Environment

Hudson Bay Mining and Smelting Co., Limited

Proposed Lalor Mine Environmental Baseline Assessment

Prepared by:

AECOM
99 Commerce Drive 204 477 5381 tel
Winnipeg, MB, Canada R3P 0Y7 204 284 2040 fax
www.aecom.com

Project Number:

60157028 (402.19.3.3)

Date:

March, 2012

Statement of Qualifications and Limitations

The attached Report (the "Report") has been prepared by AECOM Canada Ltd. ("Consultant") for the benefit of the client ("Client") in accordance with the agreement between Consultant and Client, including the scope of work detailed therein (the "Agreement").

The information, data, recommendations and conclusions contained in the Report (collectively, the "Information"):

- is subject to the scope, schedule, and other constraints and limitations in the Agreement and the qualifications contained in the Report (the "Limitations");
- represents Consultant's professional judgement in light of the Limitations and industry standards for the preparation of similar reports;
- may be based on information provided to Consultant which has not been independently verified;
- has not been updated since the date of issuance of the Report and its accuracy is limited to the time period and circumstances in which it was collected, processed, made or issued;
- must be read as a whole and sections thereof should not be read out of such context;
- was prepared for the specific purposes described in the Report and the Agreement; and
- in the case of subsurface, environmental or geotechnical conditions, may be based on limited testing and on the assumption that such conditions are uniform and not variable either geographically or over time.

Consultant shall be entitled to rely upon the accuracy and completeness of information that was provided to it and has no obligation to update such information. Consultant accepts no responsibility for any events or circumstances that may have occurred since the date on which the Report was prepared and, in the case of subsurface, environmental or geotechnical conditions, is not responsible for any variability in such conditions, geographically or over time.

Consultant agrees that the Report represents its professional judgement as described above and that the Information has been prepared for the specific purpose and use described in the Report and the Agreement, but Consultant makes no other representations, or any guarantees or warranties whatsoever, whether express or implied, with respect to the Report, the Information or any part thereof.

Without in any way limiting the generality of the foregoing, any estimates or opinions regarding probable construction costs or construction schedule provided by Consultant represent Consultant's professional judgement in light of its experience and the knowledge and information available to it at the time of preparation. Since Consultant has no control over market or economic conditions, prices for construction labour, equipment or materials or bidding procedures, Consultant, its directors, officers and employees are not able to, nor do they, make any representations, warranties or guarantees whatsoever, whether express or implied, with respect to such estimates or opinions, or their variance from actual construction costs or schedules, and accept no responsibility for any loss or damage arising therefrom or in any way related thereto. Persons relying on such estimates or opinions do so at their own risk.

Except (1) as agreed to in writing by Consultant and Client; (2) as required by law; or (3) to the extent used by governmental reviewing agencies for the purpose of obtaining permits or approvals, the Report and the Information may be used and relied upon only by Client.

Consultant accepts no responsibility, and denies any liability whatsoever, to parties other than Client who may obtain access to the Report or the Information for any injury, loss or damage suffered by such parties arising from their use of, reliance upon, or decisions or actions based on the Report or any of the Information ("improper use of the Report"), except to the extent those parties have obtained the prior written consent of Consultant to use and rely upon the Report and the Information. Any injury, loss or damages arising from improper use of the Report shall be borne by the party making such use.

This Statement of Qualifications and Limitations is attached to and forms part of the Report and any use of the Report is subject to the terms hereof.

AECOM
99 Commerce Drive
Winnipeg, MB, Canada R3P 0Y7
www.aecom.com

204 477 5381 tel
204 284 2040 fax

March 28, 2012

Mr. Stephen West
Hudson Bay Mining and Smelting Co., Limited
PO Box 1500
#1 Company Road
Flin Flon, Manitoba
R8A 1N9

Dear Mr West:

Project No: 60157028 (402.19.3.3)

Regarding: Proposed Lalor Mine Environmental Baseline Assessment

AECOM Canada Ltd. (AECOM) is pleased to provide you with our report summarizing the findings of the Proposed Lalor Mine Environmental Baseline Assessment carried out in 2007, 2008, 2010 and 2011. We trust that the information contained in this report meets your needs. If, during the course of your review, you find that further details or clarifications are required, please do not hesitate to contact Shawna Kjartanson directly at (204) 928-8456 or Cliff Samoiloff at (204) 928-7427.

Sincerely,
AECOM Canada Ltd.

R. V. Typliski

Ron Typliski, P.Eng.
Vice-President, Manitoba District
Canada West Region

SK:dh

cc: A.Weiss

Distribution List

# of Hard Copies	PDF Required	Association / Company Name
1	1	Stephen West, Hudson Bay Mining and Smelting Co., Limited
1	1	Jay Cooper, Hudson Bay Mining and Smelting Co., Limited
1	1	Sheryl Rosenberg, Thompson Dorfman Sweatman

Revision Log

Revision #	Revised By	Date	Issue / Revision Description
1	S.Kjartanson	January 24, 2012	Draft
2	S.Kjartanson	March 28, 2012	Final

AECOM Signatures

Report Prepared By:

Shawna Kjartanson, M.Sc.
Environmental Scientist

Report Reviewed By:

Cliff Samoiloff, B.Sc.
Manager, Health & Safety Consulting, Environment

Executive Summary

Hudson Bay Mining and Smelting Company Ltd. (HBMS) is currently developing an Advanced Exploration Project (AEP) for a zinc/copper/gold mine in the area of Lalor Lake, a small headwater lake located 8 km west of the Town of Snow Lake. This document describes the Lalor Project (*i.e.*, the Project), and environmental and socio-economic aspects. It also describes the terrestrial and aquatic baseline conditions of the surrounding Project area. The study area for this Baseline Assessment encompasses the Lalor AEP site, access road and several waterbodies in the Project Area.

The proposed Lalor Project site is situated on a bedrock outcrop, with some treed areas. The site is generally flat, with a gentle slope upwards towards the south and east. Over the course of baseline assessments associated with the proposed Lalor Mine site, several clearing and construction activities have been completed and continue. The Lalor exploration site has been upgraded to accommodate the advanced exploration shaft and infrastructure. Upgrades to the access road included widening, straightening and a slight extension to the previous exploration road. Clearing and leveling has been kept to the minimum extent possible.

Baseline assessments examined terrestrial and aquatic components. The terrestrial assessment includes the vicinity of the mine site and access road and the area within one (1) kilometre from the shoreline of each of the 13 waterbodies, including Lalor Lake, Maw Lake, Cook Lake, Varnson Lake, Squall Lake, Tern Lake, Snow Lake Narrows, Unnamed Lake 1, Unnamed Creek 1, Snow Creek, Tern Creek, Tern Ditch, and Tern Ditch Pond. The aquatic assessment conducted during this study included the aquatic species and habitat within the local waterbodies and surrounding wetlands.

A variety of physiographic descriptors were used to determine the setting of the Project development. These include: geology, soils, climate, air quality, and groundwater. The proposed Project area lies within the Reed Lake Ecodistrict, characterized by rocky cliffs adjacent to lakes and peat-filled depressions. Bedrock is partially covered by unconsolidated mineral and organic materials. The Flin Flon Belt, in which the proposed Lalor Project resides, is one of vital economic significance, where more than 27 copper-zinc (gold) deposits have been discovered.

Climate at the proposed Lalor site is typical of the region. There are no significant industrial operations that could impact air quality within 13 km of the proposed Lalor site. Occasional impediments to air quality could occur through smoke released from forest fires, emissions from vehicles and fuel storage tanks.

Though no specific information is available regarding regional groundwater flow in the proposed Project area, it is expected to be relatively shallow and controlled by topography and bedrock surface in the region. There are no groundwater wells in use within 5 km of the proposed Lalor Project site.

The nearest significant heritage resource is the Tramping Lake petroglyphs, approximately 20 km south of the Lalor Mine site. Information from the Historic Resources Branch of Manitoba Culture, Heritage and Tourism does not indicate any historic or heritage resources at the proposed Lalor Mine site or in the immediate surrounding area.

Mining, forestry, recreation, tourism, trapping and hunting are some of the more important economic sources in the Snow Lake area. Many in the Town of Snow Lake are employed directly or indirectly at the mines in the area. Regional resource users include trappers, cottage owners, lodge owners, snowmobiliers, forestry industry, and First Nations. The nearest First Nations community to the proposed Project site is Mathias Colomb Cree Nation at Pukatawagan, located approximately 125 km northwest of Snow Lake.

Terrestrial baseline surveys were conducted in 2007, 2010 and 2011. Overall, the region around the Lalor Project site is naturally a dense boreal forest, primarily Black Spruce interspersed with Jack Pine and hardwoods. Dense forest canopy has limited understory growth in all areas within the Project region. Sphagnum forms the dominant ground cover. In general, the proposed Lalor Project site is typical for this region. No rare or endangered plant species were encountered at the proposed Lalor Project site. There are no indications that this area contains unique opportunities for plant growth outside of that present in the general region.

Concurrent with the vegetation surveys, wildlife and wildlife habitat surveys were conducted. There was no specific critical wildlife value observed at the proposed Lalor Project site (such as calving or over-wintering areas) and based on site conditions and field observations, it is expected that there is no critical wildlife value in the proposed Project area. The absence of suitable waterbodies for waterfowl in the general area makes it unlikely that they are nesting anywhere within the immediate area of the proposed Lalor Project site

No protected or critical species were observed during the wildlife surveys. As confirmed through field observations conducted in 2007, 2010 and 2011, the wildlife habitats within the area of the proposed Lalor Mine were considered to be typical for the region, with no unique or rare habitats encountered.

Within 130 km from the proposed Lalor Mine site, there are five (5) protected areas: Grass River Provincial Park, Cormorant Provincial Forest, Clearwater Lake Provincial Park, Saskeram Wildlife Management Area and Tom Lamb Wildlife Management Area.

The waterbodies in the Project area generally drain eastward through Wekusko Lake towards the Nelson River, as part of the Grass River watershed. Terrain falls about 0.6 m to 1.0 m and bogs cover between 20 % to 40 % of the Lalor Lake area. Some lakes, such as Cook Lake and Snow Lake support fisheries resources (with recreational and/or commercial value), however these are separated from Lalor Lake a watershed divide and by large bog and wetland areas repectively.

Bathymetric surveys were conducted on Lalor Lake, Maw Lake, Varnson Lake, Tern Lake, Cook Lake and Tern Ditch Pond. Lalor Lake has a relatively small surface area and volume and a relatively homogenous bottom topography. Cook Lake was the largest lake examined while Tern Ditch Pond was the smallest. Sediments were highly organic, often flocculent. Limited areas of cobble or mineral soils were available in most lakes examined.

In September 2007, an aquatic baseline survey was conducted on 12 waterbodies in the Project region. This involved collection of water and sediment samples, phytoplankton, zooplankton, benthic invertebrates, fish community, and fish whole-body metal concentrations. A brief environmental survey in 2008, focussed on Cook Lake and included a brief fish community assessment, targeting large-bodied fish. A supplemental environmental survey in 2010 included collection of water and sediment samples, phytoplankton, zooplankton, fish community, and fish whole-body metal concentrations. The information collected from the baseline assessments will ultimately be used to support the Environmental Impact Assessment for the development.

Overall, water quality is considered to be relatively good in the assessed waterbodies in the Project area. Water quality in 2007 was screened against federal and provincial water quality guidelines available at the time of the assessment. In 2010, water quality was screened against current (i.e., 2011) federal water quality guidelines. Exceedances in 2007 included aluminum, arsenic, copper and iron. In total, there were nine (9) exceedances in 2007. In 2010, there were eleven (11) exceedances including pH, aluminum, arsenic, and iron. Overall, Tern Ditch had the highest concentrations of aluminum, arsenic, copper and iron. Tern Creek had higher metals concentrations in 2010 as compared to 2007.

For samples collected in 2007, sediment quality was screened against Manitoba and Ontario provincial sediment quality guidelines available at the time of the assessment. Sediment quality in 2010 was screened against federal and provincial sediment quality guidelines available at the time of the assessment. In 2007, arsenic, cadmium, chromium, and copper concentrations exceeded at least one surficial sediment sample. Snow Lake Narrows had the most exceedances where Tern Lake had no exceedances in 2007. In 2010, there were 33 analytes that exceeded at least one applicable sediment quality guideline including arsenic, cadmium, chromium, copper, lead, selenium, and zinc. Tern Ditch Pond, in 2010, did not have any exceedances. Sediment quality is impacted in the Project area, due to such factors as historical anthropogenic activities, depositional nature of the sediments, and naturally elevated concentrations.

In 2007 and 2010, Varnson Lake had the highest productivity in terms of phytoplankton communities. Less productive lakes were Tern Lake in 2007 and Maw Lake in 2010. In 2007, Tern Lake had the highest zooplankton abundance, while in 2010 Maw Lake had the highest abundance. In terms of the benthic invertebrate community, Tern Lake had the highest average abundance while Unnamed Lake 1 had the lowest abundance and species diversity. Differences in plankton and benthic invertebrate community and density change seasonally and can be affected by basic limnological parameters (e.g., temperature and total dissolved solids) and biological factors (e.g., competition and predator abundance).

Minnow traps, gill nets, and angling were used to collect fish in the Project area in 2007, 2008 and 2010. In total, five (5) fish species were captured. In general, the larger waterbodies (i.e., Lalor Lake, Maw Lake, and Varnson Lake) had the highest species diversity and catches. Brook Stickleback were the most abundant (or only) species captured, typical of headwater waterbodies. Metal residue concentrations in all but one fish analyzed (a total of 170 fish were analyzed) were below the applicable guideline. All lakes provided diverse cover types and varying degrees of shoreline complexity. However, while the smaller creeks and lakes within the Project Area provided a diversity of habitats, shallow depth and limited connectivity to other waterbodies suggests that it cannot support populations of large-bodied fish. Habitat for large-bodied fish is available in the larger waterbodies, i.e., Cook Lake, Squall Lake and Snow Lake.

In general, water and sediment quality as well as biological diversity and productivity was typical of the region. Waterbodies and other areas impacted by historical or current mining and land use activities demonstrate reduced water and sediment quality. The spatial variability in the concentrations of potential chemicals of concern needs to be considered when developing monitoring and assessment programs.

Table of Contents

Statement of Qualifications and Limitations
Letter of Transmittal
Distribution List
Executive Summary

List of Tables

Drawings

Appendices

List of Acronyms

AADT	Annual Average Daily Traffic
AECOM	AECOM Canada Ltd.
AEP	Advanced Exploration Project
CCME	Canadian Council of Ministers of the Environment
CDC	Conservation Data Centre
CSQG	Canadian Soil Quality Guidelines
CWQG	Canadian Water Quality Guidelines
DO	Dissolved Oxygen
EA	Environmental Assessment
EEM	Environmental Effects Monitoring
EBA	Environmental Baseline Assessment
EIA	Environmental Impact Assessment
EIS	Environmental Impact Statement
FFB	Flin Flon Belt
GIS	Geographical Information System
GPS	Global Positioning System
HBMS	Hudson Bay Mining and Smelting Co., Limited
ISQG	Interim Sediment Quality Guideline
LEL	Lowest Effect Level
masl	Metres Above Sea Level
MESA	Manitoba Endangered Species Act
MSQG	Manitoba Sediment Quality Guidelines
MWQSOG	Manitoba Water Quality Standards, Objectives, and Guidelines
NTU	Nephelometric Turbidity Unit
OSQG	Ontario Sediment Quality Guidelines
PEL	Probable Effect Level
QA/QC	Quality Assurance/Quality Control
RCMP	Royal Canadian Mounted Police
RTL	Registered Trap Lines
SARA	Species at Risk Act
SEL	Severe Effect Level
TP	Total Phosphorous
UTM	Universal Transverse Mercator Units
VMS	Volcanic-hosted Massive Sulphide
WMA	Wildlife Management Area
WMO	World Meteorological Organization

1. Introduction

1.1 Company Profile

Hudson Bay Mining and Smelting Co., Limited (HBMS), which is a wholly owned subsidiary of HudBay Minerals, Inc. is proposing the development of the Lalor Mine (*i.e.,* the Project). HBMS operates the 777 Mine and Trout Lake Mine in Flin Flon, Manitoba, and the Chisel North Mine in Snow Lake, Manitoba. It is anticipated that Trout Mine will close by June 2012, followed by a July 2012 closure of the Chisel North Mine. An Advanced Exploration Project (AEP) has been approved on the Reed Property, located in Grass River Provincial Park, Manitoba.

Copper and zinc ore from the 777 Mine and Trout Lake Mine is concentrated in the Flin Flon Metallurgical Complex, while zinc ore from the Chisel North Mine is concentrated at the Stall Lake Concentrator. Zinc concentrates from both Flin Flon and Snow Lake are processed to produce refined zinc in the zinc pressure leach plant (cellhouse and zinc casting plant) located in the Flin Flon Metallurgical Complex. Since closure of the Flin Flon copper smelter in June 2010, copper concentrate has been shipped out of Manitoba for further processing.

As of 2010, HBMS supported 1,286 direct jobs with an annual payroll of $186.4 million, contributed $6.6 million in municipal taxes and grants, and paid $38.5 million in income, mining and capital taxes in Canada.

The Snow Lake area (Drawing - 01) has had an active mining history for more than 50 years. HBMS has played an integral part in this history since the late 1950's by operating nine mines in the area, including Photo Lake, Rod, Chisel Lake, Stall Lake, Osborne Lake, Spruce Point, Ghost Lake, Anderson Lake, and the current operation at Chisel North Mine (Drawing – 02). The mines at Rod, Osborne Lake, Spruce Point, Ghost Lake, and Anderson Lake have been fully decommissioned, and partial decommissioning has been performed at the Chisel Lake and Stall Lake Mine sites.

The Chisel Lake Mine, located 16 km southwest of Snow Lake, was opened in 1958, and was the first copper zinc mine in the Snow Lake area. This was followed two years later with the opening of the Stall Lake Mine, located 7 km east of Snow Lake, and in 1968, a third mine at Osborne Lake was opened. In 1979, an ore concentrator was commissioned near the Stall Lake Mine, when five mines were in operation near Snow Lake. In 1988, the Chisel Lake Mine site was expanded with the development of an open pit mine. This open pit mine produced extremely high-grade zinc ore, mixed with small quantities of lead, silver, and gold. Ore was taken from the pit by truck and transported to the Snow Lake Concentrator for processing. Within two years of opening, the pit had reached a depth of nearly 76 m.

The Chisel Open Pit Mine was closed in 1994, and was followed by the opening of the Photo Lake Mine, located approximately 3 km east of the Chisel Open Pit Mine. The Photo Lake Mine was operational from 1994 to 1998. Between 1998 and 2000, a decline ramp was driven from the bottom of the Photo Lake Mine to the current Chisel North Mine, located just north of the old Chisel Lake Mine. The Chisel North Mine has been operational since 2000 and has a production of approximately 16,000 tons of zinc per year. Based on current mineable reserves and inferred resources, the Chisel North Mine is expected to be depleted in July 2012.

The Stall Lake Concentrator was commissioned in 1979 and operated continuously until shutdown in early 1993, following ore depletion at the Chisel Open Pit and Stall Lake Mines. The Concentrator was reopened in 1994 to process ore from the Photo Lake Mine and later to process ore from the Chisel North Mine. The Chisel North Mine and Stall Lake Concentrator suspended operations in 2009, but both facilities resumed operation in early 2010. The Stall Lake Concentrator has two separate crushing/grinding/flotation circuits. The smaller of the circuits is being used to mill Chisel North ore at a present rate of 313,000 tonnes per year

The history of exploration and mining in Manitoba also has included sites in the Grass River Provincial Park. HBMS operated the Spruce Point Mine on the south shore of Reed Lake from 1981 to 1992 and the approved advanced exploration project at the Reed Property located south of Reed Lake.

1.2 Background

In the fall of 2007, HBMS announced the discovery of a significant zinc ore body in the vicinity of Lalor Lake, located in north-western Manitoba approximately 8 km west of the Town of Snow Lake. Initial estimates supported by drilling investigations conducted in 2008 state the potential for 18-20 million tonnes of 7.7% to 8.8% zinc. HBMS has subsequently proposed the development of a mining operation in the area of Lalor Lake, with the proposed mine site situated at a location to the east of Lalor Lake (Drawing - 03).

The preliminary task in the development of this new mining operation is the development of an Environmental Impact Assessment (EIA). The EIA is conducted as early as possible in the planning stages of the project before irrevocable decisions are made.

In general, the objectives of the EIA are as follows:

- to predict the environmental effect of a project;
- to recommend appropriate mitigation measures that will eliminate or reduce the environmental effects of a project;
- to determine the significance of the residual environmental effects;
- to recommend any appropriate follow-up program requirements.

The EIA will comprise three (3) components: Environmental Baseline Assessment (EBA); Environmental Assessment (EA); and Environmental Impact Statement (EIS).

The EBA records the present quality of the environment within the area of influence prior to implementation of the proposed project. This includes the physical environment (geology, topography, hydrology, etc), biological environment (flora, fauna, rare and endangered species, etc) and socio-economic environment (reserves, protected areas, cultural/historical resources, etc). The information obtained during the baseline assessment will be utilized in the EA to predict and quantify potential impacts.

The EA identifies and assesses potential impacts of the proposed project as well as describes the mitigation measures required to offset potential negative impacts and any residual impacts on the environment following implementation of the mitigation measures. The EA will be completed once final location and proposed mining methodologies has been established.

The EIS is a summary of the findings of the EBA and the EA.

This EBA has been completed by AECOM utilizing information provided by HBMS and a variety of environmental, ecological, and geological data collected by AECOM and our sub-consultants through field investigations and a comprehensive literature search.

This document describes the physiographic settings of the proposed Lalor Mine site (*i.e.,* Project area) and baseline environmental conditions at the proposed mine site. The study area for the EBA encompasses the area of the proposed mine site and includes the access road and surrounding waterbodies.

The aquatic assessment included an evaluation of the aquatic species (from field investigation and desktop review), habitat, and baseline water and sediment chemistry within the 12 waterbodies in 2007 and seven (7) waterbodies in 2010 (Table 1.1).

Table – 1.1: Waterbodies Sampled in the Project Area

Waterbody	Year	
	2007	2010
Lalor Lake	X	X
Maw Lake	X	X
Cook Lake*	X	
Varnson Lake	X	X
Squall Lake	X	
Unnamed Lake 1	X	
Unnamed Creek 1	X	
Snow Creek	X	
Snow Lake	X	
Tern Creek	X	X
Tern Ditch	X	X
Tern Lake	X	X
Tern Ditch Pond		X

Notes:

** = Fishing effort and bathymetry was completed for Cook Lake in 2008.*

2. Project Description

2.1 Location

The Lalor deposit is located in the vicinity of the east shore of Lalor Lake, a small, shallow, headwater lake located approximately 8 km west of the Town of Snow Lake, Manitoba (Drawing - 03). The proposed Lalor Mine site and current Lalor AEP site is 3 km west of Highway 395, with a direct access road initially constructed in 2008 and further upgraded. The road construction materials were composed of crushed non acid generating waste rock obtained from a quarry developed at the start of the access road.

2.2 Site Exploration History

The proposed Lalor Mine site is located approximately 3 km northwest of the existing Chisel North Mine and was discovered in the spring of 2007. The initial discovery hole intersected a zinc-rich base metal horizon. Subsequent drilling confirmed the occurrence of several base metal horizons, two of which were very extensive in size. Diamond drilling has been successful in outlining these horizons and delineating to approximately 50 m to 70 m spacing. These base metal horizons are comprised primarily of zinc, with lesser amounts of copper, silver, gold and lead, which is very similar to the mineralization encountered at the operating Chisel North Mine.

In the latter part of 2008, exploration drilling encountered a gold-bearing horizon at a much deeper depth than the base metal horizons. Since the initial gold intersection, exploration drilling has been successful in intersecting additional gold-bearing horizons, all at greater depths from surface than the base metal horizons. Some of the gold-bearing horizons are located at depths greater than 1,200 m below the ground surface. Due to the great depths and complex shape of these horizons, exploration drilling from surface is limited in its ability to accurately define the shape and grade distribution. In the fall of 2009, an exploration drill hole intersected a high-grade copper-gold zone located approximately 1,300 m below surface. Since this discovery, there has been additional diamond drilling, but exploration by this method has been met with limited success. The depths at which the gold-copper zones are encountered results in the deviation of drill holes from the target zones, resulting in difficulty in accurately defining the target zones.

2.3 Site Clearing and Development

At the time of the initial baseline assessments, the proposed Lalor Mine site was undeveloped, with the exception of trails and small clearings developed as part of mineral exploration activities. Site clearing and construction of the mining camp and associated infrastructure was ongoing. The area of disturbance was kept to the minimum extent possible.

Prior to site leveling, the proposed Lalor Mine site was situated on a bedrock outcrop, with some treed areas. The site is generally flat, with a gentle slope upwards towards the south and east, with outcrops rising approximately 12 m to 15 m above the general area elevation. The site is at least 5 m to 7 m above water level of the wetland located in the general area. The site has since been leveled by blasting and backfilled to an approximately even elevation at approximately 305 metres above sea level (masl).

Over the course of baseline assessments associated with the proposed Lalor Mine site, several clearing and construction activities have been completed and continue. The Lalor AEP site has been upgraded to accommodate the advanced exploration production shaft and associated infrastructure. Upgrades to the access road included widening, straightening and a slight extension to the existing exploration road. The total area of disturbance (associated with the advanced exploration site development) was about 97 hectares, approximately half of which is presently disturbed area.

3. Physiographic Setting

3.1 Physical Environment

The Lalor Deposit is located in the Boreal Shield Ecozone. As the largest ecozone in Canada, it extends from northern Saskatchewan east to Newfoundland, north and east of Lake Winnipeg and finally north of the Great Lakes and St. Lawrence River. The Lalor Deposit and the immediate surrounding area, which includes Lalor Lake, Maw Lake, Varnson Lake and surrounding bogs and smaller waterbodies are located in the Reed Lake Ecodistrict in the Churchill River Upland Ecoregion (Smith, *et al.*, 1998).

The elevations in the Reed Lake Ecodistrict range from approximately 255 masl to 335 masl. Elevations within the region of the Lalor Deposit vary from more than 312 masl for the highest bedrock outcrops to the west to approximately 256 masl near Wekusko Lake (Department of Energy, Mines and Resources, 1985 and 1995). Slope lengths in the ecodistrict range from approximately less than 50 m to more than 150 m in length. Rocky cliffs can rise from 35 m to 40 m above the lakes and peat-filled depressions (Smith, *et al.*, 1998).

The Project region is characterized by broken, hilly to rolling bedrock, which controls relief of the area. The bedrock is partially covered by unconsolidated mineral and organic materials. Areas to the east of Lalor Lake contain extensive lacustrine deposits, while the remainder contains a mixture of lacustrine sediments, till deposits and peatlands.

3.2 Geology

The region of the Lalor Deposit is part of the Flin Flon Belt (FFB). According to the Manitoba Geological Survey, the FFB is in the juvenile internal zone of the Trans-Hudson Orogen and consists of Paleoproterozoic volcanic, plutonic and minor sedimentary rocks. According to Manitoba's Mineral Resources Geological Survey, *"the Flin Flon greenstone belt extends hundreds of kilometres to the south-southwest beneath a thin, geophysically transparent Phanerozoic cover. To the north the FFB is tectonically overthrust by younger metasedimentary rocks of the Kisseynew domain and by nappes of metavolcanic rocks that are the same age as those in the FFB."* (Government of Manitoba, 2011).

The tectonostratigraphic architecture of the FFB is of vital economic significance. The FFB is one of the largest Proterozoic volcanic-hosted massive sulphide (VMS) districts in the world, containing 27 copper – zinc (gold) deposits. Of these deposits, more than 162 million tonnes of sulphide have already been mined (Government of Manitoba, 2011).

The Snow Lake arc assemblage that hosts the Lalor Deposit is a 20 km wide by 6 km thick section that records the transition from primitive to mature arc. The mature arc Chisel Sequence that hosts the Lalor Deposit typically contains thin and discontinuous volcanoclastic deposits and intermediate to felsic flow-dome complexes. Rock units in the hanging walls of the deposit typically include mafic and felsic volcanic and volcanoclastic units, mafic wacke, fragmental and crystal tuff units. The footwall rocks have extensive hydrothermal alteration and metamorphic recrystalization which has produced exotic aluminous mineral assemblages including; chloritic and seracitic schist; and cordierite-anthophylite gneisses (Bailes & Galley, 2007).

3.3 Soils

The Reed Lake Ecodistrict extends west from Wekusko Lake to just over the Saskatchewan border. Acidic granitoid bedrock in the form of sloping uplands and lowlands can be found in this ecodistrict. Bedrock areas are subdominant and widely distributed areas of permafrost can occur in peatlands.

Dystric Brunisols are the dominant soils in the ecodistrict. These soils have developed over glacial till overlying bedrock and consist of shallow, sandy and stoney veneers. Peat-filled depressions with very poorly drained Typic and Terric Fibrisolic and Mesisolic Organic soils can be found throughout the ecodistrict. These soils are overly loamy to clayey glaciolacustrine sediments. Eutric Brunisols and Gray Luvisols can be found on sandy bars, beaches, and exposed clayey deposits (Smith, *et al.*, 1998).

3.4 Climate and Meteorology

Although the closest community to the Project Site is Snow Lake, the closest weather station to the site is located near Baker's Narrows at the Flin Flon airport, approximately 99 km west of Lalor Lake. The Flin Flon airport is located at an elevation of 304 masl and is considered to be climatically representative of the Project Site. The mean annual air temperature at the Flin Flon airport is -0.2°C. The daily mean temperature ranges between 18°C in July and -21°C in January. Total annual precipitation at the Flin Flon airport is composed of 339 mm of rain and 141 cm of snow. July has the highest average rainfall (77 mm), whereas November and December have the highest average snowfall (25 cm and 24 cm, respectively). (Environment Canada, 2012)

The average temperature, precipitation and wind conditions measured at the Flin Flon airport each month are provided in Table 3.1.

Table 3.1: Climate Data for the Flin Flon A, Manitoba (1971-2000)
Latitude 54^0 41' N Longitude 101^0 41' W Elevation 303.90 m

	Month													
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Year**	**Code**
Temperature (^{o}C)														
Daily Average	-21.4	-16.7	-9.3	0.7	8.8	14.9	17.8	16.6	9.8	2.7	-8.4	-18.4	-0.2	A
Daily Maximum	-16.6	-11	-2.9	6.9	15	20.4	23.1	21.8	14.2	6.2	-5.1	-14	4.8	A
Daily Minimum	-26.2	-22.3	-15.8	-5.5	2.6	9.3	12.6	11.4	5.4	-0.8	-11.7	-22.6	-5.3	A
Precipitation														
Rainfall (mm)	0.1	0.3	0.9	8.6	36.9	66.6	76.5	66.6	55.3	25.6	1.4	0.4	339.2	A
Snowfall (cm)	19.6	14.6	19.1	20	3.7	0	0	0	2	13	25.4	23.9	141.3	A
Wind Conditions (km/h)														
Speed	9.4	9.7	10	10.9	11.1	11.2	10.9	10.7	12.1	12.2	11.1	9.3	10.7	A
Most Frequent Direction	NW	NW	S	S	NE	S	NW	S	NW	NW	NW	NW	NW	A

Notes:

Data obtained from Environment Canada Flin Flon A meteorological station (2012)

"A": World Meteorological Organization (WMO) "3 and 5 rule" (i.e. no more than 3 consecutive and no more than 5 total missing for either temperature or precipitation) between 1971 and 2000.

3.5 Air Quality

Specific measurements of air quality in the Project Region are not available. However, it is expected that the air quality in this area is considered very good compared with larger cities and commercial and industrial areas in Manitoba. There are no industrial operations that release to the atmosphere within 13 km of the proposed Lalor Mine site. The closest significant industrial activity is in the City of Flin Flon and the Town of The Pas located approximately 109 km and 135 km from the proposed Lalor Mine site, respectively. Occasional regional impediments to air quality, although uncommon, may occur in the Project Region. This could include smoke from forest fires and wood-burning stoves, emissions from fuel storage tanks and vehicle emissions.

3.6 Groundwater

There is no information available on the regional groundwater flow system. However, based on conditions in similar environments, the regional shallow groundwater flow, in particular in the overburden, is likely controlled by the topography and bedrock surface in the region. Recharge of shallow groundwater can be expected to occur in elevated areas. From there, shallow groundwater flow will generally follow the topography and drain to the low-lying areas where it will discharge to surface waterbodies and wetlands. Shallow groundwater tables are high in most peat lands and in low areas bordering the peat lands. Shallow groundwater levels in the area are generally at or near surface in the spring and early summer and drop as the year progresses. Locally, the topography of the buried bedrock surface can have a significant effect on groundwater flow direction.

The Manitoba Water Stewardship water well records indicate little groundwater development near the proposed Project Site. There are no groundwater wells in use within a distance of at least 5 km from Lalor Lake. Bedrock groundwater wells, when present, are likely connected to fractures or discontinuities that are connected to the local water table and are not likely regionally interconnected.

Hydrogeological testing of the bedrock in the vicinity of the Lalor deposit determined the bulk hydraulic conductivity of the fractured rock to be within the upper range for unfractured metamorphic or igneous rocks and the lower range for fractured metamorphic or igneous rocks ($K_{BULK} = 8.3 \times 10^{-10}$ m/s). This hydraulic conductivity is low and it is not anticipated that large volumes of groundwater seepage will be generated at the proposed Lalor Mine (Golder Associates Ltd., 2009).

3.7 Heritage Resources

Information from the Historic Resources Branch of Manitoba Culture, Heritage and Tourism does not indicate any historic or heritage resources at Lalor Mine site or in the immediate surrounding area.

Approximately 20 km south of Lalor Lake is Tramping Lake, the site of one of Manitoba's largest known concentrations of aboriginal petrographs. At the narrows of Tramping Lake, in the southeastern part of the Grass River waterway, ancient artwork appears on a series of 14 rock faces, on a granite outcropping that dominates the shore. The paintings of deer, bison, moose, birds, fish, snakes and humans are thought to have been created 1,500 to 3,000 years ago by the Algonkian-speaking ancestors of the Cree and Ojibway First Nations. The proposed Lalor development will have no impact on the Trampling Lake petrographs.

3.8 Socio-Economic Environment

3.8.1 Economy

3.8.1.1 Town of Snow Lake

The main settlement in Project Region is the Town of Snow Lake, an important mining and service centre for the surrounding area. Snow Lake has a population of 837 according to the 2006 census data from Statistics Canada, with the majority of these residents employed at, or supported by, the mines located throughout the area. Many other Snow Lake residents are employed in the industries and services that support the region's mining operations (Statistics Canada, 2010a).

The Snow Lake area has had an active mining history for more than 50 years. HBMS has played an integral part in this history since the late 1950's by operating nine mines in the area including Photo Lake, Rod, Chisel Lake, Stall Lake, Osborne Lake, Spruce Point, Ghost Lake, Anderson Lake and in current production at Chisel North Mine.

In addition to mining activities, extensive forestry operations have occurred within the region and surrounding area, with wood sent to the pulp and paper mill operation in The Pas, Manitoba. Trapping and hunting are popular activities in this region.

3.8.1.2 City of Flin Flon

The City of Flin Flon has an approximate population of 5,594 people according to the 2006 census data from Statistics Canada (Statistics Canada, 2010b). The City of Flin Flon is the main mining community in north-western Manitoba and north-eastern Saskatchewan. Flin Flon is located just over 800 km north-northwest of Winnipeg, Manitoba, and 120 km west of the Town of Snow Lake. The community occupies portions of both Manitoba and Saskatchewan.

In addition to mining, Flin Flon has a strong tourism industry which includes hunting, fishing, camping, and boating.

3.8.2 Community Infrastructure - Traffic

Highways in the vicinity of the proposed Lalor Mine are shown in Drawing - 02. According to Manitoba Infrastructure and Transportation, the 2009 annual average daily traffic (AADT) flow for PR 392 north of Provincial Trunk Highway (PTH) 39 and south of the PR 395 junction is 520 vehicles per day. The average daily traffic flow for PR 395 west of the PR 392 junction is 80 vehicles per day (Manitoba Infrastructure and Transportation, 2009)

3.8.2.1 Town of Snow Lake

The Town of Snow Lake is situated mid-way between Thompson, Flin Flon and The Pas. Year-round road access is provided to Snow Lake by Provincial Road (PR) 392. The community is serviced directly by Manitoba Hydro transmission lines and has telephone access through Manitoba Telecom Services Inc. Potable water is obtained from Snow Lake, and is treated in a WTP located in the Town of Snow Lake.

3.8.2.2 City of Flin Flon

Access to Flin Flon is along paved PTH 10 from The Pas and Southern Manitoba, PTH 39 from Snow Lake and Thompson, and Highway 106 from Saskatchewan. Flin Flon is serviced directly by Manitoba Hydro transmission lines and has telephone and cellular access through Manitoba Telecom Services Inc.

3.8.3 Community Services

3.8.3.1 Town of Snow Lake

The Town of Snow Lake has various community services including: a health facility that is staffed by two doctors, a grocery store, two hotels/motels, two service stations, a hockey arena, a curling rink and a nine-hole golf course. There is an un-serviced gravel municipal airstrip located approximately 20 km east of the proposed Lalor Mine site that is designed to accommodate air ambulances for medical evacuations. Other services include a Royal Canadian Mounted Police (RCMP) station and a volunteer fire department. There are also numerous recreational opportunities including camping, hiking trails, fishing, hunting, snowmobiling and all terrain vehicle trails (Snow Lake, 2011).

3.8.3.2 City of Flin Flon

The City of Flin Flon operates an airport located 20 km southeast of the city near Baker's Narrows. Other services such as a hospital, a fire hall and a police/RCMP station are located in Flin Flon along with a hockey arena, curling rinks, a golf course, a public swimming pool and numerous sports fields for recreational opportunities (City of Flin Flon, 2008).

3.8.4 Personal/Family/Community Life

3.8.4.1 Town of Snow Lake

Some of the larger community events held in Snow Lake include the Winter Whoot Festival and the Sno-Drifters Radar Runs. Other events include Bingo and Texas Hold'em that are held at The Royal Canadian Legion #241 (Snow Lake, 2011).

3.8.4.2 City of Flin Flon

Various community events are held in Flin Flon during the year. Some of these events include: The Friendship Center Sled Dog Races, Baker's Narrows Day, Phantom Lake Father's Day Picnic and the Trout Festival. Other smaller events include a Spring Breakout Program, Canada Health Day Event, Terry Fox Run and the Christmas Family Event (City of Flin Flon, 2008).

3.8.5 Regional Resource Use

3.8.5.1 Trappers

The Manitoba Conservation office in Snow Lake has confirmed that there are two registered trap lines (RTL) in the area of Cook Lake and Lalor Lake. These lines include RTL 23 and RTL 14 which are owned by Martin McLaughlin and Jim Schollie, respectively. Manitoba Conservation has confirmed that the area of Anderson Creek and Wekusko Bay is registered as RTL 13. This trap line is owned by Russell Bartlett (assisted by Greg Foord).

3.8.5.2 Cottages or Remote Residences

During AECOM's Cook Lake bathymetry field investigation in September 2008, five cabins were observed on Cook Lake. All five cabins were unoccupied on the first day of the investigation. On the second day of the investigation, one resident was present at Cabin 5. In a brief interview with the resident, it was indicated that cabins have only been on the lake in the last 15 years and that five cabins is the maximum allotted to Cook Lake by Manitoba Conservation. Boats and all terrain vehicles were observed during the September 2007 field study.

3.8.5.3 Lodge Owners

There are no lodges in the area immediately surrounding the proposed Lalor Mine site, however there are four lodges located in the Snow Lake region. The Diamond Willow Inn & Willow House is located in the Town of Snow Lake at 200 Lakeshore Drive and is approximately 9 km east of the proposed Lalor Mine site. Wekusko Falls Lodge and Tawow Lodge Ltd. (Herb Lake Landing) are located approximately 18 km and 35 km southeast of the proposed Lalor Mine site, respectively. Burntwood Lodge is a fly in fishing lodge located on Burntwood Lake and is approximately 60 km northwest of the proposed Lalor Mine site.

3.8.5.4 Snowmobilers

The Snow Lake area is home to the Snow Lake Sno-Drifters snowmobiling club. A map of snowmobile trails maintained by the club in the Snow Lake area is maintained online.

3.8.5.5 Forestry

The Cormorant Provincial Forest is located approximately 80 km southwest of the proposed Lalor Mine site and covers an area of 1,479 km^2. Provincial forests are Crown lands managed by Manitoba Natural Resources on a sustainable yield basis. A licence or permit allows harvesting of trees on Crown lands and also indicates the quantity of each type of trees that can be harvested. Large companies must regenerate forest lands that they have harvested according to their Forest Management License. A forest renewal fee is paid by individuals or small companies for reforestations (Manitoba Conservation, 2011a).

Tolko Industries Ltd. (Manitoba Solid Wood Division, Woodlands), located in The Pas, Manitoba has three Forest Sections (Highrock, Nelson River and Saskatchewan River) where wood is harvested. These Forest Sections include areas surrounding Snow Lake, Flin Flon and Grass River Provincial Park (Tolko Industries Ltd., 2011).

3.8.5.6 Fisheries – Recreational and/or Commercial

Small lakes in the Project Area include Lalor Lake, Maw Lake and Varnson Lake do not provide habitat for large-bodied fish and are therefore, limited in the recreational value. Although Iverach Lake, Erzinger Lake and Gutray Lake are larger lakes that may support small-bodied fish throughout the majority of the year, in terms of fisheries resources, these lakes likely do not support any commercial or recreational opportunities. Larger lakes in the Project area include Squall Lake, Cook Lake and Snow Lake. Squall Lake is north of Snow Lake and is likely able to support a variety of fish species. Snow Lake supports a variety of fish species throughout the year.

Given its proximity to the Town of Snow Lake, there are recreational opportunities such as fishing, swimming, canoeing and snowmobiling in and around Snow Lake. According to Grant McVittie, The Regional Fisheries Manager in The Pas, there was a commercial gill net fishery in Snow Lake from 1989-90 targeting Lake Whitefish, but was suspended due to the high bycatch (~41% of round weight) of Walleye and Northern Pike (Grant McVittie, pers comm.). Anecdotal evidence exists of a failed commercial trap net fishery in 1998 (Grant McVittie, pers comm.). Cook Lake and Squall Lake likely support limited recreational opportunities, including cabins, camping, fishing, swimming, canoeing and snowmobiling.

3.8.6 First Nations

The Mathias Colomb Cree Nation, located approximately 122 km northwest of Snow Lake at the community of Pukatawagan, is the closest First Nation community to the proposed Lalor Mine site. Pukatawagan had a population of 1,478 people in 2006 (Statistics Canada, 2010c). Mathias Colomb has a band population of 1,576 people in 2006 (Statistics Canada, 2007).

Other First Nations that are within a similar distance to the proposed Lalor Mine site include:

- Nisichawayasihk Cree Nation at Nelson House (129 km)
- Mosakahiken Cree Nation at Moose Lake (131 km)
- Opaskwayak Cree Nation at Opaskwayak (137 km)
- Cross Lake First Nation at Cross Lake (155 km)
- Norway House Cree Nation at Norway House (182 km)

4. Terrestrial Environment

4.1 Terrestrial Survey

AECOM completed a baseline terrestrial survey in September 2007 that included a review of local geology, soil, vegetation and wildlife located in the vicinity of the exploration site and access road and an area within 1 km of the shoreline of each of the twelve waterbodies in the area including: Lalor Lake, Maw Lake, Cook Lake, Varnson Lake, Squall Lake, Tern Lake, Snow Lake, Unnamed Lake 1, Unnamed Creek 1, Snow Creek, Tern Creek and Tern Ditch. The survey consisted of a random meander survey by qualified AECOM biologists. In July 2010, AECOM conducted a terrestrial survey of the Lalor AEP site (site of the future proposed Lalor Mine) and access road and immediately surrounding habitat. The Lalor AEP site and access road and immediately surrounding habitat were re-examined in May/June 2011 for flowering plants and nesting songbirds by qualified AECOM biologists. Representative photos taken as part of the terrestrial survey can be found in Appendix A.

The Manitoba Conservation Data Centre (CDC) lists rare and endangered plants for the province on an ecoregion basis. The CDC listed species for the area surrounding the proposed Lalor Mine site are presented in Appendix B Tables – 01 and 02. Expected plant species for the area is shown in Appendix B Table – 03. Wildlife species recorded for this region are presented in Appendix B Table – 04.

4.2 Vegetation

Vegetation in the Reed Lake Ecodistrict is typical of the northern Boreal forest region with Black Spruce, Jack Pine, Trembling Aspen and White Spruce. The bog peat-lands have stunted Black Spruce, moss, and ericaceous shrub vegetation, while fens have sedge, shrub and tamarack vegetation in varying mixtures. Forest composition is reflective of a forest fire history (Smith *et al.*, 1998).

The general area of the proposed Lalor Mine site is a boreal forest biome typical of the rock outcrop and bog landscape. Rock outcrops are primarily igneous and common, forming open lichen woodlands of White Spruce and Jack Pine. Black Spruce bog has developed in the areas between rocky outcrops and created deep deposits of sphagnum moss that restrict drainage. The bog is fairly mature with large areas of even-aged Black Spruce stands. One indication of tree stand density is the relative lack of understory shrubs. Alder dominates the shrub layer in openings created by watercourses. There were no Hazel, Saskatoon, Chokecherry, or other typical understory shrubs noted during the survey. Ground cover is moss with typical boreal ground plants such as Bunchberry and Solomon's Seal. Soil development has occurred in pockets between rock outcrops with good drainage. Jack Pine grows in sporadic open sandy areas. (Drawing – 04)

The general historical disturbance in this area has opened the canopy. However, most of this activity has been limited to narrow cut lines and drag roads that grow in rapidly. Regrowth in such areas is largely hardwoods but these areas also offer some growth opportunity for shrubs that were largely lacking in other parts of the forest stand. The historical regrowth in this area is a minor part of the forest canopy, however, it is extensive and likely important in terms of offering linear features that present more diversity than the surrounding forest and providing openings in an otherwise dense canopy.

A list of confirmed vegetation (based on desktop review and supported by field observation in 2007, 2010 and 2011) is provided in Table 4.1. The spring 2011 survey did not reveal any species not previously observed in the 2010 work.

Table – 4.1: Vegetation Observed in the General Project Area (2007, 2010 and 2011)

Awned hair cap moss (*Polytrichum piliferum)*	Lily of the Valley (*Maianthemum canadense*)
Balsam Fir (*Abies balsamea*)	Marsh Cinquefoil (*Potentilla palustris*)
Bearberry (*Arctostaphylos uva-ursi*)	Mountain Cranberry (*Vaccinium visit-idaea)*
Black Spruce (*Picea mariana*)	Northern Reindeer Lichen (*Cladina stellaris)*
Bog Cranberry (*Vaccinium vitis-idaea*)	Paper Birch (*Betula papyrifera*)
Bunchberry (*Cornus canadensis*)	Perennial Sow Thistle (*Sonchus arvensis*)*
Canada Anemone (*Anemone canadensis*)	Reed Canary Grass (*Phalaris arundinacea*)
Canada Bluejoint (*Calamagrostis canadensis)*	Rough Cinquefoil (*Potentilla norvegica*)
Canada Buffaloberry (*Sheperdia canadensis*)	Sedge (*Carex sp.*)
Canada Thistle (*Cirsium arvense*)*	Shore-Growing Peat Moss (*Sphagnum riparium*)
Cladonia (*Cladonia sp.*)	Snowberry (*Symphoricarpos albus*)
Common Reed Grass (*Phragmites australis*)	Speckled Alder (*Alder rugosa)*
Common Cattail (*Typha latifolia*)	Sphagnum moss (*Sphagnum sp.*)
Drooping Wood-Reed (*Cinna latifolia)*	Squarrose Peat Moss (*Sphagnum squarrosum*)
Dwarf Billberry (*Vaccinium caespitosum)*	Stiff Club Moss (*Lycopodium annotinum)*
Early Blue Violet (*Viola adunca)*	Stinging Nettle (*Urtica dioica*)*
Fern (*Matteuccia sp.*)	Tall Cotton-Grass (*Eriophorum angustifolium*)
Finger Felt Lichen (*Peltigera neopolydactyla)*	Trembling Leaf Aspen (*Populus tremuloides*)
Girgensohn's Peat Moss (*Sphagnum girgensohnii)*	Tufted Moss (*Aulacomium palustre)*
Ground Cedar (*Lycopodium complanatum*)	Velvet Leaf Blueberry (*Vaccinium myrtilloides*)
Ground Pine (*Lycopodium obscurum*)	Wavy Dicranum (*Dicranum undulatum)*
Jack Pine (*Pinus banksiana*)	Wax Paper Lichen (*Parmelia sulcata*)
Labrador Tea (*Ledum groenlandicum*)	Wild Mint (*Mentha arvensis*)
Large Cranberry (*Vaccinium macrocarpon)*	Wintergreen (*Pyrola asarifolia*)
Leatherleaf (*Chamaedaphne calyculata*)	

** Invasive species*

Overall, the region around the proposed Lalor Mine site is naturally a dense boreal forest, primarily Black Spruce interspersed with Jack Pine and hardwoods. Dense forest canopy has limited understory growth in all areas within the Project Region. Sphagnum forms the dominant ground cover. In general, the proposed Lalor Mine site is typical for this region. No rare or endangered plant species were encountered at the proposed Lalor Mine site. There are no indications that this area contains unique opportunities for plant growth outside of that present in the general region.

4.3 Wildlife and Wildlife Habitat

The Churchill River Upland Ecoregion provides habitat for moose, Woodland Caribou, Black Bear, lynx, wolf, beaver, muskrat and Snow-shoe Hares. This ecoregion is also a winter range for Barren-ground Caribou. Various bird species including Sandhill Crane, grouse, waterfowl (ducks, geese and pelicans) along with many other birds are found in this ecoregion (Smith *et al.*, 1998).

During the field studies conducted in September 2007, signs of bear and moose in the area were apparent and wildlife observed included a coyote, fox, White Tail Deer, timberwolf, otter, Beavers, eagles, pelicans, crane, loons, and frogs. With the exception of a variety of waterfowl, there were no signs of wildlife observed within one (1) km of Lalor Lake at the time of the field investigation in 2010. In 2010, ravens were seen in the area, however terrestrial wildlife was largely absent during the survey. The densely forested Black Spruce bog offers little in the way of nesting habitat for birds and very few were seen or heard in the area during the 2011 survey. No species were found in the spring 2011 survey that were not previously recorded.

The density of the forest canopy and poor diversity of plant life under the trees make this a poor area in terms of wildlife diversity in general. This is especially true for nesting birds, which benefit from the edge effects of different tree stands and open areas. Warblers and other insectivorous birds benefit from open areas that promote insect flight. The general region around the proposed Lalor Mine site has some variation in terms of upland rocky outcrops that promote hardwood growth and open areas in lichen outcrops.

Wildlife populations have open access to a large area of natural woodland in the region that provides river and lake shore edge habitat and many burned areas in various stages of regrowth. Such areas provide a large diversity of habitats that favours wildlife populations and adjoin the immediate areas. Wildlife species can make use of the area in the vicinity of the proposed Lalor Mine site to the extent that it benefits them and there is no restriction on wildlife species to move to more favourable areas in the general region.

There is no specific critical wildlife value observed at the proposed Lalor Mine site (such as calving or over-wintering areas) and based on site conditions and limited field observations, it is expected that there is no critical wildlife value in the Project area. At both the Lalor Deposit and along the access road, the low diversity of plant communities and extremely dense black spruce stand offers a very restricted habitat for wildlife. The absence of suitable waterbodies for waterfowl in the general area makes it unlikely that they are nesting anywhere within the immediate area of the proposed Lalor Mine site.

4.4 Protected Species

Protected species are species that are endangered, threatened or are of special interest as defined by either Federal or Provincial legislation. In the Province of Manitoba, endangered, threatened or special interest species are protected by the *Manitoba Endangered Species Act* (*MESA*) which may have species that overlap with the federal *Species at Risk Act* (*SARA*). The Boreal Woodland Caribou is classified as threatened under *MESA* and may be found in the Churchill River Upland Ecoregion. No other provincially listed species occur in the Project Region. A search of the *Species at Risk Public Registry* revealed occurrences within the study region of species listed as endangered, threatened or of special concern under *SARA*. A list of protected species with potential to occur in the Project Region is included in Table 4.2.

Table – 4.2: List of Protected Species with Potential to Occur in the Project Region

Common Name	Scientific Name	SARA Status	MESA Status
Boreal Woodland Caribou	*Rangifer tarandus caribou*	Threatened	Threatened
Yellow Rail	*Coturnicops noveboracensis*	Special Concern	Not Ranked
Shortjaw Cisco	*Coregonus zenithicus*	Threatened	Not Ranked
Monarch	*Danaus plexippus*	Special Concern	Not Ranked
Flooded Jellyskin	*Leptogium rivulare*	Threatened	Not Ranked

Source: Manitoba Conservation, 2011b and Government of Canada, 2011

According to Manitoba Conservation Fact Sheets, Manitoba recognizes three varieties of caribou: Coastal, Barren Ground and Boreal Woodland. The Boreal Woodland Caribou was designated as threatened under *MESA* in June 2006 (Manitoba Conservation, 2011b). Such factors as habitat destruction, hunting, disturbance by humans (including construction of roads and pipelines), and predation (by wolves, coyotes, and bears) have all contributed to the decline of caribou. In many parts of their range, anthropogenic activities have resulted in the loss and alteration of important caribou habitat. Other factors such as weather and climate change are also influential however, are more difficult to control. One of the current challenges in caribou management is to learn more about how these factors interact and how to decrease their threat to caribou populations (Government of Canada, 2011).

The Manitoba CDC provides a ranking of species of conservation concern for the Churchill River Upland Ecoregion. The term “species of concern” includes species that are rare, distinct, or at risk throughout their range or in Manitoba and need further research. Species are evaluated and ranked on the basis of their range-wide (global) status, and their province-wide (sub-national) status according to a standardized procedure used by all Conservation Centres and Natural Heritage Programs. Fourteen species of fungi, plants and vertebrate animals are listed as species of special concern in the Churchill River Upland Ecoregion (Table 4.3).

Table – 4.3: List of Species of Special Concern

Common Name	Scientific Name	Rank
Fungi		
Flooded Jellyskin	*Leptogium rivulare*	Globally and provincially the species is not ranked; a rank has not yet been assigned or the species has not been evaluated.
Vascular Plants		
Few-Flowered Sedge	*Carex pauciflora*	Globally ranked demonstrably widespread, abundant and secure throughout its range and provincially ranked uncommon in the province.
Few-Fruited Sedge	*Carex oligosperma*	Globally ranked demonstrably widespread, abundant and secure throughout its range and provincially ranked uncommon in the province, but status is uncertain.
Fragrant Shield Fern	*Dryopteris fragrans*	Globally ranked demonstrably widespread, abundant and secure throughout its range and provincially ranked uncommon to widespread, abundant and apparently secure throughout the province.
Limestone Oak Fern	*Gymnocarpium robertianum*	Globally ranked demonstrably widespread, abundant and secure throughout its range and provincially ranked very rare throughout the province.
Long-Fruited Sedge	*Carex michauxiana*	Globally ranked demonstrably widespread, abundant and secure throughout its range and provincially ranked rare throughout the province.
Moor Rush	*Juncus stygius ssp. americanus*	a) Globally ranked demonstrably widespread, abundant and secure throughout its range including its subspecies and provincially ranked very rare in the province, but status is uncertain.
Northern Oak Fern	*Gymnocarpium jessoense*	Globally ranked demonstrably widespread, abundant and secure throughout its range and provincially ranked uncommon to widespread, abundant and apparently secure throughout the province.

Common Name	Scientific Name	Rank
Northern Woodsia	*Woodsia alpina*	Globally ranked widespread, abundant and apparently secure throughout its range and provincially ranked very rare in the province.
Round-Leaved Bog Orchid	*Platanthera orbiculata*	Globally ranked demonstrably widespread, abundant and secure throughout its range and provincially ranked uncommon in the province.
Small Water-Lily	*Nymphaea tetragona*	Globally ranked demonstrably widespread, abundant and secure throughout its range and provincially ranked rare throughout the province.
White Beakrush	*Rhynchospora alba*	Globally ranked demonstrably widespread, abundant and secure throughout its range and provincially ranked uncommon in the province, but status is uncertain.
b) Vertebrate Animal		
Caribou	*Rangifer tarandus caribou*	Globally ranked demonstrably widespread, abundant and secure throughout its range while its subspecies is widespread, abundant and apparently secure throughout its range and provincially ranked widespread, abundant and apparently secure throughout the province.
Shortjaw Cisco	*Coregonus zenithicus*	Globally ranked uncommon throughout its range and provincially ranked uncommon in the province.

Source: Manitoba Conservation, 2011c

As confirmed through field observations conducted in 2007, 2010 and 2011, the wildlife habitats within the area of the Lalor Mine were considered to be typical for the region, with no unique or rare habitats encountered.

4.5 Protected Areas

Grass River Provincial Park is located approximately 25 km southwest of the proposed Lalor Mine site and covers an area of 2,279 km^2. This Provincial Park is also classified as a Natural Park as its purpose is to preserve natural areas that represent the Churchill River Upland portion of the Precambrian Boreal Forest. Woodland Caribou can be found throughout the park year round, and are usually found in areas with mature forest and treed muskeg (Manitoba Conservation, 2011d).

Cormorant Provincial Forest is located approximately 80 km southwest of the proposed Lalor Mine site and is the most northern Provincial Forest in Manitoba. This provincial forest was established in 1947 and covers an area of 1,479 km^2 including Clearwater Lake Provincial Park. Provincial forests are Crown Lands managed by Manitoba Natural Resources (Manitoba Conservation, 2011a).

Clearwater Lake Provincial Park is located approximately 105 km southwest of the proposed Lalor Mine site and covers an area of 593 km^2. This Provincial Park is classified as a Natural Park as its purpose is to preserve natural areas that represent the Mid-Boreal portion of the Manitoba Lowlands (Manitoba Conservation, 2011e).

The Saskeram Wildlife Management Area (WMA) is located approximately 130 km southwest of the proposed Lalor Mine site and occupies an area of 958 km^2. The Tom Lamb WMA is located approximately 85 km south-southwest of the proposed Lalor Mine site and occupies an area of 2,083 km^2. Both of these WMAs encompass a large portion of the Saskatchewan River Delta. These areas provide breeding and staging areas for waterfowl and habitat for moose, wolves, Black Bears and furbearers (Manitoba Conservation, 2011f).

4.6 Terrain Analysis

4.6.1 Terrain Units

A review of existing reports and documents was conducted to determine what soil types would likely underlay different vegetative areas and the geologic processes that would contribute to soil formation. The vegetation cover types present in the general Project Area were identified using the digital provincial forest inventory map (Drawing - 05). This Geographical Information System (GIS) information was used to correlate the terrain units documented in the existing reports with vegetation types to attempt to extrapolate the probable soil units of the area. A terrain map based on this analysis has been provided as Drawing - 06.

The analysis determined the following terrain units:

Till (T)
The till unit in the areas are generally thin and discontinuous sandy loam to loamy sand. Varying quantities of gravel to stone sized coarse fragments are contained within the matrix. The till is generally derived from Precambrian bedrock and is neutral to moderately acidic. Deeper deposits are found on the lee side of bedrock outcrops and in bedrock depressions. Vegetation is a mix of Jack Pine, Black Spruce and some White Birch or Trembling Aspen. The aspen areas tend to occur in the better-drained areas, due primarily to increased slope, while the spruce areas occur in the low-lying areas where drainage is more limited. Calcareous clay textured lacustrine sediments are found in areas of shallower slope and are indicated by areas of black spruce mixed with Jack Pine and Trembling Aspen. Most lacustrine deposits occur as pockets and blankets of limited extent. Extensive areas can be found east of Lalor Lake. Isolated willow groves and fields/meadows occur in this unit as well. The fields and meadows are primarily caused by anthropomorphic or recent fire action and the willow area occurs in a less well-drained area or where the water table is high.

Till over Rock (T/R)
The till over rock unit occurs primarily on the crests of hills where local relief has reduced the thickness of the till overburden to typically less than 1 m. Bedrock is frequently exposed as outcrop, typically over more than 50% of the area. Vegetation cover is predominately Jack Pine due to fire history and widespread, shallow, coarse textured soils with little waterholding capacity. Black Spruce can become dominant if there is no history of fire and where deposits are deeper or in depressions.

Organics (O)
The organics unit consists primarily of areas of peat. The peat is generally moderately well decomposed with a slightly decomposed surface peat. Most are a layered mixture of peats formed in fen, swamp, and bog environments. Most peatlands in the area may have started as fens and later evolved into treed fens , swamps or bogs. These areas usually occur in the low-lying areas and valley bottoms where drainage is restricted. Thickness of organics can be significant.

Organics over Till (O/T)
The organics over till unit consists primarily of areas of treed muskeg. These areas usually occur in the low-lying areas or valley bottoms where drainage is restricted and accumulation of organic matter over the lacustrine deposits and tills has occurred. Thickness of organics can be significant.

Organics (peat) over Water (O/W)
The organics over water unit consists primarily of bogs and fens where the drainage is poor enough to allow open water to cover a portion of the area or where an O/T unit is bounded by water from a large water body.

Water (W)

The water unit consists primarily of open water areas either natural or otherwise. Included in these areas are beaver floods and small lakes within Organic over Water units (i.e. marshes and fens).

Unclassified (U)

The unclassified unit consists primarily of area that have been modified by anthropogenic activities, which have either removed the original vegetation cover or modified the ground surface to make terrain analysis difficult. Underlying surficial geology can be identified by inference by extrapolating from the surrounding unmodified terrain units. Included in these areas are power lines, urban development, roads and other area clearing activities.

5. Aquatic Environment

5.1 Hydrology

5.1.1 Regional Hydrology

The Reed Lake Ecodistrict lies within the glacial Lake Agassiz basin and is part of the Nelson River drainage system. The area drains generally eastward through Wekusko Lake, other medium sized lakes in the general region, and an irregular bedrock-controlled network of streams that are all part of the Grass River watershed (Smith *et al.*, 1998).

5.1.2 Project Area Hydrology

Lalor Lake is a small (0.4 km^2) headwater lake to the west of the Lalor Mine site which drains north for approximately 300 m through a creek and marsh into Maw Lake (0.16 km^2). Maw Lake then continues to drain northward for approximately 4 km via Unnamed Creek 1 into Varnson Lake (0.7 km^2). Varnson Lake continues to drain east via a creek into Squall Lake, a relatively large and deep lake. Squall Lake then drains south via Snow Creek and eventually into Snow Lake Narrows, which makes up the west arm of Snow Lake. Snow Lake also receives water from the south via Tern Creek and Tern Lake, a small lake with a total surface area of approximately 0.15 km^2.

Cook Lake, a relatively large and deep lake, is located west of Lalor Lake. Cook Lake is isolated from Lalor Lake by at least a 300 m wide band of elevated forest underlain by bedrock. Another small and shallow lake, Unnamed Lake 1, is located southwest of Lalor Lake and drains northwest into Cook Lake. Cook Lake drains to the south whereas Lalor Lake drains north as shown in Drawing – 03. Area waterbodies and watershed boundaries in the area of the Lalor Mine are presented in Drawing – 06.

As a result of varying topography created by hummocky bedrock surfaces, the drainage conditions vary considerably over short distances. Regionally the terrain falls at about 0.6 m to 1.0 m per km. Locally, runoff from bedrock and upland areas collects in peat filled lows (bogs), which slowly release excess water to surrounding lakes and creeks. Groundwater tables are high in most bogs and in low areas bordering the bogs. Similar to much of the Boreal Shield Ecozone, contiguous and isolated bogs cover between 20% and 40% of the Lalor Lake area. Bogs are widespread and stagnant in the region. Prior to clearing and leveling, the site of the proposed Lalor Mine was a large rocky outcrop in a large stand of dense black spruce surrounded by wet bog. The rock outcrop has since been leveled and a bog/wet area exists to the north of the extent of leveling of the mine site within an area that has been cleared of vegetation.

5.2 Lake Bathymetry

In September 2007, North/South Consultants assessed lake bathymetry of Lalor Lake, Maw Lake, Varnson Lake, and Tern Lake (Appendix C). With the exception of Maw Lake, lake profiles were determined with a boat-mounted sonar unit. Depth was manually surveyed in Maw Lake because it was too shallow to effectively operate the boat-mounted sonar unit. AECOM assessed lake bathymetry in Cook Lake in September 2008 and in Tern Ditch Pond in 2010 (Drawings – 07 and 08).

The lake bathymetry survey was conducted using an aluminum boat with motor and a chart plotting sonar attachment to log depth to bottom. The chart plotter utilizes a built in Global Positioning System (GPS) to allow a significant number of points to be collected with both horizontal position (3 m to 5 m accuracy) and depth (0.1 m accuracy) collected simultaneously and automatically. The sonar was set to collect a data point every 10 m to allow an even collection of points independent of the speed of the boat or the track taken. The survey was conducted by first travelling near to the shore to delineate the near shore depth and then infilling the resulting perimeter shots with a series of tracks to cover the reminder of the lake.

Overall in terms of both surface area and volume, Tern Ditch Pond was the smallest waterbody while Cook Lake was the largest waterbody (Table 5.1). Maximum depth ranged from 1.0 m to 9.5 m in Tern Ditch Pond and Cook Lake, respectively (Table 5.1).

Table – 5.1: Summary of Bathymetric Surveys

Waterbody	Year	Surface Area (m^2)	Volume (m^3)	Mean Depth (m)	Maximum Depth (m)
Lalor Lake	2007	413,650	477,823	1.2	2.1
Maw Lake	2007	163,675	120,918	0.7	1.4
Varnson Lake	2007	711,350	1,229,410	1.7	2.6
Tern Lake	2007	153,150	246,701	1.6	2.2
Cook Lake	2008	2,284,027	11,533,364	5.0	9.5
Tern Ditch Pond	2010	75,125	39,750	0.5	1.0

At the time of the assessment, Lalor Lake was a relatively shallow lake with a mean depth of 1.2 m and a maximum depth of 2.1 m. The total surface area of Lalor Lake was 413,650 m^2 and the total calculated volume was 477,823 m^3. The bottom topography of Lalor Lake was largely homogeneous, with a few deeper (*i.e.,* 2 m) holes along the north-south transect. The majority of substrate was composed of flocculent sediments and aquatic vegetation, with very limited amounts of gravel/sand (Appendix C).

Similar to Lalor Lake, Maw Lake is a relatively shallow lake. Maw Lake had a mean depth of 0.7 m and a maximum depth of 1.4 m. The Maw Lake, with a total surface area of 163,675 m^2 and total calculated volume of 120,918 m^3, was less than half the size of Lalor Lake. Regularly spaced depth contours characterize Maw Lake bottom topography. In the west end of Maw Lake, a shoal-like structure nears the surface (Appendix C).

Varnson Lake had a mean depth of 1.7 m and a maximum depth of 2.6 m. Varnson Lake was nearly twice the size of Lalor Lake, with a total surface area of 711,350 m^2 and the total calculated volume was 1,229,410 m^3. The bottom topography of Varnson Lake was more heterogenous than the other waterbodies examined in 2007 (Appendix C). The southern end of Varnson Lake was generally shallower than the northern end. Varnson Lake sediments were dominated by aquatic vegetation, with less flocculent sediments than in Lalor Lake.

Tern Lake is a small lake with a total surface area of 153,150 m^2. Tern Lake had a mean depth of 1.6 m and a maximum depth of 2.2 m. The total calculated volume of Tern Lake was 246,701 m^3. The homogeneous bottom topography of Tern Lake was similar to that of Maw Lake (Appendix C). Tern Lake had similar composition and distribution of sediments as Lalor Lake.

Cook Lake, the largest waterbody assessed, had a modeled volume of 11,533,364 m^3 and total surface area of 2,284,027 m^2. A north-south trench of more than 6 m in depth characterizes the lake. The majority of the storage was along the eastern shore of the lake with the deepest portion of the lake reaching greater than 9 m in depth. The far north and south ends of the lake were significantly shallower, likely due to a combination of shallower slopes and the effects of sedimentation from the long term deposition resulting from the lake's inflows and outflows (Drawing - 07). Cook Lake was the longest and deepest of the lakes investigated.

Tern Ditch Pond had a modeled area of 75,125 m^2, a volume of 39,750 m^3, and a mean depth of 0.5 m. Depth was homogenous over the majority of the pond except for one northeast-southwest trending trench of up to 1.0 m in depth (Drawing - 08). The average grade of the lake bottom was 1.9% which is characteristic of a shallow gently sloping headwater lake. The shallow bottom allows for significant vegetation to grow within the pond itself. Only one small rock island with associated small rocky ridges was observed in the east end of the pond. Sediment was highly organic with limited distribution of cobble or mineral soils. Leaf matter was also present in near-shore areas, particularly on the south-eastern shore.

5.3 Aquatic Sampling Methods

Water quality, sediment quality, phytoplankton, zooplankton, benthic community and fish and fish habitat were assessed in the area of proposed Lalor Mine site. In 2007, North/South Consultants, on behalf of AECOM, conducted an aquatic study of 12 waterbodies in the area (Appendix C). In 2010, AECOM conducted a follow-up supplemental study in seven (7) waterbodies in the area (Table 1.1).

5.3.1 Water Quality

The objective of the water quality sampling program was to collect *in situ* measurements and samples for analysis at an accredited laboratory at sites in twelve waterbodies in 2007 and seven waterbodies in 2010 (Table 1.1). The water quality values were used to establish the baseline water chemistry of the tested lakes and will function as a benchmark for future water quality, toxicological analysis and Environmental Effects Monitoring (EEM) in the lakes and other waterbodies, within the potential area of effect of a mining operation at Lalor Lake.

In situ water quality parameters such as pH, temperature (°C), specific conductance (µS/cm), turbidity (NTU), and dissolved oxygen (DO, mg/L) were collected at 0.5 m intervals from each sampling site using a YSI Model 63 pH/temperature/conductivity Meter, YSI Model 55A DO Meter and Analite 160 Turbidity Meter in 2007 and a Horiba U-53 Multi-Parameter Unit in 2010. Secchi disk depth was also measured at the centre of each lake. Weather, qualitative descriptions of the site and Universal Transverse Mercator (UTM) coordinates were recorded at each sampling site.

Samples submitted to the laboratory for analysis were collected from the surface at all sites. Surface water samples were collected by directly submerging the water bottles. Preservatives, if required, were added immediately to the sample and mixed. Filtration and preservation of samples for analysis of dissolved metals and mercury was completed at the analytical laboratory upon receipt of the samples. Samples were kept cool and out of direct sunlight to the extent possible. Samples were shipped to ALS Laboratory Group in Winnipeg within the specified 48-hr holding time for analysis of the following parameters:

- Routine parameters (e.g., physical and nutrients);
- Major Ions (i.e., chloride, sulphate, bromide and silicate);
- Total and Dissolved Metals;
- Total and Dissolved Mercury;
- Biological (i.e., chlorophyll a and pheophytin).

ALS is an accredited analytical laboratory and employs standard laboratory Quality Assurance/Quality Control (QA/QC) measures. As part of the field QA/QC program, analysis included one (1) field blank and one (1) trip blank in association with the field program. The field blank was filled with deionized water in the field and stored and transported with field samples. The trip blank was filled with deionized water by the laboratory prior to the field program and was stored and transported with field samples but never opened. In addition, a duplicate sample was collected at one (1) sampling site in Lalor Lake.

Water quality data was compared to Provincial and Federal guidelines and objectives that have been generated for various water quality parameters, with the purpose of protecting aquatic life and various human uses (i.e., drinking water or protection of freshwater aquatic life). The guidelines applied were those available at the time of the surveys (Table 5.2).

Table – 5.2: Applied Water and Sediment Quality Guidelines, 2007 and 2010

Baseline Survey	Water Quality Guideline	Sediment Quality Guideline
2007 (North-South)	Canadian Council of Ministers of the Environment Phosphorus and Lake Trophic Status (CCME, 1999) Manitoba Water Quality Standards, Objectives and Guidelines (Williamson, 2002)	Manitoba Sediment Quality Guidelines (Williamson, 2002) Ontario Sediment Quality Guidelines (Persaud et al., 1993)
2010 (AECOM)	Canadian Council of Ministers of the Environment Canadian Water Quality Guidelines for the Protection of Aquatic Life (CCME, 2011)	Canadian Soil Quality Guidelines for Residential/Parkland Use (CCME, 2007) Manitoba Water Quality Standards, Objectives and Guidelines (Williamson, 2002)

5.3.1 Sediment Quality

Sediment samples were collected for chemical and physical analysis in all lakes and creeks within the Study Area. The sediment quality values measured as part of this baseline work establishes the baseline sediment chemistry of the tested water bodies, and will function as a benchmark for future sediment quality and toxicological analysis in the lakes which may be potentially influenced by the operations at the Lalor Mine site.

Samples were collected near the middle of each water body and multiple sample locations were spread out to be representative of the lake or creek.

Samples of surficial sediment were collected using an Ekman dredge (0.023 m^2). Where triplicate samples were collected, each grab was separated spatially to ensure that sampling disturbances from one grab did not affect the subsequent grab. Acceptable grab samples were retrieved to the surface and the water was decanted from the dredge. The upper 5 cm of the collected sediment was sub-sampled with a stainless steel spoon. Samples were then placed in the appropriate sample containers; ensuring headspace was kept to a minimum. Samples were kept cool and in the dark and shipped to ALS Laboratory Group in Winnipeg, Manitoba for processing and analysis. All sampling equipment was rinsed prior to and following the sampling at each location. A duplicate sample was collected from the center of Lalor Lake (LL-2).

Sediment quality data was compared to Provincial and Federal guidelines and objectives that have been generated for various sediment quality parameters, with the purpose of protecting aquatic life and various human uses (*i.e.*, drinking water or protection of freshwater aquatic life). The guidelines applied are described in Table 5.2.

5.3.2 Phytoplankton

Phytoplankton samples were collected by directly filling the required bottles below the surface of the water. Each sample was preserved with a sufficient quantity of Lugol's solution. The samples were kept cool and in the dark and submitted to ALS Laboratory Group in Winnipeg, Manitoba for processing and analysis of algal biomass and taxonomic identification. There were no QA/QC samples associated with phytoplankton.

The results of the phytoplankton study have been used to establish the baseline biological content of the tested lakes and will function as a benchmark for water quality and toxicological analysis in the lakes and other waterbodies potentially influenced by the mining operation at the proposed Lalor Mine site.

5.3.3 Zooplankton

Zooplankton samples were collected at each site using a 1.0 m long, 63 µm mesh size conical net, complete with a weighted cod-end attached to a single 0.25 m diameter steel hoop frame. Due to the shallow depths of the lakes in the study area, a horizontal tow was performed. The tow net was lowered horizontally at the stern of the boat and pulled along the length of the boat towards the bow (5.5 m in 2007 and 7.3 m in 2010). Upon retrieval, zooplankton were rinsed into the collecting cup, washed into a labelled sampling jar and preserved. In 2007, samples were fixed in 10 % formalin then transferred to 70 % ethanol for storage. In 2010, samples were fixed in 70 % ethanol directly.

The estimate of abundance for each taxon per tow was calculated as the number of individuals per cubic meter of water (individuals/m^3). Volume of water filtered was estimated by multiplying the net mouth area (0.049 m^2) by the length and number of horizontal tows.

The results of the zooplankton study have been used to establish the baseline biological content of the tested lakes and will function as a benchmark for water quality and toxicological analysis in the lakes and other waterbodies potentially influenced by a mining operation at the Lalor site.

5.3.1 Benthic Community

Sampling sites were located across the longitudinal axis of each lake to provide a representative gradient of habitat conditions with the exception of Maw Lake which is more circular. Sampling sites were accessed by boat or helicopter during the September 2007 study (Appendix C). Samples of surficial sediment were collected using an Ekman dredge (0.0232 m^2). Each sample was sieved in the boat through a 500 µm mesh, placed in a 1 L plastic jar labelled and preserved in 10 % formalin. All samples were kept cool and transported to the laboratory at North/South Consultants Inc. in Winnipeg, Manitoba for processing.

At the laboratory, benthic samples were sieved using 355 µm mesh, rinsed with water, sorted under a magnifying lamp and transferred to vials containing 70% ethanol. Benthic invertebrates were counted and identified to family using published reference keys.

The results of the benthic community assessment will establish the baseline biological content of the tested lakes and will function as a benchmark for water quality and toxicological analysis in the lakes and other water bodies potentially influenced by the mining operation at the proposed Lalor Mine site.

5.3.2 Fish Community

A comprehensive fish study was conducted in waterbodies within the Study Area during the initial assessment conducted in 2007 (Table 1.1). Large-bodied fish were targeted in a brief fish community survey in 2008 on Cook Lake. Tern Ditch Pond, was included in the supplemental baseline study in 2010 (Table 1.1).

Fish collection was attempted using several types of sampling gear, including:

- 2007:
  - Standard Gang index gill nets: six (6) 22.9 m long by 1.8 m deep panels of 38, 51, 76, 95, 108, and 127 mm twisted nylon stretched mesh;
  - Swedish Gang gill nets: three (3) 10 m long 1.8 m deep panels of 16, 20, and 25 mm twisted nylon stretched mesh;
  - Vinyl coated round minnow traps;
  - Seines.

- 2008:
  - Angling and trawling from boat with baited hooks.

- 2010:
  - Small mesh gill nets: three (3) 10 m long 1.8 m deep panels of 13, 19, and 25 mm twisted nylon stretched mesh;
  - Baited (bread) Gee minnow traps;
  - Seine net: 7.6 m long net with 4.7 mm mesh.

All captured fish were identified to species, enumerated, measured and weighed. A small sub-sample of forage fish species captured in each lake was retained for taxonomic verification in the laboratory at AECOM.

5.3.3 Fish Habitat

A fish habitat assessment of the major waterbodies in the Study Area was completed in the initial 2007 survey. Based on the initial study and analysis of air photos and existing information, additional potential aquatic habitats in the Study Area and access road are limited to disconnected, intermittent and ephemeral wetlands. To confirm this lack of connection and the lack of potential for impacts to fish habitat associated with the project, a brief survey was conducted at Tern Ditch Pond.

For this habitat assessment, water depths and habitat characteristics such as woody debris, aquatic macrophytes and substrates were documented at Tern Ditch Pond. Additionally, substrates were characterized using a combination of Ekman grab samples and a probe along various points within Tern Ditch Pond.

5.3.4 Metal Residues in Fish

It is anticipated that the EIA will require description of baseline metal concentrations in fish tissues. Fish from Lalor Lake, Maw Lake, Varnson Lake and Tern Lake were submitted for analysis during the 2007 baseline survey. Fish from Tern Ditch Pond, were submitted for metals analysis in the 2010 study.

A total of 20 Brook Stickleback (*Culaea inconstans*) were retained for analysis from Tern Ditch Pond. Fish were identified to species, measured and weighed. Laboratory tissue requirements necessitated submission of whole fish, rather than samples of liver and muscle for metals analysis. Samples were submitted to ALS Laboratory Group in Winnipeg for analysis of the following parameters:

- Total metals;
- Total mercury; and,
- Moisture.

Results are presented as wet weights (w.w.). Note that the analytical detection limits varied between samples for the same parameter due to matrix interferences. There were no QA/QC samples associated with tissue metals analysis.

Metal residues of whole-body forage fish were compared to Manitoba aquatic life tissue residue guidelines for human consumption (Willamson, 2002). The three applicable chemical parameters include arsenic (3.5 µg/g), lead (0.5 µg/g), and mercury (0.5 µg/g).

5.4 Aquatic Sampling Results

The majority of waterbodies were classified as oligotrophic based on total phosphorus concentrations (Table 5.3). Tern Ditch had the highest total phosphorus concentration in 2007 (0.07 mg/L) and 2010 (0.04 mg/L) was classified as eutrophic. Total phosphorus concentrations were higher in 2010 than in 2007 for Lalor Lake, Maw Lake, Varnson Lake, and Tern Creek. Trophic status changed from oligotrophic to mesotrophic for Lalor Lake, Maw Lake, and Tern Creek between 2007 and 2010.

Table – 5.3: Average Total Phosphorus Concentrations and Trophic Status in the Project area

Waterbody	Year	Average TP (mg/L)	Trophic Status
Lalor Lake	2007	0.009	Oligotrophic
	2010	0.013	Mesotrophic
Maw Lake	2007	0.010	Oligotrophic
	2010	0.012	Mesotrophic
Varnson Lake	2007	0.012	Mesotrophic
	2010	0.014	Mesotrophic
Cook Lake	2007	0.024	Meso-eutrophic
Unnamed Lake 1	2007	0.008	Oligotrophic
Squall Lake	2007	0.017	Mesotrophic
Snow Lake Narrows	2007	0.032	Meso-eutrophic
Tern Lake	2007	0.017	Mesotrophic
	2010	0.016	Mesotrophic
Unnamed Creek 1	2007	0.007	Mesotrophic
Snow Creek	2007	0.025	Meso-eutrophic
Tern Creek	2007	0.008	Oligotrophic
	2010	0.012	Mesotrophic
Tern Ditch	2007	0.074	Eutrophic
	2010	0.036	Eutrophic
Tern Ditch Pond	2010	0.017	Mesotrophic

Source: CCME, 1999.

5.4.1 Water Quality

At the time of sampling, the majority of waterbodies were alkaline, clear and well-oxygenated in 2007. Unnamed Creek 1, however, had dissolved oxygen concentration (5.1 mg/L) below the most conservative guideline (6.0 mg/L). No thermal or oxygen stratification was observed in any waterbody during the 2007 survey.

In 2007, 35 samples were submitted from 12 waterbodies in the area surrounding the proposed Lalor Mine site. Surface and bottom water samples were collected from Lalor Lake, and Cook Lake. There were no obvious differences in water quality between the depth stratums. Water chemistry data measured during the 2007 baseline survey was compared to the *Manitoba Water Quality Standards, Objectives and Guidelines* (*MWQSOG*) (Williamson, 2002) (Appendix C; Table 5.4). The majority of metal concentrations were at or near detection limit and the guideline for selenium and silver were equal to the detection limit.

Table – 5.4: Applicable Water Quality Guidelines, 2007

Parameter	***MWQSOG* (Williamson, 2002)**	
	Total, mg/L	**Dissolved, mg/L**
Aluminum	0.1	-
Arsenic	-	0.150
Cadmium	0.00267	0.00242
Chromium	0.094	0.081
Copper	0.0098	0.010
Iron	0.3	-
Lead	0.0036	0.0028
Mercury	-	0.0001
Molybdenum	0.073	-
Nickel	0.057	0.0568
Selenium	0.001	-
Silver	-	0.0001
Thallium	-	0.0008
Zinc	0.06-0.13	0.129

The *MWQSOG* were exceeded for total aluminum, iron and selenium in at least one (1) sample in Squall Lake, Snow Creek, Snow Lake Narrows, and Tern Ditch (Appendix C). In Squall Lake, concentrations of total aluminum (0.11 mg/L) and total selenium (0.002 mg/L) exceeded the applicable guidelines of 0.1 mg/L and 0.001 mg/L, respectively. Concentrations of total aluminum (0.13 mg/L and 0.5 mg/L) and total iron (0.41 mg/L and 0.81 mg/L) also exceeded applicable guidelines of 0.1 mg/L and 0.3 mg/L, respectively. In Snow Lake Narrows, only the concentration of total iron (0.3 mg/L) equalled the applicable guideline (0.3 mg/L). Concentrations of total aluminum and total iron in Tern Ditch were six (6) times greater than the applicable water quality guideline (Appendix C).

Overall, water quality in the waterbodies surrounding the proposed Project Site were of good quality in 2007, exceeding the applicable water quality guidelines in only nine (9) instances for three (3) total metals. The exceedances were also small, with the exception of concentrations of total aluminum and total iron in Tern Ditch, which were nearly six (6) times greater than the guideline.

Thirteen (13) water quality samples were collected from each site, including a duplicate water sample at LL-WQ3, a field blank and trip blank in 2010 (Appendix D Table – 01; Drawing – 09). In 2010, seven (7) waterbodies were included in the sampling program. During the 2010 survey, the sampling location in Tern Creek was moved from the previous location due to low water levels in the general area. The creek was a series of small, disconnected ponds.

All waterbodies, as measured in July 2010, were well-oxygenated with no evidence of thermal stratification (Appendix D Table – 01). Several conventional parameters measured (*e.g.,* carbonate, total dissolved solids and pH) were highest in Lalor Lake (Appendix D Table – 02). Based on total phosphorus concentrations ranging from <0.01 to 0.04 mg/L, all waterbodies in the Study Area were classified mesotrophic with the exception of eutrophic Tern Ditch (Appendix D Table – 02). Nutrient and chlorophyll *a* concentrations were lowest in Varnson Lake and highest in Tern Ditch (Appendix D Table – 01).

In general, metals concentrations were low and over half of the analytes were undetected in all waterbodies sampled in the Study Area (Appendix D Table – 01). Concentrations in 2010 were screened against the federal Canadian Council of Ministers of the Environment *Canadian Water Quality Guidelines* (*CWQG) for the Protection of Aquatic Life* (Table 5.5; CCME, 2011).

Table – 5.5: Applicable Water Quality Guidelines, 2010

Parameter	***CWQG*, mg/L**
Aluminum	0.1
Arsenic	0.005
Boron	1.5
Cadmium	0.000018 – 0.000044
Copper	0.001 – 0.003
Iron	0.3
Lead	0.001 – 0.004
Mercury	0.000026
Molybdenum	0.073
Nickel	0.055 – 0.123
Selenium	0.001
Silver	0.0001
Thallium	0.0008
Uranium	0.015
Zinc	0.03

Source: CCME, 2011

Exceedances over *CWQG* included field-measured pH, aluminum, arsenic, and iron (Appendix D Table – 01). Total aluminum and total iron concentrations in Tern Creek (0.28 mg/L and 1.6 mg/L, respectively) and Tern Ditch (0.39 mg/L and 1.1 mg/L, respectively) were several times higher than the applicable guidelines (0.1 mg/L and 0.3 mg/L, respectively). Tern Ditch had the highest concentrations of most metals and the most exceedances of *CWQG* (aluminum, arsenic and iron), in both sampling years (Appendix D Tables – 02 and 03).

Overall, water quality in the waterbodies surrounding the proposed Lalor Mine site were of good quality in 2010, exceeding the applicable water quality guidelines in only 11 instances (*i.e.,* less than 5% of the concentrations that were screened exceeded the water quality guideline) for three (3) total metals and pH. The exceedances were also small, with the exception of concentrations of total aluminum and total iron in Tern Ditch and Tern Creek.

In general, limnological and conventional water quality parameters were similar between the 2007 and 2010 sampling events. Waterbodies in the Lalor area were clear, alkaline and well-oxygenated. Water quality was considered high in both 2007 and 2010, with few exceptions. There were nine (9) exceedances in 2007 and 11 in 2010 (Table 5.6). In general, Tern Ditch had higher metal concentrations (especially aluminum and iron) in both sampling events. Tern Creek in 2010, had similar exceedances to Tern Ditch.

Table – 5.6: Maximum Concentrations in Water, 2007 and 2010

Waterbody	Year	pH (field)	Aluminum	Arsenic	Copper	Iron
CWQG		***6.5 - 9.0***	***0.1***	***0.005***	***0.001 - 0.003***	***0.3***
Lalor Lake	2007	8.16	0.021	0.0008	<0.001	0.13
	2010	**9.03**	0.0126	0.00065	0.00066	0.112
Maw Lake	2007	8.44	0.008	0.0009	<0.001	0.12
	2010	**9.05**	0.0160	0.00065	0.00069	0.082
Varnson Lake	2007	7.67	0.011	0.0005	**0.003**	0.07
	2010	8.07	0.0085	0.00041	0.00024	0.074
Tern Creek	2007	7.48	0.017	0.0005	<0.001	0.13
	2010	7.00	**0.2780**	0.00111	0.00069	**1.57**
Tern Ditch	2007	7.18	**0.611**	**0.0095**	**0.002**	**1.73**
	2010	7.37	**0.3950**	**0.0087**	0.00112	**1.11**
Tern Lake	2007	7.40	0.015	0.00028	<0.001	0.18
	2010	8.37	0.0139	0.00342	0.0007	0.158

Notes: Maximum total metals concentrations, in mg/L., shown. Only waterbodies sampled in both years are shown. Only parameters that had one exceedance in at least one sample are shown. Shaded values are those that exceed CWQG (CCME, 2011).

5.4.2 Sediment Quality

In 2007, 26 sediment samples were submitted for physical and chemical analysis. Sediment was collected in triplicate at LL-2 (Appendix C). Sediment quality was compared against the *Manitoba Sediment Quality Guidelines* (*MSQG*) (Williamson, 2002) and *Ontario Sediment Quality Guidelines* (*OSQG*) (Persaud *et al.,* 1993) (Table 5.7).

Table – 5.7: Applicable Sediment Quality Guidelines and Exceedances, 2007

Parameter	*MSQG**, µg/g d.w.		*OSQG***, µg/g d.w.	
	ISQG	PEL	LEL	SEL
Arsenic	5.9	17	-	-
Cadmium	0.6	3.5	-	-
Chromium	37.3	90	-	-
Copper	35.7	197	-	-
Iron	-	-	20,000	40,000
Lead	35	91.3	-	-
Manganese	-	-	460	1,100
Mercury	0.17	0.486	-	-
Nickel	-	-	16	75
Zinc	123	315	-	-
Total Nitrogen	-	-	0.055	0.48
Total Phosphorus	-	-	600	2,000
Total Organic Carbon (%)	-	-	1	10

ISQG=Interim Sediment Quality Guideline; PEL=Probable Effect Level;
LEL=Lowest Effect Level; SEL=Severe Effect Level
*Source: * Williamson, 2002 and ** Persaud et al., 1993*

Of the thirteen parameters for which there was an applicable sediment quality guideline, only lead and mercury were not exceeded in any sample in 2007 (Appendix C). In total, there were 135 incidences of exceedances over applicable sediment quality guidelines (i.e., nearly 40% of concentrations that were screened exceeded at least one sediment quality guideline; Table 5.7). Total nitrogen and total organic carbon concentrations in all samples exceeded the *OSQG* (Appendix C). Snow Lake Narrows had metals concentrations that exceeded six (6) applicable sediment quality guidelines. In contrast, Tern Lake had no metal exceedances. Unnamed Lake 1 and Varnson Lake only had one exceedance each, manganese and nickel, respectively. The zinc guideline (123 µg/g dry weight) was exceeded only in Tern Creek (157 µg/g dry weight).

Overall, sediment quality was impacted in each waterbody, with the exception of Tern Lake. All but two parameters, for which there was an applicable sediment quality guideline was exceeded in at least one sample. Arsenic, chromium, copper, manganese, nickel, total nitrogen and total organic carbon were exceeded most frequently.

In 2010, 13 surficial sediment samples were collected from seven (7) waterbodies. One sediment sample was collected in duplicate at LL-3 (Appendix D Table – 03). Sediment quality was screened against the federal Canadian Council of Ministers of the Environment *Canadian Soil Quality Guidelines* (*CSQG) for the Protection of Environmental and Human Health, Residential/Parkland Use* (CCME, 2007) and the *Manitoba Sediment Quality Guidelines* (Williamson, 2002) (Table 5.8).

Table – 5.8: Applicable Sediment Quality Guidelines, 2010

Parameter	*CSQG**, mg/kg d.w.	*MSQG***, ug/g d.w.	
		ISQG	PEL
Arsenic	12	5.9	17
Barium	500	-	-
Cadmium	10	0.6	3.5
Chromium	64	37.3	90
Copper	63	35.7	197
Lead	140	35	91.3
Mercury	6.6	0.17	0.486
Nickel	50	-	-
Selenium	1	-	-
Thallium	1	-	-
Uranium	23	-	-
Vanadium	130	-	-
Zinc	200	123	315

*Source: * CCME, 2007; ** Williamson, 2002*

Sediments in waterbodies tested in 2010 were characterized as either silty clay or silty loam with relatively high moisture content (Appendix D Table – 03). None of the concentrations in Tern Ditch Pond exceeded applicable sediment quality guidelines. Out of 182 concentrations that were screened, 33 concentrations exceeded at least one (1) sediment quality guideline. Concentrations of barium, mercury, nickel, thallium, uranium, and vanadium did not exceed applicable sediment quality guidelines. Maw Lake, Tern Ditch and Tern Lake samples exceeded guidelines for four metals each (Appendix D Table – 03). Concentrations of arsenic in Tern Ditch (24.8 mg/kg d.w.) and Tern Lake (29.7 mg/kg d.w.) exceeded all three (3) applicable sediment quality guidelines (Appendix D Table – 03).

Overall, sediment quality in the waterbodies examined in 2010 was fair. Though there were exceedances, these were generally of small magnitude, with the exception of arsenic concentrations in Tern Ditch and Tern Lake. Several guidelines were not exceeded. Concentrations of selenium and copper most frequently exceeded the applicable sediment quality guideline in 2010. These metals are likely high naturally in this region. Concentrations of arsenic in Tern Ditch and Tern Lake had the highest amplitude of exceedance, suggesting potential contamination (given the limited geographic extent of this magnitude of exceedance).

In general, concentrations of most metals were higher in 2007 as compared to 2010 and overall, there were more exceedances of applicable sediment quality guidelines in 2007 than in 2010 (Table 5.9). Sediment heterogeneity is the likely source of these observed differences. Overall, the sediment quality was impacted, due to historical mining and other anthropogenic influences and/or natural composition of the soils in this region. Congruent with water quality, Tern Ditch sediments in 2010 were impacted.

Table – 5.9: Maximum Concentrations in Surficial Sediments, 2007 and 2010

Parameter	Year	Arsenic	Cadmium	Chromium	Copper	Lead	Zinc
MSQG	*ISQG*	*5.9*	*0.6*	*37.3*	*35.7*	*35*	*123*
	PEL	*17*	*3.5*	*90*	*197*	*91.3*	*315*
Lalor Lake	2007	**14.3**	**0.67**	**38.8**	**46.3**	15.2	66
	2010	2.7	0.39	36	**46**	**35.3**	90
Maw Lake	2007	**7.24**	**0.7**	11.3	**38**	18.7	69
	2010	**7.7**	**0.98**	9	**62**	30.4	80
Varnson Lake	2007	3.8	0.46	17.2	18.5	8.36	77
	2010	4.3	**0.67**	24	27	14.9	90
Tern Creek	2007	**22.1**	**0.64**	23	27.6	14.7	**157**
	2010	4.4	0.26	32	25	6.2	60
Tern Ditch	2007	**24.7**	0.29	19.6	27.9	6.24	103
	2010	**24.8**	0.41	**45**	**39**	10.4	**140**
Tern Lake	2007	3.7	0.14	11.7	11.7	3.24	23
	2010	**29.7**	**0.67**	26	34	18.3	**190**

Notes: Maximum concentrations, in mg/kg d.w., shown. Only waterbodies sampled in both years are shown. Only parameters that had one exceedance in at least one sample are shown. Shaded values are those that exceed MSQG (Williamson, 2002).

5.4.3 Phytoplankton

The following sections provide a summary and interpretation of the phytoplankton results for each tested waterbody. Detailed results for zooplankton sampling in 2007 has been provided Appendix C.

Phytoplankton samples were collected in Varnson Lake, Lalor Lake, Maw Lake and Tern Lake for enumeration and taxonomic composition in 2007 (Table 5.10). Varnson Lake had the highest total biomass (451 mg/m³) while Tern Lake had the lowest total biomass (125 mg/m³) (Appendix C). The dominant class of phytoplankton in Lalor Lake, Maw Lake, and Varnson Lake was Cyanophyceae (blue green algae) at 56% to 90% relative abundance in 2007 (Table 5.10). Tern Lake was dominated by mostly unidentified Chrysophyceae.

Table – 5.10: Relative Abundance of Phytoplankton

Waterbody	2007				2010			
	n	Dominant Class	Relative Biomass (%)	Biomass (mg/m³)	n	Dominant Class	Relative Biovolume (%)	Biovolume (mm³/L)
Lalor Lake	22	Cyanophyceae	89.7	311.1	24	Myxophyceae	69.8	1.1785
Maw Lake	20	Cyanophyceae	82.1	174.0	28	Myxophyceae	51.9	0.8512
Varnson Lake	35	Cyanophyceae	55.9	451.1	35	Myxophyceae	90.8	4.1139
Tern Lake	24	Chrysophyceae	41.7	124.9	37	Myxophyceae	65.7	1.7250
Tern Ditch Pond	-	-	-	-	37	Chlorophyceae	52.1	1.9486

Notes:

n = count of species; % = percent; mg/m³ = milligrams per cubic metre.

In 2010, phytoplankton samples were collected from Varnson Lake, Lalor Lake, Maw Lake, Tern Lake and Tern Ditch Pond (Appendix D Table – 04; Table 5.9). Species diversity ranged from 24 (Lalor Lake) to 37 (Tern Lake and Tern Ditch Pond) and biovolume ranged from 0.8 mm³/L (Maw Lake) to 4.1 mm³/L (Varnson Lake). The dominant class of phytoplankton in Lalor Lake, Maw Lake, Varnson Lake and Tern Lake was Myxophyceae (previously called Cyanophyceae) with relative abundance ranging from 52% to 91% in 2010 (Appendix D Table – 04). Tern Ditch Pond was dominated by Chlorophyceae (52%). Nearly 80% of the Tern Ditch Pond sample was composed of species in Chlorophyceae and Chrysophyceae, which on average typically composed less than 10% of the samples from the other waterbodies (Appendix D Table – 04). Euglenophyceae species were present only in Varson Lake and Tern Lake.

It should be noted that the difference in reporting units from 2007 (biomass mg/m^3) and 2010 (biovolume mm^3/L) is due to the fact that analysis and volumes were completed at two different laboratories.

In 2007, the phytoplankton community was different in Tern Lake, as compared with the rest of the waterbodies. The phytoplankton communities did not significantly differ, in terms of relative composition. Similar species were found in both 2007 and 2010 phytoplankton communities.

5.4.4 Zooplankton

The following sections provide a summary and interpretation of the zooplankton results for each tested waterbody. Detailed results for zooplankton sampling in 2007 have been provided in Appendix C.

In conjunction with the phytoplankton samples, zooplankton samples were collected for enumeration and taxonomic composition. In 2007, total abundance ranged from 315 individuals /m³ in Lalor Lake to 2,494 individuals/m³ in Tern Lake (Appendix C; Table 5.11). Only Copepoda were present in the Lalor Lake sample. Tern Lake also had the highest species diversity, with nine (9) species identified in the sample. Copepods represented the majority (96% to 100%) of organisms collected.

Table – 5.11: Relative Abundance of Zooplankton

Waterbody	2007				2010			
	n	Dominant Class	Relative Abundance (%)	Total Abundance (n/m³)	n	Dominant Class	Relative Abundance (%)	Total Abundance (n/m³)
Lalor Lake	2	Copepoda	100.0	315	17	Monogononta	45.6	13,341
Maw Lake	4	Copepoda	97.4	434	19	Monogononta	74.7	20,910
Varnson Lake	8	Copepoda	95.8	671	15	Ciliata	39.8	6,649
Tern Lake	9	Copepoda	99.3	2,494	15	Monogononta	61.3	17,160
Tern Ditch Pond	-	-	-	-	15	Branchiopoda	39.0	5,437

Notes:

n = count of species; % = percent; n/m³ = individuals per cubic metre.

In 2010, zooplankton samples were collected in Varnson Lake, Lalor Lake, Maw Lake, Tern Lake and Tern Ditch Pond for enumeration and taxonomic composition. In 2010, Maw Lake had the highest abundance of zooplankton (Table 5.11). The dominant class of zooplankton in 2010 was Monogononta (rotifers) in Lalor Lake, Maw Lake and Tern Lake (46%, 75%, and 61% respectively). Ciliata represented 40% of the relative abundance in Varnson Lake but there were almost equal percentages of Copepoda (24%) and Monogononta (32%) (Appendix D Table – 04). The zooplankton community in Tern Ditch Pond (as with the phytoplankton community) is slightly different from other waterbodies in the Lalor Zone. Branchiopoda accounted for 39% of the relative abundance in Tern Ditch Pond, whereas this class composes less than 5% in each of the other waterbodies (Appendix D Table – 04).

The zooplankton communities were dominated by Copepoda in 2007 in all the waterbodies examined, with Lalor Lake having the lowest species diversity and lowest total abundance. In 2010, Maw Lake had the highest abundance and the highest species diversity. There were significant differences in the diversity of species identified in the samples in 2007 and 2010. This variability could be due to seasonal differences at the time of sample collection, differences in analytical reporting, sorting procedures, and/or taxonomic identification. Abundance will be evaluated in the fall of 2012 to evaluate variability observed in the two studies and confirm abundance in each waterbody.

5.4.5 Benthic Community

Samples for benthic invertebrate taxonomy and enumeration were only collected in 2007. Six (6) samples were collected for the enumeration and identification of benthic invertebrates from Lalor Lake, Maw Lake and Varnson Lake, and three (3) samples were collected from each of Tern Lake and Unnamed Lake 1. The following sections provide a summary of the benthic invertebrate assessment for each tested waterbody. The detailed results of the study have been provided in Appendix C.

Sediments in the Study Area were largely organic with aquatic vegetation. In total, five (5) classes of benthic invertebrates were identified in the samples collected in 2007. All waterbodies were dominated overall by Insecta, with relative abundance ranging from 72% to 90% (Table 5.12). Mollusca and Annelida are the sub-dominant class, overall (Appendix C). Varnson Lake had the highest species diversity with 21 species, while Unnamed Lake 1 had the lowest species diversity with six (6) species (Table 5.12).

Table – 5.12: Relative Abundance of Benthic Invertebrates, 2007

Waterbody	n	Dominant Class	Average Relative Abundance (%)	Average Total Abundance (n/m²)
Lalor Lake	11	Insecta	89.6	2,565
Maw Lake	12	Insecta	83.8	1,377
Varnson Lake	21	Insecta	77.7	6,420
Tern Lake	13	Insecta	77.8	12,681
Unnamed Lake 1	6	Insecta	72.3	188

Notes: n = count of species; % = percent; n/m^2 = individuals per cubic metre.

The average total abundance (total abundance divided by number of stations in a waterbody) ranged from 188 n/m² to 12,681 n/m² in Unnamed Lake 1 and Tern Lake, respectively. There was a range of total abundance within waterbodies: for example, total abundance ranged from 0 n/m² to 20,348 n/m² among stations in Varnson Lake (Appendix C).

5.4.6 Fish Community

Fishing effort in 2007 included Standard Gang and Swedish gang index gill nets, seine nets and minnow traps in Lalor Lake, Maw Lake, Varnson Lake, Tern Lake and Unnnamed Lake 1 (Appendix C). No fish were captured in the experimental gill nets in 2007. In 2008, large-bodied species were targeted with trawling from the boat and angling from shore as fishing methods in Cook Lake. In 2010, only Tern Ditch Pond was fished using Swedish gang gill nets, seine nets and minnow traps (Appendix D Table – 06).

In 2007, Brook Stickleback (*Culaea inconstans*), Fathead Minnow (*Pimephales promelas*) and Central Mudminnow (*Umbra limi*) were captured. Minnow traps were the most successful fishing method and Brook Stickleback were the most commonly captured species (Appendix C). In 2008, Northern Pike (*Esox lucius*) and Walleye (*Sander vitreus*) were captured in Cook Lake. In 2010, only Brook Stickleback were captured in Tern Ditch Pond (Appendix D Table – 06). A summary of fish catch is provided in Table 5.13.

Table – 5.13: Fish Catch in the Lalor Mine Area

Year	Waterbody	Brook Stickleback	Fathead Minnow	Central Mudminnow	Northern Pike	Walleye
2007	Lalor Lake	35	17	1	-	-
	Maw Lake	8	55	1	-	-
	Varnson Lake	13	19	20	-	-
	Tern Lake	20	-	-	-	-
2008	Cook Lake	-	-	-	6	4
2010	Tern Ditch Pond	26	-	-	-	-

The most abundant species captured, regardless of sampling gear, was the Brook Stickleback. No large-bodied fish were captured in either the 2007 or the 2010 baseline surveys. Northern Pike and Walleye were captured in 2008 in Cook Lake. Fish species present in the Nelson River watershed are listed in Table 5.14.

5.4.7 Fish Habitat

Based on the results of the aquatic study, it is not likely that Unnamed Creek 1, Lalor Lake, Maw Lake, Varnson Lake and Tern Lake could support any significant populations of large-bodied fish. The shallow depth, limited suitable habitat types and lack of connectivity limit these waterbodies to support only small-bodied (i.e., forage) fish species. The forage fish species that were found in the proposed Lalor Mine area were the Brook Stickleback, Fathead Minnow and Central Mudminnow. These three (3) species are often associated with one another, particularly in bog and headwater habitats (Stewart & Watkinson, 2004). A number of other lakes, streams, creeks, ponds, and wetlands may also support small-bodied fish species. Large-bodied fish populations are supported in the larger lakes, such as Cook Lake, Squall Lake, and Snow Lake. These lakes are well-connected with other waterbodies, have greater depths and abundant fish habitat types available.

Lalor Lake, Maw Lake and Varnson Lake are small lakes within the Project Area. Iverach Lake, Erzinger Lake and Gutray Lake are moderately sized lakes within the Project Area but were not part of the baseline studies (Drawing - 03). Although these lakes are relatively shallow, each are likely to support small-bodied fish throughout the majority of the year. Larger lakes in the Project Area include Squall Lake, Cook Lake and Snow Lake. Squall Lake is north of Snow Lake and is likely able to support a variety of fish species. Snow Lake supports a variety of fish species throughout the year.

Table – 5.14: Fish Species in the Nelson River Watershed

Family Name	Common Name	Species Name	Distribution
Petromyzontidae	Silver Lamprey	*Ichthyomyzon unicuspis*	N
Acipenseridae	Lake Sturgeon	*Acipenser fulvescens*	N
Hiodontidae	Mooneye	*Hiodon tergisus*	N
Cyprinidae	Lake Chub	*Couesius plumbeus*	N
	Carp	*Cyprinus carpio*	I
	Pearl Dace	*Margariscus margarita*	N
	Emerald Shiner	*Notrophis atherinoides*	N
	Blacknose Shiner	*Notropis heterolepis*	N
	Spottail Shiner	*Notropis hudsonius*	N
	Fathead Minnow	*Pimephales promelas*	N
	Longnose Dace	*Rhinichthys cataractae*	N
Catostomidae	Longnose Sucker	*Catostomus catostomus*	N
	White Sucker	*Catostomus commersoni*	N
	Shorthead Redhorse	*Moxostoma erythurum*	N
Ictaluridae	Channel Catfish	*Ictalurus punctatus*	R
Esocidae	Northern Pike	*Esox lucius*	N
Umbridae	Central Mudminnow	*Umbra limi*	0
Osmeridae	Rainbow Smelt	*Osmerus mordax*	I
Salmonidae	Cisco	*Coregonus artedi*	N
	Lake Whitefish	*Coregonus clupeaformis*	N
	Rainbow Trout	*Oncorhynchus mykiss*	I
	Brook Trout	*Salvelinus fontinalis*	N
	Lake Trout	*Salvelinus namaycush*	N
Percopsidae	Trout-perch	*Percopsis omiscomaycus*	N
Gadidae	Burbot	*Lota lota*	N
Gasterosteidae	Brook Stickleback	*Culaea inconstans*	N
	Ninespine Stickleback	*Pungitius pungitius*	N
Cottidae	Slimy Sculpin	*Cottus cognatus*	N
Percidae	Johnny Darter	*Etheostoma nigrum*	N
	Yellow Perch	*Perca flavescens*	N
	River Darter	*Percina shumardi*	N
	Sauger	*Sander canadensis*	N
	Walleye	*Sander vitreus*	N
Sciaenidae	Freshwater Drum	*Aplodinotus grunniens*	N

Source: Stewart & Watkinson, 2004.

Notes: Estuarine species are excluded from this list. N = native; I = introduced; 0 = not previously captured in this watershed.

5.4.8 Metal Residues in Fish

In total, 140 fish were submitted from Lalor Lake, Maw Lake, Varnson Lake and Tern Lake. With one exception, concentrations of arsenic, lead and mercury were below the *MWQSOG* for all fish analyzed and the majority of metal concentrations were at or below the detection limit. The mercury concentration in a single Fathead Minnow from Varnson Lake equalled the guideline with a concentration of 0.5 µg/g wet weight in 2007 (Appendix C).

A total of 20 Brook Stickleback (sex unidentified) captured in Tern Ditch Pond were submitted for analysis of whole-body metal concentrations in 2010. Concentrations of most analytes were low or below detection limit and none exceeded the *MWQSOG* aquatic life residue guidelines for human consumption for arsenic, lead or mercury (Appendix D Table – 07).

5.5 Summary

The majority of waterbodies were oligotrophic, with higher total phosphorus concentrations in 2007 as compared to 2010. Tern Ditch had the highest total phosphorus concentrations in both 2007 and 2010 as compared to other waterbodies examined. In general, limnological and conventional water quality parameters were similar between the 2007 and 2010 sampling events. Waterbodies in the Lalor area were clear, alkaline and well-oxygenated. Water quality was considered high in both 2007 and 2010, with few exceptions.

In 2007 and 2010, 35 and 13 water samples were submitted for chemical analysis, respectively. Exceedances in 2007 included aluminum, arsenic, copper and iron. In total, there were nine (9) exceedances in 2007. In 2010, there were 11 exceedances including pH, aluminum, arsenic, and iron. Overall, Tern Ditch had the highest concentrations of alumimum, arsenic, copper and iron. Tern Creek had higher metals concentrations in 2010 as compared to 2007. Overall, water quality is considered to be relatively good in the waterbodies in the Project Area.

Surficial sediments were collected from 12 and seven (7) waterbodies in the Snow Lake region and analysed for particle size distribution, major elements and chemicals of potential concern to determine baseline characteristics of the sediments in 2007 and 2010, respectively. Sediments were highly organic and had high moisture content. In 2007, arsenic, cadmium, chromium, and copper concentrations exceeded at least one sample. Snow Lake Narrows had the most exceedances where Tern Lake had no exceedances in 2007. In 2010, there were 33 concentrations that exceeded at least one applicable sediment quality guideline including arsenic, cadmium, chromium, copper, lead, selenium, and zinc. Tern Ditch Pond, in 2010, did not have any exceedances. Sediment quality is impacted in the Project area, due to such factors as historical anthropogenic activities, depositional nature of the sediments, and naturally elevated concentrations.

In both years, the dominant class of phytoplankton was Cyanophyceae (also known as Myxophyceae) and Varnson Lake had the highest biomass/biovolume. Less productive lakes were Tern Lake in 2007 and Maw Lake in 2010. In 2007, the zooplankton community was dominated by Copepoda while in 2010, it was dominated by Monogononta, Ciliata and Branchiopoda. In 2007, Tern Lake had the highest abundance while in 2010, Maw Lake had the highest abundance of zooplankton. Differences in plankton community and density change seasonally and can be affected by basic limnological parameters (e.g., temperature and total dissolved solids) and biological factors (e.g., competition and predator abundance).

Insecta dominated the benthic invertebrate community, with Mollusca and Annelida as sub-dominant classes. Tern Lake had the highest average abundance while Unnamed Lake 1 had the lowest abundance and species diversity.

Minnow traps, gill nets, and angling were used to collect fish in the Project Area in 2007, 2008 and 2010. In total, five (5) fish species were captured. In general, the larger waterbodies (*e.g.,* Maw Lake, and Varnson Lake) had the highest species diversity and catches. Brook Stickleback were the most abundant (or only) species captured, typical of headwater waterbodies. Of the 170 fish analyzed for metals residues in 2007 and 2010, only a single Fathead Minnow from Varnson Lake in 2007 had a concentration of mercury that was equal to the applied guideline.

All lakes provided diverse cover types and varying degrees of shoreline complexity. However, while the smaller creeks and lakes within the Project Area provided a diversity of habitats, shallow depth and limited connectivity to other waterbodies suggests that it cannot support populations of large-bodied fish. Habitat for large-bodied fish is available in the larger waterbodies, i.e., Cook Lake, Squall Lake and Snow Lake.

In general, water and sediment quality as well as biological diversity and productivity was typical of the region. Waterbodies impacted by historical or current mining and land use activities demonstrate reduced water and sediment quality. The current spatial patterns with respect to water and sediment quality are probably related to local releases of the elements and subsequent transport through complex aquatic systems with depositional and erosional areas. This interpretation is consistent with the land use patterns in the area and the presence of historic mining activity and natural sources of the elements in a mineral-rich region. The spatial variability in the concentrations of potential chemicals of concern needs to be considered when developing monitoring and assessment programs.

6. Closure

The physical environment (*e.g.,* geology, topography, hydrology) at the proposed Project Site is typical of the region. Terrestrial baseline surveys conducted in the area did not identify any critical or unique wildlife habitat or vegetation communities at or near the Project Site. No protected or listed species was observed during any of the surveys. Most waterbodies in the area are small lakes, creeks, wetlands or bogs. Abundant habitat for small-bodied fish is available in many waterbodies, while habitat for large-bodied fish are limited to the largest lakes. Water and sediment quality as well as aquatic biological diversity and abundance was typical of the region. Waterbodies impacted by anthropogenic activities demonstrate elevated levels of contaminants, also typical of the region. The development of the Lalor site could present a number of positive opportunities and socio-economic benefits for the residents of Snow Lake and Flin Flon.

This document summarizes the environmental and socio-economic aspects that may be affected by the Project activities. This baseline report also summarizes the terrestrial and aquatic baseline conditions at the proposed mine site, access road and several waterbodies in the area. Information presented here will feed into the Environmental Assessment (EA), which will identify and assess potential impacts of the proposed project and describe mitigation measure required to offset potential negative impacts. Residual impacts, remaining following implementation of the mitigation measures will also be described. Following the development of the EA, an Environmental Impact Statement (EIS) will summarize the baseline report and EA.

7. References

Bailes, A.H. & Galley A.G. (2007). *Geology of the Chisel-Anderson lakes area, Snow Lake, Manitoba (NTS areas 63K16SW and west half of 63J13SE)*; *Geoscientific map 2007-1, 1 colour map with accompanying notes. Scale 1:20,000.* Retrieved from http://www.gov.mb.ca/stem/mrd/info/libmin/MAP2007-1.zip.

Canadian Council of Ministers of the Environment (CCME). (1999). *Canadian water quality guidelines for the protection of aquatic life - phosphorus: Canadian Guidance Framework for the Management of Freshwater Systems*. Winnipeg, MB: Author.

Canadian Council of Ministers of the Environment (CCME). 2007. *Canadian soil quality guidelines for the protection of environmental and human health: Summary Table*. Winnipeg MB: Author.

Canadian Council of Ministers of the Environment (CCME). (2011). *Canadian water quality guidelines for the protection of aquatic life: Summary table*. Winnipeg, MB: Author.

City of Flin Flon. (2008). *Flin Flon*. Retrieved from http://www.cityofflinflon.com/index-frameset.html.

Department of Energy, Mines and Resources, Survey and Mapping Branch. (1985). *File Lake, Manitoba*. *ETopo, 63K16, Edition 3, UTM Zone 14.* Winnipeg, MB: Author.

Department of Energy, Mines and Resources, Survey and Mapping Branch. (1995). *Herb Lake, Manitoba*. *ETopo, 63J13, Edition 3, UTM Zone 14.* Winnipeg, MB: Author.

Environment Canada. (2012, February 24*). Canadian Climate Normals (1971-2000) – Flin Flon A*. Retrieved from http://www.climate.weatheroffice.ec.gc.ca

Golder Associates Ltd. (2009, July 23). *Hydrogeological Testing Program – Lalor Lake Zinc/Gold Project. (Report Number: 09-1428-0012)*. Burnaby, BC: Author.

Government of Canada. (2011, June 7). *Species at Risk Public Registry*. Retrieved from www.sararegistry.gc.ca.

Government of Manitoba, Geological Survey. (2011, June 6). *Manitoba Geology – Trans-Hudson Orogen*. Retrieved from http://www.gov.mb.ca/stem/mrd/geo/exp-sup/mbgeology.html#transhudsonorogen.

Manitoba Conservation. (2011a, June 21). *Manitoba's Provincial Forests*. Retrieved from http://www.gov.mb.ca/conservation/forestry/pdf/woodlot/provincial_forests.pdf.

Manitoba Conservation. (2011b, June 7). *Wildlife and Ecosystem Protection – Species at Risk, Species Listed Under the Manitoba Endangered Species Act*. Retrieved from http://www.gov.mb.ca/conservation/wildlife/sar/sarlist.html.

Manitoba Conservation. (2011c, June 7). *Manitoba Conservation Data Centre, Occurrence of Species by Ecoregion – Churchill River Upland*. Retrieved from http://www.gov.mb.ca/conservation/cdc/ecoreg/churchill.html.

Manitoba Conservation, Parks and Natural Areas Branch. (2011d, June 21). *Grass River Provincial Park*. Retrieved from http://www.gov.mb.ca/conservation/parks/popular_parks/northwest/grass_info.html?print.

Manitoba Conservation, Parks and Natural Areas Branch. (2011e, June 21). *Northwest Parks, Clearwater Lake Provincial Park*. Retrieved from http://www.gov.mb.ca/conservation/parks/popular_parks/northwest/clearwater_info.html.

Manitoba Conservation, Wildlife and Ecosystem Protection. (2011f, June 22*). Habitat Conservation, Wildlife Management Areas, Northwestern Region*. Retrieved from http://www.gov.mb.ca/conservation/wildlife/habcons/wmas/northwestern.html.

Manitoba Infrastructure and Transportation Traffic Engineering Branch. (2009). *Annual Average Daily Traffic on Provincial Trunk Highways and Provincial Roads, 2009 Traffic Flow Map*. Retrieved from http://umtig.mgmt.umanitoba.ca/flowmap2010.pdf.

Persaud D., Jaagumagi, R., and Hayton, A. (1993). *Guidelines for the protection and management of aquatic sediment quality in Ontario.* Toronto, ON: Ontario Ministry of the Environment, Water Resources Branch.

Smith, R.E., Veldhuis, H., Mills, G.F., Eilers, R.G., Fraser, W.R., and Lelyk, G.W.. (1998). *Terrestrial Ecozones, Ecoregions, and Ecodistricts, An Ecological Stratification of Manitoba's Natural Landscapes (Technical Bulletin 98-9E).* Winnipeg, MB: Agriculture and Agri-Food Canada.

Snow Lake. (2011, June 21). *Snow Lake Manitoba*. Retrieved from http://www.snowlake.ca/default.asp.

Statistics Canada. (2007). *Aboriginal Population Profile. 2006 Census: Mathias Colomb, Manitoba (Code630268) (Catalogue no. 92-594-XWE).* Retrieved from http://www12.statcan.ca/census-recensement/2006/dp-pd/prof/92-594/index.cfm?Lang=E.

Statistics Canada. (2010a, December 6). *2006 Community Profiles, Snow Lake, Manitoba*. Retrieved from http://www12.statcan.gc.ca/census-recensement/2006/dp-pd/prof/92-591/details/page.cfm?Lang=E&Geo1=CSD&Code1=4621071&Geo2=PR&Code2=46&Data=Count&SearchText=snow%20lake&SearchType=Begins&SearchPR=01&B1=All&Custom=.

Statistics Canada. (2010b, December 7). *2006 Community Profiles, Flin Flon, Manitoba*. Retrieved from http://www12.statcan.gc.ca/census-recensement/2006/dp-pd/prof/92-591/details/page.cfm?Lang=E&Geo1=CSD&Code1=4621064&Geo2=PR&Code2=46&Data=Count&SearchText=flin%20flon&SearchType=Begins&SearchPR=01&B1=All&Custom=.

Statistics Canada. (2010c, December 6). *2006 Community Profiles, Pukatawagan 198*. Retrieved from http://www12.statcan.gc.ca/census-recensement/2006/dp-pd/prof/92-591/details/Page.cfm?Lang=E&Geo1=CSD&Code1=4623064&Geo2=PR&Code2=46&Data=Count&SearchText=pukatawagan&SearchType=Begins&SearchPR=01&B1=All&Custom=

Stewart, K.W. & Watkinson, D.A. (2004). *The Freshwater Fishes of Manitoba*. Winnipeg, MB: University of Manitoba Press.

Tolko Industries Ltd. (2011, May 31). *Woodlands*. Retrieved from http://www.tolkomanitoba.com/.

Williamson, D.A. (2002). *Manitoba Water Quality Standards, Objectives and Guidelines* (Report 2002-11). Winnipeg, MB: Manitoba Conservation.