CLOUD RIVER WATERSHED
Assessment Report

Lakehead Region Conservation Authority
Conserve Today...For A Better Tomorrow

2014

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Written and Published by:

Lakehead Region Conservation Authority
Conserve Today...For A Better Tomorrow

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The 2014 Cloud River Watershed Assessment was completed by Amanda Suttie, Assistant Water Resource Technologist. Scott Drebit, GIS Technician/Planner of the Lakehead Region Conservation Authority produced the maps for this report and provided input and revisions towards the final copy. Tammy Cook, Watershed Manager, provided guidance, input and revisions towards the completion of this report.

This report has been prepared in-house at the Lakehead Region Conservation Authority for internal purposes to document the condition of the Cloud River watershed in 2014.

Executive Summary

The Cloud River watershed is located within the Municipality of Neebing (Geographic Townships of Crooks, Blake, Pearson and Pardee). The watershed covers a drainage area of approximately 79.5 square kilometres. The Cloud River is approximately 21.7 kilometres in length and is a meandering river which travels from Cloud Lake into Lake Superior. The gradient is steep in the upper reaches (within the first 1.6 kilometres) then the river valley gradually widens until a flatter lowland area is reached. The general slope of the watershed is 0.74 percent. A major factor affecting the ultimate flood flow on the river is the storage provided by Cloud Lake. During a storm the lake stores runoff from the upper 20 square kilometres of the basin and dissipates the storage over a length of time.

The majority of the Cloud River watershed is privately owned land (90.97 percent) and the remainder is provincially owned crown land (9.03 percent). A very small portion of the Cloud Bay Provincially Significant wetland is located in the Cloud River watershed near the confluence with Lake Superior.

The surficial geology of the Cloud River watershed is mainly glaciolacustrine plains from the Rove Formation. Other landform features not associated with glacial activity that are present in the watershed include: bedrock, organic accumulation, esker/kame/outwash plains and moraines. The Cloud River watershed is composed of seven different soil types. The most abundant soil type is clay loam which covers 21.48 square kilometres of the watershed. Moderately coarse sandy loam, organic and peaty phase soils cover 3.90 square kilometres of the watershed. The remaining soil is made up of rock, silt loam and silty clay loam which cover 50.06 square kilometres.

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

For this report, eight sample sites located within the Cloud River watershed were chosen based on a variety of attributes including: accessibility, physical features, land use designation, and proximity to man-made features that may alter water quality, as well as headwaters used as a base reference. Site 1 was located near the confluence of the Cloud River and Lake Superior. Site 2, 3, 6 and 7 were located at various tributaries to the main channel. Sites 4 and 5 were located in the main river channel and Site 8 was located on Cloud Lake.

At each of the eight sample locations, surface water samples and field measurements were collected on June 10 - 12 and July 9 and 10, 2014. Surface water samples were analyzed by ALS Laboratory Group for conductivity, total dissolved solids, turbidity, total ammonia, nitrate, nitrite, total phosphorus, *Escherichia coli (E. coli,)* total coliforms and a full metal scan. Field measurements included water temperature, pH, conductivity

and dissolved oxygen. Field and laboratory results were compared to the Ministry of Environment's *Provincial Water Quality Objectives* (PWQO), 1994 and the *Canadian Water Quality Guidelines for the Protection of Aquatic Life: Summary Table*, produced by the Canadian Council of Resources and Environmental Ministers (CCREM), updated 2012.

The PWQO acceptable pH range is 6.5-8.5. The observed range within the Cloud River watershed was 6.96 to 7.81.

Phosphorus exceeded the PWQO criterion (0.03 mg/L) at every site with the exception of Site 8. Phosphorus ranged from 0.0101 mg/L at Site 8 on July 9, 2014 to 0.0679 mg/L at Site 6 on July 10, 2014. The high levels of phosphorous are likely due to high clay content in the water column.

PWQO criterion for *E. coli* bacteria is that levels be below 100 counts per 100 mL of water for safe swimming and bathing. During the June sampling, all sample sites were below the PWQO criterion. During the July sampling period, Site 2 (150 counts/100 mL) and Site 8 (160 counts/100 mL) exceeded the criterion.

As there is no current PWQO for total coliform, results were compared to the pre-1994 PWQO criterion (1,000 MPN/100 mL). Every site in 2014 for both sampling periods exceeded the criterion with the exception of Site 8. The total coliform concentrations in 2014 ranged from 108 MPN/100mL to 7,270 MPN/100 mL for the watershed.

All sites were above the PWQO criterion of 0.075 mg/L for aluminum during both sampling months except for Site 8. Aluminum concentrations ranged from 0.048 mg/L (Site 8) to 2.44 mg/L (Site 4). These values are typically associated with fine sediments.

All sites were above the PWQO criterion of 0.30 mg/L for iron during both the sampling months of June and July, 2014 except for Site 8. Iron concentrations ranged from 0.076 mg/L to 2.68 mg/L for the entire sampling year of 2014.

Copper exceeded the criterion (0.005 mg/L) during the June sampling at Sites 1-6 and during the July sampling a Sites 1-4, 6 and 7. Copper concentrations ranged from 0.0022 mg/L to 0.0081 mg/L.

Cobalt exceeded the PWQO (0.0009 mg/L) in July at Sites 1, 3 and 4. Cobalt concentration ranged from <0.005 to 0.00112 mg/L.

The flora and fauna inventory indicated that the Cloud River watershed supports a healthy population of diverse plants and animals. The stream banks were stable and showed little signs of erosion. Both bridges were in good and stable condition and the culverts were also in good condition. Culvert 6 was in the process of being replaced during the July sampling period, with a permit issued by the Lakehead Region Conservation Authority.

At the time of sampling in 2014 the Cloud River Watershed was considered to be in good health.

The Cloud River watershed was also assessed using the *Guide to Developing Conservation Authority Watershed Report Cards*, 2011. Using this guideline, surface water quality and forest conditions for the Cloud River watershed were used to determine a grade for the watershed. Surface water quality maintained a good rating with exceedances of phosphorus and *E. coli* present within the Cloud River watershed. Forest condition scored an excellent rating with very high forest coverage and a high percentage of riparian forest cover. Overall the quality of the Cloud River watershed in 2014 was determined to be in good health and graded a B based on the surface water quality and an A based on the forest condition.

Upon completion of the 2014 Cloud River Watershed Assessment, the following recommendations have been made for consideration:

- Staff and funding permitting it is recommended that an update to the 2014 Cloud River Watershed Assessment be completed in the next five to ten years.
- Benthic analysis indicates water quality over an extended period of time and should be considered for future watershed assessments.
- 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 Cloud River watershed is located within the Municipality of Neebing (Geographic Townships of Crooks, Pearson, Blake and Pardee) as shown on Map M-1: Key Plan Map. Areas regulated by the Lakehead Region Conservation Authority and Township boundaries can be found on Map M-2: Regulated Areas.

A watershed can be defined as all the land and water within the confines of a drainage divide. The watershed includes Cloud Lake, Cloud River and many other streams and creeks which flow into the main channel and then to Cloud Bay in Lake Superior. In essence, the Cloud River watershed consists of all the surrounding land that naturally drains its lakes, streams, wetlands and precipitation runoff into the Cloud River which then flows into Lake Superior. The headwaters of the main branch initiate near the northwest boundaries of the geographic Township of Crooks and the eastern boundaries of the geographic Townships of Pardee and Pearson, in the Municipality of Neebing. The watershed covers a drainage area of approximately 79.5 square kilometres. The prevailing soil type throughout the watershed is clay loam over bedrock. Most of the watershed is dominated by black spruce, jack pine, white birch and trembling aspen. The Cloud River is primarily bedrock-controlled and runs 21.6 kilometres in length and meanders through swampy lowlands. In numerous areas the river widens and appears similar to long narrow lakes.

The goal of this report is to document the conditions of the watershed, especially surface water quality, as observed in June and July of 2014. 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 streambank cover observed within the watershed
- Document active erosion sites
- Document the physical condition of all Cloud River water crossings (bridges/culverts)
- Interpret results to record the health status of the watershed

2 Background

2.1 Physical Attributes

2.1.1 Topography

The Cloud River originates in Cloud Lake. The water from the lake drains into the Cloud River and meanders its way in an easterly direction into Lake Superior. The highest point in the watershed is approximately 470 metres above sea level bordering the mid-western boundary of the watershed (5328433 N, 318031 E). The lowest point in elevation can be found near the confluence at 184 metres above sea level (5338557 N, 313502 E). The general slope of the watershed is 0.74 percent. This area is characterized by predominately flat to gently rolling topography with minor occurrences of diabase dikes and sills (LRCA, 2008). Map M-3 illustrates the Cloud River watershed topography.

2.1.2 Geology and Soils

Bedrock

The bedrock geology in the Cloud River watershed is a product of two geological eras. The first is the Precambrian era which took place between 600,000 and over 3.5 billion years ago. The second is the Pleistocene period which ended approximately 10,000 years ago. The area is underlain by ancient Precambrian rocks of the Canadian Shield. The Gunflint and Rove formation of the Animikie series are one of the rock formations that compose the Canadian Shield, including the Cloud River watershed. The Gunflint formations are made up of taconite, algalchert, chert-carbonate, sandstone, shale, minor limestone and small amounts of volcanic rock. Rove formations are made up of greywackes and black shale. The Keweenawan intrusion of igneous material into the Gunflint formation rock masses was the most recent episode in the Proterozoic era and occurred approximately 100 - 110 million years ago. The intrusion formed vertical diabase dikes and horizontal diabase sills which are responsible for the relief of the immediate and surrounding area. The dikes stick up as massive ridges trending north-easterly and the sills are formed as resistant caprocks that form the large mesa landforms known as the Nor'Wester Mountains.

The watershed is comprised of sedimentary rocks from the Paleoproterozoic era (2,500 – 1,600 million years ago) and mafic intrusive rocks from the Mesoproterozoic era (1,600 – 1,000 million years ago). More specifically, 66.7 percent of the rock type is from the Paleoproterozoic era, which is composed of the Animikie Group rocks and includes wacke, shale, iron formation, limestone and minor volcanic rocks. The remaining 33.3 percent of the rocks are from the Mesoproterozoic era and these include the Logan and Nipigon sills and diabase sills. Map M-4: Bedrock Geology illustrates the rock types present in the watershed.

Surficial Geology and Soils

Throughout northwestern Ontario there is a close relationship between landform features and sediment types. During the advance of the Laurentide Ice Sheet subglacial till was deposited in the form of drumlins, drumlinoid ridges, crag and tail features and undifferentiated ground moraine which resulted in a structured topographic grain to landscape. Roughly 20,000 years ago when the ice sheet began to recede, entrained materials in the ice melted out as ablation till. Meltwaters left behind sands and gravels within esker outwash systems and moraines. These esker outwash systems cover about 4.3 percent of the watershed and moraines about 28.1 percent. In addition to these glacial features, 2.2 percent of the watershed is slope/talus piles. The majority of the surficial geology, at 47.3 percent, is composed of glaciolacustrine plains. Other landform features not associated with glacial activity that are present in the watershed include bedrock and organic accumulations. A visual representation of the surficial geology of the watershed is shown on Map M-5: Surficial Geology. Due to the large occurrence of bedrock many of the surficial deposits are relatively thin throughout the area and are usually less than 14 metres thick.

The Cloud River watershed is composed of seven different soil types. The most abundant soil type is clay loam which covers 21.48 square kilometres of the watershed. Moderately coarse sandy loam, organic and peaty phase soils cover 3.90 square kilometres of the watershed. The remaining soil is made up of rock, silt loam, and silty clay loam which cover 50.06 square kilometres. The distribution of soil types throughout the watershed is illustrated on Map M-6: Soils.

2.1.3 Climate

The climate of the Cloud River watershed is similar to the Thunder Bay region, in that is a modified continental climate influenced by Lake Superior. From the months of July to March the westerly winds prevail whereas the easterly winds prevail the rest of the year (LRCA, 1985). These winds modify the climate of Thunder Bay and the surrounding regions. The mean daily temperatures in degrees Celsius and precipitation levels in millimetres for Thunder Bay were recorded at the Thunder Bay Airport from 1971 to 2000 (Environment Canada, 2011) as shown in Table 2.1-1. This table also summarizes the extreme daily precipitation in millimetres recorded within a 24-hour period the year and number of days in which 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 (degrees Celsius)	-14.8	-12	-5.5	2.9	9.5	14	17.6	16.6	11	5	-3	-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 Maximum Daily Precipitation (millimetres)	51.6	33.5	41.9	69.3	76.2	49.3	53.8	87.1	131.2	47.8	63	42.7
Date (year / # of days)	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) for Thunder Bay were recorded at the Thunder Bay Airport for 2014 (Environment Canada, 2014), as shown below.

Table 2.1-2: Average Monthly Temperature and Precipitation for Thunder Bay, January-July 2014

	Jan	Feb	Mar	Apr	May	June	July
Average Temperature							
Daily (degrees Celsius)	-18.8*	-17.1	-10.7	0.4	9.3	13.7	16.8
Precipitation							
Total Precipitation (millimetres)	23.1	25.5	25.4	81.7	59.6	106.7	98.7

*The value displayed is based on incomplete data

The average monthly temperature for the June and July sampling periods was 15.3 degrees Celsius and the average monthly precipitation was 102.7 millimetres. In comparison with the historical data, the 2014 temperature was within 0.5 degree Celsius of the average for June and July. The 2014 precipitation for June was 21.0 millimetres greater than recorded historical average precipitation. The precipitation for July 2014 was 9.7 millimetres greater than recorded historical average precipitation. In general temperatures in June and July were very near normal while received precipitation was above average.

2.1.4 Hydrology

The Cloud River is 21.7 kilometres long from the headwaters at Cloud Lake to the confluence with Lake Superior. The drainage area for the Cloud River watershed is 79.5 square kilometres. The general slope of the watershed is 0.74 percent. The Cloud River is fed by several unnamed creeks and water bodies which cover an area of 4.3 square

kilometres. Wetlands are present in the watershed near the confluence and they cover an area of 0.429 square kilometres squared, 0.159 square kilometres of that area is the Cloud Bay Provincially Significant Wetland (PSW).

2.2 Biological Attributes

2.2.1 Flora

The Cloud River watershed is located within the boundaries of the Great Lakes forest region and the boreal forest region as shown on the Forest Regions of Canada map (Refer to Figure 1). 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. The trees present are predominantly black spruce, jack pine, white birch and trembling aspen as opposed to the white pine, red pine and yellow birch of the Great Lakes forest region. 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 Forest Regions of Canada distribution map is only a basic division of the forest types, there is no discrete line which separates the two zones. Factors such as the ones mentioned above could easily alter forest types which are located between two zones.

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

2.2.2 Fauna

The Cloud River watershed provides breeding grounds for a variety of wildlife. Some of the more common species that live in the watershed include otters, beavers, deer and peregrine falcons. A complete list of the wildlife observed in this area is given in Appendix D: Common and Scientific Names of Identified Flora and Fauna. The Cloud Bay watershed is part of the Ontario Ministry of Natural Resources (OMNR) Wildlife Management Unit 13 and Fisheries Management Zone 6.

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 11 species at risk in the Thunder Bay area that have potential to exist within the Cloud River watershed. The surrounding area is considered in addition to the watershed boundary limits, as it is also boreal forest region which would allow for movement of individuals in and out of the watershed boundary.

Table 2.2-2: Species at Risk in the Cloud River Watershed		
Species Name		Status of Risk
Common Name	Scientific Name	
Bald eagle	*Haliaeetus leucocephalus*	Special concern
Eastern whip-poor-will	*Caprimulgus vociferus*	Threatened
Golden eagle	*Aquila chrysaetos*	Endangered
Little brown bat	*Myotis lucifugus*	Endangered
Northern brook lamprey	*Ichthyomyzon fossor*	Special concern
Peregrine falcon	*Falco peregrinus*	Special concern
Shortjaw cisco	*Coregonus zenithicus*	Threatened
Snapping turtle	*Chelydra serpentina*	Special concern

Source: Ontario Ministry of Natural Resources, Species at Risk – Thunder Bay Region, 2013

2.2.4 Invasive Species

Invasive species are a threat to native plants and animals and can disturb the entire ecosystem in which they are a part of. Invasive species that may be present in the Cloud River watershed according to the OMNR and Ontario Federation of Anglers and Hunters' Invasive Tracking System include, but are not limited to: purple loosestrife, Japanese knotweed, spiny water flea, rusty crayfish and rainbow smelt. There are many other invasive aquatic species that may be present in or near the confluence of the Cloud River with Lake Superior. Below is a table showing the species at risk, with documented sightings in the Cloud River watershed and immediate surrounding area.

2.3 Socio-Economic Attributes

2.3.1 Planning and Development Controls

Land Tenure

The majority of the Cloud River watershed is privately owned land (90.97%). Provincially owned crown land constitutes 9.03%. Land ownership in the watershed is illustrated on Map 7: Land Ownership.

Areas of Jurisdiction

The hydrological boundaries of the Cloud River watershed fall within the Municipality of Neebing which includes the Geographic Townships of Crooks, Pearson, Blake and Pardee. Map 8: Site Plan, illustrates the location of the Cloud River watershed within the Geographic Townships of Crooks, Pearson, Blake and Pardee boundaries.

The entire Cloud River watershed is within the Lakehead Region Conservation Authority (LRCA) area of jurisdiction. Within the regulated area 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 or Use Limitation, steep slopes and 15 metres landward and one kilometre lakeward from the 100 year flood level on Lake Superior (i.e. 184.0 metres Geodetic Survey of Canada). Activities within the approximate regulated area may require a permit from the Authority.

Land Use Designation/Zoning

Municipal Official Plans contain long term goals and policies that serve as guidelines for future land use and development. The Cloud River watershed is affected by the Municipality of Neebing (Geographic Townships of Crooks, Pearson, Blake and Pardee) Official Plan and Zoning by-law. Land use designations within the Cloud River watershed can be found on Map 9: 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 which must be satisfied such as buffering, suitable distances between uses and parking requirements.

Within the Municipality of Neebing, the Cloud River watershed has been zoned as:

- Rural
- Recreational 1 Zone
- Use Limitation Zone
- Light Industrial Zone
- Extractive Industrial Zone
- Disposable Industrial Zone
- General Commercial Zone
- Institutional Zone

The following definitions are taken from the Municipality of Neebing zoning by-law No. 860 – 2010, dated August 2010.

Rural Zone

No person shall within any Rural Zone use any lot or erect, alter or use any building or structure for any purpose except in accordance with the following; (a) a single dwelling (b) a modular dwelling (c) agricultural use (d) forestry use (e) stables, riding academics (f) Watershed management and conservation uses (g) a home occupation (h) a home industry (i) a guest cottage (j) a bed and breakfast (k) mineral exploration (l) wind farms (m) buildings, structures and uses accessory to the above.

Recreational 1 Zone

On existing lots of record as of the date of passing of this By-law, no person shall within any Recreation 1 Zone use any lot or erect, alter or use any building or structure for any purpose except in accordance with the following; (a) a recreational dwelling (b) a

recreational modular home (c) a guest cottage (d) a bed and breakfast (e) a boat house (f) buildings, structures and uses accessory to the above uses.

Use Limitation Zone

No person shall within the Use Limitation Zone use any lot or erect, alter or use any building or structure for human habitation. Building or structures may be used for the following; (a) agricultural use (b) conservation use (c) forestry use (d) watershed management (e) watershed protection (f) public parks (g) outdoor passive recreational uses (h) mineral exploration (i) wind farms (j) dwellings existing on the date of passing of this By-law, and uses, buildings and structures accessory thereto.

Light Industrial Zone

No person shall within any Light Industrial Zone use any lot or erect, alter or use any building or structure for any purpose except in accordance with the following; (a) an automotive use (b) an equipment sales and service dealership (c) a manufacturing operation (d) a trade shop (e) a warehouse (f) a business office or commercial outlet associated with one of the above permitted uses (g) an accessory dwelling to the uses listed above (h) buildings, structures and uses accessory to the above.

Extractive Industrial Zone

No person shall within any Extractive Industrial Zone use any lot or erect, alter or use any building or structure for any purpose except in accordance with the following; (a) pits and quarries for extracting sand, clay, gravel, earth, stone, shale, peat, amethyst and minerals (b) stockpiling of sand, clay, gravel, earth, stone, shale, peat, amethyst and any minerals (c) a temporary asphalt plant (d) a temporary crushing plant (e) buildings, structures and uses accessory to the above uses.

Disposable Industrial Zone

No person shall, within any Disposable Industrial Zone, use any lot or erect, alter or use any building or structure for any purpose except in accordance with the following; (a) a waste disposal site (b) building, structures and uses accessory to the above uses.

General Commercial Zone

No person shall within any General Commercial Zone use lot or erect, alter or use any building or structure for any purpose except in accordance with the following; (a) an automobile service station (b) a commercial garage (c) a community centre, club or fraternal organization (d) an entertainment facility (e) a gasoline retail outlet (f) a hotel, motel, cabins (g) a personal service shop (h) a restaurant (i) a retail lumber yard (j) a wind farm (k) a retail outlet (l) a merchandise repair shop (m) a vehicle repair shop (n) a

vehicle sales or rental establishment (o) an accessory dwelling to the uses listed above (p) building, structures and uses accessory to the above uses.

Institution Zone

No person shall within any Institutional Zone use nay lot or erect, alter or use any building or structure for any purpose except in accordance with the following; (a) a public or private school (b) a cemetery (c) a Federal, Provincial, or Municipal building, garage or office (d) a fire station (e) a church (f) a community hall (g) assembly hall club or fraternal organization (h) building, structures and uses accessory to the above.

2.3.1 Existing Land Uses

Sand Hill Landfill Site

The Sand Hill Landfill site is located 0.5 kilometres on Sand Hill Road west of Highway 61. This landfill is one of two landfills located in the Municipality of Neebing and the only one located in the Geographic Township of Crooks. There are designated areas at the landfill for household garbage, recycling, metal, local building material, brush and raw lumber, burn piles, used tires, electronic waste, compost materials and ashes. Any recyclable materials brought to the landfill are shipped off site for processing. Sand Hill Landfill Site is zoned as B4, Municipal and Domestic Wastes – Rural, and is still active.

2.3.2 Provincially Significant Wetlands

The Cloud River watershed contains a portion of one Provincially Significant Wetland, which is known as the Cloud Bay Wetland. The Cloud Bay Wetland is located in the southern portion of the Cloud River watershed (as shown on Map M-8: Site Plan) at the confluence with Lake Superior. The Cloud Bay Wetland has a total area of 3.02 square kilometres, however only 5.26 percent (0.16 square kilometres) of the wetland is located in the Cloud River watershed. It is classified as a coastal wetland and is comprised of 95 percent marsh and 5 percent swamp. Soil composition has been surveyed by the Ministry of Natural Resources as 70 percent clays, loams or silts and 30 percent organic. Vegetation can be classified as floating and emergent dominant species that occur in patches, some of which are quite large. The vegetation communities consist of rushes, sedges, grasses, horsetails, arrowhead, bulrushes and cattails. Floating plants include the bullhead lily, pickerel weed and watermilfoil.

3 Methods and Materials

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

3.1 Site Selection

Eight sites were chosen along the Cloud River to assess the overall health of the watershed. Each site was chosen based on its accessibility and its proximity to natural or man-made features that may alter water quality.

Site 8 was located on Cloud Lake Road at Cloud Lake in order to obtain water samples of the head waters of the watershed. Site 7 was located on Jarvis Bay Road East in order to obtain water samples of downstream from the Sand Hill Landfill Site. Site 6 was located on Cloud Bay Road South. From this site water samples would reflect the water draining into the Could River from the northeastern part of the watershed. Site 5 was located on Cloud River Road East and represented water entering the Cloud River from the northwestern part of the watershed. Site 4 was also located on Cloud River Road East. This site was chosen to represent several streams entering the Cloud River from the northeastern part of the watershed. Site 3 was located on Cloud River Road South. This site was chosen to represent the water that the Cloud River receives from the southeastern part of the watershed. Site 2 was located on Little Trout Bay Road and this site encompassed drainage water from a small unnamed stream which represented the southwest part of the watershed. Site 1 was also located on Little Trout Bay Road and was meant to be a representation of the entire watershed upstream of the confluence. The UTM coordinates and elevation of each site were marked using the Trimble Geo XH GPS unit as shown on Map M-8: Site Plan.

3.2 Quantitative Assessment

Several parameters were measured to assess surface water quality of the Cloud River. Surface water samples were collected in laboratory supplied new 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-total nitrogen, nitrate, nitrite and phosphorus), bacteria (*E. coli* and total coliforms) and total metals. Sampling for the first data set was conducted on June 10, 11 and 12, 2014. The second set was collected on July 9 and 10, 2014.

Methodology for water sample collection was based on the Provincial Water Quality Monitoring Network (PWQMN), Ministry of the Environment, 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 four collection bottles for each site to conduct the following tests: routine, nutrient, metal and bacterial analysis. The routine analysis sample bottles and lids were rinsed twice before a true sample was collected. The ALS Laboratory Group pre-charged the nutrient 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 bacterial 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 and dissolved oxygen were measured using an YSI 6000 QS multi-parameter water quality sampler at the same time as 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, stop watch 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 are attached in Appendix A: Water Quality Parameters.

3.3 Applicable Criteria

Surface water quality results from the Cloud River watershed were compared to applicable criteria published in the *Provincial Water Quality Objectives* (PWQO) by the Ontario Ministry of Environment and Energy (MOEE), July 1994. The goal of the PWQO is to "ensure that the surface waters of the province are of the quality which is satisfactory for aquatic life and recreation". Applicable criteria published in the *Canadian Water Quality Guidelines for the Protection of Aquatic Life: Summary Table* by the Canadian Council of Resource and Environment Ministers (CCREM), September 2012 were also used for comparison to surface water quality results for the Cloud River watershed. The information in these guidelines and supporting text is used to complement the PWQO and Interim Objectives.

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

3.4 Qualitative Assessment

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. Several 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 E: Forest Ecosystem Classification. Common and Latin names of plant species are attached in Appendix D: 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 Cloud River water crossings (bridges and 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 and bridge locations can be found on Map M-10: Bridges and Culverts Sites. The bridge and culvert assessments are attached in Appendix F: Bridge Assessments and 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 and forest conditions were identified for the Cloud River watershed. The three indicators used to assess surface water quality for the watershed are total phosphorus, *Escherichia coli (E. coli*), and benthic macroinvertebrates (data not available). The average point score of the surface water indicators is used to determine the overall surface water quality grade. No wetland or 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 are currently being developed.

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	**% Forest Interior**	**% Riparian Zone Forested**	**Point Score**	**Grade**	**Final Points**	**Final Grade**
>35.0	>11.5	>57.5	5	A	>4.4	A
25.1 - 35.0	8.6 - 11.5	42.6- 57.5	4	B	3.5 - 4.4	B
15.1 - 25.0	5.6 - 8.5	27.6 - 42.5	3	C	2.5 - 3.4	C
5.0 – 15.0	2.5 - 5.5	12.5 - 27.5	2	D	1.5 - 2.4	D
<5.0	<2.5	<12.5	1	F	<1.5	F

3.6 Materials

Materials used during the assessment included:

- Chest waders
- Cooler and ice packs
- Clipboard and observation chart paper
- Dip net
- Digital camera
- Field guides
- Fluorescent orange vests
- Latex gloves
- Measuring tape reel
- Measuring tape reel with lead weights (for measuring depth)
- Mercury thermometer
- Metre stick
- Pens and pencils
- Reaching pole
- Road map

- Sampling bottles and preservative provided by ALS Laboratory Group
- Scissors
- Shovel
- Stick (to measure velocity)
- Stopwatch
- Trimble Geo XH GPS
- Tweezers
- YSI 556 MPS metre
- Ziploc bags

Field Guides:

- Field Guide to the Forest Ecosystem Classification for Northwestern Ontario (Sims *et al.,* 1997)
- Field Guide to Trees and Shrubs 2nd Edition (Petrides, 1958)
- Native Trees of Canada 8th Edition (Hosie, 1990)
- ROM Field Guide to Wildflowers of Ontario (Dickinson *et al.*, 2004)
- Wetland Plants of Ontario (Newmaster *et al.*, 1997)
- Atlas of the Breeding Birds of Ontario (Cadman *et al.*, 2007)

4 Results

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

The results for the Cloud River watershed are summarized in the tables below for each site.

4.1 Site 1

Site 1 was privately owned property near the confluence of Cloud River and Lake Superior and was accessed from Little Trout Bay Road, 3.5 kilometres south of Highway 61. The sampling was completed along the bank of the Cloud River. Due to low water clarity, substrate was difficult to identify and was assumed to be deposits of fine grain sediment. There were only a few visible emergent aquatic plants present at the sample area; however, they were too far away to identify. There was a school of emerald shiners observed near the bank of the river and geese were heard downstream. The banks of the shoreline were very stable with abundant vegetation in the riparian zone. Vegetation included many different species of grasses and sedges growing on clay loam soils. The water was fast moving but a flow velocity was not taken for this site because it was too windy. Channel depth was not recorded because the river was too deep to obtain a measurement and channel width was not recorded because the river was too wide to measure.

This site was classified as a V12 White Spruce Mixedwood. The terrestrial vegetation included dominant species such as tamarack, white spruce and birch. The shrub layer included an abundance of red osier dogwood, speckled alder, and wild red raspberry. Herbs such as common strawberry and cow vetch were also prevalent on this site.

The laboratory results of samples taken June 11 and July 10, 2014 found that total coliforms, aluminum, copper, iron, and phosphorus exceeded the PWQO for those parameters. Total coliforms were above the pre-1994 PWQO criterion of 1,000 MPN/100mL with a value of 2,420 MPN/100mL in June and 3,080 MPN/100mL in July. Aluminum results exceeded the PWQO criterion (0.075 mg/L) with a value of 1.35 mg/L in June and 1.85 mg/L in July. Copper results exceeded the PWQO criterion of 0.005 mg/L (interim) with a value of 0.0063 mg/L in June and 0.0071 mg/L in July. Iron exceeded the PWQO criterion (0.3 mg/L) with a value of 1.35 mg/L in June and 2.19 mg/L in July. Phosphorus results exceeded the PWQO criterion (0.030 mg/L) with a value of 0.0411 mg/L in June and 0.0568 mg/L in July. Cobalt exceeded the PWQO criterion (0.009 mg/L) in July with a value of 0.00094 mg/L.

Table 4.1-1: Location References for Site 1	
Location Description	Near the confluence of the Cloud River flowing into Lake Superior; accessed by Little Trout Bay Road, 3.5 kilometres south of Highway 61; private property.
UTM Coordinates	5328612 Northing/ 317794 Easting
Altitude/Elevation	183.43 metres above sea level

Table 4.1-2: Field Measurements for Site 1			
Parameter	**Unit**	**Date:** 11-JUN-14	**Date**: 10-JUL-14
		Time: 13:40	**Time**: 13:05
Water Temperature	ºC	17.52	16.45
Conductivity	uS/cm	131	168
Dissolved Oxygen	mg/L	5.08	3.72
Dissolved Oxygen	%	54.3	37.2
pH		7.54	7.52
Turbidity	NTU	20.2	26.7
Air Temperature	ºC	14.27	20.0
Channel Width	m	N/A	N/A
Sample Depth	m	N/A	N/A
Velocity	m/s	N/A	N/A
Salinity		0.06	0.08
Oxygen Reduction Potential (ORP)		118.2	125

Table 4.1-3: Laboratory Water Quality Results for Site 1				
Parameter	**Unit**	**PWQO Guidelines**	**Date:** 11-JUN-14	**Date:** 10-JUL-14
			Time: 13:40	**Time:** 13:05
Bacteriological				
Escherichia Coli	MPN/100mL	100	41	40
Total Coliforms	MPN/100mL	1,000 (prior to 1994)	**2,420**	**3,080**
Physical				
Conductivity (EC)	uS/cm	N/A	130	163
pH		6.5-8.5	6.96	7.56
Total Dissolved Solids	mg/L	N/A	112	146
Turbidity	NTU	<10% of natural	29.0	36.7
Nutrients and Anions				
Ammonia-N, Total	mg/L	N/A	<0.020	0.052
Chloride (Cl)	mg/L	N/A	4.50	7.47
Nitrate-N (NO3-N)	mg/L	N/A	0.039	0.121
Nitrite-N (NO2-N)	mg/L	N/A	<0.020	<0.020
Phosphorus (P)-Total	mg/L	0.030	**0.0411**	**0.0568**
Sulfate (SO4)	mg/L	N/A	4.73	4.35
Metals				
Aluminum (Al)	mg/L	0.075	**1.35**	**1.85**
Cadmium (Cd)	mg/L	0.0002 (interim)	0.000047	0.000074
Cobalt (Co)	mg/L	0.0009	0.00066	**0.00094**
Copper (Cu)	mg/L	0.005 (interim)	**0.0063**	**0.0071**
Iron (Fe)	mg/L	0.300	**1.35**	**2.19**
Lead (Pb)	mg/L	0.001 (interim)	<0.0010	<0.0010
Sodium (Na)	mg/L	N/A	3.36	5.20

Bold indicates exceedance above PWQO guidelines

Table 4.1-4: Flora Observed at Site 1			
FEC V-Type: V12 White Spruce Mixedwood			
Forest Density / Stream Cover	20% stream cover.		
Terrestrial Species			
Trees	**Shrubs**	**Herbs**	**Ferns / Horsetails / Mosses / Grasses**
Tamarack White Spruce White Birch	Red Osier Dogwood Wild Red Raspberry Speckled Alder	Common Strawberry Cow Vetch Sweet Coltsfoot	Woodland Horsetail Common Reid Sedge spp.
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	Canada Goose
Crustaceans	-
Fish	Emerald Shiners (school)
Insects	Water Spider Water Beetle Water Strider Black Flies Mosquitoes
Mammals	-
Mollusca	-
Reptiles	-

Table 4.1-6: Physical Features Observed at Site 1							
Soil Type: Clay loam							
In-stream Substrate							
Bedrock	**Boulder**	**Cobbles**	**Gravel**	**Sand**	**Silt**	**Muck**	**Clay**
-	-	-	-	-	-	~100%	-
Bank Stability / Erosion	Stable/abundant vegetation						

4.2 Site 2

Site 2 was located on the west side of Little Trout Bay Road, 1.8 kilometres south of Highway 61. This sampling site was located near a culvert, and a beaver dam was located on the opposite side of the road of the sampling area. The soil type present on this site was clay loam. There was an abundance of vegetation along the stream including wild red raspberry, woodland horsetail grasses and sedges. Dominate woody species included white spruce and tamarack. Red osier dogwood was also prevalent on the sample site.

The second sampling period determined that *E. coli* exceeded the PWQO guidelines on July 10, 2014. During both sampling periods total coliforms, phosphorus, aluminum, copper and iron were in exceedance of the PWQO guidelines. Total coliforms exceeded the PWQO of 1,000 MPN/100mL on both June 11, 2014 and July 10, 2014 with values of >2,420 MPN/100mL and 7,270 MPN/100mL, respectively. Phosphorus exceeded PWQO criterion of 0.030 mg/L with values of 0.0499 mg/L on June 11, 2014, and 0.0578 mg/L on July 10, 2014. Aluminum exceeded the PWQO criterion of 0.075 mg/L with values of 1.48 mg/L on June 11, 2014 and 1.26 mg/L on July 10. Copper exceeded the PWQO criterion of 0.005 mg/L (interim) on both June 11, 2014 and July 1, 2014 with values of 0.0065 mg/L and 0.0063 mg/L respectively. The PWQO criterion of 0.3 mg/L for iron was exceeded on June 11, 2014 and July 10, 2014 with values of 1.53 mg/L and 1.79 mg/L, respectively. All other parameters were within PWQO guidelines.

Table 4.2-1: Location References for Site 2

Location Description	Unnamed Stream; accessed off of Highway 61, 1.8 kilometres down Little Trout Bay Road.
UTM Coordinates	5330260 Northing/ 317440 Easting
Altitude/Elevation	197.88 metres above sea level

Table 4.2-2: Field Measurements for Site 2

Parameter	**Unit**	**Date:** 11-JUN-14 **Time:** 12:30	**Date**: 10-JUL-14 **Time**: 12:25
Water Temperature	ºC	16.71	17.19
Conductivity	uS/cm	222	289
Dissolved Oxygen	mg/L	5.13	3.57
Dissolved Oxygen	%	53.0	37.4
pH		7.39	7.42
Turbidity	NTU	17.2	18.7
Air Temperature	ºC	20.0	21.0
Channel Width	m	2.10	2.10
Sample Depth	m	0.20	0.44
Velocity	m/s	0.43	N/A
Salinity		0.11	0.14
Oxygen Reduction Potential (ORP)		135.4	132.0

Table 4.2-3: Laboratory Water Quality Results for Site 2				
Parameter	**Unit**	**PWQO Guidelines**	**Date:** 11-JUN-14 **Time:** 12:30	**Date:** 10-JUL-14 **Time:** 12:25
Bacteriological				
Escherichia Coli	MPN/100mL	100	48	**150**
Total Coliforms	MPN/100mL	1,000 (prior to 1994)	**>2,420**	**7,270**
Physical				
Conductivity (EC)	uS/cm	N/A	223	289
pH		6.5-8.5	N/A	7.55
Total Dissolved Solids	mg/L	N/A	180	211
Turbidity	NTU	<10% of natural	23.9	25.8
Nutrients and Anions				
Ammonia-N, Total	mg/L	N/A	<0.020	<0.020
Chloride (Cl)	mg/L	N/A	23.0	34.9
Nitrate-N (NO3-N)	mg/L	N/A	<0.030	<0.030
Nitrite-N (NO2-N)	mg/L	N/A	<0.020	<0.020
Phosphorus (P)-Total	mg/L	0.030	**0.0499**	**0.0578**
Sulfate (SO4)	mg/L	N/A	2.05	1.71
Metals				
Aluminum (Al)	mg/L	0.075	**1.48**	**1.26**
Cadmium (Cd)	mg/L	0.0002 (interim)	0.000065	0.000073
Cobalt (Co)	mg/L	0.0009	0.00067	0.00072
Copper (Cu)	mg/L	0.005 (interim)	**0.0065**	**0.0063**
Iron (Fe)	mg/L	0.300	**1.53**	**1.79**
Lead (Pb)	mg/L	0.001 (interim)	<0.0010	<0.0010
Sodium (Na)	mg/L	N/A	14.8	21.8

Bold indicates exceedance above PWQO guidelines

Table 4.2-4: Flora Observed at Site 2			
FEC V-Type: V12 White Spruce Mixwood			
Forest Density / Stream Cover	80% stream cover.		
Terrestrial Species			
Trees	**Shrubs**	**Herbs**	**Ferns / Horsetails / Mosses / Grasses**
White Spruce Trembling Aspen Balsam Poplar Tamarack	Willow spp. Serviceberry Red Osier Dogwood Speckled Alder Wild Red Raspberry		Woodland Horsetail
Aquatic Macrophytes and Algae			
Emergent	-	**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	-
Birds	Partridge
Crustaceans	-
Fish	-
Insects	Water Strider Eastern Tiger Swallowtail Black Flies Mosquitoes
Mammals	-
Mollusca	-
Reptiles	-

Table 4.2-6: Physical Features Observed at Site 2							
Soil Type: Clay loam							
In-stream Substrate							
Bedrock	**Boulder**	**Cobbles**	**Gravel**	**Sand**	**Silt**	**Muck**	**Clay**
-	~50%	~30%	~20%	-	-	-	-
Bank Stability / Erosion	Stable/abundant vegetation						

4.3 Site 3

Site 3 was located on Cloud Bay Road South, 2.3 kilometres south of Cloud River Road East. The slopes along the stream were fairly stable with little to no erosion occurring. Abundant vegetation along the riparian zone and along the road slope promoted bank stability at this site. The vegetation was growing on a clay loam soil type. The river was flowing at a relatively constant rate. The substrate was composed of mainly cobbles with some boulders and gravels. Aquatic vegetation was not present during either site visit. The terrestrial vegetation included dominant species such as balsam poplar, trembling aspen and white spruce. Shrubs observed at the site included prickly wild rose, speckled alder and serviceberry. Herb species included northern bluebell and cow vetch.

The second sampling period on July 10, 2014 determined that *E. coli* and cobalt exceeded the PWQO guidelines. *E. coli* exceeded the PWQO criterion of 100 MPN/100mL with a value of 160 MPN/100mL. Cobalt exceeded the PWQO criterion of 0.0009 mg/L with a value of 0.00097 mg/L. Total coliforms, phosphorus, aluminum, copper and iron all exceeded the PWQO for both the June 11, 2014 sampling period and July 10, 2014 sampling period. Total coliforms exceeded the PWQO criterion of 1,000 MPN/100mL with a value of 2,420 MPN/100mL on June 11, 2014 and 2,280 MPN/100mL on July 10, 2014. Phosphorus exceeded the PWQO criterion of 0.030 mg/L with a value of 0.0407 mg/L on June 11, 2014 and 0.0529 mg/L on July 9, 2014. Aluminum exceeded the PWQO criterion of 0.075 mg/L with a value of 2.23 mg/L during both sampling periods. The PWQO criterion of 0.005mg/L (interim) for copper was in exceedance on June 11,

2014 with a value of 0.0072 mg/L and on July 10, 2014 with a value of 0.0074 mg/L. Iron was in exceedance of the PWQO criterion of 0.3 mg/L with values of 2.05 mg/L on June 11, 2014 and 2.51 mg/L on July 10, 2014.

Table 4.3-1: Location References for Site 3	
Location Description	Unnamed Stream; located down Cloud Bay Road South, 2.3 kilometres south of Cloud River Road East.
UTM Coordinates	5329729 Northing/ 319025 Easting
Altitude/Elevation	192.92 metres above sea level

Table 4.3-2: Field Measurements for Site 3			
Parameter	**Unit**	**Date:** 11-JUN-14 **Time:** 11:30	**Date**: 10-JUL-14 **Time**: 11:30
Water Temperature	ºC	13.77	15.08
Conductivity	uS/cm	86	93
Dissolved Oxygen	mg/L	5.49	3.79
Dissolved Oxygen	%	53.5	38.0
pH		7.59	7.64
Turbidity	NTU	18.7	24.7
Air Temperature	ºC	16.5	17.0
Channel Width	m	2.20	2.20
Sample Depth	m	0.18	0.22
Velocity	m/s	0.90	N/A
Salinity		0.04	0.04
Oxygen Reduction Potential (ORP)		130.2	121.8

Table 4.3-3: Laboratory Water Quality Results for Site 3				
Parameter	**Unit**	**PWQO Guidelines**	**Date:** 11-JUN-14 **Time:** 11:30	**Date:** 10-JUL-14 **Time:** 11:30
Bacteriological				
Escherichia Coli	MPN/100mL	100	20	**160**
Total Coliforms	MPN/100mL	1,000 (prior to 1994)	**2,420**	**2,280**
Physical				
Conductivity (EC)	uS/cm	N/A	90.4	94.2
pH		6.5-8.5	N/A	7.28
Total Dissolved Solids	mg/L	N/A	141	133
Turbidity	NTU	<10% of natural	25.6	33.5
Nutrients and Anions				
Ammonia-N, Total	mg/L	N/A	0.025	0.032
Chloride (Cl)	mg/L	N/A	0.67	0.52
Nitrate-N (NO3-N)	mg/L	N/A	0.032	0.055
Nitrite-N (NO2-N)	mg/L	N/A	<0.020	<0.020
Phosphorus (P)-Total	mg/L	0.030	**0.0407**	**0.0529**
Sulfate (SO4)	mg/L	N/A	2.30	1.23
Metals				
Aluminum (Al)	mg/L	0.075	**2.23**	**2.23**
Cadmium (Cd)	mg/L	0.0002 (interim)	0.000074	0.00090
Cobalt (Co)	mg/L	0.0009	0.00077	**0.00097**
Copper (Cu)	mg/L	0.005 (interim)	**0.0072**	**0.0074**
Iron (Fe)	mg/L	0.300	**2.05**	**2.51**
Lead (Pb)	mg/L	0.001 (interim)	<0.0010	<0.0010
Sodium (Na)	mg/L	N/A	1.85	1.85

Bold indicates exceedance above PWQO guidelines

Table 4.3-4: Flora Observed at Site 3			
FEC V-Type: V12 White Spruce Mixedwood			
Forest Density / Stream Cover	60% stream cover.		
Terrestrial Species			
Trees	**Shrubs**	**Herbs**	**Ferns / Horsetails / Mosses / Grasses**
Balsam Poplar Trembling Aspen White Spruce Tamarack White Birch	Red Osier Dogwood Prickly Wild Rose Wild Red Raspberry Speckled Alder Serviceberry Willow spp.	Dandelion Cow Vetch	Field Horsetail Common Reid Bulrush spp.
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	-
Crustaceans	-
Fish	-
Insects	Black Flies Mosquitoes Caddisfly Larva
Mammals	-
Mollusca	-
Reptiles	-

Table 4.3-6: Physical Features Observed at Site 3							
Soil Type: Clay loam							
In-stream Substrate							
Bedrock	**Boulder**	**Cobbles**	**Gravel**	**Sand**	**Silt**	**Muck**	**Clay**
-	~10%	~70%	~20%	-	-	-	-
Bank Stability / Erosion	Stable/abundant vegetation						

4.4 Site 4

Site 4 was located on Cloud River Road East, 600 metres east of Highway 61. The samples were collected from the Cloud River at the location off a wooden bridge (Appendix F: Bridge Assessments). The soil was clay loam and erosion on the banks of the river downstream side of the bridge was apparent. Abundant vegetation along the riparian zone and along the road slope promoted bank stability at the sample area. The substrate at this site included boulders, cobbles and gravels.

Aquatic vegetation was not present at the site during the time of visit. The terrestrial vegetation included dominant species such as jack pine, balsam fir, trembling aspen and white spruce growing on clay loam soils. Red osier dogwood was abundant along the banks of the sample site. During sampling in June there were a school of larval shiners observed underneath the bridge.

During the second sampling period on July 9, 2014 cobalt exceeded the PWQO guidelines. Total coliforms, phosphorus, aluminum, copper and iron all exceeded the PWQO for both the June 11, 2014 sampling period and July 9, 2014 sampling period. Total coliforms exceeded the PWQO criterion of 1,000 MPN/100mL with a value of 1,990 MPN/100mL on June 11, 2014 and 6,130 MPN/100mL on July 9, 2014. Phosphorus exceeded the PWQO criterion of 0.030 mg/L with a value of 0.0372 mg/L on June 11, 2014 and 0.0655 mg/L on July 9, 2014. Aluminum exceeded the PWQO criterion of 0.075 mg/L with a value of 1.13 mg/L on June 11, 2014 and 2.44 mg/L on

July 9, 2014. Copper exceeded the PWQO criterion of 0.005 mg/L (interim) with a value of 0.0055 mg/L on June 11, 2014 and 0.0081 mg/L on July 9, 2014. Iron was in exceedance of the PWQO criterion of 0.3 mg/L with values of 1.25 mg/L on June 11, 2014 and 2.68 mg/L on July 9, 2014.

Table 4.4-1: Location References for Site 4	
Location Description	Cloud River; accessed off of Cloud River Road East, 600 metres east of Highway 61.
UTM Coordinates	5332219 Northing/ 318169 Easting
Altitude/Elevation	196.20 metres above sea level

Table 4.4-2: Field Measurements for Site 4			
Parameter	**Unit**	**Date:** 11-JUN-14	**Date**: 09-JUL-14
		Time: 10:10	**Time**: 12:15
Water Temperature	ºC	14.72	16.11
Conductivity	uS/cm	110	180
Dissolved Oxygen	mg/L	5.03	3.65
Dissolved Oxygen	%	49.7	37.2
pH		7.56	7.62
Turbidity	NTU	15.9	36.9
Air Temperature	ºC	16.7	21
Channel Width	m	5.9	5.9
Sample Depth	m	0.35	0.21
Velocity	m/s	0.28	
Salinity		0.05	0.09
Oxygen Reduction Potential (ORP)		135.5	134.1

Table 4.4-3: Laboratory Water Quality Results for Site 4				
Parameter	**Unit**	**PWQO Guidelines**	**Date:** 11-JUN-14 **Time:** 10:10	**Date:** 09-JUL-14 **Time:** 12:15
Bacteriological				
Escherichia Coli	MPN/100mL	100	41	90
Total Coliforms	MPN/100mL	1,000 (prior to 1994)	**1,990**	**6,130**
Physical				
Conductivity (EC)	uS/cm	N/A	113	1,660
pH		6.5-8.5	N/A	7.65
Total Dissolved Solids	mg/L	N/A	69	152
Turbidity	NTU	<10% of natural	26.1	48.2
Nutrients and Anions				
Ammonia-N, Total	mg/L	N/A	<0.020	<0.020
Chloride (Cl)	mg/L	N/A	3.26	5.21
Nitrate-N (NO3-N)	mg/L	N/A	<0.030	0.056
Nitrite-N (NO2-N)	mg/L	N/A	<0.020	<0.020
Phosphorus (P)-Total	mg/L	0.030	**0.0372**	**0.0655**
Sulfate (SO4)	mg/L	N/A	3.81	4.75
Metals				
Aluminum (Al)	mg/L	0.075	**1.13**	**2.44**
Cadmium (Cd)	mg/L	0.0002 (interim)	0.000037	0.000086
Cobalt (Co)	mg/L	0.0009	0.00057	**0.00112**
Copper (Cu)	mg/L	0.005 (interim)	**0.0055**	**0.0081**
Iron (Fe)	mg/L	0.300	**1.25**	**2.68**
Lead (Pb)	mg/L	0.001 (interim)	<0.0010	<0.0010
Sodium (Na)	mg/L	N/A	2.62	4.41

Bold indicates exceedance above PWQO guidelines

Table 4.4-4: Flora Observed at Site 4			
FEC V-Type: V7 Trembling Aspen – Balsam Fir/Balsam Fir Shrub			
Forest Density / Stream Cover	20% stream cover.		
Terrestrial Species			
Trees	**Shrubs**	**Herbs**	**Ferns / Horsetails / Mosses / Grasses**
Jack Pine Balsam Poplar Trembling Aspen White Spruce	Pincherry Red Osier Dogwood Wild Red Raspberry Willow spp. Green Alder Chokecherry	Dandelion Red Clover Sweet Coltsfoot Three-leaved Smilacina	Woodland Horsetail Meadow Horsetail Common Reid
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	-
Fish	Shiner spp. (larvae)
Insects	Black Flies Mosquitoes
Mammals	Whitetail Deer
Mollusca	-
Reptiles	-

Table 4.4-6: Physical Features Observed at Site 4							
Soil Type: Clay loam							
In-stream Substrate							
Bedrock	**Boulder**	**Cobbles**	**Gravel**	**Sand**	**Silt**	**Muck**	**Clay**
-	~20%	~20%	~30%	-	-	~30%	-
Bank Stability / Erosion	Potential for erosion						

4.5 Site 5

Site 5 was located on Cloud River Road East, 400 metres east of Highway 61. The watercourse passed under a wooden bridge (Appendix F: Bridge Assessments) and the slopes along the river were very stable; however, erosion was present upstream from the sample area. The substrate was composed of mainly muck with some boulders, cobbles and gravels. Aquatic vegetation was not present during both visits to the site. The terrestrial vegetation included dominant species such as balsam poplar, trembling aspen and white spruce. Red osier dogwood was prevalent along the banks of the Cloud River as well as wild red raspberry, high bush cranberry and pincherry. The soil type present on this site was clay loam.

Samples taken on July 9, 2014 showed an exceedance of the PWQO (0.005 mg/L) for copper with a concentration of 0.0065 mg/L. Total coliforms, phosphorus, aluminum and iron all exceeded the PWQO for both the June 10, 2014 sampling period and July 9, 2014 sampling period. Total coliforms exceeded the PWQO criterion of 1,000 MPN/100mL with a value of 1,550 MPN/100mL on June 10, 2014 and 4,880 MPN/100mL on July 9, 2014. Phosphorus exceeded the PWQO criterion of 0.030 mg/L with a value of 0.0356 mg/L on June 10, 2014 and 0.0425 mg/L on July 9, 2014. Iron was in exceedance of the PWQO criterion of 0.3 mg/L with values of 1.01 mg/L on June 10, 2014 and 1.61 mg/L on July 9, 2014.

Table 4.5-1: Location References for Site 5	
Location Description	Cloud River; accessed off of Cloud River Road East, 400 metres east of Highway 61.
UTM Coordinates	5332284 Northing/ 318006 Easting
Altitude/Elevation	196.22 metres above sea level

Table 4.5-2: Field Measurements for Site 5			
Parameter	**Unit**	**Date:** 10-JUN-14	**Date**: 09-JUL-14
		Time: 14:38	**Time**: 13:00
Water Temperature	ºC	17.73	16.54
Conductivity	uS/cm	97	174
Dissolved Oxygen	mg/L	5.55	3.80
Dissolved Oxygen	%	58.7	39.0
pH		7.56	7.59
Turbidity	NTU	12.9	20.4
Air Temperature	ºC	19.6	21
Channel Width	m	6	0.24
Sample Depth	m	0.35	0.24
Velocity	m/s	0.52	
Salinity		0.05	0.08
Oxygen Reduction Potential (ORP)		111.3	137.5

Table 4.5-3: Laboratory Water Quality Results for Site 5				
Parameter	**Unit**	**PWQO Guidelines**	**Date:** 10-JUN-14	**Date:** 09-JUL-14
			Time: 14:38	**Time:** 13:00
Bacteriological				
Escherichia Coli	MPN/100mL	100	28	100
Total Coliforms	MPN/100mL	1,000 (prior to 1994)	**1,550**	**4,880**
Physical				
Conductivity (EC)	uS/cm	N/A	100	172
pH		6.5-8.5	N/A	7.81
Total Dissolved Solids	mg/L	N/A	93	131
Turbidity	NTU	<10% of natural	20.2	28.6
Nutrients and Anions				
Ammonia-N, Total	mg/L	N/A	<0.020	<0.020
Chloride (Cl)	mg/L	N/A	1.87	3.55
Nitrate-N (NO3-N)	mg/L	N/A	0.031	0.073
Nitrite-N (NO2-N)	mg/L	N/A	<0.020	<0.020
Phosphorus (P)-Total	mg/L	0.030	**0.0356**	**0.0423**
Sulfate (SO4)	mg/L	N/A	3.33	3.88
Metals				
Aluminum (Al)	mg/L	0.075	**0.696**	**1.16**
Cadmium (Cd)	mg/L	0.0002 (interim)	0.000026	0.000051
Cobalt (Co)	mg/L	0.0009	<0.00050	0.00067
Copper (Cu)	mg/L	0.005 (interim)	0.0046	**0.0065**
Iron (Fe)	mg/L	0.300	**1.01**	**1.61**
Lead (Pb)	mg/L	0.001 (interim)	<0.0010	<0.0010
Sodium (Na)	mg/L	N/A	1.94	3.80

Bold indicates exceedance above PWQO guidelines

Table 4.5-4: Flora Observed at Site 5			
FEC V-Type: V7 Balsam Fir/ Balsam Fir Shrub			
Forest Density / Stream Cover	10% stream cover		
Terrestrial Species			
Trees	**Shrubs**	**Herbs**	**Ferns / Horsetails / Mosses / Grasses**
Balsam Poplar Trembling Aspen White Spruce Black Ash	Pincherry Red Osier Dogwood Wild Red Raspberry Northern Wild Black Currant Virginia Creeper Prickly Wild Rose	Dandelion Cow Vetch	Lady Fern Woodland Horsetail
Aquatic Macrophytes and Algae			
Emergent	-	**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	Black Flies Mosquitoes
Mammals	Whitetail Deer
Mollusca	-
Reptiles	-

Table 4.5-6: Physical Features Observed at Site 5							
Soil Type: Clay loam							
In-stream Substrate							
Bedrock	**Boulder**	**Cobbles**	**Gravel**	**Sand**	**Silt**	**Muck**	**Clay**
-	~20%	~20%	~30%	-	-	~30%	-
Bank Stability / Erosion	Potential for erosion						

4.6 Site 6

Site 6 was located on Cloud Bay Road South, 350 metres south of Jarvis Bay Road East. During the July sampling period the culvert was being replaced. A permit for the culvert replacement was issued by the LRCA (22/14) under the Development Interference with Wetlands and Alterations to Shorelines and Watercourses Regulation. The water at this site was murky which made determining the substrate difficult. The banks of the creek

were fairly stable with little to no erosion occurring. Abundant vegetation along the riparian zone and along the road promoted bank stability at this site. Terrestrial vegetation included dominant species such as white spruce, tamarack, black spruce, and trembling aspen. Shrubs included wild red raspberry and red osier dogwood. Aquatic vegetation was not present during both site visits.

Total coliforms, phosphorus, aluminum, copper and iron all exceeded the PWQO for both the June 10 sampling period and July 10 sampling period. Total coliforms exceeded the PWQO criterion of 1,000 MPN/100mL with a value of <2,420 MPN/100mL on June 10 and 5,790 MPN/100mL on July 10. Phosphorus exceeded the PWQO criterion of 0.030 mg/L with a value of 0.0534 mg/L on June 10 and 0.0679 mg/L on July 10. Aluminum was in exceedance of the PWQO criterion of 0.075 mg/L with values of 2.04 mg/L on June 10 and 1.52 mg/L on July 10. Copper was in exceedance of the PWQO criterion of 0.005 mg/L (interim) with values of 0.0074 mg/L on June 10 and 0.0061 mg/L on July 10. Iron was in exceedance of the PWQO criterion of 0.300 mg/L with values of 2.32 mg/L on June 10 and 2.47 mg/L on July 10.

Table 4.6-1: Location References for Site 6

Location Description	Unnamed stream; located on Cloud Bay Road South, 350 metres south of Jarvis Bay Road East
UTM Coordinates	5333130 Northing/ 319255 Easting
Altitude/Elevation	207.95 metres above sea level

Table 4.6-2: Field Measurements for Site 6

Parameter	**Unit**	**Date:** 10-JUN-14 **Time:** 13:15	**Date**: 10-JUL-14 **Time**: 14:15
Water Temperature	ºC	15.86	19.67
Conductivity	uS/cm	89	88
Dissolved Oxygen	mg/L	5.55	3.91
Dissolved Oxygen	%	56.2	43.1
pH		7.72	7.52
Turbidity	NTU	23.7	19.6
Air Temperature	ºC	18.1	24.0
Channel Width	m	2.41	2.41
Sample Depth	m	0.46	0.25
Velocity	m/s	N/A	N/A
Salinity		0.04	0.04
Oxygen Reduction Potential (ORP)		113.1	120.4

Table 4.6-3: Laboratory Water Quality Results for Site 6				
Parameter	**Unit**	**PWQO Guidelines**	**Date:** 10-JUN-14 **Time:** 13:15	**Date:** 10-JUL-14 **Time:** 14:15
Bacteriological				
Escherichia Coli	MPN/100mL	100	4	10
Total Coliforms	MPN/100mL	1,000	**<2,420**	**5,790**
Physical				
Conductivity (EC)	uS/cm	N/A	89.8	88.6
pH		6.5-8.5	N/A	7.30
Total Dissolved Solids	mg/L	N/A	128	139
Turbidity	NTU	<10% of natural	30.5	24.7
Nutrients and Anions				
Ammonia-N, Total	mg/L	N/A	<0.020	<0.020
Chloride (Cl)	mg/L	N/A	0.99	0.24
Nitrate-N (NO3-N)	mg/L	N/A	<0.030	<0.030
Nitrite-N (NO2-N)	mg/L	N/A	<0.020	<0.0200
Phosphorus (P)-Total	mg/L	0.030	**0.0534**	**0.0679**
Sulfate (SO4)	mg/L	N/A	1.11	0.44
Metals				
Aluminum (Al)	mg/L	0.075	**2.04**	**1.52**
Cadmium (Cd)	mg/L	0.0002 (interim)	0.000076	0.00077
Cobalt (Co)	mg/L	0.0009	0.00090	0.00084
Copper (Cu)	mg/L	0.005 (interim)	**0.0074**	**0.0061**
Iron (Fe)	mg/L	0.300	**2.32**	**2.47**
Lead (Pb)	mg/L	0.001 (interim)	<0.0010	<0.0010
Sodium (Na)	mg/L	N/A	1.79	1.40

Bold indicates exceedance above PWQO guidelines

Table 4.6-4: Flora Observed at Site 6			
FEC V-Type: V12 White Spruce Mixedwood			
Forest Density / Stream Cover	0% stream cover		
Terrestrial Species			
Trees	**Shrubs**	**Herbs**	**Ferns / Horsetails / Mosses / Grasses**
Tamarack White Spruce Black Spruce Balsam Fir Trembling Aspen Balsam Poplar	Wild Red Raspberry Prickly Wild Rose Red Osier Dogwood Serviceberry Gooseberry Speckled Alder	Common Strawberry Dandelions Cow Vetch Sweet Coltsfoot Ox-eyed Daisy Red Clover Rough Bedstraw	Field Horsetail Woodland Horsetail Common Cattail
Aquatic Macrophytes and Algae			
Emergent	-	**Floating Algae**	-
Rooted Floating	-	**Filaments**	-
Submergent	-	**Attached Algae**	-
Free Floating	-	**Slimes or Crusts**	-

Table 4.6-5: Fauna Observed at Site 6	
Fauna Species	
Amphibians	-
Birds	-
Crustaceans	-
Fish	-
Insects	Eastern Tiger Swallowtail Water Strider Red Ants Black Flies Mosquitoes
Mammals	-
Mollusca	-
Reptiles	-

Table 4.6-6: Physical Features Observed at Site 6							
Soil Type: Clay loam							
In-stream Substrate							
Bedrock	**Boulder**	**Cobbles**	**Gravel**	**Sand**	**Silt**	**Muck**	**Clay**
-	-	-	-	-	-	~100%	-
Bank Stability / Erosion	Stable/abundant vegetation						

4.7 Site 7

Site 7 was located on Jarvis Bay Road West, 200 metres west of Highway 61. This site was a small stream and was chosen because it was downstream of the active Sand Hill Landfill Site north of the creek on 35 Sand Hill Road. Aquatic vegetation was not present at the site during both visits. Along the banks of the creek there was an abundance of shrubs, herbs and grass species. Shrub species included showy mountain ash, high bush cranberry, chokecherry, serviceberry and speckled alder. Herb species included cow vetch, Canada anemone and northern sweet coltsfoot. Dominate tree species included black spruce, tamarack, birch and trembling aspen.

The lab results from the June 10, 2014 sampling period showed that copper exceeded the PWQO guidelines of 0.005 mg/L (interim) with a value of 0.007 mg/L. Total coliforms, phosphorus, aluminum and iron all exceeded the PWQO guidelines on both the June 10, 2014 and July 9, 2014 sampling periods. Total coliforms exceeded the PWQO criterion of 1,000 MPN/100mL with a value of 1,550 MPN/100mL on June 10, 2014 and >2,420 MPN/100mL on July 9, 2014. Phosphorus exceeded the PWQO criterion of 0.030 mg/L with a value of 0.0387 mg/L on June 10, 2014 and 0.0383 mg/L on July 9, 2014. Aluminum exceeded the PWQO criterion of 0.075 mg/L with a value of 0.566 mg/L on June 10, 2014 and 0.404 mg/L on July 9, 2014. Iron was in exceedance of the PWQO criterion of 0.3 mg/L with values of 1.38 mg/L on June 10, 2014 and 1.01 mg/L on July 9, 2014.

Table 4.7-1: Location References for Site 7	
Location Description	Unnamed stream; accessed off of Highway 61, 200 metres down Jarvis Bay Road. West.
UTM Coordinates	5333566 Northing/ 317491 Easting
Altitude/Elevation	215.24 metres above sea level

Table 4.7-2: Field Measurements for Site 7			
Parameter	**Unit**	**Date:** 10-JUN-14 **Time:** 11:54	**Date**: 09-JUL-14 **Time**: 11:20
Water Temperature	ºC	16.65	17.29
Conductivity	uS/cm	232	249
Dissolved Oxygen	mg/L	5.88	3.81
Dissolved Oxygen	%	60.6	40.1
pH		7.31	7.47
Turbidity	NTU	9.66	8.24
Air Temperature	ºC	16.5	21
Channel Width	m	1.30	1.30
Sample Depth	m	0.19	0.25
Velocity	m/s	0.45	
Salinity		0.11	0.12
Oxygen Reduction Potential (ORP)		142.3	149.8

Table 4.7-3: Laboratory Water Quality Results for Site 7				
Parameter	**Unit**	**PWQO Guidelines**	**Date:** 10-JUN-14 **Time:** 11:54	**Date:** 09-JUL-14 **Time:** 11:20
Bacteriological				
Escherichia Coli	MPN/100mL	100	7	47
Total Coliforms	MPN/100mL	1000 (prior to 1994)	**1550**	**>2420**
Physical				
Conductivity (EC)	uS/cm	N/A	213	287
pH		6.5-8.5	N/A	7.78
Total Dissolved Solids	mg/L	N/A	145	204
Turbidity	NTU	<10% of natural	15.9	9.97
Nutrients and Anions				
Ammonia-N, Total	mg/L	N/A	<0.020	0.023
Chloride (Cl)	mg/L	N/A	1.23	0.94
Nitrate-N (NO3-N)	mg/L	N/A	<0.030	<0.030
Nitrite-N (NO2-N)	mg/L	N/A	<0.020	<0.020
Phosphorus (P)-Total	mg/L	0.030	**0.0387**	**0.0383**
Sulfate (SO4)	mg/L	N/A	16.2	25.5
Metals				
Aluminum (Al)	mg/L	0.075	**0.566**	**0.404**
Cadmium (Cd)	mg/L	0.0002 (interim)	0.000040	0.000031
Cobalt (Co)	mg/L	0.0009	<0.00050	<0.00050
Copper (Cu)	mg/L	0.005 (interim)	**0.0070**	0.0030
Iron (Fe)	mg/L	0.300	**1.38**	**1.01**
Lead (Pb)	mg/L	0.001 (interim)	<0.0010	<0.0010
Sodium (Na)	mg/L	N/A	3.02	2.94

Bold indicates exceedance above PWQO guidelines

Table 4.7-4: Flora Observed at Site 7			
FEC V-Type: V19 Black Spruce Mixedwood/ Herb Rich			
Forest Density / Stream Cover	30% stream cover		
Terrestrial Species			
Trees	**Shrubs**	**Herbs**	**Ferns / Horsetails / Mosses / Grasses**
Black Spruce Balsam Fir Tamarack White Birch Trembling Aspen Balsam Poplar	Wild Red Raspberry Prickly Wild Rose Chokecherry Red Osier Dogwood Serviceberry Willow spp. Showy Mountain-ash High-bush Cranberry Speckled Alder	Swamp Thistle Common Strawberry Cow Vetch Canada Anemone Sweet Coltsfoot	Lady Fern Meadow Horsetail Field Horsetail Common Reid
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	-
Crustaceans	-
Fish	-
Insects	Black Flies Mosquitoes
Mammals	-
Mollusca	-
Reptiles	-

Table 4.7-6: Physical Features Observed at Site 7							
Soil Type: Clay Loam							
In-stream Substrate							
Bedrock	**Boulder**	**Cobbles**	**Gravel**	**Sand**	**Silt**	**Muck**	**Clay**
-	-	~5%	~5%	-	-	~90%	-
Bank Stability / Erosion	Some erosion occurring						

4.8 Site 8

Site 8 was located on the northwest side of Cloud Lake and was accessed on Cloud Lake Road, west of Highway 61. This site was a good representation of the headwaters of the

watershed. The samples were taken along the shoreline of the lake in order to avoid contamination that could occur from the nearby boat launch. Along the shore of the sampling area, there was rip rap present with little to no vegetation. There was a small amount of algae present near the shore.

This site was characterized as a White Pine Mixwood with dominant species including white pine, showy mountain-ash and white birch. Stagnant water within the lake did not sustain any wave action and therefore the velocity was not applicable. The substrate of the lake was composed of mainly boulders, cobbles and gravels. During the June sampling period two common mergansers and flock of Canadian geese were seen flying. During the July sampling period two smallmouth bass were seen swimming around the shore.

No samples taken at this site exceeded the PWQO guidelines for any parameters.

Table 4.8-1: Location References for Site 8

Location Description	Cloud Lake; accessed by Cloud Lake Road, 9.6 kilometres west of Highway 61.
UTM Coordinates	5334815 Northing/ 317491 Easting
Altitude/Elevation	353.62 metres above sea level

Table 4.8-2: Field Measurements for Site 8

Parameter	**Unit**	**Date:** 10-JUN-14 **Time:** 9:50	**Date**: 09-JUL-14 **Time**: 10:15
Water Temperature	ºC	16.32	19.34
Conductivity	uS/cm	67	67
Dissolved Oxygen	mg/L	6.39	4.03
Dissolved Oxygen	%	65.4	43.6
pH		7.48	7.72
Turbidity	NTU	1.04	1.00
Air Temperature	ºC	21	17
Channel Width	m	N/A	N/A
Sample Depth	m	0.7	0.64
Velocity	m/s	N/A	N/A
Salinity		0.03	0.03
Oxygen Reduction Potential (ORP)		1.42	144.5

Table 4.8-3: Laboratory Water Quality Results for Site 8				
Parameter	**Unit**	**PWQO Guidelines**	**Date:** 10-JUN-14 **Time:** 9:50	**Date:** 09-JUL-14 **Time:** 10:15
Bacteriological				
Escherichia Coli	MPN/100mL	100	<1	1
Total Coliforms	MPN/100mL	1,000 (prior to 1994)	108	276
Physical				
Conductivity (EC)	uS/cm	N/A	68.4	69.7
pH		6.5-8.5	7.20	7.49
Total Dissolved Solids	mg/L	N/A	43	49
Turbidity	NTU	<10% of natural	1.38	0.71
Nutrients and Anions				
Ammonia-N, Total	mg/L	N/A	<0.020	0.044
Chloride (Cl)	mg/L	N/A	1.37	1.69
Nitrate-N (NO3-N)	mg/L	N/A	0.039	0.041
Nitrite-N (NO2-N)	mg/L	N/A	<0.020	<0.020
Phosphorus (P)-Total	mg/L	0.030	0.0165	0.0101
Sulfate (SO4)	mg/L	N/A	2.09	2.50
Metals				
Aluminum (Al)	mg/L	0.075	0.0651	0.0476
Cadmium (Cd)	mg/L	0.0002 (interim)	<0.000017	<0.000017
Cobalt (Co)	mg/L	0.0009	<0.00050	<0.00050
Copper (Cu)	mg/L	0.005 (interim)	0.0022	0.0015
Iron (Fe)	mg/L	0.300	0.129	0.076
Lead (Pb)	mg/L	0.001 (interim)	<0.0010	<0.0010
Sodium (Na)	mg/L	N/A	1.39	1.32

Bold indicates exceedance above PWQO guidelines

Table 4.8-4: Flora Observed at Site 8			
FEC V-Type: V12 White Pine Mixedwood			
Forest Density / Stream Cover	0% stream cover		
Terrestrial Species			
Trees	**Shrubs**	**Herbs**	**Ferns / Horsetails / Mosses / Grasses**
White Pine White Birch Trembling Aspen Jack Pine White Spruce	Wild Red Raspberry Beaked Hazel Mountain Maple Showy Mountain-Ash Serviceberry Gooseberry	Dandelions Lupines Red Clover Ox-eyed Daisy Yellow Hawkweed Northern Bluebell Eastern Red Columbine	Common Reid
Aquatic Macrophytes and Algae			
Emergent	-	**Floating Algae**	-
Rooted Floating	-	**Filaments**	-
Submergent	-	**Attached Algae**	Green Algae
Free Floating	-	**Slimes or Crusts**	-

Table 4.8-5: Fauna Observed at Site 8	
Fauna Species	
Amphibians	-
Birds	Common Merganser Canada Goose
Crustaceans	-
Fish	Smallmouth Bass
Insects	Red Ants Midges (in the thousands) Black Flies Mosquitoes Spring Azure
Mammals	-
Mollusca	-
Reptiles	-

Table 4.8-6: Physical Features Observed at Site 6							
Soil Type: Talus/slope							
In-stream Substrate							
Bedrock	**Boulder**	**Cobbles**	**Gravel**	**Sand**	**Silt**	**Muck**	**Clay**
-	~30%	~50%	~20%	-	-	-	-
Bank Stability / Erosion	Stable/abundant vegetation						

4.9 Watershed Report Card

The overall surface water quality for the Cloud River Watershed maintained a total averaged point score that is greater than 3.5. With exceedances for phosphorus and *E.coli*, the rating of the surface water quality for the Cloud River watershed was determined to have a grade of B.

The forest coverage for the Cloud River watershed was 70.2 square kilometres (88.3 percent), interior forest coverage was 51.9 square kilometres (65.3 percent) and the riparian forest cover was 4.8 square kilometres (46.8 percent). These percentages generated a total point score of fifteen (average of 4.6) for the forest conditions, which determined a grade A.

Table 4.11-1: Cloud 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	0.0489	40.5	N/A	7	B	3.5	B
2	0.0539	99	N/A	7	B	3.5	B
3	0.0468	90	N/A	7	B	3.5	B
4	0.0514	65.5	N/A	7	B	3.5	B
5	0.0389	64	N/A	7	B	3.5	B
6	0.0607	7	N/A	8	B	4	B
7	0.0385	27	N/A	8	B	4	B
8	0.0133	1	N/A	10	A	5	A

Table 4.11-2: Cloud 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
88.3	65.3	46.8	15	A	4.6	A

5 Discussion

The Cloud 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. Two visits were completed for each site. The first sampling period ran June 10, 11, 12 and the second sampling period on July 9, 10.

The average air temperature for the June 2014 sampling period was 17.8 ºC which exceeded the monthly average temperature of 13.7 ºC for June 2014 as well as the historical average of 14 ºC for June 1971-2000 in Thunder Bay. The average air temperature for the July sampling period was 20.3 ºC which exceeded the monthly average temperature of 16.8 ºC for July 2014 as well as the historical average of 17.6 ºC of July 1971-2000. Precipitation for the month of June totaled 119.5 millimetres which exceeded the historical monthly average of 85.7 millimetres for Thunder Bay from June 1971-2000. In July, precipitation totaled 112.2 millimetres which exceeded the historical monthly average of 89 millimetres for July 1971-2000. During the June sampling period, the sky was mostly clear with few clouds. During the first two days for sampling in July, it was a mix of sun and clouds.

Water temperature ranged from 13.77 ºC to 17.73 ºC in June and 15.08 ºC to 19.67 ºC in July. Water temperatures can be seen on Figure 4: Cloud River Watershed Water Temperature. A comparable trend can be seen during both sample periods. The cool water temperatures were present in the moderate to fast flowing streams and rivers with Site 3 having the coolest temperatures. The warmer water was observed at sites with slower or negligible velocity, such as the lake sites, with Site 1 containing the warmest water temperature in June and Site 8 containing the warmest water temperature in July. The stream depth could not be measured at some of the sites due to inaccessibility or very fast flowing water. Therefore sample depth was taken as opposed to a channel depth, often at the deepest spot that could be reached from shore or in chest waders. Site 1 and Site 8 were measured in a similar manner, only taking into account the depth at which the samples were taken and will not be considered in the following trends. Depths at the remaining sites ranged from 0.18 metres to 0.46 metres in June and 0.21 metres to 0.64 metres in July. Water levels increased at Sites 2, 3 and 7 and decreased at Sites 4, 5, and 6 between June and July. These results were considered negligible due to approximate readings in the field and the stream bed topography being extremely variable. This resulted in the depth being measured in slightly different locations during each sampling period.

From the eight sample locations, six of them were water crossings which required a bridge or culvert to support the road. There were two bridges total, one at Site 4 and one at Site 5. Both bridges were wooden crib support and did not appear to alter flow in a significant way, or change the natural stream course. The fill used in the wooden cribs as well as for footing on either bank, consisted of boulders, cobble and gravel. The fill used was similar to the natural stream bank substrate and aided in bridge support as well as

erosion and sedimentation control from road run-off. Culverts were present at Sites 2, 3, 6 and 7. The culverts at these sites were in good condition and were large enough to withstand increased velocity and water levels from heavy rainfall. During the July sampling period the culvert at Site 6 was being replaced. A permit for the culvert replacement was issued by the LRCA (22/14) under the Development, Interference with Wetlands and Alterations to Shorelines and Watercourses regulation.

A vegetation assessment was carried out at each site, recording species present within view of each site. Forest Ecosystem Classification type V-12 White Spruce Mixedwood, was the most common and occurred at Sites 1, 2, 3 and 6. There remaining sites still had a similar mixedwood forest type, sometimes favouring coniferous species as opposed to hardwood. The dominant tree species within the Cloud River watershed included white birch, black spruce and balsam fir. The shrub layer was very diverse throughout the watershed, with many species present. Some commonly observed species in the shrub layer were red raspberry, red osier dogwood, serviceberry, speckled alder and willow species. The ground cover and herb layer included wildflowers typical of disturbed sites, most likely due to the habitat provided by roadsides. The most commonly observed herb and wildflower species included dandelion, ox-eyed daisy, red clover, yellow and orange hawkweed and cow vetch. No invasive plant species or species at risk were seen at the sample sites within the Cloud River watershed. Aquatic vegetation was not present during both site visits.

Overall, the stream banks documented within the Cloud River watershed were stable. The clay loam did not display significant erosion, as it is a compacting type soil which aids in river stability. Site 4 and 5 had the greatest potential for erosion and unstable banks as the beginning of an undercut was observed along the steepening sides of both sites.

The PWQO acceptable pH range is 6.5-8.5. The range within the Cloud River watershed was 6.25 to 7.81 as illustrated on Figure 3: Cloud River Watershed pH Levels. The average pH lies within a good water quality range, being slightly acidic in some areas of the watershed. It is noted that due to a reported laboratory error laboratory pH values have not been reported for the June sampling period.

Total Dissolved Solids (TSD) can be related to conductivity since the dissolved solids are what 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 6: Cloud River Watershed Conductivity and Figure 5: Cloud River Watershed Total Dissolved Solids (TDS), the highest reading for TDS and conductivity was at Site 2, and the lowest readings for both parameters was at Site 8. The highest TDS reading was 289 mg/L at Site 2 on July 10, 2014. The lowest TDS reading found was 43 mg/L at Site 8 on June 10, 2014.

Turbidity in the Cloud River watershed ranged from 0.71 NTU to 48.2 NTU. All sites were below the *Canadian Recreational Water Quality* drinking guidelines of 50 NTU

(Health Canada, 1992). The lowest turbidity value was recorded on July 9, 2014 at Site 8. The highest turbidity value was from Site 4 on July 9, 2014.

As a limiting nutrient to aquatic vegetation, phosphorus is important to monitor in watersheds to avoid excessive vegetation growth, which can lead to lowered dissolved oxygen. Phosphorus exceeded the PWQO of 0.03 mg/L during both sampling periods at all sites except for Site 8. Phosphorus levels ranged from 0.0101 mg/L at Site 8 on July 9, 2014 to 0.0679 mg/L at Site 6 on July 10, 2014. The average concentration of phosphorus was 0.0391 mg/L for all sites during the June sampling month and 0.0490 mg/L during the July sampling month.

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. The *E. coli* levels at Site 2 and Site 3 were in exceedance of the PWQO of 100 MPN/100mL on July 10, 2014. Site 2 had a value of 150 MPN/100mL and Site 3 had a value of 160 MPN/100mL. The rest of the sampling sites did not show any exceedances. The presence of *E. coli* in the watershed ranged from <1 to 160 MPN/100mL. Presence of *E. coli* indicates a fecal contamination source nearby, but there are instances when fecal contamination occurs and testing does not show *E. coli* are present. 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. 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. Total coliforms exceeded the pre-1994 PWQO of 1,000 MPN/100 mL at all the sites with the exception of Site 8. The highest level of total coliform present was 7,270 MPN/100mL at Site 2 on July 10, 2014. Total coliforms ranged from 108 to 7,270 MPN/100mL.

Nitrogen was analyzed in three biologically-usable forms: nitrate (NO_3), nitrate (NO_2), and ammonia (NH_3). All three forms of nitrogen in the Cloud River watershed were below the maximum concentrations published in the PWQO and CCREM guidelines. All nitrate concentrations at the sampling sites ranged from <0.030 to 0.121 mg/L (with a CCREM criterion of 2.900 mg/L). All nitrite concentrations at the sampled sites were < 0.020 mg/L (with a CCREM criterion of 0.060 mg/L). Total ammonia ranged from <0.020 mg/L to 0.052mg/L. Total ammonia does not have a singular criterion because its speciation between un-ionized (NH_3) and (NH_4) forms are dependent on pH and temperature parameters. Total ammonia concentrations reported by the laboratory were converted into un-ionized (NH_3) ammonia concentrations using the conversion table provided in the PWQO guidelines. All un-ionized ammonia concentrations in the Cloud River watershed were <0.0003 mg/L (with PWQO criterion of 0.020 mg/L). These guidelines were put in place for protection from direct toxic effects and do not consider indirect effects due to eutrophication (large algae blooms).

All sites were above the PWQO criterion of 0.075 mg/L for aluminum except for Site 8. During the sampling period, aluminum concentrations ranged from 0.048 mg/L on Site 8 on July 9, 2014 to 2.44 mg/L at Site 4 on July 9, 2014. The average concentration of aluminum was 1.24 mg/L for all sites during the June sampling month and 1.36 mg/L during the July sampling month.

All sites except for Site 8 were above the PWQO criterion of 0.3 mg/L for iron during both the sampling months of June and July, 2014. Iron concentrations ranged between 0.076 mg/L at Site 8 on July 9, 2014 and 2.68 mg/L at Site 4 on July 9, 2014 with an average concentration of 1.58 mg/L for the sampling season. 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.

Cobalt exceeded the PWQO (0.0009 mg/L) in July at Sites 1, 3 and 4. Cobalt concentration ranged from <0.005 to 0.00112 mg/L.

Copper was above the PWQO of 0.005 mg/L at all sites except for Site 8. The copper concentrations ranged from 0.0022 mg/L to 0.0081 mg/L during sampling. High copper levels could be a result of natural sources as copper occurs in nature as a metal or an ore (sulphide, oxide or carbonate minerals in rock). Copper is also used in pesticide formulation and as an anti-fungal, anti-microbial agent for treated wood.

Lead concentrations were found to be below the PWQO criterion of 0.001 mg/L at each site. Lead can occur naturally from the weathering of rock ores or from human sources such as historical atmospheric emissions from leaded gasoline, batteries, alloys, pigments, chemicals, and solid and liquid waste discharge (usually from landfills). There was no evidence at the ten sites sampled that any of these factors significantly affected the concentrations of lead in the watershed.

The overall health of the Cloud River watershed was determined using the ratings from surface water quality and forest conditions, which were combined to give a grade for the Watershed Report Card. Given the number of exceedances for phosphorus and *E.coli*, the overall health of the Cloud River watershed surface water quality has maintained a rating (B) for its Watershed Report Card rating. The Cloud River forest conditions based on forest coverage, forest interior, and riparian zone forested, were determined to result in an excellent rating (A). Based on this rating and other observed conditions, the Cloud River watershed has been determined to have good overall health.

6 Conclusion

The Cloud River watershed was determined to be in good condition with minimal evident anthropogenic impacts. Surface water quality at the time of the study was good, with the exceedances of the Provincial Water Quality Objectives being 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 seemed consistent with previous water markings. Erosion was not typically a concern as the stream banks were composed of bedrock and boulders. Stream cover was often provided by shrubs and trees growing along the river banks which also helped prevent erosion. Bridges and culverts were in stable condition with no immediate concern for maintenance.

7 Recommendations

Upon completion of the 2014 Cloud River Watershed Assessment, the following recommendations have been made for considerations:

- Staff and funding permitting it is recommended that an update to the 2014 Cloud River Watershed Assessment be completed in the next five to ten years
- Benthic analysis indicates water quality over an extended period of time and should be considered for future watershed assessments.
- 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

Agriculture and Agri-Food Canada and Ontario Institute of Pedology. “Soils of Thunder Bay Area Report– Map Thunder Bay1.” Updated: June 25, 2013. Online. Accessed: July 22, 2013. Available: <http://sis.agr.gc.ca/cansis/publications/surveys/on/on48/index.html>

Canadian Council of Ministers of the Environment (CCME). “Canadian Environmental Quality Guidelines Summary Table – Protection of Aquatic Life”. Updated: 2012. Online. Accessed: July 22, 2013. Available: <http://st-ts.ccme.ca/>

Canadian Forest Service. “Canada’s Forest Regions”. Natural Resources Canada. Webpage Updated: March 21, 2013. Online. Available: <http://cfs.nrcan.gc.ca/pages/125>

Conservation Ontario. “2011 Guide to Developing Conservation Authority Watershed Report Cards”. 2011. Print.

Cudmore, Becky and Nicholas E. Mandrak. “The Baitfish Primer”. Fisheries and Oceans Canada. Winnipeg, Manitoba. 2011. Print.

Dickinson, T., Metsger, D., Bull, J., & R. Dickinson. “The ROM Field Guide to Wildflowers of Ontario”. Royal Ontario Museum and McClelland and Stewart Ltd., Toronto, Ontario. 2004. Print.

Eakins, R. J. “Ontario Freshwater Fishes Life History Database”. Version 4.37. American Fisheries Society – Ontario Chapter. 2013. Online. Accessed: July 15, 2013. Available: <http://www.ontariofishes.ca>

Environment Canada. “Canadian Climate Normals 1971-2000 Station Data”. Modified: July 10, 2013. Online. Accessed: August 7, 2013. Available: <http://climate.weather.gc.ca/climate_normals/results_e.html?stnID=4055&lang=e&dCode=0&province=ONT&provBut=Go&month1=0&month2=12>

Environment Canada. “Daily Climate Data Report - Thunder Bay”. Modified: 2013. Online. Accessed: August 7, 2013. Available: <http://climate.weather.gc.ca/index_e.html#access>

Environment Canada and Canadian Wind Energy Association. “Wind Energy Bird and Bat Monitoring Database - Summary of the findings from post-construction monitoring reports”. August 2012. Online. Accessed: July 12, 2013. Available: <http://www.birdscanada.org/resources/wind/wind_database_summary_Aug2012.pdf>

Harris, Allan G., S.C. McMurray, P.W.C. Uhlig, J.K. Jeglum, R.F. Foster and G.D. Racey. “Field Guide to Wetland Ecosystem Classification for Northwestern Ontario”. Queen’s Printer for Ontario, Ontario, Canada. 1996. Print.

Health Canada. “Guidelines for Canadian Recreational Water Quality”. Ministry of National Health and Family Welfare. 1992. Ottawa: Supply and Services Canada. Online. Accessed: June 29, 2013. Available: <http://www.hc-sc.gc.ca>

Legasy, Karen, Shayna LaBelle-Beadman, and Brenda Chambers. “Forest Plants of Northeastern Ontario”. Canada. Lone Pine Publishing & Queen’s Printer for Ontario. 1995. Print.

Lenntech B.V. “Aluminum and water: reaction mechanisms, environmental impact and health effects”. 2012. Online. Accessed: August 6, 2013. Available: <http://www.lenntech.com/periodic/water/aluminium/aluminum-and-water.htm#ixzz2bJ86RbwN>

Ministry of the Environment and Energy (MOEE). “Policies, Guidelines, Provincial Water Quality Objectives”. Toronto, Ontario. Queen’s Printer. July 1994. Online. Accessed: July 22, 2013. Available: <http://www.ene.gov.on.ca/environment/en/resources/STD01_076352.html>

Municipality of Neebing. “The Municipality of Neebing Zoning: By-law No. 806 - 2010”.

Newmaster, Steven G., Allen G. Harris, and Linda J. Kershaw. “Wetland Plants of Ontario”. Toronto, Ontario. Queen’s Printer. 1997. Print.

Ontario Federation of Anglers and Hunters. Invasives Tracking System. 2011. Online. Accessed: July 3, 2013. Available: <http://www.invasivestrackingsystem.ca>

Ontario Geological Survey. “Map 2545 Bedrock geology of Ontario, explanatory notes and legend”. Ontario. Queen’s Printer. 1991. Print.

Ontario Ministry of Natural Resources. “Fish ON-line.” Queen’s Printer. June 27, 2012. Online. Accessed: Aug 5, 2014. Available: <http://www.web2.mnr.gov.on.ca/fish_online/fishing/fishingExplorer_en.html>

Ontario Ministry of Natural Resources. “Ontario's Forest Regions: Boreal Forest.” Queen’s Printer. July 10, 2012. Online. Accessed: July 3, 2013. Available: <http://www.mnr.gov.on.ca/en/Business/Forests/2ColumnSubPage/STDPROD_091286.html>

Ontario Ministry of Natural Resources. "Species at Risk in Thunder Bay Region." Queen's Printer. July 2, 2013. Online. Accessed: July 5, 2013. Available: <http://www.mnr.gov.on.ca/en/Business/Species/2ColumnSubPage/MNR_SAR_WHTS_RSK_THNDR_BY_EN.html>

Rempel, Rob. "The Spatial Ecology Program". May 1, 2012. Ontario Ministry of Natural Resources – Centre for Northern Forest Ecosystem Research. Brochure – Online. Accessed: July 17, 2013. Available: <http://www.mnr.gov.on.ca/stdprodconsume/groups/lr/@mnr/@cnfer/documents/document/stel02_164517.pdf>

R. J. Burnside and Associates Limited, AMEC Earth and Environmental, and Lakehead Region Conservation Authority. "The Lakehead Region Conservation Authority Thunder Bay Area Aquifer Characterization Groundwater Management and Protection Study Final Report". July 2005. Print.

Sims, Richard A., William D. Towill, Kenneth A. Baldwin, and Gregory M. Wickware. "Field Guide to Forest Ecosystem Classification for Northwestern Ontario". Twin Offset Ltd., Ontario, Canada. 1997. Print.

Thunderbayarchaeology.ca. Western Heritage. Dave Norris. Online. Accessed: July 23, 2013. Available: <http://thunderbayarchaeology.ca/Welcome.html>

United States Geographical Survey (USGS). Hem, John D. "Study and interpretation of the chemical characteristics of natural water". 3rd ed. U.S. Geological Survey Water-supply Paper 2254. Department of the Interior. United States Government Printing Office. 1985. Print.

Figures

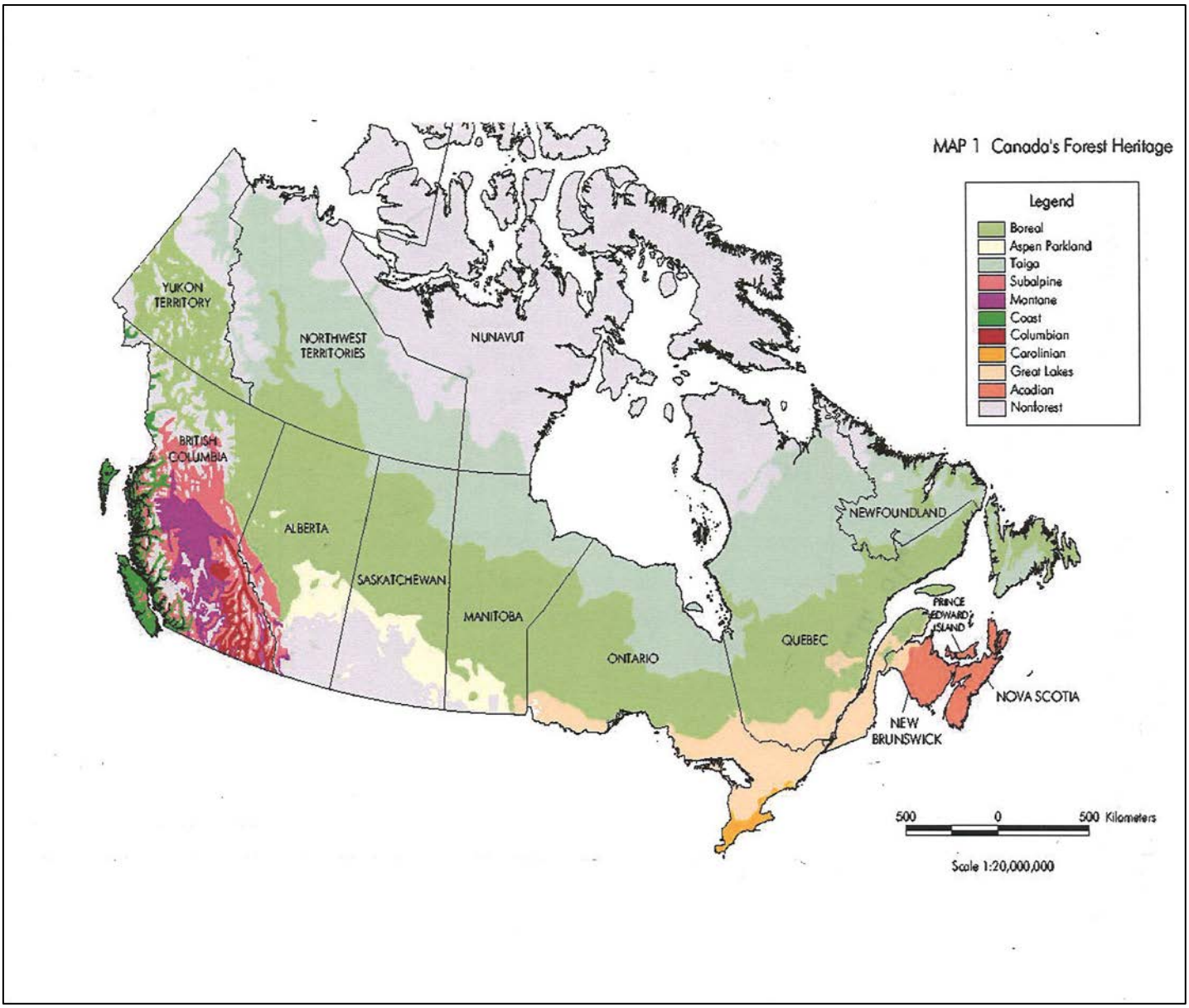


Figure 1: Canada's Forest Heritage (Global Forest Watch, 1977)

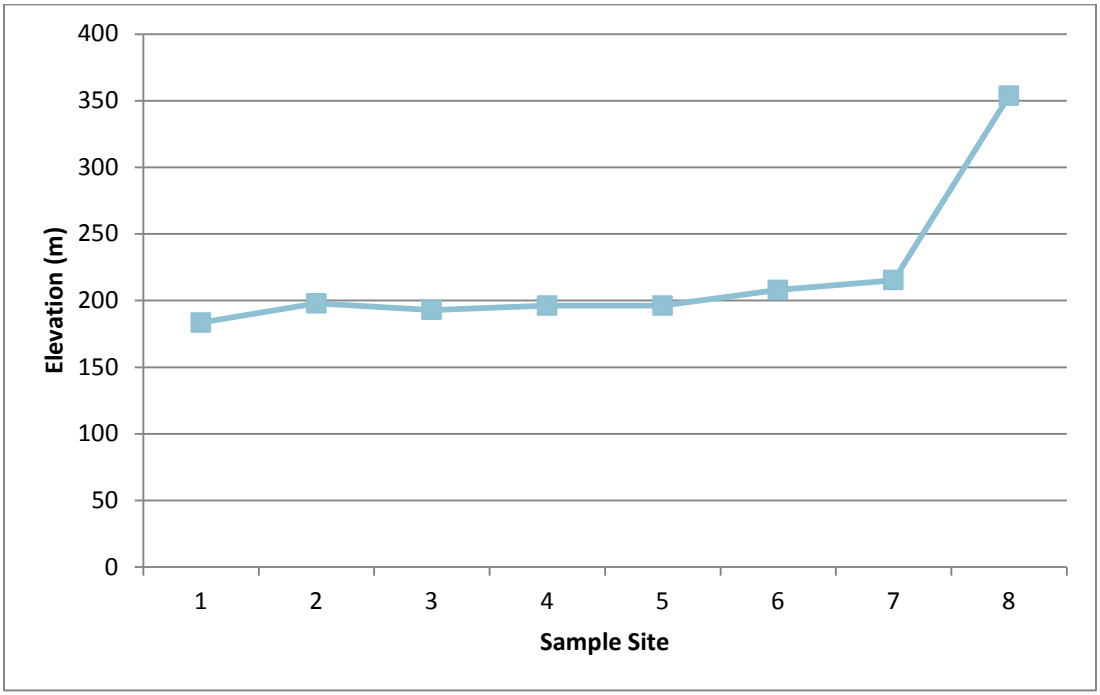


Figure 2: Cloud River Stream Gradient

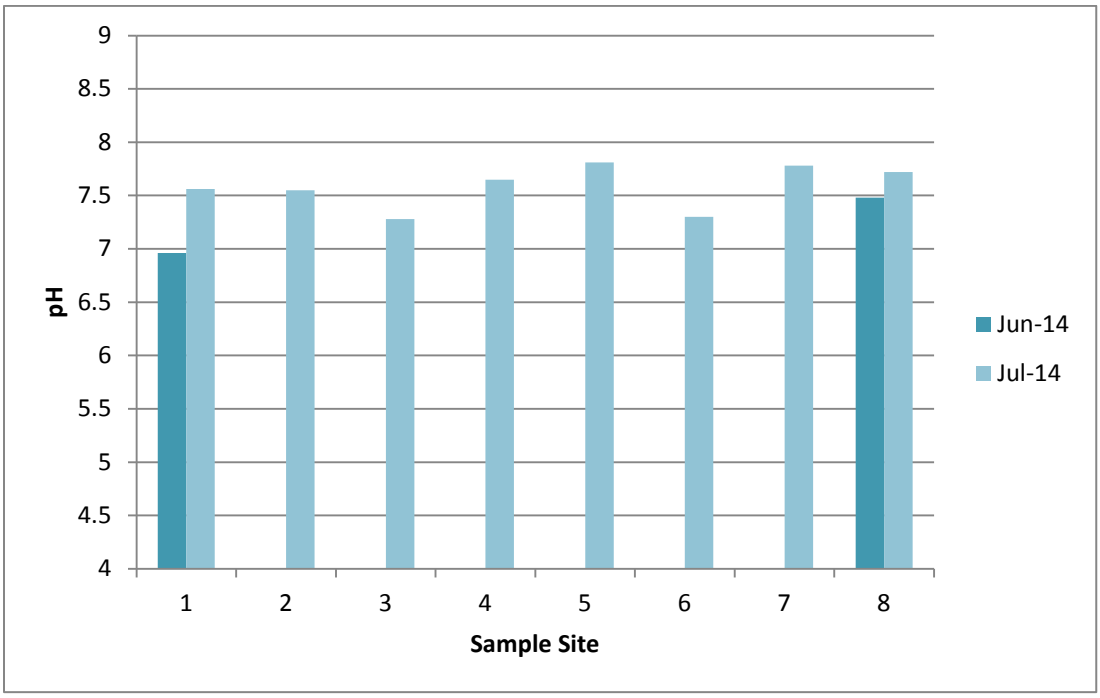


Figure 3: pH Level at Cloud River Sample Sites

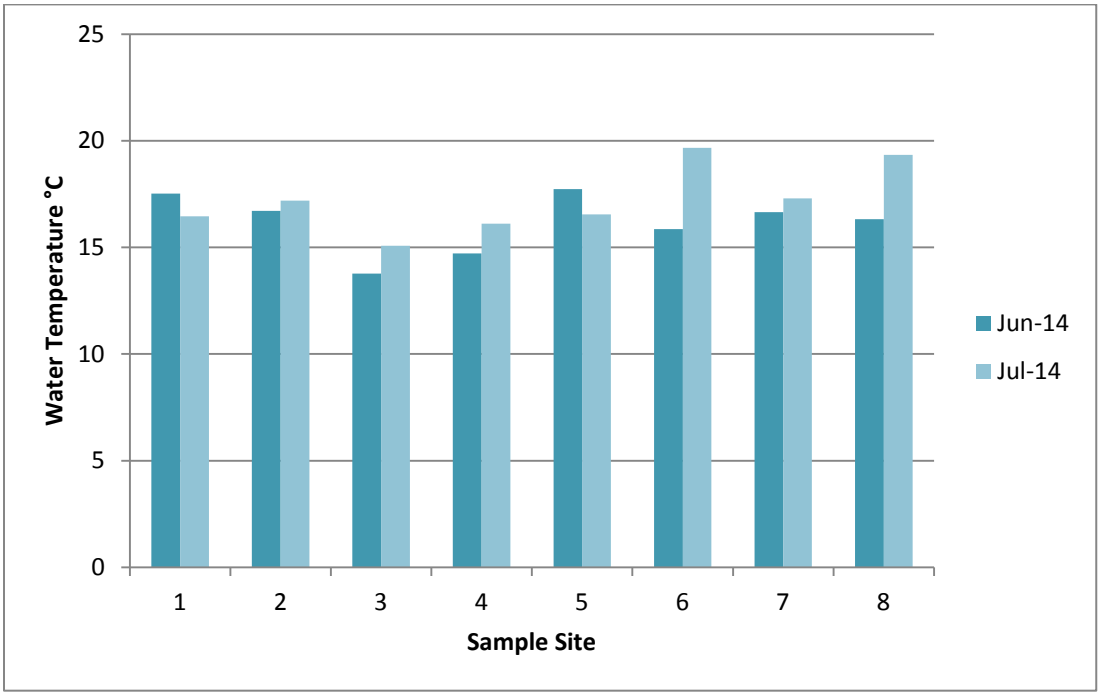


Figure 4: Water Temperature at Cloud River Sample Sites

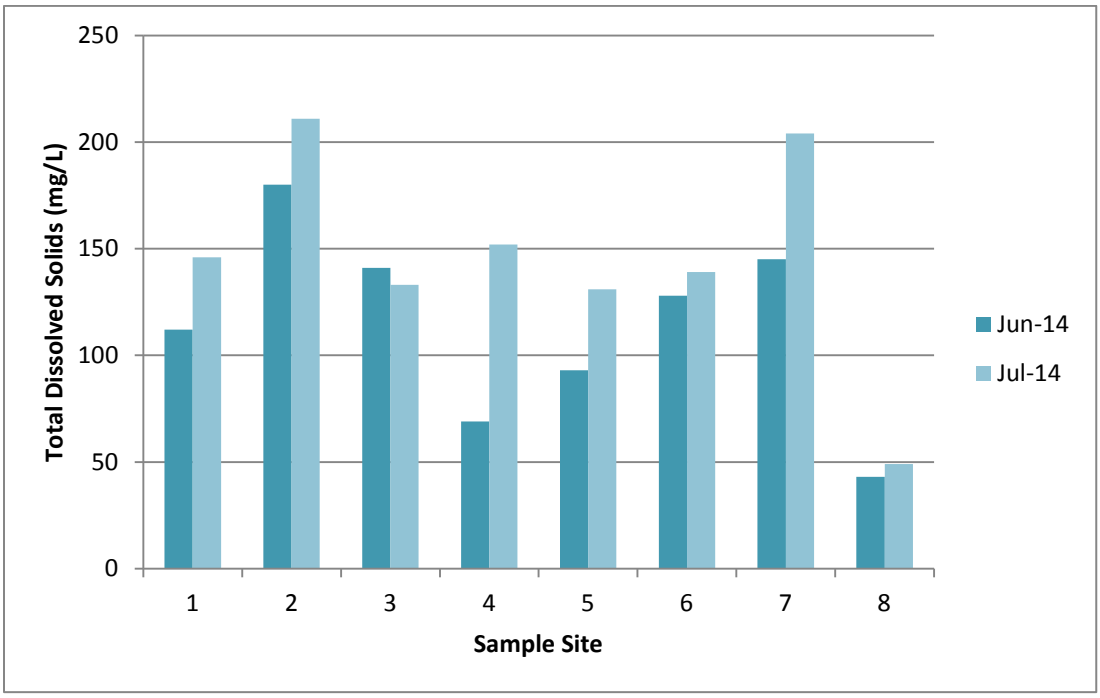


Figure 5: Total Dissolved Solids at Cloud River Sample Sites

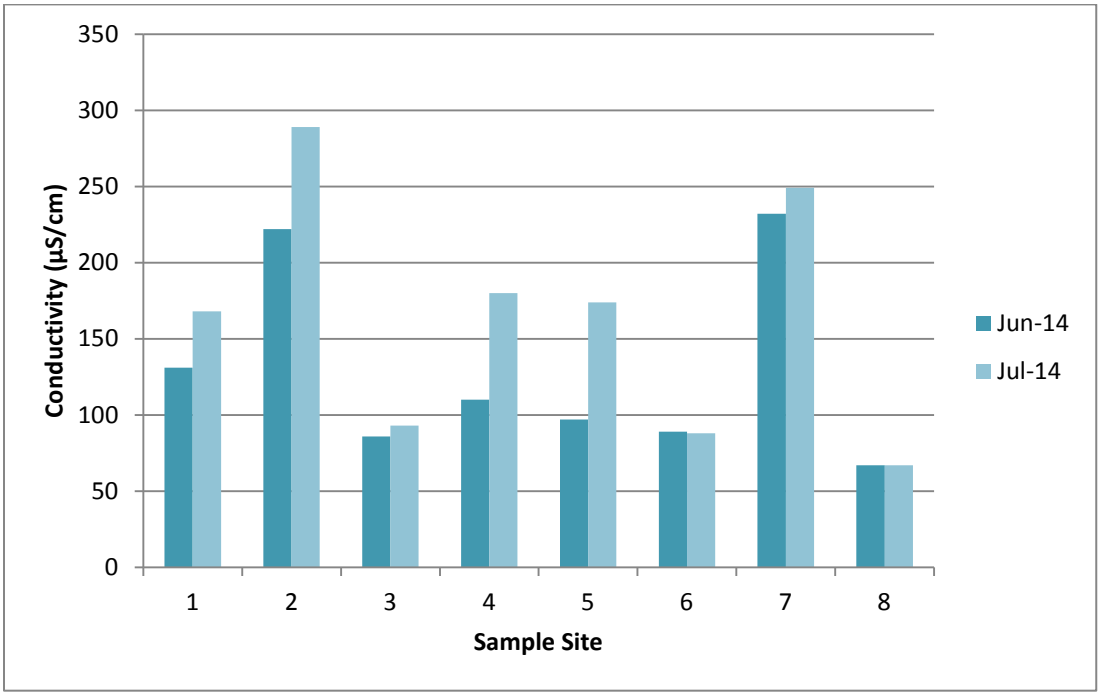


Figure 6: Conductivity at Cloud River Sample Sites

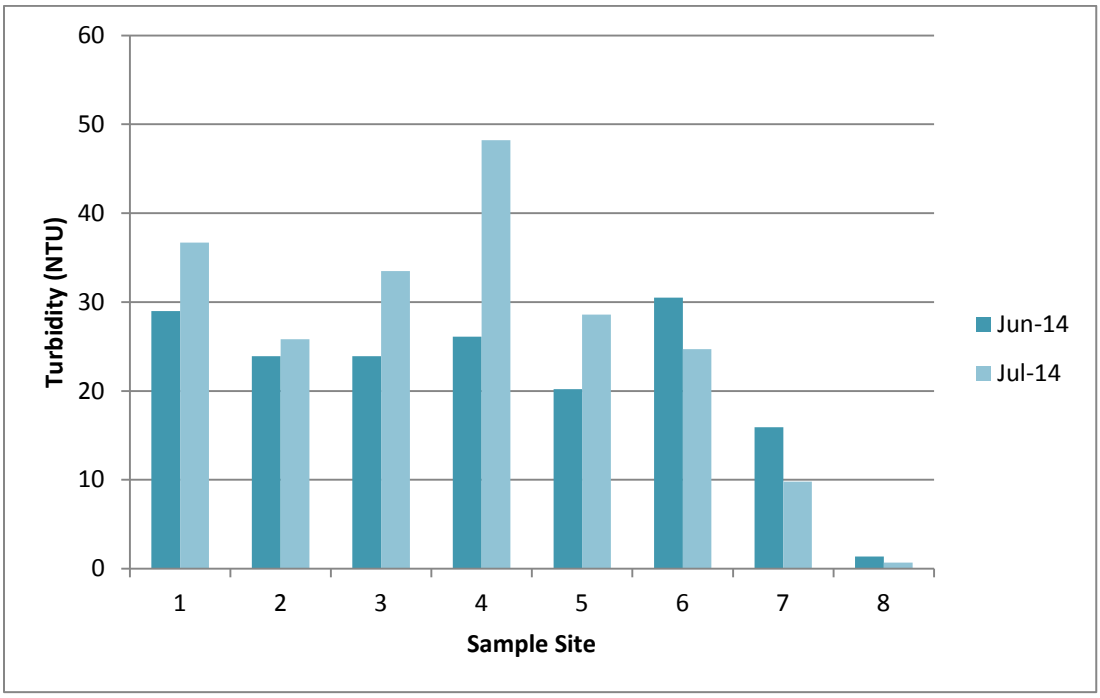


Figure 7: Turbidity at Cloud River Sample Sites

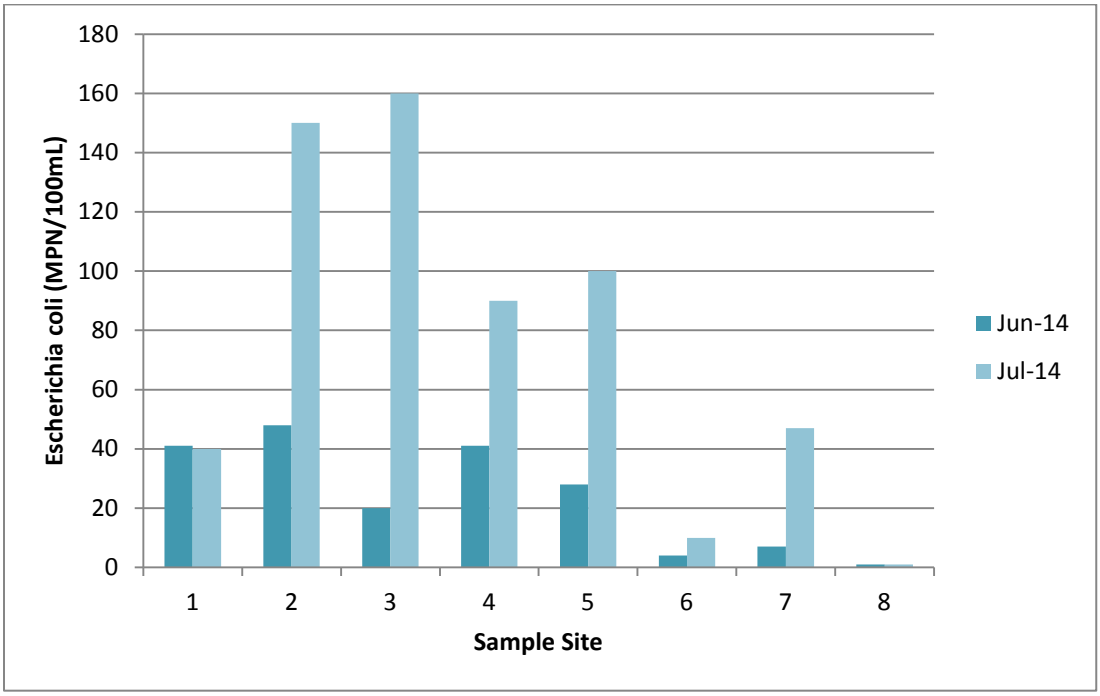


Figure 8: Escherichia coli bacteria counts at Cloud River Sample Sites

Appendix A:
Water Quality Parameters

Appendix A: Water Quality Parameters

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, then the number of species will decrease until there is none. Temperature also influences water chemistry which in turn affects biological activity. Chemical reactions generally speed up with warmer temperatures. Temperature is important, as warmer water holds less dissolved oxygen and warmer water will allow 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.

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 if the water is colder, turbulent (a lot of mixing at the air-water interface) and during the day when aquatic plants have had time to produce oxygen during photosynthesis. PWQO's have an acceptable range for dissolved oxygen in water dependent upon temperature. At 20 degrees Celsius the minimum amount of dissolved oxygen is 5 milligrams per liter.

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). Geology of the watershed can give the river some buffering capacity to resist changes in pH but overall the range has to stay between 6.5 and 8.5 to protect aquatic life.

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.

Conductivity

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

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 scatter the sunlight. The diversity of species will be affected by how far the sunlight can penetrate the water column. Fish gills will become clogged with a lot of suspended material, as well the material can settle on top of fish spawning grounds (and their eggs). Highly turbid water will appear murky or dirty. Turbidity will be higher after heavy rainfall, but high levels may also indicate soil erosion.

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

Phosphorus
Total phosphorus gives a measurement of all forms of phosphorus in the water, but the most important form within this measurement is soluble inorganic phosphate (PO_4) or orthophosphate ion (PO_4^{-3}) because it is the fraction utilized by aquatic plants.

While phosphorus is essential to life, too much of it will increase algae growth attached to rocks in the river. Excessive growths of attached algae 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 the most ecologically sensitive species. Natural decomposition of organic matter such as leaves, twigs, 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 from developed watersheds. Milkhouse waste from dairy farms is also a large source of phosphorus and has become one of the main environmental issues surrounding dairy farming.

Nitrogen
Nitrogen (N) is one of the most common gases in our atmosphere. It makes up approximately 78% of the earth's atmosphere. Like phosphorus, these nutrients are often applied to agricultural crops as fertilizers and having too much in the river can increase plant growth and productivity to unhealthy levels. Nitrogen is constantly being recycled through the environment through decomposition, etc. The most important forms that plants can readily use are ammonia, nitrate (NO_3) and nitrite (NO_2). There are many different ways to report nitrogen so it is necessary to note that the 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).

Bacteria
Escherichia coli (*E. coli*) are 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 water combined with its short survival time in water environments 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. beavers and Canadian Geese). These bacteria can cause irritation of the skin and eyes when contact is made and can cause gastro-intestinal disorders.

Metals
The following is a complete list of the total metal scan performed on the water samples:

Aluminum (Al)
Antimony (Sb)
Arsenic (As)
Barium (Ba)
Beryllium (Be)
Bismuth (Bi)
Boron (B)
Cadmium* (Cd)
Chromium (Cr)
Cobalt (Co)
Copper (Cu)
Iron (Fe)
Lead (Pb)
Manganese (Mn)
Molybdenum (Mo)
Nickel (Ni)
Selenium (Se)
Silicon (Si)
Silver (Ag)
Strontium (Sr)
Thallium (TI)
Tin (Sn)
Titanium (Ti)
Tungsten (W)
Uranium (U)
Vanadium (V)
Zinc (Zn)
Zirconium (Zr)

Most of these metals are found naturally within the earth's crust and weathering of rock can transport them into surface water.

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 and exposure is inevitable. 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, in 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, its role in 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.

Antimony
Antimony is a metallic element that is a blue-white colour in its stable form. 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. 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. 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 PWQO guidelines 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 plastics, rubber, electronics and textiles industries. At high concentrations, barium causes strong vasoconstriction by its direct stimulation of arterial muscle, peristalsis 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, 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 a number of compounds. 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 and brain, and may eventually lead to death. The maximum level of boron under PWQO guidelines is 200 μg/L.

Cadmium
Cadmium is an extremely toxic metal even in low concentrations. It is used commercially as a stabilizer in plastic, fungicides for golf courses, television picture tube phosphors, nickel–cadmium batteries, motor oils, and curing agents for rubber. Cadmium poisoning can lead to itai-itai disease, which initiates bone softening, joint pain and kidney failure. The maximum concentration of cadmium under PWQO guidelines is 0.2 μg/L. The interim PWQO guideline states if hardness as $CaCO_3$ is 0-100 the maximum cadmium concentration is 0.1 μg/L and if hardness is >100, 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, hard metal. Chromium (III) is an essential nutrient, but higher intake may cause skin rashes. Chromium (VI) is known to cause various health effects such as skin rashes, upset stomachs and ulcers, 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. 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 in minerals. Copper is an essential element to human metabolism, although intake at higher doses can cause adverse health effects. Acute copper poisoning health effects include vomiting, diarrhea, jaundice, haemolysis, haemoglobinuria, haematuria, and oliguria. In severe cases, the stool and saliva may appear green or blue. In the terminal phases, anuria, hypotension, and coma precede death. The maximum concentration of copper under PWQO guidelines is 5 μg/L.

Iron
Iron is also an abundant metal found in rock. The precipitation of excessive iron creates an objectionable reddish-brown colour to water. Iron may also stain laundry and plumbing fixtures, produce undesirable tastes in beverages, and promote the growth of certain iron-bacteria, leading 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, causing neurological damage and even death. Although natural occurrences can occur 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.

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, lung embolism and bronchitis. There are currently no PWQO guidelines for manganese.

Molybdenum
Molybdenum is a by-product of copper and tungsten mining. It is used as an alloy for various metals and occurs naturally in soil and rock. 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 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 surface of the earth. It occurs naturally in the environment and is also released by human activities. The health effects of various forms of selenium can vary from brittle hair and deformed nails, to rashes, heat, swelling of the skin and severe pains. Selenium poisoning may become so severe in some cases that it can even cause death. The maximum concentration of selenium under PWQO guidelines is 100 μg/L.

Silicon
Silicon is the most abundant element on earth after oxygen. In drinking water only silicic acid is present, which is relatively safe. However, there are a number of silicon compounds that are carcinogenic. There are currently no PWQO guidelines for silicon.

Silver
Silver does not react with pure water. It is stable in both water and air. Moreover, it is acid and base resistant, but it corrodes when it comes in contact with sulphur compounds. Silver oxide is harmful upon swallowing, because it irritates the eyes, 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.

Strontium
Strontium is a bright silvery metal that is softer than calcium and even more reactive in water. 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.

Thallium
Thallium is a silvery-grey metal that is very toxic by inhalation, ingestion and skin absorption. 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. Overdoses do not occur very often. 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, 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 B:
Water Quality Guidelines

Appendix B: Water Quality Guidelines

The following are taken from the Ministry of the Environment water quality guidelines, Provincial Water Quality Objectives (PWQO), July 1994.

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 maintained 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 MOEE 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).*

Turbidity:
Suspended matter should not be added to surface water in concentrations that will change the natural Secchi disc reading by more than **10 percent**.

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 20°C 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 Emerson et al. 197511 but percentages are rounded to two significant figures. The equations given by Emerson et al. 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.

Temp.	pH								
°C	6.0	6.5	7.0	7.5	8.0	8.5	9.0	9.5	10.0
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.
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 0.2 µg/L.

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 5 µg/L.

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

Iron*:*
The amount of Iron should not exceed 300µg/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.

The following are taken from the Canadian Council of Resource and Environment Ministers (CCREM) Canadian water quality guidelines for the protection of aquatic life: Summary table, September 2007.

The information in these guidelines and supporting text is used to complement the Provincial Water Quality Objectives and Interim Objectives.

Nitrate:
The amount of nitrate in freshwater should not exceed 2900 μg NO_3-N/ L.
For protection from direct toxic effects: the guidelines do not consider indirect effects due to eutrophication.

Nitrite:
The amount of nitrite in freshwater should not exceed 60 μg NO_2-N/L.
For protection from direct toxic effects: the guidelines do not consider indirect effects due to eutrophication.

Appendix C:
Techniques for Data Collections

Appendix C: Techniques for Data Collection

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.

Latitude, Longitude, and Elevation
The Universal Transverse Mercator (UTM) coordinates for each site were measured with a Trimble Geo XH 2005 hand held GPS unit.

Photographs
Photographs were taken at each site using both the Stylus 1030SW shock and water proof camera and the Capilo 500SE GPS Camera. Upstream and downstream photographs as well as culvert, bridge, and outstanding litter or erosion photographs were all taken at each site. Substrate photographs were attempted at each site with the waterproof camera.

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.

Flow
The velocity of river flow at sites was measured using a leaf 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.

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

Water Temperature
Water temperature was measured with the YSI 600 QS. The readings were taken after the probe was submerged and all variables on the meter were stabilized.

Conductivity
Conductivity was measured with the YSI 600 QS. 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.

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

Dissolved Oxygen
The YSI 600 QS measured dissolved oxygen for the samples. The readings were recorded once the probe was submerged in the water and all variables were stabilized.

Tree, Shrub & Herb Species
Identification was made in the vicinity of the sample sites, no transects were made. Observations were made approximately 50 metres from either stream edge were taken.

Aquatic Plants
Aquatic plants were determined through careful observation and identification via a field guide.

OBBN In-Stream Materials Key

Stream Bed Description
The bed description was given a set of 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
Muck	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

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.

Appendix D:

Common and Scientific Names of Identified Flora and Fauna

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

Flora	
Common Name	**Scientific (Latin) Name**
Trees	
Apple spp.	*Malus spp.*
Balsam poplar	*Populus balsamifera*
Black ash	*Fraxinus nigra*
Black spruce	*Picea mariana*
Jack pine	*Pinus banksiana*
Tamarack	*Larix laricina*
Trembling aspen	*Populus tremuloides*
White birch	*Betula papyrifera*
White pine	*Pinus strobus*
White spruce	*Picea glauca*
Shrubs	
Beaked hazel	*Corylus cornuta*
Bush honeysuckle	*Diervilla lonicera*
Canada goldenrod	*Solidago canadensis*
Fringed bindweed	*Polygonum cilinode*
Green alder	*Alnus viridis*
Highbush cranberry	*Viburnum trilobum*
Showy mountain-ash	*Sorbus americana*
Mountain maple	*Acer spicatum*
Northern wild black current	*Ribes hudsonianum*
Pin cherry	*Prunus pensylvanica*
Prickly wild rose	*Rosa acicularis*
Red-osier dogwood	*Cornus stolonifera*
Saskatoon (serviceberry)	*Amelanchier alnifolia*
Speckled alder	*Alnus rugosa*
Virginia creeper	*Parthenocissus quinquefolia*
Wild red raspberry	*Rubus idaeus*
Willow spp.	*Salix spp.*
Herbs	
American vetch	*Vicia americana*
Canada anemone	*Anemone canadensis*
Canada goldenrod	*Solidago canadensis*
Common strawberry	*Fragaria virginiana*
Cow parsnip	*Heracleum lanatum*
Cow vetch	*Vivia cracca*
Dandelion	*Taraxacum officinale*
Mullein	*Verbascum thapsus*
Northern bluebell	*Mertensia paniculata*

Large leaved aster	*Aster macrophyllus*
Lupines	*Lupinus albus*
Orange hawkweed	*Hieracium aurantiacum*
Ox-eye daisy	*Leucanthemum vulgare*
Red clover	*Trifolium pratense*
Rose-twisted stalk	*Streptopus amplexifolius*
Rough Bedstraw	*Galium asprellum*
Sweet coltsfoot	*Petasites frigidus*
Swamp thistle	*Cirsium muticum*
Wild Columbine	*Aquilegia canadensis*
Wild Pea	*Lathyrus palustris*
Woodland strawberry	*Fragaria vesca*
Yarrow	*Achillea millefolium*
Yellow hawkweed	*Hieracium pratense*
Ferns/Mosses/Graminoids/Lichens	
Bulrush spp.	*Scirpus spp.*
Common reed	*Phragmites australis*
Dog's tooth lichen	*Peltigera canina*
Horsetail - field	*Equisetum arvense*
Horsetail - swamp	*Equisetum fluviatile*
Horsetail - woodland	*Equisetum sylvaticum*
Lady fern	*Athyrium filix-femina*
Oak fern	*Gymnocarpium dryopteris*
Plume moss	*Ptilium crista-castrensis*
Sedge spp.	*Carex spp.*
Sphagnum spp.	*Sphagnum spp.*
Aquatic Plants	
Common cattail	*Typha latifolia*

Fauna	
Common Name	**Scientific (Latin) Name**
Fish	
Smallmouth bass	*Micropterus dolomieu*
Emerald Shiner	*Notropis atherinoides*
Shiner spp.	*Notropis spp.*
Invertebrates	
Black flies	*Simuliidae spp.*
Eastern tiger swallowtail	*Papilio glaucus*
Midges	*Pseudochironomus spp.*
Mosquitoes	*Culicidae spp.*
Red ants	*Solenopsis spp.*
Spring azure	*Celastrina ladon*
Water spider	*Papilio glaucus*
Water strider	*Gerridae spp.*
Aves	
Canada goose	*Branta canadensis*
Ruffled grouse	*Bonasa umbellus*
Common merganser	*Mergus merganser*
Mammals	
White tail deer	*Odocoileus virginianus*

Appendix E:
Forest Ecosystem Classification

Appendix E: Forest Ecosystem Classification

Site 1, Site 2, Site 3 and Site 6: V12 White Spruce Mixedwood

Description: A variable mixedwood with white spruce as the main canopy species. The understory ranges from herb and shrub rich 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.

Common Overstory Species:
White spruce, balsam fir, 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, Tinetalis borealis, Galium triflorum, Aster macrophyllus, Mitella nuda, Viola renifolia, Anemone quinquefolia, Petasites palmatus*
Mosses:	*Pleurozium schreberi, Ptillium crista-castrensis, Rhytidiadelphus triquetrus, Plagiomnium cuspidatum*

Forest Floor Cover:

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

Site 4 and Site 5: V7 Trembling Aspen – Balsam Fir/Balsam Fir Shrub

Description: Hardwood mixed woods, 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* is often abundant. This occurs mainly on deep, fresh, well-drained, fine-textured mineral soils.

Common Overstory Species:
Balsam fir, trembling aspen, white birch, white spruce, black spruce, jack pine

Common Understory Species:

Shrubs:	*Abies balsamia, Rubus pubescens, Diervilla lonicera, Acer spicatum, Rosa acicularis, Populus tremuloides, 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, Gallium trifoli*
Mosses:	*Pleurozium schreberi, Rhytidiadelphus triquetrus*

Forest Floor Cover:

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

Site 7: V19 Black Spruce Mixedwood/ Herb Rich

Description: A black spruce mixedwood type with several potential in overstory. The understory is typically dominated by a rich herb/ 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 of site conditions although mostly on fresh to most mineral soils.

Common Overstory Species:
Black spruce, trembling aspen, balsam fir, white birch, white spruce, balsam poplar

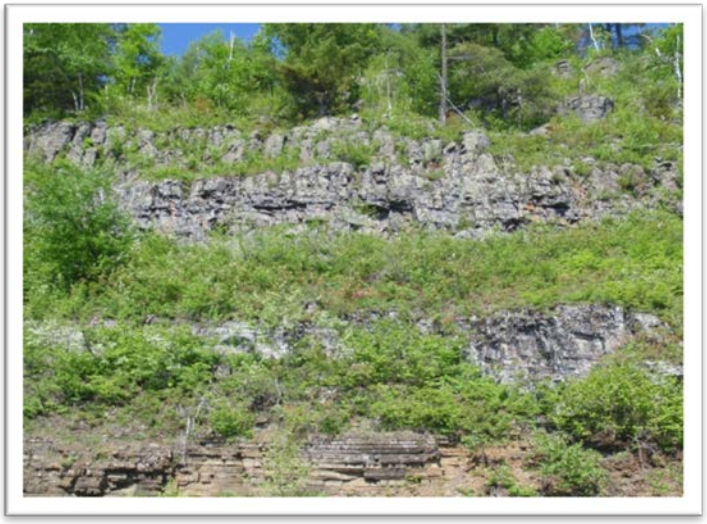
Common Understory Species:

Shrubs:	*Linnaea borealis,* balsam fir, *Rubus pubescens, Vaccinium myrtilloides,* black spruce, *Rosa acicularis, Amelanchier* spp., *Vaccinium angustifolium, Sorbus decora, Gaultheria hispidula, 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 polysetum, Hylocomium splendens, Rhytidiadelphus triquestrus*

Species	Broadleaf Litter	Moss	Conifer Litter	Wood
Forest Floor Cover (%)	33	49	12	0

Site 8: V12 White Pine Mixedwood

Description: Mixedwood stands, often with a tall overstory of white pine and a secondary canopy of other tree species. The understory is typically shrub and herb rich. Occurring on deep, fresh, non-calcareous, coarse-textured, upland mineral sites.



Common Overstory Species:
White pine, white birch, trembling aspen, balsam fir, white spruce, red pine, white cedar, black spruce, large-toothed aspen, jack pine, red maple

Common Understory Species:

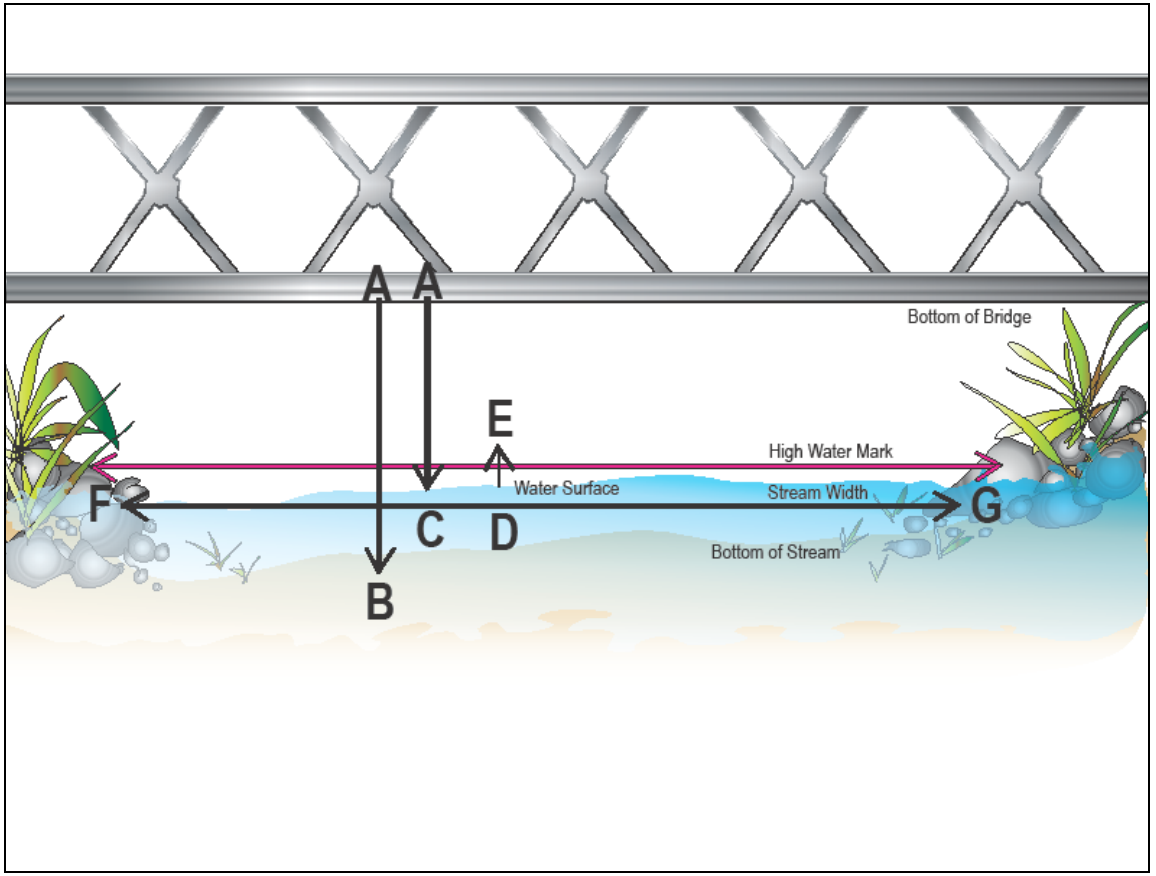
Shrubs:	balsam fir, *Corylus cornuta, Acer spicatum, Linnaea borealis, Amelanchier* spp., *Lonicera Canadensis, Diervilla lonicera,* trembling aspen
Herbs:	*Aralia nudicaulis, Maianthemum canadenses, Aster macrophyllus, Cornus canadensis, Trientalis borealis, Clintonia borealis, Streptopus roseus, Oryzopsis asperifolia*
Mosses:	*Pleurozium schreberi, Dicranum polysetum*

Forest Floor Cover:

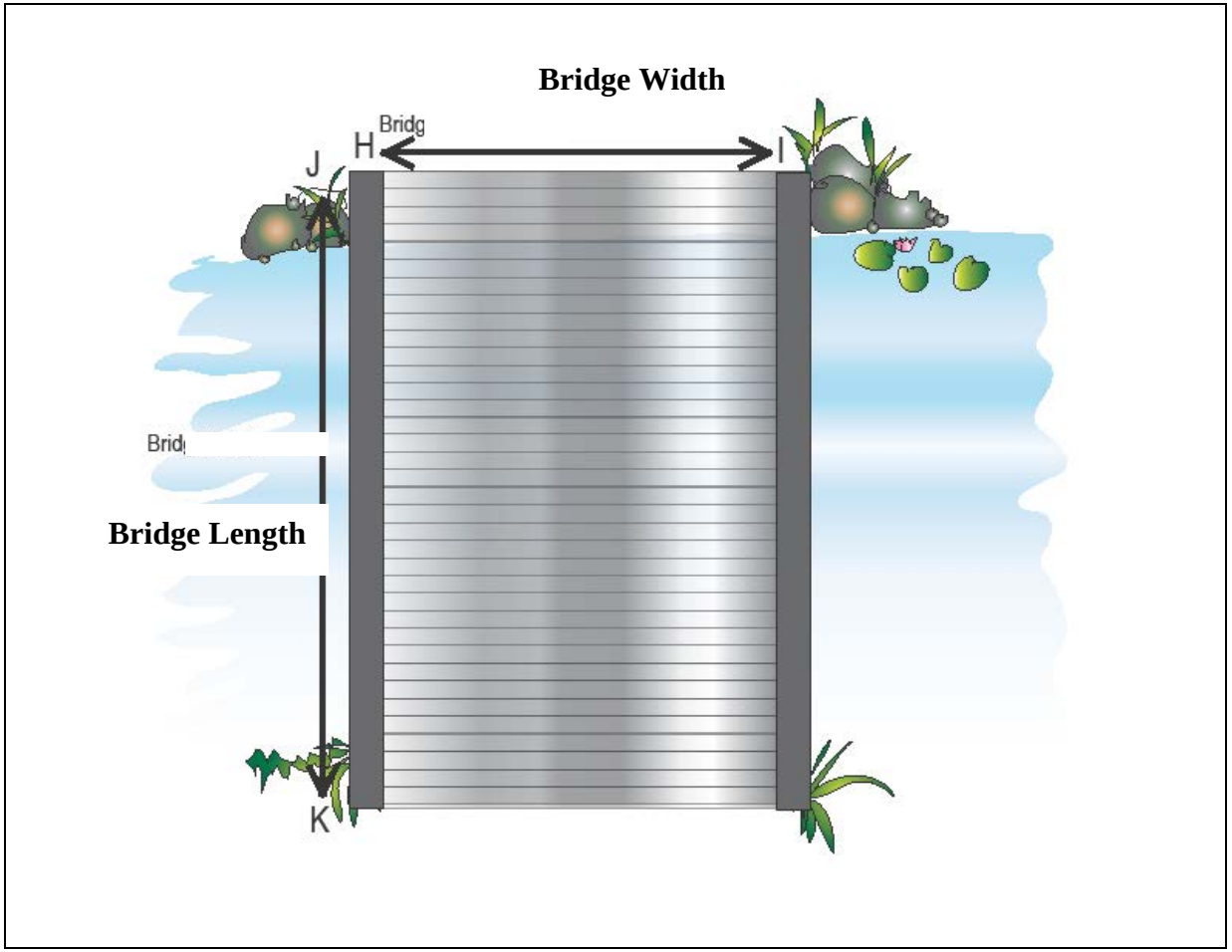
Species	Broadleaf Litter	Moss	Conifer Litter	Wood
Forest Floor Cover (%)	40	0	50	0

Appendix F:
Bridge Assessments

Appendix F: Bridge Assessments



Bridge Measurement Parameters



Bridge Measurement Parameters

Cloud River 2014 Bridge Measurements

Site Number	Bridge Number	**A-C** Bottom of Bridge to Water Surface (m)	**A-B** Bottom of Bridge to Bottom of Stream (m)	**D-E** Outlet Pool Water Surface to Outlet Pool High Water Mark (m)	**F-G** Width of Stream (m)	**H-I** Length of Bridge (m)	**J-K** Width of Bridge (m)
4	1	2.5	3.0	1.1	5.9	12.2	4.9
5	2	2.4	2.0	1.2	6.0	11.0	5.3

Bridge 1

Location: Cloud River Road East

GPS Coordinates: Northing 5332219 Easting 318169

Description: This bridge was a wooden bridge with a steel undercarriage and wooden planks on the deck. The wooden support cribs on either side of the bridge were filled in with cobble and gravel as well as geotextile cloth to filter runoff from the road. Along the side of the bridge there were wooden bumpers and guardrails. The boulders and cobble at the site were largely from the bridge construction. They were placed there to create a stable setting and for erosion control of the banks leading down to the road. The cribs did not enter the water; however the boulders at the footings of the bridge may have narrowed the channel. When the current water level was measured it was well below the high water mark. The bridge was in a low-lying area with steep hills on either side. The bridge was in very good condition.

Upstream

Downstream

Bridge 2

Location: Cloud River Road East

GPS Coordinates: Northing 5332284 Easting 318006

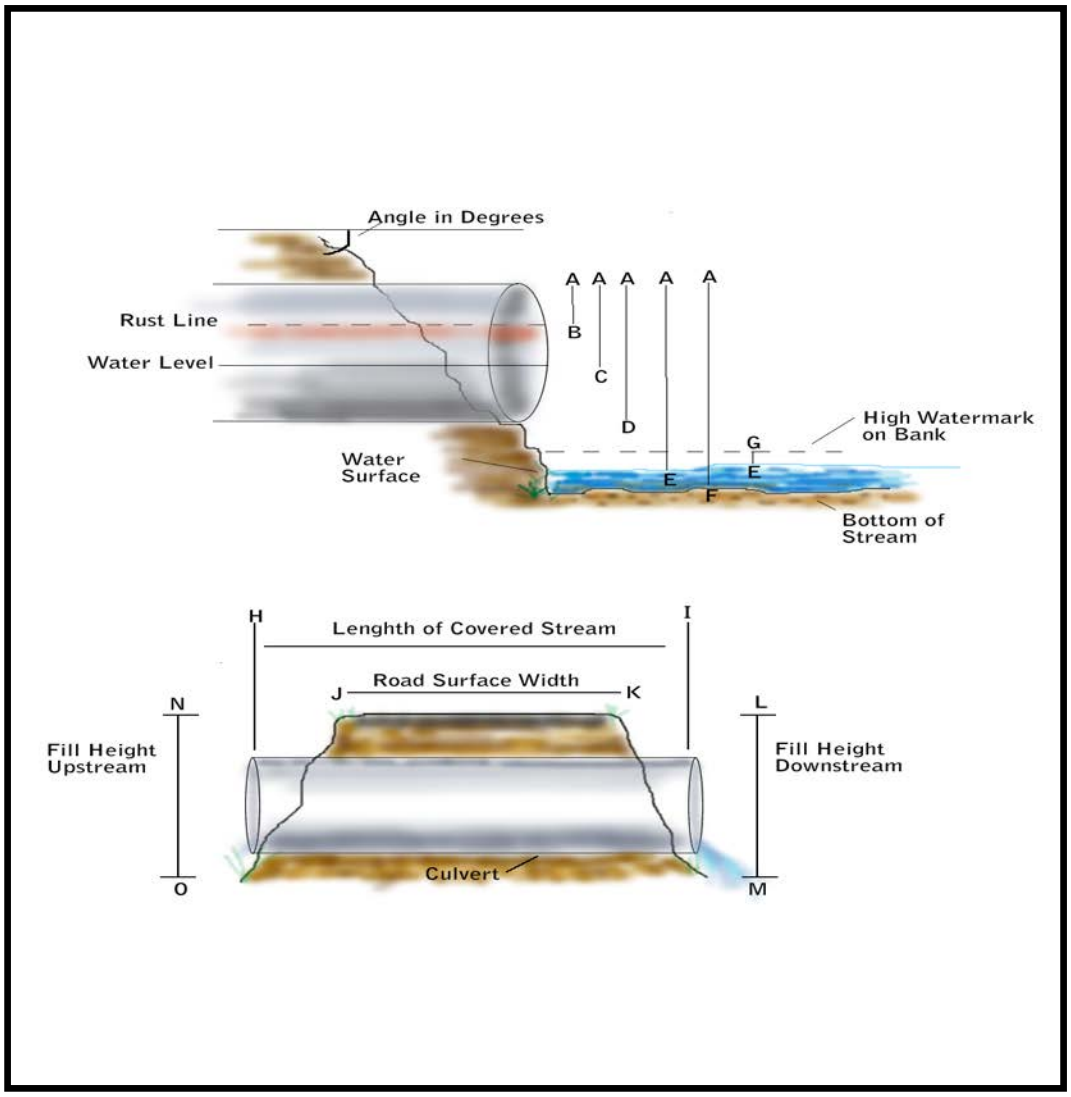
Description: This bridge was the same construction as Bridge 1 and was made of wood beams with steel support beams underneath and wooden cribs on either bank filled with gravel and cobble. The deck of the bridge was made of wooden planks with shallow wooden bumpers along the sides. Boulder and cobble were used as a base for the two cribs for stability, which joined well with the natural stream bank and substrate of the site. The banks of the river were well vegetated with shrubs which provided excellent erosion control. The water level at the time of the site visit was well below the high water mark. The bridge did not interfere with water flow and the channel width appears to be of natural course. The bridge was well maintained and in good condition.

Upstream

Downstream

Appendix G:
Culvert Assessments

Appendix G: Culvert Assessments



Cloud River 2014 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)
Culvert 1 Site 7	7.0	N/A	1.9	Could not reach	Upstream	2.0	1.4	1.6	1.6	0.6	1.8
					Downstream	2.0	-	-	-	-	-
Culvert 2* Site 6	N/A	18.0	N/A	N/A	Upstream	2.4	-	-	-	-	-
					Downstream	2.4	-	-	-	-	-
Culvert 3 Site 3	7.9	23.0	1.9	1.8	Upstream	3.0	N/A	2.9	2.9	0.7	3.0
					Downstream	3.0	N/A	2.9	2.9	0.7	3.0
Culvert 4 Site 2	8.9	20.0	1.4	1.2	Upstream	3.0	1.6	1.9	1.9	0.9	2.4
					Downstream	3.0	1.6	1.9	1.9	0.9	2.4

* Culvert was being replaced during time of July site visit. Measurements taken from the issued LRCA permit (22/14).

Culvert 1

Location: Accessed off of Highway 61, 200 metres down Jarvis Bay Road. West.

GPS Coordinates: Northing 5333566 Easting 317491

Description: This aluminum culvert was in good condition and was the optimal size to support water flow during times of high and low flow. Culvert measurements could only be taken downstream because it was not accessible upstream. No rust line was observed during either month. The water level was relatively low compared to the size of the culvert opening, but the culvert was not perched. There was evidence of slight erosion located on the downstream side.

Upstream

Downstream

Culvert 2

Location: Cloud River Road South, 350 metres south of Jarvis Bay Road East

GPS Coordinates: Northing 5333130 Easting 319255

Description: Culvert 2 was replaced this year with a permit issued by the LRCA (22/14). The measurements were taken from the permit application.

Upstream

Downstream

Culvert 3

Location: Cloud Bay Road, 2.3 kilometres south of Cloud River Road East.

GPS Coordinates: Northing 5329729 Easting 319025

Description: This was an aluminum culvert that appeared to be in excellent condition and seemed large enough to be able to support water flow during times of both high water level and low water level. No rust line was observed during either month. The water level was relatively low compared to the size of the culvert opening, but the culvert was not perched. Rip rap was used to prevent erosion around the culvert.

Upstream

Downstream

Culvert 4

Location: Accessed off of Highway 61, 1.8 kilometres down Little Trout Bay Road.

GPS Coordinates: Northing 5328612 Easting 317794

Description: This culvert was located down Little Trout Bay Road. The culvert appeared to be new and this was evident from the lack of rust present on the culvert. The culvert was in excellent condition and was large enough to support the water flowing through it. The culvert was also large enough to support any extra water that could be generated from heavy rainfall.

Upstream

Downstream

Appendix H:

Site Photography and Description

Appendix H: Site Photography and Description

Site 1 - Near the confluence of the Cloud River flowing into Lake Superior; accessed off of Highway 61, 3.5 kilometres down Little Trout Bay Road; private property.

A: Upstream

B: Downstream

C: Vegetation

Comments:

Sample Site 1 was located on the main channel of the Cloud River near the confluence with Lake Superior and was accessed from Little Trout Bay Road, 3.5 kilometres south of Highway 61. Access to the sampling site was on private property just off of a private driveway. The water was very murky and the substrate could not be identified. The water was very deep with uniformly slow moving water. The banks of the river appeared stable and were vegetated further back from the water with shrub, herb and grass growth on clay loam soil. No erosion was apparent along the banks of the channel. During the June sampling period a school of emerald shiner were seen at the sampling area.

Site 2 – Tributary to the main channel; accessed off of Highway 61, 1.8 kilometres down Little Trout Bay Road	
A: Upstream	**B: Downstream**
	
C: Vegetation	**D: Substrate Photo**
	

Comments:

Sample Site 2 was located on Little Trout Bay Road, 1.8 kilometres south of Highway 61 on a tributary to the main channel of the Cloud River. The water was relatively clear at the sample area. The dominate substrate observed was cobbles, boulders and gravels visible above the surface of the river. Terrestrial vegetation was abundant with many shrubs and herbs present along the banks of the creek. Aquatic vegetation was not present during both sample periods. During the visit in June a partridge was heard in the nearby forest.

Site 3 – Tributary to main channel; accessed off of Cloud River Rd, 2.3 kilometres down Cloud Bay Road South.

A: Upstream	B: Downstream
	

D: Substrate Photo

Comments:
Site 3 was located at a water crossing on a tributary flowing southwest to the main channel of the Cloud River. Assess was from Cloud River Road, 2.3 kilometers south Cloud Bay Road. The banks to access the creek were fairly steep with rip rap installed on both sides of the water crossing to eliminate road runoff into the stream. There did not seem to be any erosion present due to the rip rap installation and boulder and cobble substrate. Site 3 had varying channel depth due to large boulders with a moderate water flow. The terrestrial soils type at this site was clay loam. There was shrub growth right to the water's edge with 60 percent stream cover. Dominant vegetation in the area included balsam poplar, red osier dogwood, trembling aspen, serviceberry and speckled alder.

Site 4 - Cloud River; accessed off of Highway 61, 600 metres down Cloud River Road East (bridge site B1).

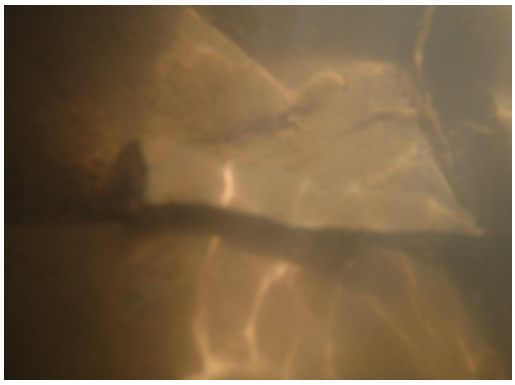
A: Upstream

B: Downstream

C: Vegetation

Comments:

Site 4 was located on Cloud River Road East, 600 metres east of Highway 61 and was characterized by a wooden bridge. There was no evidence of erosion at this site on each side of the bridge. The water levels appeared to be relatively uniform both upstream and downstream of the bridge. The water was moving at a fast pace and a velocity measurement was obtained. A high water mark was observed on both sides of the exposed banks, indicating a fluctuating water level. Vegetation along the banks was primarily grasses, herbs and shrubs. The soil was a clay loam. The banks of the river appeared to be in stable condition and there was no evidence of erosion.

Site 5 - Cloud River; accessed off of Highway 61, 400 metres down Cloud River Road East (bridge site B2).	
A: Upstream	**B: Downstream**
	
C: Vegetation	**D: Substrate Photo**
	

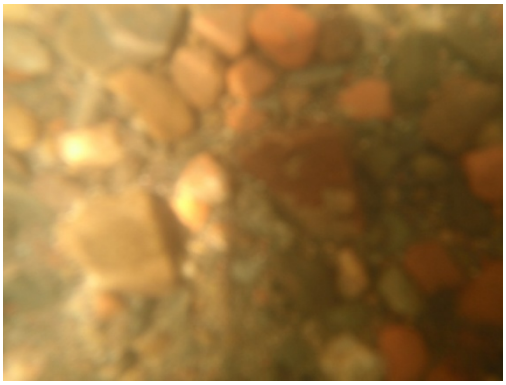
Comments:

Site 5 was located on the main channel of the Cloud River on Cloud River Road East, 400 metres east of Highway 61 and was characterized by a wooden bridge. The water was fast moving and relatively clear. The dominate substrate observed was muck, with boulders, cobbles and gravels present. The soil type was clay loam. There was no evidence of erosion occurring on the banks. There was little to no aquatic vegetation observed at this site as water was moving fast through the channel. The river had a relatively uniform width with alternating flow rates. The vegetation that was present on the bank was mainly shrubs and a few grasses. Further back from the river bank there was more diversity of shrubs, herbs and eventually trees.

Site 6 – Tributary to Cloud River; accessed off Jarvis Bay Road East, 350 metres down Cloud Bay Road South.	
A: Upstream	**B: Downstream**
	
C: Vegetation	
	

Comments:

Site 6 was located on a tributary to the Cloud River on Cloud Bay Road South, 350 metres south of Jarvis Bay Road East. This site had a culvert replaced in 2014 under LCRA permit 22/14. The original culvert was relatively large compared to the water level present and the water level in the past could be seen by the rust line inside the culvert. There was no measureable velocity present at the site. There was no significant bank erosion observed and the bank was covered by grasses, herbs and some shrubs. The vegetation cover provided good erosion control. There was a clear definition to the channel width which was meandering on both sides of the culvert. There was fairly little stream cover (0-5 percent). The stream cover came from the shrubs which were growing tall enough to cover a small portion of the river. Due to the colour of the water, a substrate photo was not obtained.

Site 7 – Tributary to the Cloud River; accessed off of Highway 61, 200 metres down Jarvis Bay Road West.	
A: Upstream	**B: Downstream**
	
C: Vegetation	**D: Substrate Photo**
	

Comments:

Site 7 was located on a tributary to Cloud River on Jarvis Bay Road West, 200 metres off of Highway 61 and was characterized a recently removed beaver dam just upstream. There was evidence of heavy erosion on the site and a majority of the trees upstream are damaged or dead from the pre-existing beaver dam. Upstream there was a stagnant pool of water that was likely due to stick debris containing water in the area. The substrate of the creek was mucky with some cobbles and gravels. Terrestrial vegetation was present at the site but no aquatic vegetation was presents during both site visits. The forest soil was determined to be clay loam supporting dominant vegetation species black spruce, tamarack, balsam fir and white birch.

Site 8 - Cloud Lake; accessed off of Highway 61, 9.6 metres down Cloud Lake Road.	
A: West Side	**B: East Side**
	
C: Vegetation	**D: Substrate Photo**
	

Comments:

Site 8 was located at Cloud Lake on Cloud Lake Road, west of Highway 61. The site was characterized by the shale cliff that was present near the shore of the lake. There was no aquatic vegetation present on the site during both visits but there were many shrubs and herbs along the shoreline. White pine was the dominate tree species on the shale cliff. White birch and white spruce were also present. The water at this site was relatively clear with a rocky bottom. The velocity was not measurable due to wind effect and non-flowing water. There were thousands of midges present at the sample site during the June visit suggesting that a hatching had just taken place. There was also a flock of Canada Geese flying over during sampling.

Appendix I:

Laboratory Water Quality Results Summary Table

Laboratory Water Quality Results for June 10-11, 2014

Parameter	Units	PWQO Criterion	CR1 Cloud River - SITE#1 11-Jun-14	CR2 Cloud River - SITE#2 11-Jun-14	CR3 Cloud River - SITE#3 11-Jun-14	CR4 Cloud River - SITE#4 11-Jun-14	CR5 Cloud River - SITE#5 10-Jun-14	CR6 Cloud River - SITE#6 10-Jun-14	CR7 Cloud River - SITE#7 10-Jun-14	CR8 Cloud River - SITE#8 10-Jun-14	Average June
Physical Tests											
Conductivity (EC)	(uS/cm)	N/A	130	223	90.4	113	100	89.8	213	68.4	128.5
pH		6.5-8.5	6.96	**6.46**	**6.30**	**6.35**	**6.27**	**6.25**	6.50	7.2	6.54
Total Dissolved Solids	(mg/L)	N/A	112	180	141	69	93	128	145	43	113.9
Turbidity	(NTU)	<10% of natural	29	23.9	25.6	26.1	20.2	30.5	15.9	1.38	21.6
Anions and Nutrients											
Alkalinity, Total (as CaCO3)	(mg/L)	25% of natural	55.4	74.7	42.1	48.8	42.2	42.3	90.9	30.4	53.4
Ammonia-N, Total	(mg/L)	N/A	<0.020	<0.020	0.025	<0.020	<0.020	<0.020	<0.020	<0.020	0.03
Chloride (Cl)	(mg/L)	N/A	4.50	23.0	0.67	3.26	1.87	0.99	1.23	1.37	4.61
Nitrate-N (NO3-N)	(mg/L)	N/A	0.039	<0.030	0.032	<0.030	0.031	<0.030	<0.030	0.039	0.035
Nitrite-N (NO2-N)	(mg/L)	N/A	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020
Total Kjeldahl Nitrogen	(mg/L)	N/A	0.854	1.10	1.35	0.667	0.605	1.42	0.869	0.526	0.924
Phosphorus (P)-Total	(mg/L)	0.03	**0.0411**	**0.0499**	**0.0407**	**0.0372**	**0.0356**	**0.0534**	**0.0387**	0.0165	**0.0391**
Sulphate (SO4)	(mg/L)	N/A	4.73	2.05	2.30	3.81	3.33	1.11	16.2	2.09	4.45
Bacteriological Tests											
Escherichia Coli	(MPN/100mL)	100	41	48	20	41	28	4	7	<1	27
Total Coliforms	(MPN/100mL)	1000 (prior to 1994)	**2420**	**>2420**	**2420**	**1990**	**1550**	**>2420**	**1550**	108	**1673**
Total Metals											
Aluminum (Al)-Total	(mg/L)	0.075	**1.35**	**1.48**	**2.23**	**1.13**	**0.696**	**2.04**	**0.566**	0.065	**1.195**
Antimony (Sb)-Total	(mg/L)	0.02	<0.00060	<0.00060	<0.00060	<0.00060	<0.00060	<0.00060	<0.00060	<0.00060	<0.00060
Arsenic (As)-Total	(mg/L)	0.005 (interim)	0.0012	<0.0010	0.0010	<0.0010	<0.0010	<0.0010	0.0019	<0.0010	0.0014
Barium (Ba)-Total	(mg/L)	N/A	0.022	0.024	0.024	0.017	0.013	0.025	0.024	<0.010	0.021
Beryllium (Be)-Total	(mg/L)	0.011	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Bismuth (Bi)-Total	(mg/L)	N/A	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Boron (B)-Total	(mg/L)	0.2	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Cadmium (Cd)-Total	(mg/L)	0.0001	0.000047	0.000065	0.000074	0.000037	0.000026	0.000076	0.00004	<0.000017	0.000052
Calcium (Ca)-Total	(mg/L)	N/A	15.3	22.1	12.5	14.8	11.9	11.0	29.8	7.58	15.62
Chromium (Cr)-Total	(mg/L)	N/A	0.0021	0.0024	0.0033	0.0018	0.0013	0.0036	0.0013	<0.0010	0.0023
Cobalt (Co)-Total	(mg/L)	0.0009	0.00066	0.00067	0.00077	0.00057	<0.00050	0.0009	<0.00050	<0.00050	0.00071
Copper (Cu)-Total	(mg/L)	0.001 (<20 mg/L CaCO3) 0.005 (>20 mg/L CaCO3)	**0.0063**	**0.0065**	**0.0072**	**0.0055**	0.0046	**0.0074**	**0.0070**	0.0022	**0.0058**
Iron (Fe)-Total	(mg/L)	0.3	**1.35**	**1.53**	**2.05**	**1.25**	**1.01**	**2.32**	**1.38**	0.129	**1.377**
Lead (Pb)-Total	(mg/L)	0.001	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Lithium (Li)-Total	(mg/L)	N/A	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Magnesium (Mg)-Total	(mg/L)	N/A	6.04	8.17	5.93	5.23	4.12	5.62	12.10	2.60	6.23

Bold indicates exceedance of PWQO criteria

Laboratory Water Quality Results for June 10-11, 2014

Parameter	Units	PWQO Criterion	CR1 Cloud River - SITE#1 11-Jun-14	CR2 Cloud River - SITE#2 11-Jun-14	CR3 Cloud River - SITE#3 11-Jun-14	CR4 Cloud River - SITE#4 11-Jun-14	CR5 Cloud River - SITE#5 10-Jun-14	CR6 Cloud River - SITE#6 10-Jun-14	CR7 Cloud River - SITE#7 10-Jun-14	CR8 Cloud River - SITE#8 10-Jun-14	Average June
Total Metals Continued											
Manganese (Mn)-Total	(mg/L)	N/A	0.0306	0.0461	0.0331	0.0282	0.0233	0.0453	0.125	0.0057	0.0422
Molybdenum (Mo)-Total	(mg/L)	0.004	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	0.0015	<0.0010	0.0015
Nickel (Ni)-Total	(mg/L)	0.025	0.0032	0.0035	0.0042	0.0025	<0.0020	0.0045	0.0023	<0.0020	0.0034
Potassium (K)-Total	(mg/L)	N/A	1.23	1.41	1.04	1.16	0.97	1.18	1.54	0.74	1.16
Selenium (Se)-Total	(mg/L)	0.1	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Silver (Ag)-Total	(mg/L)	0.0001	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.0010
Sodium (Na)-Total	(mg/L)	N/A	3.36	14.8	1.85	2.62	1.94	1.79	3.02	1.39	3.85
Strontium (Sr)-Total	(mg/L)	N/A	0.0351	0.0472	0.0240	0.0349	0.0274	0.0273	0.0524	0.0195	0.0335
Tellurium (Te)-Total	(mg/L)	N/A	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Thallium (Tl)-Total	(mg/L)	0.0003	<0.00030	<0.00030	<0.00030	<0.00030	<0.00030	<0.00030	<0.00030	<0.00030	<0.0030
Tin (Sn)-Total	(mg/L)	N/A	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Titanium (Ti)-Total	(mg/L)	N/A	0.0367	0.0352	0.0610	0.0309	0.0182	0.0485	0.0157	<0.0020	0.0352
Tungsten (W)-Total	(mg/L)	0.03	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.0010
Uranium (U)-Total	(mg/L)	0.005	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Vanadium (V)-Total	(mg/L)	N/A	0.0040	0.0044	0.0056	0.0033	0.0026	0.0052	0.0031	<0.0010	0.0040
Zinc (Zn)-Total	(mg/L)	0.02 (interim)	0.0066	0.0068	0.0072	0.0052	0.004	0.0102	0.0040	<0.0030	0.0063
Zirconium (Zr)-Total	(mg/L)	0.004	0.0011	0.0011	0.0023	<0.0010	<0.0010	0.002	<0.0010	<0.0010	0.0016

Laboratory Water Quality Results for July 9-10, 2014

Parameter	Units	PWQO Criterion	CR1 Cloud River - SITE#1 10-Jul-14	CR2 Cloud River - SITE#2 10-Jul-14	CR3 Cloud River - SITE#3 10-Jul-14	CR4 Cloud River - SITE#4 09-Jul-14	CR5 Cloud River - SITE#5 09-Jul-14	CR6 Cloud River - SITE#6 10-Jul-14	CR7 Cloud River - SITE#7 09-Jul-14	CR8 Cloud River - SITE#8 09-Jul-14	Average July
Physical Tests											
Conductivity (EC)	(uS/cm)	N/A	163	289	94.2	166	172	88.6	287	69.7	166.2
pH		6.5-8.5	7.56	7.55	7.28	7.65	7.81	7.30	7.78	7.49	7.55
Total Dissolved Solids	(mg/L)	N/A	146	211	133	152	131	139	204	49	146
Turbidity	(NTU)	<10% of natural	36.7	25.8	33.5	48.2	28.6	24.7	9.97	0.71	26.0
Anions and Nutrients											
Alkalinity, Total (as CaCO3)	(mg/L)	25% of natural	65.9	88.0	44.5	72.1	79.1	42.4	123	27.6	67.8
Ammonia-N, Total	(mg/L)	N/A	0.052	<0.020	0.032	<0.020	<0.020	<0.020	0.023	0.044	0.038
Chloride (Cl)	(mg/L)	N/A	7.47	34.9	0.52	5.21	3.55	0.24	0.94	1.69	6.82
Nitrate-N (NO3-N)	(mg/L)	N/A	0.121	<0.030	0.055	0.056	0.073	<0.030	<0.030	0.041	0.069
Nitrite-N (NO2-N)	(mg/L)	N/A	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020
Total Kjeldahl Nitrogen	(mg/L)	N/A	1.28	1.45	1.72	1.24	0.977	1.60	0.960	0.564	1.224
Phosphorus (P)-Total	(mg/L)	0.03	**0.0568**	**0.0578**	**0.0529**	**0.0655**	**0.0423**	**0.0679**	**0.0383**	0.0101	**0.0490**
Sulphate (SO4)	(mg/L)	N/A	4.35	1.71	1.23	4.75	3.88	0.44	25.5	2.50	5.55
Bacteriological Tests											
Escherichia Coli	(MPN/100mL)	100	40	**150**	**160**	90	100	10	47	1	75
Total Coliforms	(MPN/100mL)	1000 (prior to 1994)	**3080**	**7270**	**2280**	**6130**	**4880**	**5790**	**>2420**	276	**4244**
Total Metals											
Aluminum (Al)-Total	(mg/L)	0.075	**1.85**	**1.26**	**2.23**	**2.44**	**1.16**	**1.52**	**0.404**	0.0476	**1.364**
Antimony (Sb)-Total	(mg/L)	0.02	<0.00060	<0.00060	<0.00060	<0.00060	<0.00060	<0.00060	<0.00060	<0.00060	<0.0060
Arsenic (As)-Total	(mg/L)	0.005 (interim)	0.0013	0.0012	0.0012	0.0014	0.0010	0.0011	0.0017	<0.0010	0.0013
Barium (Ba)-Total	(mg/L)	N/A	0.029	0.024	0.027	0.031	0.020	0.020	0.020	<0.010	0.0244
Beryllium (Be)-Total	(mg/L)	0.011	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Bismuth (Bi)-Total	(mg/L)	N/A	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Boron (B)-Total	(mg/L)	0.2	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Cadmium (Cd)-Total	(mg/L)	0.0001	0.000074	0.000073	0.00009	0.000086	0.000051	0.000077	0.000031	<0.000017	0.000069
Calcium (Ca)-Total	(mg/L)	N/A	18.8	22.5	13.5	20.3	19.9	10.3	33.2	7.36	18.23
Chromium (Cr)-Total	(mg/L)	N/A	0.0030	0.0024	0.0038	0.0037	0.0020	0.0030	<0.0010	<0.0010	0.0030
Cobalt (Co)-Total	(mg/L)	0.0009	**0.00094**	0.00072	**0.00097**	**0.00112**	0.00067	0.00084	<0.00050	<0.00050	0.00088
Copper (Cu)-Total	(mg/L)	0.001 (<20 mg/L CaCO3) 0.005 (>20 mg/L CaCO3)	**0.0071**	**0.0063**	**0.0074**	**0.0081**	**0.0065**	**0.0061**	0.0030	0.0015	**0.0058**
Iron (Fe)-Total	(mg/L)	0.3	**2.19**	**1.79**	**2.51**	**2.68**	**1.61**	**2.47**	**1.01**	0.076	**1.79**
Lead (Pb)-Total	(mg/L)	0.001	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Lithium (Li)-Total	(mg/L)	N/A	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Magnesium (Mg)-Total	(mg/L)	N/A	7.29	9.51	6.16	8.20	7.70	5.88	13.90	2.41	7.63

Bold indicates exceedance of PWQO criteria

Laboratory Water Quality Results for July 9-10, 2014

Parameter	Units	PWQO Criterion	CR1 Cloud River - SITE#1 11-Jun-14	CR2 Cloud River - SITE#2 11-Jun-14	CR3 Cloud River - SITE#3 11-Jun-14	CR4 Cloud River - SITE#4 09-Jul-14	CR5 Cloud River - SITE#5 09-Jul-14	CR6 Cloud River - SITE#6 10-Jun-14	CR7 Cloud River - SITE#7 09-Jul-14	CR8 Cloud River - SITE#8 09-Jul-14	Average July
Total Metals Continued											
Manganese (Mn)-Total	(mg/L)	N/A	0.0450	0.0608	0.0388	0.0493	0.0405	0.0624	0.0646	0.0064	0.046
Molybdenum (Mo)-Total	(mg/L)	0.004	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	0.0017	<0.0010	0.0017
Nickel (Ni)-Total	(mg/L)	0.025	0.0044	0.0039	0.0054	0.0051	0.0033	0.0041	<0.0020	<0.0020	0.0044
Potassium (K)-Total	(mg/L)	N/A	1.21	1.24	0.90	1.42	1.32	1.13	1.29	0.71	1.15
Selenium (Se)-Total	(mg/L)	0.1	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Silver (Ag)-Total	(mg/L)	0.0001	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.0010
Sodium (Na)-Total	(mg/L)	N/A	5.20	21.8	1.85	4.41	3.80	1.40	2.94	1.32	5.34
Strontium (Sr)-Total	(mg/L)	N/A	0.0419	0.0552	0.0267	0.0471	0.0418	0.0263	0.0552	0.0179	0.039
Tellurium (Te)-Total	(mg/L)	N/A	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Thallium (Tl)-Total	(mg/L)	0.0003	<0.00030	<0.00030	<0.00030	<0.00030	<0.00030	<0.00030	<0.00030	<0.00030	<0.00030
Tin (Sn)-Total	(mg/L)	N/A	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Titanium (Ti)-Total	(mg/L)	N/A	0.0476	0.0326	0.0469	0.0507	0.0283	0.0368	0.0104	<0.0020	0.036
Tungsten (W)-Total	(mg/L)	0.03	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Uranium (U)-Total	(mg/L)	0.005	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Vanadium (V)-Total	(mg/L)	N/A	0.0049	0.0042	0.0054	0.0057	0.0038	0.0049	0.0023	<0.0010	0.004
Zinc (Zn)-Total	(mg/L)	0.02 (interim)	0.0085	0.0059	0.0095	0.0108	0.0054	0.0147	0.0030	0.0045	0.0078
Zirconium (Zr)-Total	(mg/L)	0.004	0.0010	<0.0010	0.0014	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	0.0012

Appendix J:

Laboratory Certificates of Analysis and Test Results

LAKEHEAD REGION CONSERVATION AUTHORITY
ATTN: ATTN: SCOTT DREBIT
130 CONSERVATION ROAD
P.O. BOX 10427
THUNDER BAY ON P7B 6T8

Date Received: 11-JUN-14
Report Date: 20-JUN-14 14:48 (MT)
Version: FINAL

Client Phone: 807-344-5857

Certificate of Analysis

Lab Work Order #: L1468637

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

Bobbie Shortreed
Account Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1468637-1	L1468637-2	L1468637-3	L1468637-4	
	Description	WATER	WATER	WATER	WATER	
	Sampled Date	10-JUN-14	10-JUN-14	10-JUN-14	10-JUN-14	
	Sampled Time	10:20	12:10	13:20	14:45	
	Client ID	CLOUD RIVER - SITE #8	CLOUD RIVER - SITE #7	CLOUD RIVER - SITE #6	CLOUD RIVER - SITE #5	
Grouping	**Analyte**					
WATER						
Physical Tests	Conductivity (EC) (uS/cm)	68.4	213	89.8	100	
	Hardness (as CaCO3) (mg/L)	29.6	124	50.5	46.7	
	pH (pH)	7.20	6.50	6.25	6.27	
	Total Dissolved Solids (mg/L)	43	145	128	93	
	Turbidity (NTU)	1.38	15.9	30.5	20.2	
Anions and Nutrients	Alkalinity, Total (as CaCO3) (mg/L)	30.4	90.9	42.3	42.2	
	Ammonia, Total (as N) (mg/L)	<0.020	<0.020	<0.020	<0.020	
	Chloride (Cl) (mg/L)	1.37	1.23	0.99	1.87	
	Nitrate (as N) (mg/L)	0.039	<0.030	<0.030	0.031	
	Nitrite (as N) (mg/L)	<0.020	<0.020	<0.020	<0.020	
	Total Kjeldahl Nitrogen (mg/L)	0.526	0.869	1.42	0.605	
	Phosphorus (P)-Total (mg/L)	0.0165	0.0387	0.0534	0.0356	
	Sulfate (SO4) (mg/L)	2.09	16.2	1.11	3.33	
Bacteriological Tests	Escherichia Coli (MPN/100mL)	<1	7	4	28	
	Total Coliforms (MPN/100mL)	108	1550	>2420	1550	
Total Metals	Aluminum (Al)-Total (mg/L)	0.0651	0.566	2.04	0.696	
	Antimony (Sb)-Total (mg/L)	<0.00060	<0.00060	<0.00060	<0.00060	
	Arsenic (As)-Total (mg/L)	<0.0010	0.0019	<0.0010	<0.0010	
	Barium (Ba)-Total (mg/L)	<0.010	0.024	0.025	0.013	
	Beryllium (Be)-Total (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010	
	Bismuth (Bi)-Total (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010	
	Boron (B)-Total (mg/L)	<0.050	<0.050	<0.050	<0.050	
	Cadmium (Cd)-Total (mg/L)	<0.000017	0.000040	0.000076	0.000026	
	Calcium (Ca)-Total (mg/L)	7.58	29.8	11.0	11.9	
	Chromium (Cr)-Total (mg/L)	<0.0010	0.0013	0.0036	0.0013	
	Cobalt (Co)-Total (mg/L)	<0.00050	<0.00050	0.00090	<0.00050	
	Copper (Cu)-Total (mg/L)	0.0022	0.0070	0.0074	0.0046	
	Iron (Fe)-Total (mg/L)	0.129	1.38	2.32	1.01	
	Lead (Pb)-Total (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010	
	Lithium (Li)-Total (mg/L)	<0.050	<0.050	<0.050	<0.050	
	Magnesium (Mg)-Total (mg/L)	2.60	12.1	5.62	4.12	
	Manganese (Mn)-Total (mg/L)	0.0057	0.125	0.0453	0.0233	
	Molybdenum (Mo)-Total (mg/L)	<0.0010	0.0015	<0.0010	<0.0010	
	Nickel (Ni)-Total (mg/L)	<0.0020	0.0023	0.0045	<0.0020	
	Potassium (K)-Total (mg/L)	0.74	1.54	1.18	0.97	
	Selenium (Se)-Total (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010	

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1468637-1	L1468637-2	L1468637-3	L1468637-4	
	Description	WATER	WATER	WATER	WATER	
	Sampled Date	10-JUN-14	10-JUN-14	10-JUN-14	10-JUN-14	
	Sampled Time	10:20	12:10	13:20	14:45	
	Client ID	CLOUD RIVER - SITE #8	CLOUD RIVER - SITE #7	CLOUD RIVER - SITE #6	CLOUD RIVER - SITE #5	
Grouping	**Analyte**					
WATER						
Total Metals	Silver (Ag)-Total (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	
	Sodium (Na)-Total (mg/L)	1.39	3.02	1.79	1.94	
	Strontium (Sr)-Total (mg/L)	0.0195	0.0524	0.0273	0.0274	
	Tellurium (Te)-Total (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010	
	Thallium (Tl)-Total (mg/L)	<0.00030	<0.00030	<0.00030	<0.00030	
	Tin (Sn)-Total (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010	
	Titanium (Ti)-Total (mg/L)	<0.0020	0.0157	0.0485	0.0182	
	Tungsten (W)-Total (mg/L)	<0.010	<0.010	<0.010	<0.010	
	Uranium (U)-Total (mg/L)	<0.0050	<0.0050	<0.0050	<0.0050	
	Vanadium (V)-Total (mg/L)	<0.0010	0.0031	0.0052	0.0026	
	Zinc (Zn)-Total (mg/L)	<0.0030	0.0040	0.0102	0.0040	
	Zirconium (Zr)-Total (mg/L)	<0.0010	<0.0010	0.0020	<0.0010	

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Matrix Spike	Ammonia, Total (as N)	MS-B	L1468637-1, -2, -3, -4
Matrix Spike	Ammonia, Total (as N)	MS-B	L1468637-1, -2, -3, -4
Matrix Spike	Barium (Ba)-Total	MS-B	L1468637-1, -2, -3, -4
Matrix Spike	Calcium (Ca)-Total	MS-B	L1468637-1, -2, -3, -4
Matrix Spike	Magnesium (Mg)-Total	MS-B	L1468637-1, -2, -3, -4
Matrix Spike	Potassium (K)-Total	MS-B	L1468637-1, -2, -3, -4
Matrix Spike	Sodium (Na)-Total	MS-B	L1468637-1, -2, -3, -4
Matrix Spike	Strontium (Sr)-Total	MS-B	L1468637-1, -2, -3, -4

Qualifiers for Individual Parameters Listed:

Qualifier	Description
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 2320

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-IC-TB	Water	Chloride by Ion Chromatography	EPA 300.1 (modified)

Anions in aqueous matrices are analyzed using ion chromatography with conductivity and/or UV absorbance detectors.

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-L-CALC-WP	Water	Hardness Calculated	HARDNESS CALCULATED
N-TOTKJ-TB	Water	Total Kjeldahl Nitrogen by Colourimetry	APHA 4500-Norg B (modified)

Total Kjeldahl Nitrogen in aqueous matrices is analyzed using an autoanalyzer with colourimetric detection.

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-TB	Water	Nitrite by Ion Chromatography	EPA 300.1 (modified)

Anions in aqueous matrices are analyzed using ion chromatography with conductivity and/or UV absorbance detectors.

NO3-IC-TB	Water	Nitrate by Ion Chromatography	EPA 300.1 (modified)

Anions in aqueous matrices are analyzed using ion chromatography with conductivity and/or UV absorbance detectors.

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-TB	Water	Sulfate by Ion Chromatography	EPA 300.1 (modified)

Anions in aqueous matrices are analyzed using ion chromatography with conductivity and/or UV absorbance detectors.

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

Aqueous matrices are analyzed using gravimetry and evaporation

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.

TURBIDITY-TB	Water	Turbidity	APHA 2130 B-Nephelometer

Reference Information

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

UMET-T-L-MS-WP Water Total Metals by ICP-MS APHA 3030E/EPA 6020A

This analysis involves preliminary sample treatment by hotblock acid digestion (APHA 3030E). Instrumental analysis is by inductively coupled plasma - mass spectrometry (EPA Method 6020A).

** 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
WP	ALS ENVIRONMENTAL - WINNIPEG, MANITOBA, CANADA

Chain of Custody Numbers:

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
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-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
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.

ALS Environmental

ADDRESS 1081 Barton Street, Thunder Bay Ontario P7B 5N3 Canada PHONE +1 807 623 6463 FAX +1 807 623 7598
ALS CANADA LIMITED Part of the ALS Group A Campbell Brothers Limited Company www.alsglobal.com

L1468637

Company:	Lakehead Region Conservation Authority		
Contact:	Scott Drebit		
Address:	130 Conservation Rd. P7B 6T8		
Phone:	807-344-5857	Fax:	807-345-9156
Email:	scott@lakeheadca.com;tammy@lakeheadca.com,info@lakeheadca.com		
Project:	Cloud River	PO:	
Quote #	Q40232		
Invoice To:	Tammy Cook	Same as Report:	☑ Yes ☐ No
Company:	Lakehead Region Conservation Authority		
Contact:	Scott Drebit		
Address:	130 Conservation Rd Box 10427		
Email:			
Account Manager		Sampler:	S. Drebit A. Suttie

Regulatory Information

- ☐ O. Reg 153 (O. Reg 511 Amend) Table:____
- Record of Site Condition ☐ Yes ☐ No
- PWQO ☒ MISA ☐ MMER ☐ CCME ☐
- Guideline Required:
- TCLP Regulation 558 ☐ Other:

Service Requested

- ☒ Regular TAT (7 Days)
- ☐ Priority TAT 50% Surcharge (3-5 Days)
- ☐ Emergency TAT 100% Surcharge (1-2 Days)
- Specify Date Required:

All TAT quoted material is in business days which exclude statutory holidays and weekends. Samples received past 3:00pm or Saturday/Sunday begin the next day.

Both questions below must answered for water samples

- Are any samples taken from a regulated DW System? ☐ Yes ☒ No
- If yes, an authorized DW COC must be used.
- Is the water sampled intended for human consumption? ☐ Yes ☒ No

Analysis Request

Please indicate below Filtered, Preserved or both (F, P, F/P)

Sample #	Sample Identification (This description will appear on the report)	Date	Time	Sample Type	Alkalinity, CL, Conductivity, Hardness, TKN	NH3, NO2, NO3, Total Phosphours	pH, SO4, Solids, TC, EC, Turbidity	Routine	Metals							Number of Containers
CR8	Cloud River - Site # 8	06/10/14	10:20	grab	x	x	x	x	x							4
CR7	Cloud River - Site #7	06/10/14	12:10	grab	x	x	x	x	x							4
CR6	Cloud River - Site # 6	06/10/14	13:20	grab	x	x	x	x	x							4
CR5	Cloud River - Site # 5	06/10/14	14:45	grab	x	x	x	x	x							4
					x	x	x									
					x	x	x									
					x	x	x									
					x	x	x									
					x	x	x									
					x	x	x									
					x	x	x									

Special Instructions / Comments

L1468637-COFC

SHIPMENT RELEASE (client use)		SHIPMENT RECEPTION (lab use only)				SHIPMENT VERIFICATION (lab use only)		
Released by:	Date & Time	Received by:	Date & Time	Temp	Cooling Initiated	Verified by:	Date & Time	Observations: Yes / No ? If Yes add SIF
Asuttie	06/10/14 9:15		11/6/14 9:15	1.4	☑ Yes ☐ No		11/6/14 9:50	

***Failure to complete all portions of this form may delay analysis.* **TAT may vary dependant on complexity of analysis and lab workload at time of submission. Please contact the lab to confirm TATs. Any known or suspected hazards relating to a sample must be noted on the chain of custody in the comments section. By use of the form the user acknowledges and agrees with the Terms and Conditions as specified on the back page.

LAKEHEAD REGION CONSERVATION AUTHORITY
ATTN: ATTN:
130 CONSERVATION ROAD
P.O. BOX 10427
THUNDER BAY ON P7B 6T8

Date Received: 12-JUN-14
Report Date: 24-JUN-14 06:51 (MT)
Version: FINAL

Client Phone: 807-344-5857

Certificate of Analysis

Lab Work Order #: L1469471

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

Bobbie Shortreed
Account Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

Grouping	Analyte	L1469471-1 GRAB 11-JUN-14 13:40 CLOUD RIVER - SITE #1	L1469471-2 GRAB 11-JUN-14 12:30 CLOUD RIVER - SITE #2	L1469471-3 GRAB 11-JUN-14 11:30 CLOUD RIVER - SITE #3	L1469471-4 GRAB 11-JUN-14 10:20 CLOUD RIVER - SITE #4	
WATER						
Physical Tests	Conductivity (EC) (uS/cm)	130	223	90.4	113	
	Hardness (as CaCO3) (mg/L)	63.0	88.8	55.6	58.4	
	pH (pH)	6.96	6.46	6.30	6.35	
	Total Dissolved Solids (mg/L)	112	180	141	69	
	Turbidity (NTU)	29.0	23.9	25.6	26.1	
Anions and Nutrients	Alkalinity, Total (as CaCO3) (mg/L)	55.4	74.7	42.1	48.8	
	Ammonia, Total (as N) (mg/L)	<0.020	<0.020	0.025	<0.020	
	Chloride (Cl) (mg/L)	4.50	23.0	0.67	3.26	
	Nitrate (as N) (mg/L)	0.039	<0.030	0.032	<0.030	
	Nitrite (as N) (mg/L)	<0.020	<0.020	<0.020	<0.020	
	Total Kjeldahl Nitrogen (mg/L)	0.854	1.10	1.35	0.667	
	Phosphorus (P)-Total (mg/L)	0.0411	0.0499	0.0407	0.0372	
	Sulfate (SO4) (mg/L)	4.73	2.05	2.30	3.81	
Bacteriological Tests	Escherichia Coli (MPN/100mL)	41	48	20	41	
	Total Coliforms (MPN/100mL)	2420	>2420	2420	1990	
Total Metals	Aluminum (Al)-Total (mg/L)	1.35	1.48	2.23	1.13	
	Antimony (Sb)-Total (mg/L)	<0.00060	<0.00060	<0.00060	<0.00060	
	Arsenic (As)-Total (mg/L)	0.0012	<0.0010	0.0010	<0.0010	
	Barium (Ba)-Total (mg/L)	0.022	0.024	0.024	0.017	
	Beryllium (Be)-Total (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010	
	Bismuth (Bi)-Total (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010	
	Boron (B)-Total (mg/L)	<0.050	<0.050	<0.050	<0.050	
	Cadmium (Cd)-Total (mg/L)	0.000047	0.000065	0.000074	0.000037	
	Calcium (Ca)-Total (mg/L)	15.3	22.1	12.5	14.8	
	Chromium (Cr)-Total (mg/L)	0.0021	0.0024	0.0033	0.0018	
	Cobalt (Co)-Total (mg/L)	0.00066	0.00067	0.00077	0.00057	
	Copper (Cu)-Total (mg/L)	0.0063	0.0065	0.0072	0.0055	
	Iron (Fe)-Total (mg/L)	1.35	1.53	2.05	1.25	
	Lead (Pb)-Total (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010	
	Lithium (Li)-Total (mg/L)	<0.050	<0.050	<0.050	<0.050	
	Magnesium (Mg)-Total (mg/L)	6.04	8.17	5.93	5.23	
	Manganese (Mn)-Total (mg/L)	0.0306	0.0461	0.0331	0.0282	
	Molybdenum (Mo)-Total (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010	
	Nickel (Ni)-Total (mg/L)	0.0032	0.0035	0.0042	0.0025	
	Potassium (K)-Total (mg/L)	1.23	1.41	1.04	1.16	
	Selenium (Se)-Total (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010	

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1469471-1	L1469471-2	L1469471-3	L1469471-4	
	Description	GRAB	GRAB	GRAB	GRAB	
	Sampled Date	11-JUN-14	11-JUN-14	11-JUN-14	11-JUN-14	
	Sampled Time	13:40	12:30	11:30	10:20	
	Client ID	CLOUD RIVER - SITE #1	CLOUD RIVER - SITE #2	CLOUD RIVER - SITE #3	CLOUD RIVER - SITE #4	
Grouping	**Analyte**					
WATER						
Total Metals	Silver (Ag)-Total (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	
	Sodium (Na)-Total (mg/L)	3.36	14.8	1.85	2.62	
	Strontium (Sr)-Total (mg/L)	0.0351	0.0472	0.0240	0.0349	
	Tellurium (Te)-Total (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010	
	Thallium (Tl)-Total (mg/L)	<0.00030	<0.00030	<0.00030	<0.00030	
	Tin (Sn)-Total (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010	
	Titanium (Ti)-Total (mg/L)	0.0367	0.0352	0.0610	0.0309	
	Tungsten (W)-Total (mg/L)	<0.010	<0.010	<0.010	<0.010	
	Uranium (U)-Total (mg/L)	<0.0050	<0.0050	<0.0050	<0.0050	
	Vanadium (V)-Total (mg/L)	0.0040	0.0044	0.0056	0.0033	
	Zinc (Zn)-Total (mg/L)	0.0066	0.0068	0.0072	0.0052	
	Zirconium (Zr)-Total (mg/L)	0.0011	0.0011	0.0023	<0.0010	

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Duplicate	Escherichia Coli	DUPM	L1469471-1, -2, -3, -4
Matrix Spike	Sulfate (SO4)	MS-B	L1469471-1, -2, -3, -4
Matrix Spike	Aluminum (Al)-Total	MS-B	L1469471-1, -2, -3, -4
Matrix Spike	Barium (Ba)-Total	MS-B	L1469471-1, -2, -3, -4
Matrix Spike	Calcium (Ca)-Total	MS-B	L1469471-1, -2, -3, -4
Matrix Spike	Iron (Fe)-Total	MS-B	L1469471-1, -2, -3, -4
Matrix Spike	Magnesium (Mg)-Total	MS-B	L1469471-1, -2, -3, -4
Matrix Spike	Manganese (Mn)-Total	MS-B	L1469471-1, -2, -3, -4
Matrix Spike	Sodium (Na)-Total	MS-B	L1469471-1, -2, -3, -4
Matrix Spike	Strontium (Sr)-Total	MS-B	L1469471-1, -2, -3, -4
Matrix Spike	Titanium (Ti)-Total	MS-B	L1469471-1, -2, -3, -4

Qualifiers for Individual Parameters Listed:

Qualifier	Description
DUPM	MPN duplicate results were outside default ALS Data Quality Objective, but within 95% confidence interval for MPN reference method. Sample results are reliable.
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 2320
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-IC-TB	Water	Chloride by Ion Chromatography	EPA 300.1 (modified)
Anions in aqueous matrices are analyzed using ion chromatography with conductivity and/or UV absorbance detectors.			
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-L-CALC-WP	Water	Hardness Calculated	HARDNESS CALCULATED
N-TOTKJ-TB	Water	Total Kjeldahl Nitrogen by Colourimetry	APHA 4500-Norg B (modified)
Total Kjeldahl Nitrogen in aqueous matrices is analyzed using an autoanalyzer with colourimetric detection.			
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-TB	Water	Nitrite by Ion Chromatography	EPA 300.1 (modified)
Anions in aqueous matrices are analyzed using ion chromatography with conductivity and/or UV absorbance detectors.			
NO3-IC-TB	Water	Nitrate by Ion Chromatography	EPA 300.1 (modified)
Anions in aqueous matrices are analyzed using ion chromatography with conductivity and/or UV absorbance detectors.			
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-TB	Water	Sulfate by Ion Chromatography	EPA 300.1 (modified)
Anions in aqueous matrices are analyzed using ion chromatography with conductivity and/or UV absorbance detectors.			
SOLIDS-TDS-TB	Water	Total Dissolved Solids	APHA 2540 C (modified)
Aqueous matrices are analyzed using gravimetry and evaporation			
TC,EC-QT97-TB	Water	Total Coliform and E.coli	APHA 9223 B

Reference Information

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.

TURBIDITY-TB Water Turbidity APHA 2130 B-Nephelometer

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

UMET-T-L-MS-WP Water Total Metals by ICP-MS APHA 3030E/EPA 6020A

This analysis involves preliminary sample treatment by hotblock acid digestion (APHA 3030E). Instrumental analysis is by inductively coupled plasma - mass spectrometry (EPA Method 6020A).

** 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
WP	ALS ENVIRONMENTAL - WINNIPEG, MANITOBA, CANADA

Chain of Custody Numbers:

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
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-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
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.

ALS Environmental

ADDRESS 1081 Barton Street, Thunder Bay Ontario P7B 5N3 Canada | PHONE +1 807 623 6463 | FAX +1 807 623 7598
ALS CANADA LIMITED Part of the ALS Group A Campbell Brothers Limited Company www.alsglobal.com

L1469471

Company:	Lakehead Region Conservation Authority		
Contact:	Scott Drebit		
Address:	130 Conservation Rd. P7B 6T8		
Phone:	807-344-5857	Fax:	807-345-9156
Email:	scott@lakeheadca.com;tammy@lakeheadca.com,info@lakeheadca.com		
Project:	Cloud River	PO:	
Quote #	Q40232		
Invoice To:	Tammy Cook	Same as Report:	☑ Yes ☐ No
Company:	Lakehead Region Conservation Authority		
Contact:	Scott Drebit		
Address:	130 Conservation Rd. Box 10427		
Email:	scott@lakeheadca.com		
Account Manager		Sampler:	S. Drebit + A. Suttie

Regulatory Information

- ☐ O. Reg 153 (O. Reg 511 Amend) Table:____
- Record of Site Condition ☐ Yes ☐ No
- PWQO ☒ MISA ☐ MMER ☐ CCME ☐
- Guideline Required:
- TCLP Regulation 558 ☐ Other:

Service Requested

- ☒ Regular TAT (7 Days)
- ☐ Priority TAT 50% Surcharge (3-5 Days)
- ☐ Emergency TAT 100% Surcharge (1-2 Days)
- Specify Date Required:

All TAT quoted material is in business days which exclude statutory holidays and weekends. Samples received past 3:00pm or Saturday/Sunday begin the next day.

Both questions below must answered for water samples

Are any samples taken from a regulated DW System? ☐ Yes ☒ No

If yes, an authorized DW COC must be used.

Is the water sampled intended for human consumption? ☐ Yes ☒ No

Analysis Request

Please indicate below Filtered, Preserved or both (F, P, F/P)

Sample #	Sample Identification (This description will appear on the report)	Date	Time	Sample Type	Alkalinity, Cl, Conductivity, Hardness, TKN -	NH3, NO2, NO3, Total Phosphours	pH, SO4, Solids, TC-EC, Turbidity	Routine	Metals								Number of Containers
CR1	Cloud River - Site # 1	06/11/14	13:40	Grab	x	x	x	x	x								4
CR2	Cloud River - Site # 2	06/11/14	12:30	Grab	x	x	x	x	x								4
CR3	Cloud River - Site # 3	06/11/14	11:30	Grab	x	x	x	x	x								4
CR4	Cloud River - Site # 4	06/11/14	10:20	Grab	x	x	x	x	x								4
					x	x	x										
					x	x	x										
					x	x	x										
					x	x	x										
					x	x	x										
					x	x	x										
					x	x	x										

Special Instructions / Comments

L1469471-COFC

SHIPMENT RELEASE (client use)		SHIPMENT RECEPTION (lab use only)				SHIPMENT VERIFICATION (lab use only)		
Released by:	Date & Time	Received by:	Date & Time	Temp	Cooling Initiated	Verified by:	Date & Time	Observations:
A Suttie	06/12/14 9:52		12-6-14 9:55	7.1	☑ Yes ☐ No		12-6-14 10:05	Yes (No) If Yes add SIF

Failure to complete all portions of this form may delay analysis. **TAT may vary dependant on complexity of analysis and lab workload at time of submission. Please contact the lab to confirm TATs. Any known or suspected hazards relating to a sample must be noted on the chain of custody in the comments section. By use of the form the user acknowledges and agrees with the Terms and Conditions as specified on the back page.

LAKEHEAD REGION CONSERVATION AUTHORITY
ATTN: Tammy Cook
130 CONSERVATION ROAD
P.O. BOX 10427
THUNDER BAY ON P7B 6T8

Date Received: 10-JUL-14
Report Date: 21-JUL-14 03:58 (MT)
Version: FINAL

Client Phone: 807-344-5857

Certificate of Analysis

Lab Work Order #: L1484535

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

Bobbie Shortreed
Account Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

Grouping	Analyte	L1484535-1 GRAB 09-JUL-14 10:15 CLOUD RIVER-SITE #8	L1484535-2 GRAB 09-JUL-14 11:20 CLOUD RIVER-SITE #7	L1484535-3 GRAB 09-JUL-14 12:15 CLOUD RIVER-SITE #4	L1484535-4 GRAB 09-JUL-14 13:00 CLOUD RIVER-SITE #5	
WATER						
Physical Tests	Conductivity (EC) (uS/cm)	69.7	287	166	172	
	Hardness (as CaCO3) (mg/L)	28.3	140	84.5	81.5	
	pH (pH)	7.49	7.78	7.65	7.81	
	Total Dissolved Solids (mg/L)	49	204	152	131	
	Turbidity (NTU)	0.71	9.97	48.2	28.6	
Anions and Nutrients	Alkalinity, Total (as CaCO3) (mg/L)	27.6	123	72.1	79.1	
	Ammonia, Total (as N) (mg/L)	0.044	0.023	<0.020	<0.020	
	Chloride (Cl) (mg/L)	1.69	0.94	5.21	3.55	
	Nitrate (as N) (mg/L)	0.041	<0.030	0.056	0.073	
	Nitrite (as N) (mg/L)	<0.020	<0.020	<0.020	<0.020	
	Total Kjeldahl Nitrogen (mg/L)	0.564	0.960	1.24	0.977	
	Phosphorus (P)-Total (mg/L)	0.0101	0.0383	0.0655	0.0423	
	Sulfate (SO4) (mg/L)	2.50	25.5	4.75	3.88	
Bacteriological Tests	Escherichia Coli (MPN/100mL)	1	47	90	100	
	Total Coliforms (MPN/100mL)	276	>2420	6130	4880	
Total Metals	Aluminum (Al)-Total (mg/L)	0.0476	0.404	2.44	1.16	
	Antimony (Sb)-Total (mg/L)	<0.00060	<0.00060	<0.00060	<0.00060	
	Arsenic (As)-Total (mg/L)	<0.0010	0.0017	0.0014	0.0010	
	Barium (Ba)-Total (mg/L)	<0.010	0.020	0.031	0.020	
	Beryllium (Be)-Total (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010	
	Bismuth (Bi)-Total (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010	
	Boron (B)-Total (mg/L)	<0.050	<0.050	<0.050	<0.050	
	Cadmium (Cd)-Total (mg/L)	<0.000017	0.000031	0.000086	0.000051	
	Calcium (Ca)-Total (mg/L)	7.36	33.2	20.3	19.9	
	Chromium (Cr)-Total (mg/L)	<0.0010	<0.0010	0.0037	0.0020	
	Cobalt (Co)-Total (mg/L)	<0.00050	<0.00050	0.00112	0.00067	
	Copper (Cu)-Total (mg/L)	0.0015	0.0030	0.0081	0.0065	
	Iron (Fe)-Total (mg/L)	0.076	1.01	2.68	1.61	
	Lead (Pb)-Total (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010	
	Lithium (Li)-Total (mg/L)	<0.050	<0.050	<0.050	<0.050	
	Magnesium (Mg)-Total (mg/L)	2.41	13.9	8.20	7.70	
	Manganese (Mn)-Total (mg/L)	0.0064	0.0646	0.0493	0.0405	
	Molybdenum (Mo)-Total (mg/L)	<0.0010	0.0017	<0.0010	<0.0010	
	Nickel (Ni)-Total (mg/L)	<0.0020	<0.0020	0.0051	0.0033	
	Potassium (K)-Total (mg/L)	0.71	1.29	1.42	1.32	
	Selenium (Se)-Total (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010	

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1484535-1	L1484535-2	L1484535-3	L1484535-4	
	Description	GRAB	GRAB	GRAB	GRAB	
	Sampled Date	09-JUL-14	09-JUL-14	09-JUL-14	09-JUL-14	
	Sampled Time	10:15	11:20	12:15	13:00	
	Client ID	CLOUD RIVER-SITE #8	CLOUD RIVER-SITE #7	CLOUD RIVER-SITE #4	CLOUD RIVER-SITE #5	
Grouping	**Analyte**					
WATER						
Total Metals	Silver (Ag)-Total (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	
	Sodium (Na)-Total (mg/L)	1.32	2.94	4.41	3.80	
	Strontium (Sr)-Total (mg/L)	0.0179	0.0552	0.0471	0.0418	
	Tellurium (Te)-Total (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010	
	Thallium (Tl)-Total (mg/L)	<0.00030	<0.00030	<0.00030	<0.00030	
	Tin (Sn)-Total (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010	
	Titanium (Ti)-Total (mg/L)	<0.0020	0.0104	0.0507	0.0283	
	Tungsten (W)-Total (mg/L)	<0.010	<0.010	<0.010	<0.010	
	Uranium (U)-Total (mg/L)	<0.0050	<0.0050	<0.0050	<0.0050	
	Vanadium (V)-Total (mg/L)	<0.0010	0.0023	0.0057	0.0038	
	Zinc (Zn)-Total (mg/L)	0.0045	0.0030	0.0108	0.0054	
	Zirconium (Zr)-Total (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010	

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Duplicate	Cadmium (Cd)-Total	DLM	L1484535-1, -2, -3, -4
Duplicate	Escherichia Coli	DUPM	L1484535-1, -2, -3, -4
Matrix Spike	Sulfate (SO4)	MS-B	L1484535-1, -2, -3, -4
Matrix Spike	Aluminum (Al)-Total	MS-B	L1484535-1, -2, -3, -4
Matrix Spike	Calcium (Ca)-Total	MS-B	L1484535-1, -2, -3, -4
Matrix Spike	Chromium (Cr)-Total	MS-B	L1484535-1, -2, -3, -4
Matrix Spike	Cobalt (Co)-Total	MS-B	L1484535-1, -2, -3, -4
Matrix Spike	Copper (Cu)-Total	MS-B	L1484535-1, -2, -3, -4
Matrix Spike	Iron (Fe)-Total	MS-B	L1484535-1, -2, -3, -4
Matrix Spike	Magnesium (Mg)-Total	MS-B	L1484535-1, -2, -3, -4
Matrix Spike	Nickel (Ni)-Total	MS-B	L1484535-1, -2, -3, -4
Matrix Spike	Strontium (Sr)-Total	MS-B	L1484535-1, -2, -3, -4
Matrix Spike	Antimony (Sb)-Total	MS-B	L1484535-1, -2, -3, -4
Matrix Spike	Barium (Ba)-Total	MS-B	L1484535-1, -2, -3, -4
Matrix Spike	Calcium (Ca)-Total	MS-B	L1484535-1, -2, -3, -4
Matrix Spike	Magnesium (Mg)-Total	MS-B	L1484535-1, -2, -3, -4
Matrix Spike	Molybdenum (Mo)-Total	MS-B	L1484535-1, -2, -3, -4
Matrix Spike	Potassium (K)-Total	MS-B	L1484535-1, -2, -3, -4
Matrix Spike	Sodium (Na)-Total	MS-B	L1484535-1, -2, -3, -4
Matrix Spike	Strontium (Sr)-Total	MS-B	L1484535-1, -2, -3, -4
Matrix Spike	Aluminum (Al)-Total	MS-B	L1484535-1, -2, -3, -4
Matrix Spike	Barium (Ba)-Total	MS-B	L1484535-1, -2, -3, -4
Matrix Spike	Calcium (Ca)-Total	MS-B	L1484535-1, -2, -3, -4
Matrix Spike	Iron (Fe)-Total	MS-B	L1484535-1, -2, -3, -4
Matrix Spike	Magnesium (Mg)-Total	MS-B	L1484535-1, -2, -3, -4
Matrix Spike	Manganese (Mn)-Total	MS-B	L1484535-1, -2, -3, -4
Matrix Spike	Sodium (Na)-Total	MS-B	L1484535-1, -2, -3, -4
Matrix Spike	Strontium (Sr)-Total	MS-B	L1484535-1, -2, -3, -4
Matrix Spike	Titanium (Ti)-Total	MS-B	L1484535-1, -2, -3, -4
Matrix Spike	Manganese (Mn)-Total	MS-B	L1484535-1, -2, -3, -4

Qualifiers for Individual Parameters Listed:

Qualifier	Description
DLM	Detection Limit Adjusted due to sample matrix effects.
DUPM	MPN duplicate results were outside default ALS Data Quality Objective, but within 95% confidence interval for MPN reference method. Sample results are reliable.
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 2320

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-IC-TB	Water	Chloride by Ion Chromatography	EPA 300.1 (modified)

Anions in aqueous matrices are analyzed using ion chromatography with conductivity and/or UV absorbance detectors.

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-MS-TB	Water	Total Metals by ICPMS	APHA 3030E/EPA 6020A

This analysis involves preliminary sample treatment by hotblock acid digestion (APHA 3030E). Instrumental analysis is by inductively coupled plasma - mass spectrometry (EPA Method 6020A).

Reference Information

N-TOTKJ-TB	Water	Total Kjeldahl Nitrogen by Colourimetry	APHA 4500-Norg B (modified)

Total Kjeldahl Nitrogen in aqueous matrices is analyzed using an autoanalyzer with colourimetric detection.

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-TB	Water	Nitrite by Ion Chromatography	EPA 300.1 (modified)

Anions in aqueous matrices are analyzed using ion chromatography with conductivity and/or UV absorbance detectors.

NO3-IC-TB	Water	Nitrate by Ion Chromatography	EPA 300.1 (modified)

Anions in aqueous matrices are analyzed using ion chromatography with conductivity and/or UV absorbance detectors.

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-TB	Water	Sulfate by Ion Chromatography	EPA 300.1 (modified)

Anions in aqueous matrices are analyzed using ion chromatography with conductivity and/or UV absorbance detectors.

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

Aqueous matrices are analyzed using gravimetry and evaporation

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.

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

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
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-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
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.

ALS Environmental

ADDRESS 1081 Barton Street, Thunder Bay Ontario P7B 5N3 Canada PHONE +1 807 623 6463 FAX +1 807 623 7598
ALS CANADA LIMITED Part of the ALS Group A Campbell Brothers Limited Company www.alsglobal.com

L1484535

Company:	Lakehead Region Conservation Authority		
Contact:	Scott Drebit		
Address:	130 Conservation Rd. P7B 6T8		
Phone:	807-344-5857	Fax:	807-345-9156
Email:	scott@lakeheadca.com;tammy@lakeheadca.com,info@lakeheadca.com		
Project:	Cloud River	PO:	
Quote #	Q40232		
Invoice To:	Tammy Cook	Same as Report:	☑ Yes ☐ No
Company:	Lakehead Region Conservation Authority		
Contact:	Scott Drebit		
Address:	130 Conservation Rd. Box 10427		
Email:	scott@lakeheadca.com		
Account Manager		Sampler:	S. Drebit + A. Suttie

Regulatory Information

- ☐ O. Reg 153 (O. Reg 511 Amend) Table:____
- Record of Site Condition ☐ Yes ☐ No
- PWQO ☒ MISA ☐ MMER ☐ CCME ☐
- Guideline Required:
- TCLP Regulation 558 ☐ Other:

Service Requested

- ☒ Regular TAT (7 Days)
- ☐ Priority TAT 50% Surcharge (3-5 Days)
- ☐ Emergency TAT 100% Surcharge (1-2 Days)
- Specify Date Required:

All TAT quoted material is in business days which exclude statutory holidays and weekends. Samples received past 3:00pm or Saturday/Sunday begin the next day.

Both questions below must answered for water samples

Are any samples taken from a regulated DW System? ☐ Yes ☒ No

If yes, an authorized DW COC must be used.

Is the water sampled intended for human consumption? ☐ Yes ☒ No

Analysis Request

Please indicate below Filtered, Preserved or both (F, P, F/P)

Sample #	Sample Identification (This description will appear on the report)	Date	Time	Sample Type	Alkalinity, CL, Conductivity, Hardness, TKN	NH3, NO2, NO3, Total Phosphours	pH, SO4, Solids, TC, EC, Turbidity	Routine	Metals							Number of Containers
CR 8	Cloud River - Site #8	July 9/14	10:15	Grab	x	x	x	X	X							4
CR 7	Cloud River - Site #7	July 9/14	11:20	Grab	x	x	x	X	X							4
CR 4	Cloud River - Site #4	July 9/14	12:15	Grab	x	x	x	X	X							4
CR 5	Cloud River - Site #5	July 9/14	13:00	Grab	x	x	x	X	X							4
					x	x	x									
					x	x	x									
					x	x	x									
					x	x	x									
					x	x	x									
					x	x	x									
					x	x	x									

L1484535-COFC

Special Instructions / Comments

SHIPMENT RELEASE (client use)		SHIPMENT RECEPTION (lab use only)				SHIPMENT VERIFICATION (lab use only)		
Released by:	Date & Time	Received by:	Date & Time	Temp	Cooling Initiated	Verified by:	Date & Time	Observations: Yes / No? If Yes add SIF
Asuttie	July 10/14 9:10	[illegible]	10/7/14 9:10	6.3	☐ Yes ☐ No	MM	10/Jul/14 2:25	

Failure to complete all portions of this form may delay analysis. **TAT may vary dependant on complexity of analysis and lab workload at time of submission. Please contact the lab to confirm TATs. Any known or suspected hazards relating to a sample must be noted on the chain of custody in the comments section. By use of the form the user acknowledges and agrees with the Terms and Conditions as specified on the back page.

LAKEHEAD REGION CONSERVATION AUTHORITY
ATTN: Tammy Cook
130 CONSERVATION ROAD
P.O. BOX 10427
THUNDER BAY ON P7B 6T8

Date Received: 11-JUL-14
Report Date: 21-JUL-14 04:14 (MT)
Version: FINAL

Client Phone: 807-344-5857

Certificate of Analysis

Lab Work Order #: L1485038

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

Bobbie Shortreed
Account Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1485038-1	L1485038-2	L1485038-3	L1485038-4	
	Description	GRAB	GRAB	GRAB	GRAB	
	Sampled Date	10-JUL-14	10-JUL-14	10-JUL-14	10-JUL-14	
	Sampled Time	11:30	12:25	13:05	14:15	
	Client ID	CLOUD RIVER SITE #3	CLOUD RIVER SITE #2	CLOUD RIVER #1	CLOUD RIVER SITE #6	
Grouping	**Analyte**					
WATER						
Physical Tests	Conductivity (EC) (uS/cm)	94.2	289	163	88.6	
	Hardness (as CaCO3) (mg/L)	59.2	95.3	77.0	49.9	
	pH (pH)	7.28	7.55	7.56	7.30	
	Total Dissolved Solids (mg/L)	133	211	146	139	
	Turbidity (NTU)	33.5	25.8	36.7	24.7	
Anions and Nutrients	Alkalinity, Total (as CaCO3) (mg/L)	44.5	88.0	65.9	42.4	
	Ammonia, Total (as N) (mg/L)	0.032	<0.020	0.052	<0.020	
	Chloride (Cl) (mg/L)	0.52	34.9	7.47	0.24	
	Nitrate (as N) (mg/L)	0.055	<0.030	0.121	<0.030	
	Nitrite (as N) (mg/L)	<0.020	<0.020	<0.020	<0.020	
	Total Kjeldahl Nitrogen (mg/L)	1.72	1.45	1.28	1.60	
	Phosphorus (P)-Total (mg/L)	0.0529	0.0578	0.0568	0.0679	
	Sulfate (SO4) (mg/L)	1.23	1.71	4.35	0.44	
Bacteriological Tests	Escherichia Coli (MPN/100mL)	160	150	40	10	
	Total Coliforms (MPN/100mL)	2280	7270	3080	5790	
Total Metals	Aluminum (Al)-Total (mg/L)	2.23	1.26	1.85	1.52	
	Antimony (Sb)-Total (mg/L)	<0.00060	<0.00060	<0.00060	<0.00060	
	Arsenic (As)-Total (mg/L)	0.0012	0.0012	0.0013	0.0011	
	Barium (Ba)-Total (mg/L)	0.027	0.024	0.029	0.020	
	Beryllium (Be)-Total (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010	
	Bismuth (Bi)-Total (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010	
	Boron (B)-Total (mg/L)	<0.050	<0.050	<0.050	<0.050	
	Cadmium (Cd)-Total (mg/L)	0.000090	0.000073	0.000074	0.000077	
	Calcium (Ca)-Total (mg/L)	13.5	22.5	18.8	10.3	
	Chromium (Cr)-Total (mg/L)	0.0038	0.0024	0.0030	0.0030	
	Cobalt (Co)-Total (mg/L)	0.00097	0.00072	0.00094	0.00084	
	Copper (Cu)-Total (mg/L)	0.0074	0.0063	0.0071	0.0061	
	Iron (Fe)-Total (mg/L)	2.51	1.79	2.19	2.47	
	Lead (Pb)-Total (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010	
	Lithium (Li)-Total (mg/L)	<0.050	<0.050	<0.050	<0.050	
	Magnesium (Mg)-Total (mg/L)	6.16	9.51	7.29	5.88	
	Manganese (Mn)-Total (mg/L)	0.0388	0.0608	0.0450	0.0624	
	Molybdenum (Mo)-Total (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010	
	Nickel (Ni)-Total (mg/L)	0.0054	0.0039	0.0044	0.0041	
	Potassium (K)-Total (mg/L)	0.90	1.24	1.21	1.13	
	Selenium (Se)-Total (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010	

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1485038-1	L1485038-2	L1485038-3	L1485038-4	
	Description	GRAB	GRAB	GRAB	GRAB	
	Sampled Date	10-JUL-14	10-JUL-14	10-JUL-14	10-JUL-14	
	Sampled Time	11:30	12:25	13:05	14:15	
	Client ID	CLOUD RIVER SITE #3	CLOUD RIVER SITE #2	CLOUD RIVER #1	CLOUD RIVER SITE #6	
Grouping	**Analyte**					
WATER						
Total Metals	Silver (Ag)-Total (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	
	Sodium (Na)-Total (mg/L)	1.85	21.8	5.20	1.40	
	Strontium (Sr)-Total (mg/L)	0.0267	0.0552	0.0419	0.0263	
	Tellurium (Te)-Total (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010	
	Thallium (Tl)-Total (mg/L)	<0.00030	<0.00030	<0.00030	<0.00030	
	Tin (Sn)-Total (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010	
	Titanium (Ti)-Total (mg/L)	0.0469	0.0326	0.0476	0.0368	
	Tungsten (W)-Total (mg/L)	<0.010	<0.010	<0.010	<0.010	
	Uranium (U)-Total (mg/L)	<0.0050	<0.0050	<0.0050	<0.0050	
	Vanadium (V)-Total (mg/L)	0.0054	0.0042	0.0049	0.0049	
	Zinc (Zn)-Total (mg/L)	0.0095	0.0059	0.0085	0.0147	
	Zirconium (Zr)-Total (mg/L)	0.0014	<0.0010	0.0010	<0.0010	

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Matrix Spike	Sulfate (SO4)	MS-B	L1485038-1, -2, -3, -4
Matrix Spike	Calcium (Ca)-Total	MS-B	L1485038-1, -2, -3, -4
Matrix Spike	Magnesium (Mg)-Total	MS-B	L1485038-1, -2, -3, -4
Matrix Spike	Sodium (Na)-Total	MS-B	L1485038-1, -2, -3, -4
Matrix Spike	Strontium (Sr)-Total	MS-B	L1485038-1, -2, -3, -4

Qualifiers for Individual Parameters Listed:

Qualifier	Description
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 2320

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-IC-TB	Water	Chloride by Ion Chromatography	EPA 300.1 (modified)

Anions in aqueous matrices are analyzed using ion chromatography with conductivity and/or UV absorbance detectors.

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-MS-TB	Water	Total Metals by ICPMS	APHA 3030E/EPA 6020A

This analysis involves preliminary sample treatment by hotblock acid digestion (APHA 3030E). Instrumental analysis is by inductively coupled plasma - mass spectrometry (EPA Method 6020A).

N-TOTKJ-TB	Water	Total Kjeldahl Nitrogen by Colourimetry	APHA 4500-Norg B (modified)

Total Kjeldahl Nitrogen in aqueous matrices is analyzed using an autoanalyzer with colourimetric detection.

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-TB	Water	Nitrite by Ion Chromatography	EPA 300.1 (modified)

Anions in aqueous matrices are analyzed using ion chromatography with conductivity and/or UV absorbance detectors.

NO3-IC-TB	Water	Nitrate by Ion Chromatography	EPA 300.1 (modified)

Anions in aqueous matrices are analyzed using ion chromatography with conductivity and/or UV absorbance detectors.

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-TB	Water	Sulfate by Ion Chromatography	EPA 300.1 (modified)

Anions in aqueous matrices are analyzed using ion chromatography with conductivity and/or UV absorbance detectors.

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

Aqueous matrices are analyzed using gravimetry and evaporation

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.

TURBIDITY-TB	Water	Turbidity	APHA 2130 B-Nephelometer

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

Reference Information

** 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

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
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-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
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.

ALS Environmental

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L1485038 Page 1 of 1

Company:	Lakehead Region Conservation Authority		
Contact:	Scott Drebit		
Address:	130 Conservation Rd. P7B 6T8		
Phone:	807-344-5857	Fax:	807-345-9156
Email:	scott@lakeheadca.com;tammy@lakeheadca.com,info@lakeheadca.com		
Project:	Cloud River	PO:	
Quote #	Q40232		
Invoice To:	Tammy Cook	Same as Report:	☑ Yes ☐ No
Company:	Lakehead Region Conservation Authority		
Contact:	Scott Drebit		
Address:	130 Conservation Rd. Box 10427		
Email:	scott@lakeheadca.com		
Account Manager		Sampler:	S. Drebit + A. Suttie

Regulatory Information

- ☐ O. Reg 153 (O. Reg 511 Amend) Table:____
- Record of Site Condition ☐ Yes ☐ No
- PWQO ☒ MISA ☐ MMER ☐ CCME ☐
- Guideline Required:
- TCLP Regulation 558 ☐ Other:

Service Requested

- ☒ Regular TAT (7 Days)
- ☐ Priority TAT 50% Surcharge (3-5 Days)
- ☐ Emergency TAT 100% Surcharge (1-2 Days)
- Specify Date Required:

All TAT quoted material is in business days which exclude statutory holidays and weekends. Samples received past 3:00pm or Saturday/Sunday begin the next day.

Both questions below must answered for water samples

- Are any samples taken from a regulated DW System? ☐ Yes ☒ No
- If yes, an authorized DW COC must be used.
- Is the water sampled intended for human consumption? ☐ Yes ☒ No

Analysis Request

Please indicate below Filtered, Preserved or both (F, P, F/P)

Sample #	Sample Identification (This description will appear on the report)	Date	Time	Sample Type	Alkalinity, Cl, Conductivity, Hardness, TKN	NH_3, NO_2, NO_3, Total Phosphours	pH, SO_4, Solids, TC, EC, Turbidity	Routine	Metals	Number of Containers
CR3	Cloud River - Site #3	July 10/14	11:30	Grab	x	x	x	X	X	4
CR 2	Cloud River - Site #2	July 10/14	12:25	Grab	x	x	x	X	X	4
CR 1	Cloud River - Site #1	July 10/14	13:05	Grab	x	x	x	X	X	4
CR 6	Cloud River - Site #6	July 10/14	14:15	Grab	x	x	x	X	X	4
					x	x	x			1
					x	x	x			
					x	x	x			
					x	x	x			
					x	x	x			
					x	x	x			
					x	x	x			

Special Instructions / Comments

SHIPMENT RELEASE (client use)		SHIPMENT RECEPTION (lab use only)				SHIPMENT VERIFICATION (lab use only)		
Released by:	Date & Time	Received by:	Date & Time	Temp	Cooling Initiated	Verified by:	Date & Time	Observations: Yes / No ? If Yes add SIF
A Suttie	07/11/14 9:10		July 11, 14 9:10	8.2	☑ Yes ☐ No		July 11, 14 9:50	

Failure to complete all portions of this form may delay analysis. **TAT may vary dependant on complexity of analysis and lab workload at time of submission. Please contact the lab to confirm TATs. Any known or suspected hazards relating to a sample must be noted on the chain of custody in the comments section. By use of the form the user acknowledges and agrees with the Terms and Conditions as specified on the back page.

MAPS

Lakehead Region Conservation Authority
Conserve Today...For A Better Tomorrow

Cloud River Watershed

M-1: Key Plan

TOWNSHIP OF DORION

MUNICIPALITY OF SHUNIAH

TOWNSHIP OF CONMEE

TOWNSHIP OF O'CONNOR

MUNICIPALITY OF OLIVER PAIPOONGE

CITY OF THUNDER BAY

TOWNSHIP OF GILLIES

MUNICIPALITY OF NEEBING

Caribou Is.

Brodeur Is.

Grey Is.

Shaganash Is.

Edward Is.

Porphyry Is.

Pie Is.

Flatland Is.

Thompson Is.

Spar Is.

Victoria Is.

Isle Royale

Lake Superior

Legend

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

0 10 20 km

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Projection: UTM Zone 16N
Date: June, 2014

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Cloud River Watershed

M-2: Regulated Area

N

Legend

- Approximate Regulated Area
- Cloud River Watershed
- LRCA Owned Lands
- Township Boundary
- LRCA Jurisdiction Boundary

Permanent Watercourse

- River
- Creek
- Stream

Drainage

- Waterbody
- Wetland
- Provincially Significant Wetland

0 1 2 km

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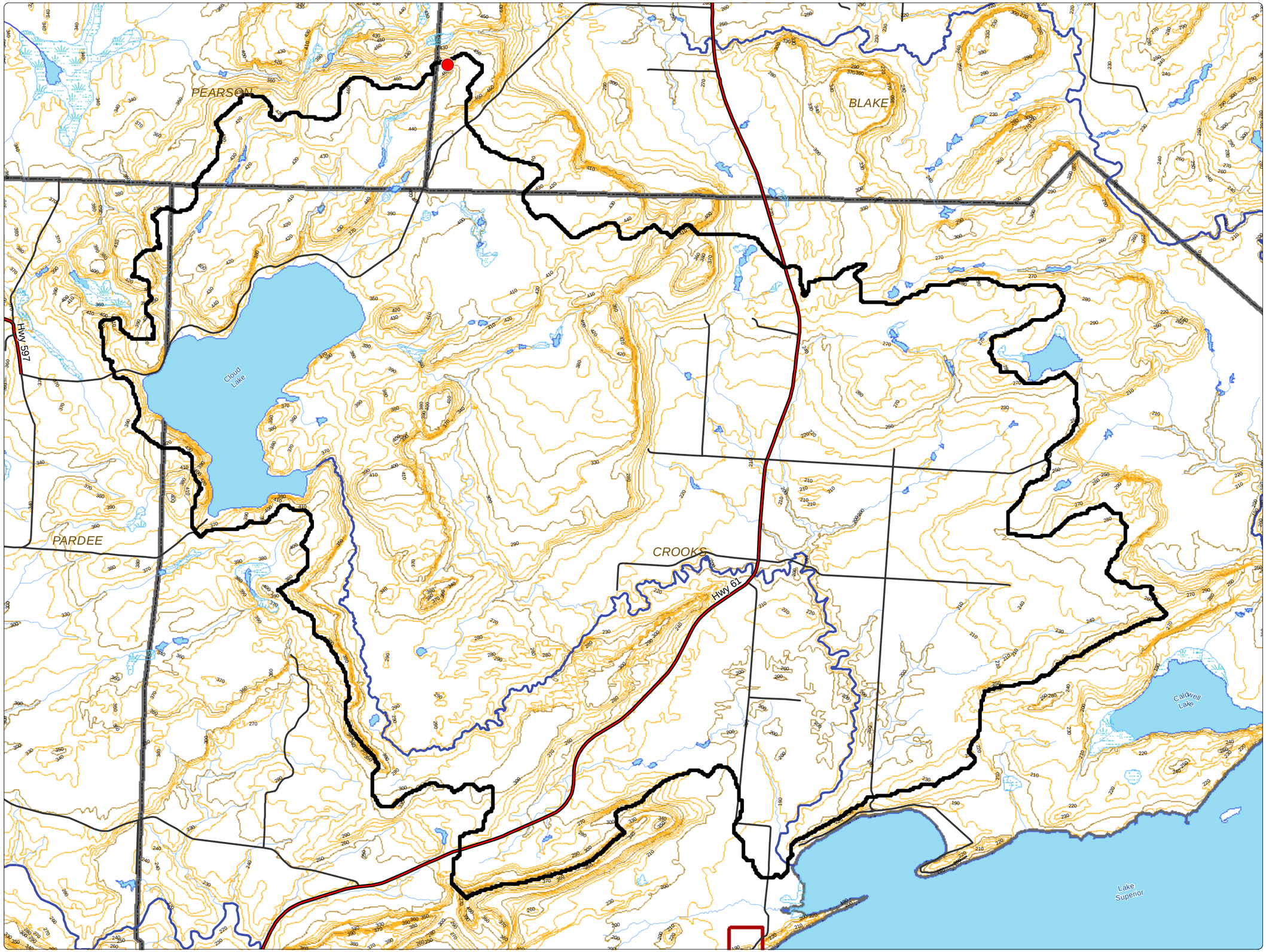
Cloud River Watershed

M-3: Topography



N

Legend

- Highest Point in Watershed
- Cloud River Watershed
- Township Boundary
- LRCA Owned Lands

Contour Lines

- 10m Contour Intervals
- 50m Contour Intervals

Roads

- Highway
- Road

Permanent Watercourse

- River
- Creek
- Stream

Drainage

- Waterbody
- Wetland

0 1 2 km

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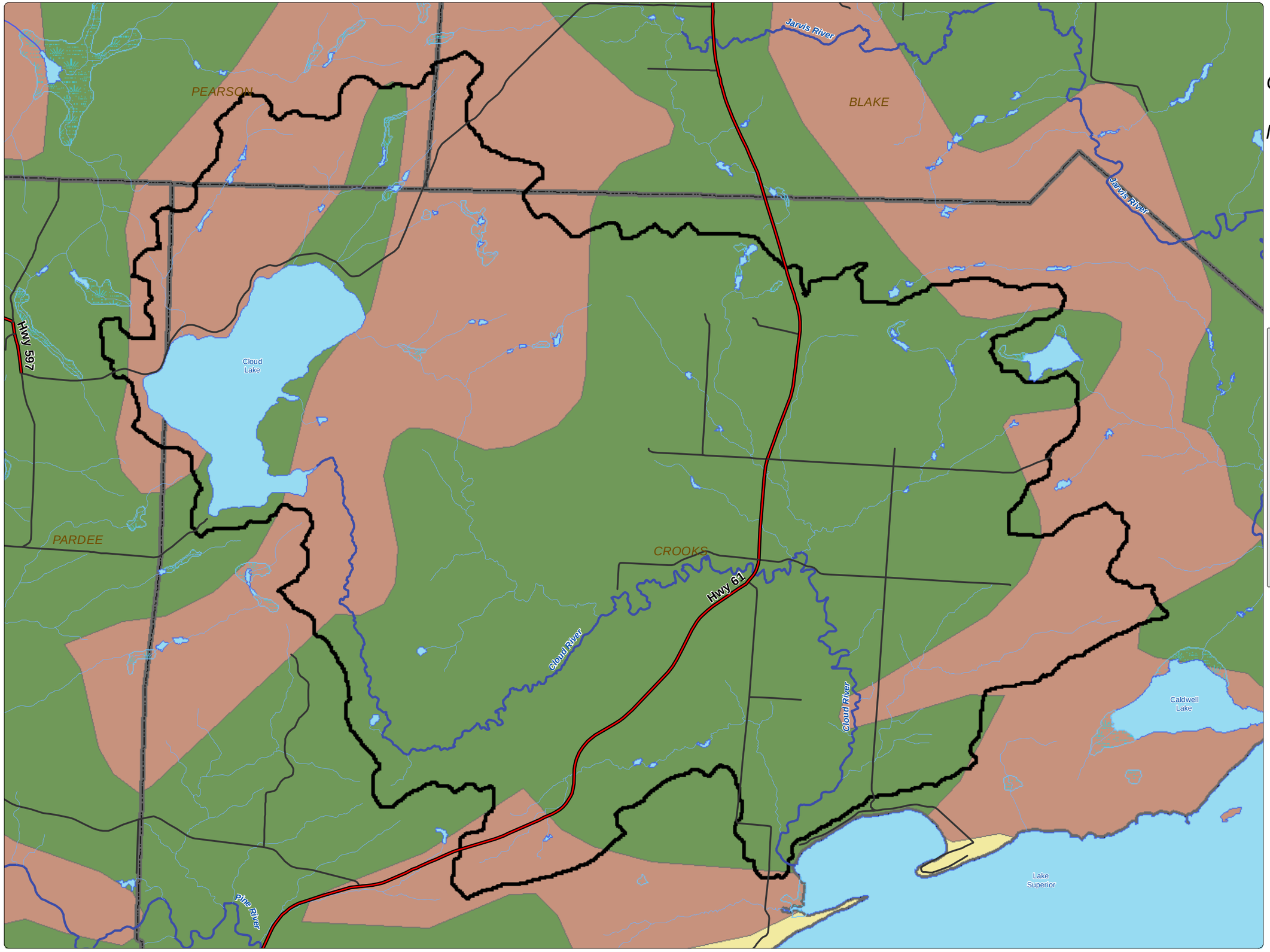
Cloud River Watershed

M-4: Bedrock Geology



N

Legend

- Cloud River Watershed
- Township Boundary

Bedrock_Formation

PALEOPROTEROZOIC

- 22a, Sedimentary rocks

MESOPROTEROZOIC

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

Roads

- Highway
- Road

Permanent Watercourse

- River
- Creek
- Stream

Drainage

- Waterbody
- Wetland

0 1 2 km

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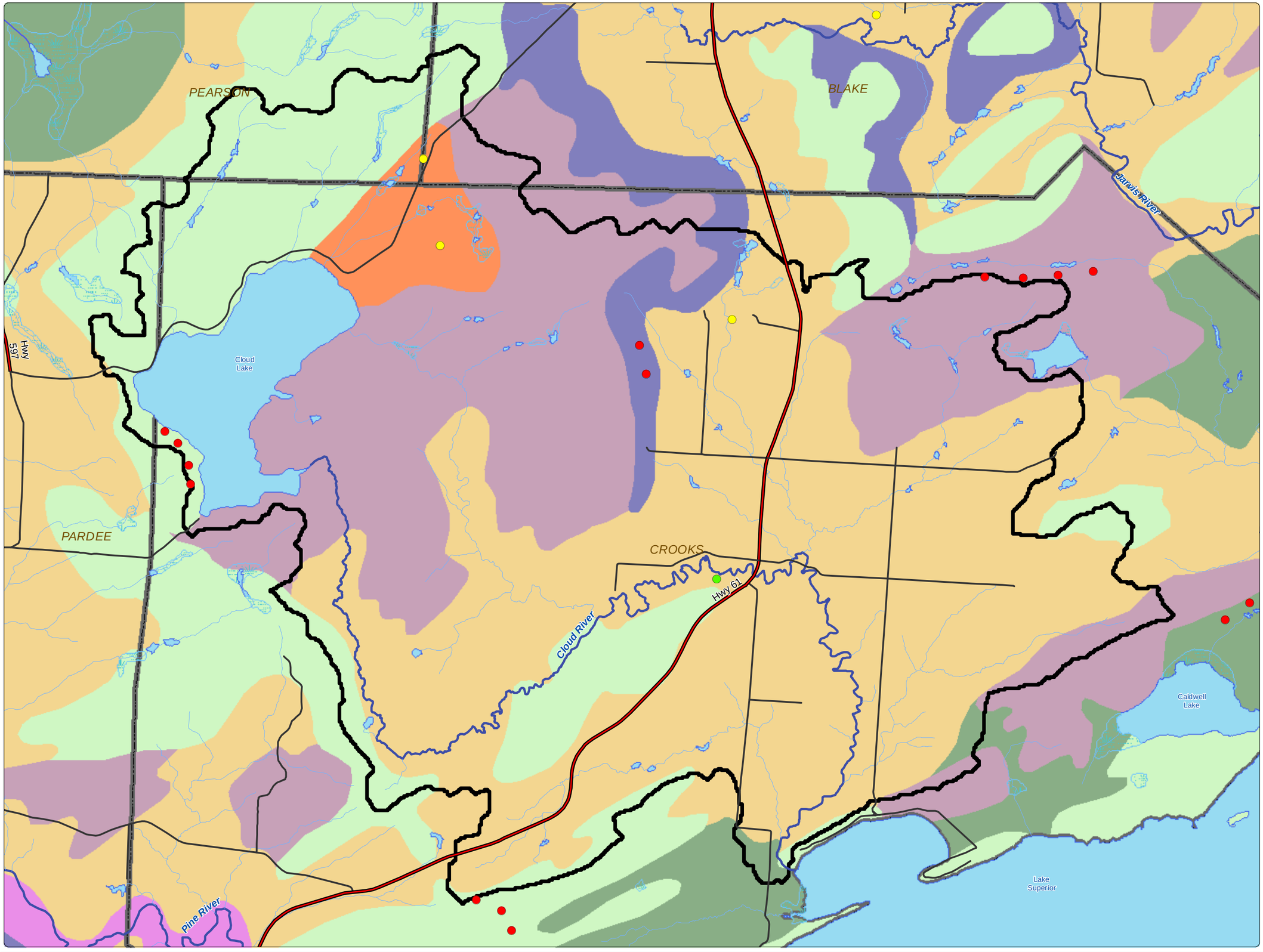
Cloud River Watershed

M-5: Surficial Geology

N



Legend

- Cloud River Watershed
- Township Boundary

Surficial Points Features

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

Roads

- Highway
- Road

Permanent Watercourse

- River
- Creek
- Stream

Drainage

- Waterbody
- Wetland

Surficial Geology

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

0 1 2 km

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Cloud River Watershed

M-6: Soils

N

Legend

- MacKenzie River Watershed
- Township Boundary

OMAFRA Soils

- Organic
- Clay
- Clay Loam
- Fine Sandy Loam
- Gravel
- Gravelly Sand
- Gravelly Sand Loam
- Medium to Moderately Fine Loam
- Loamy Sand
- Peaty Phase
- Rock
- Coarse Sand and Loamy Sand
- Silty Clay Loam
- Silt Loam
- Moderately Coarse Sandy Loam
- Very Fine Sandy Loam

Roads

- Highway
- Road

Permanent Watercourse

- River
- Creek
- Stream

Drainage

- Waterbody
- Wetland

0 1 2 km

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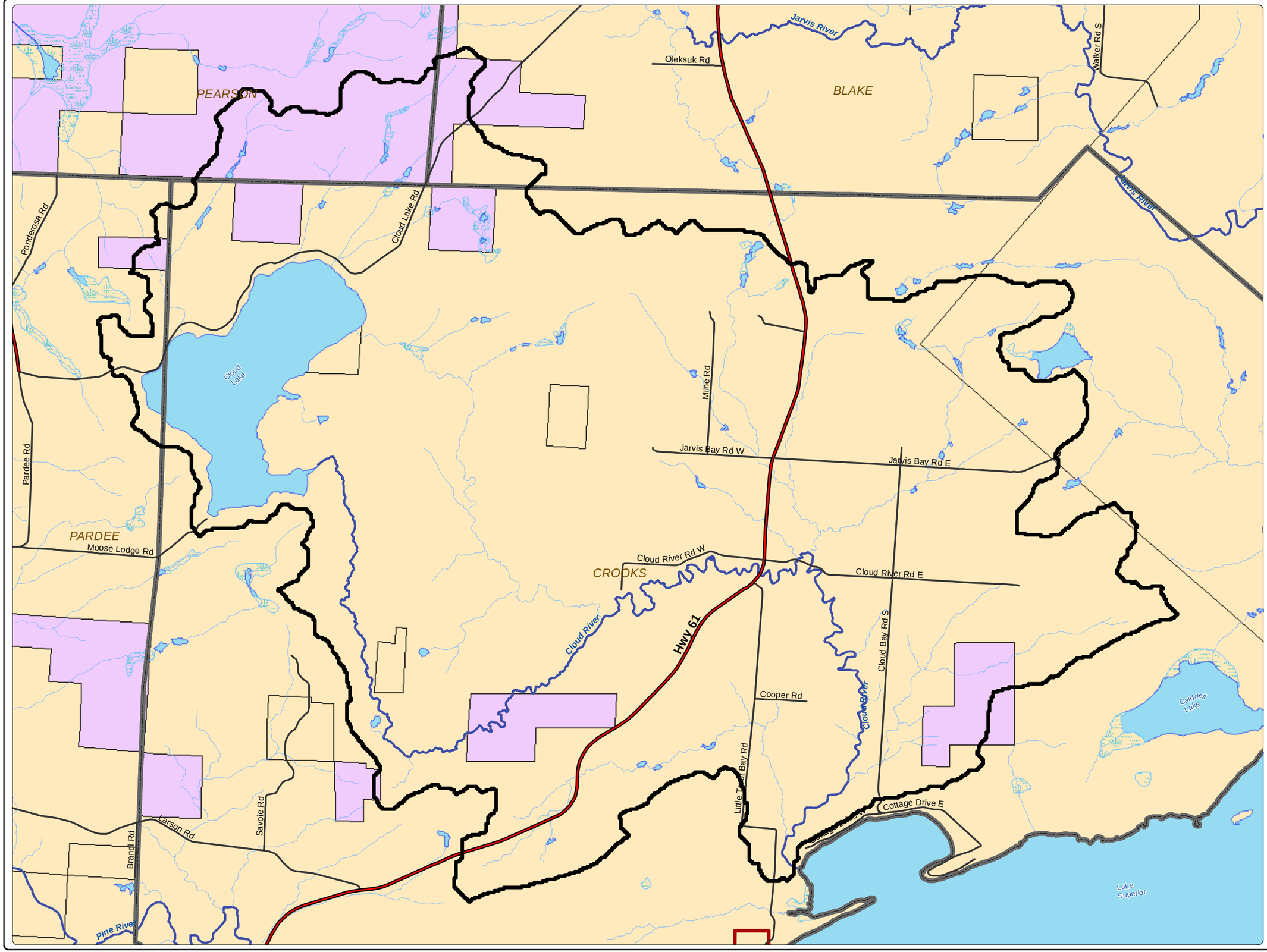
Cloud River Watershed

M-7: Land Ownership



N

Legend

- Cloud River Watershed
- Township Boundary
- LRCA Owned Lands

Land Ownership

- Crown Land
- Private Land

Roads

- Highway
- Road

Permanent Watercourse

- River
- Creek
- Stream

Drainage

- Waterbody
- Wetland

0 1 2 km

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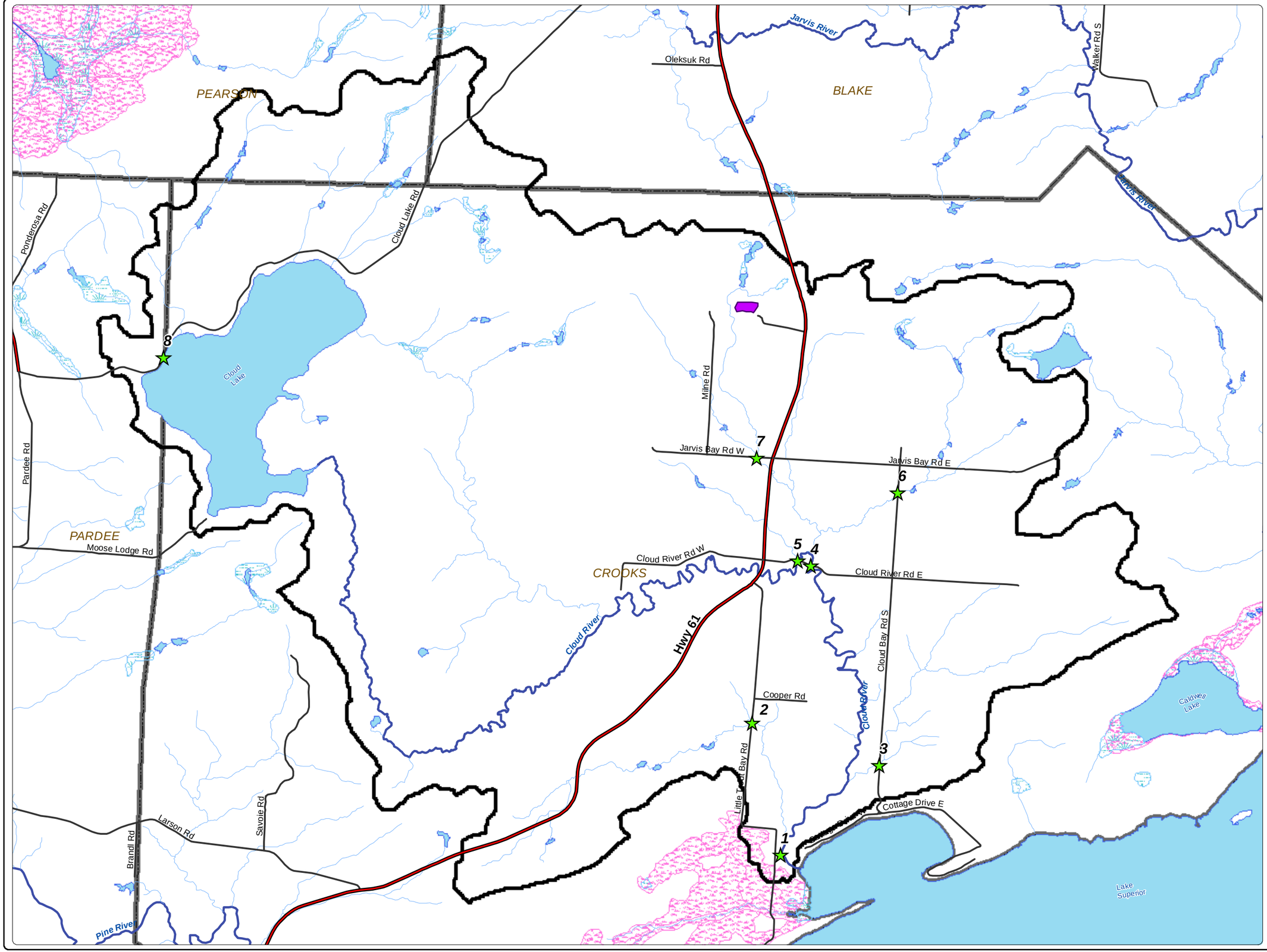
Cloud River Watershed

M-8: Site Plan



N

Legend

- Sampling Sites
- Cloud River Watershed
- Township Boundary
- Household Waste Disposal Site

Permanent Watercourse

- River
- Creek
- Stream

Drainage

- Waterbody
- Wetland
- Provincially Significant Wetland

Roads

- Highway
- Road

0 1 2 km

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Cloud River Watershed

M-9: Zoning

N

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

Legend

- Cloud River Watershed
- Township Boundary

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

Roads

- Highway
- Road

Permanent Watercourse

- River
- Creek
- Stream

Drainage

- Waterbody
- Wetland

0 1 2 km

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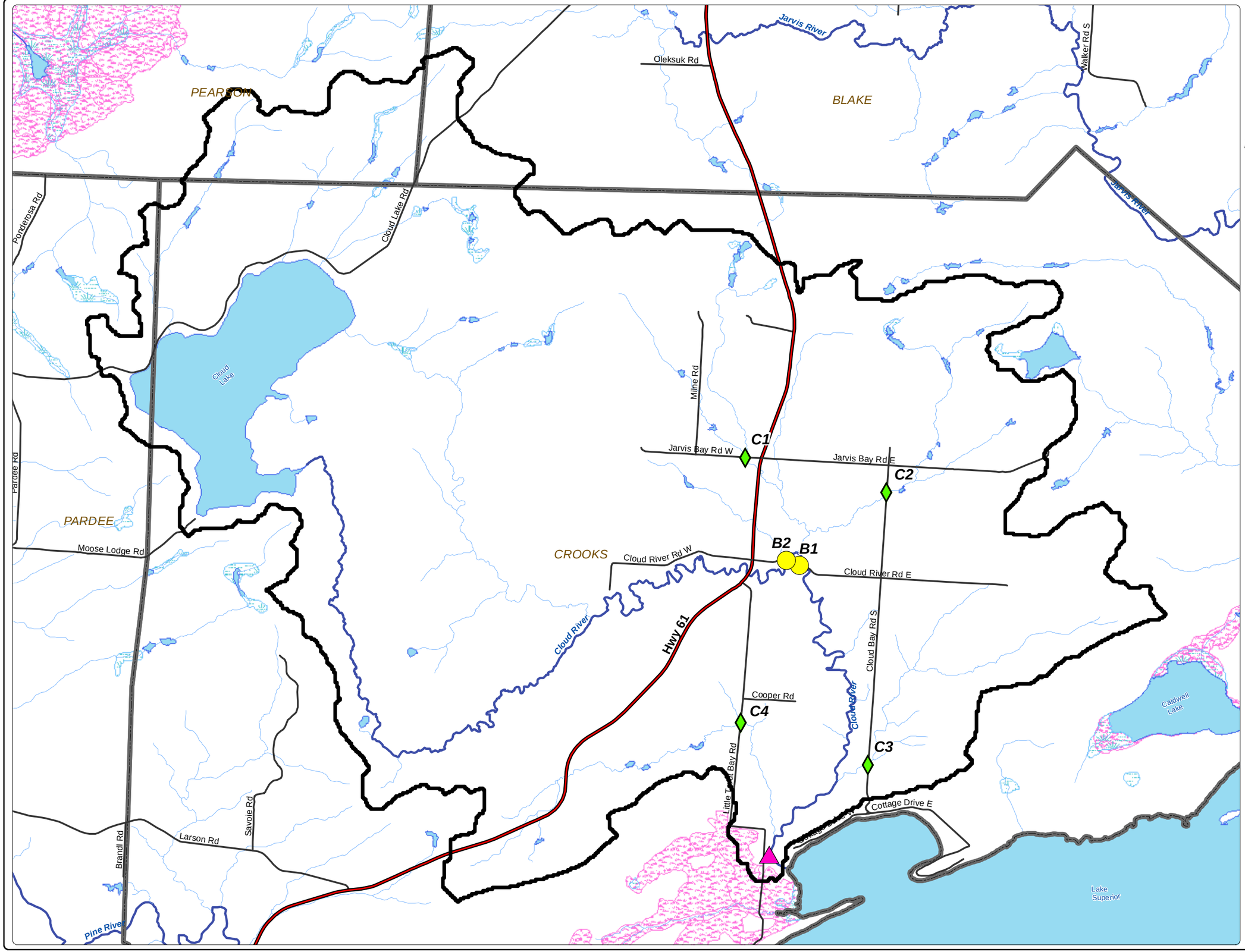
Cloud River Watershed

M-10: Bridge & Culvert Sites



N

Legend

- Bridge
- Culvert
- Confluence
- Cloud River Watershed
- Township Boundary

Permanent Watercourse

- River
- Creek
- Stream

Drainage

- Waterbody
- Wetland
- Provincially Significant Wetland

0 1 2 km

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