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North Bay-Mattawa Conservation Authority

Surface Water Vulnerability and Threats Assessment for Drinking Water Source Protection for the City of North Bay

Prepared by:

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Project Number:

107618

Date:

January 6, 2010

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January 6, 2010 Project Number: 107618/70382

Ms. Sue Miller
Manager, Drinking Water Source Protection
North Bay – Mattawa Conservation Authority
15 Janey Avenue
North Bay, ON P1C 1N1

Dear Ms. Miller:

Re: Surface Water Vulnerability and Threats Assessment for Drinking Water Source Protection for the City of North Bay

I am pleased to submit this final report that provides technical input for Drinking Water Source Protection for the City of North Bay municipal drinking water intake under the *Clean Water Act, 2006*. This report has been revised from its draft version (dated June 9, 2009) to address comments received from the Technical Advisory Committee and recent changes to the MOE's Technical Rules: Assessment Report (November 20 2008) as amended November 16, 2009 and including updates to the MOE's drinking water threats tables.

This report provides the necessary technical information for the completion of an Assessment Report for the following components of Drinking Water Source Protection Planning:

- Part VI – Delineation of Vulnerable Areas: Surface Water Intake Protection Zones
- Part VIII - Vulnerability: Surface Water Intake Protection Zones
- Part XI – Drinking Water Threats: Water Quality
- Part I.4 – Uncertainty Analysis – Water Quality

AECOM (formerly Gartner Lee Limited, GLL) had previously completed three draft reports for Source Protection planning, which followed earlier guidance provided by MOE. These included:

- Surface Water Vulnerability Study for Source Protection (July, 2007),
- Issues Evaluation and Threats Inventory for Drinking Water Source Protection Planning for the City of North Bay (October, 2007), and
- Risk Assessment for Drinking Water Source Protection Planning for the City of North Bay (February, 2008).

:

All pertinent information contained in these earlier reports have been incorporated into this final report to meet the requirements of drinking water source protection legislated by the *Act*. We therefore request that the earlier GLL draft reports be withdrawn from any circulation.

It has been a pleasure assisting the North Bay-Mattawa Conservation Authority with this study and I wish the CA the best of luck with upcoming phases of Source Protection Planning for the City of North Bay drinking water intake.

Please do not hesitate to contact me if you have any questions or concerns.

Sincerely,
AECOM Canada Ltd.

Tammy Karst-Riddoch, Ph.D.
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TKR:tkr
Encl.

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Revision Log

Revision #	Revised By	Date	Issue / Revision Description
1	TKR	6-Jan-10	Address comments from Technical Advisory Committee; updates following amendments to the Technical Rules of November 16, 2009 and changes to the threats database (version 7.1.2)

Signature Page

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1. Introduction

As part of its strategy to protect Ontario's drinking water from source to tap, the Ontario government has released legislation under the *Clean Water Act* (2006) requiring the creation of source protection plans for all municipal drinking water sources. These plans provide strategies to reduce or eliminate risks to drinking water quality and supply. A key part of the source protection planning process is the development of an Assessment Report. The purpose of the Assessment Report is to identify and assess risks to the quality and quantity of municipal drinking water sources using a science-based watershed approach to inform the source protection plan. Technical requirements of the Assessment Report are set out in the "Assessment Report: Technical Rules" (November 20, 2008 and amended December 12, 2008 and November 16, 2009) under the *Clean Water Act* (2006), herein referred to as the 'Rules'.

This study provides the necessary technical information as per Part I of the Rules to complete specific components of the Assessment Report for the North Bay municipal drinking water intake in Delaney Bay of Trout Lake that include the following Parts of the Rules:

- Part VI – Delineation of Vulnerable Areas: Surface Water Intake Protection Zones
- Part VIII - Vulnerability: Surface Water Intake Protection Zones
- Part XI – Drinking Water Threats: Water Quality
- Part I.4 – Uncertainty Analysis – Water Quality

2. Water Treatment Plant (WTP) and Intake Characteristics

The City of North Bay water treatment plant is located at 248 Lakeside Drive and is operated by the Ontario Clean Water Agency (OCWA). The current treatment plant was originally built in 1929, upgraded in 1972. In August 2002, the primary disinfectant was changed to ultraviolet (UV) sterilization instead of chlorine and the chlorination point was moved to the outer end of the intake to increase contact time. Raw water is still also chlorinated just prior to entering the distribution system in order to maintain a chlorine residual.

In order to comply with the new Ontario Drinking Water Regulations and Standards (Ontario Regulation 459/00) and an amended Certificate of Approval requiring the City to provide a filtered water supply, a new water treatment plant has been constructed at the site of the existing plant and is scheduled to come fully online by the end of January, 2010. The new plant is equipped with chemically assisted membrane filtration with the ability to add coagulant if required. It can therefore treat for particulates (including *Giardia* and *Cryptosporidium* cysts), but not for dissolved substances (spills or taste and odour compounds).

The water treatment plant has a rated capacity of 79,500 m^3/day with annual water takings of approximately 13 x 10^6 m^3 from Delaney Bay (2001 estimate). Operating ranges are smaller in volume. It takes

approximately six hours for the City of North Bay to top up its three reservoirs, with capacities of 15,000, 760, and 1,900 m^3. The storage supply can accommodate the City's water usage requirements for up to an estimated 12 hours at low demand times and assuming that the storage reservoirs are full.

The City of North Bay's drinking water intake is a Type D intake (Rule 55) and is located near the centre of Delaney Bay in the western basin of Trout Lake. The approximate co-ordinates of the intake crib are 622779, 5131488 (NAD 83, UTM 17) as determined by the NBMCA based on estimates from orthophotos and parcel fabric. The exact location of the intake in Delaney Bay is unknown and should be determined using a global positioning system (GPS). The intake crib lies 314 m from the water treatment plant at a lake depth of approximately 22 m and is raised 3.4 m above the lake bottom (176.8 m ASL). The intake pipe itself is constructed of polyethylene and has a diameter of 1.22 m. Details of the structural design for the intake are provided by Proctor & Redfern Limited, Drawing No. B-72137-G1 (1972).

The intake features an on-line turbidity monitor that samples from the bell chamber ahead of the chlorination point via a separate sampling line that also serves to collect raw water for chemical analysis. Travel time for raw water in the intake to reach the intake chamber of the water treatment plant ranges from approximately 15 to 30 minutes, averaging about 20 minutes (P. Bullock, pers. comm.).

In case of emergency, the drinking water plant can be shut down within 15 minutes (P. Bullock, pers. Comm.).

3. Background Information

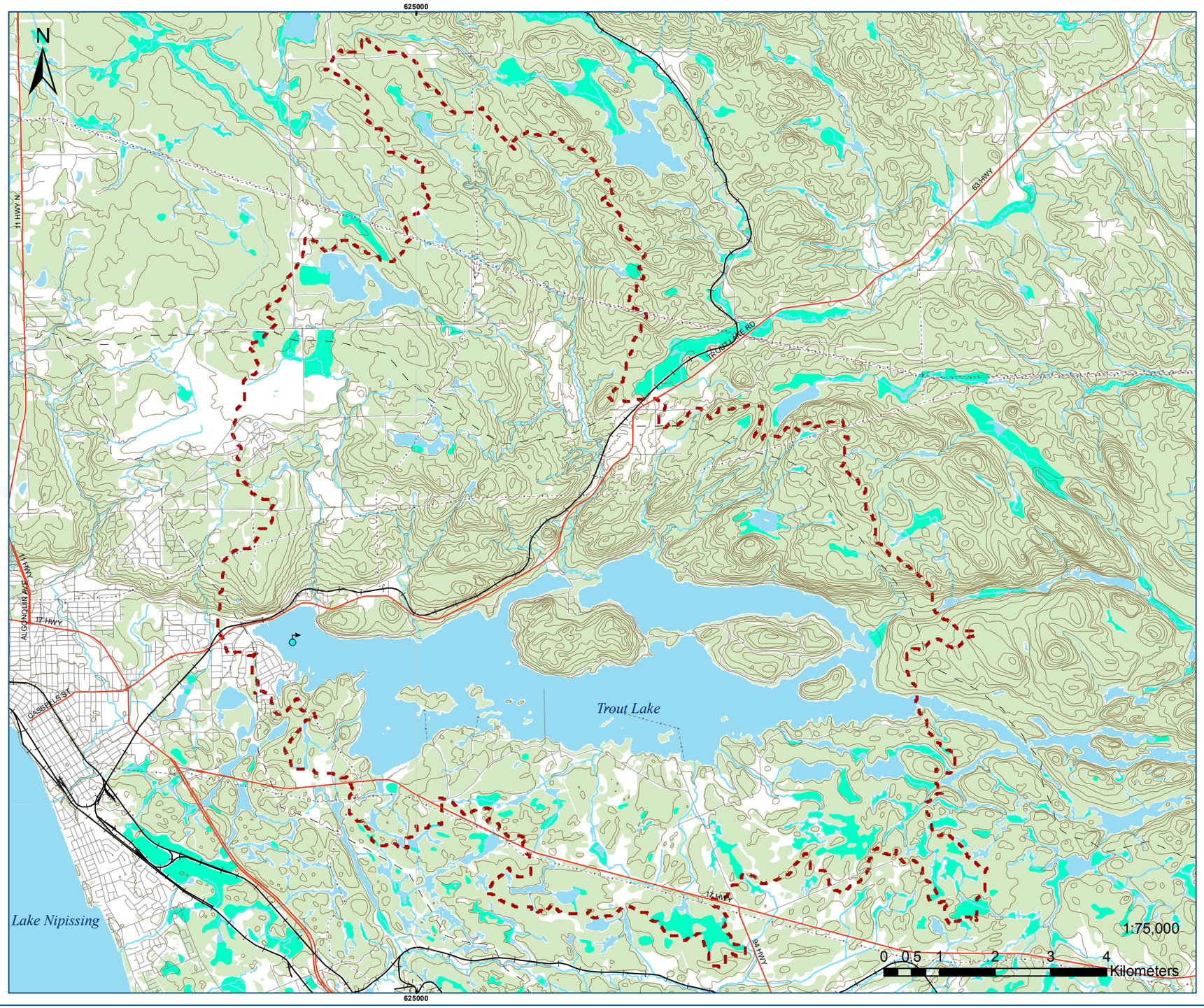
The following sections provide general information regarding watershed characteristics, hydrology and limnology of Trout Lake, which was used to inform technical decisions to complete the requirements set out in the Rules.

3.1 General Watershed Characteristics of Trout Lake

The watershed and subsubwatersheds of Trout Lake are delineated from a hydrologic model constructed from the Ministry of Natural Resources' improved Digital Elevation Model (DEM) (version 2.0.0; 20-m resolution) and an Enhanced Flow Direction grid (version 2.0.0). ArcHYDRO, a GIS-based modelling suite, was used to identify the overall catchment of the lake (Figure 1). Most of the Trout Lake watershed is forested, with some urban/residential and agricultural areas in the west and northwest (Figure 1).

The watershed of Trout Lake has an area of 106 km^2 and is comprised of 14 stream subwatersheds (83.6 km^2) and the local drainage subwatershed (22.4 km^2) that surrounds the lake as illustrated in Figure 2. Areas of each of the subwatersheds are provided in Table 1.

NORTH BAY – MATTAWA SOURCE WATER PROTECTION



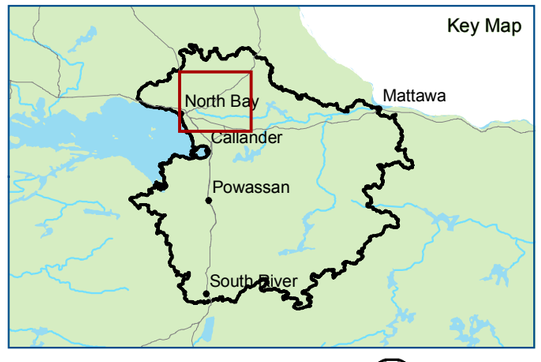
Trout Lake Watershed
Source Water Protection Study
Trout Lake Catchment
Figure 1

Legend

- WaterWithdrawal
- Elevation Contour

Utility Line

- Hydro Line
- Pipeline
- Railway
- Highway
- Road
- Trout Lake Catchment
- River/Creek
- Intermittent Stream
- Waterbody
- Wetland
- Wooded Area



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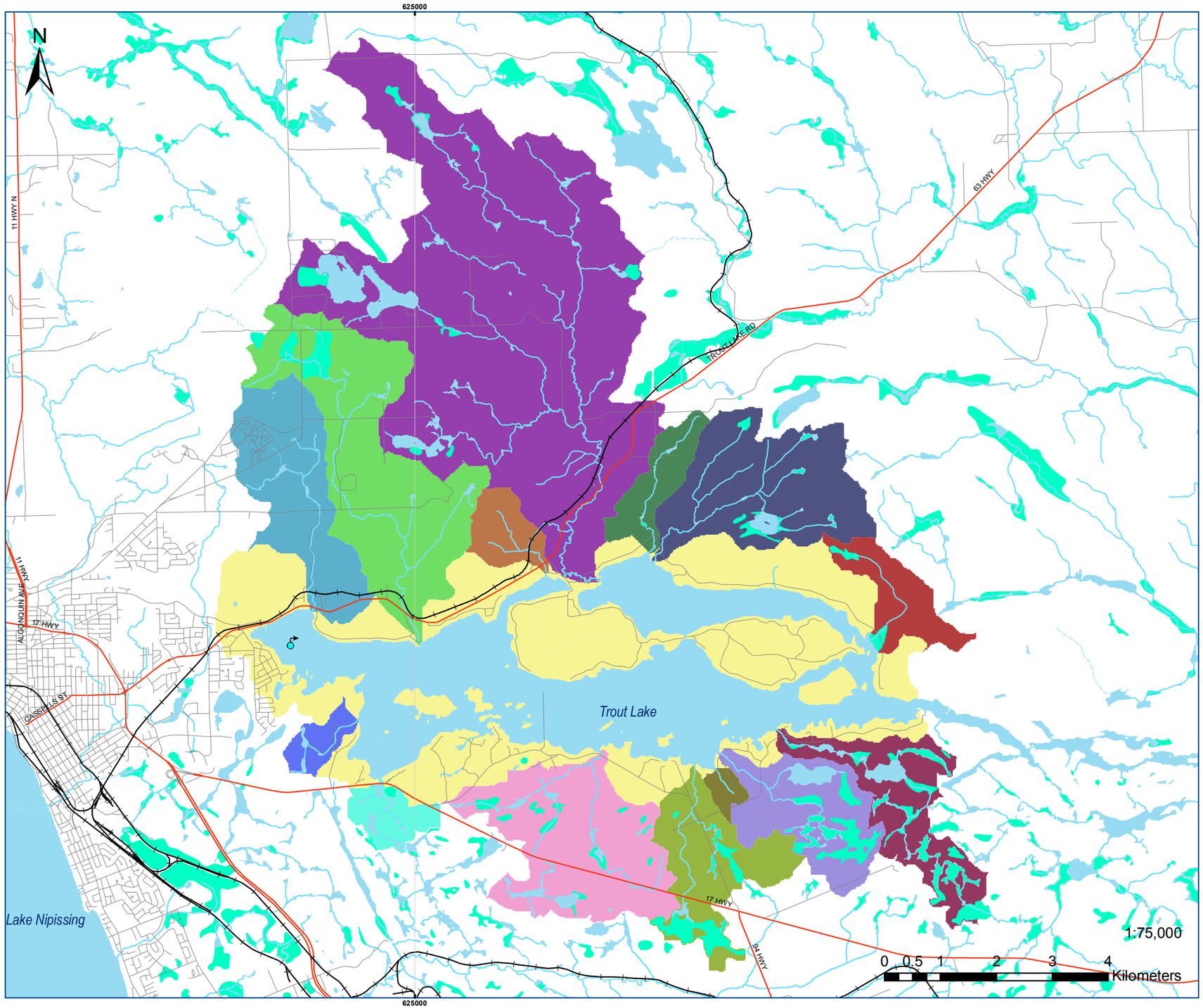
NORTH BAY – MATTAWA

SOURCE WATER PROTECTION



Trout Lake Subwatersheds Source Water Protection Study Figure 2

Legend

- WaterWithdrawal
- Highway
- Road
- Railway
- River/Creek
- Intermittent Stream
- Waterbody
- Wetland

Trout Lake Subwatersheds

- Doran Creek
- Four Mile Creek
- Hogan Creek
- Lees Creek
- Local Drainage
- Unnamed Creek
- Unnamed Creek NB-2411
- Unnamed Creek NB-2411a
- Unnamed Creek NB-2427
- Unnamed Creek NB-2431
- Unnamed Creek NB-2433
- Unnamed Creek NB-2433a
- Unnamed Creek NB-2433b
- Unnamed Creek NB-2433c
- Unnamed Creek NB-3141

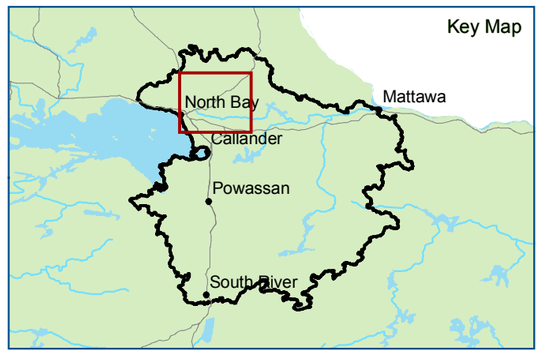


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Table 1. Trout Lake Watershed and Subwatershed Areas

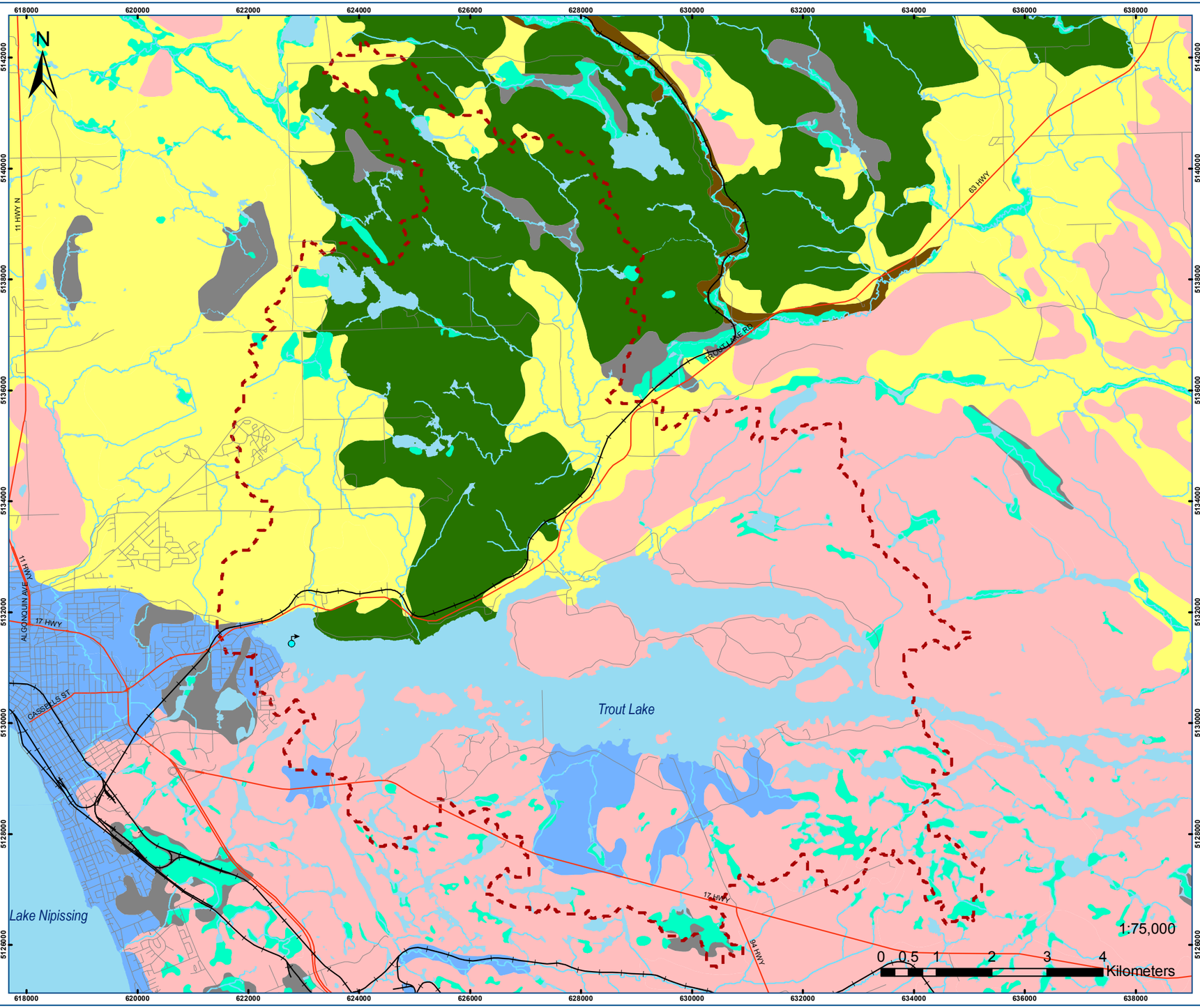
Subwatershed	Area (km2)
Doran Creek	10.3
Four Mile Creek	32.1
Hogan Creek	1.4
Lees Creek	5.6
Local Drainage	22.4
Unnamed Creek	7.5
Unnamed Creek NB2411	1.8
Unnamed Creek NB2411a	6.9
Unnamed Creek NB2427	0.9
Unnamed Creek NB2431	1.3
Unnamed Creek NB2433	4.5
Unnamed Creek NB2433a	4.4
Unnamed Creek NB2433b	0.4
Unnamed Creek NB2433c	4.3
Unnamed Creek NB3141	2.2
Total Trout Lake Watershed	**106.0**

The major geological landforms within the Trout Lake watershed are illustrated in Figure 3. Precambrian Shield bedrock knobs interspersed with glaciolacustrine plains characterize the catchment areas that lie south and northeast of the lake. In the subwatersheds of Doran, Four Mile, Hogan and Lees creeks that lie in the northwest, the terrain consists primarily of ground moraines and outwash plains with few organic deposits (Figure 3). In these northern watershed areas there are steep stream gradients to Trout Lake (Figure 1).

NORTH BAY – MATTAWA

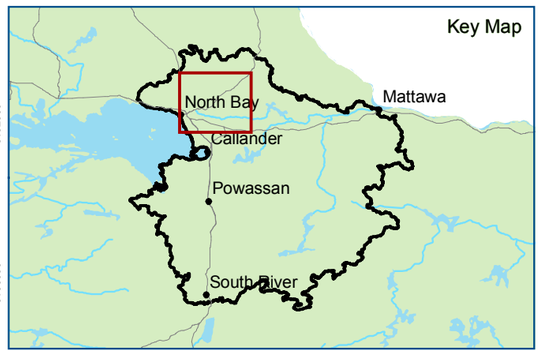
SOURCE WATER PROTECTION

Trout Lake Watershed Geology
Source Water Protection Study
Local Terrain
Figure 3



Legend

- WaterWithdrawal
- Railway
- Highway
- Road
- Trout Lake Catchment
- River/Creek
- Intermittent Stream
- Waterbody
- Wetland
- Ground moraine
- Outwash plain
- Raised beach
- Glaciolacustrine plain
- Alluvial
- Organics
- Bedrock knob



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3.2 Hydrodynamics and Hydrology of Trout Lake and Delaney Bay

The total volume of Trout Lake is 331 x 106 m^3. The lake is divided into three sub-basins including Four Mile Bay, One Mile Bay, and the 'main basin', which includes Delaney Bay. Delaney Bay, located at the extreme west end of Trout Lake, has a volume of 20 x 106 m^3, representing approximately 7% of the volume of the main basin (279 x 106 m^3).

The main basin of Trout Lake discharges to the east at its outlet to Turtle Lake and the Mattawa River and had an estimated flushing rate of 6.9 years for the period between 1980 and 1988. Under normal flow conditions, therefore, flow within the main basin is eastward, away from Delaney Bay and the drinking water intake such that movement of water toward the intake from the main basin is likely rare. The prevailing southwest winds that occur during the open-water season generally push surface waters eastward, away from the intake (Aquafor Beech Limited, 2001), but flow reversals may occur when the wind drops or by subsurface counter flow. There are no known hydrodynamic studies of water flow or measurements of surface currents in Trout Lake.

Flow reversals within the hypolimnion of Trout Lake may occur for short periods due to withdrawals by the drinking water plant. This is of particular concern during the summer months when water takings may exceed the volume of water discharged from the lake, thereby resulting in a westward flow of hypolimnetic water from the main basin toward the intake and eliminating discharge to the Mattawa River. As part of the original Permit to Take Water, a study was undertaken by D.L. Rees to determine safe water taking levels (P. Bullock, pers. comm.).

It has been estimated that 5.5 x 106 m^3 of water is drawn by the intake over the summer stratification period (June to September) (Miller Environmental Services Inc., 2001). This volume is nearly equivalent to the entire volume of the hypolimnion (below 13.5 m) in Delaney Bay (5.8 x 106 m^3, Miller Environmental Services Inc., 2001). Water removed from the hypolimnion will be replaced gradually by downward displacement of surface waters. Although the rate of withdrawal is slow enough to allow thermal equilibration and maintenance of lake stratification, it will result in the gradual entrainment of surface waters to the hypolimnion over the course of the summer, which in principle could introduce surface pollutants into the hypolimnion. We also note that this process occurs in the spring and fall of each year during lake turnover, independently of the water taking.

3.3 General Limnology of Trout Lake

For the most part, limnological conditions of Trout Lake are typical of most large, deep Precambrian Shield lakes. Based on 1986 MOE monitoring data, the lake water of the main basin (including Delaney Bay) is circumneutral (pH = 7.24 to 7.57), has low alkalinity (12.1 to 13.5 mg/L), and is ionically dilute with conductivity ranging from 84.1 to 91.4 μmhos/cm. Trout Lake therefore has slightly greater ionic strength than most Shield lakes, and hence a relatively higher pH and alkalinity. This reflects its position in an area of slightly thicker soils and glacial deposits, and groundwater contributions from glacial deposits in the watershed.

Trout Lake is biologically unproductive with low concentrations of nutrients and is considered oligotrophic by MOE standards with a mean long-term spring total phosphorus concentration of 7 μg/L. Four Mile Bay is considered to be limnologically isolated (i.e., mixes little with the main basin) and distinct from the main basin with lower alkalinity (7.4 to 9.0 mg/L) and higher colour and nutrients (Table 2).

Table 2. Water Quality Characteristics of Trout Lake in 1986 (reproduced from Northland Engineering Ltd., 1992). Bold Values Exceed the Applicable Ontario Drinking Water Quality Standard, Objective or Guideline (ODWQSOG)[1].

Parameter	Main Basin	Four Mile Bay	ODWQSOG[1]
Alkalinity	12.0-18.0	7.4-9.0	30-50
Aluminum	0.007-0.032	0.016-0.055	0.1
Ammonia	0-0.058	0.012-0.106	
Cadmium	0.00015	0.00015	0.005
Calcium	5.33-6.09	3.85-4.36	
Chlorides	10.7-11.8	3.45-5.10	250
Chromium	0.0005-0.0010	0.005	0.05
Colour (TCU)	**6.5-9.5**	**11-13.5**	5
Conductivity (□μmhos/cm)	84.3-91.4	48.8-51.3	
Copper	0.0010-0.0030	0.0010-0.0030	1
Dissolved inorganic carbon	2.2-2.6	1.2-1.6	
Dissolved organic carbon	3.1-3.9	3.4-4.3	5
Hardness (mg/L $CaCO_3$)	20.0-21.5	13-15	
Iron	0-0.034	0.025-0.095	0.3
Lead	0.0015-0.0060	0.0015	0.010
Magnesium	1.52-1.64	0.95-1.06	
Nickel	0.0010-0.0030	0.0010	
Nitrate	0.09-0.28	0.06-0.24	10
Nitrite	0.001-0.008	0.001-0.008	1
pH	7.24-7.57	7.00-7.32	6.5-8.5
Phosphate	0-0.0025	0-0.003	
Potassium	1.1-1.2	2.5-3.0	
Sodium	6.23-6.94	2.53-2.95	200
Sulphates	3.00-10.30	2.34-8.13	500
Total Kjeldahl nitrogen	0.220-1.090	0.210-0.340	
Total phosphorus	0-0.007	0.001-0.0011	
Zinc	0.009-0.025	0.014-0.025	5

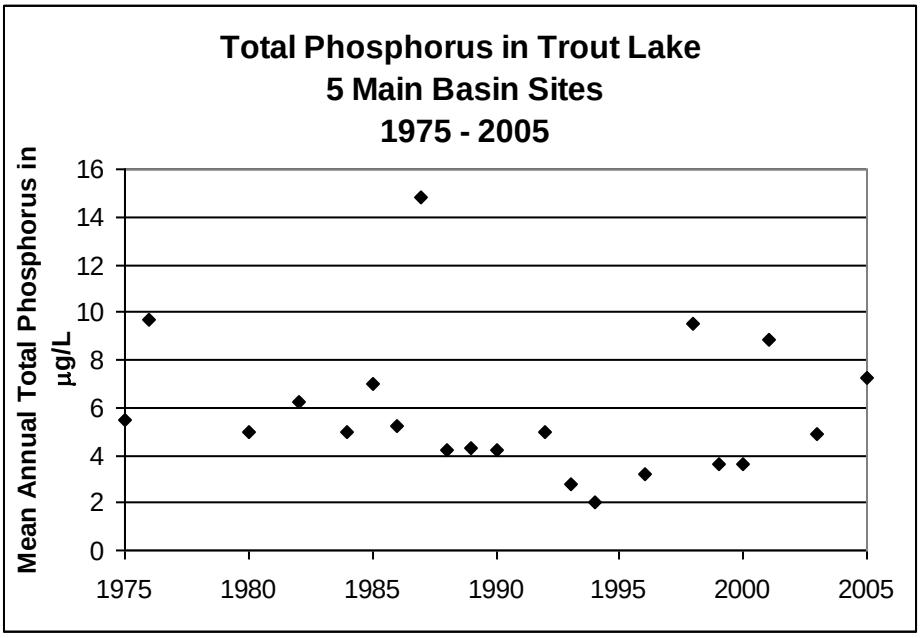
Note: Units are mg/L unless otherwise stated; [1]as per Schedule 1, 2 or 3 of the Ontario Drinking Water Standards (O.Reg. 169/03, Safe Drinking Water Act, 2002) or Table 4 of the Technical Support Document for Ontario Drinking Water Standards, Objectives and Guidelines (MOE, 2003, revised June 2006).

Based on monitoring data collected between 1975 and 2005 by the City of North Bay (Table 3), there is no evidence of a trend in phosphorus concentrations in Trout Lake over time (Figure 4). Mean annual concentrations (1996-2005) are 5.6 μg/L for the main basin and 5.6 μg/L for Delaney Bay. Similarly, spring overturn total phosphorus concentrations collected under the MOE's Lake Partner Program (1992-2007) are relatively low (mean spring overturn TP = 5.7 μg/L) with no apparent directional trends over time (AECOM memorandum to Kristen Green, NBMCA, September 9, 2009).

Table 3. City of North Bay Phosphorus Data for Trout Lake (µg/L)

Year	Main Basin - Trout Lake					Four Mile Bay		One Mile Bay	Average	
	1	2	3	4	5	6	7	8	Main	Four Mile
1975			5.0	6.0		5.0			5.5	5.0
1976	9.0		10.0	10.0		8.0			9.7	8.0
1980	6.0	5.0	6.0	6.0/2.0	5.0	11.0/2.0			5.0	6.5
1982	8.0	7.0	4.0	5.0	7.0	7.0			6.2	7.0
1984	8.0	3.0	4.0	3.0	8.0	10.0	5.0		5.0	7.5
1985	12.0	10.0	4.0	5.0	4.0	5.0	5.0		7.0	5.0
1986	8.0	6.0	4.0	4.0	4.0	3.0	6.0	3.0	5.2	4.5
1987	17.0	15.0	17.0	15.0	10.0	9.0	13.0	17.0	14.8	15.0
1988	4.0	4.0	5.0	4.0	4.0	5.0	5.0	5.0	4.2	5.0
1989	4.0	4.0	5.0	4.0	-	6.0	6.0	8.0	4.3	7.0
1990	4.0	4.0	4.0	5.0	4.0	7.0	6.0	5.0	4.2	5.5
1992	3.0	2.0	3.0/10.0	2.0/13.0	3.0	4.0/12.0	4.0	2.0	5.0	3.0
1993	2.0	3.0	3.0	3.0	3.0	7.0	4.0	1.0	2.8	5.5
1994	2.0	2.0	2.0	2.0	2.0	4.0	6.0	92.0**	2.0	5.0
1996	2.0	2.0	4.0	4.0	4.0	8.0	4.0	4.0	3.2	6.0
1998	10.0	-	12.0	10.0	6.0	14.0	-	-	9.5	14.0
1999	4.0	4.0	4.0	4.0	2.0	8.0	-	-	3.6	8.0
2000	2.0	8.0	2.0	2.0	4.0	8.0	8.0	4.0	3.6	8.0
2001	6.0	4.0	6.0	20.0	8.0	8.0	8.0	8.0	8.8	8.0
2003	5.0	3.5	4.8	5.3	4.3	7.3	6.1	4.5	4.9	6.7
2005	10.0	8.0	ND	6.0	5.0	6.0	6.0	5.0	7.3	6.0
Average 1980-2005	**6.2**	**5.3**	**5.44**	**4.6**	**4.9**	**7.2**	**6.1**	**5.5**	**5.3**	**6.7**
GROUP Average			**5.5**			**6.7**		**5.5**		
Average 1996-2005	**5.6**	**4.9**	**5.5**	**7.3**	**4.8**	**8.5**	**6.4**	**5.1**	**5.6**	**7.5**
GROUP Average			**5.6**			**7.6**		**5.1**		

Figure 4. City of North Bay Total Phosphorus Data from the Main Basin of Trout Lake



As with most deep, northern temperate lakes, Trout Lake undergoes thermal stratification during the open water season. Following the melting of ice on Trout Lake in early to mid-April, spring turnover begins and usually extends into May until surface waters warm sufficiently to cause the lake to stratify. By mid summer (late July), the epilimnion of the lake is approximately 5 m deep and is of a uniform temperature of above 20°C. The epilimnion remains well oxygenated as its waters are readily mixed by wind.

The hypolimnion generally occurs at a depth below 15 m and ranges in temperature from about 5 to 7°C. While some oxygen depletion occurs in the hypolimnion of Trout Lake (and in Delaney Bay) at the height of stratification in mid-summer, bottom waters remain relatively well-oxygenated maintaining dissolved oxygen concentrations greater than 5 mg/L until fall turnover. Particulate materials will settle to the bottom waters during the stratification period, but their settling will be slowed by the thermal stratification. Fall turnover typically begins between mid-October and early November, extending to December until ice cover develops. Most fall turnover events are very rapid and seem to have durations of a couple of hours to a couple of days. A rapid change in water temperature and a brief deterioration in raw water quality have often been observed at the intake during fall turnover (P. Bullock, pers. comm.). This occurs because any contaminants in the surface waters can be transported to the bottom of the lake and reach the drinking water intake during turnover. Early turnover events may be triggered by strong winds that can readily mix the water column once the thermal stability of the lake has been lowered with progressive cooling of surface waters in the fall. A strong precipitation event and associated runoff can also result in earlier fall turnover by rapidly cooling surface waters.

4. Delineation of Vulnerable Areas: Surface Water Intake Protection Zones (IPZs)

The delineation of vulnerable areas for the City of North Bay drinking water intake follows Part VI of the Rules for a Type D intake.

4.1 Intake Protection Zone 1 (IPZ-1)

IPZ-1 is intended to provide a protective area around the intake that is most vulnerable to contamination. If a contaminant enters this area, it will have little or no dilution potential before reaching the intake.

Intake Protection Zone 1 (IPZ-1) is defined as the surface area of Trout Lake within a 1-km radius centered on the crib of the drinking water intake in Delaney Bay[1], and where this area abuts land, a maximum setback of 120 m inland measured from the high water mark where overland flow drains into the lake (as per Rules 61 and 62) (Figure 5).

[1] *Note that the exact position of the intake is unknown. The IPZ delineations may need to be revised if the location of the intake differs that the coordinates provided to Aecom.*

North Bay – Mattawa

DRINKING WATER SOURCE PROTECTION
ACT FOR CLEAN WATER

FIGURE 5

City of North Bay
IPZ-1

AECOM

NORTH BAY-MATTAWA CONSERVATION AUTHORITY

Intake Protection Zones
- IPZ 1
- IPZ 2/3

Water Withdrawal
- CNB Intake

Stormwater Outlets
- Outlet

Water Body
- Waterbody
- Wetland Area
- Stream/Creek

- Rail
- Streets/Roads

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Map Projection: NAD83 UTM Zone 17N

0 250 m

4.2 Intake Protection Zone 2 (IPZ-2)

The IPZ- 2 provides a secondary protective zone that reflects the response time for the water treatment plant operator to respond to an emergency (i.e., time to shut down the intake). IPZ-2 is defined by the Rules (Part VI.4) as the area within each surface water body or stormwater sewershed draining toward the intake where the time of travel to the intake is the greater of 1) 2 hours, or 2) the time that is sufficient to allow the operator of the water treatment plant to respond to an adverse condition in the quality of the surface water. Where this area abuts land, the IPZ-2 boundary is reduced to a setback of not more than 120 m inland from the high water mark of the surface water body that encompasses the area where overland flow drains into the surface water body. The setback may be extended to include the area that contributes water via a transport pathway that is natural or man-made (Part VI.6). IPZ-2 does not include water or land area that lies within the IPZ-1.

In the absence of a hydrodynamic model, time of travel to the intake within Trout Lake is estimated using major limnological principals guiding wind-driven surface water current speeds. The velocity of wind-driven currents is about 2% of the speed of the wind generating them up to a critical wind speed of approximately 6 m/s (21.6 km/h) beyond which surface water velocity decreases in a non-linear fashion (Wetzel, 2001). The maximum wind speed from the 1971-2000 climate normals recorded at the North Bay A weather station (6085700) is 70 km/h (recorded October 4, 2002), which exceeds the critical wind speed of 21.6 km/h for generation of surface water currents. The distance from the intake to encompass a minimum 2 hour time-of-travel[2] at the critical wind speed is 864 m. This distance is less than the 1,000 m minimum distance required for the IPZ-1 delineation such that the IPZ-2 does not extend beyond the IPZ-1 within Trout Lake.

The IPZ-2 for the North Bay drinking water intake (Figure 6) includes the following areas:

1. The area of the stormwater sewershed draining to Delaney Bay that lies within 864 m of the intake (to approximate a 2 hour time-of-travel to the intake in accordance with Rule 65(2)). Time-of-travel in the sewershed is unknown, but is likely to be much slower than that which occurs due to wind driven surface currents in Delaney Bay (overland flows are generally slower than surface water currents). The 846-m distance to the intake, which was estimated as the maximum current speed that would occur in Delaney Bay, is therefore a conservative estimate to approximate the necessary 2-hour time-of-travel to the intake from the sewershed area.
2. The portion of the natural transport pathway, Armstrong Creek and associated 120-m setback that lies within 846-m of the intake, which approximates the maximum 2-hour time-of-travel to the intake (see Section 5)

[2] *For the North Bay water treatment plant, time to shut down the intake is less than 2 hours, therefore the 2 hour time-of-travel to the intake is used to delineate the extent of the IPZ-2 area within water bodies or the stormwater sewershed.*

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FIGURE 6

City of North Bay
IPZ-2

AECOM

NORTH BAY-MATTAWA CONSERVATION AUTHORITY

Intake Protection Zones
- IPZ-1
- IPZ-2
- IPZ-3

Water Withdrawal
- CNB Intake

Water Body
- Waterbody
- Wetland Area
- Streams/Creeks
- Rail
- Roads

0 >250 m

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3. Lees Creek and associated 120-m buffer inland from the high water mark of the creek and extending upstream to a widening of the creek where water flows would be attenuated. Lees Creek is the only tributary that outlets to Trout Lake within the 2-hour time-of-travel distance to the intake. No known data exist for Lee's Creek to calculate flow velocities under storm conditions, but the suggested IPZ-2 delineation most likely encompasses the necessary minimum 2-hour time-of-travel requirements set out in the Rules. Under maximum estimated wind driven surface currents, the time-of-travel from the outlet of Lees Creek to the intake would be ~1.5 hours, requiring the IPZ-2 delineation to extend upstream in Lees Creek to encompass a 0.5 hour time-of-travel. The IPZ-2 extends 2,100 m upstream in Lees Creek, which would require a very high velocity of 1.2 m/s for a contaminant entering the creek to reach the intake within 2 hours.
4. The extent of two transport pathways that drain to Lees Creek near its outlet to Delaney Bay in Trout Lake (see Section 5).

4.3 Intake Protection Zone 3 (IPZ-3)

The IPZ-3 protects water quality of the drinking water source from long term chronic exposure of contaminants and other materials that can have a negative impact on drinking water quality at the intake.

The IPZ-3 is defined by the Rules (Part VI.5) as the area within each surface water body that may contribute water to the intake, including areas that contribute water via a transport pathway, and where this area abuts land, a setback area of not more than 120 m inland measured from the high water mark of the surface water body encompassing the area where overland flow drains into the surface water body. The IPZ-3 does not include areas of land or water that lies within an IPZ-1 or IPZ-2. The IPZ-3 for the North Bay therefore includes the surface area of Trout Lake, all water bodies draining to Trout Lake and associated 120-m setbacks on land exclusive of those areas encompassed by the IPZ-1 and IPZ-2 as illustrated in Figure 7.

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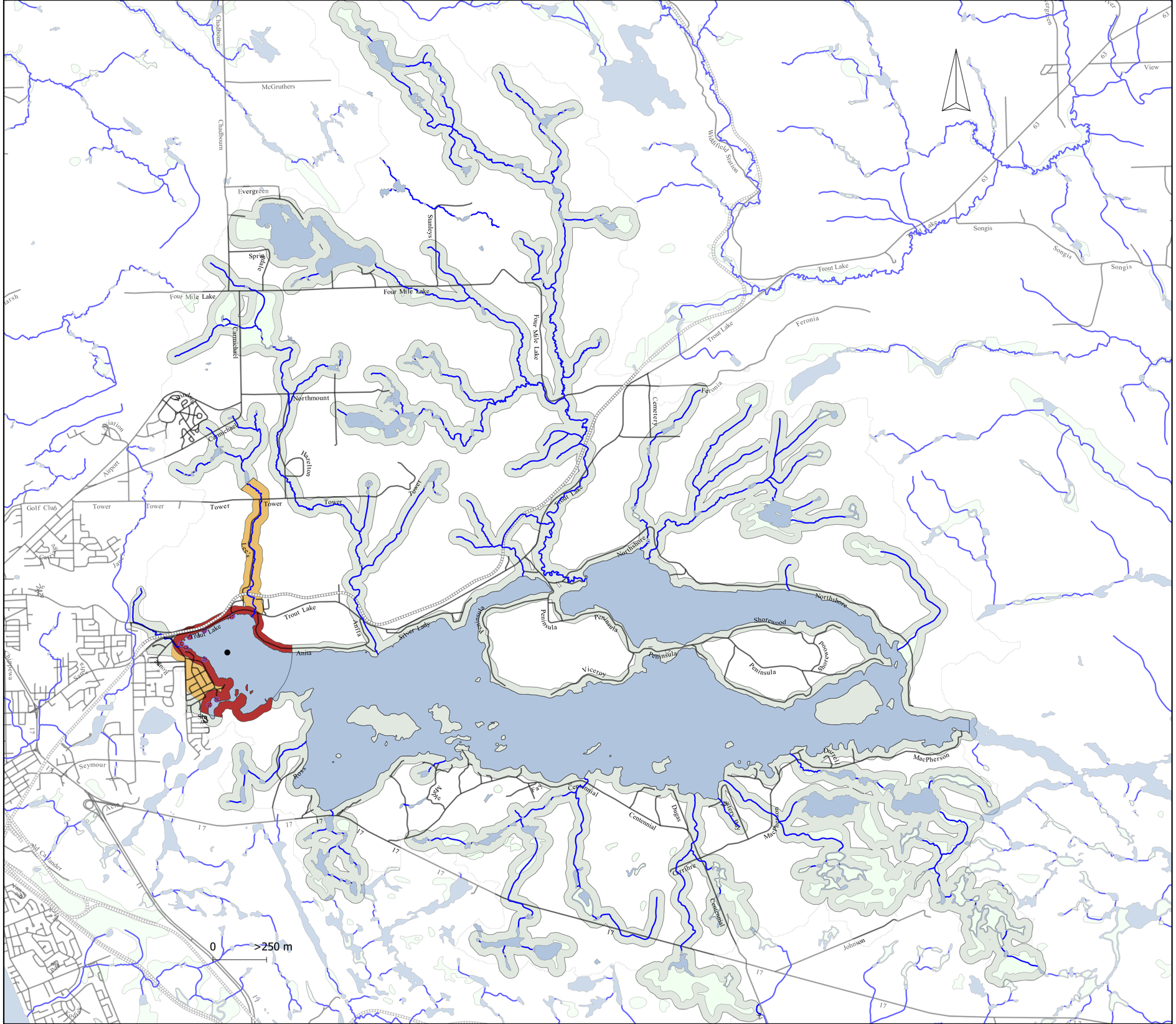

FIGURE 7

City of North Bay
IPZ-3

AECOM

NORTH BAY-MATTAWA CONSERVATION AUTHORITY

Intake Protection Zones
- IPZ-3
- IPZ-2
- IPZ-1

Water Withdrawal
- CNB Intake

- Rail
- Streets/Roads

Water Body
- Waterbody
- Wetland Area
- Streams/Creeks

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5. Transport Pathways

Transport pathways are natural or constructed pathways that facilitate the transport of contaminants to the intake. The shoreline area of Delaney Bay and the area surrounding the lower reaches of Lees Creek were surveyed during 2 site visits in the summer of 2007 to identify transport pathways. The position of each of the pathways was determined using a hand held GPS unit.

Several constructed transport pathways were identified within the IPZ-1 that can act to direct potential contaminants to Delaney Bay and the intake (Figure 5). These include:

1. Five stormwater outlets that drain urban areas of North Bay and form part of the City's sewershed; three of the outlets discharge directly to Delaney Bay, and two discharge to Delaney Bay via an narrow inlet from Camelot Lake;
2. six stormwater outlets that drain areas along the north end of Delaney Bay (including the ONR line, areas of Highway 63 (Trout Lake Road) between Lakeside Drive and Anita Avenue, and a parking lot of the National Defense installation);
3. three ditches that capture and direct flow to Delaney Bay from high elevations on the north side of Anita Avenue; and
4. two ditches on either side of Birchaven Cove Beach that capture and direct drainage to Delaney Bay from residential areas and a parking lot.

Natural preferential pathways to Trout Lake include the 14 inlet creeks identified from GIS mapping (MNR base mapping, resolution = 20 m) (Figure 2). Three additional creeks, Armstrong Park and Margaret creeks and an unnamed creek that drains to Lees Creek, are not visible on the GIS mapping or available orthophotos. The exact locations of these creeks and their outlets were confirmed by GPS during field site visits (June 22 and 29, 2007) and are illustrated in Figure 5. Armstrong Park Creek enters Trout Lake at the extreme westerly end of the lake within Delaney Bay at Armstrong Beach. It is an intermittent watercourse, which drains portions of Ski Hill Road and crossing under the ONR line, Highway 63 (Trout Lake Road) and Lakeside Drive. The IPZ-2 was extended to include this natural pathway and associated 120-m maximum setback within a 2-hour time of travel to the intake (area of the creek that lies within 846 m of the intake, based on the same principal as the time-of-travel estimate for the stormwater sewershed). The remaining upstream portion of the creek was included as part of the IPZ-3 delineation. Margaret Creek drains to Lees Creek near its outlet to Delaney Bay via a culvert that passes under Hwy. 63. The unnamed creek bed drains areas along the east side of Lees Creek where it outlets just upstream of Margaret Creek. The IPZ-2 area was extended to include these two creeks and associated 120-m setbacks.

Of all the creeks draining directly to Trout Lake, only Armstrong and Lees creeks have outlets to Delaney Bay and influence the IPZ-1. While considered natural pathways, these creeks have been significantly altered with road and land development. The remaining creeks discharge to the main basin of Trout Lake or to Four Mile Bay outside of IPZ-1 and IPZ-2. No additional natural (surface) pathways were identified by a walked shoreline survey of the east and north shoreline of Delaney Bay extending from the Camelot Lake inlet to near the inlet from Doran Creek.

6. Vulnerability: Surface Water Intake Protection Zones

Vulnerability scores (V) provide a comparative assessment of the likelihood that a contaminant originating within the intake protection zones would reach the North Bay intake. Guidance for the calculation of vulnerability scores is provided in Part VIII of the Rules.

Vulnerability scores for all vulnerable areas are calculated by multiplying the Area Vulnerability factor (Vfa) by the Source Vulnerability factor (Vfs).

The Source Vulnerability factor (Vfs) can range from 0.8 to 1.0 and is based on 1) the depth of the intake from the surface of the water, 2) the distance of the intake from land, and 3) the history of drinking water concerns relating to the intake. The North Bay intake is relatively far from shore (approximately 314 m) and deep (withdraws water from the hypolimnion) thereby reducing the potential for contaminants at the surface to reach the intake. The water quality is excellent in Trout Lake with only one major concern related to past turbidity events. However, turbidity is not expected to be problematic once the new chemically assisted membrane filtration system comes online at the water treatment plant. Given these considerations, the lowest source vulnerability factor of 0.8 was assigned for the North Bay drinking water intake.

Area Vulnerability factors (Vfa) were assigned to the IPZs in accordance with Rules 88-93. Vfa is a fixed value of 10 for the IPZ-1. For the IPZ-2 and IPZ-3 Vfa scores, the following may be considered:

1. the percentage of area that is composed of land;
2. land cover, soil type, permeability of the land and the slope of any setbacks;
3. hydrological and hydrogeological conditions in the area that contribute water to the area through transport pathways; and
4. in respect of the IPZ-3, the proximity of the area of the IPZ-3 to the intake.

A Vfa of 9 from a possible range of 7 to 9 was assigned for IPZ-2. This score reflects the fact 1) most of the IPZ-2 is comprised of land, 2) a large portion of the area in the sewershed is comprised of urban and residential lands that have high runoff generation potential and the setback areas along Lees Creek include steep-sided riverbanks, and 3) there are numerous transport pathways that direct drainage to the IPZ-1 including tributaries and stormwater drains and ditches (Figures 5 and 6).

Vfa were assessed for areas of the IPZ-3 as the total of the individual scores (0, 1 or 2) that were assigned (by equal weight) to each of the four factors listed above as summarized in Table 4. Rule 90 allows for different Vfa scores to be assigned to different areas within the IPZ-3, but these scores must be lower than those of the IPZ-2, and so must range between 1 and 8. Given the large area encompassed by the IPZ-3, different Vfa scores were assigned to areas within the IPZ-3 dependent upon their distance to the intake.

The final Vulnerability scores for the vulnerable areas for the North Bay drinking water intake are provided in Table 5 and illustrated in Figure 8.

Table 4. Breakdown of Area Vulnerability Factor Scores for the IPZ-3

Factors to Consider	IPZ-3 Va Scores			Rationale
	Areas within 5 km of the intake	Areas within 10 km of the intake	Areas beyond 10 km of the intake	
% land area	1	1	1	• approximately equal proportions of land and water
Land cover, soils, permeability, slope of setbacks	1	1	1	• land cover mostly forested; good permeability of soils in many areas, but some outcrops with little to no soils; some high slopes of setbacks in areas north of Trout Lake
Transport pathways	0	0	0	• some transport pathways exist but flow is strongly directed away from the intake toward the outlet
Proximity to the intake	2	1	0	• IPZ3 boundary extends to only 1-km from the intake (near the mouth of Delaney Bay increasing the score; with increasing distance from the intake there is reduced potential for contamination and thus a lower vulnerability score
Total (Vfa)	**4**	**3**	**2**	

Table 5. Vulnerability Scores for the North Bay Drinking Water Intake Protection Zones

Zone	Source Vulnerability Factor (Vfs)	Area Vulnerability Factor (Vfa)	Vulnerability Score (V)
IPZ-1	0.8	10	8.0
IPZ-2	0.8	9	7.2
IPZ-3 within 5 km of the intake	0.8	4	3.2
IPZ-3 within 10 km of the intake	0.8	3	2.4
IPZ-3 beyond 10 km of the intake	0.8	2	1.6

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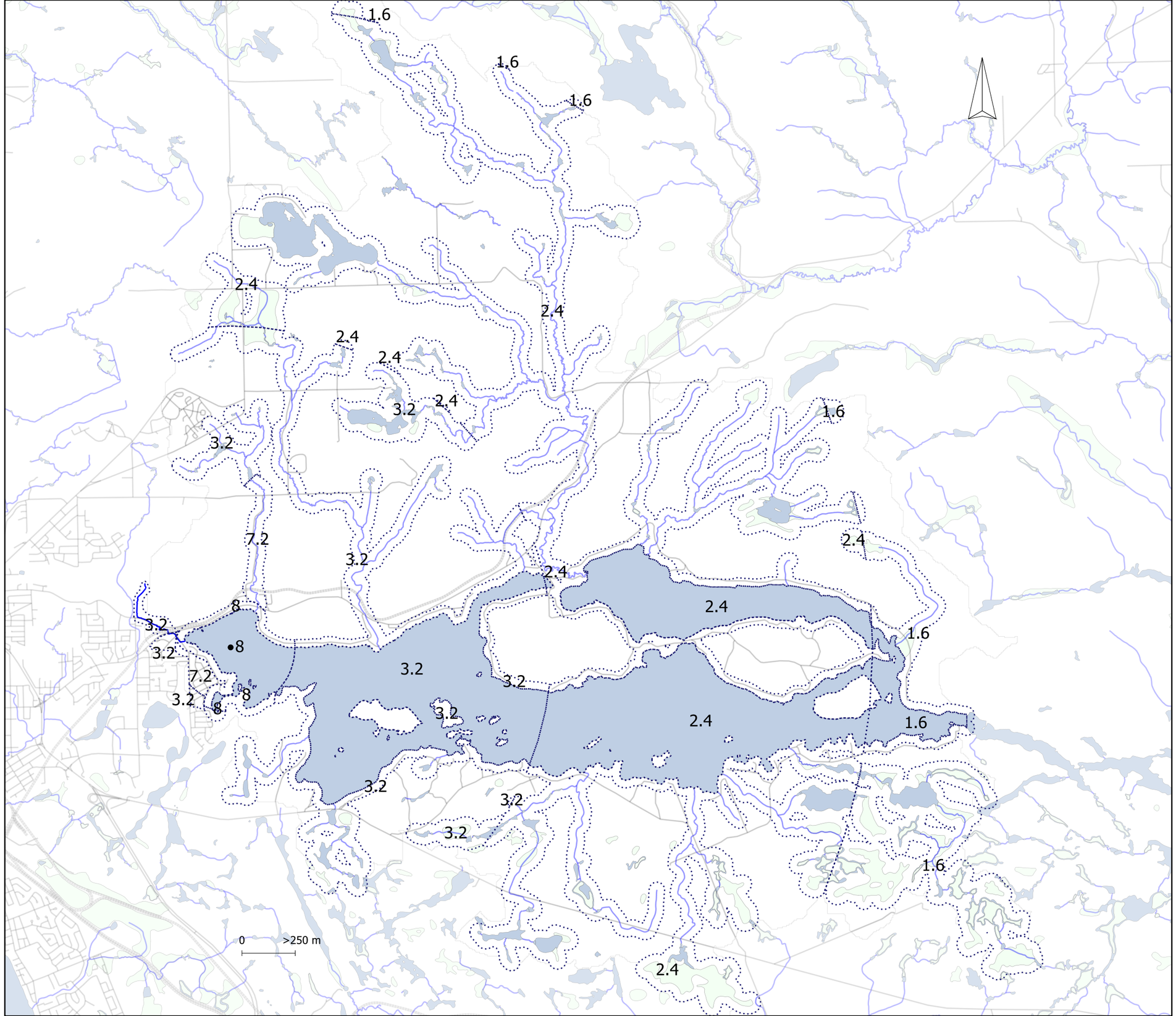

FIGURE 8

City of North Bay
IPZ Vulnerability
Scores

AECOM

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Intake Vulnerability
Scored Zones
Water Withdrawal
CNB Intake
Rail
Streets/Roads
Water Body
Waterbody
Wetland Area
Streams/Creeks

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7. Uncertainty Analysis – Water Quality

Part I.4 of the Rules requires that an uncertainty of 'high' or low' be made with respect to the delineation of the surface water intake protection zones (Rule 13 (3)) and the assessment of vulnerability of the zones (Rule 13(4)). Based on the consideration of factors set out in Rule 14, an overall 'low' uncertainty is given to all of the IPZ delineations and the associated vulnerability scores. There are data gaps that result in some uncertainty, but these are unlikely to result in any significant changes in the delineation or vulnerability scoring of the IPZs, as described below.

Intake Protection Zone Delineations - There is some uncertainty in the delineation of IPZ-1 because the exact positioning of the drinking water intake is not known. We note, however, that only the boundary of the IPZ-1 at the mouth of Delaney Bay (and associated setback) would be altered by a change in the position of the intake. Given that the length of the intake pipe is known based on engineering reports, it is likely that the actual position of the intake is not sufficiently different from the estimated position to significantly alter the IPZ-1 delineation. The delineation of the IPZ-2 would not be affected by a small difference in the position of the intake because the IPZ-2 does not extend beyond the IPZ-1 within Trout Lake. Once the exact position of the intake is known, the IPZ-1 and IPZ-2 can be adjusted as necessary.

There is some uncertainty associated with the methods used to delineate the IPZ-2 due to the lack of a current hydrodynamic model for Trout Lake and flow data for tributaries to estimate time-of-travel to the intake. A conservative approach, however, was used to delineate the IPZ-2 with knowledge of major flow direction in Trout Lake, dominant wind directions and speeds, and observed time-of–travel for turbidity to reach the intake from the outlet of Lees Creek (12 hours). The use of a hydrodynamic model and flow data from Lees Creek would refine the IPZ-2 delineation, but it is unlikely that this information would result a significant change to the delineation.

The vulnerability scoring requires knowledge of water quality as it relates to drinking water issues (see Section 8.1). Raw water records and treated water records from the Water Treatment Plant did not encompass the entire operational history of the plant and treated water records prior to 2006 and raw water records post 2006 were not reviewed in this assessment creating some uncertainty in the data and the ability to validate the drinking water issues. Despite this, available records were adequate to evaluate the tested parameters as drinking water issues in relation to the ODWQS.

8. Drinking Water Threats: Water Quality

8.1 Drinking Water Issues

Drinking water issues, as defined in Part XI.1 of the Rules relate to the presence of a 'listed parameter'[3] in water at the intake if:

1. the parameter is present at a concentration that may result in the deterioration of the quality of the water for use as a source of drinking water; or
2. there is an increasing trend of the parameter that would result in the deterioration of water quality for use as drinking water.

Drinking water issues can also relate to a pathogen in water at a surface water intake that are not one of the 'listed parameters', but require that a microbial risk assessment be conducted with respect to that pathogen. For the North Bay intake, no microbial risk assessment was undertaken for any pathogens. The only pathogens considered in this issues evaluation are total coliforms and *E. coli*, which are listed parameters.

The Rules do not specifically define 'deterioration of the quality of water for use as a source of drinking water'. We therefore assessed water quality parameters as issues using the following approach:

1. All listed parameters for raw and treated water from the North Bay water treatment plant were compared to the applicable Ontario Drinking Water Quality Standard (ODWQS), Aesthetic Objective (AO), or Operational Guideline (OG).
2. Any parameter in treated water that has exceeded the applicable benchmark is considered a drinking water issue.
3. Any parameter in raw water that has exceeded the applicable benchmark or that has come within 25% of the benchmark were identified and evaluated for trends. If an increasing trend occurred, and a continuation of that trend would result in the inability of the water treatment plant to treat that parameter, the parameter was considered an issue.

8.1.1 Data Sources

The following assessment of raw water quality is based on a review of available monitoring data supplied by the City of North Bay, and various technical reports, as listed below.

1. Drinking Water Surveillance Program (DWSP) Monitoring Data

[3] *Parameters listed in Schedule 1, 2 or 3 of the Ontario Drinking Water Quality Standards or Table 4 of the Technical Support Document for Ontario Drinking Water Standards, Objectives and Guidelines.*

A comprehensive suite of water quality parameters in raw water from the Trout Lake drinking water intake have been monitored by the City of North Bay under the Drinking Water Surveillance Program (DWSP) since 1990. Monitoring has generally been performed from 2 to 4 times per year and has included:

- general chemical and physical properties (e.g., nutrients, ions, total metals, pH, temperature, turbidity, etc.);
- aesthetic (taste and odour) parameters;
- pollutants (i.e., pesticides, chloroaromatics, chlorophenols, phenolics, polynuclear aromatic hydrocarbons and volatile organics); and
- bacteriological data.

2. Drinking Water Information System (DWIS) Monitoring Data

Microbiological data (*E. coli*, total coliforms) and turbidity have been monitored in raw water from the intake at the North Bay Water Treatment Plant and reported on a monthly basis, under the Drinking Water Systems Regulation (O. Reg. 170/03) of the Safe Drinking Water Act (2002). These data are archived in the Drinking Water Information System (DWIS) that is maintained by the Drinking Water Management Division of the OMOE.

3. O. Reg. 170/03 Annual Reports (2006-2008)

At the time of production of this report, annual reports for the North Bay water treatment plant were available only for 2006 to 2008. Previous annual reports should be provided to confirm Aecom's assessment of drinking water quality issues.

4. Trout Lake Parasite Study (Miller Environmental Services Inc., 2000)

This technical report provided historical pathogen data (*E. coli* and total coliforms) at the intake for the period from 1993 to 1998.

8.1.2 Evaluation of Chemical Parameters

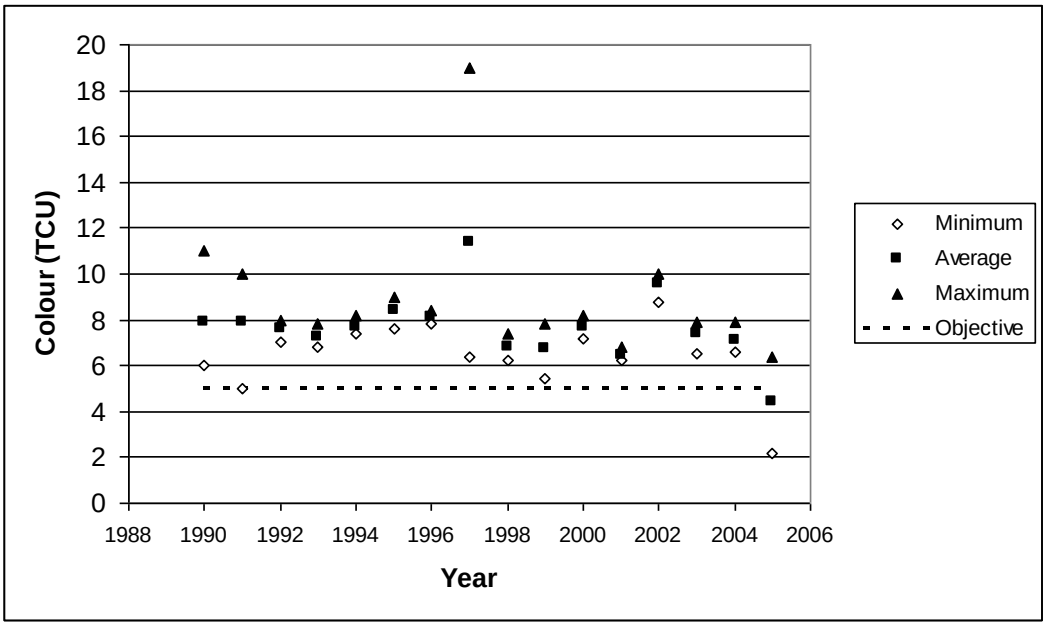
Based on a review of chemical data from raw water, four parameters were found to exceed the applicable Ontario Drinking Water Standard, Objective or Guideline (ODWQSOG) including colour, antimony, 2,4-dichlorophenol and turbidity. No chemical parameter exceeded 75% of the applicable ODWQSOG with the exception of turbidity.

Colour consistently exceeded the Ontario Drinking Water aesthetic objective of 5 TCU between 1990 and 2005 in raw water at the intake (Figure 9), but is not considered to be a drinking water issue based on the following:

- there is no significant increasing trend in colour over this time period (regression; R^2=0.10, p=0.23),

- colour has been maintained at levels below the objective in treated water, and
- colour in Trout Lake is considered to be natural, and is likely due to moderately high concentrations of coloured dissolved organic carbon (DOC) ($mean_{1990-2005}$ DOC = 2.9 mg/L), but also naturally-occurring iron concentrations ($mean_{1990-2005}$ iron = 40.0 µg/L).

Figure 9. Colour in Raw Water at the North Bay Intake (1990-2005)

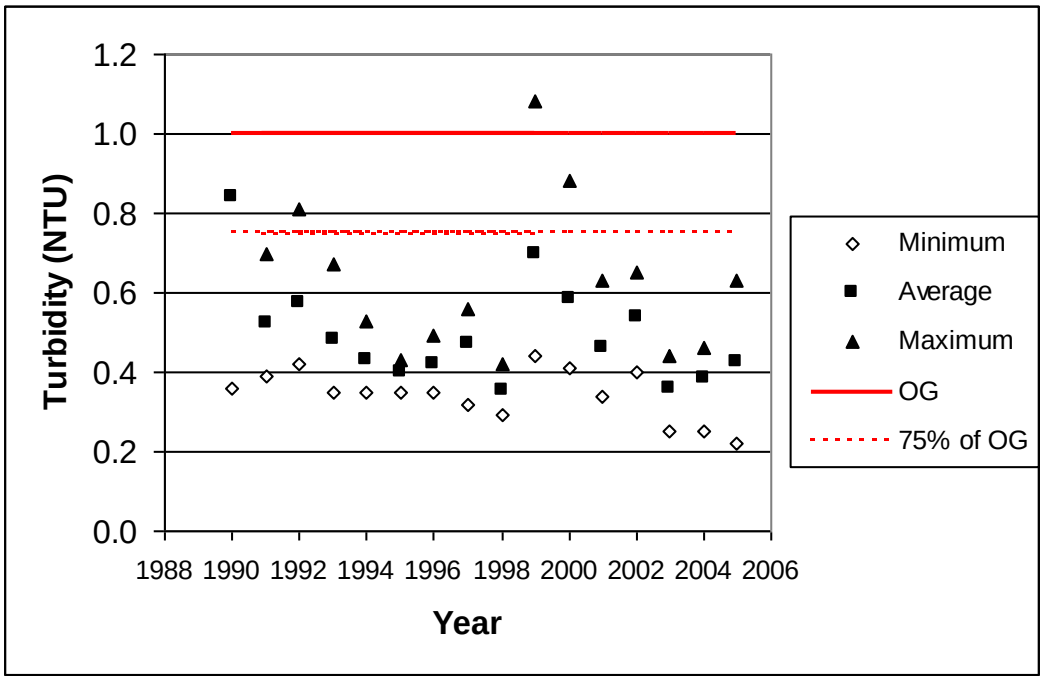


Antimony exceeded the ODWQS of 0.006 mg/L on a single occasion in 1992 with a reported concentration of 0.03 mg/L. This anomalously high value was most likely a result of laboratory error. Antimony has not exceeded the ODWQS in treated water and from 2006 to 2008, antimony concentration in treated water has been below analytical detection limits (<0.001 mg/L). Concentrations in raw water have been below 0.002 mg/L since 1992. For these reasons, antimony is not considered a drinking water issue.

Between 1994 and 1996, 2,4-dichlorophenol was measured in raw water on 5 occasions with a reported concentration of 0.002 mg/L, which exceeds the aesthetic objective of 0.0003 mg/L but is well below the ODWQS of 0.9 mg/L. Chlorophenols are synthetic materials that can occur in drinking water due to the action of chlorine on phenolic precursors from industrial sources. At levels above 0.0003 mg/L, 2,4-dichlorophenol can cause an unpleasant taste or odour to the water. Insufficient data exist to assess trends in 2,4-dichlorophenol in raw water. 2,4-dichlorophenol was below analytical detection limits in treated water between 2006 and 2008 (<0.0005 mg/L), but it should be noted that this detection limit exceeds the aesthetic objective. It is also suspected that the reported values between 1994 and 1996 reflect the laboratory detection limit at that time and that 2,4-dichlorophenol concentrations should have been reported as <0.002 mg/L. Insufficient data exist to determine whether or not the aesthetic objective has been met in raw or treated water since 1996. Following discussions with the Technical Advisory Committee, it was decided that there is insufficient evidence to list 2,4-dichlorophenol as a drinking water issue under Rule 114.

In the DWSP dataset, which provides minimum, maximum and mean annual data, the operational guideline (OG) for turbidity (1 NTU) was exceeded on at least two occasions (in 1990 and 1999) in raw water at the intake between 1990 and 2005, and values fell within 25% of the guideline on at least two occasions in 2000 and 2002 (Figure 10). There is no trend in mean turbidity for the 1990 to 2005 period (regression, p>0.05).

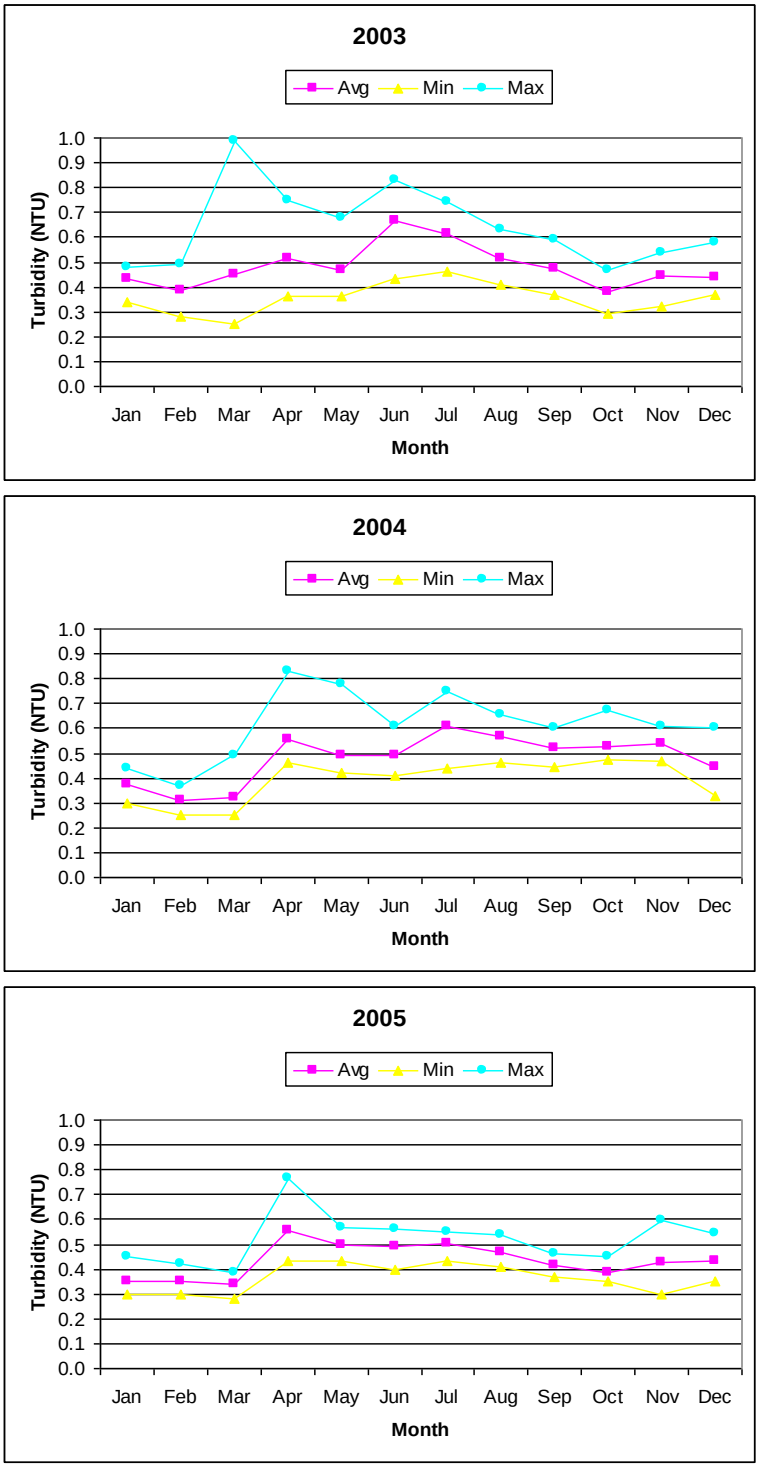
Figure 10. Turbidity in Raw Water at the North Bay Intake (1990-2005)



Note: A maximum turbidity of 3.6 NTU was recorded in 1990, but was not included in the figure due to scale.

In the Monthly Data Process Reports for 2003-2005, turbidity in raw water did not exceed the OG, but came within 25% of the OG on several occasions (Figure 11). Maximum turbidity levels at the Trout Lake drinking water intake occur primarily during the spring when catchment runoff and input from tributaries is greatest and the lake is destratified and turning over. The timing and magnitude of peaks in spring turbidity vary from year to year and are dependent upon the timing of snowmelt and precipitation patterns. For example, in 2003, a maximum turbidity of 0.98 NTU was reached in March (Figure 11). In 2004 and 2005, maximum spring turbidity levels were lower and not attained until April (Figure 11). Turbidity levels generally decline after the spring peak, maintaining mean levels between approximately 0.4 to 0.7 NTU until the development of ice cover in December when turbidity is further reduced. From 2003 to 2005, mean monthly turbidity levels were less than 0.5 NTU during the ice-covered season.

Figure 11. North Bay Water Treatment Plant Raw Water Mean Monthly Turbidity (2003-2005)



Turbidity has also exceeded the OG on a number of occasions in treated water however these episodes have usually been of a short duration (<12 hours) and have very rarely exceeded 3 NTU. The medical Officer of Health has historically issued 'boil water' advisories if turbidity values at the North Bay intake water remained above 1 NTU (but less than 3 NTU) for >12 hours while pumping. A 'boil water' advisory was last issued at the North Bay Water Treatment Plant in 2001, and another was narrowly avoided in 2002 by taking evasive action. At that time, the plant was shut down for several hours until the turbidity event subsided (P. Bullock, City of North Bay, pers. comm.). These turbidity events were associated with erosion in Margaret Creek, which has since been addressed by installation of rip rap on the creek bed. Since the correction of the erosion problems from Margaret Creek, however, the OG has still been exceeded on occasion in treated water at the plant. Based on a review of the O. Reg. 170 Section 11 Annual Reports for the North Bay WTP from 2006 to 2008, there were 6 Adverse Water Quality Incidents related to treated water turbidity, but 2 of the incidents were likely due to monitoring issues.

While turbidity has exceeded applicable guidelines in the past, improved treatment by chemically assisted filtration at the North Bay Water Treatment Plant, which is expected to become fully operational in January 2010, is capable of producing water with a turbidity of 0.3 NTU (MOE, 2003). Once the chemically assisted filtration is online, the turbidity levels observed in raw water from Trout Lake would not be considered to cause a deterioration of water quality for use as a source of drinking water. Turbidity is therefore not considered a drinking water issue under Rule 114.

8.1.3 Evaluation of Pathogens

E. coli and total coliforms should be non detectable in drinking water as per Table 1 of the ODWQS, and for heterotrophic plate counts (HPC), increases in concentrations above baseline conditions are considered undesirable according to the Operational Guideline (OG) (MOE, 2006).

Bacteriological characterization of the raw water for the North Bay intake is based on a review of daily total coliform and *E. coli* counts between 2000 and 2005. Additional raw water total coliform and *E. coli* data were evaluated from the plant's Annual Reports (2006-2008). To identify long-term trends or changes in bacteriological contamination, the 2000-2005 data were compared with 1993-1998 data that were previously assessed in the 'Trout Lake Parasite Study' by Miller Environmental Services Inc. (2000).

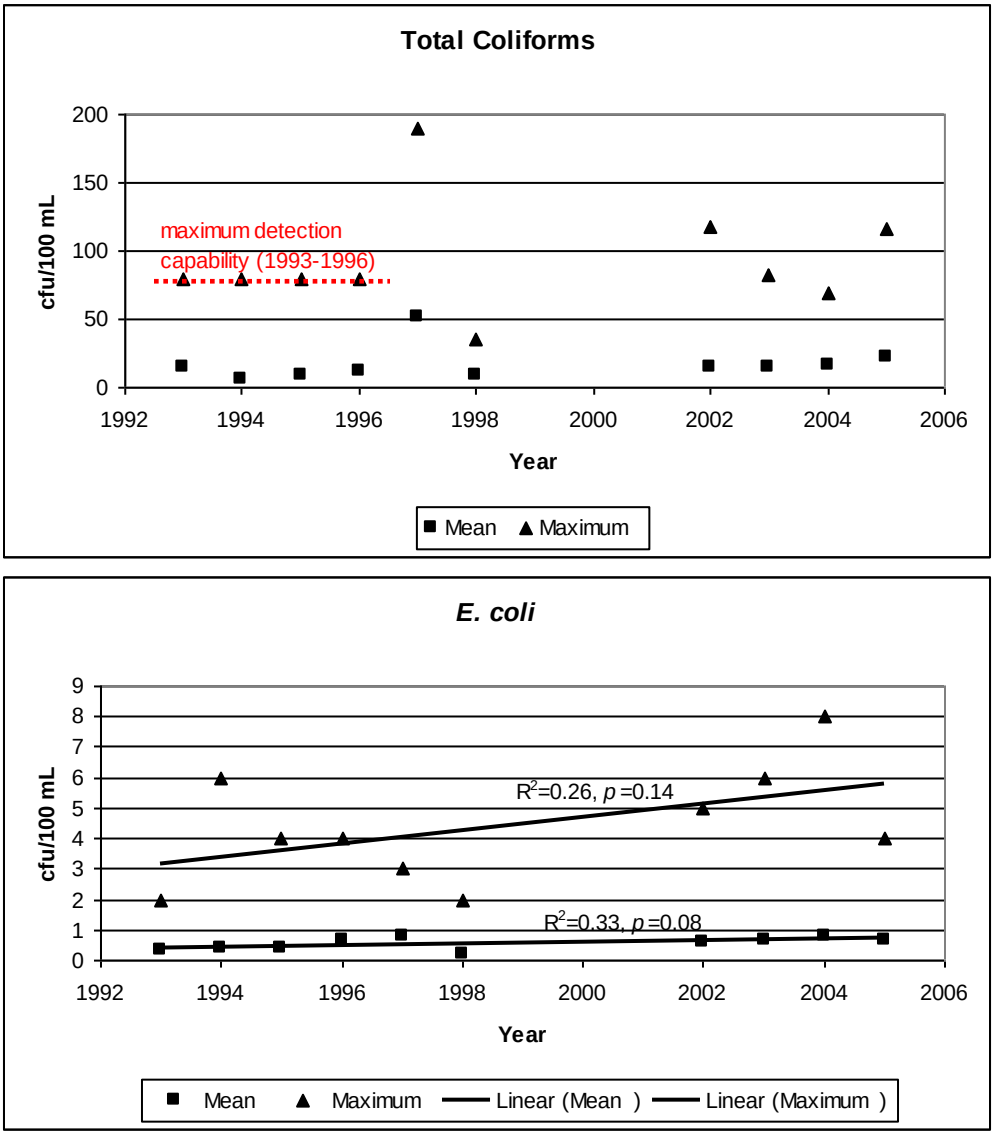
Total coliforms and *E. coli* are naturally occurring bacteria in surface water and are typically detected in raw water samples at the North Bay intake, therefore exceeding the ODWQS.

Based on available data, there are no apparent trends in maximum or mean annual *E. coli* counts (regression analysis, $p>0.05$) (Figure 12). Statistical analysis of trends in total coliform was precluded due to changes in analytical capabilities over the 1993-2005 time frame and the occurrence of numerous counts that exceeded the detectable capabilities of the test (i.e., >80 counts/100 mL) between 1993 and 1996. Given that maximum total coliforms prior to 1997 were at least 80 cfu/100 mL, an increasing trend in these bacteria are unlikely because the observed mean maximum concentration from 2002 to 2006 was similar (92 cfu/100 mL).

E. coli and total coliforms are not considered to be drinking water issues for the North Bay intake because:

1. they have maintained relatively low levels in raw water at the intake without evidence of an increasing trend, and
2. there have been no reported Adverse Water Quality Incidents related to total coliforms or *E. coli* in treated or distribution water from 2006-2008 suggesting that the plant is capable of effectively treating the levels of these bacteria that presently occur in the source water.

Figure 12. Total Coliforms and *E. coli* in Raw Water at the North Bay Intake (1990-2005)



8.1.4 List of Drinking Water Issues

Based on the evaluation of available raw and treated water records, there are no drinking water issues for the North Bay intake as defined by Rule 114.

8.2 Drinking Water Threats

The threats evaluation for Source Protection Planning involves the identification of threats that can cause contamination of drinking water by a chemical or pathogen. Threats can include 'activities' or 'conditions' that occur within the Intake Protection Zones (IPZs). There are 19 activities that can be considered as threats with respect to drinking water as prescribed in the Clean Water Act (2006) O. Reg. 287/07 (General) in paragraphs 1 through 18 and paragraph 21 of subsection 1.1(1) (Table 6). Conditions, as defined by Part XI.3 of the Rules, result from past activities and can include the presence of:

1. a non-aqueous phase liquid in groundwater in a highly vulnerable aquifer, significant groundwater recharge area or wellhead protection area,
2. a single mass of more than 100 L of one or more dense non-aqueous phase liquids (DNAPLs) in surface water in a surface water IPZ,
3. a contaminant in groundwater in a highly vulnerable aquifer, significant groundwater recharge area or wellhead protection area, if the contaminant is listed in, and its concentration exceeds the potable groundwater standard in, Table 2 of the Soil, Ground Water and Sediment Standards,
4. a contaminant is surface soil in a surface water IPZ if the contaminant is listed in, and its concentration exceeds the standard for industrial/commercial/community property in, Table 4 of the Soil, Ground Water and Sediment Standards, or
5. a contaminant in sediment if the contaminant is listed in, and its concentration exceeds the standard in, Table 1 of the Soil, Ground Water and Sediment Standards.

Table 6. Activities Prescribed to be Drinking Water Threats in the *Clean Water Act* (2006)

O. Reg. 287/07 par.	Activity
1	**The establishment, operation or maintenance of a waste disposal site within the meaning of Part V of the *Environmental Protection Act*.**
2	**The establishment, operation or maintenance of a system that collects, stores, transmits, treats or disposes of sewage.**
3	**The application of agricultural source material to land.**
4	**The storage of agricultural source material.**
5	**The management of agricultural source material.**
6	**The application of non-agricultural source material to land.**
7	**The handling and storage of non-agricultural source material.**
8	**The application of commercial fertilizer to land.**
9	**The handling and storage of commercial fertilizer.**
10	**The application of pesticide to land.**
11	**The handling and storage of pesticide.**
12	**The application of road salt.**
13	**The handling and storage of road salt.**
14	**The storage of snow.**
15	**The handling and storage of fuel.**
16	**The handling and storage of a dense non-aqueous phase liquid.**
17	**The handling and storage of an organic solvent.**
18	**The management of runoff that contains chemicals used in the de-icing of aircraft.**
21	**The use of land as livestock grazing or pasturing land, an outdoor confinement area or a farm-animal yard**

Note: "agricultural source material", "application", "commercial fertilizer", "livestock", "non-agricultural source material" and "outdoor confinement area" have the same meanings as in Ontario Regulation 267/03 (General) made under the Nutrient Management Act*, 2002; "management" means, with respect to agricultural source material, the collection, handling, treatment, transportation or disposal of agricultural source material; "pesticide" has the same meaning as in the* Pesticides Act*; "sewage" has the same meaning as in the* Ontario Water Resources Act*, O. Reg. 385/08, s. 3.*

There are two major components to addressing drinking water threats to comply with the Rules. These involve:

1. The LISTING of activities that would be significant, moderate or low threats if they were conducted within the vulnerable areas and,
2. The ENUMERATION of significant threats (activities or conditions) that presently exist in the vulnerable areas.

8.2.1 Listing of Significant, Moderate and Low Drinking Water Threats

8.2.1.1 Activities

Part XI.4 of the Technical Rules describe the methods for identifying significant, moderate and low drinking water threats related to activities in areas of the intake protection zones of a drinking water intake. A threat is deemed significant, moderate or low dependent upon a set of specific circumstances, the vulnerable area in which the activity occurs or would occur, and the vulnerability score of that area as specified in Table 1 or Table 2 of the Tables of Drinking Water Threats provided by the MOE (Table 1 lists drinking water threats related to chemicals and Table 2 lists drinking water threats related to pathogens). For example, in Table 7

below, the drinking water threat in Column 1 would be considered to be Significant if it was located in an area of the IPZ-1 with a vulnerability score of 9 under the circumstances set out in Column 2. The same threat would be considered to be Low in an area of an IPZ-2 with a vulnerability score of 5.1.

Table 7. Example from Table 2 of the Tables of Drinking Water Threats to Identify Significant, Moderate and Low Threats.

DRINKING WATER THREAT:	Reference number	Under the following CIRCUMSTANCES:	Area within Vulnerable Area	Threat is Significant in Areas with a Vulnerability Score of:	Threat is Moderate in Areas with a Vulnerability Score of:	Threat is Low in Areas with a Vulnerability Score of:
Column 1	Column 2		Column 3	Column 4	Column 5	Column 6
The application of agricultural source material to land	1	1. Agricultural source material is applied to land in any quantity. 2. The application may result in the presence of one or more pathogens in groundwater or surface water.	**IPZ-1, IPZ-2, IPZ-3 & WHPA-E**	8 - 10	6 - 7.2	4.2 - 5.6
			WHPA-A & WHPA-B	10	8	6

The Rules require that areas within vulnerable areas where activities that are or would be a significant, moderate or low drinking water threats be listed (that is, regardless of whether the activities presently exist in the vulnerable area) in the Assessment Report. Lists of significant, moderate and low drinking water threats related to chemicals and pathogens were compiled for each of the vulnerable areas of the North Bay intake using a Ministry of the Environment, Microsoft Access database (Threats_LUT_v7.1.2) that allows the user to query threats based on a range in risk scores for each vulnerable area. Due to the large size of these data files, the lists of significant, moderate and low threats are provided in digital format in Appendix A. A summary of the number of significant, moderate or low threats in vulnerable areas of the North Bay intake is provided in Table 8. Given the low vulnerability scores for the IPZ-3, there are no significant, moderate or low threats for this vulnerable area.

Table 8. Numbers of activities that are or would be significant, moderate or low drinking water threats related to chemicals or pathogens in vulnerable areas of the North Bay intake.

Threat Risk	IPZ-1 (V=8.0)		IPZ-2 (V=7.2)	
	Chemical Threats	Pathogen Threats	Chemical Threats	Pathogen Threats
Significant	13	40	0	0
Moderate	835	13	436	41
Low	888	15	1176	27

There are 13 significant chemical drinking water threats that are or would be significant in the IPZ-1 of the North Bay intake, all of which are related to circumstances with “the establishment, operation or maintenance of a system that collects, stores, transmits, or treats or disposes of sewage” (Table 9). There are 40 threats related to pathogens that are or would be significant threats in the IPZ-1 of the North Bay intake (Table 10). There are no threats that are or would be significant in the IPZ-2 or IPZ-3.

Table 9. List of Chemical Drinking Water Threats Related to the North Bay Intake that Are or Would be Significant.

Drinking Water Threat: "the establishment, operation or maintenance of a system that collects, stores, transmits, or treats or disposes of sewage"	
Reference #	**Under the following circumstance:**
269	1. The system is a combined sewer that may discharge sanitary sewage containing human waste to surface water other than by way of a designed bypass. 2. The combined sewer is part of a system that includes a wastewater treatment facility designed to discharge treated sanitary sewage at an average daily rate that is more than 50,000 cubic metres on an annual basis. 3. The discharge from the combined sewer may result in the presence of Mercury or one or more of its compounds containing Mercury in groundwater or surface water.
272	1. The system is a combined sewer that may discharge sanitary sewage containing human waste to surface water other than by way of a designed bypass. 2. The combined sewer is part of a system that includes a wastewater treatment facility designed to discharge treated sanitary sewage at an average daily rate that is more than 50,000 cubic metres on an annual basis. 3. The discharge from the combined sewer may result in the presence of one or more Polychlorinated Biphenyls (PCBs) in groundwater or surface water.
487	1. The system is a storm water management facility designed to discharge storm water to land or surface water. 2. The drainage area associated with the storm water management facility is more than 100 hectares and the predominant land uses in the area are industrial or commercial. 3. The discharge may result in the presence of Arsenic or one or more of its compounds containing Arsenic in groundwater or surface water.
495	1. The system is a storm water management facility designed to discharge storm water to land or surface water. 2. The drainage area associated with the storm water management facility is more than 100 hectares and the predominant land uses in the area are industrial or commercial. 3. The discharge may result in the presence of Mercury or one or more of its compounds containing Mercury in groundwater or surface water.
570	1. The system discharges to surface water and has as its primary function the collection, transmission or treatment of industrial sewage. 2. The system is part of a facility for which the NPRI Notice requires a person to report and the report must include information in relation to a substance listed in Group 1, 2, 3 or 4 of Part 1 of Schedule 1 or Part 2 of Schedule 1 of the notice. 3. The discharge may result in the presence of Arsenic or one or more of its compounds containing Arsenic in groundwater or surface water.
600	1. The system discharges to surface water and has as its primary function the collection, transmission or treatment of industrial sewage. 2. The system is part of a facility for which the NPRI Notice requires a person to report and the report must include information in relation to a substance listed in Group 1, 2, 3 or 4 of Part 1 of Schedule 1 or Part 2 of Schedule 1 of the notice. 3. The discharge may result in the presence of Mercury or one or more of its compounds containing Mercury in groundwater or surface water.
609	1. The system discharges to surface water and has as its primary function the collection, transmission or treatment of industrial sewage. 2. The system is part of a facility for which the NPRI Notice requires a person to report and the report must include information in relation to a substance listed in Group 1, 2, 3 or 4 of Part 1 of Schedule 1 or Part 2 of Schedule 1 of the notice. 3. The discharge may result in the presence of one or more Adsorbable Organic Halides (AOXs) in groundwater or surface water.
776	1. The system is a wastewater treatment facility that may discharge sanitary sewage containing human waste to surface water by way of a designed bypass. 2. The wastewater treatment facility is designed to discharge treated sanitary sewage at an average daily rate that is more than 50,000 cubic metres on an annual basis. 3. The discharge from the designed bypass may result in the presence of Mercury or one or more of its compounds containing Mercury in groundwater or surface water.
779	1. The system is a wastewater treatment facility that may discharge sanitary sewage containing human waste to surface water by way of a designed bypass. 2. The wastewater treatment facility is designed to discharge treated sanitary sewage at an average daily rate that is more than 50,000 cubic metres on an annual basis. 3. The discharge from the designed bypass may result in the presence of one or more Polychlorinated Biphenyls

Drinking Water Threat: "the establishment, operation or maintenance of a system that collects, stores, transmits, or treats or disposes of sewage"	
Reference #	**Under the following circumstance:**
	(PCBs) in groundwater or surface water.
880	1. The system is a wastewater treatment facility that discharges directly to land or surface water through a means other than a designed bypass. 2. The system is designed to discharge treated sanitary sewage at average daily rate that is more than 50,000 cubic metres on an annual basis. 3. The discharge may result in the presence of Antimony or one or more of its compounds containing Antimony in groundwater or surface water.
881	1. The system is a wastewater treatment facility that discharges directly to land or surface water through a means other than a designed bypass. 2. The system is designed to discharge treated sanitary sewage at average daily rate that is more than 50,000 cubic metres on an annual basis. 3. The discharge may result in the presence of Arsenic or one or more of its compounds containing Arsenic in groundwater or surface water.
895	1. The system is a wastewater treatment facility that discharges directly to land or surface water through a means other than a designed bypass. 2. The system is designed to discharge treated sanitary sewage at average daily rate that is more than 50,000 cubic metres on an annual basis. 3. The discharge may result in the presence of MCPA (2-methyl-4-chlorophenoxyacetic acid) in groundwater or surface water.
896	1. The system is a wastewater treatment facility that discharges directly to land or surface water through a means other than a designed bypass. 2. The system is designed to discharge treated sanitary sewage at average daily rate that is more than 50,000 cubic metres on an annual basis. 3. The discharge may result in the presence of Mercury or one or more of its compounds containing Mercury in groundwater or surface water.

Table 10. List of Pathogen Drinking Water Threats Related to the North Bay Intake that Are or Would be Significant.

Prescribed Drinking Water Threat	Number of Circumstances Under Which the Threat is Significant
The application of agricultural source material to land	5
The application of non-agricultural source material to land	5
The establishment, operation or maintenance of a system that collects, stores, transmits, treats or disposes of sewage	4
The establishment, operation or maintenance of a waste disposal site within the meaning of Part V of the Environmental Protection Act.	1
The handling and storage of non-agricultural source material.	1
The storage of agricultural source material.	14
The use of land as livestock grazing or pasturing land, an outdoor confinement area or a farm-animal yard. O. Reg. 385/08, s. 3.	10

8.2.1.2 Conditions

Three potential conditions related to past activities were identified within the vulnerable areas for the North Bay intake in an earlier threats inventory that was based on previous MOE guidance (Gartner Lee Limited, 2007) (Table 11). There are no known monitoring data that exist to confirm the presence of contaminants

resulting from these past activities; therefore they cannot be confirmed as conditions in accordance with Rule 126.

A condition would be considered significant if the risk score of the area in respect of the condition is equal to or greater than 80, where the risk score is the product of 1) the hazard rating of the condition, and 2) the vulnerability score of the area within the vulnerable area where the condition exists. Conditions with risk scores greater than 60 and less than 80 would be moderate threats, and risk scores greater than 40 and less than 60 would be low threats. Table 11 provides hazard ratings and risk scores for the potential conditions identified by Gartner Lee Limited (2007). Calculated risk scores from this evaluation suggests that none of the identified possible conditions related to past activities would be considered as significant (all three would be considered as moderate threats) in the vulnerable areas of the North Bay intake if monitoring confirmed their presence.

Table 11. Potential Conditions, Hazard Ratings, Risk Scores that Could be Significant, Moderate or Low Drinking Water Threats.

Past Activity	Contaminant of Concern	Location Within the Vulnerable Area	Vulnerability Score	Risk Hazard	Risk Score	Significant, Moderate or Low Threat
Copper Ore Spill from Train Derailment	Copper	IPZ-2	7.2	8.5	61.2	Moderate
Milne Lumber Company Mill	NAICS various chemicals	IPZ-1	8	8	64	Moderate
Montreal Smelting and Reduction Refinery	NAICS various chemicals	IPZ-1	8	8	64	Moderate

8.2.2 Enumeration of Significant Threats

8.2.2.1 Activities

Rules 9(e) requires that the Assessment Report list the number of locations at which an activity that is a ***significant*** drinking water threat is being engaged in. Similarly, Rule 9(f) requires the listing of the number of locations at which a condition resulting from a past activity is a ***significant*** threat. In a draft report by Gartner Lee Limited (2007), 61 possible drinking water threats were identified for the North Bay intake based on previous MOE guidance for Source Protection Planning. This comprehensive threats list was compiled based on a desktop research approach, site investigations (conducted in July and August, 2007) and discussions with the Source Protection Committee.

The threats identified in the 2007 Gartner Lee draft report were re-evaluated as threats based on the current 'Rules'. It was confirmed that all potential activities prescribed to be drinking water threats were encompassed by the 2007 Gartner Lee draft report, with the exception of the application of road salt (O. Reg. 287/07 par. 12) and the storage and handling of road salt (O. Reg. 287/07 par. 13) (see Table 6).

Given the low vulnerability scores assigned to the IPZ-2 and IPZ-3, there are no activities that could be considered as significant in theses zones. Only zones with a vulnerability of 8 to 10 can have prescribed threats related to activities that are significant based on the MOE's Tables of Drinking Water Threats.

As described in Section 8.2.1.1, there are 13 activities related to chemicals (Table 9) and 40 activities (Table 10) related to pathogens that could be significant threats to drinking water in North Bay within the IPZ-1 under certain circumstances. None of the potential threats inventoried in the Gartner Lee (2007) report met the circumstances that would result in a significant threat. Based on this evaluation, there are no significant drinking water threats related to either chemicals or pathogens in the IPZ-1.

8.2.2.2 Conditions

There are no known conditions that would be significant drinking water threats for the North Bay intake as defined by Rule 140. It is also noted that of the past activities that are potential conditions, none would be considered as significant threats to drinking water quality should they be confirmed as conditions (Table 11).

9. References

Aquafor Beech Limited, 2001:

Delaney Bay Spills Contingency Plan. Draft report prepared for the Corporation of the City of North Bay, November 2001, Reference Number 63410.

Gartner Lee Limited, 2007:

Issues Evaluation and Threats Inventory for Drinking Water Source Protection Planning for the City of North Bay. Draft technical report prepared for the North Bay-Mattawa Conservation Authority, October 2007.

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Guidelines for Canadian Drinking Water Quality: Supporting Documentation, Turbidity. Ottawa, Ontario, October 2003.

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Trout Lake Parasite Study. Final report prepared for the Corporation of the City of North Bay, January 2000.

Northland Engineering Limited, 1992:

Trout Lake Pollution Control Planning Study. Support Document #2 Limnology and Hydrology Analysis. Report prepared for the City of North Bay and the Ministry of the Environment, January 1992. Reference No. 3322.

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