Corbett Creek Watershed Assessment Update

Lakehead Region Conservation Authority

Conserve Today...For A Better Tomorrow

2010

2010 Corbett Creek Watershed Assessment Update

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

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Executive Summary

The Corbett Creek watershed is located within the Municipality of Oliver Paipoonge, covering an area of approximately 71 square kilometers, residing within the Lakehead Region Conservation Authority (LRCA) Area of Jurisdiction. The 2010 Corbett Creek Watershed Study was completed as an update to the 1997 Corbett Creek Watershed Report completed by the Lakehead Region Conservation Authority.

The 2010 Corbett Creek Watershed Assessment Update included water quality analysis, as well as documentation of the physical and biological attributes of seven sampling locations. Surface water sampling, photo documentation and comprehensive field notes were completed for each sampling location.

Each site was chosen based upon accessibility and the proximity to any natural and manmade features which may have affected surface water quality. Site selection was also chosen based on sampling locations from the 1997 Corbett Creek Watershed Report. Of the twelve locations assessed in 1997, six were re-assessed and sampled for water quality. The six sites that were re-assessed during the 2010 assessment were Sites; 1 (moved slightly south), 3, 5, 7, 9 and 10. Site 13, the confluence of Corbett Creek and the Kaministiquia River, was a new site established for the 2010 study.

Water quality analysis completed for the 2010 Corbett Creek Watershed Assessment indicated that the Corbett Creek Watershed was in good condition, with minimal exceedances of the Provincial Water Quality Objectives (PWQO) at the time of sampling. Iron, phosphorus and aluminum were in exceedance of the PWQO in the 2010 assessment.

The 2010 laboratory results indicated that iron was the only parameter that consistently exceeded PWQO criteria (0.3 mg/L) at every sampling site, with the exception of Site 13. Iron ranged from 0.1 mg/L to 3.07 mg/L with an overall average of 1.23 mg/L. High iron concentrations and iron rich soils were found at every site, suggesting the iron concentrations are likely geological in origin.

Laboratory results also indicated a single PWQO exceedance of phosphorus at Site 1, as well as a single PWQO exceedance of aluminum at Site 10. These higher than average concentrations were still relatively low and were likely from natural sources. Total coliforms were considered high at every site when compared to the pre-1994 PWQO (currently there is no PWQO for total coliform).

Lead was the only parameter that exceeded PWQO criteria at almost every assessed site in 1997 and did not exceed the criteria at any site in 2010.

Comparison of the 1997 and 2010 water quality results indicate that between the two study periods there have been negligible changes to the water quality within the Corbett

Creek watershed. Average values from 1997 and 2010 reported close correlation with only some site specific changes observed. Changes to physical parameters reported from 1997 to 2010 (i.e. conductivity, water temperature and depth) were all likely caused by natural processes and common variation.

Beaver activity and a nearly completed beaver dam were observed just upstream of the stream flow/precipitation gauge (02AB022) located directly upstream of McNally Drive and Site 5. This may have considerably affected the data recorded from the stream flow gauge and it is recommended that this location be investigated to assess the potential effect of the observed beaver activity.

Staff and funding permitting, it is recommended that an update to the 2010 Corbett Creek Watershed Assessment be completed in the next five to ten years. Future sampling should include a re-analysis of Site 9, as this site indicated the highest observed *E. coli* concentrations. To minimize variability caused by point source contamination, future sampling should consider two sampling periods, where laboratory analysis and field measurements are to be completed. As benthic analysis indicates water quality over an extended period of time, benthic analysis should be considered for future watershed assessments. In addition, future documentation of biological attributes should consider the use of transects to quantify site vegetation.

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1 Introduction

The Corbett Creek Watershed covering an area of approximately 71 square kilometres is located within the Municipality of Oliver Paipoonge. The entire watershed resides within the Lakehead Region Conservation Authority (LRCA) Area of Jurisdiction. The jurisdictional boundaries of the Corbett Creek watershed are shown on the map: M-1: Key Plan; the general features found within the watershed are shown on map: M-2: Site Plan. Map M-7: Approximate Regulated Areas shows the area considered to be regulated by the LRCA under the Development, Interference with Wetlands and Alterations to Shorelines and Watercourses, Ontario Regulation 180/06.

The Thunder Bay Region contains a diverse array of watersheds each composed of a unique assemblage of ecological communities. A watershed, also simply known as a catchment or drainage basin, is essentially the area of land drained by a river system. A watershed is composed of tributaries (i.e. streams and creeks) which join together into a main channel and then into a lake. Corbett Creek flows into the Kaministiqua River which then flows into Lake Superior.

The goal of this report was to document the physical and chemical conditions of the Corbett Creek watershed as observed for the month of July, 2010 and compare observations to the Corbett Creek Watershed Assessment completed by the LRCA in 1997. The information gained will be used to maintain the programs consistent with the Natural Hazards and Natural Heritage Policies of the Province of Ontario. This report will also serve as an update to the previous 1997 report. The main objectives of this report were to:

- Summarize the physical and biological attributes of the watershed
- Collect surface water quality samples
- Collect field measurements
- Conduct an inventory of the flora and fauna observed from each sampling location
- Conduct an inventory of soil, streambed substrate and stream bank cover observed from each sampling location
- Document active erosion sites
- Interpret results to record the health status of the watershed
- Compare and contrast results obtained in 2010 with results observed in the 1997 Corbett Creek Watershed Assessment

2 Background

2.1 Physical Attributes

2.1.1 Topography

The regions varied topography and hydrology is largely owing to previous glaciations which molded and transformed the landscape into what it is today. The Corbett Creek watershed boundary spans 70.65 square kilometres and is located within the Municipality of Oliver Paipoonge. The elevation of the watershed ranges from 209 metres above sea level to 430 metres above sea level, with a total change in elevation of 221 metres. The topography of the region is illustrated on map M-3: Topography.

2.1.2 Geology and soils

Bedrock

The Thunder Bay region lies within a 3,219,000 square kilometre area known as the Canadian Shield. The Canadian Shield is composed of ancient sedimentary, igneous and metamorphic rocks dating back to the Precambrian era. The Precambrian era comprises two main divisions: the Archaean Period composed of rocks greater than 2,470 million years old (McGlynn, 1970), and the Proterozoic Period which includes rocks aged from 570 million years (Stockwell, 1964) to 2,480 million years. The Thunder Bay area hosts rocks from these main age groups, with the youngest rocks being approximately 1,100 million years old (Palmer, 1970). The bedrock in the Corbett Creek watershed region is composed of a diverse assemblage of Neo- Archean, Neo to Meso-Archean and Paleoproterozoic rock formations. Reference to the locations of bedrock formation within the Corbett Creek watershed can be found on map M-4: Bedrock.

Paleoproterozoic Formations:

Sedimentary rocks cover 29.31 square kilometres of the watersheds. Sedimentary rocks of the region are composed of an animikie grey-pan, wacke, shale, iron formation, limestone and minor volcanic rocks.

Neo to Meso-Archean Formations:

Mafic to intermediate metavolcanic rocks are the dominant bedrock type and cover 33.29 square kilometres of the areas total bedrock. This bedrock is composed of many types of rock formations including basaltic and andesitic flows, tuffs and breccias, iron formation, minor sedimentary and intrusive rocks.

Massive granodiorite to granite formations are a bedrock formation within the study area covering 1.91 square kilometres.

Felsic to intermediate metavolcanic rocks make up a relatively small portion of the watersheds bedrock, covering 6.13 square kilometres.

Surficial Geology

Surface deposits of the area are the result of glacial and alluvial events. Kame moraines and eskers, often flattened by subsequent lake action, are found throughout the area and commonly consist of gravelly, sandy, outwash deposits, especially in the Kaministiqua River Valley. The River appears to be a relic of a series of post glacial lakes which occupied the Lake Superior basin, extending inland from the present shoreline (LRCA, 1975).

The surficial geology of the area is largely composed of moraine deposits which cover 54.22 square kilometres of the study area. Outwash, eskers and kame terraces account for significantly less, covering 14.26 square kilometres. Organics are relatively abundant, covering 12.2 square kilometres and glaciolacustrine plain covers 10.45 square kilometres. Bedrock and alluvial surface deposits comprise significantly less, covering 1.92 square kilometres and 0.66 square kilometres. Reference to the locations of surface deposits within the Corbett Creek watershed is illustrated on map M-5: Surficial Geology.

Soils

Nolalu soils cover 43.64 square kilometres of the watershed. Nolalu soils are non-calcareous fine sandy loam stony glacial till derived from shale. These soils are scattered throughout the watershed and have good drainage.

Pennassen organic soils cover 12.22 square kilometres of the watershed. These soils are made of partially decomposed organic material derived from hypnum moss and reeds 40-90 centimetres thick and underlain by lacustrine clay. Pennassen soils have very poor drainage.

Rockland soils cover 8.69 square kilometres of the watershed. Rockland soils are composed of less than 10 centimetres of soil material overlying bedrock.

Oskondoga soils cover 1.83 square kilometres of the watershed. These soils are composed of calcareous reddish clay loam, clay or silty clay varved lacustrine with imperfect drainage.

Muck covers 1.61 square kilometres of the watershed. Muck is mostly decomposed thick organic materials and provides very poor drainage.

Lappe soils cover 1.34 square kilometres of the watershed. Lappe soils are made of calcareous reddish clay loam, clay or silty clay, varved lacustrine and have poor drainage.

Wamsley soils cover 1.16 square kilometres of the watershed. These soils are characterized by non-calcareous fine and very fine sandy loam outwash or deltaic material.

Formal soils cover the smallest portion of the watershed, covering 0.16 square kilometres. Soil characteristics are displayed on map M-6: Soils.

2.1.3 Climate

Climate throughout the watershed can be characterized by a continental climate that is influenced and modified by Lake Superior. Westerly winds predominate from July to March, while easterly winds prevail for the remainder of the year (LRCA 1985). Table 1.0 displays the average daily temperature, total precipitation and extreme maximum daily temperatures for the Thunder Bay Region from 1971-2000. Table 2.0 displays the average daily temperature and total precipitation for the 1997 sampling year and Table 3.0 displays the average daily temperature and total precipitation for the 2010 sampling year.

Table 1.0: Mean temperature and total precipitation from the Thunder Bay International Airport, 1971-2000

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Temperature												
Daily (ºC)	-14.8	-12	-5.5	2.9	9.5	14	17.6	16.6	11	5	-3	-11.6
Precipitation												
Total Precip. (mm)	31.3	24.9	41.6	41.5	66.5	85.7	89	87.5	88	62.6	55.6	37.5
Extreme Max. Daily Precip. (mm)	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

Table 2.0: Mean temperature and total precipitation from the Thunder Bay International Airport, January-July 1997

	Jan	Feb	Mar	Apr	May	Jun	Jul
Temperature							
Daily (ºC)	-14.93	-12.06	-7.1	1.72	6.59	15.98	17.5
Precipitation							
Total Precipitation (mm)	29	10	26.5	24.5	38.0	87	149.5

Table 3.0: Mean temperature and total precipitation from the Thunder Bay International Airport, January-July 2010

	Jan	Feb	Mar	Apr	May	Jun	Jul
Temperature							
Daily (ºC)	-12.09	-9.78	1.4	6.04	11.14	14.41	19.19
Precipitation							
Total Precipitation (mm)	27.0	9.0	18.0	37.5	38.5	83.0	43.0

2.1.4 Hydrology

Corbett Creek originates to the south of Highway 102 near Mud Lake Road, flowing in a general north to south direction flowing through the Municipality of Oliver Paipoonge. Corbett Creek has a total length of 28.14 kilometres and an average slope of 0.79 percent. The Creek drains into the Kaministiqua River downstream of Kakabeka Falls, approximately two kilometres downstream of the Village of Stanley. The Corbett Creek Watershed has a total drainage area of 70.65 square kilometres.

Corbett Creek has a hydrometric gauge station (02AB022) located just upstream of Site 5 and McNally Drive. The gauge station is operated by Environment Canada in partnership with the LRCA. The gauge records water levels which are used to calculate discharge rates and a tipping bucket measures received precipitation. The gauge has collected data from 2003 to present.

The averages for discharge rates and water level from 2003 to 2009 are summarized in Appendix I and illustrated on Figures 1 and 2 respectively. The average monthly discharge rates and water level from January to August, 2010 are located in Appendix I and illustrated on Figures 3 and 4. It should be noted that beaver activity was observed near the gauge station which may have affected the recorded levels of the gauge.

3 Methods and Materials

3.1 Site Selection

Six sites were chosen within the watershed boundaries in order to assess the overall health of the Corbett Creek Watershed. Each site was chosen based on accessibility and its proximity to any natural and/or manmade features that may affect surface water quality. The site selection was also completed based on the Corbett Creek Watershed Assessment completed in 1997, as six of the twelve sites sampled in 1997 were re-sampled in 2010. The location of sites sampled in 1997 and 2010 are illustrated on map M-2: Site Plan. Site 1, located just off of Mud Lake Road, was previously sampled in 1997 and was sampled during the July, 2010 sampling period. The exact location for Site 1 could not be re-sampled due to its location on private property. A location just downstream from the 1997 site was chosen to represent the headwaters site. Site 3, located off of Miller Heights Drive, was previously sampled in 1997 and was re-sampled in the July, 2010 sampling period. Site 5, located off McNally Drive was previously sampled in 1997 and was re-sampled in the July, 2010 sampling period. Site 7 was located off of Oliver Road and was previously sampled in 1997 and was re-sampled in the July, 2010 sampling period. Site 7 was located off Oliver Road and was a former streambed rehabilitation site initiated by the LRCA. Site 9 was located off of Pebblestone Road and was sampled in 1997 as well as during the July, 2010 sampling period. This site was located in a highly rural area, with agricultural activity adjacent. Site 10, located off Highway 11/17, was previously sampled in 1997 and re-sampled in the July, 2010 sampling period. Site 10 was a former streambed rehabilitation site initiated by the LRCA. Site 13, located at the confluence with Kaministiqua River was not previously sampled in 1997 and was chosen for the July, 2010 sampling period to obtain a confluence sample.

Site 14, located west of the Corbett Creek/Kaministiquia River confluence, was sampled during the 2010 assessment, however, it was mistakenly thought to be the confluence. As the sample was analyzed the data has been included in the report for reference purposes.

3.2 Quantitative Assessment

Several parameters were measured to assess surface water quality of the Corbett Creek Watershed. Surface water samples were collected for laboratory analysis in new clean bottles provided by ALS Laboratory Group, 1081 Barton Street, Thunder Bay, Ontario. The parameters analyzed were conductivity, total dissolved solids, turbidity, nutrients (nitrate, nitrite, ammonia and total phosphorus), bacteria (Escherichia coli and total coliforms) and total metals.

Water Quality Sampling was completed at as many of the sites as possible a single sampling day. Weather permitting, sampling was finished by the end of the work week.

Heavy rainfall events the day prior to or during a scheduled sampling day prevented sampling due to potentially disturbed substrate and inconsistency in meteorological conditions. Methodology for water sample collection was based on the Provincial Water Quality Monitoring Network (PWQMN), Ministry of Environment Protocol (2006). Grab samples were collected away from the stream bank (facing upstream) within the main current either by wading or by using a reaching pole. In order to avoid disturbing as little sediment as possible, entrance to the river was always downstream of the sampling location.

ALS Laboratory Group provided four collection bottles for each site: routine, nutrient, metal and bacterial analysis. Sulfuric acid and nitric acid were added as preservative on site to the nutrient and metal bottles. Bottles for bacterial analysis were pre-charged with sodium thiosulphate preservative and care was taken not to open the bottle until the true sample was to be filled. All sample bottles were transported using a cooler and ice packs.

Field parameters of water temperature, pH, conductivity and dissolved oxygen were measured using an YSI 600 MDS multi parameter water quality sampler at the same time and location as water sample collection. Other standard field measurements were also taken. Air temperature was measured by mercury thermometer; channel width using a measuring tape and channel depth using a metre stick. Velocity was measured using a floatation device, measuring tape, stop watch and appropriate calculations. This was only employed for use in water which was running downstream. Techniques for data collection are outlined in Appendix A.

3.3 Applicable Criteria

Surface water quality results were compared to applicable criteria published in the Provincial Water Quality Objectives (PWQO) by the Ministry of the Environment and Energy (MOEE), July 2004. 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 2007, were also used for comparison to surface water quality results for the Corbett Creek watershed. The information in these guidelines and supporting text was used to compliment the PWQO and Interim Objectives. The applicable criteria published in the PWQO and CCREM water quality guidelines are attached in Appendix C. There are no current standards for total coliforms and fecal coliforms, however, recreational water quality guidelines published by the Ontario Ministry of Health in 1992 were used. These objectives were 1000 counts per 100 ml (based on a geometric mean density for a series of water samples) for total coliforms and 100 counts per 100 ml for fecal coliforms.

3.4 Qualitative Assessment

Watershed health can also be assessed by qualitative monitoring (visual inspection). The composition of in-stream substrate, forest soil and the stream bank riparian community can affect surface water quality. The presence or absence of certain flora and fauna can indicate the status of the watershed to provide a suitable habitat.

Flora was assessed using the Field Guide to Forest Ecosystem Classification for Northwestern Ontario (Sims *et al.* 1997). Each site was evaluated based on a 50 metre proximity to the creek. Each site that had significant forest vegetation was given a vegetation type or FEC V-Type. Common and scientific names are located within Appendix G.

Fauna was assessed by identifying the species and number of individuals observed at each site. This process did not utilize netting of any kind and therefore fish species and insect species are only described generally (i.e. minnows, water striders, etc.). Physical dimensions were measured, Universal Transverse Mercator (UTM) coordinates and pictures were taken, and general observations were noted.

Erosion potential, slope stability and culverts were documented only where outstanding cases could be observed. A camera and short hand notes on the field sheet were used for documentation. Soil observations were conducted by digging a small pit approximately 30 x 30 x 30 centimetres. Due to the lack of in depth data, which could be provided only through more extensive testing, only general descriptions of the soil characteristics were noted. Documentation of culverts throughout the Corbett Creek watershed was completed for the 1997 Corbett Creek Watershed Assessment. Wherever possible, 1997 photos were compared to photos taken in 2010 and significant physical changes were noted. Photo documentation and comparison is located in Appendix H.

3.5 Materials

The following materials were used during the study:

- Chest waders
- Cooler
- Underwater digital camera
- GPS camera
- Field guides
- Fluorescent orange vests
- Ice packs
- Knife
- Latex gloves
- Lined paper
- Measuring tape reel
- Mercury thermometer
- Meter stick
- Paper towel

- Pens and pencils
- Reaching pole
- Road map
- Sampling bottles provided by ALS Laboratory Group
- Shovel
- Squeeze Bottles
- Stopwatch
- Topographic map
- Trimble Geo XH GPS
- Whistle
- Work gloves
- YSI 600 MDS multi parameter water quality sampler
- 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)
- Newcombs Wildflower Guide (Newcomb, 1977)
- ROM Field Guide to Wildflowers of Ontario (Dickinson *et al.* 2004)
- Wetland Plants of Ontario (Newmaster *et al.* 1997)

4 Results

All laboratory results from ALS Laboratory Group for the 2010 Assessment are summarized in Appendix D and all results from the 1997 Assessment are summarized in Appendix E. Site photos from both 1997 and 2010 are included in Appendix H. The Certificate of Analysis from ALS Laboratory Group is attached in Appendix J.

4.1 Site 1: Headwaters off of Mud Lake Road, Downstream

Location Reference for Site 1	
Location Description	Site 1 was located off of Mud Lake Road, just south of Dawson Road upstream of the northern culvert.
UTM Coordinates	Northing 5374433/ Easting 314621
Altitude/Elevation	405.2 metres above sea level

Field Measurements for Site 1							
		Date Collected					
		June 25, 1997	July 9, 1997	July 23, 1997	August 6, 1997	1997 Average	July 22, 2010
		Time Collected:					
Parameter	Unit	9:50 am	9:35 am	9:25 am	9:45 am		9:45 am
Water Temperature	ºC	15.2	14.2	15.8	16.0	15.30	18.44
Conductivity	µS/cm	160	180	185	NA	191.30	150
Dissolved Oxygen	mg/L	6.3	5.1	**4.5**	**3.2**	**4.78**	5.07
Dissolved Oxygen	%	NA	NA	NA	NA	NA	55.1
pH		7.45	7.25	6.95	7.20	7.21	7.56
Air Temperature	ºC	23.5	19	17.5	17	19.21	21.1
Channel Width	m	NA	NA	NA	NA	NA	0.79
Channel Depth	m	0.42	0.40	0.43	0.29	0.39	0.05
Velocity	m/s	NA	NA	NA	NA	NA	0.0132

*Bold #'s indicate exceedance of PWQO guidelines

Laboratory Water Quality Results for Site 1				
		Date: July 9, 1997	Date: August 6, 1997	Date: July 22, 2010
Parameter	Unit	Time: 9:35 am	Time: 9:45 am	Time: 9:45 am
Bacteriological				
Escherichia Coli	MPN/100mL	NA	NA	30
Total Coliforms	MPN/100mL	NA	NA	**2400**
Physical				
Conductivity (EC)	µS/cm	NA	NA	281
Total Dissolved Solids	mg/L	NA	NA	212
Turbidity	NTU	16	25	5.60
Nutrients and Anions				
Ammonia-N, Total	mg/L	NA	NA	0.026
Chloride (Cl)	mg/L	NA	NA	19.7
Nitrate-N (NO3-N)	mg/L	NA	NA	<0.030
Nitrite-N (NO2-N)	mg/L	NA	NA	<0.020
Phosphorus (P)-Total	mg/L	0.01	0.02	**0.0348**
Sulphate (SO4)	mg/L	NA	NA	0.31

Metals				
Aluminum (Al)	mg/L	NA	NA	0.021
Cadmium (Cd)	mg/L	0.0001	<0.0001	9×10^{-5}
Copper (Cu)	mg/L	NA	NA	<0.0010
Iron (Fe)	mg/L	**0.14**	**0.64**	**3.07**
Lead (Pb)	mg/L	<0.0001	0.0033	<0.0010

*Bold #'s indicate exceedance of PWQO guidelines

Flora Observed at Site 1	
FEC V-Type: V-1: Balsam Poplar Hardwood Mixedwood	
Dominant Species *	
Species	
Trees	Balsam Poplar White Spruce Black Ash Birch Balsam Fir
Shrubs	Slender Willow Alder*
Ground Cover	Cow Vetch Yellow Hawkweed Pickerel Weed Spotted Joe-Pye Weed Goldenrod Red Clover Marsh Cinquefoil Thistle Spotted Water Hemlock Floating Bulrush Wild Mint Fowl Meadow Grass Lesser Panicled Sedge Wool Grass Redtop Grass Cotton Grass Drooping Woodreep Bulrush Green Sedge
Aquatic Macrophytes and Algae	Cattail Starwort Wild Calla Algae

Substrate Observations for Site 1		Soil Pit Observations	
Percentage Shaded	50-75%	**Soil Characteristics**	Organic soil with a low percentage of sand and clay. Silt predominant ~10 cm
Substrate Classification	Gravel and Cobble		
Abundance of aquatic vegetation	Abundant algae as well as abundant emergent plants.		

General Observations

For reasons of accessibility, Site 1 was moved just south of the 1997 Site 1 headwaters site. Although the position was moved, the 1997 water quality results were used for comparison purposes due to the close proximity of the two sites. Channel characteristics such as depth and flow as well as vegetation were not compared. Site 1 was characterized by a very shallow channel composed of an organic surface substrate with cobble dispersed throughout. The sampling site was perpendicular and upstream to the road. Upstream of the sampling site the channel had considerable vegetation creating a highly shaded channel. The streamside vegetation directly adjacent to the sampling site was characterized by grasses and reeds, with cattails predominating just upstream of the culvert. Downstream from Site 1 was a recently dredged ditch with sediment spilling into the channel. The soil observed was mostly organic with a high moisture level. Sand and clay were nearly absent with a high silt content that was ten centimetres in depth.

When comparing 2010 photo documentation from Site 1 to the photos taken in 1997 there were some observable changes. The culvert appeared to have been replaced and may not have been constructed in the same precise location. Vegetation surrounding the culvert had shown considerable change from grasses in 1997, to cattails in 2010. A ditch on the west side just of the culvert had been constructed sometime between 1997 and 2010. This ditch now drained a portion of the water away from the culvert, preventing full flow.

Results and Discussion

Site 1 was very shallow, resulting in the probe being held on an angle to ensure it was completely submerged. Site 1 exceeded PWQO criteria of three laboratory parameters at the time of sampling on July 22, 2010. Total coliforms exceeded the pre-1994 PWQO guideline of 1,000 counts per 100 ml of water (MPN/100 mL), with a concentration of 2,400 MPN/100 mL. Iron exceeded the PWQO guideline of 0.3 milligrams per litre (mg/L) with a concentration of 3.07 mg/L, and was the highest iron concentration reported from all sampling locations. Phosphorus exceeded PWQO criteria (0.03 mg/L) with a concentration of 0.0348 mg/L. The dissolved oxygen (DO) concentration (5.07) did not exceed PWQO criterion (minimum of 5 mg/L) but was low considering the shallow depth of the channel.

Water quality results from Site 1 indicated little change from 1997 to 2010. DO and pH were both within similar ranges, with the phosphorus showing only a slight increase from 1997 to 2010. Iron increased considerably from 1997 to 2010. The highest iron concentration reported in 1997 was 0.64 mg/L. The iron concentration reported from 2010 was significantly greater, with a concentration of 3.07 mg/L. This variation is likely due to natural sources. The change in location from 1997 to 2010, although slight, may have been the reason for the varied results observed from 1997 to 2010.

4.2 Site 2: Mud Lake Road. South of 6th Concession Road, Downstream

Site 2 was sampled June 25, July 9, July 23 and August 6, 1997 for the Corbett Creek Watershed Assessment Report. Site 2 was not resampled during the 2010 sampling period. The 1997 laboratory results and field observations from Site 2 are located in Appendix E.

4.3 Site 3: Miller Heights Drive, Downstream

Location Reference for Site 3	
Location Description	Located off of Miller Heights Drive, in a tributary to the north of Corbett Creek.
UTM Coordinates	Northing 5373381/ Easting 311853
Altitude/Elevation	388.2 metres above sea level

Field Measurements for Site 3							
Parameter	Unit	Date: June 25, 1997 Time: 11:05 am	Date: July 9, 1997 Time: 10:40 am	Date: July 23, 1997 Time: 10:40 am	Date: August 6, 1997 Time: 10:30 am	Average of 1997 Data	Date: July 22, 2010 Time: 10:55 am
Water Temperature	ºC	15	10.5	12.2	14.0	12.93	18.43
Conductivity	µS/cm	160	175	180	225	185.0	243
Dissolved Oxygen	mg/L	12.4	12.0	11.8	10.0	11.5	6.70
Dissolved Oxygen	%	NA	NA	NA	NA	NA	71.5
pH		6.90	7.15	6.9	7.00	6.99	7.61
Air Temperature	ºC	25	20	19	19	20.75	25
Channel Width	m	NA	NA	NA	NA	NA	1.45
Channel Depth	m	0.53	0.21	0.19	0.14	0.27	0.15
Velocity	m/s	NA	NA	NA	NA	NA	0.087

Laboratory Water Quality Results for Site 3		
		Date: July 22, 2010
Parameter	Unit	Time: 10:55 am
Bacteriological		
Escherichia Coli	MPN/100mL	32
Total Coliforms	MPN/100mL	**1600**
Physical		
Conductivity (EC)	µS/cm	237
Total Dissolved Solids	mg/L	178
Turbidity	NTU	3.69
Nutrients		
Ammonia-N, Total	mg/L	<0.020
Chloride (Cl)	mg/L	0.81
Nitrate-N (NO3-N)	mg/L	<0.030
Nitrite-N (NO2-N)	mg/L	<0.020
Phosphorus (P)-Total	mg/L	0.0244
Sulphate (SO4)	mg/L	0.46
Metals		
Aluminum (Al)	mg/L	0.018
Cadmium (Cd)	mg/L	9×10^{-5}
Copper (Cu)	mg/L	<0.0010
Iron (Fe)	mg/L	**1.86**
Lead (Pb)	mg/L	<0.0010

*Bold #'s indicate exceedance of PWQO guidelines

Flora Observed at Site 3	
FEC V-Type: V-1 Balsam Poplar Hardwood and Mixedwood	
Dominant Species *	
Species	
Trees	Black Ash Balsam Poplar White Spruce Balsam Fir Trembling Aspen
Shrubs	Mountain Maple Mountain Ash Wild Red Raspberry Speckled Alder
Ground Cover	Swamp Milkweed Cow Parsnip Bur Marigold Cow Vetch Evening Primrose Hop Clover Fireweed Yellow Hawkweed Lady Fern Horsetail Fowl Meadow Grass Common Wire Grass

	Blue Joint Grass Reed Canary* Green Sedge Floating Bulrush
Aquatic Macrophytes and Algae	Starwort Floating Pondweed Arrowhead, Wapato Duckweed Wild Calla

Substrate Observations for Site 3		**Soil Pit Observations**	
Percentage Shaded	25-50%	**Soil Characteristics**	~five cm of organics overlying clay.
Substrate Classification	Gravel and Cobble		
Abundance of aquatic vegetation	Abundant algae		

General Observations

Site 3 was located off of Miller Heights Drive and was previously sampled in 1997. The road was directly adjacent to the sampling site with flow running parallel. Vegetation was mostly reeds and grasses. Reed canary grass was the dominant vegetation, with a diverse assemblage of low lying herbs and no trees directly adjacent to the creek. The channel was fairly shallow with slow flow and a murky water column. Shallow flow enabled horsetails to grow directly in the current. The substrate was mostly composed of cobble, and algae were also abundant, covering much of the substrate. Soil pit observations showed approximately five centimetres of organics overlying a predominately clay soil.

When comparing 2010 photos of Site 3 with the culvert photo taken in 1997, some observable changes were noted. There was a new culvert (perched) which had been installed since the 1997 documentation. The appearance of the channel was similar to 1997 observations, consisting of murky water and grasses covering the banks.

Results and Discussion

At the time of sampling, Site 3 was in good condition exceeding two PWQO parameters on July 28, 2010. Total coliforms exceeded the pre-1994 PWQO criterion (1,000 MPN/100 mL) with a concentration of 1,600 MPN/100 mL and iron exceeded PWQO criterion (0.3 mg/L) with a concentration of 1.86 mg/L. Laboratory analysis was not completed for the 1997 assessment. Field measurements reported some considerable changes from 1997 to 2010. DO concentrations indicated a decrease from 1997 (11.5 mg/L) to 2010 (6.70 mg/L). This may be in part due to the increase in water temperature from 1997 (average of 12.93 degrees Celsius) to 2010 (18.43 degrees Celsius).

The vegetation of Site 3 appears to have changed little, with an FEC V-1: Balsam Poplar Hardwood and Mixedwood reported from both 1997 and 2010 assessments. A complete absence of black ash in the 1997 report suggests significant successional changes to the adjacent forest.

4.4 Site 4: 5th Concession Road

Site 4 was sampled June 25, July 9, July 23 and August 6, 1997 for the Corbett Creek Watershed Assessment Report. Site 4 was not resampled during the 2010 sampling period. Laboratory results and field observations from 1997 from Site 4 are located in Appendix E.

4.5 Site 5: McNally Drive, Downstream

Location Reference for Site 5	
Location Description	Located off of McNally Drive, downstream.
UTM Coordinates	Northing 5367056/ Easting 311690
Altitude/Elevation	303.978 metres above sea level

Field Measurements for Site 5							
Parameter	Unit	Date: June25, 1997 Time: 12:00 pm	Date: July 9, 1997 Time: 11:30 am	Date: July 23, 1997 Time: 11:00 am	Date: August 6, 1997 Time: 11:45 am	Average of 1997 Data	Date: July 22, 2010 Time: 11:50 am
Water Temperature	ºC	14.0	15.1	16.0	17.2	15.58	19.88
Conductivity	µS/cm	200	170	190	28	205.0	305
Dissolved Oxygen	mg/L	11.2	10.2	9.8	9.5	10.18	8.19
Dissolved Oxygen	%	NA	NA	NA	NA	NA	90.0
pH		7.00	7.20	6.95	7.10	7.06	7.65
Air Temperature	ºC	27	22	21	28	24.50	28
Channel Width	m	NA	NA	NA	NA	NA	4.6
Channel Depth	m	0.54	0.36	0.35	0.17	0.36	0.32
Velocity	m/s	NA	NA	NA	NA	NA	0.027

Laboratory Water Quality Results for Site 5		
Parameter	Unit	Date: July 22, 2010 Time: 11:50 am
Bacteriological		
Escherichia Coli	MPN/100mL	54
Total Coliforms	MPN/100mL	**2400**
Physical		
Conductivity (EC)	µS/cm	287
Total Dissolved Solids	mg/L	215
Turbidity	NTU	2.58
Nutrients		
Ammonia-N, Total	mg/L	<0.020
Chloride (Cl)	mg/L	5.79
Nitrate-N (NO3-N)	mg/L	<0.030
Nitrite-N (NO2-N)	mg/L	<0.020
Phosphorus (P)-Total	mg/L	0.0210
Sulphate (SO4)	mg/L	0.84
Metals		
Aluminum (Al)	mg/L	0.033
Cadmium (Cd)	mg/L	9×10^{-5}
Copper (Cu)	mg/L	<0.0010
Iron (Fe)	mg/L	**0.59**
Lead (Pb)	mg/L	<0.0010

*Bold #'s indicate exceedance of PWQO guidelines

Flora Observed at Site 5	
FEC V-Type: V-2 Black Ash Hardwood and Mixedwood	
Dominant Species *	
Species	
Trees	Black Ash White Spruce Pin Cherry Balsam Poplar Trembling Aspen
Shrubs	Mountain Maple Mountain Ash Willow Saskatoon Wild Red Raspberry Red Osier Dogwood Gooseberry
Ground Cover	Yarrow Birdsfoot Trefoil Canada Goldenrod Northern Bog Goldenrod Hawkweed Sensitive Fern

	Lady Fern Evening Primrose Ox-Eye Daisy Pickerel Weed Thistle Quack Grass Bulrush Marsh Timothy Reed Canary Wire Grass Meadowsweet Grass
Aquatic Macrophytes and Algae	Arrowhead, Wapato Algae

Substrate Observations for Site 5		**Soil Pit Observations**	
Percentage Shaded	25-50%	**Soil Characteristics**	Thick organic layer overlying silty soil.
Substrate Classification	Cobble and boulders		
Abundance of aquatic vegetation	Low density		

General Observations

Site 5, located off of McNally Drive was previously sampled in 1997. This site had relatively easy access with a wide shoulder on the road for parking. The bridge upstream of the sampling location was perpendicular to flow and was in relatively good condition. A large stick jam was observed directly below the bridge. Flow was relatively slow with a very murky water column. The substrate was mostly cobble with boulders dispersed throughout. Aquatic plants were nearly absent with only a few small patches of algae and a few arrow head plants observed. Terrestrial vegetation on both sides of the creek was characterized by thick shrub growth. On the east side of the creek, fill from the road and bridge construction was eroding into the water channel.

At the time of sampling, a beaver dam was observed directly upstream of the stream flow gauge, located upstream of the McNally Bridge. The presence of a beaver dam may have significantly affected discharge and water level readings during the sampling period.

When comparing photo documentation from 1997 and 2010 it was apparent that the location had undergone minimal change. The substrate and stream side vegetation appeared nearly identical between the 1997 and 2010 photos, with no aquatic vegetation apparent for either sampling year. One difference observed between the two years was that the bridge had undergone construction, with much of the structure having been replaced.

Results and Discussion

Results from Site 5 indicated good water quality with two parameters exceeding PWQO criteria at the time of sampling. Total coliforms exceeded the pre-1994 PWQO criterion (1,000 MPN/100 mL) with a concentration of 2,400 MPN/100 mL. Iron exceeded PWQO criterion (0.3 mg/L) with a concentration of 0.59 mg/L. All field measurements were considered to indicate good water quality.

Laboratory analysis was not completed at this location in 1997. Field measurements have changed relatively little from 1997 to 2010. The DO indicated a slight decrease from an average DO concentration of 10.18 mg/L in 1997 to an average DO concentration of 8.19 mg/L in 2010. The water temperature observed in 1997 was 15.58 degrees Celsius, where the water temperature observed in 2010 was significantly higher at 19.88 degrees Celsius. The vegetation of Site 5 appears to have changed very little, with many of the same species recorded, and an FEC of V-2: Black Ash Hardwood and Mixedwood reported in both 1997 and 2010.

4.6 Site 6: 5th Side Road

Site 6 was sampled June 25, July 9, July 23 and August 6, 1997 for the Corbett Creek Watershed Assessment Report. Site 6 was not sampled in 2010. The 1997 laboratory and field results for Site 6 are located in Appendix E.

4.7 Site 7: Oliver Road, Downstream

Location Reference for Site 7	
Location Description	Located downstream of Oliver Road
UTM Coordinates	Northing 5365341/ Easting 312893
Altitude/Elevation	285.443 metres above sea level

Field Measurements for Site 7							
		Date: June 25, 1997	Date: July 9, 1997	Date: July 23, 1997	Date: August 6, 1997	Average of 1997	Date: July 19, 2010
Parameter	Unit	Time: 1:40 pm	Time: 12:10 pm	Time: 11:45 am	Time: 12:25 pm		Time: 2:55 pm
Water Temperature	ºC	15.5	15.2	15.0	17.8	15.88	24.39
Conductivity	µS/cm	210	180	200	255	211.3	319
Dissolved Oxygen	mg/L	12.5	10.2	10.7	8.8	10.55	8.57
Dissolved Oxygen	%	NA	NA	NA	NA	NA	102.5
pH		6.85	7.25	7.10	7.20	7.10	8.10
Air Temperature	ºC	28.5	22.5	22.3	28	25.50	26.1
Channel Width	m	NA	NA	NA	NA	NA	4.5
Channel Depth	m	0.92	0.58	0.52	0.37	0.60	0.22
Velocity	m/s	NA	NA	NA	NA	NA	0.2

Laboratory Water Quality Results for Site 7				
Parameter	Unit	Date: July 9, 1997 Time: 12:10 pm	Date: August 6, 1997 Time: 12:25 pm	Date: July 19, 2010 Time: 2:55 pm
Bacteriological				
Escherichia Coli	MPN/100mL	NA	NA	**110**
Total Coliforms	MPN/100mL	NA	NA	> **2420**
Physical				
Conductivity (EC)	µS/cm	NA	NA	300
Total Dissolved Solids	mg/L	NA	NA	240
Turbidity	NTU	18	18	4.23
Nutrients and Anions				
Ammonia-N, Total	mg/L	NA	NA	<0.020
Chloride (Cl)	mg/L	NA	NA	5.89
Nitrate-N (NO3-N)	mg/L	NA	NA	<0.030
Nitrite-N (NO2-N)	mg/L	NA	NA	<0.020
Phosphorus (P)-Total	mg/L	0.02	0.02	0.02
Sulphate (SO4)	mg/L	NA	NA	1.49
Metals				
Aluminum (Al)	mg/L	NA	NA	0.027
Cadmium (Cd)	mg/L	0.0006	<0.0001	9×10^{-5}
Copper (Cu)	mg/L	NA	NA	<0.0010
Iron (Fe)	mg/L	**0.25**	**0.43**	**0.83**
Lead (Pb)	mg/L	0.0030	0.0031	<0.0010

*Bold #'s Indicate Exceedance of PWQO Guidelines

Flora Observed at Site 7	
FEC V-Type: V-1 Balsam Poplar Hardwood and Mixedwood	
Dominant Species*	
Species	
Trees	Balsam Poplar* Jack Pine White Pine White Spruce Pin Cherry Black Ash
Shrubs	Red Osier Dogwood* Speckled Alder Willow spp. Mountain Ash Green Alder
Ground Cover	Cow Vetch Yellow Hawkweed Bulrush Thistle Swamp Milkweed Reed Canary Grass Timothy Grass Tall Buttercup Sensitive Fern
Aquatic Macrophytes and Algae	-

Substrate Observations for Site 7		Soil Pit Observations	
Percentage Shaded	0-25%	**Soil Characteristics**	Thick organic layer ~ 8 cm thick overlying loam
Substrate Classification	Cobble and boulders		
Abundance of aquatic vegetation	Absent		

General Observations

Site 7 was located off of Oliver Road and was previously sampled in 1997. The surrounding area was highly rural with private properties both upstream and downstream. An agricultural area was located upstream from the sampling location. The Oliver Road Bridge was in good condition, perpendicular to flow, and did not appear to be affecting channel dynamics. Stream bank vegetation was thick, mostly characterized by red osier dogwood, reed canary and an assemblage of herbs that extending over into the channel. The substrate was predominately cobble with large boulders distributed throughout. Soil in this location had a relatively thick organic layer of approximately eight centimetres, overlying a loam soil.

When comparing the 1997 culvert photo to photos taken in 2010 there were no observable changes. The bridge was in the same condition and did not appear to have undergone any significant alterations. The substrate had a similar composition of large boulders and vegetation that appeared to have undergone very little change.

Results and Discussion

Site 7 exceeded three PWQO parameters on July 19, 2010. Total coliforms exceeded the pre-1994 PWQO criterion (1,000 MPN/100 mL) with a concentration greater than 2,420 MPN/100 mL and *E. coli* exceeded pre-1994 PWQO criterion (100 MPN/100 mL) with a concentration of 110 MPN/100 mL. Iron exceeded PWQO criterion (0.3 mg/L) with a concentration of 0.83 mg/L. Agricultural activity upstream of the site may have caused higher than average *E. coli* concentration.

Results from 1997 to 2010 for turbidity, pH and water temperature indicated significant changes between the two years. The highest pH observed in 1997 report was 7.25, where the pH reported in 2010 showed an increase to a pH of 8.10. Water temperatures reported in 1997 ranged from 15 to 17.8 degrees Celsius, where the temperature reported in 2010 was considerably higher at 24.39 degrees Celsius. Turbidity dropped from a consistent 18 Nephelometric Turbidity Units (NTU) reported in 1997 to a much lower value of 4.23 NTU in 2010.

The 2010 inventory reported an FEC of V-1 Balsam Poplar Hardwood and Mixedwood, while the 1997 classified observations as a FEC V-15: White Spruce Mixedwood. In 1997, poplar and black ash were not recorded, however, both species were present in 2010.

4.8 Site 8: Pole Line Road

Site 8 was sampled June 25, July 9, July 23 and August 6, 1997 for the Corbett Creek Watershed Assessment Report. Site 8 was not re-sampled during the 2010 sampling period. The 1997 Laboratory results and field observations from Site 8 are located in Appendix E.

4.9 Site 9: Pebblestone Road

Location Reference for Site 9	
Location Description	Located off of Pebblestone Road in a tributary to the west of Corbett Creek.
UTM Coordinates	Northing 5363164/ Easting 311017
Altitude/Elevation	264.527 metres above sea level

Field Measurements for Site 9							
Parameter	Unit	Date: June 25, 1997 Time: 2:25 pm	Date: July 9, 1997 Time: 1:50 pm	Date: July 23, 1997 Time: 1:20 pm	Date: August 15, 1997 Time: 1:35 pm	Average of 1997 Data	Date: July 19, 2010 Time: 2:10pm
Water Temperature	ºC	16.5	15.2	15.8	15.0	15.63	23.62
Conductivity	µS/cm	275	230	340	425	317.5	580
Dissolved Oxygen	mg/L	10.2	7.1	5.2	7.6	7.53	6.88
Dissolved Oxygen	%	NA	NA	NA	NA	NA	81.5
pH		6.8	7.10	6.85	6.90	6.91	7.71
Air Temperature	ºC	28	25.5	25.5	29	27.00	26
Channel Width	m	NA	NA	NA	NA	NA	0.9
Channel Depth	m	0.46	0.30	0.21	0.19	0.29	0.17
Velocity	m/s	NA	NA	NA	NA	NA	0.004

Laboratory Water Quality Results for Site 9		
Parameter	Unit	Date: July 19, 2010 Time: 2:10 pm
Bacteriological		
Escherichia Coli	MPN/100mL	**210**
Total Coliforms	MPN/100mL	**2000**
Physical		
Conductivity (EC)	µS/cm	549
Total Dissolved Solids	mg/L	424
Turbidity	NTU	3.92
Nutrients		
Ammonia-N, Total	mg/L	<0.020
Chloride (Cl)	mg/L	30.5
Nitrate-N (NO3-N)	mg/L	<0.030
Nitrite-N (NO2-N)	mg/L	<0.020
Phosphorus (P)-Total	mg/L	0.0298
Sulphate (SO4)	mg/L	<0.30

Metals		
Aluminum (Al)	mg/L	0.030
Cadmium (Cd)	mg/L	9×10^{-5}
Copper (Cu)	mg/L	<0.0010
Iron (Fe)	mg/L	**0.596**
Lead (Pb)	mg/L	<0.0010

*Bold #'s indicate exceedance of PWQO guidelines

Flora Observed at Site 9	
FEC V-Type: V-1 Balsam Poplar Hardwood and Mixedwood	
Dominant Species*	
Species	
Trees	Balsam Poplar Pin Cherry Saskatoon
Shrubs	Red Osier Dogwood Speckled Alder Willow spp. Mountain Ash Wild Rose
Ground Cover	Cow Vetch Yellow Hawkweed Strawberry Coltsfoot Dandelion Thistle Yellow Sweet Clover Swamp Milkweed Reed Canary Grass Timothy Grass Tall Buttercup Sensitive Fern Lady Fern Horsetail Swamp Milkweed Ox-Eye Daisy Red Clover Birdsfoot Trefoil Spotted Water Hemlock Large Leaved Aster Bulrush Drooping Woodreep Inland Sedge
Aquatic Macrophytes and Algae	Water Plantain Starwort Wild Calla

Substrate Observations for Site 9		Soil Pit Observations	
Percentage Shaded	75-100%	**Soil Characteristics**	Thin organic layer, overlying loam soil.
Substrate Classification	Muck, clay and some cobble.		
Abundance of aquatic vegetation	High density.		

General Observations

Site 9, located off of Pebblestone Road was previously sampled in 1997. This site was located in an area characterized by agricultural and rural lands. The private property adjacent to the site partook in agricultural activity. This tributary of the creek was essentially a ditch, running parallel to a gravel road. Upstream from site 9 there were three culverts flowing from the opposite side of the road. Flow was slow and nearly stagnant upstream. The water of the sampling site was shallow and murky with abundant aquatic vegetation. The road side was manicured, with thick shrubs and herbs on the west side of the creek. The vegetation on the west side of the creek was dense, resulting in 75-100 percent shade being provided to the sampling site. The substrate of this site was muck and clay with some cobble throughout. Aquatic vegetation was abundant on the substrate, covering greater than 50 percent. There was minor bank erosion at the edge of the creek which exposed a moist clayey loam soil.

When the 1997 culvert photo was compared to the 2010 photos it appeared that the culvert had been replaced. In 2010 under low flow, the culverts were partially submerged, while in 1997 the culvert was perched. Two culverts now exist in this location and the channel resembled a ditch rather than a creek. There was a visible change in vegetation from what appeared to be a shrub dominated bank in 1997 to an herb dominated bank in 2010.

Results and Discussion

Site 9 exceeded PWQO criteria of three parameters on July 19, 2010. Total coliforms exceeded the pre-1994 PWQO criterion (1,000 MPN/100 mL) with a concentration of 2,000 MPN/100 mL and *E. coli* exceeded pre-1994 PWQO criterion (100 MPN/100 mL) with a concentration of 210 MPN/100 mL. Iron exceeded PWQO criterion (0.3 mg/L) with a relatively low concentration of 0.6 mg/L.

Site 9 was reported to have the highest *E. coli* concentration of all sample locations. This site was directly adjacent to agricultural activity and was essentially within a ditch. The high concentrations of *E. coli* may have been a result of the sites close proximity to a farm. The iron concentration was relatively low and likely of natural origin.

Field measurements reported significant change from 1997. Water temperatures showed a substantial increase from a high of 16.5 degrees Celsius in 1997 to a high of 23.5 degrees Celsius in 2010. The conductivity results indicated a slight increase from a high of 425

µS/cm reported in 1997, to 580 µS/cm (field data) and 549 µS/cm (lab data) reported from the 2010 sampling period. The pH reported from 1997 was 6.91, which increased slightly in 2010 to 7.71.

The vegetation at the site appeared to have changed as well. The 1997 inventory reported a FEC of V-15: White Spruce Mixedwood, while the 2010 report did not indicate the presence of any conifer species, reporting an FEC of V-1: Balsam Poplar Hardwood and Mixedwood.

4.10 Site 10: Highway 11/17, Downstream

Location Reference for Site 10	
Location Description	Downstream of Highway 11/17, located at the Corbett Creek Stream rehabilitation project.
UTM Coordinates	Northing 5361652 / Easting 313671
Altitude/Elevation	233.666 metres above sea level

Field Measurements for Site 10							
		Date: June 25, 1997	Date: July 9, 1997	Date: July 23, 1997	Date: August 6, 1997	Average of 1997 Data	Date: July 22, 2010
Parameter	Unit	Time: 2:45 pm	Time: 2:30 pm	Time: 1:40 pm	Time: 2:00 pm		Time: 1:10 pm
Water Temperature	ºC	17.0	17.0	16.0	18.5	17.13	19.95
Conductivity	µS/cm	210	180	200	275	216.3	349
Dissolved Oxygen	mg/L	12.4	10.3	10.8	9.8	10.83	8.54
Dissolved Oxygen	%	NA	NA	NA	NA	NA	93.9
pH		7.10	7.25	7.20	7.15	7.18	7.82
Air Temperature	ºC	27.5	26	26	28	26.88	25
Channel Width	m	NA	NA	NA	NA	NA	3.7
Channel Depth	m	0.73	0.25	0.34	0.19	0.38	0.25
Velocity	m/s	NA	NA	NA	NA	NA	3.7

Laboratory Water Quality Results for Site 10				
		Date: July 9, 1997	Date: August 6, 1997	Date: July 22, 2010
Parameter	Unit	Time: 2:41 pm	Time: 1:30 pm	Time: 1:10 pm
Bacteriological				
Escherichia Coli	MPN/100mL	NA	NA	**120**
Total Coliforms	MPN/100mL	NA	NA	> **2420**
Physical				
Conductivity (EC)	µS/cm	NA	NA	320
Total Dissolved Solids	mg/L	NA	NA	227
Turbidity	NTU	19	16	8.70
Nutrients and Anions				
Ammonia-N, Total	mg/L	NA	NA	<0.020
Chloride (Cl)	mg/L	NA	NA	9.80
Nitrate-N (NO3-N)	mg/L	NA	NA	0.047

Nitrite-N (NO2-N)	mg/L	NA	NA	<0.020
Phosphorus (P)-Total	mg/L	0.02	0.02	0.0255
Sulphate (SO4)	mg/L	NA	NA	1.39
Metals				
Aluminum (Al)	mg/L	NA	NA	**0.168**
Cadmium (Cd)	mg/L	0.0012	<0.0001	9×10^{-5}
Copper (Cu)	mg/L	NA	NA	0.0014
Iron (Fe)	mg/L	0.29	0.37	**1.21**
Lead (Pb	mg/L	0.0018	0.0035	<0.0010

*Bold #'s indicate exceedance of PWQO guidelines

Flora Observed at Site 10	
FEC V-Type: NA	
Dominant Species*	
Species	
Trees	Poplar White Spruce
Shrubs	Red Osier Dogwood Wild Rose Willow spp.* Saskatoon Alder
Ground Cover	Birdsfoot Trefoil Cow Vetch Horsetails Common Reed Marsh Hemlock Thistle Bulrush Fowl Meadow Reed Canary Grass Manna Grass Narrow Leaved Meadowsweet Spotted Joe-Pye Weed Swamp Milkweed Blue Joint Grass
Aquatic Macrophytes and Algae	Floating Leaved Pondweed Wapato

Substrate Observations for Site 10		**Soil Pit Observations**	
Percentage Shaded	25-50%	**Soil Characteristics**	Poor structure, easily crumbles. High organic content with low clay content. Site is predominant below organic layer.
Substrate Classification	Mostly silt and clay with some gravel and cobble distributed throughout.		
Abundance of aquatic vegetation	Low density		

General Observations

Site 10 was located off Highway 11/17 was sampled in 1997, and was also the former stream rehabilitation site facilitated by the LRCA in 1987. Fencing and cattle passes were installed to restrict cattle from trampling the creek bed and banks, however, in 2010 there were no cattle on site. The bridge at this site was the largest of all sampling locations and appeared to be in good condition. The surrounding area was rural, with a residence adjacent to the sampling site. The vegetation of the area was characterized by abundant herbs and grasses, with shrubs dominating downstream. There were very few trees within the area. The flow of the creek was relatively slow given the large width and shallow depth of the stream. The water was highly turbid, only a stream bank photo could be taken. There appeared to be to be a high level of sedimentation at the site. There were also a large number of fallen trees within the channel upstream which did not appear to disrupt overall flow substantially, but caused small pockets of slow flow. A roadside runoff drain from the bridge was located upstream of the site with a considerable buildup of sludge appearing on the outside of the drain.

When comparing the 1997 culvert photo to photos taken in 2010, there does not appear to be any significant changes regarding the physical structure of the creek or bridge. The vegetation, predominately composed of grasses, on the upstream side appeared to have remained the same. The large sediment bar on the west side of the bridge was apparent in both 1997 and 2010 photo documentation.

Results and Discussion

At the time of sampling on July 22, 2010, Site 10 exceeded three PWQO parameters. Iron exceeded PWQO criterion (0.3 mg/L) with a concentration of 1.21 mg/L and aluminum exceeded PWQO (0.075 mg/L) with a concentration of 0.168 mg/L. Total coliforms exceeded the pre-1994 PWQO criterion (1,000 MPN/100 mL) with a concentration greater than 2,420 MPN/100 mL. *E. coli* exceeded pre-1994 PWQO criterion (100 MPN/100 mL) with a concentration of 120 MPN/100 mL.

Site 10 was downstream of an agricultural area with the previous upstream site also in exceedance of *E. coli*. Site 10 was located within a rural area, a local point source contaminant from wild animals or small scale livestock may be responsible for high *E. coli* levels. The iron concentration of the site has shown an increase from the previous site but is likely due to the local geology with what appeared to be orange sediment and iron bacteria directly adjacent to the site. The aluminum concentration was fairly low and it is likely that local geology is again responsible.

The 2010 field measurements have shown some changes from the previous 1997 report. At the time of sampling in 2010 the water temperature was 19.95 degrees Celsius, slightly higher compared to 18.5 degrees Celsius reported in 1997. DO concentrations

showed a slight decrease from 9.8 mg/L in 1997 to a DO concentration of 8.54 mg/L in 2010. This change may have been in response to higher temperatures and/or less aquatic plants or sediment.

The dominant vegetation at Site 10 was shrubs, grasses and herbs. An insufficient number of trees were present in order to effectively determine an FEC. Farther upstream and downstream there were spruce and ash growing. The 1997 report classified observations as a FEC of V-17: Jack Pine Mixedwood/ Shrub Rich. In 2010 willow was the dominant species, no jack pines were observed. In the 1997 report willows were not included in the species inventory.

4.11 Site 11: Private Property off of Highway 11/17

Site 11 was sampled June 25, July 9, July 23 and August 6, 1997 for the Corbett Creek Watershed Assessment Report. This site was not resampled during the 2010 sampling period. Laboratory results and field observations from 1997 for Site 1 are located in Appendix E.

4.12 Site 12: Near Confluence with Kaministiqua River, Harstone Drive

Site 12 was sampled June 25, July 9, July 23 and August 6, 1997 for the Corbett Creek Watershed Assessment Report. This site was not resampled for the 2010 sampling period. The 1997 laboratory results and field observations from Site 12 are located in Appendix E.

4.13 Site 13: Confluence with Kaministiqua

Location Reference for Site 13	
Location Description	Confluence with Kaministiqua River, located downstream of Harstone Drive, private property.
UTM Coordinates	Northing 5359710/ Easting 312724
Altitude/Elevation	209 metres above sea level

Field Measurements from Site 13		
		Date: August 17, 2010
Parameter	Unit	Time: 1:30pm
Water Temperature	ºC	18.96
Conductivity	µS/cm	315
Dissolved Oxygen	mg/L	7.28
Dissolved Oxygen	%	79.3
pH		7.6
Air Temperature	ºC	21
Channel Width	m	5.4
Channel Depth	m	1.7
Velocity	m/s	No flow

Laboratory Water Quality Results from Site 13		
Parameter	Unit	Date: August 17, 2010 Time: 1:30 pm
Bacteriological		
Escherichia Coli	MPN/100mL	**150**
Total Coliforms	MPN/100mL	**>2420**
Physical		
Conductivity (EC)	µS/cm	314
Total Dissolved Solids	mg/L	219
Turbidity	NTU	1.47
Nutrients and Anions		
Ammonia-N, Total	mg/L	<0.020
Chloride (Cl)	mg/L	10.8
Nitrate-N (NO3-N)	mg/L	<0.030
Nitrite-N (NO2-N)	mg/L	<0.020
Phosphorus (P)-Total	mg/L	<0.0050
Sulphate (SO4)	mg/L	8.45
Metals		
Aluminum (Al)	mg/L	0.031
Cadmium (Cd)	mg/L	9×10^{-5}
Copper (Cu)	mg/L	0.0017
Iron (Fe)	mg/L	0.101
Lead (Pb)	mg/L	<0.0010

*Bold #'s indicate exceedance of PWQO guidelines

Flora Observed at Site 13	
FEC V-Type: V-2 Black Ash Hardwood and Mixedwood	
Dominant Species*	
Species	
Trees	Black Ash* White Spruce Balsam Fir Black Spruce
Shrubs	Red Osier Dogwood Green Alder* Slender Willow* Balsam Willow Hawthorn Wild Rose
Ground Cover	Cow Vetch Fireweed Slender White Aster Wild Mint Swamp Milkweed Golden Rod Reed Canary Lady's Thumb

Aquatic Macrophytes and Algae	Algae		
Substrate Observations for Site 13		**Soil Pit Observations**	
Percentage Shaded	0-25%	**Soil Characteristics**	Low organic content Loam
Substrate Classification	Sand and cobble		
Abundance of aquatic vegetation	Algae		

General Observations

Site 13 was the confluence of Corbett Creek and the Kaministiqua River. This site was adjacent to private property off of Harstone Drive. The flow of the creek was nearly stagnant upstream of the sampling site and flow from the Kaministiqua River was rushing into the mouth of the creek which caused some backflow. Water levels within the creek channel appeared to be low and could not overpower the flow of the river. The adjacent property was manicured, with adequate buffer vegetation from the mowed grass to the creek bed. Vegetation on the creek banks was abundant, with the west side dominated by grasses and thick slender willow growth farther from the water's edge. The west side of the creek was shrub and herb dominated, with hawthorn, lady's thumb and alder present.

Results and Discussion

Water from the Kaministiqua River flowed into the mouth of Corbett Creek which appeared to be causing some mixing. This may have altered water quality results due to the mixing of river water with creek water. In an effort to reduce this potential effect of the mixing water, samples were taken as far away as possible from this influx while attempting to maintain the appropriate distance for a confluence sample. Site 13 exceeded two PWQO parameters on August 17, 2010. Total coliforms exceeded the pre-1994 PWQO criterion (1,000 MPN/100 mL) with a concentration greater than 2,420 MPN/100 mL, and *E.coli* exceeded pre-1994 PWQO criterion (100 MPN/100 mL) with a concentration of 150 MPN/100mL. A dog was seen standing in the water upstream of the sampling site which may have affected the results. Laboratory results indicated that Site 13 was the only sampling location with an iron concentration below PWQO criterion (0.3 mg/L).

4.14 Site 14: Tributary West of Site 13

Location Reference for Site 14	
Location Description	Located on the tributary just west of Corbett Creek and Kaministiqua River Confluence.
UTM Coordinates	Northing 5360171/ Easting 311906
Altitude/Elevation	210.393 metres above sea level

Field Measurements for Site 14		
		Date: July19, 2010
Parameter	Unit	Time: 1:00 pm
Water Temperature	ºC	19.43
Conductivity	µS/cm	370
Dissolved Oxygen	mg/L	8.97
Dissolved Oxygen	%	97.7
pH		8.12
Air Temperature	ºC	27
Channel Width	m	1.2
Channel Depth	m	0.15
Velocity	m/s	0.028

Laboratory Water Quality Results for Site 14		
		Date: July 19, 2010
Parameter	Unit	Time: 1:30 pm
Bacteriological		
Escherichia Coli	MPN/100mL	35
Total Coliforms	MPN/100mL	**2000**
Physical		
Conductivity (EC)	µS/cm	374
Total Dissolved Solids	mg/L	283
Turbidity	NTU	2.40
Nutrients		
Ammonia-N, Total	mg/L	<0.020
Chloride (Cl)	mg/L	35.8
Nitrate-N (NO3-N)	mg/L	0.856
Nitrite-N (NO2-N)	mg/L	<0.020
Phosphorus (P)-Total	mg/L	<0.0050
Sulphate (SO4)	mg/L	7.78
Metals		
Aluminum (Al)	mg/L	0.042
Cadmium (Cd)	mg/L	9×10^{-5}
Copper (Cu)	mg/L	0.0017
Iron (Fe)	mg/L	**0.436**
Lead (Pb)	mg/L	<0.0010

*Bold #'s indicate exceedance of PWQO guidelines

Flora Observed at Site 14	
FEC V-Type: NA	
Dominant Species*	
Species	
Trees	Balsam Poplar White Birch Mountain Maple
Shrubs	Speckled Alder Sage Leaved Willow Slender Willow
Ground Cover	Cow Vetch Fireweed Red Clover Dark Green Bulrush Inland Sedge
Aquatic Macrophytes and Algae	Floating Leaved Burreed Floating Leaved Pond Weed Algae Wild Calla

Substrate Observations for Site 14		Soil Pit Observations	
Percentage Shaded	0-25%	**Soil Characteristics**	Gravel Sandy Clay
Substrate Classification	Sand and cobble		
Abundance of aquatic vegetation	Low density		

General Observations

Site 14 was located west of Site 13 at the confluence of an unnamed creek and the Kaministiqua River. This site was initially sampled as it was thought to be the confluence of Corbett Creek with the Kaministiqua River. As the collected sample was analyzed, the results were reported for comparison/reference purposes. The site was characterized by a gravel washout and two small channels which had split and now flow into the river independently. Both channels were very shallow, with the deeper channel being chosen for sampling. The sampling site had many boulders (and a tire) which were slowing the flow of water to the river. The substrate was generally characterized by sand and cobble, with abundant aquatic vegetation downstream of the sampling site. The terrestrial vegetation upstream from the sampling site was dominated by thick shrubs, providing almost complete shade cover. A large number of minnows were observed at this location, with one larger attempting to swim upstream. Site 14 appeared to have similar water quality to that observed in Corbett Creek.

Results and Discussion

Site 14 appeared to be in good condition at the time of sampling and exceeded PWQO for three parameters; total coliforms, *E.* coli, and iron on July 19, 2010. Total coliforms exceeded the pre-1994 PWQO criterion (1,000 MPN/100 mL) with a concentration of 2,000 MPN/100 mL, and *E. coli* exceeded pre-1994 PWQO criterion (100 MPN/100 mL) with a concentration of 150 MPN/100mL. Iron exceeded PWQO criterion (0.3 mg/L) with a concentration of 0.436 mg/L. All other parameters were below PWQO guidelines and at healthy levels.

4.15 Overall Site Summary

Table 4.0: Summary of 2010 Field Measurements

Parameter	Unit	Site 1	Site 3	Site 5	Site 7	Site 9	Site 10	Site 13
		Date: July 22, 2010	Date: July 22, 2010	Date: July 22, 2010	Date: July 19, 2010	Date: July 19, 2010	Date: July 22, 2010	Date: August 17, 2010
		Time: 9:45am	Time: 10:55am	Time: 11:50am	Time: 2:55pm	Time: 2:10pm	Time: 1:10pm	Time: 1:30pm
Water Temperature	ºC	18.44	18.43	19.88	24.39	23.62	19.95	18.96
Conductivity	uS/ cm	150	243	305	319	580	349	315
Dissolved Oxygen	mg/ L	5.07	6.70	8.19	8.57	6.88	8.54	7.28
Dissolved Oxygen	%	55.1	71.5	90.0	102.5	81.5	93.9	79.3
pH		7.56	7.61	7.65	8.10	7.71	7.82	7.6
Air Temperature	ºC	21.1	25	28	26.1	26	25	21
Channel Width	m	0.79	1.45	4.6	4.5	0.9	3.7	5.4
Channel Depth	m	0.05	0.15	0.32	0.22	0.17	0.25	1.7
Velocity	m/s	0.0132	0.087	0.027	0.2	0.004	0.08	No flow

Table 5.0: Summary of Averages for 1997 and 2010 Field Measurements

Parameter	Unit	Averages from all 1997 Data	Averages from all 2010 Data
Water Temperature	ºC	15.73	20.52
Conductivity	µS/cm	213.67	323
Dissolved Oxygen	mg/L	9.95	7.32
Dissolved Oxygen	%	NA	81.97
pH		7.09	7.72
Air Temperature	ºC	24.10	24.60
Channel Width	m	NA	3.05
Channel Depth	m	0.45	0.19
Velocity	m/s	NA	0.06

Table 6.0: Summary of 2010 Laboratory Results								
		Site 1	**Site 3**	**Site 5**	**Site 7**	**Site 9**	**Site 10**	**Site 13**
		Date: July 22, 2010	Date: July 22, 2010	Date: July 22, 2010	Date: July 19, 2010	Date: July 19, 2010	Date: July 19, 2010	Date: Aug 17, 2010
Parameter	Unit	Time: 9:45am	Time: 10:55am	Time: 11:50am	Time: 2:55pm	Time: 2:10pm	Time: 1:10pm	Time: 12:00am
Bacteriological								
Escherichia Coli	MPN/ 100mL	30	32	54	**110**	**210**	**120**	**150**
Total Coliforms	MPN/ 100mL	**2400**	**1600**	**2400**	**> 2420**	**2000**	**> 2420**	**>2420**
Physical								
Cond (EC)	µS/cm	281	237	287	300	549	320	314
Total Dissolved Solids	mg/L	212	178	215	240	424	227	219
Turbidity	NTU	5.60	3.69	2.58	4.23	3.92	8.70	1.47
Nutrients								
Ammonia-N, Total	mg/L	0.026	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020
Chloride (Cl)	mg/L	19.7	0.81	5.79	5.89	30.5	9.80	10.8
Nitrate-N (NO3-N)	mg/L	<0.030	<0.030	<0.030	<0.030	<0.030	0.047	<0.030
Nitrite-N (NO2-N)	mg/L	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020
Phosphorus (P)-Total	mg/L	**0.0348**	0.0244	0.0210	0.0159	0.0298	0.0255	<0.0050
Sulphate (SO4)	mg/L	0.31	0.46	0.84	1.49	<0.30	1.39	8.45
Metals								
Aluminum (Al)	mg/L	0.021	0.018	0.033	0.027	0.030	**0.168**	0.031
Cadmium (Cd)	mg/L	9×10^{-5}	9×10^{-5}	9×10^{-5}	9×10^{-5}	9×10^{-5}	9×10^{-5}	9×10^{-5}
Copper (Cu)	mg/L	<0.0010	<0.001	<0.0010	<0.0010	<0.001	0.0014	0.0017
Iron (Fe)	mg/L	**3.07**	**1.86**	**0.590**	**0.832**	**0.596**	**1.21**	0.101
Lead (Pb)	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

*Bold indicates exceedance of PWQO guidelines

Table 7.0: Summary of Averages of 1997 and 2010 Laboratory Results			
Parameter	Unit	Averages for all **1997** Data	Averages for all **2010** Data
Bacteriological			
Escherichia Coli	MPN/100mL	NA	**100.86**
Total Coliforms	MPN/100mL	NA	**2100**
Physical			
Conductivity (EC)	µS/cm	NA	326.86
Total Dissolved Solids	mg/L	NA	245
Turbidity	NTU	18.8	4.31
Nutrients			
Ammonia-N, Total	mg/L	NA	0.03
Chloride (Cl)	mg/L	NA	11.9
Nitrate-N (NO3-N)	mg/L	NA	0.05
Nitrite-N (NO2-N)	mg/L	NA	<0.020
Phosphorus (P)-Total	mg/L	0.022	0.03
Sulphate (SO4)	mg/L	NA	2.16
Metals			
Aluminum (Al)	mg/L	NA	0.05
Cadmium (Cd)	mg/L	0.00074	<0.000090
Copper (Cu)	mg/L	NA	0.002
Iron (Fe)	mg/L	**0.34**	**1.23**
Lead (Pb)	mg/L	**0.003**	<0.0010

*Bold indicates exceedance of PWQO guidelines

When comparing the overall averages for both the 1997 and 2010 assessments, general variances in recorded field parameters were noted. Iron, which on average exceeded the PWQO criterion in both the 1997 and 2010 assessments, had increased in concentration since 1997. Lead exceeded PWQO criterion in 1997, but did not exceed the criterion at any site in 2010. Both elements occur frequently in nature and levels are considered to be from natural sources. Total coliform and *E. coli* concentrations were not assessed in 1997, but were evaluated in the 2010 assessment.

5 Overall Discussion

Water quality analysis indicated that the Corbett Creek watershed was in overall good health for the July 2010 sampling period, with little change reported from the 1997 Corbett Creek Assessment. Changes of water quality from 1997 to 2010 were reported in regards to site specific locations only.

5.1 Climate

Meteorological data located in Table 1.0, Table 2.0 and Table 3.0 indicate that the 2010 sampling period had higher than average air temperature and lower than average total precipitation. Precipitation is an important consideration for many reasons including its effect upon mixing. Lower levels of precipitation can affect water quality results by reducing the mixing of layers within the water column. It is important to note that the LRCA Area of Jurisdiction and Thunder Bay District was in a declared Level I Low Water Condition (i.e. received precipitation less than 80% of average) for the months of April, July, August, September, October and November. These districts were also in a declared Level II Low Water Condition (i.e. received precipitation between 40-60% of average) for the months of May and June.

5.2 Hydrology

Elevation plays an important role in the direction of water drainage and stream velocity. The highest point of elevation recorded for the 2010 sampling period was Site 1, with an elevation of 405.2 metres above sea level. The lowest point of elevation was Site 13 which was 209 metres above sea level. From the headwaters (Site 1) to the confluence (Site 13) there was a total difference in elevation of 196.2 metres.

Channel depths reported from 2010 sampling locations ranged from 0.05 metres to 0.32 metres with an average depth of 0.19 metres. Depths recorded from 1997 ranged from 0.19 metres to 0.74 metres, with an average depth of 0.45 metres. Overall depth for the watershed appeared to have dropped by 50 percent from the 1997 to 2010 observations. This may be in response to the low water condition and below average rainfall during the 2010 sampling period. Width measurements during the 2010 sampling period were highly variable, ranging from 0.79 metres to 5.4 metres with an average of 3.05 metres. Width was not measured during the 1997 sampling period. Velocity measured in 2010 was relatively low overall ranging from 0.09 cubic metres per second, to no flow, with an average velocity of 0.06 cubic metres per second for all sampling sites.

Water levels and discharge were recorded at the Environment Canada Hydrometric Station (02AB022) from January to August 2010 and are graphically illustrated in Appendix I. Water levels ranged from a low of 5.19 metres on April 22 to a maximum

level of 6.34 metres on May 15. When compared to the average water levels and flow recorded from 2003 to 2009, discharge and water levels recorded from 2010 are comparable, and in many cases, higher. Observations of beaver activity and a nearly completed beaver dam were noted just upstream of this stream flow gauge. This partial interruption to flow may have considerably affected the hydrometric data recorded from this location.

5.3 Dissolved Oxygen

DO concentrations throughout the watershed during the 2010 sampling were reported to be healthy, without a single site exceeding PWQO criterion. DO concentrations during the 2010 sampling period ranged from 5.07 mg/L to 8.57 mg/L with an average of 7.32 mg/L. The DO concentrations observed in the 1997 study were comparable, but higher overall than those observed in 2010. DO concentrations observed in 1997 ranged from 4.78 mg/L to 11.55 mg/L, with an average of 9.95 mg/L. Results from both 1997 and 2010 sampling show that Site 1 had significantly lower DO concentration than other sites for each sampling period (4.78 mg/L in 1997 and 5.07 mg/L in 2010).

5.4 pH

All pH values observed in 2010 were within PWQO guidelines (6.5-8.5), ranging from 7.56 to 8.10 with an overall average pH of 7.72. The 1997 observations were similarly healthy and fairly similar ranging from 6.9 to 7.23 with an overall average of 7.09. The relatively healthy and stable pH values observed in both 1997 and 2010 sampling periods may be an indicator of adequate buffering capacity within Corbett Creek.

5.5 Bacteriological

Total coliforms exceeded the pre-1994 PWQO criterion (1,000 MPN/100 mL) at every sampling site in 2010. The total coliform concentrations observed in 2010 ranged from 1,600 MPN/100 mL to greater than 2,400 MPN/100 mL, for an overall average of 2,100 MPN/100 mL. High total coliform concentrations can be from a variety of sources both natural and anthropogenic in origin. The natural niches for members of coliform bacteria range from being fecal specific, such as *E. coli*, to being widely distributed in the water, soil, and vegetation (Leclerc *et al.*, 2001; Rompré *et al.*, 2002). If densities of warm blooded wildlife are high, natural sources of fecal coliforms can often be concentrated in wetlands and along the shorelines of lakes and rivers. Other sources such as human or livestock waste may also be common and can cause concentrated amounts to occur through runoff or poor waste water management techniques.

Laboratory results from 2010 sampling locations indicated that four of the sampling sites (Sites 7, 9, 10 and 13) reported *E. coli* concentrations which exceeded pre-1994 PWQO criterion. Site 9 was reported to have the highest concentration of 210 MPN/100 mL, Site 7 had a concentration of 110 MPN/100 mL, Site 10 a concentration of 120 MPN/100 mL

and Site 13 a concentration of 150 MPN/100 mL. Total coliforms and *E. coli* were not tested in 1997.

5.6 Metals

During the 2010 sampling period iron ranged from 0.1 mg/L to 3.07 mg/L with an overall average of 1.23 mg/L. Iron concentrations consistently exceeded PWQO criterion (0.3 mg/L) at every site with the exception of Site 13. High iron concentrations and iron rich soils were found at every site, suggesting that iron concentrations are likely of geologic origin. The bedrock in the region is known to be composed in part by iron formation, where natural occurrences of the metal are inevitable. High iron levels in water may lead to the production of iron bacteria which are un-aesthetically appealing and may cause build up in water lines and pipes.

The only other metal to exceed PWQO criteria from the 2010 sampling period was aluminum. Aluminum concentrations reported from 2010 sampling ranged from 0.021 mg/L to 0.168 mg/L with an average of 0.05mg/L. Site 10 was the only sampling location which exceeded PWQO (0.075 mg/L) with a concentration of 0.168 mg/L reported from July 19, 2010. Lead and cadmium were tested for both the 1997 and 2010, with slight decreases in concentrations observed. The laboratory results from 2010 sampling reported lead to be below PWQO criterion (0.001 mg/L to 0.005 mg/L dependent upon hardness) for all sites. Lead concentrations reported from 1997 sampling ranged from less than 0.0001 to 0.0041 mg/L with an average of 0.003 mg/L. Lead consistently exceeded the PWQO criterion in 1997, but was not in exceedance at any site in 2010.

5.7 Nutrients

Laboratory results indicated low nutrient concentrations for all sampling locations, with only one exceedance from all sampling locations. Phosphorus exceeded PWQO criterion (0.03 mg/L) at Site 1, with a concentration of 0.035 mg/L. Phosphorus concentrations reported from the 1997 and 2010 sampling periods were comparable. The average level of phosphorus reported from 2010 was 0.03 mg/L, where an average of 0.02 mg/L in 1997. Ammonia concentrations were low and mostly below the detectable level during 2010 sampling. Chloride, nitrate and nitrite concentrations for all sites were well below PWQO criteria as well, with much of the nitrite and nitrate concentrations less than the detectable level. Laboratory analysis was not completed for ammonia, chloride, nitrate and nitrite in 1997.

5.8 Conductivity and Turbidity

Conductivity laboratory results from 2010 ranged from 237 µS/cm to 549 µS/cm with an average of 326.86 µS/cm, while field results of conductivity range from 150 µS/cm to 580 µS/cm with an average of 323 µS/cm. Laboratory results of turbidity ranged from 1.47 NTU to 8.7 NTU with an average of 4.31. Laboratory results indicated that Site 9

had the highest conductivity (549 µS/cm) as well as the highest turbidity (8.70 NTU). The higher than average values reported from Site 9 may have been caused by its ditch like location and sediment inputs from the adjacent road, however, in general the turbidity was considered low. Observed average turbidity in 2010 was 4.31 NTU, a decreased from the 1997 average turbidity of 18.8 NTU.

Substrate observations were highly variable between sampling locations, however, common substrate found throughout the watershed was comprised of muck, cobble, boulders and bedrock. Wildlife observations were highly variable as well, with no trend or outstanding observations of any kind. The 2010 vegetation survey did not yield any species which were invasive or endangered at the time of sampling, however, changes to the structure and composition of vegetation from 1997 and 2010 were noted. Sites 3 and 5 were the only two sampling locations with the same FEC used to classify both 1997 and 2010 observations of site vegetation.

6 Conclusion

Water quality results from the 2010 Corbett Creek Watershed Assessment Update indicated that the Corbett Creek Watershed was in relatively good condition at the time of sampling (July, 2010). Only three parameters, total coliforms (pre-1994 criteria), *E. coli* and iron consistently exceeded PWQO criteria at several sampling locations. Total coliforms, *E. coli* and iron commonly occur at high concentrations under natural conditions and most of the concentrations reported from the 2010 study were likely from natural processes within the watershed. Site 9 was reported to have the highest *E. coli* concentrations of all sample locations and may be the result of agricultural activity in the area.

The overall water quality of the watershed appeared to be healthy in both 1997 and 2010 with only negligible changes observed. Turbidity levels appeared to have decreased over time for all sites. Slight decreases in the concentrations of lead and cadmium were also observed. Changes to physical parameters reported for most sites from 1997 to 2010 such as conductivity, water temperature and depth, were likely caused by natural variation. Observations of beaver activity and a nearly completed beaver dam were noted just upstream of this stream flow gauge. This may have affected the data recorded from the stream flow gauge.

7 Recommendations

Based on the 2010 Corbett Creek Watershed Assessment Update, the recommendations are as follows:

- Staff and funding permitting, it is recommended that an update to the 2010 Corbett Watershed Assessment be completed in the next five to ten years.
- Site 9 should be considered a key point of interest for future sampling within the Corbett Creek Watershed.
- The stream flow gauge (02AB022) located directly upstream of McNally Drive and Site 5 should be investigated to assess the potential effect of the partial beaver dam upon water level and discharge.
- To minimize variability in the occurrence of point source contamination, future sampling should consider two sampling periods, in which both physical and chemical analysis is completed.
- As benthic analysis indicates water quality over an extended period of time, benthic analysis should be considered for future watershed assessments.
- Future documentation of biological attributes should consider the use of transects to quantify site vegetation.
- A copy of the report should be provided to the Municipality of Oliver Paipoonge for reference purposes.

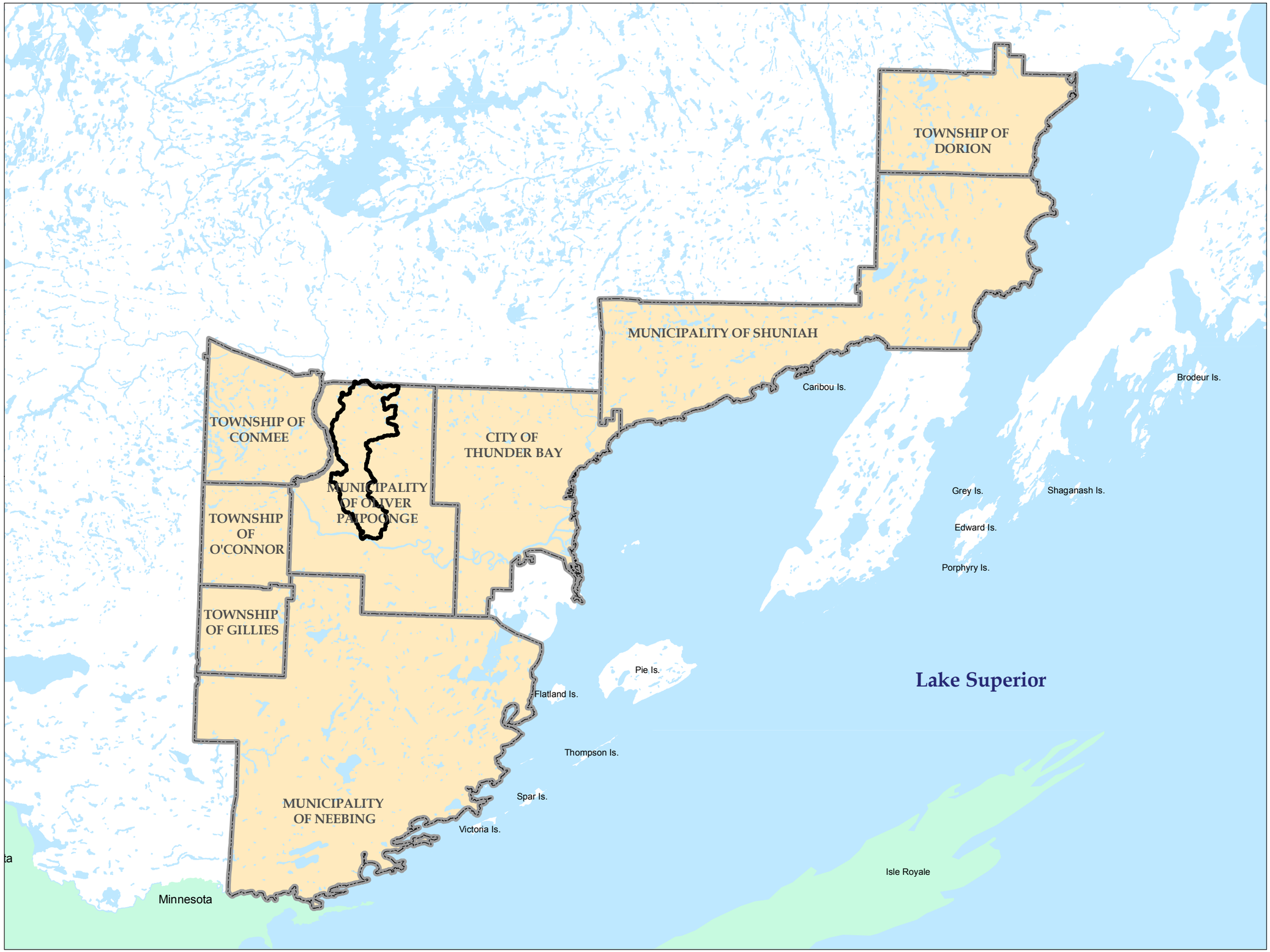
A copy of this report should be made available to the residents of the Municipality of Oliver Paipoonge. The Report should be kept on file a the LRCA Administration Office for review by interested parties.

MAPS

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

Corbett Creek Watershed

M-1: Key Plan



N

Legend

- Corbett Creek Watershed
- Municipal Boundary
- LRCA Jurisdiction Boundary
- Water Body

0 10 20 km

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Datum: NAD 83
Projection: UTM Zone 16N
Date: August, 2010

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

Corbett Creek Watershed

M-2: Site Plan

N

Legend

- Sampling Site 1997
- Sampling Site 1997 & 2010
- New Sampling Site 2010
- Corbett Creek Watershed
- Railway

Roads

- Highway
- Road

Permanent Watercourse

- River
- Creek
- Stream

Drainage

- Waterbody
- Wetland
- Provincially Significant Wetland

0 1 2 3 km

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Corbett Creek Watershed

M-3: Topography

N

Legend

- Corbett Creek Watershed
- Township Boundary

Roads

- Highway
- Road

Contour Lines

- 50m Contour Intervals
- 10m Contour Intervals

Permanent Watercourse

- River
- Creek
- Stream

Drainage

- Waterbody
- Wetland

0 1 2 3 km

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Corbett Creek Watershed

M-4: Bedrock Geology

N

Legend

- Corbett Creek Watershed

Surficial Points Features

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

Roads

- Highway
- Road

Permanent Watercourse

- River
- Creek
- Stream

Drainage

- Waterbody
- Wetland

Bedrock Formation

PALEOPROTEROZOIC

- 22a, Sedimentary rocks

NEO-ARCHEAN

- 9, Coarse clastic metasedimentary rocks

NEO-TO MESOARCHEAN

- 4, Mafic to ultramafic metavolcanic rocks
- 5, Mafic to intermediate metavolcanic rocks
- 6, Felsic to intermediate metavolcanic rocks
- 10, Mafic and ultramafic rocks
- 14, Diorite - monzonite - granodiorite suite
- 15, Massive granodiorite to granite

0 1 2 3 km

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Datum: NAD 83
Projection: UTM Zone 16N
Date: August, 2010

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Corbett Creek Watershed

M-5: Surficial Geology

N

Legend

- Corbett Creek 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

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

0 1 2 3 km

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Datum: NAD 83
Projection: UTM Zone 16N
Date: August, 2010

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Corbett Creek Watershed

M-6: Soils

N

Legend

- Corbett Creek Watershed
- Township Boundary

Roads

- Highway
- Road

Permanent Watercourse

- River
- Creek
- Stream

Drainage

- Waterbody
- Wetland

Thunder Bay Soils

- BINABICH (Bi)
- CURRENT RIVER (C)
- DORION (D)
- FORMAL (F)
- JARVIS RIVER (J)
- LAPPE (L)
- MUCK (M)
- NEEBING (Ne)
- NOLALU (N)
- ORGANICS - BAIRD (Bd)
- ORGANICS - INNES LAKE (In)
- ORGANICS - MURILLO (Mo)
- ORGANICS - PASSER (Ps)
- ORGANICS - PENASSEN (Pn)
- ORGANICS - WOLF RIVER (Wf)
- OSKONDOGA (O)
- PAIPOONGE (Pa)
- PEARL (Pe)
- PEAT (P)
- ROCKLAND (R)
- SLATE RIVER (SR)
- WAMSLEY (Wa)
- WOLFPUP (W)

0 1 2 3 km

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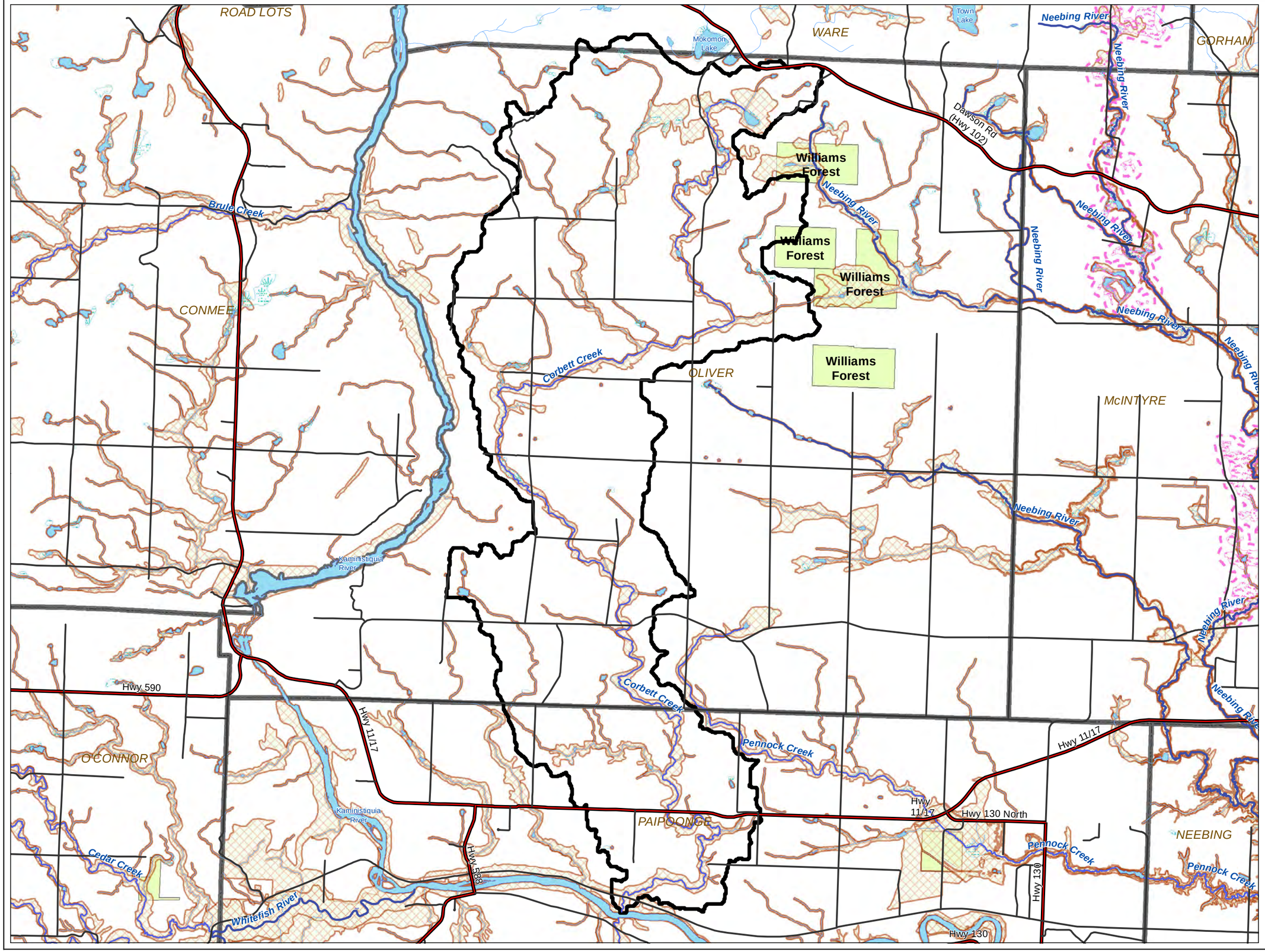
This map is illustrative only. Do not rely on it as being a precise indicator of routes or features, nor as a guide to navigation.

Datum: NAD 83
Projection: UTM Zone 16N
Date: August, 2010



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

Corbett Creek Watershed

M-7: Approximate Regulated Areas

N

Legend

- Corbett Creek Watershed
- Township Boundary

Roads

- Highway
- Road

Permanent Watercourse

- River
- Creek
- Stream

Drainage

- Waterbody
- Wetland
- Approximate Regulated Area
- Provincially Significant Wetland (PSW) (Regulated)
- PSW 120 Metre Regulated Area
- LRCA Owned Property

0 1 2 3 km

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

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APPENDIX A:

TECHNIQUES FOR DATA COLLECTION

Appendix A: 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 with the waterproof camera.

Channel width & depth
The width of the Stream was done using a 100 m fibreglass measuring tape. Channel depth was measured by using a stainless steel meter stick.

Flow
The velocity of river flow at sites was measured using a bobber and 100 m fibreglass measuring tape. 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 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 B:

WATER QUALITY PARAMETERS

Appendix B: 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 breath. 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 know 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 C:

WATER QUALITY GUIDELINES

Appendix C: 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.
9	.017	.054	.17	.54	1.7	5.2	15.	35.	63.
10	.019	.059	.19	.59	1.8	5.6	16.	37.	65.

Temp.	**pH**								
°C	**6.0**	**6.5**	**7.0**	**7.5**	**8.0**	**8.5**	**9.0**	**9.5**	**10.0**
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

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

Bismuth:
There are currently no PWQO guidelines for Bismuth.

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

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.

Strontium:
There are currently no PWQO guidelines for Strontium.

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 D:

2010 LABORATORY WATER QUALITY RESULTS

Appendix D: 2010 Laboratory Water Quality Results

Laboratory Water Quality Results for Site 1: Headwaters, Mud Lake Road			
Parameter	**Units**	**PWQO**	22-Jul- 10
Physical Tests			09:45
Conductivity (EC)	uS/cm	n/a	281
Total Dissolved Solids	mg/L	n/a	212
Turbidity	NTU	<10% of natural	5.60
Anions and Nutrients			
Ammonia-N, Total	mg/L	n/a	0.026
Chloride (Cl)	mg/L	n/a	19.7
Nitrate-N (NO3-N)	mg/L	n/a	<0.030
Nitrite-N (NO2-N)	mg/L	n/a	<0.020
Phosphorus (P)-Total	mg/L	0.03	**0.0348**
Sulphate (SO4)	mg/L	n/a	0.31
Bacteriological Tests			
Escherichia Coli	MPN/100mL	100	30
Total Coliforms	MPN/100mL	1000 (prior to 1994)	**2400**
Total Metals			
Aluminum (Al)	mg/L	0.075	0.021
Antimony (Sb)	mg/L	0.02	<0.0050
Arsenic (As)	mg/L	0.005 (interim)	0.0010
Barium (Ba)	mg/L	n/a	0.040
Beryllium (Be)	mg/L	0.011	<0.0010
Bismuth (Bi)	mg/L	n/a	<0.0010
Boron (B)	mg/L	0.2	<0.050
Cadmium (Cd)	mg/L	0.0001 (interim)	<0.000090
Calcium (Ca)	mg/L	n/a	36.0
Chromium (Cr)	mg/L	0.001 for Cr(VI)	<0.0010
Cobalt (Co)	mg/L	0.0009	0.00058
Copper (Cu)	mg/L	0.005 (interim)	<0.0010
Iron (Fe)	mg/L	0.3	**3.07**
Lead (Pb)	mg/L	0.001 (interim)	<0.0010
Magnesium (Mg)	mg/L	n/a	12.8
Manganese (Mn)	mg/L	n/a	1.56
Molybdenum (Mo)	mg/L	0.04	<0.0010
Nickel (Ni)	mg/L	0.025	<0.0020
Potassium (K)	mg/L	n/a	<1.0
Selenium (Se)	mg/L	0.1	<0.00040
Silicon (Si)	mg/L	n/a	7.6
Silver (Ag)	mg/L	0.0001	<0.00010
Strontium (Sr)	mg/L	n/a	0.0550
Thallium (Tl)	mg/L	0.0003	<0.00030
Tin (Sn)	mg/L	n/a	<0.0010
Titanium (Ti)	mg/L	n/a	<0.0020
Tungsten (W)	mg/L	0.03	<0.010
Uranium (U)	mg/L	0.005	<0.0050
Vanadium (V)	mg/L	0.006	<0.0010
Zinc (Zn)	mg/L	0.02 (interim)	<0.0030
Zirconium (Zr)	mg/L	0.004	<0.0040

*Bold #'s indicate exceedance of PWQO guidelines

Laboratory Water Quality Results for Site 3: Miller Heights Drive			
Parameter	**Units**	**PWQO**	22-Jul-10
Physical Tests			10:55
Conductivity (EC)	uS/cm	n/a	237
Total Dissolved Solids	mg/L	n/a	178
Turbidity	NTU	<10% of natural	3.69
Anions and Nutrients			
Ammonia-N, Total	mg/L	n/a	<0.020
Chloride (Cl)	mg/L	n/a	0.81
Nitrate-N (NO3-N)	mg/L	n/a	<0.030
Nitrite-N (NO2-N)	mg/L	n/a	<0.020
Phosphorus (P)-Total	mg/L	0.03	0.0244
Sulphate (SO4)	mg/L	n/a	0.46
Bacteriological Tests			
Escherichia Coli	MPN/100mL	100	32
Total Coliforms	MPN/100mL	1000 (prior to 1994)	**1600**
Total Metals			
Aluminum (Al)	mg/L	0.075	0.018
Antimony (Sb)	mg/L	0.02	<0.0050
Arsenic (As)	mg/L	0.005 (interim)	<0.0010
Barium (Ba)	mg/L	n/a	0.020
Beryllium (Be)	mg/L	0.011	<0.0010
Bismuth (Bi)	mg/L	n/a	<0.0010
Boron (B)	mg/L	0.2	<0.050
Cadmium (Cd)	mg/L	0.0001 (interim)	<0.000090
Calcium (Ca)	mg/L	n/a	37.1
Chromium (Cr)	mg/L	0.001 for Cr(VI)	<0.0010
Cobalt (Co)	mg/L	0.0009	<0.00050
Copper (Cu)	mg/L	0.005 (interim)	<0.0010
Iron (Fe)	mg/L	0.3	**1.86**
Lead (Pb)	mg/L	0.001 (interim)	<0.0010
Magnesium (Mg)	mg/L	n/a	11.4
Manganese (Mn)	mg/L	n/a	0.769
Molybdenum (Mo)	mg/L	0.04	<0.0010
Nickel (Ni)	mg/L	0.025	<0.0020
Potassium (K)	mg/L	n/a	<1.0
Selenium (Se)	mg/L	0.1	<0.00040
Silicon (Si)	mg/L	n/a	7.8
Silver (Ag)	mg/L	0.0001	<0.00010
Strontium (Sr)	mg/L	n/a	0.0505
Thallium (Tl)	mg/L	0.0003	<0.00030
Tin (Sn)	mg/L	n/a	<0.0010
Titanium (Ti)	mg/L	n/a	<0.0020
Tungsten (W)	mg/L	0.03	<0.010
Uranium (U)	mg/L	0.005	<0.0050
Vanadium (V)	mg/L	0.006	<0.0010
Zinc (Zn)	mg/L	0.02 (interim)	0.0124
Zirconium (Zr)	mg/L	0.004	<0.0040

*Bold #'s indicate exceedance of PWQO guidelines

Laboratory Water Quality Results for Site 5: McNally Drive			
Parameter	**Units**	**PWQO**	22-Jul-10
Physical Tests			11:50
Conductivity (EC)	uS/cm	n/a	287
Total Dissolved Solids	mg/L	n/a	215
Turbidity	NTU	<10% of natural	2.58
Anions and Nutrients			
Ammonia-N, Total	mg/L	n/a	<0.020
Chloride (Cl)	mg/L	n/a	5.79
Nitrate-N (NO3-N)	mg/L	n/a	<0.030
Nitrite-N (NO2-N)	mg/L	n/a	<0.020
Phosphorus (P)-Total	mg/L	0.03	0.0210
Sulphate (SO4)	mg/L	n/a	0.84
Bacteriological Tests			
Escherichia Coli	MPN/100mL	100	54
Total Coliforms	MPN/100mL	1000 (prior to 1994)	**2400**
Total Metals			
Aluminum (Al)	mg/L	0.075	0.033
Antimony (Sb)	mg/L	0.02	<0.0050
Arsenic (As)	mg/L	0.005 (interim)	<0.0010
Barium (Ba)	mg/L	n/a	0.014
Beryllium (Be)	mg/L	0.011	<0.0010
Bismuth (Bi)	mg/L	n/a	<0.0010
Boron (B)	mg/L	0.2	<0.050
Cadmium (Cd)	mg/L	0.0001 (interim)	<0.000090
Calcium (Ca)	mg/L	n/a	43.9
Chromium (Cr)	mg/L	0.001 for Cr(VI)	<0.0010
Cobalt (Co)	mg/L	0.0009	<0.00050
Copper (Cu)	mg/L	0.005 (interim)	<0.0010
Iron (Fe)	mg/L	0.3	**0.590**
Lead (Pb)	mg/L	0.001 (interim)	<0.0010
Magnesium (Mg)	mg/L	n/a	14.0
Manganese (Mn)	mg/L	n/a	0.126
Molybdenum (Mo)	mg/L	0.04	<0.0010
Nickel (Ni)	mg/L	0.025	<0.0020
Potassium (K)	mg/L	n/a	<1.0
Selenium (Se)	mg/L	0.1	<0.00040
Silicon (Si)	mg/L	n/a	7.7
Silver (Ag)	mg/L	0.0001	<0.00010
Strontium (Sr)	mg/L	n/a	0.0574
Thallium (Tl)	mg/L	0.0003	<0.00030
Tin (Sn)	mg/L	n/a	<0.0010
Titanium (Ti)	mg/L	n/a	<0.0020
Tungsten (W)	mg/L	0.03	<0.010
Uranium (U)	mg/L	0.005	<0.0050
Vanadium (V)	mg/L	0.006	<0.0010
Zinc (Zn)	mg/L	0.02 (interim)	<0.0030
Zirconium (Zr)	mg/L	0.004	<0.0040

*Bold #'s indicate exceedance of PWQO guidelines

Laboratory Water Quality Results for Site 7: Oliver Road			
Parameter	**Units**	**PWQO**	19-Jul-10
Physical Tests			11:30
Conductivity (EC)	uS/cm	n/a	494
Total Dissolved Solids	mg/L	n/a	380
Turbidity	NTU	<10% of natural	11.0
Anions and Nutrients			
Ammonia-N, Total	mg/L	n/a	<0.020
Chloride (Cl)	mg/L	n/a	76.1
Nitrate-N (NO3-N)	mg/L	n/a	0.049
Nitrite-N (NO2-N)	mg/L	n/a	<0.020
Phosphorus (P)-Total	mg/L	0.03	0.0128
Sulphate (SO4)	mg/L	n/a	7.74
Bacteriological Tests			
Escherichia Coli	MPN/100mL	100	10
Total Coliforms	MPN/100mL	1000 (prior to 1994)	> **2420**
Total Metals			
Aluminum (Al)	mg/L	0.075	0.027
Antimony (Sb)	mg/L	0.02	<0.0050
Arsenic (As)	mg/L	0.005 (interim)	<0.0010
Barium (Ba)	mg/L	n/a	0.013
Beryllium (Be)	mg/L	0.011	<0.0010
Bismuth (Bi)	mg/L	n/a	<0.0010
Boron (B)	mg/L	0.2	<0.050
Cadmium (Cd)	mg/L	0.0001 (interim)	<0.000090
Calcium (Ca)	mg/L	n/a	45.7
Chromium (Cr)	mg/L	0.001 for Cr(VI)	<0.0010
Cobalt (Co)	mg/L	0.0009	<0.00050
Copper (Cu)	mg/L	0.005 (interim)	<0.0010
Iron (Fe)	mg/L	0.3	**0.832**
Lead (Pb)	mg/L	0.001 (interim)	<0.0010
Magnesium (Mg)	mg/L	n/a	15.0
Manganese (Mn)	mg/L	n/a	0.0963
Molybdenum (Mo)	mg/L	0.04	0.0012
Nickel (Ni)	mg/L	0.025	<0.0020
Potassium (K)	mg/L	n/a	1.1
Selenium (Se)	mg/L	0.1	<0.00040
Silicon (Si)	mg/L	n/a	7.0
Silver (Ag)	mg/L	0.0001	<0.00010
Strontium (Sr)	mg/L	n/a	0.0640
Thallium (Tl)	mg/L	0.0003	<0.00030
Tin (Sn)	mg/L	n/a	<0.0010
Titanium (Ti)	mg/L	n/a	<0.0020
Tungsten (W)	mg/L	0.03	<0.010
Uranium (U)	mg/L	0.005	<0.0050
Vanadium (V)	mg/L	0.006	<0.0010
Zinc (Zn)	mg/L	0.02 (interim)	<0.0030
Zirconium (Zr)	mg/L	0.004	<0.0040

*Bold #'s indicate exceedance of PWQO guidelines

Laboratory Water Quality Results for Site 10: Pebblestone Road			
Parameter	**Units**	**PWQO**	19-Jul-10
Physical Tests			14:10
Conductivity (EC)	uS/cm	n/a	549
Total Dissolved Solids	mg/L	n/a	424
Turbidity	NTU	<10% of natural	3.92
Anions and Nutrients			
Ammonia-N, Total	mg/L	n/a	<0.020
Chloride (Cl)	mg/L	n/a	30.5
Nitrate-N (NO3-N)	mg/L	n/a	<0.030
Nitrite-N (NO2-N)	mg/L	n/a	<0.020
Phosphorus (P)-Total	mg/L	0.03	0.0298
Sulphate (SO4)	mg/L	n/a	<0.30
Bacteriological Tests			
Escherichia Coli	MPN/100mL	100	**210**
Total Coliforms	MPN/100mL	1000 (prior to 1994)	**2000**
Total Metals			
Aluminum (Al)	mg/L	0.075	0.030
Antimony (Sb)	mg/L	0.02	<0.0050
Arsenic (As)	mg/L	0.005 (interim)	0.0013
Barium (Ba)	mg/L	n/a	0.018
Beryllium (Be)	mg/L	0.011	<0.0010
Bismuth (Bi)	mg/L	n/a	<0.0010
Boron (B)	mg/L	0.2	<0.050
Cadmium (Cd)	mg/L	0.0001 (interim)	<0.000090
Calcium (Ca)	mg/L	n/a	83.6
Chromium (Cr)	mg/L	0.001 for Cr(VI)	<0.0010
Cobalt (Co)	mg/L	0.0009	<0.00050
Copper (Cu)	mg/L	0.005 (interim)	<0.0010
Iron (Fe)	mg/L	0.3	**0.596**
Lead (Pb)	mg/L	0.001 (interim)	<0.0010
Magnesium (Mg)	mg/L	n/a	25.8
Manganese (Mn)	mg/L	n/a	1.27
Molybdenum (Mo)	mg/L	0.04	<0.0010
Nickel (Ni)	mg/L	0.025	<0.0020
Potassium (K)	mg/L	n/a	1.1
Selenium (Se)	mg/L	0.1	0.00044
Silicon (Si)	mg/L	n/a	8.6
Silver (Ag)	mg/L	0.0001	<0.00010
Strontium (Sr)	mg/L	n/a	0.109
Thallium (Tl)	mg/L	0.0003	<0.00030
Tin (Sn)	mg/L	n/a	<0.0010
Titanium (Ti)	mg/L	n/a	<0.0020
Tungsten (W)	mg/L	0.03	<0.010
Uranium (U)	mg/L	0.005	<0.0050
Vanadium (V)	mg/L	0.006	<0.0010
Zinc (Zn)	mg/L	0.02 (interim)	0.0098
Zirconium (Zr)	mg/L	0.004	<0.0040

*Bold #’s indicate exceedance of PWQO guidelines

Laboratory Water Quality Results for Site 10: Highway 11/17, Stream Rehabilitation Site			
Parameter	**Units**	**PWQO**	22-Jul-10
Physical Tests			13:10
Conductivity (EC)	uS/cm	n/a	320
Total Dissolved Solids	mg/L	n/a	227
Turbidity	NTU	<10% of natural	8.70
Anions and Nutrients			
Ammonia-N, Total	mg/L	n/a	<0.020
Chloride (Cl)	mg/L	n/a	9.80
Nitrate-N (NO3-N)	mg/L	n/a	0.047
Nitrite-N (NO2-N)	mg/L	n/a	<0.020
Phosphorus (P)-Total	mg/L	0.03	0.0255
Sulphate (SO4)	mg/L	n/a	1.39
Bacteriological Tests			
Escherichia Coli	MPN/100mL	100	120
Total Coliforms	MPN/100mL	1000 (prior to 1994)	**>2420**
Total Metals			
Aluminum (Al)	mg/L	0.075	**0.168**
Antimony (Sb)	mg/L	0.02	<0.0050
Arsenic (As)	mg/L	0.005 (interim)	<0.0010
Barium (Ba)	mg/L	n/a	0.025
Beryllium (Be)	mg/L	0.011	<0.0010
Bismuth (Bi)	mg/L	n/a	<0.0010
Boron (B)	mg/L	0.2	<0.050
Cadmium (Cd)	mg/L	0.0001 (interim)	<0.000090
Calcium (Ca)	mg/L	n/a	46.8
Chromium (Cr)	mg/L	0.001 for Cr(VI)	<0.0010
Cobalt (Co)	mg/L	0.0009	<0.00050
Copper (Cu)	mg/L	0.005 (interim)	0.0014
Iron (Fe)	mg/L	0.3	**1.21**
Lead (Pb)	mg/L	0.001 (interim)	<0.0010
Magnesium (Mg)	mg/L	n/a	15.6
Manganese (Mn)	mg/L	n/a	0.138
Molybdenum (Mo)	mg/L	0.04	0.0011
Nickel (Ni)	mg/L	0.025	<0.0020
Potassium (K)	mg/L	n/a	1.3
Selenium (Se)	mg/L	0.1	<0.00040
Silicon (Si)	mg/L	n/a	7.3
Silver (Ag)	mg/L	0.0001	<0.00010
Strontium (Sr)	mg/L	n/a	0.0691
Thallium (Tl)	mg/L	0.0003	<0.00030
Tin (Sn)	mg/L	n/a	<0.0010
Titanium (Ti)	mg/L	n/a	0.0058
Tungsten (W)	mg/L	0.03	<0.010
Uranium (U)	mg/L	0.005	<0.0050
Vanadium (V)	mg/L	0.006	0.0014
Zinc (Zn)	mg/L	0.02 (interim)	<0.0030
Zirconium (Zr)	mg/L	0.004	<0.0040

*Bold #’s indicate exceedance of PWQO guidelines

Laboratory Water Quality Results for Site 13: Kaministiqua Confluence			
Parameter	**Units**	**PWQO**	22-Jul-10
Physical Tests			13:10
Conductivity (EC)	uS/cm	n/a	320
Total Dissolved Solids	mg/L	n/a	227
Turbidity	NTU	<10% of natural	8.70
Anions and Nutrients			
Ammonia-N, Total	mg/L	n/a	<0.020
Chloride (Cl)	mg/L	n/a	9.80
Nitrate-N (NO3-N)	mg/L	n/a	0.047
Nitrite-N (NO2-N)	mg/L	n/a	<0.020
Phosphorus (P)-Total	mg/L	0.03	0.0255
Sulphate (SO4)	mg/L	n/a	1.39
Bacteriological Tests			
Escherichia Coli	MPN/100mL	100	120
Total Coliforms	MPN/100mL	1000 (prior to 1994)	**>2420**
Total Metals			
Aluminum (Al)	mg/L	0.075	**0.168**
Antimony (Sb)	mg/L	0.02	<0.0050
Arsenic (As)	mg/L	0.005 (interim)	<0.0010
Barium (Ba)	mg/L	n/a	0.025
Beryllium (Be)	mg/L	0.011	<0.0010
Bismuth (Bi)	mg/L	n/a	<0.0010
Boron (B)	mg/L	0.2	<0.050
Cadmium (Cd)	mg/L	0.0001 (interim)	<0.000090
Calcium (Ca)	mg/L	n/a	46.8
Chromium (Cr)	mg/L	0.001 for Cr(VI)	<0.0010
Cobalt (Co)	mg/L	0.0009	<0.00050
Copper (Cu)	mg/L	0.005 (interim)	0.0014
Iron (Fe)	mg/L	0.3	**1.21**
Lead (Pb)	mg/L	0.001 (interim)	<0.0010
Magnesium (Mg)	mg/L	n/a	15.6
Manganese (Mn)	mg/L	n/a	0.138
Molybdenum (Mo)	mg/L	0.04	0.0011
Nickel (Ni)	mg/L	0.025	<0.0020
Potassium (K)	mg/L	n/a	1.3
Selenium (Se)	mg/L	0.1	<0.00040
Silicon (Si)	mg/L	n/a	7.3
Silver (Ag)	mg/L	0.0001	<0.00010
Strontium (Sr)	mg/L	n/a	0.0691
Thallium (Tl)	mg/L	0.0003	<0.00030
Tin (Sn)	mg/L	n/a	<0.0010
Titanium (Ti)	mg/L	n/a	0.0058
Tungsten (W)	mg/L	0.03	<0.010
Uranium (U)	mg/L	0.005	<0.0050
Vanadium (V)	mg/L	0.006	0.0014
Zinc (Zn)	mg/L	0.02 (interim)	<0.0030
Zirconium (Zr)	mg/L	0.004	<0.0040

*Bold #'s indicate exceedance of PWQO guideline

APPENDIX E:

1997 WATER QUALITY RESULTS/FIELD OBSERVATIONS

Appendix E: 1997 Water Quality Results/Field Observations

Water Sampling - June 25, 1997								
Site #	**Time Sampled**	**Depth (m)**	**Air Temp. (°C)**	**Water Temp. (°C)**	**pH**	**D.O. (mg/L)**	**Conductivity (µmhos/cm)**	**Comments**
1	9:50 a.m.	0.42	23.5	15.2	7.45	6.3	160	algae growth near banks
2	10:45 a.m.	1.28	26.5	14.0	7.25	11.7	150	flooded banks
3	11:05 a.m.	0.53	25	15.0	6.90	12.4	160	fast flowing water
4	11:30 a.m.	0.96	26	14.0	6.95	12.0	160	fast flowing water
5	12:00 p.m.	0.54	27	14.0	7.00	11.2	200	fast flowing water
6	12:25 p.m.	0.70	29	14.5	6.95	11.6	210	fast flowing water
7	1:40 p.m.	0.92	28.5	15.5	6.85	12.5	210	tree debris dams flow
8	2:00 p.m.	0.38	27	15.5	6.75	13.5	220	upstream - rapids
9	2:25 p.m.	0.46	28	16.5	6.80	10.2	275	potato farm upstream
10	2:45 p.m.	0.73	27.5	17.0	7.10	12.4	210	flooded banks
11	3:00 p.m.	1.40	28	17.0	6.95	12.8	220	flooded banks
12	3:25 p.m.	0.65	27	17.5	6.95	11.8	230	deep pooling area just downstream

Water Sampling - July 9, 1997								
Site #	**Time Sampled**	**Depth (m)**	**Air Temp. (°C)**	**Water Temp. (°C)**	**pH**	**D.O. (mg/L)**	**Conductivity (µmhos/cm)**	**Comments**
1	9:35 a.m.	0.40	19	14.2	7.25	5.1	180	algae along banks
2	10:10 a.m.	0.76	19	13.5	7.10	10.2	145	water level dropped, muck on banks
3	10:40 a.m.	0.21	20	10.5	7.15	12.0	175	ditch draining into creek
4	11:10 a.m.	0.65	21.5	14.0	7.05	9.3	155	tree debris in stream
5	11:30 a.m.	0.36	22	15.1	7.20	10.2	170	flattened shrubs due to overflow
6	11:50 a.m.	0.34	23	15.0	7.20	10.2	175	flattened shrubs due to overflow
7	12:10 p.m.	0.58	22.5	15.2	7.25	10.2	180	water level dropped
8	1:25 p.m.	0.14	25	15.8	7.15	10.6	175	cascades upstream
9	1:50 p.m.	0.30	25.5	15.2	7.10	7.1	230	horse ranch & potato farm
10	2:30 p.m.	0.25	26	17.0	7.25	10.3	180	flattened shrubs due to overflow
11	2:45 p.m.	0.48	25.5	16.9	7.30	10.5	195	flattened shrubs due to overflow
12	3:10 p.m.	0.25	26	17.8	7.20	10.3	200	murky water, debris in stream and on banks

Water Sampling - July 23, 1997								
Site #	**Time Sampled**	**Depth (m)**	**Air Temp. (°C)**	**Water Temp. (°C)**	**pH**	**D.O. (mg/L)**	**Conductivity (µmhos/cm)**	**Comments**
1	9:25 a.m.	0.43	17.5	15.8	6.95	4.5	185	very slow flow, algae growth present
2	9:45 a.m.	0.52	18	15.0	7.30	10.0	170	
3	10:40 a.m.	0.19	19	12.2	6.90	11.8	180	water flowing quickly, shaded area
4	10:15 a.m.	0.78	18	15.0	6.90	9.0	180	
5	11:00 a.m.	0.35	21	16.0	6.95	9.8	190	
6	11:25 a.m.	0.36	22	15.0	6.95	12.4	195	moss on rocks, tree debris in creek
7	11:45 a.m.	0.52	223	15.0	7.10	10.7	200	tree debris in creek
8	12:05 p.m.	0.12	24	16.2	7.15	11.4	200	
9	1:20 p.m.	0.21	25.5	15.8	6.85	5.2	340	very slow flow, algae growth present
10	1:40 p.m.	0.34	26	16.0	7.20	10.8	200	tree debris in creek
11	2:00 p.m.	0.64	26	16.4	7.30	10.6	200	muck on banks
12	2:30 p.m.	0.30	27	16.2	7.20	10.1	210	deep pooling area just downstream

Water Sampling - August 6, 1997								
Site #	**Time Sampled**	**Depth (m)**	**Air Temp. (°C)**	**Water Temp. (°C)**	**pH**	**D.O. (mg/L)**	**Conductivity (µmhos/cm)**	**Comments**
1	9:45 a.m.	0.29	17	16.0	7.20	3.2	240	water almost stagnant
2	10:10 a.m.	0.40	17.5	15.0	7.25	9.1	235	slow water flow
3	10:30 a.m.	0.14	19	14.0	7.00	10.0	225	water flow slightly faster
4	10:50 a.m.	0.48	20.5	16.8	6.90	8.4	250	
5	11:45 a.m.	0.17	28	17.2	7.10	9.5	260	
6	12:05 p.m.	0.10	29	17.0	7.15	9.1	240	drop in water level , dead algae on dry rocks
7	12:25 p.m.	0.37	28	17.8	7.20	8.8	255	water level low, undercut banks
8	1:15 p.m.	0.10	28	19.0	7.25	11.1	270	water level low
9	1:35 p.m.	0.19	29	15.0	6.90	7.6	425	water murky with foul smell, slow flow
10	2:00 p.m.	0.19	28	18.5	7.15	9.8	275	water level low
11	2:20 p.m.	0.35	28	18.5	7.10	10.2	280	water level low, undercut banks
12	2:50 p.m.	0.14	28.5	19.5	7.15	9.5	285	water slightly murky

Water Sampling Averages - June 25, July 9, July 23, August 6, 1997						
Site #	**Depth (m)**	**Air Temp. (°C)**	**Water Temp. (°C)**	**pH**	**D.O. (mg/L)**	**Conductivity (µmhos/cm)**
1	0.39	19.25	15.30	7.21	4.78	191.3
2	0.74	20.25	14.38	7.23	10.25	175.0
3	0.27	20.75	12.93	6.99	11.55	185.0
4	0.72	21.50	14.95	6.95	9.68	186.25
5	0.36	24.50	15.58	7.06	10.18	205.0
6	0.38	25.75	15.38	7.06	10.83	205.0
7	0.60	25.50	15.88	7.10	10.55	211.3
8	0.19	23.75	16.63	7.08	11.73	216.3
9	0.29	27.00	15.63	6.91	7.53	317.5
10	0.38	26.88	17.13	7.18	10.83	216.3
11	0.72	26.88	17.20	7.16	11.03	223.8
12	0.34	27.13	17.75	7.13	10.43	231.3

Water Chemical Analysis #1 - July 9, 1997								
Analytical Parameters	**Units**	**Site 1**	**Site 4**	**Site 7**	**Site 10**	**Site 12**	**Range**	**Average**
Cadmium (Cd)	mg/L	0.0001	0.0002	0.0006	0.0012	0.0016	0.0015	0.00074
Iron (Fe)	mg/L	0.14	0.28	0.25	0.29	0.33	0.19	0.258
Lead (Pb)	mg/L	<0.0001	0.0041	0.0030	0.0018	<0.0001	0.0040	0.00182
Total Alkalinity	mg/L	58.89	69.87	75.86	83.85	86.84	27.95	75.062
Total Phosphorus (P)	mg/L	0.01	0.02	0.02	0.02	0.03	0.02	0.02
Total Suspended Solids	mg/L	0.5	1.5	0.5	3.5	5.0	4.5	2.2
Turbidity	NTU	16	17	18	19	21	4	18.2

Water Chemical Analysis #2 - August 6, 1997								
Analytical Parameters	**Units**	**Site 1**	**Site 4**	**Site 7**	**Site 10**	**Site 12**	**Range**	**Average**
Cadmium (Cd)	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0	<0.0001
Iron (Fe)	mg/L	0.64	0.41	0.43	0.37	0.27	0.37	0.424
Lead (Pb)	mg/L	0.0033	0.0021	0.0031	0.0035	<0.0001	0.0034	0.00242
Total Alkalinity	mg/L	99.82	125.77	124.78	136.75	133.76	36.93	124.176
Total Phosphorus (P)	mg/L	0.02	0.03	0.02	0.02	0.03	0.01	0.024
Total Suspended Solids	mg/L	1.0	0.5	1.0	2.0	9.0	8.5	2.7
Turbidity	NTU	25	14	18	16	24	11	19.4

Forest Ecosystem Classification for 1997 Survey			
Site #	**Vegetation Type**		**Vegetation Type Description**
1	V-4	Mainly Hardwood	White Birch Hardwood and Mixedwood
2	V-23	Conifer	Tamarack, (Black Spruce) / Speckled Alder
3	V-1	Mainly Hardwood	Balsam Poplar Hardwood and Mixedwood
4	V-15	Conifer Mixedwood	White Spruce Mixedwood
5	V-2	Mainly Hardwood	Black Ash Hardwood and Mixedwood
6	V-1	Mainly Hardwood	Balsam Poplar Hardwood and Mixedwood
7	V-15	Conifer Mixedwood	White Spruce Mixedwood
8	V-17	Conifer Mixedwood	Jack Pine Mixedwood / Shrub Rich
9	V-15	Conifer Mixedwood	White Spruce Mixedwood
10	V-17	Conifer Mixedwood	Jack Pine Mixedwood / Shrub Rich
11	V-17	Conifer Mixedwood	Jack Pine Mixedwood / Shrub Rich
12	V-15	Conifer Mixedwood	White Spruce Mixedwood

Physical Attributes Observed in 1997 Survey					
Site #	**In-stream Materials**	**Creek Bed Characteristics**	**Bank Stability**	**Terrain Characteristics**	**Stream Cover**
1	Organic Debris	Sand	Stable	Mainly Hardwood	Partly Open 25 to 75%
2	Organic Debris, Undercut Banks	Muck	Stable	Swamp Conifer	Open 0 to 25%
3	Organic Debris and Rocks	Rubble	Stable	Mainly Hardwood	Partly Open 25 to 75%
4	Organic and Tree Debris	Sand	Stable	Conifer Mixedwood	Partly Open 25 to 75%
5	Rocks and Tree Debris	Boulders with some Sand	Stable	Mainly Hardwood	Partly Open 25 to 75%
6	Organic Debris and Rocks	Rubble and Boulder	Stable	Mainly Hardwood	Dense 75 to 100%
7	Organic and Tree Debris, Undercut Banks	Rubble and Boulder	Stable	Conifer Mixedwood	Partly Open 25 to 75%
8	Rocks	Bedrock	Stable	Conifer Mixedwood	Partly Open 25 to 75%
9	Organic Debris, Undercut Banks	Rubble and Silt	Stable	Conifer Mixedwood	Partly Open 25 to 75%
10	Organic Debris	Sand	Stable	Meadow	Open 0 to 25%
11	Organic Debris	Silt and Sand	Stable	Conifer Mixedwood	Partly Open 25 to 75%
12	Organic and Tree Debris	Gravel and Rubble	Stable	Conifer Mixedwood	Partly Open 25 to 75%

Terrestrial Vegetation from 1997 Survey			
	Trees	**Shrubs**	**Herbs**
1	white spruce black spruce white birch	wild red raspberries tail-meadow rue speckled alder glaucous willow peach-leafed willow	cow vetch daisies creeping buttercups clover (red and alsike) climbing hempweed orange hawkweed king devil grasses
2	tamarack poplar white spruce black spruce	wild red raspberries tail-meadow rue speckled alder glaucous willow	cow vetch field strawberries common thistle buttercups king devil cut-leaf tooth wart grasses
3	white spruce poplar	early-meadow rue angelica bebb willow tree of heaven speckled alder	cow vetch daisies dandelions buttercups white clover water horsetails common fern common thistle
4	white spruce birch jack pine poplar and balsam poplar	early-meadow rue angelica pasture rose speckled alder bebb willow ash-leafed maple	cow vetch yellow vetchling clover daisies Canada anemone king devil dandelions common thistle bladder campion forking catchfly grasses
5	black ash mountain ash birch white spruce balsam poplar	wild red raspberries pasture rose spreading dogbane mock bishop's weed ash-leafed maple speckled alder	cow vetch Canada anemone buttercups king devil daisies grasses
6	black ash mountain ash poplar and balsam poplar white spruce	wild red raspberries angelica bebb willow peach-leaf willow speckled alder	cow vetch Canada anemone common fern buttercups king devil mertensia (virginia cowslip) marsh marigold (cowslip) water horsetails and grasses

7	mountain ash tamarack black spruce white spruce	angelica yarrow wild pasture rose bebb willow weeping willow speckled alder alternate leaf dog wood	cow vetch yellow vetchling daisies red clover Canada anemone common fern common thistle wild cucumber golden rod bladder campion water horsetails and grasses
8	birch poplar jack pine mountain ash black spruce white spruce	wild red raspberries swamp rose spreading dogwood bebb willow speckled alder	daisies Canada anemone king devil common thistle common fern buttercups black-eyed susans grasses
9	poplar white spruce	wild red raspberries early-meadow rue swamp rose red osier dogwood bebb willow speckled alder ash-leaved maple	cow vetch Canada anemone buttercups common fern water horsetails grasses
10	jack pine	wild red raspberries water parsnip bebb willow speckled alder	cow vetch yellow vetchling daisies Canada anemone red clover common thistle buttercups water horsetails and grasses
11	black willow poplar tamarack jack pine white spruce	swamp rose spreading dogwood osier willow bebb willow speckled alder ash-leaved maple	cow vetch Canada anemone daisies common thistle devil king spotted joe-pye weed water horsetails and grasses
12	poplar white spruce	wild red raspberries swamp rose early-meadow rue red osier dogwood bebb willow speckled alder ash-leaved maple	Canada anemone daisies king devil red clover buttercups field strawberries yellow vetchling black-eyed susans water horsetails and grasses

APPENDIX F:

FOREST ECOSYSTEM CLASSIFICATION

Appendix F: Forest Ecosystem Classification used for 2010 observations

Site 1: V-1 Balsam Poplar Hardwood and Mixedwood
Site 3: V-1 Balsam Poplar Hardwood and Mixedwood
Site 5: V-2 Black Ash Hardwood and Mixedwood
Site 7: V-1 Balsam Poplar Hardwood and Mixedwood
Site 9: V-1 Balsam Poplar Hardwood and Mixedwood
Site 10: NA
Site 13: V-2 Black Ash Hardwood and Mixedwood

V1 Balsam Poplar Hardwood and Mixedwood

Description: Hardwood and mixedwood stands containing balsam poplar in the overstory. The understory is typically herb and shrub rich with a broad diversity of species. Occurring on deep, fresh to moist mineral soils, often of lacustrine origin.

V2 Black Ash Hardwood and Mixedwood

Description: Hardwood and mixedwood stands containing black ash in the overstory. The understory is typically dense and floristically diverse. Of limited areal extent; occurring in low-lying locations on deep, moist to wet, usually no-calcareous substrates.

APPENDIX G:

PLANT SPECIES COMMON AND LATIN NAMES

Appendix G: Common and Latin Names of Identified Species

Common and Latin Names of Identified Plants

Trees	
Common Names	**Latin Names**
Balsam Fir	*Abies balsamea*
Balsam Poplar	*Populus balsamifera*
Black Ash	*Fraxinus nigra*
Black Spruce	*Picea mariana*
Eastern White Cedar	*Thuja occidentalis*
Jack Pine	*Pinus banksiana*
Manitoba Maple	*Acer negundo*
Mountain Ash	*Sorbus americana*
Mountain Maple	*Acer spicatum*
Red Ash	*Fraxinus pennsylvanica*
Red Pine	*Pinus resinosa*
Speckled Alder	*Alnus rugosa*
Tamarack/Eastern Larch	*Larix laricina*
Trembling Aspen	*Populus tremuloides*
White Birch	*Betula papyrifera*
White Pine	*Pinus strobus*
White Spruce	*Picea glauca*

Shrubs	
Common Names	Latin Names
Balsam Poplar	*Populus balsamifera*
Beaked Hazel	*Corylus cornuta*
Bear Berry	*Arctostaphylos uva-ursi*
Buffalo Berry	*Shepherdia canadensis*
Bush Honeysuckle	*Diervilla lonicera*
Canada Elderberry	*Sambucus canadensis*
Chokecherry	*Prunus virginiana*
Currant Spp.	*Ribes spp.*
Gooseberry	*Ribes spp.*
Hairy Honeysuckle	*Lonicera hispidula*
High-bush Cranberry	*Viburnum trilobum*
Honeysuckle Spp.	*Lonicera spp.*

Ninebark	*Physocarpus Spp.*
Pincherry	*Prunus pensylvanica*
Prickly Wild rose	*Rosa acicularis*
Pussy Willow	*Salix discolor*
Red Berried Elder	*Sambucus racemosa*
Red-osier Dogwood	*Cornus stolonifera*
Saskatoon (serviceberry)	*Amelanchier alnifolia*
Slender Willow	*Salix petiolaris*
Swamp Red Currant	*Ribes triste*
Sweet Gale	*Myrica gale*
Wild Red Raspberry	*Rubus idaeus var. strigosus*
Willow	*Salix spp.*
Leather Leaf	*Chamaedaphne calyculata*

Herbs	
Common Names	**Latin Names**
Aster	*Symphyotrichum spp.*
Birdsfoot Trefoil	*Lotus cornicutatus*
Meadowsweet	*Latifolia*
Bunch Berry	*Cornus canadensis*
Buttercup	*Ranunculus repens*
Canada Anemone	*Anemone Canadensis*
Canada Goldenrod	*Solidago Canadensis*
Canada Mayflower	*Maianthemum*
Canada Thistle	*Cirsium arvense*
Common Evening Primose	*Oenothera biennis*
Common Plantain	*Plantago major*
Common Strawberry	*Fragaria virginiana*
Common Yarrow	*Achillea millefolium*
Corn Sow Thistle	*Sonchus arvensis*
Cow Parsnip	*Heracleum lanatum*
Cow Vetch	*Vivia cracca*
Cream Colored Vetchling	*Lathyrus ochroleucus*
Creeping Bellflower	*Campanula rapunculoides*
Crown Vetch	*Coronilla varia*
Dandelion	*Taraxacum officinale*
Dwarf Raspberry	*Rubus pubesiens*
Early Meadow-Rue	*Thalictrum dioicum*

Heal-All	*Prunella vulgaris*
Hop Clover	*Trifolium aureum*
Kidney-leaved Violet	*Viola renifolia*
Jewelweed	*Impatiens capensis*
Large Leaf Aster	*Aster macrophyllus*
Fragrant Bedstraw	*Galium triflorum*
Golden Rod	*Solidago spp.*
Grasses	*Poaceae spp.*
Lily	*Liliaceace spp.*
Lupine	*Lupinus polyphyllus*
Meadow-rue	*Thalictrum*
Mountain Blueeyed Grass	*Sisyrinchium montanum*
Naked Mitrewort	*Mitella nuda*
Narrowleaf Spirea	*Spiraea alba*
Northern Bluebell	*Mertensia paniculata*
Northern Blueflag	*Iris versicolor*
Northern Blue Violet	*Viola septentrionalis*
Northern Marsh Violet	*Viola epipsila*
Northern Sweet Coltsfoot	*Petasites frigidus*
Nodding Trillum	*Trillium cernum*
Orange Hawkweed	*Hieracium aurantiacum*
Ox-eye Daisy	*Leucanthemum vulgare*
Pearly Everlasting	*Anaphalis margaritacea*
Pineapple Weed	*Matricaria discoidea*
Pink Pyrola	*Pyrola asarifolia*
Red Clover	*Trifolium pratense*
Rose-Twisted Stalk	*Streptopus amplexifolius*
Wild Sasparilla	*Aralia nudicaulis*
Sedges	*Cyperaceae spp.*
Silverwort	*Hepatica triloba*
Stone Crop	*Sedum spp.*
Sweet Coltsfoot	*Petasites frigidus*
Tall White Bog Orchid	*Platanthera dilotata*
Twin Flower	*Linnaea borealis*
Thyme Leaved Sandwort	*Arenaria serphyllifolia*
Violet	*Viola spp.*
Water Horsetail	*Equisetum fluviatile*
Wild Columbine	*Aquilegia canadensis*

Wild Lily-of-the-valley	*Maianthemum canadense*
Wood Lily	*Lilium philadelphicum*
White Baneberry	*Actaea pachypoda*
White Pea Spp.	*Lathyrus sativa*
White Sweet-Clover	*Melilotus alba*
Wild Chamomile	*Matricaria chamomilla*
Wild Chives	*Allium schoenoprasum*
Wood Aneome	*Anemone quinquefolia*
Woodland Strawberry	*Fragaria Vesca*

Ferns/Mosses	
Common Names	**Latin Names**
Spike Moss	*Selaginella spp.*
Central Peat Moss	*Sphagnum centrale*
Cinnamon Fern	*Osmunda cinnamomea*
Common Fern Moss	*Thuidium delicatulum*
Horsetail	*Equisetum spp.*
Lady Fern	*Athyrium filix-femina*
Meadow Horsetail	*Equisetum pratense*
Plume Moss	*Ptilium crista-castrensis*
Sensitive Fern	*Onoclea sensibilis*
Stair Step Moss	*Hylocomium splendens*
Wavy Moss	*Dicranum polysetum*
Field Horsetail	*Equisetum arvense*

Aquatic Plants	
Common Names	**Latin Names**
Broad-leaved Arrowhead	*Sagittaria latifolia*
Common Cattail	*Typha latifolia*
Green Algae	*Chlorophyta*
Pondweed	*Potamogeton spp.*
Water Smartweed	*Polygonum amphibium*
Yellow Pond Lily	*Nuphar lutea*
Common Bladderwort	*Utricularia vulgaris*
Water Plantain	*Alisma plantago-aquatica*
Floating Arrowhead	*Saggitaria cuneata*
Broad Leaved Arrowhead	*Saggitaria latifolia*
Water Arum, Wild Calla	*Calla palustis*

Pickerelweed	*Pontederia cordata*
Floating Leaved Burreed	*Sparganium fluctuans*
Duckweed	*Lemna spp*
Large Leaved Pondweed	*Potamogeton amplifolius*
Floating Leaved Pondweed	*Potamogeton natans*
Submerged Water Starwort	*Callitriche hermaphroditica*
Coontail	*Ceratophyllum demersum*
Small Yellow Water Crowfoot	*Ranunculus gmelinii*

APPENDIX H

SITE PHOTOGRAPHY AND DESCRIPTIONS

Appendix H: Site Photography of Upstream, Downstream and Substrate Conditions

Site 1 – Headwaters, Mud Lake Road

A: 2010 Upstream Photo

B: 2010 Downstream Photo

C: 2010 Substrate Photo

D: 2010 Photo of Dredged Ditch

1997 Culvert Photo

Comments

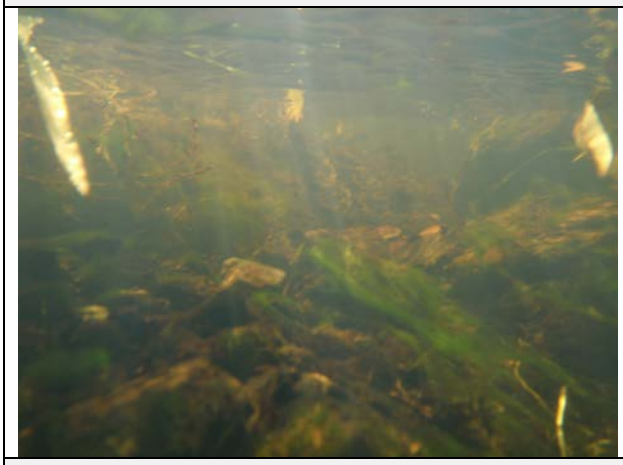
Located upstream of Mud Lake Road, Site 1 was characterized by a shallow channel with a highly organic substrate. Upstream of the sampling site the channel had dense terrestrial vegetation which provided almost complete shade to the channel. The streamside vegetation directly adjacent to the sampling site was mostly grasses and reeds, with cattails just downstream of the sample location. Downstream from Site 1 was a recently dredged ditch from which sediment was flowing into the creek channel. When comparing 2010 and 1997 photos of Site 1, significant changes are apparent. The culvert appears to have been replaced and the ditch observed in 2010 was not present in the 1997 photo. This ditch may have significantly altered the sediment load downstream of this location. Vegetation surrounding the culvert had shown considerable change as well, with cattails growing in 2010, where grasses were the dominant species in 1997.

Site 3 – Miller Heights Drive

A: 2010 Upstream Photo

B: 2010 Downstream Photo

C: 2010 Substrate Photo



D: 2010 Culvert Photo

E: 1997 Culvert Photo Facing Upstream

Comments

Site 3 was located off of Miller Heights Drive in a rural area. The road at the sampling location ran parallel to the flow of the stream. Site 3 was characterized by dense shoreline vegetation comprised of reeds and grasses. Reed canary grasses were the dominant vegetation, with no trees directly adjacent to the creek and a diverse assemblage of low lying herbs. The channel was fairly shallow with slow flow and murky water observed. The substrate was mostly cobble with considerable algae growth. Shallow flow allowed for the growth of horsetails directly in the current. An old culvert was observed adjacent to the sampling site with what appeared to be relatively new culvert installed. When comparing 2010 and 1997 photos, minimal changes were observed. There was a new culvert (perched) which had been installed since 1997. The vegetation appears to have changed very little from the two periods, with the dominant vegetation continuing to be grasses and herbs.

Site 5 - McNally Drive, Downstream

A: 2010 Upstream Photo

B: 2010 Downstream Photo

C: 2010 Substrate Photo

D: 2010 Beaver Activity Photo

E: 1997 Bridge Photo Facing Upstream

Comments

Site 5 was located off of McNally Drive with relatively easy access and a wide shoulder on the road for parking. The bridge upstream was in relatively good condition, with a stick jam which did not appear to be affecting flow directly below it. Flow in the channel was fairly slow with a murky water column observed at the time of sampling. The substrate was mostly cobble with large boulders dispersed throughout. Aquatic plants were mostly absent with only a few small patches of algae. Terrestrial vegetation on both sides of the creek was characterized by thick shrub growth. On the east side of the creek fill from the road and bridge construction was eroding into the water channel. Upstream of the site there was evidence of beaver activity with what was almost a fully completed beaver dam. When comparing the 1997 photo to the 2010 photos it was apparent that the location had undergone little change. The substrate and stream side vegetation appeared to be nearly identical in the 1997 and 2010 photos, with no aquatic vegetation apparent for either year. The bridge appeared to have undergone construction, the wooden structure had been replaced with a similar steel design.

Site 7 – Oliver Road, Downstream	
A: 2010 Upstream Photo	**B: 2010 Downstream Photo**
	
C: 2010 Substrate Photo	**D: 1997 Bridge Photo, Facing Upstream**
	

Comments

Site 7 was located downstream of Oliver Road in a rural area with private property both upstream and downstream. Traffic was high at the time of sampling and close-by parking was unavailable. The terrestrial vegetation was very thick extending over into the channel itself. Vegetation was mostly characterized by dogwood, reed canary and an assemblage of herbs. The substrate was mostly cobble with large boulders distributed throughout, with very little organic material was present. The site was highly turbid, with slow flow. When comparing the 1997 culvert photo to photos taken in 2010 there are almost no observable changes. The bridge was in good condition in both 1997 and 2010 photos with no observable changes to its structure. The substrate also appears to have changed very little from 1997 to 2010 with boulders and cobble apparent during both periods.

Site 9 - Pebblestone Road

A: 2010 Upstream Photo

B: 2010 Downstream Photo

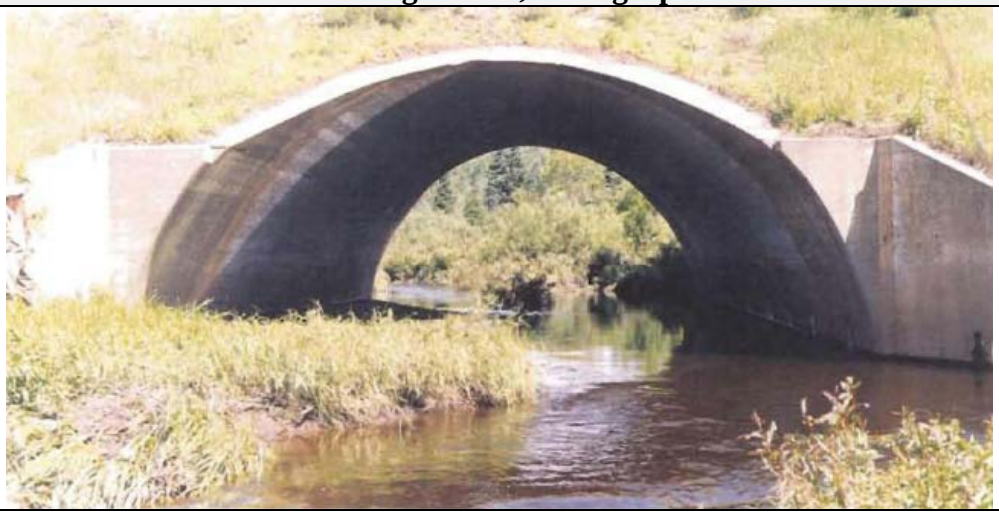
C: 2010 Substrate Photo

D: 2010 Culvert Photo

E: 1997 Culvert Photo, Facing Upstream

Comments

Site 9 located off of Pebblestone Road was in an area characterized by agricultural and rural lands. This sampling location was essentially within a ditch, running parallel to the gravel road with three culverts flowing from the opposite side of the road. The shallow water column was very turbid, with abundant diverse aquatic vegetation. The road side was manicured, with the east side of the creek containing thick shrub and herb rich vegetation. The vegetation on the east side of the creek was such that 75 to 100 percent shade was provided to the sampling site. The substrate of this site was mostly muck and clay with some cobble throughout. Aquatic vegetation was abundant on the substrate covering more than 50 percent of the substrate surface. When comparing the 1997 culvert photo to the 2010 photos it would appear that the culvert had been replaced. During low flow conditions observed at this location in 2010, the culverts were partially submerged, where in 1997 the culvert at this location was perched under heavy flow. The vegetation had changed from what appears to be a mostly shrub dominated bank in 1997 to an herb dominated bank in 2010.

Site 10 - Highway 11/17, Downstream	
A: 2010 Upstream Photo	**B: 2010 Downstream Photo**
	
C: 2010 Substrate Photo	**D: 2010 Roadside Bridge Drain Photo**
	
E: 1997 Bridge Photo, Facing Upstream	
	

Comments

Site 10 was located off of Highway 11/17 and was a former rehabilitation site of the LRCA. The bridge upstream of this sampling site was the largest of all sampling sites and appeared to be in good condition. The area was highly rural with a residence adjacent to the sampling property. The vegetation of the area was characterized by abundant herbs and grasses, with shrubs dominating downstream. The flow of the creek was relatively slow given the large width and shallow depth of the stream. The water was highly turbid, which prevented an adequate substrate photo to be taken. This appeared to be caused by the high level of sedimentation, with the substrate covered by silt. There were also a large number of fallen trees upstream which did not appear to disrupt overall flow substantially, but caused small pockets of slow flow. A roadside drain from bridge was located upstream of the site with a considerable buildup of sludge appearing to form on the outside of the drain. When comparing the 1997 culvert photo to photos taken in 2010, there does not appear to be any significant differences regarding the physical structure of the creek or bridge. Based on photo comparison between 1997 and 2010, grasses continue to be the dominant vegetation on the upstream side, and the large sediment bar on the right side of the bridge was still apparent.

Site 13 – Corbett Creek and Kaministiqua River Confluence	
A: 2010 Upstream Photo	**B: 2010 Downstream Photo**
	
C: 2010 Substrate Photo	
	

Comments

Site 13, the confluence of Corbett Creek and the Kaministiqua River, was located off Harstone Drive adjacent to private property. The residents of the area were fully cooperative and allowed us to gain access through their property. The flow of the site was very slow (no flow could be recorded) with a cobble beach up stream, narrowing the channel width significantly. The Kaministiqua River appeared to be forcing water upstream into the creek, concentrating the flow from Corbett Creek to a small section to the east. The substrate was mostly cobble with boulders throughout. A thin layer of sediment had built up on the substrate with some algae present. There were no site photos taken from this location in 1997.

Site 14 – Kaministiqua River and Tributary Confluence, Harstone Drive	
A: 2010 Upstream Photo	**B: 2010 Downstream Photo**
	
C: 2010 Substrate Photo	
	

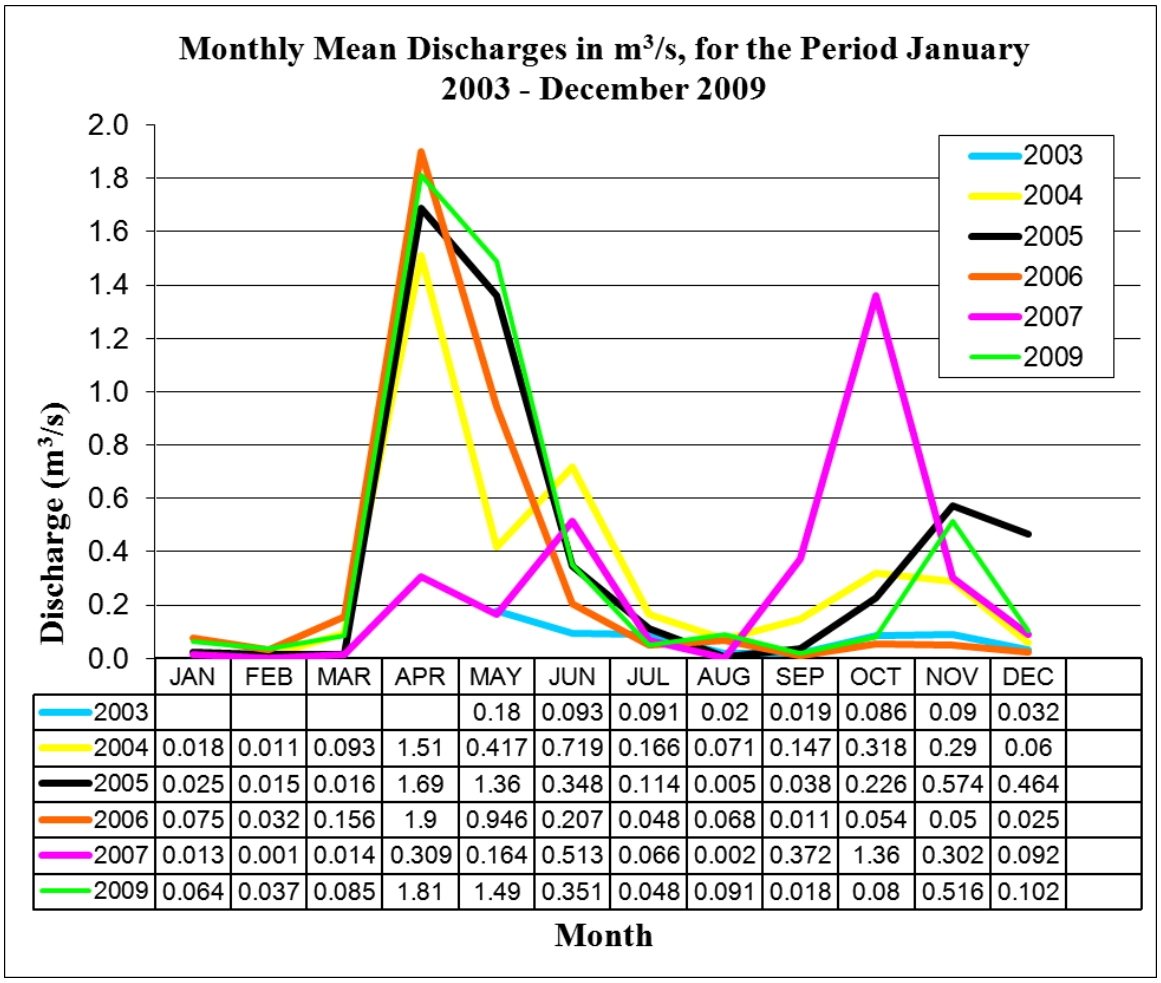
Comments

Site 12 was located west of Site 13. This site was characterized by a gravel washout and two small channels which had split and were flowing into the river independently. Both channels were very shallow, with the deeper one chose for sampling. The sampling site had considerable amounts of boulders (and a tire) which were slowing the flow of water to the river. The substrate was generally characterized by sand and cobble, with abundant aquatic vegetation just downstream of the sampling site. The terrestrial vegetation upstream from the sampling site was very thick, with shrubs being the dominant species. Many minnows could be seen swimming within the shallow channel. There were no site photos taken of this location in 1997. This site was sampled as it was mistaken during sampling as the Corbett Creek confluence site.

APPENDIX I

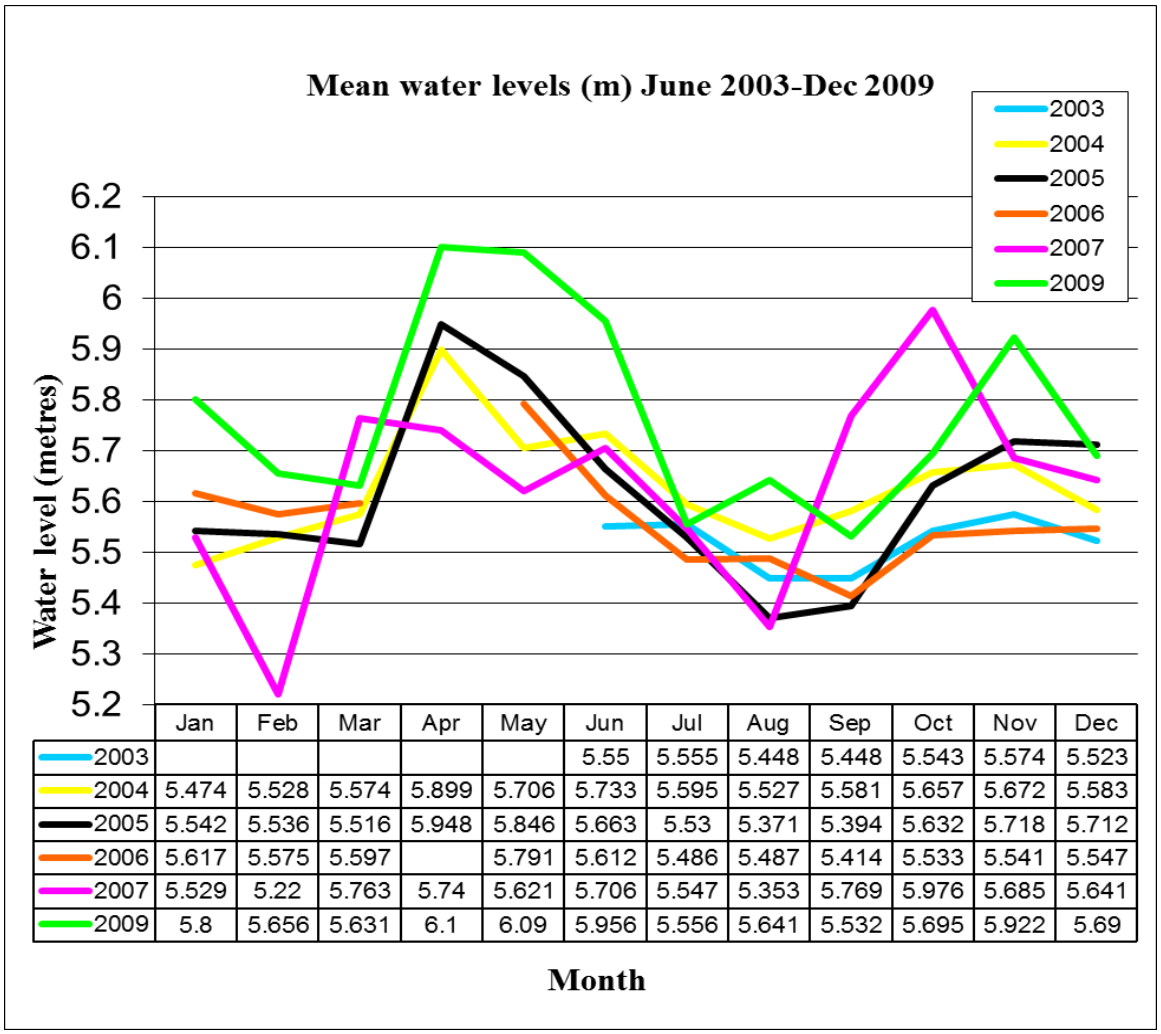
FIGURES

Appendix I: Figures



	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	
2003					0.18	0.093	0.091	0.02	0.019	0.086	0.09	0.032	
2004	0.018	0.011	0.093	1.51	0.417	0.719	0.166	0.071	0.147	0.318	0.29	0.06	
2005	0.025	0.015	0.016	1.69	1.36	0.348	0.114	0.005	0.038	0.226	0.574	0.464	
2006	0.075	0.032	0.156	1.9	0.946	0.207	0.048	0.068	0.011	0.054	0.05	0.025	
2007	0.013	0.001	0.014	0.309	0.164	0.513	0.066	0.002	0.372	1.36	0.302	0.092	
2009	0.064	0.037	0.085	1.81	1.49	0.351	0.048	0.091	0.018	0.08	0.516	0.102	

Figure 1.0: Monthly mean discharge in cubic metres per second, from the period January 2003 to December 2009



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2003						5.55	5.555	5.448	5.448	5.543	5.574	5.523
2004	5.474	5.528	5.574	5.899	5.706	5.733	5.595	5.527	5.581	5.657	5.672	5.583
2005	5.542	5.536	5.516	5.948	5.846	5.663	5.53	5.371	5.394	5.632	5.718	5.712
2006	5.617	5.575	5.597		5.791	5.612	5.486	5.487	5.414	5.533	5.541	5.547
2007	5.529	5.22	5.763	5.74	5.621	5.706	5.547	5.353	5.769	5.976	5.685	5.641
2009	5.8	5.656	5.631	6.1	6.09	5.956	5.556	5.641	5.532	5.695	5.922	5.69

Figure 2.0: Monthly mean water level in metres, from the period January 2003 to December 2009

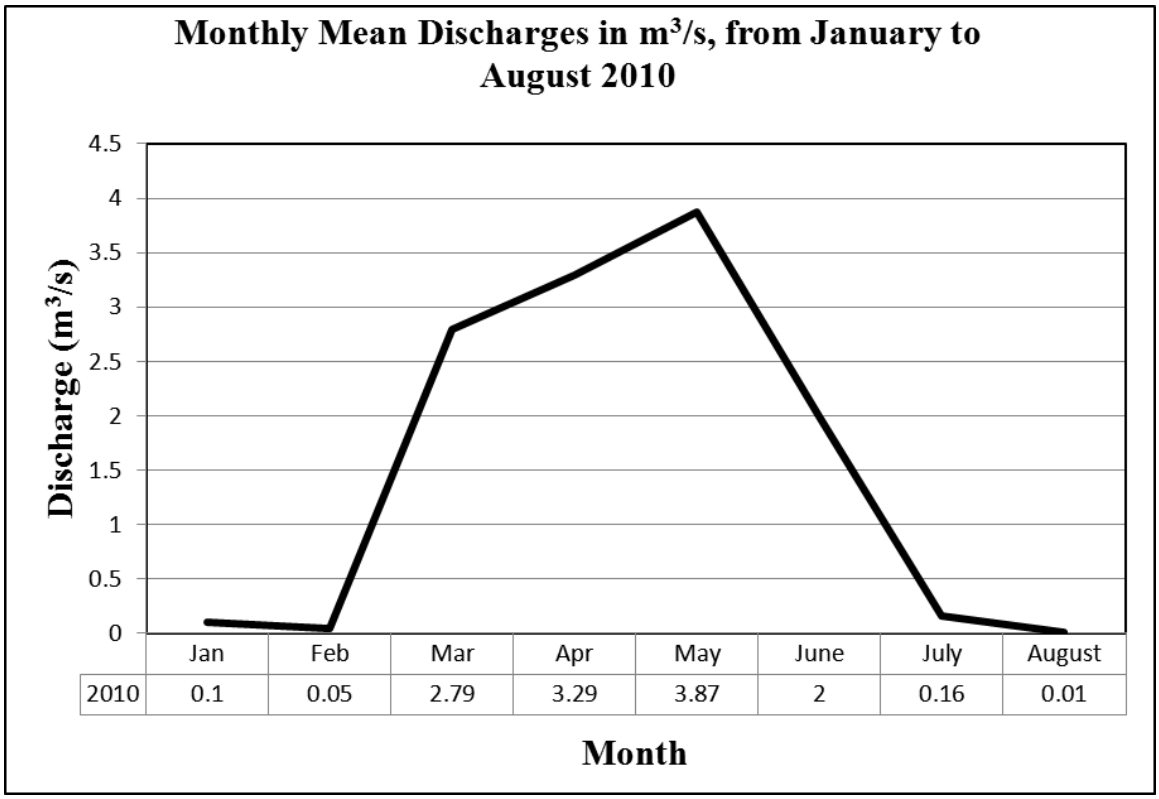


Figure 3.0: Monthly mean discharge in cubic metres per second, from the period January to August, 2010

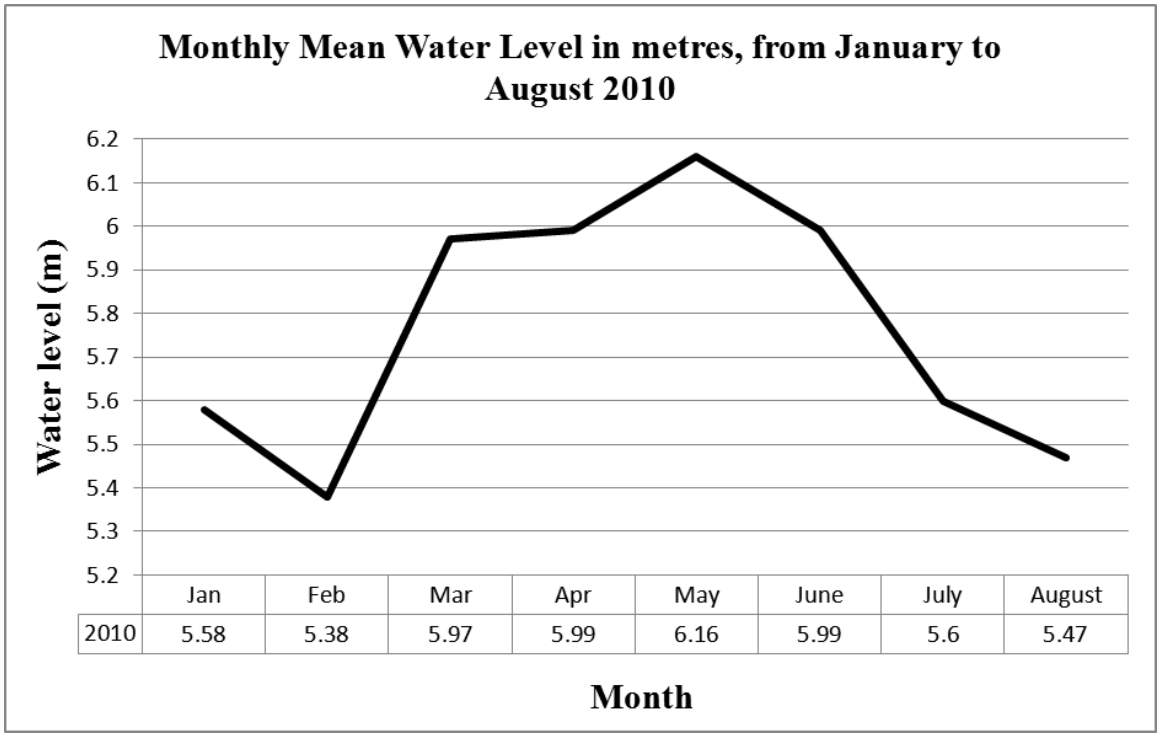


Figure 4.0: Monthly mean water level in metres, from the period January to August, 2010

APPENDIX J

LABORATORY CERTIFICATES OF ANALYSIS

Due to a technical error in the field, samples collected in 2010 at sampling Site 14 were mislabelled as Site 12, which was only sampled during the 1997 Watershed Assessment. Laboratory analytical results reported as Site 12 in 2010 have been referred to within the text of the report as Site 14.

Certificate of Analysis

LAKEHEAD REGION CONSERVATION AUTHORITY

ATTN: TAMMY COOK

130 CONSERVATION ROAD
P.O. BOX 10427
THUNDER BAY ON P7B 6T8

Report Date: 30-JUL-10 14:26 (MT)
Version: FINAL

Lab Work Order #: **L910511** **Date Received:** **20-JUL-10**

Project P.O. #: NOT SUBMITTED
Job Reference:
Legal Site Desc:
CofC Numbers: L910511

Other Information:

Comments:

Richard Clara
General Manager, Thunder Bay

ALS LABORATORY GROUP ANALYTICAL REPORT

	Sample ID	L910511-1	L910511-2	L910511-3	L910511-4	
	Description	WATER	WATER	WATER	WATER	
	Sampled Date	19-JUL-10	19-JUL-10	19-JUL-10	19-JUL-10	
	Sampled Time	11:15	13:00	14:10	14:55	
	Client ID	PC9 PENNOCK CREEK - SITE #9	CC12 CORBETT CREEK - SITE #12	CC9 CORBETT CREEK - SITE #9	CC7 CORBETT CREEK - SITE #7	
Grouping	**Analyte**					
WATER						
Physical Tests	Conductivity (EC) (uS/cm)	549	374	549	300	
	Total Dissolved Solids (mg/L)	425	283	424	240	
	Turbidity (NTU)	16.3	2.40	3.92	4.23	
Anions and Nutrients	Ammonia-N, Total (mg/L)	<0.020	<0.020	<0.020	<0.020	
	Chloride (Cl) (mg/L)	77.3	35.8	30.5	5.89	
	Nitrate-N (NO3-N) (mg/L)	0.124	0.856	<0.030	<0.030	
	Nitrite-N (NO2-N) (mg/L)	<0.020	<0.020	<0.020	<0.020	
	Phosphorus (P)-Total (mg/L)	0.0169	<0.0050	0.0298	0.0159	
	Sulphate (SO4) (mg/L)	8.25	7.78	<0.30	1.49	
Bacteriological Tests	Escherichia Coli (MPN/100mL)	63	35	210	110	
	Total Coliforms (MPN/100mL)	1600	2000	2000	> 2420	
Total Metals	Aluminum (Al) (mg/L)	0.175	0.042	0.030	0.027	
	Antimony (Sb) (mg/L)	<0.0050	<0.0050	<0.0050	<0.0050	
	Arsenic (As) (mg/L)	0.0017	<0.0010	0.0013	<0.0010	
	Barium (Ba) (mg/L)	0.056	0.016	0.018	0.013	
	Beryllium (Be) (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010	
	Bismuth (Bi) (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010	
	Boron (B) (mg/L)	<0.050	<0.050	<0.050	<0.050	
	Cadmium (Cd) (mg/L)	<0.000090	<0.000090	<0.000090	<0.000090	
	Calcium (Ca) (mg/L)	66.8	41.6	83.6	45.7	
	Chromium (Cr) (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010	
	Cobalt (Co) (mg/L)	<0.00050	<0.00050	<0.00050	<0.00050	
	Copper (Cu) (mg/L)	0.0022	0.0017	<0.0010	<0.0010	
	Iron (Fe) (mg/L)	1.52	0.436	0.596	0.832	
	Lead (Pb) (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010	
	Magnesium (Mg) (mg/L)	18.3	14.9	25.8	15.0	
	Manganese (Mn) (mg/L)	0.232	0.0179	1.27	0.0963	
	Molybdenum (Mo) (mg/L)	0.0010	<0.0010	<0.0010	0.0012	
	Nickel (Ni) (mg/L)	<0.0020	<0.0020	<0.0020	<0.0020	
	Potassium (K) (mg/L)	2.0	2.1	1.1	1.1	
	Selenium (Se) (mg/L)	0.00041	<0.00040	0.00044	<0.00040	
	Silicon (Si) (mg/L)	8.4	8.7	8.6	7.0	
	Silver (Ag) (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	
	Strontium (Sr) (mg/L)	0.0978	0.0572	0.109	0.0640	
	Thallium (Tl) (mg/L)	<0.00030	<0.00030	<0.00030	<0.00030	
	Tin (Sn) (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010	

ALS LABORATORY GROUP ANALYTICAL REPORT

	Sample ID	L910511-1	L910511-2	L910511-3	L910511-4	
	Description	WATER	WATER	WATER	WATER	
	Sampled Date	19-JUL-10	19-JUL-10	19-JUL-10	19-JUL-10	
	Sampled Time	11:15	13:00	14:10	14:55	
	Client ID	PC9 PENNOCK CREEK - SITE #9	CC12 CORBETT CREEK - SITE #12	CC9 CORBETT CREEK - SITE #9	CC7 CORBETT CREEK - SITE #7	
Grouping	**Analyte**					
WATER						
Total Metals	Titanium (Ti) (mg/L)	0.0074	0.0022	<0.0020	<0.0020	
	Tungsten (W) (mg/L)	<0.010	<0.010	<0.010	<0.010	
	Uranium (U) (mg/L)	<0.0050	<0.0050	<0.0050	<0.0050	
	Vanadium (V) (mg/L)	0.0017	<0.0010	<0.0010	<0.0010	
	Zinc (Zn) (mg/L)	<0.0030	<0.0030	0.0098	<0.0030	
	Zirconium (Zr) (mg/L)	<0.0040	<0.0040	<0.0040	<0.0040	

Reference Information

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
CL-TB	Water	Chloride (Cl)	APHA 4110 B-Ion Chromatography
EC-CAP-TB	Water	Conductivity (EC)	APHA 2510 B-electrode
MET-ONT-PWQO-WT	Water	Metals, Total PWQO	EPA 200.8 (ICP/MS)
NH4-TB	Water	Ammonia-N, Total	APHA 4500-NH3 G - Colourimetry
NO2-TB	Water	Nitrite-N	APHA 4110 B-Ion Chromatography
NO3-TB	Water	Nitrate-N	APHA 4110 B-Ion Chromatography
P-TOT-TB	Water	Phosphorus (P)-Total	APHA 4500-P B,F Colourimetry
SO4-TB	Water	Sulphate (SO4)	APHA 4110 B-Ion Chromatography
SOLIDS-TDS-TB	Water	Total Dissolved Solids	APHA 2540 C
TC,EC-18QT97-TB	Water	Total Coliform and E.coli	APHA SM 9223B C-18
TURBIDITY-TB	Water	Turbidity	APHA 2130 B-Nephelometer

** 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
WT	ALS LABORATORY GROUP - WATERLOO, ONTARIO, CANADA
TB	ALS LABORATORY GROUP - THUNDER BAY, ONTARIO, CANADA

Chain of Custody Numbers:

L910511

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 receieved 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.

Report To	Tammy Cook
Company:	Lakehead Region Conservation Authority
Contact:	Scott Drebit
Address:	130 Conservation Rd P.O. Box 10427
	Thunder Bay, ON P7B 6T8
Phone:	344-5857 Fax: 345-9156
Invoice To	Same as Report ? (Yes) No

THE QUESTIONS BELOW MUST BE ANSWERED FOR WATER SAMPLES (circle Yes or No)

Are any samples taken from a regulated DW System? Yes (No)

If yes, an authorized Drinking Water COC MUST be used for this submission.

Is the water sampled intended to be potable for human consumption? Yes (No)

Report Format / Distribution

Standard ✓ Other (specify):

PDF ✓ Excel ✓ Digital Fax

Email 1: info@lakeheadca.com

Email 2: Scott@lakeheadca.com

Client / Project Information

Job #:

PO / AFE:

LSD:

Quote #: Q23274

Service Requested (Rush for routine analysis subject to availability)

✓ Regular (Default)

Priority (Specify Date Required → →) Surcharges apply

Emergency (1 Business Day) - 100% Surcharge

For Emergency < 1 Day, ASAP or Weekend - Contact ALS

Lab Work Order # (lab use only):

ALS Contact:

Sampler: S. Drebit, D. Brazeau

Analysis Request

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

Sample #	Sample Identification (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	Routine	Total Metals (P)	Nutrients (P)	Total Coliform/E.Coli (P)	Number of Containers
1 PC9	Pemock Creek - Site #9	19-JUL-10	11:15	Grab	✓	✓	✓	✓	4
2 CC17	Corbett Creek - Site #17	19-JUL-10	13:00	Grab	✓	✓	✓	✓	4
3 CC9	Corbett Creek - Site #9	19-JUL-10	14:10	Grab	✓	✓	✓	✓	4
4 CC7	Corbett Creek - Site #7	19-JUL-10	14:55	Grab	✓	✓	✓	✓	4

Special Instructions / Regulations / Hazardous Details

Reg 153 Table 1 2 3 TCLP MISA (PWQO) OTHER (please specify):

Circle one - Note drinking water samples MUST USE DW Chain of Custody

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY.

By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

SHIPMENT RELEASE (client use)			SHIPMENT RECEPTION (lab use only)				SHIPMENT VERIFICATION (lab use only)			
Released by:	Date:	Time:	Received by:	Date:	Time:	Temperature:	Verified by:	Date:	Time:	Observations: Yes / No ? If Yes add SIF
	Jul 20/10	3:08 pm	VB	20-Jul-10	3:08 pm	9.6 °C		July 20/10	3:10	

8:04 9.0 °C

TYFM014 26-Mar-10

Certificate of Analysis

LAKEHEAD REGION CONSERVATION AUTHORITY

ATTN: SCOTT DREBIT

130 CONSERVATION ROAD
P.O. BOX 10427
THUNDER BAY ON P7B 6T8

Report Date: 30-JUL-10 14:32 (MT)
Version: FINAL

Lab Work Order #: **L911730** **Date Received:** **22-JUL-10**

Project P.O. #: NOT SUBMITTED
Job Reference:
Legal Site Desc:
CofC Numbers: L911730

Other Information:

Comments:

Richard Clara
General Manager, Thunder Bay

ALS LABORATORY GROUP ANALYTICAL REPORT

	Sample ID	L911730-1	L911730-2	L911730-3	L911730-4	
	Description	WATER	WATER	WATER	WATER	
	Sampled Date	22-JUL-10	22-JUL-10	22-JUL-10	22-JUL-10	
	Sampled Time	09:45	10:55	11:50	13:10	
	Client ID	CC1 CORBETT CREEK SITE #1 (TY504519)	CC3 CORBETT CREEK SITE #3 (TY504520)	CC5 CORBETT CREEK SITE #5 (TY504521)	CC10 CORBETT CREEK SITE #10 (TY504522)	
Grouping	**Analyte**					
WATER						
Physical Tests	Conductivity (EC) (uS/cm)	281	237	287	320	
	Total Dissolved Solids (mg/L)	212	178	215	227	
	Turbidity (NTU)	5.60	3.69	2.58	8.70	
Anions and Nutrients	Ammonia-N, Total (mg/L)	0.026	<0.020	<0.020	<0.020	
	Chloride (Cl) (mg/L)	19.7	0.81	5.79	9.80	
	Nitrate-N (NO3-N) (mg/L)	<0.030	<0.030	<0.030	0.047	
	Nitrite-N (NO2-N) (mg/L)	<0.020	<0.020	<0.020	<0.020	
	Phosphorus (P)-Total (mg/L)	0.0348	0.0244	0.0210	0.0255	
	Sulphate (SO4) (mg/L)	0.31	0.46	0.84	1.39	
Bacteriological Tests	Escherichia Coli (MPN/100mL)	30	32	54	120	
	Total Coliforms (MPN/100mL)	2400	1600	2400	> 2420	
Total Metals	Aluminum (Al) (mg/L)	0.021	0.018	0.033	0.168	
	Antimony (Sb) (mg/L)	<0.0050	<0.0050	<0.0050	<0.0050	
	Arsenic (As) (mg/L)	0.0010	<0.0010	<0.0010	<0.0010	
	Barium (Ba) (mg/L)	0.040	0.020	0.014	0.025	
	Beryllium (Be) (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010	
	Bismuth (Bi) (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010	
	Boron (B) (mg/L)	<0.050	<0.050	<0.050	<0.050	
	Cadmium (Cd) (mg/L)	<0.000090	<0.000090	<0.000090	<0.000090	
	Calcium (Ca) (mg/L)	36.0	37.1	43.9	46.3	
	Chromium (Cr) (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010	
	Cobalt (Co) (mg/L)	0.00058	<0.00050	<0.00050	<0.00050	
	Copper (Cu) (mg/L)	<0.0010	<0.0010	<0.0010	0.0014	
	Iron (Fe) (mg/L)	3.07	1.86	0.590	1.21	
	Lead (Pb) (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010	
	Magnesium (Mg) (mg/L)	12.8	11.4	14.0	15.6	
	Manganese (Mn) (mg/L)	1.56	0.769	0.126	0.138	
	Molybdenum (Mo) (mg/L)	<0.0010	<0.0010	<0.0010	0.0011	
	Nickel (Ni) (mg/L)	<0.0020	<0.0020	<0.0020	<0.0020	
	Potassium (K) (mg/L)	<1.0	<1.0	<1.0	1.3	
	Selenium (Se) (mg/L)	<0.00040	<0.00040	<0.00040	<0.00040	
	Silicon (Si) (mg/L)	7.6	7.8	7.7	7.3	
	Silver (Ag) (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	
	Strontium (Sr) (mg/L)	0.0550	0.0505	0.0574	0.0691	
	Thallium (Tl) (mg/L)	<0.00030	<0.00030	<0.00030	<0.00030	
	Tin (Sn) (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010	

ALS LABORATORY GROUP ANALYTICAL REPORT

	Sample ID	L911730-1	L911730-2	L911730-3	L911730-4	
	Description	WATER	WATER	WATER	WATER	
	Sampled Date	22-JUL-10	22-JUL-10	22-JUL-10	22-JUL-10	
	Sampled Time	09:45	10:55	11:50	13:10	
	Client ID	CC1 CORBETT CREEK SITE #1 (TY504519)	CC3 CORBETT CREEK SITE #3 (TY504520)	CC5 CORBETT CREEK SITE #5 (TY504521)	CC10 CORBETT CREEK SITE #10 (TY504522)	
Grouping	**Analyte**					
WATER						
Total Metals	Titanium (Ti) (mg/L)	<0.0020	<0.0020	<0.0020	0.0058	
	Tungsten (W) (mg/L)	<0.010	<0.010	<0.010	<0.010	
	Uranium (U) (mg/L)	<0.0050	<0.0050	<0.0050	<0.0050	
	Vanadium (V) (mg/L)	<0.0010	<0.0010	<0.0010	0.0014	
	Zinc (Zn) (mg/L)	<0.0030	0.0124	<0.0030	<0.0030	
	Zirconium (Zr) (mg/L)	<0.0040	<0.0040	<0.0040	<0.0040	

Reference Information

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
CL-TB	Water	Chloride (Cl)	APHA 4110 B-Ion Chromatography
EC-CAP-TB	Water	Conductivity (EC)	APHA 2510 B-electrode
MET-ONT-PWQO-WT	Water	Metals, Total PWQO	EPA 200.8 (ICP/MS)
NH4-TB	Water	Ammonia-N, Total	APHA 4500-NH3 G - Colourimetry
NO2-TB	Water	Nitrite-N	APHA 4110 B-Ion Chromatography
NO3-TB	Water	Nitrate-N	APHA 4110 B-Ion Chromatography
P-TOT-TB	Water	Phosphorus (P)-Total	APHA 4500-P B,F Colourimetry
SO4-TB	Water	Sulphate (SO4)	APHA 4110 B-Ion Chromatography
SOLIDS-TDS-TB	Water	Total Dissolved Solids	APHA 2540 C
TC,EC-18QT97-TB	Water	Total Coliform and E.coli	APHA SM 9223B C-18
TURBIDITY-TB	Water	Turbidity	APHA 2130 B-Nephelometer

** 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
WT	ALS LABORATORY GROUP - WATERLOO, ONTARIO, CANADA
TB	ALS LABORATORY GROUP - THUNDER BAY, ONTARIO, CANADA

Chain of Custody Numbers:

L911730

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 receieved 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

Chain of Custody / Analytical Request Form
Canada Toll Free: 1 800 668 9878
www.alsglobal.com

COC # _____

L911730

Page 1 of 1

Report To Tammy Cook	**Report Format / Distribution**
Company: Lakehead Region Conservation Authority	Standard ✓ Other (specify):
Contact: Scott Drebit	PDF ✓ Excel ✓ Digital Fax
Address: 130 Conservation Rd Box 10427 Thunder Bay ON P7B 6T8	Email 1: info@lakeheadca.com
Phone: 344-5857 Fax: 345-9156	Email 2: Scott@lakeheadca.com
Invoice To Same as Report ? (Yes) No	
THE QUESTIONS BELOW MUST BE ANSWERED FOR WATER SAMPLES (circle Yes or No)	**Client / Project Information**
Are any samples taken from a regulated DW System? Yes (No)	Job #:
If yes, an authorized Drinking Water COC MUST be used for this submission.	PO / AFE:
Is the water sampled intended to be potable for human consumption? Yes (No)	LSD:
	Quote #: Q232-74
Lab Work Order # (lab use only)	**ALS Contact:** **Sampler:** S. Drebit D. Brazeau

Service Requested (Rush for routine analysis subject to availability)
- ✓ Regular (Default)
- Priority (Specify Date Required → →) Surcharges apply
- Emergency (1 Business Day) - 100% Surcharge
- For Emergency < 1 Day, ASAP or Weekend - Contact ALS

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

Sample #	Sample Identification (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	Routine	Total Metals (P)	Nutrients (P)	Total Coliform / E.coli (P)	Number of Containers
CC1	Corbett Creek - Site #1	22-Jul-10	09:45	Grab	✓	✓	✓	✓	4
CC3	Corbett Creek - Site #3	22-Jul-10	10:55	Grab	✓	✓	✓	✓	4
CC5	Corbett Creek - Site #5	22-Jul-10	11:50	Grab	✓	✓	✓	✓	4
CC10	Corbett Creek - Site #10	22-Jul-10	13:10	Grab	✓	✓	✓	✓	4

[redacted]

Special Instructions / Regulations / Hazardous Details

Reg 153 Table 1 2 3 TCLP MISA (PWQO) OTHER (please specify):
Circle one - Note drinking water samples MUST USE DW Chain of Custody

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

SHIPMENT RELEASE (client use)			SHIPMENT RECEPTION (lab use only)				SHIPMENT VERIFICATION (lab use only)			
Released by:	Date:	Time:	Received by:	Date:	Time:	Temperature:	Verified by:	Date:	Time:	Observations: Yes / No? If Yes add SIF
	July 22/10	2:45pm	KM	July 22/10	2:45	17.5°C	KM	July 22/10	3:40pm	

TYFM014 26-Mar-10