MARATHON PALLADIUM PROJECT – AQUATIC ENVIRONMENT BASELINE REPORT UPDATE

Report prepared for:

GENERATION PGM INC.
First Canadian Place
100 King Street West, Suite 7010
P.O. BOX 70
Toronto, Ontario, Canada M5X 1B1

Report prepared by:

ECOMETRIX INCORPORATED
www.ecometrix.ca
Mississauga, ON

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Joseph Tetreault, B.Sc.
Senior Aquatic Scientist

Jason Dietrich, M.Sc.
Senior Aquatic Scientist

Brian Fraser, M.Sc.
Principal and Senior Consultant
Quality Reviewer

EXECUTIVE SUMMARY

Ecometrix Incorporated (Ecometrix) has been retained by Generation PGM Inc (GenPGM) to provide an updated assessment of aquatic environment baseline conditions for the Marathon Palladium project (the Project) in the Town of Marathon, Ontario. The updated aquatic environment baseline study provides information required to complete the EIS Addendum for the Project.

The original aquatic environment baseline characterization program at the Project site included multi-year, multi-season surveys of aquatic habitats and communities in the study area. The existing characterization of the aquatic environment was re-considered within the context of several factors to assess its suitability to support the updated assessment of potential Project-related effects. Only minor additional information was identified as a need, and this information was collected in July 2020.

The existing aquatic environment baseline characterization as represented by the original baseline program and subsequent follow up work as summarized herein provides a suitable basis for the updated assessment.

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1.0 INTRODUCTION

Generation PGM Inc. (GenPGM) proposes to develop the Marathon Palladium Project (the "Project"), which is a platinum group metals (PGM) and copper (Cu) open pit mine and milling operation near the Town of Marathon, Ontario. The Project is being assessed in accordance with the *Canadian Environmental Assessment Act* (2012) and Ontario's *Environmental Assessment Act* (EA Act) through a Joint Review Panel (the Panel) pursuant to the *Canada-Ontario Agreement on Environmental Assessment Cooperation* (2004).

Ecometrix Incorporated (Ecometrix) has been retained by Generation PGM Inc (GenPGM) to provide an updated assessment of aquatic environment baseline conditions for the Marathon Palladium Project (the Project). This report provides an update to the baseline conditions as described in the information currently on the record, including:

- Supporting Information Document 3: Aquatic Resources Baseline Report For The Marathon PGM-Cu Project prepared by Ecometrix (July 2012) (CIAR #227).
- Responses to IRs 13.2.1-13.2.2 (CIAR #430), 13.3-13.5.6 (CIAR #409), 13.7-13.8 (CIAR #397), SIR 5, AIRs 10 (CIAR #430), 11 (CIAR #430), 19 (CIAR #430), and an additional agency information request dated April 24, 2013 (CIAR #417).

This aquatic environment baseline study has been completed to inform the Addendum to the Marathon Palladium Environmental Impact Statement (EIS Addendum) as input to the Joint Review Panel process. It has been prepared pursuant to the Canadian Environmental Assessment Act, 2012 and in consideration of the Guidelines for the Preparation of an Environmental Impact Statement – Marathon Platinum Group Metals and Copper Mine Project (EIS Guidelines) (Canadian Environmental Assessment Agency (CEAA) and Ontario Ministry of Environment (MOE), 2011).

The information presented in this report is intended to summarize and document changes to the existing environmental conditions relating to the aquatic environment, relative to those conditions considered in the previous assessment, in order to support the updated assessment of potential environmental effects provided in the EIS Addendum. The information presented herein was obtained from a review of historical information and the updated design plans for the Project provided by GenPGM.

1.1 Project Location and Setting

The Project is located approximately 10 km north of the Town of Marathon, Ontario (**Figure 1-1**). Marathon is a community of approximately 3,300 people (Statistics Canada, 2017) located adjacent to the Trans-Canada Highway (Highway 17) on the northeast shore of Lake Superior approximately 300 km east of Thunder Bay and 400 km northwest of Sault Ste. Marie. The centre of the Project footprint sits at approximately 48° 47' N latitude, 86°

19' W longitude (UTM Easting 550197 and Northing 5403595). The footprint of the proposed mine location is roughly bounded by Highway 17 and the Marathon Airport to the south, the Pic River and Camp 19 Road to the east, Hare Lake to the west, and Bamoos Lake to the north. Access is currently gained through Camp 19 Road.

The Project is proposed within an area characterized by relatively dense vegetation, comprised largely of a birch and spruce-dominated mixed wood forest. The terrain is moderate to steep, with frequent bedrock outcrops and prominent east-west oriented valleys. Several watercourses and lakes traverse the area, with drainage flowing either eastward to the Pic River or westward to Lake Superior. The climate of this area is typical of northern areas within the Canadian Shield, with long winters and short, warm summers.

The Project is proposed on Crown Land, with GenPGM holding surface and/or mineral rights for the area. Regional land use activities in the area include hunting, fishing, trapping and snowmobiling, as well as mineral exploration (and mining) and forestry. Other localized land uses in the area include several licensed aggregate pits, the Marathon Municipal Airport, the Marathon Landfill, a municipal works yard and several commercial and residential properties.

The primary industries in the area have historically been forestry, pulp and paper, mining and tourism. Exploration for copper and nickel deposits in the area extend as far back as the 1920s. A large copper-PGM deposit was discovered in 1963. Advanced exploration programs have continued across the site since then. These programs have been supported by various feasibility studies to confirm the economic viability of extracting the deposits.

Several First Nation and Métis groups were originally identified as having a potential interest in the Project based on Treaty Rights, asserted traditional territory and proximity to the Project. Traditional uses which they have identified as occurring in the area include hunting, trapping, fishing and plant harvesting, with activities generally focused on the larger waterways, such as the Pic River, Bamoos Lake and Hare Lake.

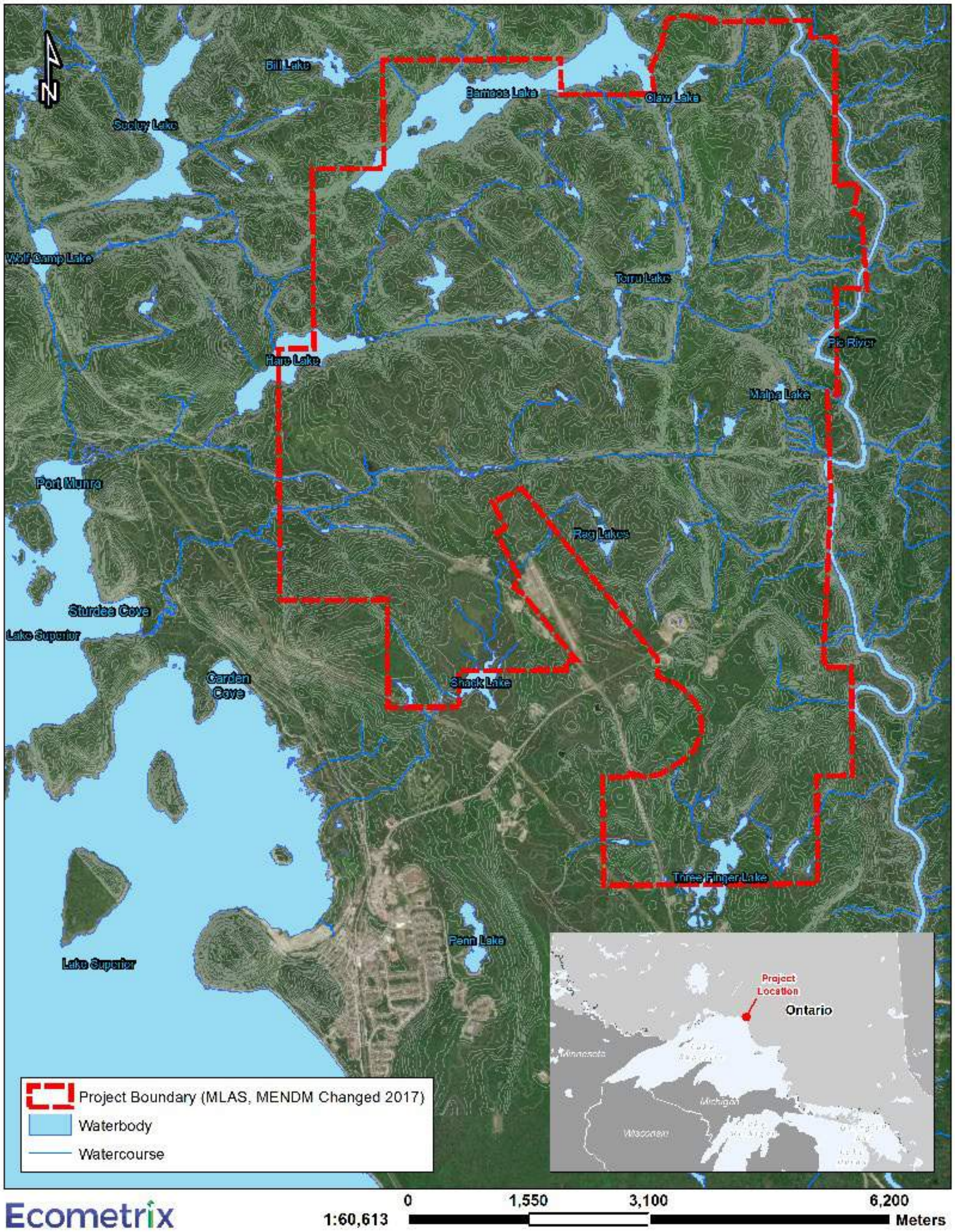

Figure 1-1: Regional Project Location

1.2 Project Overview

The Project is based on the development of an open pit mining and milling operation for copper and platinum group metals. Ore will be mined from the pits and processed (crushed, ground, concentrated) at an on-site processing facility. Final concentrates containing copper and platinum group metals will be transported off-site via existing roadways and/or rail to a smelter and refinery for subsequent metal extraction and separation. Iron sulfide magnetite and vanadium concentrates may also be produced, depending upon the results of further metallurgical testing and market conditions at that time.

The construction workforce will average approximately 450 – 550 people, with a peak workforce of an estimated 900 people, and will be required for between 18 and 24 months. During operations, the workforce will comprise an estimated 350 workers. The mine workforce will reside in local and surrounding communities, as well as in an accommodations complex that will be constructed off-site.

Most of the mine rock[1] produced through mining activities is non-acid generating (non-PAG) and will be permanently stored in a purposefully built Mine Rock Storage Area (MRSA). The non-PAG rock (also referred to as Type 1 mine rock) will also be used in the construction of access roads, dams and other site infrastructure, as needed. Drainage from the MRSA will be collected in a series of collection basins and treated, as necessary, to meet applicable water quality criteria prior to discharge to the Pic River. The remaining small portion of mine rock is considered to be potentially acid generating (PAG) (also referred to as Type 2 mine rock) and will be stored in the open pits or the Process Solids Management Facility (PSMF). This will ensure that drainage from the Type 2 mine rock will be contained during operations. Following closure, the Type 2 mine rock will be permanently stored below water by flooding the open pits and maintaining saturated conditions in the PSMF to prevent acid generation in the future.

Most of the process solids[2] produced at the site will be non-PAG (Type 1 process solids) with the minority being PAG (Type 2 process solids). Both the Type 1 and Type 2 process solids will be stored in the PSMF and potentially within the open pits. In both cases, the Type 2 process solids will be managed to prevent acid generation during both the operation and closure phases of the project. Water collected within the PSMF as well as water collected around the mine site (other than the MRSA), such as water pumped from the pits or run-off collected from the plant site, will be managed within the PSMF. Excess water not needed for processing ore will be discharged, following treatment as necessary, to Hare Lake.

[1] Mine rock: rock that has been excavated from active mining areas but does not have sufficient ore grades to process for mineral extraction.
[2] Process solids: solids generated during the ore milling process following extraction of the ore (minerals) from the host material.

Access to the Project site is currently provided by the Camp 19 Road, opposite Peninsula Road at Highway 17. The existing road will be upgraded and utilized from its junction with Highway 17 to a new road running north that will be constructed to access the Project site. The Project will also require the construction of a new 115 kV transmission line that will connect to either the Terrace Bay-Manitouwadge transmission line (M2W Line). The width of the transmission corridor will be approximately 30 m.

Disturbed areas of the Project footprint will be reclaimed in a progressive manner during all Project phases. Natural drainage patterns will be restored as much as possible. The ultimate goal of mine decommissioning will be to reclaim land within the Project footprint to permit future use by resident biota and as determined through consultation with the public, Indigenous people and government. A certified Closure Plan for the Project will be prepared as required by Ontario Regulation (O.Reg.) 240/00 as amended by O.Reg.194/06 "Mine Development and Closure under Part VII of the Mining Act" and "Mine Rehabilitation Code of Ontario".

A further description of the Project and associated project activities and phases will be provided under separate cover in the EIS Addendum.

1.3 Study Objectives

This updated aquatic baseline study provides information to inform the EIS Addendum for the Project. The objectives of this update were to describe and present available information and characterize changes to the baseline conditions in the study area. The scope of the updated geological baseline study includes the following:

- summary of findings of the existing baseline studies (**Section 2.0**).
- identification of regulatory guidance for the collection of baseline data (**Section 3.0**).
- confirmation of spatial boundaries (**Section 4.0**).
- describe the collection and review of available background information and data, including any additional and/or on-going data collection efforts (**Section 5.0**).
- analysis of information to characterize existing baseline conditions and to determine any changes that have occurred since publication of the original EIS and its supporting documentation (**Section 6.0**).
- provide an updated summary of baseline conditions in the Site Study Area (SSA), Local Study Area (LSA) and Regional Study Area (RSA) specific to conditions relevant to the effects being assessed in the EIS Addendum (**Section 7.0**).

2.0 PREVIOUS CHARACTERIZATION OF EXISTING CONDITIONS

2.1 Scope of the Baseline Surveys

The aquatic environment baseline characterization program at the Project site included multi-year, multi-season surveys of aquatic habitats and communities in the study area. There was limited historical aquatic environmental information available for the site location prior to the development of the Project initially by Marathon PGM. The majority of these data were collected by the Ontario Ministry of Natural Resources (MNR[3], Department of Lands and Forests) and were limited mainly to lake and stream survey summaries of some of the larger lakes and streams within the Project footprint. Historical data were available for Hare Lake, the Rag Lakes, Shack Lake, Shack Creek and Angler Creek.

In 2006, N.A.R. Environmental Consultants Ltd. (NAR) was retained by Marathon PGM to conduct an Environmental Baseline Assessment (NAR, 2007), in relation to advanced exploration at the site. This environmental baseline survey comprised sampling at a total of 16 small lakes and ponds and included the characterization of the water and sediment quality, benthic macroinvertebrate communities, the fisheries communities, and prominent shoreline features.

Subsequent to the NAR report and after the decision was made by Marathon PGM to move forward with the development of the Project, Golder Associates Limited (Golder) was retained to conduct a baseline assessment of the aquatic and terrestrial environments associated with the proposed Marathon PGM-Cu Mining Project to support a Feasibility Study (Golder, 2009). Using an updated site plan, the potential environmental impacts associated with the Project were assessed with the purpose of characterizing the aquatic biological community within the Project footprint, identifying environmental constraints associated with the Project, and gathering information to support permit applications required as the mine development progressed. This aquatic baseline assessment comprised a number of small lakes and streams on the property as well as the Pic River. It included the characterization of water and sediment quality, benthic community, fish community and fish habitat in those waterbodies.

In 2008, EcoMetrix Incorporated (EcoMetrix) was retained by Marathon PGM to complete additional aquatic environment baseline studies. EcoMetrix continued to work on describing the aquatic environment after the 2010 sale of Marathon PGM to Stillwater Canada Inc. The purpose of this additional work was to address temporal and spatial deficiencies in the existing data compiled during previous work at the site. To this end, further studies were undertaken by EcoMetrix in 2009, 2010 and 2011. It included the

[3] Now MNRF, Ministry of Natural Resources and Forestry.

characterization of water and sediment quality, benthic communities, plankton communities, fish communities and fish habitat in waterbodies/water courses on the Project site, as well as those in areas downstream of the Project site.

Additional focussed sampling was undertaken by EcoMetrix in 2013 to supplement existing baseline data. The scope and details of the field program, and in particular the fish sampling component, were developed in consultation with MNR staff. In summary, this work included:

- Closed station electrofishing in Stream 1 (2 stations), Stream 2 (2 stations), Stream 3 (1 station), Stream 6 (2 stations) and Hare Creek (2 stations) to derive fish population density estimates by species and age class using the Moran-Zippin method.
- Execution of the MNR Broadscale Method (BsM) in Hare Lake.
- Fish were netted in the Pic River in August 2013 with specimens retained for chemical analyses.
- Benthic invertebrate sampling was completed at stations S30 (Hare Creek) and S31 (Stream 6). The sampling conducted was consistent with the requirements of the federal Environmental Effects Monitoring (EEM) Program under the Metal Mining Effluent Regulations (MMER[4]) (Fisheries Act) in terms of sampling methodology and rigour, taxonomic analyses and data analysis.
- Zooplankton and phytoplankton samples were collected in Hare Lake in September 2013, and then again in June, July, August and September of 2014.

2.2 Characterization of the Aquatic Environments in the Study Area

A summary of the aquatic environment baseline data collected in each subwatershed is provided below. **Figure 2-1** and **Figure 2-2** are maps showing the subwatersheds that are associated with the study area and identifies locations at which surveys were undertaken.

[4] Now MDMER – Metal and Diamon Mining Effluent Regulations

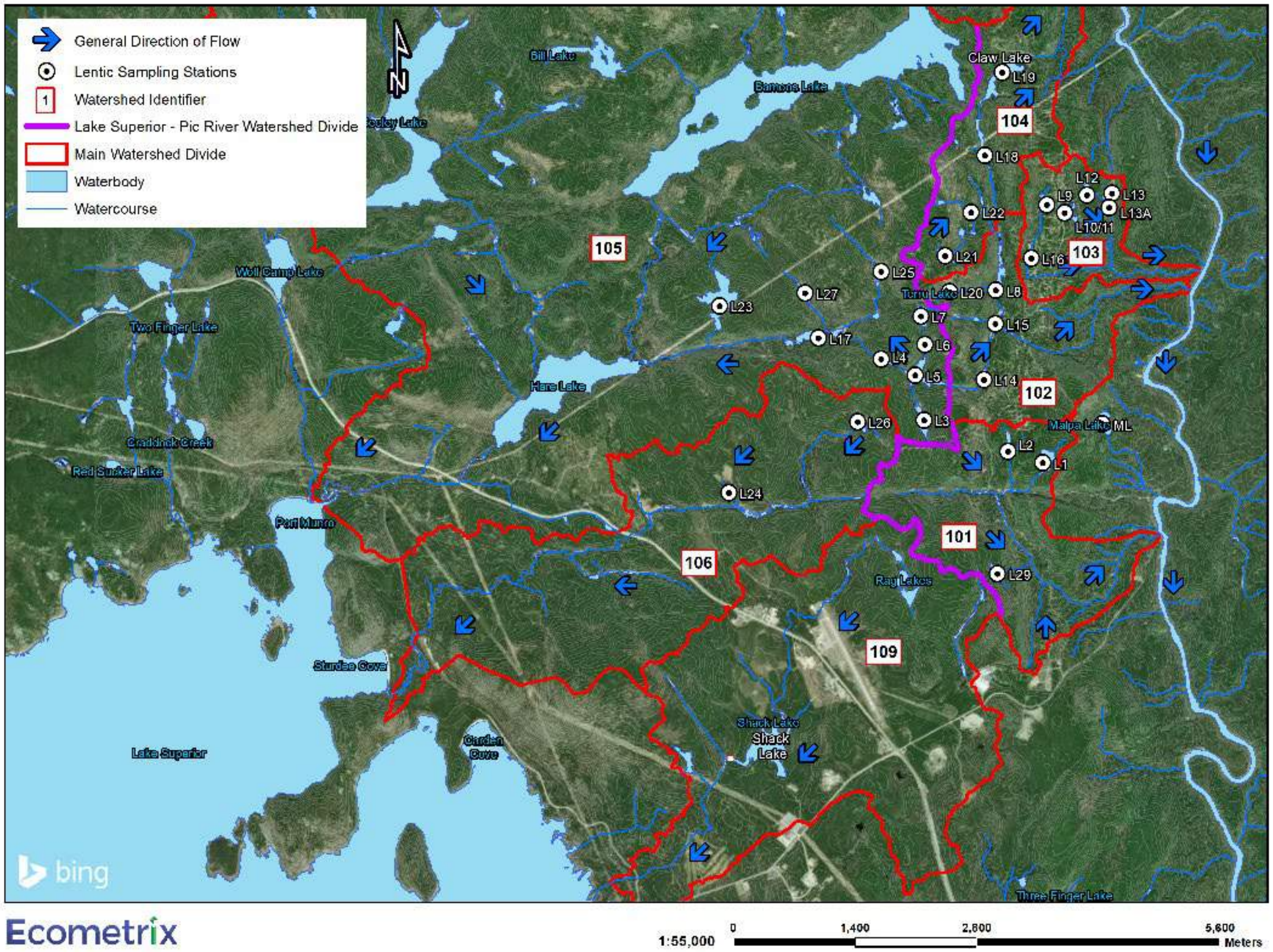

Figure 2-1: Subwatersheds and lentic survey locations for the aquatic environment baseline surveys

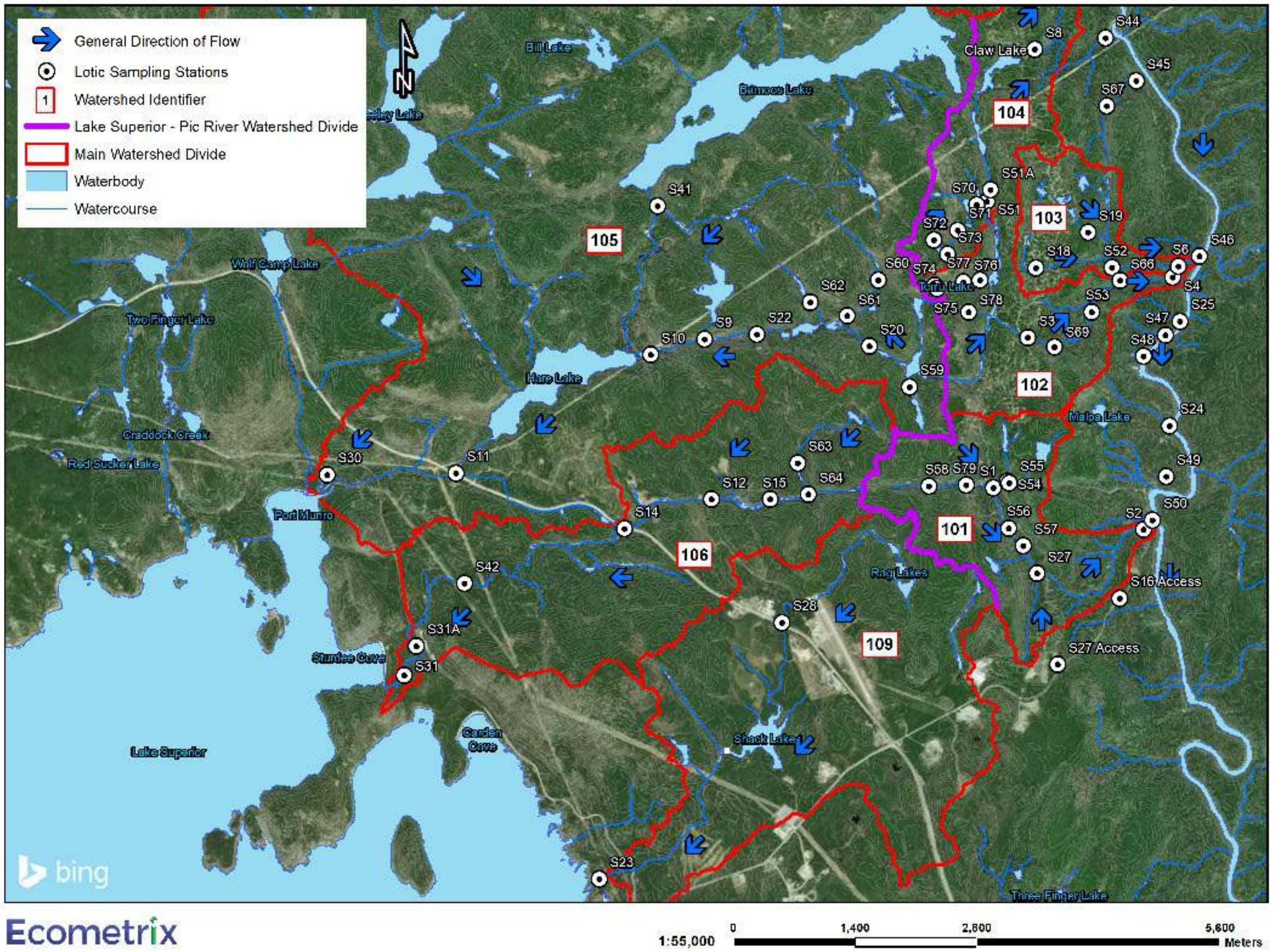

Figure 2-2: Subwatersheds and lotic survey locations for the aquatic environment baseline surveys

2.2.1 Subwatershed 101 Summary

Figure 2-3 provides a map of the subwatershed 101 (Stream 1) aquatic sampling stations.

There were a variety of benthic organisms identified representing a wide range of taxa including worms, leeches, amphipods, mayflies, stoneflies, caddisflies, beetles, midges, clams and snails. The different habitats (lakes and ponds versus streams) resulted in expected differences in the community composition. Stations L1, L2 and S1 were classified as having fair water quality according to the Hilsenhoff Biotic Index; S2 was classified as having good water quality; and L29 was classified as having fairly poor water quality. The quantitative samples conducted at S1 and S2 by Golder resulted in wide ranging densities (i.e., 32 to 3,902 invertebrate/m^2). The Simpson's Diversity and Evenness numbers were moderate to high at both S1 and S2, with the S1 community being more diverse than the downstream community. EPT taxa were collected at the upstream and downstream stations and were generally more prevalent than more tolerant organisms like chironomids.

Sediment samples collected by NAR (2007) in both L1 and L2 and in L2 and L29 by Ecometrix resulted in a number of parameters exceeding the provincial sediment quality guidelines (PSQG). Total kjehldal nitrogen (TKN), total organic carbon (TOC) and copper

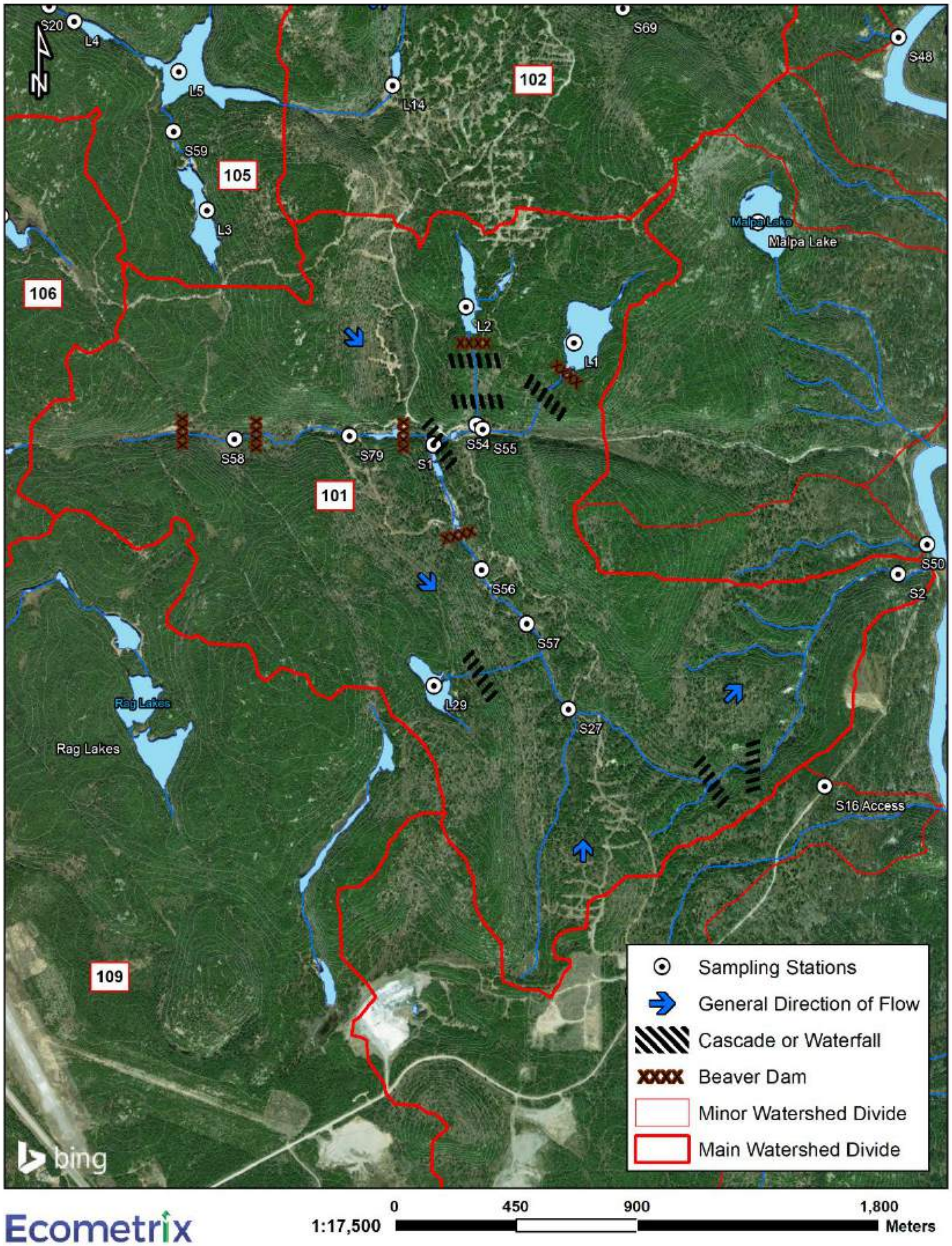

Figure 2-3: Subwatershed 101 aquatic sampling stations

(Cu) all exceeded the severe effect level[5] (SEL) in at least one of the samples whereas total phosphorus (TP), arsenic (As), iron (Fe), cadmium (Cd), lead (Pb), nickel (Ni) and zinc (Zn) all exceeded the lowest effect level (LEL) in L1, L2 or L29. S1 sediment exceeded the LEL for TP, TOC, Cu, Fe, Ni and Zn whereas only TOC was above the LEL in the Golder sample from Station S2.

Multi-season passive and active fishing efforts in the headwater lakes (i.e., L1, L2 and L29) within the Stream 1 watershed resulted in the capture of no fish. There are several possible reasons for no fish present within these lakes. There is likely limited overwintering habitat in these lakes and in L2 and L29 in particular. In addition, oxygen depletion in the hypolimnion of L1 suggests that suitable fish habitat may be limited to the littoral zone of the epilimnion during much of the summer months. All three lakes are situated at the top of fairly steep gradients, which impedes fish colonization from downstream source populations. Overall, it is probable that a lack of overwintering habitat, combined with downstream barriers (to upstream fish movement) in the form of natural topography, likely account for the absence of fish in these lakes.

No fish were collected within the most upstream reaches of Stream 1 (Stations S54, S55, and S58). Fish were captured at S1 and the extent of upstream fish inhabitation was documented in June 2011 (i.e., S79). At Station S79 and within the remaining upper 2nd order reaches, small baitfish species were present. Progressing downstream within the watershed, viable habitat for resident coldwater salmonids (i.e., Brook Trout) occurred in the mid-reaches, while a more diverse coldwater community including both resident and migratory salmonids were present within the lower reach. It is possible that natural barriers (e.g., low or intermittent flow, dams) to migration occur, which partition the fish communities into mid to upper versus mid to lower segments of the watercourse. At the outlet of Stream 1 to the Pic River, there is a perched culvert that impedes the upstream movement of fish during non-freshet flows.

2.2.2 Subwatershed 102 Summary

Figure 2-4 provides a map of the subwatershed 102 (Stream 2) aquatic sampling stations.

Similar to the subwatershed 1, there were a variety of benthic invertebrates identified in the samples from a wide range of taxa including worms, leeches, amphipods, mayflies, stoneflies, caddisflies, beetles, midges, clams and snails. The different habitats (lakes and ponds versus stream stations) resulted in expected differences in the community

[5] Lowest effect level (LEL): A level of contamination which has no effect on the majority of sediment dwelling organisms; and Severe effect level (SEL): A level of contamination considered detrimental to sediment dwelling organisms.

composition. Stations L8, L14 and L15 were classified as having fair water quality

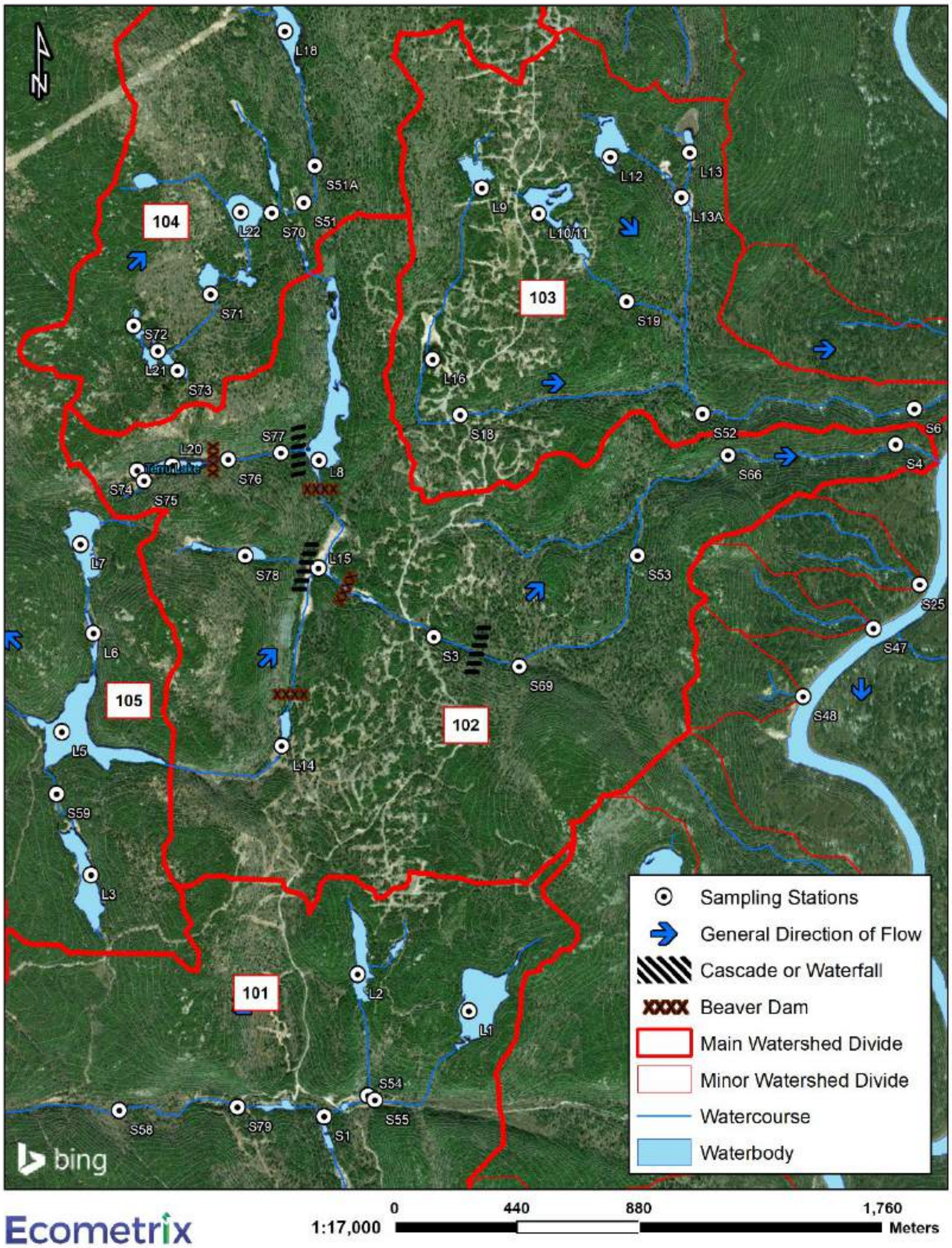

Figure 2-4: Subwatershed 102 aquatic sampling stations

according to the Hilsenhoff Biotic Index, whereas Station L20 (Terru Lake) was classified as having fairly poor water quality.

The quantitative benthic macroinvertebrate samples collected at S3 and S4 by Golder had wide ranging densities with the upstream station having higher densities (i.e., 258 to 753 invertebrates/m^2), Simpson's Diversity (i.e., mean 0.85), and taxa richness (i.e., mean 15) compared to the downstream station. Sensitive species such as mayflies (Ephemeroptera), stoneflies (Plecoptera) and caddisflies (Trichoptera), collectively know as the EPT taxa, were prevalent at the both the upstream and downstream stations but were generally absent in the mid-reach between S3 and S4. According to the Hilsenhoff index, the water quality was very good to excellent in the middle and lower reaches.

Sediment samples collected by NAR (2007) from the majority of the waterbodies within subwatershed 102 found a number of parameters exceeding the PSQG. TKN and TP exceeded the SEL in L8 and L15 and TOC exceeded the SEL in L8. Copper exceeded the SEL in L15 and exceeded the LEL in L8 and L14. Pb and Ni exceeded the LEL in L*, L14 and L15 whereas CD only exceeded the LEL in L8 and Zinc only exceeded the LEL in L8. Sediment samples from the stream stations (i.e., S3 and S4) had fewer parameters exceed the PSQG. TOC and Ni exceeded the LEL at both stations, whereas Cu exceeded the LEL at S3 only. TP and Fe exceeded the SEL. All other parameters were below the PSQG.

Terru Lake at the headwaters of the Stream 2 watershed was fishless. The pH in Terru Lake was relatively low (in the 4.0 to 5.5 range) in 2009, and may in part explain the absence of fish. Additional pH measurements taken in 2011 indicated Terru Lake had an acceptable pH at that time. Terru Lake is relatively deep and may provide overwintering habitat, though reduced oxygen at depth and below winter ice was measured, which may indicate at least the possibility of winter-kill due to oxygen deprivation. Beaver activity, topography and low flows in connecting channels also likely impede upstream migration of fish into Terru Lake.

In the middle portion of the watershed (i.e., Stations L14 and L15) only one or two species were captured. L15 contained only Brook Stickleback. Both Lake Chub and Brook Stickleback were collected in L14; however, only a single Lake Chub was captured.

No fish were captured in the beaver pond west of L15 during the 2020 supplement fishing effort. This is likely the result of the natural topography that serve as a barrier to upstream fish migration. All stream stations from L15 proceeding downstream supported fish. Station S3, the most upstream location, only contained Brook Stickleback. At the downstream end of this station (S3), there was a significant natural barrier to upstream migration in the form of a waterfall. This barrier, as well as other topographic barriers which occur downstream, likely contributes to the lack of species diversity encountered in the upstream reaches of the watershed compared to the downstream reaches. The middle reaches of Stream 2 (Stations S53 and S69) support a resident coldwater fishery that includes Brook Trout (S53 and S69) and Slimy Sculpin (S53). The presence of Rainbow Trout at S53 indicates that this area has connectivity with the lower reaches and the Pic River. Within the lowest reaches, upstream of the confluence with the Pic River (S4), Stream 2 supports a diverse fishery. Three surveys (September 2007, May 2009, and August 2009) have occurred at this location and 10 species of fish have been collected including Rainbow Trout, Chinook Salmon, Brook Trout, Lake Chub, Finescale Dace, Longnose Dace, White Sucker, Trout-perch, Brook Stickleback and Slimy Sculpin. This tributary affords potential coldwater spawning and nursery habitats for resident species (i.e., Brook Trout, Slimy Sculpin) as well as migratory species (i.e., Rainbow Trout, Chinook Salmon).

2.2.3 Subwatershed 103 Summary

Figure 2-5 provides a map of the subwatershed 103 (Stream 3) aquatic sampling stations.

Subwatershed 103 (Stream 3) watershed benthic invertebrate community was composed of a variety of taxa from a wide range of groups including worms, chironomids, leeches, amphipods, mayflies, stoneflies, caddisflies, beetles, midges, clams and snails. The different habitats (lentic stations versus stream stations) resulted in expected differences in the community composition. The collected samples classified all stations as having fair water quality according to the Hilsenhoff Biotic Index with the exception of S18 which had good water quality. Quantitative samples collected at Stations S19 and S6 by Golder (2009) had wide ranging densities within the upper reach (S19), having higher densities compared to the downstream reach (S6). Mean taxa richness was more than twice as high in the S19 samples compared to the downstream S6 samples. The downstream station had a higher Simpson's Diversity and higher Evenness compared to the upper reach station' however, this is likely a result of the low number of individuals collected downstream. Simpson's Diversity and Evenness were high and low respectively in L9, L13, L13a and L16 in 2009 (Table 3.12). EPT species were found in the upstream, mid-reach and downstream Stream 3 stations.

Sediment samples were collected in 2006 by NAR (2007) at L9, L10, L11, L12 and L16. Sediment samples were collected by Golder (2009) in 2007 at S19 and S6. In 2009, sediment samples were collected at L9, L13, L13a and L16. Samples from 2006, 2007 and 2009 resulted in a number of parameters exceeding the PSQG. TKN, TOC and Cu exceeded the SEL in the majority of the waterbodies within the watershed, whereas TP, Ni and Cd generally exceeded the LEL. There were also occurrences of As, Fe and Pb exceeding the LEL criteria.

Despite intensive fish surveys, including increased efforts in 2009, 2010 and 2011, all streams, lakes and ponds surveyed within upper and mid-reaches of the Stream 3 watershed have yielded no fish. The potential for re-population of this area from

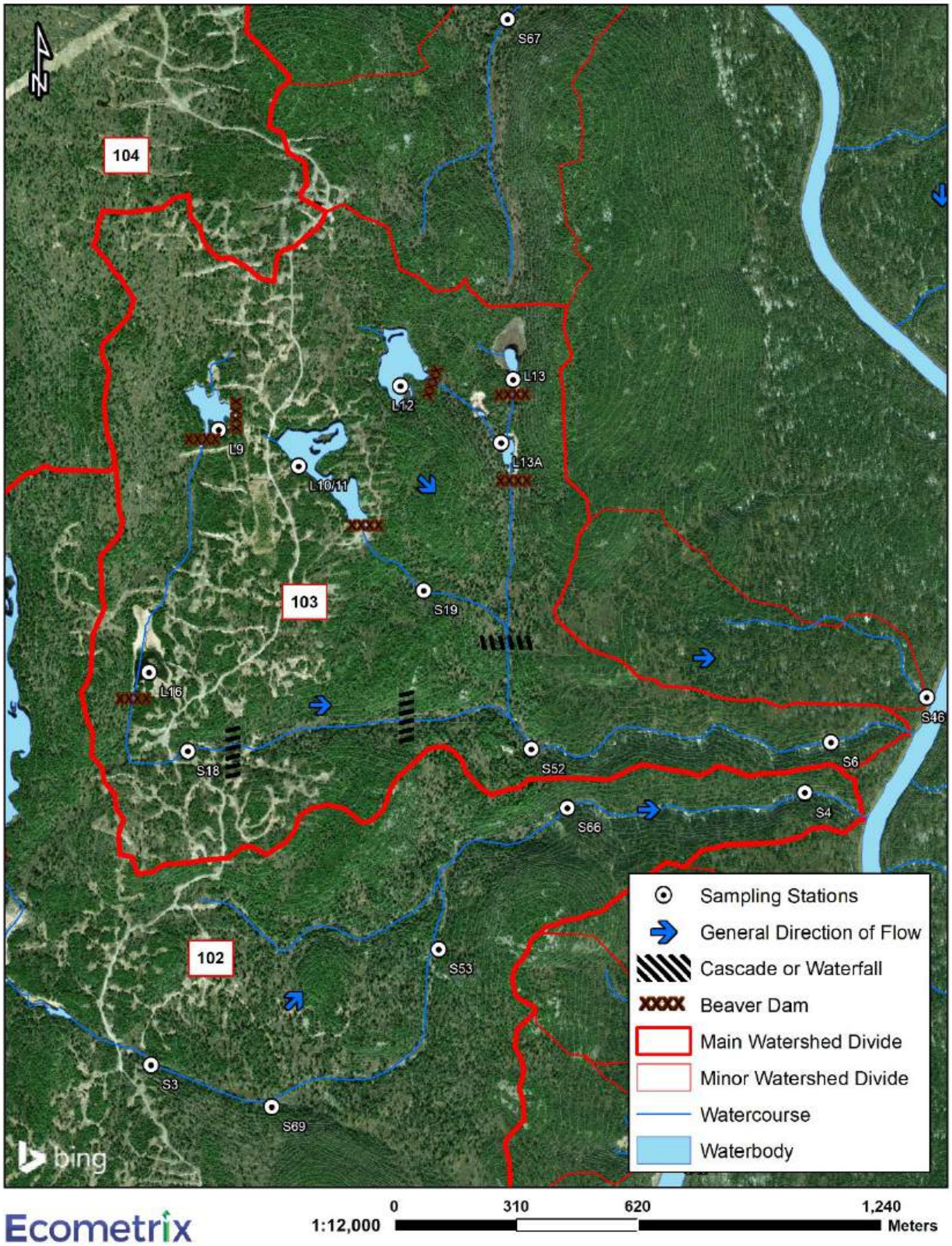

Figure 2-5: Subwatershed 103 aquatic sampling stations

downstream reaches is unlikely due to topographic barriers afforded by the steep relief as the watershed drains to the east towards the Pic River

Within the lower reaches, upstream of the confluence with the Pic River, Stream 3 (Station S6) supports a fairly diverse fishery. Three surveys (September 2007, May 2009, and August 2009) have occurred at this location and five species of fish have been collected including Rainbow Trout, Brook Trout, Longnose Dace, Slimy Sculpin and Johnny Darter. This lower reach of the tributary affords coldwater spawning and nursery habitat for a community of migratory and resident salmonids as well as other small (baitfish) species.

2.2.4 Subwatershed 104 Summary

Figure 2-6 provides a map of the subwatershed 104 (Stream 4) aquatic sampling stations.

The Stream 4 watershed benthic invertebrate samples indicated that a relatively diverse benthic community was present with representatives from a wide range of groups including worms, leeches, amphipods, mayflies, stoneflies, caddisflies, beetles, midges, clams and snails. The different habitats (lentic versus stream stations) resulted in expected differences in the community composition. The density of invertebrates varied among replicates and between waterbodies. Stream stations sampled by Golder (2009) exhibited similar taxa richness, with the upstream station having higher Simpson's Diversity and Evenness. Taxa richness in the lower reach was lower than in the middle and upper reaches. EPT taxa comprised a similar proportion of the community at the downstream and upstream stations (i.e., 42% and 31%) which was higher than in the mid-reach station (i.e., 11%). According to the Hilsenhoff Biotic Index, Stations L18, L19 (Claw Lake) and L21 had fairly poor water quality whereas L22 had fair water quality. The upper reach, mid-reach and lower reach stations (i.e., S51, S8 and S43) were classified as having very good, fair and good water quality, respectively according to the Hilsenhoff Biotic Index.

Sediment samples were collected in 2007 by Golder (2009) in L18, Claw Lake (L19), L21 and L22 and at S8 and S51. During the 2009 field season, a sediment sample was collected at S43 by EcoMetrix. Many sediment samples from both 2007 and 2009 resulted in a number of parameters exceeding the PSQG. TOC exceeded the SEL in all lakes except L18, whereas Cu exceeded the SEL in L18 and Claw Lake and the LEL in L22. Cd and Ni exceeded the LEL in L18, Claw Lake and L22. At all three stream stations, Ni exceeded and Cu was equal to or exceeded the LEL. In the upstream and downstream stations, TP exceeded the SEL and LEL, respectively, whereas TOC exceeded the LEL in the upper and mid-reach stations. Zn, As and Fe also had exceedances in the Stream 4 watershed.

No fish were captured upstream of a waterfall located at Station S51a (i.e., Stations S51, L21, L22 and all connecting tributaries). This could possibly be a result of low pH in some of the areas of the upper watershed (i.e., pH of 4.4 in L21). However, water quality was

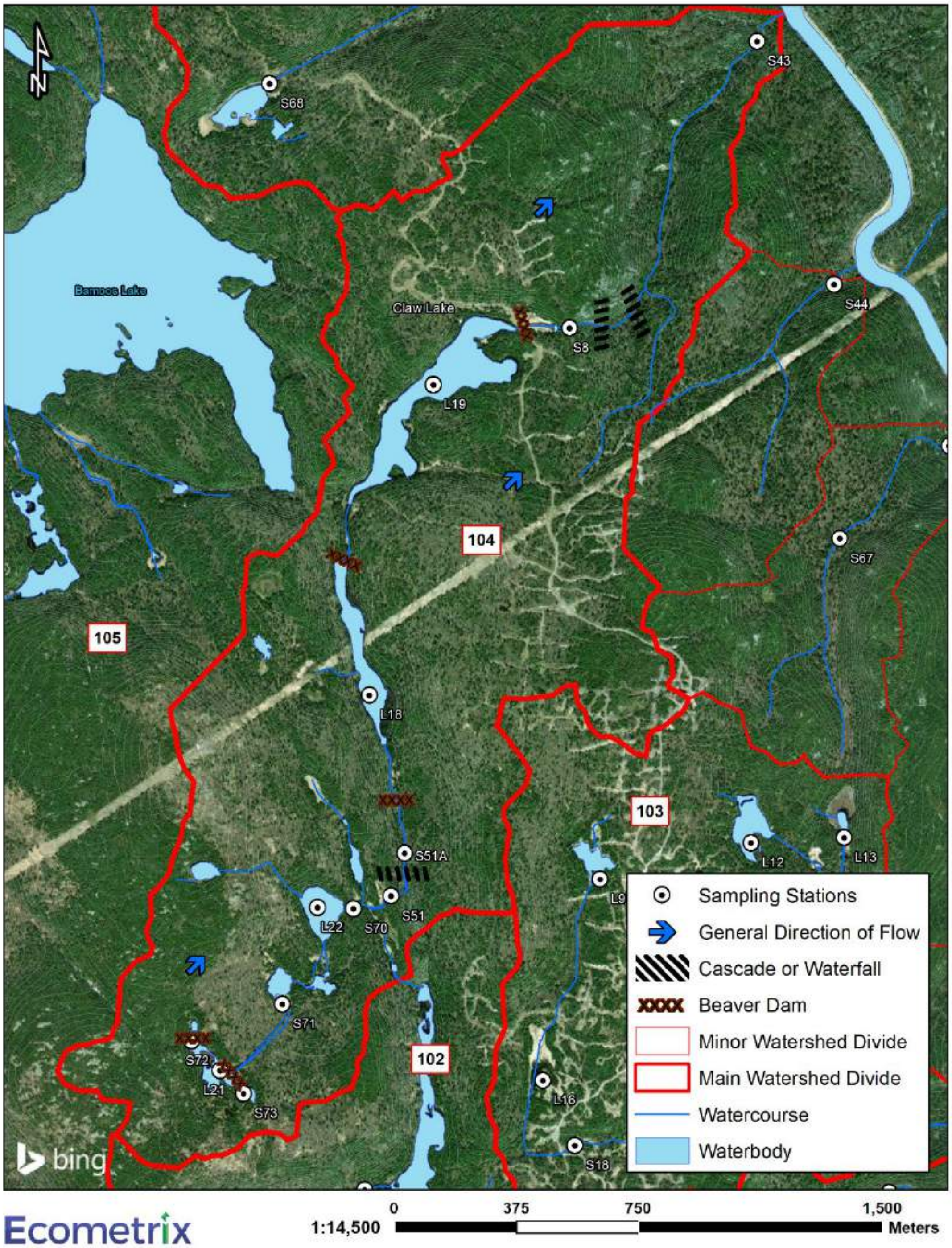

Figure 2-6: Subwatershed 104 aquatic sampling stations

suitable in L22 at the time of the survey suggesting that a lack of overwintering habitat, combined with downstream barriers in the form of beaver dams and/or natural topography such as the waterfall at the downstream end of S51A, likely account for the absence of fish. Stations L18 and L19 and the mid-reach of Stream 4 (S8) supported a variety of fish species including Blacknose Shiner, Finescale Dace, Fathead Minnow, Longnose Sucker, Brook Stickleback, Lake Chub, and Northern Redbelly Dace. The extremely steep cascades within the mid-reaches of Stream 4 may impede upstream migration of fish from the lower reaches.

Within the lower reaches, upstream of the confluence with the Pic River, Stream 4 (S43) supports a diverse fishery. Two surveys (May 2009, August 2009) resulted in the capture of nine species including Rainbow Trout, Brook Trout, Chinook Salmon, Finescale Dace, White Sucker, Trout-perch, Brook Stickleback, Slimy Sculpin and Johnny Darter. This lower reach of the tributary affords potential coldwater spawning and nursery habitat for both migratory and resident salmonids as well as other small (baitfish) species.

2.2.5 Subwatershed 105 Summary

Figure 2-7 provides a map of the subwatershed 105 (Stream 5) aquatic sampling stations.

In 2009, quantitative benthic samples were collected from five littoral and five profundal zone sites in Bamoos Lake and Hare Lake and a semi-quantitative sample was collected from S41 on Bamoos Creek. Five replicate quantitative samples were also collected at S11 in September 2011. Additionally, in 2011, semi-quantitative samples were collected at lentic stations L25, L27 and stream stations S20, S60, S61 and S62. Previously, samples were collected by NAR (2007) at L3, L4, L5 (Canoe Lake), L6 and L7 in 2006 and by Golder (2009) in 2007 at Stations S9, S10, S11 and L17. Benthic samples were collected at five replicate stations at S30, Hare Creek downstream of the Hwy 17 crossing, with a standard Surber sampler fitted with a 500 micron mesh net in 2013. The NAR sample from L4, L5, L6, and L7 and the 2009 littoral zone samples from Bamoos Lake and Hare Lake classified the water quality as fair.

The Hilsenhoff value classified L17 water quality as poor and L25, L27, L3 and Bamoos and Hare Lake profundal areas as fairly poor. The water quality of the outlets of a number of the headwater ponds were classified as poor to fair, whereas farther downstream, the Hilsenhoff values classified the water quality as good to very good.

A wide variety of invertebrates were collected at the stream stations in 2007, 2009, 2011 and 2013. S9, S10, S11 and S41 were dominated by EPT taxa, whereas the headwater stations S60, S61 and S62 were dominated by chironomids.

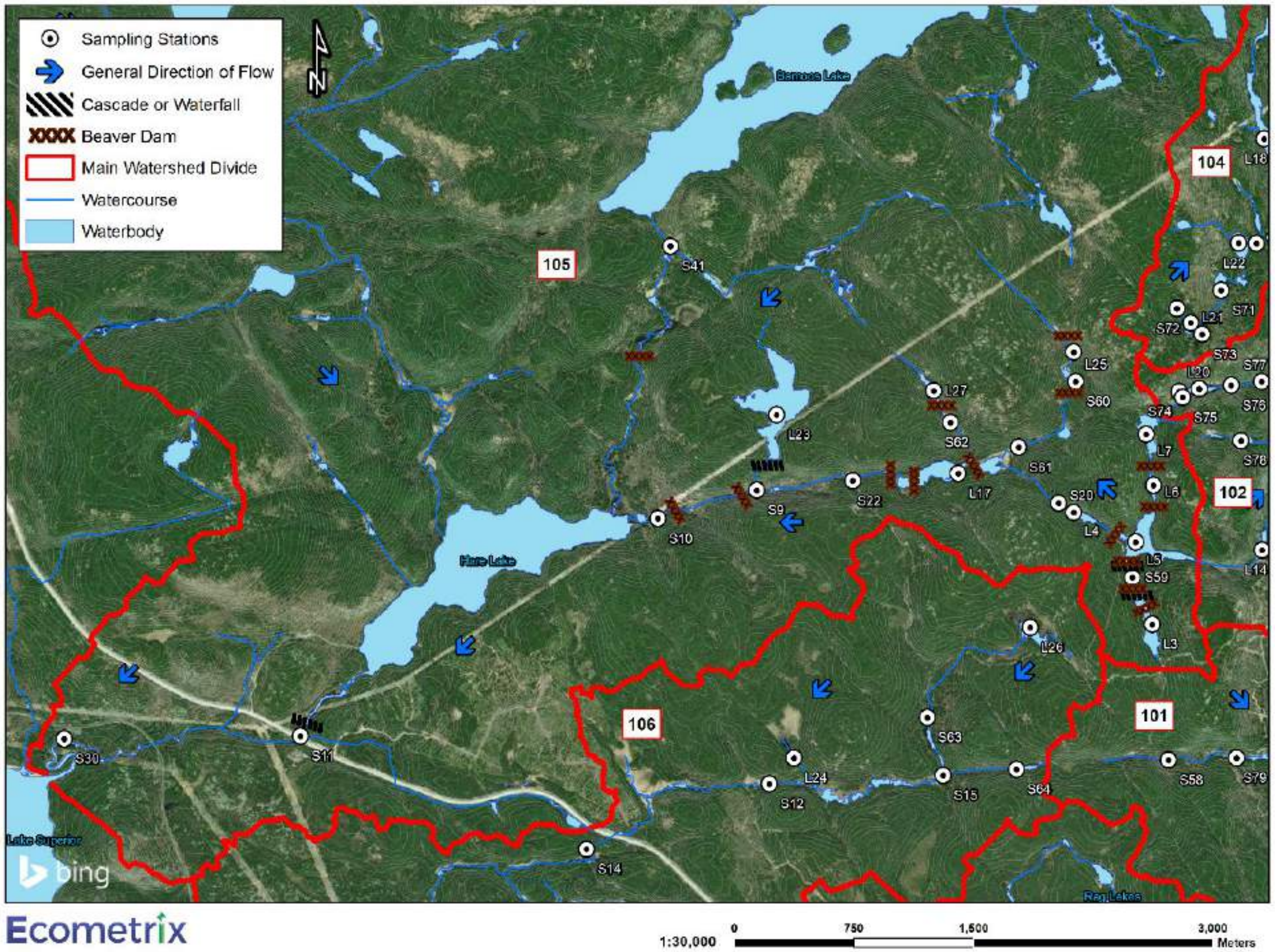

Figure 2-7: Subwatershed 105 aquatic sampling stations

S20 had a fairly even split in dominance between chironomids and EPT taxa. Mollusks (predominantly sphaeriid clams), oligochaetes, and leeches also comprised substantial proportions of most stream station benthic communities. Total taxa numbers at S30 were on the order of 50 with the EPT taxa comprising about 80% of total density. In both Bamoos and Hare Lakes, the littoral zone benthic samples were more diverse and generally had higher densities than the profundal stations. In both lakes, dipterans and sphaeriids dominated the benthic communities in both littoral and profundal zones with a number of other groups comprising smaller proportions of the community. Simpson's Diversity was moderate to high at all stations within the watershed and Evenness was generally moderate. Within Canoe Lake and surrounding stations (i.e., L3, L6 and L7) the community was diverse with family level richness ranging from 10 to 21.

Sediment samples were collected coincident with the benthic sampling in Bamoos and Hare Lakes and Bamoos Creek (S41) in 2009 and additionally at L4, L25 and L27 in 2011. Sediments were previously collected in L3, L5, L6 and L7 by NAR in 2006 and in L17 and at S9, S10 and S11 by Golder in 2007. Many samples resulted in a number of parameters exceeding the PSQG. TOC and TP exceeded the LEL at all sampled stations except S11. TKN exceeded the LEL or SEL at all stations. Mean Cu exceed the LEL in both the littoral and profundal areas of both Bamoos and Hare Lakes and for the samples from L3, L5, L7 and S41. Cd exceeded the LEL in all of the lentic stations except for the Bamoos littoral zone. Other parameters that exceeded the LEL in the Stream 5 watershed were As, Fe, manganese (Mn), Pb, Ni and Zn.

The small headwater basins within the Hare Lake watershed support no fish or sustain a very limited community. The western portion of watershed headwaters at Station L7 supported only a single coolwater species (Lake Chub) in abundance, whereas Station L3 was fishless. The pH in L3 was relatively low (in the 4.0 to 5.5 range) in 2009, and may in part explain the absence of fish. Additional pH measurements taken in 2011 confirmed the low pH in L3. L3 and L7 are both relatively deep and may provide overwintering habitat, though reduced oxygen at depth and below winter ice was measured at both, which may indicate at least the possibility of winter-kill due to oxygen deprivation. Beaver activity, topography and low flows in the connecting channel also likely impede upstream migration of fish into L3. Proceeding downstream Canoe Lake and Station L6 appear to only support Lake Chub, whereas Station L4 and L17 contained Lake Chub and Brook Stickleback. Stations L23, L25 and L27 were fishless, as were their downstream tributaries (Stations S60, S61 and S62). These headwater basins and tributaries are probably fishless due to a lack of overwintering habitat, combined with barriers in the form of beaver dams and steep gradients, which impede re-colonization from downstream. Within the mid-reach of Stream 5, only Brook Stickleback have been collected (i.e., S22 and S9). Within the lower reach (S10), just upstream of Hare Lake, a resident cold/coolwater community existed including Brook Trout and Brook Stickleback. Bamoos Creek between Bamoos Lake and

Hare Lake (S41) supported a resident coldwater fish community including Slimy Sculpin and Brook Trout.

Bamoos Lake supports a diverse cold/coolwater community. Twelve species were captured during the 2009 survey including Lake Trout, Brook Trout, Cisco, Slimy Sculpin, Longnose Sucker, White Sucker, Trout-perch, Brook Stickleback, Ninespine Stickleback, Lake Chub, Finescale Dace and Fathead Minnow with two additional species, Lake Whitefish and Burbot reported, according to MNRF records.

Hare Lake provides coldwater habitat; however, the extensive 2009 and 2011 fish surveys indicated that the majority of the community is composed primarily of coolwater species, with only low numbers of coldwater thermal guild fish species present. The species captured in 2009 included Northern Pike, Cisco, Burbot, Yellow Perch, Spottail Shiner and Logperch. In 2011, a single Lake Trout and low numbers of Trout-perch, Spoonhead Sculpin and Longnose Sucker were captured in Hare Lake increasing the total species captured to ten. Historic records also report Fathead Minnow being present and Walleye stocking in the lake. Extensive fishing efforts in 2009 and 2011 did not result in the capture of either of these two species.

Hare Creek downstream of Hare Lake was surveyed at two locations, below the Hwy 17 crossing (S11) and upstream of the outlet to Lake Superior (S30). Both surveys indicated that the lower portions of Hare Creek support a relatively diverse coldwater fish community including both migratory and resident salmonid species. The fish community in lower Hare Creek includes: Rainbow Trout, Chinook Salmon, Brook Trout, Brook Stickleback, Slimy Sculpin, Rainbow Smelt, Longnose Dace, Longnose Sucker, Ninespine Stickleback and Mottled Sculpin. The lower reaches of Hare Creek afford spawning and nursery habitat for both migratory and resident coldwater fishes.

2.2.6 Subwatershed 106 Summary

Figure 2-8 provides a map of the subwatershed 106 (Stream 6/Angler Creek aquatic sampling stations.

EcoMetrix collected benthic samples at stations S12, S15 and S42 within Stream 6/Angler Creek) to compliment the sample collected in the headwaters at S63 in 2007. Five replicates samples were collected via Ekman grab at S31, the lower reach near Lake Superior, in 2013. Station L26, which is situated at the headwaters of Stream 6, was sampled during the 2009 study and L24 was sampled in June 2011. Chironomids were the dominant taxa in both L24 and L26. At S31, invertebrate density was, on average, low (< 100 animals/m^2). At S12 and S63, EPT taxa were most common. Annelids and ostracods dominated the S15 benthic community. At S42, near the power transmission lines, chironomids and clams were the principal components of the benthic invertebrate community. Generally, chironomids, annelids and mollusks were more prevalent in slower sections of Stream 6 and in L26 and L24 compared to the areas where there were coarser substrates. In general, the Simpson's Diversity and Evenness values indicated diverse communities that were dominated by a limited number of taxa. The water quality was categorized as excellent at the headwater stream stations to fair downstream according to the Hilsenhoff Biotic Index.

A limited number of parameters exceeded the LEL in sediment samples. In the upper portion of the creek (S15), TKN and TOC both exceeded the LEL value. Farther downstream (S12), TP, TKN, TOC and Fe exceeded the LEL. At S42, only TKN exceeded the LEL. In L24 and L26, TP, TKN and TOC exceeded the LEL, SEL and LEL values, respectively. In addition, Cd also exceeded the SEL value in L26. No sediment samples have been collected at S31 or S14 to date.

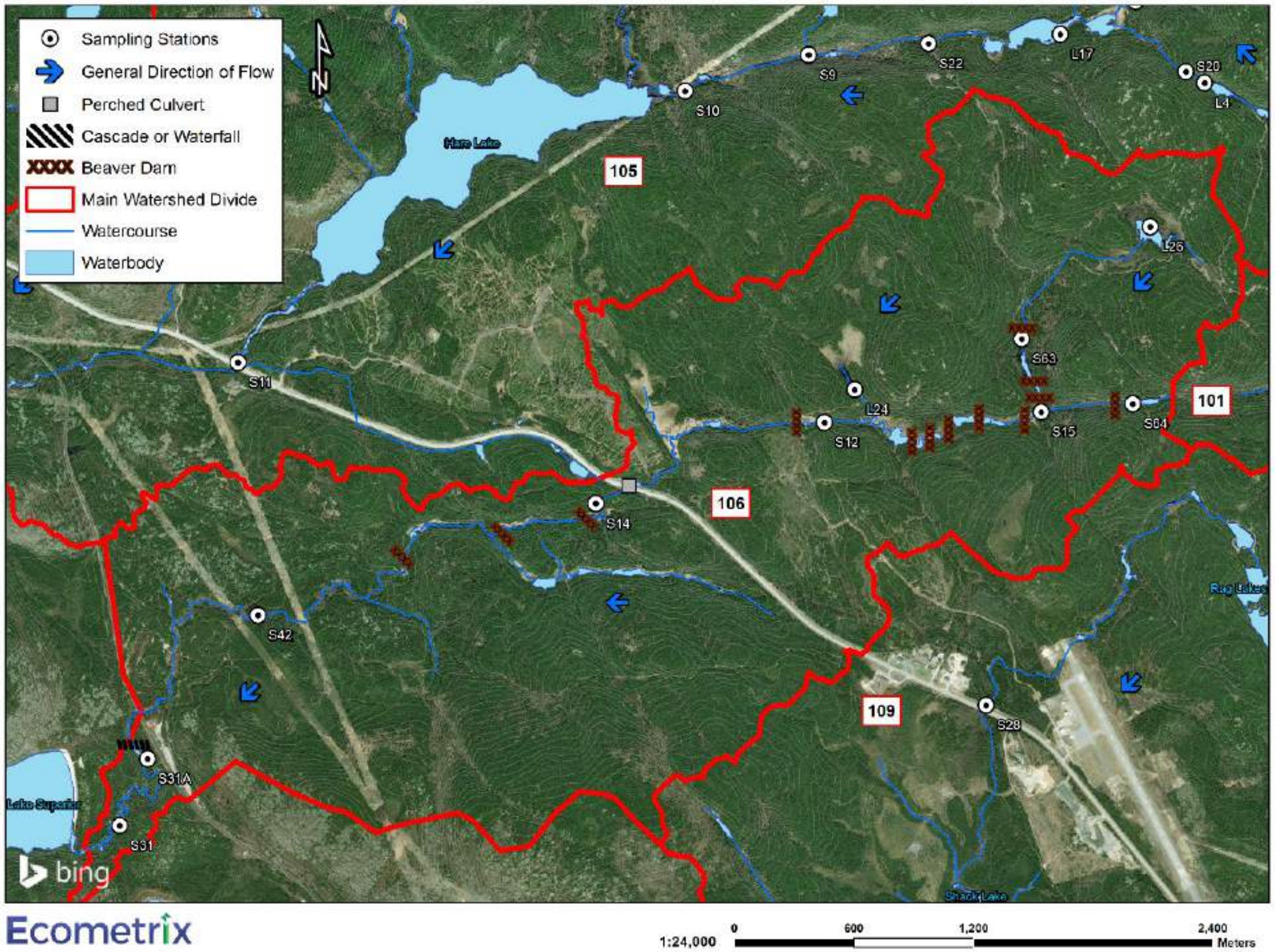

Figure 2-8: Subwatershed 106 aquatic sampling stations

Multiple fisheries surveys of L26 during 2009, 2010 and 2011 have resulted in no fish being collected. Backpack electrofishing at L24 in 2010 and 2011 indicates that it does not support fish. Only Brook Stickleback have been collected at Stream 6 stations upstream of

the cascade/falls which occurs in the lower reaches. Possible explanations for such a limited fish community in the upstream reaches and headwater lakes include acidity (low pH), a lack of overwintering habitat, low flows and barriers (including beaver dams and cascades). Angler Creek, at Station S14, below the Hwy 17 crossing there were a number of cascades that would be impediments to upstream fish passage. The cascade/waterfall which occurs in the lower reach upstream of S31 prevents migrating Lake Superior species from getting past that point under essentially any flow conditions.

Within the lowest reaches, upstream of the outlet to Lake Superior, a limited number of salmonids were captured in 2009. In total, four species were collected including Rainbow Trout, Chinook Salmon, Longnose Dace and Mottled Sculpin. This reach of Stream 6 provides a limited amount of nursery and spawning habitat for migratory coldwater species from Lake Superior as well as some other small-bodied species. The quality of this lower reach for nursery and spawning habitat is reduced compared to other tributaries in the area due to the primarily sandy substrates compared to more productive habitats which are typically comprised of coarser substrates (i.e., gravel, cobble).

2.2.7 Subwatershed 109 Summary

Figure 2-9 provides a map of the subwatershed 109 (Shack Creek/Stream 7 aquatic sampling stations.

Shack Creek/Stream 7/subwatershed 109 is mostly outside of the planned mine development area and is unlikely to be impacted by mine activities. The headwater Rag Lakes and man-made Shack Lake, have historically been coldwater Brook Trout lakes. No recent surveys of the Rag Lakes have been completed so the current state of the fishery in these lakes is unknown. Shack Lake, although historically a coldwater lake, has appeared to have transitioned to a coolwater lake dominated by Yellow Perch, and no attempts to manage it as a coldwater fishery have been made.

Within its lower reaches, Shack Creek provides spawning and nursery habitat for migratory and resident salmonids, other migratory Lake Superior fish and some resident small-bodied species.

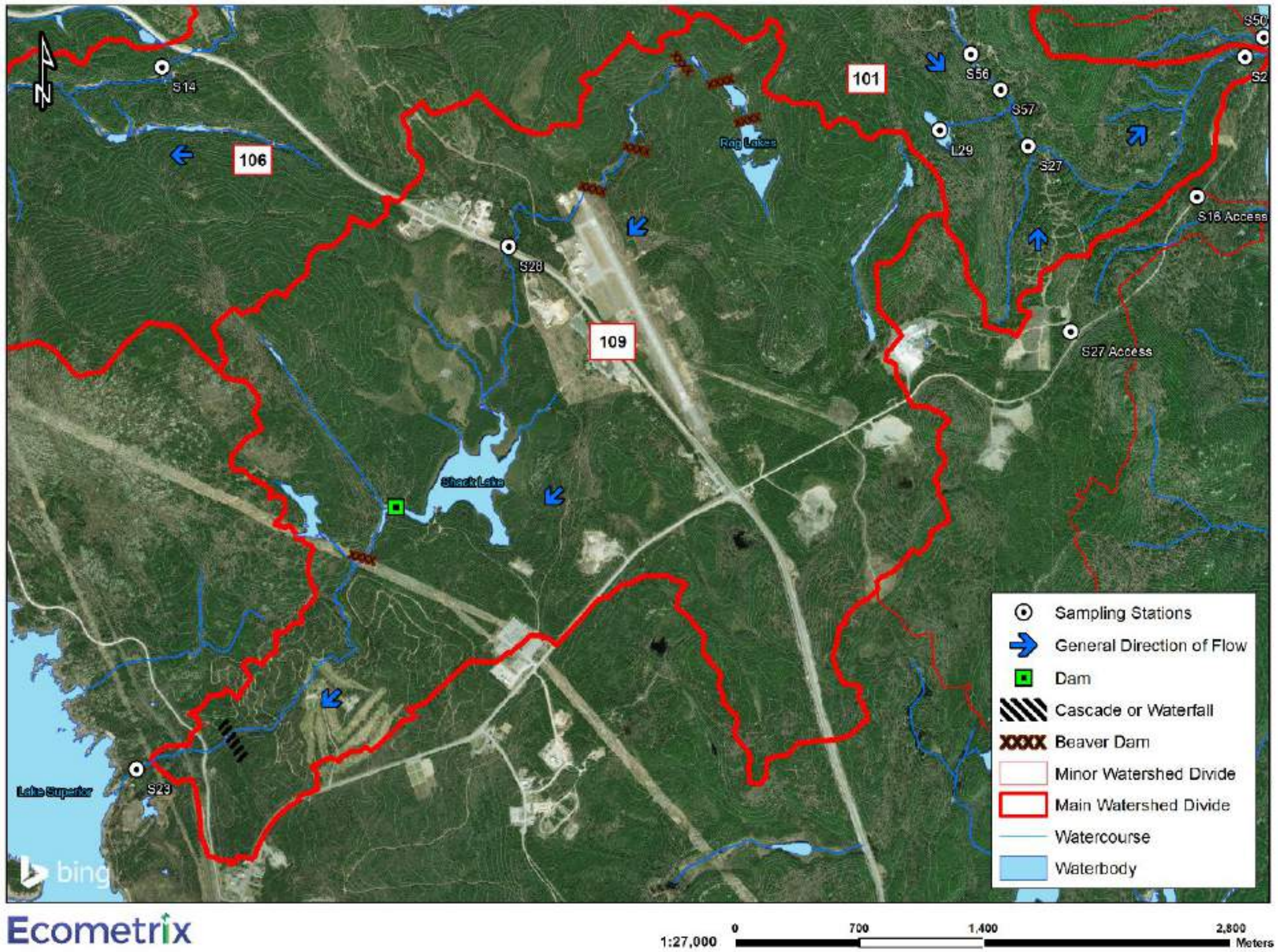

Figure 2-9: Subwatershed 109 aquatic sampling stations

2.2.8 Pic River and Small Tributaries Summary

There are a number of small tributaries of the Pic River within the vicinity of the Project Area (Figure 2-10). Many are 1st order streams with total stream lengths of 1 km or less. Most rely on precipitation runoff as a primary source of flow and have been determined to be intermittent in nature. Five of these watercourses only flow during part of the year, typically during the spring freshet and after significant rainfall events, and have severely limited fisheries habitat potential. Surveys of these creeks were based on the flow conditions encountered during the survey periods and have been discussed accordingly.

A benthic sample was collected in Malpa Lake in 2006 by NAR (2007) that classified the benthic community as fair despite the lake having the lowest number of taxa of any of the lakes sampled within the Project Area. Benthic samples were collected in 2009 at S24, S32, S44, S45 and S46. The water quality in these tributaries ranged from fairly poor to good based on the Hilsenhoff value. EPT taxa dominated the communities in S32, S44 and S46, whereas chironomids were dominant in S24 and S45. The community differences likely result from the variability of substrates encountered at these stations, some of which were predominantly fine sediments and others that were mainly coarse materials. A number of other invertebrate groups were collected including annelid worms, tipulid midges, dixid flies, mites, ostracods and springtails.

A 2006 sediment sample from Malpa Lake resulted in eight parameters (i.e., TKN, TOC, TP, Cd, Cu, Pb, Ni, Zn) exceeding the LEL or SEL. In 2009, sediment samples were collected at S24, S32, S44, S45 and S46. At S32, sediment quality exceeded the LEL for TP, TKN, Cu, Fe and Ni. TKN was equal to or exceeded the LEL at S24, S44 and S46. TOC also exceeded the LEL at S44. All other parameters at these stations met the PSQG and no parameters exceeded provincial guidelines at S45.

Of all of the Pic River Tributaries which appeared to have some fisheries potential, fish were only collected in one. The presence of Rainbow Trout fry at Station S32 indicates that this tributary affords potential (albeit limited) coldwater spawning and nursery habitat. Overall, the value of these small streams from a fish habitat perspective is considered minimal as flows are dependent on the amount of precipitation, and salmonid spawning habitat is relative scarce due to the paucity of coarse substrates in most of the tributaries.

Golder (2009) collected benthic samples in three areas of the Pic River in 2007. The Simpson's Diversity was moderate for all three areas. Evenness was moderately high in the adjacent and downstream areas but low in the upstream area. Density ranged widely between areas. Invertebrate density in the upstream area was an order of magnitude higher than in the other two areas. Dominant taxa were chironomids upstream, annelids adjacent to and biting-midges downstream. EPT taxa were identified in all three areas but the number of taxa was low throughout all areas. The Hilsenhoff Index values classified the water as fairly poor in upstream and adjacent areas and good in the downstream area.

TOC was the only key parameter that exceeded the PSQG, exceeding the LEL of 1% in all three areas sampled on the Pic River.

The fish community of the Pic River is diverse, with a variety of coolwater and coldwater fish species reported including Lake Sturgeon, Walleye, Longnose Sucker, Silver Redhorse, Muskellunge, Trout-perch, Spottail Shiner, Northern Redbelly Dace, Rainbow Trout, Coho Salmon, Chinook Salmon, Brook Trout, Rainbow Smelt, Northern Pike, White Sucker and Shorthead Redhorse.

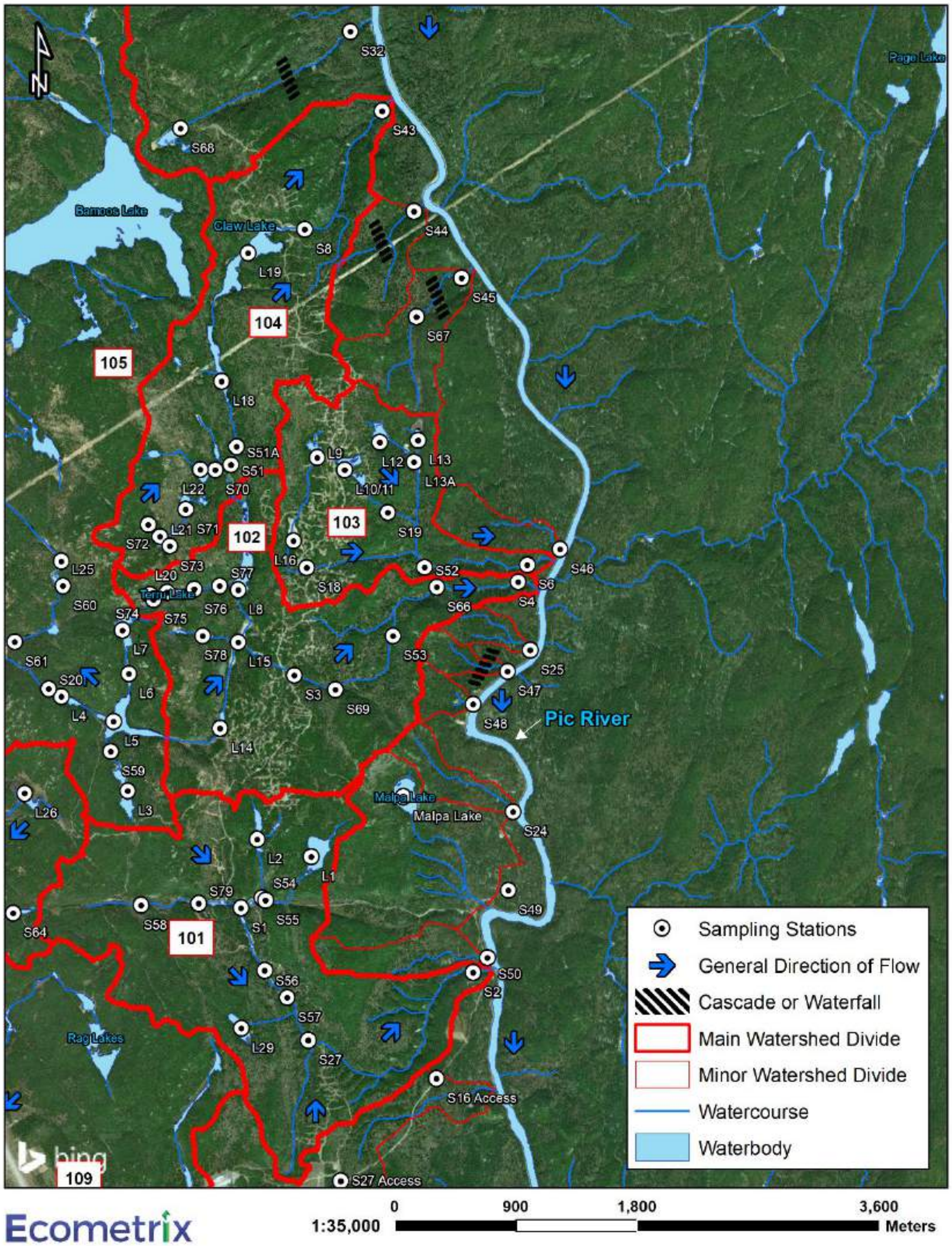

Figure 2-10: Pic River and small tributary aquatic sampling stations

2.2.8.1 Metal Levels in Fish Tissues in the Pic River

Fish were netted in the Pic River in the vicinity of the Project site in August 2013 (in the vicinity of S4). Five individual Walleye (*Sander vitreus*) were retained. Boneless, skinless fillets and livers were dissected from the fish and analyzed for metal contents. The results of these analyses are provided below in **Table 2.1** (fillet) and **Table 2.2** (liver).

Table 2.1: Metal concentrations in Walleye fillets (5)- Pic River, Aug. 2013 (mg/kg wet weight)

Constituent	Min (mg/kg wet weight)	Max (mg/kg wet weight)	Mean (mg/kg wet weight)
Aluminum	<2.0	<2.0	<2.0
Antimony	<0.010	<0.010	<0.010
Arsenic	0.025	0.046	0.0324
Barium	<0.020	0.045	0.033
Beryllium	<0.10	<0.10	<0.10
Bismuth	<0.06	<0.06	<0.06
Cadmium	<0.006	<0.006	<0.006
Calcium	145	407	245
Chromium	<0.10	<0.10	<0.10
Cobalt	<0.02	<0.02	<0.02
Copper	0.129	0.285	0.171
Iron	1.7	2.4	2.0
Lead	<0.02	<0.02	<0.02
Lithium	<0.1	<0.1	<0.1
Magnesium	303	325	319
Manganese	0.097	0.200	0.165
Mercury	0.30	1.27	0.68
Molybdenum	<0.01	<0.01	<0.01
Nickel	<0.10	<0.10	<0.10
Phosphorus	2,290	2,540	2,400
Potassium	4,420	4,850	4,626
Selenium	0.22	0.28	0.25
Sodium	214	366	275
Strontium	0.026	0.071	0.046
Thallium	<0.01	<0.01	<0.01
Tin	<0.05	<0.05	<0.05
Titanium	<0.10	<0.10	<0.10
Uranium	<0.002	<0.002	<0.002
Vanadium	<0.10	<0.10	<0.10
Zinc	3.36	4.55	3.84

Table 2.2: Metal concentrations in Walleye livers (5) - Pic River, Aug. 2013 (mg/kg wet weight)

Constituent	Min (mg/kg wet weight)	Max (mg/kg wet weight)	Mean (mg/kg wet weight)
Aluminum	<2.0	14.3	<5.2
Antimony	<0.01	<0.10	<0.06
Arsenic	0.017	<0.10	<0.063
Barium	<0.02	<0.20	<0.12
Beryllium	<0.10	<1.0	<0.56
Bismuth	<0.06	<0.60	<0.34
Cadmium	0.079	0.401	0.232
Calcium	46.8	461	170
Chromium	<0.10	<0.10	<0.10
Cobalt	<0.11	<0.36	<0.20
Copper	0.95	2.43	1.66
Iron	15.1	81.1	39.5
Lead	<0.02	<0.20	<0.11
Lithium	<0.10	<1.0	<0.56
Magnesium	124	192	162
Manganese	1.12	1.90	1.63
Mercury	0.200	0.659	0.393
Molybdenum	0.109	0.215	0.166
Nickel	<0.10	<1.0	<0.56
Phosphorus	2,000	3,160	2,730
Potassium	2,170	3,030	2,584
Selenium	<0.7	<2.0	<1.4
Sodium	804	1,200	1,053
Strontium	0.020	0.176	0.104
Thallium	<0.01	<0.10	<0.06
Tin	<0.05	<0.50	<0.28
Titanium	<0.10	0.79	0.35
Uranium	<0.002	<0.020	<0.011
Vanadium	<0.10	<1.0	<0.56
Zinc	13.6	24.9	20.6

2.2.9 Lake Superior Summary

In 2009, quantitative benthic invertebrate surveys were conducted in both Port Munro (mouth of Stream 5/Hare Creek) and Sturdee Cove (mouth of Stream 6/Angler Creek). The dominant invertebrate groups in both cases were chironomids, ostracods, sphaeriids and tubificid worms, comprising 87 and 88% of the mean benthic communities in Port Munro and Sturdee Cove, respectively. Additional taxa included mites, amphipods, trichopterans, emphemeropterans, snails and isopods. Simpson's Diversity values indicated that the benthic communities were diverse at both locations. Evenness was moderate resulting from the small number of taxa dominating the communities.

Sediment samples collected coincident with the benthic surveys indicated that no parameters of concern exceeded the SEL and only a limited number exceeded the LEL at Port Munro. Mean values for TKN, TP, TOC and Cu exceeded the LEL and at least one sample replicate exceeded the LEL for Cd, Fe and Ni.

No mean parameter values exceeded the LEL for the Sturdee Cove sediment, although some analytes did result in individual replicate exceedances.

The nearshore embayments of Lake Superior provide habitat for a variety of fishes, including both coldwater and coolwater species. These embayments offer nursery habitats for many species including whitefish, salmon, trout and suckers. Spawning habitat for species such as whitefish is also likely present. In addition, many Lake Superior species migrate through the embayments to spawning tributaries which outlet to the lake including Hare Creek and Shack Creek.

2.2.10 Hare Lake

Hare Lake was seen as a key aspect of the development and the assessment of potential effects as it was proposed that effluent from the Process Solids Management Facility (PSMF) would be discharged to the lake. A stand-alone report was developed that collated all Hare Lake related information in response to SIR #5. This information is summarized below. Additional plankton information that was collected in 2014 is also provided for completeness.

2.2.10.1 Setting

Hare Lake is oriented northeast to southwest (upstream to downstream) and is approximately 2 km long by about 400 to 500 m wide on average. It is situated in the Stream 5 subwatershed. The subwatershed occupies an area of approximately 4,800 ha. Hare Lake receives inflows from Bamoos Creek and Stream 5, at the eastern end of the lake, as well as an unnamed creek originating from a group of lakes approximately 2 km to the north, discharging mid-lake. Hare Lake discharges to Hare Creek/Stream 5 at the western end, which crosses Highway 17 and outlets to Lake Superior approximately 3 km downstream at Port Munro.

2.2.10.2 Bathymetry

Hare Lake bathymetry is shown on **Figure 2-11**. The surface area of the lake is about 57 ha and the total lake volume is approximately 8.5 million m^3. The maximum depth of Hare Lake is approximately 30 m. Mean lake depth is approximately 15 m.

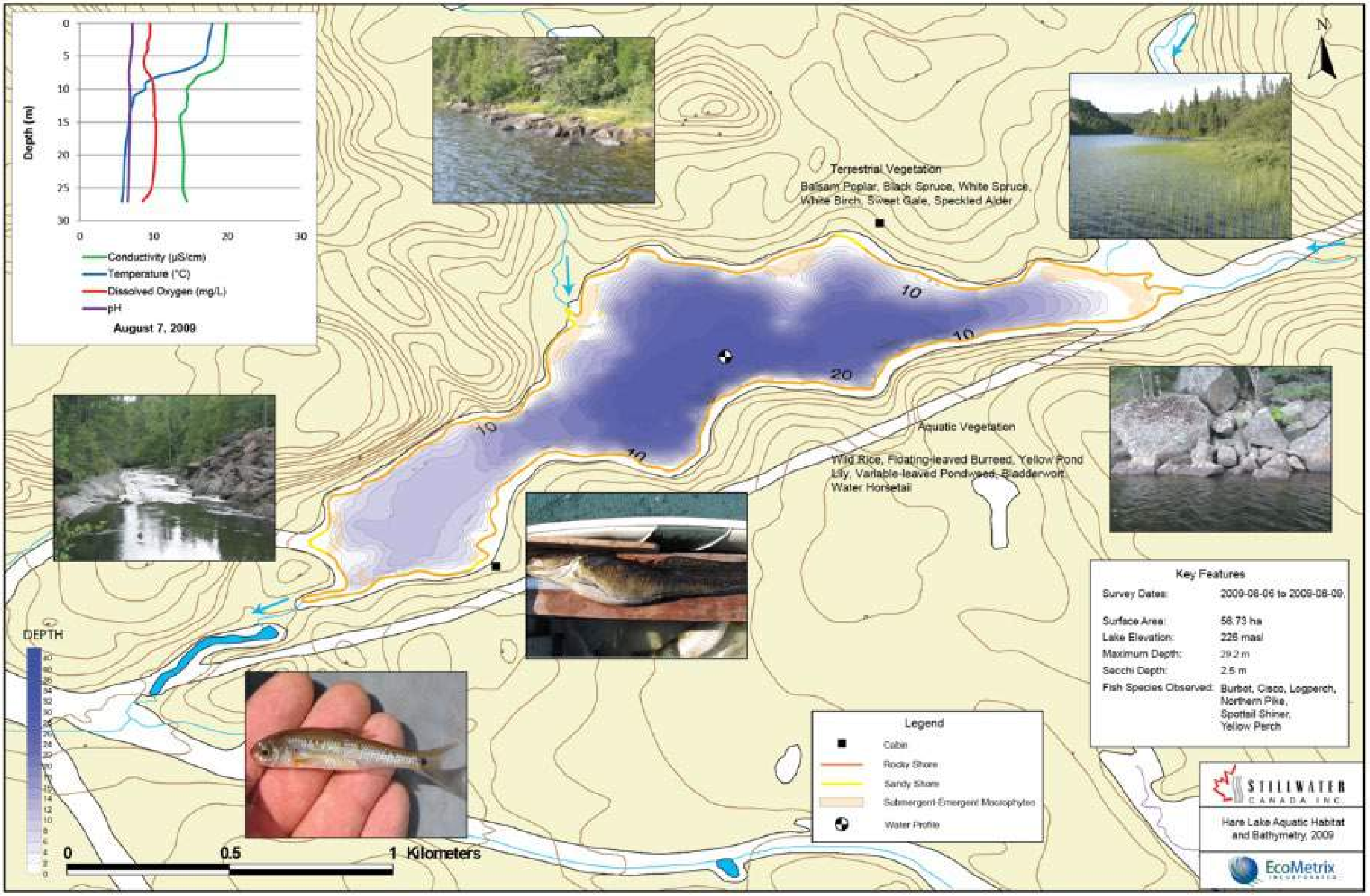

Figure 2-11: Bathymetry of Hare Lake (source; Supporting Information Document 3: Aquatic Resources Baseline Report For The Marathon PGM-Cu Project prepared by Ecometrix (July 2012)

2.2.10.3 Habitat Features

Hare Lake is characterized by a single basin which is situated mid-lake. Relatively long stretches of both the north and south sides of the lake shelve steeply and afford little in the way of littoral habitat. The majority of littoral zone habitat is isolated to the main inlet and outlet areas of the lake, as well as a couple of small embayments on both the north and south sides of the lake.

Bottom substrates in Hare Lake are primarily fine-grained organic silt (muck), with lesser amounts of boulder, bedrock, cobble, gravel, sand and detritus typically in nearshore areas.

Aquatic plant beds are limited to nearshore embayments and in particular at the main inlet and outlet areas of the lake. Observed aquatic macrophytes included wild rice (*Zizania palustris*), floating-leaved burreed, yellow pond lily, variable-leaved pondweed, bladderwort (*Ulticulaire* sp.) and water horsetail (*Equisetum fluviatile*).

The terrain surrounding the lake is quite steep along the northwestern and southeastern shores. The adjacent upland forest community is comprised of white spruce, black spruce, white birch, balsam poplar, sweet gale and speckled alder.

2.2.10.4 Hydrology

Subwatershed 105 drains approximately 4,800 ha and discharges to Lake Superior. Of this area, approximately 4,450 ha drains to Hare Lake.

The hydrograph of the system based on flow monitoring in the vicinity of the Hare Lake outlet is typical from streams in the area. Freshet flows occur in April and May, as well as June though to a lesser extent, and make up about half the cumulative annual flow. Stream flows decrease through the summer and then increase in October and November with fall precipitation. Winter baseflows occur January through March.

Retention time, based on annual average flows is in the order of 6 to 7 months.

2.2.10.5 Water Quality

The water in Hare Lake is circumneutral with pH on average about 7.5. Over the period of record pH ranged from 5.8 to 10.3. Sulphate concentrations averaged 3.4 mg/L and had a minimum concentration of 2.5 mg/L and a maximum concentration of 4.2 mg/L. TSS levels in Hare Lake were on average about 3.3 mg/L, though most measurements were in fact generally below the method detection limit (MDL) of 2 mg/L.

DOC averaged 6.4 mg/L, with minimum and maximum concentration of 4 mg/L and 9.7 mg/L, respectively.

Approximately two-thirds of the samples had phosphorus concentrations below the MDL (0.005 mg/L). For the remaining third the range was between 0.005 and 0.01 mg/L.

Nitrate (as N) averaged 0.12 mg/L, had a minimum concentration of 0.034 mg/L and a maximum concentration of 0.19 mg/L. TKN levels ranged from about 0.2 to 0.4 mg/L and were on average 0.26 mg/L. Ammonia concentrations ranged from below the MDL (i.e., 0.02 mg/L) to 0.04 mg/L.

Several analytes including arsenic, cadmium, cobalt, copper, lead, mercury, molybdenum, nickel and selenium were generally below their respective MDL.

Dissolved aluminum concentration ranged from 0.039 to 0.23 mg/L, with a mean of 0.088 mg/L exceeding the provincial water quality objective (PWQO) of 0.075 mg/L. Iron concentrations averaged 0.23 mg/L and ranged from 0.07 to 0.42 mg/L. Iron concentrations exceeded the PWQO of 0.3 mg/L on three occasions over the period of record. No other metals exceeded their respective PWQOs.

2.2.10.6 Temperature Regime

The temperature regime of Hare Lake fits the general conceptual model of a dimictic lake, based on seasonal and continuous temperature measurements taken over several years. Hare Lake circulates freely twice per year in the spring and fall and is directly stratified in the summer and inversely stratified in the winter (Wetzel, 2001). The general conceptual model of a dimictic lake, as it concerns water temperatures, is described briefly below, beginning the cycle in the summer months.

- In the summer, relatively high solar radiation input and warm air temperatures contribute to the warming of surface waters and the development of the thermal stratification of the water column. Winds tend to keep the surface water well-mixed, and this upper mixed region of the lake is called the epilimnion. Below the mixing action of the wind and the penetration depth of the solar radiation, a strong temperature and accompanying density gradient develops. This region of strong gradients is called the thermocline. Below the thermocline, a weaker temperature gradient is observed and the water is cool and comparatively quiescent. The bottom region of the lake is called the hypolimnion and the bottom water will have a temperature near 4°C, the temperature of maximum density of water. The strong density gradients in the thermocline inhibit exchange between the epilimnion and the hypolimnion. Thus, bottom water in a stratified lake does not actively interact with the atmosphere and can easily become deprived of important dissolved gases.

- As the air temperature gets cooler and the solar radiation input decreases in the fall, the surface water begins to cool. Eventually, the surface water and thermocline cool down to the temperature of the hypolimnion and the lake is no longer stratified. In this state, the lake can easily be mixed, even by a light wind; thus, the lake mixes, or in other words experiences a turnover event. This gives the bottom water an opportunity to aerate with the atmosphere.

- If the air temperature in the winter goes below 4°C so that the surface water can cool below this temperature, then the surface water becomes lighter than the bottom water and a so-called winter inverse stratification develops. The term inverse refers to the fact that the surface water is colder than the bottom water; however, the surface water remains less dense. When ice forms at the water surface, wind mixing is not possible and the winter density profile may not exhibit a well-defined thermocline. As the surface water heats up again in the spring, the lake will again reach a state of thermal homogeneity and, in the presence of a light wind, will turn over. As the surface waters become warmer, stratification sets in and the summer stratification state returns.

2.2.10.7 Sediment Quality

The substrate in the littoral and profundal zones were similar and was primarily composed of organic silt (muck).

Sediment quality in Hare Lake is summarized in **Table 2.3**. The data are provided relative to LELs and SELs.

For littoral zone samples, the mean of five parameters exceeded the LEL and one parameter's mean exceeded the SEL. TP (786 mg/kg), TOC (6.2%), Cd (1.4 mg/kg), Cu (21 mg/kg) and Zn (208 mg/kg) all exceeded the LEL criteria of 600 mg/kg, 1%, 0.6 mg/kg, 16 mg/kg and 120 mg/kg, respectively. TKN (5,622 mg/kg) exceeded the SEL of 4,800 mg/kg (Table 2.5-1). In addition, there were two samples at which Fe and Ni also exceeded the LEL criteria.

The profundal sediment samples had a larger number of mean values that exceeded PSQG criteria. TP, As, Cd, Cu, Pb, Ni and Zn all exceeded the LEL criteria with mean values of 1,256 mg/kg, 14 mg/kg, 3.5 mg/kg, 32 mg/kg, 65 mg/kg, 17 mg/kg and 338 mg/kg, respectively. TKN (10,686 mg/kg), TOC (12%), and Fe (47,500 mg/kg) all exceeded the SEL criteria of 4,800 mg/kg, 10% and 40,000 mg/kg, respectively.

Table 2.3: Sediment Chemistry in Hare Lake

Parameter	Units	LEL	SEL	Hare Littoral	Hare Profundal
Total Phosphorus	(mg/kg)	600	2,000	786	1,256
Total Kjeldahl Nitrogen	(mg/kg)	550	4,800	5,622	10,686
Organic / Inorganic Carbon					
Total Organic Carbon	%	1	10	6.19	11.94

Parameter	Units	LEL	SEL	Hare Littoral	Hare Profundal
Total Metals					
Aluminum	(mg/kg)	-	-	14,320	21,860
Arsenic	(mg/kg)	6	33	3.9	13.7
Cadmium	(mg/kg)	0.6	10	1.36	3.49
Cobalt	(mg/kg)	50		9.82	18.88
Copper	(mg/kg)	16	110	20.88	31.56
Iron	(mg/kg)	20,000	40,000	19,940	47,500
Lead	(mg/kg)	31	250	18.2	65.2
Molybdenum	(mg/kg)	-	-	0.74	1.72
Nickel	(mg/kg)	16	75	15.12	17.16
Selenium	(mg/kg)	-	-	1.02	2.48
Zinc	(mg/kg)	120	820	208.0	338.4

2.2.10.8 Chemical and Nutrient Influx

Once in the system, nutrients are transported through the water column to the sediments that make up the lake bottom through the process of sedimentation. Through various physical, biological, and chemical processes, these nutrients can then be cycled back into the water column (Forsberg, 1989).

Internal nutrient cycling processes are very complex and vary with lake type and bottom conditions. **Figure 2-12** illustrates a simplified nutrient cycle in a stratified lake. The rate at which nutrients cycle between the sediment and water is influenced by a number of factors including hydrological conditions, lake morphology, water residency, temperature, and the size and density of the particles (Forsberg, 1989). The rate of sedimentation and resuspension is strongly influenced by lakes that turn over twice per year or more (i.e., dimictic or polymictic lakes) and the trophic level (e.g., oligotrophic or eutrophic), which creates different conditions for lake metabolism. The organisms that live on or in the upper sediments are also an important part of the nutrient cycling process (Forsberg, 1989). In Hare Lake a portion of the nutrients that are held in the sediment pool are re-circulated into the water column twice per year, during spring and fall turnover.

The main biogeochemical cycles describe the movement of carbon, nitrogen and phosphorus within the lake system. Inorganic carbon, mainly in the form of dissolved carbon dioxide and bicarbonate, is the primary source of carbon for generating organic matter through photosynthesis. However, photosynthesis is more often limited by nitrogen and phosphorous than inorganic carbon as nitrogen and phosphorous both occur in lower amounts (Wetzel, 2001).

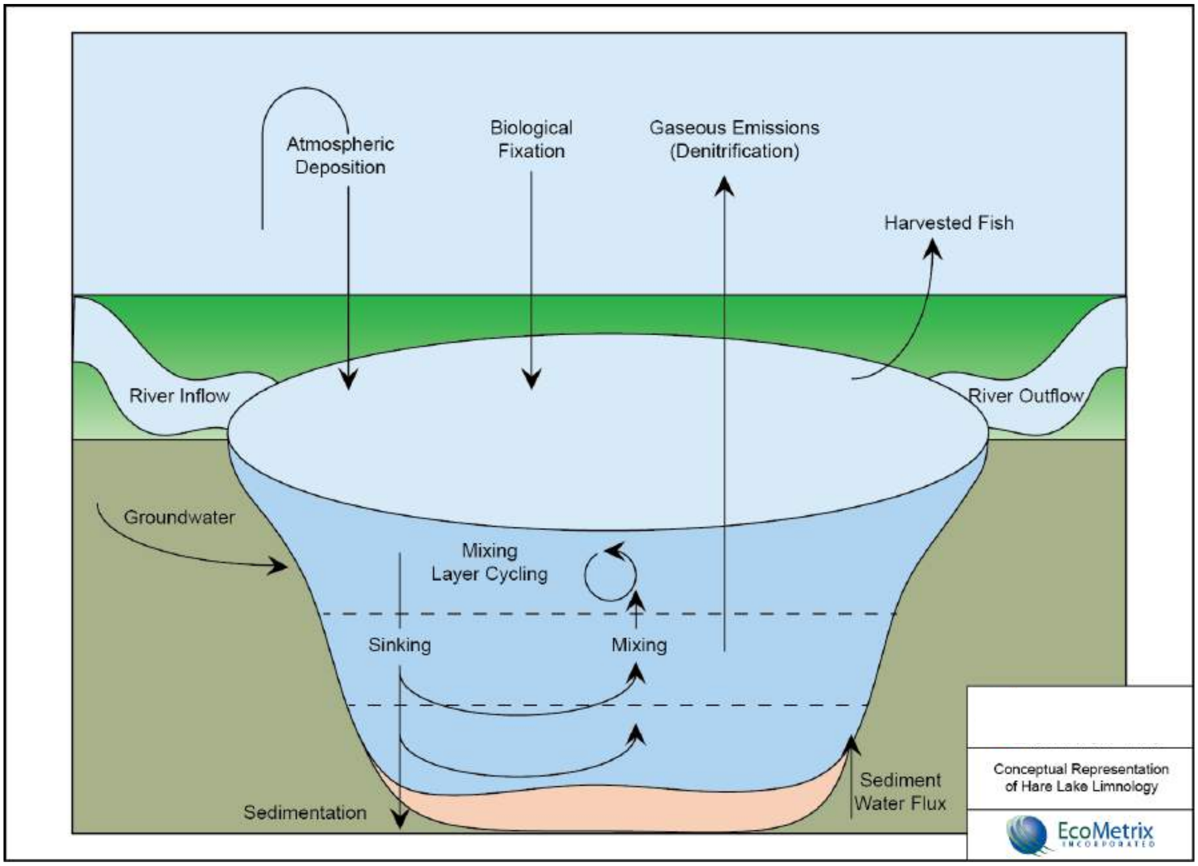

Figure 2-12: Simplified Nutrient Cycle in a Stratified Lake (Source: Bootsma and Hecky, 1999.)

2.2.10.9 Primary Productivity

Depth-integrated samples were collected for characterization of chlorophyll a (Chl a), phytoplankton and zooplankton from three locations in Hare Lake between September 2013 and September 2014. The 2014 data provide an indication of seasonal variation as monthly samples were collected between June and September.

Chl a concentrations, and the biovolume of plankton, increased between June and July, was similar in August, and then decreased in September. Chl a concentrations ranged from 0.95 to 1.15 ug/L, from 1.53 to 1.97 ug/L, from 1.4 to 1.5 ug/L, and from 1.07 to 1.34 ug/L in June, July, August and September, respectively.

A total of 19 phytoplankton taxa were identified in June, with the majority of phytoplankton biovolume composed of taxa from the green and blue-green algae. A total of 19 zooplankton taxa were identified in June, with the majority of zooplankton biovolume comprised of copepod taxa.

A total of 29 phytoplankton taxa were identified in July, with the majority of phytoplankton biovolume composed of taxa from the green and blue-green algae. A total of 19 zooplankton taxa were identified in July, with the majority of phytoplankton biovolume composed of copepod taxa and the cladoceran *Diaphanosoma*.

A total of 27 phytoplankton taxa were identified in August, with the majority of phytoplankton biovolume composed of taxa from the green and blue-green algae. A total of 17 zooplankton taxa were identified in August, with the majority of phytoplankton biovolume comprised of copepod taxa and the cladoceran *Diaphanosoma*.

A total of 22 phytoplankton taxa were identified in September, with the majority of phytoplankton biovolume composed of taxa from the green and blue-green algae. A total of 13 zooplankton taxa were identified in September, with the majority of phytoplankton biovolume composed of copepod taxa and the cladoceran *Bosmina*.

2.2.10.10 Benthic Invertebrates

Hare Lake benthic invertebrate data are summarized in **Table 2.4**.

The mean invertebrate density of the littoral and profundal stations were 5,516 and 1,140 organisms/m^2, respectively, with a range of 1,043 to 9,960 organisms/m^2 and 314 to 1,715 organisms/m^2, respectively. A total of 37 taxa were identified from the littoral zone samples with a mean per sample of 14 taxa and a range of 11 to 22. The profundal samples contained 12 discrete taxa with a mean of six and a range of four to eight. Simpson's Diversity values for the littoral and profundal samples had means of 0.84 and 0.68 with ranges of 0.76 to 0.90 and 0.55 to 0.76, respectively. The mean value of the littoral zone was relatively high with a mean maximum diversity value of 0.93. The profundal maximum attainable D value was 0.82 indicating the mean value was moderate. The mean Simpsons' Evenness values for the littoral and profundal zones were 0.52 and 0.57, respectively. The range of Evenness values for the littoral and profundal samples was 0.32 to 0.77 and 0.46 to 0.68, respectively. Both mean values were moderate as the Evenness scale ranges from 0 to 1 with 1 indicating a balanced community and 0 being indicative of a community dominated by large numbers of a relatively few taxa.

The benthic invertebrate communities in both littoral and profundal habitats were dominated by chironomids and sphaeriids. These two families comprised over 65% and 86% in the littoral and profundal zones, respectively. Three other taxa present in the profundal samples comprised more that 1% of the community (i.e., nemertean roundworms, mites, and ostracods). One family of amphipods and Tipulidae (crane flies) accounted for the remainder of the community. The littoral zone was more diverse than the profundal zone with additional taxa accounting for 1% of more of the community including, annelid worms, amphipods, mayflies, caddisflies and snails. Taxa present but not highly abundant (i.e.,

<1% relative abundance) included dragonflies, caddisflies, biting midges, midges and clams.

Table 2.4: Benthos in Hare Lake

Benthic Community Endpoint	Hare Lake	
	Profundal	Littoral
TOTAL NUMBER OF ORGANISMS	80	386
DENSITY (No./m^2)	1140	5516
TOTAL NUMBER OF TAXA	12	37
MEAN NUMBER OF TAXA	6	14
SIMPSON'S DIVERSITY	0.68	0.84
SIMPSON'S EVENNESS	0.57	0.52
TOTAL EPT INDEX	0	3
MEAN EPT INDEX	0.0	1.0
HILSENHOFF INDEX	7.45	6.17
EPT/CHIRONOMIDAE	0.00	0.10
MAYFLIES	0%	2%
STONEFLIES	0%	0%
CADDISFLIES	0%	2%
EPT	0%	3%
CHIRONOMIDS	47%	39%
ANNELID WORMS	0%	4%
SPHAERIID CLAMS	39%	27%

2.2.10.11 Fish Community

2.2.10.11.1 Fish Species

During the 1960s and 1970s, Hare Lake supported coldwater fish species such as Lake Trout and Cisco (*Coregonus artedi*) (ODLF, 1960). In 1991, it was recommended that Splake (Brook Trout [*Salvelinus fontinalis*] x Lake Trout hybrid) be stocked and, if successful, that Lake Trout be stocked (MNRF, 1991). Currently, Hare Lake supports a predominantly coolwater fish community with Yellow Perch and Northern Pike the most abundant large-bodied fish species. Limited coldwater species remain (i.e., Cisco, Burbot [*Lota lota*]); however, these species are not nearly as abundant as the coolwater species.

Since baseline studies were completed in 2009, eleven species have been documented for Hare Lake. These efforts included following the Broad-scale fish community protocol developed by the MNRF to assess lake communities. Yellow Perch and Spottail Shiner have been the most abundant species inhabiting the lake. Northern Pike and Cisco were common, while the Longnose Sucker, Trout-perch, Logperch and Spoonhead Sculpin were uncommon[6]. Burbot and Slimy Sculpin were rare. Two additional species, Walleye and Fathead Minnow (*Pimephales promelas*), have been reported (ODLF, 1960; MNRF 1975, 1991) but were not captured during any of the aquatics baseline work conducted for the project. Walleye were stocked in the 1950s but based on a lack of captures, despite a reasonable level of effort during the baseline studies, is unlikely to currently inhabit the lake. As indicated above, a single Lake Trout specimen was collected, which was marked by a fin-clip indicating that it was a stocked fish.

2.2.10.11.2 Fish Community Age Structure

The age structure of the fish community in Hare Lake has been inferred from length distribution data. It is assumed that Hare Lake supports all age classes (young-of-the-year, juvenile, adult) of each of the resident fish species[7] that were captured between 2009 and 2013 during the baseline program, although not all age classes of each individual species have been collected.

Length distribution data for the two most populous fish species in Hare Lake, Yellow Perch and Spottail Shiner, were plotted to provide more insight into the age structure of these species on a year-by-year basis. The length frequency distribution plots are provided as **Figure 2-13** (2011) and **Figure 2-14** (2013) for Yellow Perch and **Figure 2-15** (2011) and **Figure 2-16** (2013) for Spottail Shiner.

[6] See response to Supplemental Information Request No. 5 – Hare Lake Compendium Report.
[7] Excluding Lake Trout – The single Lake Trout specimen that was collected was a stocked fish and does not represent a population in the lake.

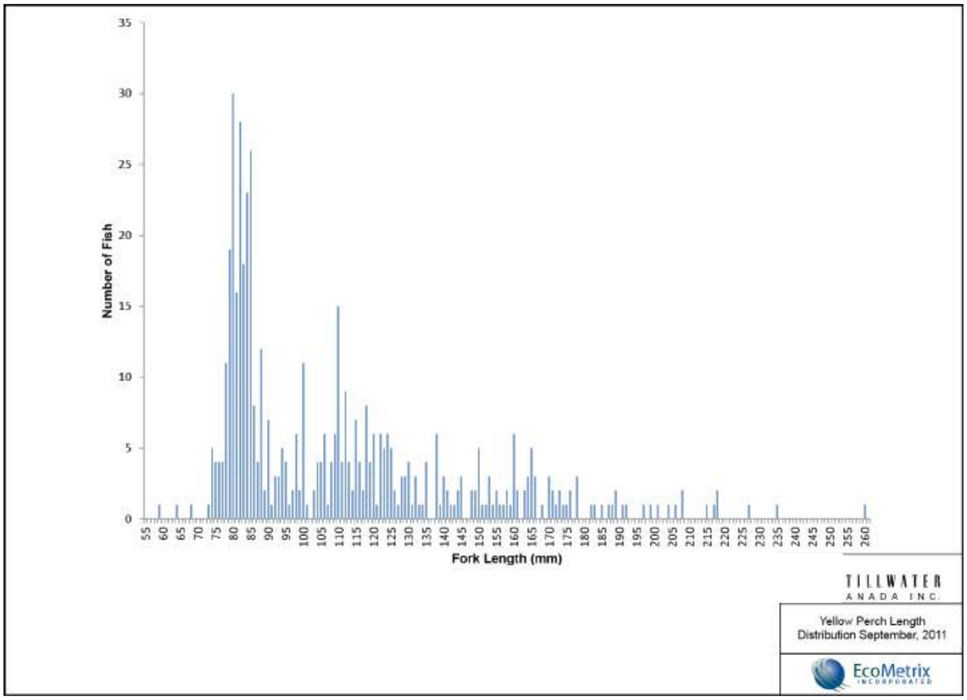

Figure 2-13: Yellow Perch Length Distribution September, 2011

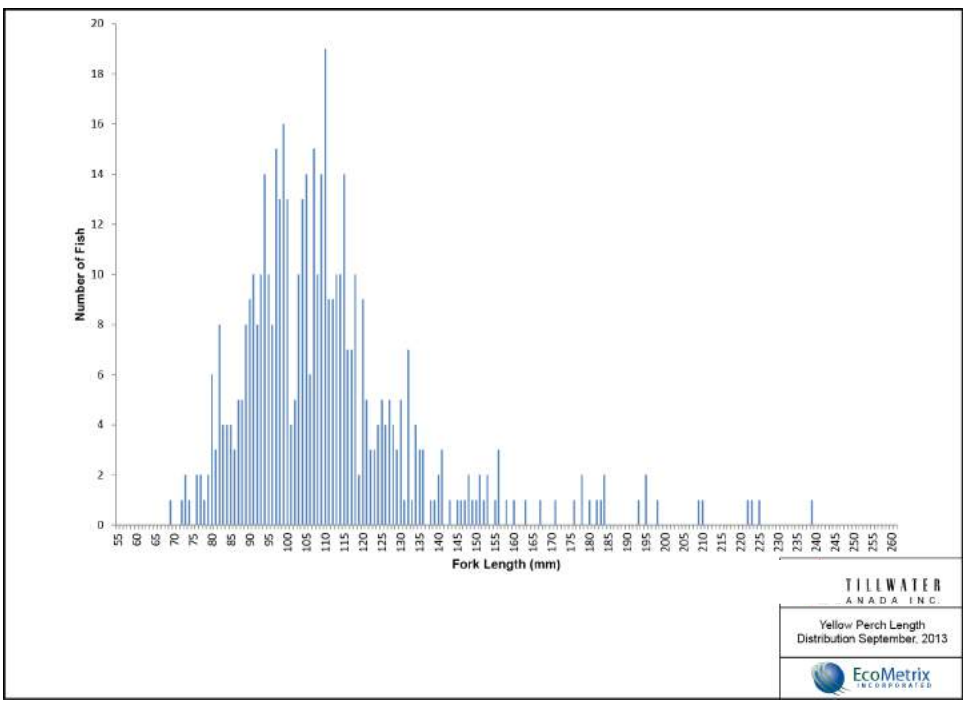

Figure 2-14: Yellow Perch Length Distribution August, 2013

The length frequency plots for Spottail Shiner based on collections made in 2011 and 2013 also provide similar results. It is inferred from the data that Spottail Shiner in Hare Lake range in age from 0+ years (young-of-the-year) to 2+ years. In 2011 the 1+ age cohort was more abundant than the 0+ cohort, whereas in 2013 the 0+ age cohort was the most abundant followed by the 1+ fish and 2+ fish.

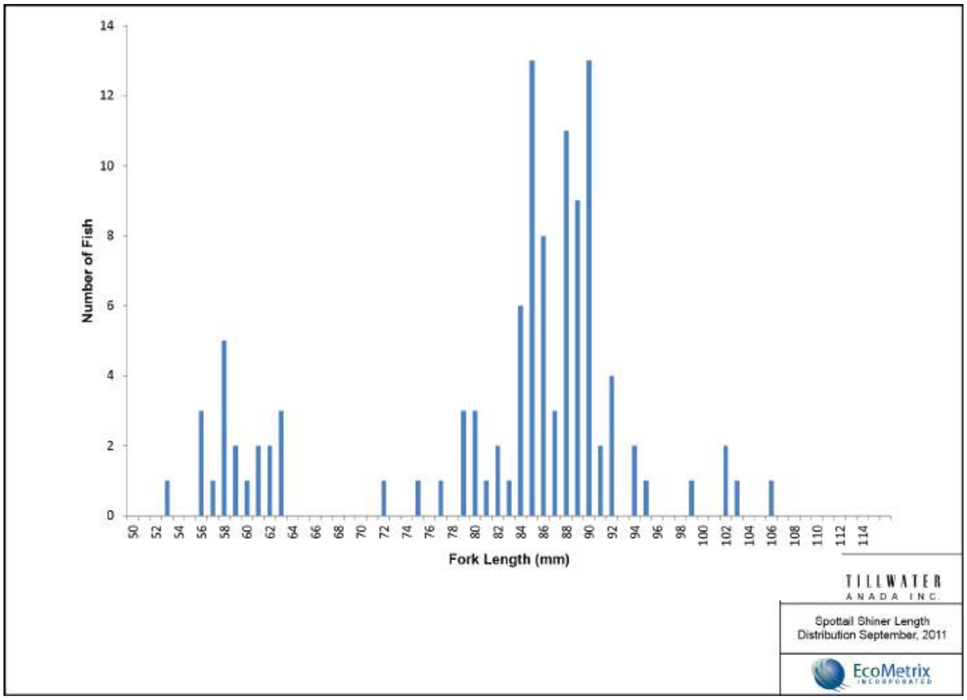

Figure 2-15: Spottail Shiner Length Distribution September, 2011

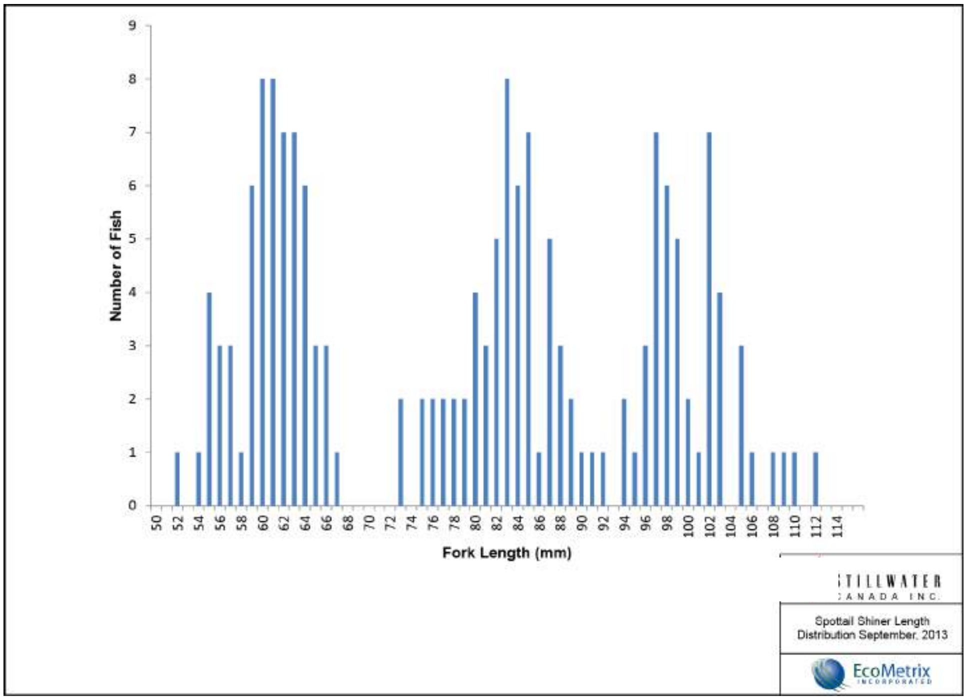

Figure 2-16: Spottail Shiner Length Distribution August, 2013

2.2.10.11.3 Hare Lake Broad-scale Netting Program Results

Broad-scale netting that was generally consistent with the MNRF Broad-scale Fish Community Monitoring Program, (Sandstrom et al, 2013) was conducted in Hare Lake in 2011 and 2013.

The key results from the 2011 program are as follows:

- Nine species of fish were captured during the 2011 BsM survey: Spottail Shiner (156), Longnose Sucker (5), Northern Pike (67), "dwarf" form Cisco (29), Lake Trout (1), Trout-perch (3), Spoonhead Sculpin (1), Yellow Perch (513), and Logperch (21).

- A total of 796 fish were captured: 699 fish in the small mesh nets and 97 fish in the large mesh nets. Northern Pike and Yellow Perch were the most common large-bodied fish, whereas Spoonhead Sculpin were relatively scarce. The single Lake Trout that was collected had its left pectoral fin clipped indicating it was a stocked fish.

- The 6-12 m stratum included representative fish from the most species (8) while the 20-35 m stratum had the fewest species (1). Catches varied greatly between the two different net sizes, with only pike, perch, sucker and trout being captured in large mesh nets while small mesh nets collected all species with the exception of Lake Trout.

- Catch-per-unit-effort (CPUE) was 0.24 fish/hr for large-mesh nets and 2.15 fish/hr for the small-mesh nets. CPUE decreased with increased depth ranging from 0.56 to 0.02 fish/hr for large-mesh and 3.32 to 0.36 fish/hr for small-mesh sets. When the two gear types were combined, CPUE decreased from 1.90 fish/hr in the shallowest depth strata (i.e., 1 to 3 m) to 0.15 fish/hr in the fourth depth strata (i.e., 12 to 20 m). The overall CPUE for all gear combined was 1.08 fish/hr.

- Biomass per unit effort for large mesh nets was 151.88 g/hr, for small mesh nets was 60.05 g/hr, and all gear combined was 111.34 g/hr. To establish a baseline, the total biomass (i.e., g/net) was calculated by net size (i.e., large and small) and for the small mesh nets by gang (i.e., gang 1 and gang 2). Large mesh nets had a mean biomass of 3,129 g and the small mesh nets had a combined gang mean biomass of 611 g (gang 1 mean, 733 g; gang 2 mean, 490 g).

- To gauge the species diversity in Hare Lake, the Shannon diversity index and Berger-Parker dominance index were calculated. The Shannon diversity index was 1.10 and the Berger-Parker dominance index was 1.55.

The key results from the 2013 program are as follows:

- Eight species of fish were captured during the 2013 BsM program: Spottail Shiner (212), Longnose Sucker (3), Northern Pike (12), Cisco (21), Trout-perch (2), Slimy Sculpin (1), Spoonhead Sculpin (2) and Yellow Perch (498). A total of 751 fish were captured; 728 fish in the small mesh nets and 23 fish in the large mesh nets. Northern Pike and Yellow Perch were again the most common sport fish while Trout-perch, Spoonhead Sculpin and Slimy Sculpin were relatively scarce. All captured Cisco were “dwarf” form based on size and sexual maturity.

- The number of fish species captured from the different depth strata sampled varied with the shallower depth strata (1-3, 3-6 and 6-12 m) including fish from 4 species, the deepest depth strata (12-20 and 20-35 m) included fish from 3 species, and the 12-20 m depth strata including fish from 2 species. The number of fish captured in the 1-3 and 3-6 m depth strata (326 and 390 respectively) was much higher than any of the deeper strata (15, 6 and 14).

- The data from the 2013 survey yielded a CPUE of 0.09 fish/hr for the large mesh nets, 3.40 fish/hr for the small mesh nets and 1.63 fish/hr when both mesh sizes are combined. Large mesh CPUE was greatest for the 1-3 m stratum (0.25 fish/hr) followed by the 20-35 m (0.11 fish/hr), 3-6 m and 12-20 m (0.08 fish/hr), and 6-12 m (0.04 fish/hr). The combined small mesh CPUE was greatest for the 3-6 m stratum

(7.43 fish/hr) followed by the 1-3 m (5.98 fish/hr), 6-12 m (0.30 fish/hr), 20-35 m (0.29 fish/hr), and 12-20 m (0.08 fish/hr). Catch by gang (the first value being gang 1 and always closest to shore) showed little or no difference for the 1-3 m (54.9% to 45.1%), 3-6 m (49.1% to 50.9%) depth strata. The 6 12 m stratum had a larger percentage capture from gang 1 at 72.7% verses gang 2 at 27.3%, whereas the 20-35 m stratum had a lower percentage captive from gang 1 at 40% versus gang 2 at 60%. At the 2-20 m depth stratum all fish were captioned in gang 2.

- Biomass per unit of effort for large mesh nets was 56.68 g/hr. To establish a baseline, the total biomass (i.e., g/net) was calculated for large mesh nets. Large mesh nets had a mean biomass of 1072 g.

- To gauge the overall species diversity in Hare Lake, the Shannon diversity index and Berger-Parker dominance index were calculated using the 2013 data. The Shannon diversity index was 0.86 and the Berger-Parker dominance index was 1.52. By stratum the Shannon diversity index and Berger-Parker dominance index were highest in the 6-12 m (1.25, 2.5) and 1-3 m (0.76, 1.73) strata. In decreasing order the Shannon diversity and Berger-Parker dominance values for the other strata were: 12-20 m (0.69, 2.0); 3-6 m (0.458, 1.27); and 20-35 m (0.51, 1.17).

2.2.10.12 Metal Levels in Fish Tissues

Fish were collected for scientific purposes during the baseline program to establish existing levels of metals in tissues at Hare Lake. Boneless, skinless fillets and liver samples from Northern Pike and composite whole-body samples of Spottail Shiner were collected and analyzed for metals. A summary of mean metal concentrations for each of these fish species is presented in **Table 2.5**. Mercury levels in Northern Pike are above the level at which consumption restrictions begin, typical for lakes in the region (EcoMetrix, 2012a).

Table 2.5: Mean metal concentrations in fish collected in Hare Lake

Parameter	n	Units	MDL	Spottail Shiner	Northern Pike	
				whole	muscle	liver
Aluminum	5	mg/kg	2	<2	<2	2
Arsenic	5	mg/kg	0.01	0.07	0.24	0.07
Cadmium	5	mg/kg	0.1	<0.1	<0.1	0.3
Cobalt	5	mg/kg	0.1	<0.1	<0.1	<0.1
Copper	5	mg/kg	0.1	0.8	0.2	11.8
Iron	5	mg/kg	1	16	3	168
Lead	5	mg/kg	0.02	0.04	<0.02	<0.02
Mercury	5	mg/kg	0.002	0.182	2.084	1.510
Molybdenum	5	mg/kg	0.01	0.04	0.02	0.13
Nickel	5	mg/kg	0.1	0.3	0.1	0.1
Selenium	5	mg/kg	0.2	0.9	0.9	3.1
Zinc	5	mg/kg	0.1	54.8	3.7	41.6

2.2.10.13 Hare Lake Food Web

A conceptual representation of the Hare Lake food web is depicted on **Figure 2-17**. The representation includes the main species, or species groups (e.g., “benthic invertebrates), and describes how energy and nutrients flow in the lake through the different trophic levels from primary producers (e.g., phytoplankton), to first level consumers such as zooplankton which graze the phytoplankton, to secondary consumers such as Spottail Shiner and Yellow Perch and finally the top level aquatic predator resident in the lake, Northern Pike. **Figure 2-17** also shows potential linkages between the aquatic environment of Hare Lake and terrestrial biota such as moose (which graze on aquatic vegetation), ducks (which graze benthic fauna) and mink (which eat lake fish).

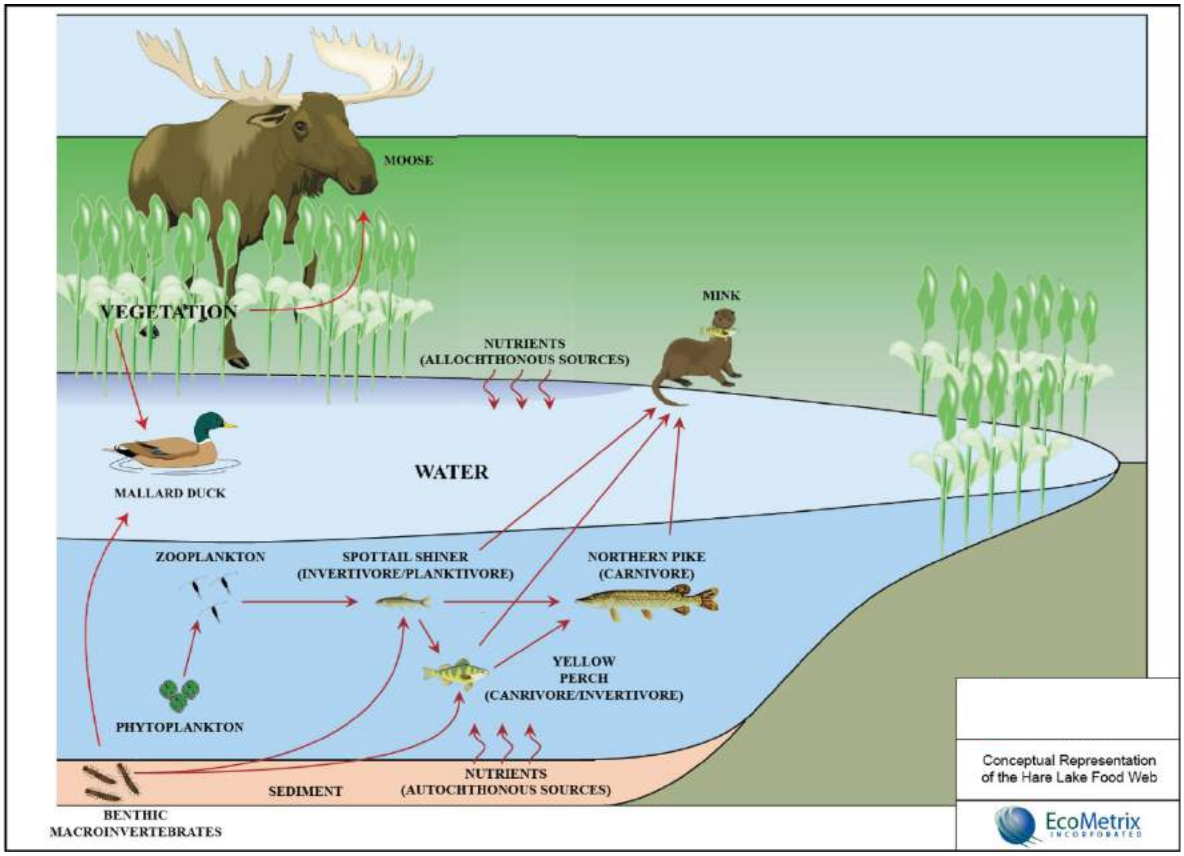

Figure 2-17: Conceptual representation of the Hare Lake food web

2.2.10.14 Key Indicator Species

Based on the above description of the existing conditions in Hare Lake, the following table lists the key indicator species and summarizes the rationale for their designation as such. The list includes representative aquatic species that occupy different trophic levels.

Table 2.6: Key indicator species in Hare Lake

Species	Rationale
Phytoplankton	Phytoplankton are primary producers and form the base of the food chain. Phytoplankton communities are very seasonally dynamic and therefore chlorophyll a levels are proposed as a surrogate measure of primary productivity. Chl a levels are commonly used in this fashion.
Zooplankton	Zooplankton are grazers of phytoplankton and as such convert primary production into a resource for consumers on higher trophic levels.

Species	Rationale
Benthic Invertebrates	Benthic invertebrates represent the larger organisms that inhabit lake substrates. They play a “middleman” role in aquatic food webs and therefore play an important role in nutrient and energy flow. They are considered good monitoring tools because, amongst other reasons, they are relatively immobile and their abundance and distribution provides a reflection of overall environmental conditions.
Spottail Shiners	Spottail shiners are the most abundant forage fish species in Hare Lake.
Yellow Perch	Yellow Perch are abundant in the lake and are omnivores.
Northern Pike	Northern Pike are the top level aquatic carnivore in Hare Lake.

2.3 Understanding of the Distribution of Fish in the Study Area

The proposed Project will interact both directly and indirectly with fish and fish habitat during all Project phases. Understanding the distribution of fish in the study area is fundamental to understanding the nature of these interactions and contributes to understanding fish habitat offset needs with respect to Section 35(2) of the Fisheries Act and Section 27.1 of the Metal and Diamond Mining Effluent Regulations.

The distribution of fish across the study area is summarized in **Figure 2-18.** A summary of the results from the aquatic baseline studies are discussed below on a watershed basis. “S” stations denote sampling that occurred at stream or flowing water locations. “L” stations denote sampling that occurred at lentic (lake, pond) habitat locations.

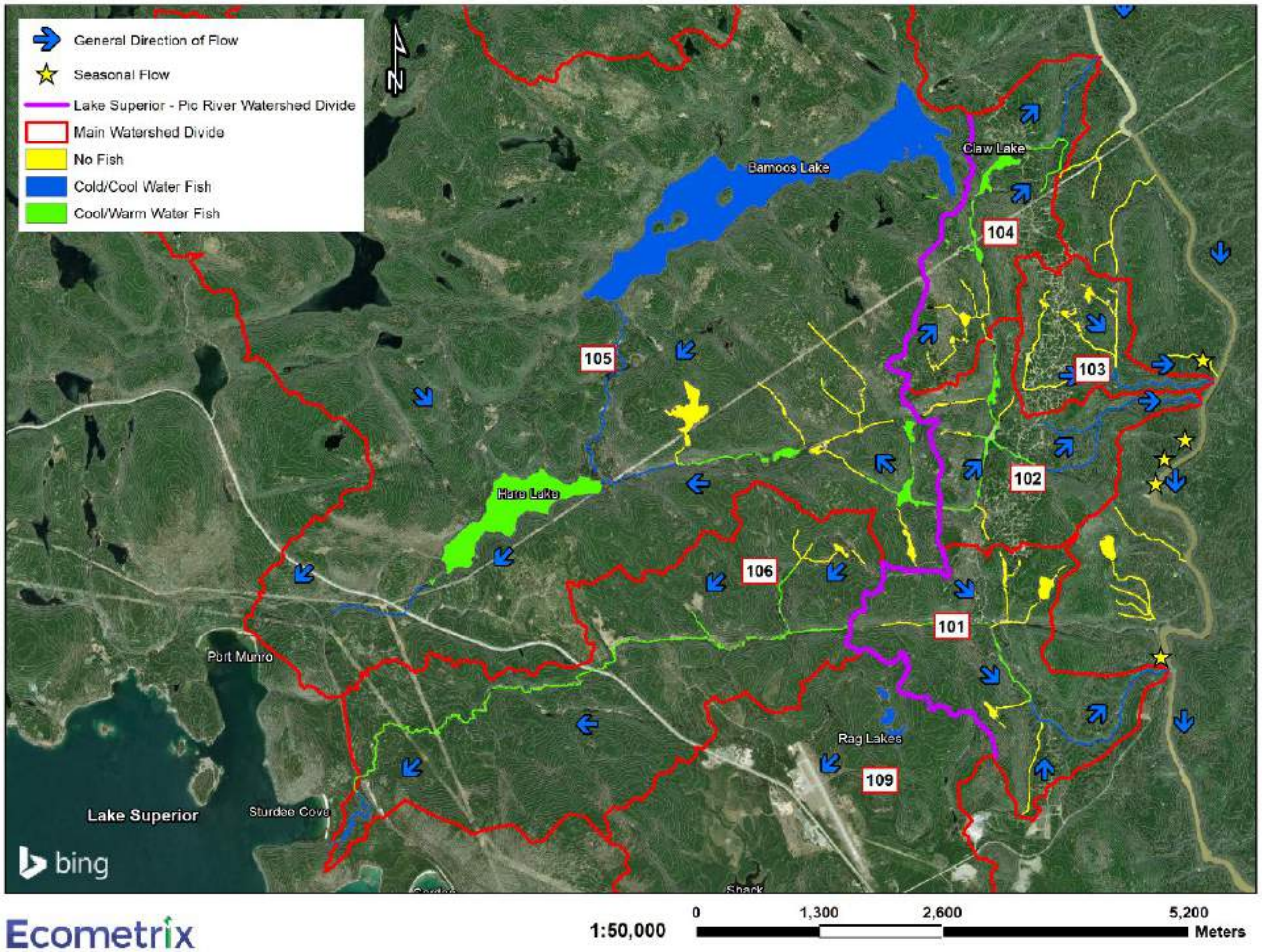

Figure 2-18: Distribution of fish across the study area

2.3.1 Subwatershed 101

Multi-season passive and active fishing effort in the headwater lakes (i.e., L1, L2 and L29) within the Stream 1 watershed resulted in the capture of no fish. There are several possible reasons for the absence of fish within these lakes. There is likely limited overwintering habitat in these lakes and in L2 and L29 in particular. In addition, oxygen depletion in the hypolimnion of L1 during August 2009, suggests that suitable fish habitat may be limited to the littoral zone of the epilimnion during much of the summer months. All three lakes are situated at the top of fairly steep gradients, which impedes fish colonization from downstream source populations. Overall, it is probable that a lack overwintering habitat, combined with downstream barriers (to upstream fish movement) in the form of natural topography likely account for the absence of fish in these lakes.

No fish were collected within the most upstream reaches of Stream 1 (Stations S54, S55, and S58). Fish were captured at S1 and the extent of upstream fish inhabitation was documented as S79. At Station S79 and within the remaining upper 2nd order reaches, small baitfish species were present. Progressing downstream within the watershed, viable habitat for resident coldwater salmonids occurred in the mid-reaches, and fish species captured included Brook Trout, Rainbow Trout, Northern Redbelly Dace, and Finescale Dace. The lower reach provides coldwater community habitat for all age classes of both resident and migratory salmonids and fish species captured there included Brook Trout, Rainbow Trout, Northern Redbelly Dace, Finescale Dace, Longnose Dace and Fathead Minnow.

It is possible that natural barriers (e.g., low or intermittent flow, dams) to migration occur, which partition the fish communities within this watercourse, among the middle and upper, and lower and middle reaches. At the outlet of Stream 1 to the Pic River, there is a perched culvert that impedes the upstream movement of fish during non-freshet flows.

2.3.2 Subwatershed 102

Terru Lake at the headwater of the Stream 2 watershed was fishless. The pH in Terru Lake was relatively low (in the 4.0 to 5.5 range) in 2009 but was acceptable for fish inhabitation in 2011. Terru Lake is relatively deep and may provide overwintering habitat, although reduced oxygen at depth and below winter ice was measured which may indicate at least the possibility of winter kill due to oxygen deprivation. Beaver activity, topography and low flows in the downstream connecting channel also likely impede upstream migration of fish into this waterbody. The fishless status of Terru Lake was confirmed again in 2020 with a no fish being present upstream of the cascades where the outlet of Terru Lake enters into L8.

In the middle portion of the watershed (i.e., L8, L14 and L15), few species (two maximum) were captured at each water body. Stations L8 and L15 contained only Brook Stickleback whereas both Lake Chub and Brook Stickleback were collected in L14; however, only a single Lake Chub was captured. Supplemental fishing efforts in July 2020 provided no catches of fish in the beaver ponds west of L15 or in the stream at S78. This is likely the result of the elevated topography and a number of cascades that act as a barrier to upstream fish movement.

All stream stations from L15 downstream supported fish. Station S3, the most upstream location, only contained Brook Stickleback. At the downstream end of this station (S3), there was a significant natural barrier to upstream migration in the form of a waterfall. This barrier, as well as other topographic barriers which occur downstream, likely contribute to the lack of species diversity encountered in the upstream reaches of the watershed compared to the downstream reaches. The middle reaches of Stream 2 (Station S53 and S69) support a resident coldwater fishery that includes Brook Trout (S53 and S69), Rainbow Trout (S69) and Slimy Sculpin (S53 and S69). The presence of Rainbow Trout at S53 and S69 likely indicates that this area has connectivity with the lower reaches and the Pic River.

Within the lowest reaches, upstream of the confluence with the Pic River (S4), Stream 2 supports a diverse fishery. Four surveys (September 2007, May 2009, August 2009, August 2013) have occurred at this location and ten species of fish have been collected including Rainbow Trout, Chinook Salmon, Brook Trout, Lake Chub, Finescale Dace, Longnose Dace, White Sucker, Trout-perch, Brook Stickleback and Slimy Sculpin. This tributary affords potential spawning and nursery habitats for resident species (i.e., Brook Trout, Slimy Sculpin), as well as migratory species (i.e., Rainbow Trout, Chinook Salmon).

2.3.3 Subwatershed 103

Despite relatively intensive fish surveys, including increased efforts in 2009, 2010 and 2011, all streams, lakes and ponds surveyed within upper and mid-reaches of the Stream 3 watershed yielded no fish. The potential for re-population of this area from downstream reaches is unlikely due to topographic barriers afforded by the steep relief as the watershed drains to the east towards the Pic River

Within the lower reaches, upstream of the confluence with the Pic River, Stream 3 (Station S6) supports a few fish species. Four surveys (September 2007, May 2009, August 2009, and August 2013) have occurred at this location and five species of fish have been collected including Rainbow Trout, Brook Trout, Longnose Dace, Slimy Sculpin and Johnny Darter. This lower reach of the tributary affords some nursery and potential spawning habitat but the lower reach of Stream 3 sees intermittent flow during low flow periods.

2.3.4 Subwatershed 104

No fish were captured upstream of a waterfall located at Station S51a (i.e., Stations S51, L21, L22 and all connecting tributaries). This could possibly be a result of low pH in some of the areas of the upper watershed (i.e., pH of 4.4 in L21). However, water quality was suitable in L22 at the time of the survey suggesting that a lack of overwintering habitat combined with downstream barriers in the form of beaver dams and/or natural topography, such as the waterfall at the downstream end of S51A, likely account for the absence of fish. Stations L18 and L19 and the mid-reach of Stream 4 (S8) supported a variety of fish species including Blacknose Shiner, Finescale Dace, Fathead Minnow, Longnose Sucker, Brook Stickleback, Lake Chub, and Northern Redbelly Dace. The extremely steep cascades within the mid-reaches of Stream 4 may impede upstream migration of fish from the lower reaches.

Within the lower reaches, upstream of the confluence with the Pic River, Stream 4 (S43) supports a number of fish species. Two surveys (May 2009, August 2009) have resulted in the capture of nine species including Rainbow Trout, Brook Trout, Chinook Salmon, Finescale Dace, White Sucker, Trout-perch, Brook Stickleback, Slimy Sculpin and Johnny Darter. This lower reach of the tributary affords potential spawning and nursery habitat for both migratory and resident salmonids, as well as other small (baitfish) species.

2.3.5 Subwatershed 105

The small headwater segments within the Hare Lake watershed do not support fish or in cases where they do, sustain a very limited population. In the western portion of headwaters Station L7 contained a large number of Lake Chub whereas Station L3 was fishless. The pH in L3 was relatively low (in the 4.0 to 5.5 range) in 2009, and may in part explain the absence of fish. Additional pH measurements taken in 2011 confirmed the low pH in L3. L3 and L7 are both relatively deep (approximately 5 m or greater) and may provide overwintering habitat, though reduced oxygen at depth and below winter ice was measured at both, which may indicate at least the possibility of winter-kill due to oxygen deprivation. Beaver activity, topography and low flows in the connecting channel also likely impede upstream migration of fish into L3. Proceeding downstream Canoe Lake and Station L6 appear to only support Lake Chub whereas Station L4 and L17 contained Lake Chub and Brook Stickleback. Stations L23, L25 and L27 were fishless, as were their downstream tributaries (Stations S60, S61 and S62). These headwater tributaries fragmented from fish colonization due to barriers to upstream movement (elevated topography, beaver activity, cascades) and a lack of overwintering habitat. Within the mid-reach of Stream 5, only Brook Stickleback have been collected (i.e., S22 and S9). Within the lower reach (S10), just upstream of Hare Lake, a resident cold/coolwater fishery existed including Brook Trout and Brook Stickleback. Bamoos Creek between Bamoos Lake and Hare Lake (S41) also supported a resident coldwater fish community including Slimy Sculpin and Brook Trout.

Bamoos Lake supports a diverse cold/coolwater community. Twelve species were captured during the 2009 survey including Lake Trout, Brook Trout, Cisco, Slimy Sculpin, Longnose Sucker, White Sucker, Trout-perch, Brook Stickleback, Ninespine Stickleback, Lake Chub, Finescale Dace and Fathead Minnow. Two additional species, Lake Whitefish and Burbot, are also reported for the lake according to MNRF records.

Hare Lake provides coldwater habitat; however, the extensive 2009 and 2011 fish surveys indicated that the majority of the community is comprised of coolwater species. Fish species captured in 2009 included Northern Pike, Yellow Perch, Spottail Shiner, Logperch, Cisco and Burbot. In 2011, a single Lake Trout and low numbers of Trout-perch, Spoonhead Sculpin and Longnose Sucker were also captured in Hare Lake increasing the total species captured to ten. The Lake Trout that was captured was a hatchery fish (fin-clipped) and its origin is unknown – it does not represent a population of Lake Trout in Hare Lake. Historical records also report Fathead Minnow inhabiting the lake. Walleye and Splake were stocked in the past but have not persisted. Extensive fishing efforts in 2009 and 2011 did not result in the capture of either of these two species.

Hare Creek (Stream 5) downstream of Hare Lake was surveyed at two locations, below the Highway 17 crossing (S11) and upstream of the outlet to Lake Superior (S30) into Port Munro. Based on sampling at these locations, it is evident that the lower portions of Hare Creek support a relatively diverse coldwater fish community including all age classes of both migratory and resident salmonid species. The fish community in lower Hare Creek included: Rainbow Trout, Chinook Salmon, Coho Salmon, Brook Trout, Brook Stickleback, Slimy Sculpin, Rainbow Smelt, Longnose Dace, Longnose Sucker, Ninespine Stickleback and Mottled Sculpin. The lower reaches of Hare Creek afford spawning and nursery habitat for both migratory and resident coldwater fishes.

2.3.6 Subwatershed 106

Multiple surveys of L26 during 2009, 2010 and 2011 resulted in no fish being collected. Backpack electrofishing at L24 in 2010 and 2011 indicated that this area does not support fish. Only Brook Stickleback have been collected at Stream 6 (Angler Creek) stations upstream of Highway 17. Possible explanations for such a limited fish community in the upstream reaches and headwater lakes include a lack of overwintering habitat, low flow and barriers (including beaver dams and cascades). For example, at Station S14, there are a number of cascades that would be impediments to upstream fish passage.

There is a waterfall which occurs in the lower reach of Angler Creek, upstream of S31, which prevents Lake Superior species from migrating upstream. Fishing was conducted there (S31a) in August 2013 and Brook Trout, Rainbow Trout, Coho Salmon, Lake Chub, Longnose Dace and Slimy Sculpin were captured. A small area just below the barrier falls near S31 has coarser substrate and does provide limited potential spawning habitat for spring spawning salmonids that can move upstream from the lake during freshet flows.

Within the lowest reaches, upstream of the outlet to Lake Superior into Sturdee Cove, salmonids were captured in 2009 and 2013. In total, five fish species were collected including Rainbow Trout, Coho Salmon, Chinook Salmon, Longnose Dace and Mottled Sculpin. This reach of Stream 6 provides a limited amount of nursery habitat for migratory coldwater species from Lake Superior, as well as some other small-bodied species. The quality of this lower reach for nursery is reduced compared to other tributaries in the area primarily due to the predominantly sandy substrates compared to more productive habitats which are typically comprised of coarser substrates (i.e., gravel, cobble).

2.3.7 Pic River and Small Tributaries

Of the 10 Pic River Tributaries which appeared to have some potential to contain a resident fish community, fish were only captured at one. The presence of Rainbow Trout fry at Station S32 (a small tributary north of the Project site) indicates that this tributary affords potential (albeit limited) nursery habitat – no potential spawning habitat was noted. Overall, the value of these small streams from a fish habitat perspective is considered minimal as flows are dependent on the amount of precipitation and their channels are only wetted for a period of time each year. Salmonid spawning habitat is relatively scarce due to the paucity of coarse substrates in most of the tributaries.

The fish community of the Pic River is diverse, with a variety of coolwater and coldwater fish species reported including Lake Sturgeon, Walleye, Longnose Sucker, Silver Redhorse, Muskellunge, Trout-perch, Spottail Shiner, Northern Redbelly Dace, Rainbow Trout, Coho Salmon, Chinook Salmon, Brook Trout, Rainbow Smelt, Northern Pike, White Sucker and Shorthead Redhorse.

2.3.8 Lake Superior

The near shore embayments of Lake Superior provide habitat for a variety of fishes, including both coldwater and coolwater species. These embayments offer nursery habitats for many species including whitefish, salmon, trout and suckers. Spawning habitat for species such as whitefish is also likely present. Fishing effort conducted from 2000 through 2009 in Peninsula Harbour and in Port Munro resulted in the capture of Alewife, Pink Salmon, Coho Salmon, Rainbow Trout, Lake Trout, Cisco, Lake Whitefish, Round Whitefish, Northern Pike, Lake Chub, Longnose Dace, Longnose Sucker, White Sucker Burbot, Threespine Stickleback, Mottle Sculpin, Slimy Sculpin and Yellow Perch.

Although, many Lake Superior species migrate through the embayments to spawning tributaries which outlet to the lake, within the project study area, only Hare Creek and Shack Creek provide a migratory path that is barrier free beyond the lowest reach. Only the lowest reach of Angler Creek is accessible to lake-resident fish due to a bedrock barrier upstream of the Angler Creek confluence.

2.3.9 Summary

Some subwatersheds within the LSA provide cold/coolwater nursery and spawning habitat for both resident and downstream Pic River and Lake Superior cold water fish species including salmonids. The diversity and species within these cold/coolwater communities vary as a result of the physical size of the watershed as well as barriers to colonization. Hare Creek and Shack Creek watersheds are the only two that allow unimpeded access beyond the lowest reaches. The communities in these two watersheds have salmonids in abundance including trout and Coho Salmon. Stream 1 and 2, both of smaller physical size than the aforementioned creeks, have coldwater fish communities up to their mid-reaches, however salmonids in these communities are represented by Rainbow Trout and Brook Trout but no salmon. A perched culvert at the confluence of Stream 1 limits upstream fish dispersal at most times from the Pic River. Topography limits upstream fish dispersal in Stream 2. Above the mid-reaches in of each of these watersheds they are either fishless or contain a limited cool/warm water community. Three other subwatersheds (101,103 and 106) also provide coldwater habitat but the extent of this habitat is limited to the lowest reaches. The limited extent of available habitat is due to steep topography in the form of waterfalls and cascades or other types of naturally occurring barriers such as landslides, logjams and beaver dams.

3.0 REGULATORY SETTING

There are no regulatory requirements, *per se*, that are specifically associated with characterization of baseline aquatic environment conditions at the project site.

Baseline sampling programs were guided by the requirements described in the EIS guidelines and were executed consistent with published protocols, such as those, for example, associated with the Metal and Diamond Mining Environmental Effects Monitoring Program.

Consideration of relevant legislation such as the *Fisheries Act* and the Metal and Diamond Mining Effluent Regulations and how these regulations frame the assessment of potential effects also provide guidance as to the nature and extent of baseline collections.

4.0 STUDY AREA

For the purpose of this assessment, the spatial boundaries considered in this assessment include the direct and indirect effects related to site preparation, construction, operation, and decommissioning / project closure of the Project. These areas are generally consistent with the spatial boundaries used in the EIS (2012) and associated supporting information documents, with appropriate revisions / refinements and rationale provided below.

4.1 Site Study Area (SSA)

The Site Study Area (SSA) is the direct footprint of the Project. Based on refinements to the Project footprint, and in recognition of project components originally located outside of the SSA, a revised SSA has been developed that encompasses the immediate area in which Project activities and components may occur and, as such, represents the area within which direct physical disturbance may occur as a result of the Project, whether temporary or permanent. The SSA is consistent for all VECs as depicted on **Figure 4-1**.

4.2 Local Study Area (LSA)

The Local Study Area (LSA) is the maximum area within which environmental effects from Project activities and components can be predicted or measured with a reasonable degree of accuracy and confidence. It consists of the PDA and adjacent areas where Project-related environmental effects are reasonably expected to occur based on available information and professional judgment. The LSA for soils is depicted on **Figure 4-2**. The LSA was established as the watercourses/watersheds that are potentially affected (in terms of water quality or quantity) by the Project.

The LSA used in this baseline report is the same as that used in the original EIS documentation.

4.3 Regional Study Area (RSA)

The Regional Study Area (RSA) is the area within which residual environmental effects from Project activities and components may interact cumulatively with the residual environmental effects of other past, present and future (i.e., certain or reasonably foreseeable) physical activities. The RSA is based on the potential for interactions between the Project and other existing or future potential projects.

The RSA for the aquatic environment includes the whole of the Pic River watershed and the whole of the east end of the Lake Superior Watershed.

The RSA used in this baseline is the same as that used in the original EIS documentation.

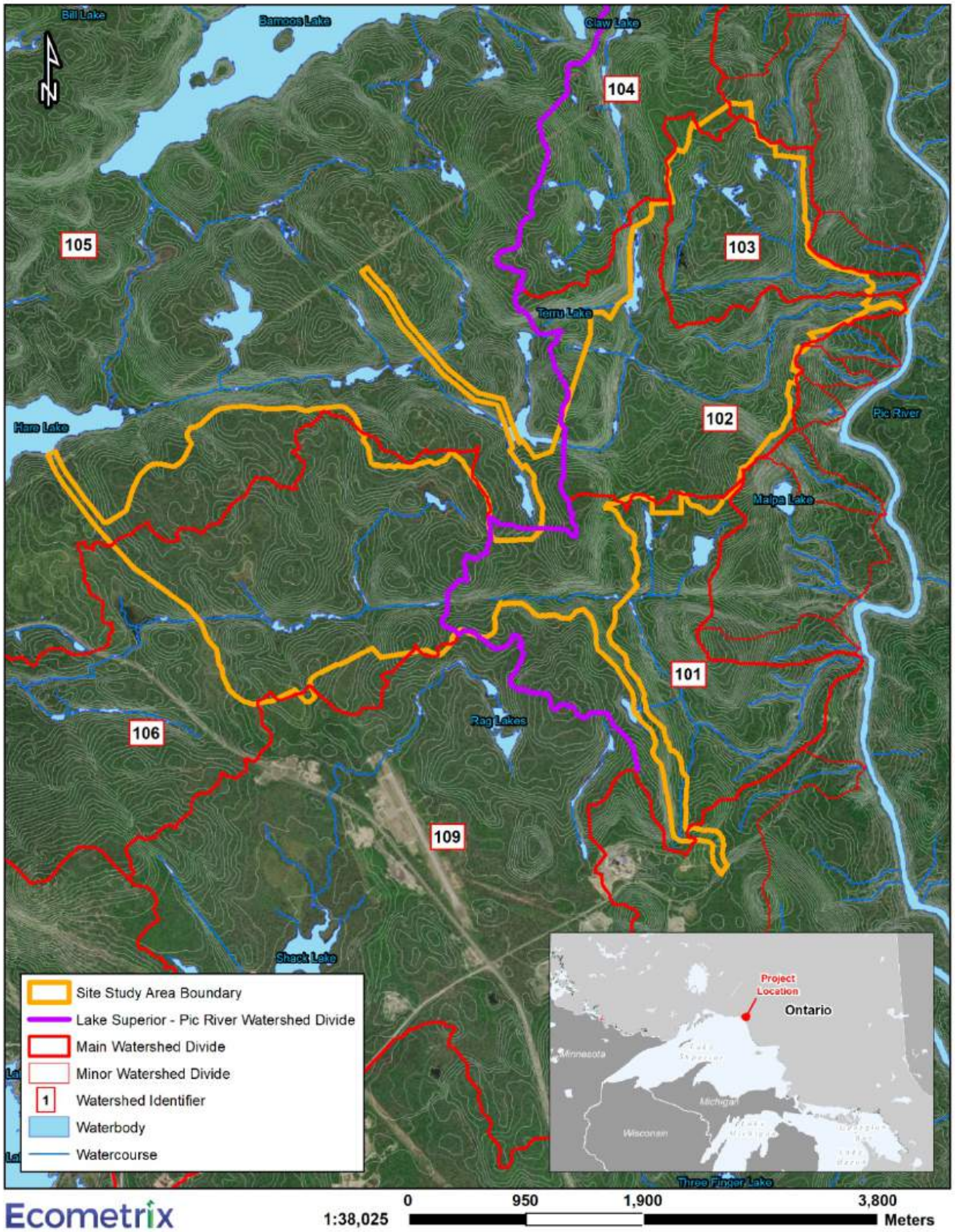

Figure 4-1: SSA for the Aquatic Environment Baseline Characterization

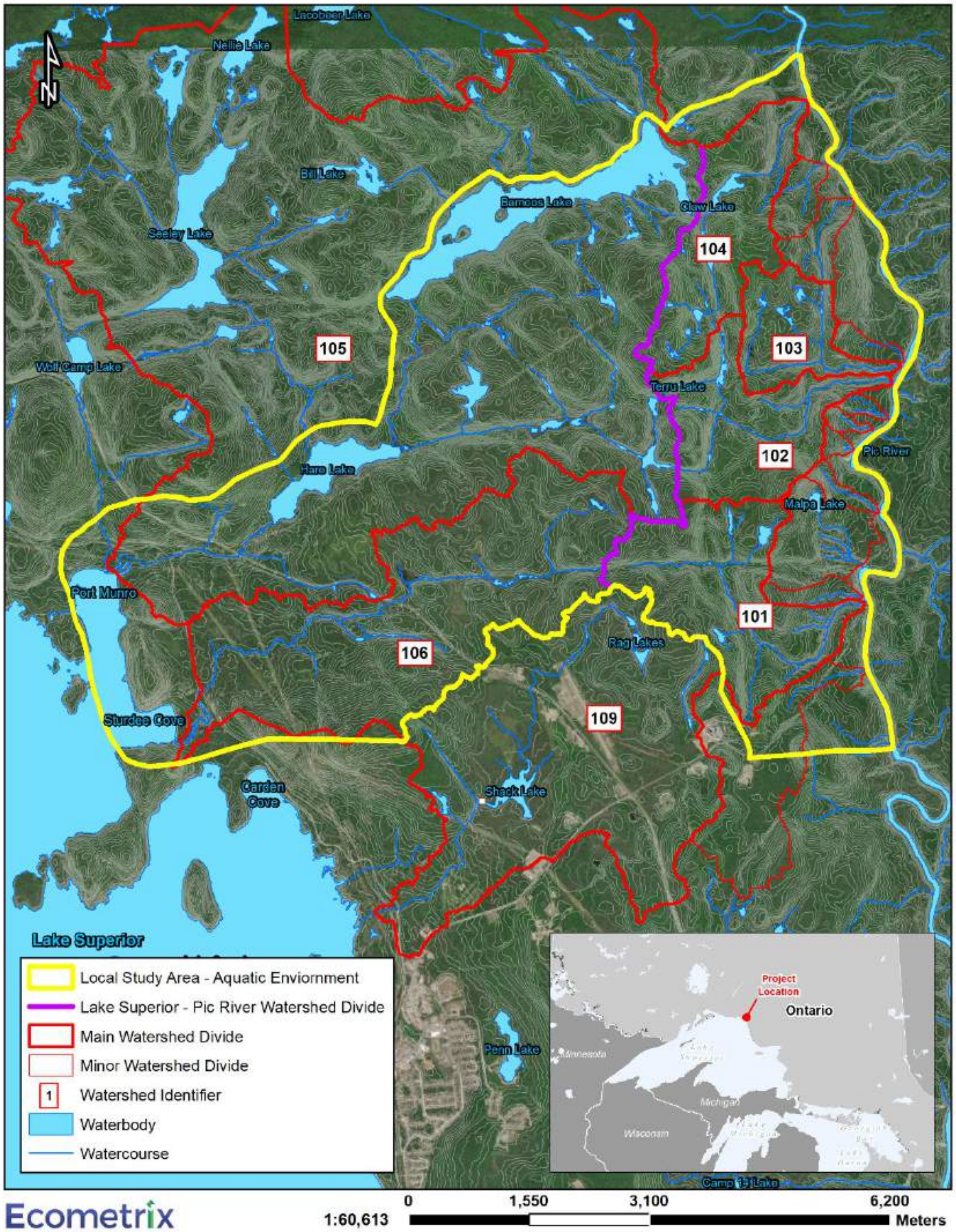

Figure 4-2: LSA for the Aquatic Environment Baseline Characterization

5.0 METHODOLOGY

5.1 Review of Existing Information

The aquatic environment data previously collected, that were used to characterize existing conditions in the study area, were reviewed to identify the adequacy of those data as it related to the updated assessment of potential project-related effects. The review considered several factors as follows: changes to municipal/provincial/federal legislation or guidelines that have occurred since 2012; changes to existing site conditions that may have occurred in the Project area that could affect baseline conditions (i.e., new or reduced development, new industry, etc.) or potential effects of the Project; and, consideration of changes to the project (footprint and emissions), if any, and how those changes might affect the need for additional baseline information to support the assessment of potential impacts.

With respect to changes to municipal/provincial/federal legislation or guidelines the following is noted. Recent changes to the *Fisheries Act* have, among other things, restored protections previously provided to fish and fish habitat, rather than fisheries. This change does not necessitate the collection of additional aquatic environment data.

There have been no significant changes to technical criteria and standards that have been introduced since 2012 for which additional data are needed to fill a perceived data gap.

With respect to potential changes in site conditions, the following is noted.

- Comparison of aerial/satellite imagery over the last 30 years does not show significant changes in configuration of waterbodies and water courses on site. Such observations are confirmed by those made on the ground during routine sampling that has been ongoing since 2014, as well as anecdotal reports by GenPGM, Stantec and Northern Bioscience staff that have been on-site for various reasons over the last number of years.
- There have been no changes to land/resource uses in the project area.
- There have been no significant anthropogenic activities on the site in the intervening years, beyond continued early exploration activities carried out by GenPGM.
- There have been no significant or atypical non-anthropogenic disturbances on the site (e.g., flood events, meteorological events, fire activity, seismic events) on the site. Water quality and site hydrology are unchanged based on review of data collected in the years subsequent to the EA going into hiatus.

Based on the above, we can conclude there has been no change in aquatic environment conditions associated with changes in site conditions.

Finally, with respect to changes to the Project (emissions and footprint), the following is noted. The Project continues to envision discharge from the PSMF to Hare Lake and discharge from the mine rock storage area (MRSA) to the Pic River. On this basis, no additional information on which to base the assessment of potential Project-related effects was considered necessary. Minor changes in the orientation of site aspects are proposed. The most significant of these were a possible expansion of the open pit to the west and the placement of some mine related infrastructure (crusher, ore stockpiles) to the west of the proposed main open pit where over-printing of additional water courses / water bodies in the Stream 2 subwatershed was possible. This area was sampled on several occasions between 2009 and 2011 with baited minnow, small mesh gill nets and electrofisher, as appropriate based on habitat. Nevertheless, it was recommended that confirmatory sampling be conducted to corroborate current understanding of fish distribution in the area (see **Section 5.2**).

5.2 Follow-up Field Studies

Northern Bioscience (see **Appendix A**) completed a fish survey in July 2020 to reconfirm the baseline conditions for the small headwater waterbody (L20) and two small unnamed beaver ponds that drain into Lake 8 and Lake 15 via stream networks S76-77 and S78. Standard (9” diameter) minnow traps baited with dog food and bread were left overnight in shallow water (<2 m deep) on July 7-9, 2020 for a minimum of 18 hours and checked the following day. Fish were identified, enumerated, and live-released at the point of capture. Fisheries sampling was done under authorization of Scientific Collectors Permit #1095952 issued by MNRF, Nipigon District.

5.3 Input from Indigenous Peoples

Traditional ecological knowledge and land use information studies were completed by First Nation and Métis communities, these reports have been provided to GenPGM. This information is provided in **Section 6.0** for reference.

6.0 UPDATED BASELINE CONDITIONS

6.1 Results of Follow-up Field Studies

As indicated in **Section 5.0**, Northern Bioscience (see **Appendix A**) completed a fish survey in July 2020 to reconfirm the baseline conditions for the small headwater waterbody (L20) and two small unnamed beaver ponds that drain into Lake 8 and Lake 15 via stream networks S76-77 and S78.

Overall, minnow-trapping in 2020 corroborated previous assessments of fish communities.

Low numbers of brook stickleback were caught in L8 and its downstream tributary linking it to L15. Although no fish were caught in L15, brook stickleback is expected to be present since there are no barriers to fish passage in the 50 m of connecting stream reach. Absence of fish in traps in L15 may be due to the recently flooded (due to beaver activity) margins where the traps were set, and possibly the presence of a large number of predacious diving beetle larvae (Coleoptera: Dytiscidae) in traps.

One brook stickleback was observed in the lower reach of Stream S77 and several others were observed in the shallow water at its mouth. No fish were found farther upstream or in Terru Lake due to multiple 0.5-1m+ vertical or near vertical drops along the stream channel.

Upstream passage to Terru Lake is not considered possible from L8. Fish presence in Terru Lake would therefore require anthropogenic introduction or post-glacial dispersal during significantly higher water levels. In addition, in the absence of upstream dispersal, is not clear if Terru Lake would be deep enough to prevent winterkill from anoxia without the presence of a beaver dam at its outlet (i.e., continued presence of Terru Lake fish communities might have required continuous post-glacial presence of a beaver dam).

No fish were found in Stream S78 or in the upstream beaver pond to the west. The maximum depth of the beaver pond is approximately 1 m, and it may experience anoxia during winter months thus precluding continued fish presence. Upstream passage from L15 via S78 is not possible due to the high gradient and multiple 1+ m vertical drops.

6.2 Fish Species of Importance to Indigenous Peoples

The table below identifies fish species that have been identified as having importance by Indigenous peoples with interest in the project. The table also identifies if the species have been found in the SSA and/or LSA and provides general information about the nature of the habitats utilized by the species.

Table 6.1: Fish Species of Importance as Identified by Indigenous Peoples with Interest in the Marathon Palladium Project

Species of Interest to Indigenous Peoples	Scientific Name	Recorded in the SSA and/or LSA During Baseline Survey?	Habitat
Brook Trout (Speckled Trout)	*Salvelinus fontinalis*	Limited distribution in the SSA (Subwatershed 2). Wider distribution in LSA where habitat is appropriate.	Cold, clear, well-oxygenated streams, rivers, ponds and lakes with maximum water temperature less than 22°C
Burbot	*Lota lota*	Not found in SSA. Found in Hare Lake, Bamoos Lake and Lake Superior embayments.	Moderate to deep waters (to 90 m) of lakes, large cool rivers and streams, often under rocks, among roots or in holes in the banks; preferred water temperature range 7-18°C
Carp	*Cyprinus carpio*	Not found in SSA nor LSA.	Pools of small to large low gradient rivers, lakes, reservoirs and ponds, with abundant aquatic vegetation, at depths of <30 m; preferred water temperature range 27-32°C
Chub	Leuciscidae (Family)	Lake Chub (Couesius plumbeus) only member of the Leuciscidae (Family) fiund in the study area. Found in SSA and LSA and one of most widely distributed forage fish species.	Open waters of lakes, lake margins and gravel-bottomed pools and runs of creeks and rivers; moves to deeper waters in the summer; preferred water temperature <27°C.
Cisco	*Coregonus artedi*	Dwarf and normal forms found in LSA (Bamoos Lake, Hare Lake, Lake Superior)	Open, mid-waters (13-53 m) of lakes and large rivers, below the thermocline; preferred water temperature range 7-10°C.
Coho Salmon	*Oncorhynchus kisutch*	Open, mid-waters (13-53 m) of lakes and large rivers, below the thermocline; preferred water temperature range 7-10°C.	Introduced to Great Lakes. Adults perfer mid-waters (16-60 m), with preferred water temperature range 11-17°C. Adults spawn in small lake tributaries on gravel substrates in late fall at age 3 or 4 and then die. Fry and junvenile fish remain in streams for some time.
Crappie	*Poxomis sp.*	Not found in SSA nor LSA.	Black crappie limited distribution in Lake Superior near Thunder Bay. Clear, quiet waters of large ponds, small lakes, bays and shallower areas of larger lakes and areas of low flow in larger rivers, associated with abundant aquatic vegetation and mud or sand substrate; preferred water temperature range 21-25°C.
Lake Sturgeon	*Acipenser fulvescens*	Not found in SSA. Present in the LSA (Pic River).	Bottoms of lakes and large rivers, usually 5 to 10 m deep, over clay, mud, sand and gravel; preferred water temperature range 15-17°C.
Lake Trout	*Salvelinus namaycush*	Not found in SSA. Present in the LSA (Bamoos Lake, Hare Lake, Lake Superior embayments).	Cold deeper waters (12-23m) of lakes, below the thermocline in summer; preferred water temperature range 9-13°C.
Largemouth Bass	*Micropterus salmoides*	Not found in SSA nor LSA.	Limited distribution in the Lake Superior basin. Clear, warm, shallow lakes, bays, ponds, marshes and backwaters and pools of creeks and small to large rivers, often with soft mud or sand substrate and dense aquatic vegetation; usually at depths <6 m; preferred water temperature range 26-30°C.
Longnose Dace	*Rhinichthys cataractae*	Not found in SSA. Present in the LSA.	cobble, boulder or gravel riffles of clean, cool, swiftly-flowing creeks and small to medium rivers, and rocky shores of lakes; preferred water temperature range 13-21°C.
Muskellunge	*Esox masquinongy*	Not found in SSA. Present in the LSA (Pic River).	Clear, cool to warm waters of medium to large lakes and slow rivers; preferred water temperature range 22-26°C.
Northern Pike	*Esox lucius*	Not found in SSA. Present in the LSA (Bamoos Lake, Hare Lake, Lake Superior embayments).	Clear, cool to warm, weedy bays of lakes and slow, meandering, heavily vegetated rivers; preferred water temperature range 17-24°C.
Yellow Perch	*Perca flavescens*	Not found in SSA. Present in the LSA (Hare Lake, Shack Lake, Lake Superior embayments).	Lakes, ponds and pools of creeks and small to large rivers with moderate aquatic vegetation and clear water, usually at depths <9 m; preferred water temperature range 18-24°C.
Rainbow Smelt	*Osmerus mordax*	Not found in SSA. Present in the LSA (Hare Creek, Pic River, Lake Superior embayments).	Introduced to Great Lakes. Adults - cool, clear, mid-waters (14-64 m) of lakes and medium to large rivers; preferred water temperature range 7-16°C. Adults are broadcast spawners that spean in the lower reache of stream afer ice out.
Rainbow Trout	*Oncorhynchus mykiss*	Present in SSA in Stream 2. Present in the LSA (Lower reaches of Lake Superior and Pic River tributaries, Pic River, Lake Superior embayments).	Adults - mid-waters of lakes; creeks and rivers with moderate flow, gravelly bottoms and riffle-pool habitat; preferred water temperature range 12-18°C. Spring spawners in trbitary stream with gravel substrates.
Slimy Sculpin	*Cottus cognatus*	Limited distribution in the SSA (Subwatershed 2). Wider distribution in LSA where habitat is appropriate, in particular laoer reaches of tributaries to Lake Superior and Pic River, as well as Bamoos Lake and its outlet	Gravelly, rocky riffles of coldwater streams and rocky substrates in deep (37-108 m), cooler waters of lakes; preferred water temperature range 9-14°C.
Smallmouth Bass	*Micropterus dolomieu*	Not found in SSA nor LSA.	Clear, gravel-bottomed runs and flowing pools of small to large rivers and shallow (5-7 m), rocky and sandy areas of lakes; preferred water temperature range 20-27°C.
Splake	*Salvelinus fontinalis x S. namaycush*	Not found in SSA nor LSA. Historically stocked in Hare Lake.	Introduced in Lake Superior. Adults - mid-waters (9-11m) of lakes, near the thermocline; preferred water temperature range 10-16°C.
Sucker	*Catostomus sp.*	Not found in SSA. White Sucker and Longnose Sucker present in the LSA.	White Sucker - Pools and riffles of creeks and rivers, warm shallow lakes and embayments of larger lakes usually at depths of 6-9 m; preferred water temperature range 17-24°C. Longnose Sucker - Clear, cold, deep water (up to 55 m) of lakes and tributary streams; occasionally brackish water; preferred water temperature range 8-17°C.
Threespine Stickleback	*Gasterosteus aculeatu*	Not found in SSA. Present in lower reach of Stream 6 and Lake Superior embayments.	Shallow vegetated areas of creeks and rivers, protected bays of lakes with mud or sand bottom, and coastal marine/estuarine environments; preferred water temperature range 9-12°C.
Walleye (Pickerel)	*Sander vitreus*	Not found in SSA. Present in Pic River and Lake Superior embayments.	Lakes (at depths up to 21 m), and pools, backwaters and runs of medium to large rivers; preferred water temperature range 19-23°C.
Whitefish	F. Salmonidae	Not found in SSA. Lake Whitefish (Coregonus clupeaformis; Bamoos Lake, Hare Lake, Lake Superior embayments) and Round Whitefish (Prosopium cylindraceum; Lake Superior embayments) found in LSA.	Lake Whitefish - Cool waters (18-37 m) of lakes and large rivers, below the thermocline; preferred water temperature range 8-14°C. Round Whitefish - Shallow waters (<37 m) of deep lakes and clear streams; preferred water temperature 17.5°C

7.0 SUMMARY AND CONCLUSIONS

The aquatic environment baseline characterization program at the Project site included multi-year, multi-season surveys of aquatic habitats and communities in the study area. The existing characterization of the aquatic environment was re-considered within the context of several factors to assess its suitability to support the updated assessment of potential Project-related effects. Only minor additional information was identified as a need and this information was collected in July 2020.

The existing aquatic environment baseline characterization as represented by the original baseline program and subsequent follow up work as summarized herein provides a suitable basis for the updated assessment. As described in the original baseline aquatic environment documentation, much of the interior of the project is fishless with limited upstream dispersal potential. Coldwater fish habitat is provided in the LSA in tributaries to the Pic River and Lake Superior that is utilized by a variety of resident and migratory species. Currently, Hare Lake supports a predominantly coolwater fish community with Yellow Perch and Northern Pike the most abundant large-bodied fish species. Limited coldwater species remain.

8.0 REFERENCES

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ODLF. 1960. Lake card (Hare Lake) – July 2, 1960.

Appendix A Northern Bioscience July 2020 Fish Survey Report

Northern Bioscience
363 Van Horne Street
Thunder Bay, Ontario
Canada P7A 3G3
Office (807) 346-4950
Cell (807) 621-9351
www.northernbioscience.com

MEMORANDUM

Attention:	Brian Fraser, Ecometrix
From:	Dr. Robert Foster
Subject:	2020 GenPGM Fish Sampling
Date:	2020-07-27
Pages:	10

Introduction

Baseline fish communities were extensively sampled during baseline sampling for Stillwater Canada Inc.'s Marathon PGM-Cu Project near Marathon, Ontario (Ecometrix Inc 2012)(Figure 1). (Figure 2). Due to design changes, additional waterbodies within the Stream 2 watershed (Figure 2) may potentially be impacted GenerationPGM Inc.'s proposed Marathon Palladium Project. As a result, further fish surveys were conducted in July 2020 to update the baseline conditions for selected watercourses and waterbodies including the small headwater waterbody (L20) and two small unnamed beaver ponds that drained into Lake 8 and Lake 15 via stream networks S76-77 and S78.

Previous Sampling

L8 was sampled in 2009 with baited minnow traps, small experimental gillnet, and Nordic net. A total of 20 brook stickleback were caught. Sampling in 2006 with six minnow traps caught two brook stickleback.

Previous sampling of Terru Lake (L20)(Figure 5) in 2007, 2009, 2011 using baited minnow traps, Nordic nets, small mesh experimental gillnet, and/or backpack electrofishing did not catch any fish . No fish were found in the outlet stream (S77) of Terru Lake, except for brook stickleback (*Culaea inconstans*) in its lowermost reach at L8. No fish caught during electrofishing of its first order tributaries S74 or S75 in 2011 either.

L15 was sampled with four baited minnow traps in August 2009 and September 2006, both times catching small numbers of brook stickleback. Station S78 on the 1st order stream that flows from into the western side of L15 was visually surveyed in June 2011 - no fish were detected. No fish surveys were previously conducted in the upstream beaver ponds.

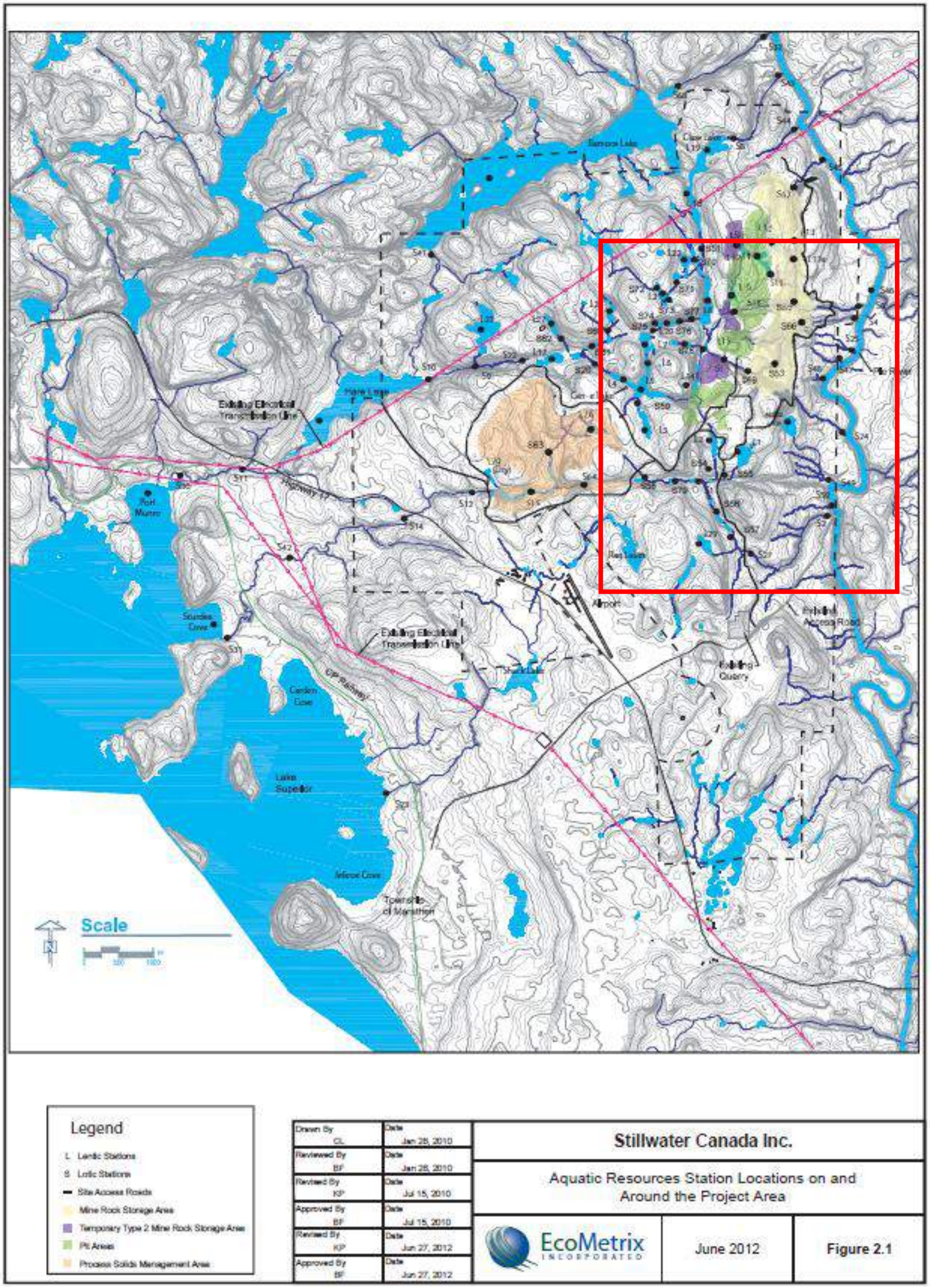

Figure 1. Original aquatic resources station locations for the Marathon PGM-Cu Project (Ecometrix Inc. 2012). Red inset box indicates location of Figure 2.

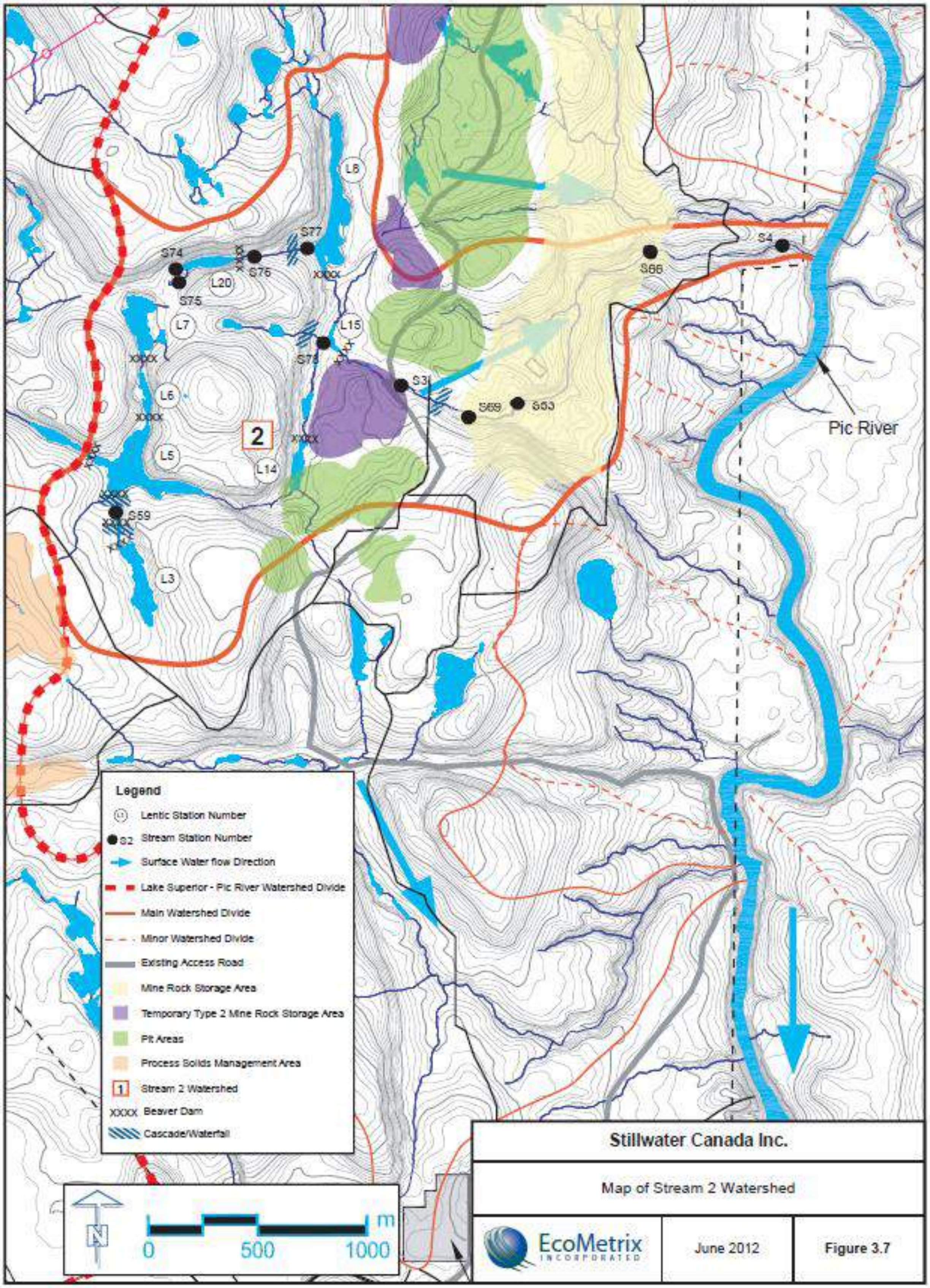

Figure 2. Map of Stream 2 Watershed (Ecometrix Inc. 2012).

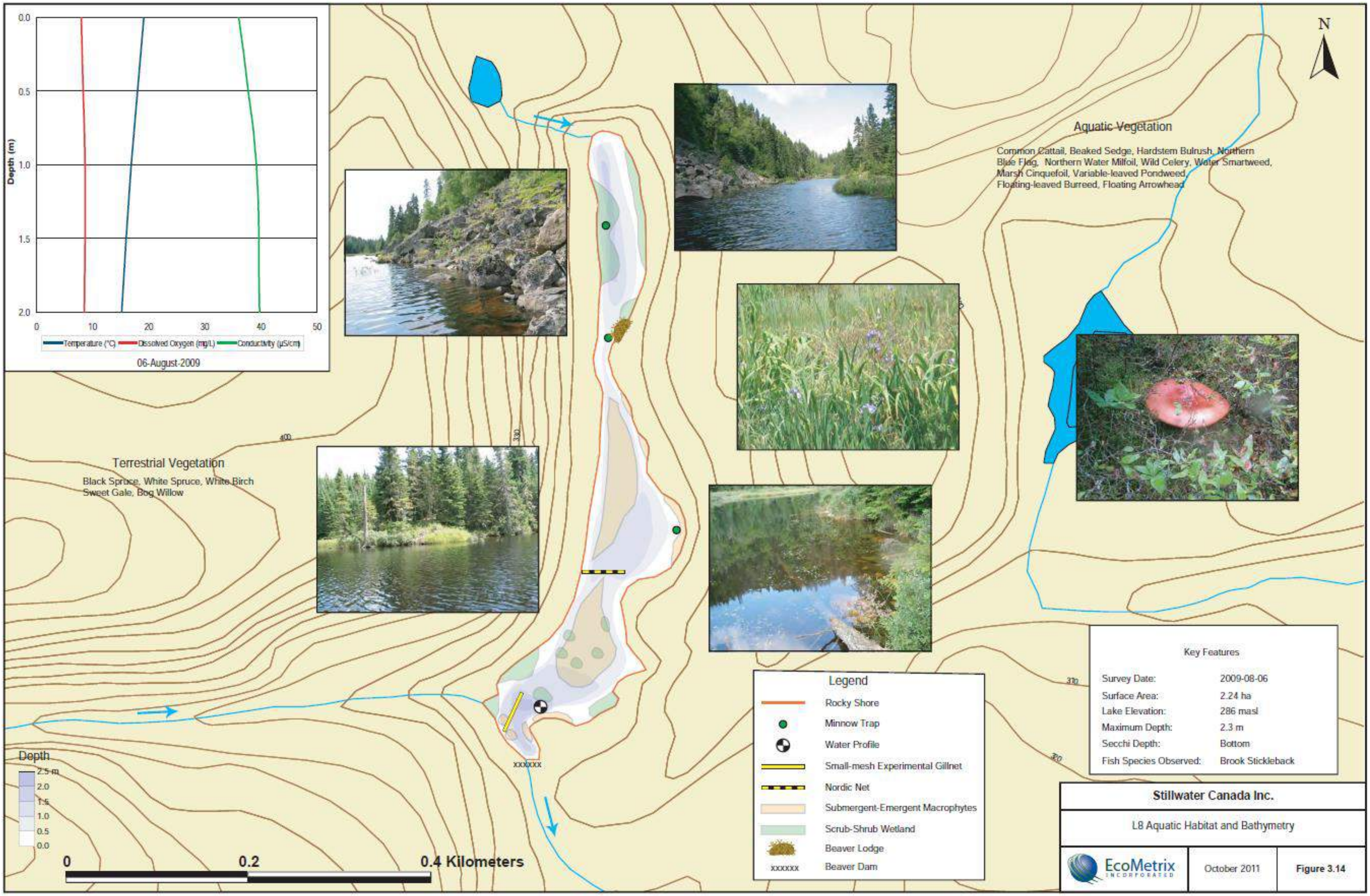

Figure 3. L8 Aquatic Habitat and Bathymetry (Ecometrix Inc. 2012).

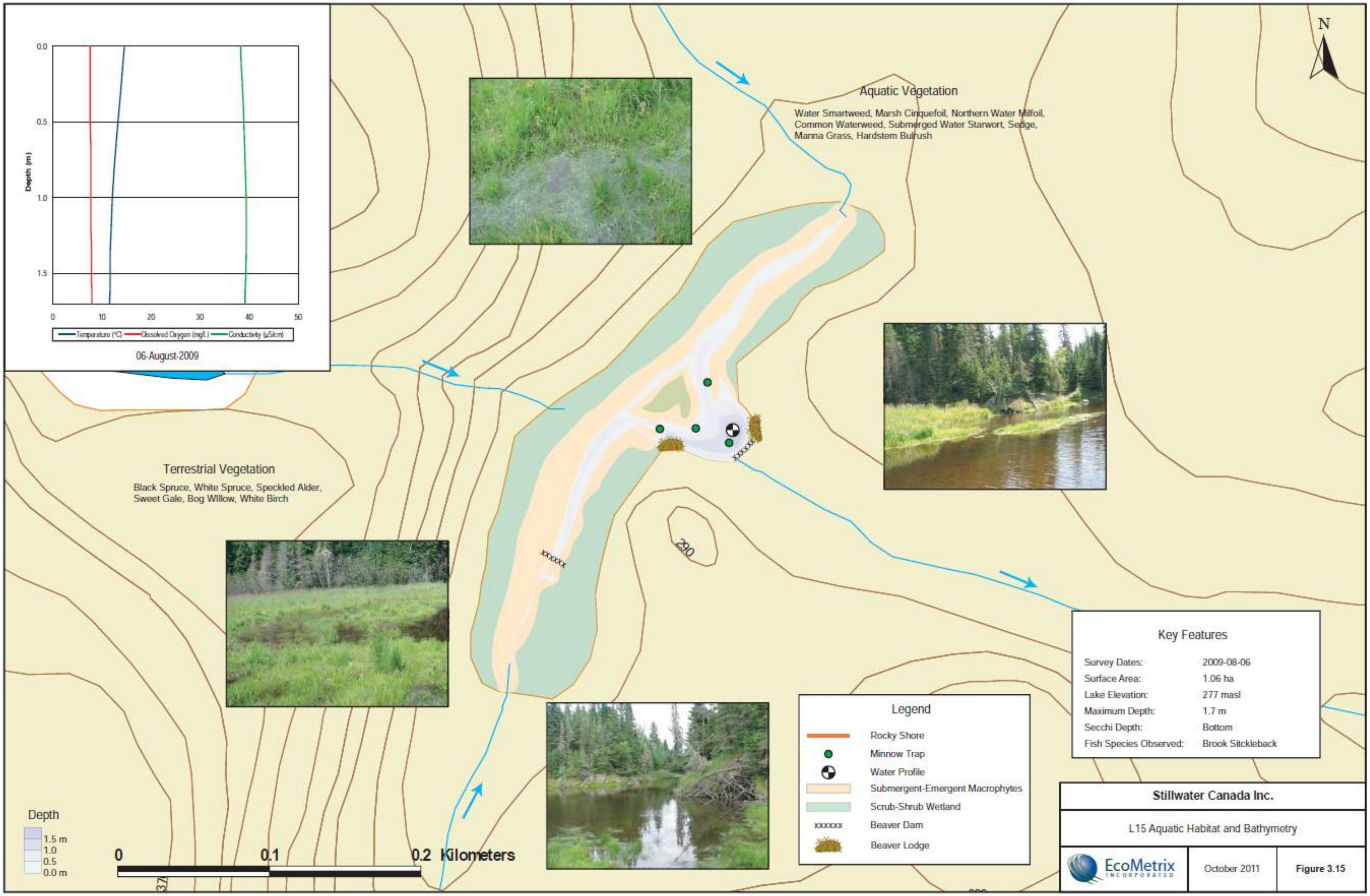

Figure 4. L15 Aquatic Habitat and Bathymetry (Ecometrix Inc. 2012).

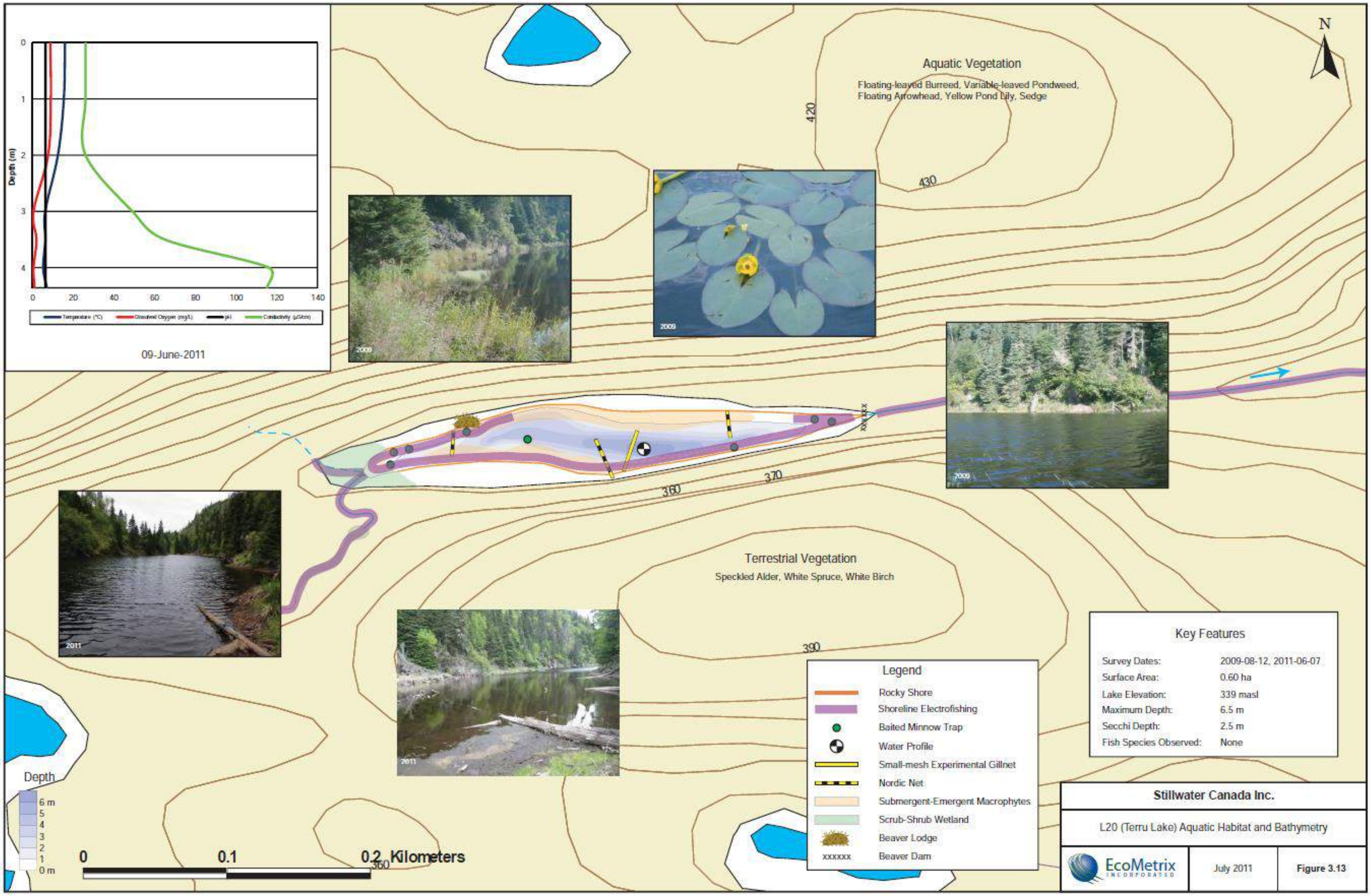

Figure 5. Terru Lake (L20) Aquatic Habitat and Bathymetry (Ecometrix Inc. 2012).

2020 Methods

Standard (9" diameter) minnow traps (Figure 6) baited with dog food and bread were left overnight in shallow water (<2 m deep) on July 7-9, 2020 for a minimum of 18 hours and checked the following day. Fish were identified, enumerated, and live-released at the point of capture. Fisheries sampling was done under authorization of Scientific Collectors Permit #1095952 issued by OMNRF, Nipigon District.

Figure 6. Minnow trap in situ in L8.

Results and Discussion

Minnow-trapping in 2020 confirmed previous assessments of fish communities. Low numbers of brook stickleback were caught in L8 and its downstream tributary linking it to L15. Although no fish were caught in L15, brook stickleback is expected to be present since there are no barriers to fish passage in the 50 m of connecting stream reach. Absence of fish in traps in L15 may be due to the recently flooded (due to beaver activity) margins where the traps were set, and possible the presence of Large number of predacious diving beetle larvae (Coleoptera: Dytiscidae) in traps.

One brook stickleback was observed in the lower reach of Stream S77 and several others were observed in the shallow water at its mouth (Figure 7). No fish were found further upstream or in Terru Lake due to multiple 0.5-1m+ vertical or near vertical drops along the stream channel. Upstream passage to Terru Lake is not considered possible from L8. Fish presence in Terru Lake would therefore require anthropogenic introduction or post-glacial dispersal during significantly higher water levels on proto-Lake Superior. In addition, in the absence of upstream dispersal, is not clear if Terru Lake would be deep enough to prevent winterkill from anoxia without the presence of a beaver dam at its outlet (i.e., continued presence of Terru Lake fish communities might have required continuous post-glacial presence of a beaver dam).

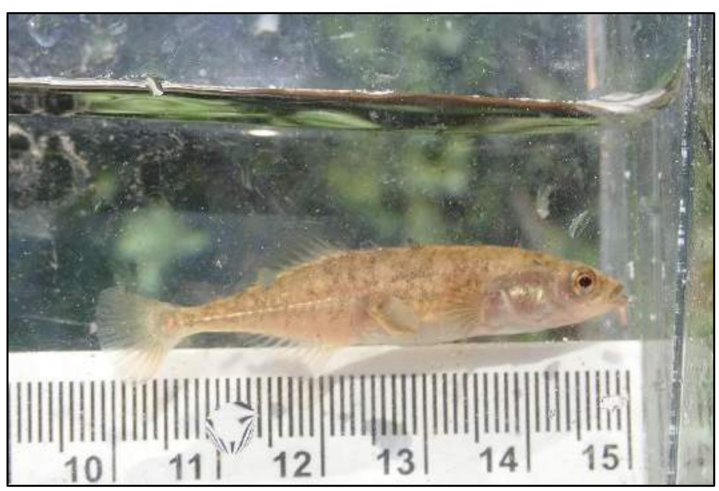

Figure 7. Brook stickleback caught during 2020 sampling for the Marathon Palladium Project.

No fish were found in Stream S78, nor in the upstream beaver pond to the west. The maximum depth of the beaver pond is approximately 1 m, and it may experience anoxia during winter months thus precluding continued fish presence. Upstream passage from L15 via S78 is not possible due to the high gradient and multiple 1+ m vertical drops (Figure 8).

Figure 8. Near vertical drops representing an upstream barrier to fish passage on Stream S78.

Table 1. Summary of 2020 minnow-trapping for the GenPGM Marathon Palladium Project

Trap #	Date Set	Easting	Northing	Fish Present	Species
1	2020/07/07	549719	5404934	Y	3 brook stickleback
2	2020/07/07	549717	5404953	N	
3	2020/07/07	549688	5404999	Y	1 brook stickleback; damaged by bear
4	2020/07/07	549636	5405004	N	
5	2020/07/07	549617	5404999	N	
6	2020/07/07	549601	5404998	N	
7	2020/07/07	549709	5404550	N	
8	2020/07/07	549709	5404556	N	
9	2020/07/07	549712	5404571	N	
10	2020/07/07	549714	5404581	N	
11	2020/07/07	549803	5404766	Y	15 brook stickleback
12	2020/07/08	549345	5404945	N	
13	2020/07/08	549307	5404950	N	
14	2020/07/08	549319	5404936	N	
15	2020/07/08	549316	5404949	N	
16	2020/07/08	549325	5404936	N	
17	2020/07/08	549546	5404617	N	
18	2020/07/08	549544	5404597	N	
19	2020/07/08	549516	5404599	N	
20	2020/07/08	549530	5404633	N	
21	2020/07/08	549535	5404621	N	

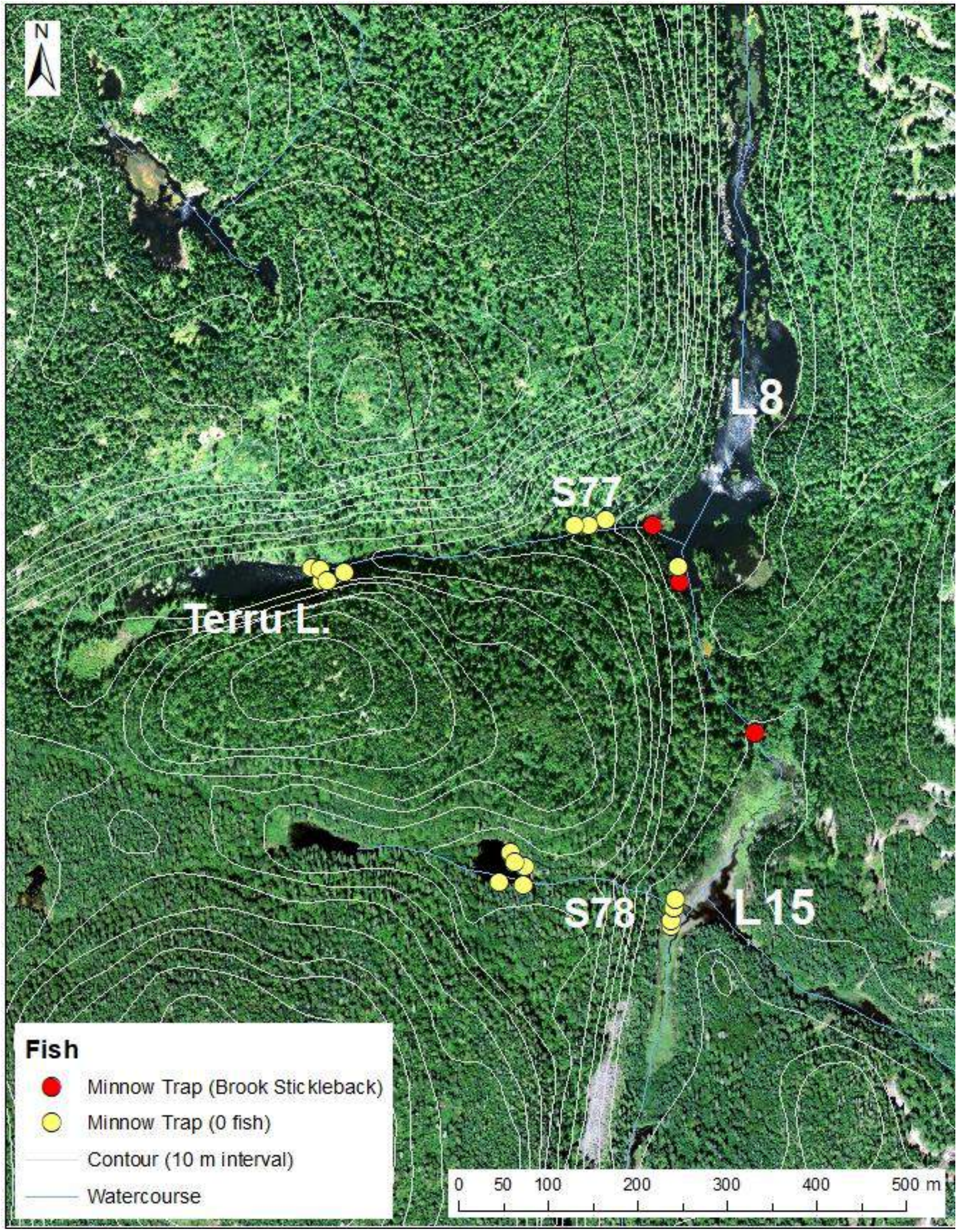

Figure 9. Location of 2020 minnow traps for GenPGM's Marathon Palladium Project.

Literature Cited

Ecometrix Inc. 2012. Marathon PGM-Cu Project Site – Aquatic Resources Baseline Report. Report prepared for Stillwater Canada Inc. by Ecometrix Incorporated, Mississauga, ON. Supporting Information Document (SID) No. 1. 894 p.