure 3.2-5). The Simpson Diversity Index and Evenness Index were stable between sites and years. Diversity was moderate to high at all lake and pond sites, ranging from 0.65 (Pond Z, 2007) to 0.82 (Ore Pond, 2006). Phytoplankton communities were fairly even, ranging from 0.57 (Pond Z, 2007) to 0.76 (Ore Pond, 2006).

Different taxonomic groups dominated different sites, and community shifts were observed between the years at Ore Pond and ponds X and Z. Ore Pond phytoplankton community shifted from shared dominance of Cryptophyta (35%) and Chrysophyta (32%) in 2006 to being dominated by Cryptophyta (62%) in 2007. Pond X was dominated by Chlorophyta (74%) in 2006, but in 2007 shared dominance between Cryptophyta (27%), Chrysophyta (36%), and Chlorophyta (26%). The Pond Z community shifted from being dominated by Chrysophyta in 2006 to Cryptophyta in 2007. Booker Lake was dominated by Cryptophyta, while Pond Y shared dominance between Cryptophyta and Chrysophyta for both 2006 and 2007.

3.2.3 Secondary Producers

The average density of benthic invertebrates ranged from 7 (Booker Lake, 2007) to 2,560 organisms/m^2 (Pond Y, 2007). Density was consistently higher at Pond Y and Pond Z in both years and substantially lower at Booker Lake and Pond X in 2007 (Figure 3.2-5). Most sites had densities ranging between 880 to 1,220 organisms/m^2. Average benthos genus richness ranged from 2.5 to 16 genera, with most sites ranging from 6 to 9 genera (Figure 3.2-5). Most sites were dominated by or had high proportions of dipterans (16 to 83%). Amphipods dominated the community at Pond X in both years, and represented a large proportion of the communities at Booker Lake and Ore Pond in 2007. Nematodes composed a large proportion of the community at Pond Y in both years and Pond Z in 2006.

Cladocerans and copepods were prevalent only in 2007 in Ore Pond and Booker Lake, respectively. Simpson diversity values were similar across years and sites, ranging from 0.47 (Ore Pond, 2007) to 0.9 (Booker Lake, 2007). Most sites ranged between 0.6 and 0.8. Evenness values showed the same general pattern as diversity, ranging from 0.48 (Ore Pond, 2007) to 0.96 (Booker Lake, 2007), with most sites averaging between 0.6 and 0.77.



Note: Error bars represent standard error of the mean.

Morrison Copper/Gold Project Lake and Pond Phytoplankton Biomass as Chlorophyll *a*, 2006 and 2007

FIGURE 3.2-3

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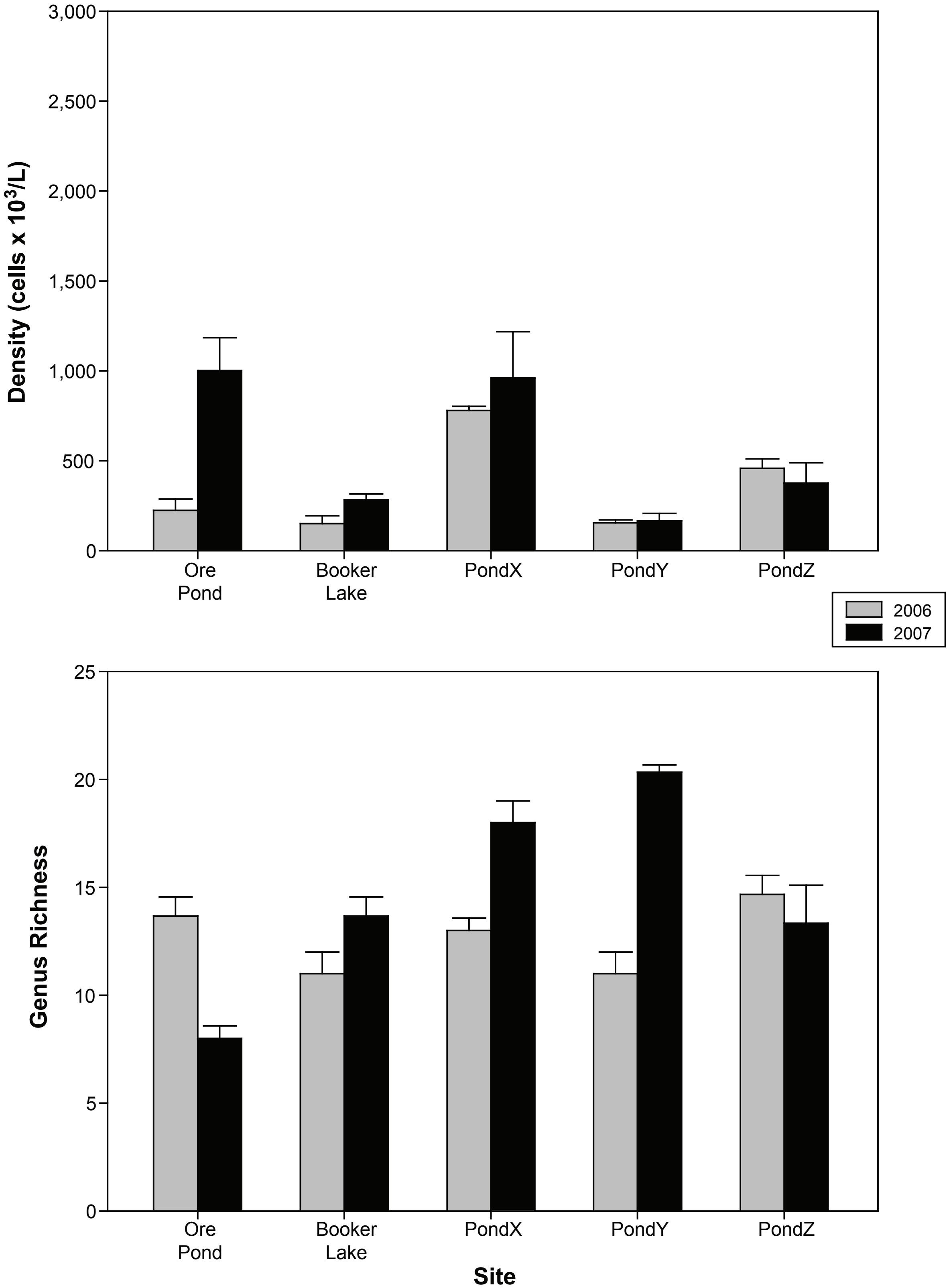

Note: Error bars represent standard error of the mean.

Phytoplankton Density and Genus Richness in Morrison Copper/Gold Project Lakes and Ponds, 2006 and 2007

FIGURE 3.2-4

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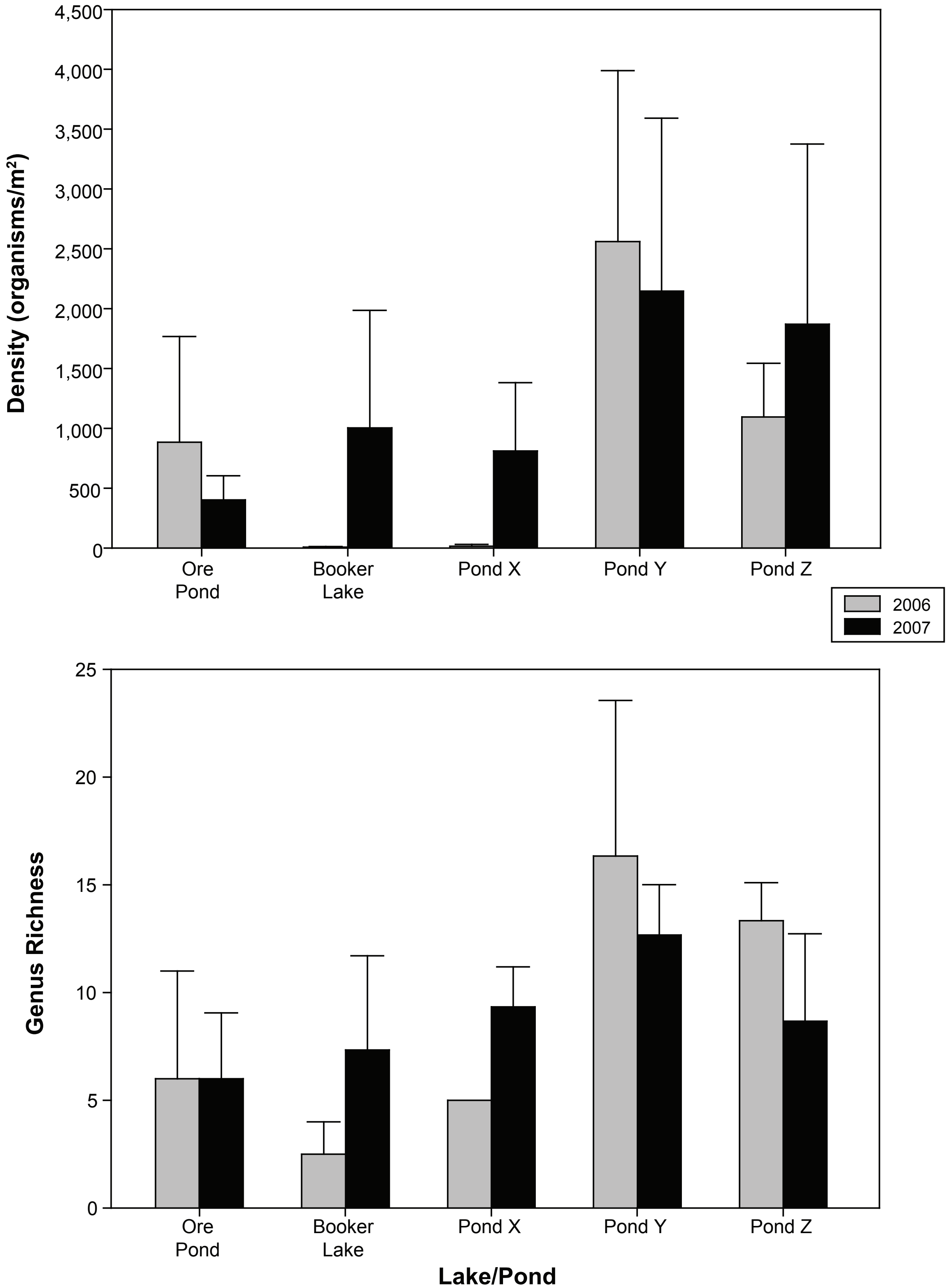

Note: Error bars represent standard error of the mean.

Benthos Density and Genus Richness in Morrison Copper/Gold Project Lakes and Ponds, 2006 and 2007

FIGURE 3.2-5

Zooplankton densities were higher in 2007 than 2006, ranging from 3,431 to 24,004 organisms/m^3 in 2006, and from 23,896 to 101,934 organisms/m^3 in 2007. Genus richness was similar across both years, ranging from 6 genera at Ore Pond in both years to 13 genera at Pond Z in 2006. There was no correlation between size of the waterbody and density or richness. Simpson diversity values ranged from 0.2 to 0.7. Values were typically similar except at Booker Lake, Pond X and Pond Y in 2006, which were approximately half of the value in 2007. Pielou evenness values showed the same pattern, ranging from 0.2 to 0.66 with most sites falling between 0.5 and 0.7.

Communities in 2006 were dominated at most sites by cyclopoid copepods and rotifers although Pond X was dominated by *Daphnia*. In 2007, sites were dominated by *Daphnia*, rotifers and strong proportions of calanoid copepods. The differences in community composition were likely caused by differences in sampling dates (late August in 2006 and mid-July in 2007).

3.3 Wetland Ecosystems

A total of 17 wetland ecosystem plots were surveyed in the study area. All five federally recognized wetland classes were observed in the study area (Figure 3.3-1). Shallow open water wetlands were not mapped as individual communities but were instead combined into the area of the overall wetland complex at a given site. The areas of each wetland class are presented in Table 3.3-1.

Table 3.3-1
Wetland Class Areas in the Wetland Study Area

Wetland Class	Wetland Area (ha)
Bog[1]	33.16
Swamp	7.63
Marsh[1]	16.72
Fen	9.24

[1] Includes shallow open water wetlands.

3.3.1 Bog

A bog is a nutrient-poor, *Sphagnum*-dominated peatland ecosystem in which the rooting zone is isolated from mineral-enriched groundwater, soils are acidic, and few minerotrophic plant species occur (MacKenzie and Moran 2004). Bogs may be treed or tree-less and are usually covered with *Sphagnum* spp. and ericaceous shrubs.

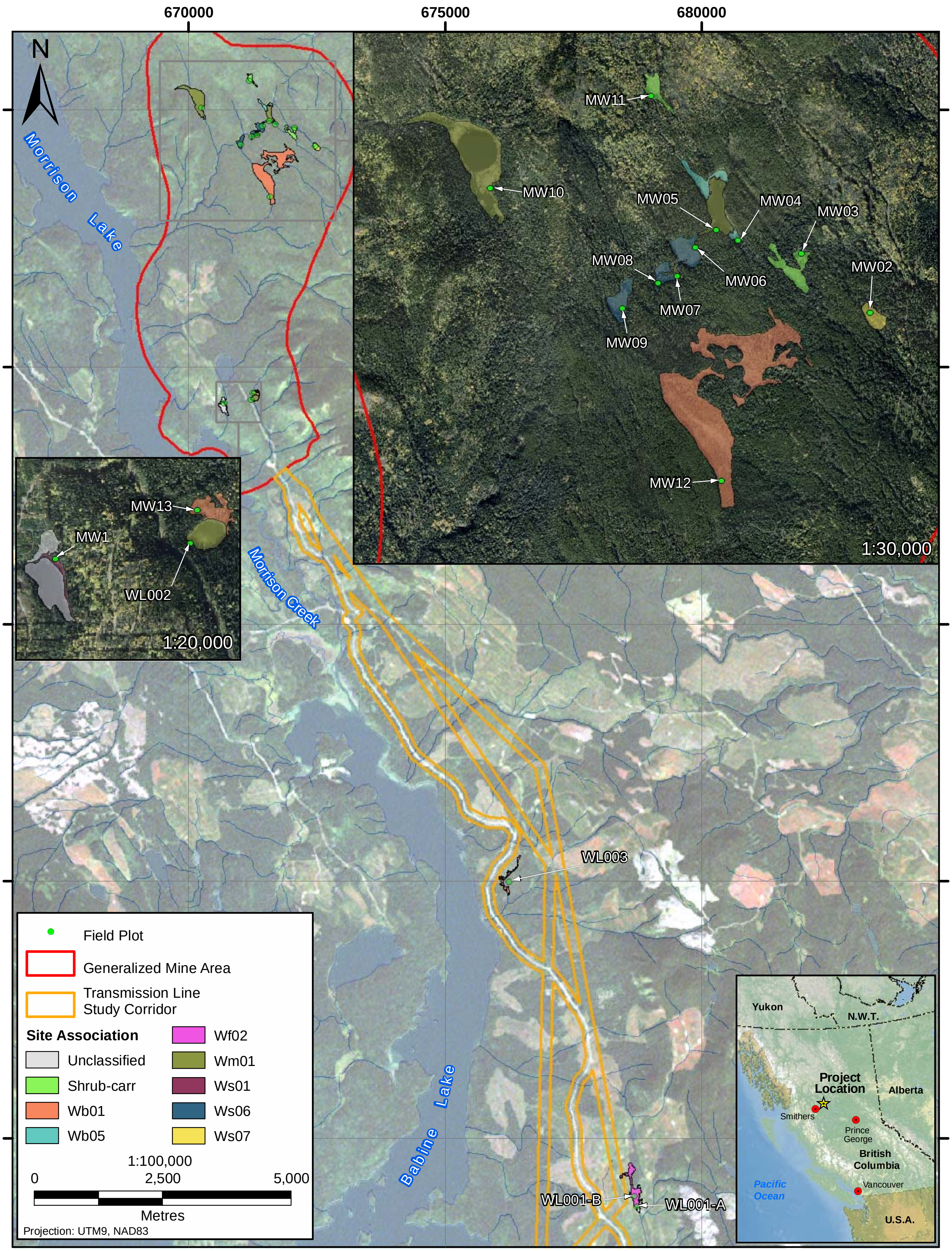

FIGURE 3.3-1

Morrison Copper/Gold Project
Wetland Ecosystems

Wetland Class: Bog **Site Name:** Spruce – creeping-snowberry – peat-moss
Site association: Wb01 **Wetland Area:** 31.10 ha

Site Description:

These bogs are uncommon in the boreal and sub-boreal forests at elevations between 500 and 1,000 m. They form in closed basins and in complexes with larger peatlands where there is little influence from groundwater (MacKenzie and Moran 2004). This type of bog was observed at sites MW12, MW13, and WL003 with elevations of 841, 978m, and 748 masl respectively. The vegetation at MW12 and MW13 was dominated by *Picea* spp., *Carex aquitilis*, and *Calamagrostis canadensis* (Plate 3.3-1).The vegetation at WL003 was dominated by *Picea* spp., *Betula nana*, and *Equisetum arvense*. The moss layer at all sites was dominated by *Sphagnum* spp. Soils were largely mesic to humic sphagnum peat and the soil nutrient regime was moderate. When mineral soils exist they tended to be sandy in texture. The hydrodynamic index ranged from stagnant to sluggish, soil water pH ranged from 6.4 to 7.0, and the soil moisture regime was very moist to very wet. Open water pH ranged from 6.4 to 7.1.

Plate 3.3-1. Wb01 at site MW13.

Wetland Class: Bog **Site Name:** Spruce – water sedge – peat-moss
Site association: Wb05 **Wetland Area:** 2.06 ha

Site Description:

These bogs are common throughout the sub-boreal and central interior below 1,300 m. They occur as components of larger peatlands or in small, closed basins where there is little lateral and groundwater movement and water table depression (MacKenzie and Moran 2004). This type of bog was observed at site MW04. The vegetation was dominated by *Carex sitchensis*, *Salix* spp., and *Picea* spp. (Plate 3.3-2). The moss layer was dominated by *Sphagnum* and *Mnium* spp. The soil was mesic sphagnum peat and the soil nutrient regime was moderate. The hydrodynamic index was sluggish, soil water pH was approximately 6.6, and the soil moisture regime was very moist to very wet. Open water pH was approximately 7.0.

Plate 3.3-2. Wb05 at site MW04.

3.3.2 Swamp

A swamp is a nutrient-rich wetland ecosystem with significant groundwater inflow, periodic surface aeration, and elevated microsites supporting the growth of trees and tall shrubs (MacKenzie and Moran 2004). Generally there is more than 30% tree or tall shrub cover. Soils are often gleyed mineral soils with a surface layer of anaerobically decomposed woody peat. In general, there are three physically different swamp communities (shrub-thicket, coniferous forest, and hardwood (deciduous) swamps; Warner and Rubec 1997). Swamps have a more vertical structure than other wetland classes and support a more diverse avifauna (MacKenzie and Moran 2004). Forested swamps typically have an open canopy that appears to be favoured by many bird and bat species (MacKenzie and Moran 2004; Lausen 2006).

Wetland Class: Swamp
Site Name: Mountain alder – skunk cabbage – lady fern
Site association: Ws01
Wetland Area: 0.40 ha

Site Description:

These swamps are common in wet regions of the sub-boreal interior and southern interior mountains, particularly in areas underlain by glaciolacustrine deposits. They frequently occur in wet gullies or along small creeks where there is continuous seepage near the surface and poor drainage. It also occurs in the lagg of peatlands, where seepage from upslope enriches peat deposits (MacKenzie and Moran 2004). This type of swamp was observed at site MW01, at an elevation of 834 masl. The vegetation was dominated by *Carex aquitilis*, *Calamagrostis canadensis*, and *Alnus incana* (photo not available). The soil was humic sphagnum peat and the soil nutrient regime was moderate to rich. When present, the mineral soils were sandy in texture with >70% coarse fragment content. The hydrodynamic index was mobile, soil water pH was approximately 7.2, and the soil moisture regime was very moist to very wet.

Wetland Class: Swamp
Site association: Ws06
Site Name: Sitka willow – sitka sedge
Wetland area: 5.87 ha

Site Description:

These swamps are uncommon at low elevations in the coast and mountains, Nass basin, and wet subzones of the southern interior mountains and sub-boreal interior. These sites are usually associated with fluvial systems or linked basins and experience prolonged saturation and brief early-season flooding (MacKenzie and Moran 2004). This type of swamp was observed at sites MW06, MW08, MW09 at elevations of 972, 967, and 953 masl respectively. The vegetation was dominated by *Salix* spp., *Carex sitchensis* with a generally open overstorey of *Picea* spp. (Plate 3.3-3). Soil type varied considerably, from mesic to fibric peat. When present, the mineral soil was clayey in texture with very low coarse fragment content. The hydrodynamic index ranged from sluggish to mobile, soil water pH ranged from 6.5 to 7.3, and the soil moisture regime was very moist to very wet. Soil nutrient regime varied from poor to medium.

Plate 3.3-3. Ws06 at site MW09.

Wetland Class: Swamp
Site association: Ws07
Site Name: spruce – common horsetail – leafy moss
Wetland area: 1.36 ha

Site Description:

These swamps are common in the northern boreal mountains and central and sub-boreal interior from low to subalpine elevations. They occur on lower and toe slopes and margins of wetlands, where there is significant flow of mineral-rich groundwater. These can be moderately productive sites with spruce to 25 m tall rooting on elevated mounds (MacKenzie and Moran 2004). This type of swamp was observed at sites MW02 at an elevation of 1,011 masl. The vegetation was diverse with an open overstorey of *Picea* spp., and *Alnus crispa* dominant in the shrub layer, and a species rich understorey with *Equisetum arvense* as the most common species present (photo not available). Soil types were largely mesic/humisols, with sandy textured mineral soil. The hydrodynamic index was sluggish, soil water pH is 7.1, and the soil moisture regime was wet. The soil nutrient regime was medium to rich.

3.3.3 Marsh

A marsh is a permanently to seasonally flooded non-tidal mineral wetland dominated by emergent grass-like vegetation (MacKenzie and Moran 2004). Marshes are the most heavily used wetland type for most wetland-using wildlife species. They are typically eutrophic and support large standing crops of palatable vegetation, plankton, and aquatic invertebrates. They are the favoured wetland class for most waterfowl, amphibians, and semi-aquatic mammals because they provide good cover, open water, and food. Soils are typically mineral but can also have a well-decomposed organic surface tier (Warner and Rubec 1997; MacKenzie and Moran 2004).

Wetland Class: Marsh
Site Name: beaked sedge – water sedge
Site association: Wm01
Wetland area: 16.72 ha

Site Description:

This association is the most widespread marsh association in the province. These marshes are found from low to subalpine elevations in all Biogeoclimatic Ecosystem Classification subzones on sites that are inundated by shallow low energy flood waters, on the margins of beaver ponds, lake margins, and palustrine basins (MacKenzie and Moran 2004). This type of marsh was observed at sites MW05, MW07, MW10, and WL002 at elevations of 986, 962, 970, and 843 masl respectively, and was often associated with shallow, open waters. Species diversity was low; sites were dominated by *Carex utriculata*, *C. aquatilis*, and *C. sitchensis*, with an absent or sparse overstorey of *Picea* spp. (Plate 3.3-4). Soil types were largely mesic peats, with sandy textured mineral soil. The hydrodynamic index was sluggish to mobile, soil water pH ranged from 6.3 to 7.0, and the soil moisture regime was wet. The soil nutrient regime was poor to medium. Beaver dams were at sites MW05 and MW07.

Plate 3.3-4. Wm01 at site MW10.

3.3.4 Fen

A fen is a nutrient-medium peatland ecosystem dominated by sedges and brown mosses, where mineral-bearing groundwater is within the rooting zone and minerotrophic plant species are common (MacKenzie and Moran 2004). Fens can have fluctuating water tables and are often rich in dissolved minerals. Surface water flow can be direct, through channels, pools, and other open features that can often form characteristic surface patterns. The vegetation in fens is closely related to the depth and chemistry of groundwater. Shrubs occupy drier sites and minerotrophic graminoid vegetation (grass) is typically found in wetter sites (Warner and Rubec 1997).

Wetland Class: Fen | **Site Name:** scrub birch – water sedge

Site association: Wf02 | **Wetland area:** 9.24 ha

Site Description:

This site association is one of the most common peatland site associations throughout the province's interior. It is frequently a major component of large peatlands where there is some water table fluctuation and the surface becomes aerated by mid-season. These sites are often hummocked, with shrubs rooting on elevated microsites (MacKenzie and Moran 2004). This type of fen was observed at sites WL001-A and WL001-B. Elevation of both sites is approximately 860 masl. Species diversity was low; sites were dominated by *Carex aquatilis* and *Betula nana* (photo not available). Organic soil type ranged from typic to mesic fibrisol, with no mineral soil present within 1.5 m of the soil surface. The hydrodynamic index was sluggish, soil water pH ranged from 6.4 to 7.4, and the soil moisture regime was very moist to very wet. The soil nutrient regime was medium-poor to medium-rich.

3.3.5 Shrub-carr

The shrub-carr ecosystem has traditionally been described as wetlands in BC; however, this ecosystem type does not meet the soils or vegetation criteria for wetlands. This ecosystem type frequently occurs adjacent to wetlands, and is considered transitional to upland ecosystems. Shrub-carrs are low shrub ecosystems that occur in areas prone to growing-season frosts, in frost-prone depressions or cold-air drainage valleys where frost and cold, moist soils prevent tree growth. Shrub-carrs are most common in the cold and dry climates of the Chilcotin Plateau, the western Fraser Plateau, and the Northern Boreal Mountains. Soils are imperfectly drained and cold. Distinctly hummocky microtopography is common (MacKenzie and Moran 2004).

Shrub-carr ecosystems were found at sites MW03 and MW11, at elevations of 978 and 1,006 masl respectively. The total area of the shrub-carr ecosystem within the study area is 4.19 ha; however, because these communities are not actually wetlands and were not the focus of this survey it is likely that shrub-carrs cover a larger area. Site association was not determined for this vegetation class. The shrub layer was dominated by various *Salix* spp., with *Calamagrostis canadensis* dominating the herbaceous understorey (Plate 3.3-5). Organic soils were composed of woody peat, with soil water pH ranging from 6.5 to 6.7. When present, mineral soil was sandy in texture and the soil nutrient regime was rich. The hydrodynamic index was stagnant to sluggish.

Plate 3.3-5. Shrub-carr ecosystem type at site MW11.

3.3.6 Incidental Wildlife Observations

A number of wildlife and wildlife features were observed in wetlands in the study area. Table 3.3-2 presents the wildlife species/feature observed and the location.

These species and features are incidental observations and not part of a scientific survey. For complete wildlife results refer to Rescan (Rescan 2008, 2009b, 2009c).

Table 3.3-2
Wildlife Observations from Morrison Lake Study Area Wetlands

Plot	Location	Species or Feature
MW03	Proposed tailings storage facility	Wildlife Trees
MW05	Proposed tailings storage facility	Beaver Dam
MW06	Proposed tailings storage facility	Frog
MW07	Proposed tailings storage facility	Beaver Dam

3.3.7 Rare and Endangered Ecosystems

This section presents a summary of ecosystems that were either listed on the provincial red/blue list or uncommon within the study area. Ecosystem survey notes were compared against information compiled by the BC Conservation Data Centre for consideration as provincially rare ecosystems. This was done to ensure due diligence and to identify whether ecosystems in the study area have been classified by the BC MOE as:

- Red-listed: Any ecological community that is extirpated, endangered, or threatened in British Columbia (BC MOE 2007).
- Blue-listed: Any ecological community considered to be of Special Concern (formerly Vulnerable) in British Columbia (BC MOE 2007).

One blue-listed bog association was identified in the study area at three sites. Table 3.3-3 presents a summary of the rare ecosystem information.

Table 3.3-3
Summary of Rare Wetland Ecosystems

Class	Association Code	Location	Site	Area (ha)
Bog	Wb01	Proposed tailings storage facility	MW12	26.65
Bog	Wb01	Proposed waste rock dump	MW13	1.21
Bog	Wb01	Proposed transmission line	WL003	3.24

4. Discussion

4.1 Wetland Functions

The field data collected during the hydrology survey, ecosystem assessment, and aquatic biology sampling were used to identify the functions of wetlands in the study area. Table 4.1-1 shows which wetland functions are described by the field data. Wetland functions are described following Environment Canada (EC 2003).

Table 4.1-1
Wetland Function and Associated Fieldwork Component

Wetland Function	Fieldwork Component
Hydrological Function	Hydrology monitoring and Ecosystem survey (Hydrodynamics)
Biochemical Function	Aquatic Biology (Sediment and water quality) Ecosystem Survey (Soil Water pH and Soil Horizon Identification)
Ecological Function	Aquatic biology (Productivity) and Ecosystem survey (Classification)
Habitat Function	Fisheries Sampling/Habitat Assessment and Ecosystem survey (Classification and Wildlife observations)

4.1.1 Hydrological Function

The hydrological function of a wetland is described as its ability to regulate water contributions to and from surface and groundwater reserves. For example, wetlands help regulate water levels in downstream aquatic habitats. During high precipitation periods such as the spring snow melt and fall rainy season wetlands hold and store water, preventing all of the water from immediately entering streams, which would likely result in flooding. Throughout the summer months wetlands slowly release the water allowing small streams to maintain flow during this time.

The hydrological function is quantified through hydrological surveys at a sample of wetlands and ecosystem observations. Ecosystem observations incorporate two indicators to describe hydrological function:

1. Minerotrophic plant species: The presence of minerotrophic species indicates mineral rich groundwater is supplying the wetland with water.
2. Hydrodynamic index: This index categorizes the amounts of vertical and horizontal movement of water at a site. The index rating is arrived at through observations of surface erosion, soil pit infiltration, and mineral leaching in soil layers.

Static water level monitoring indicates that the water continually drains from wetlands throughout the summer, likely recharging small streams and open water features. It is probable that wetland water levels are highest immediately after snow melt or in September/October during the rainy season. The water is stored in the wetland communities and slowly released throughout the year buffering aquatic communities from flooding and drought.

Wetlands help maintain the level of the water table and exert control on the hydraulic head, which provides the force for groundwater recharge and discharge. The extent of groundwater recharge by a wetland is dependent upon its soil, vegetation, site, perimeter to volume ratio, and water table gradient. A high perimeter to volume ratio, such as in small fen wetlands, means that there is a large surface area through which water can infiltrate into the groundwater. Groundwater recharge of up to 20% of wetland volume per season is typical (Turner and Gannon 2003).

The presence of minerotrophic plant species such as *Carex aquatilis*, *Equisetum* spp., and *Comarum palustre* (MacKenzie and Moran 2004) in certain wetlands indicates mineral rich groundwater supplying these wetlands with water, and thus that the wetland is important for moderating groundwater flow.

4.1.2 Biochemical Function

Biochemical function is defined as a wetland's contribution to the quality of surface water and groundwater. This function is identified through sediment and water sampling as well as through field pH measurements and soil horizon identification.

The 2006 sediment samples were primarily composed of clay and silt, where as in 2007 sediment samples were silt and sand; this difference in sediment composition highlights the variability in wetland communities. Wetlands are known for their filtration properties and have often been constructed as a passive water purification measure (Hammer 1989). As sediments and particles settle out in the slow moving wetland water, nutrients, metals, and toxins bound to these particles also settle out. Plants, microorganisms, and chemical processes specific to wetlands help to breakdown, sequester, and metabolize nutrients, metals, and toxins, effectively removing them from the larger surface water network and facilitating the energy transfer of nutrients from aquatic species to terrestrial ecosystems.

Wetlands in the study area play a prominent role in the aquatic biochemical cycle. They remove sediments and prevent metals trapped within those sediments from being released into the larger aquatic environment.

4.1.3 Ecological Function

Ecological function is the role of the wetland in the surrounding ecosystem. It is qualified through aquatic biology productivity sampling and through ecosystem structure observations during the ecosystem classification.

Wetlands in the study area have many important ecological functions. They typically are an integral part of an important water drainage system. They often form complexes (groups of several wetlands of different types) with several types of wetland associations but maintain a similar level of productivity, thereby offering various types of habitat and different ecological niches.

Committee on the Status of Endangered Wildlife In Canada (COSEWIC) listed species and provincially listed ecosystems were observed in the study area. These sensitive ecosystems and species are present because specific habitats and biophysical factors are available that allow for the occupation and maintenance of these rare communities and species of concern.

4.1.4 Habitat Function

Wetlands provide terrestrial and aquatic habitats unique from stream networks or larger bodies of open water, allowing for the development of specialized floral and faunal communities. Wetlands also function to maintain other habitats by protecting natural shorelines from erosion. The habitat function provided by wetlands is identified during fisheries sampling and fish habitat assessments and through wildlife observations during the ecosystem survey.

Wetlands in the study area provide food, cover, rearing, nesting, and migration habitats for a multitude of species. Many mammals, birds, reptiles, amphibians, molluscs, crustaceans, invertebrates, and plants are found in wetland environments.

The study area fens provide important browse habitat for moose (*Alces americanus*). In the summer, moose will feed upon aquatic vegetation such as lily (*Nuphar* spp.) rhizomes, and pondweed (*Potamogeton* spp.) that grow in marshes and shallow water wetlands (Belovsky and Jordan 1981). Moose also visit marshes and shallow water wetlands in the summer to cool off and escape from pests (Flook 1959; Renecker and Hudson 1986). In the winter, willows (*Salix* spp.), found in many of the study area's fens and swamps, provide valuable forage for moose. Wetlands in the study area also provide habitat for bears (*Ursus* spp.).

Wetlands provide habitat for various species of amphibians. During the amphibian survey (Rescan 2008) western toads, (*Bufo boreas*), a COSEWIC species of special concern, as well as Columbia spotted frogs (*Rana luteiventris*) and wood frogs (*Rana sylvatica*) were all located in multiple wetlands with differing site associations.

In addition to providing habitat to many animal species, one provincially blue-listed wetland ecosystems was identified in the study area. This ecosystem is of special concern because it represents a plant community that is potentially vulnerable or not common throughout the province.

5. Summary

5.1 Area and Extent

Field studies were conducted and digital wetland TRIM data were analyzed to classify wetlands within the study area. Wetlands were surveyed using established field methods and were identified as they related to federal descriptors of class (Warner and Rubec 1997) and the provincial description of ecosystem association (MacKenzie and Moran 2004).

All five federally recognized wetland classes encompassing eight provincial wetland ecosystem associations covering a total of 66.75 ha were mapped in the study area. Four bog wetlands (33.16 ha), four marsh wetlands (16.72 ha), two fen wetlands (9.24 ha), and five swamp wetlands (7.63 ha) were identified during the surveys. Shallow open water wetlands were identified in two small lakes. Two shrub-carr ecosystems (4.19 ha) were identified as well. The majority of identified wetlands are in the proposed tailings storage facility area (54.53 ha), although three are in the proposed open pit and waste rock dump areas (2.98 ha), and two are along the proposed transmission line route (9.24 ha).

5.2 Wetland Hydrology and Aquatic Biology

Wetland hydrology studies were conducted during the summer field season of 2007 at two representative wetlands in the proposed Project area. The wetland hydrology study was conducted using static surveys of the wetland water table in monitoring wells. Generally the data showed that the water table declined over the growing season. This suggests that wetlands are actively maintaining water levels in shallow groundwater reserves and in downstream ecosystems.

Water and sediment quality samples, as well as aquatic biological samples of primary and secondary production communities were sampled in the summer months of 2006 and 2007 from one small lake and four ponds. All dissolved metal and nutrient concentrations were below posted guideline limits with the exception of cyanide and aluminum. At least once at all lake and pond sites, naturally occurring cyanide concentrations exceeded the limit specified in federal (CCME) and provincial (BC MOE) guidelines for the protection of aquatic life. In 2007, surface waters of two ponds were roughly double the cyanide guideline. Dissolved aluminum concentrations exceeded the BC MOE mean guideline in 2007 at the surface waters of two tested ponds. Primary producer (phytoplankton) density and biomass varied greatly between the lake and four ponds, with considerable variation observed between the years. Densities of secondary producers (zooplankton and benthic invertebrates) varied significantly between waterbodies and years, with no discernable pattern detected.

5.3 Wetland Ecosystems

A total of 17 wetland ecosystem plots were surveyed in the study area. Thirteen wetlands were surveyed in 2007, and four wetlands were surveyed in 2008. All five federally recognized wetland classes encompassing eight provincial wetland ecosystem associations covering a total of 66.75 ha were mapped in the study area. The most common wetland class was bog. The most common wetland ecosystem association, a provincially blue-listed ecosystem, was Wb01 (Spruce - creeping-snowberry - peat moss). This association composed approximately 40% of the wetlands in the area, and was generally dominated by spruce and birch with a sedge understorey and organic, peat soils.

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APPENDIX 1 – MORRISON COPPER/GOLD PROJECT WETLAND VEGETATION SPECIES LIST

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Appendix 1
Morrison Copper/Gold Project Wetland Vegetation Species List

Plot	Genus	Species
MW01	Alnus	incana
MW01	Sambucus	racemosa
MW01	Lonicera	involucrata
MW01	Viburnum	edule
MW01	Picea	spp.
MW01	Athyrium	filix-femina
MW01	Equisetum	arvense
MW01	Viola	spp.
MW01	Galium	triflorum
MW01	Calamagrostis	canadensis
MW01	Carex	aquatilis
MW01	Gymnocarpium	dryopteris
MW01	Geum	macrophyllum
MW02	Alnus	crispa
MW02	Cornus	canadensis
MW02	Ribes	lacustre
MW02	Picea	spp.
MW02	Viburnum	edule
MW02	Rubus	pubescens
MW02	Linnaea	borealis
MW02	Rubus	pedatus
MW02	Epilobium	angustifolium
MW02	Equisetum	arvense
MW02	Calamagrostis	canadensis
MW02	Senecio	triangularis
MW02	Pyrola	uniflora
MW02	Heracleum	maximum
MW02	Athyrium	filix-femina
MW02	Geum	macrophyllum
MW02	Viola	spp.
MW02	Symphyotrichum	foliaceum
MW02	Galium	boreale
MW02	Sphagnum	spp.
MW02	Mnium	spp.
MW02	Moss	spp.
MW03	Salix	barclayi/lucida
MW03	Viburnum	edule
MW03	Rubus	pubescens
MW03	Calamagrostis	canadensis
MW03	Symphyotrichum	foliaceum
MW03	Geum	macrophyllum
MW03	Viola	spp.
MW03	Equisetum	arvense
MW03	Galium	boreale
MW03	Orthilia	secunda
MW03	Cornus	canadensis
MW03	Senecio	triangularis
MW03	Moss	spp.
MW04	Salix	barclayi
MW04	Betula	nana
MW04	Rubus	arcticus
MW04	Viburnum	edule
MW04	Picea	spp.
MW04	Carex	aquatilis
MW04	Equisetum	arvense
MW04	Viola	spp.
MW04	Mnium	spp.
MW04	Sphagnum	spp.
MW05	Potamogeton	spp.
MW05	Geum	macrophyllum
MW05	Carex	aquatilis
MW05	Calamagrostis	canadensis
MW05	Equisetum	arvense
MW05	Comarum	palustre
MW05	Carex	sitchensis
MW06	Salix	sitchensis
MW06	Rosa	nutkana
MW06	Picea	spp.
MW06	Carex	sitchensis
MW06	Senecio	triangularis
MW06	Rubus	arcticus
MW06	Symphyotrichum	foliaceum
MW06	Calamagrostis	canadensis
MW06	Cornus	canadensis
MW06	Galium	boreale
MW06	Equisetum	arvense
MW06	Geum	macrophyllum
MW06	Viola	spp.
MW06	Moss	spp.
MW06	Mnium	spp.
MW07	Rhododendron	glandulosum
MW07	Betula	nana
MW07	Picea	spp.
MW07	Rubus	arcticus
MW07	Cornus	canadensis
MW07	Salix	spp.
MW07	Carex	sitchensis
MW07	Carex	aquatilis
MW07	Equisetum	arvense
MW07	Symphyotrichum	foliaceum
MW07	Calamagrostis	canadensis
MW07	Sphagnum	spp.
MW07	Moss	spp.
MW08	Salix	sitchensis
MW08	Cornus	canadensis
MW08	Rubus	arcticus
MW08	Vaccinium	membranaceum
MW08	Picea	spp.
MW08	Equisetum	arvense
MW08	Galium	boreale
MW08	Orthilia	secunda
MW08	Calamagrostis	canadensis
MW08	Viola	spp.
MW08	Aster	spp.
MW08	Carex	sitchensis
MW08	Sphagnum	spp.
MW08	Moss	spp.
MW09	Salix	sitchensis
MW09	Betula	nana
MW09	Rubus	arcticus
MW09	Picea	spp.
MW09	Salix	barclayi
MW09	Carex	sitchensis
MW09	Comarum	palustre
MW09	Sphagnum	spp.
MW10	Salix	barclayi
MW10	Carex	sitchensis
MW10	Carex	utriculata
MW10	Carex	aquatilis
MW10	Comarum	palustre
MW10	Calamagrostis	canadensis
MW11	Salix	barclayi
MW11	Alnus	crispa
MW11	Picea	spp.
MW11	Ribes	lacustre
MW11	Salix	spp.
MW11	Rubus	pubescens
MW11	Rubus	arcticus
MW11	Calamagrostis	canadensis
MW11	Viola	spp.
MW11	Moss	spp.
MW12	Salix	spp.
MW12	Abies	lasiocarpa
MW12	Rhododendron	groenlandicum
MW12	Gaultheria	humifusa
MW12	Calamagrostis	canadensis
MW12	Cornus	canadensis
MW12	Orthilia	secunda
MW12	Mitella	spp.
MW12	Equisetum	arvense
MW12	Carex	limosa
MW12	Sphagnum	spp.
MW12	Moss	spp.
MW13	Cornus	canadensis
MW13	Salix	spp.
MW13	Rubus	arcticus
MW13	Gaultheria	humifusa
MW13	Rosa	gymnocarpa
MW13	Vaccinium	membranaceum
MW13	Picea	spp.
MW13	Abies	lasiocarpa
MW13	Rhododendron	groenlandicum
MW13	Alnus	crispa
MW13	Linnaea	borealis
MW13	Carex	aquatilis
MW13	Equisetum	arvense
MW13	Symphyotrichum	foliaceum
MW13	Viola	spp.
MW13	Platanthera	dilatata
MW13	Moss	spp.
MW13	Sphagnum	spp.
WL001a	Picea	spp.
WL001a	Betula	glandulosum
WL001a	Salix	pedatus
WL001a	Salix	barclayi
WL001a	Carex	aquatilis
WL001a	Carex	sitchensis
WL001a	Carex	lasiocarpa
WL001a	Carex	cordillerana
WL001a	Drepanocladus	aduncus
WL001a	Tomentella	nitellina
WL001a	Aulacomnium	palustre
WL001b	Betula	nana
WL001b	Oxycoccus	oxycoccos
WL001b	Salix	barclayi
WL001b	Picea	spp.
WL001b	Eriophorum	chamissonis
WL001b	Carex	aquatilis
WL001b	Carex	spp.
WL001b	Tomentella	nitellina
WL001b	Sphagnum	capillifolium
WL001b	Aulacomnium	palustre
WL002	Betula	nana
WL002	Oxycoccus	oxycoccos
WL002	Salix	barclayi
WL002	Salix	spp.
WL002	Salix	sitchensis
WL002	Calamagrostis	canadensis
WL002	Calamagrostis	stricta
WL002	Carex	aquatilis
WL002	Carex	sitchensis
WL002	Potentilla	palustre
WL002	Tomentella	nitellina
WL002	Sphagnum	capillifolium
WL002	Aulacomnium	palustre
WL003	Betula	nana
WL003	Picea	spp.
WL003	Gaultheria	hispidula
WL003	Rhododendron	groenlandicum
WL003	Empetrum	nigrum
WL003	Ribes	spp.
WL003	Salix	pedatus
WL003	Carex	aquatilis
WL003	Carex	disperma
WL003	Equisetum	arvense
WL003	Pleurozium	schreberi
WL003	Sphagnum	capillifolium
WL003	Sphagnum	angustifolium
WL003	Aulacomnium	palustre

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APPENDIX 2 – MORRISON COPPER/GOLD PROJECT WETLAND ECOSYSTEM, FIELD DATA, AND CLASSIFICATION

Appendix 2
Morrison Copper/Gold Project Wetland Ecosystem, Field Data, and Classification

Plot	Date	Location	Easting	Northing	Elevation	Aspect 0	Slope %	SMR	SNR	Soil Water pH	Open Water pH	Wetland Class_1	Ass_ Code_1
MW01	11-Sep-07	Open Pit	670692	6119323	834	184	0.5	Mo	D	7.2		Swamp	Ws01
MW02	12-Sep-07	Tailing Storage Facility	672461	6124319	1011	12	2.0	SL	C/D	7.1		Swamp	Ws07
MW03	12-Sep-07	Tailing Storage Facility	672057	6124665	978	-1	0.0	St	D	6.7		Shrub-Carr	
MW04	12-Sep-07	Tailing Storage Facility	671689	6124740	969	324	4.0	SL	C	6.6	7.0	Bog	Wb05
MW05	12-Sep-07	Tailing Storage Facility	671559	6124804	986	-1	0.0	Mo	-	-	7.0	Marsh	Wm01
MW06	12-Sep-07	Tailing Storage Facility	671436	6124702	972	-1	0.0	Mo	C	7.3	7.6	Swamp	Ws06
MW07	12-Sep-07	Tailing Storage Facility	671329	6124532	962	265	5.0	SL	C	7.0	7.4	Marsh	Wm01
MW08	12-Sep-07	Tailing Storage Facility	671220	6124493	967	-1	0.0	SI to Mo	B/C	6.8	6.7	Swamp	Ws06
MW09	12-Sep-07	Tailing Storage Facility	671011	6124346	953	-1	0.0				6.5	Swamp	Ws06
MW10	12-Sep-07	Tailing Storage Facility	670238	6125050	970	-1	0.0	Mo	B		6.4	Marsh	Wm01
MW11	12-Sep-07	Tailing Storage Facility	671178	6125569	1006	-1	0.0	SL		6.5		Shrub-Carr	
MW12	13-Sep-07	Tailing Storage Facility	671588	6123339	978	-1	0.0	SL	C	6.6	6.4	Bog	Wb01
MW13	13-Sep-07	Waste Rock Dump		6119514	841	-1	0.0	SL	C/D	7.0	7.1	Bog	Wb01
WL001a	8 to 11-Sept-08	Transmission Line	678725	6103695	860			SI	C+	7.4		Fen	Wf02
WL001b	8 to 11-Sept-08	Transmission Line	678683	6103885	860			SI	C-	6.4		Fen	Wf02
WL002	8 to 11-Sept-08	Waste Rock Dump	671218	6119384	843			SI	B-	6.3		Marsh	Wm01
WL003	8 to 11-Sept-08	Transmission Line	676247	6109997	748			ST	B	6.4		Bog	Wb01