Jarvis River Watershed Assessment Report

LAKEHEAD REGION
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2018

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ACKNOWLEDGEMENTS

The 2018 Jarvis River Watershed Assessment was prepared by Rachael Kuipery and Lydia Johnson, Assistant Water Resources Technologists of the Lakehead Region Conservation Authority. Scott Drebit, GIS/Water Resources Technologist of the Lakehead Region Conservation Authority, produced the maps for this report and provided input and revisions towards the final copy. Tammy Cook, Chief Administrative Officer, and Gail Willis, Watershed Manager, also provided guidance, input and revisions towards the completion of this report. Gene Kent, Education Coordinator of the LRCA, assisted with identification and sampling of the soils, and completed the section on geology.

This report has been prepared in-house at the Lakehead Region Conservation Authority for internal purposes to document the condition of the Jarvis River Watershed in 2018.

EXECUTIVE SUMMARY

The Jarvis River Watershed Assessment Report provides baseline data to track progress and water quality over time, and provides the LRCA with a better understanding of the local environment to focus future actions where needed. The results from the collected data were analyzed, and the Jarvis River Watershed was given an overall watershed grade rating; thereby, determining the health status of the watershed.

Background

The Jarvis River Watershed is located within the Municipality of Neebing and covers a drainage area of approximately 110.7 square kilometres. Jarvis River runs approximately 34.1 kilometres in length from its headwaters northeast of Cloud Lake to its confluence with Lake Superior in the southeastern area of the watershed. The general slope of the watershed is approximately 0.40 percent.

The majority of the Jarvis River Watershed is privately owned land (95.5 percent) with the remainder crown land (4.5 percent). The watershed is mainly designated as a rural land use zone within Municipality of Neebing's Official Plan. The Jarvis River outlets to Lake Superior at Jarvis Bay, which is designated as part of the Western Lake Superior Conservation Reserve by the Ministry of Natural Resources and Forestry. The Western Lake Superior Conservation Reserve was selected under *Ontario's Living Legacy* due to significant features such as provincially significant wetlands and various forest communities. The Conservation Reserve also holds cultural and historical significance as well as recreational value. Two abandoned cabins have been located at Jarvis Bay along with abandoned forest access roads (Ministry of Natural Resources, 2004); however, only one abandoned cabin was found on the Jarvis Bay beach during the watershed assessment site visits.

Physical and Biological Attributes

The surficial geology distribution of the Jarvis River Watershed changes from bedrock in the headwaters area, to a ribbon of slope/talus pile adjacent to the bedrock, to glaciolacustrine plain in the central area, to moraine in the eastern portion of the watershed. There are small bands of organics and esker/kame/outwash plains. The bedrock formation is mostly composed of sedimentary rocks; however, there is a significant presence of mafic and related intrusive rocks in the watershed.

The Jarvis River Watershed is located within the boundaries of the Great Lakes and Boreal forest regions. The most common tree species in the watershed are white spruce, trembling aspen, balsam fir, tamarack, white birch, and black spruce. There are a variety of other plants present in the watershed including ferns, shrubs, herbs, mosses and lichens.

Watershed Site Assessment

Eight sample sites located within the Jarvis River Watershed were chosen based on a variety of attributes including: accessibility, physical features, land use designation, proximity to man-made features (that may alter water quality), as well as headwaters used as for baseline conditions. Site 1 is located near the confluence of the Jarvis River at Lake Superior. Sites 4 and 8 were located on the main channel. Sites 2, 3, 5, 6, and 7 were located on tributaries of the main channel.

Surface Water Quality – PWQO Comparison

At each of the eight sample locations, surface water samples and field measurements were collected in 2018 on June 13th and 14th, and July 10th and 11th. Subsequently, the surface water samples were analyzed by ALS Laboratory Group for physical parameters (conductivity, pH, total dissolved solids, and turbidity), nutrients and anions (alkalinity, total ammonia, chloride, nitrate, nitrite, total Kjeldahl Nitrogen, total phosphorus, and sulfate), bacteriological tests (*Escherichia coli (E. coli)*, total coliforms), and a full metal scan. Field measurements were taken using an YSI Pro DSS Multi-Parameter Probe, which included sampling of water temperature, pH, conductivity, turbidity, total dissolved solids, oxidation-reduction potential and dissolved oxygen. Field and laboratory results were compared to the Ministry of Environment and Energy's *Provincial Water Quality Objectives* (PWQO), 1994. Parameters that exceeded the PWQOs include *E. coli*, total coliforms, alkalinity, un-ionized ammonia, phosphorus, aluminum, cadmium, cobalt, copper, iron, vanadium, and zinc.

a) Bacteriological Exceedance

PWQO criterion for *E. coli* bacteria levels is 100 counts per 100 mL. *E. coli*. Counts greater than the criterion indicate that bacterial contamination may be a problem with a waterbody. During the June sampling period, Site 4 (135 MPN/100 mL) exceeded the criterion. During the July sampling period Site 1 (387 MPN/100 mL) and Site 4 (145 MPN/100 mL) exceeded the PWQO criterion. LRCA staff noted that heavy rains occurred in the watershed locally, and 37 mm of rainfall was recorded on July 8, 2018 (i.e. two days prior to July sampling period), which may have caused the higher *E. coli* counts in July.

As there is no current PWQO for total coliforms, results were compared to the pre-1994 PWQO criterion (1,000 MPN/100 mL). During the June sampling period, Sites 2, 3, 4, 5, 6, and 7 were above the criterion. During the July sampling period all sites were above the criterion. Total coliform concentrations in 2018 ranged from 308 MPN/100 mL (Site 1) to >2,420 MPN/100 mL (multiple sites) for the watershed.

Coliform bacteria are living organisms and can multiply quickly when conditions are favorable for growth, or die in large numbers when conditions are not. Additionally, coliform bacteria is a common occurrence in nature from the predatory community. Bacterial concentrations are dependent on specific conditions such as precipitation,

temperature, and stream substrate. The 2018 average temperature during the sampling period was 1.0 degree Celsius higher than the Thunder Bay historical average. The total precipitation in 2018 was 12.3 mm below average compared to the historical total precipitation. As such, higher temperatures and lower precipitation in the Jarvis River Watershed could affect bacteriological counts.

b) Nutrient and Anions Exceedance

The PWQO criterion for alkalinity states that alkalinity should not be decreased by more than 25% of the natural conditions. Based on headwater conditions the criterion was 56.6 mg/L for June and 36.5 mg/L for July. During the June sampling period, Site 1 and 3 were the only sites to meet the criterion. Alkalinity concentrations ranged from 41.4 mg/L (Site 3) to 98 mg/L (Site 6).

The PWQO for un-ionized ammonia is 0.02 mg/L. During the July sampling period Site 6 exceeded the criterion with a value of 0.0216 mg/L. un-ionized ammonia concentrations ranged from 0.0017 mg/L (Site 5) to 0.0216 mg/L (Site 6).

c) Metals Exceedance

The PQWO criterion for phosphorus is 0.03 mg/L. During the June sampling period Sites 2, 3, 4, 5, 6, and 7 were all above the criterion. During the July sampling period Sites 1, 2, 4, 5, 6, and 7 were all above the criterion. Phosphorous concentrations ranged from 0.0153 mg/L (Site 1) to 0.0963 mg/L (Site 1).

The PWQO criterion for aluminum is 0.075 mg/L. During both the June and July sampling periods all sites were above the criterion. Aluminum concentrations ranged from 0.109 mg/L (Site 8) to 2.240 mg/L (Site 1). These values are typically associated with fine-grained sediments.

The PWQO criterion for cobalt is 0.0009 mg/L. During the June sampling period Site 2 (0.00118 mg/L) and Site 6 (0.0010 mg/L) were above the criterion. During the July sampling period Site 1 was above the criteria for cobalt. Cobalt concentrations ranged from 0.00022 mg/L (Site 3 and 8) to 0.00148 mg/L (Site 1).

The PWQO criterion for copper is 0.001 mg/L (0-20 mg/L $CaCO_3$) and 0.005 mg/L (>20 mg/L $CaCO_3$). During the June sampling period Site 2 and 6 were above the criterion. During the July sampling period Sites 1, 2, 4, 6, and 8 were above the criterion. Copper concentrations ranged from 0.00248 mg/L (Site 1) to 0.00961 mg/L (Site 2).

The PWQO criterion for iron is 0.30 mg/L. During both the June and July sampling periods all sites were above the criterion. Iron concentrations ranged from 0.342 mg/L (Site 8) to 3.72 mg/L (Site 1) for the watershed. Iron exceedances are common in the region, due to natural sources.

The PWQO criterion for cadmium is 0.0001 mg/L (0-100 mg/L $CaCO_3$) and 0.0005 mg/L (>100 mg/L $CaCO_3$). During the July sampling period Site 1 was above the criterion. Cadmium concentrations ranged from 0.0000131 mg/L (Site 8) to 0.000109 mg/L (Site 1). The PWQO criterion for vanadium is 0.006 mg/L. During the July sampling period Site 1 was above the criterion. Vanadium concentrations ranged from 0.00095 mg/L (Site 8) to 0.00675 (Site 1).

The PWQO criterion for zinc is 0.02 mg/L. During the June sampling period Site 8 was above the criterion. Zinc concentrations ranged from < 0.003 mg/L (Site 1, 3, 5) to 0.0333 mg/L (Site 8).

Site Observations

The flora and fauna inventory indicated that the Jarvis River Watershed supports a healthy population of diverse plants and animals. The stream banks were stable and showed little signs of erosion although Site 2 showed some signs of erosion on the stream bank in the form of slumping. The culverts located at Sites 5, 6, 7, and 8 were in good and stable condition.

Watershed Report Card Rating

The Jarvis River Watershed was also assessed using the *Guide to Developing Conservation Authority Watershed Report Cards*, 2017. Using the guide, surface water quality, forest conditions, and wetland conditions for the Jarvis River Watershed were used to determine a grade rating for the watershed. Surface water quality maintained a good rating with a few exceedances of *E. coli* present and some exceedances for nutrients and metals within the Jarvis River Watershed. Forest condition scored an overall excellent rating with high forest coverage, forest interior, and of riparian forest cover. Wetland conditions scored an excellent rating with high wetland coverage.

Overall the quality of the Jarvis River Watershed in 2018 was determined to be in good to excellent health, and has a grade of 'B' based on the surface water quality, an 'A' based on the forest conditions, and an 'A' based on the wetland conditions.

Recommendations

Upon completion of the watershed assessment, we offer the following recommendations:

- Staff and funding permitting, it is recommended that an update to the 2018 Jarvis River Watershed Assessment be completed in the next five to ten years.
- Benthic sampling and monitoring should be considered for future watershed assessments because it is a useful indicator of water quality over time.
- Additional sampling should be conducted in the spring to observe the water quality differences between high and low flow seasons.
- A copy of this report should be provided to the Municipality of Neebing for reference purposes. The Report should be kept on file at the LRCA Administration Office for review by interested parties.

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1 INTRODUCTION

The Jarvis River Watershed is located within the Municipality of Neebing as shown on Map M-1: Key Plan Map. Areas regulated by the Lakehead Region Conservation Authority (LRCA) and Municipal boundaries can be found on Map M-2: Regulated Area Map.

A watershed can be defined as all the land and water within the confines of a drainage divide. In essence, the Jarvis River Watershed consists of all the surrounding land that naturally drains its lakes, streams, wetlands and precipitation runoff into the Jarvis River which then flows into Lake Superior.

The headwaters of the main branch begin just north of Oleksuk Road, which lies within the boundaries of the Municipality of Neebing. The watershed covers a drainage area of approximately 110.7 square kilometres. Most of the watershed is dominated by white spruce, white birch, tamarack, black spruce, balsam fir, and trembling aspen. The Jarvis River runs approximately 34.1 kilometres in length through well-defined drainage courses and valleys.

The goal of this report is to document the conditions of the watershed, especially surface water quality, as observed in June and July of 2018. Eight sampling sites were chosen to access the health of the watershed as a whole. This information will ultimately be used to develop and maintain programs to sustain a healthy ecosystem consistent with the Natural Hazards and Natural Heritage Policies of the Province of Ontario.

The main objectives of this assessment report are to:

- Summarize the physical, biological and socio-economic attributes of the watershed,
- Collect surface water quality data,
- Collect field measurements,
- Conduct an inventory of the forest ecosystem and fauna observed within the watershed,
- Conduct an inventory of soil, streambed substrate and stream bank cover observed within the watershed,
- Document active erosion sites,
- Document the physical condition of all Jarvis River water crossings (bridges/culverts), and
- Interpret results to record the health status of the watershed.

2 BACKGROUND

2.1 Physical Attributes

2.1.1 Topography

Jarvis River originates in the northwestern area of the watershed and flows in a southeast direction through to its confluence at Jarvis Bay in Lake Superior. The highest elevation is approximately 492 metres above sea level (315206 E, 5341174 N) to the northwest, which is underlain by sedimentary rock. The lowest elevation is approximately 183 metres above sea level (324751 E, 5332054 N) at the mouth of the Jarvis River at Jarvis Bay in Lake Superior. The overall slope of the Jarvis River is approximately 0.90 percent, having a channel length of 34.1 kilometres.

The general topography of the Jarvis River Watershed has irregular areas that are slightly sloped at 0.5 percent to 2.0 percent; however, as shown on the Soils of the Thunder Bay Area map, some areas have steep slopes greater than 16 percent (see Figure 1: Soils of the Thunder Bay Area). The overall Jarvis River Watershed topography is shown on Map M-3: Topography.

2.1.2 Geology & Soils

2.1.2.1 Bedrock

The Jarvis River Watershed headwaters, and western boundary, which is composed of Paleoproterozoic sedimentary rocks and Mesoproterozoic mafic and related intrusive rocks, begins in an area of high elevation bounded by a bedrock ridge of diabase that divides it from Cloud Lake and Cloud River Watershed. The eastern end of the watershed is bounded by diabase sheets and dykes which mainly trend north to south from Loch Lomond towards Jarvis Bay. The diabase rock is about 1.1 billion years old, and represents the youngest and most erosion resistant rock formation in the area. These diabase sills form flat top hills called mesas. The diabase rock, which forms the mesas, were intruded as flat lying magma in between layers of sedimentary rock. The southern and central portion of the watershed is a deeply eroded area underlain by the Rove Formation. Most of the low lying watershed areas are underlain by Paleo-Proterozoic rocks consisting of argillaceous shales of the Rove Formation as well as mudstone, greywacke, argillite and siltstone. These rocks are between 1.6 and 2.2 billion years old. The sedimentary rocks form the lowland valleys in the central portion of the watershed.

The overlying sediments have eroded away over the last billion years leaving the igneous rock exposed along the tops of the mesas. The hard diabase sills form steep talus slopes where erosion has occurred along the edge of the mountains. A broken area of shale

regolith can be seen at the base of some of the mesas; this may form the bedrock interface throughout the watershed. The shale rock and regolith layers are permeable; this means that bedrock source water wells in the area could be affected by groundwater runoff infiltrating into the rock. The interface between the shale and intrusive diabase sills forms another area in which groundwater is channeled.

2.1.2.2 Surficial Geology

Map M-5: Surficial Geology is based on the Northern Ontario Engineering Geology Terrain Study (NOEGTS); it details the main types of overburden as well as their glaciofluvial origins. The surficial geology distribution changes from bedrock (14.2 percent) and slope/ talus pile (6.4 percent) in the headwaters area of Jarvis River, with esker/ kame/ outwash plain (0.6 percent) in the northeastern area near Loch Lomond Lake, to moraine (32.6 percent) in the eastern area of the watershed, organic soils (7.7 percent) and to glaciolacustrine plain (38.6 percent) at the confluence of Jarvis River at Lake Superior. A number of sand and gravel pits are mapped along Highway 61 and the beginning of Sturgeon Bay Road. These aggregate pits, and at Site 8, indicate that moraine deposits exist at the western end of the watershed where the provincial data shows silty loams and clay of glaciolacustrine origin.

Most of the underlying sedimentary bedrock in the Jarvis River Watershed is deeply eroded and the visible geology consists of Holocene Age sediments. The substrates or sediments were laid down as glacial outwash and lake bottom deposits called glaciolacustrine horizons. The majority of the sediments and soils have been deposited by the Jarvis River and by historical flooding of the area by Glacial Lake Kaministiquia and Glacial Lake Minong. During the time period of 8,000 to 10,000 years ago, thick beds of silt and clay loam material were deposited on the glacial lake bottom. These lacustrine soils form the lowland and river valley of the watershed.

2.1.2.3 Soils

Soil logging for this Watershed Assessment Report was completed to test the extent of the Northern Ontario Engineering Geology Terrain Study (NOEGTS) soil types. The soil logging was completed using criteria derived from the “Field Guide to the Substrates of Ontario” (MNRF, March 2015). Soil samples were taken and logged using a 1.2 metre soil auger. The depth of the organic layer as well as the depth, composition and characteristics of the A, B and C soil horizons were logged at the eight sampling sites along Jarvis River. Map M-6: Soils illustrates the location of the eight soil sampling sites.

Clay soils were encountered at Site 6. This suggests that the provincial soils data is fairly accurate in the central part of the watershed. Silty-clay was encountered in auger samples at Site 2. The entire access road which travels north from Jarvis Bay Road East is situated

on clay. The large organic area mapped could not be established in this study as none of the soils tested had a well developed organic layer. The "A" horizon soils are always less than 0.3 metre in thickness and often transition directly to the "C" horizon of mineral soils. The photograph at Site 8 shows a typical moraine type of substrate. The high percentage of cobbles and sand is typical of ground moraine with some reworking by fluvial processes. The silty loam and silty clay loam areas mapped in the centre of the watershed is a fair characterization and has been confirmed by the sampling program. The moraine and organic areas could not be substantiated. The majority of soils consist of silty loam with areas of moderately fine loam with occurrences of silty clay loam.

The soil testing results and photographs of each soil profile are shown in Appendix A: Soil Logging Summary and Photography.

2.1.3 Climate

The climate of the Jarvis River Watershed is similar to the Thunder Bay region, in that it is a modified continental climate influenced by Lake Superior. From the months of March to July the westerly winds prevail, whereas the easterly winds prevail the remainder of the year (LRCA, 1985). These winds modify the climate of Thunder Bay and the surrounding regions. The mean daily temperatures (degrees Celsius) and precipitation levels (millimetres) were recorded at the Thunder Bay Airport from 1971 to 2000 (Environment Canada, 2018) as shown in Table 2.1-1. This table also summarizes the extreme daily precipitation in millimetres recorded within a 24-hour period and the date it occurred.

Table 2.1-1: Average Monthly Temperature and Precipitation for Thunder Bay, 1971-2000

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Temperature												
Daily (° C)	-14.8	-12.0	-5.5	2.9	9.5	14.0	17.6	16.6	11.0	5.0	3.0	-11.6
Precipitation												
Total Precipitation (millimetres)	31.3	24.9	41.6	41.5	66.5	85.7	89	87.5	88	62.6	55.6	37.5
Extreme Max. Daily Precipitation (millimetres)	51.6	33.5	41.9	69.3	76.2	49.3	53.8	87.1	131.2	47.8	63.0	42.7
Date (yyyy /dd)	1956 /20	1951 /26	1957 /14	1954 /30	1971 /24	1947 /04	1973 /27	1973 /19	1977 /08	1968 /09	1973 /21	1948 /05

The average monthly temperatures (degrees Celsius) and precipitation levels (millimetres) were recorded at the Thunder Bay Airport for 2018 (Environment Canada, 2018), as shown below.

Table 2.1-2: Average Monthly Temperature and Precipitation for Thunder Bay, January-July 2018

	Jan	Feb	Mar	Apr	May	June	July
Average Temperature							
Daily (° C)	-13.1	-14.1	-5.6	-1.2	10.2	14.7	18.9
Precipitation							
Total Precipitation (millimetres)	26.5	29.7	5.0	12.0	53.5	79.2	70.9

The average monthly temperature for the June and July sampling periods was 16.8 degrees Celsius and the average monthly precipitation was 75.1 millimetres. In comparison with the historical data, the 2018 temperature was 1.0 degree Celsius higher than the average for June and July. The 2018 precipitation for June was 12.3 millimetres lower than the historical average precipitation. In general, temperatures in June and July were near normal while the received precipitation for June and July was below average.

Additionally, the average precipitation for the February, March and April was 40% below the historical average, and thus the Lakehead Region Conservation Authority declared a Level 1 Low Water condition on May 15, 2018. Subsequently, a Level II Low Water condition was declared on June 1, 2018 based on observations and calculations for the period of March, April and May. The low water conditions continued through to the end of September and until the LRCA un-declared it on October 4, 2018.

2.1.4 Hydrology

The main channel of the Jarvis River Watershed is 34.1 kilometres in length and the watershed itself covers an area of approximately 110.7 square kilometres which flows, generally, in a south-easterly direction to its confluence with Lake Superior. The surface water drainage area has been estimated at 1.6 square kilometres and the wetland area has been estimated to be 13.6 square kilometres. There are no identified provincially significant wetlands within the watershed.

2.2 Biological Attributes

2.2.1 Flora

The Jarvis River Watershed is located within the boundaries of the Great Lakes forest region and the Boreal forest region as shown on the Canada's Forest Regions map (Figure 2: Canada's Forest Regions). The trees, which comprise the Great Lakes forest region, are primarily white pine, red pine and yellow birch. Although the watershed is geographically located in this forest region, the tree species observed are more indicative of a Boreal forest region, as the trees present are predominantly black spruce, tamarack, jack pine, white birch and trembling aspen. This discrepancy is likely due to the fact that the

watershed is relatively close to the Boreal forest region and mechanisms such as local climate (slope, aspect), site condition (soil characteristics), disturbance regimes and species interaction can affect the species distribution in the area. The coarse scale of the Canada's Forest Regions distribution map is only a basic division of the forest types, and there is no discrete line that separates the two zones. Factors mentioned above could easily alter forest types, which are located between two zones.

There are a variety of other plant species present in the Jarvis River Watershed including ferns, shrubs, herbs, mosses and lichens. Plant species identified at the sample sites are listed in Appendix B: Common and Scientific Names of Identified Flora and Fauna.

2.2.2 Fauna

The Jarvis River Watershed provides breeding grounds for a variety of wildlife. Species of amphibians, reptiles, and butterflies that have been sighted in the watershed and surrounding area historically, and recently, are listed below in Table 2.2-1. The Jarvis River Watershed is part of the Ontario Ministry of Natural Resources and Forestry (OMNRF) Wildlife Management Unit 13 and Fisheries Management Zone 6.

A complete list of the wildlife observed in the watershed is shown in Appendix B: Common and Scientific Names of Identified Flora and Fauna.

Table 2.2-1 : Common Reptiles, Amphibians, and Butterflies

Species Name	
Common Name	**Scientific Name**
Amphibians and Reptiles	
Blue-Spotted Salamander	*Ambystoma laterale*
Jefferson Salamander	*Ambystoma jeffersonianum*
Snapping Turtle	*Chelydra serpentine*
Western Painted Turtle	*Chrysemys picta bellii*
Eastern Garter Snake	*Thamnophis sirtalis sirtalis*
Eastern Newt	*Notophthalmus viridescens viridescens*
Mudpuppy	*Necturus maculosus*
American Toad	*Anaxyrus americanus*
Boreal Chorus Frog	*Pseudacris maculata*
Gray Tree Frog	*Hyla versicolor*
Green Frog	*Lithobates clamitans*
Mink Frog	*Lithobates septentrionalis*
Northern Leopard Frog	*Lithobates pipiens*
Spring Peeper	*Pseudacris crucifer*
Wood Frog	*Lithobates sylvaticus*
Butterflies	
Juvenal's Duskywing	*Erynnis juvenalis*
European Skipper	*Thymelicus lineola*
Common Branded Skipper	*Hesperia comma*

Table 2.2-1 : Common Reptiles, Amphibians, and Butterflies	
Species Name	
Common Name	Scientific Name
Long Dash Skipper	*Polites mystic*
Canadian Tiger Swallowtail	*Papilio Canadensis*
Mustard White	*Pieris oleracea*
Cabbage White	*Pieris oleracea*
Clouded Sulphur	*Colias philodice*
Atlantis Fritillary	*Speyeria atlantis*
Northern Crescent	*Phyciodes cocyta*
Satyr Comma	*Polygonia satyrus*
Mourning Cloak	*Nymphalis antiopa*
Milbert's Tortoiseshell	*Algais milberti*
American Lady	*Vanessa virginiensis*
Painted Lady	*Vanessa cardui*
Red Admiral	*Vanessa atalanta*
White Admiral	*Limenitis arthemis*
Northern Pearly-Eye	*Lethe anthedon*
Common Wood-Nymph	*Cercyonis pegala*
Monarch	*Danaus plexippus*

Source: Ontario Butterfly Atlas & Reptile and Amphibian Atlas, 2015

2.2.3 Species at Risk

Ontario has more than 200 species at risk living in its forests and lakes, all at varying degrees of risk. There are approximately 19 species at risk in the Thunder Bay region that have potential to exist within the Jarvis River Watershed. In addition to the watershed boundary limits, the surrounding area is considered Boreal forest region, which would allow for movement of individuals in and out of the watershed boundary.

Table 2.2-2, below, shows the species at risk in the Thunder Bay region.

Table 2.2-2: Species at Risk		
Species Name		Status of Risk
Common Name	Scientific Name	
American White Pelican	*Pelecanus erythrorhynchos*	Threatened
Bald Eagle	*Haliaeetus leucocephalus*	Special Concern
Barn Swallow	*Hirundo rustica*	Threatened
Black Tern	*Chlidonias niger*	Special Concern
Bobolink	*Dolichonyx oryzivorus*	Threatened
Eastern Whip-poor-will	*Antrostomas vociferus*	Threatened
Golden Eagle	*Aquila chrysaetos*	Endangered
Least Bittern	*Ixobrychus exilis*	Threatened
Loggerhead Shrike	*Lanius ludovicianus*	Endangered
Peregrine Falcon	*Falco peregrinus*	Special Concern
Yellow Rail	*Coturnicops noveboracensis*	Special Concern

Table 2.2-2: Species at Risk		
Species Name		Status of Risk
Common Name	Scientific Name	
Lake Sturgeon	*Acipenser fulvescens*	Special Concern
Northern Brook Lamprey	*Ichthyomyzon fossor*	Special Concern
Shortjaw Cisco	*Coregonus zenithicus*	Threatened
American Badger	*Taxidea taxus*	Endangered
Wolverine	*Gulo gulo*	Threatened
Caribou, Boreal population	*Rangifer tarandus*	Threatened
Pitcher's Thistle	*Cirsium pitcheri*	Threatened
Snapping Turtle	*Chelydra serpentina*	Special Concern

Source: Ontario Ministry of Natural Resources and Forestry - Species at Risk in Thunder Bay Region, 2016

2.2.4 Invasive Species

Invasive species are a threat to native plants and animals and can disturb entire ecosystems. They are introduced and spread as a result of movement of people and goods around the world, increased urbanization, improved transportation routes and through recreational activities.

Some of the ways invasive species can enter Ontario include, but are not limited to,:

- All-terrain vehicles,
- Aquarium, water garden and pet trades,
- Ballast water of ships,
- Canals and changes to waterways,
- Gardening and landscaping,
- Release of live fish and bait,
- Transport of topsoil,
- Recreational and commercial boating,
- Transport of animal carcasses or products made from them, and
- Transport of raw wood and other forest products.

Invasive species that were observed in the Lake Superior or District of Thunder Bay area may be present in the Jarvis River Watershed according to the Canada/Ontario Invasive Species Centre, OMNRF and the Ontario Federation of Anglers and Hunters' Early Detection and Distribution Mapping System. These invasive species are listed below in Table 2.2-3.

Table 2.2-3 : Invasive Species	
Species Name	
Common Name	Scientific Name
Canada Thistle	*Cirsium arvense*
Chinese Mitten Crab	*Eriocheir sinensis*
Common Reed	*Phragmites australis*

Table 2.2-3 : Invasive Species	
Species Name	
Common Name	**Scientific Name**
Eurasian Ruffe	*Gymnocephalus cernua*
European Common Reed	*Phragmites australis ssp. australis*
European Flounder	*Platichthys flesus*
Flowering-Rush	*Butomus umbellatus*
Garlic Mustard	*Alliaria Petiolata*
Goldfish	*Carassius auratus*
Himalayan Balsam	*Impatiens glandulifera*
Hybrid Cattail	*Typha x glauca*
Japanese Knotweed	*Reynoutria japonica*
Narrow-leaved Cattail	*Typha angustifolia*
New Zealand Mud Snail	*Potamopyrgus antipodarum*
Purple Loosestrife	*Lythrum salicaria*
Rainbow Smelt	*Osmerus mordax*
Round Goby	*Neogobius melanostomus*
Rusty Crayfish	*Orconectes rusticus*
Spiny Water Flea	*Bythotrephes longimanus*
Tatarian honeysuckle	*Lonicera tatarica*
Three Spine Stickleback	*Gasterosteus aculeatus*
Tubenose Goby	*Proterorhinus marmoratus*
White Perch	*Morone Americana*
Wild Chervil	*Anthriscus sylvestris*
Wild Parsnip	*Pastinaca sativa*
Yellow Sweet-Clover	*Melilotus officinalis*
Yellow Iris	*Iris pseudacorus*
Zebra Mussel	*Dreissena polymorpha*

Source: Early Detection & Distribution Mapping System for Ontario, 2018

2.3 Socio-Economic Attributes

2.3.1 Planning & Development Controls

Land Tenure

The majority of the Jarvis River Watershed is designated as privately owned land (95.5 percent) with the remainder designated as provincially owned Crown land (4.5 percent). Land ownership in the watershed is illustrated on Map M-7: Land Ownership.

Areas of Jurisdiction

The hydrological boundaries of the Jarvis River Watershed fall within the Municipality of Neebing, which includes the Geographic Township of Blake, Crooks, and Pearson. Map M-7: Land Ownership, illustrates the location of the Jarvis River Watershed within these areas.

Within Regulated Areas, the Authority administers the Development, Interference with Wetlands and Alterations to Shorelines and Watercourses O. Reg 180/06 under the Conservations Authorities Act. Areas considered regulated include: Provincially Significant Wetlands and 120 metres adjacent, all watercourses, all land zoned Hazard Land, Use Limitation or Environmental Protection, steep slopes, and 15 metres landward and one kilometre lakeward from the 100-year flood level on Lake Superior (i.e. 183.90 metres Geodetic Survey of Canada), as shown on Map M-2: Regulated Area. Activities within the approximate regulated area may require a permit from the Authority.

2.3.1.1 Land Use Designation/Zoning

Municipal Official Plans contain long term goals and policies that serve as guidelines for future land use and development. The Jarvis River Watershed is affected by the the Municipality of Neebing Official Plan and Zoning by-laws. Land use designations within the Jarvis River Watershed can be found on Map M-8: Zoning.

The policies of the Official Plan and all land use designations are implemented through zoning by-laws. Zoning provides an additional level of detail, particularly with respect to the range of permitted uses and any specific conditions that must be satisfied such as buffering, suitable distances between uses and parking requirements.

Within the Municipality of Neebing, the Jarvis River Watershed has been identified for the following land-use zones:

- Use Limitation (UL) Zone,
- Rural (R) Zone,
- Light Industrial (M1) Zone,
- Extractive Industrial (E) Zone,
- Institutional (I) Zone, and
- General Commercial (C1) Zone.

The following definitions are taken from the Municipality of Neebing Zoning By-Law No. 2017-030, dated September 2017.

Use Limitation (UL) Zone

The Use Limitation (UL) Zone is always a dual zone, which is applied together with an underlying main Zone. The purpose of the Use Limitation (UL) Zone is to control land uses near watercourses, wetlands, areas requiring protection, and other hazards, such as talus slopes. This Zone is under the jurisdiction of the Lakehead Region Conservation Authority. That public authority has the jurisdiction to regulate and/or prohibit development in these areas. Lands controlled in this regard include the lands falling within the Use Limitation (UL) Zone areas on the Schedules to this By-Law, and also include: i) Land within

45 metres of a watercourse, ii) Land within 45 metres of a wetland, or iii) Land within 45 metres of other hazards or area of protection regulated by the Lakehead Region Conservation Authority.

Rural (R) Zone

No person shall, within any Rural (R) Zone, use any lot or erect, alter or use any building or structure for any purpose except for one of the following uses: (1) a single dwelling, (2) a modular dwelling, (3) an agricultural use, (4) a forestry use, (5) a stable, (6) watershed management and conservation areas, (7) a home occupation, (8) a home industry, (9) a guest cottage, (10) a bed and breakfast establishment, (11) mineral exploration, or (12) buildings or structures that would be accessory buildings to any of the above uses, had those uses been established prior to the erection of the accessory building or structure.

Light Industrial (M1) Zone

No person shall, within any Light Industrial (M1) Zone, use any lot or erect, alter or use any building or structure for any purpose except for one of the following uses: (1) an automotive use, (2) an equipment sales and service dealership, (3) manufacturing operations or establishment, (4) a trade shop, (5) a warehouse, (6) a business office or commercial outlet associated with one of the above permitted uses, or (7) an accessory dwelling to the uses listed above.

Extractive Industrial (E) Zone

No person shall, within any Extractive Industrial (E) Zone, use any lot or erect, alter or use any building or structure for any purpose except for one or more of the following uses: (1) pits and quarries for extracting sand, clay, gravel, earth, stone, shale, peat, amethyst, and minerals, (2) stockpiling of sand, clay, gravel, earth, stone, shale, peat, amethyst, and any mineral, (3) a temporary asphalt plant, or (4) a temporary crushing plant.

Institutional (I) Zone

No person shall, within any Institutional (I) Zone, use any lot or erect, alter or use any building or structure for any purpose except for one of the following uses: (1) a public or private school, (2) an adult or child day care facility, (3) a group home, (4) a cemetery, (5) a Federal, Provincial, or Municipal building, garage or office, (6) a fire station, (7) a church, (8) a church camp, (9) a community hall, (10) a community center, or (11) an assembly hall.

General Commercial (C1) Zone

No person shall, within any General Commercial (C1) Zone, use any lot or erect, alter or use any building or structure for any purpose except for one of the following uses: (1) an automobile service station, (2) a commercial garage, (3) a community center, (4) an entertainment facility, (5) a gasoline retail outlet, (6) a hotel, (7) a restaurant, (8) a retail lumber yard, (10) a retail outlet, (11) a merchandise repair shop, (12) a vehicle repair shop, (13) a vehicle sales or rental establishment, or (14) an accessory dwelling to the uses listed above.

3 WATERSHED SITE ASSESSMENT

A summary of the sampling techniques used is included in Appendix C: Techniques for Data Collection.

3.1 Site Selection

Eight sites were chosen within the Jarvis River Watershed to assess the health of the watershed as a whole. Each site was chosen based on its accessibility and its proximity to natural or man-made features that may alter water quality. Site locations can be found on Map M-9: Site Plan.

3.2 Quantitative Assessment – Surface Water Quality

Several parameters were measured to assess surface water quality of the Jarvis River. Surface water samples were collected in laboratory supplied bottles by LRCA staff and summer students and transported on ice, to ALS Laboratory Group, 1081 Barton Street, Thunder Bay, Ontario. An analysis was conducted on the samples to determine conductivity, total dissolved solids (TDS), turbidity, nutrients (ammonia-N total nitrogen, alkalinity, chloride, sulfate, nitrate, nitrite and phosphorus), bacteria (*E. coli* and total coliforms) and total metals.

Sampling was conducted on two separate occasions for each site, to enable comparisons and reveal discrepancies. The first data set was collected on June 13 and 14, 2018. The second data set was collected on July 10 and 11, 2018.

Methodology for water sample collection was based on the Provincial Water Quality Monitoring Network (PWQMN), Ministry of the Environment and Climate Change, protocol. Grab samples were collected away from the stream bank in the main current by wading or by using a reaching pole. Effort was taken to enter the stream downstream of the sampling location in order to disturb as little sediment as possible. Additionally, samples were taken upstream from any water crossings and/or outlet culverts and were taken facing upstream into the current. In cases where current was not detectable (stagnant water) or current was flowing in the opposite direction (influenced by wind direction), samples were still collected facing upstream. Samples were collected at a depth of 0.3 metres below the surface of the water to avoid capturing any floating debris.

ALS Laboratory Group provided five collection bottles for each site to conduct the following tests: physical parameters, anions and nutrients, bacteriological, and total metals. The physical analysis sample bottles and lids were rinsed three times before a true sample was collected. The ALS Laboratory Group pre-charged the anion and nutrients sample bottles with sulfuric acid and the total metals bottles were pre-charged with nitric

acid to preserve the samples taken, and were not rinsed before filling. Bottles for bacteriological analysis were also not rinsed as they were pre-charged with sodium thiosulphate preservative and special care was taken not to open the bottle until the true sample was to be filled. All filled sample bottles were transported on ice for delivery to the laboratory.

Field parameters of water temperature, pH, conductivity, turbidity, dissolved oxygen, total dissolved solids, and oxygen reduction potential were measured using an YSI ProDSS multi-parameter water quality sampler at the time of water sample collection. The following additional field parameters were also measured: air temperature by mercury thermometer, channel width using a measuring-tape reel, channel depth using a weighted measuring tape reel and velocity was measured using a stick, measuring tape, stopwatch and appropriate calculations. Velocity was only measured for water running downstream (not in ponds producing only windblown results). A description of the water quality parameters is attached in Appendix D: Summary of Water Quality Parameters.

3.3 Applicable Criteria – Provincial Water Quality Objectives

Surface water quality results from the Jarvis River Watershed were compared to applicable criteria published in the *Provincial Water Quality Objectives* (PWQO) by the Ontario Ministry of Environment and Energy, July 1994. The goal of the PWQO is to ensure that the surface waters of the province are of the quality that is satisfactory for aquatic life and recreation.

The applicable criteria published in the PWQO water quality guidelines are attached in Appendix E: Water Quality Guidelines. Total Coliform results were compared to the pre-1994 PWQO, as there are no current criteria.

3.4 Qualitative Assessment – Site Observations

Watershed health can also be assessed by qualitative monitoring (i.e. visual inspection). The composition of in-stream substrate, forest soil, stream bank riparian community, shoreline vegetation and condition of the stream bank can all affect water quality. The presence or absence of certain flora and fauna can indicate the status of the watershed to provide suitable habitat. Twelve field guides were used to identify terrestrial and aquatic species. Each site was given a Vegetation Type (V-type) allocation based on the *Field Guide to the Forest Ecosystem Classification for Northwestern Ontario* (Sims *et al.* 1997). Sites were assessed based on vegetation that could be seen from the site, with no distinct sample area, using a dichotomous key. It is important to note that these classifications are a general overview of a larger area and no site was exactly the same as another. Differences or inconsistencies between the V-types should be expected.

Vegetation Types for each site are attached in Appendix F: Forest Ecosystem Classification. Common and Latin names of plant species are attached in Appendix B: Common and Scientific Names of Identified Flora and Fauna. Fauna was assessed by identifying the species and number of individuals observed at each site.

An inventory of the Jarvis River water crossings (culverts) was conducted. Physical dimensions were measured, Universal Transverse Mercator (UTM) coordinates and pictures were taken and general observations were noted including high water marks, stability of fill and any restriction of flow. Culvert locations can be found on Map M-10: Culvert Sites. The culvert assessments are attached in Appendix G: Culvert Assessments.

3.5 Watershed Report Card Rating

The Conservation Authorities in Ontario have developed the Watershed Report Card (WRC) as a means of reporting and designating watershed health through the use of environmental indicators and to utilize the information to better target programs and measure environmental change. Four resource categories are measured in the Watershed Report Cards, which include surface water quality, forest conditions, wetland conditions, and groundwater quality. The grading system for each resource category is recognized as A-Excellent; B-Good; C-Fair; D-Poor; F-Very Poor.

Surface water quality, forest conditions, and wetland cover was measured for the Jarvis River Watershed. The three indicators used to assess surface water quality for the watershed are total phosphorus, *Escherichia coli* (*E. coli*), and benthic macroinvertebrates. Benthic macroinvertebrates were not studied in this watershed assessment so the data is not available for assessment. The average point score of the surface water indicators is used to determine the overall surface water quality grade. No groundwater data was available for the watershed.

Forest conditions utilize three indicators to determine the grade for the quality of the forest, which include forest coverage, forest interior percentage and percentage of riparian zone forested. Forest cover is the percentage of the watershed that is forested. Forest interior is the area of forest that lies more than 100 metres from a forest edge. Forest riparian zone measures the amount of forest cover within 30 metres adjacent to all open watercourses. Northern Ontario Forest Cover criteria requires a different scoring system because the targets used for the Watershed Report Card were set by Environment Canada for southern Ontario. The minimum threshold set by Environment Canada for forest cover in Northern Ontario is probably well over 30% because it must be able to sustain species such as bear, moose, and boreal birds. A preliminary grading system for percentage forest cover in Northern Ontario has been suggested for the Watershed Report Card.

Percent wetland cover is the percentage of the watershed that is in wetland cover. Wetlands include swamps (treed and thicket), bogs, fens, and marshes.

Table 3.5-1: 2011 Surface Water Quality Indicator Guidelines

					Overall Surface Water Quality Grade	
Total Phosphorus (mg/L)	***E. coli* (#100 mL)**	**Benthic Invertebrates**	**Point Score**	**Grade**	**Final Points**	**Final Grade**
<0.020	0-30	0.00-4.25	5	A	>4.4	A
0.020-0.030	31-100	4.26-5.00	4	B	3.5 - 4.4	B
0.031-0.060	101-300	5.01-5.75	3	C	2.5 - 3.4	C
0.061-0.180	301-1000	5.76-6.50	2	D	1.5 - 2.4	D
>0.180	>1000	6.51-10.00	1	F	<1.5	F

Table 3.5-2: 2011 Forest Conditions Indicator Guidelines

					Overall Forest Conditions	
% Forest Cover (N. Ontario Grading Option 1)	**% Forest Interior**	**% Riparian Zone Forested**	**Point Score**	**Grade**	**Final Points**	**Final Grade**
>75.0	>11.5	>57.5	5	A	>4.4	A
65.1 - 75.0	8.6 - 11.5	42.6- 57.5	4	B	3.5 - 4.4	B
55.1 - 65.0	5.6 - 8.5	27.6 - 42.5	3	C	2.5 - 3.4	C
45.1 – 55.0	2.5 - 5.5	12.5 - 27.5	2	D	1.5 - 2.4	D
<45.1	<2.5	<12.5	1	F	<1.5	F

Table 3.5-3: 2017 Grading system for Percentage Wetland Cover

Grade	% Wetland Cover
A	>11.5
B	8.6-11.5
C	5.6-8.5
D	2.5-5.5
F	<2.5

3.6 Materials

Materials used during the assessment included:

- Auger,
- Chest waders,
- Clipboard and observation chart paper,
- Cooler and ice packs,
- Digital underwater camera,
- Field guides,
- High visibility vests,
- Latex gloves,
- Measuring tape reel,

- Mercury thermometer,
- Metre stick,
- Road map,
- Sampling bottles and preservative provided by ALS Laboratory Group,
- Stopwatch,
- Tarp,
- Trimble Geo XH GPS,
- Writing utensils, and
- YSI Pro DSS metre.

Field Guides:

- Field Guide to the Forest Ecosystem Classification for Northwestern Ontario (Sims *et al.,* 1997),
- Terrestrial and Wetland Ecosites of Northwestern Ontario (G. Racey *et al.*, 1996),
- Wetland Plants of Ontario (Newmaster *et al.*, 1997),
- Atlas of the Breeding Birds of Ontario (Cadman *et al.*, 2007),
- Newcomb's Wildflower Guide (Newcomb, 1977),
- Forest Plants of Northeastern Ontario (Legasy *et al*.,1995),
- Bugs of Ontario (Acorn, 2003),
- Shrubs of Ontario (Heimburger & Soper, 1982),
- Trees in Canada (Farrar, 1995),
- Forest Plants of Central Ontario (Chambers *et al.*,1996),
- Birds of Ontario (Bezener, 2000), and
- INaturalist app (California Academy of Sciences, 2008).

4 RESULTS

Site photos from each sampling site are attached in Appendix H: Site Photography. The laboratory water quality results and PWQO criteria have been compared and attached in Appendix I: Laboratory Water Quality Results Summary Tables June and Appendix J: Laboratory Water Quality Results Summary Tables July. The original Laboratory Certificates of Analysis and Analytical Reports have been attached in Appendix K: Laboratory Certificates of Analysis and Test Results.

The results for the Jarvis River Watershed are summarized in the tables below for each site.

4.1 Site 1

Site 1 was located at the confluence of the Jarvis River and Lake Superior at Jarvis Bay. The area has been identified as part of the Western Lake Superior Conservation Reserve. The substrate at this site consisted of predominantly sand mixed with gravel. The banks of the creek were stable with abundant vegetation in the riparian zone including: white spruce, balsam fir, tamarack, and speckled alder. There was no erosion present along the banks. The soil type present at this site was a sand in the "C" Horizon.

The laboratory results from both the June and July 2018 sampling periods showed that aluminum and iron exceeded the PWQO guidelines. During the July sampling period had additional exceedances in alkalinity, phosphorous, cadmium, copper, cobalt, vanadium, *E. coli*, and total coliforms.

Aluminum results exceeded the PWQO criterion (0.075 mg/L) with a value of 0.317 mg/L on June 14, 2018 and 2.240 mg/L on July 10, 2018.

Iron exceeded the PWQO criterion (0.3 mg/L) with a value of 0.487 mg/L on June 14, 2018 and a value of 3.72 mg/L on July 10, 2018.

Alkalinity results exceeded the PWQO criterion (36.5 mg/L as $CaCO_3$ for July) with a value of 58.2 mg/L on July 10, 2018.

Phosphorous results exceeded the PWQO criterion (0.03 mg/L) with a value of 0.0963 mg/L on July 10, 2018.

Cadmium results exceeded the PWQO criterion (0.0001 when 0-100 mg/L $CaCO_3$) with a value of 0.0001090 mg/L on July 10, 2018.

Copper results on July 10, 2018 exceeded the PWQO criterion (0.005 when <20 mg/L $CaCO_3$) with a value of 0.00898 mg/L.

Cobalt results exceeded the PWQO criterion (0.0009 mg/) with a value of 0.00148 mg/L on July 10, 2018.

Vanadium results exceeded the criterion (0.006 mg/L) with a value of 0.00675 mg/L on July 10, 2018.

E. coli results exceeded the PWQO criterion (100 MPN/100 mL) with a value of 387 MPN/100 mL on July 10, 2018.

Total Coliforms were above the pre-1994 PWQO criterion (1,000 MPN/100 mL) with a value of >2,420 MPN/100 mL) on July 10, 2018.

Table 4.1-1: Location References for Site 1

Location Description	Confluence of Jarvis River with Lake Superior, Jarvis Bay Road East
UTM Coordinates	Northing 5331983 Easting 324756
Altitude/Elevation	183 metres above sea level

Table 4.1-2: Field Measurements for Site 1

Parameter	**Unit**	**Date:** 14-JUN-18 **Time:** 10:30	**Date**: 10-JUL-18 **Time**: 13:10
Water Temperature	°C	11.8	20.2
Conductivity	uS/cm	106.8	113.6
Dissolved Oxygen	mg/L	11.27	8.34
Dissolved Oxygen	%	103.8	92.1
pH		8.92	7.73
Turbidity	NTU	10.5	51.1
Air Temperature	°C	22.0	25.0
Total Dissolved Solids	mg/L	69.804	73.884
Channel Width	m	37.3	37.3
Channel Depth	m	0.6 (at sampling location)	0.6
Velocity	m/s	N/A	N/A

Table 4.1-3: Select Laboratory Water Quality Results for Site 1

Parameter	**Unit**	**PWQO Guidelines**	**Date:**14-JUN-18 **Time:** 10:30	**Date:** 10-JUL-18 **Time:** 13:10
Bacteriological				
Escherichia coli	MPN/100mL	100	6	**387**
Total Coliforms	MPN/100mL	1,000 (prior to 1994)	308	**>2,420**
Physical				
Conductivity (EC)	uS/cm	-	130	133
pH		6.5-8.5	7.62	7.59
Total Dissolved Solids	mg/L	-	90	134
Turbidity	NTU	-	9.93	58.2

Table 4.1-3: Select Laboratory Water Quality Results for Site 1				
Parameter	**Unit**	**PWQO Guidelines**	**Date:**14-JUN-18 **Time:** 10:30	**Date:** 10-JUL-18 **Time:** 13:10
Anions and Nutrients				
Alkalinity, Total (as $CaCO_3$)	mg/L	56.6 (June); 36.5 (July)	53.4	**58.2**
Ammonia-N, Total	mg/L	-	0.021	0.447
Un-ionized Ammonia	mg/L	0.02	0.004	0.0054
Chloride (Cl)	mg/L	-	4.20	4.18
Nitrate-N (NO3-N)	mg/L	-	0.259	0.158
Nitrite-N (NO2-N)	mg/L	-	<0.010	<0.010
Phosphorus (P)-Total	mg/L	0.03	0.0153	**0.0963**
Sulfate (SO4)	mg/L	-	5.03	4.28
Total Metals				
Aluminum (Al)	mg/L	0.075	**0.317**	**2.240**
Cadmium (Cd)	mg/L	0.0001 (0-100 mg/L $CaCO_3$)	0.0000230	**0.0001090**
	mg/L	0.0005 (>100 mg/L $CaCO_3$)	-	-
Cobalt (Co)	mg/L	0.0009	0.00024	**0.00148**
Copper (Cu)	mg/L	0.001 (0-20 mg $CaCO_3$)	-	-
	mg/L	0.005 (>20 mg/L $CaCO_3$)	0.00248	**0.00898**
Iron (Fe)	mg/L	0.300	**0.487**	**3.72**
	mg/L	0.001 (<30 mg/L $CaCO_3$)	-	-
Lead (Pb)	mg/L	0.003 (30- 80 mg/L $CaCO_3$)	0.00018	0.00107
	mg/L	0.005 (>80 mg/L $CaCO_3$)	-	-
Sodium (Na)	mg/L	-	2.64	3.54
Vanadium (V)-Total	mg/L	0.006	0.00133	**0.00675**
Zinc (Zn)-Total	mg/L	0.02 (interim)	<0.0030	0.0122

Bold indicates exceedance above PWQO guidelines

Table 4.1-4: Flora Observed at Site 1			
FEC V-Type: V15 White Spruce Mixedwood			
Forest Density / Stream Cover	10% stream cover		
Terrestrial Species			
Trees	**Shrubs**	**Herbs**	**Ferns / Horsetails / Mosses / Grasses**
Balsam Fir Tamarack White Spruce	Green Alder Speckled Alder Red-osier Dogwood	Dandelion Sweet Coltsfoot Common Bluebell Lupine spp.	Woodland Horsetail Meadow Horsetail Common Reed
Aquatic Macrophytes and Algae			
Emergent	-	**Floating Algae**	-
Rooted Floating	-	**Filaments**	-
Submergent	-	**Attached Algae**	-
Free Floating	-	**Slimes or Crusts**	-

Table 4.1-5: Fauna Observed at Site 1	
Fauna Species	
Amphibians	-
Birds	Great Blue Heron, Cormorant, Seagull
Crustaceans	-

Table 4.1-5: Fauna Observed at Site 1	
Fish	-
Insects/Arachnids	Mosquito, Black fly, Canadian Tiger Swallowtail, Mourning Cloak, Dragonfly, Deer fly
Mammals	-
Mollusca	-
Reptiles	-
Animal Tracks	Gray Wolf, Canada Goose

Table 4.1-6: Physical Features Observed at Site 1							
In-stream Substrate							
Bedrock	**Boulder**	**Cobbles**	**Gravel**	**Sand**	**Silt**	**Organic**	**Clay**
-	-	-	10%	90%	-	-	-
Bank Stability/Erosion	No erosion – stable, vegetated						

4.2 Site 2

Site 2 was located approximately 5.6 kilometres down Jarvis Bay Road East and 0.8 kilometres down an unnamed road. The substrate at this site included: clay, cobbles, and silt. The banks of the creek were stable with abundant vegetation in the riparian zone including: white spruce, balsam fir, trembling aspen, and speckled alder. There were slight signs of erosion along the banks, including slumping of the ground slightly adjacent to the stream and a white spruce uprooting and falling over the tributary. The soil type present at this site in the “A” and “C” Horizon was silty clay.

The laboratory results from both the June and July 2018 sampling periods showed that alkalinity, phosphorous, iron, aluminum, cobalt, copper, and total coliforms exceeded the PWQO guidelines.

Alkalinity results exceeded the PWQO criterion (56.6 mg/L as $CaCO_3$ for June; 36.5 mg/L as $CaCO_3$ for July) with a value of 72.8 mg/L on June 14, 2018 and 64.1 mg/L on July 10, 2018.

Phosphorous results exceeded the PWQO criterion (0.03 mg/L) with a value of 0.0567 mg/L on June 14, 2018 and 0.0469 mg/L on July 10, 2018.

Iron exceeded the PWQO criterion (0.3 mg/L) with a value of 2.670 mg/L on June 14, 2018 and a value of 2.110 mg/L on July 10, 2018.

Aluminum results exceeded the PWQO criterion (0.075 mg/L) with a value of 1.830 mg/L on June 14, 2018 and 1.220 mg/L on July 10, 2018.

Cobalt results exceeded the PWQO criterion (0.0009 mg/L) with a value of 0.00118 mg/L on June 14, 2018.

Copper results exceeded the PWQO criterion (0.005 when >20 mg/L $CaCO_3$) with a value of 0.00961 mg/L on June 14, 2018 and a value of 0.00733 mg/L on July 10, 2018.

Total coliforms were above the pre-1994 PWQO criterion (1,000 MPN/100 mL) with a value of >2,420 MPN/100 mL on June 14, 2018 and a value of >2,420 MPN/100 mL on July 10, 2018.

Table 4.2-1: Location References for Site 2

Location Description	0.8 kilometres down an unnamed road. Approximately 5.6 kilometres down Jarvis Bay Road East
UTM Coordinates	Northing 5333474 Easting 323371
Altitude/Elevation	197 metres above sea level

Table 4.2-2: Field Measurements for Site 2

Parameter	**Unit**	**Date:** 14-JUN-18 **Time:** 11:50	**Date**: 10-JUL-18 **Time**: 11:15
Water Temperature	°C	16.8	18.7
Conductivity	uS/cm	139.3	109.9
Dissolved Oxygen	mg/L	10.02	8.81
Dissolved Oxygen	%	103.1	94.1
pH		8.47	8.08
Turbidity	NTU	40.5	33.0
Air Temperature	°C	16.0	22.0
Total Dissolved Solids	mg/L	90.561	71.219
Channel Width	m	2.85	2.85
Channel Depth	m	0.1	0.2
Velocity	m/s	0.13	0.14

Table 4.2-3: Select Laboratory Water Quality Results for Site 2

Parameter	**Unit**	**PWQO Guidelines**	**Date:**14-JUN-18 **Time:** 11:50	**Date:** 10-JUL-18 **Time:** 11:15
Bacteriological				
Escherichia coli	MPN/100mL	100	18	26
Total Coliforms	MPN/100mL	1,000 (prior to 1994)	**>2,420**	**>2,420**
Physical				
Conductivity (EC)	uS/cm	-	164	126
pH		6.5-8.5	7.31	7.62
Total Dissolved Solids	mg/L	-	163	157
Turbidity	NTU	-	44.8	28.3
Nutrients and Anions				
Alkalinity, Total (as $CaCO_3$)	mg/L	56.6 (June); 36.5 (July)	**72.8**	**64.1**
Ammonia-N, Total	mg/L	-	0.04	0.19
Un-ionized Ammonia	mg/L	0.02	0.0036	0.0068
Chloride (Cl)	mg/L	-	2.83	0.99
Nitrate-N (NO3-N)	mg/L	-	0.084	0.097
Nitrite-N (NO2-N)	mg/L	-	<0.010	<0.010

Table 4.2-3: Select Laboratory Water Quality Results for Site 2				
Parameter	**Unit**	**PWQO Guidelines**	**Date:**14-JUN-18 **Time:** 11:50	**Date:** 10-JUL-18 **Time:** 11:15
Phosphorus (P)-Total	mg/L	0.03	**0.0567**	**0.0469**
Sulfate (SO4)	mg/L	-	4.91	2.15
Metals				
Aluminum (Al)	mg/L	0.075	**1.830**	**1.220**
Cadmium (Cd)	mg/L	0.0001 (0-100 mg/L $CaCO_3$)	0.000089	0.000060
	mg/L	0.0005 (>100 mg/L $CaCO_3$)	-	-
Cobalt (Co)	mg/L	0.0009	**0.00118**	0.00077
Copper (Cu)	mg/L	0.001 (0-20 mg $CaCO_3$)	-	-
	mg/L	0.005 (>20 mg/L $CaCO_3$)	**0.00961**	**0.00733**
Iron (Fe)	mg/L	0.300	**2.670**	**2.110**
Lead (Pb)	mg/L	0.001 (<30 mg/L $CaCO_3$)	-	-
	mg/L	0.003 (30- 80 mg/L $CaCO_3$)	0.00018	0.00060
	mg/L	0.005 (>80 mg/L $CaCO_3$)	-	-
Sodium (Na)	mg/L	-	3.69	2.57
Vanadium (V)-Total	mg/L	0.006	0.00591	0.00479
Zinc (Zn)-Total	mg/L	0.02 (interim)	0.0072	0.005

Bold indicates exceedance above PWQO guidelines

Table 4.2-4: Flora Observed at Site 2			
FEC V-Type: V16 Balsam Fir- White Spruce Mixedwood/ Feathermoss			
Forest Density / Stream Cover	5% stream cover		
Terrestrial Species			
Trees	**Shrubs**	**Herbs**	**Ferns / Horsetails / Mosses / Grasses**
White Spruce Trembling Aspen Balsam Fir Tamarack	Speckled Alder Green Alder Wild Red Raspberry	Dandelion Common Bluebell Wild Strawberry Sweet Coltsfoot Large Leaved Aster Clover spp. Cow Vetch Wintercress Fragrant Bedstraw Buttercup Daisy spp. Wood Anemone	Common Reed Meadow Horsetail Woodland Horsetail Moss spp.
Aquatic Macrophytes and Algae			
Emergent	Broadleaf Arrowhead	**Floating Algae**	-
Rooted Floating	-	**Filaments**	-
Submergent	-	**Attached Algae**	-
Free Floating	-	**Slimes or Crusts**	-

Table 4.2-5: Fauna Observed at Site 2	
Fauna Species	
Amphibians	Frog , Toad
Birds	-
Crustaceans	-

Table 4.2-5: Fauna Observed at Site 2	
Fish	-
Insects/Arachnids	Black Fly, Mosquito, Dragonfly, Deer fly, Wasp, American Dog Tick
Mammals	-
Mollusca	-
Reptiles	-
Animal Tracks	Moose, White-Tailed Deer, Black Bear, American Beaver, Red Fox, Gray Wolf

Table 4.2-6: Physical Features Observed at Site 2							
In-stream Substrate (%)							
Bedrock	**Boulder**	**Cobbles**	**Gravel**	**Sand**	**Silt**	**Organic**	**Clay**
-	-	5%	-	-	5%	-	90%
Bank Stability/ Erosion		Some erosion – mostly stable, abundant vegetation Signs of ground slumping beside stream, large dying white spruce uprooting and falling over stream					

4.3 Site 3

Site 3 was located approximately 2.5 kilometres past the end of Walker Road South. The substrate at this site included: gravel, sand, organic matter, and predominantly clay. The banks of the creek were stable with abundant vegetation in the riparian zone including: white spruce, trembling aspen, common reed, and balsam fir. The soil type present at this site in the "A" Horizon was a loam; the "B" Horizon was a silty clay loam; and the "C" Horizon was a silty clay.

The laboratory results from both the June and July 2018 sampling periods showed that aluminum, alkalinity, phosphorous, iron, and total coliforms exceeded the PWQO guidelines.

Aluminum results exceeded the PWQO criterion (0.075 mg/L) with a value of 0.521 mg/L on June 13, 2018 and 0.238 mg/L on July 11, 2018.

Alkalinity results failed to meet the PWQO criterion (36.5 mg/L as CaCO3 for July) with a value of 47.6 mg/L on July 11, 2018.

Phosphorous results exceeded the PWQO criterion (0.03mg/L) with a value of 0.0390 mg/L June 13, 2018.

Iron results exceeded the PWQO criterion (0.300 mg/L) with a value of 1.47 mg/L on June 13, 2018 and 0.684 mg/L on July 11, 2018.

Total coliforms were above the pre-1994 PWQO criterion (1,000 MPN/100 mL) with a value of >2,420 MPN/100 mL on June 13, 2018 and >2,420 MPN/100 mL on July 11, 2018.

Table 4.3-1: Location References for Site 3	
Location Description	Approximately 2.0 kilometres past the end of Walker Road South
UTM Coordinates	Northing 5336598 Easting 324308
Altitude/Elevation	199 metres above sea level

Table 4.3-2: Field Measurements for Site 3			
Parameter	**Unit**	**Date:** 13-JUN-18 **Time:** 10:50	**Date**: 11-JUL-18 **Time**: 11:10
Water Temperature	°C	18.6	21
Conductivity	uS/cm	104.1	94.5
Dissolved Oxygen	mg/L	6.70	7.61
Dissolved Oxygen	%	71.6	85.4
pH		7.45	7.82
Turbidity	NTU	18.7	16.1
Air Temperature	°C	21.0	26.0
Total Dissolved Solids	mg/L	67.656	61.395
Channel Width	m	2.0	2.0
Channel Depth	m	0.2	0.1
Velocity	m/s	0.28	N/A

Table 4.3-3: Select Laboratory Water Quality Results for Site 3				
Parameter	**Unit**	**PWQO Guidelines**	**Date:**13-JUN-18 **Time:** 10:50	**Date:**11-JUL-18 **Time:** 11:10
Bacteriological				
Escherichia coli	MPN/100mL	100	44	33
Total Coliforms	MPN/100mL	1,000 (prior to 1994)	**>2420**	**>2420**
Physical				
Conductivity (EC)	uS/cm	-	121	112
pH		6.5-8.5	7.07	7.42
Total Dissolved Solids	mg/L	-	97	87
Turbidity	NTU	-	17.10	5.89
Nutrient and Anions				
Alkalinity, Total (as $CaCO_3$)	mg/L	56.6 (June); 36.5 (July)	47.6	**41.4**
Ammonia-N, Total	mg/L	-	0.295	0.361
Un-ionized Ammonia	mg/L	0.02	0.0035	0.0148
Chloride (Cl)	mg/L	-	7.71	7.34
Nitrate-N (NO3-N)	mg/L	-	<0.020	0.025
Nitrite-N 2-N)	mg/L	-	<0.010	<0.010
Phosphorus (P)-Total	mg/L	0.03	**0.0390**	0.0246
Sulfate (SO4)	mg/L	-	2.19	2.48
Metals				
Aluminum (Al)	mg/L	0.075	**0.521**	**0.238**
Cadmium (Cd)	mg/L	0.0001 (0-100 mg/L $CaCO_3$)	0.000028	0.000060
	mg/L	0.0005 (>100 mg/L $CaCO_3$)	-	-
Cobalt (Co)	mg/L	0.0009	0.00062	0.0002
Copper (Cu)	mg/L	0.001 (0-20 mg $CaCO_3$)	-	-
	mg/L	0.005 (>20 mg/L $CaCO_3$)	0.00330	0.00242
Iron (Fe)	mg/L	0.300	**1.47**	**0.684**
Lead (Pb)	mg/L	0.001 (<30 mg/L $CaCO_3$)	-	-
	mg/L	0.003 (30- 80 mg/L $CaCO_3$)	0.00037	0.00013
	mg/L	0.005 (>80 mg/L $CaCO_3$)	-	-

Table 4.3-3: Select Laboratory Water Quality Results for Site 3				
Parameter	**Unit**	**PWQO Guidelines**	**Date:**13-JUN-18 **Time:** 10:50	**Date:**11-JUL-18 **Time:** 11:10
Sodium (Na)	mg/L	-	3.65	3.31
Vanadium (V)-Total	mg/L	0.006	0.00191	0.00110
Zinc (Zn)-Total	mg/L	0.02 (interim)	<0.0030	<0.0030

Bold indicates exceedance above PWQO guidelines

Table 4.3-4: Flora Observed at Site 3			
FEC V-Type: V15 White Spruce Mixedwood			
Forest Density / Stream Cover	50% stream cover		
Terrestrial Species			
Trees	**Shrubs**	**Herbs**	**Ferns / Horsetails / Mosses / Grasses**
Balsam Poplar Trembling Aspen White Spruce Black Spruce White Birch Tamarack	Green Alder Willow spp. Wild Red Raspberry	Sweet Coltsfoot Dandelion Marsh Marigold Spotted Joe-Pye Weed Cow Vetch Pearly Everlasting Ox-Eye Daisy	Meadow Horsetail Common Reed
Aquatic Macrophytes and Algae			
Emergent	-	**Floating Algae**	-
Rooted Floating	-	**Filaments**	-
Submergent	-	**Attached Algae**	-
Free Floating	-	**Slimes or Crusts**	-

Table 4.3-5: Fauna Observed at Site 3	
Fauna Species	
Amphibians	-
Birds	Bald Eagle, Hawk
Crustaceans	-
Fish	Minnow
Insects/Arachnids	Black Fly, Mosquito, Deer Fly, Dragonfly, Dragonfly Larvae, Canadian Tiger Swallowtail, Honeybee, Grasshopper
Mammals	-
Mollusca	-
Reptiles	-
Animal Tracks	-

Table 4.3-6: Physical Features Observed at Site 3							
In-stream Substrate							
Bedrock	**Boulder**	**Cobbles**	**Gravel**	**Sand**	**Silt**	**Organic**	**Clay**
-	-	-	5%	5%	-	10%	80%
Bank Stability/ Erosion	Stable/abundant vegetation						

4.4 Site 4

Site 4 was located approximately 1.5 kilometres past the end of Walker Road South. The substrate at this site included: boulders, cobbles, gravel, sand, organic matter. The banks of the creek were stable with abundant vegetation in the riparian zone including: green alder, balsam fir, red-osier dogwood, lady fern, black spruce, white spruce, and white birch. The soil type present at this site in the "A" Horizon was a silty loam; the "B" Horizon was a loam; and the "C" Horizon was a silty clay loam.

The laboratory results from both the June and July sampling periods showed that alkalinity, aluminum, phosphorous, copper, iron, *E. coli*, and total coliforms exceeded the PWQO guidelines.

Alkalinity results exceeded the PWQO criterion (56.5 mg/L as $CaCO_3$ for June; 36.5 mg/L as $CaCO_3$ for July) with a value of 94.7 mg/L on June 13, 2018 and 62.8 mg/L on July 11, 2018.

Aluminum results exceeded the PWQO criterion (0.075 mg/L) with a value of 0.493 mg/L on June 13, 2018 and 1.020 mg/L on July 11, 2018.

Phosphorous results exceeded the PWQO criterion (0.03 mg/L) with a value of 0.0340 mg/L on June 13, 2018 and 0.0603 mg/L on July 11, 2018.

Copper results exceeded the PWQO criterion (0.005 when >20 mg/L CaCO3) with a value of 0.00720 mg/L on July 11, 2018.

Iron results exceeded the PWQO criterion (0.300 mg/L) with a value of 1.110 mg/L on June 13, 2018 and 2.180 mg/L on July 11, 2018.

E. coli exceeded the PWQO criterion (100 MPN/100 mL) with a value of 135 MPN/100 mL on June 13, 2018 and 145 MPN/100 mL on July 11, 2018.

Total coliforms were above the pre-1994 PWQO criterion (1,000 MPN/100 mL) with a value of 1,550 MPN/100 mL on June 13, 2018 and >2,420 MPN/100 mL on July 11, 2018.

Table 4.4-1: Location References for Site 4	
Location Description	Approximately 1.5 kilometres past the end of Walker Road South
UTM Coordinates	Northing 5336634 Easting 323380
Altitude/Elevation	199 metres above sea level

Table 4.4-2: Field Measurements for Site 4			
Parameter	**Unit**	**Date:** 13-JUN-18 **Time:** 11:55	**Date**: 11-JUL-18 **Time**: 11:35
Water Temperature	°C	18.7	19.3
Conductivity	uS/cm	233.7	133.1
Dissolved Oxygen	mg/L	7.61	8.68
Dissolved Oxygen	%	81.5	95.2
pH		7.84	7.76
Turbidity	NTU	13.0	21.3
Air Temperature	°C	25.0	24.0
Total Dissolved Solids	mg/L	151.920	86.516
Channel Width	m	6.5	6.5
Channel Depth	m	0.3	0.2
Velocity	m/s	N/A	0.63

Table 4.4-3: Select Laboratory Water Quality Results for Site 4				
Parameter	**Unit**	**PWQO Guidelines**	**Date:**13-JUN-18 **Time:** 11:55	**Date:**11-JUL-18 **Time:** 11:35
Bacteriological				
Escherichia coli	MPN/100mL	100	**135**	**145**
Total Coliforms	MPN/100mL	1,000 (prior to 1994)	**1550**	**>2420**
Physical				
Conductivity (EC)	uS/cm	-	276	157
pH		6.5-8.5	7.7	7.77
Total Dissolved Solids	mg/L	-	200	124
Turbidity	NTU	-	13.1	23.4
Nutrients and Anions				
Alkalinity, Total (as $CaCO_3$)	mg/L	56.6 (June); 36.5 (July)	**94.7**	**62.8**
Ammonia-N, Total	mg/L	-	0.165	0.245
Un-ionized Ammonia	mg/L	0.02	0.0059	0.0088
Chloride (Cl)	mg/L	-	20.7	6.85
Nitrate-N (NO3-N)	mg/L	-	0.031	0.076
Nitrite-N (NO2-N)	mg/L	-	<0.010	<0.010
Phosphorus (P)-Total	mg/L	0.03	**0.0340**	**0.0603**
Sulfate (SO4)	mg/L	-	12.7	4.51
Metals				
Aluminum (Al)	mg/L	0.075	**0.493**	**1.020**
Cadmium (Cd)	mg/L	0.0001 (0-100 $CaCO_3$)	0.0000522	0.0000650
	mg/L	0.0005 (>100 mg/L $CaCO_3$)	-	-
Cobalt (Co)	mg/L	0.0009	0.00046	0.00067
Copper (Cu)	mg/L	0.001 (0-20 mg $CaCO_3$)	-	-
	mg/L	0.005 (>20 mg/L $CaCO_3$)	0.00491	**0.00720**
Iron (Fe)	mg/L	0.300	**1.110**	**2.180**
Lead (Pb)	mg/L	0.001 (<30 mg/L $CaCO_3$)	-	-
	mg/L	0.003 (30- 80 mg/L $CaCO_3$)	-	0.00058
	mg/L	0.005 (>80 mg/L $CaCO_3$)	0.000302	-
Sodium (Na)	mg/L	-	8.210	4.770
Vanadium (V)-Total	mg/L	0.006	0.00258	0.0043
Zinc (Zn)-Total	mg/L	0.02 (interim)	0.0032	<0.015

Bold indicates exceedance above PWQO guidelines

Table 4.4-4: Flora Observed at Site 4			
FEC V-Type: V15- White Spruce Mixedwood			
Forest Density / Stream Cover	10% stream cover		
Terrestrial Species			
Trees	**Shrubs**	**Herbs**	**Ferns / Horsetails / Mosses / Grasses**
White Birch Balsam Fir Black Spruce White Spruce Tamarack	Red-Osier Dogwood Green Alder	Sweet Coltsfoot Thistle spp. Dandelion	Lady Fern Meadow Horsetail Common Reed
Aquatic Macrophytes and Algae			
Emergent	-	**Floating Algae**	-
Rooted Floating	-	**Filaments**	-
Submergent	-	**Attached Algae**	-
Free Floating	-	**Slimes or Crusts**	-

Table 4.4-5: Fauna Observed at Site 4	
Fauna Species	
Amphibians	-
Birds	-
Crustaceans	Common Crayfish
Fish	Minnow spp.
Insects/Arachnids	Black Fly, Deer Fly, Mosquito, Water strider, Grasshopper
Mammals	-
Mollusca	-
Reptiles	-
Animal Tracks	Gray Wolf, Common Racoon

Table 4.4-6: Physical Features Observed at Site 4							
In-stream Substrate							
Bedrock	**Boulder**	**Cobbles**	**Gravel**	**Sand**	**Silt**	**Organic**	**Clay**
-	10%	5%	5%	5%	-	5%	70%
Bank Stability/ Erosion	Stable/abundant vegetation						

4.5 Site 5

Site 5 was located approximately 20 metres north of the intersection of Sturgeon Bay Road and Walker Road North. The substrate at this site included: clay, silt, and cobbles. The banks of the creek were stable with abundant vegetation in the riparian zone including: white spruce, black spruce, tamarack, trembling aspen, jack pine, and red osier dogwood. The soil type present at this site in the “A” Horizon was silty loam. The soil type present in the “C” Horizon was a silty clay.

The laboratory results from both the June and July 2018 sampling periods showed that alkalinity, phosphorous, aluminum, iron, and total coliforms exceeded the PWQO guidelines.

Alkalinity results exceeded the PWQO criterion (56.5 mg/L as $CaCO_3$ for June; 36.5 mg/L as $CaCO_3$ for July) with a value of 75.0 mg/L on June 13, 2018 and 64.7 mg/L on July 11, 2018.

Phosphorous results exceeded the PWQO criterion (0.03 mg/L) with a value of 0.0301 mg/L on June 13, 2018 and 0.0379 mg/L on July 11, 2018.

Aluminum results exceeded the PWQO criterion (0.075 mg/L) with a value of 0.205 mg/L on June 13, 2018 and 0.210 mg/L on July 11, 2018.

Iron results exceeded the PWQO criterion (0.300 mg/L) with a value of 1.000 mg/L on June 13, 2018 and 1.280 mg/L on July 11, 2018.

Total coliforms were above the pre-1994 PWQO criterion (1,000 MPN/100 mL) with a value of 1,990 MPN/100 mL on June 13, 2018 and >2,420 MPN/100 mL on July 11, 2018.

Table 4.5-1: Location References for Site 5

Location Description	20 metres north of the intersection of Sturgeon Bay Road and Walker Road North
UTM Coordinates	Northing 5340053 Easting 321861
Altitude/Elevation	219 metres above sea level

Table 4.5-2: Field Measurements for Site 5

Parameter	**Unit**	**Date:** 13-JUN-18 **Time:** 13:10	**Date**: 11-JUL-18 **Time**: 12:40
Water Temperature	°C	20.1	20.7
Conductivity	uS/cm	133.5	116.7
Dissolved Oxygen	mg/L	6.10	6.02
Dissolved Oxygen	%	67.2	67.3
pH		8.21	7.97
Turbidity	NTU	6.2	7.3
Air Temperature	°C	29.0	22.0
Total Dissolved Solids	mg/L	86.804	75.740
Channel Width	m	2.65	2.65
Channel Depth	m	0.35	0.45
Velocity	m/s	0.089	0.089

Table 4.5-3: Select Laboratory Water Quality Results for Site 5

Parameter	**Unit**	**PWQO Guidelines**	**Date:**13-JUN-18 **Time:** 13:10	**Date:** 11-JUL-18 **Time:** 12:40
Bacteriological				
Escherichia coli	MPN/100mL	100	11	33

Table 4.5-3: Select Laboratory Water Quality Results for Site 5				
Parameter	**Unit**	**PWQO Guidelines**	**Date:**13-JUN-18 **Time:** 13:10	**Date:** 11-JUL-18 **Time:** 12:40
Total Coliforms	MPN/100mL	1,000 (prior to 1994)	**1,990**	**>2,420**
Physical				
Conductivity (EC)	uS/cm	-	151	135
pH		6.5-8.5	7.39	7.35
Total Dissolved Solids	mg/L	-	118	120
Turbidity	NTU	-	6.22	4.91
Nutrients and Anions				
Alkalinity, Total (as $CaCO_3$)	mg/L	56.6 (June); 36.5 (July)	**75.0**	**64.7**
Ammonia-N, Total	mg/L	-	0.045	0.134
Un-ionized Ammonia	mg/L	0.02	0.0017	0.0055
Chloride (Cl)	mg/L	-	3.31	2.6
Nitrate-N (NO3-N)	mg/L	-	<0.020	0.027
Nitrite-N (NO2-N)	mg/L	-	<0.010	<0.010
Phosphorus (P)-Total	mg/L	0.03	**0.0301**	**0.0379**
Sulfate (SO4)	mg/L	-	0.89	0.56
Metals				
Aluminum (Al)	mg/L	0.075	**0.205**	**0.210**
Cadmium (Cd)	mg/L	0.0001 (0-100 mg/L $CaCO_3$)	0.000025	<0.000025
	mg/L	0.0005 (>100 mg/L $CaCO_3$)	-	-
Cobalt (Co)	mg/L	0.0009	0.0004	<0.00050
Copper (Cu)	mg/L	0.001 (0-20 mg/L $CaCO_3$)	-	-
	mg/L	0.005 (>20 mg/L $CaCO_3$)	0.00251	0.00330
Iron (Fe)	mg/L	0.300	**1.000**	**1.280**
Lead (Pb)	mg/L	0.001 (<30 mg/L $CaCO_3$)	-	-
	mg/L	0.003 (30- 80 mg/L $CaCO_3$)	0.00012	<0.00025
	mg/L	0.005 (>80 mg/L $CaCO_3$)	-	-
Sodium (Na)	mg/L	-	3.29	2.52
Vanadium (V)-Total	mg/L	0.006	0.00156	<0.0025
Zinc (Zn)-Total	mg/L	0.02 (interim)	<0.0030	<0.015

Bold indicates exceedance above PWQO guidelines

Table 4.5-4: Flora Observed at Site 5			
FEC V-Type: V15– White Spruce Mixedwood			
Forest Density / Stream Cover	0% stream cover		
Terrestrial Species			
Trees	**Shrubs**	**Herbs**	**Ferns / Horsetails / Mosses / Grasses**
Tamarack White Spruce White Birch Black Spruce Trembling Aspen Jack Pine	Wild Raspberry Red-Osier Dogwood Willow spp. Wild Prickly Rose	Yarrow Wood Anemone Thistle spp. Cow Vetch Dandelion Bird's-Foot Trefoil	Common Reed Meadow Horsetail False Melic Grass Wire Grass Quack Grass
Aquatic Macrophytes and Algae			
Emergent	Water Lily	**Floating Algae**	-
Rooted Floating	-	**Filaments**	-
Submergent	-	**Attached Algae**	-
Free Floating	-	**Slimes or Crusts**	-

Table 4.5-5: Fauna Observed at Site 5	
Fauna Species	
Amphibians	-
Birds	-
Crustaceans	-
Fish	-
Insects/Arachnids	Deer Fly, Horse Fly , Water Strider, Carpenter Ant, American Dog Tick
Mammals	-
Mollusca	-
Reptiles	Water snake spp.
Animal Tracks	-

Table 4.5-6: Physical Features Observed at Site 5							
In-stream Substrate							
Bedrock	**Boulder**	**Cobbles**	**Gravel**	**Sand**	**Silt**	**Organic**	**Clay**
-	-	10%	-	-	10%	-	80%
Bank Stability/ Erosion	Stable/ abundant vegetation						

4.6 Site 6

Site 6 was located on Sturgeon Bay Road, approximately 3 kilometres east of Highway 61. The substrate at this site included: clay, and organic matter. The banks of the creek had slight undercutting but were stable with vegetation in the riparian zone including: white spruce, black spruce, trembling aspen, tamarack, balsam poplar, and green alder. The soil type present at this site in the "A", "B", and "C" Horizon was a clay.

The laboratory results for both the June and July 2018 sampling periods showed that alkalinity, phosphorous, aluminum, cobalt, copper, iron, un-ionized ammonia, and total coliforms exceeded the PWQO guidelines.

Alkalinity results exceeded the PWQO criterion (56.5 mg/L as $CaCO_3$ for June; 36.5 mg/L as $CaCO_3$ for July) with a value of 98.0 mg/L on June 13, 2018 and 66.0 mg/L on July 10, 2018.

Phosphorous results exceeded the PWQO criterion (0.03 mg/L) with a value of 0.0566 mg/L on June 13, 2018 and 0.0422 mg/L on July 10, 2018.

Aluminum results exceeded the PWQO criterion (0.075 mg/L) with a value of 1.160 mg/L on June 13, 2018 and 0.811 mg/L on July 10, 2018.

Cobalt results slightly exceeded the PWQO criterion (0.0009 mg/L) with a value of 0.00097 mg/L on June 13, 2018.

Copper results exceeded the PWQO criterion (0.005 mg/L when <20 mg/L $CaCO_3$) with a value of 0.00525 mg/L on June 13, 2018 and 0.00503 mg/L on July 10, 2018.

Iron results exceeded the PWQO criterion (0.300 mg/L) with a value of 2.120 mg/L for June 13, 2018 and 1.530 mg/L for July 10, 2018.

Un-ionized Ammonia results exceeded the PWQO criterion (0.02 mg/L) with a value of 0.0216 mg/L on July 10, 2018.

Total coliforms were above the pre-1994 PWQO criterion (1,000 MPN/100 mL) with a value of 1990 MPN/100 mL on June 13, 2018 and >2,420 MPN/100 mL on July 10, 2018.

Table 4.6-1: Location References for Site 6

Location Description	Sturgeon Bay Road, approximately 3 kilometres east of Highway 61
UTM Coordinates	Northing 5339989 Easting 319893
Altitude/Elevation	223 metres above sea level

Table 4.6-2: Field Measurements for Site 6

Parameter	**Unit**	**Date:** 13-JUN-18 **Time:** 13:40	**Date**: 10-JUL-18 **Time**: 13:00
Water Temperature	°C	20.80	21.2
Conductivity	uS/cm	187.6	118.5
Dissolved Oxygen	mg/L	8.32	8.01
Dissolved Oxygen	%	94.2	90.2
pH		7.93	7.89
Turbidity	NTU	13.8	12.6
Air Temperature	°C	27.0	27.0
Total Dissolved Solids	mg/L	122.10	77.107
Channel Width	m	1.7	2.9
Channel Depth	m	0.20	0.40
Velocity	m/s	N/A	N/A

Table 4.6-3: Select Laboratory Water Quality Results for Site 6

Parameter	**Unit**	**PWQO Guidelines**	**Date:** 13-JUN-18 **Time:** 13:40	**Date:** 10-JUL-18 **Time:** 13:00
Bacteriological				
Escherichia coli	MPN/100mL	100	12	75
Total Coliforms	MPN/100mL	1,000 (prior to 1994)	**1,990**	**>2,420**
Physical				
Conductivity (EC)	uS/cm	-	216	138
pH		6.5-8.5	7.6	7.47
Total Dissolved Solids	mg/L	-	157	139
Turbidity	NTU	-	14.4	13.8
Nutrients and Anions				
Alkalinity, Total (as $CaCO_3$)	mg/L	56.6 (June); 36.5 (July)	**98.0**	**66.0**
Ammonia-N, Total	mg/L	-	0.187	0.526
Un-ionized Ammonia	mg/L	0.02	0.0077	**0.0216**
Chloride (Cl)	mg/L	-	10.1	2.38

Table 4.6-3: Select Laboratory Water Quality Results for Site 6				
Parameter	**Unit**	**PWQO Guidelines**	**Date:** 13-JUN-18 **Time:** 13:40	**Date:** 10-JUL-18 **Time:** 13:00
Nitrate-N (NO3-N)	mg/L	-	<0.020	0.039
Nitrite-N (NO2-N)	mg/L	-	<0.010	<0.010
Phosphorus (P)-Total	mg/L	0.03	**0.0556**	**0.0422**
Sulfate (SO4)	mg/L	-	2.32	1.75
Metals				
Aluminum (Al)	mg/L	0.075	**1.160**	**0.811**
Cadmium (Cd)	mg/L	0.0001 (0-100 mg/L $CaCO_3$)	-	0.000056
	mg/L	0.0005(>100mg/L $CaCO_3$)	0.0000818	-
Cobalt (Co)	mg/L	0.0009	**0.00097**	0.0005
Copper (Cu)	mg/L	0.001 (0-20 mg $CaCO_3$)	-	-
	mg/L	0.005 (>20 mg/L $CaCO_3$)	**0.00525**	**0.00503**
Iron (Fe)	mg/L	0.300	**2.120**	**1.530**
Lead (Pb)	mg/L	0.001 (<30 mg/L $CaCO_3$)	-	-
	mg/L	0.003 (30-80 mg/L $CaCO_3$)	-	0.00029
	mg/L	0.005 (>80 mg/L $CaCO_3$)	0.00058	-
Sodium (Na)	mg/L	-	5.580	2.830
Vanadium (V)-Total	mg/L	0.006	0.00441	0.00299
Zinc (Zn)-Total	mg/L	0.02 (interim)	0.0123	0.0057

Bold indicates exceedance above PWQO guidelines

Table 4.6-4: Flora Observed at Site 6			
FEC V-Type: V19 Black Spruce Mixedwood/ Herb Rich			
Forest Density /Stream Cover	0% stream cover		
Terrestrial Species			
Trees	**Shrubs**	**Herbs**	**Ferns / Horsetails / Mosses / Grasses**
White Spruce Black Spruce Trembling Aspen Balsam Poplar Tamarack White Birch	Pin Cherry Green Alder Red-Osier Dogwood Wild Red Raspberry	Dandelion Sweet Coltsfoot Ox-Eye Daisy Bird's-Foot Trefoil Yellow Hawkweed Aster spp.	Meadow Horsetail Common Reed Bulrush spp. False Melic Grass Wire Grass
Aquatic Macrophytes and Algae			
Emergent	Broadleaf Arrowhead, Sweet Flag	**Floating Algae**	-
Rooted Floating	Floating Bur Reed	**Filaments**	-
Submergent	-	**Attached Algae**	-
Free Floating	-	**Slimes or Crusts**	-

Table 4.6-5: Fauna Observed at Site 6	
Fauna Species	
Amphibians	Tadpole
Birds	American Pelican, Mallard
Crustaceans	-

Table 4.6-5: Fauna Observed at Site 6	
Fauna Species	
Fish	Minnow
Insects/Arachnids	-
Mammals	-
Mollusca	-
Reptiles	-
Annelids	Leech
Animal Tracks	-

Table 4.6-6: Physical Features Observed at Site 6							
In-stream Substrate							
Bedrock	**Boulder**	**Cobbles**	**Gravel**	**Sand**	**Silt**	**Organic**	**Clay**
-	-	-	-	-	-	10%	90%
Bank Stability/Erosion	Stable/ abundant vegetation, slight undercutting on both sides of the bank upstream of the culvert						

4.7 Site 7

Site 7 was located at the end of Gammond Road approximately 0.9 kilometres from Sturgeon Bay Road. The substrate at this site included: clay and organic material. The banks of the creek were stable with abundant vegetation in the riparian zone including: balsam fir, balsam poplar, white spruce, and green alder. The soil type present at this site in the "A" Horizon was a silty clay loam; and the "C" Horizon was silty clay.

The laboratory results for the June and July sampling periods showed that alkalinity, phosphorous, aluminum, iron, and total coliforms exceeded the PWQO guidelines.

Alkalinity results exceeded the PWQO criterion (56.5 mg/L as $CaCO_3$ for June; 36.5 mg/L as $CaCO_3$ for July) with a value of 85.4 mg/L on June 14, 2018 and 54.0 mg/L on July 10, 2018.

Phosphorous results exceeded the PWQO criterion (0.03mg/L) with a value of 0.0712 mg/L on June 14, 2018 and 0.0542 mg/L on July 10, 2018.

Aluminum results exceeded the PWQO criterion (0.075 mg/L) with a value of 0.223 mg/L on June 14, 2018 and 0.182 mg/L on July 10, 2018.

Iron results exceeded the PWQO criterion (0.300 mg/L) with a value of 2.12 mg/L on June 14, 2018 and 1.66 mg/L on July 10, 2018.

Total coliforms results exceeded the pre-1994 PWQO criterion (1,000 MPN/100 mL) with a value of >2,420 MPN/100 mL on June 14, 2018 and >2,420 MPN/100 mL on July 10, 2018.

Table 4.7-1: Location References for Site 7	
Location Description	End of Gammond Road approximately 0.9 kilometres from Sturgeon Bay Road
UTM Coordinates	Northing 5339139 Easting 319404
Altitude/Elevation	223 metres above sea level

Table 4.7-2: Field Measurements for Site 7			
Parameter	**Unit**	**Date:** 14-JUN-18 **Time:** 14:45	**Date**: 10-JUL-18 **Time**: 14:15
Water Temperature	°C	22.20	21.3
Conductivity	uS/cm	157.30	108.5
Dissolved Oxygen	mg/L	7.40	6.81
Dissolved Oxygen	%	84.80	76.8
pH		7.82	8.15
Turbidity	NTU	8.20	6.4
Air Temperature	°C	26.0	29.0
Total Dissolved Solids	mg/L	102.066	70.498
Channel Width	m	2.25	4.50
Channel Depth	m	0.20	0.76
Velocity	m/s	N/A	0.59

Table 4.7-3: Select Laboratory Water Quality Results for Site 7				
Parameter	**Unit**	**PWQO Guidelines**	**Date:** 14-JUN-18 **Time:** 14:45	**Date:** 10-JUL-18 **Time:** 14:15
Bacteriological				
Escherichia coli	MPN/100mL	100	60	68
Total Coliforms	MPN/100mL	1000 (prior to 1994)	**>2,420**	**>2,420**
Physical				
Conductivity (EC)	uS/cm	-	179	126
pH		6.5-8.5	7.35	7.27
Total Dissolved Solids	mg/L	-	145	121
Turbidity	NTU	-	7.08	5.41
Nutrients and Anions				
Alkalinity, Total (as $CaCO_3$)	mg/L	56.6 (June); 36.5 (July)	**85.4**	**54.0**
Ammonia-N, Total	mg/L	-	0.118	0.347
Un-ionized Ammonia	mg/L	0.02	0.0052	0.0142
Chloride (Cl)	mg/L	-	5.28	5.56
Nitrate-N (NO3-N)	mg/L	-	<0.020	0.021
Nitrite-N (NO2-N)	mg/L	-	<0.010	<0.010
Phosphorus (P)-Total	mg/L	0.03	**0.0712**	**0.0542**
Sulfate (SO4)	mg/L	-	0.59	2.78
Metals				
Aluminum (Al)	mg/L	0.075	**0.223**	**0.182**
Cadmium (Cd)	mg/L	0.0001 (0-100 mg/L $CaCO_3$)	0.000067	0.000025
	mg/L	0.0005(>100mg/L $CaCO_3$)	-	-
Cobalt (Co)	mg/L	0.0009	0.0006	<0.00050
Copper (Cu)	mg/L	0.001 (0-20 mg $CaCO_3$)	-	-

Table 4.7-3: Select Laboratory Water Quality Results for Site 7				
Parameter	**Unit**	**PWQO Guidelines**	**Date:** 14-JUN-18 **Time:** 14:45	**Date:** 10-JUL-18 **Time:** 14:15
	mg/L	0.005 (>20 mg/L $CaCO_3$)	0.00256	<0.0025
Iron (Fe)	mg/L	0.300	**2.12**	**1.66**
Lead (Pb)	mg/L	0.001 (<30 mg/L $CaCO_3$)	-	-
	mg/L	0.003 (30-80 mg/L $CaCO_3$)	-	<0.00025
	mg/L	0.005 (>80 mg/L $CaCO_3$)	0.000211	-
Sodium (Na)	mg/L	-	5.370	4.400
Vanadium (V)-Total	mg/L	0.006	0.00234	<0.0025
Zinc (Zn)-Total	mg/L	0.02 (interim)	0.0036	<0.015

Bold indicates exceedance above PWQO guidelines

Table 4.7-4: Flora Observed at Site 7			
FEC V-Type: V7 Trembling Aspen- Balsam Fir/ Balsam Fir Shrub			
Forest Density /Stream Cover	25% stream cover		
Terrestrial Species			
Trees	**Shrubs**	**Herbs**	**Ferns / Horsetails / Mosses / Grasses**
Balsam Poplar Balsam Fir White Spruce	Green Alder Willow spp. Wild Red Raspberry Red-Osier Dogwood Beaked Hazelnut	Tall Buttercup Wintercress Canada Anemone Pearly Everlasting Northern Bluebell Yellow Violet Milkweed spp. Yarrow Cow Vetch Yellow Hawkweed Orange Hawkweed Bird's-Foot Trefoil	Lady Fern Meadow Horsetail Wire Grass
Aquatic Macrophytes and Algae			
Emergent	-	**Floating Algae**	-
Rooted Floating	-	**Filaments**	-
Submergent	-	**Attached Algae**	-
Free Floating	-	**Slimes or Crusts**	-

Table 4.7-5: Fauna Observed at Site 7	
Fauna Species	
Amphibians	-
Birds	Blue Jay
Crustaceans	-
Fish	-
Insects/Arachnids	Dragonfly, Canada Tiger Swallowtail, Spring Azure, Northern Crescent
Mammals	-
Mollusca	-
Reptiles	-
Annelids	-
Animal Tracks	-

Table 4.7-6: Physical Features Observed at Site 7							
In-stream Substrate							
Bedrock	**Boulder**	**Cobbles**	**Gravel**	**Sand**	**Silt**	**Organic**	**Clay**
-	-	-	-	-	-	10%	90%
Bank Stability/Erosion	Stable/abundant vegetation						

4.8 Site 8

Site 8 was located on Cloud Lake Road approximately 1.5 kilometres west of Highway 61. The substrate at this site included: boulders, cobbles, sand, and silt. The banks of the creek were stable with abundant vegetation in the riparian zone including: trembling aspen, white spruce, mountain maple, balsam fir, and black ash. The soil type present at this site in the "A" Horizon is a loamy sand; the soil present in the "C" Horizon was cobbles.

The laboratory results from both the June and July 2018 sampling periods showed that alkalinity, aluminum, copper, iron, zinc and total coliforms exceeded the PWQO guidelines.

Alkalinity results exceeded the PWQO criterion (56.6 mg/L as $CaCO_3$ for June; 36.5 mg/L as $CaCO_3$ for July) with a value of 75.4 mg/L on June 13, 2018 and 48.6 mg/L on July 10, 2018.

Aluminum results exceeded the PWQO criterion (0.075 mg/L) with a value of 0.109 mg/L on June 13, 2018 and 0.865 mg/L on July 10, 2018.

Copper results exceeded the PWQO criterion (0.005 when >20 mg/L $CaCO_3$) with a value of 0.00502 mg/L on July 10, 2018.

Iron results exceeded the PWQO criterion (0.3 mg/L) with a value of 0.342 mg/L on June 13, 2018 and 1.01 mg/L on July 10, 2018.

Zinc results exceeded the PWQO criterion (0.02 mg/L) with a value of 0.0333 mg/L on June 13, 2018.

Total coliforms results exceeded the pre-1994 PWQO criterion (1,000 MPN/100 mL) with a value of >2,420 MPN/100 mL on July 10, 2018.

Table 4.8-1: Location References for Site 8	
Location Description	Cloud Lake Road approximately 1.5 kilometres west of Highway 61
UTM Coordinates	Northing 5339244 Easting 315331
Altitude/Elevation	262 metres above sea level

Table 4.8-2: Field Measurements for Site 8			
Parameter	**Unit**	**Date:** 13-JUN-18	**Date**: 10-JUL-18
		Time: 13:45	**Time**: 10:00
Water Temperature	°C	17.20	14.8
Conductivity	uS/cm	127.80	82.9
Dissolved Oxygen	mg/L	7.61	9.39
Dissolved Oxygen	%	78.20	92.6
pH		8.51	8.57
Turbidity	NTU	6.0	16.4
Air Temperature	°C	28.0	24.0
Total Dissolved Solids	mg/L	83.001	53.868
Channel Width	m	1.1	1.1
Channel Depth	m	0.05	0.17
Velocity	m/s	N/A	0.126

Table 4.8-3:Select Laboratory Water Quality Results for Site 8				
Parameter	**Unit**	**PWQO Guidelines**	**Date:** 13-JUN-18	**Date:** 10-JUL-18
			Time: 13:45	**Time:** 10:00
Bacteriological				
Escherichia coli	MPN/100mL	100	3	50
Total Coliforms	MPN/100mL	1,000 (prior to 1994)	687	**<2,420**
Physical				
Conductivity (EC)	uS/cm	-	144	97.9
pH		6.5-8.5	7.45	7.61
Total Dissolved Solids	mg/L	-	107	94
Turbidity	NTU	-	4.93	16.8
Nutrients and Anions				
Alkalinity, Total (as $CaCO_3$)	mg/L	56.6 (June); 36.5 (July)	**75.4**	**48.6**
Ammonia-N, Total	mg/L	-	0.125	0.215
Un-ionized Ammonia	mg/L	0.02	0.0114	0.0172
Chloride (Cl)	mg/L	-	0.59	0.16
Nitrate-N (NO3-N)	mg/L	-	0.111	0.123
Nitrite-N (NO2-N)	mg/L	-	<0.010	<0.010
Phosphorus (P)-Total	mg/L	0.03	0.0169	0.0296
Sulfate (SO4)	mg/L	-	3.14	2.68
Metals				
Aluminum (Al)	mg/L	0.075	**0.109**	**0.865**
Cadmium (Cd)	mg/L	0.0001 (0-100 mg/L $CaCO_3$)	0.000013	0.000022
	mg/L	0.0005 (>100 mg/L $CaCO_3$)	-	-
Cobalt (Co)	mg/L	0.0009	0.0001	0.0004
Copper (Cu)	mg/L	0.001 (0-20 mg $CaCO_3$)	-	-
	mg/L	0.005 (>20 mg/L $CaCO_3$)	0.00475	**0.00502**
Iron (Fe)	mg/L	0.300	**0.342**	**1.01**
Lead (Pb)	mg/L	0.001 (<30 mg/L CaCO3)	-	-
	mg/L	0.003 (30- 80 mg/L $CaCO_3$)	0.00015	0.00033
	mg/L	0.005 (>80 mg/L $CaCO_3$)	-	-
Sodium (Na)	mg/L	-	2.610	1.910
Vanadium (V)-Total	mg/L	0.006	0.00095	0.00231
Zinc (Zn)-Total	mg/L	0.02 (interim)	**0.0333**	0.0044

Bold indicates exceedance above PWQO guidelines

Table 4.8-4: Flora Observed at Site 8			
FEC V-Type: V9 Trembling Aspen Mixedwood			
Forest Density / Stream Cover	95% stream cover		
Terrestrial Species			
Trees	**Shrubs**	**Herbs**	**Ferns / Horsetails / Mosses / Grasses**
Trembling Aspen White Spruce Mountain Maple Balsam Fir Black Ash	Saskatoon Berry Wild Red Raspberry Wild Rose Northern Bush Honeysuckle	Dandelion Wild Strawberry Sweet Coltsfoot Cow Vetch Fragrant Bedstraw Pearly Everlasting Marsh Marigold Tall Buttercup Black-Eyed Susan Thistle spp. Hairy Goldenrod Wild Mint Bird's-Foot Trefoil	Meadow Horsetail Bulrush spp.
Aquatic Macrophytes and Algae			
Emergent	-	**Floating Algae**	-
Rooted Floating	-	**Filaments**	-
Submergent	-	**Attached Algae**	-
Free Floating	-	**Slimes or Crusts**	-

Table 4.8-5: Fauna Observed at Site 8	
Fauna Species	
Amphibians	-
Birds	-
Crustaceans	-
Fish	-
Insects/Arachnids	Water Strider, Burying Beetle
Mammals	-
Mollusca	-
Reptiles	-
Animal Tracks	-

Table 4.8-6: Physical Features Observed at Site 8							
In-stream Substrate							
Bedrock	**Boulder**	**Cobbles**	**Gravel**	**Sand**	**Silt**	**Organic**	**Clay**
-	40%	40%	-	10%	10%	-	-
Bank Stability/ Erosion	Stable/abundant vegetation						

4.9 Watershed Report Card Results

The overall surface water quality for the Jarvis River Watershed maintained a total averaged point score of 3.5. With many exceedances for phosphorus and two exceedances for *E. coli*, the rating of the surface water quality for the Jarvis River Watershed was determined to have a grade of B, which is considered good quality.

The forest coverage for the Jarvis River Watershed was 110.7 square kilometres (92.1 percent), interior forest coverage was 83.6 square kilometres (75.5 percent) and the riparian forest cover was 11.4 square kilometres (8.4 percent). These percentages generated a total point score of fifteen (average of 5.0) for the forest conditions, which is determined to have a grade of A, and is considered to be of excellent quality.

The wetland coverage for the Jarvis River Watershed was 11.6 square kilometres (12.3 percent). This generated a grade of A, which is considered to be excellent quality.

Table 4.9-1: Jarvis River Watershed Surface Water Indicators and Overall Grade Calculation

Site Number	Average Total Phosphorus (mg/L)	Average *E. coli* (MPN/ 100mL)	Average of Benthic Invertebrates	Total Point Score	Grade	Overall Surface Water Quality Grade	
						Final Points	Grade
1	0.0558	196.5	-	6	C	3	C
2	0.0518	22	-	8	B	4	B
3	0.0318	38.5	-	7	B	3.5	B
4	0.04715	140	-	6	C	3	C
5	0.034	22	-	8	B	4	B
6	0.0489	43.5	-	7	B	3.5	B
7	0.0627	64	-	6	C	3	C
8	0.02325	26.5	-	9	A	4.5	A
					Overall	**3.5**	**B**

Table 4.9-2: Jarvis River Watershed Forest Conditions and Overall Grade Calculation

					Overall Forest Conditions	
% Forest Cover	% Forest Interior	% Riparian Zone Forested	Total Point Score	Grade	Final Points	Final Grade
92.1	75.5	73.3	15	A	**5**	**A**

Table 4.9-3: Jarvis River Watershed Wetland Conditions

% Wetland cover	Final Grade
12.3	A

5 DISCUSSION

The Jarvis River Watershed was sampled at eight different locations, chosen based on accessibility and possible contamination sources, as well as attempting to reach all areas of the watershed. The first sampling period was on June 13 and 14, 2018 and the second sampling period on July 10 and 11, 2018.

The average air temperature for the June 13 and 14, 2018 sampling period was 21.5 degrees Celsius, which exceeded the monthly average temperature of 19.5 degrees Celsius for June 2018 as well as the historical average of 14.0 degrees Celsius for June 1971-2000 in Thunder Bay. The average air temperature for the July 10 and 11, 2018 sampling period was 24.9 degrees Celsius, which was above the monthly average temperature of 18.9 degrees Celsius and exceeded the historical average of 17.6 degrees Celsius for July 1971-2000.

Precipitation for the month of June totaled 50.0 millimetres, which was below the historical monthly average of 85.7 millimetres for Thunder Bay from June 1971-2000. In July, precipitation totaled 70.9 millimetres, which was below the historical monthly average of 89.0 millimetres for July 1971-2000. However, LRCA staff noted heavy rain locally and approximately 37 mm of rainfall was recorded on July 8, 2018 (ie., two days prior to July sampling period).

Furthermore, the average precipitation for the February, March and April was 40% below the historical average, and thus the Lakehead Region Conservation Authority declared a Level 1 Low Water condition on May 15, 2018. Subsequently, a Level II Low Water condition was declared on June 1, 2018 based on observations and calculations for the period of March, April and May. The low water conditions continued through to the end of September and until the LRCA un-declared it on October 4, 2018.

Water temperatures ranged from 11.8 to 22.2 degrees Celsius in June and 14.8 to 21.3 degrees Celsius in July, which can be seen on Figure 3: Water Temperature at Jarvis River Sampling Sites. The site with the lowest recorded water temperature, 11.8 degrees Celsius, was Site 1 in June most likely attributed to the confluence point with Lake Superior. The stream depths observed ranged from 0.05 metres to 0.60 metres for both June and July. The shallowest of all the stream depths was located at Site 8 in June (0.05 metres) and the deepest at Site 1 in both June and July (0.60 metres).

Four of the sample locations were water crossings that required a culvert to support the road. The culverts present at Sites 5, 6, 7, and 8 were made of galvanized steel and in excellent, stable condition and will not require extensive monitoring in the future. Monitoring of the culverts should be carried out to ensure no vegetation blockages cause problems in the future.

A vegetation assessment was carried out at each site, recording species present within view of each site. A summary of each site is included in Appendix F: Forest Ecosystem Classification. Forest Ecosystem Classification (FEC) type V-15 White Spruce Mixedwood, was the most common and occurred at Sites 1, 3, 4, and 5. The remaining sites had a similar mixedwood forest type with some favouring coniferous species, like black spruce, and some favouring hardwood species such as trembling aspen. The dominant tree species within the Jarvis River Watershed included: white spruce, trembling aspen, balsam fir, tamarack, white birch, and black spruce. The shrub layer was very diverse throughout the watershed, with many species present. Some commonly observed species in the shrub layer were: green alder, prickly wild rose, red osier dogwood, speckled alder, and wild red raspberry. The most commonly observed herb and wildflower species included dandelions, sweet coltsfoot, common reed, woodland and meadow horsetail, cow vetch, wild strawberry, and large leaf aster.

No invasive plant species or species at risk were seen at the sample sites within the Jarvis River Watershed.

Overall, the stream banks documented within the Jarvis River Watershed were stable. The main soil type was silty clay loam; however, almost all sites had some element of clay present whether it be silty clay loam, clay or silty clay, etc. The confluence (Site 1) was identified as sand. Site 4 showed some signs of ground slumping approximately ten metres adjacent to the stream. This site had a high moisture and clay content and future monitoring should be done to ensure a small mass wasting event does not occur here. These types of substrate aid the banks by helping with slope stability and keeping erosion to a minimum; however, some soil types are more effective than others. For example, a combination of sand, clay, and loam works quite effectively at mitigating the effects of erosion caused by the flowing rivers/creeks/stream because the clay content aids in cohesion and prevents the sand from eroding easily (in comparison to a strictly sand substrate).

The PWQO acceptable pH range is 6.5-8.5. The range within the Jarvis River Watershed was 7.07 to 7.77, as illustrated on Figure 4: pH Level at Jarvis River Sample Sites. The average pH of the watershed was within an acceptable water quality range.

Total Dissolved Solids (TDS) can be related to conductivity since the dissolved solids help to conduct an electric current through the water. The more dissolved solids present in a solution, the greater the conductive potential, as there are more ions present to carry the charge. The relationship can be seen in the watershed data when comparing between Figure 5: Total Dissolved Solids at Jarvis River Sample Sites and Figure 6: Conductivity at Jarvis River Sample Sites. The highest measured levels of TDS and conductivity were at Site 4, and the lowest for both parameters were at Site 3. In regards to drinking water, TDS levels are a secondary drinking water standard, meaning that this standard is based

on aesthetic properties such as odour, colour, taste, corrosivity, foaming, and staining, and not based on health considerations.

Monitoring of bacterial levels in surface water is often limited to *E. coli*, as this is the most common water-borne pathogen that can cause illness and death. During the June sampling period the levels of *E. coli* at Site 4 were in exceedance of the PWQO of 100 MPN/100 mL with a value of 135 MPN/100 mL, as illustrated on Figure 7: *Escherichia coli* Bacteria Counts at Jarvis River Sample Sites. During the July sampling period the levels of *E. coli* at Site 1 and Site 4 were in exceedance of the PWQO criterion with values of 387 MPN/100 mL and 145 MPN/100 mL.

Presence of *E. coli* generally indicates a fecal contamination source nearby and many studies have shown that the presence of farm animals near a stream can significantly influence bacteria counts. *E. coli* could also enter the watershed from leaking residential septic tanks and/or from manure. The *E. coli* exceedance at Site 1 during the July sampling period could be attributed to previous heavy rains in the watershed area and high river discharge, which was noted locally by LRCA staff on July 8, 2018 (i.e., approximately 37 mm of rainfall in the area). The water at Site 1 was much more turbid during the July sampling period than the previous June sampling period, which indicates high discharge and velocity from the Jarvis River.

Total coliforms are among the flora present in the intestinal tract of animals and are often present in much greater numbers than potential pathogens, such as *E. coli*. Therefore, coliforms are easier to isolate and identify within a water sample. In order to better determine the possibility of contamination, total coliforms are measured in surface water as indicators of pathogenic bacteria contamination. No current PWQO exists for total coliforms; however, total coliforms exceeded the pre-1994 PWQO of 1,000 MPN/100 mL at Sites 2, 3, 4, 5, 6, and 7 during the June 2018 sampling period and at all of the sites during the July 2018 sampling period. The highest level of total coliforms present was >2,420 MPN/100 mL at Sites 2, 3 and 7 on June 13 and 14, 2018 and all of the sites on July 10 and 11, 2018. Total coliforms for all sampling results ranged from 308 to >2,420 MPN/100 mL.

The PWQO criterion of 0.075 mg/L for aluminum was exceeded at all the sites during the June and July sampling periods. Aluminum concentrations ranged from 0.109 mg/L at Site 8 on June 14, 2018 to 2.240 mg/L at Site 1 on July 10, 2018. The average concentration of aluminum was 0.607 mg/L for all sites during the June sampling period and 0.848 mg/L during the July sampling period, which are both above the PWQO criterion.

The PWQO criterion of 0.3 mg/L for iron was exceeded at all sites during the June and July sampling periods. Iron concentrations ranged between 0.342 mg/L at Site 8 on June 14, 2018 to 3.72 mg/l at Site 1 on July 10, 2018. The average concentration of iron was

calculated to be 1.415 mg/L for the June sampling period and 1.772 mg/L for the July sampling period, which are both above the PWQO criterion.

High aluminum and iron levels may be caused by the underlying geology. These metals may naturally dissociate from mineral-rich rocks. The exceedances are likely a result of natural sources and are commonly high within the region.

The PWQO criterion of 0.03 mg/L for phosphorous was exceeded at Sites 2, 3, 4, 5, 6, and 7 during the June sampling period and at Sites 1, 2, 4, 5, 6, and 7 during the July sampling period. Phosphorous concentrations ranged between 0.0153 mg/L at Site 1 on June 14, 2018 and 0.0963 mg/L at Site 1 on July 10, 2018. The average concentration of phosphorous was calculated to be 0.04 mg/L for the June sampling period and 0.05 mg/L for the July sampling period, which are both above the PWQO criterion.

The PWQO criterion of 0.0009 mg/L for cobalt was exceeded at Site 2 and 6 during the June sampling period and at Site 1 during the July sampling period. Cobalt concentrations ranged from 0.00013mg/L at Site 6 on June 14, 2018 to 0.00148 mg/L at Site 1 on July 10, 2018. The average concentration of cobalt was calculated to be 0.00058 mg/L for the June sampling period and 0.00067 mg/L for the July sampling period, which are below the PWQO criterion. Cobalt is an essential element for the growth of various marine algae species and it is shown to enhance the growth of plant at low concentrations. In high concentrations, cobalt can be toxic to humans as well as terrestrial and aquatic plants and animals. Cobalt is present naturally in rock, soil, water, plants, animals, and the air in small concentrations. It is often associated with nickel, silver, lead, copper, and iron ores. Cobalt can also have anthropogenic sources in the aquatic environment such as through cobalt mining, production of alloys and chemicals containing cobalt, sewage effluent, as well as urban and agricultural run-off (Nagpal, 2004). The exceedances in cobalt for the Jarvis River Watershed are likely attributed to the geology of the area and do not have an anthropogenic origin.

The PWQO criterion of 0.005 mg/L for copper when $CaCO_3$ is <20 mg/L was exceeded at Site 2 and 6 during the June sampling period and at Site 1, 2 ,4, 6 and 8 during the July sampling period. Copper concentrations ranged between 0.00242 mg/L at Site 3 on July 11, 2018 and 0.00961 mg/L at Site 1 on June 14, 2018. The average concentration of copper was calculated to be 0.00442 mg/L for the June sampling period and 0.00561 mg/L for the July sampling period.

High cobalt levels and high copper levels occurred at the same sites and may show indication of contamination from past mining activities. It is more likely, however, that the high levels of copper and cobalt can be attributed to the geology of the area.

The PWQO criterion of 0.0001 when $CaCO_3$ is <75 mg/L for cadmium was exceeded at Site 1 during the July sampling period. Cadmium concentrations ranged from 0.0000090 mg/L

at Site 3 on July 11, 2018 to 0.000109 mg/L at Site 1 on July 10, 2018. The average concentration of cadmium was 0.000054 mg/L for the June sampling period and 0.000049 mg/L for the July sampling period, which are below the PWQO criterion.

The PWQO criterion of 0.006 mg/L for vanadium was exceeded at Site 1 during the July sampling period. Vanadium concentrations ranged from 0.00095 mg/L at Site 8 on June 14, 2018 to 0.00675 mg/L at Site 1 on July 10, 2018. The average concentration of vanadium was 0.0026 mg/L for the June sampling period and 0.0037 mg/L for the July sampling period, which are below the PWQO criterion.

The PWQO criterion of 0.02 mg/L for zinc was exceeded at Site 8 during the June sampling period. Zinc concentrations ranged from <0.0030 mg/L at multiple sites to 0.0333 mg/L at Site 8 on June 13, 2018. The average concentration of zinc was 0.0119 mg/L for the June sampling period and 0.0068 mg/L for the July sampling period, which are below the PWQO criterion.

The overall health of the Jarvis River Watershed was determined using the ratings from surface water quality, forest conditions, and wetland conditions, which are combined to give a grade rating for the Watershed Report Card. Given that there were three exceedance of *E. coli* and many exceedances of phosphorus, the overall health of the Jarvis River Watershed surface water quality has received a rating of 'B' for its Watershed Report Card rating which is of good quality. The Jarvis River forest conditions based on forest coverage, forest interior, and riparian zone forested, were determined to result in a rating of 'A'. The Jarvis River wetland conditions based on percentage wetland cover was determined to result in a rating of 'A'.

Based on these rating and other observed conditions, the Jarvis River Watershed has been determined to be in good to excellent overall health.

6 CONCLUSION

The Jarvis River Watershed was determined to be in good to excellent overall health. Surface water quality at the time of the study was good, with the exceedances of the Provincial Water Quality Objectives being mostly attributed to natural sources. Plant species composition seems characteristic of the boreal forest, with diversity at each site among the overstory, understory, and herb layer. A more comprehensive fauna study would give a clear indication of the species and populations present, but at the time of the study multiple species were observed giving a good representation of a typical boreal forest area. Water levels appeared consistent with previous water markings. Erosion was not typically a concern, as the stream banks were stable. Stream cover was often provided by shrubs and trees growing along the river banks which also helped prevent erosion. Culverts were in stable condition with no immediate concern for maintenance.

7 RECOMMENDATIONS

Upon completion of the 2018 Jarvis River Watershed Assessment Report, we offer the following recommendations:

- Staff and funding permitting, it is recommended that an update to the 2018 Jarvis River Watershed Assessment be completed in the next five to ten years.
- Benthic sampling and monitoring should be considered for future watershed assessments because it is a useful indicator of water quality over time.
- Additional sampling should be conducted in the spring to observe the water quality differences between high and low flow seasons.
- A copy of this report should be provided to the Municipality of Neebing for reference purposes. The Report should be kept on file at the LRCA Administration Office for review by interested parties.

8 REFERENCES

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Figures

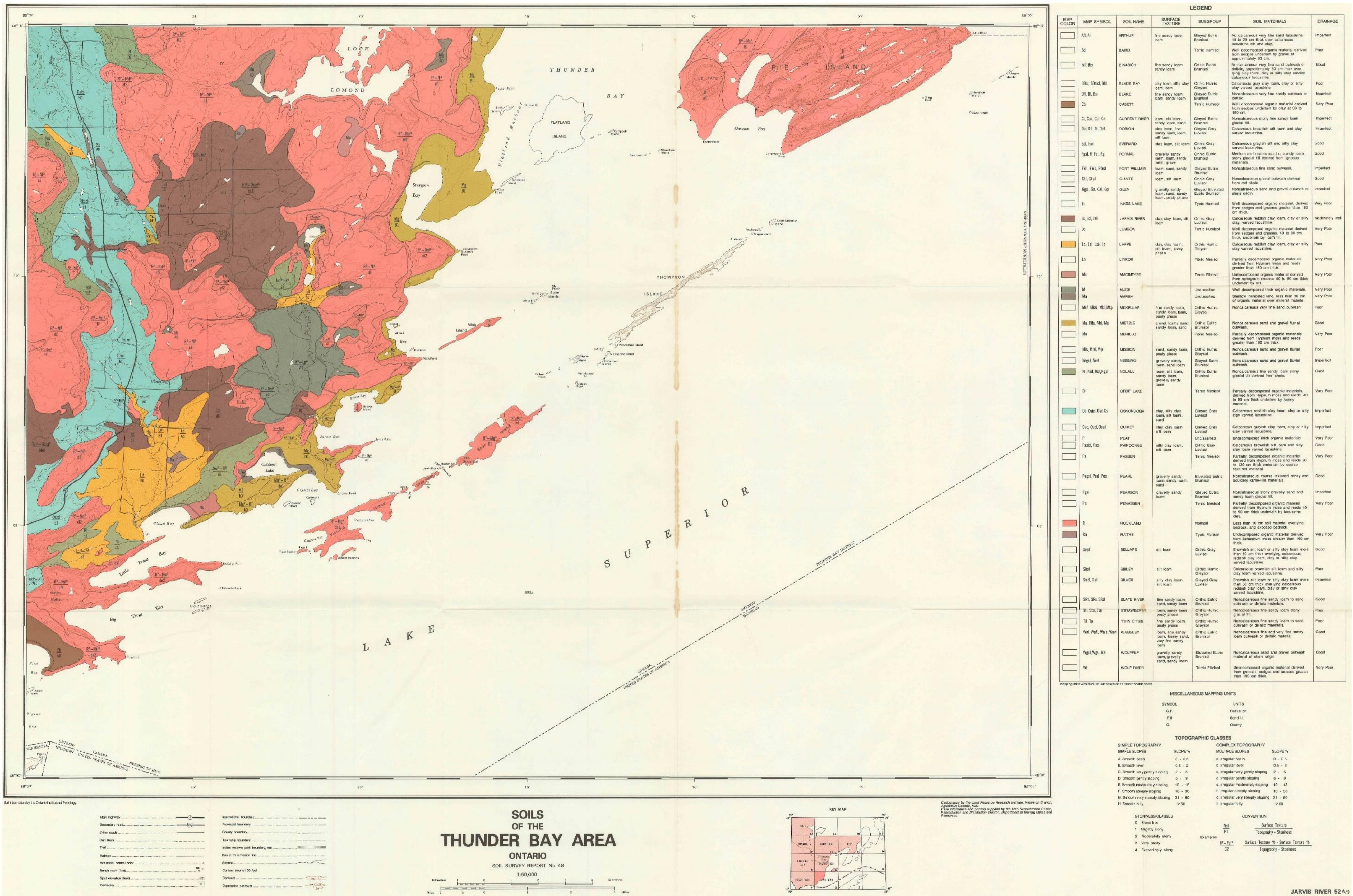


Figure 1: Soils of the Thunder Bay Area

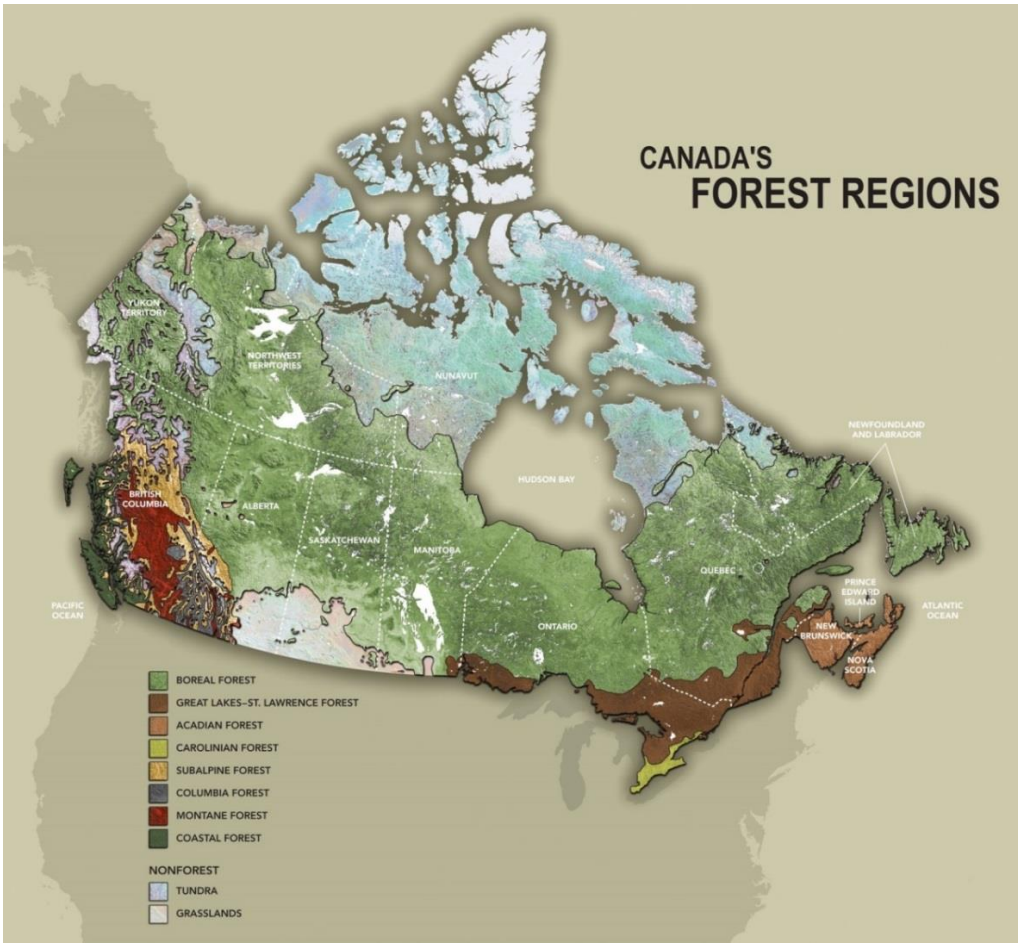


Figure 2: Canada's Forest Regions (Canadian Forest Service, 2013)

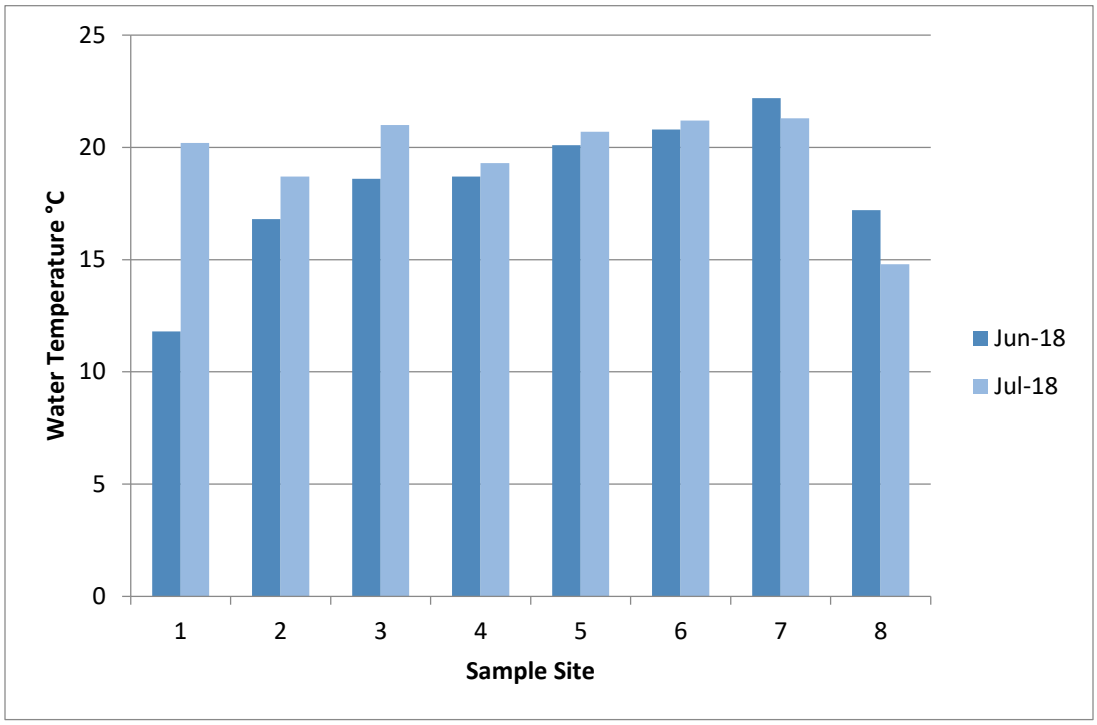


Figure 3: Water Temperature at Jarvis River Sample Sites

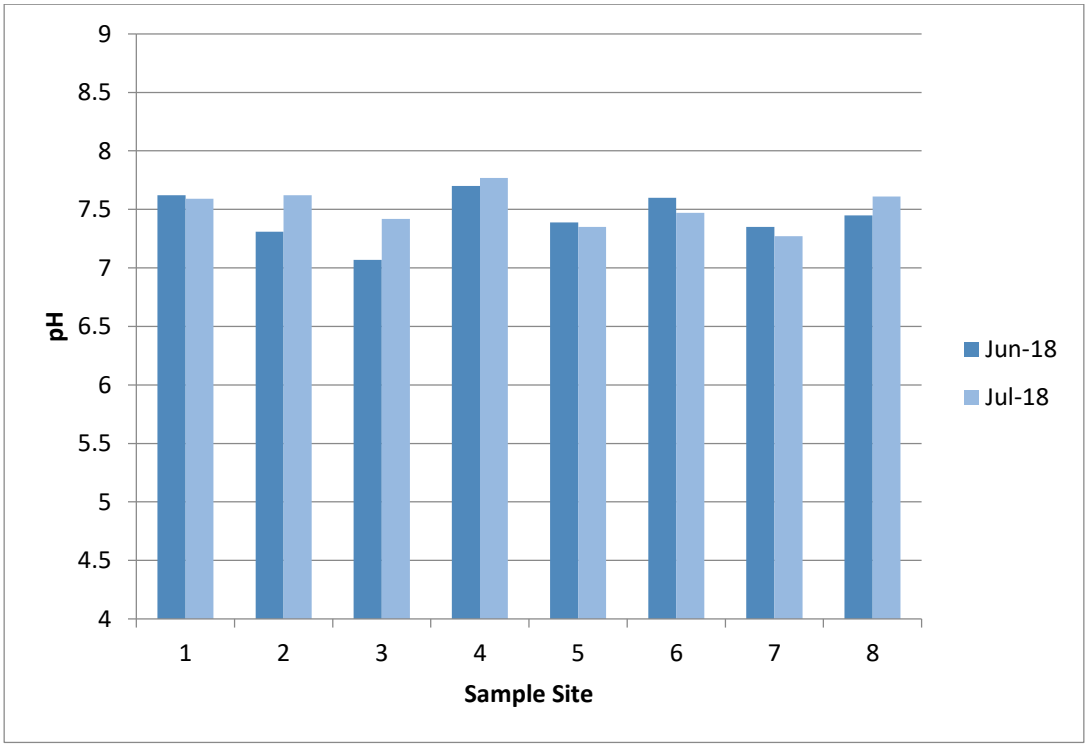


Figure 4: pH Level at Jarvis River Sample Sites

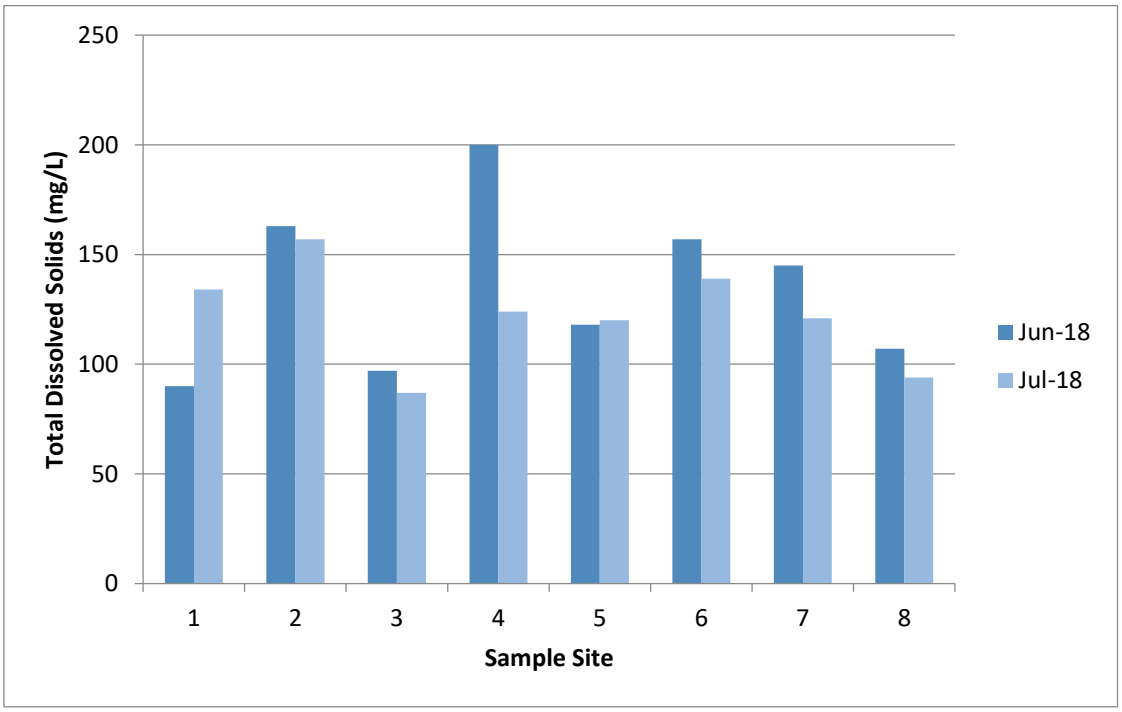


Figure 5: Total Dissolved Solids at Jarvis River Sample Sites

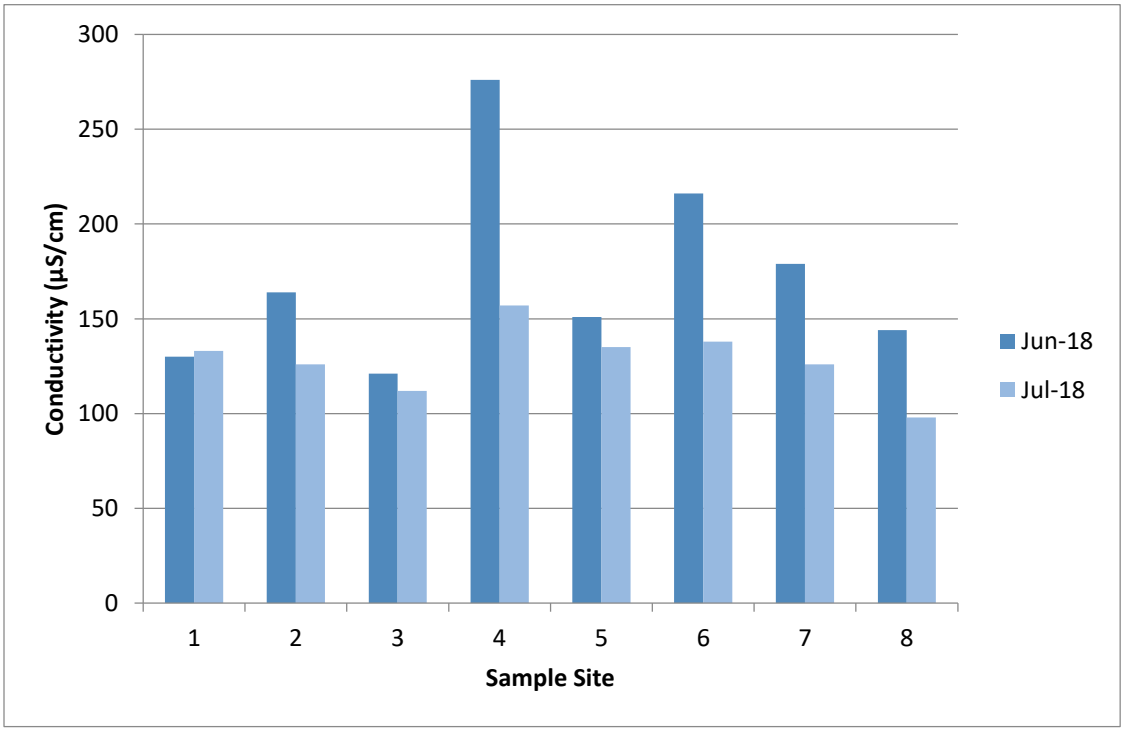


Figure 6: Conductivity at Jarvis River Sample Sites

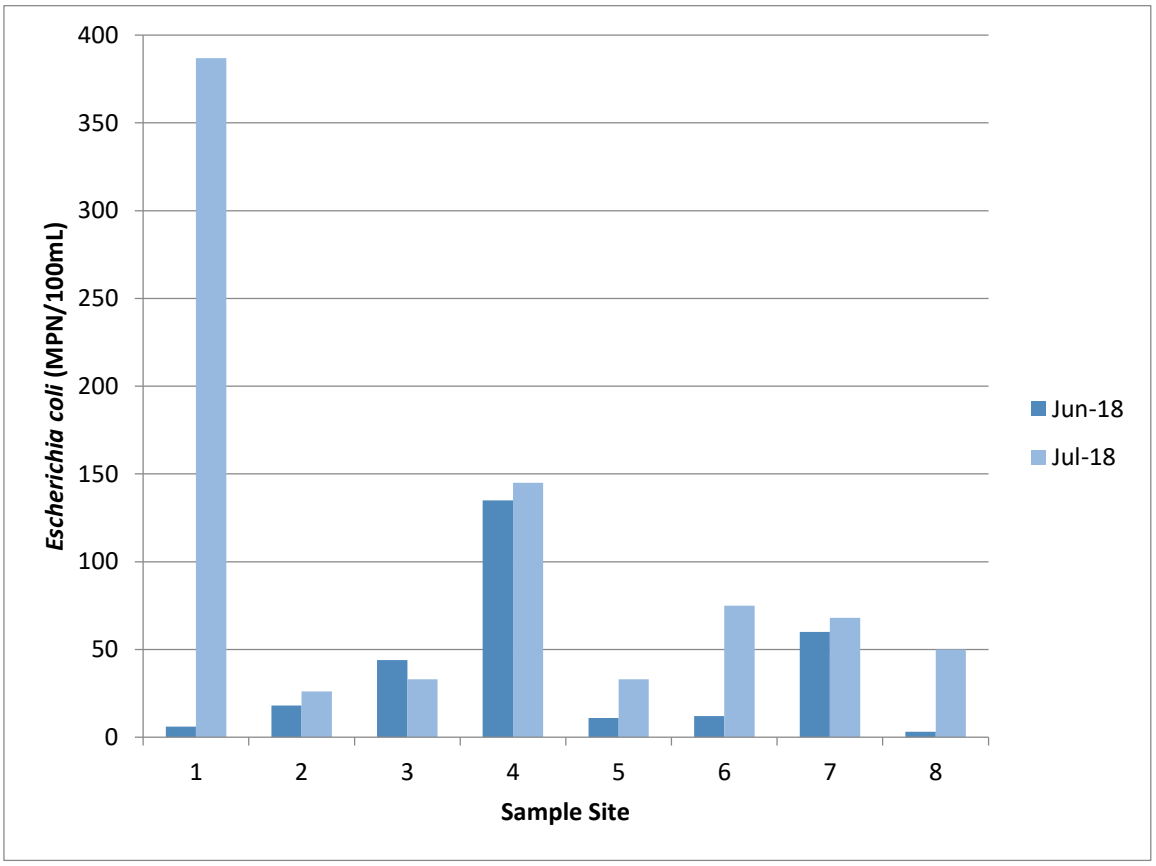


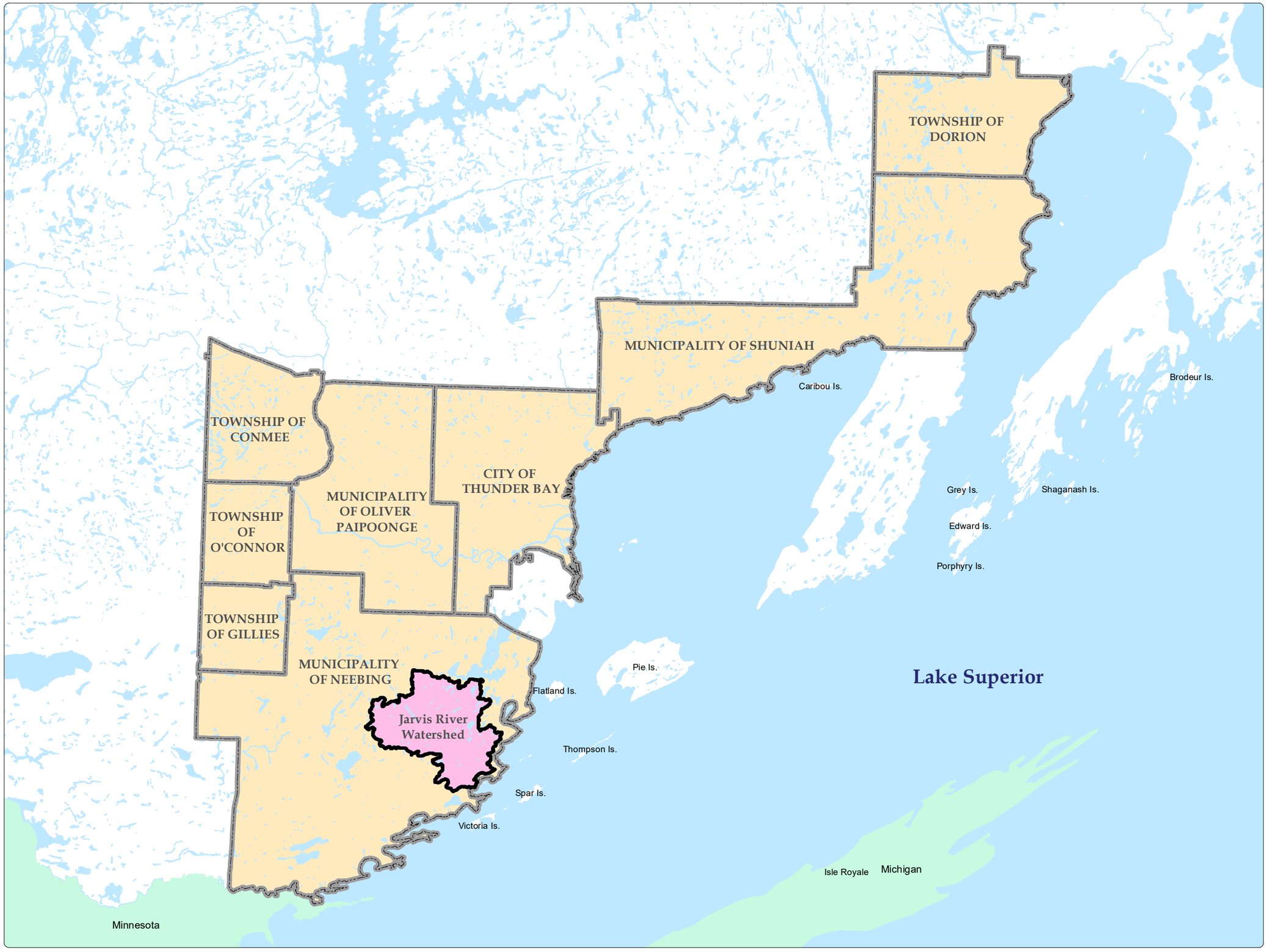
Figure 7: *Escherichia coli* Bacteria Counts at Jarvis River Sample Sites

Maps

LAKEHEAD REGION
CONSERVATION AUTHORITY

Jarvis River Watershed

M-1: Key Plan



N

Legend

- Jarvis River Watershed
- Municipal Boundary
- LRCA Jurisdiction Boundary
- Water Body

0 10 20 km

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Projection: UTM Zone 16N
Date: October, 2018

LAKEHEAD REGION CONSERVATION AUTHORITY

Jarvis River Watershed

M-2: Regulated Area

N

Legend

- Approximate Regulated Area
- Approximate Regulated Area within Lake Superior
- Jarvis River Watershed
- Municipal Boundary

Drainage

- Water Body
- Provincially Significant Wetland
- Wetland
- Stream
- River
- Ditch

Roads

- Highway
- Road
- Street

0 1 2 km

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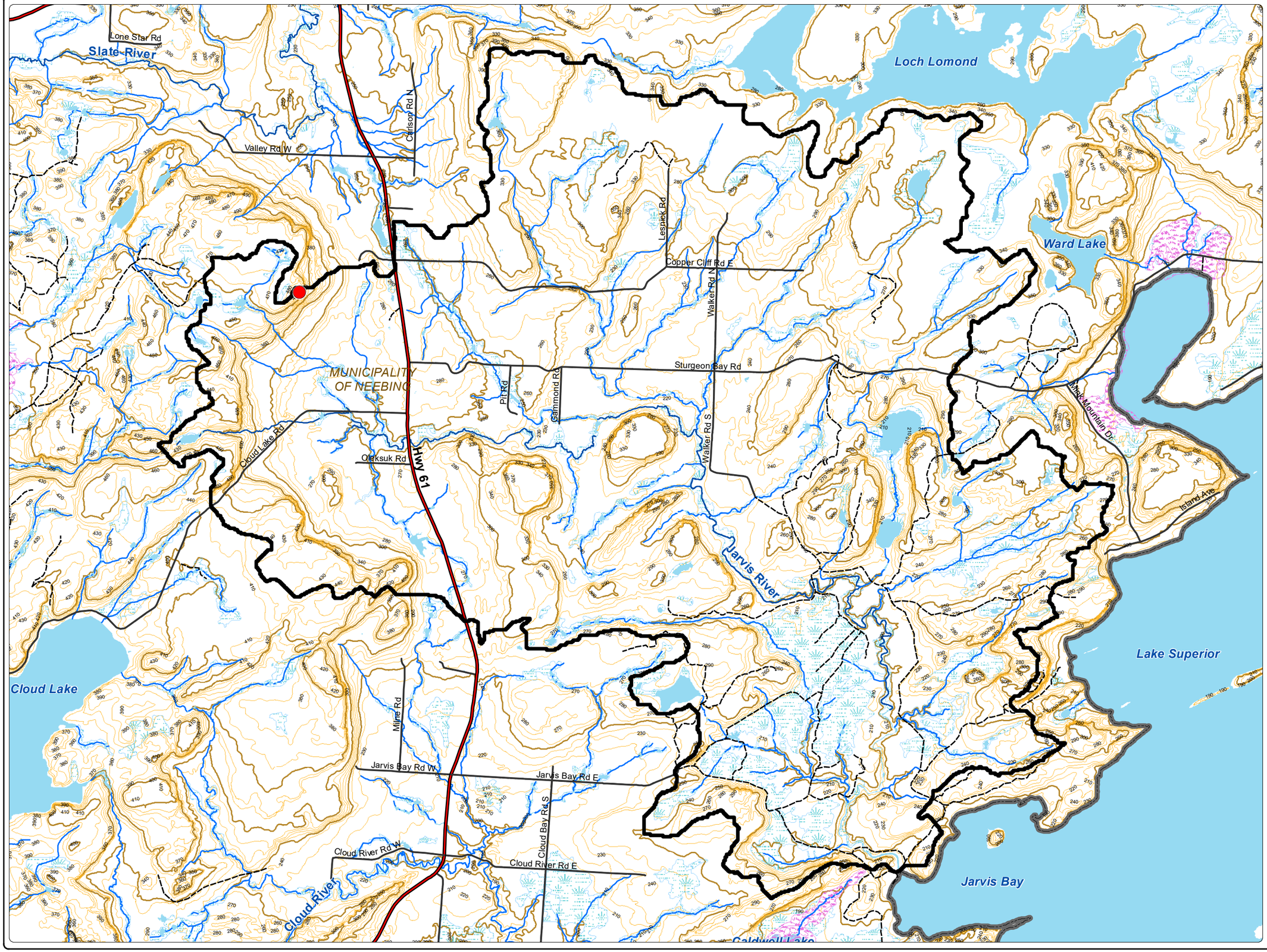
LAKEHEAD REGION CONSERVATION AUTHORITY

Jarvis River Watershed

M-3: Topography

N



Legend

- Highest Point in Watershed
- Jarvis River Watershed
- Municipal Boundary

Drainage

- Water Body
- Provincially Significant Wetland
- Wetland
- Stream
- River
- Ditch

Contour Lines

- 10m Contour Intervals
- 50m Contour Intervals

Roads

- Highway
- Road
- Street
- Bush Roads

0 1 2 km

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LAKEHEAD REGION CONSERVATION AUTHORITY

Jarvis River Watershed

M-4: Bedrock Geology

N

Lone Star Rd
Slate
Carlson Rd N
Valley Rd W
Loch Lomond
Lesnick Rd
Copper Cliff Rd E
Walker Rd N
Ward Lake
Sturgeon Bay Rd
Pitt Rd
Gammond Rd
MUNICIPALITY OF NEEBING
Walker Rd S
Oleksuk Rd
Hwy 61
Mirk Mountain Dr
Island Ave
Cloud Lake Rd
Jarvis River
Cloud Lake
Milne Rd
Jarvis Bay Rd W
Jarvis Bay Rd E
Cloud Bay Rd S
Cloud River Rd W
Cloud River Rd E
Cloud River
Lake Superior
Jarvis Bay
Caldwell Lake

Legend

- Abandoned Mines Points
- Jarvis River Watershed
- Municipal Boundary

Bedrock Formation

PALEOPROTEROZOIC

- 22a, Sedimentary rocks

MESOPROTEROZOIC

- 31c, Mafic and related intrusive rocks (Keweenawan age)
- 31a, Mafic and related intrusive rocks (Keweenawan age)

Drainage

- Water Body
- Provincially Significant Wetland
- Wetland
- Stream
- River
- Ditch

Roads

- Highway
- Road
- Street
- Bush Roads

0 1 2 km

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Date: October, 2018

LAKEHEAD REGION CONSERVATION AUTHORITY

Jarvis River Watershed

M-5: Surficial Geology

N

Legend

- Jarvis River Watershed
- Municipal Boundary

Surficial Geology

- Alluvial
- Bedrock
- Esker/Kame/Outwash plain
- Glaciolacustrine plain
- Moraine
- Organics
- Slope/Talus pile

Surficial Points Features

- QUARRY/MINE WORKINGS
- SAND/GRAVEL PIT
- TALUS

Drainage

- Water Body
- Provincially Significant Wetland
- Wetland
- Stream
- River
- Ditch

Roads

- Highway
- Road
- Street
- Bush Roads

0 1 2 km

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Datum: NAD 83
Projection: UTM Zone 16N
Date: October, 2018

LAKEHEAD REGION CONSERVATION AUTHORITY

Jarvis River Watershed

M-6: Soils

N

Legend

- Sampling Sites
- Jarvis River Watershed
- Municipal Boundary

Drainage

- Water Body
- Provincially Significant Wetland
- Wetland
- Stream
- River
- Ditch

OMAFRA Soils

- Organic (O)
- Clay (c)
- Clay Loam (cl)
- Fine Sandy Loam (fsl)
- Gravel (g)
- Gravelly Sand (gs)
- Gravelly Sand Loam (gsl)
- Medium to Moderately Fine Loam (l)
- Loamy Sand (ls)
- Peaty Phase (pp)
- Rock (r)
- Coarse Sand and Loamy Sand (s)
- Silty Clay Loam (sicl)
- Silt Loam (sil)
- Moderately Coarse Sandy Loam (sl)
- Very Fine Sandy Loam (vfsl)

Roads

- Highway
- Road
- Street
- Bush Roads

0 1 2 km

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Date: October, 2018

LAKEHEAD REGION CONSERVATION AUTHORITY

Jarvis River Watershed

M-7: Land Ownership

N

Legend

- Jarvis River Watershed
- Municipal Boundary

Land Ownership

- Crown Land
- Private Land

Drainage

- Water Body
- Provincially Significant Wetland
- Wetland
- Stream
- River
- Ditch

Roads

- Highway
- Road
- Street
- Bush Roads

0 1 2 km

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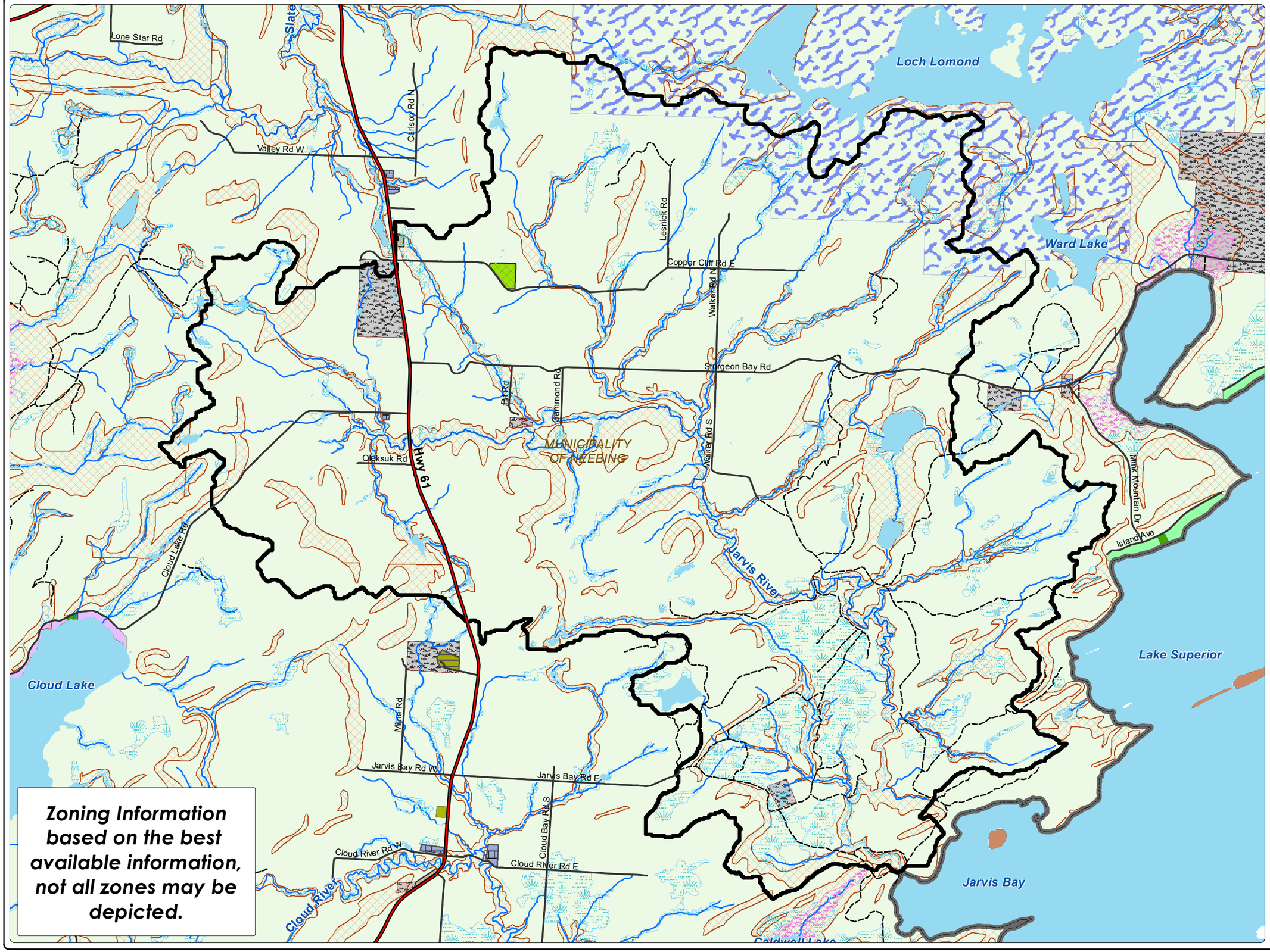
Projection: UTM Zone 16N
Date: October, 2018

LAKEHEAD REGION CONSERVATION AUTHORITY

Jarvis River Watershed

M-8: Zoning



Zoning Information based on the best available information, not all zones may be depicted.

N

Legend

- Jarvis River Watershed

Municipality of Neebing Zoning

- A - Agricultural Zone
- C1 - General Commercial Zone
- C2 - Recreation Commercial Zone
- D - Disposable Industrial Zone
- E - Extractive Industrial Zone
- I - Institutional Zone
- M1 - Light Industrial Zone
- OS - Open Space Zone
- S1 - Recreation 1 Zone
- S2 - Recreation 2 Zone
- S3 - Remote Recreation 3 Zone
- S4 - Recreation Back Lot 4
- WR - Watershed Reserve Zone
- UL - Use Limitation Zone
- Rural Zone

Drainage

- Water Body
- Provincially Significant Wetland
- Wetland
- Stream
- River
- Ditch

Roads

- Highway
- Road
- Street
- Bush Roads

0 1 2 km

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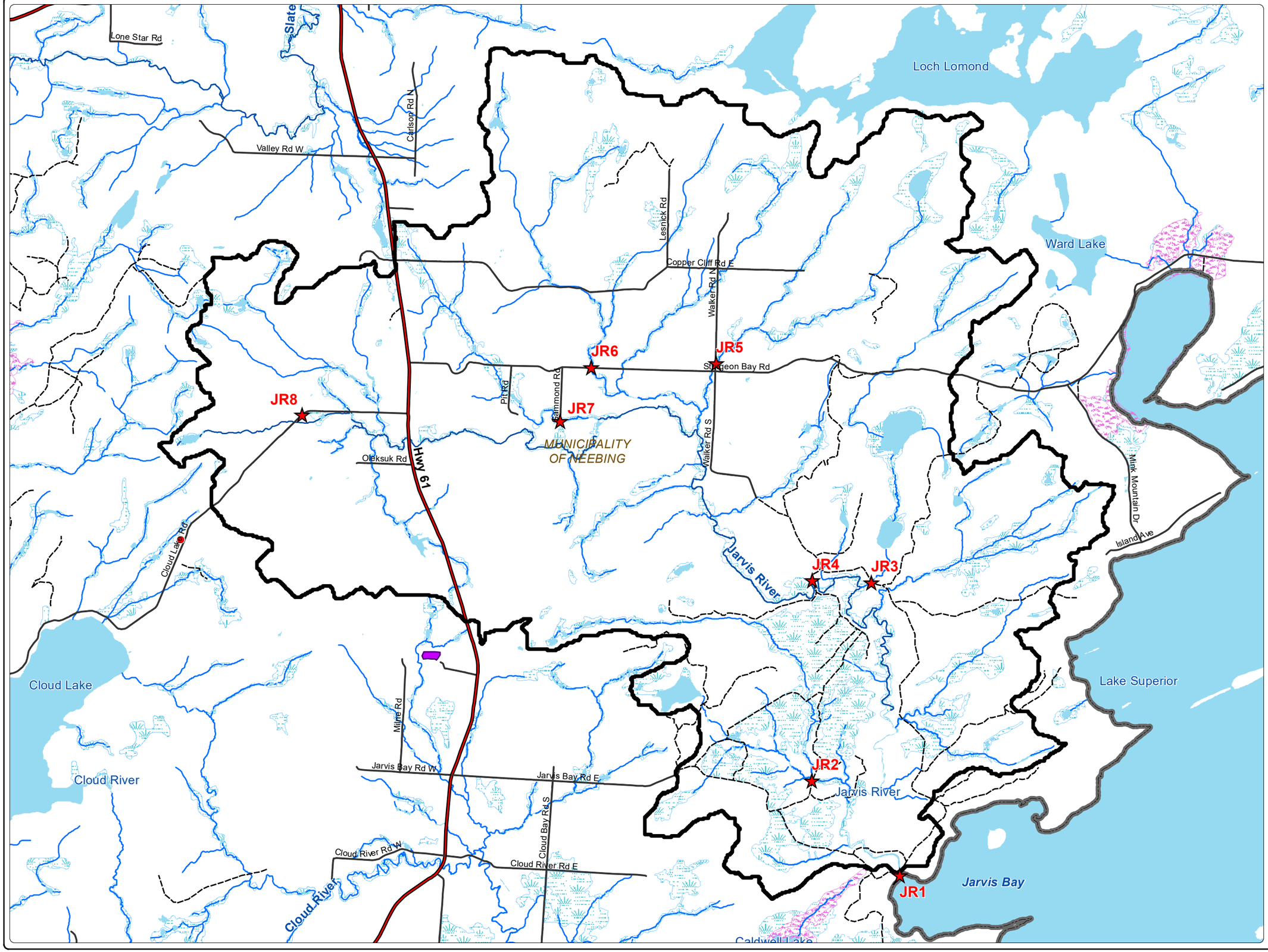
Datum: NAD 83
Projection: UTM Zone 16N
Date: October, 2018

LAKEHEAD REGION CONSERVATION AUTHORITY

Jarvis River Watershed

M-9: Site Plan



N

Legend

- Sampling Sites
- Jarvis River Watershed
- Municipal Boundary
- Household Waste Disposal Site
- Inactive Waste Disposal Site

Drainage

- Water Body
- Wetland
- Provincially Significant Wetland
- Stream
- River
- Ditch

Roads

- Highway
- Road
- Street
- Bush Roads

0 1 2 km

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130 Conservation Rd.
Thunder Bay, ON
P7B 6T8

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Datum: NAD 83
Projection: UTM Zone 16N
Date: October, 2018

LAKEHEAD REGION CONSERVATION AUTHORITY

Jarvis River Watershed

M-10: Culvert Sites

N

Loch Lomond

Ward Lake

Lake Superior

Jarvis Bay

Cloud Lake

Caldwell Lake

Jarvis River

Cloud River

MUNICIPALITY OF NEEBING

C1

C2

C3

C4

Lone Star Rd

Slate

Valley Rd W

Carlson Rd N

Lesnick Rd

Copper Cliff Rd E

Walker Rd N

Walker Rd S

Sturgeon Bay Rd

Pitt Rd

Hammond Rd

Oleksuk Rd

Hwy 61

Cloud Lake Rd

Milne Rd

Jarvis Bay Rd W

Jarvis Bay Rd E

Cloud Bay Rd S

Cloud River Rd W

Cloud River Rd E

Mirik Mountain Dr

Island Ave

Legend

- Confulence
- Culvert
- Jarvis River Watershed
- Municipal Boundary

Drainage

- Water Body
- Wetland
- Stream
- River
- Ditch

Roads

- Highway
- Road
- Street

0 1 2 km

This publication was produced by:
Lakehead Region Conservation Authority
130 Conservation Rd.
Thunder Bay, ON
P7B 6T8

This map is illustrative only. Do not rely on it as being a precise indicator of routes or features, nor as a guide to navigation.

Datum: NAD 83
Projection: UTM Zone 16N
Date: October, 2018

Appendix A:

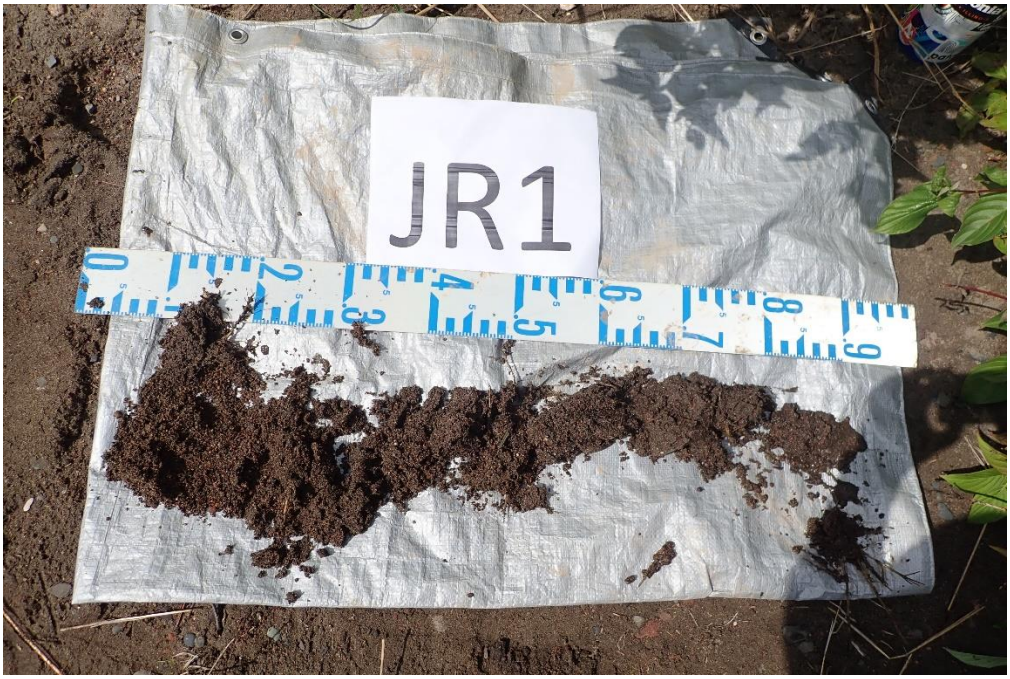
Soil Logging Summary and Photography

Appendix A: Soil Logging Summary and Photography

Soil Logging Summary

SITE ID	Organic Layer "O"	"A" Horizon	"B" Horizon	"C" Horizon
JR1				0-40 cm Sand
JR2		0-5 cm Silty Clay		5-95 cm Silty Clay
JR3		0-7 cm Loam	7-60 cm Silty clay loam	60-100 cm Silty Clay
JR4		0-27 cm Silty loam	27-40cm Loam	40-100 cm Silty clay loam
JR5		0-17 cm Silty loam		17-90 cm Silty clay
JR6		0-5 cm Clay	5-47 cm Clay	47-100 cm Clay
JR7		0-30 cm Silty clay loam		30-100 cm Silty clay
JR8		0-15 cm Loamy Sand		15-100 cm Cobbles

Soil Photography



Site 1

Site 2

Site 3

Site 4

Site 5

Site 6

Site 7

Site 8

Appendix B:

Common and Scientific Names of Identified Flora and Fauna

Appendix B: Common and Scientific Names of Identified Flora and Fauna

Flora	
Common Name	**Scientific (Latin) Name**
Trees	
Balsam fir	*Abies balsamea*
Balsam poplar	*Populus balsamifera*
Black ash	*Fraxinus nigra*
Black spruce	*Picea mariana*
Eastern White Cedar	*Thuja occidentalis*
Jack pine	*Pinus banksiana*
Tamarack	*Larix laricina*
Trembling aspen	*Populus tremuloides*
White birch	*Betula papyrifera*
White spruce	*Picea glauca*
Shrubs	
Beaked hazelnut	*Corylus cornuta*
Northern bush honeysuckle	*Diervilla lonicera*
Green alder	*Alnus viridis*
Mountain maple	*Acer spicatum*
Pin cherry	*Prunus pensylvanica*
Prickly wild rose	*Rosa acicularis*
Red-osier dogwood	*Cornus stolonifera*
Saskatoon berry (serviceberry)	*Amelanchier alnifolia*
Speckled alder	*Alnus rugosa*
Wild prickly rose	*Rosa acicularis*
Wild red raspberry	*Rubus idaeus*
Willow spp.	*Salix spp.*
Herbs	
Black-eyed Susan	*Rudbeckia hirta*
Canada anemone	*Anemone canadensis*
Canada goldenrod	*Solidago canadensis*
Common strawberry	*Fragaria virginiana*
Bird's-foot trefoil	*Lotus corniculatus*
Canada anemone	*Phragmites australis*
Cow vetch	*Vicia cracca*
Dandelion	*Taraxacum officinale*
Dwarf raspberry	*Rubus pubescens*
Evening primrose	*Oenothera biennis*
Fireweed	*Chamaenerion angustifolium*
Fragrant bedstraw	*Galium triflorum*

Flora	
Common Name	**Scientific (Latin) Name**
Herbs	
Large leaved aster	*Eurybia macrophyllus*
Lupines	*Lupinus albus*
Marsh marigold	*Caltha palustris*
Milkweed spp.	*Asclepias spp.*
Northern bedstraw	*Galium boreale*
Northern bluebell	*Mertensia paniculata*
Orange hawkweed	*Hieracium aurantiacum*
Ox-eye daisy	*Leucanthemum vulgare*
Pearly everlasting	*Anaphalis margaritacea*
Red clover	*Trifolium pratense*
Rose-twisted stalk	*Streptopus amplexifolius*
Spotted joe-pye weed	*Eutrochium maculatum*
Swamp thistle	*Cirsium muticum*
Sweet coltsfoot	*Petasites frigidus*
Tall buttercup	*Ranunculus acris*
Wild columbine	*Aquilegia canadensis*
Wild mint	*Mentha arvensis*
Wintercress spp.	*Barbarea spp.*
Woodland strawberry	*Fragaria vesca*
Yarrow	*Achillea millefolium*
Yellow hawkweed	*Hieracium pratense*
Yellow violet	*Viola pubescens*
Ferns/Mosses/Graminoids/Lichens	
Bulrush spp.	*Scirpus spp.*
Canada bluegrass	*Poa compressa*
Common reed	*Phragmites australis*
Dog's tooth lichen	*Peltigera canina*
False melic grass	*Schizachne purpurascens*
Horsetail - field	*Equisetum arvense*
Horsetail - swamp	*Equisetum fluviatile*
Horsetail - woodland	*Equisetum sylvaticum*
Lady fern	*Athyrium filix-femina*
Moss spp.	*Bryophyta spp.*
Quack grass	*Elymus repens*
Timothy grass	*Phleum pratense*
Aquatic Plants	
Algae spp.	*Chlorophyta spp.*
Broadleaf arrowhead	*Sagittaria latifolia*

Flora	
Common Name	**Scientific (Latin) Name**
Aquatic Plants	
Floating bur reed	*Sparganium fluctuans*
Sweet flag	*Acorus calamus*

Fauna	
Common Name	**Scientific (Latin) Name**
Fish	
Minnow spp.	*Phoxinus spp.*
Invertebrates	
Black fly	*Simuliidae spp.*
Burying beetle	*Nicrophorus spp.*
Canadian tiger swallowtail	*Papilio canadensis*
Carpenter ant	*Camponotus spp.*
Deer fly	*Chrysops spp.*
Dragonfly spp.	*Anisoptera spp.*
Grasshopper	*Melanoplus spp.*
Honeybee	*Apis spp.*
Horse fly	*Hybomitra spp.*
Mosquito	*Culicidae spp.*
Mourning cloak	*Nymphalis antiopa*
Northern crescent	*Phyciodes cocyta*
Spring azure	*Celastrina ladon*
Wasp spp.	*Vespula spp.*
Water snake spp.	*Nerodia spp.*
Water strider	*Gerridae spp.*
Aves	
American pelican	*Pelecanus erythrorhynchos*
Bald eagle	*Haliaeetus leucocephalus*
Blue jay	*Cyanocitta cristata*
Canada goose	*Branta canadensis*
Cormorant spp.	*Phalacrocoracidae spp.*
Great blue heron	*Ardea herodias*
Hawk spp.	Accipiter spp.
Mallard	*Anas platyrhynchos*
Seagull spp.	*Laridae spp.*
Mammals	
American beaver	*Castor canadensis*
Black bear	*Ursus americanus*
Common raccoon	*Procyon lotor*

Mammals	
Gray wolf	*Canis lupus*
Moose	*Alces alces*
Red fox	*Vulpes vulpes*
White tail deer	*Odocoileus virginianus*
Amphibians	
Frog spp.	*Rana spp.*
Toad spp.	*Bufo spp.*
Annelids	
Common earthworm	*Lumbricus terrestris*
Leech spp.	*Clitellata spp.*

Appendix C:

Techniques for Data Collection

Appendix C: Techniques for Data Collection

Air Temperature
The air temperature was measured with a basic mercury thermometer.

Channel Width & Depth
The width of the stream was measured using a nylon measuring-tape reel. Channel depth was measured by using a stainless steel meter stick.

Conductivity
Conductivity was measured with the YSI Pro DSS. The accuracy of the reading was ±0.001 mS/cm or ±1.0%; whichever was greater. The readings were recorded once the probe was completely submerged and all readings stabilized. In addition to conductivity readings taken in the field, laboratory analysis of the samples provided a second reading of conductivity which is included within the results.

Dissolved Oxygen
The YSI Pro DSS measured dissolved oxygen for the samples. The readings were recorded once the probe was submerged in the water and all variables were stabilized.

Flora and Fauna Identification
Identification was made in the vicinity of the sample sites, no transects were made. Observations were made approximately 50 metres from either stream edge. Field guides and the INaturalist app were used to accurately identify species.

Flow
The velocity of river flow at sites was measured using a stick and nylon measuring-tape reel. Distances measured varied depending upon stream obstructions and variable depth. The flow was then calculated using the equation **Q=V*A**, where **Q** is flow/ discharge, **V** is velocity (distance divided by time), and **A** is the cross sectional area of the stream.

Latitude, Longitude, and Elevation
The Universal Transverse Mercator (UTM) coordinates for each site were measured with a Trimble Geo XH 2008 hand held GPS unit.

Location
The sample sites were chosen using a 1:50,000 scale topographic map. The sample sites were also described in terms of road access and road crossings.

pH
The YSI Pro DSS measured pH for the water sample sites. The readings were recorded once the probe was submerged in the water and all the variables were stabilized. A pH reading was also taken during the analysis at the laboratory.

Photographs
Photographs were taken at each site using the Olympus Tough TG-5 shock and water proof camera. Upstream, downstream, soil, and vegetation photographs as well as culvert and outstanding litter or erosion photographs were all taken at each site. Substrate photographs were attempted at each site with the waterproof camera.

Surface Water Sampling
Samples were taken at the same position at each site wherever possible. Grab sampling technique was used when conducting surface water sampling. Sample bottles were pre-charged with preservatives, so this did not have to be done in the field. Sample bottles were submerged 15 to 30 centimetres below the surface of the water body and positioned towards the flow of the water source. Samples were kept cool and delivered to ALS Laboratory for analyzing.

Total Dissolved Solids
The total dissolved solids (TDS) were measured in laboratory.

Turbidity
Turbidity of the water was measured with the YSI Pro DSS. The readings were taken after the probe was submerged and all variables on the meter were stabilized.

Water Temperature
Water temperature was measured with the YSI Pro DSS. The readings were taken after the probe was submerged and all variables on the meter were stabilized.

OBBN In-Stream Materials Key

Soil Type
Like stream bed description, soil type on land will impact vegetation and erosion potential. Soil type was categorized based on its grain size using the FEC Manual for North Western Ontario.

Stream Bed Description

The bed description was described by means of a visual scan of the sample site area, with percentages assigned to the appropriate categories of varying grain sizes:

Grain Size	Description
Boulder	> 25.6 cm in diameter
Cobbles	6.4 - 25.6 cm in diameter
Gravel	0.2 – 6.4 cm in diameter
Sand	< 0.2 cm in diameter
Silt	Finer inorganic material than sand
Organic	Mainly organic combination of silt and clay
Clay	Inorganic origin with no apparent structure

Stream Cover

Stream cover describes the vegetation density along the river bank no more than 5 metres from the water's edge. Stream cover was divided into three categories of density:

Description	% Cover
Dense	75-100% shaded by canopy
Partly Open	25-75% shaded by canopy
Open	0-25% shaded by canopy

Appendix D:

Summary of Water Quality Parameters

Appendix D: Summary of Water Quality Parameters

Physical Properties

The abiotic factors of water quality are very influential on aquatic plants and animals and can have a significant impact on the ecosystem. The following physical parameters were measured either in the field or in the laboratory.

Conductivity
Conductivity is the measure of the ability of water to carry an electrical current expressed in micro seimens per centimeter (µS/cm). The reading is used to determine the total dissolved solids (TDS) in the water sample. There is no Provincial Water Quality Objective (PWQO) for conductivity.

Dissolved Oxygen
Like terrestrial animals, fish and other aquatic species require oxygen to breathe. It is not the mere presence of dissolved oxygen that is important; the gas has to be above a certain concentration in order to sustain life. As well, oxygen is required to decompose organic matter in the stream. Dissolved oxygen levels will be highest and during the day when aquatic plants have had time to produce oxygen during photosynthesis, as well as in cold and turbulent (a lot of mixing at the air-water interface) water. PWQO's have an acceptable range for dissolved oxygen in water dependent upon temperature. At 15 degrees Celsius the minimum amount of dissolved oxygen is 5 mg/L and at 20 degrees Celsius the minimum amount of dissolved oxygen is 4 milligrams per litre for cold water biota.

pH
The pH measures the concentration of hydrogen ions in the water based on a logarithmic scale of 0 to 14. Lower pH is acidic (many free hydrogen ions) and higher pH is alkaline (few free hydrogen ions). The pH of water determines the solubility and biological availability of chemicals constituents such as nutrients (eg. nitrogen, phosphorus) and heavy metals (eg. lead, copper). Extreme pH levels can increase the solubility of elements and compounds and it can make potentially toxic chemicals more mobile and increase the risk of absorption by aquatic life (Frondriest Environmental Inc.). The natural factors that can affect pH are interactions with surrounding rocks and other materials, precipitation (especially acid rain), and CO_2 concentrations. The anthropogenic factors that influence pH include wastewater and mining discharges, acid rain as a result of emissions from mining or fossil fuel combustion, and point source pollution from agricultural runoff (Frondriest Environmental Inc.). Geology of the watershed can give the river some buffering capacity to resist changes in pH but overall the range should stay between 6.5 and 8.5 to protect aquatic life, and avoid irritation to anyone using the water for recreational purposes.

Temperature

Water temperature is important because it dictates the kind of aquatic life that can live in a stream. Fish, insects, plankton and other aquatic species all have a preferred temperature range. If the temperature goes too far above or below their preferred range, the number of species may decrease. Temperature also influences water chemistry, generally causing chemical reactions to increase with higher temperatures. Temperature can also affect biological activity because warmer water holds less dissolved oxygen which can harm fish and aquatic life that require a high dissolved oxygen to live. Warmer temperatures also encourage bacteria to reproduce and grow more quickly. Temperature can vary depending on the source of the water, depth, and velocity of the stream, sunlight intensity and the amount of shade by the shoreline vegetation. There is no PWQO for temperature.

Total Dissolved Solids

Total dissolved solids (TDS) measure the amount of inorganic salts and small amounts of organic matter that is dissolved in water. The principal constituents are usually calcium, magnesium, sodium, potassium, carbonate, bicarbonate, chloride, sulphate, and nitrate (from agricultural use). Most of these originate from natural geological sources yet high levels may indicate runoff from of road salts, runoff from agricultural and erosion from exposed soil/no stream bank vegetation. There is no PWQO for TDS.

Turbidity

Turbidity is the measure of the relative clarity of water. Turbidity in water is caused by suspended matter such as silt, clay and algae that can often be seen in the sunlight. The diversity of species can be affected by how far the sunlight can penetrate the water column. Fish gills can become clogged with this suspended material, and the material may also settle on top of fish spawning grounds (and their eggs). Highly turbid water appears murky or dirty. Turbidity will often become higher after heavy rainfall, but high levels may also indicate soil erosion. There is no PWQO for turbidity.

Nutrients

Like terrestrial plants, aquatic plants and algae require nutrients for growth and productivity. The main nutrients of concern are nitrogen and phosphorus.

Nitrogen

Nitrogen (N) is one of the most common gases in the earth's atmosphere making up approximately 78%. Nitrogen nutrients are often applied to agricultural crops as fertilizers, but having too much in a watershed can increase plant growth and productivity to unhealthy levels. Nitrogen is constantly being recycled through the environment through the nitrogen cycle which includes fixation, ammonification, nitrification, and denitrification. The most important forms that plants can readily use are ammonia, nitrate

(NO_3) and nitrite (NO_2). Nitrogen levels can be reported in several ways, results from ALS Laboratory Group were given in Total ammonia-nitrogen (mg/L), Nitrate-nitrogen (NO_3-N mg/L), and Nitrite-nitrogen (NO_2-N mg/L). There is no PWQO for ammonia total. The PWQO for un-ionized ammonia is 0.02 mg/L.

Phosphorus

Total phosphorus gives a measurement of all forms of phosphorus found in the watershed, but the most important form within this measurement is soluble inorganic phosphate (PO_4) or orthophosphate ion (PO_4^{-3}). These two forms are of utmost importance because they are utilized by aquatic plants. While phosphorus is essential to life, too much can increase algae growth within the watershed. Excessive growths or build ups of algae on abiotic features (like rocks) can use up all the dissolved oxygen leaving other species, like fish, with anoxic (no oxygen) conditions. Nutrient loading may cause a decrease in biodiversity and a decrease in ecologically sensitive species. Natural decomposition of organic matter such as leaves, twigs, and grass that is washed into the stream during the winter does constitute an important source of nutrients. However, high levels of phosphorus may indicate unnatural sources such as detergent, pesticide, and fertilizer runoff or waste from farms contaminating the watershed. The PWQO criteria for phosphorus is 0.03 mg/L.

Bacteria

Escherichia coli

Escherichia coli (*E. coli*) are bacteria naturally found in the intestines of humans and warm-blooded animals. Unlike other bacteria in this family, *E. coli* does not usually occur naturally on plants or in soil and water. The inability of *E. coli* to grow in aquatic environments, combined with its short survival time means that the detection of *E. coli* in a water system is a good indicator of recent fecal contamination. Potential sources of *E. coli* include: leaking septic systems, runoff from manure storage facilities, or wild animal waste (i.e. American beavers and Canadian geese). These bacteria can cause irritation of the skin and eyes when contact is made, and can cause gastro-intestinal disorders in humans. The PWQO for *E. coli* is 100 *E. coli* per 100 mL.

Total Coliforms

Total coliforms are a group of bacteria that are naturally found on plants, in soils, water, and the intestines of humans and warm-blooded animals. Due to the fact that total coliforms are widespread in the environment, they can be used as one of the many operational tools to determine the efficacy of a drinking water treatment system. The total coliform group contains various species of the genera *Escherichia, Klebsiella, Enterobacte, Citrobacter, Serratia,* and many others. There is no current PWQO for total coliforms; however, the previous guideline from prior to 1994 was 1000 MPN per 100 mL.

Metals

Most of the metals listed below are found naturally within the earth's crust and weathering of rock can transport them into surface water. The following is a complete list of the metals analysis performed on the water samples and their qualities.

Aluminum
Aluminum is the most abundant metal on Earth, comprising about 8% of the Earth's crust. It is found in a variety of minerals, such as feldspars and micas, which, with time, weather to clays. Aluminum in the aquatic environment comes from both natural and anthropogenic sources but the amount of aluminum found naturally in the environment exceeds aluminum from anthropogenic sources. Soil derived dusts from activities like farming, mining, and coal combustion can directly release aluminum into aquatic environments. Wind and water erosion from agricultural lands also releases aluminum into the aquatic environment. Acid rain can also lower environmental pH and make aluminum more soluble in the environment (Environment and Climate Change, 2017). High levels of aluminum will put strain on the kidneys of animals when they attempt to excrete it but it is not normally fatal. Aluminum and its compounds are often used in food as additives, in drugs, consumer products, and in the treatment of drinking water. Aluminum poisoning has been linked to neurological dementia in kidney dialysis patients and, in recent years, Alzheimer's disease, Parkinson's disease, and Lou Gehrig's disease. The intake of large amounts of aluminum can also cause anaemia, osteomalacia (brittle or soft bones), glucose intolerance, and cardiac arrest in humans. The PWQO guideline for aluminum varies with pH, the maximum concentration being 75 μg/L at pH >6.5.

Antimony
Antimony is a metallic element that is a blue-white colour in its stable form. Antimony is present in the aquatic environment as a result of rock weathering, soil runoff, and anthropogenic activities (Filella, M., Belzile, N., & Chen, Y., 2001). Acute intoxication is characterized by abdominal pain, vomiting, diarrhea, dehydration, muscular pain, shock, haemoglobinuria, anuria, and uraemia. In addition, severe myocardial symptoms and convulsions have been observed with acute doses of antimonials, as well some deaths were attributed to liver necrosis. Concentrations of Antimony in freshwater systems typically range from a few ng/l to a few μg/l (Filella, M., Belzile, N., & Chen, Y., 2001). The maximum concentration of antimony under PWQO guidelines is 20 μg/L.

Arsenic
Arsenic is a natural element abundantly found within the earth's crust. It may be found in some drinking water supplies, including wells. The largest natural source of arsenic is from weathered rocks and soils. The main anthropogenic source is from smelting and refining industries. Arsenic is used in manufacturing wood preservatives, herbicides, pharmaceuticals, glass manufacturing, and metallurgical applications (Canadian Council

of Ministers of the Environment, 2001). Long-term exposure (over many years or decades) to high levels of arsenic in drinking water may cause thickening and discoloration of the skin, nausea and diarrhea, decreased production of blood cells, abnormal heart rhythm and blood vessel damage, or numbness in the hands and feet. Short term exposure (days/weeks) to very high levels of arsenic can result in abdominal pain, vomiting and diarrhea, muscular cramping or pain, weakness and flushing of skin, skin rash, numbness, burning or tingling sensation on the palms of the hands and soles of the feet, or loss of movement and sensory response. The maximum concentration of arsenic under the PWQO guideline is 5 μg/L.

Barium

Barium is present as a trace element in both igneous and sedimentary rocks. Although it is not found free in nature, barium occurs in a number of compounds. Barium compounds have a wide variety of industrial applications. They are used in the plastic, rubber, electronic, and textile industries. Barium can anthropogenically enter surface water during coal processing as the effluent from a coal conversion plant contains high concentrations of barium, also through barium ore processing and subsequent industrial chemical processes involving barium. Barium can enter freshwater systems naturally through leaching and eroding of sedimentary rocks (CCME, 2013). At high concentrations, barium causes strong vasoconstriction (increase in blood pressure) by its direct stimulation of arterial muscle, peristalsis (radial contraction and relaxation of muscles) due to the violent stimulation of smooth muscle, and convulsions and paralysis following stimulation of the central nervous system. Depending on the dose and solubility of the barium salt, death may occur in a few hours or a few days. There are currently no PWQO guidelines for barium.

Beryllium

Beryllium is a hard grey metal that is extracted from the earth, refined, and reduced to a very fine powder. It occurs as a chemical component of certain rocks, coal and oil, soil, and volcanic dust. People exposed to beryllium are at risk of developing serious debilitating diseases. Chronic beryllium disease (CBD or berylliosis) is a painful scarring of the lung tissue. Less common than CBD, acute (short—term) beryllium disease, causes lung inflammation resembling pneumonia. In severe cases, both diseases may be fatal. The maximum concentration of beryllium under PWQO guidelines depends on hardness. If $CaCO_3$ is >75 mg/L, the maximum concentration of beryllium is 1100 μg/L, and if the $CaCO_3$ is <75 mg/L, the maximum concentration of Beryllium is 11 μg/L.

Bismuth

Bismuth is a brittle metal with a pinkish colour, often found in its native form. Exposure to bismuth at low doses may cause gastrointestinal disorders, low stomach acid, heartburn, bloating, calcification, warts, diarrhea, and gastric ulcers. At large doses it may cause mental confusion, memory problems, tremors, staggering gait, muscle twitching,

slurring speech, joint problems, hypoadrenalism (under activity of adrenal glands), hearing and visual disturbances, hallucinations, and coma. There are currently no PWQO guidelines limiting the intake of bismuth.

Boron

Boron is a non-metallic element that is not found in nature in its elemental form but can be found in over 80 compounds. High concentrations of boron are found in sediments and sedimentary rocks, especially in clay rich marine sediments. (Canadian Council of Ministers of the Environment, 2009). Natural sources of boron to the aquatic environment is through atmospheric deposition, natural weathering processes, volcanic emissions, soil dust, and plant aerosols. Anthropogenic sources of boron include fossil fuel combustion, biomass burning, municipal sewage, waste waters from coal-burning power plants, irrigation, copper smelters, and industries that use boron. Natural weathering of boron releases more boron into the environment than industrial sources due to the high occurrence of clay-rich sedimentary rocks on the Earth's surface. Boron concentrations in freshwater are more likely dependent on the leaching of boron from the surrounding geology than from waste water or pollution (Canadian Council of Ministers of the Environment, 2009). Exposure to boron in small doses may cause irritation to the nose, throat, and eyes. In larger doses, boron can affect the stomach, liver, kidneys, brain, and may eventually lead to death. The maximum level of boron under PWQO guidelines is 200 µg/L.

Cadmium

Cadmium is a relatively rare element and an extremely toxic metal even in low concentrations. It is used commercially as a stabilizer in plastic, in fungicides for golf courses, in televisions, in nickel–cadmium batteries, in motor oils, and in curing agents for rubber. Anthropogenic sources of cadmium are industrial wastes from metallurgical plants, plating works, plants manufacturing cadmium pigments, textile operations, cadmium-stabilized plastics, or nickel-cadmium batteries, or by effluents from sewage treatment plants (Health Canada). Natural sources of cadmium include dissolution of sediment containing cadmium, especially in more acidic waters (Health Canada). Cadmium poisoning can lead to itai-itai disease, which initiates bone softening, joint pain, and kidney failure. The interim PWQO guideline states if hardness as $CaCO_3$ is 0-100 mg/L, the maximum cadmium concentration is 0.1 µg/L, and if hardness is >100 mg/L, the maximum cadmium concentration is 0.5 µg/L.

Calcium

Calcium is the third most abundant metal in the Earth's crust. Calcium is also the most abundant metal in the human body and is the main constituent of bones. Calcium is a dietary requirement and there are no adverse health effects from intake of large doses of calcium. There are currently no PWQO guidelines for calcium.

Chromium

Chromium is a lustrous, grey metal. Natural sources of chromium include volcanic emissions, forest fires, vegetative debris, and marine aerosols (Canadian Council of Ministers of the Environment, 1999). Anthropogenic sources of chromium to the aquatic environment include tanneries, cooling towers, steel and nonferrous foundries, metal finishing and plating operations, flat glass and asbestos producing plants, wood treatment facilities, paint and chemical works, oil drilling and recovery rigs, as well as wastes from pulp and paper mills, cement and fertilizer plants, textile mills, power plants, chlor-alkali plants, petrochemical industries, as well as urban runoff and industrial storm waters (Canadian Council of Ministers of the Environment, 1999). Chromium (III) is an essential nutrient for the human body, but higher intake may cause skin rashes. Chromium (VI) is known to cause various health effects such as upset stomachs and ulcers, skin rashes, respiratory problems, weakened immune systems, kidney and liver damage, alteration of genetic material, lung cancer and death. The maximum concentration of chromium under PWQO guidelines is 1 μg/L for Chromium (VI) and 8.9 μg/L for Chromium (III).

Cobalt

Cobalt is a hard, lustrous, silver-grey metal and is found in various ores. Cobalt is an essential element for the growth of various marine algae species and it is shown to enhance the growth of plant at low concentrations. In high concentrations, cobalt can be toxic to humans as well as terrestrial and aquatic plants and animals. Cobalt is present naturally in rock, soil, water, plants, animals, and the air in small concentrations. It is often associated with nickel, silver, lead, copper, and iron ores. Cobalt can also have anthropogenic sources in the aquatic environment such as through cobalt mining, production of alloys and chemicals containing cobalt, sewage effluent, as well as urban and agricultural run-off (Nagpal, 2004). Health effects resulting from exposure to high concentrations include vomiting and nausea, vision problems, heart problems and thyroid damage. The maximum concentration of cobalt under PWQO guidelines is 0.9 μg/L.

Copper

Copper occurs in nature as a metal and can also be found in various minerals. Copper is an essential element to human metabolism, although intake at higher doses can cause adverse health effects. Acute copper poisoning can cause health effects including vomiting, diarrhea, and jaundice. In severe cases, stool and saliva may appear green or blue. In the terminal phases, anuria (kidney failure), hypotension (low blood pressure), and coma precede death. The PWQO criterion for copper is dependent upon the hardness of the water and so varies between 0.001 mg/L to 0.005 mg/L.

Iron

Iron is an abundant metal found in all types of rock. The precipitation of excessive iron creates an objectionable reddish-brown colour to water. Iron may stain plumbing fixtures, produce undesirable tastes in beverages, and promote the growth of certain iron-

bacteria, which can lead to the deposition of a slimy coating in water distribution pipes. The PWQO guideline stipulates that the levels of iron in the water must be below 300 μg/L.

Lead

Lead is a very toxic metal to all forms of life, and can cause neurological damage or death. Although natural occurrences can result from precipitation and the weathering of ores, the majority of lead in watercourses comes from anthropogenic sources. The PWQO requirement for lead varies with different alkalinity as $CaCO_3$ (mg/L). The maximum lead concentration is 25 μg/L.

Lithium

Lithium is a soft, silver-white metal belonging to the alkali metal group of chemical elements. Like all alkali metals, lithium is highly reactive and flammable. Lithium forms a minor part of igneous rocks, with the largest concentrations in granites. Lithium and its compounds have a range of effects on the human body. For instance, compounds of lithium tend to harm the kidneys and lithium carbonate can affect a person's mental health. There are no current PWQO guidelines for lithium.

Magnesium

Magnesium is very abundant in nature and is found in many minerals. It is a dietary requirement, but too much can lead to muscle weakness, lethargy and confusion. There are no current PWQO guidelines for magnesium.

Manganese

Manganese is a very common compound that can be found everywhere on earth. It is essential for humans to survive, but toxic when concentrations in the body are too high. Manganese can cause Parkinson's disease, lung embolism, and bronchitis. There are currently no PWQO guidelines for manganese.

Molybdenum

Molybdenum is an element that is found in minerals containing iron, bismuth, or copper and it is a by-product of copper and tungsten mining. It is commonly associated with coal or uranium deposits. Natural sources of molybdenum to the aquatic environment includes weathering of ores from igneous or sedimentary rocks (shale), and subsequent runoff to streams and lakes (Canadian Council of Ministers of the Environment, 1999). Anthropogenic sources of molybdenum to the aquatic environment includes use of fertilizers containing molybdenum, atmospheric wet deposition, leaching processes near molybdenum mines, and burning of fossil fuels It is used as an alloy for various metals and occurs naturally in soil and rock (Canadian Council of Ministers of the Environment, 1999). Potential health impacts associated with molybdenum include neurotoxicity and

Reproductive toxicity. The maximum concentration of molybdenum under PWQO guidelines is 40 µg/L.

Nickel

Nickel is a compound that occurs in the environment only at very low levels. An uptake of large quantities of nickel may cause higher risks of cancer, respiratory failure, birth defects and heart disorders. The maximum concentration of nickel under PWQO guidelines is 25 µg/L.

Potassium

Potassium is a soft silvery white metal, which is a key plant element and is found in most fertilizers. Potassium is an essential element in humans and is seldom found in drinking water at levels that could be a concern for healthy humans. It is present in all animal and plant tissues so it is found in all foods. Potassium is also a dietary requirement, but many potassium compounds may cause adverse health effects. Such compounds include potassium alum or potassium cyanide. There are currently no PWQO guidelines for potassium.

Selenium

Selenium is one of the rarer elements on the earth. It occurs naturally in the environment and is also released by human activities. Natural sources of selenium in the environment are volcanoes, biogenic processes, atmospheric release, and forest fires. The main source of selenium in surface water today is the result of weathering and sedimentary processes acting on volcanic parent rocks that have high concentrations of selenium (Beatty & Russo, 2014). Anthropogenic sources of selenium in the environment are industrial, agricultural, mining, and petrochemical operations, wastewater discharges from municipal sewage treatment plants, landfills, combustion of coal and fossil fuels, and emissions from smelting and manufacturing of pyritic ores (Beatty & Russo, 2014). Depending on the form of selenium varying health effects can occur including brittle hair and deformed nails, rashes, swelling of the skin, and severe pain. Selenium poisoning may become so severe that it may cause death. Background selenium concentrations in surface waters range from 0.1 to 0.4 µg/L (Beatty & Russo, 2014). The maximum concentration of selenium under PWQO guidelines is 100 µg/L.

Silver

Silver is stable in both water and air and is acid and base resistant, but corrodes when it comes in contact with sulphur compounds. Silver oxide may irritate the eyes and is harmful upon swallowing, affecting the respiratory tract and skin. Silver nitrate is much more harmful, because it is a strong oxidant. It causes corrosion, and an oral uptake can lead to vomiting, dizziness and diarrhea. The maximum concentration of silver under PWQO guidelines is 0.1 µg/L.

Sodium

Sodium is a soft, silvery-white, highly reactive metal. It is the sixth most abundant element in the Earth's crust, and exists in numerous minerals such as feldspars, sodalite and rock salt. Sodium has a number of important functions in plants, humans, and animals. In humans, it is involved in controlling the amount of fluid present in cells. An excess or lack of sodium can cause cells to gain or lose water. Either of these changes can prevent cells from carrying out their normal functions. There are currently no PWQO guidelines for sodium.

Strontium

Strontium is a bright silvery metal that is reactive in water. Natural sources of Strontium includes leaching from limestone. Anthropogenic sources of strontium include being released into the environment as a by-product of other mining operations, air deposition from coal burning and phosphate fertilizers (Federal-Provincial-Territorial Committee on Drinking Water, 2018). Acute effects of strontium include vomiting and diarrhea if ingested, and may also cause irritation to the skin. Chronic skin contact may cause dermatitis. There are currently no PWQO guidelines for strontium.

Tellurium

Tellurium is a brittle, mildly toxic, rare, silver-white metalloid. It is chemically related to selenium and sulfur. It is occasionally found in native form as elemental crystals. Tellurium is far more common in the universe as a whole than on Earth. When taken internally, tellurium can have harmful effects. It may cause nausea, vomiting, and damage to the central nervous system. There are currently no PWQO guidelines for tellurium.

Thallium

Thallium is a silvery-grey metal that is very toxic by inhalation, ingestion and skin absorption. Natural inputs of thallium into the aquatic environment includes weathering processes. Anthropogenic inputs of thallium into the aquatic environment includes potash, effluents production of sulphuric acid, the mining and smelting of copper, gold, zinc, lead, and cadmium, and combustion of coal and oil (Canadian Council of Ministers of the Environment, 1999). It may act as a systemic poison, neurotoxin, and may cause birth abnormalities. It is also a respiratory and eye irritant. The maximum concentration of thallium under PWQO guidelines is 0.3 μg/L.

Tin

Tin is a soft, pliable, silvery-white metal. Acute effects of tin include skin or eye irritation, headaches, stomach aches, dizziness, and breathlessness. Long-term effects include liver damage, malfunctioning of immune systems, chromosomal damage, shortage of red blood cells, and brain damage. There are currently no PWQO guidelines limiting the intake of tin.

Titanium
Titanium is a white-silvery metallic colour and is always found bound to other elements in nature. There are no known health hazards of titanium in water, but it is known to have adverse health effects in powder form. There are currently no PWQO guidelines for titanium.

Tungsten
Tungsten is a lustrous, silvery-white metal. Acute health effects include irritation to the skin and eyes causing watering and redness. There are no known long-term health effects. The maximum concentration of tungsten under PWQO guidelines is 30 μg/L.

Uranium
Uranium is a hard, dense, malleable, ductile, silver-white, radioactive metal. No harmful radiation effects of natural levels of uranium have been found. However, chemical effects may occur after the uptake of large amounts of uranium, which can cause health effects such as kidney disease. Exposure to uranium radionuclides that form during radioactive decay may cause cancer. The maximum concentration of uranium under PWQO guidelines is 5 μg/L.

Vanadium
Vanadium is a rare, soft, ductile grey-white element found combined in certain minerals and used mainly to produce certain alloys. The uptake of vanadium by humans mainly takes place through foodstuffs, such as buckwheat, soy beans, olive oil, sunflower oil, apples and eggs. Some acute health effects associated with the high intake of vanadium include inflammation of stomach and intestines, sickness and headaches, dizziness, skin rashes, nosebleeds and throat pain. Chronic exposure may cause eye, skin and respiratory problems. The maximum concentration of vanadium under PWQO guidelines is 6 μg/L.

Zinc
Zinc is a lustrous bluish-white metal. Zinc is an essential element for all living things (Health Canada, 1987) and overdoses do not occur very often. Anthropogenic sources of zinc include primary iron and steel production, primary copper and nickel production, fuel combustion, transportation, solid waste incineration, and pesticide applications (Health Canada, 1987). Symptoms include nausea, vomiting, dizziness, fevers, and diarrhea. The maximum concentration of zinc under PWQO guidelines is 20 μg/L.

Zirconium
Zirconium is a very strong, malleable, ductile, and lustrous, silver-grey metal. Zirconium and its salts generally have low systemic toxicity. The maximum concentration of Zinc under PWQO guidelines is 4 μg/L.

Appendix E:

Water Quality Guidelines

Appendix E: Water Quality Guidelines

The following are taken from the Ministry of the Environment, Provincial Water Quality Objectives (PWQO), July 1994 and was updated January 2018.

Physical

Alkalinity
Alkalinity should not be decreased by more than 25% of the natural concentration.

Dissolved Oxygen
Dissolved oxygen concentrations should not be less than the values specified below for cold water biota (e.g. salmonid fish communities) and warm water biota (e.g. centrarchid fish communities):

Dissolved Oxygen Concentration				
Temperature	Cold Water Biota		Warm Water Biota	
°C	% Saturation	mg/L	% Saturation	mg/L
0	54	8	47	7
5	54	7	47	6
10	54	6	47	5
15	54	6	47	5
20	57	5	47	4
25	63	5	48	4

In waters inhabited by sensitive biological communities, or in situations where additional physical or chemical stressors are operating, more stringent criteria may be required. For example, a sensitive species such as lake trout may require more specific water quality objectives.

In some hypolimnetic waters, dissolved oxygen is naturally lower than the concentrations specified in the above table. Such a condition should not be altered by adding oxygen-demanding materials causing a depletion of oxygen.

pH
The pH should be in the range of 6.5 – 8.5

- to protect aquatic life
- both alkaline and acidic waters may cause irritation to anyone using the water for recreational purposes

Temperature
The natural thermal regime of any body of water shall not be altered so as to impair the quality of the natural environment. In particular, the diversity, distribution and abundance of plant and animal life shall not be significantly changed.

Waste Heat Discharge

1. Ambient Temperature Changes

   The temperature at the edge of a mixing zone shall not exceed the natural ambient water temperature at a representative control location by more than 10°C (18°F). However, in special circumstances, local conditions may require a significantly lower temperature difference than 10°C (18°F). Potential dischargers are to apply to the MOECC for guidance as to the allowable temperature rise for each thermal discharge. This ministry will also specify the nature of the mixing zone and the procedure for the establishment of a representative control location for temperature recording on a case-by-case basis.

2. Discharge Temperature Permitted

   The maximum temperature of the receiving body of water, at any point in the thermal plume outside a mixing zone, shall not exceed 30°C (86°F) or the temperature of a representative control location plus 10°C (18°F) or the allowed temperature difference, whichever is the lesser temperature. These maximum temperatures are to be measured on a mean daily basis from continuous records.

3. Taking and Discharging of Cooling Water

   Users of cooling water shall meet both the Objectives for temperature outlined above and the "Procedures for the Taking and Discharge of Cooling Water" as outlined in the MOEE publication *Deriving Receiving-Water Based, Point-Source Effluent Requirements for Ontario Waters (1994).*

Nutrients

Ammonia (un-ionized)
The amount of un-ionized ammonia should not exceed 20 µg/L.

The percentages of un-ionized ammonia (NH3) in aqueous ammonia solution for different temperature and pH conditions are listed in the table below. For example, at 20ºC and pH

of 8.0, a total ammonia concentration of 500 µg/L would give an un-ionized ammonia concentration of 500 x 3.8/100 = 19 µg/L which is less than the un-ionized ammonia Objective of 20 µg/L.

The table below is taken from the PWQO; percentages are rounded to two significant figures. The equations given by may be used to interpolate values between those given in the table:

$f = 1/(10^{pKa-pH} +1)$, where **f is the fraction of NH3**

pKa = 0.09018 + 2729.92/T, where T = ambient water temperature in Kelvin (K = °C + 273.16)

Results should be converted to percent and rounded to two significant figures. Extrapolations should not be made beyond the ranges of the table.

Note: Under certain temperature and pH conditions, the total ammonia criteria for the protection of aquatic life may be less stringent than the criteria for other beneficial uses (e.g. public water supply).

Percent NH3 in aqueous ammonia solutions for 0-30 °C and pH 6-10

Temp.	**pH**								
°C	**6.0**	**6.5**	**7.0**	**7.5**	**8.0**	**8.5**	**9.0**	**9.5**	**10.0**
0	.0083	.026	.083	.26	.82	2.6	7.6	21.	45.
1	.0090	.028	.090	.28	.89	2.8	8.3	22.	47.
2	.0098	.031	.098	.31	.97	3.0	8.9	24.	49.
3	.011	.034	.11	.34	1.1	3.3	9.6	25.	52.
4	.012	.036	.12	.36	1.1	3.5	10.	27.	54.
5	.013	.040	.13	.39	1.2	3.8	11.	28.	56.
6	.014	.043	.14	.43	1.3	4.1	12.	30.	58.
7	.015	.046	.15	.46	1.5	4.4	13.	32.	60.
8	.016	.050	.16	.50	1.6	4.8	14.	34.	61.
9	.017	.054	.17	.54	1.7	5.2	15.	35.	63.
10	.019	.059	.19	.59	1.8	5.6	16.	37.	65.
11	.020	.064	.20	.63	2.0	6.0	17.	39.	67.
12	.022	.069	.22	.68	2.1	6.4	18.	41.	69.
13	.024	.074	.24	.74	2.3	6.9	19.	43.	70.
14	.025	.080	.25	.80	2.5	7.4	20.	45.	72.
15	.027	.087	.27	.86	2.7	8.0	22.	46.	73.
16	.030	.093	.29	.93	2.9	8.5	23.	48.	75.

Temp.	pH								
°C	6.0	6.5	7.0	7.5	8.0	8.5	9.0	9.5	10.0
17	.032	.10	.32	1.0	3.1	9.1	24.	50.	76.
18	.034	.11	.34	1.1	3.3	9.8	26.	52.	77.
19	.037	.11	.37	1.2	3.6	11.	27.	54.	79.
20	.040	.13	.40	1.2	3.8	11.	28.	56.	80.
21	.043	.14	.43	1.3	4.1	12.	30.	58.	81.
22	.046	.15	.46	1.4	4.4	13.	32.	59.	82.
23	.049	.16	.49	1.5	4.7	14.	33.	61.	83.
24	.053	.17	.53	1.7	5.0	14.	35.	63.	84.
25	.057	.18	.57	1.8	5.4	15.	36.	64.	85.
26	.061	.19	.61	1.9	5.8	16.	38.	66.	86.
27	.065	.21	.65	2.0	6.2	17.	40.	67.	87.
28	.070	.22	.70	2.2	6.6	18.	41.	69.	88.
29	.075	.24	.75	2.3	7.0	19.	43.	70.	88.
30	.081	.25	.80	2.5	7.5	20.	45.	72.	89.

Phosphorus

Current scientific evidence is insufficient to develop a firm objective at this time. Accordingly, the following phosphorus concentrations should be considered as general guidelines, which should be supplemented by site-specific studies:

- To avoid nuisance concentrations of algae in lakes, average total phosphorus concentrations for the ice-free period should not exceed 20 µg/L;
- A high level of protection against aesthetic deterioration will be provided by a total phosphorus concentration for the ice-free period of 10 µg/L or less. This should apply to all lakes naturally below this value;
- Excessive plant growth in rivers and streams should be eliminated at a total phosphorus concentration below 30 µg/L.

Bacteriological

Escherichia coli

The amount of *Escherichia coli* should not exceed 100 counts per 100 mL of water (based on a geometric mean of at least 5 samples).

Based on a recreational water quality guideline published by the Ontario Ministry of Health in 1992, this Ministry of Health guideline was specifically intended for application by the local Medical Officer of Health to swimming and bathing beaches. It is based upon a geometric mean of levels of *E. coli* determined from a minimum of 5 samples per site taken within a given swimming area and collected within a one month period. If the geometric mean *E. coli* level for

the sample series at a given site exceeds 100 per 100 mL, the site should be considered unsuitable for swimming and bathing. *E. coli* was selected for the guideline because studies have determined that, among bacteria of the coliform group, *E. coli* is the most suitable and specific indicator of fecal contamination.

An analytical test with a high degree of specificity for *E. coli* regardless of water sample source, requiring no confirmation procedures, and which produces results in 21 hours has been developed and adopted by both the Ministry of Health, and Ministry of Environment and Energy laboratories.

Where testing indicates sewage or fecal contamination, a site-specific judgment must be made as to the severity of the problem and the appropriate course of action.

As of May 1, 1994, MOEE staff has been advised to base all **new** compliance, enforcement and monitoring activities on the *E. coli* test. Some water managers may find it necessary to continue testing for fecal coliforms or total coliforms. For example, where testing at a long term water quality monitoring station requires a continuous record of results using either the fecal or total coliform test to monitor trends in water quality. As a benchmark for the long term monitoring results, the former objectives for fecal coliforms and total coliforms are referenced for your information. For fecal coliforms the objective was 100 counts per 100 ml (based on a geometric mean density for a series of water samples). For total coliforms the objective was 1000 counts per 100 ml (based on a geometric mean density for a series of water samples).

Metals

Aluminum

Aluminum amounts should not exceed the following:

PH values	Interim PWQO (µg/L)
4.5 to 5.5	15
>5.5 to 6.5	No more than 10 % of natural background
> 6.5 to 9.0	75

Antimony

The amount of Antimony should not exceed 20 µg/L.

Arsenic

The amount of Arsenic should not exceed 5 µg/L.

Barium

There are currently no PWQO guidelines for Barium.

Beryllium

Beryllium amounts should not exceed the following:

Hardness as CaCO3 (mg/L)	Interim PWQO (µg/L)
< 75	11
>75	1100

Bismuth

There are currently no PWQO guidelines for Bismuth.

Boron

The amount of Boron should not exceed 200 µg/L.

Cadmium

Cadmium amounts should not exceed the following:

Hardness as CaCO3 (mg/L)	Interim PWQO (µg/L)
0 – 100	0.1
>100	0.5

Calcium

There are currently no PWQO guidelines for Calcium.

Chromium

Chromium amounts should not exceed the following:

	Interim PWQO (µg/L)
Hexavalent Chromium (Cr VI)	1
Trivalent Chromium (Cr III)	8.9

Cobalt

The amount of Cobalt should not exceed 0.9 µg/L.

Copper

The amount of Copper should not exceed the following:

Hardness as CaCO3 (mg/L)	Interim PWQO (µg/L)
0-20	1
>20	5

Iron

The amount of Iron should not exceed 300 µg/L.

Lead
Lead amounts should not exceed the following:

Hardness as CaCO3 (mg/L)	Interim PWQO (µg/L)
< 30	1
30 to 80	3
> 80	5

Lithium
There are currently no PWQO guidelines for Lithium.

Magnesium
There are currently no PWQO guidelines limiting the intake of Magnesium.

Manganese
There are currently no PWQO guidelines for Manganese.

Molybdenum
The amount of Molybdenum should not exceed 40 µg/L.

Nickel
The amount of Nickel should not exceed 25 µg/L.

Potassium
There are currently no PWQO guidelines for Potassium.

Selenium
The amount of Selenium should not exceed 100 µg/L.

Silicon
There are currently no PWQO guidelines for Silicon.

Silver
The amount of Silver should not exceed 0.1 µg/L.

Sodium
There are currently no PWQO guidelines for Sodium.

Strontium
There are currently no PWQO guidelines for Strontium.

Tellurium
There are currently no PWQO guidelines for Tellurium

Thallium
The amount of Thallium should not exceed 0.3 μg/L.

Tin
There are currently no PWQO guidelines for Tin.

Titanium
There are currently no PWQO guidelines for Titanium.

Tungsten
The amount of Tungsten should not exceed 30 μg/L.

Uranium
The amount of Uranium should not exceed 5 μg/L.

Vanadium
The amount of Vanadium should not exceed 6 μg/L.

Zinc
The amount of Zinc should not exceed 20 μg/L.

Zirconium
The amount of Zirconium should not exceed 4 μg/L.

Appendix F:

Forest Ecosystem Classification

Appendix F: Forest Ecosystem Classification

Site 1, Site 3, Site 4, Site 5: V15 White Spruce Mixedwood

Description: A variable mixedwood Type with white spruce as the main canopy species. The understory ranges from herb and shrub to poor, with balsam fir commonly abundant in the shrub layer. Occurring over a broad range of soil and site conditions but primarily on deep, fresh to moist, mineral soils.

Site 1

Site 3

Site 4

Site 5

Common Overstory Species (in descending order):
White spruce, balsam fir, trembling aspen, white birch, black spruce, balsam poplar, red maple, jack pine

Common Understory Species:

Shrubs:	Balsam fir, *Acer spicatum, Rubus pubescens, Corylus cornuta, Sorbus decora, Linnaea borealis, Diervilla lonicera, Rosa acicularis, Amelanchier* spp., trembling aspen
Herbs:	*Aralia nudicaulis, Cornus Canadensis, Clintonia borealis, Maianthemum canadense, Streptopus roseus, Trientalis borealis, Galium triflorum, Aster macrophyllus, Mitella nuda, Viola renifolia, Anemone quinquefolia, Petasites palmatus*
Mosses:	*Pleurozium schreberi, Ptilium crista-castrensis, Rhytidiadelphus triquestrus, Plagiomnium cuspidatum*

Forest Floor Cover:

Species	Broadleaf Litter	Moss	Conifer Litter	Wood
Forest Floor Cover (%)	61	16	13	5

Site 2: V16 Balsam Fir- White Spruce Mixedwood/ Feathermoss

Description: A variable mixedwood Type with balsam fir and/or white spruce as the main tree species. The understory generally lacks an abundance of broadleaved species but balsam fir can occur in dense thickets. Extensive feathermoss mats cover the forest floor. Occurring on a broad range of soil and site conditions but primarily on fresh to moist, upland mineral soils

Common Overstory Species (in descending order):
balsam fir, white spruce, white birch, black spruce, trembling aspen, jack pine

Common Understory Species:

Shrubs:	balsam fir, *Linnaea borealis, Diervilla lonicera, Vaccinium myrtilloides, Sorbus decora, Acer spicatum, Rubus pubescens, Picea mariana, Rosa acicularis, Gaultheria hispidula*
Herbs:	*Cornus canadensis, Clintonia borealis, Aralia nudicaulis, Maianthemum canadense, Trientalis borealis, Streptopus roseus, Coptis trifolia, Lycopodium annotinum, Viola renifolia,*
Mosses:	*Pleurozium schreberi, Ptilium crista-castrensis, Dicranum polysetum, Hylocomium splendens, Dicranum fuscescens, Rhytidiadelphus triquetrus*

Forest Floor Cover:

Species	Broadleaf Litter	Moss	Conifer Litter	Wood
Forest Floor Cover (%)	19	64	11	5

Site 6: V19 Black Spruce Mixed wood/ Herb Rich

Description: A black spruce mixedwood Type with several potential species in the overstory. The understory is typically dominated by an herb rich / dwarf shrub layer. The shrub stratum ranges from dense to open, usually with balsam fir and black spruce as important components. Forest floor cover varies from moss rich to mainly broadleaf litter. Occurring on a range on site conditions mostly on fresh to moist, mineral soils.

Common Overstory Species (in descending order):
Black spruce, trembling aspen, jack pine, balsam fir, white birch, white spruce, balsam poplar

Common Understory Species:

Shrubs:	*Linnae borealis,* balsam fir, *Rubus pubescens, Vaccinium myrtilloides,* black spruce, *Rosa acicularis, Amelanchier* spp., *Vaccinium angustifolium, Sorbus decora, Gaultheria bispidula, Diervilla lonicera, Ledum groenlandicum,* trembling aspen
Herbs:	*Cornus Canadensis, Maianthemum canadense, Clintonia borealis, Trientalis borealis, Aralia nudicaulis, Coptis trifolia, Petasites palmatus, Aster macrophyllus, Streptopus roseus, Viola renifolia*
Mosses:	*Pleurozium schreberi, Ptilium crista-castrensis, Dicranum polystum, Hylocomium splendens, Rhytidiadelphus triquestrus*

Forest Floor Cover:

Species	Broadleaf Litter	Moss	Conifer Litter
Forest Floor Cover (%)	33	49	12

Site 7: V7 Trembling Aspen-Balsam Fir/Balsam Fir Shrub

Description: Hardwood mixedwoods, typically with a two-tiered canopy. In general, trembling aspen constitutes the overstory with balsam fir in the secondary canopy. Understory development is variable with balsam fir, *Aralia nudicaulis* and *Diervilla lonicera* often abundant. Occurring mainly on deep, fresh, well-drained mineral soils.

Common Overstory Species (in descending order):
Balsam fir, trembling aspen, white birch, white spruce, black spruce, jack pine

Common Understory Species:

Shrubs:	balsam fir, *Rubus pubescens, Diervilla lonicera, Acer spicatum, Rosa acicularis,* trembling aspen*, Corylus cornuta, Linnaea borealis, Sorbus decora*
Herbs:	*Maianthemum canadense, Aralia nudicaulis, Cornus canadensis, Clintonia borealis, Aster macrophyllus, Streptopus roseus, Trientalis borealis, Viola renifolia, Mitella nuda, Petasites palmatus, Anemone quinquefolia, Galium triflorum*
Mosses:	*Pleurozium schreberi, Rhytidiadelphus triquetrus*

Forest Floor Cover:

Species	Broadleaf Litter	Moss	Conifer Litter	Wood
Forest Floor Cover (%)	81	7	6	5

Site 8: V9 Trembling Aspen Mixedwood

Description: Hardwood mixedwoods with a shrub and herb rich understory. Typically, trembling aspen is the main tree species. *Corylus cornuta*, balsam fir, *Alnus crispa, Diervilla lonicera, Aralia nudicaulis* and *Aster macrophyllus* can be abundant in the understory. Occuring mainly on deep, fresh, well-drained mineral soils.

Common Overstory Species (in descending order):
trembling aspen, white spruce, white birch, balsam fir, black spruce, jack pine, red maple

Common Understory Species:

Shrubs:	*Rubus pubescens, Acer spicatum,* balsam fir*, Corylus cornuta, Diervilla lonicera, Amelanchier* spp., *Rosa acicularis,* trembling aspen, *Linnaea borealis*
Herbs:	*Viola renifolia, Mitella nuda, Maianthemum canadense, Cornus Canadensis, Aralia nudicaulis, Aster macrophyllus, Streptopus roseus, Clintonia borealis, Trientalis borealis, Galium triflorum, Viola renifolia, Petasites palmatus, Anemone quinquefolia*
Mosses:	*Plagiomnium cuspidatum, Pleurozium schreberi, Rhytidiadelphus triquetrus, Ptilium crista-castrensis*

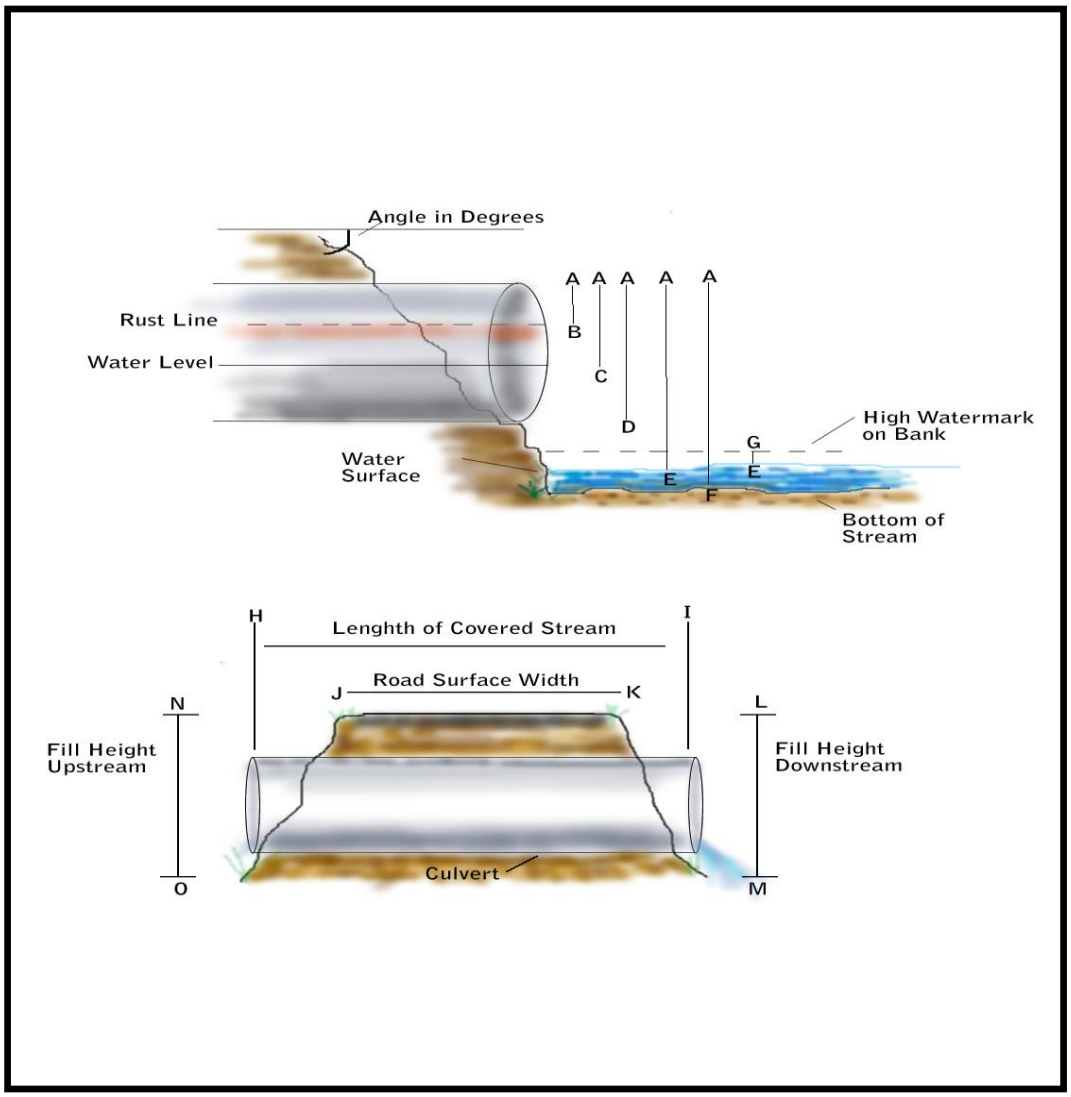
Forest Floor Cover:

Species	Broadleaf Litter	Moss	Conifer Litter
Forest Floor Cover (%)	84	5	5

Appendix G:

Culvert Assessments

Appendix G: Culvert Assessments



Jarvis River 2018 Culvert Assessments

Culvert Number/ Site Number	**J-K** Road Surface Width (m)	**H-I** Length of Covered Stream (m)	**N-O** Fill Height Upstream (m)	**L-M** Fill Height Downstream (m)		**A-D** Width of Opening (m)	**A-B** Inside Top to Rust Line (m)	**A-C** Inside Top to Water Surface (m)	**A-E** Height Above Outlet Pool (m)	**E-G** Water Surface to High Water Mark (m)	**A-F** Inside Top to Bottom of Stream (m)
C1/Site 5											
Culvert	6.10	19.8	4.50	4.30	Upstream	2.35	0.7	1.77	-	<0.50	2.35
					Downstream	2.35	0.65	1.8	-	0.80	2.35
C2/Site 6											
Culvert	7.40	20.54	5.15	4.90	Upstream	3.14	2.10	2.90	-	2.00	3.15
					Downstream	2.97	-	2.50	-	1.00	2.96
C3/Site 7											
Culvert	3.30	9.75	2.00	2.20	Upstream	1.76	0.95	1.75	-	0.5	1.85
					Downstream	1.88	0.95	1.83	-	0.5	1.85
C4/Site 8											
Culvert	7.4	19.5	2.42	2.40	Upstream	0.93	-	0.85	-	<0.35	0.93
					Downstream	0.66	0.53	0.60	-	<0.35	0.66

Culvert 1 / Site 5

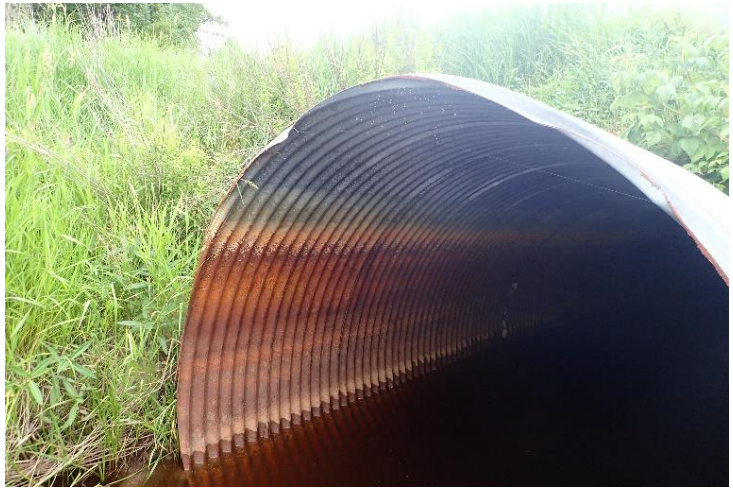
Location: 20 metres north of the intersection of Sturgeon Bay Road and Walker Road North

GPS Coordinates: Northing 5340053 Easting 32186

Description: The large corrugated steel culvert is in good condition with a minor structural damage on the top of the downstream opening. It was large enough to be able to support water flow during times of both high water level and low water. The water level was relatively low compared to the size of the culvert opening, and although rust was present it did not seem to be affecting the integrity of the culvert. There is abundant vegetation surrounding the culvert and the banks appear to be stable.

Upstream

Downstream



Culvert 2 / Site 6

Location: Sturgeon Bay Road, approximately 3 kilometres east of Highway 61

GPS Coordinates: Northing 5339989 Easting 319893

Description: The corrugated steel culvert is the largest with respect to the other sites. The large size seems appropriate to handle both low and high water levels efficiently. The culvert is in good condition and the top of the upstream culvert is slightly warped. Vegetation is abundant and banks for the most part are stable, other than some minor undercutting. A large log places on the top of the upstream culvert could block flow in the future if it falls in front of the culvert. Removal of the log is recommended.

Upstream

Downstream

Culvert 3 / Site 7

Location: End of Gammond Road approximately 0.9 kilometres from Sturgeon Bay Road

GPS Coordinates: Northing 5339139 Easting 319404

Description: The corrugated steel culvert is in good condition however vegetation may begin to impede flow on the upstream side. The culvert seems to be efficient at transmitting water during both high and low water levels. Although some rust was present and the top of the culvert was slightly warped, the bottom was sound and working well with the fast flowing water conditions. Upon a second visit to the site there appeared to be a vegetation blockage in the culvert that was seriously impeding the flow through the culvert and causing high water levels on the upstream side.

Upstream

Downstream

Culvert 4 / Site 8

Location: Cloud Lake Road approximately 1.5 kilometres west of Highway 61

GPS Coordinates: Northing 5339244 Easting 315331

Description: This steel corrugated culvert was in good condition and was set lower than the stream itself. There was abundant vegetation both upstream and downstream and the culvert was to able transmit water efficiently during both high and low water levels. In the future the debris downstream may impede flow.

Upstream

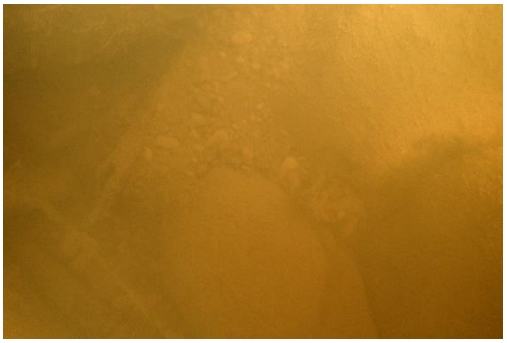
Downstream

Appendix H:

Site Photography

Appendix H: Site Photography

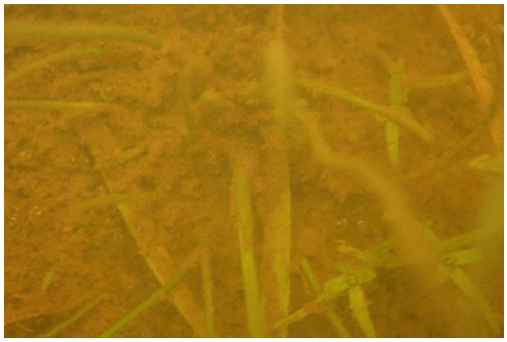
Site 1 – Confluence of Jarvis River with Lake Superior, Jarvis Bay Road East	
A: Upstream	**B: Downstream**
	
C: Vegetation	**D: Substrate**
	

Site 2 – 0.8 kilometres down an unnamed road. Approximately 5.6 kilometres down Jarvis Bay Road East	
A: Upstream	**B: Downstream**
	
C: Vegetation	**D: Substrate**
	

Site 3 – Approximately 2.0 kilometres past the end of Walker Road South	
A: Upstream	**B: Downstream**
	
C: Vegetation	**D: Substrate**
	

Site 4 – Approximately 1.5 kilometres past the end of Walker Road South	
A: Upstream	**B: Downstream**
	
C: Vegetation	**D: Substrate**
	

Site 5 – 20 metres north of the intersection of Sturgeon Bay Road and Walker Road North	
A: Upstream	**B: Downstream**
	
C: Vegetation	**D: Substrate**
	

Site 6 – Sturgeon Bay Road, approximately 3 kilometres east of Highway 61	
A: Upstream	**B: Downstream**
	
C: Vegetation	**D: Substrate**
	

Site 7 – End of Gammond Road approximately 0.9 kilometres from Sturgeon Bay Road	
A: Upstream	**B: Downstream**
	
C: Vegetation	**D: Substrate**
	

Site 8 – Cloud Lake Road approximately 1.5 kilometres west of Highway 61	
A: Upstream	**B: Downstream**
	
C: Vegetation	**D: Substrate**
	

Appendix I:

Laboratory Water Quality Results Summary Tables June

Jarvis River Watershed Assessment 2018
Laboratory Water Quality Results Summary Tables June

Laboratory Water Quality Results for June 13, 14, 2018

Parameter	Units	PWQO Criterion	JR1 Jarvis River - SITE#1	JR2 Jarvis River - SITE#2	JR3 Jarvis River - SITE#3	JR4 Jarvis River - SITE#4	JR5 Jarvis River - SITE#5	JR6 Jarvis River - SITE#6	JR7 Jarvis River - SITE#7	JR8 Jarvis River - SITE#8	Average
			14-Jun-18	14-Jun-18	13-Jun-18	13-Jun-18	13-Jul-18	13-Jun-18	14-Jun-18	14-Jun-18	June
Physical Tests											
Conductivity (EC)	(uS/cm)	N/A	130	164	121	276	151	216	179	144	172.6
pH		6.5-8.5	7.62	7.31	7.07	7.70	7.39	7.60	7.35	7.45	7.4
Total Dissolved Solids	(mg/L)	N/A	90	163	97	200	118	157	145	107	134.6
Turbidity	(NTU)	N/A	9.93	44.8	17.1	13.1	6.22	14.4	7.08	4.93	14.7
Anions and Nutrients											
Alkalinity, Total (as $CaCO_3$)*	(mg/L)	56.55	53.4	**72.8**	47.6	**94.7**	**75.0**	**98.0**	**85.4**	**75.4**	**75.3**
Ammonia-N, Total	(mg/L)	N/A	0.021	0.040	0.295	0.165	0.045	0.187	0.118	0.125	0.1245
Un-ionized Ammonia (calculated)**	(mg/L)	0.02	0.004	0.0036	0.0035	0.0059	0.0017	0.0077	0.0052	0.0114	0.0054
Chloride (Cl)	(mg/L)	N/A	4.20	2.83	7.71	20.7	3.31	10.1	5.28	0.59	6.84
Nitrate-N (NO_3-N)	(mg/L)	N/A	0.259	0.084	<0.020	0.031	<0.020	<0.020	<0.020	0.111	0.12
Nitrite-N (NO_2-N)	(mg/L)	N/A	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Total Kjeldahl Nitrogen	(mg/L)	N/A	0.31	1.04	0.66	0.84	0.76	1.11	1.23	0.54	**0.81**
Phosphorus (P)-Total	(mg/L)	0.03	0.0153	**0.0567**	**0.0390**	**0.0340**	**0.0301**	**0.0556**	**0.0712**	0.0169	**0.04**
Sulphate (SO_4)	(mg/L)	N/A	5.03	4.91	2.19	12.7	0.89	2.32	0.59	3.14	3.97
Bacteriological Tests											
Escherichia Coli	(MPN/100mL)	100	6	18	44	**135**	11	12	60	3	36
Total Coliforms	(MPN/100mL)	1000 (prior to 1994)	308	**>2420**	**>2420**	**1550**	**1990**	**1990**	**>2420**	687	**1305**
Total Metals											
Aluminum (Al)-Total***	(mg/L)	0.075	**0.317**	**1.83**	**0.521**	**0.493**	**0.205**	**1.16**	**0.223**	**0.109**	**0.607**
Antimony (Sb)-Total	(mg/L)	0.02	<0.00010	0.00014	<0.00010	<0.00010	<0.00010	0.00016	0.00011	0.00010	0.00013
Arsenic (As)-Total	(mg/L)	0.005 (interim)	0.00067	0.00171	0.00126	0.00137	0.00097	0.00127	0.00202	0.00059	0.00123
Barium (Ba)-Total	(mg/L)	N/A	0.0166	0.0301	0.0319	0.0407	0.0168	0.0243	0.0204	0.0116	0.02405
Beryllium (Be)-Total****	(mg/L)	0.011 (<75 mg/L $CaCO_3$)	<0.00010	N/A	<0.00010	N/A	N/A	N/A	N/A	<0.00010	<0.00010
	(mg/L)	1.10 (>75 mg/L $CaCO_3$)	N/A	<0.00010	N/A	<0.00010	<0.00010	<0.00010	<0.00010	N/A	<0.00010
Bismuth (Bi)-Total	(mg/L)	N/A	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
Boron (B)-Total	(mg/L)	0.2	<0.010	0.012	0.011	0.014	0.011	0.014	0.010	0.015	0.012
Cadmium (Cd)-Total****	(mg/L)	0.0001 (0-100 mg/L $CaCO_3$)	0.0000230	0.0000888	0.0000284	N/A	0.0000252	N/A	0.0000668	0.0000131	0.000041
	(mg/L)	0.0005 (>100 mg/L $CaCO_3$)	N/A	N/A	N/A	0.0000522	N/A	0.0000818	N/A	N/A	0.0000670
Calcium (Ca)-Total	(mg/L)	N/A	16.6	21.7	13.9	30.3	18.3	25.6	20.8	18	20.7
Chromium (Cr)-Total	(mg/L)	0.0089	0.00070	0.00381	0.00114	0.00146	0.00079	0.00262	0.00084	0.00061	0.00150
Cobalt (Co)-Total	(mg/L)	0.0009	0.00024	**0.00118**	0.00062	0.00046	0.00040	**0.00097**	0.00062	0.00013	0.00058
Copper (Cu)-Total****	(mg/L)	0.001 (0-20 mg/L CaCO3)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	(mg/L)	0.005 (>20 mg/L CaCO3)	0.00248	**0.00961**	0.00330	0.00491	0.00251	**0.00525**	0.00256	0.00475	0.00442

Notes:

PWQO - Provincial Water Quality Objectives. **Bold indicates exceedance of PWQO criteria**

* - Alkalinity should not be decreased by more than 25% of the natual conditions (Site 8)

** - indicates criterion is pH and temperature dependent

*** - indicates criterion is pH dependent

**** - indicates criteria are Alkalinity dependent

Jarvis River Watershed Assessment 2018
Laboratory Water Quality Results Summary Tables June

Laboratory Water Quality Results for June 13,14 2018

Parameter	Units	PWQO Criterion	JR1 Jarvis River - SITE#1	JR2 Jarvis River - SITE#2	JR3 Jarvis River - SITE#3	JR4 Jarvis River- SITE#4	JR5 Jarvis River - SITE#5	JR6 Jarvis River - SITE#6	JR7 Jarvis River- SITE#7	JR8 Jarvis River - SITE#8	Average
			14-Jun-18	14-Jun-18	13-Jun-18	13-Jun-18	13-Jun-18	13-Jun-18	14-Jun-18	14-Jun-18	June
Total Metals Continued											
Iron (Fe)-Total	(mg/L)	0.3	**0.487**	**2.67**	**1.47**	**1.11**	**1.00**	**2.12**	**2.12**	**0.342**	**1.415**
Lead (Pb)-Total****	(mg/L)	0.001 (<30 mg/L CaCO3)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	(mg/L)	0.003 (30-80 mg/L CaCO3)	0.000175	N/A	0.000369	N/A	0.000115	N/A	N/A	0.000151	0.00020
	(mg/L)	0.005 (>80 mg/L $CaCO_3$)	N/A	0.000851	N/A	0.000302	N/A	0.000581	0.000211	N/A	0.000486
Lithium (Li)-Total	(mg/L)	N/A	0.0011	0.0023	0.0018	0.0040	<0.0010	0.0023	<0.0010	<0.0010	0.0023
Magnesium (Mg)-Total	(mg/L)	N/A	4.92	9.10	5.27	12.8	8.07	11.3	9.09	6.82	8.4213
Manganese (Mn)-Total	(mg/L)	N/A	0.0224	0.0633	0.168	0.0876	0.157	0.111	0.202	0.00906	0.1025
Molybdenum (Mo)-Total	(mg/L)	0.04	0.000359	0.00146	0.000366	0.00130	0.000560	0.00106	0.00118	0.000565	0.0009
Nickel (Ni)-Total	(mg/L)	0.025	0.00097	0.00467	0.00164	0.00242	0.00167	0.00353	0.00220	0.00130	0.0023
Potassium (K)-Total	(mg/L)	N/A	0.703	1.15	0.912	1.35	0.731	0.973	1.07	1.33	1.0274
Selenium (Se)-Total	(mg/L)	0.1	0.000118	0.000263	0.000108	0.000217	0.000169	0.000173	0.000187	0.000151	0.0002
Silver (Ag)-Total	(mg/L)	0.0001	<0.000010	0.000017	<0.000010	<0.000010	<0.000010	0.000018	0.00001	<0.000010	0.000015
Sodium (Na)-Total	(mg/L)	N/A	2.64	3.69	3.65	8.21	3.29	5.58	5.37	2.61	4.38
Strontium (Sr)-Total	(mg/L)	N/A	0.0470	0.0444	0.0771	0.172	0.0552	0.0847	0.0405	0.0433	0.07
Tellurium (Te)-Total	(mg/L)	N/A	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020
Thallium (Tl)-Total	(mg/L)	0.0003	<0.000010	0.000031	0.000014	0.000019	0.000011	0.000031	0.000011	<0.000010	0.000020
Tin (Sn)-Total	(mg/L)	N/A	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
Titanium (Ti)-Total	(mg/L)	N/A	0.00874	0.0583	0.0141	0.0133	0.00607	0.0305	0.00696	<0.0029	0.0197
Tungsten (W)-Total	(mg/L)	0.03	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
Uranium (U)-Total	(mg/L)	0.005	0.000119	0.000486	0.000051	0.000309	0.000083	0.000269	0.000101	0.000078	0.0002
Vanadium (V)-Total	(mg/L)	0.006	0.00133	0.00591	0.00191	0.00258	0.00156	0.00441	0.00234	0.00095	0.0026
Zinc (Zn)-Total	(mg/L)	0.02 (interim)	<0.0030	0.0072	<0.0030	0.0032	<0.0030	0.0123	0.0036	**0.0333**	0.0119
Zirconium (Zr)-Total	(mg/L)	0.004	0.000212	0.00160	0.000284	0.000439	0.000303	0.000564	0.000340	0.000230	0.0005

Notes:

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Appendix J:

Laboratory Water Quality Results Summary Tables July

Jarvis River Watershed Assessment 2018
Laboratory Water Quality Results Summary Tables July

Laboratory Water Quality Results for July 10-11, 2018

Parameter	Units	PWQO Criterion	JR1 Jarvis River - SITE#1	JR2 Jarvis River - SITE#2	JR3 Jarvis River - SITE#3	JR4 Jarvis River - SITE#4	JR5 Jarvis River - SITE#5	JR6 Jarvis River - SITE#6	JR7 Jarvis River - SITE#7	JR8 Jarvis River - SITE#8	Average
			10-Jul-18	10-Jul-18	11-Jul-18	11-Jul-18	11-Jul-18	10-Jul-18	10-Jul-18	10-Jul-18	July
Physical Tests											
Conductivity (EC)	(uS/cm)	N/A	133	126	112	157	135	138	126	97.9	128.1
pH		6.5-8.5	7.59	7.62	7.42	7.77	7.35	7.47	7.27	7.61	7.5
Total Dissolved Solids	(mg/L)	N/A	134	157	87	124	120	139	121	94	122.0
Turbidity	(NTU)	N/A	58.2	28.3	5.89	23.4	4.91	13.8	5.41	16.8	19.6
Anions and Nutrients											
Alkalinity, Total (as $CaCO_3$)*	(mg/L)	36.5	**58.2**	**64.1**	**41.4**	**62.8**	**64.7**	**66.0**	**54.0**	**48.6**	**57.5**
Ammonia-N, Total	(mg/L)	N/A	0.447	0.190	0.361	0.245	0.134	0.526	0.347	0.215	0.3081
Un-ionized Ammonia (calculated)**	(mg/L)	0.02	0.0054	0.0068	0.0148	0.0088	0.0055	**0.0216**	0.0142	0.0172	0.0118
Chloride (Cl)	(mg/L)	N/A	4.18	0.99	7.34	6.85	2.60	2.38	5.56	0.16	3.76
Nitrate-N (NO_3-N)	(mg/L)	N/A	0.158	0.097	0.025	0.076	0.027	0.039	0.021	0.123	0.07
Nitrite-N (NO_2-N)	(mg/L)	N/A	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Total Kjeldahl Nitrogen	(mg/L)	N/A	1.470	1.37	0.80	1.27	1.13	1.43	1.42	0.73	1.20
Phosphorus (P)-Total	(mg/L)	0.03	**0.0963**	**0.0469**	0.0246	**0.0603**	**0.0379**	**0.0422**	**0.0542**	0.0296	**0.05**
Sulphate (SO_4)	(mg/L)	N/A	4.28	2.15	2.48	4.51	0.56	1.75	2.78	2.68	2.65
Bacteriological Tests											
Escherichia Coli	(MPN/100mL)	100	**387**	26	33	**145**	33	75	68	50	**102**
Total Coliforms	(MPN/100mL)	1000 (prior to 1994)	**>2420**	**>2420**	**>2420**	**>2420**	**>2420**	**>2420**	**>2420**	**>2420**	**>2420**
Total Metals											
Aluminum (Al)-Total***	(mg/L)	0.075	**2.24**	**1.22**	**0.238**	**1.02**	**0.210**	**0.811**	**0.182**	**0.865**	**0.848**
Antimony (Sb)-Total	(mg/L)	0.02	0.00011	0.00011	<0.00010	<0.00050	<0.00050	<0.00010	<0.00050	<0.00010	0.0001
Arsenic (As)-Total	(mg/L)	0.005 (interim)	0.00202	0.00199	0.00083	0.00159	0.00116	0.00112	0.00142	0.00064	0.00135
Barium (Ba)-Total	(mg/L)	N/A	0.0362	0.0224	0.0238	0.0283	0.0158	0.0190	0.0152	0.0127	0.02168
Beryllium (Be)-Total****	(mg/L)	0.011 (<75 mg/L $CaCO_3$)	<0.00010	<0.00010	<0.00010	<0.00050	<0.00050	<0.00010	<0.00050	<0.00010	<0.00010
	(mg/L)	1.10 (>75 mg/L $CaCO_3$)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Bismuth (Bi)-Total	(mg/L)	N/A	<0.000050	<0.000050	<0.000050	<0.00025	<0.00025	<0.000050	<0.00025	<0.000050	<0.000050
Boron (B)-Total	(mg/L)	0.2	0.130	0.011	0.011	<0.050	<0.050	0.011	<0.050	0.015	0.036
Cadmium (Cd)-Total****	(mg/L)	0.0001 (0-100 mg/L $CaCO_3$)	**0.000109**	0.0000598	0.0000090	0.000065	<0.000025	0.0000563	0.000025	0.0000221	0.000049
	(mg/L)	0.0005 (>100 mg/L $CaCO_3$)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Calcium (Ca)-Total	(mg/L)	N/A	15.7	17.2	12.4	18.3	17.1	15.9	13.1	11.4	15.1
Chromium (Cr)-Total	(mg/L)	0.0089	0.00423	0.00282	0.00051	0.00199	0.00083	0.00180	<0.00050	0.00160	0.00197
Cobalt (Co)-Total	(mg/L)	0.0009	**0.00148**	0.00077	0.00022	0.00067	<0.00050	0.00048	<0.00050	0.00040	0.00067
Copper (Cu)-Total****	(mg/L)	0.001 (0-20 mg/L $CaCO_3$)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	(mg/L)	0.005 (>20 mg/L $CaCO_3$)	**0.00898**	**0.00733**	0.00242	**0.0072**	0.0033	**0.00503**	<0.0025	**0.00502**	**0.00561**

Notes:

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* - Alkalinity should not be decreased by more than 25% of the natual conditions (Site 8)

** - indicates criterion is pH and temperature dependent

*** - indicates criterion is pH dependent

**** - indicates criteria are Alkalinity dependent

Jarvis River Watershed Assessment 2018
Laboratory Water Quality Results Summary Tables July

Laboratory Water Quality Results for July 10-11, 2018

Parameter	Units	PWQO Criterion	JR1 Jarvis River - SITE#1 10-Jul-18	JR2 Jarvis River - SITE#2 10-Jul-18	JR3 Jarvis River - SITE#3 11-Jul-18	JR4 Jarvis River - SITE#4 11-Jul-18	JR5 Jarvis River - SITE#5 11-Jul-18	JR6 Jarvis River - SITE#6 10-Jul-18	JR7 Jarvis River - SITE#7 10-Jul-18	JR8 Jarvis River - SITE#8 10-Jul-18	Average July
Total Metals Continued											
Iron (Fe)-Total	(mg/L)	0.3	**3.72**	**2.11**	**0.684**	**2.18**	**1.28**	**1.53**	**1.66**	**1.01**	**1.772**
Lead (Pb)-Total****	(mg/L)	0.001 (<30 mg/L CaCO3)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	(mg/L)	0.003 (30-80 mg/L CaCO3)	0.00107	0.000603	0.000131	0.00058	<0.00025	0.000292	<0.00025	0.000326	0.00050
	(mg/L)	0.005 (>80 mg/L $CaCO_3$)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Lithium (Li)-Total	(mg/L)	N/A	0.0032	0.0021	0.0020	<0.0050	<0.0050	0.0016	<0.0050	0.0012	0.0020
Magnesium (Mg)-Total	(mg/L)	N/A	7.11	7.19	4.48	7.83	6.99	7.38	5.94	4.73	6.4563
Manganese (Mn)-Total	(mg/L)	N/A	0.0935	0.0507	0.0395	0.0599	0.0848	0.0344	0.0380	0.0217	0.0528
Molybdenum (Mo)-Total	(mg/L)	0.04	0.000731	0.000959	0.000349	0.00090	0.00049	0.000743	0.00048	0.000350	0.0006
Nickel (Ni)-Total	(mg/L)	0.025	0.00557	0.00405	0.00107	0.0034	<0.0025	0.00280	<0.0025	0.00219	0.0032
Potassium (K)-Total	(mg/L)	N/A	1.470	0.855	0.742	1.21	0.80	0.901	0.96	1.08	1.0023
Selenium (Se)-Total	(mg/L)	0.1	0.000195	0.000239	0.000112	<0.00025	<0.00025	0.000243	<0.00025	0.000082	0.0002
Silver (Ag)-Total	(mg/L)	0.0001	0.000031	0.000013	<0.000010	<0.000050	<0.000050	0.000020	<0.000050	0.000016	0.00002
Sodium (Na)-Total	(mg/L)	N/A	3.54	2.57	3.31	4.77	2.52	2.83	4.40	1.91	3.23
Strontium (Sr)-Total	(mg/L)	N/A	0.0498	0.0379	0.0713	0.0639	0.0480	0.0420	0.0258	0.0282	0.05
Tellurium (Te)-Total	(mg/L)	N/A	<0.00020	<0.00020	<0.00020	<0.0010	<0.0010	<0.00020	<0.0010	<0.00020	<0.00020
Thallium (Tl)-Total	(mg/L)	0.0003	0.000048	0.000021	<0.000010	<0.000050	<0.000050	0.000013	<0.000050	0.000014	0.00002
Tin (Sn)-Total	(mg/L)	N/A	<0.00010	<0.00010	<0.00010	<0.00050	<0.00050	<0.00010	<0.00050	<0.00010	<0.00010
Titanium (Ti)-Total	(mg/L)	N/A	0.0556	0.0372	0.00642	0.0246	0.0070	0.0204	0.0049	0.0215	0.0222
Tungsten (W)-Total	(mg/L)	0.03	<0.00010	<0.00010	<0.00010	<0.00050	<0.00050	<0.00010	<0.00050	<0.00010	<0.00010
Uranium (U)-Total	(mg/L)	0.005	0.000167	0.000287	0.000037	0.000135	0.000074	0.000139	<0.000050	0.000062	0.0001
Vanadium (V)-Total	(mg/L)	0.006	**0.00675**	0.00479	0.00110	0.0043	<0.0025	0.00299	<0.0025	0.00231	0.0037
Zinc (Zn)-Total	(mg/L)	0.02 (interim)	0.0122	0.005	<0.0030	<0.015	<0.015	0.0057	<0.015	0.0044	0.0068
Zirconium (Zr)-Total	(mg/L)	0.004	0.000976	0.00155	0.000206	0.00064	0.00199	0.000701	<0.00030	0.000396	0.0009

Notes:

PWQO - Provincial Water Quality Objectives. **Bold indicates exceedance of PWQO criteria**

* - Alkalinity should not be decreased by more than 25% of the natual conditions (Site 8)

** - indicates criterion is pH and temperature dependent

*** - indicates criterion is pH dependent

**** - indicates criteria are Alkalinity dependent

Appendix K:

Laboratory Certificates of Analysis and Test Results

LAKEHEAD REGION CONSERVATION AUTHORITY
ATTN: Scott Drebit
130 Conservation Road
P.O. Box 10427
Thunder Bay ON P7B 6T8

Date Received: 15-JUN-18
Report Date: 26-JUN-18 13:59 (MT)
Version: FINAL

Client Phone: 807-344-5857

Certificate of Analysis

Lab Work Order #: L2112994

Project P.O. #: NOT SUBMITTED
Job Reference: JARVIS RIVER
C of C Numbers:
Legal Site Desc:

Jessica Richard
Account Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L2112994-1 JR #1 - JARVIS RIVER - SITE #1 Sampled By: Client on 14-JUN-18 @ 10:30 Matrix: Grab							
Physical Tests							
Conductivity (EC)	130		3.0	uS/cm		17-JUN-18	R4084951
Hardness (as CaCO3)	61.6	HTC	0.50	mg/L		21-JUN-18	
pH	7.62		0.10	pH		17-JUN-18	R4084951
Total Dissolved Solids	90		13	mg/L		20-JUN-18	R4094116
Turbidity	9.93		0.10	NTU		15-JUN-18	R4084428
Anions and Nutrients							
Alkalinity, Total (as CaCO3)	53.4		2.0	mg/L		17-JUN-18	R4084951
Ammonia, Total (as N)	0.021		0.020	mg/L		22-JUN-18	R4095966
Chloride (Cl)	4.20		0.10	mg/L		18-JUN-18	R4088548
Nitrate (as N)	0.259		0.020	mg/L		18-JUN-18	R4088548
Nitrite (as N)	<0.010		0.010	mg/L		18-JUN-18	R4088548
Total Kjeldahl Nitrogen	0.31		0.15	mg/L	20-JUN-18	22-JUN-18	R4096284
Phosphorus (P)-Total	0.0153		0.0030	mg/L	19-JUN-18	22-JUN-18	R4096359
Sulfate (SO4)	5.03		0.30	mg/L		18-JUN-18	R4088548
Bacteriological Tests							
Escherichia Coli	6		0	MPN/100mL		15-JUN-18	R4084493
Total Coliforms	308		0	MPN/100mL		15-JUN-18	R4084493
Total Metals							
Aluminum (Al)-Total	0.317		0.0030	mg/L	16-JUN-18	20-JUN-18	R4093795
Antimony (Sb)-Total	<0.00010		0.00010	mg/L	16-JUN-18	20-JUN-18	R4093795
Arsenic (As)-Total	0.00067		0.00010	mg/L	16-JUN-18	20-JUN-18	R4093795
Barium (Ba)-Total	0.0166		0.00010	mg/L	16-JUN-18	20-JUN-18	R4093795
Beryllium (Be)-Total	<0.00010		0.00010	mg/L	16-JUN-18	20-JUN-18	R4093795
Bismuth (Bi)-Total	<0.000050		0.000050	mg/L	16-JUN-18	20-JUN-18	R4093795
Boron (B)-Total	<0.010		0.010	mg/L	16-JUN-18	20-JUN-18	R4093795
Cadmium (Cd)-Total	0.0000230		0.0000050	mg/L	16-JUN-18	20-JUN-18	R4093795
Calcium (Ca)-Total	16.6		0.050	mg/L	16-JUN-18	20-JUN-18	R4093795
Cesium (Cs)-Total	0.000030		0.000010	mg/L	16-JUN-18	20-JUN-18	R4093795
Chromium (Cr)-Total	0.00070		0.00010	mg/L	16-JUN-18	20-JUN-18	R4093795
Cobalt (Co)-Total	0.00024		0.00010	mg/L	16-JUN-18	20-JUN-18	R4093795
Copper (Cu)-Total	0.00248		0.00050	mg/L	16-JUN-18	20-JUN-18	R4093795
Iron (Fe)-Total	0.487		0.010	mg/L	16-JUN-18	20-JUN-18	R4093795
Lead (Pb)-Total	0.000175		0.000050	mg/L	16-JUN-18	20-JUN-18	R4093795
Lithium (Li)-Total	0.0011		0.0010	mg/L	16-JUN-18	20-JUN-18	R4093795
Magnesium (Mg)-Total	4.92		0.0050	mg/L	16-JUN-18	20-JUN-18	R4093795
Manganese (Mn)-Total	0.0224		0.00010	mg/L	16-JUN-18	20-JUN-18	R4093795
Molybdenum (Mo)-Total	0.000359		0.000050	mg/L	16-JUN-18	20-JUN-18	R4093795
Nickel (Ni)-Total	0.00097		0.00050	mg/L	16-JUN-18	20-JUN-18	R4093795
Phosphorus (P)-Total	<0.050		0.050	mg/L	16-JUN-18	20-JUN-18	R4093795
Potassium (K)-Total	0.703		0.050	mg/L	16-JUN-18	20-JUN-18	R4093795
Rubidium (Rb)-Total	0.00125		0.00020	mg/L	16-JUN-18	20-JUN-18	R4093795
Selenium (Se)-Total	0.000118		0.000050	mg/L	16-JUN-18	20-JUN-18	R4093795

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L2112994-1 JR #1 - JARVIS RIVER - SITE #1 Sampled By: Client on 14-JUN-18 @ 10:30 Matrix: Grab							
Total Metals							
Silicon (Si)-Total	1.80		0.10	mg/L	16-JUN-18	20-JUN-18	R4093795
Silver (Ag)-Total	<0.000010		0.000010	mg/L	16-JUN-18	20-JUN-18	R4093795
Sodium (Na)-Total	2.64		0.050	mg/L	16-JUN-18	20-JUN-18	R4093795
Strontium (Sr)-Total	0.0470		0.00020	mg/L	16-JUN-18	20-JUN-18	R4093795
Sulfur (S)-Total	1.58		0.50	mg/L	16-JUN-18	20-JUN-18	R4093795
Tellurium (Te)-Total	<0.00020		0.00020	mg/L	16-JUN-18	20-JUN-18	R4093795
Thallium (Tl)-Total	<0.000010		0.000010	mg/L	16-JUN-18	20-JUN-18	R4093795
Thorium (Th)-Total	<0.00010		0.00010	mg/L	16-JUN-18	20-JUN-18	R4093795
Tin (Sn)-Total	<0.00010		0.00010	mg/L	16-JUN-18	20-JUN-18	R4093795
Titanium (Ti)-Total	0.00874		0.00030	mg/L	16-JUN-18	20-JUN-18	R4093795
Tungsten (W)-Total	<0.00010		0.00010	mg/L	16-JUN-18	20-JUN-18	R4093795
Uranium (U)-Total	0.000119		0.000010	mg/L	16-JUN-18	20-JUN-18	R4093795
Vanadium (V)-Total	0.00133		0.00050	mg/L	16-JUN-18	20-JUN-18	R4093795
Zinc (Zn)-Total	<0.0030		0.0030	mg/L	16-JUN-18	20-JUN-18	R4093795
Zirconium (Zr)-Total	0.000212		0.000060	mg/L	16-JUN-18	20-JUN-18	R4093795
L2112994-2 JR #2 - JARVIS RIVER - SITE #2 Sampled By: Client on 14-JUN-18 @ 11:50 Matrix: Grab							
Physical Tests							
Conductivity (EC)	164		3.0	uS/cm		17-JUN-18	R4084951
Hardness (as CaCO3)	91.7	HTC	0.50	mg/L		21-JUN-18	
pH	7.31		0.10	pH		17-JUN-18	R4084951
Total Dissolved Solids	163		13	mg/L		20-JUN-18	R4094116
Turbidity	44.8		0.10	NTU		15-JUN-18	R4084428
Anions and Nutrients							
Alkalinity, Total (as CaCO3)	72.8		2.0	mg/L		17-JUN-18	R4084951
Ammonia, Total (as N)	0.040		0.020	mg/L		22-JUN-18	R4095966
Chloride (Cl)	2.83		0.10	mg/L		18-JUN-18	R4088548
Nitrate (as N)	0.084		0.020	mg/L		18-JUN-18	R4088548
Nitrite (as N)	<0.010		0.010	mg/L		18-JUN-18	R4088548
Total Kjeldahl Nitrogen	1.04		0.15	mg/L	20-JUN-18	22-JUN-18	R4096284
Phosphorus (P)-Total	0.0567		0.0030	mg/L	19-JUN-18	22-JUN-18	R4096359
Sulfate (SO4)	4.91		0.30	mg/L		18-JUN-18	R4088548
Bacteriological Tests							
Escherichia Coli	18		0	MPN/100mL		15-JUN-18	R4084493
Total Coliforms	>2420		0	MPN/100mL		15-JUN-18	R4084493
Total Metals							
Aluminum (Al)-Total	1.83		0.0030	mg/L	16-JUN-18	20-JUN-18	R4093795
Antimony (Sb)-Total	0.00014		0.00010	mg/L	16-JUN-18	20-JUN-18	R4093795
Arsenic (As)-Total	0.00171		0.00010	mg/L	16-JUN-18	20-JUN-18	R4093795
Barium (Ba)-Total	0.0301		0.00010	mg/L	16-JUN-18	20-JUN-18	R4093795
Beryllium (Be)-Total	<0.00010		0.00010	mg/L	16-JUN-18	20-JUN-18	R4093795

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L2112994-2 JR #2 - JARVIS RIVER - SITE #2 Sampled By: Client on 14-JUN-18 @ 11:50 Matrix: Grab							
Total Metals							
Bismuth (Bi)-Total	<0.000050		0.000050	mg/L	16-JUN-18	20-JUN-18	R4093795
Boron (B)-Total	0.012		0.010	mg/L	16-JUN-18	20-JUN-18	R4093795
Cadmium (Cd)-Total	0.0000888		0.0000050	mg/L	16-JUN-18	20-JUN-18	R4093795
Calcium (Ca)-Total	21.7		0.050	mg/L	16-JUN-18	20-JUN-18	R4093795
Cesium (Cs)-Total	0.000164		0.000010	mg/L	16-JUN-18	20-JUN-18	R4093795
Chromium (Cr)-Total	0.00381		0.00010	mg/L	16-JUN-18	20-JUN-18	R4093795
Cobalt (Co)-Total	0.00118		0.00010	mg/L	16-JUN-18	20-JUN-18	R4093795
Copper (Cu)-Total	0.00961		0.00050	mg/L	16-JUN-18	20-JUN-18	R4093795
Iron (Fe)-Total	2.67		0.010	mg/L	16-JUN-18	20-JUN-18	R4093795
Lead (Pb)-Total	0.000851		0.000050	mg/L	16-JUN-18	20-JUN-18	R4093795
Lithium (Li)-Total	0.0023		0.0010	mg/L	16-JUN-18	20-JUN-18	R4093795
Magnesium (Mg)-Total	9.10		0.0050	mg/L	16-JUN-18	20-JUN-18	R4093795
Manganese (Mn)-Total	0.0633		0.00010	mg/L	16-JUN-18	20-JUN-18	R4093795
Molybdenum (Mo)-Total	0.00146		0.000050	mg/L	16-JUN-18	20-JUN-18	R4093795
Nickel (Ni)-Total	0.00467		0.00050	mg/L	16-JUN-18	20-JUN-18	R4093795
Phosphorus (P)-Total	<0.050		0.050	mg/L	16-JUN-18	20-JUN-18	R4093795
Potassium (K)-Total	1.15		0.050	mg/L	16-JUN-18	20-JUN-18	R4093795
Rubidium (Rb)-Total	0.00281		0.00020	mg/L	16-JUN-18	20-JUN-18	R4093795
Selenium (Se)-Total	0.000263		0.000050	mg/L	16-JUN-18	20-JUN-18	R4093795
Silicon (Si)-Total	5.83		0.10	mg/L	16-JUN-18	20-JUN-18	R4093795
Silver (Ag)-Total	0.000017		0.000010	mg/L	16-JUN-18	20-JUN-18	R4093795
Sodium (Na)-Total	3.69		0.050	mg/L	16-JUN-18	20-JUN-18	R4093795
Strontium (Sr)-Total	0.0444		0.00020	mg/L	16-JUN-18	20-JUN-18	R4093795
Sulfur (S)-Total	1.80		0.50	mg/L	16-JUN-18	20-JUN-18	R4093795
Tellurium (Te)-Total	<0.00020		0.00020	mg/L	16-JUN-18	20-JUN-18	R4093795
Thallium (Tl)-Total	0.000031		0.000010	mg/L	16-JUN-18	20-JUN-18	R4093795
Thorium (Th)-Total	0.00028		0.00010	mg/L	16-JUN-18	20-JUN-18	R4093795
Tin (Sn)-Total	<0.00010		0.00010	mg/L	16-JUN-18	20-JUN-18	R4093795
Titanium (Ti)-Total	0.0583		0.00030	mg/L	16-JUN-18	20-JUN-18	R4093795
Tungsten (W)-Total	<0.00010		0.00010	mg/L	16-JUN-18	20-JUN-18	R4093795
Uranium (U)-Total	0.000486		0.000010	mg/L	16-JUN-18	20-JUN-18	R4093795
Vanadium (V)-Total	0.00591		0.00050	mg/L	16-JUN-18	20-JUN-18	R4093795
Zinc (Zn)-Total	0.0072		0.0030	mg/L	16-JUN-18	20-JUN-18	R4093795
Zirconium (Zr)-Total	0.00160		0.000060	mg/L	16-JUN-18	20-JUN-18	R4093795
L2112994-3 JR #3 - JARVIS RIVER - SITE #3 Sampled By: Client on 13-JUN-18 @ 10:50 Matrix: Grab							
Physical Tests							
Conductivity (EC)	121		3.0	uS/cm		16-JUN-18	R4084958
Hardness (as CaCO3)	56.4	HTC	0.50	mg/L		22-JUN-18	
pH	7.07		0.10	pH		16-JUN-18	R4084958
Total Dissolved Solids	97		13	mg/L		20-JUN-18	R4094116

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L2112994-3 JR #3 - JARVIS RIVER - SITE #3 Sampled By: Client on 13-JUN-18 @ 10:50 Matrix: Grab							
Physical Tests							
Turbidity	17.1		0.10	NTU		15-JUN-18	R4084428
Anions and Nutrients							
Alkalinity, Total (as CaCO3)	47.6		2.0	mg/L		16-JUN-18	R4084958
Ammonia, Total (as N)	0.295		0.020	mg/L		22-JUN-18	R4095966
Chloride (Cl)	7.71		0.10	mg/L		18-JUN-18	R4088548
Nitrate (as N)	<0.020		0.020	mg/L		18-JUN-18	R4088548
Nitrite (as N)	<0.010		0.010	mg/L		18-JUN-18	R4088548
Total Kjeldahl Nitrogen	0.66		0.15	mg/L	20-JUN-18	22-JUN-18	R4096284
Phosphorus (P)-Total	0.0390		0.0030	mg/L	19-JUN-18	22-JUN-18	R4096359
Sulfate (SO4)	2.19		0.30	mg/L		18-JUN-18	R4088548
Bacteriological Tests							
Escherichia Coli	44		0	MPN/100mL		15-JUN-18	R4084543
Total Coliforms	>2420		0	MPN/100mL		15-JUN-18	R4084543
Total Metals							
Aluminum (Al)-Total	0.521		0.0030	mg/L	16-JUN-18	20-JUN-18	R4093795
Antimony (Sb)-Total	<0.00010		0.00010	mg/L	16-JUN-18	20-JUN-18	R4093795
Arsenic (As)-Total	0.00126		0.00010	mg/L	16-JUN-18	20-JUN-18	R4093795
Barium (Ba)-Total	0.0319		0.00010	mg/L	16-JUN-18	20-JUN-18	R4093795
Beryllium (Be)-Total	<0.00010		0.00010	mg/L	16-JUN-18	20-JUN-18	R4093795
Bismuth (Bi)-Total	<0.000050		0.000050	mg/L	16-JUN-18	20-JUN-18	R4093795
Boron (B)-Total	0.011		0.010	mg/L	16-JUN-18	20-JUN-18	R4093795
Cadmium (Cd)-Total	0.0000284		0.0000050	mg/L	16-JUN-18	20-JUN-18	R4093795
Calcium (Ca)-Total	13.9		0.050	mg/L	16-JUN-18	20-JUN-18	R4093795
Cesium (Cs)-Total	0.000051		0.000010	mg/L	16-JUN-18	20-JUN-18	R4093795
Chromium (Cr)-Total	0.00114		0.00010	mg/L	16-JUN-18	21-JUN-18	R4095204
Cobalt (Co)-Total	0.00062		0.00010	mg/L	16-JUN-18	20-JUN-18	R4093795
Copper (Cu)-Total	0.00330		0.00050	mg/L	16-JUN-18	20-JUN-18	R4093795
Iron (Fe)-Total	1.47		0.010	mg/L	16-JUN-18	20-JUN-18	R4093795
Lead (Pb)-Total	0.000369		0.000050	mg/L	16-JUN-18	20-JUN-18	R4093795
Lithium (Li)-Total	0.0018		0.0010	mg/L	16-JUN-18	20-JUN-18	R4093795
Magnesium (Mg)-Total	5.27		0.0050	mg/L	16-JUN-18	20-JUN-18	R4093795
Manganese (Mn)-Total	0.168		0.00010	mg/L	16-JUN-18	20-JUN-18	R4093795
Molybdenum (Mo)-Total	0.000366		0.000050	mg/L	16-JUN-18	20-JUN-18	R4093795
Nickel (Ni)-Total	0.00164		0.00050	mg/L	16-JUN-18	20-JUN-18	R4093795
Phosphorus (P)-Total	<0.050		0.050	mg/L	16-JUN-18	20-JUN-18	R4093795
Potassium (K)-Total	0.912		0.050	mg/L	16-JUN-18	20-JUN-18	R4093795
Rubidium (Rb)-Total	0.00145		0.00020	mg/L	16-JUN-18	20-JUN-18	R4093795
Selenium (Se)-Total	0.000108		0.000050	mg/L	16-JUN-18	20-JUN-18	R4093795
Silicon (Si)-Total	1.98		0.10	mg/L	16-JUN-18	20-JUN-18	R4093795
Silver (Ag)-Total	<0.000010		0.000010	mg/L	16-JUN-18	20-JUN-18	R4093795
Sodium (Na)-Total	3.65		0.050	mg/L	16-JUN-18	20-JUN-18	R4093795
Strontium (Sr)-Total	0.0771		0.00020	mg/L	16-JUN-18	20-JUN-18	R4093795

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L2112994-3 JR #3 - JARVIS RIVER - SITE #3 Sampled By: Client on 13-JUN-18 @ 10:50 Matrix: Grab							
Total Metals							
Sulfur (S)-Total	0.88		0.50	mg/L	16-JUN-18	20-JUN-18	R4093795
Tellurium (Te)-Total	<0.00020		0.00020	mg/L	16-JUN-18	20-JUN-18	R4093795
Thallium (Tl)-Total	0.000014		0.000010	mg/L	16-JUN-18	20-JUN-18	R4093795
Thorium (Th)-Total	<0.00010		0.00010	mg/L	16-JUN-18	20-JUN-18	R4093795
Tin (Sn)-Total	<0.00010		0.00010	mg/L	16-JUN-18	20-JUN-18	R4093795
Titanium (Ti)-Total	0.0141		0.00030	mg/L	16-JUN-18	21-JUN-18	R4095204
Tungsten (W)-Total	<0.00010		0.00010	mg/L	16-JUN-18	20-JUN-18	R4093795
Uranium (U)-Total	0.000051		0.000010	mg/L	16-JUN-18	20-JUN-18	R4093795
Vanadium (V)-Total	0.00191		0.00050	mg/L	16-JUN-18	20-JUN-18	R4093795
Zinc (Zn)-Total	<0.0030		0.0030	mg/L	16-JUN-18	20-JUN-18	R4093795
Zirconium (Zr)-Total	0.000284		0.000060	mg/L	16-JUN-18	20-JUN-18	R4093795
L2112994-4 JR #4 - JARVIS RIVER - SITE #4 Sampled By: Client on 13-JUN-18 @ 11:55 Matrix: Grab							
Physical Tests							
Conductivity (EC)	276		3.0	uS/cm		16-JUN-18	R4084958
Hardness (as CaCO3)	128	HTC	0.50	mg/L		21-JUN-18	
pH	7.70		0.10	pH		16-JUN-18	R4084958
Total Dissolved Solids	200		20	mg/L		20-JUN-18	R4094116
Turbidity	13.1		0.10	NTU		15-JUN-18	R4084428
Anions and Nutrients							
Alkalinity, Total (as CaCO3)	94.7		2.0	mg/L		16-JUN-18	R4084958
Ammonia, Total (as N)	0.165		0.020	mg/L		22-JUN-18	R4095966
Chloride (Cl)	20.7		0.10	mg/L		18-JUN-18	R4088548
Nitrate (as N)	0.031		0.020	mg/L		18-JUN-18	R4088548
Nitrite (as N)	<0.010		0.010	mg/L		18-JUN-18	R4088548
Total Kjeldahl Nitrogen	0.84		0.15	mg/L	20-JUN-18	22-JUN-18	R4096284
Phosphorus (P)-Total	0.0340		0.0030	mg/L	19-JUN-18	22-JUN-18	R4096359
Sulfate (SO4)	12.7		0.30	mg/L		18-JUN-18	R4088548
Bacteriological Tests							
Escherichia Coli	135		0	MPN/100mL		15-JUN-18	R4084543
Total Coliforms	1550		0	MPN/100mL		15-JUN-18	R4084543
Total Metals							
Aluminum (Al)-Total	0.493		0.0030	mg/L	16-JUN-18	20-JUN-18	R4093795
Antimony (Sb)-Total	<0.00010		0.00010	mg/L	16-JUN-18	20-JUN-18	R4093795
Arsenic (As)-Total	0.00137		0.00010	mg/L	16-JUN-18	20-JUN-18	R4093795
Barium (Ba)-Total	0.0407		0.00010	mg/L	16-JUN-18	20-JUN-18	R4093795
Beryllium (Be)-Total	<0.00010		0.00010	mg/L	16-JUN-18	20-JUN-18	R4093795
Bismuth (Bi)-Total	<0.000050		0.000050	mg/L	16-JUN-18	20-JUN-18	R4093795
Boron (B)-Total	0.014		0.010	mg/L	16-JUN-18	20-JUN-18	R4093795
Cadmium (Cd)-Total	0.0000522		0.0000050	mg/L	16-JUN-18	20-JUN-18	R4093795
Calcium (Ca)-Total	30.3		0.050	mg/L	16-JUN-18	20-JUN-18	R4093795

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L2112994-4 JR #4 - JARVIS RIVER - SITE #4 Sampled By: Client on 13-JUN-18 @ 11:55 Matrix: Grab							
Total Metals							
Cesium (Cs)-Total	0.000047		0.000010	mg/L	16-JUN-18	20-JUN-18	R4093795
Chromium (Cr)-Total	0.00146		0.00010	mg/L	16-JUN-18	20-JUN-18	R4093795
Cobalt (Co)-Total	0.00046		0.00010	mg/L	16-JUN-18	20-JUN-18	R4093795
Copper (Cu)-Total	0.00491		0.00050	mg/L	16-JUN-18	20-JUN-18	R4093795
Iron (Fe)-Total	1.11		0.010	mg/L	16-JUN-18	20-JUN-18	R4093795
Lead (Pb)-Total	0.000302		0.000050	mg/L	16-JUN-18	20-JUN-18	R4093795
Lithium (Li)-Total	0.0040		0.0010	mg/L	16-JUN-18	20-JUN-18	R4093795
Magnesium (Mg)-Total	12.8		0.0050	mg/L	16-JUN-18	20-JUN-18	R4093795
Manganese (Mn)-Total	0.0876		0.00010	mg/L	16-JUN-18	20-JUN-18	R4093795
Molybdenum (Mo)-Total	0.00130		0.000050	mg/L	16-JUN-18	20-JUN-18	R4093795
Nickel (Ni)-Total	0.00242		0.00050	mg/L	16-JUN-18	20-JUN-18	R4093795
Phosphorus (P)-Total	<0.050		0.050	mg/L	16-JUN-18	20-JUN-18	R4093795
Potassium (K)-Total	1.35		0.050	mg/L	16-JUN-18	20-JUN-18	R4093795
Rubidium (Rb)-Total	0.00136		0.00020	mg/L	16-JUN-18	20-JUN-18	R4093795
Selenium (Se)-Total	0.000217		0.000050	mg/L	16-JUN-18	20-JUN-18	R4093795
Silicon (Si)-Total	2.02		0.10	mg/L	16-JUN-18	20-JUN-18	R4093795
Silver (Ag)-Total	<0.000010		0.000010	mg/L	16-JUN-18	20-JUN-18	R4093795
Sodium (Na)-Total	8.21		0.050	mg/L	16-JUN-18	20-JUN-18	R4093795
Strontium (Sr)-Total	0.172		0.00020	mg/L	16-JUN-18	20-JUN-18	R4093795
Sulfur (S)-Total	4.45		0.50	mg/L	16-JUN-18	20-JUN-18	R4093795
Tellurium (Te)-Total	<0.00020		0.00020	mg/L	16-JUN-18	20-JUN-18	R4093795
Thallium (Tl)-Total	0.000019		0.000010	mg/L	16-JUN-18	20-JUN-18	R4093795
Thorium (Th)-Total	<0.00010		0.00010	mg/L	16-JUN-18	20-JUN-18	R4093795
Tin (Sn)-Total	<0.00010		0.00010	mg/L	16-JUN-18	20-JUN-18	R4093795
Titanium (Ti)-Total	0.0133		0.00030	mg/L	16-JUN-18	20-JUN-18	R4093795
Tungsten (W)-Total	<0.00010		0.00010	mg/L	16-JUN-18	20-JUN-18	R4093795
Uranium (U)-Total	0.000309		0.000010	mg/L	16-JUN-18	20-JUN-18	R4093795
Vanadium (V)-Total	0.00258		0.00050	mg/L	16-JUN-18	20-JUN-18	R4093795
Zinc (Zn)-Total	0.0032		0.0030	mg/L	16-JUN-18	20-JUN-18	R4093795
Zirconium (Zr)-Total	0.000439		0.000060	mg/L	16-JUN-18	20-JUN-18	R4093795
L2112994-5 JR #5 - JARVIS RIVER - SITE #5 Sampled By: Client on 13-JUN-18 @ 13:10 Matrix: Grab							
Physical Tests							
Conductivity (EC)	151		3.0	uS/cm		16-JUN-18	R4084958
Hardness (as CaCO3)	78.9	HTC	0.50	mg/L		21-JUN-18	
pH	7.39		0.10	pH		16-JUN-18	R4084958
Total Dissolved Solids	118		13	mg/L		20-JUN-18	R4094116
Turbidity	6.22		0.10	NTU		15-JUN-18	R4084428
Anions and Nutrients							
Alkalinity, Total (as CaCO3)	75.0		2.0	mg/L		16-JUN-18	R4084958
Ammonia, Total (as N)	0.045		0.020	mg/L		22-JUN-18	R4095966

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L2112994-5 JR #5 - JARVIS RIVER - SITE #5 Sampled By: Client on 13-JUN-18 @ 13:10 Matrix: Grab							
Anions and Nutrients							
Chloride (Cl)	3.31		0.10	mg/L		18-JUN-18	R4088548
Nitrate (as N)	<0.020		0.020	mg/L		18-JUN-18	R4088548
Nitrite (as N)	<0.010		0.010	mg/L		18-JUN-18	R4088548
Total Kjeldahl Nitrogen	0.76		0.15	mg/L	20-JUN-18	22-JUN-18	R4096284
Phosphorus (P)-Total	0.0301		0.0030	mg/L	19-JUN-18	22-JUN-18	R4096359
Sulfate (SO4)	0.89		0.30	mg/L		18-JUN-18	R4088548
Bacteriological Tests							
Escherichia Coli	11		0	MPN/100mL		15-JUN-18	R4084543
Total Coliforms	1990		0	MPN/100mL		15-JUN-18	R4084543
Total Metals							
Aluminum (Al)-Total	0.205		0.0030	mg/L	16-JUN-18	20-JUN-18	R4093795
Antimony (Sb)-Total	<0.00010		0.00010	mg/L	16-JUN-18	20-JUN-18	R4093795
Arsenic (As)-Total	0.00097		0.00010	mg/L	16-JUN-18	20-JUN-18	R4093795
Barium (Ba)-Total	0.0168		0.00010	mg/L	16-JUN-18	20-JUN-18	R4093795
Beryllium (Be)-Total	<0.00010		0.00010	mg/L	16-JUN-18	20-JUN-18	R4093795
Bismuth (Bi)-Total	<0.000050		0.000050	mg/L	16-JUN-18	20-JUN-18	R4093795
Boron (B)-Total	0.011		0.010	mg/L	16-JUN-18	20-JUN-18	R4093795
Cadmium (Cd)-Total	0.0000252		0.0000050	mg/L	16-JUN-18	20-JUN-18	R4093795
Calcium (Ca)-Total	18.3		0.050	mg/L	16-JUN-18	20-JUN-18	R4093795
Cesium (Cs)-Total	0.000019		0.000010	mg/L	16-JUN-18	20-JUN-18	R4093795
Chromium (Cr)-Total	0.00079		0.00010	mg/L	16-JUN-18	20-JUN-18	R4093795
Cobalt (Co)-Total	0.00040		0.00010	mg/L	16-JUN-18	20-JUN-18	R4093795
Copper (Cu)-Total	0.00251		0.00050	mg/L	16-JUN-18	20-JUN-18	R4093795
Iron (Fe)-Total	1.00		0.010	mg/L	16-JUN-18	20-JUN-18	R4093795
Lead (Pb)-Total	0.000115		0.000050	mg/L	16-JUN-18	20-JUN-18	R4093795
Lithium (Li)-Total	<0.0010		0.0010	mg/L	16-JUN-18	20-JUN-18	R4093795
Magnesium (Mg)-Total	8.07		0.0050	mg/L	16-JUN-18	20-JUN-18	R4093795
Manganese (Mn)-Total	0.157		0.00010	mg/L	16-JUN-18	20-JUN-18	R4093795
Molybdenum (Mo)-Total	0.000560		0.000050	mg/L	16-JUN-18	20-JUN-18	R4093795
Nickel (Ni)-Total	0.00167		0.00050	mg/L	16-JUN-18	20-JUN-18	R4093795
Phosphorus (P)-Total	<0.050		0.050	mg/L	16-JUN-18	20-JUN-18	R4093795
Potassium (K)-Total	0.731		0.050	mg/L	16-JUN-18	20-JUN-18	R4093795
Rubidium (Rb)-Total	0.00072		0.00020	mg/L	16-JUN-18	20-JUN-18	R4093795
Selenium (Se)-Total	0.000169		0.000050	mg/L	16-JUN-18	20-JUN-18	R4093795
Silicon (Si)-Total	1.20		0.10	mg/L	16-JUN-18	20-JUN-18	R4093795
Silver (Ag)-Total	<0.000010		0.000010	mg/L	16-JUN-18	20-JUN-18	R4093795
Sodium (Na)-Total	3.29		0.050	mg/L	16-JUN-18	20-JUN-18	R4093795
Strontium (Sr)-Total	0.0552		0.00020	mg/L	16-JUN-18	20-JUN-18	R4093795
Sulfur (S)-Total	<0.50		0.50	mg/L	16-JUN-18	20-JUN-18	R4093795
Tellurium (Te)-Total	<0.00020		0.00020	mg/L	16-JUN-18	20-JUN-18	R4093795
Thallium (Tl)-Total	0.000011		0.000010	mg/L	16-JUN-18	20-JUN-18	R4093795

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L2112994-5 JR #5 - JARVIS RIVER - SITE #5 Sampled By: Client on 13-JUN-18 @ 13:10 Matrix: Grab							
Total Metals							
Thorium (Th)-Total	<0.00010		0.00010	mg/L	16-JUN-18	20-JUN-18	R4093795
Tin (Sn)-Total	<0.00010		0.00010	mg/L	16-JUN-18	20-JUN-18	R4093795
Titanium (Ti)-Total	0.00607		0.00030	mg/L	16-JUN-18	20-JUN-18	R4093795
Tungsten (W)-Total	<0.00010		0.00010	mg/L	16-JUN-18	20-JUN-18	R4093795
Uranium (U)-Total	0.000083		0.000010	mg/L	16-JUN-18	20-JUN-18	R4093795
Vanadium (V)-Total	0.00156		0.00050	mg/L	16-JUN-18	20-JUN-18	R4093795
Zinc (Zn)-Total	<0.0030		0.0030	mg/L	16-JUN-18	20-JUN-18	R4093795
Zirconium (Zr)-Total	0.000303		0.000060	mg/L	16-JUN-18	20-JUN-18	R4093795
L2112994-6 JR #6 - JARVIS RIVER - SITE #6 Sampled By: Client on 13-JUN-18 @ 13:40 Matrix: Grab							
Physical Tests							
Conductivity (EC)	216		3.0	uS/cm		16-JUN-18	R4084958
Hardness (as CaCO3)	111	HTC	0.50	mg/L		23-JUN-18	
pH	7.60		0.10	pH		16-JUN-18	R4084958
Total Dissolved Solids	157		13	mg/L		20-JUN-18	R4094116
Turbidity	14.4		0.10	NTU		15-JUN-18	R4084428
Anions and Nutrients							
Alkalinity, Total (as CaCO3)	98.0		2.0	mg/L		16-JUN-18	R4084958
Ammonia, Total (as N)	0.187		0.020	mg/L		22-JUN-18	R4095966
Chloride (Cl)	10.1		0.10	mg/L		18-JUN-18	R4088548
Nitrate (as N)	<0.020		0.020	mg/L		18-JUN-18	R4088548
Nitrite (as N)	<0.010		0.010	mg/L		18-JUN-18	R4088548
Total Kjeldahl Nitrogen	1.11		0.15	mg/L	20-JUN-18	22-JUN-18	R4096284
Phosphorus (P)-Total	0.0556		0.0030	mg/L	19-JUN-18	22-JUN-18	R4096359
Sulfate (SO4)	2.32		0.30	mg/L		18-JUN-18	R4088548
Bacteriological Tests							
Escherichia Coli	12		0	MPN/100mL		15-JUN-18	R4084543
Total Coliforms	1990		0	MPN/100mL		15-JUN-18	R4084543
Total Metals							
Aluminum (Al)-Total	1.16		0.0030	mg/L	21-JUN-18	22-JUN-18	R4095645
Antimony (Sb)-Total	0.00016		0.00010	mg/L	21-JUN-18	22-JUN-18	R4095645
Arsenic (As)-Total	0.00127		0.00010	mg/L	21-JUN-18	22-JUN-18	R4095645
Barium (Ba)-Total	0.0243		0.00010	mg/L	21-JUN-18	22-JUN-18	R4095645
Beryllium (Be)-Total	<0.00010		0.00010	mg/L	21-JUN-18	22-JUN-18	R4095645
Bismuth (Bi)-Total	<0.000050		0.000050	mg/L	21-JUN-18	22-JUN-18	R4095645
Boron (B)-Total	0.014		0.010	mg/L	21-JUN-18	22-JUN-18	R4095645
Cadmium (Cd)-Total	0.0000818		0.0000050	mg/L	21-JUN-18	22-JUN-18	R4095645
Calcium (Ca)-Total	25.6		0.050	mg/L	21-JUN-18	22-JUN-18	R4095645
Cesium (Cs)-Total	0.000115		0.000010	mg/L	21-JUN-18	22-JUN-18	R4095645
Chromium (Cr)-Total	0.00262		0.00010	mg/L	21-JUN-18	22-JUN-18	R4095645
Cobalt (Co)-Total	0.00097		0.00010	mg/L	21-JUN-18	22-JUN-18	R4095645

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L2112994-6 JR #6 - JARVIS RIVER - SITE #6 Sampled By: Client on 13-JUN-18 @ 13:40 Matrix: Grab							
Total Metals							
Copper (Cu)-Total	0.00525		0.00050	mg/L	21-JUN-18	22-JUN-18	R4095645
Iron (Fe)-Total	2.12		0.010	mg/L	21-JUN-18	22-JUN-18	R4095645
Lead (Pb)-Total	0.000581		0.000050	mg/L	21-JUN-18	22-JUN-18	R4095645
Lithium (Li)-Total	0.0023		0.0010	mg/L	21-JUN-18	22-JUN-18	R4095645
Magnesium (Mg)-Total	11.3		0.0050	mg/L	21-JUN-18	22-JUN-18	R4095645
Manganese (Mn)-Total	0.111		0.00010	mg/L	21-JUN-18	22-JUN-18	R4095645
Molybdenum (Mo)-Total	0.00106		0.000050	mg/L	21-JUN-18	22-JUN-18	R4095645
Nickel (Ni)-Total	0.00353		0.00050	mg/L	21-JUN-18	22-JUN-18	R4095645
Phosphorus (P)-Total	<0.050		0.050	mg/L	21-JUN-18	22-JUN-18	R4095645
Potassium (K)-Total	0.973		0.050	mg/L	21-JUN-18	22-JUN-18	R4095645
Rubidium (Rb)-Total	0.00194		0.00020	mg/L	21-JUN-18	22-JUN-18	R4095645
Selenium (Se)-Total	0.000173		0.000050	mg/L	21-JUN-18	22-JUN-18	R4095645
Silicon (Si)-Total	3.12		0.10	mg/L	21-JUN-18	22-JUN-18	R4095645
Silver (Ag)-Total	0.000018		0.000010	mg/L	21-JUN-18	22-JUN-18	R4095645
Sodium (Na)-Total	5.58		0.050	mg/L	21-JUN-18	22-JUN-18	R4095645
Strontium (Sr)-Total	0.0847		0.00020	mg/L	21-JUN-18	22-JUN-18	R4095645
Sulfur (S)-Total	1.00		0.50	mg/L	21-JUN-18	22-JUN-18	R4095645
Tellurium (Te)-Total	<0.00020		0.00020	mg/L	21-JUN-18	22-JUN-18	R4095645
Thallium (Tl)-Total	0.000031		0.000010	mg/L	21-JUN-18	22-JUN-18	R4095645
Thorium (Th)-Total	<0.00010		0.00010	mg/L	21-JUN-18	22-JUN-18	R4095645
Tin (Sn)-Total	<0.00010		0.00010	mg/L	21-JUN-18	22-JUN-18	R4095645
Titanium (Ti)-Total	0.0305		0.00030	mg/L	21-JUN-18	22-JUN-18	R4095645
Tungsten (W)-Total	<0.00010		0.00010	mg/L	21-JUN-18	22-JUN-18	R4095645
Uranium (U)-Total	0.000269		0.000010	mg/L	21-JUN-18	22-JUN-18	R4095645
Vanadium (V)-Total	0.00441		0.00050	mg/L	21-JUN-18	22-JUN-18	R4095645
Zinc (Zn)-Total	0.0123		0.0030	mg/L	21-JUN-18	22-JUN-18	R4095645
Zirconium (Zr)-Total	0.000564		0.000060	mg/L	21-JUN-18	22-JUN-18	R4095645
L2112994-7 JR #7 - JARVIS RIVER - SITE #7 Sampled By: Client on 14-JUN-18 @ 14:45 Matrix: Grab							
Physical Tests							
Conductivity (EC)	179		3.0	uS/cm		18-JUN-18	R4089301
Hardness (as CaCO3)	89.3	HTC	0.50	mg/L		23-JUN-18	
pH	7.35		0.10	pH		18-JUN-18	R4089301
Total Dissolved Solids	145		13	mg/L		20-JUN-18	R4094116
Turbidity	7.08		0.10	NTU		16-JUN-18	R4084456
Anions and Nutrients							
Alkalinity, Total (as CaCO3)	85.4		2.0	mg/L		20-JUN-18	R4091267
Ammonia, Total (as N)	0.118		0.020	mg/L		22-JUN-18	R4095966
Chloride (Cl)	5.28		0.10	mg/L		18-JUN-18	R4088548
Nitrate (as N)	<0.020		0.020	mg/L		18-JUN-18	R4088548
Nitrite (as N)	<0.010		0.010	mg/L		18-JUN-18	R4088548

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L2112994-7 JR #7 - JARVIS RIVER - SITE #7 Sampled By: Client on 14-JUN-18 @ 14:45 Matrix: Grab							
Anions and Nutrients							
Total Kjeldahl Nitrogen	1.23		0.15	mg/L	20-JUN-18	22-JUN-18	R4096284
Phosphorus (P)-Total	0.0712		0.0030	mg/L	19-JUN-18	22-JUN-18	R4096359
Sulfate (SO4)	0.59		0.30	mg/L		18-JUN-18	R4088548
Bacteriological Tests							
Escherichia Coli	60		0	MPN/100mL		15-JUN-18	R4084493
Total Coliforms	>2420		0	MPN/100mL		15-JUN-18	R4084493
Total Metals							
Aluminum (Al)-Total	0.223		0.0030	mg/L	21-JUN-18	22-JUN-18	R4095645
Antimony (Sb)-Total	0.00011		0.00010	mg/L	21-JUN-18	22-JUN-18	R4095645
Arsenic (As)-Total	0.00202		0.00010	mg/L	21-JUN-18	22-JUN-18	R4095645
Barium (Ba)-Total	0.0204		0.00010	mg/L	21-JUN-18	22-JUN-18	R4095645
Beryllium (Be)-Total	<0.00010		0.00010	mg/L	21-JUN-18	22-JUN-18	R4095645
Bismuth (Bi)-Total	<0.000050		0.000050	mg/L	21-JUN-18	22-JUN-18	R4095645
Boron (B)-Total	0.010		0.010	mg/L	21-JUN-18	22-JUN-18	R4095645
Cadmium (Cd)-Total	0.0000668		0.0000050	mg/L	21-JUN-18	22-JUN-18	R4095645
Calcium (Ca)-Total	20.8		0.050	mg/L	21-JUN-18	22-JUN-18	R4095645
Cesium (Cs)-Total	0.000021		0.000010	mg/L	21-JUN-18	22-JUN-18	R4095645
Chromium (Cr)-Total	0.00084		0.00010	mg/L	21-JUN-18	22-JUN-18	R4095645
Cobalt (Co)-Total	0.00062		0.00010	mg/L	21-JUN-18	22-JUN-18	R4095645
Copper (Cu)-Total	0.00256		0.00050	mg/L	21-JUN-18	22-JUN-18	R4095645
Iron (Fe)-Total	2.12		0.010	mg/L	21-JUN-18	22-JUN-18	R4095645
Lead (Pb)-Total	0.000211		0.000050	mg/L	21-JUN-18	22-JUN-18	R4095645
Lithium (Li)-Total	<0.0010		0.0010	mg/L	21-JUN-18	22-JUN-18	R4095645
Magnesium (Mg)-Total	9.09		0.0050	mg/L	21-JUN-18	22-JUN-18	R4095645
Manganese (Mn)-Total	0.202		0.00010	mg/L	21-JUN-18	22-JUN-18	R4095645
Molybdenum (Mo)-Total	0.00118		0.000050	mg/L	21-JUN-18	22-JUN-18	R4095645
Nickel (Ni)-Total	0.00220		0.00050	mg/L	21-JUN-18	22-JUN-18	R4095645
Phosphorus (P)-Total	0.093		0.050	mg/L	21-JUN-18	22-JUN-18	R4095645
Potassium (K)-Total	1.07		0.050	mg/L	21-JUN-18	22-JUN-18	R4095645
Rubidium (Rb)-Total	0.00099		0.00020	mg/L	21-JUN-18	22-JUN-18	R4095645
Selenium (Se)-Total	0.000187		0.000050	mg/L	21-JUN-18	22-JUN-18	R4095645
Silicon (Si)-Total	3.26		0.10	mg/L	21-JUN-18	22-JUN-18	R4095645
Silver (Ag)-Total	0.000010		0.000010	mg/L	21-JUN-18	22-JUN-18	R4095645
Sodium (Na)-Total	5.37		0.050	mg/L	21-JUN-18	22-JUN-18	R4095645
Strontium (Sr)-Total	0.0405		0.00020	mg/L	21-JUN-18	22-JUN-18	R4095645
Sulfur (S)-Total	0.59		0.50	mg/L	21-JUN-18	22-JUN-18	R4095645
Tellurium (Te)-Total	<0.00020		0.00020	mg/L	21-JUN-18	22-JUN-18	R4095645
Thallium (Tl)-Total	0.000011		0.000010	mg/L	21-JUN-18	22-JUN-18	R4095645
Thorium (Th)-Total	<0.00010		0.00010	mg/L	21-JUN-18	22-JUN-18	R4095645
Tin (Sn)-Total	<0.00010		0.00010	mg/L	21-JUN-18	22-JUN-18	R4095645
Titanium (Ti)-Total	0.00696		0.00030	mg/L	21-JUN-18	22-JUN-18	R4095645

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L2112994-7 JR #7 - JARVIS RIVER - SITE #7 Sampled By: Client on 14-JUN-18 @ 14:45 Matrix: Grab							
Total Metals							
Tungsten (W)-Total	<0.00010		0.00010	mg/L	21-JUN-18	22-JUN-18	R4095645
Uranium (U)-Total	0.000101		0.000010	mg/L	21-JUN-18	22-JUN-18	R4095645
Vanadium (V)-Total	0.00234		0.00050	mg/L	21-JUN-18	22-JUN-18	R4095645
Zinc (Zn)-Total	0.0036		0.0030	mg/L	21-JUN-18	22-JUN-18	R4095645
Zirconium (Zr)-Total	0.000340		0.000060	mg/L	21-JUN-18	22-JUN-18	R4095645
L2112994-8 JR #8 - JARVIS RIVER - SITE #8 Sampled By: Client on 14-JUN-18 @ 13:45 Matrix: Grab							
Physical Tests							
Conductivity (EC)	144		3.0	uS/cm		18-JUN-18	R4089301
Hardness (as CaCO3)	73.0	HTC	0.50	mg/L		23-JUN-18	
pH	7.45		0.10	pH		18-JUN-18	R4089301
Total Dissolved Solids	107		13	mg/L		20-JUN-18	R4094116
Turbidity	4.93		0.10	NTU		16-JUN-18	R4084456
Anions and Nutrients							
Alkalinity, Total (as CaCO3)	75.4		2.0	mg/L		20-JUN-18	R4091267
Ammonia, Total (as N)	0.125		0.020	mg/L		22-JUN-18	R4095966
Chloride (Cl)	0.59		0.10	mg/L		18-JUN-18	R4088548
Nitrate (as N)	0.111		0.020	mg/L		18-JUN-18	R4088548
Nitrite (as N)	<0.010		0.010	mg/L		18-JUN-18	R4088548
Total Kjeldahl Nitrogen	0.54		0.15	mg/L	20-JUN-18	22-JUN-18	R4096284
Phosphorus (P)-Total	0.0169		0.0030	mg/L	19-JUN-18	22-JUN-18	R4096359
Sulfate (SO4)	3.14		0.30	mg/L		18-JUN-18	R4088548
Bacteriological Tests							
Escherichia Coli	3		0	MPN/100mL		15-JUN-18	R4084493
Total Coliforms	687		0	MPN/100mL		15-JUN-18	R4084493
Total Metals							
Aluminum (Al)-Total	0.109		0.0030	mg/L	21-JUN-18	22-JUN-18	R4095645
Antimony (Sb)-Total	0.00010		0.00010	mg/L	21-JUN-18	22-JUN-18	R4095645
Arsenic (As)-Total	0.00059		0.00010	mg/L	21-JUN-18	22-JUN-18	R4095645
Barium (Ba)-Total	0.0116		0.00010	mg/L	21-JUN-18	22-JUN-18	R4095645
Beryllium (Be)-Total	<0.00010		0.00010	mg/L	21-JUN-18	22-JUN-18	R4095645
Bismuth (Bi)-Total	<0.000050		0.000050	mg/L	21-JUN-18	22-JUN-18	R4095645
Boron (B)-Total	0.015		0.010	mg/L	21-JUN-18	22-JUN-18	R4095645
Cadmium (Cd)-Total	0.0000131		0.0000050	mg/L	21-JUN-18	22-JUN-18	R4095645
Calcium (Ca)-Total	18.0		0.050	mg/L	21-JUN-18	22-JUN-18	R4095645
Cesium (Cs)-Total	0.000013		0.000010	mg/L	21-JUN-18	22-JUN-18	R4095645
Chromium (Cr)-Total	0.00061		0.00010	mg/L	21-JUN-18	22-JUN-18	R4095645
Cobalt (Co)-Total	0.00013		0.00010	mg/L	21-JUN-18	22-JUN-18	R4095645
Copper (Cu)-Total	0.00475		0.00050	mg/L	21-JUN-18	22-JUN-18	R4095645
Iron (Fe)-Total	0.342		0.010	mg/L	21-JUN-18	22-JUN-18	R4095645
Lead (Pb)-Total	0.000151		0.000050	mg/L	21-JUN-18	22-JUN-18	R4095645

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L2112994-8 JR #8 - JARVIS RIVER - SITE #8 Sampled By: Client on 14-JUN-18 @ 13:45 Matrix: Grab							
Total Metals							
Lithium (Li)-Total	<0.0010		0.0010	mg/L	21-JUN-18	22-JUN-18	R4095645
Magnesium (Mg)-Total	6.82		0.0050	mg/L	21-JUN-18	22-JUN-18	R4095645
Manganese (Mn)-Total	0.00906		0.00010	mg/L	21-JUN-18	22-JUN-18	R4095645
Molybdenum (Mo)-Total	0.000565		0.000050	mg/L	21-JUN-18	22-JUN-18	R4095645
Nickel (Ni)-Total	0.00130		0.00050	mg/L	21-JUN-18	22-JUN-18	R4095645
Phosphorus (P)-Total	<0.050		0.050	mg/L	21-JUN-18	22-JUN-18	R4095645
Potassium (K)-Total	1.33		0.050	mg/L	21-JUN-18	22-JUN-18	R4095645
Rubidium (Rb)-Total	0.00070		0.00020	mg/L	21-JUN-18	22-JUN-18	R4095645
Selenium (Se)-Total	0.000151		0.000050	mg/L	21-JUN-18	22-JUN-18	R4095645
Silicon (Si)-Total	4.60		0.10	mg/L	21-JUN-18	22-JUN-18	R4095645
Silver (Ag)-Total	<0.000010		0.000010	mg/L	21-JUN-18	22-JUN-18	R4095645
Sodium (Na)-Total	2.61		0.050	mg/L	21-JUN-18	22-JUN-18	R4095645
Strontium (Sr)-Total	0.0433		0.00020	mg/L	21-JUN-18	22-JUN-18	R4095645
Sulfur (S)-Total	0.94		0.50	mg/L	21-JUN-18	22-JUN-18	R4095645
Tellurium (Te)-Total	<0.00020		0.00020	mg/L	21-JUN-18	22-JUN-18	R4095645
Thallium (Tl)-Total	<0.000010		0.000010	mg/L	21-JUN-18	22-JUN-18	R4095645
Thorium (Th)-Total	<0.00010		0.00010	mg/L	21-JUN-18	22-JUN-18	R4095645
Tin (Sn)-Total	<0.00010		0.00010	mg/L	21-JUN-18	22-JUN-18	R4095645
Titanium (Ti)-Total	<0.0029	DLM	0.0029	mg/L	21-JUN-18	22-JUN-18	R4095645
Tungsten (W)-Total	<0.00010		0.00010	mg/L	21-JUN-18	22-JUN-18	R4095645
Uranium (U)-Total	0.000078		0.000010	mg/L	21-JUN-18	22-JUN-18	R4095645
Vanadium (V)-Total	0.00095		0.00050	mg/L	21-JUN-18	22-JUN-18	R4095645
Zinc (Zn)-Total	0.0333		0.0030	mg/L	21-JUN-18	22-JUN-18	R4095645
Zirconium (Zr)-Total	0.000230		0.000060	mg/L	21-JUN-18	22-JUN-18	R4095645

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Method Blank	Zinc (Zn)-Total	B	L2112994-1, -2, -3, -4, -5
Duplicate	Aluminum (Al)-Total	DUP-H	L2112994-1, -2, -3, -4, -5
Matrix Spike	Aluminum (Al)-Total	MS-B	L2112994-1, -2, -3, -4, -5
Matrix Spike	Aluminum (Al)-Total	MS-B	L2112994-1, -2, -3, -4, -5
Matrix Spike	Barium (Ba)-Total	MS-B	L2112994-1, -2, -3, -4, -5
Matrix Spike	Calcium (Ca)-Total	MS-B	L2112994-1, -2, -3, -4, -5
Matrix Spike	Calcium (Ca)-Total	MS-B	L2112994-1, -2, -3, -4, -5
Matrix Spike	Magnesium (Mg)-Total	MS-B	L2112994-1, -2, -3, -4, -5
Matrix Spike	Magnesium (Mg)-Total	MS-B	L2112994-1, -2, -3, -4, -5
Matrix Spike	Manganese (Mn)-Total	MS-B	L2112994-1, -2, -3, -4, -5
Matrix Spike	Manganese (Mn)-Total	MS-B	L2112994-1, -2, -3, -4, -5
Matrix Spike	Sodium (Na)-Total	MS-B	L2112994-1, -2, -3, -4, -5
Matrix Spike	Strontium (Sr)-Total	MS-B	L2112994-1, -2, -3, -4, -5

Sample Parameter Qualifier key listed:

Qualifier	Description
B	Method Blank exceeds ALS DQO. Associated sample results which are < Limit of Reporting or > 5 times blank level are considered reliable.
DLM	Detection Limit Adjusted due to sample matrix effects (e.g. chemical interference, colour, turbidity).
DUP-H	Duplicate results outside ALS DQO, due to sample heterogeneity.
HTC	Hardness was calculated from Total Ca and/or Mg concentrations and may be biased high (dissolved Ca/Mg results unavailable).
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-TITR-TB	Water	Alkalinity	APHA 2320B modified

This analysis is carried out using procedures adapted from APHA Method 2320 "Alkalinity". Total alkalinity is determined by potentiometric titration to a pH 4.5 endpoint. Bicarbonate, carbonate and hydroxide alkalinity are calculated from phenolphthalein alkalinity and total alkalinity values.

CL-L-IC-N-TB	Water	Chloride in Water by IC (Low Level)	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

EC-TITR-TB	Water	Conductivity	APHA 2510 B

This analysis is carried out using procedures adapted from APHA Method 2510 "Conductivity". Conductivity is determined using a conductivity electrode.

HARDNESS-CALC-TB	Water	Hardness (as CaCO3)	CALCULATION
MET-T-CCMS-TB	Water	Total Metals in Water by CRC ICPMS	EPA 200.2/6020B (mod)

Water samples are digested with nitric and hydrochloric acids, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

NH3-COL-TB	Water	Ammonia by Discrete Analyzer	APHA 4500-NH3 G. (modified)

Ammonia in aqueous matrices is analyzed using discrete analyzer with colourimetric detection.

NO2-IC-N-TB	Water	Nitrite in Water by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

NO3-IC-N-TB	Water	Nitrate in Water by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

P-T-COL-TB	Water	Total Phosphorus by Discrete Analyzer	APHA 4500-P B, F, G (modified)

Phosphorus in aqueous matrices is analyzed using discrete Analyzer with colourimetric detection.

PH-TITR-TB	Water	pH	APHA 4500-H

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode

SO4-IC-N-TB	Water	Sulfate in Water by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

TC,EC-QT97-TB	Water	Total Coliform and E.coli	APHA 9223 B

This analysis is carried out using procedures adapted from APHA Method 9223 "Enzyme Substrate Coliform Test". E. coli and Total Coliform are determined simultaneously. The sample is mixed with a mixture of hydrolyzable substrates and then sealed in a multi-well packet. The packet is

Reference Information

incubated for 18 or 24 hours and then the number of wells exhibiting a positive response are counted. The final result is obtained by comparing the positive responses to a probability table.

TDS-TB	Water	Total Dissolved Solids	APHA 2540 C (modified)

Aqueous matrices are analyzed using gravimetry and evaporation

TKN-COL-TB	Water	Total Kjeldahl Nitrogen	APHA 4500-Norg (modified)

Total Kjeldahl Nitrogen in aqueous matrices is analyzed using a discrete analyzer with colourimetric detection.

TURBIDITY-TB	Water	Turbidity	APHA 2130 B-Nephelometer

Aqueous matrices are analyzed using nephelometry with the light scatter measured at a 90” angle.

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

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

Laboratory Definition Code	Laboratory Location
TB	ALS ENVIRONMENTAL - THUNDER BAY, ONTARIO, CANADA

Chain of Custody Numbers:

GLOSSARY OF REPORT TERMS

Surrogates are compounds that are similar in behaviour to target analyte(s), but that do not normally occur in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery. In reports that display the D.L. column, laboratory objectives for surrogates are listed there.
mg/kg - milligrams per kilogram based on dry weight of sample
mg/kg wwt - milligrams per kilogram based on wet weight of sample
mg/kg lwt - milligrams per kilogram based on lipid weight of sample
mg/L - unit of concentration based on volume, parts per million.
< - Less than.
D.L. - The reporting limit.
N/A - Result not available. Refer to qualifier code and definition for explanation.

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

Quality Control Report

Workorder: L2112994 Report Date: 26-JUN-18

Client: LAKEHEAD REGION CONSERVATION AUTHORITY
130 Conservation Road P.O. Box 10427
Thunder Bay ON P7B 6T8
Contact: Scott Drebit

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
ALK-TITR-TB	**Water**							
Batch R4084951								
WG2799293-8 LCS								
Alkalinity, Total (as CaCO3)			95.2		%		85-115	17-JUN-18
WG2799293-7 MB								
Alkalinity, Total (as CaCO3)			<2.0		mg/L		2	17-JUN-18
Batch R4084958								
WG2798959-11 LCS								
Alkalinity, Total (as CaCO3)			98.2		%		85-115	16-JUN-18
WG2798959-14 LCS								
Alkalinity, Total (as CaCO3)			96.2		%		85-115	16-JUN-18
WG2798959-8 LCS								
Alkalinity, Total (as CaCO3)			97.4		%		85-115	16-JUN-18
WG2798959-10 MB								
Alkalinity, Total (as CaCO3)			<2.0		mg/L		2	16-JUN-18
WG2798959-13 MB								
Alkalinity, Total (as CaCO3)			<2.0		mg/L		2	16-JUN-18
WG2798959-7 MB								
Alkalinity, Total (as CaCO3)			<2.0		mg/L		2	16-JUN-18
Batch R4091267								
WG2801866-2 LCS								
Alkalinity, Total (as CaCO3)			101.6		%		85-115	20-JUN-18
WG2801866-1 MB								
Alkalinity, Total (as CaCO3)			<2.0		mg/L		2	20-JUN-18
CL-L-IC-N-TB	**Water**							
Batch R4088548								
WG2799675-14 LCS								
Chloride (Cl)			95.8		%		90-110	18-JUN-18
WG2799675-13 MB								
Chloride (Cl)			<0.10		mg/L		0.1	18-JUN-18
EC-TITR-TB	**Water**							
Batch R4084951								
WG2799293-8 LCS								
Conductivity (EC)			100.0		%		90-110	17-JUN-18
WG2799293-7 MB								
Conductivity (EC)			<3.0		uS/cm		3	17-JUN-18
Batch R4084958								
WG2798959-11 LCS								
Conductivity (EC)			97.1		%		90-110	16-JUN-18
WG2798959-14 LCS								

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
EC-TITR-TB	**Water**							
Batch R4084958								
WG2798959-14 LCS								
Conductivity (EC)			97.3		%		90-110	16-JUN-18
WG2798959-8 LCS								
Conductivity (EC)			97.5		%		90-110	16-JUN-18
WG2798959-10 MB								
Conductivity (EC)			<3.0		uS/cm		3	16-JUN-18
WG2798959-13 MB								
Conductivity (EC)			<3.0		uS/cm		3	16-JUN-18
WG2798959-7 MB								
Conductivity (EC)			<3.0		uS/cm		3	16-JUN-18
Batch R4089301								
WG2799628-6 DUP		**L2112994-8**						
Conductivity (EC)		144	144		uS/cm	0.3	10	18-JUN-18
WG2799628-5 LCS								
Conductivity (EC)			96.0		%		90-110	18-JUN-18
WG2799628-4 MB								
Conductivity (EC)			<3.0		uS/cm		3	18-JUN-18
MET-T-CCMS-TB	**Water**							
Batch R4093795								
WG2799004-3 DUP		**L2112994-3**						
Aluminum (Al)-Total		0.521	0.708	DUP-H	mg/L	30	20	20-JUN-18
Antimony (Sb)-Total		<0.00010	<0.00010	RPD-NA	mg/L	N/A	20	20-JUN-18
Arsenic (As)-Total		0.00126	0.00134		mg/L	6.4	20	20-JUN-18
Barium (Ba)-Total		0.0319	0.0352		mg/L	9.6	20	20-JUN-18
Beryllium (Be)-Total		<0.00010	<0.00010	RPD-NA	mg/L	N/A	20	20-JUN-18
Bismuth (Bi)-Total		<0.000050	<0.000050	RPD-NA	mg/L	N/A	20	20-JUN-18
Boron (B)-Total		0.011	0.011		mg/L	2.8	20	20-JUN-18
Cadmium (Cd)-Total		0.0000284	0.0000318		mg/L	11	20	20-JUN-18
Calcium (Ca)-Total		13.9	13.9		mg/L	0.3	20	20-JUN-18
Cesium (Cs)-Total		0.000051	0.000063	J	mg/L	0.000012	0.00002	20-JUN-18
Cobalt (Co)-Total		0.00062	0.00070		mg/L	13	20	20-JUN-18
Copper (Cu)-Total		0.00330	0.00367		mg/L	11	20	20-JUN-18
Iron (Fe)-Total		1.47	1.70		mg/L	14	20	20-JUN-18
Lead (Pb)-Total		0.000369	0.000389		mg/L	5.2	20	20-JUN-18
Lithium (Li)-Total		0.0018	0.0021		mg/L	11	20	20-JUN-18
Magnesium (Mg)-Total		5.27	5.57		mg/L	5.6	20	20-JUN-18
Manganese (Mn)-Total		0.168	0.179		mg/L	6.3	20	20-JUN-18

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-T-CCMS-TB	**Water**							
Batch R4093795								
WG2799004-3 DUP		**L2112994-3**						
Molybdenum (Mo)-Total		0.000366	0.000397		mg/L	8.4	20	20-JUN-18
Nickel (Ni)-Total		0.00164	0.00196		mg/L	18	20	20-JUN-18
Phosphorus (P)-Total		<0.050	<0.050	RPD-NA	mg/L	N/A	20	20-JUN-18
Potassium (K)-Total		0.912	1.01		mg/L	11	20	20-JUN-18
Rubidium (Rb)-Total		0.00145	0.00171		mg/L	17	20	20-JUN-18
Selenium (Se)-Total		0.000108	0.000104		mg/L	3.3	20	20-JUN-18
Silicon (Si)-Total		1.98	2.23		mg/L	12	20	20-JUN-18
Silver (Ag)-Total		<0.000010	<0.000010	RPD-NA	mg/L	N/A	20	20-JUN-18
Sodium (Na)-Total		3.65	3.80		mg/L	4.1	20	20-JUN-18
Strontium (Sr)-Total		0.0771	0.0786		mg/L	1.9	20	20-JUN-18
Sulfur (S)-Total		0.88	0.56	J	mg/L	0.32	1	20-JUN-18
Tellurium (Te)-Total		<0.00020	<0.00020	RPD-NA	mg/L	N/A	20	20-JUN-18
Thallium (Tl)-Total		0.000014	0.000014		mg/L	3.2	20	20-JUN-18
Thorium (Th)-Total		<0.00010	<0.00010	RPD-NA	mg/L	N/A	20	20-JUN-18
Tin (Sn)-Total		<0.00010	<0.00010	RPD-NA	mg/L	N/A	20	20-JUN-18
Tungsten (W)-Total		<0.00010	<0.00010	RPD-NA	mg/L	N/A	20	20-JUN-18
Uranium (U)-Total		0.000051	0.000056		mg/L	8.7	20	20-JUN-18
Vanadium (V)-Total		0.00191	0.00222		mg/L	15	20	20-JUN-18
Zinc (Zn)-Total		<0.0030	0.0031	RPD-NA	mg/L	N/A	20	20-JUN-18
Zirconium (Zr)-Total		0.000284	0.000320		mg/L	12	20	20-JUN-18
WG2799004-2 LCS								
Aluminum (Al)-Total			106.2		%		80-120	20-JUN-18
Antimony (Sb)-Total			103.6		%		80-120	20-JUN-18
Arsenic (As)-Total			101.3		%		80-120	20-JUN-18
Barium (Ba)-Total			105.1		%		80-120	20-JUN-18
Beryllium (Be)-Total			101.2		%		80-120	20-JUN-18
Bismuth (Bi)-Total			100.9		%		80-120	20-JUN-18
Boron (B)-Total			95.2		%		80-120	20-JUN-18
Cadmium (Cd)-Total			101.2		%		80-120	20-JUN-18
Calcium (Ca)-Total			98.6		%		80-120	20-JUN-18
Cesium (Cs)-Total			98.1		%		80-120	20-JUN-18
Chromium (Cr)-Total			100.0		%		80-120	20-JUN-18
Cobalt (Co)-Total			104.0		%		80-120	20-JUN-18
Copper (Cu)-Total			101.6		%		80-120	20-JUN-18

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-T-CCMS-TB	**Water**							
Batch R4093795								
WG2799004-2 LCS								
Iron (Fe)-Total			102.4		%		80-120	20-JUN-18
Lead (Pb)-Total			99.8		%		80-120	20-JUN-18
Lithium (Li)-Total			95.8		%		80-120	20-JUN-18
Magnesium (Mg)-Total			109.4		%		80-120	20-JUN-18
Manganese (Mn)-Total			104.5		%		80-120	20-JUN-18
Molybdenum (Mo)-Total			100.2		%		80-120	20-JUN-18
Nickel (Ni)-Total			98.6		%		80-120	20-JUN-18
Phosphorus (P)-Total			104.0		%		80-120	20-JUN-18
Potassium (K)-Total			103.3		%		80-120	20-JUN-18
Rubidium (Rb)-Total			98.3		%		80-120	20-JUN-18
Selenium (Se)-Total			98.7		%		80-120	20-JUN-18
Silicon (Si)-Total			96.4		%		80-120	20-JUN-18
Silver (Ag)-Total			96.7		%		80-120	20-JUN-18
Sodium (Na)-Total			108.2		%		80-120	20-JUN-18
Strontium (Sr)-Total			97.0		%		80-120	20-JUN-18
Sulfur (S)-Total			85.5		%		80-120	20-JUN-18
Tellurium (Te)-Total			99.1		%		80-120	20-JUN-18
Thallium (Tl)-Total			99.7		%		80-120	20-JUN-18
Thorium (Th)-Total			97.3		%		80-120	20-JUN-18
Tin (Sn)-Total			97.6		%		80-120	20-JUN-18
Titanium (Ti)-Total			101.5		%		80-120	20-JUN-18
Tungsten (W)-Total			100.5		%		80-120	20-JUN-18
Uranium (U)-Total			102.0		%		80-120	20-JUN-18
Vanadium (V)-Total			101.6		%		80-120	20-JUN-18
Zinc (Zn)-Total			98.0		%		80-120	20-JUN-18
Zirconium (Zr)-Total			95.1		%		80-120	20-JUN-18
WG2799004-6 LCS								
Aluminum (Al)-Total			101.9		%		80-120	20-JUN-18
Antimony (Sb)-Total			106.1		%		80-120	20-JUN-18
Arsenic (As)-Total			98.8		%		80-120	20-JUN-18
Barium (Ba)-Total			103.2		%		80-120	20-JUN-18
Beryllium (Be)-Total			101.8		%		80-120	20-JUN-18
Bismuth (Bi)-Total			103.7		%		80-120	20-JUN-18
Boron (B)-Total			99.9		%		80-120	20-JUN-18

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-T-CCMS-TB	**Water**							
Batch R4093795								
WG2799004-6 LCS								
Cadmium (Cd)-Total			99.8		%		80-120	20-JUN-18
Calcium (Ca)-Total			101.8		%		80-120	20-JUN-18
Cesium (Cs)-Total			101.0		%		80-120	20-JUN-18
Chromium (Cr)-Total			99.5		%		80-120	20-JUN-18
Cobalt (Co)-Total			99.8		%		80-120	20-JUN-18
Copper (Cu)-Total			98.1		%		80-120	20-JUN-18
Iron (Fe)-Total			103.6		%		80-120	20-JUN-18
Lead (Pb)-Total			100.8		%		80-120	20-JUN-18
Lithium (Li)-Total			97.6		%		80-120	20-JUN-18
Magnesium (Mg)-Total			106.6		%		80-120	20-JUN-18
Manganese (Mn)-Total			98.2		%		80-120	20-JUN-18
Molybdenum (Mo)-Total			103.5		%		80-120	20-JUN-18
Nickel (Ni)-Total			97.4		%		80-120	20-JUN-18
Phosphorus (P)-Total			103.3		%		80-120	20-JUN-18
Potassium (K)-Total			100.2		%		80-120	20-JUN-18
Rubidium (Rb)-Total			96.8		%		80-120	20-JUN-18
Selenium (Se)-Total			97.1		%		80-120	20-JUN-18
Silicon (Si)-Total			98.9		%		80-120	20-JUN-18
Silver (Ag)-Total			99.3		%		80-120	20-JUN-18
Sodium (Na)-Total			106.4		%		80-120	20-JUN-18
Strontium (Sr)-Total			99.7		%		80-120	20-JUN-18
Sulfur (S)-Total			86.5		%		80-120	20-JUN-18
Tellurium (Te)-Total			93.4		%		80-120	20-JUN-18
Thallium (Tl)-Total			101.6		%		80-120	20-JUN-18
Thorium (Th)-Total			101.2		%		80-120	20-JUN-18
Tin (Sn)-Total			100.8		%		80-120	20-JUN-18
Titanium (Ti)-Total			97.0		%		80-120	20-JUN-18
Tungsten (W)-Total			100.5		%		80-120	20-JUN-18
Uranium (U)-Total			103.2		%		80-120	20-JUN-18
Vanadium (V)-Total			98.4		%		80-120	20-JUN-18
Zinc (Zn)-Total			97.9		%		80-120	20-JUN-18
Zirconium (Zr)-Total			97.4		%		80-120	20-JUN-18
WG2799004-1 MB								
Aluminum (Al)-Total			<0.0030		mg/L		0.003	20-JUN-18

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-T-CCMS-TB	**Water**							
Batch R4093795								
WG2799004-1 MB								
Antimony (Sb)-Total			<0.00010		mg/L		0.0001	20-JUN-18
Arsenic (As)-Total			<0.00010		mg/L		0.0001	20-JUN-18
Barium (Ba)-Total			<0.00010		mg/L		0.0001	20-JUN-18
Beryllium (Be)-Total			<0.00010		mg/L		0.0001	20-JUN-18
Bismuth (Bi)-Total			<0.000050		mg/L		0.00005	20-JUN-18
Boron (B)-Total			<0.010		mg/L		0.01	20-JUN-18
Cadmium (Cd)-Total			<0.000005C		mg/L		0.000005	20-JUN-18
Calcium (Ca)-Total			<0.050		mg/L		0.05	20-JUN-18
Cesium (Cs)-Total			<0.000010		mg/L		0.00001	20-JUN-18
Chromium (Cr)-Total			<0.00010		mg/L		0.0001	20-JUN-18
Cobalt (Co)-Total			<0.00010		mg/L		0.0001	20-JUN-18
Copper (Cu)-Total			<0.00050		mg/L		0.0005	20-JUN-18
Iron (Fe)-Total			<0.010		mg/L		0.01	20-JUN-18
Lead (Pb)-Total			<0.000050		mg/L		0.00005	20-JUN-18
Lithium (Li)-Total			<0.0010		mg/L		0.001	20-JUN-18
Magnesium (Mg)-Total			<0.0050		mg/L		0.005	20-JUN-18
Manganese (Mn)-Total			<0.00010		mg/L		0.0001	20-JUN-18
Molybdenum (Mo)-Total			<0.000050		mg/L		0.00005	20-JUN-18
Nickel (Ni)-Total			<0.00050		mg/L		0.0005	20-JUN-18
Phosphorus (P)-Total			<0.050		mg/L		0.05	20-JUN-18
Potassium (K)-Total			<0.050		mg/L		0.05	20-JUN-18
Rubidium (Rb)-Total			<0.00020		mg/L		0.0002	20-JUN-18
Selenium (Se)-Total			<0.000050		mg/L		0.00005	20-JUN-18
Silicon (Si)-Total			<0.10		mg/L		0.1	20-JUN-18
Silver (Ag)-Total			<0.000010		mg/L		0.00001	20-JUN-18
Sodium (Na)-Total			<0.050		mg/L		0.05	20-JUN-18
Strontium (Sr)-Total			<0.00020		mg/L		0.0002	20-JUN-18
Sulfur (S)-Total			<0.50		mg/L		0.5	20-JUN-18
Tellurium (Te)-Total			<0.00020		mg/L		0.0002	20-JUN-18
Thallium (Tl)-Total			<0.000010		mg/L		0.00001	20-JUN-18
Thorium (Th)-Total			<0.00010		mg/L		0.0001	20-JUN-18
Tin (Sn)-Total			<0.00010		mg/L		0.0001	20-JUN-18
Titanium (Ti)-Total			<0.00030		mg/L		0.0003	20-JUN-18
Tungsten (W)-Total			<0.00010		mg/L		0.0001	20-JUN-18

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-T-CCMS-TB	**Water**							
Batch R4093795								
WG2799004-1 MB								
Uranium (U)-Total			<0.000010		mg/L		0.00001	20-JUN-18
Vanadium (V)-Total			<0.00050		mg/L		0.0005	20-JUN-18
Zinc (Zn)-Total			<0.0030		mg/L		0.003	20-JUN-18
Zirconium (Zr)-Total			<0.000060		mg/L		0.00006	20-JUN-18
WG2799004-5 MB								
Aluminum (Al)-Total			<0.0030		mg/L		0.003	20-JUN-18
Antimony (Sb)-Total			<0.00010		mg/L		0.0001	20-JUN-18
Arsenic (As)-Total			<0.00010		mg/L		0.0001	20-JUN-18
Barium (Ba)-Total			<0.00010		mg/L		0.0001	20-JUN-18
Beryllium (Be)-Total			<0.00010		mg/L		0.0001	20-JUN-18
Bismuth (Bi)-Total			<0.000050		mg/L		0.00005	20-JUN-18
Boron (B)-Total			<0.010		mg/L		0.01	20-JUN-18
Cadmium (Cd)-Total			<0.000005(		mg/L		0.000005	20-JUN-18
Calcium (Ca)-Total			<0.050		mg/L		0.05	20-JUN-18
Cesium (Cs)-Total			<0.000010		mg/L		0.00001	20-JUN-18
Chromium (Cr)-Total			<0.00010		mg/L		0.0001	20-JUN-18
Cobalt (Co)-Total			<0.00010		mg/L		0.0001	20-JUN-18
Copper (Cu)-Total			<0.00050		mg/L		0.0005	20-JUN-18
Iron (Fe)-Total			<0.010		mg/L		0.01	20-JUN-18
Lead (Pb)-Total			<0.000050		mg/L		0.00005	20-JUN-18
Lithium (Li)-Total			<0.0010		mg/L		0.001	20-JUN-18
Magnesium (Mg)-Total			<0.0050		mg/L		0.005	20-JUN-18
Manganese (Mn)-Total			<0.00010		mg/L		0.0001	20-JUN-18
Molybdenum (Mo)-Total			<0.000050		mg/L		0.00005	20-JUN-18
Nickel (Ni)-Total			<0.00050		mg/L		0.0005	20-JUN-18
Phosphorus (P)-Total			<0.050		mg/L		0.05	20-JUN-18
Potassium (K)-Total			<0.050		mg/L		0.05	20-JUN-18
Rubidium (Rb)-Total			<0.00020		mg/L		0.0002	20-JUN-18
Selenium (Se)-Total			<0.000050		mg/L		0.00005	20-JUN-18
Silicon (Si)-Total			<0.10		mg/L		0.1	20-JUN-18
Silver (Ag)-Total			<0.000010		mg/L		0.00001	20-JUN-18
Sodium (Na)-Total			<0.050		mg/L		0.05	20-JUN-18
Strontium (Sr)-Total			<0.00020		mg/L		0.0002	20-JUN-18
Sulfur (S)-Total			<0.50		mg/L		0.5	20-JUN-18

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-T-CCMS-TB	**Water**							
Batch R4093795								
WG2799004-5 MB								
Tellurium (Te)-Total			<0.00020		mg/L		0.0002	20-JUN-18
Thallium (Tl)-Total			<0.000010		mg/L		0.00001	20-JUN-18
Thorium (Th)-Total			<0.00010		mg/L		0.0001	20-JUN-18
Tin (Sn)-Total			<0.00010		mg/L		0.0001	20-JUN-18
Titanium (Ti)-Total			<0.00030		mg/L		0.0003	20-JUN-18
Tungsten (W)-Total			<0.00010		mg/L		0.0001	20-JUN-18
Uranium (U)-Total			<0.000010		mg/L		0.00001	20-JUN-18
Vanadium (V)-Total			<0.00050		mg/L		0.0005	20-JUN-18
Zinc (Zn)-Total			0.0061	B	mg/L		0.003	20-JUN-18
Zirconium (Zr)-Total			<0.000060		mg/L		0.00006	20-JUN-18
WG2799004-4 MS		**L2112994-4**						
Aluminum (Al)-Total			N/A	MS-B	%		-	20-JUN-18
Antimony (Sb)-Total			101.2		%		70-130	20-JUN-18
Arsenic (As)-Total			97.3		%		70-130	20-JUN-18
Barium (Ba)-Total			N/A	MS-B	%		-	20-JUN-18
Beryllium (Be)-Total			97.2		%		70-130	20-JUN-18
Bismuth (Bi)-Total			98.4		%		70-130	20-JUN-18
Boron (B)-Total			99.0		%		70-130	20-JUN-18
Cadmium (Cd)-Total			100.6		%		70-120	20-JUN-18
Calcium (Ca)-Total			N/A	MS-B	%		-	20-JUN-18
Cesium (Cs)-Total			101.7		%		70-130	20-JUN-18
Chromium (Cr)-Total			100.6		%		70-130	20-JUN-18
Cobalt (Co)-Total			99.6		%		70-130	20-JUN-18
Copper (Cu)-Total			98.1		%		70-130	20-JUN-18
Iron (Fe)-Total			99.7		%		70-130	20-JUN-18
Lead (Pb)-Total			98.0		%		70-130	20-JUN-18
Lithium (Li)-Total			95.6		%		70-130	20-JUN-18
Magnesium (Mg)-Total			N/A	MS-B	%		-	20-JUN-18
Manganese (Mn)-Total			N/A	MS-B	%		-	20-JUN-18
Molybdenum (Mo)-Total			105.9		%		70-130	20-JUN-18
Nickel (Ni)-Total			96.9		%		70-130	20-JUN-18
Phosphorus (P)-Total			100.7		%		70-130	20-JUN-18
Potassium (K)-Total			99.5		%		70-130	20-JUN-18
Rubidium (Rb)-Total			96.3		%		70-130	20-JUN-18

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-T-CCMS-TB	**Water**							
Batch R4093795								
WG2799004-4 MS		**L2112994-4**						
Selenium (Se)-Total			102.8		%		70-130	20-JUN-18
Silicon (Si)-Total			102.0		%		70-130	20-JUN-18
Silver (Ag)-Total			98.7		%		70-130	20-JUN-18
Sodium (Na)-Total			N/A	MS-B	%		-	20-JUN-18
Strontium (Sr)-Total			N/A	MS-B	%		-	20-JUN-18
Sulfur (S)-Total			103.5		%		70-130	20-JUN-18
Tellurium (Te)-Total			99.8		%		70-130	20-JUN-18
Thallium (Tl)-Total			97.2		%		70-130	20-JUN-18
Thorium (Th)-Total			103.5		%		70-130	20-JUN-18
Tin (Sn)-Total			100.6		%		70-130	20-JUN-18
Titanium (Ti)-Total			104.3		%		70-130	20-JUN-18
Tungsten (W)-Total			99.3		%		70-130	20-JUN-18
Uranium (U)-Total			102.3		%		70-130	20-JUN-18
Vanadium (V)-Total			99.2		%		70-130	20-JUN-18
Zinc (Zn)-Total			93.1		%		70-130	20-JUN-18
Zirconium (Zr)-Total			107.3		%		70-130	20-JUN-18
Batch R4095204								
WG2799004-3 DUP		**L2112994-3**						
Chromium (Cr)-Total		0.00114	0.00135		mg/L	17	20	21-JUN-18
Titanium (Ti)-Total		0.0141	0.0172		mg/L	20	20	21-JUN-18
Batch R4095645								
WG2803157-2 LCS								
Aluminum (Al)-Total			106.0		%		80-120	22-JUN-18
Antimony (Sb)-Total			113.8		%		80-120	22-JUN-18
Arsenic (As)-Total			104.0		%		80-120	22-JUN-18
Barium (Ba)-Total			105.8		%		80-120	22-JUN-18
Beryllium (Be)-Total			105.1		%		80-120	22-JUN-18
Bismuth (Bi)-Total			105.3		%		80-120	22-JUN-18
Boron (B)-Total			100.5		%		80-120	22-JUN-18
Cadmium (Cd)-Total			104.4		%		80-120	22-JUN-18
Calcium (Ca)-Total			105.8		%		80-120	22-JUN-18
Cesium (Cs)-Total			109.8		%		80-120	22-JUN-18
Chromium (Cr)-Total			105.3		%		80-120	22-JUN-18
Cobalt (Co)-Total			106.7		%		80-120	22-JUN-18

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-T-CCMS-TB	**Water**							
Batch R4095645								
WG2803157-2 LCS								
Copper (Cu)-Total			104.9		%		80-120	22-JUN-18
Iron (Fe)-Total			111.8		%		80-120	22-JUN-18
Lead (Pb)-Total			103.1		%		80-120	22-JUN-18
Lithium (Li)-Total			99.4		%		80-120	22-JUN-18
Magnesium (Mg)-Total			108.0		%		80-120	22-JUN-18
Manganese (Mn)-Total			105.0		%		80-120	22-JUN-18
Molybdenum (Mo)-Total			104.8		%		80-120	22-JUN-18
Nickel (Ni)-Total			103.1		%		80-120	22-JUN-18
Phosphorus (P)-Total			104.9		%		80-120	22-JUN-18
Potassium (K)-Total			108.4		%		80-120	22-JUN-18
Rubidium (Rb)-Total			105.9		%		80-120	22-JUN-18
Selenium (Se)-Total			106.2		%		80-120	22-JUN-18
Silicon (Si)-Total			107.3		%		80-120	22-JUN-18
Silver (Ag)-Total			112.5		%		80-120	22-JUN-18
Sodium (Na)-Total			106.8		%		80-120	22-JUN-18
Strontium (Sr)-Total			103.5		%		80-120	22-JUN-18
Sulfur (S)-Total			111.9		%		80-120	22-JUN-18
Tellurium (Te)-Total			101.3		%		80-120	22-JUN-18
Thallium (Tl)-Total			104.6		%		80-120	22-JUN-18
Thorium (Th)-Total			103.9		%		80-120	22-JUN-18
Tin (Sn)-Total			105.6		%		80-120	22-JUN-18
Titanium (Ti)-Total			102.6		%		80-120	22-JUN-18
Tungsten (W)-Total			106.8		%		80-120	22-JUN-18
Uranium (U)-Total			103.4		%		80-120	22-JUN-18
Vanadium (V)-Total			106.2		%		80-120	22-JUN-18
Zinc (Zn)-Total			97.0		%		80-120	22-JUN-18
Zirconium (Zr)-Total			100.7		%		80-120	22-JUN-18
WG2803157-1 MB								
Aluminum (Al)-Total			<0.0030		mg/L		0.003	22-JUN-18
Antimony (Sb)-Total			<0.00010		mg/L		0.0001	22-JUN-18
Arsenic (As)-Total			<0.00010		mg/L		0.0001	22-JUN-18
Barium (Ba)-Total			<0.00010		mg/L		0.0001	22-JUN-18
Beryllium (Be)-Total			<0.00010		mg/L		0.0001	22-JUN-18
Bismuth (Bi)-Total			<0.000050		mg/L		0.00005	22-JUN-18

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-T-CCMS-TB	**Water**							
Batch R4095645								
WG2803157-1 MB								
Boron (B)-Total			<0.010		mg/L		0.01	22-JUN-18
Cadmium (Cd)-Total			<0.000005(		mg/L		0.000005	22-JUN-18
Calcium (Ca)-Total			<0.050		mg/L		0.05	22-JUN-18
Cesium (Cs)-Total			<0.000010		mg/L		0.00001	22-JUN-18
Chromium (Cr)-Total			<0.00010		mg/L		0.0001	22-JUN-18
Cobalt (Co)-Total			<0.00010		mg/L		0.0001	22-JUN-18
Copper (Cu)-Total			<0.00050		mg/L		0.0005	22-JUN-18
Iron (Fe)-Total			<0.010		mg/L		0.01	22-JUN-18
Lead (Pb)-Total			<0.000050		mg/L		0.00005	22-JUN-18
Lithium (Li)-Total			<0.0010		mg/L		0.001	22-JUN-18
Magnesium (Mg)-Total			<0.0050		mg/L		0.005	22-JUN-18
Manganese (Mn)-Total			<0.00010		mg/L		0.0001	22-JUN-18
Molybdenum (Mo)-Total			<0.000050		mg/L		0.00005	22-JUN-18
Nickel (Ni)-Total			<0.00050		mg/L		0.0005	22-JUN-18
Phosphorus (P)-Total			<0.050		mg/L		0.05	22-JUN-18
Potassium (K)-Total			<0.050		mg/L		0.05	22-JUN-18
Rubidium (Rb)-Total			<0.00020		mg/L		0.0002	22-JUN-18
Selenium (Se)-Total			<0.000050		mg/L		0.00005	22-JUN-18
Silicon (Si)-Total			<0.10		mg/L		0.1	22-JUN-18
Silver (Ag)-Total			<0.000010		mg/L		0.00001	22-JUN-18
Sodium (Na)-Total			<0.050		mg/L		0.05	22-JUN-18
Strontium (Sr)-Total			<0.00020		mg/L		0.0002	22-JUN-18
Sulfur (S)-Total			<0.50		mg/L		0.5	22-JUN-18
Tellurium (Te)-Total			<0.00020		mg/L		0.0002	22-JUN-18
Thallium (Tl)-Total			<0.000010		mg/L		0.00001	22-JUN-18
Thorium (Th)-Total			<0.00010		mg/L		0.0001	22-JUN-18
Tin (Sn)-Total			<0.00010		mg/L		0.0001	22-JUN-18
Titanium (Ti)-Total			<0.00030		mg/L		0.0003	22-JUN-18
Tungsten (W)-Total			<0.00010		mg/L		0.0001	22-JUN-18
Uranium (U)-Total			<0.000010		mg/L		0.00001	22-JUN-18
Vanadium (V)-Total			<0.00050		mg/L		0.0005	22-JUN-18
Zinc (Zn)-Total			<0.0030		mg/L		0.003	22-JUN-18
Zirconium (Zr)-Total			<0.000060		mg/L		0.00006	22-JUN-18
NH3-COL-TB	**Water**							

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
NH3-COL-TB	**Water**							
Batch R4095966								
WG2804616-11 DUP		**L2112994-5**						
Ammonia, Total (as N)		0.045	0.033	J	mg/L	0.011	0.04	22-JUN-18
WG2804616-10 LCS								
Ammonia, Total (as N)			95.7		%		85-115	22-JUN-18
WG2804616-9 MB								
Ammonia, Total (as N)			<0.020		mg/L		0.02	22-JUN-18
WG2804616-12 MS		**L2112994-6**						
Ammonia, Total (as N)			80.9		%		75-125	22-JUN-18
NO2-IC-N-TB	**Water**							
Batch R4088548								
WG2799675-14 LCS								
Nitrite (as N)			96.0		%		90-110	18-JUN-18
WG2799675-13 MB								
Nitrite (as N)			<0.010		mg/L		0.01	18-JUN-18
NO3-IC-N-TB	**Water**							
Batch R4088548								
WG2799675-14 LCS								
Nitrate (as N)			100.4		%		90-110	18-JUN-18
WG2799675-13 MB								
Nitrate (as N)			<0.020		mg/L		0.02	18-JUN-18
P-T-COL-TB	**Water**							
Batch R4096359								
WG2800793-8 DUP		**L2112994-2**						
Phosphorus (P)-Total		0.0567	0.0597		mg/L	5.2	20	22-JUN-18
WG2800793-6 LCS								
Phosphorus (P)-Total			99.7		%		80-120	22-JUN-18
WG2800793-5 MB								
Phosphorus (P)-Total			<0.0030		mg/L		0.003	22-JUN-18
WG2800793-7 MS		**L2112994-3**						
Phosphorus (P)-Total			126.4		%		70-130	22-JUN-18
PH-TITR-TB	**Water**							
Batch R4084951								
WG2799293-8 LCS								
pH			6.01		pH		5.9-6.1	17-JUN-18

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
PH-TITR-TB	**Water**							
Batch R4084958								
WG2798959-11 LCS								
pH			5.99		pH		5.9-6.1	16-JUN-18
WG2798959-14 LCS								
pH			5.99		pH		5.9-6.1	16-JUN-18
WG2798959-8 LCS								
pH			6.00		pH		5.9-6.1	16-JUN-18
Batch R4089301								
WG2799628-6 DUP		**L2112994-8**						
pH		7.45	7.49	J	pH	0.04	0.2	18-JUN-18
WG2799628-5 LCS								
pH			6.02		pH		5.9-6.1	18-JUN-18
SO4-IC-N-TB	**Water**							
Batch R4088548								
WG2799675-14 LCS								
Sulfate (SO4)			97.8		%		90-110	18-JUN-18
WG2799675-13 MB								
Sulfate (SO4)			<0.30		mg/L		0.3	18-JUN-18
TC,EC-QT97-TB	**Water**							
Batch R4084493								
WG2798695-1 MB								
Total Coliforms			0		MPN/100mL		1	15-JUN-18
Escherichia Coli			0		MPN/100mL		1	15-JUN-18
Batch R4084543								
WG2798334-1 MB								
Total Coliforms			0		MPN/100mL		1	15-JUN-18
Escherichia Coli			0		MPN/100mL		1	15-JUN-18
TDS-TB	**Water**							
Batch R4094116								
WG2802034-2 LCS								
Total Dissolved Solids			99.1		%		85-115	20-JUN-18
WG2802034-1 MB								
Total Dissolved Solids			<10		mg/L		10	20-JUN-18
TKN-COL-TB	**Water**							
Batch R4096284								
WG2801224-11 DUP		**L2112994-1**						
Total Kjeldahl Nitrogen		0.31	0.32		mg/L	0.7	20	22-JUN-18
WG2801224-10 LCS								

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
TKN-COL-TB	**Water**							
Batch R4096284								
WG2801224-10 LCS								
Total Kjeldahl Nitrogen			95.6		%		75-125	22-JUN-18
WG2801224-9 MB								
Total Kjeldahl Nitrogen			<0.15		mg/L		0.15	22-JUN-18
TURBIDITY-TB	**Water**							
Batch R4084428								
WG2798795-6 DUP		**L2112994-2**						
Turbidity		44.8	45.7		NTU	2.0	15	15-JUN-18
WG2798795-2 LCS								
Turbidity			100.0		%		85-115	15-JUN-18
WG2798795-5 LCS								
Turbidity			99.5		%		85-115	15-JUN-18
WG2798795-1 MB								
Turbidity			<0.10		NTU		0.1	15-JUN-18
WG2798795-4 MB								
Turbidity			<0.10		NTU		0.1	15-JUN-18
Batch R4084456								
WG2799017-2 LCS								
Turbidity			100.0		%		85-115	16-JUN-18
WG2799017-1 MB								
Turbidity			<0.10		NTU		0.1	16-JUN-18

Legend:

Limit	ALS Control Limit (Data Quality Objectives)
DUP	Duplicate
RPD	Relative Percent Difference
N/A	Not Available
LCS	Laboratory Control Sample
SRM	Standard Reference Material
MS	Matrix Spike
MSD	Matrix Spike Duplicate
ADE	Average Desorption Efficiency
MB	Method Blank
IRM	Internal Reference Material
CRM	Certified Reference Material
CCV	Continuing Calibration Verification
CVS	Calibration Verification Standard
LCSD	Laboratory Control Sample Duplicate

Sample Parameter Qualifier Definitions:

Qualifier	Description
B	Method Blank exceeds ALS DQO. Associated sample results which are < Limit of Reporting or > 5 times blank level are considered reliable.
DUP-H	Duplicate results outside ALS DQO, due to sample heterogeneity.
J	Duplicate results and limits are expressed in terms of absolute difference.
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.
RPD-NA	Relative Percent Difference Not Available due to result(s) being less than detection limit.

Hold Time Exceedances:

ALS Product Description	Sample ID	Sampling Date	Date Processed	Rec. HT	Actual HT	Units	Qualifier
Physical Tests							
Turbidity							
	3	13-JUN-18 10:50	15-JUN-18 19:45	48	57	hours	EHTL
	4	13-JUN-18 11:55	15-JUN-18 19:45	48	56	hours	EHTL
	5	13-JUN-18 13:10	15-JUN-18 19:45	48	54	hours	EHTL
	6	13-JUN-18 13:40	15-JUN-18 19:45	48	54	hours	EHTL
Bacteriological Tests							
Total Coliform and E.coli							
	3	13-JUN-18 10:50	15-JUN-18 13:29	48	51	hours	EHTL
	4	13-JUN-18 11:55	15-JUN-18 13:29	48	50	hours	EHTL

Legend & Qualifier Definitions:

EHTR-FM:	Exceeded ALS recommended hold time prior to sample receipt. Field Measurement recommended.
EHTR:	Exceeded ALS recommended hold time prior to sample receipt.
EHTL:	Exceeded ALS recommended hold time prior to analysis. Sample was received less than 24 hours prior to expiry.
EHT:	Exceeded ALS recommended hold time prior to analysis.
Rec. HT:	ALS recommended hold time (see units).

Notes*:
Where actual sampling date is not provided to ALS, the date (& time) of receipt is used for calculation purposes.
Where actual sampling time is not provided to ALS, the earlier of 12 noon on the sampling date or the time (& date) of receipt is used for calculation purposes. Samples for L2112994 were received on 15-JUN-18 09:46.

ALS recommended hold times may vary by province. They are assigned to meet known provincial and/or federal government requirements. In the absence of regulatory hold times, ALS establishes recommendations based on guidelines published by the US EPA, APHA Standard Methods, or Environment Canada (where available). For more information, please contact ALS.

The ALS Quality Control Report is provided to ALS clients upon request. ALS includes comprehensive QC checks with every analysis to ensure our high standards of quality are met. Each QC result has a known or expected target value, which is compared against pre-determined data quality objectives to provide confidence in the accuracy of associated test results.

Please note that this report may contain QC results from anonymous Sample Duplicates and Matrix Spikes that do not originate from this Work Order.

Chain of Custody (COC) / Analytical Request Form

ALS Environmental
www.alsglobal.com

Canada Toll Free: 1 800 668 9878

L2112994-COFC

COC Number: 14 -
Page 1 of 1

Report To	[redacted]	**Report Format / Distribution**	**Select Service Level Below** (Rush Turnaround Time (TAT) is not available for all tests)
Company:	Lakehead Region Conservation Authority	Select Report Format: ☒ PDF ☒ EXCEL ☐ EDD (DIGITAL)	R ☒ Regular (Standard TAT if received by 3 pm - business days)
Contact:	Scott Drebit	Quality Control (QC) Report with Report ☐ Yes ☒ No	P ☐ Priority (2-4 bus. days if received by 3pm) 50% surcharge - contact ALS to confirm TAT
Address:	130 Conservation Rd.	☐ Criteria on Report - provide details below if box checked	E ☐ Emergency (1-2 bus. days if received by 3pm) 100% surcharge - contact ALS to confirm TAT
Phone:	807 344 5857	Select Distribution: ☑ EMAIL ☐ MAIL ☐ FAX	E2 ☐ Same day or weekend emergency - contact ALS to confirm TAT and surcharge
		Email 1 or Fax [redacted]	Specify Date Required for E2,E or P:
		Email 2 scott@lakeheadca.com	

Invoice To	Same as Report To ☑ Yes ☐ No	**Invoice Distribution**	
	Copy of Invoice with Report ☑ Yes ☐ No	Select Invoice Distribution: ☑ EMAIL ☐ MAIL ☐ FAX	
Company:		Email 1 or Fax	
Contact:		Email 2	

Project Information		**Oil and Gas Required Fields (client use)**	
ALS Quote #:	Q62558	Approver ID:	Cost Center:
Job #:	Jarvis River	GL Account:	Routing Code:
PO / AFE:		Activity Code:	
LSD:		Location:	
ALS Lab Work Order # (lab use only)	L2112994	**ALS Contact:**	**Sampler:**

Analysis Request — Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	Alkalinity, Conductivity, pH	Chloride, Nitrate, Nitrite, Sulphate	TDS, Turbidity	NH_3, TKN, TP	Metals, Total and Hardness	TC / EC								Number of Containers
	JR # 1 - Jarvis River - Site # 1	14-June-18	10:30	Grab	X	X	X	X	X	X								5
	JR # 2 - Jarvis River - Site # 2	14-June-18	11:50	Grab	X	X	X	X	X	X								5
	JR # 3 - Jarvis River - Site # 3	13-June-18	10:50	Grab	X	X	X	X	X	X								5
	JR # 4 - Jarvis River - Site # 4	13-June-18	11:55	Grab	X	X	X	X	X	X								5
	JR # 5 - Jarvis River - Site # 5	13-June-18	13:10	Grab	X	X	X	X	X	X								5
	JR # 6 - Jarvis River - Site # 6	13-June-18	13:40	Grab	X	X	X	X	X	X								5
	JR # 7 - Jarvis River - Site # 7	14-June-18	14:45	Grab	X	X	X	X	X	X								5
	JR # 8 - Jarvis River - Site # 8	14-June-18	13:45	Grab	X	X	X	X	X	X								5

Drinking Water (DW) Samples[1] (client use)	**Special Instructions / Specify Criteria to add on report (client Use)**	**SAMPLE CONDITION AS RECEIVED (lab use only)**
Are samples taken from a Regulated DW System? ☐ Yes ☒ No		Frozen ☐ SIF Observations Yes ☐ No ☐
Are samples for human drinking water use? ☐ Yes ☒ No		Ice packs Yes ☒ No ☐ Custody seal intact Yes ☐ No ☐
		Cooling Initiated ☒

INITIAL COOLER TEMPERATURES °C			FINAL COOLER TEMPERATURES °C		
9.1					

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by: Rachael	Date: 15-June-18	Time: 9:30	Received By:	Date: June 15/18	Time: 9:46	Received by:	Date:	Time:

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION — WHITE - LABORATORY COPY — YELLOW - CLIENT COPY

NAVFM-0328e v08 Front/04 January 2014

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

1. If any water samples are taken from a **Regulated Drinking Water (DW) System**, please submit using an **Authorized DW COC form**.

SD

LAKEHEAD REGION CONSERVATION AUTHORITY
ATTN: Scott Drebit
130 Conservation Road
P.O. Box 10427
Thunder Bay ON P7B 6T8

Date Received: 11-JUL-18
Report Date: 18-JUL-18 15:27 (MT)
Version: FINAL

Client Phone: 807-344-5857

Certificate of Analysis

Lab Work Order #: L2127687

Project P.O. #: NOT SUBMITTED
Job Reference: JARVIS RIVER
C of C Numbers:
Legal Site Desc:

Jessica Richard
Account Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L2127687-1 JR1 - JARVIS RIVER - SITE 1 Sampled By: Client on 10-JUL-18 @ 13:10 Matrix: Grab							
Physical Tests							
Conductivity (EC)	133		3.0	uS/cm		12-JUL-18	R4124253
Hardness (as CaCO3)	68.5	HTC	0.50	mg/L		16-JUL-18	
pH	7.59		0.10	pH		12-JUL-18	R4124253
Total Dissolved Solids	134		13	mg/L		12-JUL-18	R4124737
Turbidity	58.2		0.10	NTU		11-JUL-18	R4122881
Anions and Nutrients							
Alkalinity, Total (as CaCO3)	58.2		2.0	mg/L		13-JUL-18	R4124809
Ammonia, Total (as N)	0.447		0.020	mg/L		12-JUL-18	R4124188
Chloride (Cl)	4.18		0.10	mg/L		12-JUL-18	R4124110
Nitrate (as N)	0.158		0.020	mg/L		12-JUL-18	R4124110
Nitrite (as N)	<0.010		0.010	mg/L		12-JUL-18	R4124110
Total Kjeldahl Nitrogen	1.47		0.15	mg/L	13-JUL-18	16-JUL-18	R4126709
Phosphorus (P)-Total	0.0963		0.0030	mg/L	12-JUL-18	13-JUL-18	R4124313
Sulfate (SO4)	4.28		0.30	mg/L		12-JUL-18	R4124110
Bacteriological Tests							
Escherichia Coli	387		0	MPN/100mL		11-JUL-18	R4123429
Total Coliforms	>2420		0	MPN/100mL		11-JUL-18	R4123429
Total Metals							
Aluminum (Al)-Total	2.24		0.0030	mg/L	13-JUL-18	14-JUL-18	R4127535
Antimony (Sb)-Total	0.00011		0.00010	mg/L	13-JUL-18	14-JUL-18	R4127535
Arsenic (As)-Total	0.00202		0.00010	mg/L	13-JUL-18	14-JUL-18	R4127535
Barium (Ba)-Total	0.0362		0.00010	mg/L	13-JUL-18	14-JUL-18	R4127535
Beryllium (Be)-Total	<0.00010		0.00010	mg/L	13-JUL-18	14-JUL-18	R4127535
Bismuth (Bi)-Total	<0.000050		0.000050	mg/L	13-JUL-18	14-JUL-18	R4127535
Boron (B)-Total	0.013		0.010	mg/L	13-JUL-18	14-JUL-18	R4127535
Cadmium (Cd)-Total	0.000109		0.0000050	mg/L	13-JUL-18	14-JUL-18	R4127535
Calcium (Ca)-Total	15.7		0.050	mg/L	13-JUL-18	14-JUL-18	R4127535
Cesium (Cs)-Total	0.000206		0.000010	mg/L	13-JUL-18	14-JUL-18	R4127535
Chromium (Cr)-Total	0.00423		0.00010	mg/L	13-JUL-18	14-JUL-18	R4127535
Cobalt (Co)-Total	0.00148		0.00010	mg/L	13-JUL-18	14-JUL-18	R4127535
Copper (Cu)-Total	0.00898		0.00050	mg/L	13-JUL-18	14-JUL-18	R4127535
Iron (Fe)-Total	3.72		0.010	mg/L	13-JUL-18	14-JUL-18	R4127535
Lead (Pb)-Total	0.00107		0.000050	mg/L	13-JUL-18	14-JUL-18	R4127535
Lithium (Li)-Total	0.0032		0.0010	mg/L	13-JUL-18	14-JUL-18	R4127535
Magnesium (Mg)-Total	7.11		0.0050	mg/L	13-JUL-18	14-JUL-18	R4127535
Manganese (Mn)-Total	0.0935		0.00010	mg/L	13-JUL-18	14-JUL-18	R4127535
Molybdenum (Mo)-Total	0.000731		0.000050	mg/L	13-JUL-18	14-JUL-18	R4127535
Nickel (Ni)-Total	0.00557		0.00050	mg/L	13-JUL-18	14-JUL-18	R4127535
Phosphorus (P)-Total	0.089		0.050	mg/L	13-JUL-18	14-JUL-18	R4127535
Potassium (K)-Total	1.47		0.050	mg/L	13-JUL-18	14-JUL-18	R4127535
Rubidium (Rb)-Total	0.00341		0.00020	mg/L	13-JUL-18	14-JUL-18	R4127535
Selenium (Se)-Total	0.000195		0.000050	mg/L	13-JUL-18	14-JUL-18	R4127535

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L2127687-1 JR1 - JARVIS RIVER - SITE 1 Sampled By: Client on 10-JUL-18 @ 13:10 Matrix: Grab							
Total Metals							
Silicon (Si)-Total	7.31		0.10	mg/L	13-JUL-18	14-JUL-18	R4127535
Silver (Ag)-Total	0.000031		0.000010	mg/L	13-JUL-18	14-JUL-18	R4127535
Sodium (Na)-Total	3.54		0.050	mg/L	13-JUL-18	14-JUL-18	R4127535
Strontium (Sr)-Total	0.0498		0.00020	mg/L	13-JUL-18	14-JUL-18	R4127535
Sulfur (S)-Total	1.41		0.50	mg/L	13-JUL-18	14-JUL-18	R4127535
Tellurium (Te)-Total	<0.00020		0.00020	mg/L	13-JUL-18	14-JUL-18	R4127535
Thallium (Tl)-Total	0.000048		0.000010	mg/L	13-JUL-18	14-JUL-18	R4127535
Thorium (Th)-Total	0.00019		0.00010	mg/L	13-JUL-18	14-JUL-18	R4127535
Tin (Sn)-Total	<0.00010		0.00010	mg/L	13-JUL-18	14-JUL-18	R4127535
Titanium (Ti)-Total	0.0556		0.00030	mg/L	13-JUL-18	14-JUL-18	R4127535
Tungsten (W)-Total	<0.00010		0.00010	mg/L	13-JUL-18	14-JUL-18	R4127535
Uranium (U)-Total	0.000167		0.000010	mg/L	13-JUL-18	14-JUL-18	R4127535
Vanadium (V)-Total	0.00675		0.00050	mg/L	13-JUL-18	14-JUL-18	R4127535
Zinc (Zn)-Total	0.0122		0.0030	mg/L	13-JUL-18	14-JUL-18	R4127535
Zirconium (Zr)-Total	0.000976		0.000060	mg/L	13-JUL-18	14-JUL-18	R4127535
L2127687-2 JR2 - JARVIS RIVER - SITE 2 Sampled By: Client on 10-JUL-18 @ 11:15 Matrix: Grab							
Physical Tests							
Conductivity (EC)	126		3.0	uS/cm		12-JUL-18	R4124253
Hardness (as CaCO3)	72.5	HTC	0.50	mg/L		16-JUL-18	
pH	7.62		0.10	pH		12-JUL-18	R4124253
Total Dissolved Solids	157		13	mg/L		12-JUL-18	R4124737
Turbidity	28.3		0.10	NTU		11-JUL-18	R4122881
Anions and Nutrients							
Alkalinity, Total (as CaCO3)	64.1		2.0	mg/L		13-JUL-18	R4124809
Ammonia, Total (as N)	0.190		0.020	mg/L		12-JUL-18	R4124188
Chloride (Cl)	0.99		0.10	mg/L		12-JUL-18	R4124110
Nitrate (as N)	0.097		0.020	mg/L		12-JUL-18	R4124110
Nitrite (as N)	<0.010		0.010	mg/L		12-JUL-18	R4124110
Total Kjeldahl Nitrogen	1.37		0.15	mg/L	13-JUL-18	16-JUL-18	R4126709
Phosphorus (P)-Total	0.0469		0.0030	mg/L	12-JUL-18	13-JUL-18	R4124313
Sulfate (SO4)	2.15		0.30	mg/L		12-JUL-18	R4124110
Bacteriological Tests							
Escherichia Coli	26		0	MPN/100mL		11-JUL-18	R4123429
Total Coliforms	>2420		0	MPN/100mL		11-JUL-18	R4123429
Total Metals							
Aluminum (Al)-Total	1.22		0.0030	mg/L	13-JUL-18	14-JUL-18	R4127535
Antimony (Sb)-Total	0.00011		0.00010	mg/L	13-JUL-18	14-JUL-18	R4127535
Arsenic (As)-Total	0.00199		0.00010	mg/L	13-JUL-18	14-JUL-18	R4127535
Barium (Ba)-Total	0.0224		0.00010	mg/L	13-JUL-18	14-JUL-18	R4127535
Beryllium (Be)-Total	<0.00010		0.00010	mg/L	13-JUL-18	14-JUL-18	R4127535

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L2127687-2 JR2 - JARVIS RIVER - SITE 2 Sampled By: Client on 10-JUL-18 @ 11:15 Matrix: Grab							
Total Metals							
Bismuth (Bi)-Total	<0.000050		0.000050	mg/L	13-JUL-18	14-JUL-18	R4127535
Boron (B)-Total	0.011		0.010	mg/L	13-JUL-18	14-JUL-18	R4127535
Cadmium (Cd)-Total	0.0000598		0.0000050	mg/L	13-JUL-18	14-JUL-18	R4127535
Calcium (Ca)-Total	17.2		0.050	mg/L	13-JUL-18	14-JUL-18	R4127535
Cesium (Cs)-Total	0.000094		0.000010	mg/L	13-JUL-18	14-JUL-18	R4127535
Chromium (Cr)-Total	0.00282		0.00010	mg/L	13-JUL-18	14-JUL-18	R4127535
Cobalt (Co)-Total	0.00077		0.00010	mg/L	13-JUL-18	14-JUL-18	R4127535
Copper (Cu)-Total	0.00733		0.00050	mg/L	13-JUL-18	14-JUL-18	R4127535
Iron (Fe)-Total	2.11		0.010	mg/L	13-JUL-18	14-JUL-18	R4127535
Lead (Pb)-Total	0.000603		0.000050	mg/L	13-JUL-18	14-JUL-18	R4127535
Lithium (Li)-Total	0.0021		0.0010	mg/L	13-JUL-18	14-JUL-18	R4127535
Magnesium (Mg)-Total	7.19		0.0050	mg/L	13-JUL-18	14-JUL-18	R4127535
Manganese (Mn)-Total	0.0507		0.00010	mg/L	13-JUL-18	14-JUL-18	R4127535
Molybdenum (Mo)-Total	0.000959		0.000050	mg/L	13-JUL-18	14-JUL-18	R4127535
Nickel (Ni)-Total	0.00405		0.00050	mg/L	13-JUL-18	14-JUL-18	R4127535
Phosphorus (P)-Total	<0.050		0.050	mg/L	13-JUL-18	14-JUL-18	R4127535
Potassium (K)-Total	0.855		0.050	mg/L	13-JUL-18	14-JUL-18	R4127535
Rubidium (Rb)-Total	0.00190		0.00020	mg/L	13-JUL-18	14-JUL-18	R4127535
Selenium (Se)-Total	0.000239		0.000050	mg/L	13-JUL-18	14-JUL-18	R4127535
Silicon (Si)-Total	5.66		0.10	mg/L	13-JUL-18	14-JUL-18	R4127535
Silver (Ag)-Total	0.000013		0.000010	mg/L	13-JUL-18	14-JUL-18	R4127535
Sodium (Na)-Total	2.57		0.050	mg/L	13-JUL-18	14-JUL-18	R4127535
Strontium (Sr)-Total	0.0379		0.00020	mg/L	13-JUL-18	14-JUL-18	R4127535
Sulfur (S)-Total	0.86		0.50	mg/L	13-JUL-18	14-JUL-18	R4127535
Tellurium (Te)-Total	<0.00020		0.00020	mg/L	13-JUL-18	14-JUL-18	R4127535
Thallium (Tl)-Total	0.000021		0.000010	mg/L	13-JUL-18	14-JUL-18	R4127535
Thorium (Th)-Total	0.00026		0.00010	mg/L	13-JUL-18	14-JUL-18	R4127535
Tin (Sn)-Total	<0.00010		0.00010	mg/L	13-JUL-18	14-JUL-18	R4127535
Titanium (Ti)-Total	0.0372		0.00030	mg/L	13-JUL-18	14-JUL-18	R4127535
Tungsten (W)-Total	<0.00010		0.00010	mg/L	13-JUL-18	14-JUL-18	R4127535
Uranium (U)-Total	0.000287		0.000010	mg/L	13-JUL-18	14-JUL-18	R4127535
Vanadium (V)-Total	0.00479		0.00050	mg/L	13-JUL-18	14-JUL-18	R4127535
Zinc (Zn)-Total	0.0050		0.0030	mg/L	13-JUL-18	14-JUL-18	R4127535
Zirconium (Zr)-Total	0.00155		0.000060	mg/L	13-JUL-18	14-JUL-18	R4127535
L2127687-3 JR3 - JARVIS RIVER - SITE 3 Sampled By: Client on 11-JUL-18 @ 10:55 Matrix: Grab							
Physical Tests							
Conductivity (EC)	112		3.0	uS/cm		12-JUL-18	R4124253
Hardness (as CaCO3)	49.4	HTC	0.50	mg/L		18-JUL-18	
pH	7.42		0.10	pH		12-JUL-18	R4124253
Total Dissolved Solids	87		13	mg/L		13-JUL-18	R4125052

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L2127687-3 JR3 - JARVIS RIVER - SITE 3 Sampled By: Client on 11-JUL-18 @ 10:55 Matrix: Grab							
Physical Tests							
Turbidity	5.89		0.10	NTU		12-JUL-18	R4123258
Anions and Nutrients							
Alkalinity, Total (as CaCO3)	41.4		2.0	mg/L		13-JUL-18	R4124809
Ammonia, Total (as N)	0.361		0.020	mg/L		16-JUL-18	R4130808
Chloride (Cl)	7.34		0.10	mg/L		12-JUL-18	R4124110
Nitrate (as N)	0.025		0.020	mg/L		12-JUL-18	R4124110
Nitrite (as N)	<0.010		0.010	mg/L		12-JUL-18	R4124110
Total Kjeldahl Nitrogen	0.80		0.15	mg/L	13-JUL-18	16-JUL-18	R4126709
Phosphorus (P)-Total	0.0246		0.0030	mg/L	12-JUL-18	13-JUL-18	R4124313
Sulfate (SO4)	2.48		0.30	mg/L		12-JUL-18	R4124110
Bacteriological Tests							
Escherichia Coli	33		0	MPN/100mL		11-JUL-18	R4123429
Total Coliforms	>2420		0	MPN/100mL		11-JUL-18	R4123429
Total Metals							
Aluminum (Al)-Total	0.238		0.0030	mg/L	13-JUL-18	14-JUL-18	R4127535
Antimony (Sb)-Total	<0.00010		0.00010	mg/L	13-JUL-18	14-JUL-18	R4127535
Arsenic (As)-Total	0.00083		0.00010	mg/L	13-JUL-18	14-JUL-18	R4127535
Barium (Ba)-Total	0.0238		0.00010	mg/L	13-JUL-18	14-JUL-18	R4127535
Beryllium (Be)-Total	<0.00010		0.00010	mg/L	13-JUL-18	14-JUL-18	R4127535
Bismuth (Bi)-Total	<0.000050		0.000050	mg/L	13-JUL-18	14-JUL-18	R4127535
Boron (B)-Total	0.011		0.010	mg/L	13-JUL-18	14-JUL-18	R4127535
Cadmium (Cd)-Total	0.0000090		0.0000050	mg/L	13-JUL-18	14-JUL-18	R4127535
Calcium (Ca)-Total	12.4		0.050	mg/L	13-JUL-18	14-JUL-18	R4127535
Cesium (Cs)-Total	0.000017		0.000010	mg/L	13-JUL-18	14-JUL-18	R4127535
Chromium (Cr)-Total	0.00051		0.00010	mg/L	13-JUL-18	14-JUL-18	R4127535
Cobalt (Co)-Total	0.00022		0.00010	mg/L	13-JUL-18	14-JUL-18	R4127535
Copper (Cu)-Total	0.00242		0.00050	mg/L	13-JUL-18	14-JUL-18	R4127535
Iron (Fe)-Total	0.684		0.010	mg/L	13-JUL-18	14-JUL-18	R4127535
Lead (Pb)-Total	0.000131		0.000050	mg/L	13-JUL-18	14-JUL-18	R4127535
Lithium (Li)-Total	0.0020		0.0010	mg/L	13-JUL-18	14-JUL-18	R4127535
Magnesium (Mg)-Total	4.48		0.0050	mg/L	13-JUL-18	14-JUL-18	R4127535
Manganese (Mn)-Total	0.0395		0.00010	mg/L	13-JUL-18	14-JUL-18	R4127535
Molybdenum (Mo)-Total	0.000349		0.000050	mg/L	13-JUL-18	17-JUL-18	R4132100
Nickel (Ni)-Total	0.00107		0.00050	mg/L	13-JUL-18	14-JUL-18	R4127535
Phosphorus (P)-Total	<0.050		0.050	mg/L	13-JUL-18	14-JUL-18	R4127535
Potassium (K)-Total	0.742		0.050	mg/L	13-JUL-18	14-JUL-18	R4127535
Rubidium (Rb)-Total	0.00101		0.00020	mg/L	13-JUL-18	14-JUL-18	R4127535
Selenium (Se)-Total	0.000112		0.000050	mg/L	13-JUL-18	14-JUL-18	R4127535
Silicon (Si)-Total	1.63		0.10	mg/L	13-JUL-18	14-JUL-18	R4127535
Silver (Ag)-Total	<0.000010		0.000010	mg/L	13-JUL-18	14-JUL-18	R4127535
Sodium (Na)-Total	3.31		0.050	mg/L	13-JUL-18	14-JUL-18	R4127535
Strontium (Sr)-Total	0.0713		0.00020	mg/L	13-JUL-18	14-JUL-18	R4127535

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L2127687-3 JR3 - JARVIS RIVER - SITE 3 Sampled By: Client on 11-JUL-18 @ 10:55 Matrix: Grab							
Total Metals							
Sulfur (S)-Total	0.90		0.50	mg/L	13-JUL-18	14-JUL-18	R4127535
Tellurium (Te)-Total	<0.00020		0.00020	mg/L	13-JUL-18	14-JUL-18	R4127535
Thallium (Tl)-Total	<0.000010		0.000010	mg/L	13-JUL-18	14-JUL-18	R4127535
Thorium (Th)-Total	<0.00010		0.00010	mg/L	13-JUL-18	14-JUL-18	R4127535
Tin (Sn)-Total	<0.00010		0.00010	mg/L	13-JUL-18	14-JUL-18	R4127535
Titanium (Ti)-Total	0.00642		0.00030	mg/L	13-JUL-18	14-JUL-18	R4127535
Tungsten (W)-Total	<0.00010		0.00010	mg/L	13-JUL-18	14-JUL-18	R4127535
Uranium (U)-Total	0.000037		0.000010	mg/L	13-JUL-18	14-JUL-18	R4127535
Vanadium (V)-Total	0.00110		0.00050	mg/L	13-JUL-18	14-JUL-18	R4127535
Zinc (Zn)-Total	<0.0030		0.0030	mg/L	13-JUL-18	14-JUL-18	R4127535
Zirconium (Zr)-Total	0.000206		0.000060	mg/L	13-JUL-18	14-JUL-18	R4127535
L2127687-4 JR4 - JARVIS RIVER - SITE 4 Sampled By: Client on 11-JUL-18 @ 11:35 Matrix: Grab							
Physical Tests							
Conductivity (EC)	157		3.0	uS/cm		12-JUL-18	R4124253
Hardness (as CaCO3)	77.8	HTC	0.63	mg/L		16-JUL-18	
pH	7.77		0.10	pH		12-JUL-18	R4124253
Total Dissolved Solids	124		13	mg/L		13-JUL-18	R4125052
Turbidity	23.4		0.10	NTU		12-JUL-18	R4123258
Anions and Nutrients							
Alkalinity, Total (as CaCO3)	62.8		2.0	mg/L		13-JUL-18	R4124809
Ammonia, Total (as N)	0.245		0.020	mg/L		16-JUL-18	R4130808
Chloride (Cl)	6.85		0.10	mg/L		12-JUL-18	R4124110
Nitrate (as N)	0.076		0.020	mg/L		12-JUL-18	R4124110
Nitrite (as N)	<0.010		0.010	mg/L		12-JUL-18	R4124110
Total Kjeldahl Nitrogen	1.27		0.15	mg/L	13-JUL-18	16-JUL-18	R4126709
Phosphorus (P)-Total	0.0603		0.0030	mg/L	12-JUL-18	13-JUL-18	R4124313
Sulfate (SO4)	4.51		0.30	mg/L		12-JUL-18	R4124110
Bacteriological Tests							
Escherichia Coli	145		0	MPN/100mL		11-JUL-18	R4123429
Total Coliforms	>2420		0	MPN/100mL		11-JUL-18	R4123429
Total Metals							
Aluminum (Al)-Total	1.02		0.015	mg/L	13-JUL-18	14-JUL-18	R4127535
Antimony (Sb)-Total	<0.00050	DLM	0.00050	mg/L	13-JUL-18	14-JUL-18	R4127535
Arsenic (As)-Total	0.00159		0.00050	mg/L	13-JUL-18	14-JUL-18	R4127535
Barium (Ba)-Total	0.0283		0.00050	mg/L	13-JUL-18	14-JUL-18	R4127535
Beryllium (Be)-Total	<0.00050	DLM	0.00050	mg/L	13-JUL-18	14-JUL-18	R4127535
Bismuth (Bi)-Total	<0.00025	DLM	0.00025	mg/L	13-JUL-18	14-JUL-18	R4127535
Boron (B)-Total	<0.050	DLM	0.050	mg/L	13-JUL-18	14-JUL-18	R4127535
Cadmium (Cd)-Total	0.000065		0.000025	mg/L	13-JUL-18	14-JUL-18	R4127535
Calcium (Ca)-Total	18.3		0.25	mg/L	13-JUL-18	14-JUL-18	R4127535

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L2127687-4 JR4 - JARVIS RIVER - SITE 4 Sampled By: Client on 11-JUL-18 @ 11:35 Matrix: Grab							
Total Metals							
Cesium (Cs)-Total	0.000072		0.000050	mg/L	13-JUL-18	14-JUL-18	R4127535
Chromium (Cr)-Total	0.00199		0.00050	mg/L	13-JUL-18	14-JUL-18	R4127535
Cobalt (Co)-Total	0.00067		0.00050	mg/L	13-JUL-18	14-JUL-18	R4127535
Copper (Cu)-Total	0.0072		0.0025	mg/L	13-JUL-18	14-JUL-18	R4127535
Iron (Fe)-Total	2.18		0.050	mg/L	13-JUL-18	14-JUL-18	R4127535
Lead (Pb)-Total	0.00058		0.00025	mg/L	13-JUL-18	14-JUL-18	R4127535
Lithium (Li)-Total	<0.0050	DLM	0.0050	mg/L	13-JUL-18	14-JUL-18	R4127535
Magnesium (Mg)-Total	7.83		0.025	mg/L	13-JUL-18	14-JUL-18	R4127535
Manganese (Mn)-Total	0.0599		0.00050	mg/L	13-JUL-18	14-JUL-18	R4127535
Molybdenum (Mo)-Total	0.00090		0.00025	mg/L	13-JUL-18	14-JUL-18	R4127535
Nickel (Ni)-Total	0.0034		0.0025	mg/L	13-JUL-18	14-JUL-18	R4127535
Phosphorus (P)-Total	<0.25	DLM	0.25	mg/L	13-JUL-18	14-JUL-18	R4127535
Potassium (K)-Total	1.21		0.25	mg/L	13-JUL-18	14-JUL-18	R4127535
Rubidium (Rb)-Total	0.0019		0.0010	mg/L	13-JUL-18	14-JUL-18	R4127535
Selenium (Se)-Total	<0.00025	DLM	0.00025	mg/L	13-JUL-18	14-JUL-18	R4127535
Silicon (Si)-Total	5.45		0.50	mg/L	13-JUL-18	14-JUL-18	R4127535
Silver (Ag)-Total	<0.000050	DLM	0.000050	mg/L	13-JUL-18	14-JUL-18	R4127535
Sodium (Na)-Total	4.77		0.25	mg/L	13-JUL-18	14-JUL-18	R4127535
Strontium (Sr)-Total	0.0639		0.0010	mg/L	13-JUL-18	14-JUL-18	R4127535
Sulfur (S)-Total	<2.5	DLM	2.5	mg/L	13-JUL-18	14-JUL-18	R4127535
Tellurium (Te)-Total	<0.0010	DLM	0.0010	mg/L	13-JUL-18	14-JUL-18	R4127535
Thallium (Tl)-Total	<0.000050	DLM	0.000050	mg/L	13-JUL-18	14-JUL-18	R4127535
Thorium (Th)-Total	<0.00050	DLM	0.00050	mg/L	13-JUL-18	14-JUL-18	R4127535
Tin (Sn)-Total	<0.00050	DLM	0.00050	mg/L	13-JUL-18	14-JUL-18	R4127535
Titanium (Ti)-Total	0.0246		0.0015	mg/L	13-JUL-18	14-JUL-18	R4127535
Tungsten (W)-Total	<0.00050	DLM	0.00050	mg/L	13-JUL-18	14-JUL-18	R4127535
Uranium (U)-Total	0.000135		0.000050	mg/L	13-JUL-18	14-JUL-18	R4127535
Vanadium (V)-Total	0.0043		0.0025	mg/L	13-JUL-18	14-JUL-18	R4127535
Zinc (Zn)-Total	<0.015	DLM	0.015	mg/L	13-JUL-18	14-JUL-18	R4127535
Zirconium (Zr)-Total	0.00064		0.00030	mg/L	13-JUL-18	14-JUL-18	R4127535
L2127687-5 JR5 - JARVIS RIVER - SITE 5 Sampled By: Client on 11-JUL-18 @ 12:40 Matrix: Grab							
Physical Tests							
Conductivity (EC)	135		3.0	uS/cm		12-JUL-18	R4124253
Hardness (as CaCO3)	71.3	HTC	0.63	mg/L		16-JUL-18	
pH	7.35		0.10	pH		12-JUL-18	R4124253
Total Dissolved Solids	120		13	mg/L		13-JUL-18	R4125052
Turbidity	4.91		0.10	NTU		12-JUL-18	R4123258
Anions and Nutrients							
Alkalinity, Total (as CaCO3)	64.7		2.0	mg/L		13-JUL-18	R4124809
Ammonia, Total (as N)	0.134		0.020	mg/L		16-JUL-18	R4130808

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L2127687-5 JR5 - JARVIS RIVER - SITE 5 Sampled By: Client on 11-JUL-18 @ 12:40 Matrix: Grab							
Anions and Nutrients							
Chloride (Cl)	2.60		0.10	mg/L		12-JUL-18	R4124110
Nitrate (as N)	0.027		0.020	mg/L		12-JUL-18	R4124110
Nitrite (as N)	<0.010		0.010	mg/L		12-JUL-18	R4124110
Total Kjeldahl Nitrogen	1.13		0.15	mg/L	13-JUL-18	16-JUL-18	R4126709
Phosphorus (P)-Total	0.0379		0.0030	mg/L	12-JUL-18	13-JUL-18	R4124313
Sulfate (SO4)	0.56		0.30	mg/L		12-JUL-18	R4124110
Bacteriological Tests							
Escherichia Coli	33		0	MPN/100mL		11-JUL-18	R4123429
Total Coliforms	>2420		0	MPN/100mL		11-JUL-18	R4123429
Total Metals							
Aluminum (Al)-Total	0.210		0.015	mg/L	13-JUL-18	14-JUL-18	R4127535
Antimony (Sb)-Total	<0.00050	DLM	0.00050	mg/L	13-JUL-18	14-JUL-18	R4127535
Arsenic (As)-Total	0.00116		0.00050	mg/L	13-JUL-18	14-JUL-18	R4127535
Barium (Ba)-Total	0.0158		0.00050	mg/L	13-JUL-18	14-JUL-18	R4127535
Beryllium (Be)-Total	<0.00050	DLM	0.00050	mg/L	13-JUL-18	14-JUL-18	R4127535
Bismuth (Bi)-Total	<0.00025	DLM	0.00025	mg/L	13-JUL-18	14-JUL-18	R4127535
Boron (B)-Total	<0.050	DLM	0.050	mg/L	13-JUL-18	14-JUL-18	R4127535
Cadmium (Cd)-Total	<0.000025	DLM	0.000025	mg/L	13-JUL-18	14-JUL-18	R4127535
Calcium (Ca)-Total	17.1		0.25	mg/L	13-JUL-18	14-JUL-18	R4127535
Cesium (Cs)-Total	<0.000050	DLM	0.000050	mg/L	13-JUL-18	14-JUL-18	R4127535
Chromium (Cr)-Total	0.00083		0.00050	mg/L	13-JUL-18	14-JUL-18	R4127535
Cobalt (Co)-Total	<0.00050	DLM	0.00050	mg/L	13-JUL-18	14-JUL-18	R4127535
Copper (Cu)-Total	0.0033		0.0025	mg/L	13-JUL-18	14-JUL-18	R4127535
Iron (Fe)-Total	1.28		0.050	mg/L	13-JUL-18	14-JUL-18	R4127535
Lead (Pb)-Total	<0.00025	DLM	0.00025	mg/L	13-JUL-18	14-JUL-18	R4127535
Lithium (Li)-Total	<0.0050	DLM	0.0050	mg/L	13-JUL-18	14-JUL-18	R4127535
Magnesium (Mg)-Total	6.99		0.025	mg/L	13-JUL-18	14-JUL-18	R4127535
Manganese (Mn)-Total	0.0848		0.00050	mg/L	13-JUL-18	14-JUL-18	R4127535
Molybdenum (Mo)-Total	0.00049		0.00025	mg/L	13-JUL-18	14-JUL-18	R4127535
Nickel (Ni)-Total	<0.0025	DLM	0.0025	mg/L	13-JUL-18	14-JUL-18	R4127535
Phosphorus (P)-Total	<0.25	DLM	0.25	mg/L	13-JUL-18	14-JUL-18	R4127535
Potassium (K)-Total	0.80		0.25	mg/L	13-JUL-18	14-JUL-18	R4127535
Rubidium (Rb)-Total	<0.0010	DLM	0.0010	mg/L	13-JUL-18	14-JUL-18	R4127535
Selenium (Se)-Total	<0.00025	DLM	0.00025	mg/L	13-JUL-18	14-JUL-18	R4127535
Silicon (Si)-Total	3.54		0.50	mg/L	13-JUL-18	14-JUL-18	R4127535
Silver (Ag)-Total	<0.000050	DLM	0.000050	mg/L	13-JUL-18	14-JUL-18	R4127535
Sodium (Na)-Total	2.52		0.25	mg/L	13-JUL-18	14-JUL-18	R4127535
Strontium (Sr)-Total	0.0480		0.0010	mg/L	13-JUL-18	14-JUL-18	R4127535
Sulfur (S)-Total	<2.5	DLM	2.5	mg/L	13-JUL-18	14-JUL-18	R4127535
Tellurium (Te)-Total	<0.0010	DLM	0.0010	mg/L	13-JUL-18	14-JUL-18	R4127535
Thallium (Tl)-Total	<0.000050	DLM	0.000050	mg/L	13-JUL-18	14-JUL-18	R4127535

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L2127687-5 JR5 - JARVIS RIVER - SITE 5 Sampled By: Client on 11-JUL-18 @ 12:40 Matrix: Grab							
Total Metals							
Thorium (Th)-Total	<0.00050	DLM	0.00050	mg/L	13-JUL-18	14-JUL-18	R4127535
Tin (Sn)-Total	<0.00050	DLM	0.00050	mg/L	13-JUL-18	14-JUL-18	R4127535
Titanium (Ti)-Total	0.0070		0.0015	mg/L	13-JUL-18	14-JUL-18	R4127535
Tungsten (W)-Total	<0.00050	DLM	0.00050	mg/L	13-JUL-18	14-JUL-18	R4127535
Uranium (U)-Total	0.000074		0.000050	mg/L	13-JUL-18	14-JUL-18	R4127535
Vanadium (V)-Total	<0.0025	DLM	0.0025	mg/L	13-JUL-18	14-JUL-18	R4127535
Zinc (Zn)-Total	<0.015	DLM	0.015	mg/L	13-JUL-18	14-JUL-18	R4127535
Zirconium (Zr)-Total	0.00199		0.00030	mg/L	13-JUL-18	14-JUL-18	R4127535
L2127687-6 JR6 - JARVIS RIVER - SITE 6 Sampled By: Client on 10-JUL-18 @ 15:00 Matrix: Grab							
Physical Tests							
Conductivity (EC)	138		3.0	uS/cm		12-JUL-18	R4124253
Hardness (as CaCO3)	70.0	HTC	0.50	mg/L		16-JUL-18	
pH	7.47		0.10	pH		12-JUL-18	R4124253
Total Dissolved Solids	139		13	mg/L		12-JUL-18	R4124737
Turbidity	13.8		0.10	NTU		11-JUL-18	R4122881
Anions and Nutrients							
Alkalinity, Total (as CaCO3)	66.0		2.0	mg/L		13-JUL-18	R4124809
Ammonia, Total (as N)	0.526		0.020	mg/L		12-JUL-18	R4124188
Chloride (Cl)	2.38		0.10	mg/L		12-JUL-18	R4124110
Nitrate (as N)	0.039		0.020	mg/L		12-JUL-18	R4124110
Nitrite (as N)	<0.010		0.010	mg/L		12-JUL-18	R4124110
Total Kjeldahl Nitrogen	1.43		0.15	mg/L	13-JUL-18	16-JUL-18	R4126709
Phosphorus (P)-Total	0.0422		0.0030	mg/L	12-JUL-18	13-JUL-18	R4124313
Sulfate (SO4)	1.75		0.30	mg/L		12-JUL-18	R4124110
Bacteriological Tests							
Escherichia Coli	75		0	MPN/100mL		11-JUL-18	R4123429
Total Coliforms	>2420		0	MPN/100mL		11-JUL-18	R4123429
Total Metals							
Aluminum (Al)-Total	0.811		0.0030	mg/L	13-JUL-18	14-JUL-18	R4127535
Antimony (Sb)-Total	<0.00010		0.00010	mg/L	13-JUL-18	14-JUL-18	R4127535
Arsenic (As)-Total	0.00112		0.00010	mg/L	13-JUL-18	14-JUL-18	R4127535
Barium (Ba)-Total	0.0190		0.00010	mg/L	13-JUL-18	14-JUL-18	R4127535
Beryllium (Be)-Total	<0.00010		0.00010	mg/L	13-JUL-18	14-JUL-18	R4127535
Bismuth (Bi)-Total	<0.000050		0.000050	mg/L	13-JUL-18	14-JUL-18	R4127535
Boron (B)-Total	0.011		0.010	mg/L	13-JUL-18	14-JUL-18	R4127535
Cadmium (Cd)-Total	0.0000563		0.0000050	mg/L	13-JUL-18	14-JUL-18	R4127535
Calcium (Ca)-Total	15.9		0.050	mg/L	13-JUL-18	14-JUL-18	R4127535
Cesium (Cs)-Total	0.000055		0.000010	mg/L	13-JUL-18	14-JUL-18	R4127535
Chromium (Cr)-Total	0.00180		0.00010	mg/L	13-JUL-18	14-JUL-18	R4127535
Cobalt (Co)-Total	0.00048		0.00010	mg/L	13-JUL-18	14-JUL-18	R4127535

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L2127687-6 JR6 - JARVIS RIVER - SITE 6 Sampled By: Client on 10-JUL-18 @ 15:00 Matrix: Grab							
Total Metals							
Copper (Cu)-Total	0.00503		0.00050	mg/L	13-JUL-18	14-JUL-18	R4127535
Iron (Fe)-Total	1.53		0.010	mg/L	13-JUL-18	14-JUL-18	R4127535
Lead (Pb)-Total	0.000292		0.000050	mg/L	13-JUL-18	14-JUL-18	R4127535
Lithium (Li)-Total	0.0016		0.0010	mg/L	13-JUL-18	14-JUL-18	R4127535
Magnesium (Mg)-Total	7.38		0.0050	mg/L	13-JUL-18	14-JUL-18	R4127535
Manganese (Mn)-Total	0.0344		0.00010	mg/L	13-JUL-18	14-JUL-18	R4127535
Molybdenum (Mo)-Total	0.000743		0.000050	mg/L	13-JUL-18	14-JUL-18	R4127535
Nickel (Ni)-Total	0.00280		0.00050	mg/L	13-JUL-18	14-JUL-18	R4127535
Phosphorus (P)-Total	<0.050		0.050	mg/L	13-JUL-18	14-JUL-18	R4127535
Potassium (K)-Total	0.901		0.050	mg/L	13-JUL-18	14-JUL-18	R4127535
Rubidium (Rb)-Total	0.00145		0.00020	mg/L	13-JUL-18	14-JUL-18	R4127535
Selenium (Se)-Total	0.000243		0.000050	mg/L	13-JUL-18	14-JUL-18	R4127535
Silicon (Si)-Total	5.15		0.10	mg/L	13-JUL-18	14-JUL-18	R4127535
Silver (Ag)-Total	0.000020		0.000010	mg/L	13-JUL-18	14-JUL-18	R4127535
Sodium (Na)-Total	2.83		0.050	mg/L	13-JUL-18	14-JUL-18	R4127535
Strontium (Sr)-Total	0.0420		0.00020	mg/L	13-JUL-18	14-JUL-18	R4127535
Sulfur (S)-Total	0.58		0.50	mg/L	13-JUL-18	14-JUL-18	R4127535
Tellurium (Te)-Total	<0.00020		0.00020	mg/L	13-JUL-18	14-JUL-18	R4127535
Thallium (Tl)-Total	0.000013		0.000010	mg/L	13-JUL-18	14-JUL-18	R4127535
Thorium (Th)-Total	<0.00010		0.00010	mg/L	13-JUL-18	14-JUL-18	R4127535
Tin (Sn)-Total	<0.00010		0.00010	mg/L	13-JUL-18	14-JUL-18	R4127535
Titanium (Ti)-Total	0.0204		0.00030	mg/L	13-JUL-18	14-JUL-18	R4127535
Tungsten (W)-Total	<0.00010		0.00010	mg/L	13-JUL-18	14-JUL-18	R4127535
Uranium (U)-Total	0.000139		0.000010	mg/L	13-JUL-18	14-JUL-18	R4127535
Vanadium (V)-Total	0.00299		0.00050	mg/L	13-JUL-18	14-JUL-18	R4127535
Zinc (Zn)-Total	0.0057		0.0030	mg/L	13-JUL-18	14-JUL-18	R4127535
Zirconium (Zr)-Total	0.000701		0.000060	mg/L	13-JUL-18	14-JUL-18	R4127535
L2127687-7 JR7 - JARVIS RIVER - SITE 7 Sampled By: Client on 10-JUL-18 @ 14:15 Matrix: Grab							
Physical Tests							
Conductivity (EC)	126		3.0	uS/cm		12-JUL-18	R4124253
Hardness (as CaCO3)	57.2	HTC	0.63	mg/L		16-JUL-18	
pH	7.27		0.10	pH		12-JUL-18	R4124253
Total Dissolved Solids	121		13	mg/L		12-JUL-18	R4124737
Turbidity	5.41		0.10	NTU		11-JUL-18	R4122881
Anions and Nutrients							
Alkalinity, Total (as CaCO3)	54.0		2.0	mg/L		13-JUL-18	R4124809
Ammonia, Total (as N)	0.347		0.020	mg/L		12-JUL-18	R4124188
Chloride (Cl)	5.56		0.10	mg/L		12-JUL-18	R4124110
Nitrate (as N)	0.021		0.020	mg/L		12-JUL-18	R4124110
Nitrite (as N)	<0.010		0.010	mg/L		12-JUL-18	R4124110

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L2127687-7 JR7 - JARVIS RIVER - SITE 7 Sampled By: Client on 10-JUL-18 @ 14:15 Matrix: Grab							
Anions and Nutrients							
Total Kjeldahl Nitrogen	1.42		0.15	mg/L	13-JUL-18	16-JUL-18	R4126709
Phosphorus (P)-Total	0.0542		0.0030	mg/L	12-JUL-18	13-JUL-18	R4124313
Sulfate (SO4)	2.78		0.30	mg/L		12-JUL-18	R4124110
Bacteriological Tests							
Escherichia Coli	68		0	MPN/100mL		11-JUL-18	R4123429
Total Coliforms	>2420		0	MPN/100mL		11-JUL-18	R4123429
Total Metals							
Aluminum (Al)-Total	0.182		0.015	mg/L	13-JUL-18	14-JUL-18	R4127535
Antimony (Sb)-Total	<0.00050	DLM	0.00050	mg/L	13-JUL-18	14-JUL-18	R4127535
Arsenic (As)-Total	0.00142		0.00050	mg/L	13-JUL-18	14-JUL-18	R4127535
Barium (Ba)-Total	0.0152		0.00050	mg/L	13-JUL-18	14-JUL-18	R4127535
Beryllium (Be)-Total	<0.00050	DLM	0.00050	mg/L	13-JUL-18	14-JUL-18	R4127535
Bismuth (Bi)-Total	<0.00025	DLM	0.00025	mg/L	13-JUL-18	14-JUL-18	R4127535
Boron (B)-Total	<0.050	DLM	0.050	mg/L	13-JUL-18	14-JUL-18	R4127535
Cadmium (Cd)-Total	0.000025		0.000025	mg/L	13-JUL-18	14-JUL-18	R4127535
Calcium (Ca)-Total	13.1		0.25	mg/L	13-JUL-18	14-JUL-18	R4127535
Cesium (Cs)-Total	<0.000050	DLM	0.000050	mg/L	13-JUL-18	14-JUL-18	R4127535
Chromium (Cr)-Total	<0.00050	DLM	0.00050	mg/L	13-JUL-18	14-JUL-18	R4127535
Cobalt (Co)-Total	<0.00050	DLM	0.00050	mg/L	13-JUL-18	14-JUL-18	R4127535
Copper (Cu)-Total	<0.0025	DLM	0.0025	mg/L	13-JUL-18	14-JUL-18	R4127535
Iron (Fe)-Total	1.66		0.050	mg/L	13-JUL-18	14-JUL-18	R4127535
Lead (Pb)-Total	<0.00025	DLM	0.00025	mg/L	13-JUL-18	14-JUL-18	R4127535
Lithium (Li)-Total	<0.0050	DLM	0.0050	mg/L	13-JUL-18	14-JUL-18	R4127535
Magnesium (Mg)-Total	5.94		0.025	mg/L	13-JUL-18	14-JUL-18	R4127535
Manganese (Mn)-Total	0.0380		0.00050	mg/L	13-JUL-18	14-JUL-18	R4127535
Molybdenum (Mo)-Total	0.00048		0.00025	mg/L	13-JUL-18	14-JUL-18	R4127535
Nickel (Ni)-Total	<0.0025	DLM	0.0025	mg/L	13-JUL-18	14-JUL-18	R4127535
Phosphorus (P)-Total	<0.25	DLM	0.25	mg/L	13-JUL-18	14-JUL-18	R4127535
Potassium (K)-Total	0.96		0.25	mg/L	13-JUL-18	14-JUL-18	R4127535
Rubidium (Rb)-Total	<0.0010	DLM	0.0010	mg/L	13-JUL-18	14-JUL-18	R4127535
Selenium (Se)-Total	<0.00025	DLM	0.00025	mg/L	13-JUL-18	14-JUL-18	R4127535
Silicon (Si)-Total	3.95		0.50	mg/L	13-JUL-18	14-JUL-18	R4127535
Silver (Ag)-Total	<0.000050	DLM	0.000050	mg/L	13-JUL-18	14-JUL-18	R4127535
Sodium (Na)-Total	4.40		0.25	mg/L	13-JUL-18	14-JUL-18	R4127535
Strontium (Sr)-Total	0.0258		0.0010	mg/L	13-JUL-18	14-JUL-18	R4127535
Sulfur (S)-Total	<2.5	DLM	2.5	mg/L	13-JUL-18	14-JUL-18	R4127535
Tellurium (Te)-Total	<0.0010	DLM	0.0010	mg/L	13-JUL-18	14-JUL-18	R4127535
Thallium (Tl)-Total	<0.000050	DLM	0.000050	mg/L	13-JUL-18	14-JUL-18	R4127535
Thorium (Th)-Total	<0.00050	DLM	0.00050	mg/L	13-JUL-18	14-JUL-18	R4127535
Tin (Sn)-Total	<0.00050	DLM	0.00050	mg/L	13-JUL-18	14-JUL-18	R4127535
Titanium (Ti)-Total	0.0049		0.0015	mg/L	13-JUL-18	14-JUL-18	R4127535

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L2127687-7 JR7 - JARVIS RIVER - SITE 7 Sampled By: Client on 10-JUL-18 @ 14:15 Matrix: Grab							
Total Metals							
Tungsten (W)-Total	<0.00050	DLM	0.00050	mg/L	13-JUL-18	14-JUL-18	R4127535
Uranium (U)-Total	<0.000050	DLM	0.000050	mg/L	13-JUL-18	14-JUL-18	R4127535
Vanadium (V)-Total	<0.0025	DLM	0.0025	mg/L	13-JUL-18	14-JUL-18	R4127535
Zinc (Zn)-Total	<0.015	DLM	0.015	mg/L	13-JUL-18	14-JUL-18	R4127535
Zirconium (Zr)-Total	<0.00030	DLM	0.00030	mg/L	13-JUL-18	14-JUL-18	R4127535
L2127687-8 JR8 - JARVIS RIVER - SITE 8 Sampled By: Client on 10-JUL-18 @ 10:00 Matrix: Grab							
Physical Tests							
Conductivity (EC)	97.9		3.0	uS/cm		12-JUL-18	R4124253
Hardness (as CaCO3)	47.9	HTC	0.50	mg/L		16-JUL-18	
pH	7.61		0.10	pH		12-JUL-18	R4124253
Total Dissolved Solids	94		13	mg/L		12-JUL-18	R4124737
Turbidity	16.8		0.10	NTU		11-JUL-18	R4122881
Anions and Nutrients							
Alkalinity, Total (as CaCO3)	48.6		2.0	mg/L		13-JUL-18	R4124809
Ammonia, Total (as N)	0.215		0.020	mg/L		12-JUL-18	R4124188
Chloride (Cl)	0.16		0.10	mg/L		12-JUL-18	R4124110
Nitrate (as N)	0.123		0.020	mg/L		12-JUL-18	R4124110
Nitrite (as N)	<0.010		0.010	mg/L		12-JUL-18	R4124110
Total Kjeldahl Nitrogen	0.73		0.15	mg/L	13-JUL-18	16-JUL-18	R4126709
Phosphorus (P)-Total	0.0296		0.0030	mg/L	12-JUL-18	13-JUL-18	R4124313
Sulfate (SO4)	2.68		0.30	mg/L		12-JUL-18	R4124110
Bacteriological Tests							
Escherichia Coli	50		0	MPN/100mL		11-JUL-18	R4123429
Total Coliforms	>2420		0	MPN/100mL		11-JUL-18	R4123429
Total Metals							
Aluminum (Al)-Total	0.865		0.0030	mg/L	13-JUL-18	14-JUL-18	R4127535
Antimony (Sb)-Total	<0.00010		0.00010	mg/L	13-JUL-18	14-JUL-18	R4127535
Arsenic (As)-Total	0.00064		0.00010	mg/L	13-JUL-18	14-JUL-18	R4127535
Barium (Ba)-Total	0.0127		0.00010	mg/L	13-JUL-18	14-JUL-18	R4127535
Beryllium (Be)-Total	<0.00010		0.00010	mg/L	13-JUL-18	14-JUL-18	R4127535
Bismuth (Bi)-Total	<0.000050		0.000050	mg/L	13-JUL-18	14-JUL-18	R4127535
Boron (B)-Total	0.015		0.010	mg/L	13-JUL-18	14-JUL-18	R4127535
Cadmium (Cd)-Total	0.0000221		0.0000050	mg/L	13-JUL-18	14-JUL-18	R4127535
Calcium (Ca)-Total	11.4		0.050	mg/L	13-JUL-18	14-JUL-18	R4127535
Cesium (Cs)-Total	0.000082		0.000010	mg/L	13-JUL-18	14-JUL-18	R4127535
Chromium (Cr)-Total	0.00160		0.00010	mg/L	13-JUL-18	14-JUL-18	R4127535
Cobalt (Co)-Total	0.00040		0.00010	mg/L	13-JUL-18	14-JUL-18	R4127535
Copper (Cu)-Total	0.00502		0.00050	mg/L	13-JUL-18	14-JUL-18	R4127535
Iron (Fe)-Total	1.01		0.010	mg/L	13-JUL-18	14-JUL-18	R4127535
Lead (Pb)-Total	0.000326		0.000050	mg/L	13-JUL-18	14-JUL-18	R4127535

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L2127687-8 JR8 - JARVIS RIVER - SITE 8 Sampled By: Client on 10-JUL-18 @ 10:00 Matrix: Grab							
Total Metals							
Lithium (Li)-Total	0.0012		0.0010	mg/L	13-JUL-18	14-JUL-18	R4127535
Magnesium (Mg)-Total	4.73		0.0050	mg/L	13-JUL-18	14-JUL-18	R4127535
Manganese (Mn)-Total	0.0217		0.00010	mg/L	13-JUL-18	14-JUL-18	R4127535
Molybdenum (Mo)-Total	0.000350		0.000050	mg/L	13-JUL-18	14-JUL-18	R4127535
Nickel (Ni)-Total	0.00219		0.00050	mg/L	13-JUL-18	14-JUL-18	R4127535
Phosphorus (P)-Total	<0.050		0.050	mg/L	13-JUL-18	14-JUL-18	R4127535
Potassium (K)-Total	1.08		0.050	mg/L	13-JUL-18	14-JUL-18	R4127535
Rubidium (Rb)-Total	0.00145		0.00020	mg/L	13-JUL-18	14-JUL-18	R4127535
Selenium (Se)-Total	0.000082		0.000050	mg/L	13-JUL-18	14-JUL-18	R4127535
Silicon (Si)-Total	6.05		0.10	mg/L	13-JUL-18	14-JUL-18	R4127535
Silver (Ag)-Total	0.000016		0.000010	mg/L	13-JUL-18	14-JUL-18	R4127535
Sodium (Na)-Total	1.91		0.050	mg/L	13-JUL-18	14-JUL-18	R4127535
Strontium (Sr)-Total	0.0282		0.00020	mg/L	13-JUL-18	14-JUL-18	R4127535
Sulfur (S)-Total	0.84		0.50	mg/L	13-JUL-18	14-JUL-18	R4127535
Tellurium (Te)-Total	<0.00020		0.00020	mg/L	13-JUL-18	14-JUL-18	R4127535
Thallium (Tl)-Total	0.000014		0.000010	mg/L	13-JUL-18	14-JUL-18	R4127535
Thorium (Th)-Total	<0.00010		0.00010	mg/L	13-JUL-18	14-JUL-18	R4127535
Tin (Sn)-Total	<0.00010		0.00010	mg/L	13-JUL-18	14-JUL-18	R4127535
Titanium (Ti)-Total	0.0215		0.00030	mg/L	13-JUL-18	14-JUL-18	R4127535
Tungsten (W)-Total	<0.00010		0.00010	mg/L	13-JUL-18	14-JUL-18	R4127535
Uranium (U)-Total	0.000062		0.000010	mg/L	13-JUL-18	14-JUL-18	R4127535
Vanadium (V)-Total	0.00231		0.00050	mg/L	13-JUL-18	14-JUL-18	R4127535
Zinc (Zn)-Total	0.0044		0.0030	mg/L	13-JUL-18	14-JUL-18	R4127535
Zirconium (Zr)-Total	0.000396		0.000060	mg/L	13-JUL-18	14-JUL-18	R4127535

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Matrix Spike	Barium (Ba)-Total	MS-B	L2127687-1, -2, -3, -4, -5, -6, -7, -8
Matrix Spike	Calcium (Ca)-Total	MS-B	L2127687-1, -2, -3, -4, -5, -6, -7, -8
Matrix Spike	Magnesium (Mg)-Total	MS-B	L2127687-1, -2, -3, -4, -5, -6, -7, -8
Matrix Spike	Manganese (Mn)-Total	MS-B	L2127687-1, -2, -3, -4, -5, -6, -7, -8
Matrix Spike	Silicon (Si)-Total	MS-B	L2127687-1, -2, -3, -4, -5, -6, -7, -8
Matrix Spike	Sodium (Na)-Total	MS-B	L2127687-1, -2, -3, -4, -5, -6, -7, -8
Matrix Spike	Strontium (Sr)-Total	MS-B	L2127687-1, -2, -3, -4, -5, -6, -7, -8
Matrix Spike	Sulfate (SO4)	MS-B	L2127687-1, -2, -3, -4, -5, -6, -7, -8
Matrix Spike	Sulfate (SO4)	MS-B	L2127687-1, -2, -3, -4, -5, -6, -7, -8

Sample Parameter Qualifier key listed:

Qualifier	Description
DLM	Detection Limit Adjusted due to sample matrix effects (e.g. chemical interference, colour, turbidity).
HTC	Hardness was calculated from Total Ca and/or Mg concentrations and may be biased high (dissolved Ca/Mg results unavailable).
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-TITR-TB	Water	Alkalinity	APHA 2320B modified

This analysis is carried out using procedures adapted from APHA Method 2320 "Alkalinity". Total alkalinity is determined by potentiometric titration to a pH 4.5 endpoint. Bicarbonate, carbonate and hydroxide alkalinity are calculated from phenolphthalein alkalinity and total alkalinity values.

CL-L-IC-N-TB	Water	Chloride in Water by IC (Low Level)	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

EC-TITR-TB	Water	Conductivity	APHA 2510 B

This analysis is carried out using procedures adapted from APHA Method 2510 "Conductivity". Conductivity is determined using a conductivity electrode.

HARDNESS-CALC-TB	Water	Hardness (as CaCO3)	CALCULATION
MET-T-CCMS-TB	Water	Total Metals in Water by CRC ICPMS	EPA 200.2/6020B (mod)

Water samples are digested with nitric and hydrochloric acids, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

NH3-COL-TB	Water	Ammonia by Discrete Analyzer	APHA 4500-NH3 G. (modified)

Ammonia in aqueous matrices is analyzed using discrete analyzer with colourimetric detection.

NO2-IC-N-TB	Water	Nitrite in Water by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

NO3-IC-N-TB	Water	Nitrate in Water by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

P-T-COL-TB	Water	Total Phosphorus by Discrete Analyzer	APHA 4500-P B, F, G (modified)

Phosphorus in aqueous matrices is analyzed using discrete Analyzer with colourimetric detection.

PH-TITR-TB	Water	pH	APHA 4500-H

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode

SO4-IC-N-TB	Water	Sulfate in Water by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

TC,EC-QT97-TB	Water	Total Coliform and E.coli	APHA 9223 B

This analysis is carried out using procedures adapted from APHA Method 9223 "Enzyme Substrate Coliform Test". E. coli and Total Coliform are determined simultaneously. The sample is mixed with a mixture of hydrolyzable substrates and then sealed in a multi-well packet. The packet is incubated for 18 or 24 hours and then the number of wells exhibiting a positive response are counted. The final result is obtained by comparing the positive responses to a probability table.

TDS-TB	Water	Total Dissolved Solids	APHA 2540 C (modified)

Aqueous matrices are analyzed using gravimetry and evaporation

TKN-COL-TB	Water	Total Kjeldahl Nitrogen	APHA 4500-Norg (modified)

Total Kjeldahl Nitrogen in aqueous matrices is analyzed using a discrete analyzer with colourimetric detection.

Reference Information

TURBIDITY-TB	Water	Turbidity	APHA 2130 B-Nephelometer

Aqueous matrices are analyzed using nephelometry with the light scatter measured at a 90” angle.

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

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

Laboratory Definition Code	Laboratory Location
TB	ALS ENVIRONMENTAL - THUNDER BAY, ONTARIO, CANADA

Chain of Custody Numbers:

GLOSSARY OF REPORT TERMS

Surrogates are compounds that are similar in behaviour to target analyte(s), but that do not normally occur in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery. In reports that display the D.L. column, laboratory objectives for surrogates are listed there.
mg/kg - milligrams per kilogram based on dry weight of sample
mg/kg wwt - milligrams per kilogram based on wet weight of sample
mg/kg lwt - milligrams per kilogram based on lipid weight of sample
mg/L - unit of concentration based on volume, parts per million.
< - Less than.
D.L. - The reporting limit.
N/A - Result not available. Refer to qualifier code and definition for explanation.

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

Quality Control Report

Client: LAKEHEAD REGION CONSERVATION AUTHORITY
130 Conservation Road P.O. Box 10427
Thunder Bay ON P7B 6T8
Contact: Scott Drebit

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
ALK-TITR-TB	**Water**							
Batch R4124809								
WG2821739-6 DUP		**L2127687-1**						
Alkalinity, Total (as CaCO3)		58.2	57.0		mg/L	2.1	20	13-JUL-18
WG2821739-5 LCS								
Alkalinity, Total (as CaCO3)			99.8		%		85-115	13-JUL-18
WG2821739-8 LCS								
Alkalinity, Total (as CaCO3)			97.5		%		85-115	13-JUL-18
WG2821739-4 MB								
Alkalinity, Total (as CaCO3)			<2.0		mg/L		2	13-JUL-18
WG2821739-7 MB								
Alkalinity, Total (as CaCO3)			<2.0		mg/L		2	13-JUL-18
CL-L-IC-N-TB	**Water**							
Batch R4124110								
WG2820900-2 LCS								
Chloride (Cl)			100.1		%		90-110	12-JUL-18
WG2820900-6 LCS								
Chloride (Cl)			98.5		%		90-110	12-JUL-18
WG2820900-1 MB								
Chloride (Cl)			<0.10		mg/L		0.1	12-JUL-18
WG2820900-5 MB								
Chloride (Cl)			<0.10		mg/L		0.1	12-JUL-18
EC-TITR-TB	**Water**							
Batch R4124253								
WG2820527-2 LCS								
Conductivity (EC)			99.1		%		90-110	12-JUL-18
WG2820527-5 LCS								
Conductivity (EC)			98.2		%		90-110	12-JUL-18
WG2820527-1 MB								
Conductivity (EC)			<3.0		uS/cm		3	12-JUL-18
WG2820527-4 MB								
Conductivity (EC)			<3.0		uS/cm		3	12-JUL-18
MET-T-CCMS-TB	**Water**							
Batch R4127535								
WG2820399-2 LCS								
Aluminum (Al)-Total			99.2		%		80-120	14-JUL-18
Antimony (Sb)-Total			96.0		%		80-120	14-JUL-18
Arsenic (As)-Total			97.5		%		80-120	14-JUL-18
Barium (Ba)-Total			103.4		%		80-120	14-JUL-18

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-T-CCMS-TB	**Water**							
Batch R4127535								
WG2820399-2 LCS								
Beryllium (Be)-Total			99.9		%		80-120	14-JUL-18
Bismuth (Bi)-Total			99.0		%		80-120	14-JUL-18
Boron (B)-Total			95.6		%		80-120	14-JUL-18
Cadmium (Cd)-Total			101.5		%		80-120	14-JUL-18
Calcium (Ca)-Total			95.8		%		80-120	14-JUL-18
Cesium (Cs)-Total			92.0		%		80-120	14-JUL-18
Chromium (Cr)-Total			98.5		%		80-120	14-JUL-18
Cobalt (Co)-Total			97.4		%		80-120	14-JUL-18
Copper (Cu)-Total			95.4		%		80-120	14-JUL-18
Iron (Fe)-Total			98.6		%		80-120	14-JUL-18
Lead (Pb)-Total			96.3		%		80-120	14-JUL-18
Lithium (Li)-Total			89.7		%		80-120	14-JUL-18
Magnesium (Mg)-Total			100.0		%		80-120	14-JUL-18
Manganese (Mn)-Total			97.8		%		80-120	14-JUL-18
Molybdenum (Mo)-Total			96.6		%		80-120	14-JUL-18
Nickel (Ni)-Total			96.4		%		80-120	14-JUL-18
Phosphorus (P)-Total			105.4		%		80-120	14-JUL-18
Potassium (K)-Total			99.5		%		80-120	14-JUL-18
Rubidium (Rb)-Total			94.2		%		80-120	14-JUL-18
Selenium (Se)-Total			97.5		%		80-120	14-JUL-18
Silicon (Si)-Total			94.9		%		80-120	14-JUL-18
Silver (Ag)-Total			95.0		%		80-120	14-JUL-18
Sodium (Na)-Total			99.0		%		80-120	14-JUL-18
Strontium (Sr)-Total			97.8		%		80-120	14-JUL-18
Sulfur (S)-Total			104.4		%		80-120	14-JUL-18
Tellurium (Te)-Total			96.3		%		80-120	14-JUL-18
Thallium (Tl)-Total			99.1		%		80-120	14-JUL-18
Thorium (Th)-Total			96.8		%		80-120	14-JUL-18
Tin (Sn)-Total			97.9		%		80-120	14-JUL-18
Titanium (Ti)-Total			97.1		%		80-120	14-JUL-18
Tungsten (W)-Total			95.1		%		80-120	14-JUL-18
Uranium (U)-Total			96.0		%		80-120	14-JUL-18
Vanadium (V)-Total			97.6		%		80-120	14-JUL-18
Zinc (Zn)-Total			95.6		%		80-120	14-JUL-18

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-T-CCMS-TB	**Water**							
Batch R4127535								
WG2820399-2 LCS								
Zirconium (Zr)-Total			99.4		%		80-120	14-JUL-18
WG2820399-6 LCS								
Aluminum (Al)-Total			98.8		%		80-120	14-JUL-18
Antimony (Sb)-Total			98.5		%		80-120	14-JUL-18
Arsenic (As)-Total			97.2		%		80-120	14-JUL-18
Barium (Ba)-Total			101.4		%		80-120	14-JUL-18
Beryllium (Be)-Total			97.9		%		80-120	14-JUL-18
Bismuth (Bi)-Total			97.6		%		80-120	14-JUL-18
Boron (B)-Total			95.0		%		80-120	14-JUL-18
Cadmium (Cd)-Total			97.9		%		80-120	14-JUL-18
Calcium (Ca)-Total			97.2		%		80-120	14-JUL-18
Cesium (Cs)-Total			91.0		%		80-120	14-JUL-18
Chromium (Cr)-Total			96.9		%		80-120	14-JUL-18
Cobalt (Co)-Total			96.6		%		80-120	14-JUL-18
Copper (Cu)-Total			96.0		%		80-120	14-JUL-18
Iron (Fe)-Total			99.1		%		80-120	14-JUL-18
Lead (Pb)-Total			95.3		%		80-120	14-JUL-18
Lithium (Li)-Total			95.3		%		80-120	14-JUL-18
Magnesium (Mg)-Total			99.6		%		80-120	14-JUL-18
Manganese (Mn)-Total			96.0		%		80-120	14-JUL-18
Molybdenum (Mo)-Total			100.0		%		80-120	14-JUL-18
Nickel (Ni)-Total			94.3		%		80-120	14-JUL-18
Phosphorus (P)-Total			103.8		%		80-120	14-JUL-18
Potassium (K)-Total			100.6		%		80-120	14-JUL-18
Rubidium (Rb)-Total			98.6		%		80-120	14-JUL-18
Selenium (Se)-Total			97.6		%		80-120	14-JUL-18
Silicon (Si)-Total			96.7		%		80-120	14-JUL-18
Silver (Ag)-Total			98.7		%		80-120	14-JUL-18
Sodium (Na)-Total			101.2		%		80-120	14-JUL-18
Strontium (Sr)-Total			99.0		%		80-120	14-JUL-18
Sulfur (S)-Total			100.0		%		80-120	14-JUL-18
Tellurium (Te)-Total			92.8		%		80-120	14-JUL-18
Thallium (Tl)-Total			96.9		%		80-120	14-JUL-18
Thorium (Th)-Total			96.7		%		80-120	14-JUL-18

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-T-CCMS-TB	**Water**							
Batch R4127535								
WG2820399-6 LCS								
Tin (Sn)-Total			98.8		%		80-120	14-JUL-18
Titanium (Ti)-Total			95.0		%		80-120	14-JUL-18
Tungsten (W)-Total			96.0		%		80-120	14-JUL-18
Uranium (U)-Total			95.4		%		80-120	14-JUL-18
Vanadium (V)-Total			95.8		%		80-120	14-JUL-18
Zinc (Zn)-Total			94.1		%		80-120	14-JUL-18
Zirconium (Zr)-Total			101.2		%		80-120	14-JUL-18
WG2820399-1 MB								
Aluminum (Al)-Total			<0.0030		mg/L		0.003	14-JUL-18
Antimony (Sb)-Total			<0.00010		mg/L		0.0001	14-JUL-18
Arsenic (As)-Total			<0.00010		mg/L		0.0001	14-JUL-18
Barium (Ba)-Total			<0.00010		mg/L		0.0001	14-JUL-18
Beryllium (Be)-Total			<0.00010		mg/L		0.0001	14-JUL-18
Bismuth (Bi)-Total			<0.000050		mg/L		0.00005	14-JUL-18
Boron (B)-Total			<0.010		mg/L		0.01	14-JUL-18
Cadmium (Cd)-Total			<0.0000050		mg/L		0.000005	14-JUL-18
Calcium (Ca)-Total			<0.050		mg/L		0.05	14-JUL-18
Cesium (Cs)-Total			<0.000010		mg/L		0.00001	14-JUL-18
Chromium (Cr)-Total			<0.00010		mg/L		0.0001	14-JUL-18
Cobalt (Co)-Total			<0.00010		mg/L		0.0001	14-JUL-18
Copper (Cu)-Total			<0.00050		mg/L		0.0005	14-JUL-18
Iron (Fe)-Total			<0.010		mg/L		0.01	14-JUL-18
Lead (Pb)-Total			<0.000050		mg/L		0.00005	14-JUL-18
Lithium (Li)-Total			<0.0010		mg/L		0.001	14-JUL-18
Magnesium (Mg)-Total			<0.0050		mg/L		0.005	14-JUL-18
Manganese (Mn)-Total			<0.00010		mg/L		0.0001	14-JUL-18
Molybdenum (Mo)-Total			<0.000050		mg/L		0.00005	14-JUL-18
Nickel (Ni)-Total			<0.00050		mg/L		0.0005	14-JUL-18
Phosphorus (P)-Total			<0.050		mg/L		0.05	14-JUL-18
Potassium (K)-Total			<0.050		mg/L		0.05	14-JUL-18
Rubidium (Rb)-Total			<0.00020		mg/L		0.0002	14-JUL-18
Selenium (Se)-Total			<0.000050		mg/L		0.00005	14-JUL-18
Silicon (Si)-Total			<0.10		mg/L		0.1	14-JUL-18
Silver (Ag)-Total			<0.000010		mg/L		0.00001	14-JUL-18

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-T-CCMS-TB	**Water**							
Batch R4127535								
WG2820399-1 MB								
Sodium (Na)-Total			<0.050		mg/L		0.05	14-JUL-18
Strontium (Sr)-Total			<0.00020		mg/L		0.0002	14-JUL-18
Sulfur (S)-Total			<0.50		mg/L		0.5	14-JUL-18
Tellurium (Te)-Total			<0.00020		mg/L		0.0002	14-JUL-18
Thallium (Tl)-Total			<0.000010		mg/L		0.00001	14-JUL-18
Thorium (Th)-Total			<0.00010		mg/L		0.0001	14-JUL-18
Tin (Sn)-Total			<0.00010		mg/L		0.0001	14-JUL-18
Titanium (Ti)-Total			<0.00030		mg/L		0.0003	14-JUL-18
Tungsten (W)-Total			<0.00010		mg/L		0.0001	14-JUL-18
Uranium (U)-Total			<0.000010		mg/L		0.00001	14-JUL-18
Vanadium (V)-Total			<0.00050		mg/L		0.0005	14-JUL-18
Zinc (Zn)-Total			<0.0030		mg/L		0.003	14-JUL-18
Zirconium (Zr)-Total			<0.000060		mg/L		0.00006	14-JUL-18
WG2820399-5 MB								
Aluminum (Al)-Total			<0.0030		mg/L		0.003	14-JUL-18
Antimony (Sb)-Total			<0.00010		mg/L		0.0001	14-JUL-18
Arsenic (As)-Total			<0.00010		mg/L		0.0001	14-JUL-18
Barium (Ba)-Total			<0.00010		mg/L		0.0001	14-JUL-18
Beryllium (Be)-Total			<0.00010		mg/L		0.0001	14-JUL-18
Bismuth (Bi)-Total			<0.000050		mg/L		0.00005	14-JUL-18
Boron (B)-Total			<0.010		mg/L		0.01	14-JUL-18
Cadmium (Cd)-Total			<0.000005C		mg/L		0.000005	14-JUL-18
Calcium (Ca)-Total			<0.050		mg/L		0.05	14-JUL-18
Cesium (Cs)-Total			<0.000010		mg/L		0.00001	14-JUL-18
Chromium (Cr)-Total			<0.00010		mg/L		0.0001	14-JUL-18
Cobalt (Co)-Total			<0.00010		mg/L		0.0001	14-JUL-18
Copper (Cu)-Total			<0.00050		mg/L		0.0005	14-JUL-18
Iron (Fe)-Total			<0.010		mg/L		0.01	14-JUL-18
Lead (Pb)-Total			<0.000050		mg/L		0.00005	14-JUL-18
Lithium (Li)-Total			<0.0010		mg/L		0.001	14-JUL-18
Magnesium (Mg)-Total			<0.0050		mg/L		0.005	14-JUL-18
Manganese (Mn)-Total			<0.00010		mg/L		0.0001	14-JUL-18
Molybdenum (Mo)-Total			<0.000050		mg/L		0.00005	14-JUL-18
Nickel (Ni)-Total			<0.00050		mg/L		0.0005	14-JUL-18

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-T-CCMS-TB	**Water**							
Batch R4127535								
WG2820399-5 MB								
Phosphorus (P)-Total			<0.050		mg/L		0.05	14-JUL-18
Potassium (K)-Total			<0.050		mg/L		0.05	14-JUL-18
Rubidium (Rb)-Total			<0.00020		mg/L		0.0002	14-JUL-18
Selenium (Se)-Total			<0.000050		mg/L		0.00005	14-JUL-18
Silicon (Si)-Total			<0.10		mg/L		0.1	14-JUL-18
Silver (Ag)-Total			<0.000010		mg/L		0.00001	14-JUL-18
Sodium (Na)-Total			<0.050		mg/L		0.05	14-JUL-18
Strontium (Sr)-Total			<0.00020		mg/L		0.0002	14-JUL-18
Sulfur (S)-Total			<0.50		mg/L		0.5	14-JUL-18
Tellurium (Te)-Total			<0.00020		mg/L		0.0002	14-JUL-18
Thallium (Tl)-Total			<0.000010		mg/L		0.00001	14-JUL-18
Thorium (Th)-Total			<0.00010		mg/L		0.0001	14-JUL-18
Tin (Sn)-Total			<0.00010		mg/L		0.0001	14-JUL-18
Titanium (Ti)-Total			<0.00030		mg/L		0.0003	14-JUL-18
Tungsten (W)-Total			<0.00010		mg/L		0.0001	14-JUL-18
Uranium (U)-Total			<0.000010		mg/L		0.00001	14-JUL-18
Vanadium (V)-Total			<0.00050		mg/L		0.0005	14-JUL-18
Zinc (Zn)-Total			<0.0030		mg/L		0.003	14-JUL-18
Zirconium (Zr)-Total			<0.000060		mg/L		0.00006	14-JUL-18
NH3-COL-TB	**Water**							
Batch R4124188								
WG2820873-10 LCS								
Ammonia, Total (as N)			99.5		%		85-115	12-JUL-18
WG2820873-9 MB								
Ammonia, Total (as N)			<0.020		mg/L		0.02	12-JUL-18
Batch R4130808								
WG2823554-6 LCS								
Ammonia, Total (as N)			98.7		%		85-115	16-JUL-18
WG2823554-5 MB								
Ammonia, Total (as N)			<0.020		mg/L		0.02	16-JUL-18
NO2-IC-N-TB	**Water**							
Batch R4124110								
WG2820900-2 LCS								
Nitrite (as N)			98.8		%		90-110	12-JUL-18
WG2820900-6 LCS								

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
NO2-IC-N-TB	**Water**							
Batch R4124110								
WG2820900-6 LCS								
Nitrite (as N)			103.9		%		90-110	12-JUL-18
WG2820900-1 MB								
Nitrite (as N)			<0.010		mg/L		0.01	12-JUL-18
WG2820900-5 MB								
Nitrite (as N)			<0.010		mg/L		0.01	12-JUL-18
NO3-IC-N-TB	**Water**							
Batch R4124110								
WG2820900-2 LCS								
Nitrate (as N)			100.4		%		90-110	12-JUL-18
WG2820900-6 LCS								
Nitrate (as N)			98.6		%		90-110	12-JUL-18
WG2820900-1 MB								
Nitrate (as N)			<0.020		mg/L		0.02	12-JUL-18
WG2820900-5 MB								
Nitrate (as N)			<0.020		mg/L		0.02	12-JUL-18
P-T-COL-TB	**Water**							
Batch R4124313								
WG2820448-10 LCS								
Phosphorus (P)-Total			97.2		%		80-120	13-JUL-18
WG2820448-6 LCS								
Phosphorus (P)-Total			95.7		%		80-120	13-JUL-18
WG2820448-5 MB								
Phosphorus (P)-Total			<0.0030		mg/L		0.003	13-JUL-18
WG2820448-9 MB								
Phosphorus (P)-Total			<0.0030		mg/L		0.003	13-JUL-18
WG2820448-7 MS		**L2127687-8**						
Phosphorus (P)-Total			99.9		%		70-130	13-JUL-18
PH-TITR-TB	**Water**							
Batch R4124253								
WG2820527-2 LCS								
pH			6.01		pH		5.9-6.1	12-JUL-18
WG2820527-5 LCS								
pH			5.98		pH		5.9-6.1	12-JUL-18
SO4-IC-N-TB	**Water**							

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
SO4-IC-N-TB	**Water**							
Batch R4124110								
WG2820900-2 LCS								
Sulfate (SO4)			101.4		%		90-110	12-JUL-18
WG2820900-6 LCS								
Sulfate (SO4)			99.5		%		90-110	12-JUL-18
WG2820900-1 MB								
Sulfate (SO4)			<0.30		mg/L		0.3	12-JUL-18
WG2820900-5 MB								
Sulfate (SO4)			<0.30		mg/L		0.3	12-JUL-18
TC,EC-QT97-TB	**Water**							
Batch R4123429								
WG2819921-1 MB								
Total Coliforms			0		MPN/100mL		1	11-JUL-18
Escherichia Coli			0		MPN/100mL		1	11-JUL-18
TDS-TB	**Water**							
Batch R4124737								
WG2820666-3 DUP		**L2127687-6**						
Total Dissolved Solids		139	140		mg/L	0.2	20	12-JUL-18
WG2820666-2 LCS								
Total Dissolved Solids			95.6		%		85-115	12-JUL-18
WG2820666-1 MB								
Total Dissolved Solids			<10		mg/L		10	12-JUL-18
Batch R4125052								
WG2822166-2 LCS								
Total Dissolved Solids			96.4		%		85-115	13-JUL-18
WG2822166-1 MB								
Total Dissolved Solids			<10		mg/L		10	13-JUL-18
TKN-COL-TB	**Water**							
Batch R4126709								
WG2820887-2 LCS								
Total Kjeldahl Nitrogen			100.7		%		75-125	16-JUL-18
WG2820887-6 LCS								
Total Kjeldahl Nitrogen			106.1		%		75-125	16-JUL-18
WG2820887-1 MB								
Total Kjeldahl Nitrogen			<0.15		mg/L		0.15	16-JUL-18
WG2820887-5 MB								
Total Kjeldahl Nitrogen			<0.15		mg/L		0.15	16-JUL-18
WG2820887-4 MS		**L2127687-1**						
Total Kjeldahl Nitrogen			104.8		%		70-130	16-JUL-18

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
TURBIDITY-TB	**Water**							
Batch R4122881								
WG2819958-3 DUP		**L2127687-6**						
Turbidity		13.8	14.1		NTU	2.2	15	11-JUL-18
WG2819958-2 LCS								
Turbidity			102.0		%		85-115	11-JUL-18
WG2819958-1 MB								
Turbidity			<0.10		NTU		0.1	11-JUL-18
Batch R4123258								
WG2820487-3 DUP		**L2127687-3**						
Turbidity		5.89	6.09		NTU	3.3	15	12-JUL-18
WG2820487-2 LCS								
Turbidity			101.0		%		85-115	12-JUL-18
WG2820487-1 MB								
Turbidity			<0.10		NTU		0.1	12-JUL-18

Legend:

Limit	ALS Control Limit (Data Quality Objectives)
DUP	Duplicate
RPD	Relative Percent Difference
N/A	Not Available
LCS	Laboratory Control Sample
SRM	Standard Reference Material
MS	Matrix Spike
MSD	Matrix Spike Duplicate
ADE	Average Desorption Efficiency
MB	Method Blank
IRM	Internal Reference Material
CRM	Certified Reference Material
CCV	Continuing Calibration Verification
CVS	Calibration Verification Standard
LCSD	Laboratory Control Sample Duplicate

Hold Time Exceedances:

All test results reported with this submission were conducted within ALS recommended hold times.

ALS recommended hold times may vary by province. They are assigned to meet known provincial and/or federal government requirements. In the absence of regulatory hold times, ALS establishes recommendations based on guidelines published by the US EPA, APHA Standard Methods, or Environment Canada (where available). For more information, please contact ALS.

The ALS Quality Control Report is provided to ALS clients upon request. ALS includes comprehensive QC checks with every analysis to ensure our high standards of quality are met. Each QC result has a known or expected target value, which is compared against pre-determined data quality objectives to provide confidence in the accuracy of associated test results.

Please note that this report may contain QC results from anonymous Sample Duplicates and Matrix Spikes that do not originate from this Work Order.

Chain of Custody (COC) / Analytical Request Form

ALS Environmental

Canada Toll Free: 1 800 668 9878

www.alsglobal.com

L2127687-COFC

COC Number: 14 -

Page 1 of 1

Report To		Report Format / Distribution		Select Service Level Below (Rush Turnaround Time (TAT) is not available for all tests)
Company:	Lakehead Region Conservation Authority	Select Report Format:	☒ PDF ☒ EXCEL ☐ EDD (DIGITAL)	R ☒ Regular (Standard TAT if received by 3 pm - business days)
Contact:	Scott Drebit	Quality Control (QC) Report with Report	☐ Yes ☒ No	P ☐ Priority (2-4 bus. days if received by 3pm) 50% surcharge - contact ALS to confirm TAT
Address:	130 Conservation Road	☐ Criteria on Report - provide details below if box checked		E ☐ Emergency (1-2 bus. days if received by 3pm) 100% surcharge - contact ALS to confirm TAT
		Select Distribution:	☑ EMAIL ☐ MAIL ☐ FAX	E2 ☐ Same day or weekend emergency - contact ALS to confirm TAT and surcharge
Phone:	807-344-5857	Email 1 or Fax	~~tammy@lakeheadca.com~~	Specify Date Required for E2,E or P:
		Email 2	scott@lakeheadca.com	

Invoice To		Invoice Distribution	
	Same as Report To ☑ Yes ☐ No	Select Invoice Distribution:	☑ EMAIL ☐ MAIL ☐ FAX
	Copy of Invoice with Report ☑ Yes ☐ No	Email 1 or Fax	
Company:		Email 2	
Contact:			

Project Information		Oil and Gas Required Fields (client use)	
ALS Quote #:	Q62558	Approver ID:	Cost Center:
Job #:	Jarvis River	GL Account:	Routing Code:
PO / AFE:		Activity Code:	
LSD:		Location:	
ALS Lab Work Order # (lab use only)	L2127687	ALS Contact:	Sampler:

Analysis Request — Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	Alkalinity, Conductivity, pH	Chloride, Nitrate, Nitrite, Sulphate	TDS, Turbidity	NH_3, TKN, TP	Metals, Total + Hardness	TC/EC	Number of Containers
	JR1 - Jarvis River - Site #1	10-07-18	13:10	Grab	X	X	X	X	X	X	5
	JR2 - Jarvis River - Site #2	10-07-18	11:15	Grab	X	X	X	X	X	X	5
	JR3 - Jarvis River - Site #3	11-07-18	10:55	Grab	X	X	X	X	X	X	5
	JR4 - Jarvis River - Site #4	11-07-18	11:35	Grab	X	X	X	X	X	X	5
	JR5 - Jarvis River - Site #5	11-07-18	12:40	Grab	X	X	X	X	X	X	5
	JR6 - Jarvis River - Site #6	10-07-18	15:00	Grab	X	X	X	X	X	X	5
	JR7 - Jarvis River - Site #7	10-07-18	14:15	Grab	X	X	X	X	X	X	5
	JR8 - Jarvis River - Site #8	10-07-18	10:00	Grab	X	X	X	X	X	X	5

Drinking Water (DW) Samples[1] (client use)	Special Instructions / Specify Criteria to add on report (client Use)
Are samples taken from a Regulated DW System? ☐ Yes ☒ No	
Are samples for human drinking water use? ☐ Yes ☒ No	

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen	☐	SIF Observations	Yes ☐	No	☐
Ice packs	Yes ☑	No ☐	Custody seal intact	Yes ☐	No ☐
Cooling Initiated	☑				

INITIAL COOLER TEMPERATURES °C			FINAL COOLER TEMPERATURES °C		
9.5					

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by: Rachael May	Date: 11-07-18	Time: 16:15	Received By: SD	Date: July.11/18	Time: 2:27	Received by:	Date:	Time:

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

ALS-FM-0326e v09 Front/04 January 2014

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

1. If any water samples are taken from a Regulated Drinking Water (DW) System, please submit using an Authorized DW COC form.

LS