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ASSESSMENT REPORT

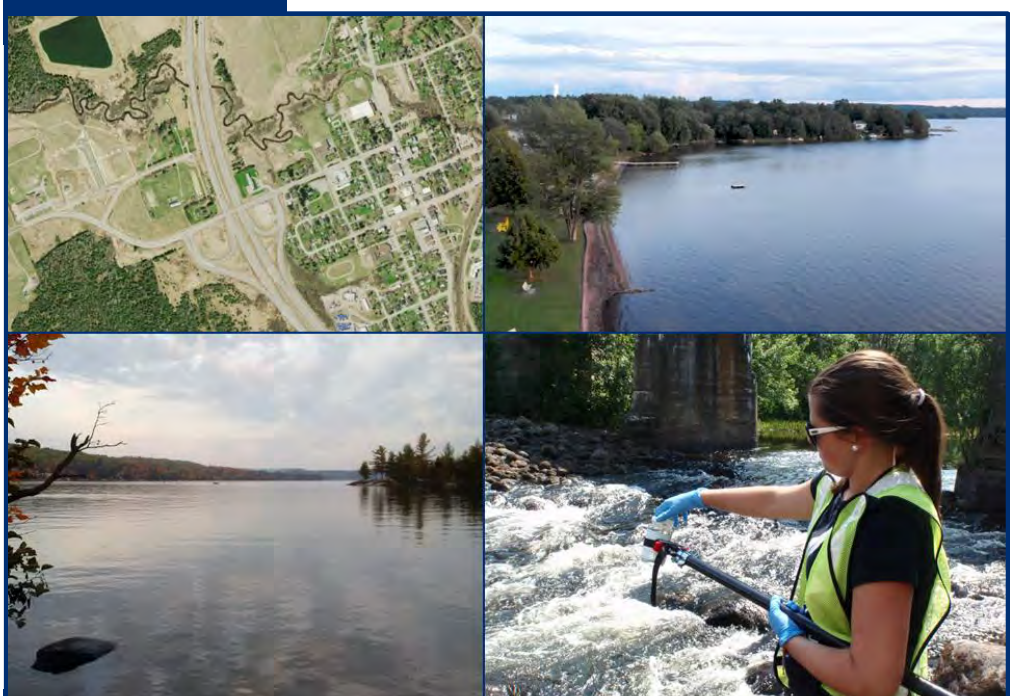
North Bay-Mattawa Source Protection Area

NORTH BAY - MATTAWA CONSERVATION AUTHORITY

DRINKING WATER SOURCE PROTECTION Our Actions Matter

Draft Proposed Update

Under section 36 of the *Clean Water Act*, 2006



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Version date: January 26, 2026

incorporating amendments to the March 5, 2015, approved document

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IMPORTANT NOTICE

The enclosed Assessment Report contains numerous updates, technical changes and editorial corrections that are under review. The review process will include public consultations as well as discussions and input from municipalities, provincial Ministries, agencies, stakeholder groups, the North Bay-Mattawa Source Protection Authority, and the North Bay-Mattawa Source Protection Committee. The final Assessment Report will then be submitted to the Minister of the Environment, Conservation and Parks for approval.

The content of this report will also inform changes to the Source Protection Plan for the North Bay-Mattawa Source Protection Area. The Source Protection Plan review is occurring concurrently with the Assessment Report.

Visit **actforcleanwater.ca** to view:

- Additional information about the process and consultation opportunities for the Assessment Report and Source Protection Plan review
- **Approved Assessment Report** (as approved February 10, 2015) which forms part of the current Source Protection Plan
- **Source Protection Plan** (approved March 5, 2015; in effect July 1, 2015) that is in force and has legal effect for the North Bay-Mattawa Source Protection Area

Contact Details

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Components of the Source Protection Plan

In addition to this document, which is primarily a compilation of technical work, the Source Protection Plan (SP Plan) includes three other documents:

- Terms of Reference
- Source Protection Plan (Policies)
- Explanatory Document

More information on these is provided in Chapter 1 of this document. The Terms of Reference outlines the scope of the project, identifying which drinking water systems will be included in the SP Plan. The Source Protection Plan (Policies) contains a description of the activities which may pose a drinking water threat and the Source Protection Plan policies intended to address these activities. The Explanatory Document provides the rationale for the policies and should be used to assist in the interpretation of the SP Plan.

Electronic copies of these documents are available for download at **www.actforcleanwater.ca**. Hard copies are available for viewing at the North Bay-Mattawa Conservation Authority Office, 15 Janey Ave., North Bay, ON, P1C 1N1. Telephone: (705) 474-5420.

This document was prepared on behalf of the North Bay-Mattawa Source Protection Committee under the *Clean Water Act*, 2006 (O. Reg. 287/07) with funding from the Government of Ontario.

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These maps are illustrative only. Do not rely on them as being a precise indicator of routes, location of features, nor as a guide to navigation. The NBMCA shall not be liable in any way for the use of, or reliance upon, the maps or any information on them.

Map Projection & Datum: NAD83 UTM Zone 17N

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Executive Summary

The purpose of Source Protection Planning is to ensure that communities are able to protect municipal drinking water supplies from overuse and contamination. This report provides the science-based assessment of the conditions within the North Bay-Mattawa Source Protection Area (SP Area) pertinent to the delineation of vulnerable areas and identification of threats.

The Assessment Report starts with a regional overview of the North Bay-Mattawa Source Protection Area and region-wide assessments. It ~~and~~ then presents the findings of the technical work for the drinking water systems in each of the municipalities, including:

- Municipality of Callander,
- Town of Mattawa,
- City of North Bay,
- Town of Powassan, and
- Village of South River

The North Bay-Mattawa Source Protection Area is located in northeastern Ontario, approximately 350 km north of Toronto and a similar distance west of Ottawa. It covers about 4,000 km^2 extending from Mattawa in the east to North Bay in the west and south to the Village of South River.

Development of the Source Protection Plan (SP Plan) is a collaborative process amongst and between municipalities (which have the responsibility of ensuring safe drinking water for residents) and other stakeholders. The integrity of the process is overseen by the Source Protection Committee (SPC), which consists of equal representation from municipalities, industrial-commercial interests, and residents at large. In addition, the North Bay-Mattawa SPC includes a seat for a First Nations representative, recognizing the territory of the Nipissing First Nation within the SP Area; (the seat is vacant at time of posting of this report).

The Source Protection Authority Board ensures that the SPC has appropriate resources to have the Source Protection Plan developed in accordance with all applicable legislation, and that it meets the requirements of the *Clean Water Act (2006)*. One ~~of those~~ requirement~~s~~ is a specific program of public consultation preceding each milestone of the project including:

- Terms of Reference – October 2008
- Proposed Assessment Report – October 2010
- Source Protection Plan – August 2012
- Updated Assessment Report – August 2014
- Updates to Approved Assessment Report – March 2026
- Updates to Source Protection Plan – March 2026

AllThe public and other interested stakeholders, including the general public, are encouraged to participate to ensure that the Source Protection Plan is relevant, appropriate and implementable. Proposed documents are submitted to the Ministry of the Environment, Conservation and Parks for review and approval. The Ministry review ensures that all requirements have been met for an effective plan and that the plan is not inappropriately restrictive or unfair.

Once approved by the Ministry of Environment (MOE) the Source Protection Plan (SPP) cannot be appealed.

The North Bay-Mattawa Source Protection Plan was approved by the Minister on March 5, 2015 and came into effect on July 1, 2015. Implementation of the SPP is expectedhas been to be achieved largely through changes to policies within municipal official plans. Such policy changes also require public consultation. Just as they are now, policies contained in and administered by municipalities within their Official Plans may be appealed. But changes to Official Plans are only one policy alternative.

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The range of voluntary and regulatory programs and tools available to the SPC to incorporate into policies to reduce or eliminate threats to drinking water includes:

- outreach and education;
- incentive programs;
- specified actions;
- land use planning (zoning by-laws, and Official Plans);
- new or amended provincial instruments;
- risk management plans;
- prohibitions; and
- land use restrictions.

Both assessment and planning must be conducted on a watershed basis - the natural landscape unit that defines a system of lakes and rivers whichthat drain to a common receiving water body. Flowing water frequently crosses political boundaries. All municipalities whichthat have lands within a watershed must work together to ensure that their downstream neighbours continue to receive clean water to meet their needs.

Technical Work

The Source Protection Plan and its related Assessment Report have been prepared in accordance with the *Clean Water Act* and its regulations. Technical work has been completed as per the version of the Technical Rules noted in the text. The technical studies of the municipal drinking water systems and the water budget were completed using the version of the Technical Rules published November 16, 2009 (MECP 2009). Other technical work has been updated to the Technical Rules version published December 3, 2021 (MECP 2021). The drinking water threats assessment has been completed using Part XII - Tables of Drinking Water Quality Threats in the 2021 Technical Rules (MECP 2021).

Water Quantity

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The Conceptual Water Budget presents the analysis of water availability and the demands on it on a regional basis. That exercise concluded that, although there was adequate water for the overall region, a more detailed analysis for each subwatershed was required. Consequently, a tiered analysis was undertaken.

Each subwatershed underwent a simple Tier One Subwatershed Stress Assessment to identify any signs of moderate or severe levels of stress. Stress was found to be low in all subwatersheds except for the Trout/Turtle Lake subwatershed, which supplies the City of North Bay.

The Trout/Turtle Lake Subwatershed Tier One analysis indicated moderate stress during the winter and summer seasons and, therefore, required more detailed assessment at the Tier Two level. The Tier Two Subwatershed Stress Assessment concluded stress levels to the Trout/Turtle Lake system exceeded the threshold for all months except March and April and, therefore, required that a Tier Three Local Area Risk Assessment be completed.

The Tier Three Local Area Risk Assessment was conducted to investigate whether the City of North Bay's municipal water supply can meet its existing and planned demands. The Tier Three Local Area Risk Assessment considers four scenarios when evaluating the level of risk for the municipal supply. They are as follows:

- Existing Land Use, Existing Pumping, Average Climate Conditions;
- Existing Land Use, Existing Pumping, Drought Conditions;
- Planned Land Use, Committed/Future Pumping, Average Climate Conditions; and
- Planned Land Use, Committed/Future Pumping, Drought Conditions.

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Simulated water levels for all four scenarios remained above critical lake level thresholds, resulting in the North Bay municipal supply quantity being assigned a risk level of Low (see Section 6.2.2). These findings indicate that Trout/Turtle Lake can meet the current and planned demands of the North Bay municipal system while maintaining critical lake levels. Due to the Low risk level, no significant or moderate water quantity threats were identified within the Trout/Turtle Lake subwatershed.

Water Quality

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The focus of planning with respect to water quality is to address all activities that are or would be a threat to drinking water if they occurred in vulnerable areas.

To identify the vulnerable areas and threats for each system:

- the system was characterized (type, population serviced, pumping rates, etc.);
- vulnerable areas were delineated and scored for vulnerability according to the Technical Rules; and
- threats, issues and conditions (both existing and potential) were identified.

There are 20 prescribed categories of activities to which all defined threats to water quality belong; two~~and an~~ additional two prescribed categories relate~~d~~ to water quantity. There are many possible circumstances for each prescribed activity. For example, the handling and storage of fuel is a prescribed activity. However,~~, but~~ its~~the~~ significance ~~of it~~ as a threat depends on specific circumstances such as volumes of~~how much~~ fuel~~ is~~ involved, how close it is occurring to the wellhead or intake, and the~~ how~~ vulnerability~~e~~ of~~is~~ the wellhead or intake. Each specific set of circumstances and the nature of the threat is counted as a separate threat in the Provincial Table of Threats set out under O. Reg. 287/07, resulting in multiple threats from a single activity.

Threats are classified as either significant, moderate or low. All significant threats must be addressed by the Source Protection Plan, with policies to reduce or eliminate the potential threat ~~posed~~ to below significant. Few of the municipal systems had any existing significant threats.

The assessment of each system includes summary tables as follows:

- areas where activities are or would be significant, moderate or low threats;
- numbers of potentially~~would be~~ significant, moderate or low threats in each vulnerable area (related to pathogens or to chemicals);
- list of applicable circumstances from the Tables of Drinking Water Threats; and
- number of existing significant threats currently within each prescribed activity.

The applicable circumstances from the Tables of Drinking Water Threats are important for property owners to understand. These help~~ in order~~ to identify the activities that may pose a threat to municipal drinking water, depending upon where their property is located relative to the vulnerable areas.

Callander was the only system that had a drinking water issue related to a non-natural source of a contaminant, and this is related to the toxin known as microcystin in cyanobacteria (blue-green algae). As such, all sources of phosphorus (a key contributing factor to the growth of cyanobacteria) within the areas of the watershed that potentially contribute water to the intake are considered significant threats. These sources are part of the Callander Subwatershed Phosphorus Study: an investigative study to assess the relative contributions of each source of phosphorus.

The numbers of existing activities considered as significant threats to each municipal drinking water source are summarized in Table ES-1 below with further information included in the municipal sections in this report (Sections 4 to 9).

Table ES-1. Summary of Existing Threats, Issues and Conditions in the North Bay-Mattawa Source Protection Area

Municipal Drinking Water System	Source Water Type	Prescribed Drinking Water Threat	# of Significant Threat Occurrences	# of Anthropogenic Issues	Conditions
City of North Bay	Surface Water	NA	0	0	0
Municipality of Callander	Surface Water	NA	0	1*	0
Village of South River	Surface Water	NA	0	0	0
Municipality of Powassan	Ground Water	The establishment, operation or maintenance of a system that collects, stores, transmits, treats or disposes of sewage	2	0	0
		The handling and storage of fuel	2		
Town of Mattawa	Ground Water	The establishment, operation or maintenance of a system that collects, stores, transmits, treats or disposes of sewage	4	0	0
		The handling and storage of fuel	~~9~~13		

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*Note: Microcystin has been identified as an issue to the Callander Bay intake. As a result, 705 significant threat occurrences related to phosphorus loading and contributing to the production of microcystin have been identified.

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1.0 Introduction

Following the public inquiry into the Walkerton drinking water crisis in May 2000, Justice Dennis O'Connor released a report in 2002 containing 121 recommendations for the protection of drinking water in Ontario. Since the release of the recommendations, the Government of Ontario has introduced legislation to safeguard drinking water from the source to the tap, including the *Clean Water Act (2006)*. The *Clean Water Act* provides a framework for the development and implementation of local, watershed-based source protection plans, and is intended to implement the drinking water source protection recommendations made by Justice O'Connor in Part II of the Walkerton Inquiry Report. The *Clean Water Act* came into effect in July 2007, along with the first five associated regulations.

The intent of the *Clean Water Act (2006)* is to ensure that communities are able to protect their municipal drinking water supplies now and in the future from overuse and contamination. It sets out a risk-based process on a watershed basis to identify vulnerable areas and associated drinking water threats and issues. It requires the development of policies and programs to reduce or eliminate the risk posed by significant threats to sources of municipal drinking water through science-based source protection plans.

Source Protection Committees work in partnership with municipalities, Conservation Authorities, water users, property owners, the Ontario Ministry of the Environment, Conservation and Parks (MECP), the Ontario Ministry of Natural Resources and Forestry (MNRF), and other stakeholders to facilitate the development of local Source Protection Plans.

The *Clean Water Act (2006)* and the Drinking Water Source Protection Program form one component of a multi-barrier approach to protecting drinking water supplies in Ontario (Figure 1-1). The five steps in the multi-barrier approach include:

- Source water protection
- Adequate treatment
- Secure distribution system
- Monitoring and warning systems
- Well thought-out responses to adverse conditions

Following the Walkerton Inquiry, the Government of Ontario enacted the *Safe Drinking Water Act* in 2002, which provides new requirements and rules for the treatment, distribution and testing of municipal drinking water supplies. Together, the *Clean Water Act (2006)* and *Safe Drinking Water Act*, along with their associated regulations, establish the legislative and regulatory framework to implement the multi-barrier approach to municipal drinking water protection in Ontario.

Figure 1-1. Multi-barrier Approach

1.1 Source Protection Planning Process

The key objectives of the source protection planning process are to complete science-based Assessment Reports that identify the risks to municipal drinking water sources and to develop local Source Protection Plans that put policies in place to protect current and future sources of drinking water. In doing so, the most up-to-date scientific understanding is used to create water management policies that are most appropriate for the unique characteristics of each Source Protection Area.

Municipalities and conservation authorities have undertaken studies to delineate the areas around municipal drinking water sources that are most vulnerable to contamination and/or overuse. Within these vulnerable areas, technical studies have identified historical, existing and possible future land use activities that are or could pose a threat to municipal water sources. This Assessment Report is a compilation of the findings of the technical studies undertaken in the North Bay-Mattawa Source Protection Area (Figure 2-2).

The Proposed Assessment Report was submitted to the MECP (then known as Ministry of the Environment) for approval on October 19, 2010. Originally the Proposed Assessment Report was due for submission to the Ministry by May 11, 2010. With approval from the Director, Source Protection Programs Branch, the submission date was extended to July 28, 2010 and subsequently to October 19, 2010.

Opportunities for public review and input were made available on the Draft Assessment Report in July and August 2010. Review and input was also sought for the Proposed Assessment Report in September 2010 before it was submitted to the Province for review and approval.

Following submission of the ~~Proposed~~ Assessment Report in October 2010, additional information became available which was incorporated into an Updated Assessment Report. The updated version was posted for public comment from May 13 to June 13, 2011, prior to submission to the Province for review and approval. The Ministry approved the Assessment Report on January 13, 2012.

A further set of updates were made to the Assessment Report in 2014. The draft ~~updated~~ version was posted for a 30-day public comment period commencing January 17, 2014. The ~~proposed updated~~ Assessment Report was then submitted to the MECP for review. The Minister approved the ~~Updated~~ Assessment Report on February 10, 2015 (Figure 1-2).

The Source Protection Plan contains policies to protect sources of drinking water against threats identified in the Assessment Report. The Source Protection Plan sets out:

- how the risks posed by drinking water threats will be reduced or eliminated;
- policy, threat and issues monitoring programs;
- who is responsible for taking action;
- timelines for implementing the policies and programs; and
- how progress will be measured.

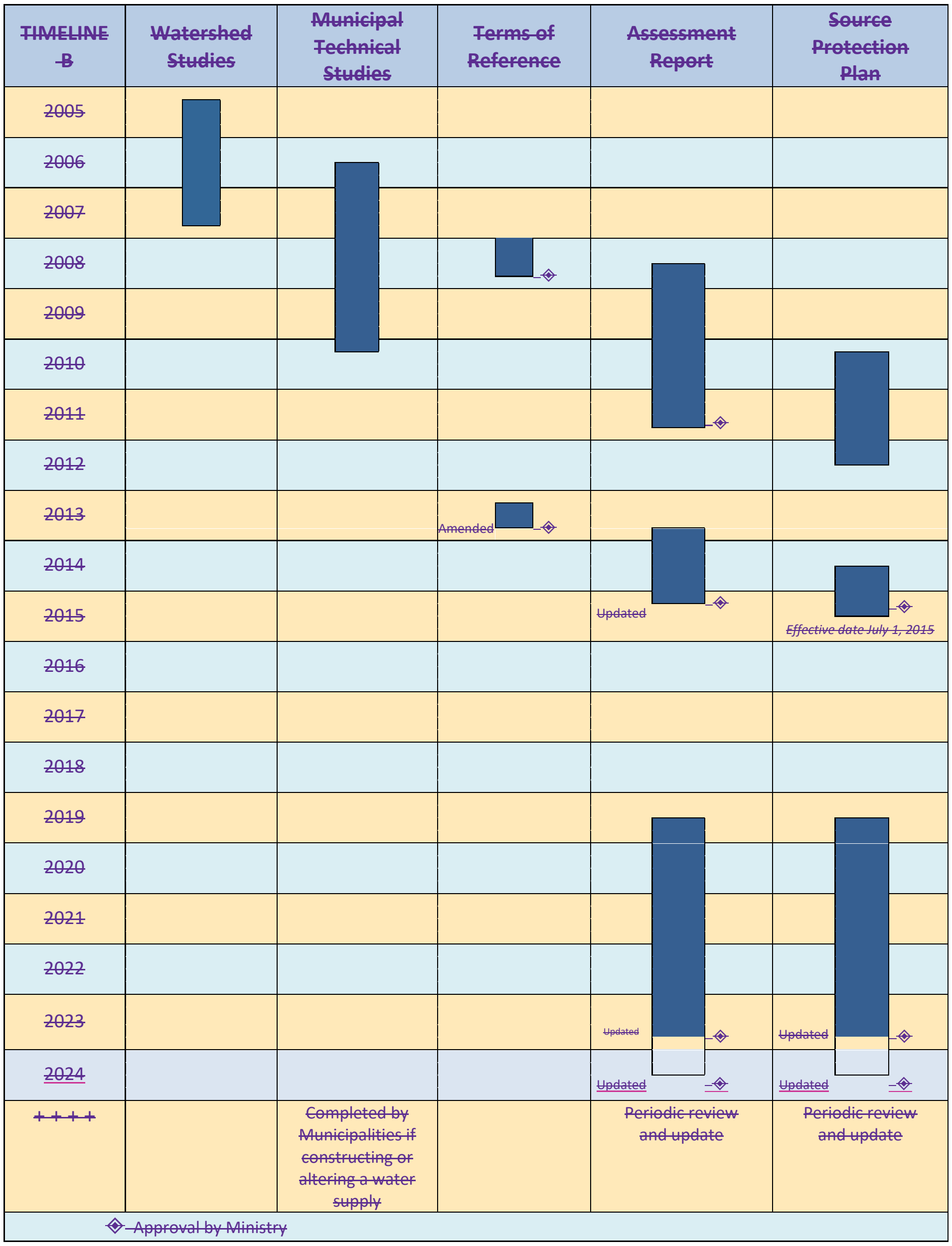
Source protection planning involves municipalities, conservation authorities, property and business owners, farmers, industries, health officials, community groups, and others working together to develop a fair, practical and implementable Source Protection Plan. Public input and consultation is an essential component of this process.

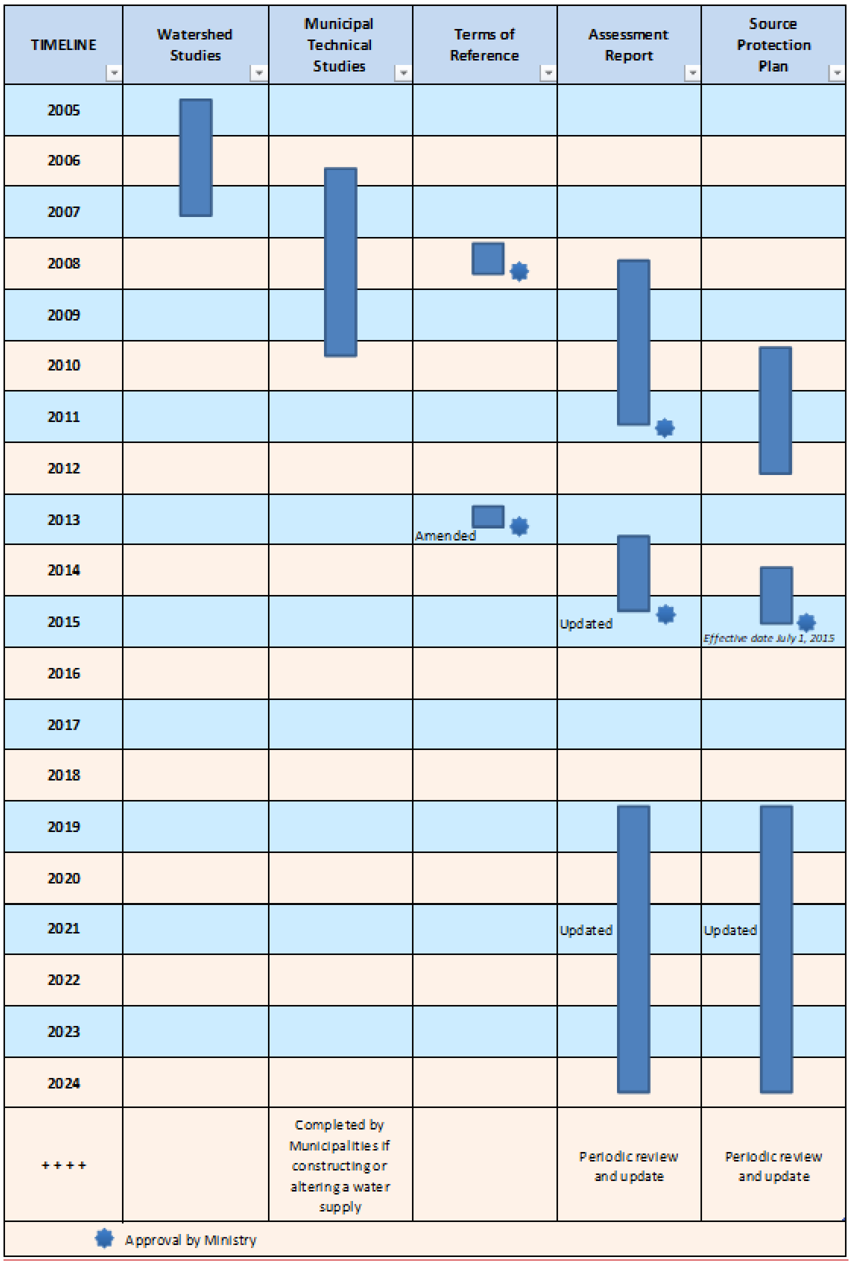
A range of voluntary and regulatory programs and tools are available to the Source Protection Committee when deciding upon a policy approach to manage drinking water threats, including:

- outreach and education;
- incentive programs;
- specified actions;
- land use planning (zoning by-laws, and Official Plans);
- new or amended provincial instruments;
- risk management plans;
- prohibition; and
- land use restrictions.

The proposed version of the first Source Protection Plan was submitted to the MECP (then known as Ministry of the Environment) in August 2012 for approval. Following a thorough review and the above-noted changes to the Assessment Report in 2014, the Minister approved the Source Protection Plan on March 5, 2015. The Source Protection Plan came into effect on July 1, 2015 (Figure 1-2).

Figure 1-2. Source Protection Timeline

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Municipal Technical Studies
Terms of Reference
Assessment Report
Source Protection Plan
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Effective date July 1, 2015
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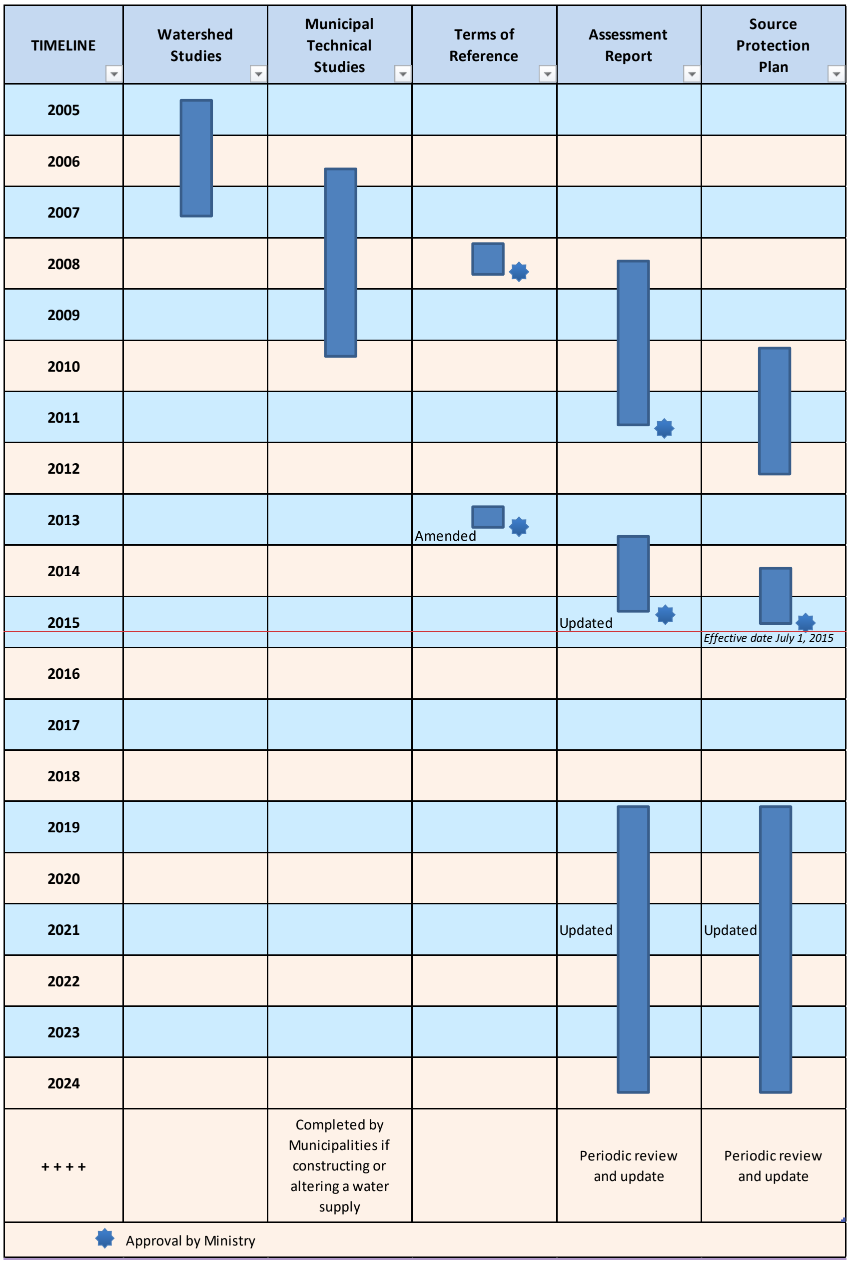
Completed by Municipalities if constructing or altering a water supply
Periodic review and update
Periodic review and update
Approval by Ministry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Completed by Municipalities if constructing or altering a water supply
Periodic review and update
Periodic review and update
Approval by Ministry

After approval of the Source Protection Plan, annual monitoring reports and progress reports on implementation are required. Implementation of the Source Protection Plan in this region will be led by municipalities in most cases. In some cases, conservation authorities, public health units or other organizations may be involved in implementing policies.

As part of the Minister's approval of the SP Plan, the Minister also made an order under s.36 of the *Clean Water Act*. The Minister directed that a workplan for the review and updating of the SP Plan and Assessment Report be prepared by November 2018. The SPC and Source Protection Authority compiled a plan in 2018 and, following public consultation, formally submitted a workplan for the s.36 update on November 30, 2018. From 2019 through 2024 the Source Protection Committee undertook a technical review of the Assessment Report and policies in the SP Plan.

1.2 Source Protection Areas (SP Area) and Authorities

The province has organized the Source Protection Program using watershed boundaries, rather than municipal or other jurisdictional areas. The watershed boundary is the most appropriate scale for water management, since both groundwater and surface water flow across political boundaries. Each planning area is referred to as a Source Protection Area under the *Clean Water Act (2006)*.

The North Bay-Mattawa Source Protection Area (SP Area) includes the North Bay-Mattawa Conservation Authority (NBMCA) administrative area of ~~(~~2800 km^2,~~)~~ with its ten member municipalities, as well as~~and~~ an additional 1200 km^2 comprised primarily of the South River watershed. This latter extension was required to provide source protection planning support to the Municipality of Powassan and the Village of South River. It brings in portions of five additional municipalities, giving each the right to participate in the governance of the project. Local governance and oversight rests with the Source Protection Authority, a board that includes the original conservation authority board as well as representatives of each of the additional participating municipalities.

1.3 Source Protection Committee (SPC)

In the SP Area, the source protection planning process is led by a multi-stakeholder steering committee called the North Bay-Mattawa Source Protection Committee (SPC), which was formed in November 2007. The Committee is responsible for directing the development and periodic updating of the Assessment Report and Source Protection Plan for the SP Area. It is evenly comprised of representatives of municipalities, the economic sector, and the public at large. Because this Source Protection Area includes First Nations' territory, the *Clean Water Act (2006)* requires that a seat be held for a representative from the band. As of the publication date of this version of the Assessment Report, no representative has been appointed by the Nipissing First Nation. The list of members of the Source Protection Committee is provided in Table 1-1.

Table 1-1. Members of the North Bay-Mattawa Source Protection Committee

Name	Seat Held	Appointed by
~~Wayne Belter~~Vacant	Chair	Minister of the Environment, Conservation and Parks
Beverley Hillier	Municipal	North Bay-Mattawa Source Protection Authority
Tim McKenna	Municipal	
~~Randy McLaren~~Vacant	Municipal	
~~George Stivrins~~Sheldon Crawford	Industrial/Commercial	
Peter Murray	Transportation	
Maurice Schlosser	Agriculture	
Lucy Emmott~~John MacLachlan~~	Public At-Large	
Andrea Labelle~~Lucy Emmott~~	Public At-Large	
Simon Foster	Public At-Large	
Vacant	First Nations	

Past SPC members: Barbara Groves (Chair, 2007-2013); Jeff Celentano (Chair, 2014-2019); George Onley; Dennis MacDonald; Kathy Parker; Ian Kilgour; Laurier Therrien; Roy Warriner; Hector Lavigne, Wayne Belter (Chair 2019-2025), Lucy Emmot, John MacLachlan, Randy McLaren, George Stirvins

In October 2008, the Committee submitted its Terms of Reference for the North Bay-Mattawa Source Protection Area Assessment Report and Source Protection Plan to the Ministry. The Terms of Reference set out the work plan for completing both the Assessment Report and Source Protection Plan. The Terms of Reference received Ministerial approval on May 11, 2009. Subsequently, the Terms of Reference was revised to remove the well cluster in the community of Trout Creek. The amended Terms of Reference was approved by the Minister in October 2013. A copy of the North Bay-Mattawa Source Protection Area Terms of Reference can be obtained by contacting the North Bay-Mattawa Conservation Authority.~~A copy of the North Bay-Mattawa Protection Area Terms of Reference can be found atwww.actforcleanwater.ca.~~

1.4 Framework of the Assessment Report

The North Bay-Mattawa Source Protection Assessment Report was completed in compliance with O. Reg. 287/07 (General) under the *Clean Water Act (2006)*, which sets out the minimum requirements for Assessment Reports. In addition, the technical work summarized in this Assessment Report was completed in conformance with the Technical Rules, Assessment Report under O. Reg. 287/07. All technical studies were managed by the North Bay-Mattawa Conservation Authority on behalf of each of the municipalities involved: Callander, Mattawa, North Bay, Powassan, and the Village of South River. Funding to complete the technical studies was provided by the Province of Ontario.

Within the SP Area there are five municipal drinking water systems (Table 1-2). The City of North Bay draws drinking water from Trout Lake, which is a part of the Mattawa River watershed. The Municipality of Callander takes water from Callander Bay, which is the outlet of the Wasi River and a part of Lake Nipissing. The Village of South River obtains drinking water from the South River. Both the Town of Mattawa and the Municipality of Powassan utilize groundwater.

Table 1-2. Municipal Drinking Water Systems Included in Assessment Report

Municipality (Owner)	Drinking Water System Name	Source Water Type	Drinking Water System Number
Municipality of Callander	Callander Water Treatment Plant	Surface Water (intake Callander Bay)	210002129
Town of Mattawa	Mattawa Well Supply	Groundwater (two wells)	210001905
City of North Bay	North Bay Water Treatment Plant	Surface Water (intake Trout Lake)	220000460
Municipality of Powassan	Powassan Well Supply	Groundwater (two wells)	220000576
Village of South River	South River Water Treatment Plant	Surface Water (intake South River)	220013562

The *Clean Water Act (2006)* focuses on the protection of municipal drinking water supplies; however, the *Clean Water Act* allows for other water systems to be considered, including clusters of private wells, communal systems and other non-municipal supplies (referred to as Type II systems). Only municipalities with water distribution systems and the Minister of the Environment, Conservation and Parks have the power to add additional non-municipal systems to the scope of the Drinking Water Source Protection studies.

The technical studies summarized in this Assessment Report start with information at the watershed scale, and then move to the scale of the municipal drinking water system. The descriptions of the technical work provided in the Assessment Report are summaries of more detailed technical reports. Readers are encouraged to view the technical studies and background reports for each municipality available online at www.actforcleanwater.ca.

1.5 Continuous Improvement

The findings of this Assessment Report are based on the best available information. It is recognized that new information relevant to the objectives of this process will continuously become available in the future. Beyond the completion of this Assessment Report, municipalities and conservation authorities will continue to refine and improve these findings based on this new information, and will address any data gaps documented in the Assessment Report to the extent possible.

Opportunities for input and review of amended Assessment Reports will be made available to those affected by the proposed changes.

1.6 Public Consultation

Public input on draft and proposed versions of the Assessment Report has been sought as an important component of the source protection planning process. ~~Further details regarding public consultations are outlined below and included in Appendix D.~~

Draft Assessment Report Consultations

The first comment period for the Draft Assessment Report was held July 26 to August 31, 2010. Comments received during this period were considered by the North Bay-Mattawa Source Protection Committee (SPC) as it prepared the subsequent Proposed Assessment Report.

The public were invited to review the Draft Assessment Report on the web at www.actforcleanwater.ca. Hard copies were also available for viewing at the North Bay-Mattawa Conservation Authority Office, Municipal Offices of the five municipal water systems and well cluster, and at public libraries of the municipalities. As well, two public open houses and presentations were held to provide the public with an opportunity to learn about the results of the technical work summarized in the Assessment Report, ask questions and provide comments.

The public meetings on the Draft Assessment Report were held on:

- August 19, 2010 in Callander; and
- August 24, 2010 in South River.

For the Draft Assessment Report consultation period, members of the public were also invited to contact dwsp.comments@nbmca.on.ca for specific meeting details.

Proposed Assessment Report Consultations

The Proposed Assessment Report was posted and available for public review and comment for 30 days. Comments on the Proposed Assessment Report were to be submitted to the North Bay-Mattawa Source Protection Authority by October 18, 2010.

No further changes to the Proposed Assessment Report were permitted to be made by the Source Protection Authority. Comments received during this second consultation period were forwarded with the Proposed Assessment Report to the Ministry of Environment (MOE, which is a previous name of the Ministry of Environment, Conservation and Parks or MECP) for review and approval. The MOE had the option to direct the local SPC to make changes.

2011 Updated Assessment Report Consultations

The Updated Assessment Report was posted and available for public review and comment for 30 days. Comments on the Updated Assessment Report were to be submitted to the North Bay-Mattawa Source Protection Committee by June 13, 2011.

No comments were received during this consultation period, so no comments were forwarded to the Ministry of Environment for review with the Updated Assessment Report.

2014 Updated Assessment Report Consultations

Similar to the consultation on the 2011 update, the 2014 Updated Assessment Report was posted and available for public review and comment for 30 days. Comments were to be submitted by February 18, 2014.

No comments were received and the Updated Assessment Report was subsequently approved by the Ministry of Environment and Climate Change on February 10, 2015.

2026 Assessment Report Consultations

Similar to the consultation on the 2015 update, the 2024 Assessment Report was posted and available for public review and comment for 35 days. Public meetings were held at the NBMCA office in North Bay on May 22 and May 29, 2024. Comments were to be submitted by June 13, 2024.

After additional revisions to the SP Plan and Assessment Report, Public Consultation is occurring again January 26 to March 1, 2026

1.7 Overview of Source Protection Risk Assessment Process

The Assessment Report attempts to summarize all of the pre-existing background knowledge and findings of current technical studies to:

- identify the vulnerable areas around municipal-residential drinking water sources;
- determine the vulnerability within various zones in those areas;
- identify existing and potential threats to water quality and quantity within each area; and
- assess the risk level for threats that may contaminate or deplete the water supply.

1.7.1 Vulnerable Areas

What are vulnerable areas?

The *Clean Water Act (2006)* identifies four types of vulnerable areas related to drinking water sources:

- Highly Vulnerable Aquifer (HVA) areas;
- Significant Groundwater Recharge Areas (SGRA);
- Wellhead Protection Areas (WHPA); and
- Intake Protection Zones (IPZ).

The first three vulnerable areas are associated with groundwater, whereas intake protection zones are associated with surface waters (rivers and lakes). Vulnerable areas surrounding wells are called Wellhead Protection Areas (WHPA). Highly Vulnerable Aquifers (HVA) and Significant Groundwater Recharge Areas (SGRA) are assessed at the watershed scale and are not necessarily associated with any particular municipal drinking water system. ~~The~~ Highly Vulnerable Aquifer ~~(HVA)~~ areas, Significant Groundwater Recharge Areas ~~(SGRA)~~ and Wellhead Protection Areas ~~(WHPA)~~ are identified through consideration of geology, groundwater flow and the permeability of surface material above the groundwater (aquifers). In some cases, complex modelling may be undertaken. The vulnerable areas associated with surface water intakes are referred to as Intake Protection Zones (IPZ) (see details in Section 3.2). Intake Protection Zones ~~(IPZ)~~ are identified by considering the flow of surface water in a river or lake. In all cases, legislated Technical Rules direct methodology to provide consistency in both approach and interpretation of results.

~~**Vulnerable areas surrounding wells are called Wellhead Protection Areas (WHPA), whereas the vulnerable areas associated with surface water intakes are referred to as Intake Protection Zones (IPZ) (see details in Section 3.2). Highly Vulnerable Aquifers (HVA) and Significant Groundwater Recharge Areas (SGRA) are assessed at the watershed scale and are not necessarily associated with any particular municipal drinking water system.**~~

What is vulnerability?

The term “vulnerability” describes how easily a source of water, such as an aquifer, river or lake, could become polluted with a dangerous substance. The vulnerability of an area can range from 1 to 10, with 10 being the most vulnerable. The process for assessing vulnerability is different for groundwater and surface water systems, and also varies depending on whether the surface water source is a lake or river.

1.7.2 Drinking Water Threats

What are threats to drinking water?

Researchers have studied the areas around municipal wells and intakes to identify the human activities that could threaten those water supplies. There are three categories of threats: chemical, pathogen and water quantity.

- **Chemical** threats include solvents, fuels, fertilizers, pesticides, and similar products. They can be found in many different places such as factories, storage depots, gasoline stations, and farms.
- A **pathogen** is a micro-organism (e.g., bacteria or virus) that can cause sickness in humans. Pathogens are often associated with human or animal waste.
- Water **quantity** threats are activities that either reduce the ability of water to “recharge” (move from the surface to) an aquifer, or that contribute to the overuse of water.

How are the locations of potential threats identified?

Technical experts working for municipalities or conservation authorities have used a variety of means to identify the locations of potential threats including provincial pesticide registries, industrial databases, interviews with property owners, questionnaires, and other ~~means~~methods. Details on individual threats, including their location and information, are not identified in the Assessment Report. Property owners will be notified directly if it is believed that an activity on their land is a potential threat in order to confirm the information.

Assigning ‘Hazard Ratings’ to Activities

Not all threats are equal. The level of risk to human health posed by particular chemicals and pathogens depends on several factors including:

- the quantity;
- the toxicity; and
- how it behaves in the environment (e.g., Does the chemical move rapidly or slowly through the ground? How long do bacteria live in groundwater? What is the method of release into the environment?)

The Ontario Ministry of the Environment, Conservation and Parks has produced ~~Provincial~~ the Tables of Drinking Water Quality Threats, identifying hundreds of chemical and pathogen threats. The threats have been assessed based on the factors listed above and given a score ~~on a scale from 1 to 10, with 10 being the most dangerous. This is~~ known as the “hazard rating.” The Tables of

Drinking Water Quality Threats ~~table indicates~~indicate the threat level of each activity based on the surface water or groundwater vulnerability score.

Determining Threat Level: Significant, Moderate or Low

The goal of the *Clean Water Act (2006)* is to reduce the risk posed by significant threats to water supplies and to prevent new significant threats from developing. So, it is necessary to sort out which threats are significant and which pose moderate or low risks. This is done by calculating the "risk score."

The risk score is a combination of two factors:

- the vulnerability of the water source (on a scale of 1 to 10); and
- the hazard rating of the threat (also on a scale of 1 to 10).

The risk score is calculated by multiplying the two factors together to provide a score out of 100.

The score is then put into one of three categories: significant, moderate or low. Table 1-3 shows the relationship between risk score and drinking water threat categories.

Table 1-3. Risk Score and Drinking Water Threat Categories

Risk Score	Drinking Water Threat Rating
80 - 100	Significant
60 ≤ and < 80	Moderate
40< and < 60	Low
Risk scores lower than 40 are below the threshold of concern.	

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1.7.3 Threats from Conditions or Issues

Threats to drinking water stemming from past or present land use activities that have impacted the land or water are referred to as conditions. A condition could be an area of known contamination in the soil or a contaminant in groundwater that is impacting or has the potential to impact a drinking water source.

Issues are identified generally by water quality analysis that reveals parameters that exceed acceptable standards. When an issue is identified that is at least partially the result of human activity, the area of concern must be delineated (i.e., Issue Contributing Area) and then any activity therein that contributes to the issue is classified as a significant threat to drinking water.

1.8 What does this mean for your property?

A property owner or business can use the Assessment Report to determine whether an activity on their property might be classified as a significant threat. If your property is close to a municipal drinking water system, you can use the vulnerability maps associated with your local system to determine whether your property is in a vulnerable area with a score of 8 to 10. Larger scale maps are available for viewing at the North Bay-Mattawa Conservation Authority or on-line at a link available on actforcleanwater.ca.

If your property is located in a Wellhead Protection Area or Intake Protection Zone with a score of 8 to 10, use the Tables of Drinking Water Threats compiled by the Ministry of the Environment, Conservation and Parks to determine whether any activities on your property might be considered a significant threat. The Tables of Drinking Water Threats can be accessed using the following links:~~https://www.ontario.ca/page/tables-drinking-water-threats~~

https://www.ontario.ca/page/2021-technical-rules-under-clean-water-act
(continue down the page to Part XII – Tables of drinking water quality threats)

https://swpip.ca
(follow link to 2021 version of threats)

1.9 Uncertainty/Limitations

All calculations contain inherent uncertainty due to incomplete data, data inaccuracies and imperfect estimation and simulation tools. Most of the sources of uncertainty are documented in the original technical studies that are available from the North Bay-Mattawa Drinking Water Source Protection website: www.actforcleanwater.ca.

Field Code Changed

It is important to consider the regional-scale nature of the analyses and interpretations presented. Any model developed to represent a natural system is inherently a simplification of that natural system. Part of the reason for this is that the complexities of the physical system can never be known well enough to incorporate all details into a numerical context. This does not negate the value of enlisting numerical models as tools to help understand and manage natural systems; however, there is a need to recognize the limitations of such tools when interpreting results.

Attempts to apply these findings to a different scale (such as individual parcels of land) may produce invalid results. Every effort was made to minimize uncertainty in all studies: data was cross checked with additional sources and external peer reviewers were consulted where either required or deemed advisable. The methodology was appropriate for current purposes.

2.0 Regional Overview

2.1 Watershed Characterization

The North Bay-Mattawa Source Protection Area (SP Area) is located in northeastern Ontario approximately 350 km north of Toronto and a similar distance west of Ottawa (Figure 2-1). The SP Area covers approximately 4,000 km^2 extending from the Town of Mattawa in the east to the City of North Bay in the west and south to the Village of South River (Figure 2-2).

A major divide cuts through the area from north to south directing water flow either towards the Mattawa River and the Ottawa River, or to Lake Nipissing and the Great Lakes.

To more easily study drainage patterns these two large watersheds are subdivided into a total of 14 subwatersheds as illustrated in Figure 2-2 and discussed in Section 2.5 Conceptual Water Budget as part of the detailed examination of how water flows through the SP Area.

2.1.1 Human Geography

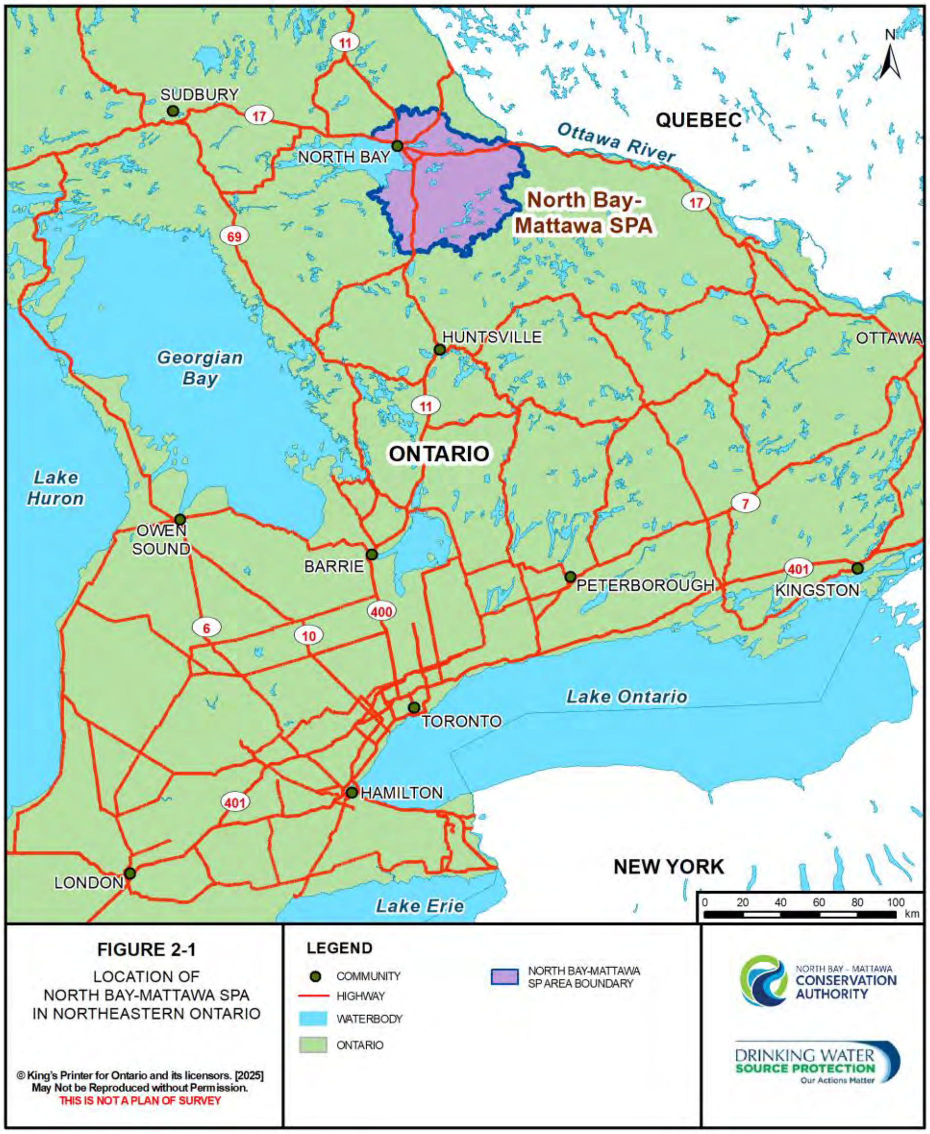
Historic settlement and development of the area was driven by the nature of the landscape, which directed access routes, limited agricultural activities and provided challenges to road construction. The Mattawa River extends from west to east across the northern portion of the SP Area. It provided a major transportation link from Lake Nipissing in the Great Lakes watershed across to the Ottawa River, traditionally for First Nations and later for European fur traders. Much of the terrain is rugged and otherwise difficult to navigate. The City of North Bay was established on the divide at the only point east of Lake Nipissing where road and (eventual) rail access from south to north was possible without a major bridge.

The total population residing within the SP Area is estimated at 72,900 (Statistics Canada, 2021). Population distribution and changes within the SP Area for the period 1996 to 2021 are indicated in Table 2-1. Note that since population data is reported based on political boundaries (municipalities, etc.) while the SP Area is defined by watershed boundaries, the total population for the SP Area is an estimate.

Municipal boundaries and population centres serviced by municipal drinking water are also illustrated in Figure 2-3. Jurisdictional considerations regarding applicability of provincial legislation to federal lands requires consideration, so the extent of federal lands and First Nation Reserve lands, mostly within the northwest portion of SP Area, are also shown in Figure 2-3.

Approximately 75% of the population is located in the City of North Bay which is the only major urban centre in the SP Area. Most of the rest live in the towns and hamlets. However, depending on the municipality, there may be a significant portion of the population on rural properties. A large portion of the SP Area is virtually uninhabited. Population distribution and density is indicated in Table 2-2.

Figure 2-1. North Bay-Mattawa Source Protection Area in Northeastern Ontario




Sault Ste. Marie
Sudbury
North Bay SPR
Ottawa
Peterborough
Toronto
St. Catharines
London
Legend
Cities
Kings Highways
Major Waterbodies
NBMCA SPR
Ontario

Figure 2-2. North Bay-Mattawa Source Protection Area Subwatersheds

DWSP Municipality
Highways
Water Body
Water Course
Drainage Divide
Source Protection Subwatersheds
Drains through Mattawa to Ottawa River
Drains through Nipissing to Huron
North Bay
Callander
Powassan
South River
Mattawa
North River
Duchesnay River
Trout Lake-Turtle Lake
Mattawa River
La Vase River
Boom Creek
Kaibuskong River
Sharpes Creek
Amable du Fond River
Pautois Creek
Bear-Boleau Creeks
Wistiwasing River
Reserve-Beatty Creeks
Upper South-Upper Amable du Fond Rivers
0 5 10 20 Kilometers

Table 2-1. Population Distribution and Change within the North Bay-Mattawa SP Area

Name	Municipal Designation	Population						% Change
		1996	2001	2006	2011	2016	2021	1996-2021
Bonfield	Township	1,765	2,064	2,009	2,016	1,990	2,146	21.6
*Callander	Municipality	3,168	3,177	3,249	3,864	3,863	3,964	25.1
Calvin	Municipality	562	603	608	568	516	557	-0.9
Chisholm	Township	1,197	1,230	1,318	1,263	1,291	1,312	9.6
East Ferris	Municipality[1]	4,139	4,291	4,228	4,512	4,862	4,946	19.5
*Mattawa	Town	2,281	2,270	2,003	2,023	1,993	1,881	-17.5
*North Bay	City	54,332	52,771	53,966	53,651	51,553	52,662	-3.1
Papineau-Cameron	Township	973	997	1,058	978	1,016	982	0.9
*Powassan	Municipality	3,311	3,252	3,309	3,378	3,455	3,346	1.1
*South River	Village	1,098	1,040	1,069	1,049	1,114	1,101	0.3
Subtotal:		72,826	71,695	72,789	73,302	71,653	72,897	0.1
Townships & First Nations Reserve only partially within SP Area (population of entire territory)								
Joly	Township	311	290	280	284	304	293	-5.8
Machar	Township	835	849	866	923	882	969	16.0
Mattawan	Municipality	115	114	147	162	161	153	33.0
Nipissing	Township	1,524	1,553	1,642	1,704	1,707	1,769	16.1
Nipissing 10	First Nation Reserve	1,381	1,378	1,413	1,450	1,593	1,640	18.8
Strong	Township	1,393	1,369	1,327	1,341	1,439	1,566	12.4
Subtotal:		5,559	5,553	5,675	5,864	6,086	6,390	14.9
Total:		78,385	77,248	78,464	79,166	77,739	79,287	1.2

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Name	Municipal Designation	1996 Population	2001 Population	2006 Population	% Change 1996-2006
Bonfield	Township	1,765	2,064	2,009	13.8
Callander	Municipality	3,168	3,177	3,249	2.6
Calvin	Township	562	603	608	8.2
Chisholm	Township	1,197	1,230	1,318	10.1
East Ferris	Municipality[1]	4,139	4,291	4,200	1.5
Mattawa	Town	2,281	2,270	2,003	-12.2
North Bay	City	54,332	52,771	53,966	-0.7
Papineau-Cameron	Township	973	997	1,058	8.7
Powassan	Municipality	3,311	3,252	3,309	-0.1
South River	Village	1,098	1,040	1,069	-2.6
Subtotal:		72,826	71,695	72,789	-0.1
Townships & First Nations Reserve only partially within SP Area (population of entire territory)					
Joly	Township	311	290	280	-10.0
Machar	Township	835	849	866	3.7
Mattawan	Township	115	114	147	27.8
Nipissing	Township	1,524	1,553	1,642	7.7
Nipissing 10	First Nation Reserve	1,381	1,378	1,413	2.3
Strong	Township	1,393	1,369	1,327	-4.7
Subtotal:		5,559	5,553	5,675	2.1
Total:		78,385	77,248	78,464	0.1

* Community with municipal drinking water system

1. ~~Effective 2010, the Township of East Ferris formally changed its name to the Municipality of East Ferris. This is simply for administrative purposes and does not affect the geographic area.~~

~~2.~~ Estimated population in 2021 of portions of Townships and First Nations within SP Area

Figure 2-3. Municipalities in the North Bay-Mattawa Source Protection Area

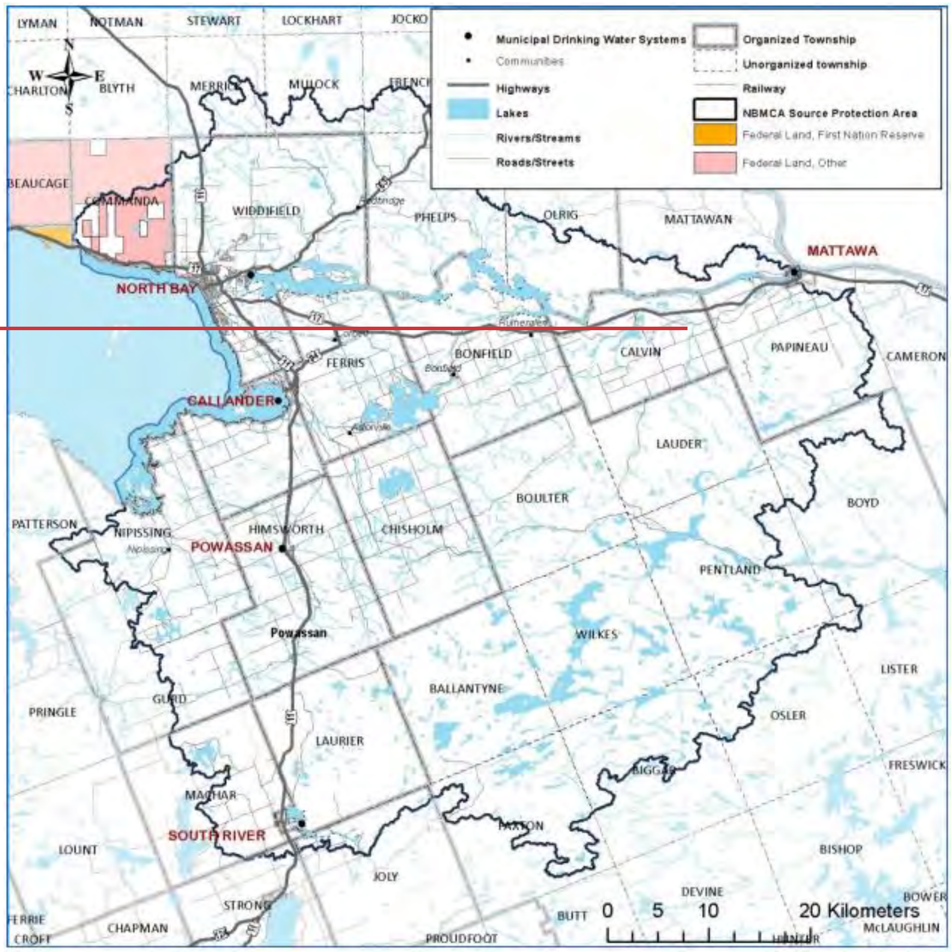

Municipal Drinking Water Systems
Communities
Highways
Lakes
Rivers/Streams
Roads/Streets
Organized Township
Unorganized township
Railway
NBMCA Source Protection Area
Federal Land, First Nation Reserve
Federal Land, Other
LYMAN
STEWART
LOCKHART
JOCKO
BLYTH
MULOCK
BEAUCAGE
WIDDIFIELD
PHELPS
OLRIG
MATTAWAN
MATTAWA
NORTH BAY
FERRIS
BONFIELD
CALVIN
PAPINEAU
CAMERON
CALLANDER
LAUDER
BOULTER
BOYD
PATTERSON
NIPISSING
HIMSWORTH
POWASSAN
CHISHOLM
PENTLAND
Powassan
WILKES
LISTER
BALLANTYNE
PRINGLE
OSLER
LAURIER
FRESWICK
SOUTH RIVER
LOUNT
BISHOP
JOLY
DEVINE
BOWER
STRONG
BUTT
0 5 10 20 Kilometers
McLAUGHLIN
CHAPMAN
PROUDFOOT

Table 2-2. Population Density within the North Bay-Mattawa SP Area (2021)

Name	Municipal Designation	2021 Population	Census Calculated Land Area (km^2)	Density 2021 (pop/km^2)
Municipalities Located Completely within the SP Area				
Bonfield	Township	2,146	206.22	10.4
*Callander	Municipality	3,964	102.98	38.5
Calvin	Municipality	557	140.13	4.0
Chisholm	Township	1,312	205.77	6.5
East Ferris	Municipality[1]	4,946	151.94	32.6
*Mattawa	Town	1,881	3.67	512.5
*North Bay	City	52,662	315.53	166.9
Papineau-Cameron	Township	982	564.23	1.7
*Powassan	Municipality	3,346	223.26	15.0
*South River	Village	1,101	4.11	267.9
Subtotal:		**72,897**	1,917.84	38.0
Municipalities Located Partially within the SP Area				
Joly	Township	293	193.95	1.5
Machar	Township	969	182.65	5.3
Mattawan	Municipality	153	200.12	0.8
Nipissing	Township	1,769	387.95	4.6
Nipissing 10	First Nation Reserve	1,640	60.87	26.9
Strong	Township	1,566	158.88	9.9
Subtotal:		**6,390**	1,184.42	5.4
TOTAL:		**79,287**	3,102.26	25.6

Name	Municipal Designation	2006 Population	Density 2006 (pop/km^2)	Census Calculated Land Area (km^2)
Municipalities Located Completely within the SP Area				
Bonfield	Township	2,009	9.8	205.75
*Callander	Municipality	3,249	32.2	100.96
Calvin	Township	608	4.4	139.17
Chisholm	Township	1,318	6.4	205.26
East Ferris	Municipality[1]	4,200	28	149.76
*Mattawa	Town	2,003	548	3.66
*North Bay	City	53,966	171.4	314.91
Papineau-Cameron	Township	1,058	1.9	561.37
*Powassan	Municipality	3,309	14.9	222.75
*South River	Village	1,069	264.5	4.04
Subtotal:		72,789		
Municipalities Located Partially within the SP Area				
Joly	Township	280	1.4	193.82
Machar	Township	866	4.7	184.38
Mattawan	Township	147	0.7	199.52
Nipissing	Township	1,642	4.2	387.4
Nipissing 10	First Nation Reserve	1,413	23.1	61.22
Strong	Township	1,327	8.4	158.73
Subtotal:		5,675		
Total:		78,464		

Note: * Community with municipal drinking water system

1. Effective 2010, the Township of East Ferris formally changed its name to the Municipality of East Ferris. This is simply for administrative purposes and does not affect the geographic area.
2. Other parts of SP Area lie within unorganized townships with average population density of 1.0 people/km^2 or less.

2.1.2 Drinking Water Systems

Five centres in this SP Area have municipal drinking water systems classified as large municipal residential systems under O. Reg. 170/03 (indicated in Table 2-2 as DWSP municipalities). The source for two of these systems is groundwater and the remaining three systems are sourced from surface water. Details for all five systems are summarized in Table 2-3 below. Information on pumping rates for each system can be found in Section 2.5.

Table 2-3. Municipal Drinking Water Systems in the North Bay-Mattawa SP Area

Municipality	Drinking Water System Name	Drinking Water Source	Drinking Water System Location	Population Serviced	Intake/Well Location	
					Easting	Northing
Callander	Callander Water Treatment Plant	Surface Water (Callander Bay)	100 Nipissing St., Callander	1,700	625480	5119098
North Bay	North Bay Water Treatment Plant	Surface Water (Trout Lake)	248 Lakeside Dr., North Bay	~~53,000~~43,700	622779	5131488
South River	South River Water Treatment Plant	Surface Water (South River Reservoir)	28 Howard St., South River	1,150~~000~~	627817	5077532
Mattawa	Mattawa Well Supply	Groundwater (Well x2)	400 Bissett St., Mattawa	~~2,251~~1900	676227	5131742
Powassan	Powassan Well Supply	Groundwater (Well x2)	Fairview Lane, Powassan	1,000	625874	5104525
					625890	5104592

Many people are serviced by other systems subject to regulation under O. Reg. 170/03 under the *Safe Drinking Water Act*, 2002. These are listed in Table 2-4 below. The abbreviated types of systems listed below represent the following (Note that there are other types of systems listed under O. Reg. 170/03 which are not mentioned in this report, since there are none known to occur in the SP Area):

- LMRS: Large Municipal Residential System (mentioned above)
- LNMNRS: Large Non Municipal Non Residential System
- NMYRRS: Non Municipal Year-Round Residential System
- SNMNRS: Small Non Municipal Non Residential System

Most of the remaining residents get their water from private residential wells or surface water intakes.

Table 2-4. Non-Municipal Drinking Water Systems in the North Bay-Mattawa SP Area

Municipality	Type	Drinking Water System Name	DWS Number	DWS Location	Population Serviced	Capacity (L/s)	Maximum Annual Capacity (L/year)
Bonfield	SNMNRS	Camp Caritou Well Supply	260038675	63 Develop-ment Road, Bonfield		0.3	9,460,800
Bonfield	SNMNRS	Ecole Lorrain Well Supply	260014729	245 Yonge Street, Bonfield	100	1.0	63,072,000
Callander	NMYRRS	Keeling Apartments Well Supply	260077701	244 Hwy 654 West, Callander	18	1	63,072,000
Callander	NMYRRS	Lagassie Trailer Park Well Supply	260072228	128 Rivers Road East, Callander	60	1.11	35,004,960
Callander	SNMNRS	North Bay Rotary's Camp Tillicum Well Supply	260031512	Tillicum Bay Rd, Callander		2.8	88,300,800
Calvin	SNMNRS	Canadian Ecology Centre Well Supply (Main Building)	260061022	6905 Highway 17, Mattawa	180	2	94,608,000
East Ferris	SNMNRS	Ecole St-Thomas D'Aquin Well Supply	260014755	1392 Village Road, Astorville		1.0	63,072,000
East Ferris	SNMNRS	Ferris Glen Public School Well Supply	260009607	30 Voyer Road, Corbeil		1.3	40,996,800
East Ferris	SNMNRS	Nipissing Manor Nursing Care Centre	260016445	1202 Hwy 94, Corbeil		2.6	81,993,600
East Ferris	SMNNRS	St-Thomas D'Aquin Well Supply	260095095	1245 Village Road, Astorville	300	0.3	
Machar	NMYRRS	Mapleton Retirement Village Well Supply	260092586	597 Ottawa St, South River	16	2.8	
Nipissing Township	SNMNRS	South Shore Education Centre Well Supply	260009672	60 Beatty St, Nipissing Township		0.6	18,921,600

Municipality	Type	Drinking Water System Name	DWS Number	DWS Location	Population Serviced	Capacity (L/s)	Maximum Annual Capacity (L/year)
North Bay	SNMNRS	Birchs Residence Well Supply	260009282	168 Birchs Road, North Bay		2.8	88,300,800
North Bay	SNMNRS	Cedarview Residence Well Supply	260009295	105 Larocque Road, North Bay		2.8	88,300,800
North Bay	NMYRRS	Fairview Trailer Park and Campground Well Supply	260044525	395 Riverbend Road, North Bay	70	1.4	44,150,400
North Bay	NMYRRS	Northway ~~Blue Sky~~ Apartments Well Supply	260084669	5429 Hwy 11 North, North Bay	10	0.3~~5~~	15,768,000
North Bay	NMYRRS	Oasis Trailer Park Well Supply	260063089	Highway 17, North Bay	42	0.7	22,075,200
North Bay	NMYRRS	Parkwood Villa Well Supply	260074542	5887 Hwy 11 North, North Bay		2.8	88,300,800
North Bay	NMYRRS	White Fawn Apartments Well Supply	260097487	4319 Highway 11 North, North Bay	13	0.5	
Powassan	SNMNRS	Almaguin Highlands Community Living Well Supply (Glendale)	260021476	8 Glendale Heights Dr, Powassan		0.8	25,228,800
Powassan	NMYRRS	Meadowview ~~Trout Creek~~ Apartments Well Supply	260048672	105 Main Street, Trout Creek	19	0.8	25,228,800
Powassan	SNMNRS	~~Lady Isabelle Nursing Home~~ Trout Creek Senior Living Well Supply	260016432	102 Corkery Street, Trout Creek		0.2	6,307,200
Powassan	SNMNRS	Mapleridge Public School Well Supply	260018642	171 Edward St. S, Powassan		0.3	9,460,800
Powassan	SNMNRS	Rutledge Residential Home Well Supply	260023946	Box 542, Powassan		0.8	25,228,800

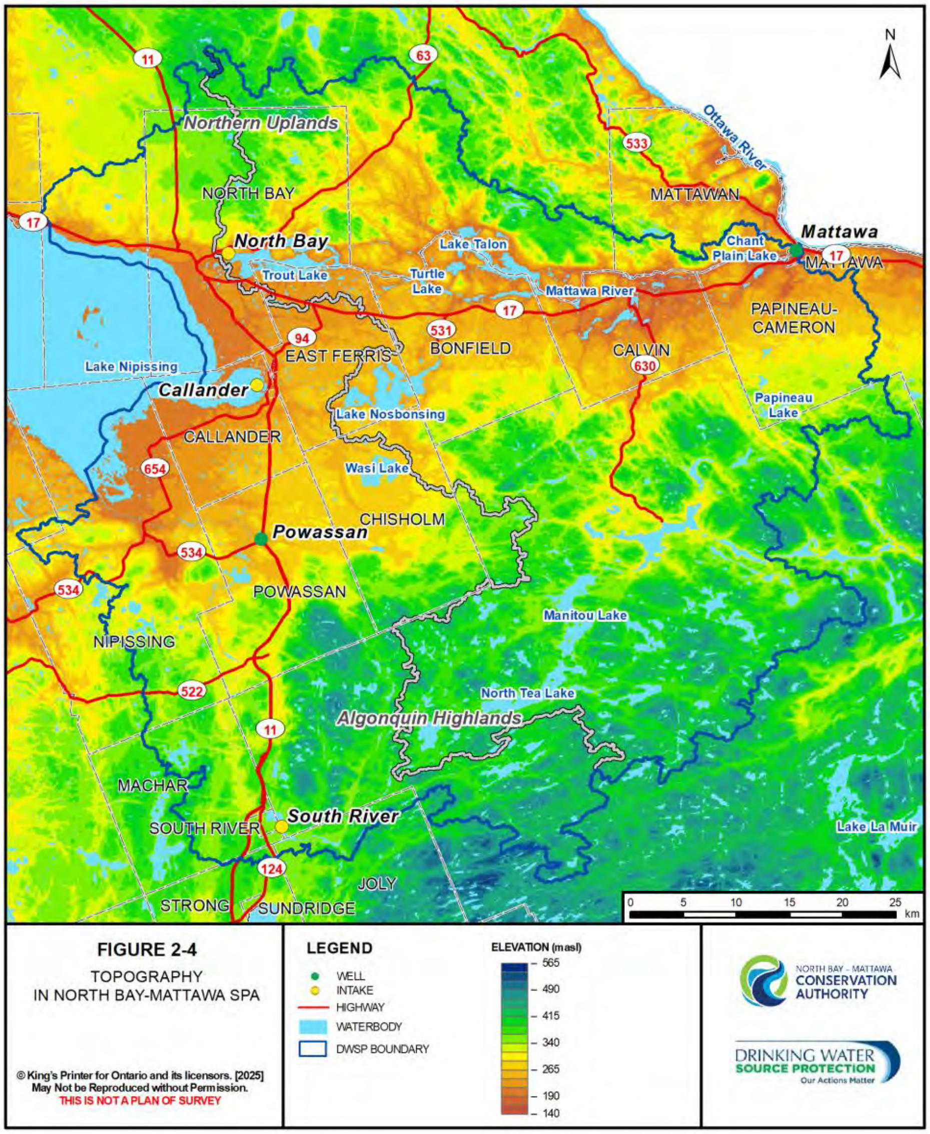
Municipality	Type	Drinking Water System Name	DWS Number	DWS Location	Population Serviced	Capacity (L/s)	Maximum Annual Capacity (L/year)
South River	SNMNRS	Almaguin Highlands Secondary School Well Supply	260009555	21 Mountain View Rd, South River		0.6	18,921,600
South River	SNMNRS	Southwind Retirement Home Well Supply	260067340	11118 Hwy 124, Sundridge, ON		2.8	88,300,800
Ballantyne Township (Unorganized) ~~South River~~	SNMNRS	Project D.A.R.E. Well Supply	260024739	Loxton Lake, Lot 4, Con 9, Ballantyne Township		1.1	34,689,600
Phelps Township (Unorganized)	SNMNRS	Phelps Central School Well Supply	260009659	19 Glenvale Drive, Redbridge		1.1	34,689,600

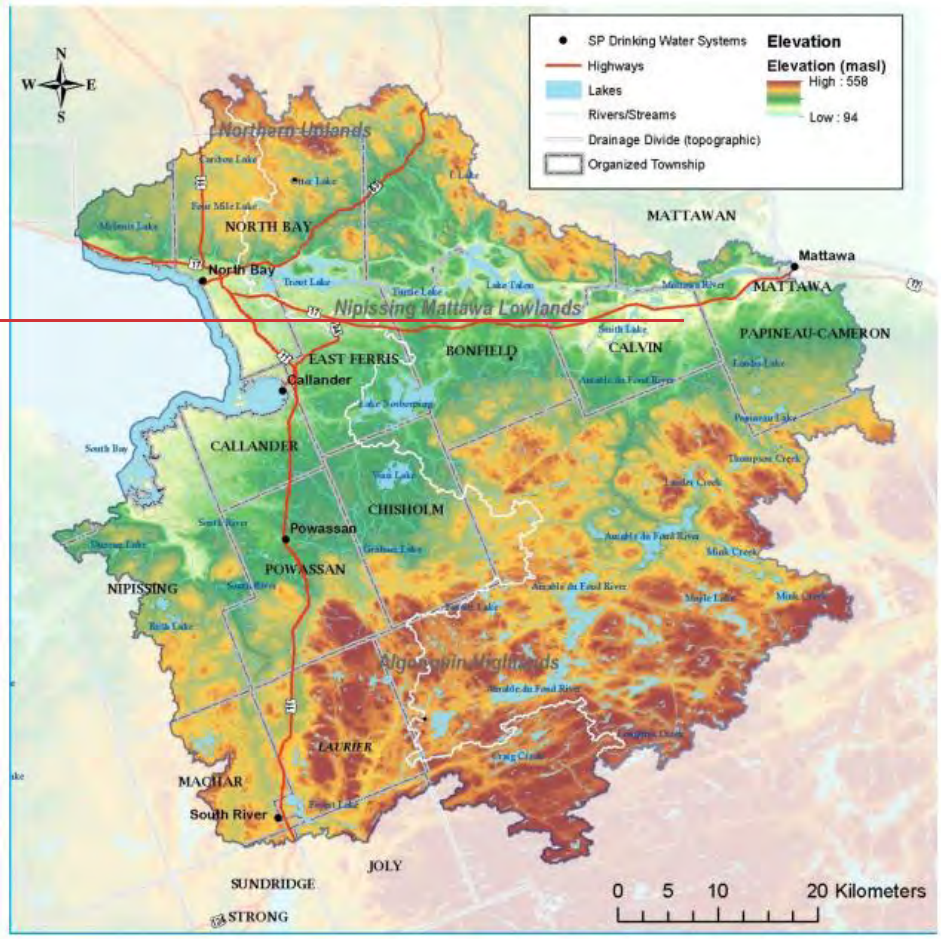
2.1.3 Physical Geography

Topography and Physiography

Topographically the SP Area consists of three distinct regions: the Northern Uplands, the Algonquin Highlands and the Nipissing-Mattawa Lowland (Figure 2-4). Faulting activities during the preglacial period resulted in a substantial scarp formation on the north side of the Mattawa River with relief of approximately 100 m. Similar scarps are seen west of Powassan. Relief of up to 260 m is found in the Algonquin Highlands. Both the Northern Uplands and Algonquin Highlands are characterized by rolling bedrock, thinly covered with glacial tills. Rock knob terrain is common throughout the SP Area. The Nipissing-Mattawa Lowland, lying mainly to the south of the Mattawa River and across the centre of the SP Area, is associated with extensive lake sediments around and between bedrock outcrops. Such lake sediments consist chiefly of varved clays with some rhythmically banded sands (Harrison, 1972). Minor ridges and several large end moraine segments, drumlins and eskers are important elements.

Figure 2-4. Topography in the North Bay-Mattawa SP Area





SP Drinking Water Systems
Highways
Lakes
Rivers/Streams
Drainage Divide (topographic)
Organized Township
Elevation
Elevation (masl)
High : 558
Low : 94
N
W
E
S
Northern Uplands
NORTH BAY
North Bay
MATTAWAN
Mattawa
MATTAWA
Nipissing Mattawa Lowlands
PAPINEAU-CAMERON
CALVIN
BONFIELD
EAST FERRIS
Callander
CALLANDER
CHISHOLM
Powassan
POWASSAN
NIPISSING
Algonquin Highlands
LAURIER
MACHAR
South River
JOLY
SUNDRIDGE
STRONG
0
5
10
20 Kilometers

Figure 2-5 depicts the physiography using soil classifications and data from the Northern Ontario Geology Terrain Study (NOGETS; Gartner & Van Dine, 1980). These classifications relate primarily to glacial processes and include the following:

- exposed bedrock,
- drift or till which is material pushed and deposited by glaciers,
- glaciofluvial material and alluvium deposited by moving streams,
- glaciolacustrine deposits formed beneath glacial lakes, and
- organic sediments formed from vegetation in poorly drained areas (including swamps).

Although this classification ignores soil particle size, the coarser grained materials tend to be associated with historic areas of moving water while finer particles settled from the still waters of glacial lakes. Coarse-grained deposits are important for groundwater movement and aquifer Recharge. Fine-grained deposits, such as clay, impede the flow of water and often occur in a layer that protects the aquifer (water-bearing layer) from water-borne contaminants.

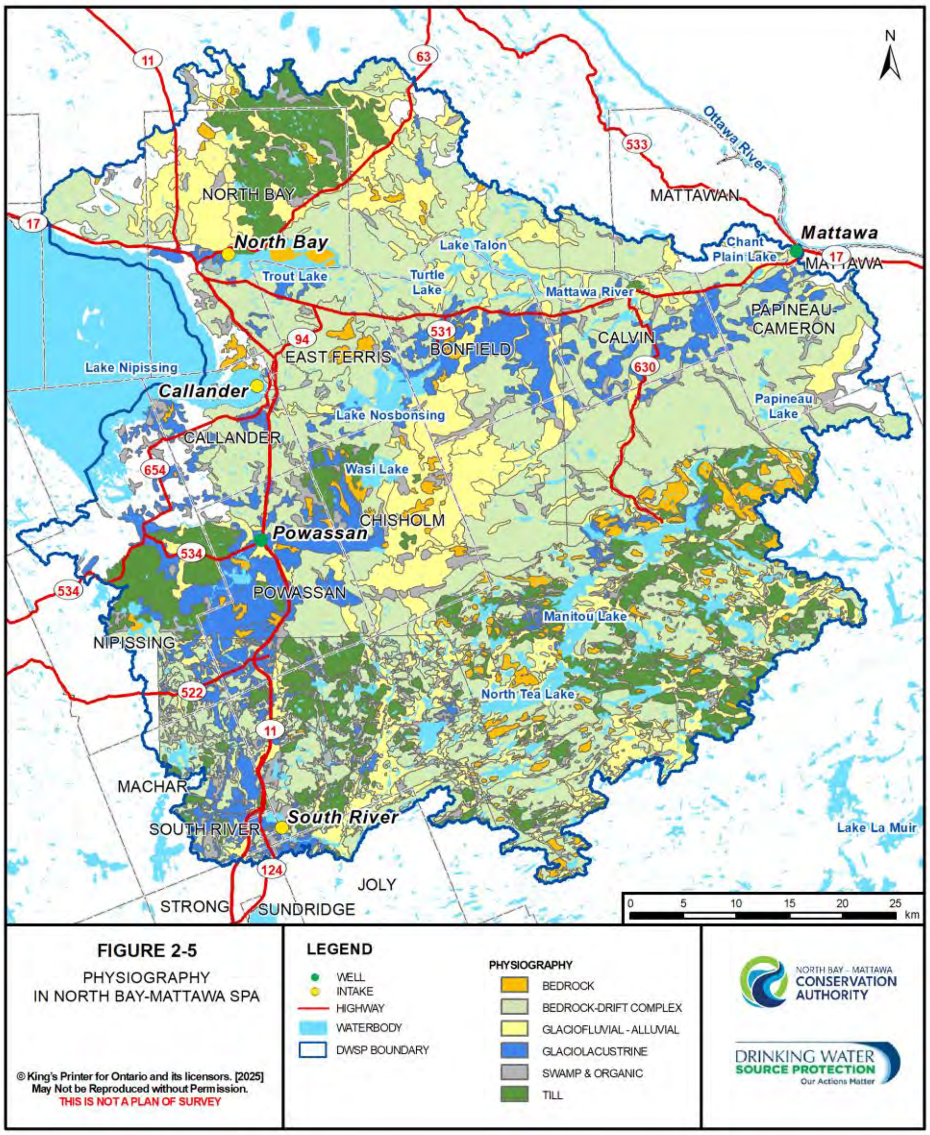
Soil coverage throughout the area tends to be shallow (Figure 2-6). The vast majority of the area has drift of less than 5 m in thickness. Till thickness reaches 5 m to 10 m in several areas. There are occasional deep sand and gravel deposits, but these are generally not extensive. Organic deposits commonly occur between the bedrock hills and in low-lying areas coupled with a high water table.

Where soils were more substantial, settlements established; soil was necessary for agriculture and facilitated road construction. Because of the shallow rolling bedrock base, aquifers are mostly small and localized. There are very few constructed overburden wells, but this may be due as much to business practicalities in the area as to a lack of suitable geologic conditions.

The bedrock geology of the SP Area is part of the Central Gneissic Belt of the Grenville Province of the Canadian Shield. Much of the study area consists of ancient gneisses that have been intruded by relatively younger granitic and monzonitic plutons (Thurston, 1991), but also includes metamorphosed mudstones (metagraywacke), sandstones (quartzite), and limestone (crystalline limestone/marble). From a hydrogeological perspective, these rocks are very hard and erosion resistant. However, continental tectonic forces have caused faulting, fracturing and jointing, providing minor pathways for groundwater movement.

On the whole, the bedrock surface represents a relatively impermeable surface. Therefore, groundwater preferentially flows through the overlying materials. Most groundwater models in overburden aquifers consider bedrock to be a no-flow boundary and exclude it from the model. Even though it is recognized that hydraulic conductivity drops sharply with increasing penetration, the data collected when modelling the groundwater flow system below the town site of Trout Creek indicated that the uppermost zone of bedrock should be included (Waters Environmental Geosciences Ltd, 2010). Only three groundwater system locations representing about 1% of the SP Area were modeled during development of this Assessment Report and each was found to be very different from the others.

Figure 2-5. Physiography in the North Bay-Mattawa SP Area



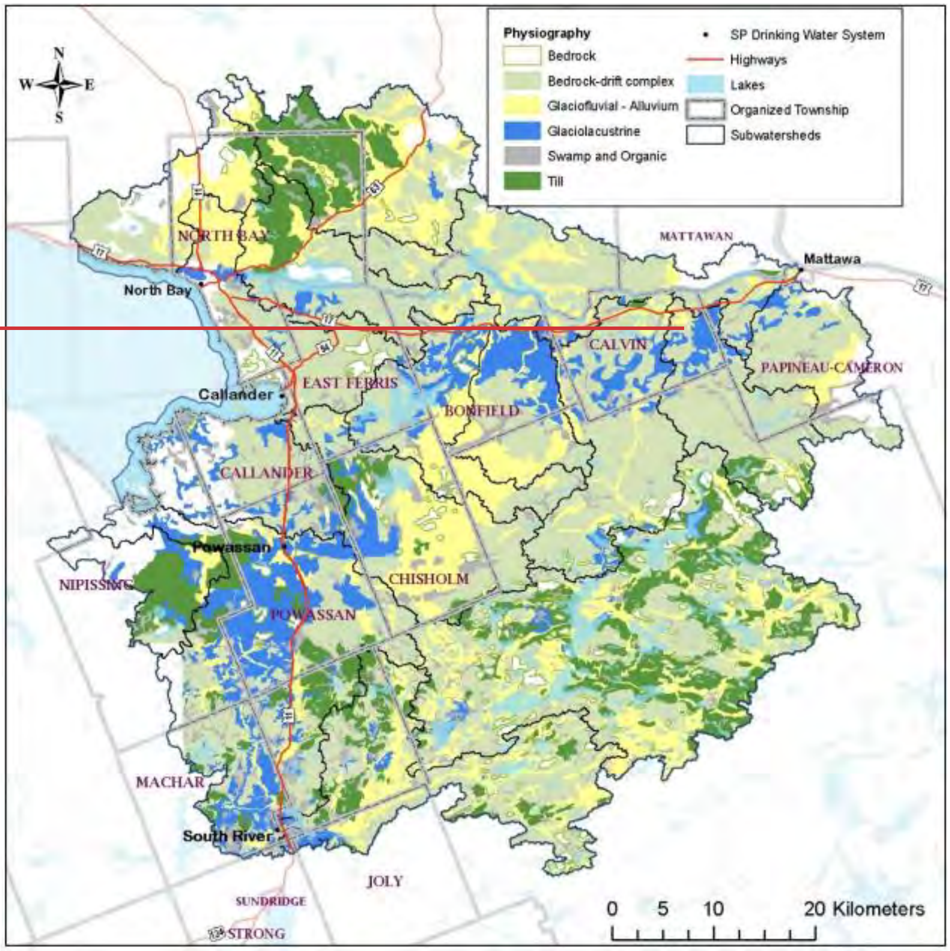
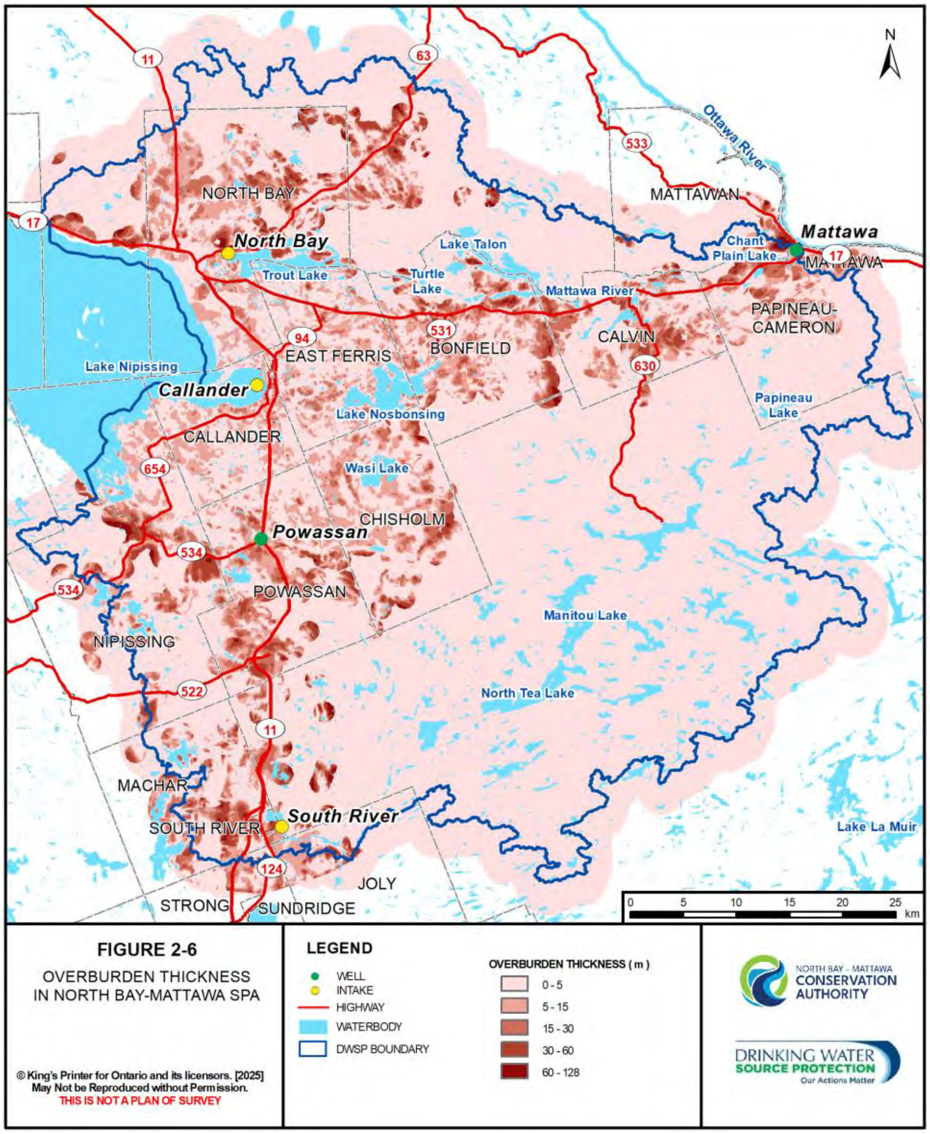
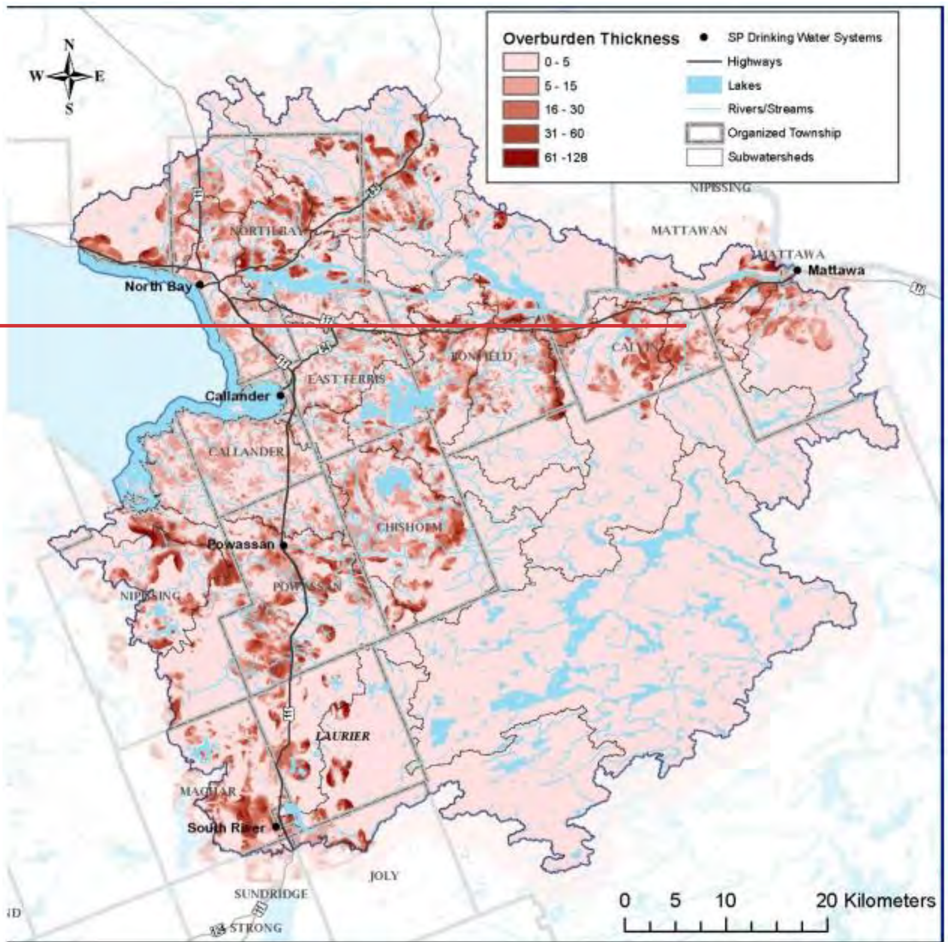

Physiography
Bedrock
Bedrock-drift complex
Glaciofluvial - Alluvium
Glaciolacustrine
Swamp and Organic
Till
SP Drinking Water System
Highways
Lakes
Organized Township
Subwatersheds
NORTH BAY
North Bay
MATTAWAN
Mattawa
CALVIN
PAPINEAU-CAMERON
EAST FERRIS
Callander
BONFIELD
CALLANDER
Powassan
NIPISSING
CHISHOLM
POWASSAN
MACHAR
South River
JOLY
SUNDRIDGE
STRONG
0 5 10 20 Kilometers

Figure 2-6. Overburden Thickness in the North Bay-Mattawa SP Area




Overburden Thickness
0 - 5
5 - 15
16 - 30
31 - 60
61 -128
SP Drinking Water Systems
Highways
Lakes
Rivers/Streams
Organized Township
Subwatersheds
N
W
E
S
NIPISSING
MATTAWAN
MATTAWA
Mattawa
North Bay
NORTH BAY
EAST FERRIS
Callander
CALLANDER
CHISHOLM
Powassan
POWASSAN
LAURIER
South River
JOLY
SUNDRIDGE
STRONG
0 5 10 20 Kilometers

A general overview of the surficial geology of the North Bay-Mattawa SP Area is provided in the following paragraphs, taken largely from Gartner and VanDine (1980).

Glacial till deposits are the predominate characteristic in the North Bay-Mattawa SP Area, with the exception of steep bedrock outcrop exposures and rock knob features. The SP Area is predominately overlain by subglacial till deposited during the last glacial ice advance (albeit thin in most places). Glacial till is a heterogeneous mixture of fine-grained and coarse-grained soils, and basically represents what is left after the glacial ice melted. The till matrix varies in texture from fine-grained silts to sands with clasts, which range from small grains to large boulders. The till forms a thin, discontinuous veneer over the bedrock surface and thickens considerably in the valleys. As such, it represents an impediment but not a barrier to groundwater flow. End and medial moraines are scattered throughout the Nipissing-Mattawa lowland area east of Lake Nipissing. These moraines consist of bouldery silty sand till, and they occur as subordinate landforms in the rock knob terrain throughout most of the area (Gartner and VanDine, 1980).

Glaciolacustrine sediments consist of well-stratified fine sand, silt and clay and are deposited in glacial lakes when melt water is trapped between the front of a glacier and a moraine or rock wall that prevents drainage. These deposits are present in a number of localities in the North Bay area and are especially concentrated along the north shore of Lake Nipissing. East of Bonfield Township the glaciolacustrine sediments range in texture from silty sand to silt and clay, and usually overlie bedrock or the till where present (Gartner and VanDine, 1980). These materials exhibit a relatively low permeability, but are flat lying and can contribute to high water table conditions. Glaciolacustrine deposits near Powassan consist of marginally more permeable sand and silt with minor clay (generally where rock knobs are less prominent) (Gartner and VanDine, 1980). In the region of Mattawa, the glaciolacustrine plains consist of clayey silt immediately south of the Mattawa and Ottawa Rivers (Gartner and VanDine, 1980).

Organic deposits are found throughout the region and have collected in low-lying areas, covering sand and gravel outwash plains, glaciolacustrine deposits, and Precambrian bedrock. Although highly permeable, they are mostly in areas of groundwater discharge and in most cases do not contribute significantly to recharge of the groundwater table other than in the summer months. In some areas they may mitigate rates of infiltration and runoff in the spring, retaining moisture like a sponge and creating reserves for drier summer months.

Coarse-grained deposits in the region are, for the most part, comprised of sand, gravel and boulders associated with kames, eskers and moraines. Well-rounded and well-sorted fluvial sands and gravels form large flat areas or terraces west of the Mattawa and Ottawa valleys (Harrison, 1972). Beach sands are also well sorted, well-rounded and form raised beaches or scarps (Harrison, 1972). These are all highly permeable and serve regionally as groundwater recharge zones.

Moraines are an accumulation of earth and stones carried by glacial outwash which is usually deposited into a high point like a ridge. Medial and end moraines lie along the margin of ice sheets, whereas ground moraine is left in the footprint of the ice after melting. Moraines can either be lower permeability materials like silty sands or sandy silts, or they can be comprised of sand and gravel and be highly permeable, depending on the material originally entrained in the ice. The Rutherglen Moraine (south of Rutherglen) and the Genesee Moraine (15 km east of Powassan) are the two major moraines formed during the last ice recession (Harrison, 1972). They formed when ice flowed from the east through the Mattawa Valley lowland. The Rutherglen Moraine extends approximately 11 km from the Mattawa River southward towards Algonquin Park. The moraine, which many consider to be an esker, consists of five segments each with unique composition ranging from sand and gravel, to till and clay (Harrison, 1972). The Genesee Moraine is a large end moraine that lies parallel to the Algonquin Highlands. This moraine is more than 8 km long and up to 3 km wide in some places, and is composed primarily of sand and gravel (Harrison, 1972).

Glacial outwash is widespread throughout the region. Immediately north of North Bay a large area of sandy gravel, gravely sand or sand blankets the Precambrian bedrock. In some places the overburden is over 30 m thick, but it is generally 3 m to 5 m thick over the bedrock (Gartner and VanDine, 1980). Therefore, these areas can serve as local or regional aquifers, if saturated, as well as groundwater recharge features. Immediately north of the Mattawa River, outwash deposits are found along Highway 533 from the Town of Mattawa northwest into Antoine Township (Gartner and VanDine, 1980). The Town of Mattawa is underlain by a large east-west trending ground moraine on the western edge of town, and a sand and gravel outwash plain upon which most of the town is built. Larger and deeper outwash deposits have good potential for groundwater supplies (Harrison, 1972). The larger portion of the Town of Powassan is underlain by a confined sand and gravel aquifer, which is utilized by the municipal well system. The silty-clay confining layer varies in thickness, and ranges from 5 m to 6 m in the immediate vicinity of the town's two municipal wells. The confining layer may not be continuous and, in some localized areas, the confining layer is interpreted to be absent.

Kames are ice-contact deposits that are typically laid down at the front of melting glaciers and they are also a common landform on the rock knob terrain of the study area (Harrison, 1972). Many kames extend from Lake Talon to the southern margin of the North Bay area, a distance of approximately 35 km. Kames are common in the Powassan area and southeast of Mattawa (Gartner and VanDine, 1980). Kames are recharge features and serve as local aquifers if extensive enough.

Eskers are sand and gravel deposits that are formed from melt-water channels within or below a glacier. These long ridges of sand and gravel are well developed in the study area. In the Mattawa region, the eskers trend in a southerly direction, with the largest located north of the Town of Mattawa (Gartner and VanDine, 1980). One esker located in Bonfield Township forms a single ridge and in most places rises 10 m to 15 m above the surrounding landscape (Harrison, 1972). While these are groundwater recharge features, eskers can also be the source of small streams at their base.

Mineral and aggregate resources within the SP Area include metallic and non-metallic deposits. However, current mining activity in the SP Area is limited to sand and gravel extraction. Historically other mining activities have taken place in the watershed, but only by relatively small operations that were involved in the extraction of surficial deposits. During the 1920s, feldspar was mined in the Mattawa area. More recently mica has been mined at several locations in the lower Mattawa valley including the Purdy Mica Mine in ~~Mattawa Township~~the Municipality of Mattawan which operated between 1941 and ~~1945~~1953. There are extensive aggregate extraction activities in the watershed, mainly within glaciofluvial deposits. A highly productive sand and gravel area is located north of the escarpment in North Bay.

Vegetative Land Cover

Only about 8% of the SP Area is classified as human land use in the forms of settlement infrastructure or agricultural pasture/cropland (Table 2-5). Over 80% is forested and 7% is open water. Dominant tree species include Red Pine, Eastern White Pine, Eastern Hemlock, Yellow Birch, Maple species, and Red Oak. The distribution of land cover classes is also shown in Figures 2-7 and 2-8.

Table 2-5. Vegetative Land Cover in the North Bay-Mattawa SP Area

Land Classification	Land Cover and Type	Area (km^2)	% Coverage	% Coverage by Class
Human Land Use	Settlement Infrastructure	80	2.0	8
	Pasture	252	6.3	
Forested	Mixed Forest	1479	37.3	80
	Deciduous Forest	1134	28.6	
	Coniferous Forest	378	9.5	
	Sparse Forest	170	4.3	
Wetland	Treed Bog	93	2.3	3
	Open Bog	4	0.1	
	Treed Fen	3	0.1	
Other	Other	72	1.8	2
	Cutovers	11	0.3	
	Burns	0	<1.0	
Water	Water – Deep or Clear	281	7.1	7
Bare Rock	Bedrock Outcrop	6	0.1	0
	Total	**3963**	100	100
~~**Total**~~	~~**3963**~~	~~100~~	~~100~~	

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Riparian areas are the lands found along shorelines. The term refers to the transition zone between upland areas, such as fields, and water features, such as streams, wetlands, lakes, and rivers. The zone may be intermittently inundated supporting wet meadow, marshy or swampy vegetation. Riparian areas are frequently ecologically diverse, providing important habitat and physical attributes that stabilize shorelines and reduce contaminants in overland flows. Residential development or agricultural activities have often resulted in alterations to shoreline areas. Large portions of the SP Area are unpopulated with riparian areas in their natural state, but there has been little data collection or assessment of those. If a 100 m strip along every shoreline were to be identified as a riparian buffer, it would amount to almost 15% of the SP Area.

Figure 2-7. Wooded Land Cover in the North Bay-Mattawa SP Area

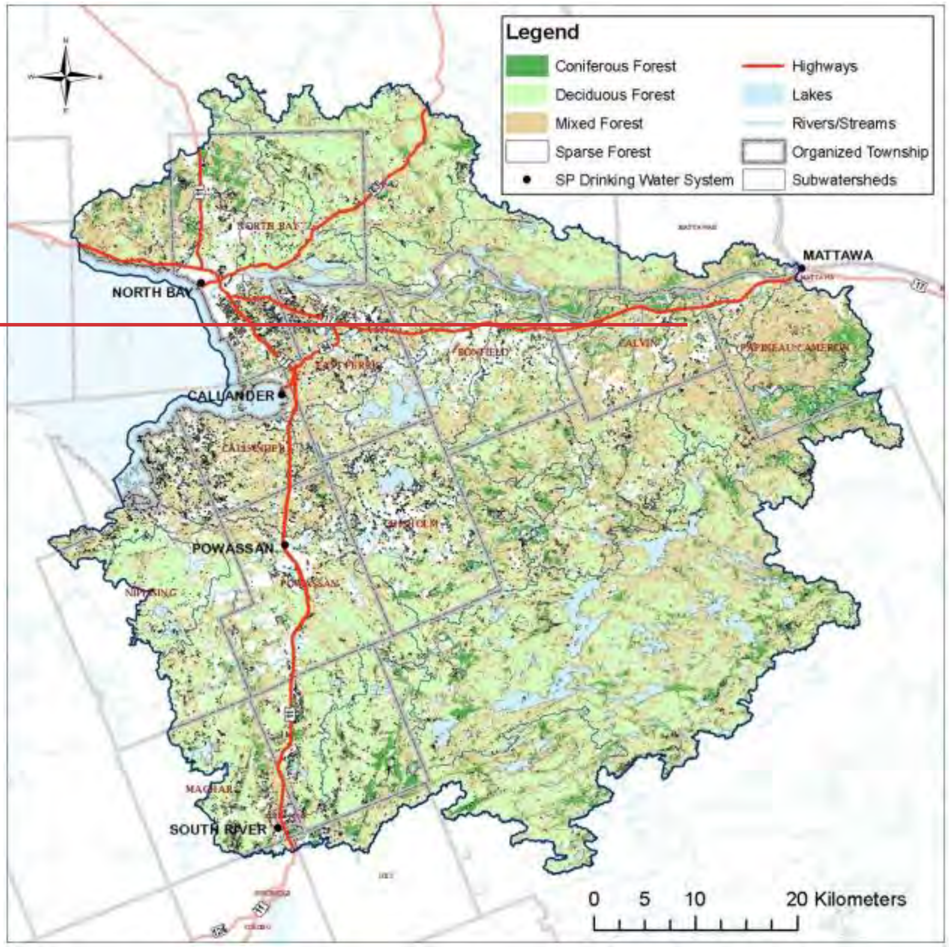
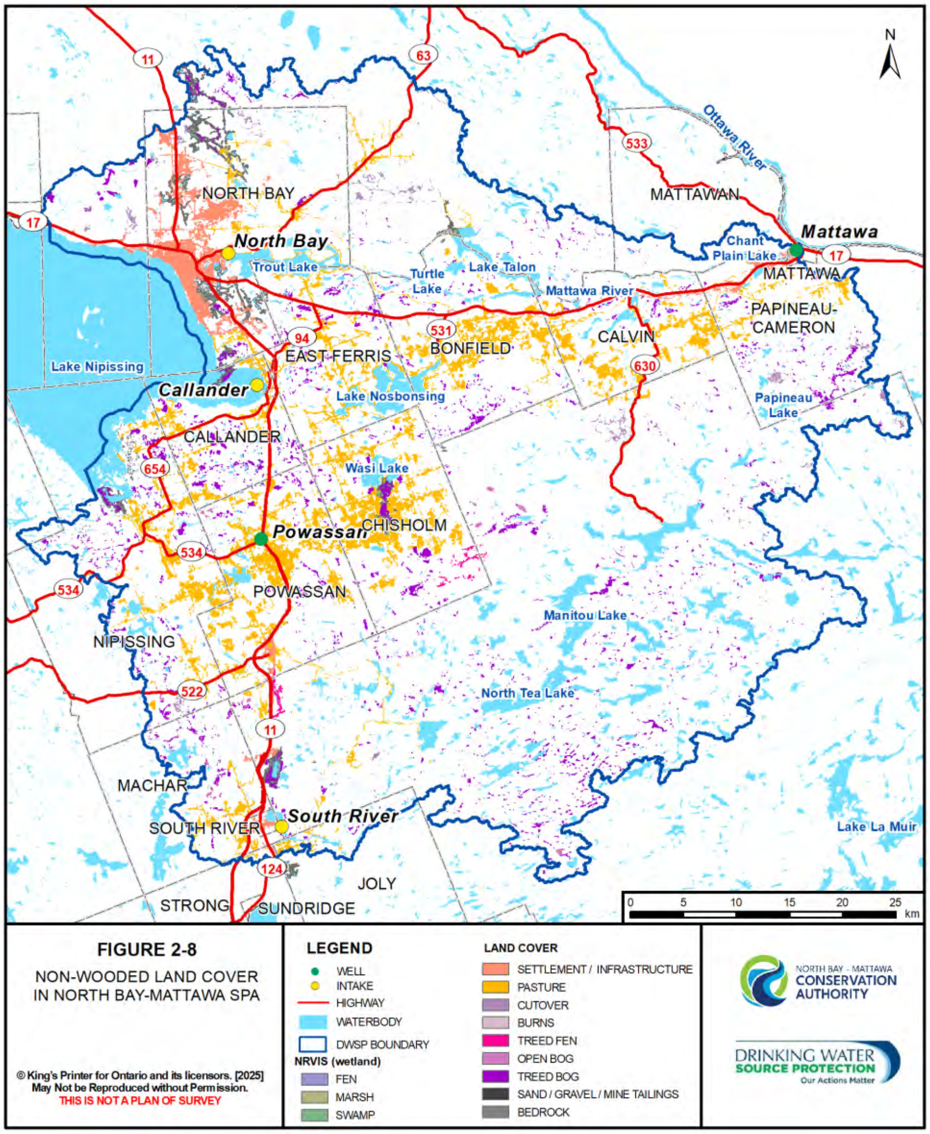
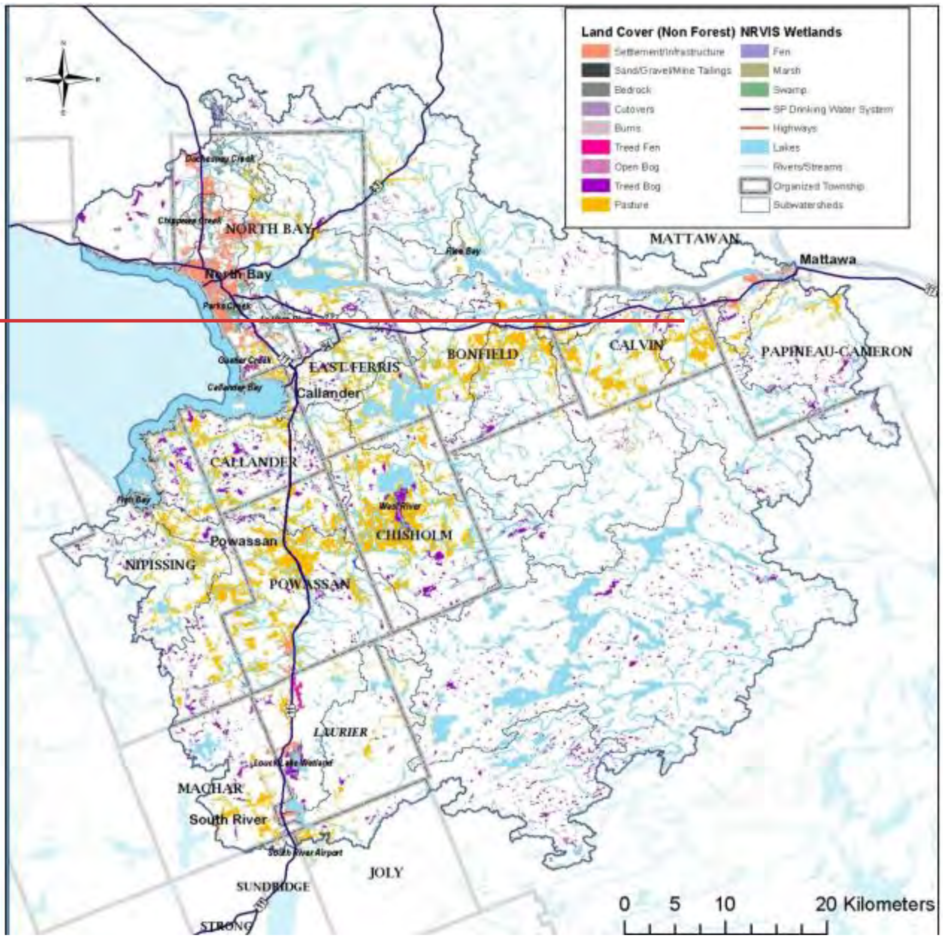

Legend
Coniferous Forest
Deciduous Forest
Mixed Forest
Sparse Forest
SP Drinking Water System
Highways
Lakes
Rivers/Streams
Organized Township
Subwatersheds
MATTAWA
NORTH BAY
CALLANDER
POWASSAN
SOUTH RIVER
0 5 10 20 Kilometers

Figure 2-8. Non-Wooded Land Cover in the North Bay-Mattawa SP Area





Land Cover (Non Forest) NRVIS Wetlands
Settlement/Infrastructure
Sand/Gravel/Mine Tailings
Bedrock
Cutovers
Burns
Treed Fen
Open Bog
Treed Bog
Pasture
Fen
Marsh
Swamp
SP Drinking Water System
Highways
Lakes
Rivers/Streams
Organized Township
Subwatersheds
NORTH BAY
North Bay
MATTAWAN
Mattawa
BONFIELD
CALVIN
PAPINEAU-CAMERON
EAST FERRIS
Callander
CALLANDER
CHISHOLM
Powassan
NIPISSING
POWASSAN
LAURIER
MACHAR
South River
JOLY
SUNDRIDGE
STRONG
0 5 10 20 Kilometers

Wetland distribution is relatively uniform across the SP Area with high concentrations of treed fens and treed bogs around Lake Nipissing in the Bear-Boileau Creeks and La Vase River watersheds. Approximately 100 km^2 of wetland covers the SP Area, or 2.5%. Of the wetlands that have been evaluated, 11 are classified as Provincially Significant. They include the Callander Bay Wetland, Chippewa Creek Conservation Area Wetland, Duchesnay Creek Wetland Complex, Fish Bay Wetland, Gauthier Creek Marsh, La Vase Portage Conservation Area, Louck Lake Wetland, Parks Creek Wetland, Rice Bay Wetland, South River Wetland, and the Upper Wasi River Swamp. In addition, locally significant wetlands have been identified in most SP Area subwatersheds.

Aquatic Habitats

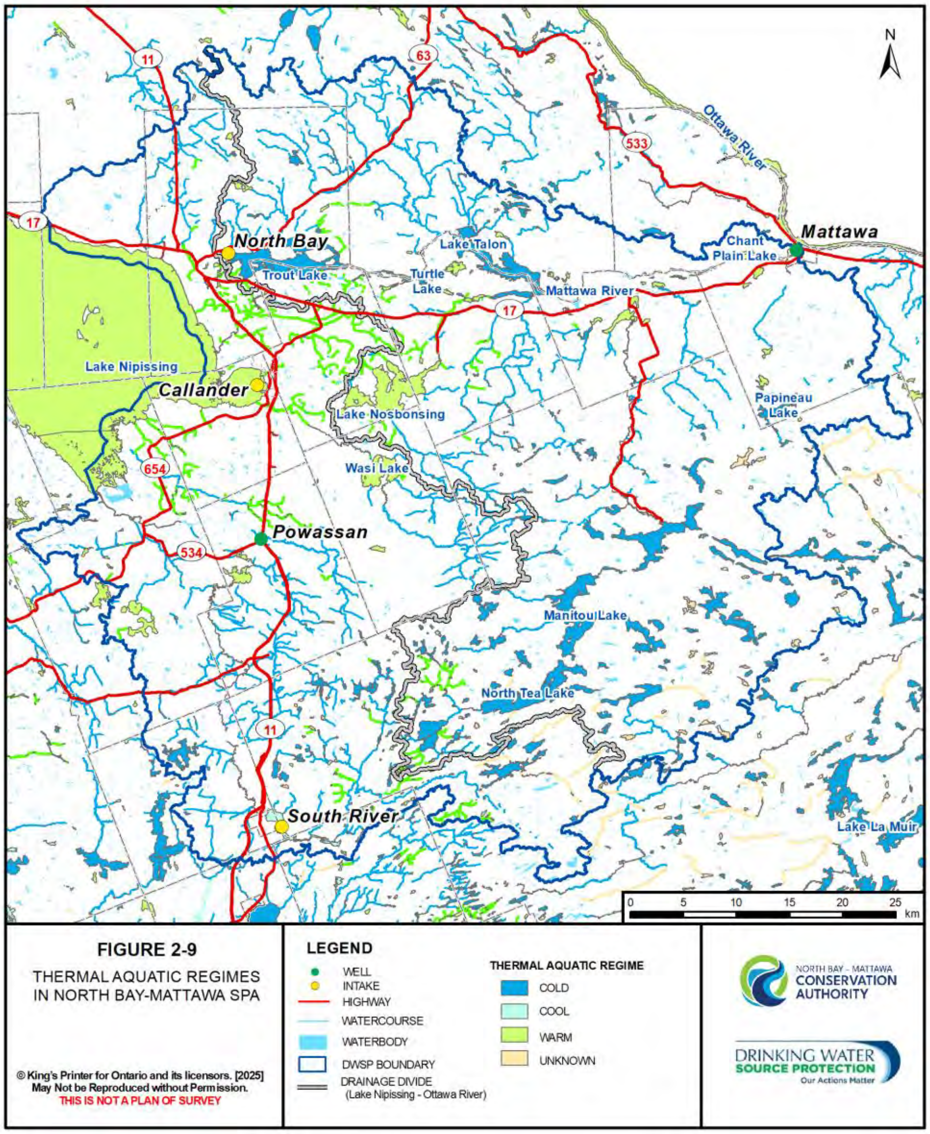
Aquatic habitats are diverse, again due to the large unpopulated and undeveloped expanses of the SP Area, as well as the varied topography, shallow soils and impervious bedrock. Locations of warm water, cool (mixed) water and coldwater fisheries are indicated according to thermal aquatic regimes (Figure 2-9).

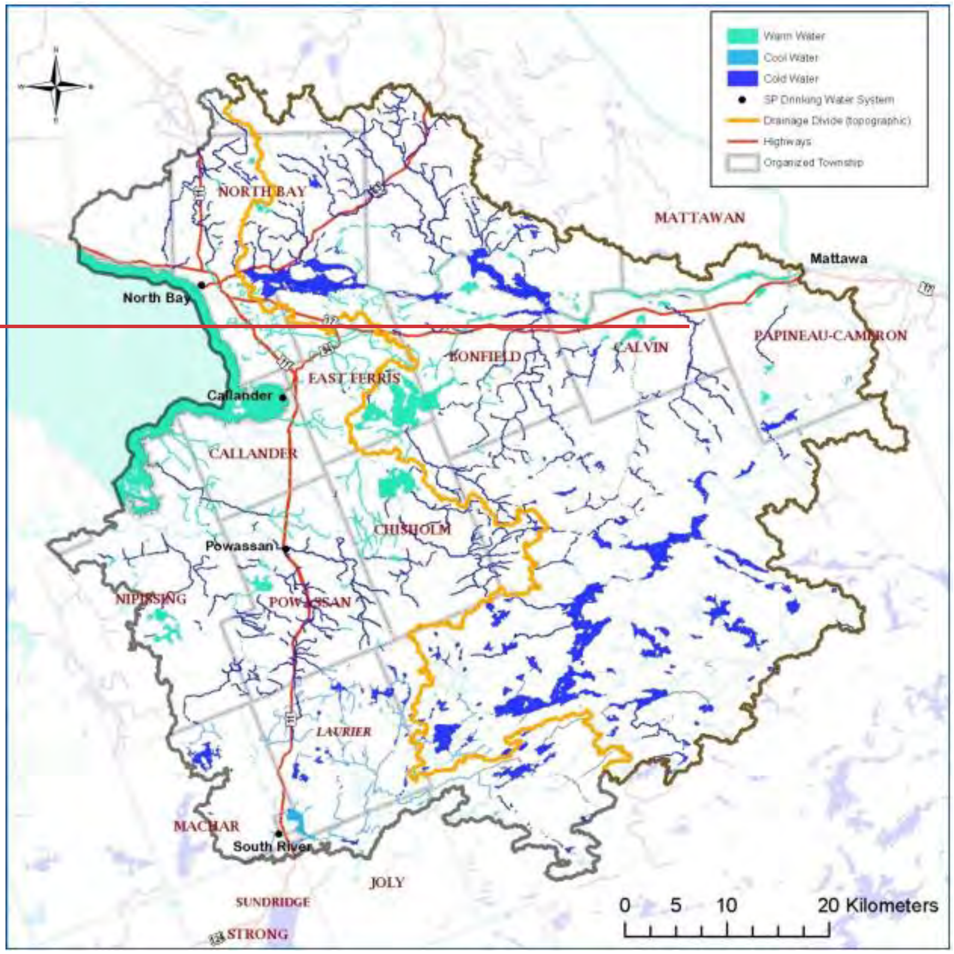
Cold water usually originates from groundwater discharge (baseflow), whereas warm water comes from overland flows. Therefore, thermal regimes are important to understanding the movement of water through the system. Observing the distribution of coldwater and warm water fish species is a relatively simple way to identify thermal regimes; the information tends to be readily available as it is collected for other purposes. In the SP Area, cold water lake fisheries tend to be located in the upland areas and warm water fisheries in the lowlands.

Macroinvertebrate communities are valuable indicators of environmental conditions in aquatic habitats and are typically found along shorelines, bottom substrates and within the water column. Benthic monitoring was started in Chippewa Creek, an urban creek in North Bay, in 2009. Prior to that, sampling of benthic macroinvertebrates was occasionally conducted as part of broader water quality studies in the 1960s and 1970s in Trout, Wasi and Graham Lakes; in Four Mile, Chiswick, Chippewa, Sharpes, Blueseal, Cahill, and Landis Creeks; and in the Kaibuskong and North Rivers. Macroinvertebrate diversity and abundance were found to be low in Graham Lake, Wasi Lake and Chiswick Creek, indicating eutrophic, oxygen-poor conditions. Macroinvertebrates were also sampled as part of the Wasi River Management Study conducted in 1984.

Aquatic habitats can be impacted by human activities, such as urban-suburban development, road construction, agriculture, forestry, mining, and hydroelectric development. Changes such as shoreline alteration, water level fluctuation, siltation, flooding, and acidification exemplify how both water quality and quantity can be affected.

Figure 2-9. Thermal Aquatic Regimes in the North Bay-Mattawa SP Area




Warm Water
Cool Water
Cold Water
SP Drinking Water System
Drainage Divide (topographic)
Highways
Organized Township
NORTH BAY
MATTAWAN
Mattawa
North Bay
PAPINEAU-CAMERON
CALVIN
BONFIELD
EAST FERRIS
Callander
CALLANDER
CHISHOLM
Powassan
NIPISSING
POWASSAN
LAURIER
MACHAR
South River
JOLY
SUNDRIDGE
STRONG
0 5 10 20 Kilometers

2.1.4 Species at Risk

The locations of species at risk are purposely not provided in this document or its associated maps due to the sensitivity of these species to disturbance and the risks for some species of illegal collection for the pet trade. Any direct linkages between source water protection features and species at risk occurrences should be handled in confidence by provincial Ministry staff with appropriate data sensitivity training. This information should be kept confidential with limited distribution.

Aquatic species are relevant to source protection planning for a number of reasons. Depending on water resources for part or all of their life cycles, these species are inherently tied to water quality and quantity issues. Their presence and abundance may serve as indicators of water quality. Considering the food web, other species depend on aquatic species for food. In this way, water quality and quantity conditions may indirectly impact these species with respect to food availability and contamination.

Designations

Designated species at risk are afforded protection under a variety of pieces of legislation, policies, and guidelines. They are also subject to stewardship initiatives and recovery efforts.

A species' status may be assessed and designated at both provincial and federal levels. Candidate species are evaluated by scientific committees of species experts. Provincially, species are assessed by the Committee on the Status of Species at Risk in Ontario and designations are assigned by the Minister of Environment, Conservation and Parks and listed in the Species at Risk in Ontario List (MECP 2020); Federally species are assessed and designated by the Committee on the Status of Endangered Wildlife in Canada which maintains a list of designated species (COSEWIC 2020). In response, the federal government may choose to assign status designations and list species under the Species at Risk Act (Species at Risk Act, 2002).

The Ontario *Endangered Species Act, 2007* classifies species at risk into one of four categories: Extirpated, Endangered, Threatened, and Special Concern. These categories build upon one another.

- Extirpated species if it lives somewhere in the world, lived at one time in the wild in Ontario, but no longer lives in the wild in Ontario;
- Endangered species if it lives in the wild in Ontario but is facing imminent extinction or extirpation;
- Threatened species if it lives in the wild in Ontario, is not endangered, but is likely to become endangered if steps are not taken to address factors threatening to lead to its extinction or extirpation;
- Special concern species if it lives in the wild in Ontario, is not endangered or threatened, but may become threatened or endangered because of a combination of biological characteristics and identified threats. (Ontario/MECP 2020 a).

Other categories used include Extinct, Data Deficient and Not at Risk.

- Extinct species. Species may be designated extinct if it no longer lives anywhere in the world (Ontario/MECP 2020a). Federal criteria define a species as extinct if, in all the world: a) there exists no remaining habitat for the species and there have been no records of the species despite recent surveys; or, b) 50 years have passed since the last credible record of the species, despite surveys in the interim; or, c) there is sufficient information to document that no individuals of the species remain alive (COSEWIC 2020).
- Data deficient. The status report has fully investigated all best available information; yet that information is insufficient to: a) satisfy any criteria or assign any status, or b) resolve the species' eligibility for assessment (COSEWIC, 2020).
- Not at risk. A wildlife species that has been evaluated and found to be not at risk of extinction given the current circumstances (COSEWIC, 2020).

These status designations are very important as they provide legal or policy protection, or stewardship direction for species and their habitats.

Legislative Protection

At the provincial level endangered species listed in regulation under the provincial *Endangered Species Act* as endangered or threatened are provided province-wide protection for both the species and its habitat. The Provincial Policy Statement, 2020 under the *Planning Act* provides protection for the habitat of endangered species and threatened species (MMAH 2020). The *Fish and Wildlife Conservation Act* provides some protection to those species at risk listed as “specially protected” under the *Endangered Species Act*. (Ontario 2020b)

At the federal level Extirpated, Endangered and Threatened species are provided species, residence and habitat protection under the *Species at Risk Act* (Government of Canada 2016). In addition, many migratory birds are provided protection under the *Migratory Birds Convention Act* (Government of Canada 2018), while fish habitat protection is given through the *Fisheries Act* and associated regulations. (MNR 2006e)

In some cases, individuals of an extirpated species may be found in captivity (i.e. zoos). For some, it may be possible to reintroduce the species if the issues causing its extirpation have been mitigated.

Threats

Threats to aquatic and semi-aquatic species include:

- shoreline development and alteration (loss of habitat);
- water pollution (via rain, runoff, direct application, spills);
- unnatural water level alteration (exposure/isolation, changes in flow patterns, erosion, flooding of nests);
- drainage (exposure/isolation, loss of habitat, loss of prey habitat);
- invasive species;

- barriers (dams, roads);
- disturbance (noise, water traffic);
- over-harvesting; and
- climate change (causing water temperature changes, changes in aquatic vegetation communities).

Species at Risk in the North Bay-Mattawa SP Area

The SP Area has 29 provincially and/or federally designated species at risk among birds, fish, reptiles, and mammals (Table 2-6).

Table 2-6. Species at Risk within the North Bay-Mattawa SP Area

Taxon	Species Common Name	Scientific Name	Ontario Status	Federal Status
Birds	Bald Eagle (northern population – north of French and Mattawa Rivers)	*Haliaeetus leucocephalus alascanus*	SC	NAR
	Bald Eagle (southern population – south of French and Mattawa Rivers)	*Haliaeetus leucocephalus alascanus*	END-R	NAR
	Bank Sswallow	*Riparia riparia*	THR	THR
	Barn sSwallow	*Hirundo rustica*	THR	THR
	Black Tern	*Chilidonias niger*	SC	NAR
	Bobolink	*Dolichonyx oryzivorus*	THR	THR
	Canada wWarbler	*Cardellina Canadensis*	SC	THR
	Chimney Sswift	*Chaetura pelagica*	THR	THR
	Common nNighthawk	*Chordeiles minor*	SC	SC
	Eastern Meadowlark	*Sturnella magna*	THR	THR
	Eastern Whip-poor-will	*Antrostomus vociferus*	THR	THR
	Eastern Wood Pewee	*Contopus virens*	SC	SC
	Evening Grosbeak	*Coccothraustes vespertinus*	SC	SC
	Least Bittern	*Ixobrychus exilis*	THR	THR
	Olive-sided Fflycatcher	*Contopus cooperi*	SC	SC
	Peregrine Falcon	*Falco peregrinus anatum/tundrius*	SC	NAR
	Wood Thrush	*Hylocichla mustelina*	SC	THR
Fish	Lake Sturgeon (Great Lakes population)	*Acipenser fulvescens*	END	THR
Fish	Northern Brook Lamprey	*Ichthyomyzon fossor*	SC	SC

Taxon	Species Common Name	Scientific Name	Ontario Status	Federal Status
	Northern Sunfish (Great Lakes population)	*Lepomis peltastes*	SC	SC
	Silver Lamprey (Great Lakes population)	*Ichthyomyzon unicuspis*	SC	SC
Reptiles	Blanding's Turtle	*Emydoidea blandingii*	THR	END
	Eastern Hog-nosed Snake	*Heterodon platirhinos*	THR	THR
	Eastern Milksnake	*Lampropeltis triangulum triangulum*	SC	SC
	Eastern Ribbon Snake	*Thamnophis sauritus sauritus*	SC	SC
	Snapping Turtle	*Chelydra serpentina*	SC	SC
Mammals	Algonquin Wolf	*Canis sp.*	THR	NAR
	Eastern Wolf	*Canis sp. cf. lycaon*	NAR	THR
	Little Brown Myotis	*Myotis lucifugus*	END	END
	Northern Myotis	*Myotis septentrionalis*	END	END

Note: END - Endangered; END-R – Endangered regional population; THR – Threatened; SC – Special concern; NAR – Not at risk

(Sources: MECP 2020; GBBR 2020; COSEWIC 2020; Government of Canada 2020; NHIC 2020; Totten Sims Hubicki 1997a citing NBMCA 1996; OPGI 2005)

As a result of their habitat and/or food sources, those directly influenced by water quality and/or quantity include: Bald Eagle, Bank Swallow, Black Tern, Least Bittern, Olive-sided Flycatcher, Peregrine Falcon, Lake Sturgeon, Northern Brook Lamprey, Northern Sunfish, Silver Lamprey, Blanding's Turtle, Eastern Hog-nosed Snake, Eastern Ribbon Snake, and Snapping Turtle.

Other Rare Species

In addition, a number of rare, aquatic and semi-aquatic species are known to occur in this area. Of particular interest are the river- and pond-breeding dragonflies associated with the Mattawa River whose presence and abundance may serve as indicators of water quality. Rare plant species of interest include Algae-like Pondweed and Blunt-lobe Grapefern due to their association with water quality and quantity.

Habitats at Risk

A patch of the rare "Atlantic Coastal Plain Shallow Marsh Type" vegetation community occurs in the South River and Reserve-Beatty Creeks watersheds in the Township of Nipissing. This vegetation community is considered very rare provincially (S3) with few remaining hectares. Available information suggests it is imperiled globally (G2). (NHIC 2006)

2.1.5 Invasive Species

There are around 200 non-native species occurring in the Great Lakes watershed of which many are considered “invasive”. The spread of invasive species is monitored through a partnership program involving Ontario Federation of Anglers and Hunters and the Ministry of Natural Resources and Forestry.

Typically non-native, invasive species have high reproductive rates, lack natural population checks such as predators and disease, and aggressively out-compete indigenous species for resources. Once introduced, invasive species spread quickly. Once established they are difficult to eradicate (OFAH 2006).

Aquatic invasive species have been introduced to the Great Lakes system as a result of world-wide boat traffic, aquarium and water garden trades, and the aquaculture industry. Through recreational activities such as boating, angling, scuba diving, and flying (float planes), these species can be spread to inland lakes and rivers. Pet release and seeds spreading from garden plantings are other vectors for invasive species introductions. Plants, fish, mussels, parasites, and other small organisms can be transported via boat hulls, boat trailers, float plane floats, scuba gear, bait buckets, ballast water, bilge water, and live wells (OFAH 2020).

Invasive Species in the SP Area

Many invasive species are found in the SP Area. For example, the Spiny Waterflea (*Bythotrephes longimanus*) was first discovered in Lake Nipissing in 1998 and occurs within Callander Bay (Filion 2011), while Purple Loosestrife (*Lythrum salicaria*) is a common and widespread invasive species which has been in the area for over a century. Other examples include spongy moth (*Lymantria dispar dispar*), emerald ash borer, phragmites, Himalayan balsam, and Japanese knotweed (OFAH 2020).

2.1.6 Water Quality

Surface Water Quality and Monitoring

In Ontario, standards and guidelines have been established to protect water for designated uses such as drinking, recreation, agricultural irrigation, and the protection of aquatic life. The Ontario Drinking Water Quality Standards (ODWS; O. Reg. 169/03) ensure that drinking water supplies pose a minimum risk to public health. The Provincial Water Quality Objectives (PWQOs) are designed to protect all forms of aquatic life and to protect recreational water uses.

Water quality is currently monitored monthly from April through November at eight locations within the SP Area as part of the Provincial Water Quality Monitoring Network (PWQMN). https://data.ontario.ca/en/dataset/provincial-stream-water-quality-monitoring-network

Data has been collected provincially since 1964, but local participation has varied over the years depending on available funding and identified issues. An attempt was made in 2006 to establish locations for more consistent long-term monitoring. Locations must be on flowing water and include watercourses draining a variety of areas: unpopulated forested, urban and agricultural. The PWQMN stations within the SP Area are listed in Table 2-7 below and shown on Figure 2.10.

Table 2-7a. Provincial Water Quality Monitoring Network (PWQMN) Stations in the North Bay-Mattawa SP Area

Station ID	Watercourse	Location	Period of Record
18607008002	Amable du Fond River	Hwy 17, E of Hwy 630, W of Mattawa	1972-75, 1992, 2007-present
03013301902	Chippewa Creek	Memorial Dr, Amelia Park, close to mouth into Lake Nipissing, North Bay	1968-91, 1993-94, 2003-05, 2007-present
03013301302	Duchesnay Creek	Main St W (Hwy 17B), North Bay	1968-91, 1993-94, 2007-present
18607006002	Kaibuskong River	Hwy 17 downstream of Lake Nosbonsing, near Hwy 531, N of Bonfield	1972-75, 1992, 2007-present
03013302402	La Vase River	At mouthChamplain Park, North Bay	1973-94, 2016-2023present
03013301502	La Vase River	At Riverbend Rd, North Bay	2024 - present
18607002002	Mattawa River	Near Mattawa Island,First St Bridge, Mattawa	1968-90, 1992-94, 2007-present
03013302302	*South River	Hwy 11, downstream of Village of South River	1973-82, 1985, 1991 2007-2016
03013304002	South River	At Chapman's Landing Rd	2017 - present
03013303002	Wasi River	Lake Nosbonsing Rd, Hwy 654, upstream of falls near outlet to Callander Bay, S of Callander	1984-1994, 2003-05, 2007-present

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Table 2-7b NBMCA Stream Monitoring Stations in the North Bay-Mattawa SP Area

Station ID	Watercourse	Location	Period of Record
BM-BMC-01	Boom Creek	Louisa St, Mattawa	2018-present
BU-BUC-01	Burford Creek	Hwy 94 near Mountain Road, Callander	2010-present

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Station ID	Watercourse	Location	Period of Record
CA-LWC-02	Lansdowne Creek	High St, Callander	2024-present
JP-JPC-01	Jessup's Creek	Lakeshore Dr, North Bay	2018-2022
LV-CKC-01	Cook Creek	Decaire Rd, North Bay	2024-present
NO-BAC-01	Balsam Creek	Songis Rd, Phelps	2018-present
NO-NOR-01	North River	Songis Rd, Phelps	2018-present
PK-PKC-01	Parks Creek	Off Mercer Dr, North Bay	2018-present
PT-PTC-01	Pautois Creek	Hwy 17 near Samuel de Champlain Provincial Park	2018-present
SH-SHC-01	Shapes Creek	Hwy 17 near Rutherglen	2018-present
TR-FMC-12	Four Mile Creek	Northshore Rd, North Bay	2010-present
TR-LEC-02	Lees Creek	Trout Lake Rd, North Bay	2024-present
WB-BDC-01	Boulder Creek	Hwy 654, Callander	2018-present
WB-BEC-01	Bear Creek	Bear Creek Rd, Nipissing	2018-present
WB-WDC-01	Windsor Creek	Pinecreek Rd, Callander	2010-present

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Water Chemistry Ddata from the PWQMN and NBMCA monitoring stations are shown in Table 2-8a to Table 2-8g. -PWQMN water chemistry parameters determined by laboratory analysis include a wide range of parameters such as chloride, total phosphorus, nitrate, total suspended solids, zinc, and many more. As well, physical parameters including temperature, pH, dissolved oxygen, turbidity, and specific conductance are measured in the field. Table 2-9a to Table 2-9e shows additional data from twofour stations where samples have been collected in the December-March period.

Table 2-8. PWQMN Sample Results (2003-2009)

Parameter	Statistic	PWQMN Location and Site Number							Guidance or Benchmark
		Amable Du Fond River	Chippewa Creek	Duchesnay Creek	Kaibuskong River	Mattawa River	South River	Wasi River	
		18607008002	3013301902	3013301302	18607006002	18607002002	3013302302	3013303002	
Chloride (mg/L)	# Samples	23	44	23	23	23	23	42	250
	Minimum	0.5	21.1	1.9	3.8	2.3	1	2	
	Maximum	2.8	176	44.1	20.2	3.6	2.9	12.1	
	Median	1	90.75	13.3	4.7	3	1.6	4	
	Average	1.14	91.99	16.62	6.13	3.05	1.73	4.57	
Nitrate (mg/L)	# Samples	23	44	23	23	23	23	42	13
	Minimum	0.001	0.242	0.001	-0.001	-0.002	0.002	0.001	
	Maximum	0.067	0.812	0.228	0.076	0.122	0.101	0.188	
	Median	0.018	0.5235	0.05	0.006	0.042	0.028	0.039	
	Average	0.03	0.53	0.07	0.01	0.05	0.04	0.06	
Total Phosphorus (mg/L)	# Samples	23	43	23	23	23	23	42	0.03
	Minimum	0.002	0.008	0.003	0.003	0.002	0.003	0.015	
	Maximum	0.020	0.080	0.052	0.081	0.020	0.031	0.112	
	Median	0.010	0.019	0.023	0.018	0.012	0.010	0.041	
	Average	0.010	0.023	0.025	0.022	0.012	0.011	0.042	
Total Suspended Solids (mg/L)	# Samples	22	43	23	23	23	23	41	25
	Minimum	0.7	0.8	1.2	1.5	0.6	0.6	3	
	Maximum	3.6	337	15.6	6.3	4	5.8	25.2	
	Median	1.5	3.4	3.7	2.9	1.6	1.8	7.1	
	Average	1.71	15.94	4.95	3.19	1.70	1.97	8.08	
Zinc (mg/L)	# Samples	23	44	23	23	23	23	42	20
	Minimum	0.373	4.83	1.65	-0.0995	0.649	0.288	1.02	
	Maximum	3.56	186	11.7	3.53	3.02	3.81	5.16	
	Median	1.9	9.18	5.61	1.12	1.4	2.12	2.615	
	Average	1.86	13.41	5.81	1.26	1.51	2.21	2.85	

Table 2-8a. Stream Total Phosphorus PWQMN Sample Results (2003–2025) for the April–November period. Values exceeding Provincial Water Quality Objective (PWQO; interim) of 30 µg/L are bold.

River	**Site ID**	**# Samples**	**Minimum (µg/L)**	**Maximum (µg/L)**	**Median (µg/L)**	**Mean (µg/L)**
Amable Du Fond River	18607008002	169	1.0	24.0	10.6	10.3
Chippewa Creek	03013301902	189	3.7	**525.0**	18.0	29.8
Duchesnay Creek	03013301302	169	1.8	**162.0**	18.3	22.1
Kaibuskong River	18607006002	164	1.9	**70.6**	16.2	17.6
La Vase River at Champlain Park (2016-2023)	03013302402	75	9.0	**70.0**	**38.9**	**39.3**
La Vase River at Riverbend Rd (since 2024)	03013301502	15	10.8	**361.0**	**36.6**	**58.5**
Mattawa River	18607002002	164	1.9	**112.0**	11.0	12.2
Ottawa River	18000036002	165	2.0	**66.0**	13.0	13.6
South River at Forest Lake (2007-2016)	03013302302	76	5.0	**31.0**	11.0	11.5
South River at Chapman's Landing (since 2017)	03013304002	89	3.0	**96.7**	18.0	21.1
Wasi River	03013303002	188	6.3	**305.0**	**36.0**	**38.1**

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Table 2-8b. Stream Total Phosphorus NBMCA Sample Results (2018–2025) for the April–November period. Values exceeding Provincial Water Quality Objective (PWQO; interim) of 30 µg/L are bold.

River	Site ID	# Samples	Minimum (µg/L)	Maximum (µg/L)	Median (µg/L)	Mean (µg/L)
Boom Creek	BM-BMC-01	46	12.0	**67.0**	29.5	**31.4**
Burford Creek	BU-BUC-01	56	11	**70**	**31.5**	**32.4**
Lansdowne Creek (since 2024)	CA-LWC-02	17	11.0	**81.0**	23.0	29.9
Jessup's Creek (2018-2022)	JP-JPC-01	30	21.0	**222.0**	**50.0**	**66.9**
Cook Creek (Since 2024)	LV-CKC-01	17	18.0	**83.0**	**33.0**	**40.5**
Balsam Creek	NO-BAC-01	45	1.0	**212.0**	13.0	**33.3**
North River	NO-NOR-01	46	4.0	**84.0**	17.0	18.3
Parks Creek	PK-PKC-01	47	8.0	**73.0**	**30.0**	**30.8**
Pautois Creek	PT-PTC-01	45	8.0	**47.0**	19.0	20.6
Sharpes Creek	SH-SHC-01	46	3.0	**87.0**	21.5	22.3
Four Mile Creek	TR-FMC-12	54	1.0	**112.0**	16.0	20.6
Lee's Creek (since 2024)	TR-LEC-02	15	4.0	**73.0**	10.0	14.7
Boulder Creek	WB-BDC-01	47	11.0	**81.0**	**41.0**	**43.7**
Bear Creek	WB-BEC-01	47	22.0	**106.0**	**50.0**	**56.0**
Windsor Creek	WB-WDC-01	56	12.0	**84.0**	**33.5**	**37.6**

Table 2-8c. Stream Chloride PWQMN Sample Results (2003–2025) for the April–November period. Values exceeding Canadian Water Quality Guidelines for the Protection of Aquatic Life (long-term toxicity) of 120 mg/L are bold.

River	Site ID	# Samples	Minimum (mg/L)	Maximum (mg/L)	Median (mg/L)	Mean (mg/L)
Amable Du Fond River	18607008002	129	0.2	2.9	1.4	1.3
Chippewa Creek	03013301902	150	11.6	**182.0**	88.6	87.8
Duchesnay Creek	03013301302	129	1.9	100.0	13.2	17.2
Kaibuskong River	18607006002					
La Vase River at Champlain Park (2016-2023)	03013302402	44	11.7	77.2	26.5	32.1
La Vase River at Riverbend Rd (since 2024)	03013301502	15	14.5	117.0	38.9	44.9
Mattawa River	18607002002	126	2.0	5.9	3.4	3.5
Ottawa River	18000036002	127	0.7	3.9	2.0	2.0
South River at Forest Lake (2007-2016)	03013302302	67	1.0	12.2	2.0	2.4
South River at Chapman's Landing (since 2017)	03013304002	60	3.8	16.4	10.8	10.3
Wasi River	03013303002	149	1.8	16.0	4.1	4.9

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Table 2-8d. Stream Chloride NBMCA Sample Results (2022–2025) for the April–November period. Values exceeding Canadian Water Quality Guidelines for the Protection of Aquatic Life (long-term toxicity) of 120 mg/L are bold

River	Site ID	# Samples	Minimum (mg/L)	Maximum (mg/L)	Median (mg/L)	Mean (mg/L)
Boom Creek	BM-BMC-01	23	0.3	3.6	1.9	1.9
Burford Creek	BU-BUC-01	33	5.8	109.0	29.6	43.8
Lansdowne Creek (since 2024)	CA-LWC-02	17	79.6	**213.0**	**145.0**	**143.3**
Jessup's Creek (2022)	JP-JPC-01	8	31.5	69.0	47.3	50.5
Cook Creek (Since 2024)	LV-CKC-01	17	37.0	**261.0**	102.0	117.8
Balsam Creek	NO-BAC-01	23	5.9	96.0	9.2	13.0
North River	NO-NOR-01	23	3.6	13.7	6.8	7.4
Parks Creek	PK-PKC-01	25	28.0	**135.0**	92.0	93.4
Pautois Creek	PT-PTC-01	23	0.9	5.2	2.8	3.0
Sharpes Creek	SH-SHC-01	23	0.3	3.6	1.6	1.8
Four Mile Creek	TR-FMC-12	31	2.5	26.7	13.0	14.0
Lee's Creek (since 2024)	TR-LEC-02	15	19.1	42.0	21.1	24.9
Boulder Creek	WB-BDC-01	25	4.3	30.2	10.2	13.0
Bear Creek	WB-BEC-01	25	9.1	52.9	24.8	26.5
Windsor Creek	WB-WDC-01	33	27.4	**151.0**	71.6	77.3

Table 2-8e. Stream Nitrate PWQMN Sample Results (2019–2025) for the April–November period. Values exceeding Canadian Water Quality Guidelines for the Protection of Aquatic Life (long-term exposure) of 3 mg N/L (13 mg NO_3^-/L) are bold.

River	Site ID	# Samples	Minimum (mg N/L)	Maximum (mg N /L)	Median (mg N /L)	Mean (mg N /L)
Amable Du Fond River	18607008002	39	0.02	0.24	0.06	0.06
Chippewa Creek	03013301902	39	0.16	**0.76**	0.43	0.44
Duchesnay Creek	03013301302	39	0.02	0.51	0.07	0.09
Kaibuskong River	18607006002	39	0.02	0.24	0.05	0.06
La Vase River at Champlain Park (until 2023)	03013302402	22	0.02	0.33	0.13	0.14
La Vase River at Riverbend Rd (since 2024)	03013301502	14	0.02	0.62	0.25	0.24
Mattawa River	18607002002	36	0.02	0.26	0.09	0.09
Ottawa River	18000036002	37	0.15	0.38	0.21	0.22
South River at Chapman's Landing	03013304002	37	0.02	0.18	0.10	0.09
Wasi River	03013303002	39	0.02	0.46	0.08	0.09

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Table 2-8f. Stream Zinc PWQMN Sample Results (2003–2025) for the April–November period. Values exceeding Provincial Water Quality Objective (PWQO; interim) of 20 µg/L are bold.

River	Site ID	# Samples	Minimum (µg/L)	Maximum (µg/L)	Median (µg/L)	Mean (µg/L)
Amable Du Fond River	18607008002					
Chippewa Creek	03013301902	144	4.8	**186.0**	9.8	14.0
Duchesnay Creek	03013301302	124	1.7	16.3	6.0	6.1
Kaibuskong River	18607006002					
La Vase River at Champlain Park (2016-2023)	03013302402	43	1.0	9.7	4.9	5.0
La Vase River at Riverbend Rd (since 2024)	03013301502	12	3.3	15.7	5.1	6.3
Mattawa River	18607002002	124	0.1	10.6	1.9	2.2
Ottawa River	18000036002	124	0.5	6.1	2.5	2.5
South River at Chapman's Landing (since 2017)	03013304002	56	1.0	9.4	2.7	2.8
Wasi River	03013303002	144	1.0	12.9	3.1	3.3

Table 2-8g. Stream Total Suspended Solids PWQMN Sample Results (2003–2025) for the April–November period. (no absolute guideline exists).

River	Site ID	# Samples	Minimum (mg/L)	Maximum (mg/L)	Median (mg/L)	Mean (mg/L)
Amable Du Fond River	18607008002	122	0.5	8.9	1.6	2.0
Chippewa Creek	03013301902	143	0.5	410.0	3.7	17.2
Duchesnay Creek	03013301302	122	0.5	67.6	2.7	5.2
Kaibuskong River	18607006002	118	0.6	19.2	2.9	3.4
La Vase River at Champlain Park (2016-2023)	03013302402	43	1.7	13.0	4.7	5.1
La Vase River at Riverbend Rd (since 2024)	03013301502	15	2.4	9.4	5.2	5.4
Mattawa River	18607002002	119	0.5	44.9	1.3	2.1
Ottawa River	18000036002	120	0.5	6.8	1.5	1.7
South River at Chapman's Landing (since 2017)	03013304002	59	0.5	90.8	1.6	5.5
Wasi River	03013303002	142	0.5	27.0	5.6	6.9

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Note: Values in **bold** ~~*ITALIC*~~ text are exceedances of the stated guideline.

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[1]CWQG = Canadian Water Quality Guideline for the Protection of Aquatic Life, Long-term Exposure, Freshwater by Canadian Council of Ministers of the Environment (CCME).

[2]The (relative) CCME guideline for Total Suspended Solids is a maximum increase of 25 mg/L from background levels for a short-term period, or 5 mg/L over background for a long-term period under "clear flow", and a maximum increase of 25 mg/L from background levels at any time when background levels are between 25 and 250 mg/L under "high flow", with a maximum increase of 10% when background is >= 250 mg/L.

[3]Analysis and detection limits have changed through time. < value signifies below current detection limits.

~~[3]Value reported as negative (value below detection limit).~~

Table 2-9a. Stream Total Phosphorus PWQMN Sample Results (2016–2025) for the December-March period. Values exceeding Provincial Water Quality Objective (PWQO; interim) of 30 µg/L are bold.

River	Site ID	# Samples	Minimum (µg/L)	Maximum (µg/L)	Median (µg/L)	Mean (µg/L)
Amable Du Fond River (since 2022)	18607008002	13	6.1	18.8	7.31	8.9
Chippewa Creek	03013301902	36	10.2	**195**	16.1	**34.3**
Duchesnay Creek (since 2022)	03013301302	13	7.3	17.2	11.4	11.8
Wasi River	03013303002	27	16.7	**51.1**	24.0	27.9

Table 2-9b. Stream Chloride PWQMN Sample Results (2016–2025) for the December-March period. Values exceeding Canadian Water Quality Guidelines for the Protection of Aquatic Life (long-term toxicity) of 120 mg/L are bold.

River	Site ID	# Samples	Minimum (mg/L)	Maximum (mg/L)	Median (mg/L)	Mean (mg/L)
Amable Du Fond River (since 2022)	18607008002	13	0.75	2.3	1.6	1.4
Chippewa Creek	03013301902	31	24.7	**404**	102	**135.4**
Duchesnay Creek (since 2022)	03013301302	14	5.7	25.8	14.1	14.6
Wasi River	03013303002	26	3	22.2	4.6	6.4

Table 2-9c. Stream Nitrate PWQMN Sample Results (2019–2025) for the December-March period. Values exceeding Canadian Water Quality Guidelines for the Protection of Aquatic Life (long-term exposure) of 3 mg N/L (13 mg NO_3^-/L) are bold.

River	Site ID	# Samples	Minimum (mg N/L)	Maximum (mg N/L)	Median (mg N/L)	Mean (mg N/L)
Amable Du Fond River (since 2022)	18607008002	13	0.02	0.18	0.08	0.09
Chippewa Creek	03013301902	14	0.32	0.66	0.50	0.50
Duchesnay Creek (since 2022)	03013301302	14	0.09	0.38	0.13	0.16
Wasi River	03013303002	14	0.11	0.43	0.15	0.17

Table 2-9d. Stream Zinc PWQMN Sample Results (2016–2019) for the December-March period. Values exceeding Provincial Water Quality Objective (PWQO; interim) of 20 µg/L are bold.

River	Site ID	# Samples	Minimum (µg/L)	Maximum (µg/L)	Median (µg/L)	Mean (µg/L)
Chippewa Creek	03013301902	8	10.1	**33.4**	14.9	18.9
Wasi River	03013303002	3	4.0	4.8	1.1	4.3

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Table 2-9e. Stream Total Suspended Solids PWQMN Sample Results (2016–2025) for the December-March period. (no absolute guideline exists).

River	Site ID	# Samples	Minimum (mg/L)	Maximum (mg/L)	Median (mg/L)	Mean (mg/L)
Amable Du Fond River (since 2022)	18607008002	13	0.5	1.3	0.5	0.7
Chippewa Creek	03013301902	31	0.5	350.0	3.9	22.4
Duchesnay Creek (since 2022)	03013301302	14	0.5	6.2	1.1	1.3
Wasi River	03013303002	26	1.6	12.7	3.9	4.5

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Note: Values in bold ***ITALIC*** text are exceedances of the stated guideline.

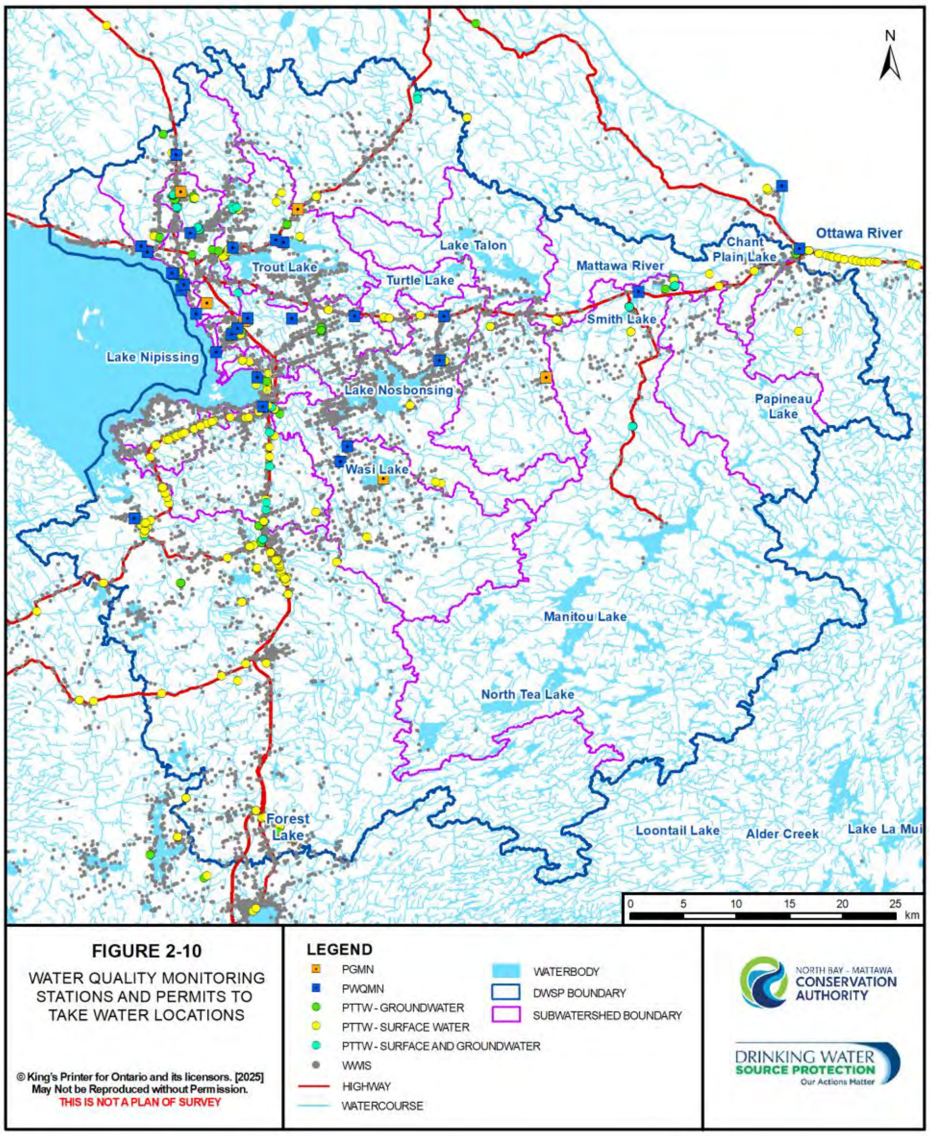
[1]CWQG = Canadian Water Quality Guideline for the Protection of Aquatic Life, Long-term Exposure, Freshwater by Canadian Council of Ministers of the Environment (CCME).

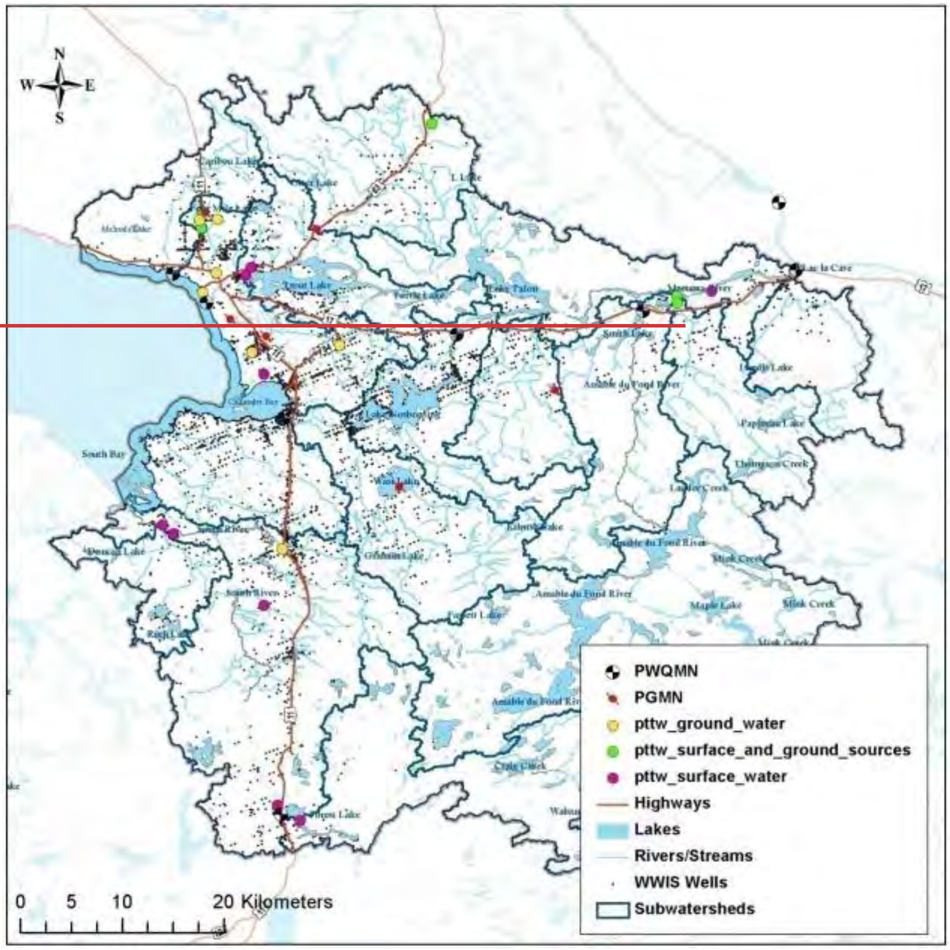
[2]The (relative) CCME guideline for Total Suspended Solids is a maximum increase of 25 mg/L from background levels for a short-term period, or 5 mg/L over background for a long-term period under "clear flow", and a maximum increase of 25 mg/L from background levels at any time when background levels are between 25 and 250 mg/L under "high flow", with a maximum increase of 10% when background is >= 250 mg/L.

[3]Analysis and detection limits have changed through time. < value signifies below current detection limits.

[4]Zinc and other metals no longer part of winter sampling protocols.

Figure 2-10. Water Quality Monitoring Stations and PTTW Locations

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Lakes
Rivers/Streams
WWIS Wells
Subwatersheds
0 5 10 20 Kilometers

At most sites within the SP Area, chemical parameters are usually below limits established by Provincial Water Quality Objectives (PWQOs) or the Canadian Water Quality Guidelines (CWQGs) for the Protection of Aquatic Life established by the Canadian Council of Ministers of the Environment (CCME). These low concentrations reflect the generally undeveloped conditions and relative lack of pollutant sources in the area. Water quality shows some evidence of degradation in the Wasi River, Chippewa Creek and the La Vase River, the latter two of which drain some urbanized portions of the City of North Bay (Table 2-8). Chippewa Creek tends to exhibit the highest levels of total suspended solids and nitrates, and chloride and phosphorus concentrations appear to be particularly elevated during winter, based on limited sampling conducted in recent years (Table 2-9).

Phosphorus is usually the limiting nutrient for algae growth in aquatic systems. It is a parameter of concern at two opposite extremes within the SP Area for the Callander and North Bay source waters. The Wasi River has consistently exhibited high levels of total phosphorus along with Wasi Lake and Callander Bay into which it drains. Eutrophication, as evident in excessive growth of algae, in the latter waterbodies has been an ongoing concern for many years. Callander Bay is the source for the municipal drinking water supply for Callander and has experienced blooms of toxic cyanobacteria (often referred to as blue-green algae). A study to identify phosphorous sources contributing to the proliferation of cyanobacteria was therefore undertaken and completed in February 2011. There is additional discussion included in the Callander Section of this report.

The other waterbody where phosphorus has been closely monitored is Trout Lake. Trout Lake is also the source for a municipal supply, namely the City of North Bay. However, Trout Lake is a deep, cold, oligotrophic lake of very low nutrient status. Until 2008, North Bay's water treatment system did not include filtration so was dependent upon very clear water largely devoid of algae or other particulates to ensure the effectiveness of disinfection. The City of North Bay has consistently supported the monitoring of phosphorus levels in Trout Lake at eight sites since 1986. Sampling was conducted from June to August on a weekly basis up until 2017. ~~Beginning in~~From 2018 to 2020, monitoring ~~now occurs~~occurred on a bi-weekly basis from May to September. ~~From~~Since 2021, monitoring has occurred monthly with duplicate samples. Over the period of record phosphorus levels have remained relatively consistent and do not display any obvious trends.

Four Mile Bay is a long, narrow and relatively shallow bay of Trout Lake, with a significant number of residences (some seasonal). Fed by Four Mile Creek, both the bay and the creek have been the subject of additional monitoring for signs of eutrophication and nutrient loading. Four Mile Creek is small and narrow, and exhibits substantial fluctuations in phosphorus concentrations, but no discernable trends are evident. High levels of zinc were noted in Four Mile Creek following an ONR train derailment in 1967 that resulted in substantial spillage of zinc and lead concentrates. Clean-up efforts were undertaken; however, 179 tons of lead concentrate and 630 tons of zinc concentrate were not recovered. ~~Current~~ Data from 2003 – 2005~~data~~ indicated ~~indicate~~ that zinc concentrations ~~are~~ were still elevated at an~~(~~ average ~~of~~ 22.7 µg/L, which is ~~between 2003 – 2005)~~ ~~and~~ close to the PWQO limit of 25 µg/L. Increases in lead concentrations were not identified.

Assessments of the quality of surface water at municipal drinking water intakes are included in the relevant municipal Sections of this report.

Groundwater Quality and Monitoring

In 2003, six monitoring wells were installed in the North Bay-Mattawa region as part of the MECP's Provincial Groundwater Monitoring Network (PGMN) program. As part of the PGMN, information on both groundwater levels and water quality is collected. Currently six stations are located in the SP Area (Table 2-10, Figure 2-10).

Table 2-109. Provincial Groundwater Monitoring Network (PGMN) Wells

ID #	Name	Location	Depth (m)	Static Water Level (mbtoc)[1]	Water Quality Sampling Years
W272-1	Fabrene Inc.	Fabrene Inc.	24.7	5.43	2003
W274-1	Marshall Park	Marshall Avenue at Booth Rd	5.18	2.94	2003, 20078-13, 2015-19, 2021-25
W277-1	TransCanada Pipeline	Hwy 11 N	10.8	7.31	2003, 20087-13, 2015-19, 2021-25
W390-1	Chisholm	Beach Rd, public beach	141	2.32	2003, 2005, 2007
W391-1	Bonfield	Grand Desert Rd and Boundary Rd	79.3	9.94	2003, 20078-11, 2013, 2015, 2018, 2021, 2023, 2025
W392-1	Feronia	Cemetery Rd and Hwy 63	91.9	10.39	2003, 20087-11, 2013, 2015, 2017, 2019, 2021, 2024

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Note: 1. mbtoc = metres below top of casing

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A summary of key groundwater quality parameters, as taken for the PGMN program from 2003 to 202218, is available in Table 2-11. The information gathered through the PGMN helps to set baseline conditions, assess how groundwater is affected by land use and water use, help identify trends and emerging issues, and provide a basis for making resource management decisions. The sampling frequency varies among wells (Table 2-10); W272-1 is not regularly sampled due to its location within a factory. The deep wells (W390-1, W391-1, W392-1) have been sampled relatively infrequently due to the time needed to purge them prior to sampling.

The data is too sparse and there are gaps in the period of record that make it difficult to identify any definitive trends in water quality. Some of the aesthetic objectives, such as copper and iron, are exceeded at certain PGMN sites. The Marshall Park site (W274-1) has the highest values for many of the tested parameters, which may be associated with it being a shallow well, whereas the other PGMN sites are deep wells.

Table 2-11. PGMN Sample Results (2003-202218)

Parameter	PGMN Location and Well ID				
	Marshall Park W274-1	Trans Canada Pipeline W277-1	Chisholm W390-1	Bonfield W391-1	Feronia W392-1
Calcium (mg/L)	no guideline				
# Samples	14	156	3	10	101
Minimum	2.598.6	2.8	9.4	16.53.3	2.938.5
Median	132.01.01.0	4.15.060	18.67.8	18.5	4447.507.5
Maximum	173.0	9.3	18.623.0	20.5150.0	72.6
Chloride (mg/L)	²ODWQS ≤ 250 mg/L aesthetic				
# Samples	14	145	3	8	101
Minimum	2.5	6.4	10.01	0.5	8.67
Median	5.97.96.7	10.71223.4	28.0	0.76	11.012.50.84.0
Maximum	44.985.0	28.1	46.1	1.6	29.5
Conductivity (µS/cm)	no guideline				
# Samples	14	165	3	10	1110
Minimum	0731	700	189	1440	2730
Median	930.5894	9810380	295	151.5	3142741
Maximum	1350	163	348	160	501
Copper (µg/L)	³ODWSOG ≤ 1.0 mg/L aesthetic				
# Samples	12	13	3	9	9
Minimum	0.04	0.2	***1.7***	0.0	0.02
Median	0.556	0.55	***2.4***	0.2	0.3
Maximum	***1.24.0***	***3.5***	***3.5***	0.33.0	0.43.0
¹DIC (mg/L)	no guideline				
# Samples	14	156	3	10	101
Minimum	1061.0	2.983.0	15.2	14.8	25.9
Median	1435.0	4.03.84.5	21.7	16.23	27.8
Maximum	206.0183.0	6.5	23.2.6	18.21	30.0
¹DOC (mg/L)	ODWSOG ≤ 5 mg/L aesthetic				
# Samples	14	156	3	10	101
Minimum	***11.0***	0.6	1.00.8	0.2	0.5
Median	***15.614.6***	0.787	1.0	0.34	0.6
Maximum	***21.0***	1.12	3.8	0.46	0.8

Parameter	PGMN Location and Well ID				
	Marshall Park W274-1	Trans Canada Pipeline W277-1	Chisholm W390-1	Bonfield W391-1	Feronia W392-1
Fluoride (mg/L)	ODWQS ≤ 1.5 mg/L				
# Samples	14	156	3	10	101
Minimum	0.1	0.0	0.7	0.1	0.7
Median	0.1	0.0	1.0	0.1	1.010
Maximum	0.3	0.110	1.31.7	0.12	1.1
Iron (µg/L)	ODWSOG ≤ 300 µg/L aesthetic				
# Samples	14	13	3	9	101
Minimum	***7310***	0	6	0	8
Median	***23250***	0	6	1020	30
Maximum	***45300***	10	65	6112000	6030
Magnesium (mg/L)	no guideline				
# Samples	14	156	3	10	101
Minimum	24.220.8	0.6	3.2	5.20	3.7
Median	29.52	0.8	5.04.5	5.5	4.76
Maximum	43.2	1.3	5.06.1	5.838.0	8.8
Nitrate (mg-N/L)	ODWQS ≤ 10 mg/L				
# Samples	13	156	3	10	101
Minimum	0.02	0.687	0.053	0.02	0.02
Median	0.054	1.426232	0.053	0.065	0.05
Maximum	0.5044	4.283	0.296	0.189	0.09
[4]Sodium (mg/L)	ODWSOG ≤ 200 mg/L aesthetic				
# Samples	14	156	3	10	101
Minimum	14.4	6.6	20.4	2.40	9.0
Median	39.86.1	11.569.5	29.831.0	2.8	10.70.91.0
Maximum	72.6	17.2	44.0	56.03.8	13.1
[1]TDS (mg/L)	ODWSOG ≤ 500 mg/L aesthetic				
# Samples	14	156	3	10	101
Minimum	47594	4626	123	9468	17744
Median	***5838***	6472	19264	998	2130412
Maximum	***8278***	106	226	104	326

Parameter	PGMN Location and Well ID Marshall Park W274-1	Trans Canada Pipeline W277-1	Chisholm W390-1	Bonfield W391-1	Feronia W392-1
[6]Total Phosphorus (µg/L)	no guideline				
# Samples	14	154	3	109	101
Minimum	<20	<10<0.55	<20	8<104.2	<103.75
Median	290330165.5	<205.0	<20	<20	<20
Maximum	1350087,10013,500	5308,730530	960	4,1803131	392<20<20
Zinc (µg/L)	ODWSOG ≤ 5000 µg/L aesthetic				
# Samples	14	15	3	9	9
Minimum	0.7	0.3	1.3	0.1	0.3
Median	2.40	2.31.3	4.2	0.5	0.8
Maximum	17.4	18.07.9	8.4	1.7	2.8

Note: 1. Figures in ***bold italic*** denote exceedances

2. DIC: dissolved inorganic carbon; DOC: dissolved organic carbon; TDS: total dissolved solids

3. ODWQS: Ontario Drinking Water Quality Standards. Maximum acceptable concentrations are established under O. Reg. 169/03

4. ODWSOG: Ontario Drinking Water Standards, Objectives and Guidelines. Aesthetic objectives are based upon "Technical Support Document for Ontario Drinking Water Standards, Objectives and Guidelines" (MOE, 2003) (Note: Ministry of Environment or MOE is a previous name of the Ministry of Environment, Conservation and Parks or MECP)

5. Persons on sodium restricted diets should consult their physician before consuming water with levels above 20 mg/L.

6. Minimum detection limits for Total Phosphorus have changed with lab methods. Lab remarks indicate detection limit of 20 µg/L between 2003 and 2012; 5 µg/L in 2013-2017; and 0.5 µg/L since 2019.

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2.1.7 Limitations

Bedrock Geology

Overburden thickness and the contour of bedrock surface were interpreted using available Water Well Information System data. Well data was only available for the smaller, populated area within the Source Protection Area. Data gaps exist for areas north and south of the populated areas, preventing interpretation of overburden thickness and the contour of bedrock topography for these areas.

Surficial Geology

The Surficial Geology of Southern Ontario dataset does not provide mapping data for surficial geology of a small section in the south-western corner of SP Area. Therefore, data from the Northern Ontario Engineering Geology Terrain Study (NOEGTS) was also used in order to provide seamless coverage of the SP Area.

Physiography

The Physiography of Southern Ontario only covers the southern section of the SP Area. Maps were developed by combining Northern Ontario Engineering Geology Terrain Study data (covers northern part of SP Area) and Surficial Geology of Southern Ontario (covers southern part of SP Area).

Soils

There is a lack of complete and accurate mapping of soils for the SP Area. Best available soil information at this point is derived from underlying geology data. (Harry Cummings & Associates Inc 2001). Soils data for most of the SP Area is covered in the 1:50000 scale soils data provided by the Ministry of Agriculture, Food and Rural Affairs so this dataset was used. No data is available for the Townships of Joly, Machar, Nipissing and Strong, and information is missing for part of Algonquin Provincial Park.

Species at Risk

The SP Area has not been extensively surveyed for occurrences of species at risk. The provincial Natural Heritage Information Centre, Ministry of Environment, Conservation and Parks, and Fisheries and Oceans Canada do not provide consistent data on species at risk in this area. Known occurrences appear to be associated with easily accessible study routes. Records may have resulted from other studies conducted in the area.

Water Quality

There are limitations in regards to assessing accurate trends relating to water quality in the SP Area. Provincial programs such as the PWQMN and PGMN each involve the collection of surface water and groundwater samples, respectively, with the overall goal of water quality monitoring and assessment. Although these are useful tools and data from other monitoring work over the past several years has improved the amount of data currently ~~on hand~~available within the North Bay-Mattawa SP Area, the data set remains too sparse to determine dominant trends in most parts of the SP Area. Monitoring will continue towards an accurate statistical analysis of water quality parameters within the broader SP Area. A water quality analysis for the separate Municipalities in this report is further discussed in later sections.

2.2 Groundwater Vulnerability across Source Protection Area

Determining groundwater vulnerability is a critical component towards the delineation of vulnerable areas in respect to groundwater. This includes Significant Groundwater Recharge Areas (SGRAs), Highly Vulnerable Aquifers (HVAs) and Wellhead Protection Areas (WHPAs). The Intrinsic Susceptibility Index (ISI) method was used for each groundwater vulnerable area in this assessment. Further refinement of individual WHPAs in relation to vulnerability are discussed in each municipal subsection, while SGRAs and HVAs are further discussed below.

The nature of surficial deposits largely determines the susceptibility (mapped as Intrinsic Susceptibility Index - ISI) of the underlying aquifers to water-borne contaminants. Overburden soil layers are classified based on how readily each transmits water, and the thickness of each is considered. The estimated protective value of each layer is then added to calculate the total susceptibility at any point.

Most of the SP Area is shown as having high susceptibility. Data for this assessment comes from various sources with water well records being perhaps the most highly relied upon because of their detail and availability. Water well records provide a description of each soil type encountered and its depth during the drilling of a well. However, it should be recognized that in unpopulated areas there are few well records and little data regarding the nature of the soils at depth. Therefore, the uniformly high susceptibility indicated in the southeast portion of the SP Area, mostly in the sparsely populated Algonquin Highlands, would probably be more variable if there were data available at a finer scale.

This mapping was originally prepared for the NBMCA Groundwater Study (Waterloo Hydrogeologic, 2006) and subsequently refined in some locations with the acquisition of additional data during the municipal groundwater studies for Mattawa, Powassan and Trout Creek; additional information is available in the 2006 Waterloo Hydrogeologic report.

SGRAs and HVAs were delineated using the mapped intrinsic susceptibility (Figure 2-11), as well as through further criteria discussed below.

2.2.1 Significant Groundwater Recharge Areas (SGRAs)

Significant Groundwater Recharge Areas (SGRAs) are a type of vulnerable area identified in the Technical Rules (MECP 2017) that are protected under the *Clean Water Act (2006)*. Recharge areas are land areas where water seeps into an aquifer from rain and melting snow, supplying water to underlying aquifers. Recharge rates have previously been quantified through the North Bay-Mattawa Source Protection Area Conceptual Water Budget (Gartner Lee 2008a), and were further utilized for the delineation of SGRAs.

The identification of the SGRAs for any given watershed is considered a two-step process. The first step is to delineate those areas that provide the most volume over the smallest area of recharge to the watershed. The second step is to consider which of these areas are hydrologically connected to a source of drinking water, both surface water and groundwater sources.

Significant Groundwater Recharge Areas were identified in accordance with Technical Rules 44, 45 and 46 as follows:

44. Subject to rule 45, an area is a significant groundwater recharge area if,

- *the area annually recharges water to the underlying aquifer at a rate that is greater than the rate of recharge across the whole of the related groundwater recharge area by a factor of 1.15 or more; or*
- *the area annually recharges a volume of water to the underlying aquifer that is 55% or more of the volume determined by subtracting the annual evapotranspiration for the whole of the related groundwater recharge area from the annual precipitation for the whole of the related groundwater recharge area.*

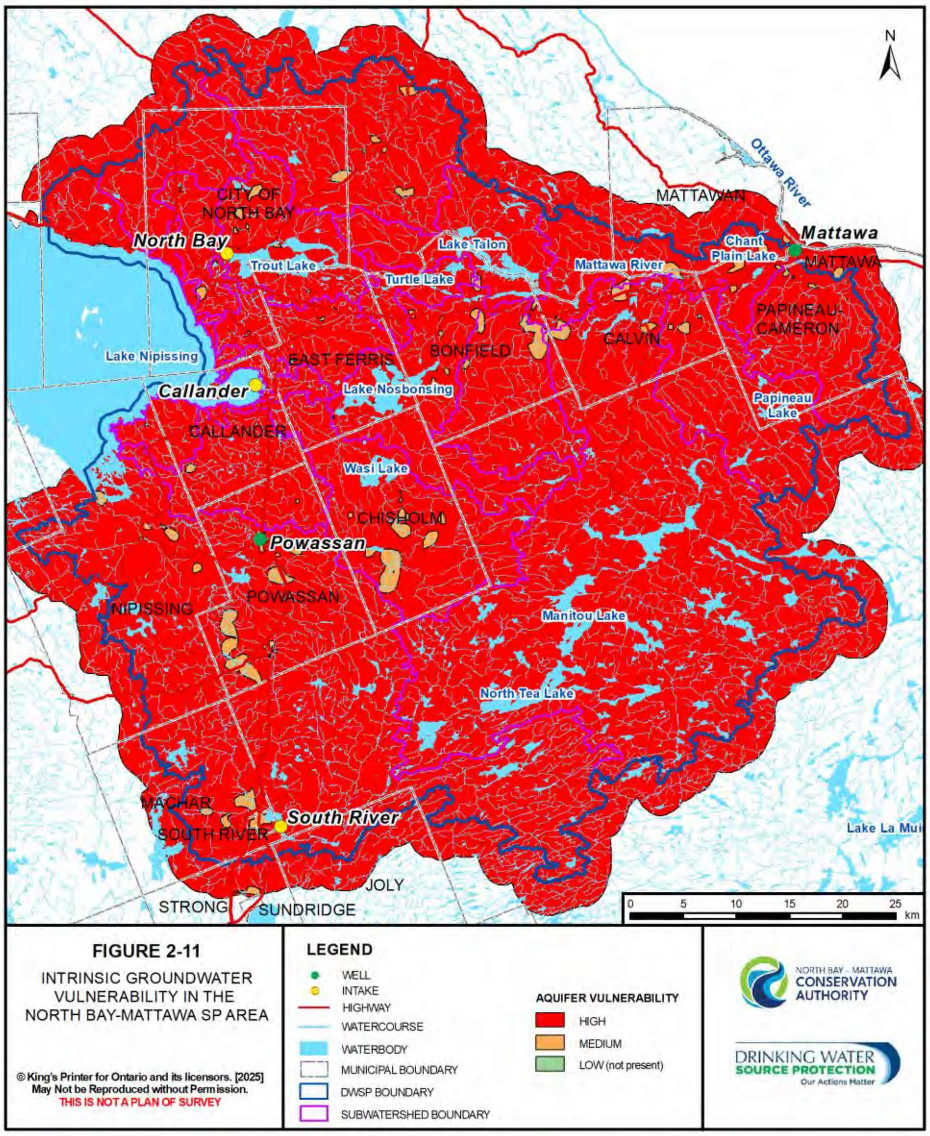
45. Despite rule 44, an area shall not be delineated as a significant groundwater recharge area unless the area has a hydrological connection to a surface water body (excluding Great Lakes, Connecting Channels, Lake Simcoe, Lake Nipissing, Lake St. Clair or the Ottawa River) or aquifer that is a source of drinking water for a drinking water system.

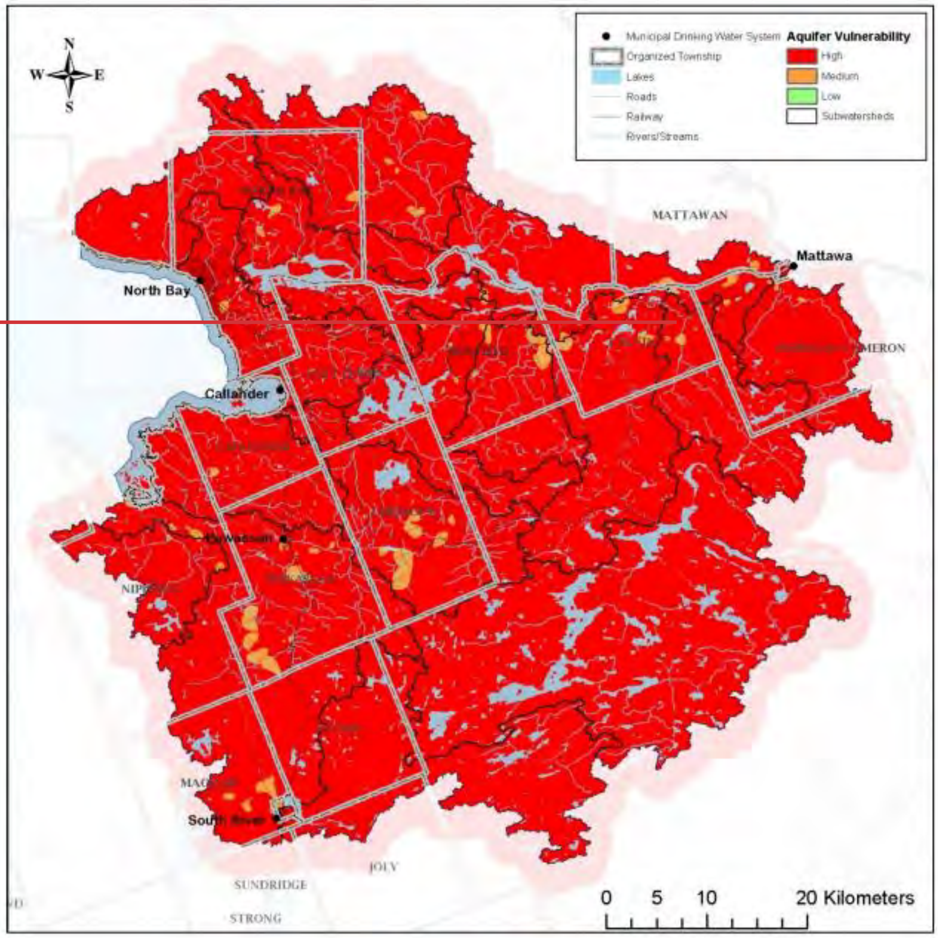
46. The areas described in rule 44 shall be delineated using the models developed for the purposes of Part III of these rules and with consideration of the topography, surficial geology, and how land cover affects groundwater and surface water.

The Technical Rules (MECP, 2017) require the identification of Significant Groundwater Recharge Areas (SGRAs) as a specific type of vulnerable area that will be protected under the *Clean Water Act (*2006). The role of SGRAs is to support the protection of drinking water across the broader landscape.

Under Rule 46, the consideration of topography, surficial geology and land cover was considered in the Intrinsic Susceptibility Index (ISI) mapping shown in Figure 2-11 and furthermore in the SGRA delineation. Greater discussion on these factors is available in the Watershed Characterization section of this report.

Figure 2-11. Intrinsic Groundwater Vulnerability in the North Bay-Mattawa SP Area




Municipal Drinking Water System
Organized Township
Lakes
Roads
Railway
Rivers/Streams
Aquifer Vulnerability
High
Medium
Low
Subwatersheds
N
W
E
S
MATTAWAN
Mattawa
North Bay
Callander
Powassan
South River
SUNDRIDGE
JOLY
STRONG
0 5 10 20 Kilometers

Before determining SGRAs, the process requires calculating the rate of recharge within the area. Groundwater recharge is defined as the supply of water which infiltrates to the water table, supplied by either rainfall or snowmelt. The Conceptual Water Budget determined the rate of recharge within the SP Area to be 208 mm/year. Greater detail on the calculations summarized below in Section 2.5 is also available in Section 4.4 of the Conceptual Water Budget (Gartner Lee 2008a).

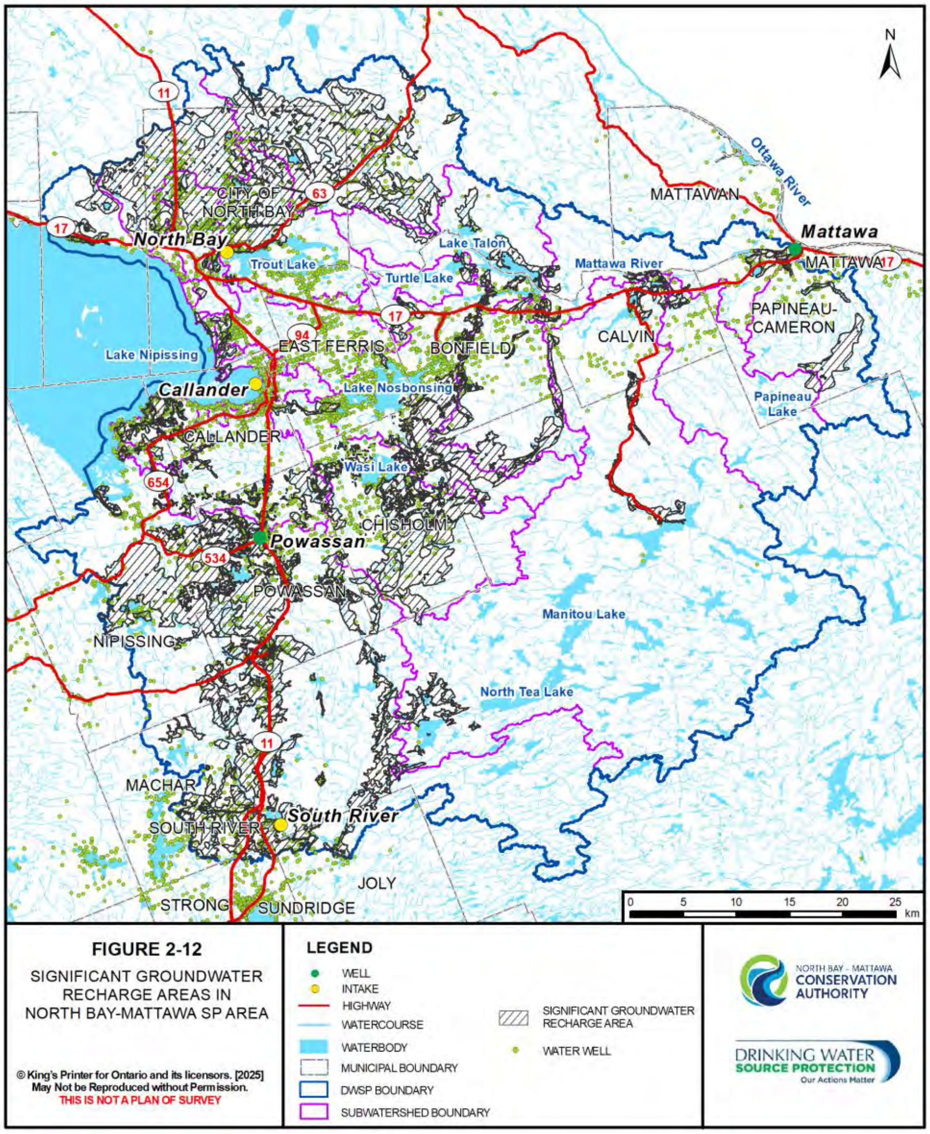
With an annual recharge rate of 208 mm/yr, and under Rule 44, SGRAs require delineating the area which annually recharges water to the underlying aquifer at a rate that is greater than a factor of 1.15 (or 115%) of the annual recharge rate. Within the North Bay-Mattawa SP Area, SGRAs are delineated as the areas with an annual recharge rate of 239.2 mm/yr or greater (208 mm/yr x 1.15).

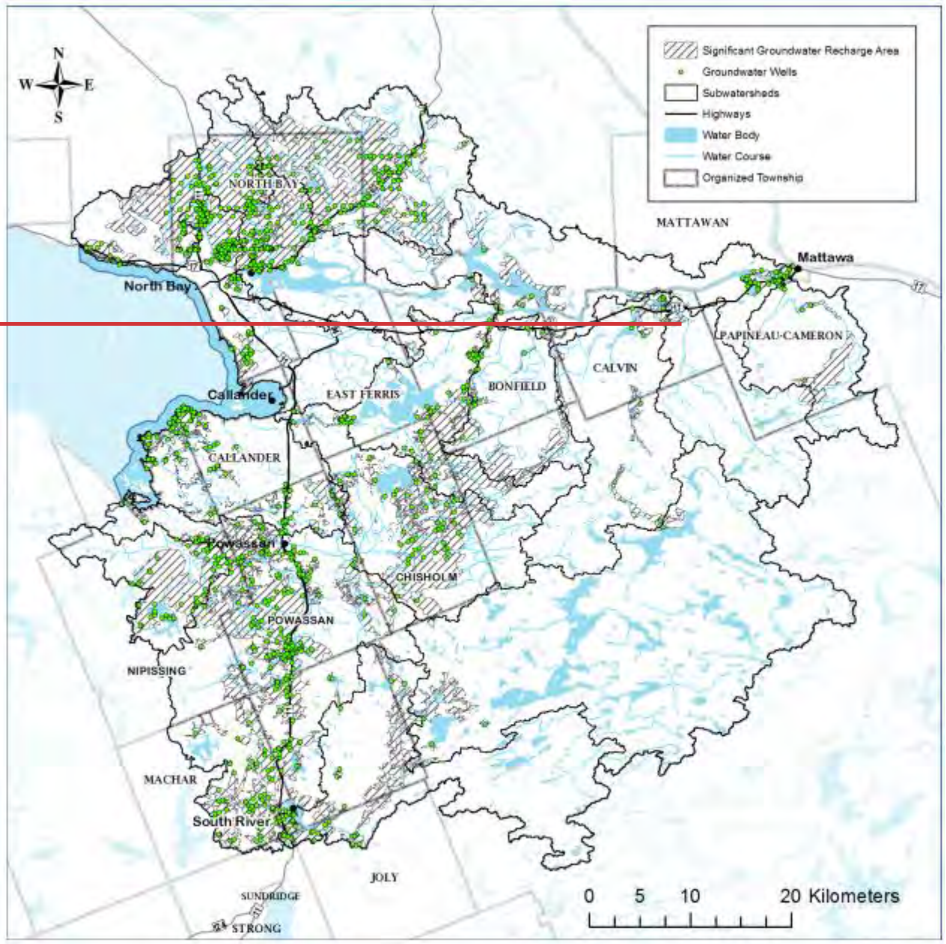
Under Rule 45, SGRAs only include areas which are hydrologically connected to a surface water body or aquifer that is a source of drinking water for a drinking water system. Hydrological connectivity was determined by using two overlays overtop of the 1.15 times recharge area layer. For determination of groundwater connectivity, the Water Well Information System layer was overlaid. If a recharge aquifer had one or more wells connected to it, it was determined that there is groundwater connectivity. For determination of surface water connectivity, the MPAC land-use layer was examined. If the source water was classified as a Lake or River, these parcels were determined to have surface water connectivity to the recharge area.

Figure 2-12 illustrates the SGRAs for the SP Area plotted in accordance with Rules 44 and 45.

SGRAs were previously given a vulnerability score; however, this was changed in the 2017 ~~Director's~~ Technical Rules and SGRAs are no longer scored. Accordingly, any reference to SGRAs was removed from the 2017 version of the Provincial Tables of Circumstances. Furthermore, drinking water threats related to conditions and issues cannot be identified in SGRAs, because there is no vulnerability score to apply to calculations under the Technical Rules Part XI.3 and XI.5.

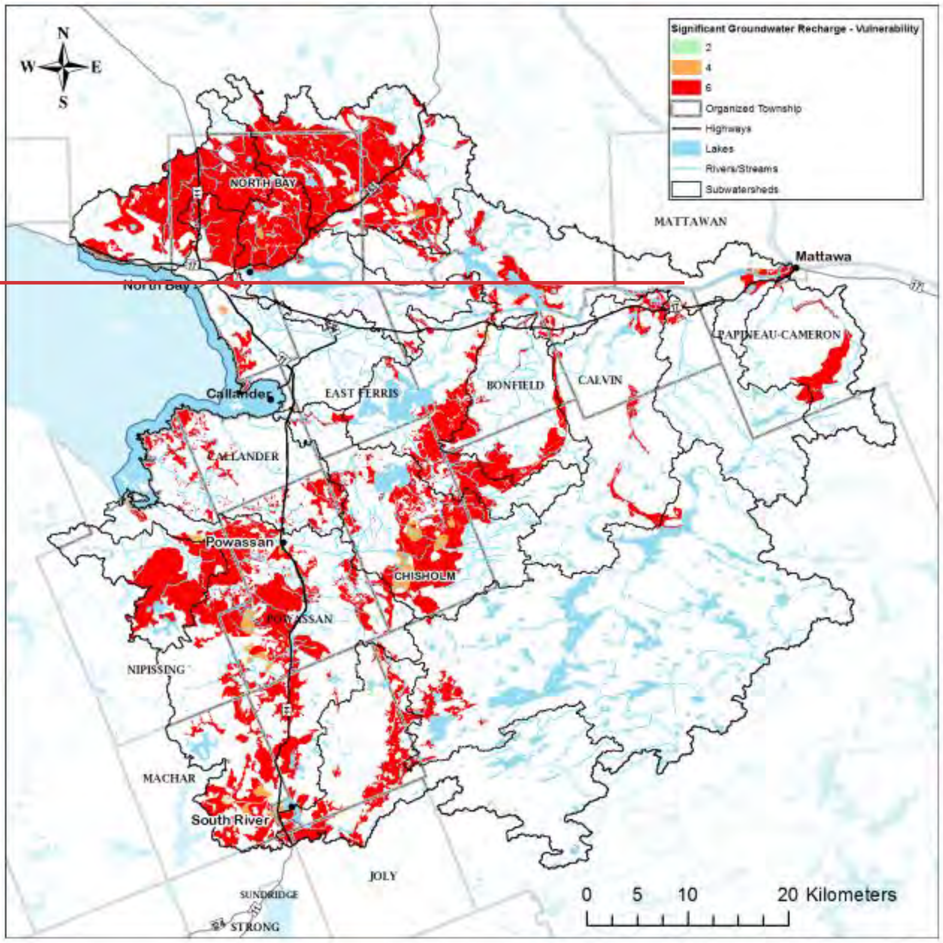
Figure 2-12. Significant Groundwater Recharge Areas (SGRAs) in the North Bay-Mattawa SP Area





Note: larger 11" x 17" version of Figure 2-12 is available in Appendix A as Figure A-7.

Figure 2-12b. Vulnerability Scoring within Significant Groundwater Recharge Areas (SGRAs) Note: larger 11" x 17" version is available in Appendix A.



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2.2.2 Highly Vulnerable Aquifers (HVAs)

A highly vulnerable aquifer (HVA) is defined as the subsurface beneath areas of high groundwater vulnerability (Technical Rule 43). The type and thickness of the overlying substrate can determine the vulnerability of the aquifer to contamination from surface activities, and as such is used as the basis for determining HVAs.

The intrinsic susceptibility index (ISI) method was used to assess groundwater vulnerability in the SP Area, which categorizes aquifers into areas of high, medium or low vulnerability (Rule 38). Areas with high vulnerability are automatically given a vulnerability score of 6 within HVAs. HVAs in the North Bay-Mattawa SP Area are shown in Figure 2-13 (a larger version of this figure is provided in Appendix A). Note that for the Trout Creek area HVAs were mapped based on the vulnerability for the shallow aquifer. Areas where significant, moderate or low drinking water threats can exist, within the umbrella of HVAs, are summarized in Table 2-12 and further supported by the HVA map.

Table 2-12. Areas within HVAs where Activities are or would be Significant, Moderate and Low Drinking Water Threats

Threat Type	Vulnerable Area	Vulnerability Score	Threat Level Possible		
			Significant	Moderate	Low
Chemical	HVA	6		✓	✓

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The Tables of Drinking Water Threats (MECP ~~2018~~2021) provide the detailed sets of circumstances for identifying if an activity meets the criteria for a significant, moderate or low drinking water threat. The Threats Tables can be found in Part XII of the Technical Rules and downloaded from the MECP webpage ~~(~~(https://www.ontario.ca/page/2021-technical-rules-under-clean-water-act~~Ontario.ca/page/source-protection)~~). ~~in an Excel file format.~~ An on-line searchable version of the Threats Tables can be accessed at swpip.ca.

~~The actual provincial Threat Tables can be found at:~~

~~https://files.ontario.ca/2017_2018_chemical_and_pathogen_tables_of_threats_12_v2.xlsx~~

The ~~Excel~~ on-line version~~file~~ of the Threats Tables can be filtered to outline the specific circumstances related to potential chemical threats (note that pathogen threats cannot exist for an HVA). After the ~~file is downloaded and~~webpage is opened, click on the "~~Data~~Search" menu tab and then "~~Filter~~Zone and Score". By applying the filter values in sequence, as shown in Table 2-13 below, it is possible to narrow the results to those activities considered at a threat level within the particular vulnerable area and vulnerability score.

Table 2-13. Summary of Circumstances in the Provincial Threats Tables Related to HVAs

Vulnerability Score	Significant	Moderate	Low
6	NA	CSGRAHVA6M DWHVASGRA6M	CSGRAHVA6L DWHVASGRA6L

Vulnerable Area	Risk	Parameter of Concern	Scores	# of threat subcategories	# of Sets of Circumstances
HVA	Significant	Chemical	6	0	0
HVA	Moderate	Chemical	6	5	8
HVA	Low	Chemical	6	44	202
HVA	Significant	Pathogen	6	0	0
HVA	Moderate	Pathogen	6	0	0
HVA	Low	Pathogen	6	0	0

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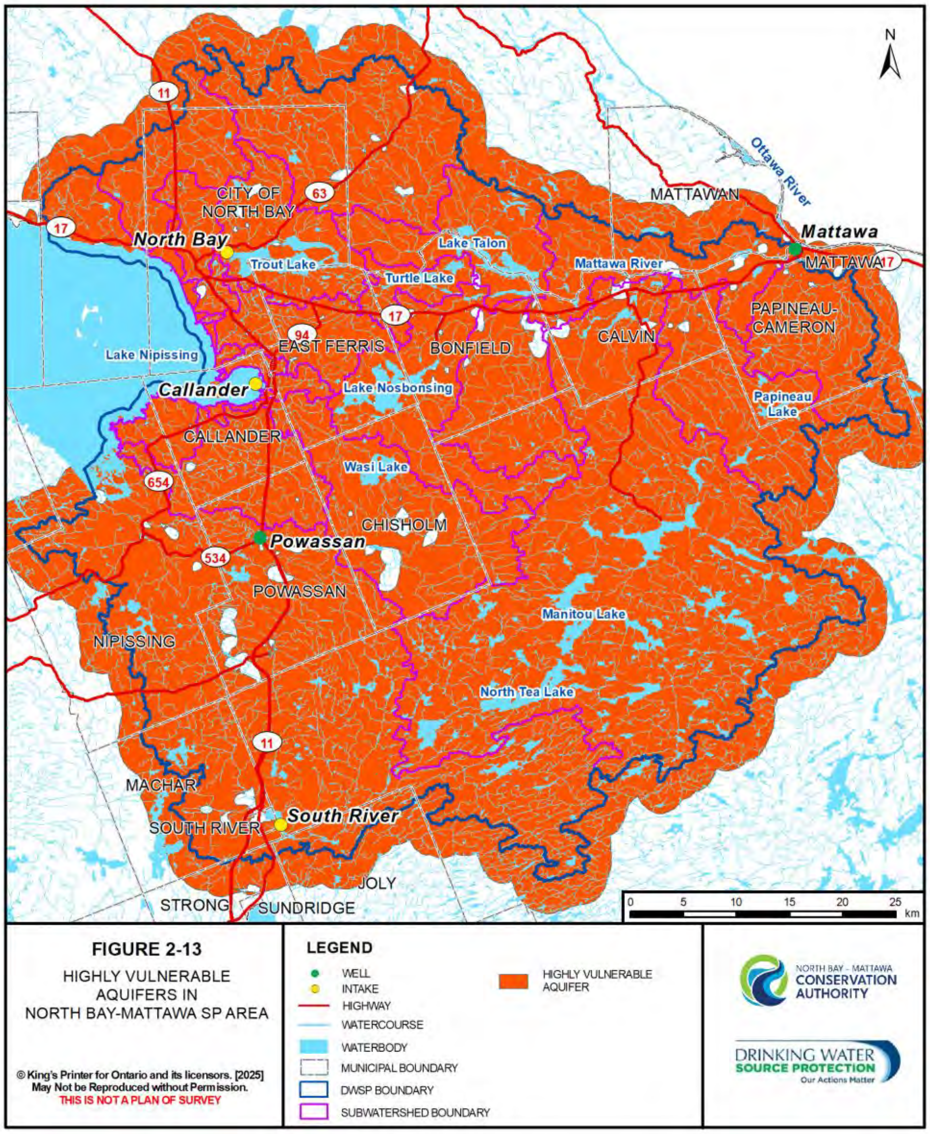
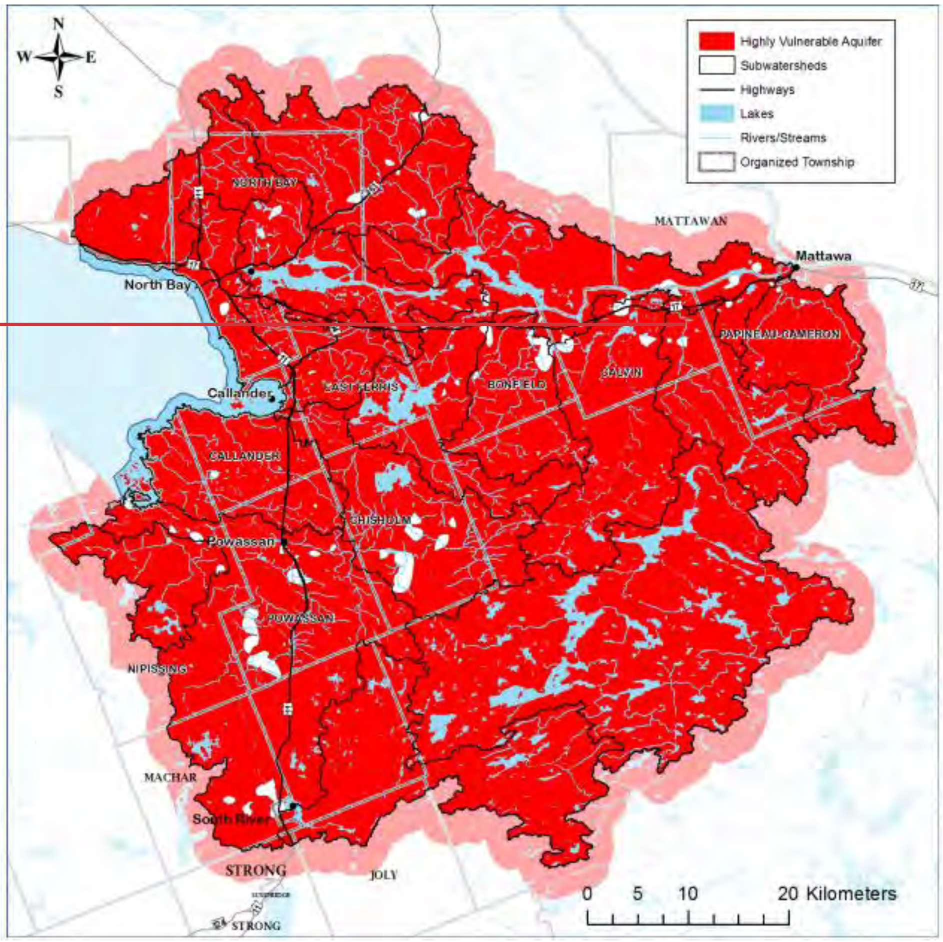
Because of the vulnerability score of six applied to HVAs, there are no significant threats associated with HVAs.

In accordance with the Technical Rules Part XI.1, a water quality issue in the HVA may be identified if the presence of a parameter listed in the Ontario Drinking Water Quality Standards is shown to deteriorate the quality of water as a source of drinking water, or there is a trend towards deterioration of the quality of the water as a source of drinking water. Groundwater quality data in the area is limited to the data collected as part of the Provincial Groundwater Monitoring Network, as discussed in Section 2.1. A review of this information indicates that there are no known issues associated with these areas. Note that this conclusion has been based on a limited amount of data. Additional data would be required to confirm that there are no issues in these areas.

Figure 2-13. Highly Vulnerable Aquifers (HVAs) in the North Bay-Mattawa SP Area





Note: larger 11” x 17” version of Figure 2-13 is available in Appendix A as Figure A-8.

2.2.3 Limitations

The lack of Water Well Information System data in some areas presents a data gap in significant hydrologic features related to groundwater discharge and recharge. It should be recognized that in unpopulated areas, there are few well records and little data regarding the nature of the soils at depth. Therefore, the uniformly high susceptibility indicated in the southeast portion of the SP Area, mostly in the sparsely populated Algonquin Highlands, would probably be more variable if there were data available at a finer scale.

2.2.4 Uncertainty

The process towards delineating SGRAs and HVAs was completed following standardized guidance from the Province. However, the lack of Water Well Information System data in certain areas of the region results in shortcomings related to knowledge of soil depth/type and the corresponding susceptibility to recharge, discharge or contamination. As such, both SGRAs and HVAs are considered to have a high uncertainty in much of the area.

2.3 Impervious Surfaces

Impervious surfaces are included in drinking water source protection because of concerns regarding road salt application. Both sodium and chloride, the component ions of road salt, have potential impacts to water quality. In the North Bay-Mattawa SP Area, only roads were considered. Data at the resolution necessary to identify parking lots was not available.

The area was divided into 1 km grids centered on the SP Area according to the provincial standard, and each square was assessed as to percentage of impervious surfaces (roadways) in the categories shown in Table 2-14 per the 2021 technical rules. ~~four categories:~~

~~Less than 1%~~
~~Between 1% and 8%~~
~~Between 8% and 80%~~
~~Equal to or greater than 80%~~

Roadways were identified using the Ontario Road Network feature class from Land Information Ontario, last updated in 2009. Estimates of paved widths varied as follows:

- 8.5 m for most streets and roadways
- 12 m for Highway 11 and Highway 17
- 15 m for major urban streets and boulevards
- 18.5 m for sections of Algonquin Avenue in North Bay

The resulting coverage of impervious surfaces was then compared to vulnerable areas to determine where the application of road salt would be either a significant moderate or low threat. Areas where the threat was less than low were not mapped. Table 2-14 summarizes the relationship between impervious surface coverage, vulnerability and resulting threat level.

Drinking water threats pertaining to the application of road salt have also been considered throughout the individual threats assessments for each municipal drinking water source (Sections 4 to 8). Through these threats assessments, any significant drinking water threat within certain vulnerable areas must be addressed in the Source Protection Plan. More details are in the subsequent municipal sections.

Table 2-14. Impervious Surfaces Threat Status within Vulnerable Areas

Vulnerable Area	% Impervious Surface	Vulnerability Score and Threat Status		
		Significant	Moderate	Low
IPZ	Less than 1%	n/a	9 - 10	6 - 8.1
IPZ	At least 1% but less than 6%	n/a	8-10	5.4-7.2
IPZ	At least 6% but less than 8%	10	8-9	4.9-7.2
IPZ	8% or more	9-10	7-8.1	5.4-6.4
WHPA	Less than 1%	n/a	n/a	8-10
WHPA	At least 1% but less than 8%	n/a	10	6-8
WHPA	At least 8% but less than 30%	n/a	8 - 10	6
WHPA	30% or more	10	8	6
HVA	Less than 1%	n/a	n/a	n/a
HVA	At least 1% but less than 8%	n/a	n/a	6
HVA	At least 8% but less than 30%	n/a	n/a	6
HVA	30% or more	n/a	n/a	6

Impervious Surface Circumstance (Ref #)	Vulnerable Area	Vulnerability Score and Threat Status		
		Significant	Moderate	Low
Less than 1% Presence of Chloride (88) or Sodium (89) in GW or SW	IPZs		9 - 10	6 - 8.1
	WHPAs			8 - 10
	HVA			
	~~SGRA~~			
Between 1% and 8% Presence of Chloride (90) or Sodium (91) in GW or SW	IPZs		8 - 10	5.4 - 7.2
	WHPAs		10	6 - 8
	HVA			6
	SGRA			6
Between 8% and 80% Presence of Chloride (92) or Sodium (93) in GW or SW	IPZs	10	8 - 9	4.9 - 7.2
	WHPAs		8 - 10	6
	HVA			6
	SGRA			6
Greater than 80% Presence of Chloride (94) or Sodium (95) in GW or SW	IPZs	9 - 10	7 - 8.1	4.5 - 6.4
	WHPAs	10	8	6
	HVA			6
	SGRA			6

2.3.1 ~~Municipality of~~ Powassan WHPA

Figure 2-14 shows a map of the~~Powassan's~~ total impervious surfaces area in the vicinity of the Powassan WHPA~~map.~~ The grid square that coincides with most of the Powassan WHPA has about 10% impervious surfaces~~Very small areas of the Powassan WHPA score high enough to consider impervious surfaces~~, including a section of Highway 11 and most of the urban section of Powassan~~a portion of Main Street~~. All other areas are considered to have a total impervious surfaces area of <8%. As a result, there are no existing significant threats relating to impervious surfaces for the ~~Municipality of~~ Powassan WHPA.

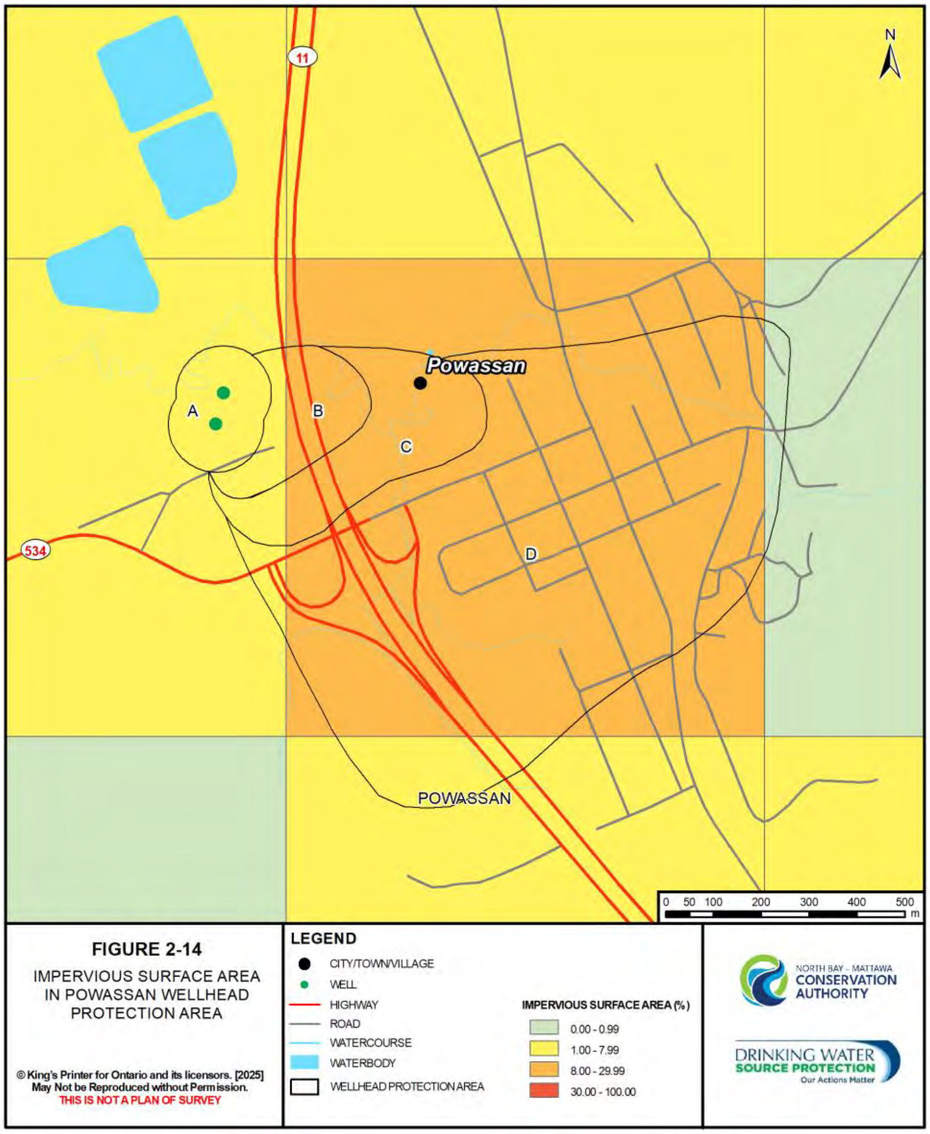
2.3.2 ~~Town of~~ Mattawa WHPA

Figure 2-15 shows a map of the~~Mattawa's~~ total impervious surfaces area in the vicinity of the Mattawa WHPA~~map~~. The intrinsic susceptibility for Mattawa is classed as high for the entire area. This means impervious surfaces were considered for all WHPA zones~~s~~ in Mattawa. The Mattawa WHPA is largely residential homes~~/~~ and properties, with small streets characterizing the general area. Most of the residential streets lie in the WHPA-A, WHPA-B and WHPA-C, while the WHPA-D is undeveloped and unpopulated forested areas. The total impervious surfaces area in Mattawa is between 1-8% with the exception of one ~~area~~ grid square that is ~~over~~ between 8-30%. As a result, there are no existing significant threats associated with impervious surfaces for the Town o~~f~~ Mattawa WHPA.

2.3.3 ~~Village of~~ South River IPZ

Figure 2-16 shows a map of the~~South River's~~ total impervious surfaces area for the South River IPZ ~~map~~. In South River, the IPZ-1 and ~~areas~~ portions of IPZ-3 have a high enough vulnerability score to be evaluated for impervious surfaces. Most of these vulnerable areas have a total impervious surfaces area of <~~1~~6%, while ~~one square kilometre~~ grid squares near the downtown area and the Highway 11 interchange are ~~area is~~ ranked as ~~1~~6-8%. Based on these circumstances, there are no existing significant threats associated with impervious surfaces for the ~~Village of~~ South River IPZ.

Figure 2-14. Impervious Surfaces in the Powassan Wellhead Protection Area



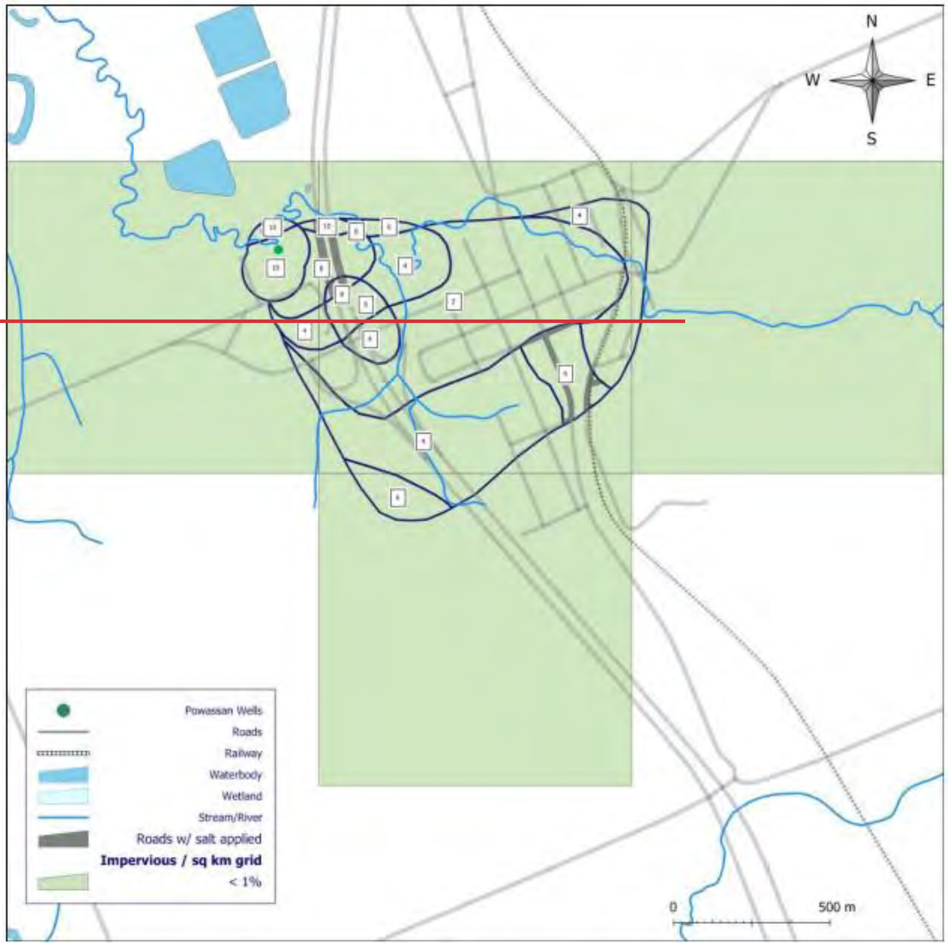
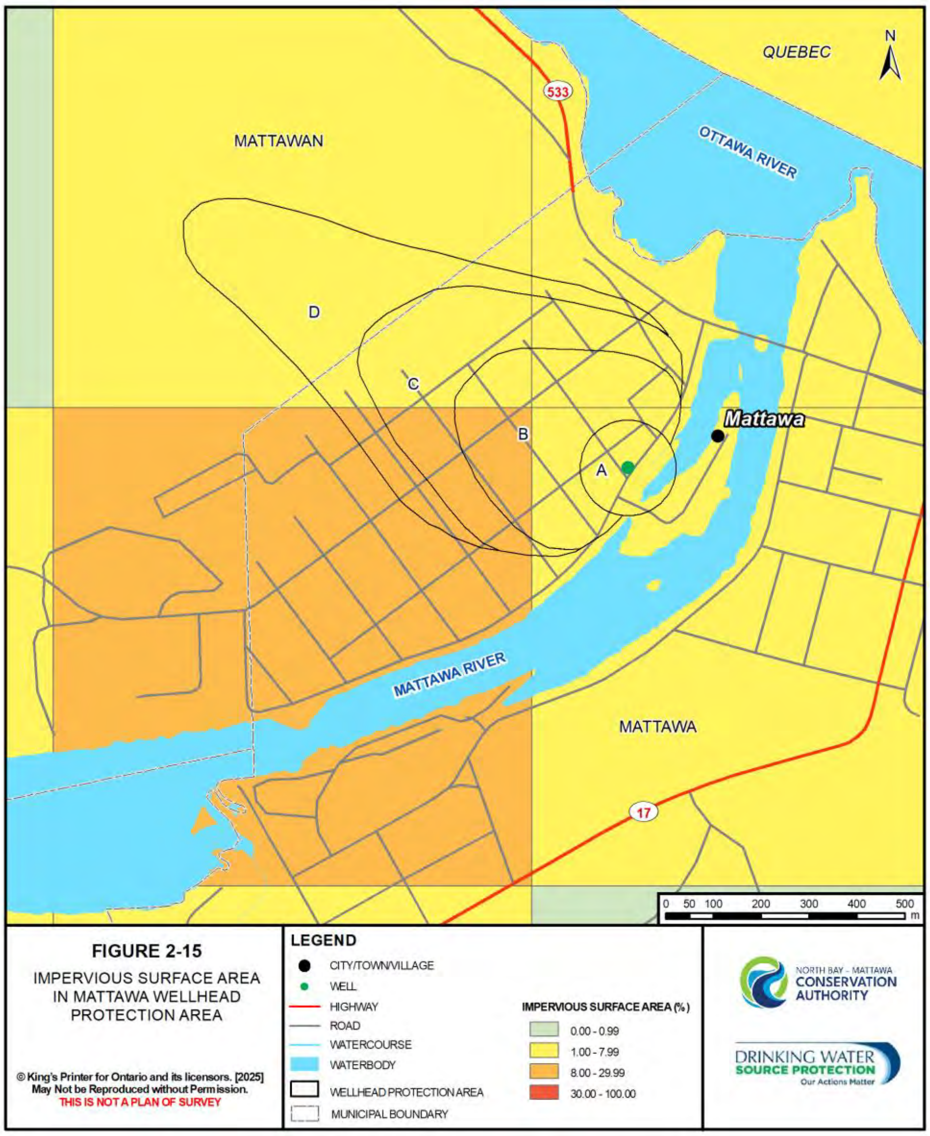
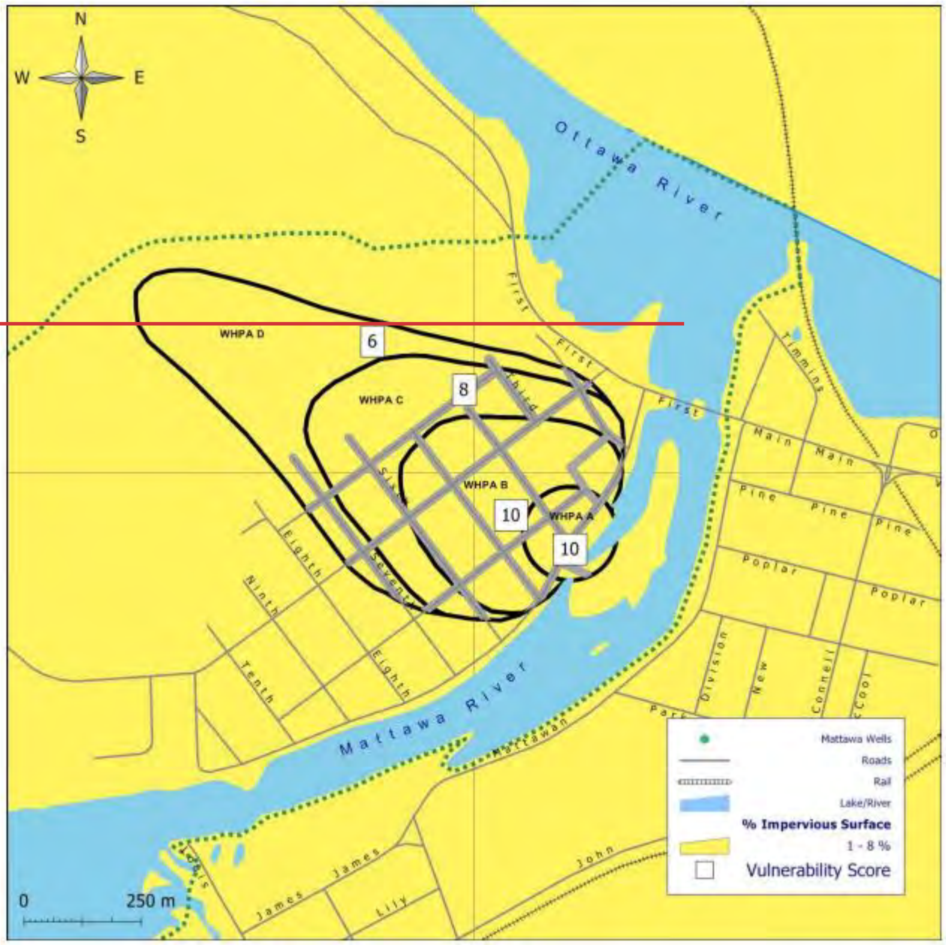

N
W
E
S
Powassan Wells
Roads
Railway
Waterbody
Wetland
Stream/River
Roads w/ salt applied
Impervious / sq km grid
< 1%
0
500 m

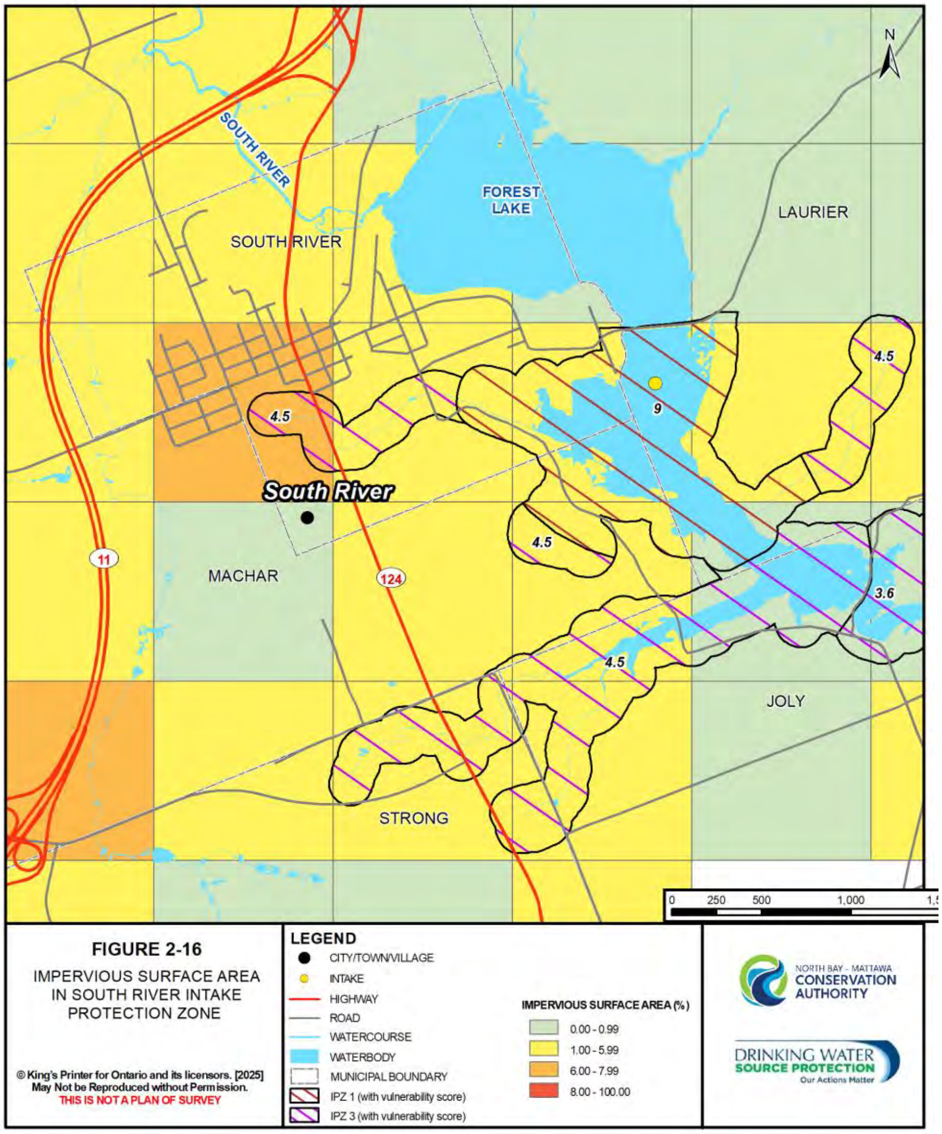
Figure 2-15. Impervious Surfaces in the Mattawa Wellhead Protection Area

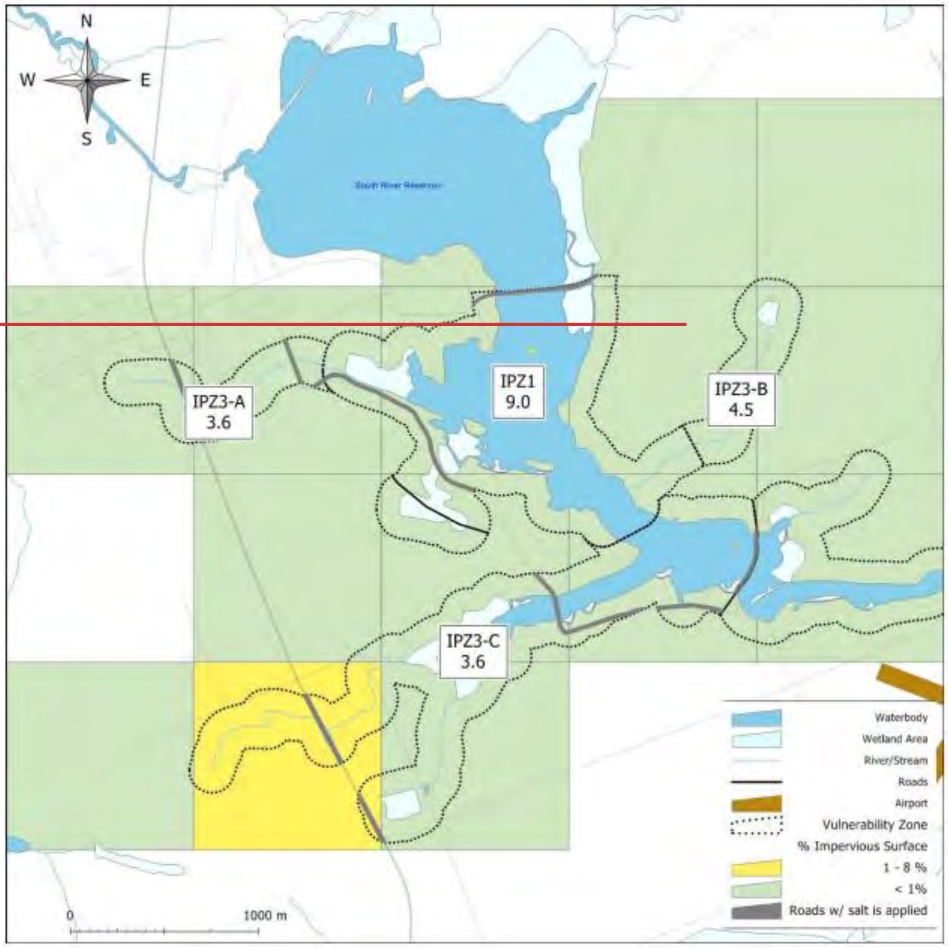




N
W
E
S
Ottawa River
Mattawa River
WHPA D
WHPA C
WHPA B
WHPA A
6
8
10
10
First
Main
Pine
Poplar
Timmins
Division
New
Eighth
Ninth
Tenth
Seventh
Sixth
Third
James
Lily
John
Mattawan
0
250 m
Mattawa Wells
Roads
Rail
Lake/River
% Impervious Surface
1 - 8 %
Vulnerability Score

Figure 2-16. Impervious Surfaces in the South River Intake Protection Zone




N
W
E
S
IPZ1
9.0
IPZ3-A
3.6
IPZ3-B
4.5
IPZ3-C
3.6
Waterbody
Wetland Area
River/Stream
Roads
Airport
Vulnerability Zone
% Impervious Surface
1 - 8 %
< 1%
Roads w/ salt is applied
0
1000 m

2.3.4 ~~City of~~ North Bay IPZ

Figure 2-17 shows a map of the~~North Bay's~~ total impervious surfaces area for the North Bay IPZ~~map~~. Most of the ~~For the City of North Bay, of the~~ grid squares that coincide with the North Bay IPZ~~1~~ have~~1 square kilometre grid zones where~~ a ~~the~~ vulnerability score ~~is~~ high enough to be evaluated for impervious surfaces. Nearly all the grid squares have less than 8~~6~~% impervious surface. One grid square to the west end of Trout Lake and extending north and south of Trout Lake Road has about 9% impervious surface area, but the vulnerability score is less than 9~~, roughly 6 square kilometres have <1% impervious surfaces because of a lack of paved roads over large portions of these areas. The other five square kilometres were ranked with a total impervious surfaces area of 1-8% where salt is applied. These areas include the Lee's Road corridor to Tower Drive, and the residential area west of Delaney Bay~~. Based on these circumstances, there are no existing significant threats associated with impervious surfaces for the ~~City of~~ North Bay IPZ.

2.3.5 ~~Municipality of~~ Callander IPZ

Figure 2-18 shows a map of the ~~Callander's~~ total impervious surfaces area for the Callander IPZ~~map~~. The IPZ-1 and IPZ-2 of the Callander Bay intake cover much of Callander's urban developed areas, while the IPZ-3 has a vulnerability score high enough to evaluate impervious surfaces in the rural areas of Chisholm.

14 square kilometre grid areas of this region were ranked as having <1% total impervious surfaces area, while ~~37~~ 36 grid areas have a total impervious surfaces area of 1-~~8~~8~~6~~%. There ~~is~~ are two ~~one~~ grid ~~area~~ areas where the total impervious surfaces area is 6-7.99~~8~~% of the total area: downtown Callander including part's of~~inside~~ Callander's IPZ 1 and 2; and along Highway 654 near the Highway 11 and Highway 94 intersections. However~~, in downtown Callander~~, ~~where the total Impervious surfaces area is 8-80% of the total area; however,~~ the vulnerability score in ~~this area~~these zones is not high enough to consider this grid as containing a significant threat to drinking water. Based on these circumstances, there are no existing significant threats associated with impervious surfaces for the ~~Municipality of~~ Callander IPZ.

~~2.3.6 Significant Groundwater Recharge Areas (SGRA)~~

~~Figure 2-21 shows the impervious surfaces for SGRAs in the area. Due to the relatively undeveloped nature of the SP Area, the majority of the region is classified as having either no impervious surfaces or <1%. Much of the 1-8% impervious surfaces occurs along city roads and connecting highways. The City of North Bay holds 8-80% impervious surfaces within much of the urban areas of the City. There are also many pockets of 8-80% impervious surfaces in developed areas of Callander, Powassan, Mattawa, and South River.~~

~~Because of the low vulnerability score, there are no significant threats associated with impervious surfaces for SGRAs.~~

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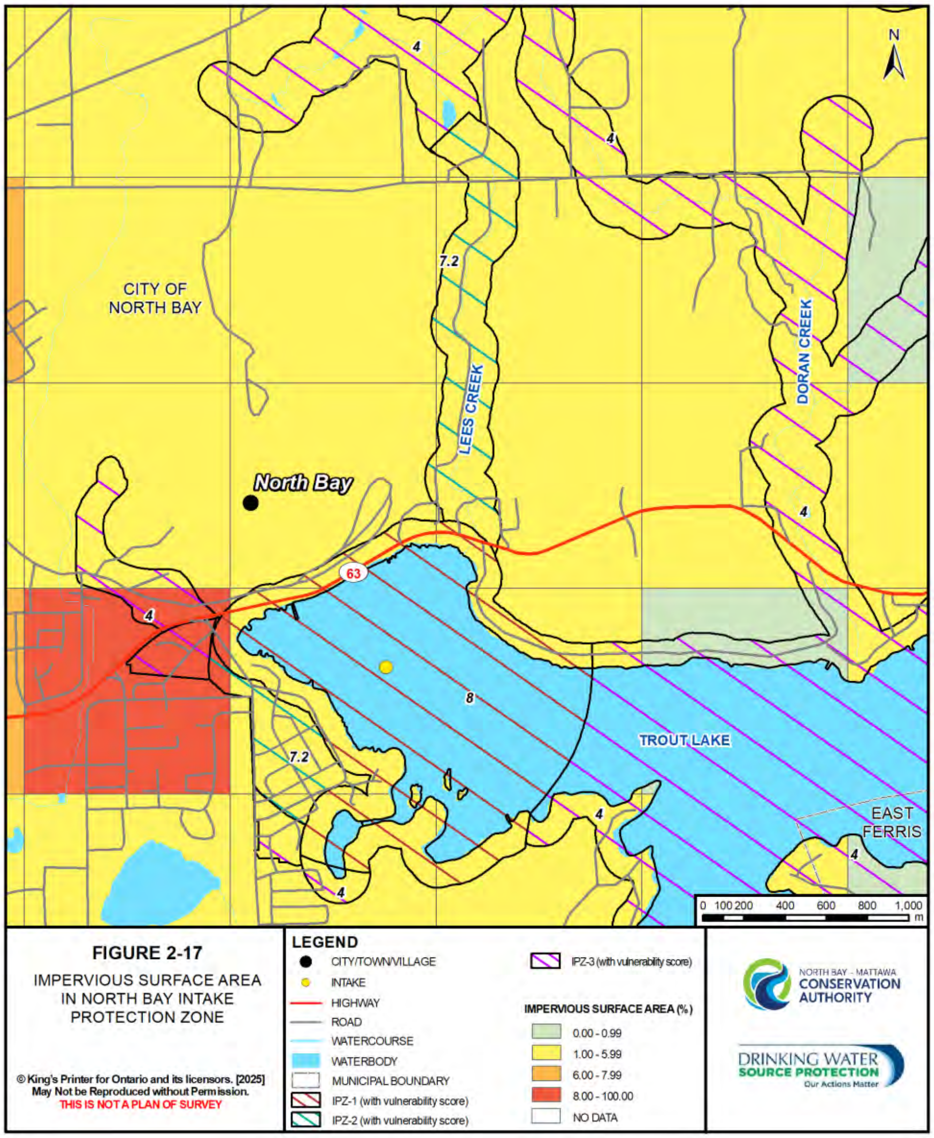
2.3.6 Highly Vulnerable Aquifers (HVA)

Most of the HVA is generally undeveloped and with low populations outside of urban areas. As such, ~~road~~ little to no impervious surfaces are present with values being less than 8~~6~~% impervious surfacsessurfacessalt application is generally low, as either <1% or no impervious surfaces are present (Figures 2-19a/b). The highest percentages of vulnerable areas with impervious surfaces are in the urban and smaller urban centres. HVAs in Powassan, Mattawa, Callander and the City of North Bay are considered to have areas of 6% or more8 – 80% impervious surfacesImpervious Surfaces. Callander has a small amount of Highly Vulnerable Aquifers in the District boundary, and South River is characterized as having between 1 and 8% impervious surfaces. Because of the low vulnerability score, there are no significant threats associated with impervious surfaces for HVAs.

2.3.7 Limitations

Private and public parking lots could not be considered in the impervious surfaces area calculation. This data was not available for the SP Area and the time to create this would be more than manageable for current staff. Since these areas are likely to have road salts applied, particularly during the winter months, impervious surfaces should be reassessed once the information becomes available.

Figure 2-17. Impervious Surfaces in the North Bay Intake Protection Zone



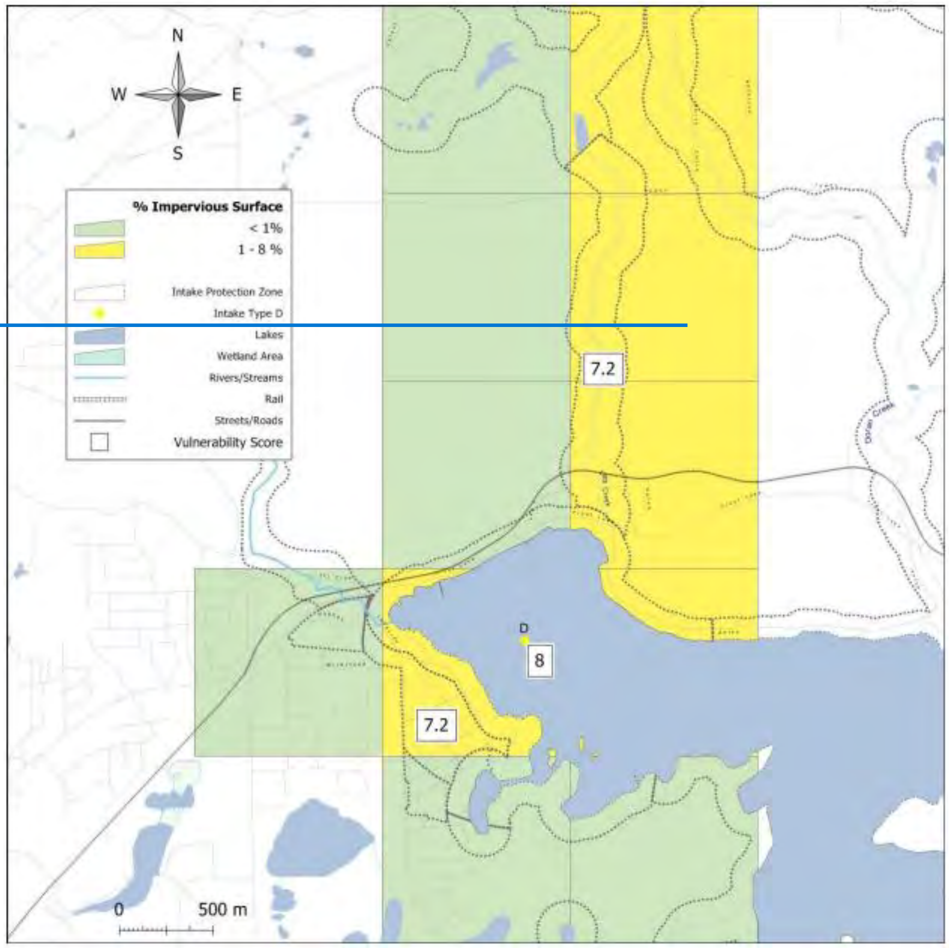
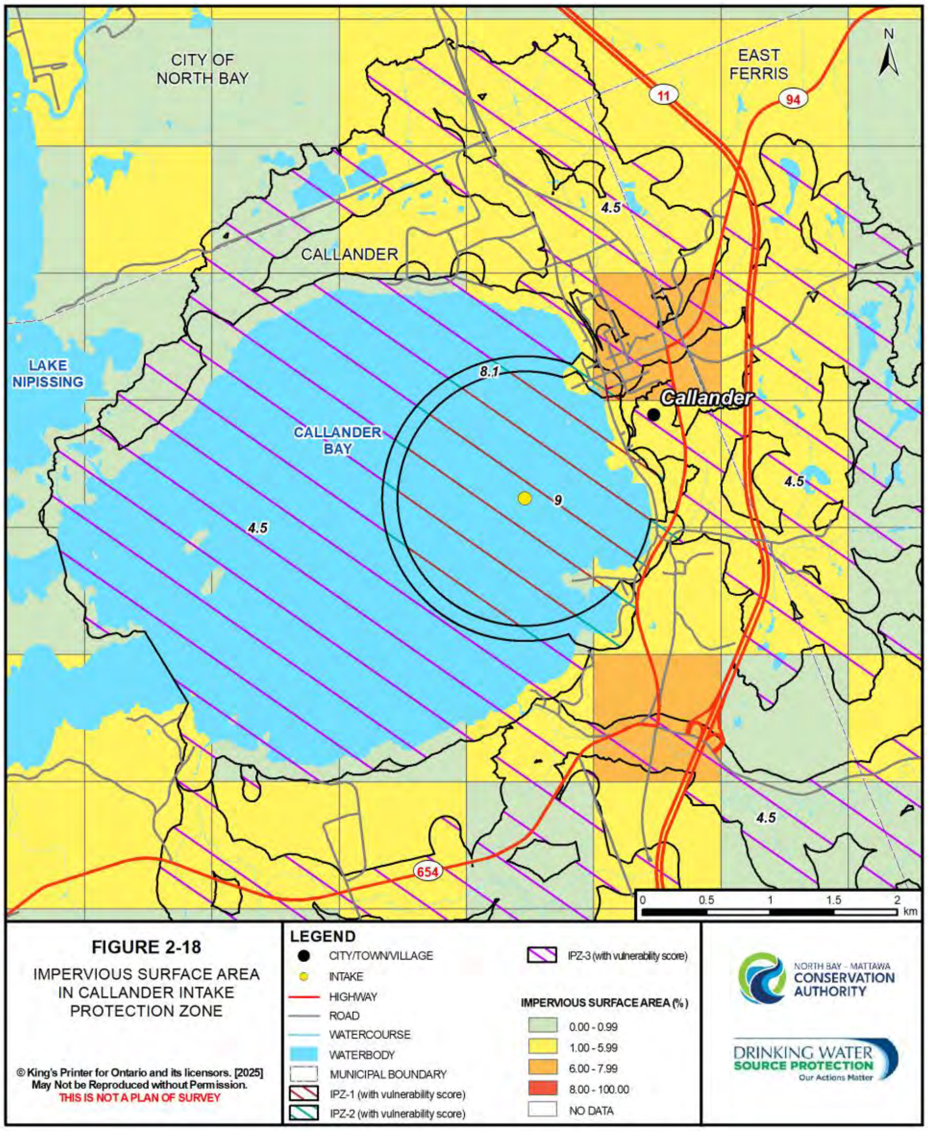
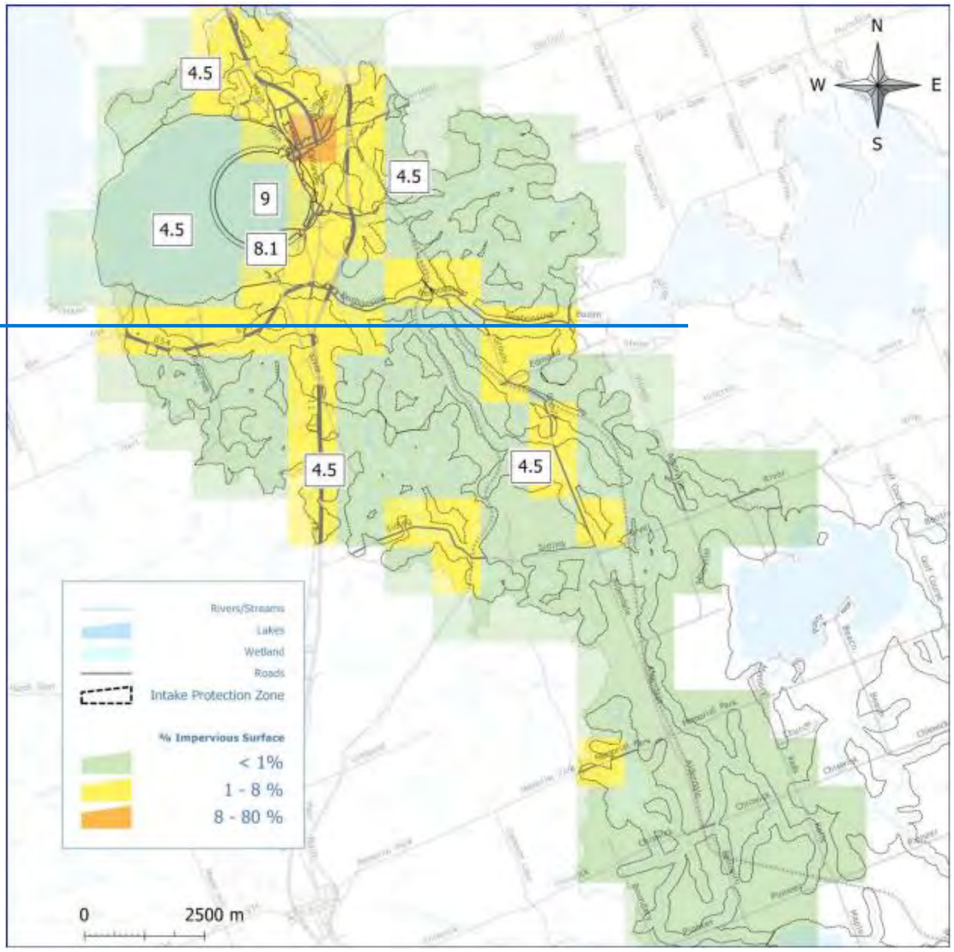

N
W
E
S
% Impervious Surface
< 1%
1 - 8 %
Intake Protection Zone
Intake Type D
Lakes
Wetland Area
Rivers/Streams
Rail
Streets/Roads
Vulnerability Score
7.2
D
8
7.2
0
500 m

Figure 2-18. Impervious Surfaces in the Callander Intake Protection Zone




4.5
9
4.5
8.1
4.5
4.5
4.5
N
W
E
S
Rivers/Streams
Lakes
Wetland
Roads
Intake Protection Zone
% Impervious Surface
< 1%
1 - 8 %
8 - 80 %
0
2500 m

~~Figure 2-19. Impervious Surfaces in Significant Groundwater Recharge Areas~~

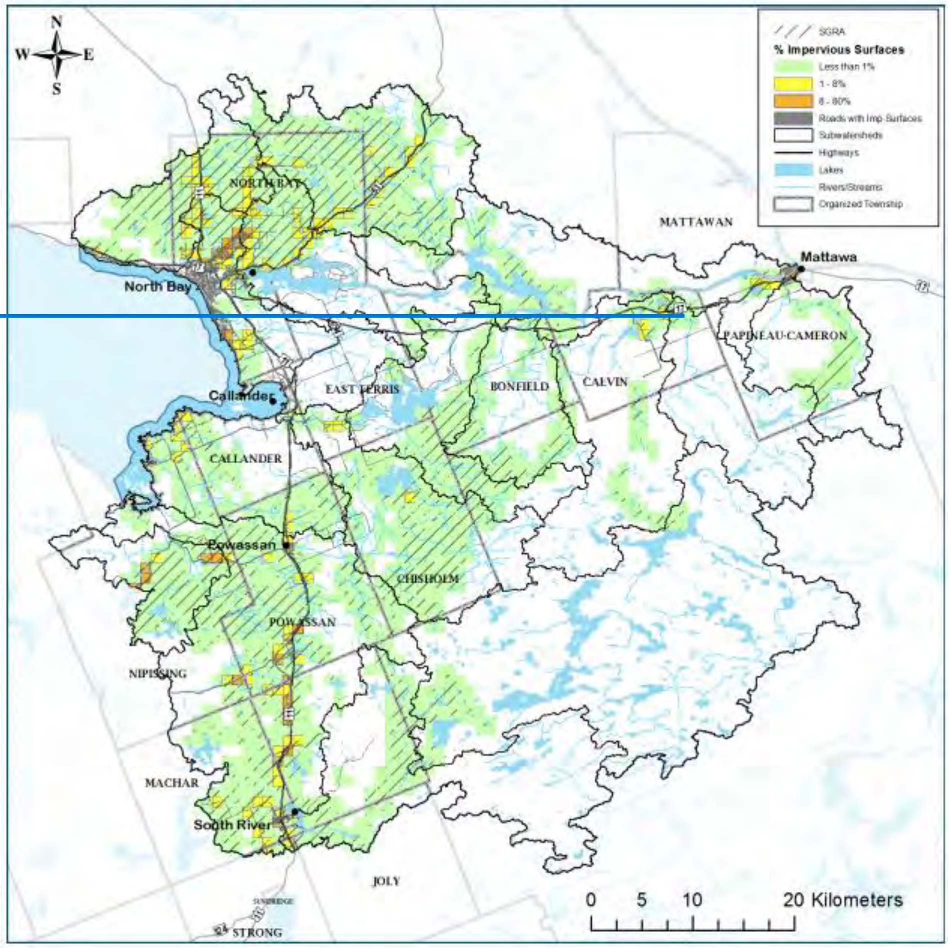
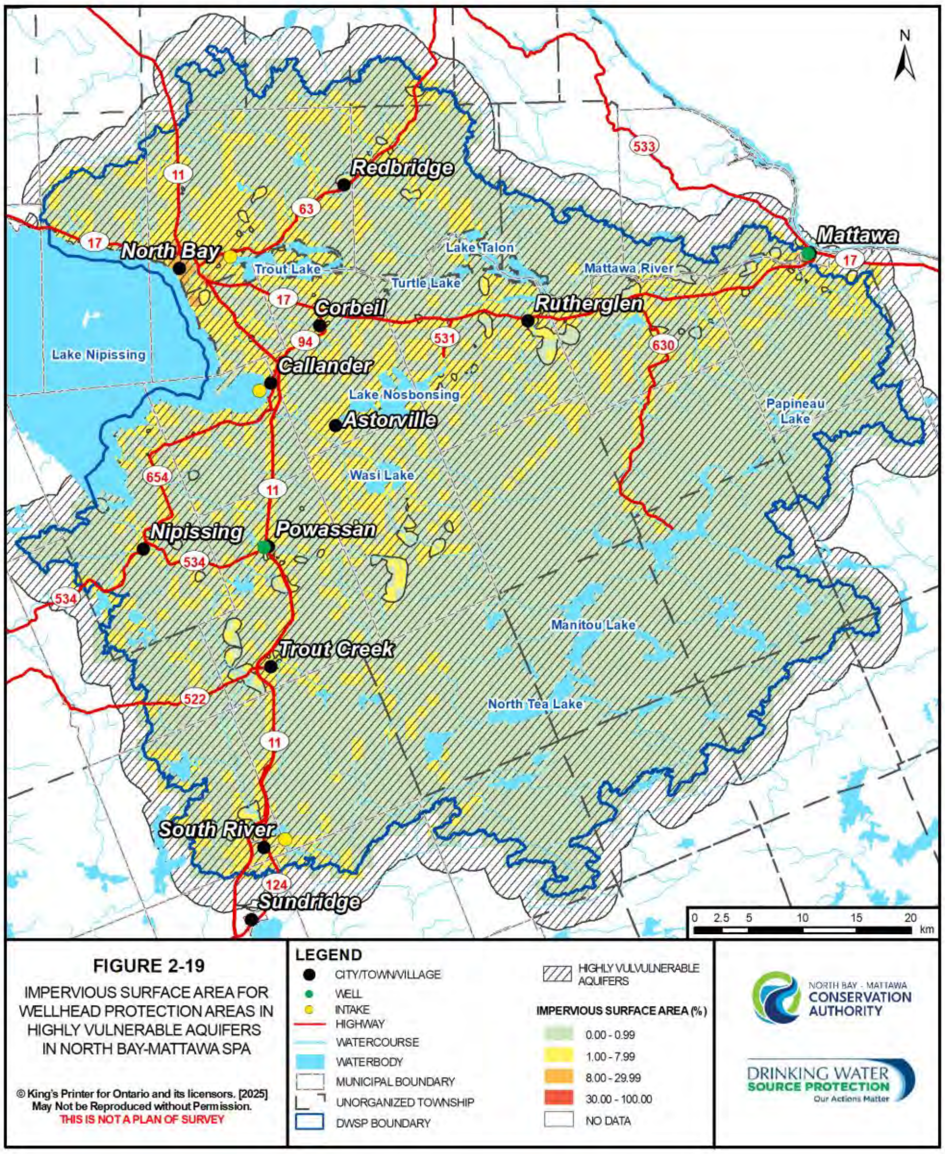
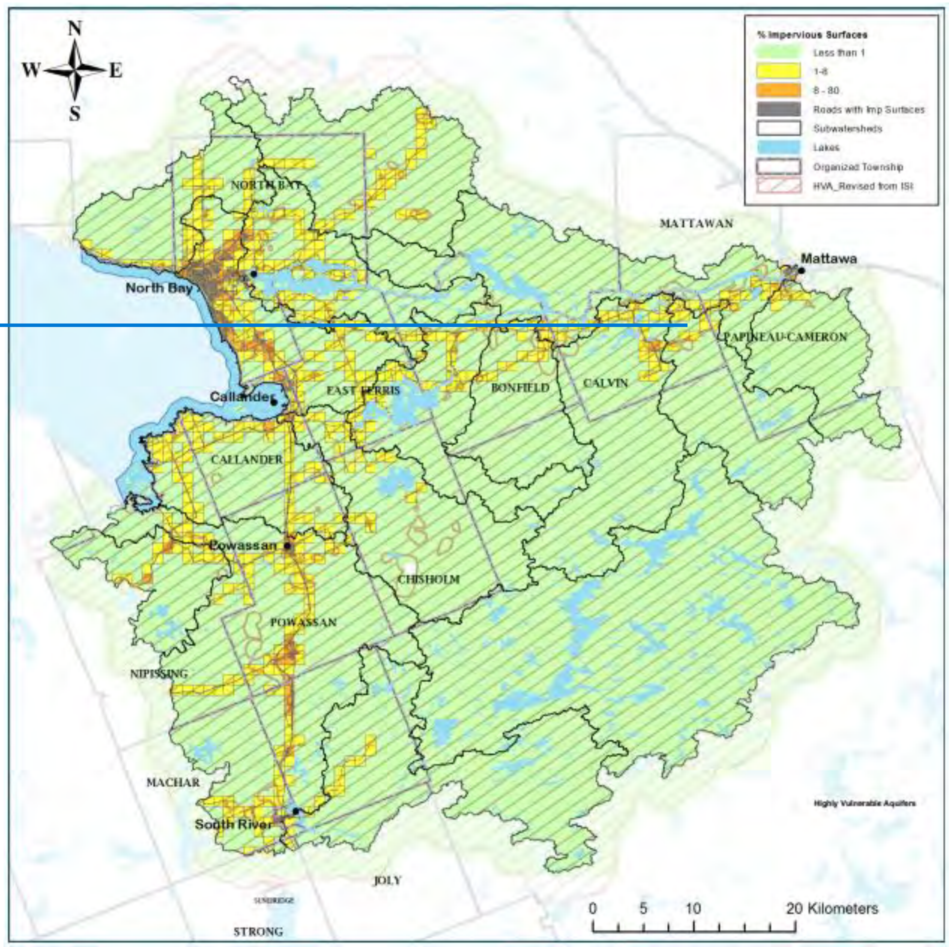


Figure 2-19. Impervious Surfaces for Highly Vulnerable Aquifers




N
W
E
S
% Impervious Surfaces
Less than 1
1-8
8 - 80
Roads with Imp Surfaces
Subwatersheds
Lakes
Organized Township
HVA_Revised from ISI
NORTH BAY
MATTAWAN
Mattawa
North Bay
PAPINEAU-CAMERON
EAST FERRIS
BONFIELD
CALVIN
Callander
CALLANDER
Powassan
CHISHOLM
POWASSAN
NIPISSING
MACHAR
South River
Highly Vulnerable Aquifers
JOLY
STRONG
0
5
10
20 Kilometers

2.4 Managed Lands and Livestock Density

Managed Lands

Managed land is land to which nutrients (fertilizer) may be applied. Managed lands can be broken into two subsets based on their use: agricultural such as cropland, fallow, and improved pasture, and non-agricultural such as golf courses, sports fields, lawns, and other grassed areas. The percentage of managed lands was calculated for each vulnerable area using data from MPAC (Municipal Property Assessment Corporation) to indicate the potential for the application of agricultural source material (ASM), non-agricultural source material (NASM) and commercial fertilizers. The separate analysis undertaken for each municipal system is described in subsequent sections.

Thresholds for threat levels for managed lands are:

- Low - areas less than 40% managed lands have a low potential for nutrient application to be causing contamination
- Moderate - areas with between 40% and 80% managed lands have a moderate potential for nutrient application to be causing contamination
- High - areas with managed lands greater than 80% have a high potential for nutrient application to be causing contamination

Livestock Density

Livestock density is used to indicate the potential for generating, storing and applying nutrients in the form of agricultural source material (manure) on agricultural lands and is expressed in nutrient units per acre (NU/acre). Nutrient units (NU) have been defined for each type of livestock based on the amount of manure they generate. For example, 1 NU could be either one beef cow, six sheep or 150 laying hens.

Within vulnerable areas, estimates of the number of animals on each property was obtained primarily from MPAC data. In some cases, landowners within vulnerable areas were contacted to verify the type of livestock operation. The potential number of NUs was calculated based on the square footage of the barns evident on aerial imagery (calculated using GIS) according to Table 2-15.

NUs were also calculated to consider livestock being raised in outdoor confinement areas (OCAs) or farm-animal yards within vulnerable areas. The nutrients generated at an annual rate were determined by the number of NU for the farm divided by the size of the livestock OCA or a farm-animal yard, in square feet. Analyses for agricultural operations near each municipal system are described below.

Table 2-15. NU Conversion Factors based on barn size for different MPAC farm classifications

MPAC Classification	ft^2/NU	m^2/NU
Dairy	120	11
Swine	70	7
Beef	100	9
Chickens	267	25
Turkeys	260	24
Horse	275	26
Goat	200	19
Sheep	150	14
Fur	2,400	223
Mixed	140	13

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The thresholds for evaluating the risk of nutrient application of ASM within vulnerable areas are:

- Low - less than 0.5 NU/acre is considered a low potential for exceeding crop requirements
- Moderate – at least 0.5 but not more than 1.0 NU/acre has a moderate potential for exceeding crop requirements
- High - greater than 1.0 NU/acre is considered a high potential for exceeding crop requirements

Determining Drinking Water Threats: Hazard Scores and Vulnerable Areas

The percentage of managed land and the livestock density of an area are then combined to represent the quantity of nutrients present as a result of nutrient generation, storage and land application within a vulnerable area. In turn, an assessment of managed lands and livestock density is one method towards determining the potential impacts on water quality, particularly in regards to chemical threats posed by nitrogen and phosphorus.

The Tables of Drinking Water Quality Threats (MECP ~~2018~~2021) requires consideration of the maps for both percentage of managed lands and livestock density when evaluating the circumstances and the thresholds for the land application of nutrients. The combination of percentage of managed lands and NU/acre gives a hazard rating for the land application of nutrients, which is then coupled with the vulnerability scores of an area to determine the overall threat status of that activity. A high hazard rating, coupled with a vulnerability score of 9 or 10, may result in a significant chemical threat to surface water or groundwater.

Managed lands and livestock density are only evaluated in vulnerable areas where the vulnerability score is high enough for activities to be considered a significant, moderate or low drinking water threat: WHPA with a vulnerability score of 6 or higher; IPZ with a vulnerability score of 4.4 or higher; or Highly Vulnerable Aquifers (HVAs) with a vulnerability score of 6.

Each of the vulnerable areas were mapped for managed lands and livestock density, and are further discussed below to determine whether a significant drinking water threat exists as a result of agricultural or non-agricultural activities. A summary of the possible threat levels involving the combination of managed lands and livestock density, coupled with specific vulnerability scores, is shown in Table 2-16.

Through this assessment, and as further discussed below, there were no significant drinking water threats relating to managed lands and livestock density in any of the vulnerable areas.

It is worth noting that drinking water threats pertaining to the application of agricultural source material (ASM), commercial fertilizer or non-agricultural source material (NASM) have also been considered throughout the individual threats assessments for each municipal drinking water source (Sections 4 to 8). Through these threats assessments, any significant drinking water threat within certain vulnerable areas must be addressed in the Source Protection Plan phase, as a means to protecting municipal drinking water. More details are available in the subsequent municipal sections.

Table 2-16. Managed Lands and Livestock Density

Managed Lands Classification	Livestock Density Classification	Vulnerable Area	Vulnerability Score and Threat Status		
			Significant	Moderate	Low
Low (<40%)	Low (<0.5 NU/acre)	IPZ		9 - 10	6 - 8.1
		WHPA		10	8
		HVA			
		~~IPZs~~		~~9 - 10~~	~~6 - 8.1~~
Low (<40%)	Medium (0.5-1 NU/acre)	IPZ		8 - 10	5.4 - 7.2
		WHPA		10	6 - 8
		HVA			6
		~~IPZs~~		~~8 - 10~~	~~5.4 - 7.2~~
Low (<40%)	High (>1 NU/acre)	IPZ	10	7 -9	4.8 - 6.4
		WHPA	10	8	6
		HVA			6
		~~IPZs~~	~~10~~	~~7 -9~~	~~4.8 - 6.4~~

Managed Lands Classification	Livestock Density Classification	Vulnerable Area	Vulnerability Score and Threat Status		
			Significant	Moderate	Low
Medium (40-80%)	Low (<0.5 NU/acre)	IPZ		8 - 10	5.4 - 7.2
		WHPA		10	6 - 8
		HVA			6
		~~IPZs~~		~~8 - 10~~	~~5.4 - 7.2~~
Medium (40-80%)	Medium (0.5-1 NU/acre)	IPZs	10	7.2 - 9	4.8 - 7
		WHPAs		8 - 10	6
		HVA			6
		~~IPZs~~	~~10~~	~~8 - 9~~	~~4.9 - 7.2~~
Medium (40-80%)	High (>1 NU/acre)	IPZs	9 - 10	7 - 8.1	4.5 - 6.4
		WHPAs	10	8	6
		HVA			6
		~~IPZs~~	~~9 - 10~~	~~7 - 8.1~~	~~4.5 - 6.4~~
High (>80%)	Low (<0.5 NU/acre)	IPZs	10	7 - 9	4.8 - 6.4
		WHPAs	10	8	6
		HVA			6
		~~IPZs~~	~~10~~	~~7 - 9~~	~~4.8 - 6.4~~
High (>80%)	Medium (0.5-1 NU/acre)	IPZs	9 - 10	7 - 8.1	4.5 - 6.4
		WHPAs	10	8	6
		HVA			6
		~~IPZs~~	~~9 - 10~~	~~7 - 8.1~~	~~4.5 - 6.4~~
High (>80%)	High (>1 NU/acre)	IPZs	9 - 10	7 - 8.1	4.5 - 6.4
		WHPAs	10	8	6
		HVA			6
		~~IPZs~~	~~9 - 10~~	~~7 - 8.1~~	~~4.5 - 6.4~~

2.4.1 ~~Municipality of~~ Powassan WHPA

Managed Lands

Powassan's managed lands are shown in Figure 2-20. Powassan's WHPAs include rural pasture land as well as the built-up town area, and so includes both agricultural and non-agricultural managed lands. Agricultural managed lands are present in WHPA-B and WHPA-C (where vulnerability score is 6 or greater); these managed lands are represented by a single dairy farm operation that includes property in both WHPAs. Several non-agricultural managed lands also exist in each of the WHPAs, including yards or unused fields and the Powassan Fairgrounds. Percentage managed lands was calculated to be less than 40% within each Powassan WHPA, which is low based on the criteria in Table 2-16. This is shown in Figure 2-21.

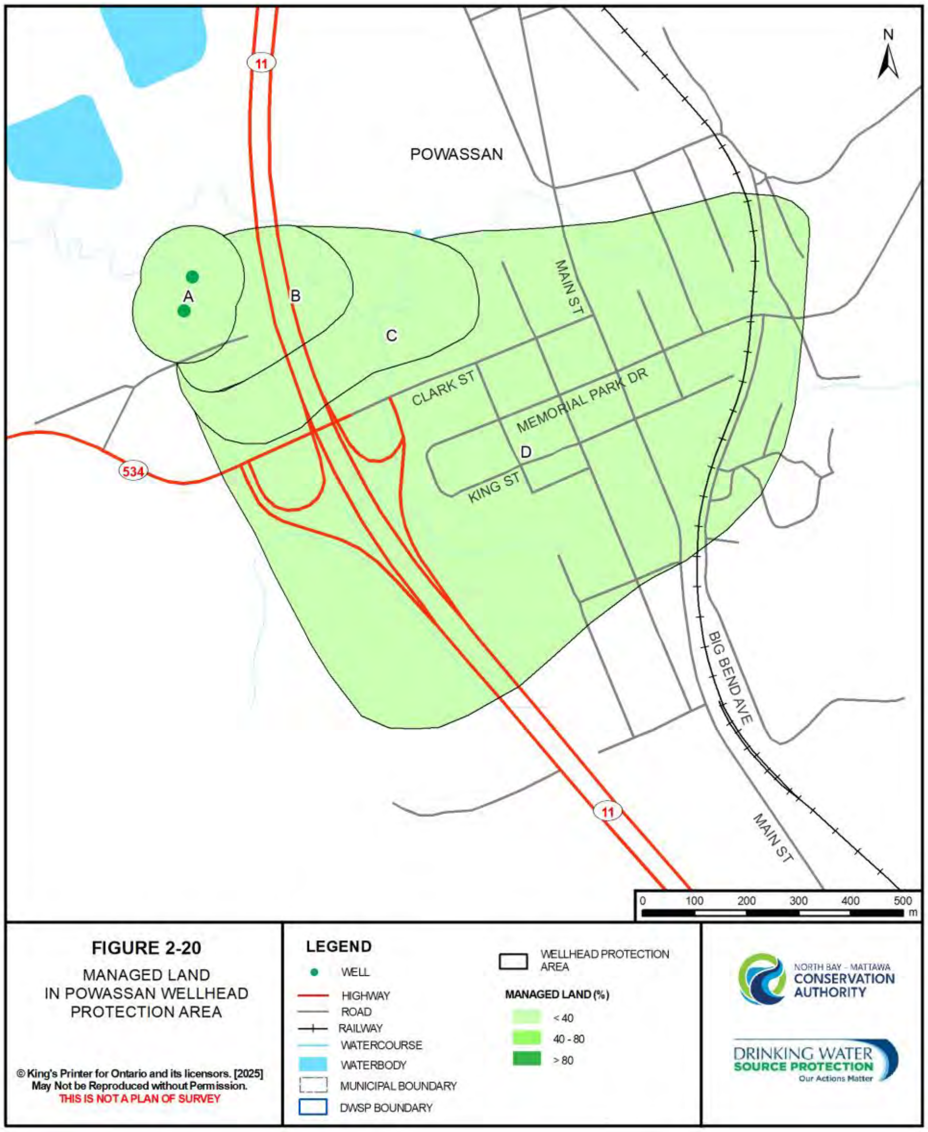
Livestock Density

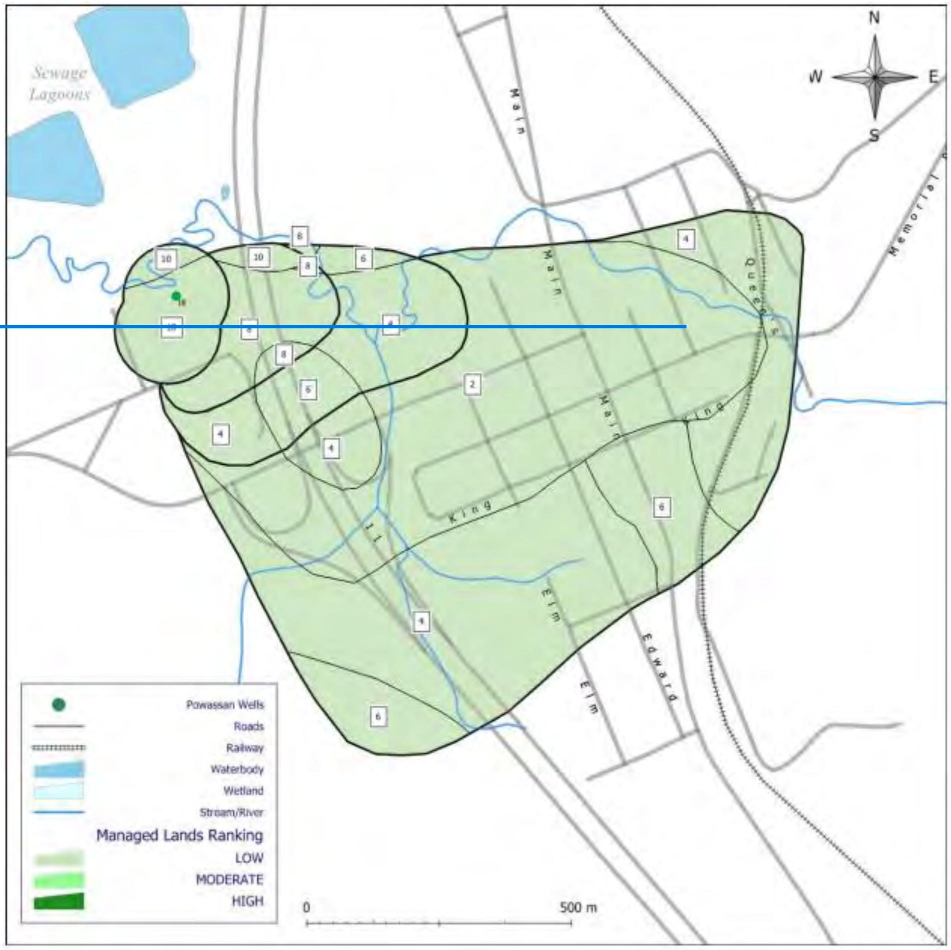
Powassan's livestock density is shown in Figure 2-21. The only property in the WHPAs with livestock is a dairy operation that covers portions of WHPA-B and C. Because the NU density is greater than 1 NU per acre, the livestock density of the area is classified as high.

Drinking Water Threats

The managed lands and livestock density hazard scores assigned by MECP guidance were coupled with the vulnerability scores within the vulnerable areas to determine significant, moderate or low drinking water threats in relation to the land application of ASM, NASM and commercial fertilizers. Based on the criteria shown in Table 2-16, there are no significant threats related to managed lands or livestock density in the Powassan WHPA.

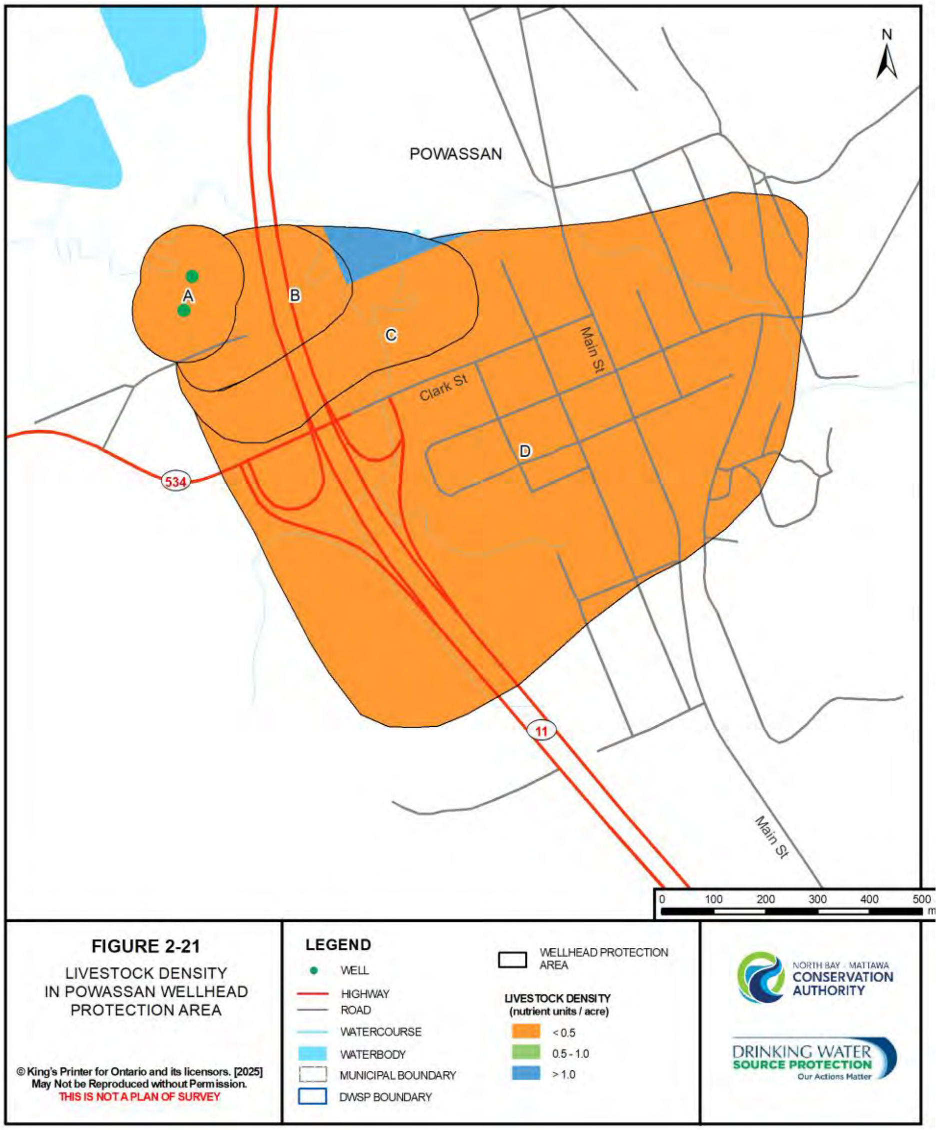
Figure 2-20. Managed Lands in the Powassan Wellhead Protection Area

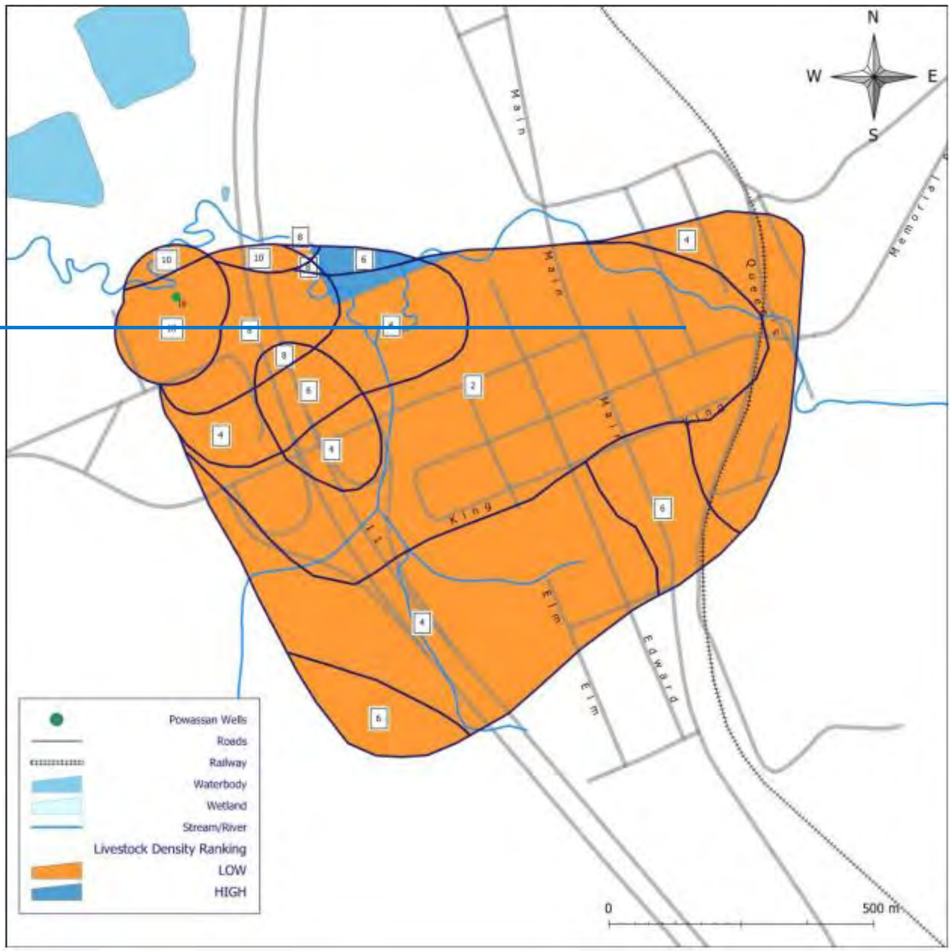




Sewage Lagoons
N
W
E
S
Main
Queen
King
Elm
Edward
Memorial
Powassan Wells
Roads
Railway
Waterbody
Wetland
Stream/River
Managed Lands Ranking
LOW
MODERATE
HIGH
0
500 m

Figure 2-21. Livestock Density in the Powassan Wellhead Protection Area




N
W
E
S
Main
Main
Main
Queen
King
King
Elm
Elm
Edward
Memorial
Powassan Wells
Roads
Railway
Waterbody
Wetland
Stream/River
Livestock Density Ranking
LOW
HIGH
0
500 m

2.4.2 ~~Town of~~ Mattawa WHPA

Managed Lands

Mattawa's managed lands are shown in Figure 2-22 below. There were no agricultural managed lands identified in any of the Mattawa WHPAs. Non-agricultural managed lands mainly relate to residential lawns, with a few commercial lawns.

The areas of each managed land parcel within individual WHPAs were combined and analyzed as an overall percentage of managed lands per each respective WHPA. The result is a managed lands percentage for each WHPA in the Mattawa vulnerable area, which were classified as high, moderate or low, depending on the criteria mentioned at the beginning of this section. Since the percentage of managed lands within each separate vulnerable area was less than 40% of each vulnerable area, the managed lands classification is low within all of Mattawa's vulnerable areas.

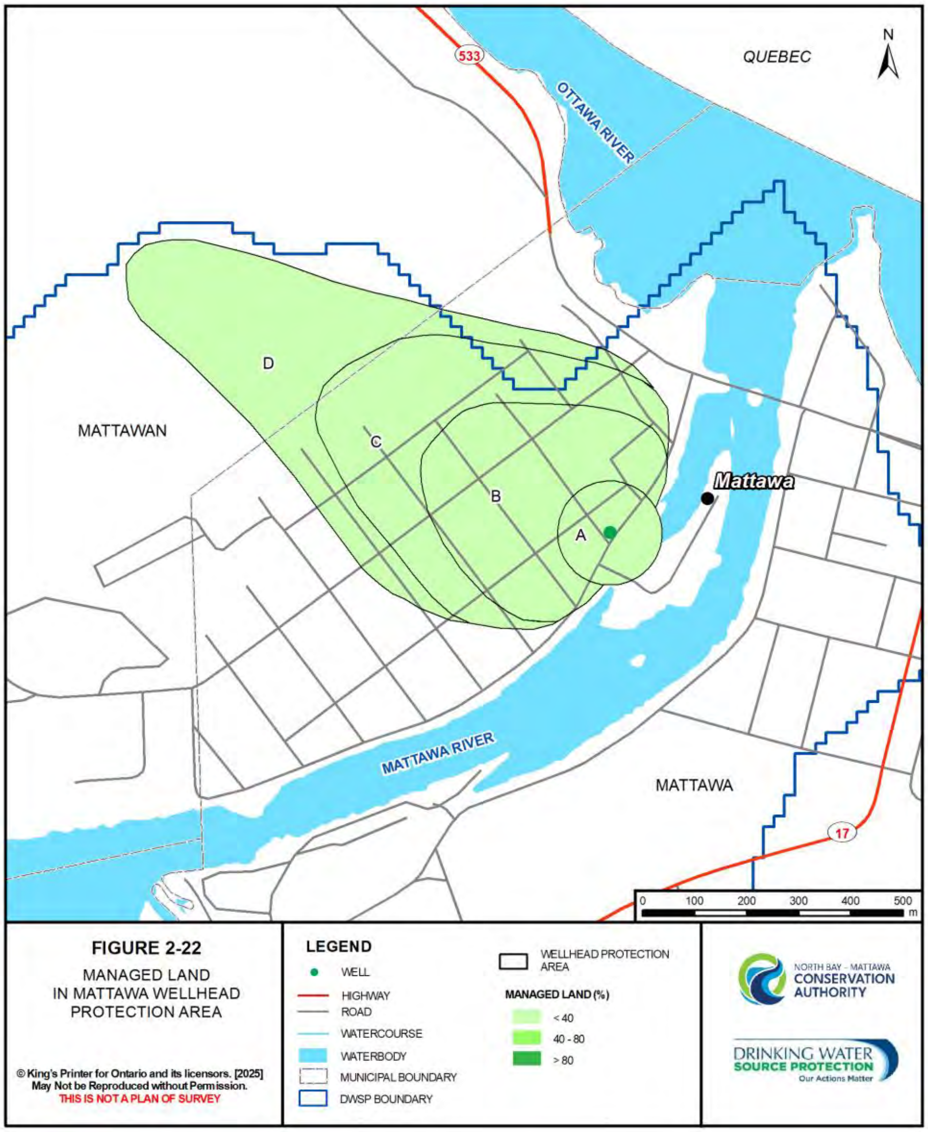
Livestock Density

There were no agricultural managed lands identified in the Mattawa vulnerable areas. Livestock density, as shown on Figure 2-23, was considered low within all WHPAs.

Drinking Water Threats

Since the entire WHPA scored low for managed lands and for livestock density, and based on the criteria shown in Table 2-16, there are no significant threats related to managed lands or livestock density in the Town of Mattawa.

Figure 2-22. Managed Lands in the Mattawa Wellhead Protection Area



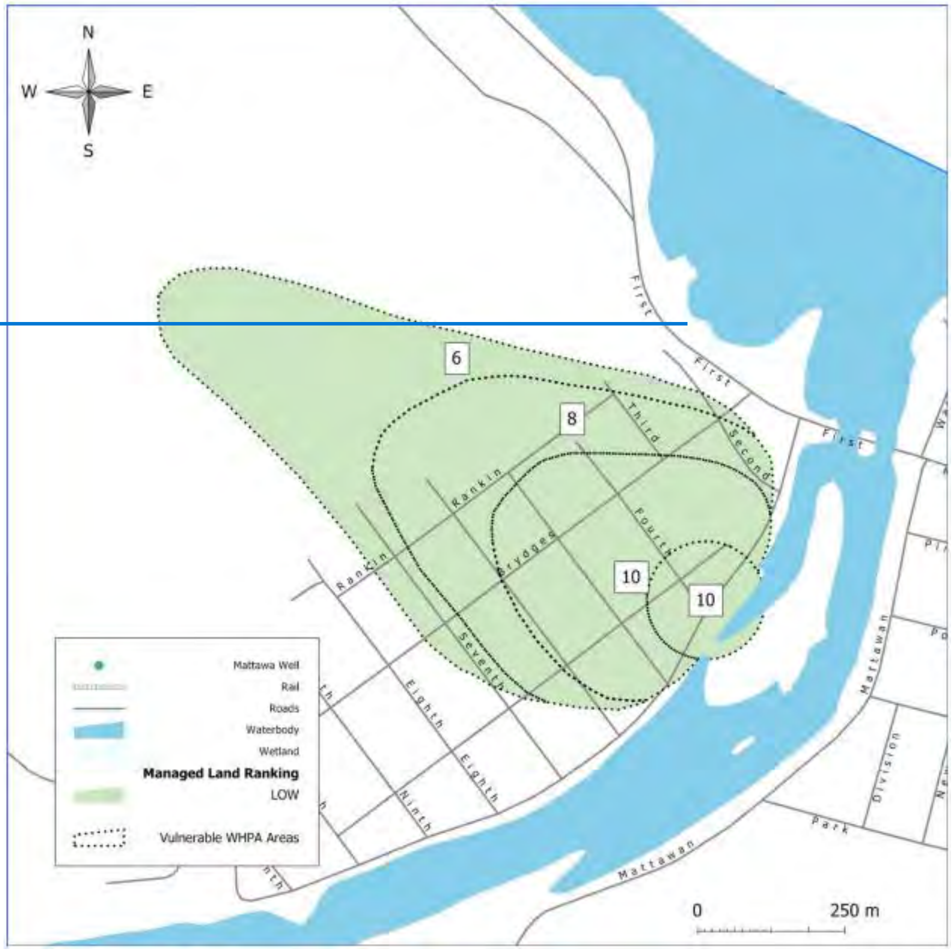
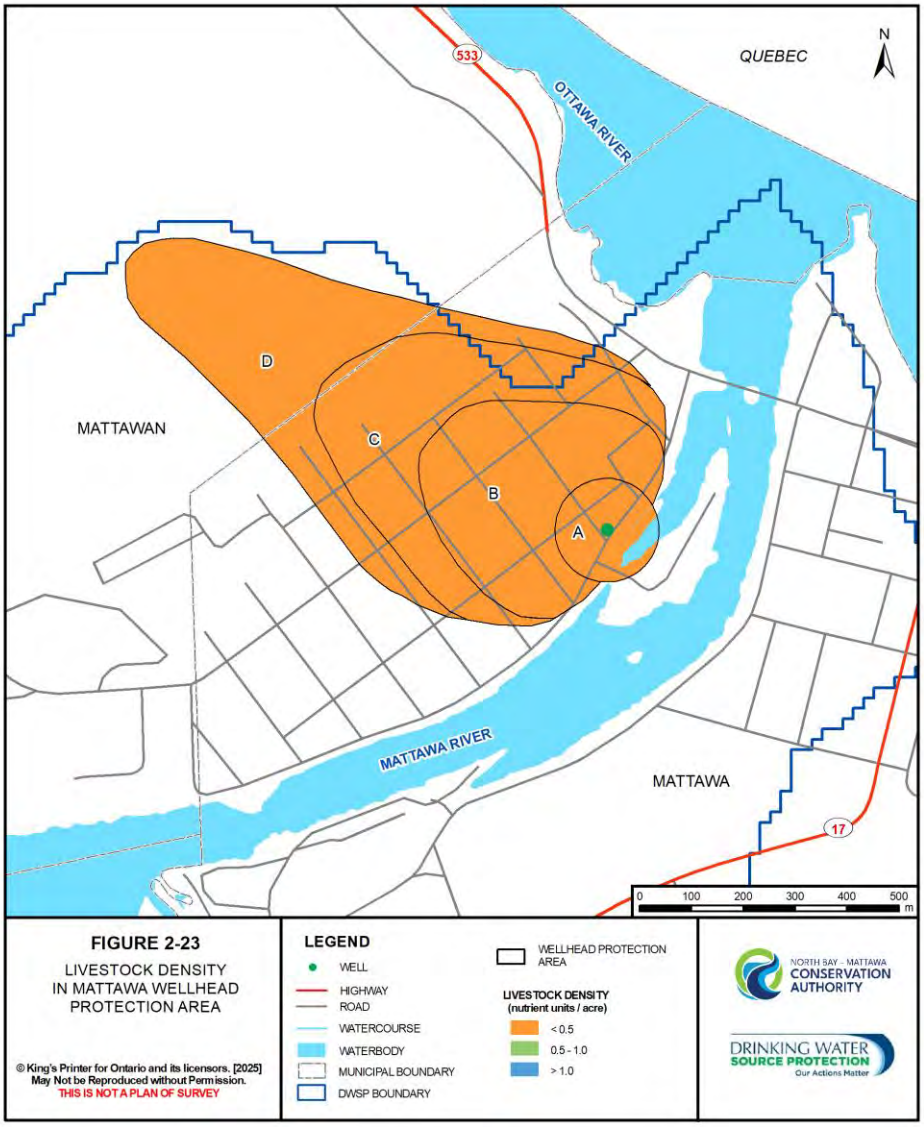

N
W
E
S
First
First
First
Third
Second
Rankin
Rankin
Brydges
Fourth
Seventh
Eighth
Eighth
Ninth
Mattawan
Mattawan
Division
Park
6
8
10
10
Mattawa Well
Rail
Roads
Waterbody
Wetland
Managed Land Ranking
LOW
Vulnerable WHPA Areas
0
250 m

Figure 2-23. Livestock Density in the Mattawa Wellhead Protection Area



2.4.3 ~~Village of~~ South River IPZ

Managed Lands

South River's managed lands are depicted below in Figure 2-24. Agricultural managed lands include a poultry operation and a beef operation, each within the IPZ-3~~A~~c for South River. Non-agricultural managed lands include residential lawns, a few commercial lawns and sports fields.

The areas of each managed lands parcel within individual IPZs were combined and analyzed as an overall percentage of managed lands per each respective IPZ. The result is a managed lands percentage for each IPZ in the South River vulnerable area, which were classified as high, moderate or low, depending on the criteria mentioned at the beginning of this section. Since the percentage of managed lands within each separate vulnerable area was less than 40% of each vulnerable area, the managed lands classification is low within South River's IPZ-1 and 3~~A~~c.

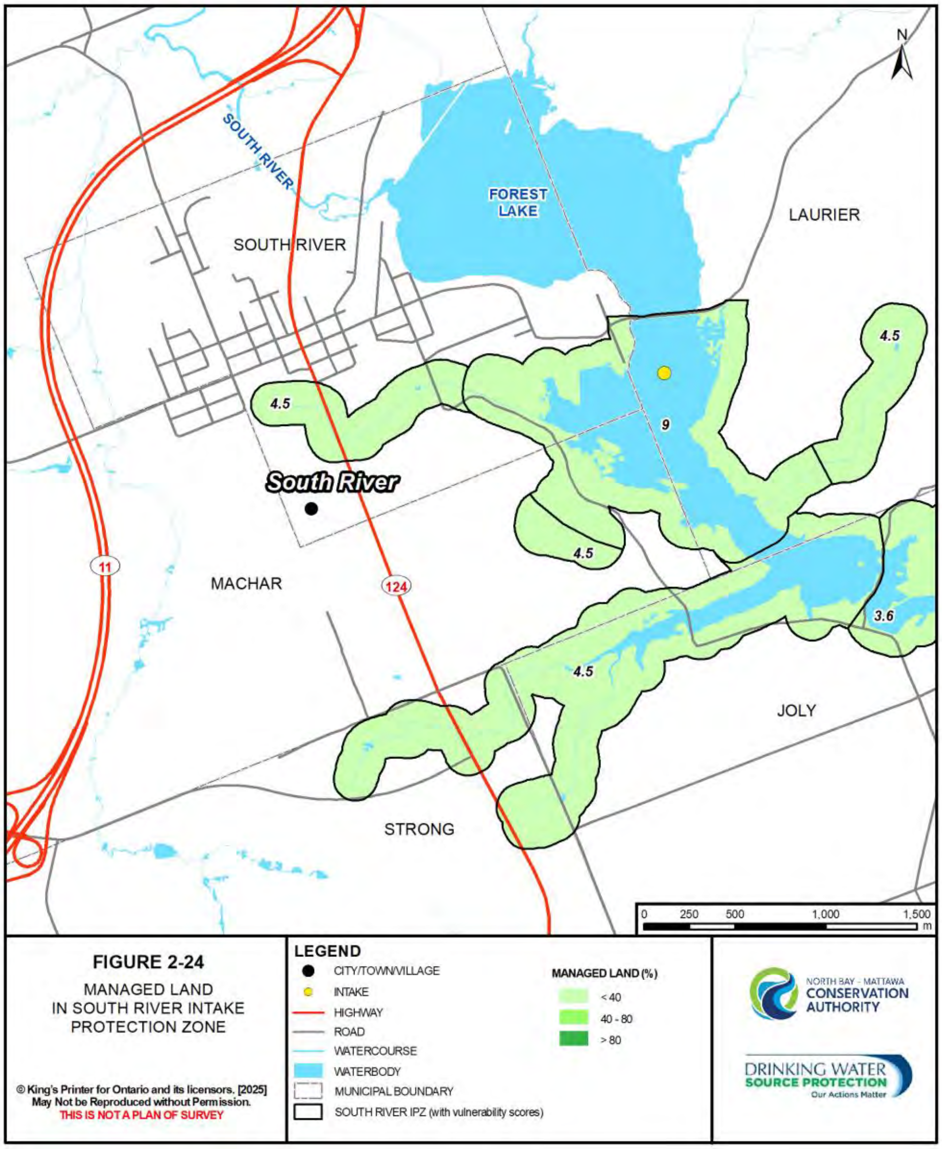
Livestock Density

South River's Livestock Density mapping is shown on Figure 2-25. According to MPAC data there are two agricultural managed lands parcels, each in the IPZ-3~~A~~c; these include a poultry operation and a beef operation. Based on the NUs generated and the total number of acres of agricultural managed lands, the livestock density was considered high with a calculated value of greater than 1.0 NU/acre.

Drinking Water Threats

The managed lands and livestock density hazard scores assigned by MECP guidance were coupled with the vulnerability scores within the vulnerable areas to determine significant, moderate or low drinking water threats in relation to the land application of ASM, NASM and commercial fertilizers. Based on the criteria shown in Table 2-16, there are no significant threats related to managed lands or livestock density in the Village of South River.

Figure 2-24. Managed Lands in the South River Intake Protection Zone



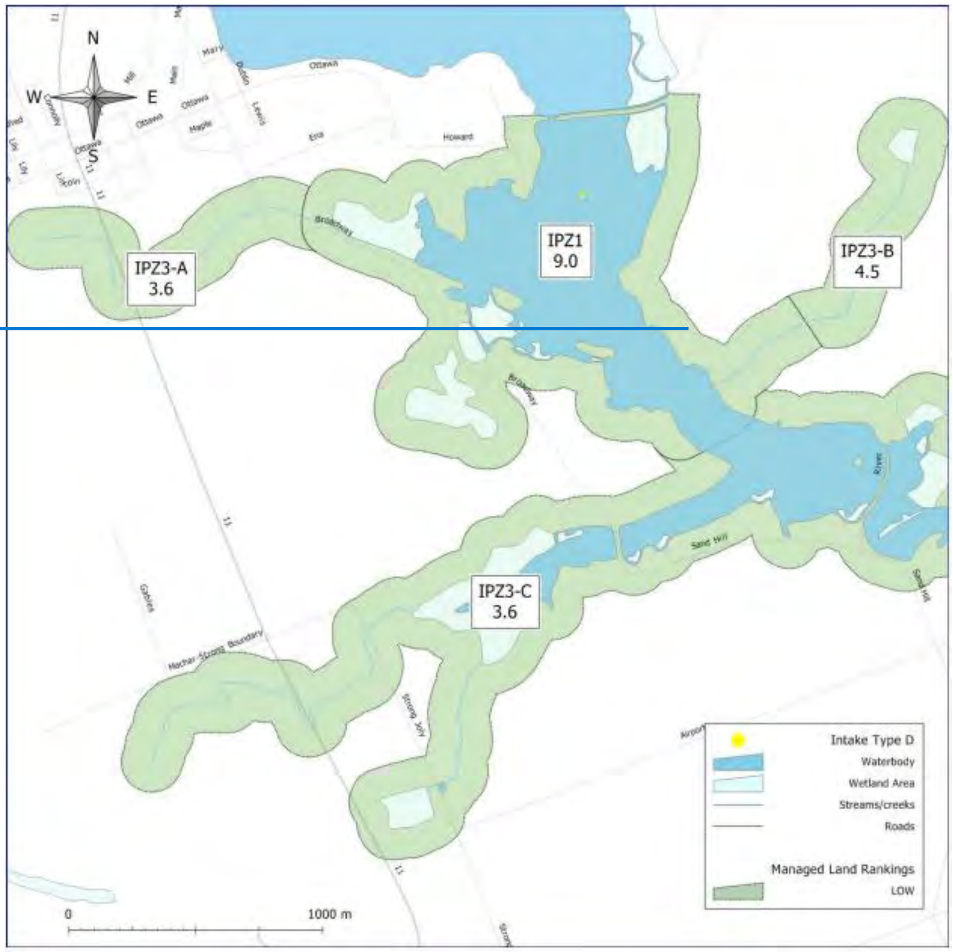
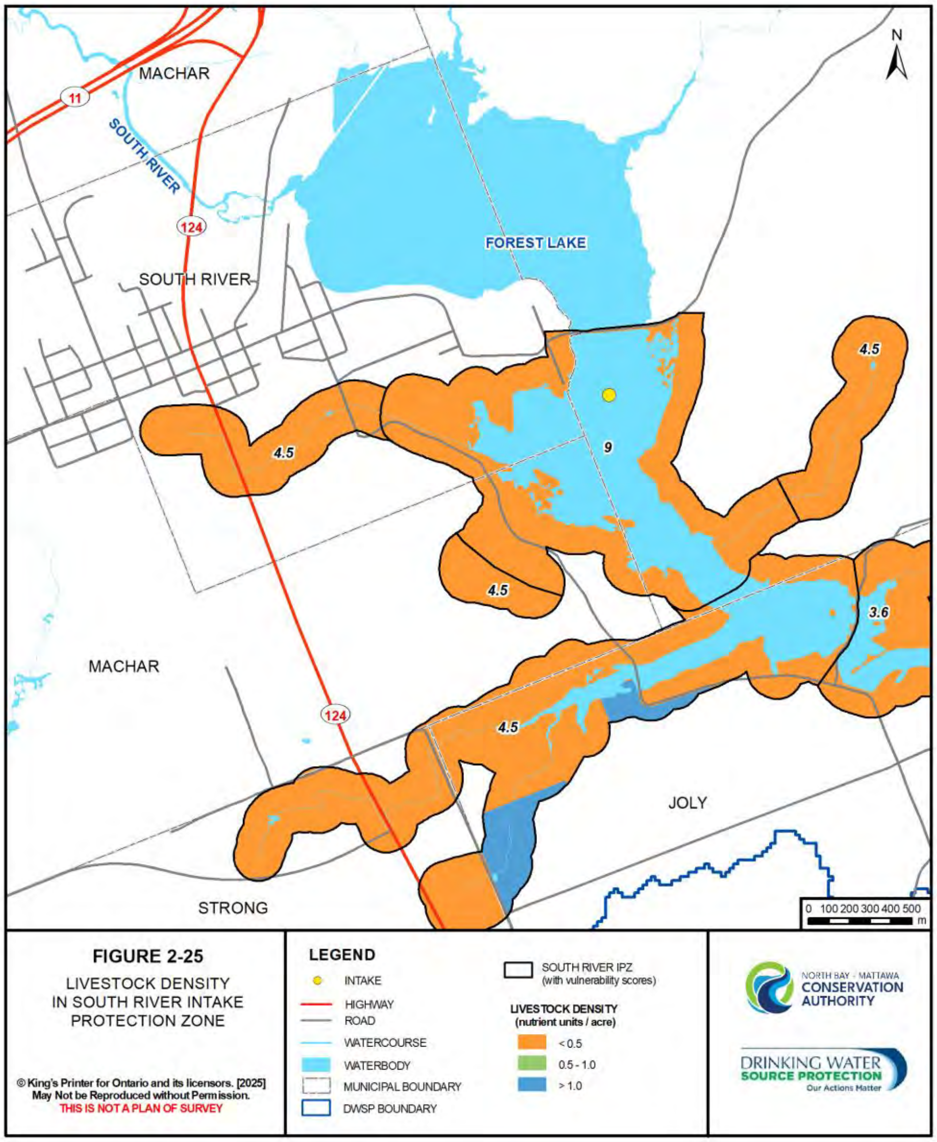
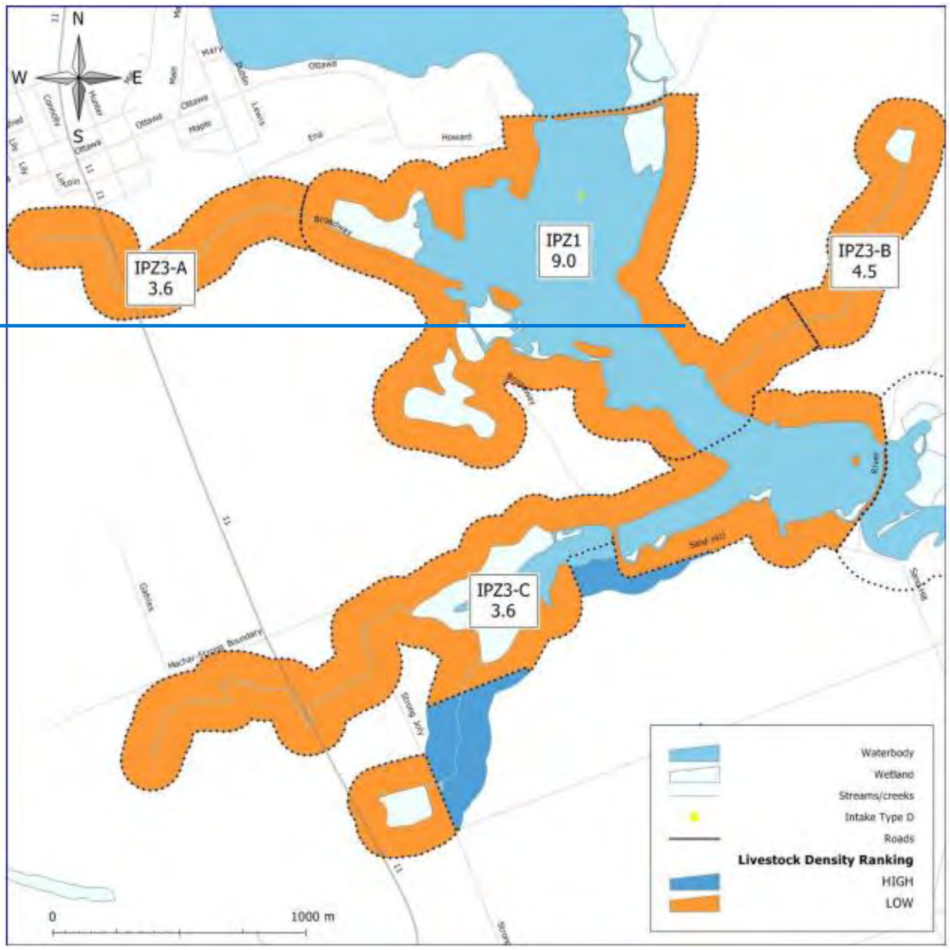

N
W
E
S
IPZ1
9.0
IPZ3-A
3.6
IPZ3-B
4.5
IPZ3-C
3.6
Intake Type D
Waterbody
Wetland Area
Streams/creeks
Roads
Managed Land Rankings
LOW
0
1000 m

Figure 2-25. Livestock Density in the South River Intake Protection Zone





N
W
E
S
IPZ1
9.0
IPZ3-A
3.6
IPZ3-B
4.5
IPZ3-C
3.6
Waterbody
Wetland
Streams/creeks
Intake Type D
Roads
Livestock Density Ranking
HIGH
LOW
0
1000 m

2.4.4 ~~City of~~ North Bay IPZ

Managed Lands

Managed lands within the vulnerable area for the City of North Bay intake are shown in Figure 2-26. Both agricultural and non-agricultural managed lands have been identified. Agricultural managed lands include one mixed farming parcel considered within the IPZ-2. Non-agricultural managed lands mainly relate to residential lawns, with a few commercial lawns.

The areas of each managed land parcel within individual IPZs were combined and analyzed as an overall percentage of managed lands per each respective IPZ. A managed lands percentage for each IPZ in the North Bay vulnerable area was calculated and classified as high, moderate or low, depending on the criteria mentioned at the beginning of this section. Since the percentage of managed lands within each separate vulnerable area was less than 40% of each vulnerable area, the managed lands classification is low within all of North Bay's IPZs.

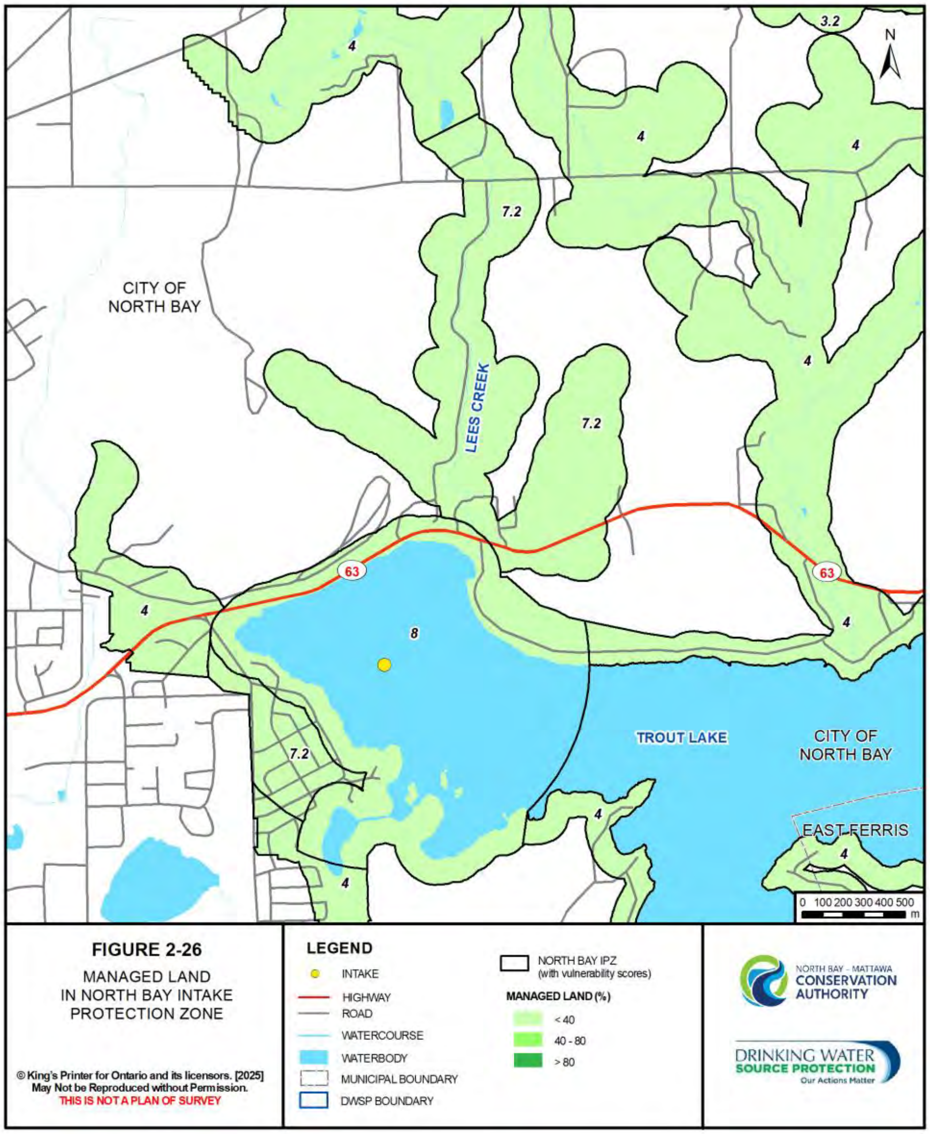
Livestock Density

North Bay's Livestock density is shown in Figure 2-27. It was determined that one active agricultural property practices 'mixed' farming activities. Based on the NUs generated and the total number of acres of agricultural managed land in the North Bay IPZ-2, less than 0.5 NU/acre is considered to be applied, resulting in a low livestock density.

Drinking Water Threats

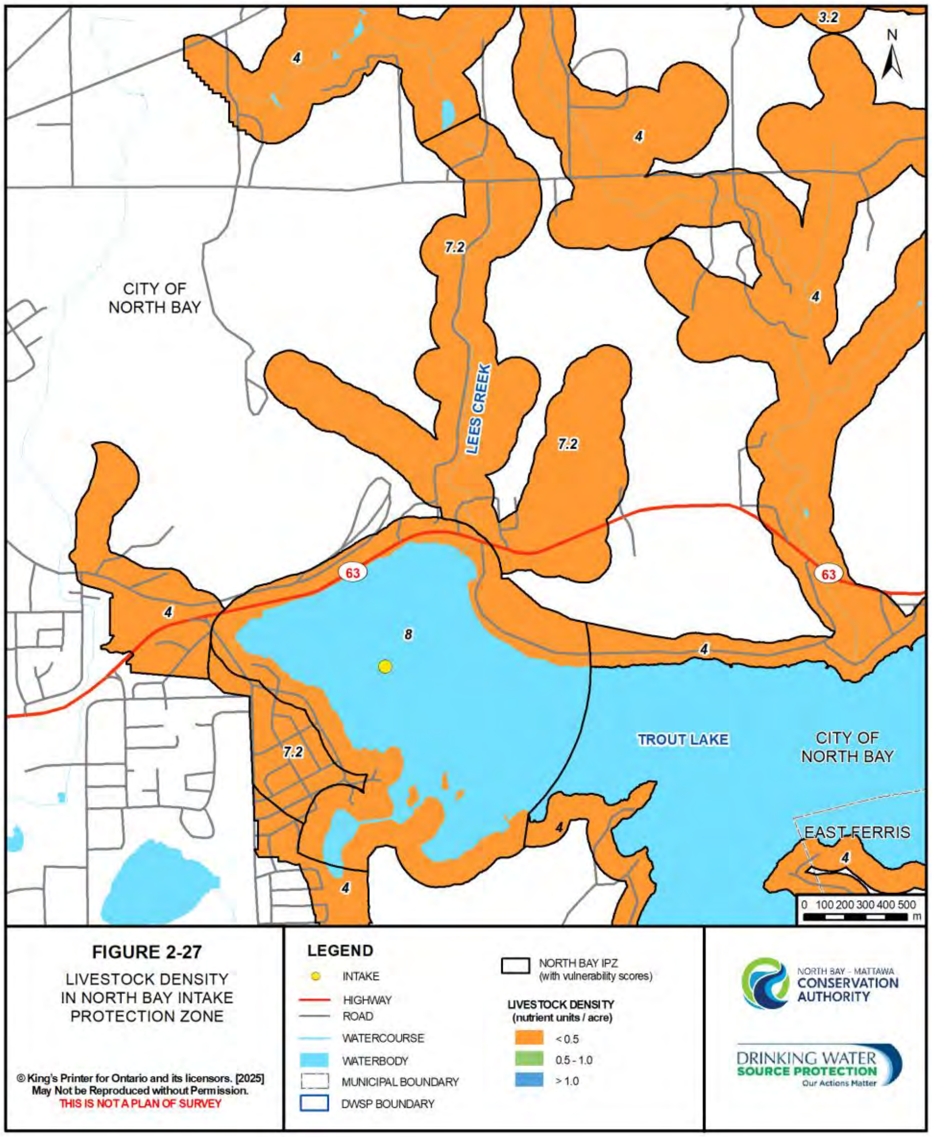
The managed lands and livestock density hazard scores assigned by MECP guidance were coupled with the vulnerability scores within the vulnerable areas to determine significant, moderate or low drinking water threats in relation to the land application of ASM, NASM and commercial fertilizers. Based on the criteria shown in Table 2-16, there are no significant threats related to managed lands or livestock density in the City of North Bay.

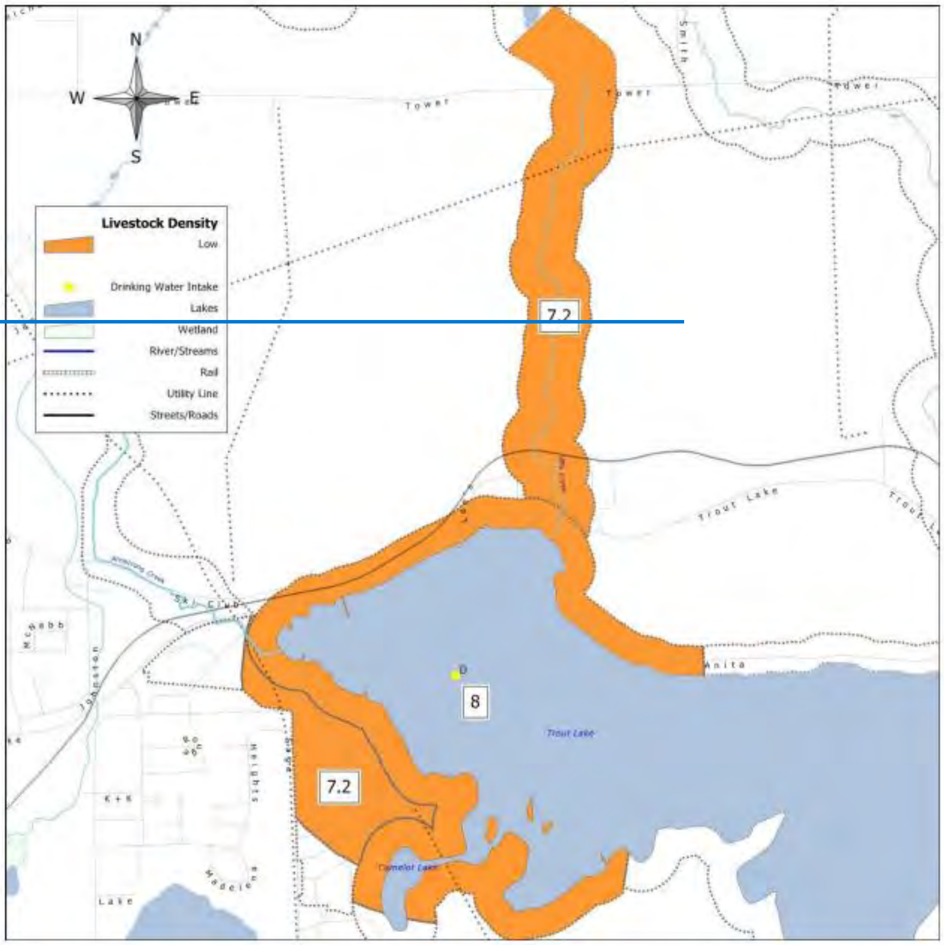
Figure 2-26. Managed Lands in the North Bay Intake Protection Zone




N
W
E
S
Managed Lands
LOW
MEDIUM
HIGH
Drinking Water Intake
Lakes
Wetland
Stream/Creek
Rail
Utility Line
Roads
7.2
8
7.2
Trout Lake
Camelot Lake
0
2.5 km

Figure 2-27. Livestock Density in the North Bay Intake Protection Zone





N
W
E
S
Livestock Density
Low
Drinking Water Intake
Lakes
Wetland
River/Streams
Rail
Utility Line
Streets/Roads
7.2
8
7.2
Tower
Trout Lake

2.4.5 ~~Municipality of~~ Callander IPZ

Managed Lands

Managed lands for the contributing area to the Callander intake are mapped in Figure 2-28. Both agricultural and non-agricultural managed lands are present in the vulnerable areas. A number of farms were identified as agricultural managed lands in the Callander vulnerable areas. Non-agricultural managed lands were also identified, and include a variety of residential lawns, commercial lawns, sports fields/parks, and golf courses. Each of these parcels are located in various sections of the IPZ-3; respective parcel areas within each vulnerable area were added up to calculate the percentage of managed lands within each vulnerable area.

Managed lands within each of Callander's vulnerable areas were classified as high, moderate or low, depending on the criteria mentioned at the beginning of this section. Since the percentage of managed lands within each separate vulnerable area was less than 40% of the corresponding vulnerable area, the managed lands classification is low within Callander's IPZ-1, 2, 3A, and 3B.

Note that large sections of the Callander vulnerable areas have historically been active agricultural areas, and this was reflected in the MPAC layer used for analysis. However, there are questions as to the validity of the land uses recorded in the MPAC layer by many local residents. Also, the MPAC database did not give sufficient information for a number of properties; if farm type was "not identified" or if there was no cropland, an analysis was not included.

Livestock Density

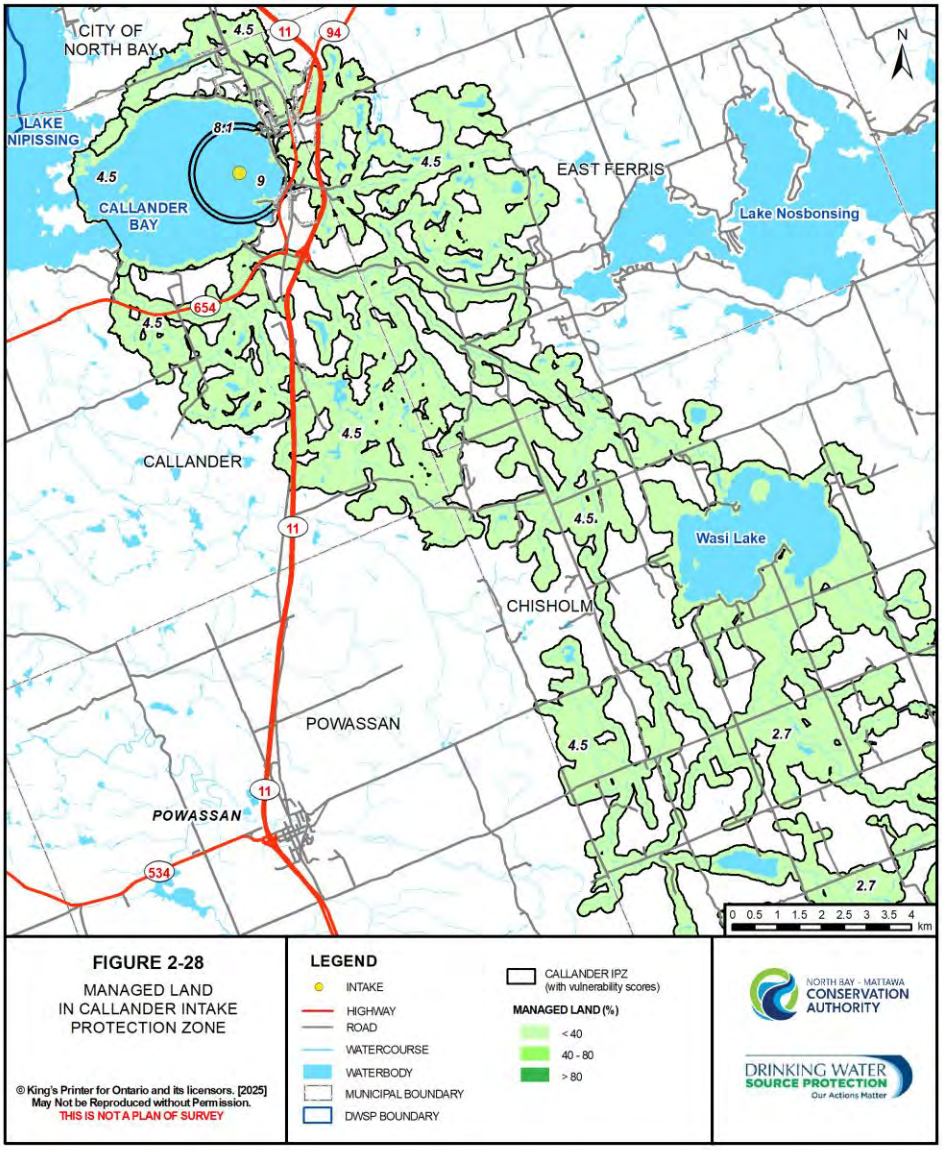
Callander's livestock density is shown in Figure 2-29. According to MPAC data there are various agricultural managed lands parcels in the IPZ-3. Based on the NUs generated and the total number of acres of agricultural managed land in the subzones of IPZ-3, the livestock density was considered high, moderate or low within various areas.

Drinking Water Threats

The managed lands and livestock density hazard scores assigned by MECP guidance were coupled with the vulnerability scores within the vulnerable areas to determine significant, moderate or low drinking water threats in relation to the land application of ASM, NASM and commercial fertilizers. Based on the criteria shown in Table 2-16, there are no significant threats related to managed lands or livestock density in the Municipality of Callander.

Although this protocol determined that there are no significant threats related to managed lands or livestock density, the drinking water issue of microcystin further explores the concept of nutrient loading contributing to drinking water threats. The topic of microcystin is more specifically addressed in the Callander section of this report (Chapter 4) and readers are encouraged to consult that section as well.

Figure 2-28. Managed Lands in the Callander Intake Protection Zone



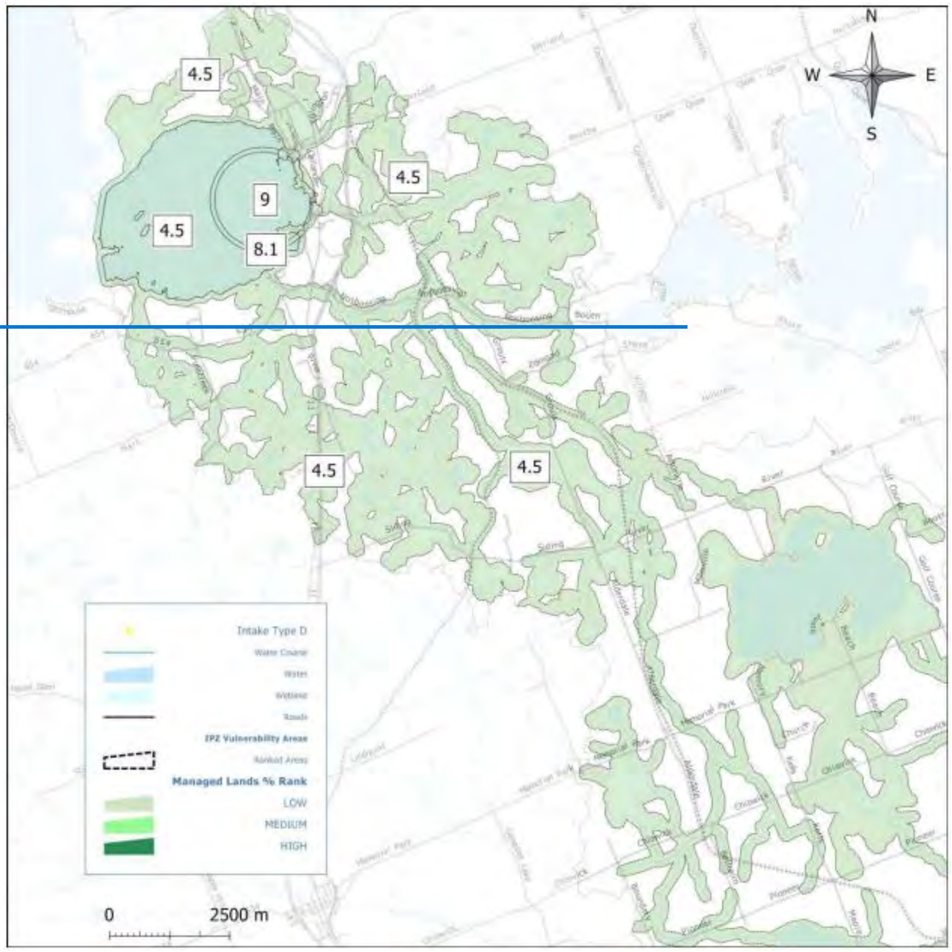
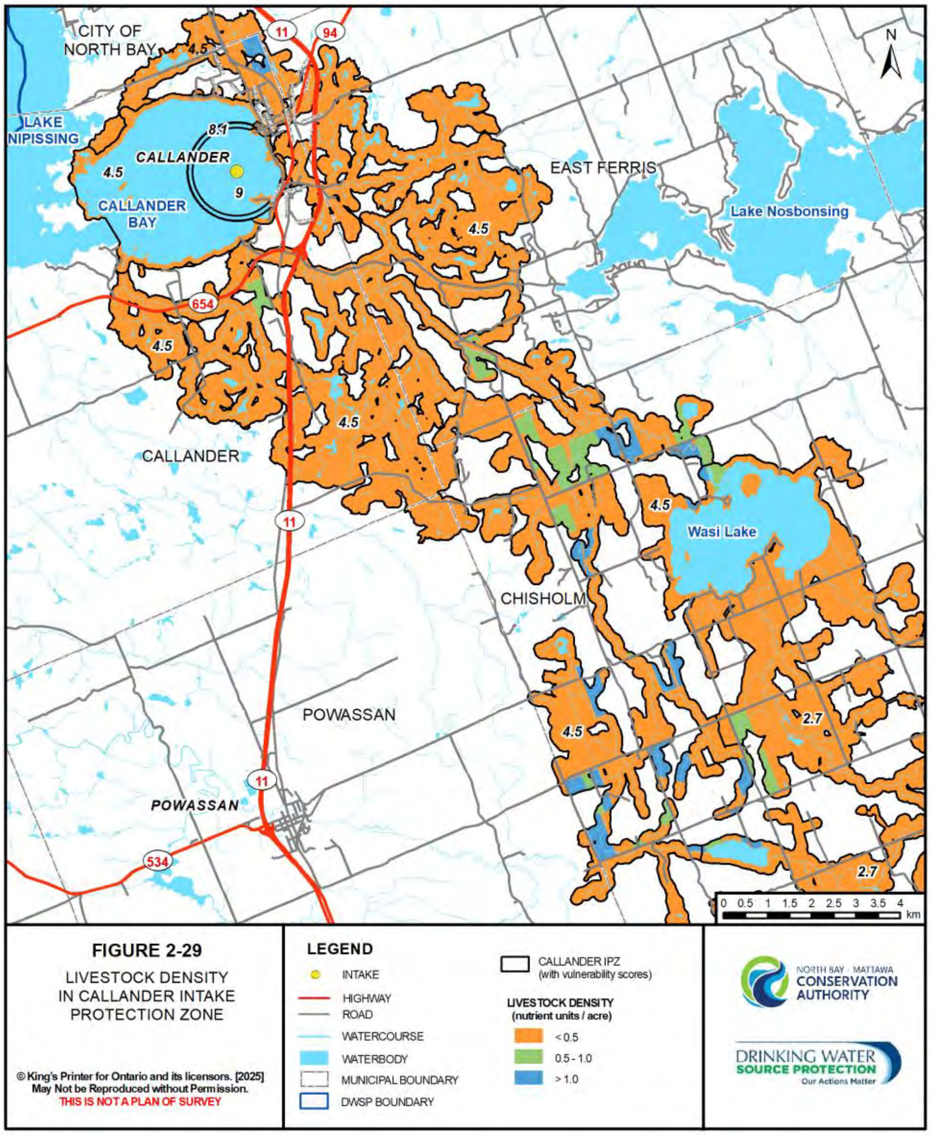
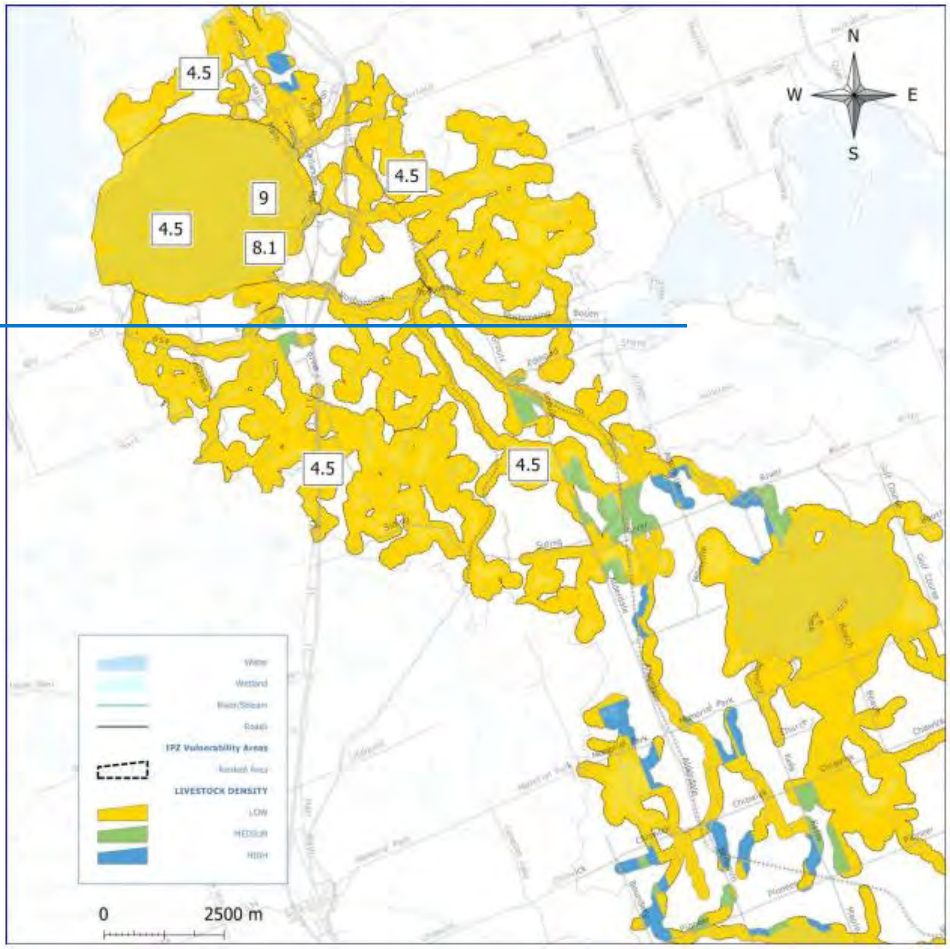

4.5
9
4.5
8.1
4.5
4.5
4.5
N
W
E
S
Intake Type D
Managed Lands % Rank
LOW
MEDIUM
HIGH
0
2500 m

Figure 2-29. Livestock Density in the Callander Intake Protection Zone





N
W
E
S
4.5
4.5
9
4.5
8.1
4.5
4.5
Wetland
IPZ Vulnerability Areas
LIVESTOCK DENSITY
LOW
HIGH
0
2500 m

2.4.6 ~~Significant Groundwater Recharge Areas (SGRAs) and~~ Highly Vulnerable Aquifers (HVAs)

Managed Lands

Figure 2-30 shows managed lands for HVAs. A number of farms were identified as agricultural managed lands in the HVAs. Non-agricultural managed lands were also identified, and include a variety of residential lawns, commercial lawns, sports fields/parks, and golf courses. The areas of each managed lands parcel within the separate HVA zones were combined and analyzed as an overall percentage of managed lands per each respective vulnerable area. A managed lands percentage was calculated and classified as high, moderate or low, depending on the criteria mentioned at the beginning of this section.

Since the percentage of managed lands within each separate vulnerable area was less than 40% of the corresponding vulnerable area, the managed lands classification is low within all the HVAs.

Livestock Density

Livestock density for HVAs is shown in Figure 2-31. Various examples of agricultural managed lands exist in the HVAs. Similarly, nutrient units and livestock density calculations were the same in many of the areas of the HVAs.~~,~~ The majority of moderate or high managed lands and livestock density areas occur within or surrounding the Township of Chisholm and the Municipality of Powassan, with various other pockets throughout the SP Area.

Drinking Water Threats

The managed lands and livestock density hazard scores assigned by MECP guidance were coupled with the vulnerability scores within the vulnerable areas to determine significant, moderate or low drinking water threats in relation to the land application of ASM, NASM and commercial fertilizers.

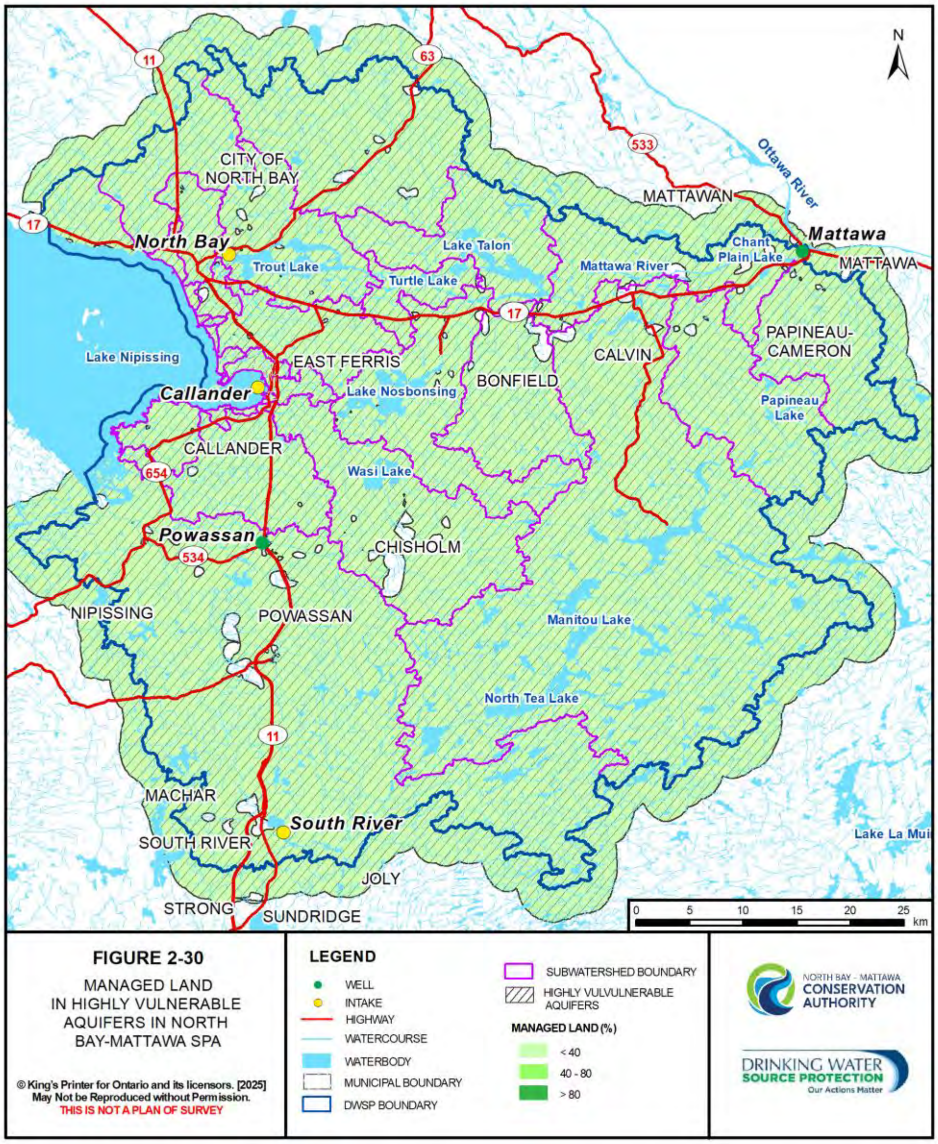
HVAs are only capable of having a maximum vulnerability score of 6. Therefore, based on the criteria shown in Table 2-16, there are no significant threats related to managed lands or livestock density within HVAs.

2.4.7 Data Gaps/Limitations

MPAC data was primarily used towards the identification and delineation of managed lands and livestock density parcels in the SP Area. It should be noted that the MPAC data on hand is considered somewhat dated and may not reflect the current conditions of the landscape; this constitutes as a data gap within the assessment.

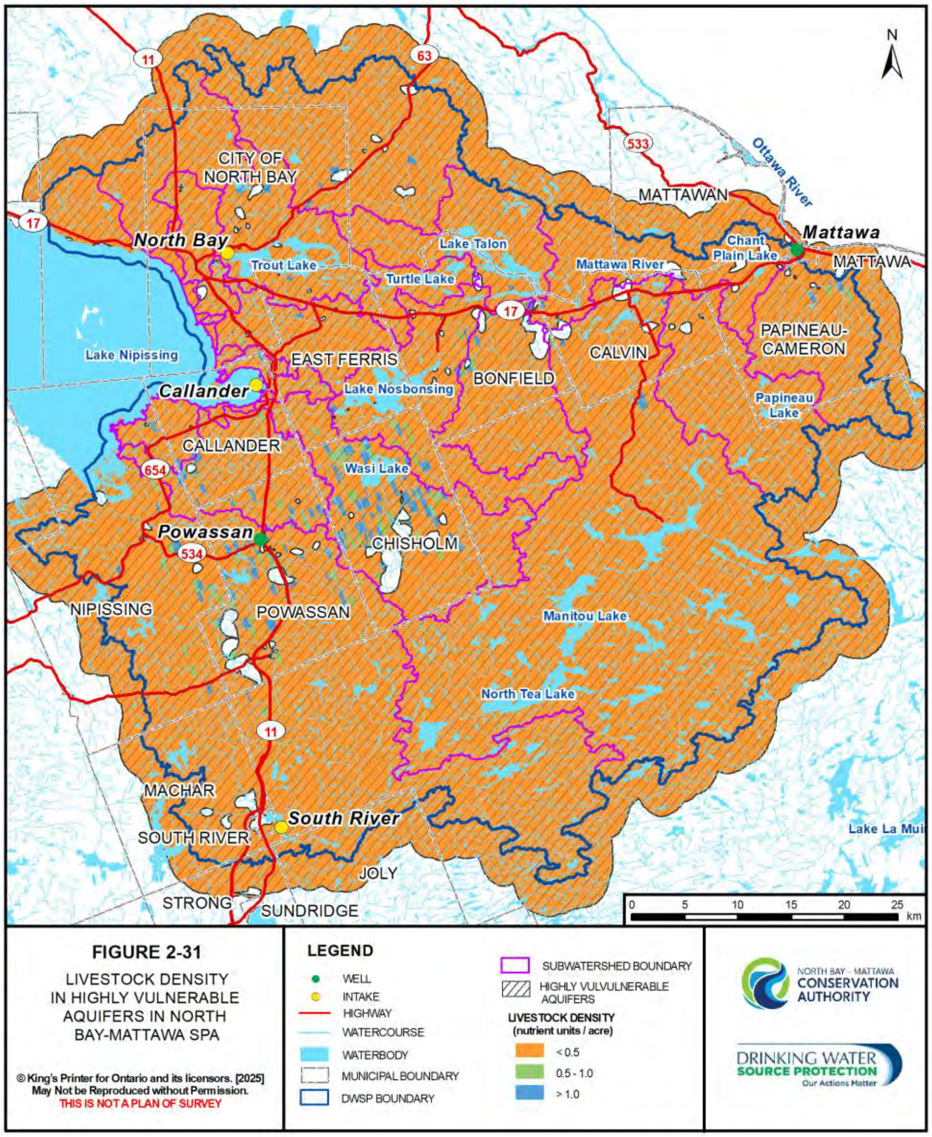
Work has been conducted towards attaining accurate land use data for the Callander subwatershed, specifically within the scope of a separate Callander Bay Subwatershed Phosphorus Budget project. Incorporating this land use data may refine the significant threats related to the drinking water issue of microcystin-LR (chemical produced by cyanobacteria blooms), which is discussed in greater detail within Section 4.0.

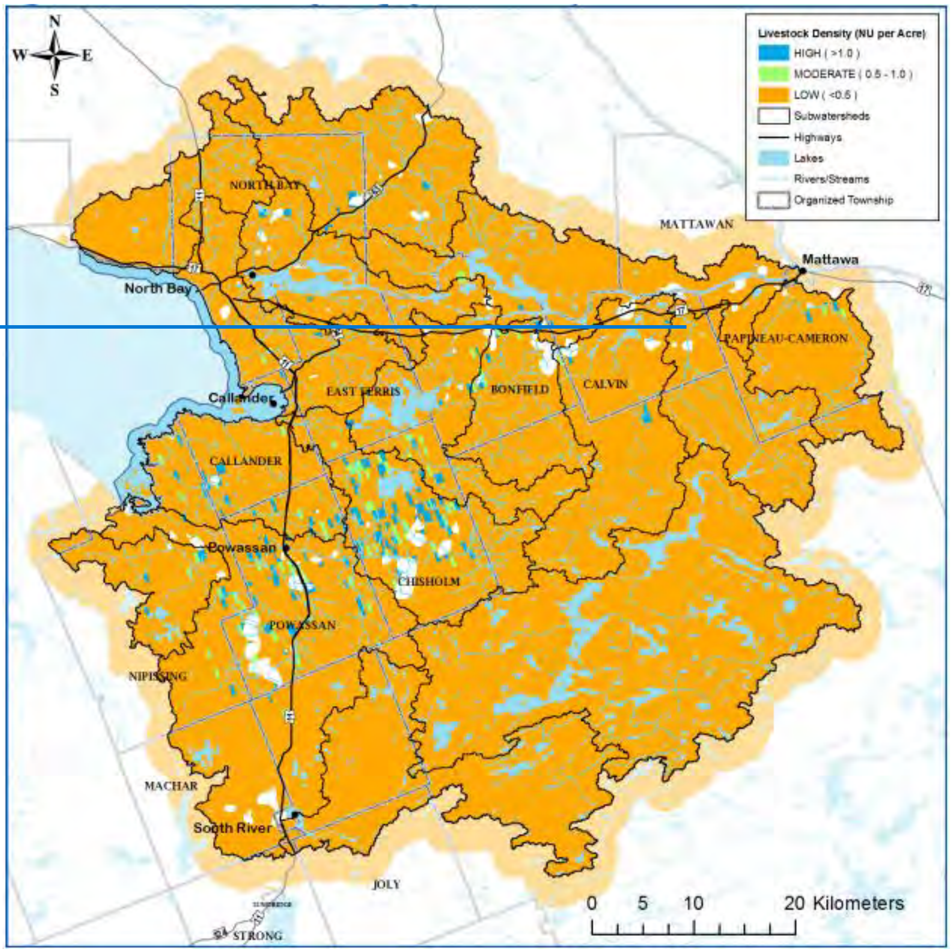
Figure 2-30. Managed Lands in Highly Vulnerable Aquifers




Managed Lands < 40%
Subwatersheds
Highways
Lakes
Rivers/Streams
Organized Township
N
S
W
E
NORTH BAY
MATTAWAN
Mattawa
North Bay
PAPINEAU-CAMERON
Callander
EAST FERRIS
BONFIELD
CALVIN
CALLANDER
Powassan
CHISHOLM
POWASSAN
NIPISSING
MACHAR
South River
JOLY
STRONG
0 5 10 20 Kilometers

Figure 2-31. Livestock Density in Highly Vulnerable Aquifers




Livestock Density (NU per Acre)
HIGH (>1.0)
MODERATE (0.5 - 1.0)
LOW (<0.5)
Subwatersheds
Highways
Lakes
Rivers/Streams
Organized Township
NORTH BAY
MATTAWAN
Mattawa
North Bay
PAPINEAU-CAMERON
Callander
EAST FERRIS
BONFIELD
CALVIN
CALLANDER
Powassan
CHISHOLM
POWASSAN
NIPISSING
MACHAR
South River
JOLY
STRONG
0 5 10 20 Kilometers

2.5 Conceptual Water Budget

The conceptual water budget provides an overview of how groundwater and surface water interact and move through the watershed. The need for, and level of, water budget assessment through numeric modelling can then be determined.

The water budget sets out to answer four questions:

1. Where is the water found?
2. How does the water move?
3. What and where are the stresses?
4. What are the trends for water availability?

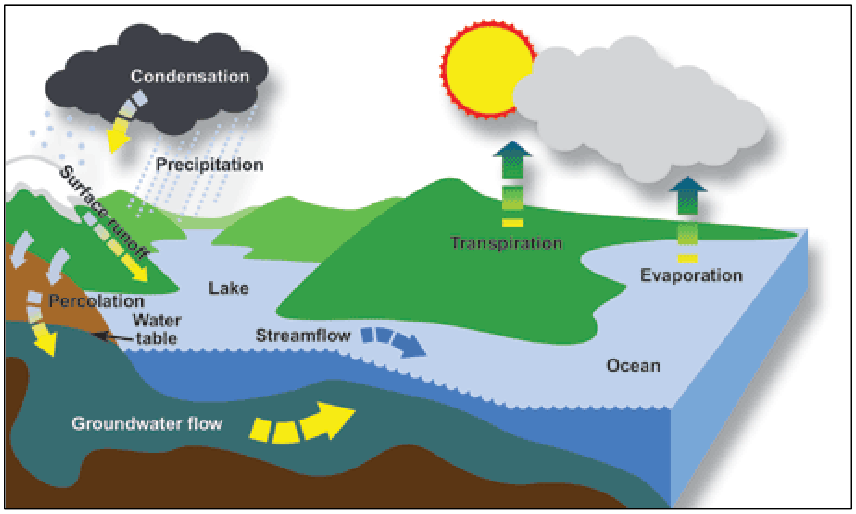
2.5.1 Principles and Components

Water vapour accumulates in the atmosphere by evaporation from open water and land surfaces and transpiration from plants. When it condenses, it falls to the land surface as precipitation (P, comprised of rain and snow). Part of this is returned to the atmosphere by evaporation and plant uptake (ET, that is, evapotranspiration). Part of the remaining precipitation soaks into the ground and recharges (R) the groundwater table. The rest runs off (RO) and is stored on the surface (e.g., lakes, ponds and marshes). From there it is evaporated back to the atmosphere to complete the cycle. The hydrologic cycle is illustrated in Figure 2-32 and explained in further detail below.

The hydrologic cycle begins with precipitation falling on the ground. The amount and rate of precipitation that actually arrives at the ground surface is controlled by the prevailing weather system that generated the precipitation on a regional scale. At the more localized scale, topography and land cover influence the movement of the precipitation amounts once upon the ground surface.

This water (as rain or snowmelt) can follow three pathways. In liquid form water either runs off across the ground surface directly to a surface watercourse, or infiltrates into the ground to recharge groundwater storage, or goes back to the atmosphere by evaporation or through plant transpiration. The latter two are generally combined under the term evapotranspiration.

Figure 2-32. Hydrologic Cycle in a Watershed



Source: Environment Canada, 2004c.

Water entering the ground is termed infiltration. The portion of the infiltration that reaches the water table is termed recharge, with the difference being lost to plant uptake (transpiration) from the rooting zone. The amount of water that actually infiltrates the ground surface is controlled by: the rate of precipitation (rainfall or snowmelt); soil type (i.e., clay, silt, sand or gravel); presence and depth to bedrock; ground surface conditions (e.g., topographic slope, seasonally frozen or desiccated soils); and vegetative cover (e.g., urban, agricultural or forested). In some areas (e.g., hummocky ground), the surface topography has created large depressions, which creates ponding before overland flow occurs. Consequently, water in these depressions either infiltrates downward and contributes to groundwater and subsurface storage or evaporates back to the atmosphere. Flow of groundwater is governed by the porosity and permeability of the soil or rock, the driving head and the geometry of the pathways.

Runoff water collects in stream channels that lead to larger channels or discharge to ponds, wetlands or lakes. While in these ponds or lakes, part of this water may return to the atmosphere by evaporation, it may infiltrate into the ground, or it may spill into downstream channels. The travel time of flow in these stream channels is governed by the length, slope, roughness, and cross-sectional shape of these channels. If the flow is high and fast enough, water may overtop the channel banks, flooding the adjacent land area, and resulting in further evaporation or recharge.

Evapotranspiration is a function of multiple factors including temperature, wind, humidity, and solar radiation. Potential evapotranspiration (PET) is the amount of water that could be evaporated and transpired if there were an infinite amount of water available in the soil. PET can be calculated indirectly, from other climatic factors, but also depends on the surface type, such as free water (for lakes and oceans), the soil type for bare soil and the species of vegetation.

Actual evapotranspiration (AET) is the actual amount of water delivered to the atmosphere by evaporation and transpiration under field conditions. AET is either equal to or less than PET. In wet months, when precipitation exceeds PET, AET is equal to PET. In dry months, when PET exceeds precipitation, AET is equal to precipitation plus the absolute value of the change in soil moisture storage (in these cases AET < PET).

At the regional scale, a Water Budget provides a conceptual understanding of how groundwater and surface water interact and move through the watershed. The following equation describes the relationship between the components. The left side of the equation accounts for all the inputs and the right side accounts for losses from the system. The difference between inputs and losses is accounted for by the change in storage **ΔS.**

$$P + Sw_{in} + Gw_{in} + ANTH_{in} = ET + Sw_{out} + Gw_{out} + ANTH_{out} + \Delta S \qquad \textit{Equation (1)}$$

Where:

P	=	Precipitation
Sw_{in}	=	Surface water inflow into the system from outside
Gw_{in}	=	Groundwater inflow into the system from outside
$ANTH_{in}$	=	Anthropogenic or human inputs
ET	=	Evapotranspiration losses
Sw_{out}	=	Surface water outflow from the system
Gw_{out}	=	Groundwater outflow from the system
$ANTH_{out}$	=	Anthropogenic or human removals
ΔS	=	Change in storage (both surface and groundwater)

Surface water inflow into the system (Sw_{in}) is equal to zero because the analysis is for the entire watershed. Groundwater inflow into the system (Gw_{in}) was assumed to be zero largely because of the limited overburden (soils) along the watershed boundary and the relatively impervious shallow bedrock. No anthropogenic inputs were identified. Equation (1) applies to the entire watershed.

An important objective of the exercise is to identify how much surplus exists which may be available for additional consumptive uses, or as a safety margin should there be changes in climate. Internal to the watershed the precipitation follows a more intricate pathway. The evapotranspiration is derived from surface water and groundwater. The groundwater recharge is only a portion of the actual infiltration, some of it being lost to transpiration. Evaporation comes from open waterways, canopy interception and temporary puddle storage. Streamflow is made up of both runoff and groundwater discharge (called baseflow).

The water balance can be simplified, on a local scale and ignoring any change in storage, as:

$$P = AET + S \qquad \textit{Equation (2)}$$

Where: **P** = Precipitation

AET = Actual Evapotranspiration

S = Surplus

The surplus is further broken down into runoff (RO) and recharge (R) by:

$$S = RO + R \qquad \textit{Equation (3)}$$

Therefore Equation (2) can be restated as:

$$P = AET + RO + R \qquad \textit{Equation (4)}$$

For the preliminary estimation of the water balance components (i.e., actual evapotranspiration, surface runoff and recharge for equation (4) above), the climactic data are used. Environment Canada has generated climate normals for the period (1971-2000) for all stations used.

Water in a river/stream is the result of precipitation that has fallen on the watershed over time. Water resulting from precipitation gains entry to the creek following three main paths: by directly falling on the creek surface, by running over the land surface to the streams/waterbodies (surface runoff) or by infiltrating into the ground and reappearing as groundwater discharge (springs or seeps) along the stream course.

It is important to note that not all of the precipitation that falls on the watershed makes its way to the surface water and groundwater system. A portion of the precipitation that falls returns to the atmosphere by evaporation from open water surfaces (including sublimation in the winter from the snow~~-~~-covered surfaces~~), or~~) or is used by plants through transpiration. A portion of the water infiltrates into the ground and may leave the watershed by discharge to an adjacent watershed.

The path that water follows in a watershed will determine to a great extent how the watershed responds to precipitation. The local climate and physiography (surficial geology, topography and land use) are dominant factors that influence how water is delivered to the streams and rivers that form a watershed. In the SP Area, consumptive activities (e.g., drinking water, irrigation, etc.) are locally dominant, but minor in comparison to the overall availability of water. Streamflow is the response to how water is delivered to the streams and creeks forming the drainage network of a watershed. Each of these factors must be considered when describing the water balance within a watershed.

To develop a conceptual water budget the following elements were considered using available data (some of which is discussed below, while other portions are covered in Section 2.1):

- Climate
- Land Cover
- Geology/Physiography
- Groundwater
- Surface Water (including reservoirs and major discharges) and
- Water Use.

2.5.2 Summary of Conceptual Water Budget Findings

The detailed water balance components are described mathematically at the beginning of Section 5.1.3 of the Conceptual Water Budget (Gartner Lee, 2007). A brief summary of the data for the North Bay-Mattawa Source Protection Area is given below.

The Mattawa and South Rivers are the two major watersheds comprising the North Bay-Mattawa Source Protection Area (North Bay-Mattawa SP Area). North Bay is the major urban centre with a population of about 56,000. At the eastern end of the region where the Mattawa River flows into the Ottawa River is the Town of Mattawa (population ~2,300). Powassan, Callander and the Village of South River are all small communities lying along the north-south Highway 11 corridor and together host about 7,400 people.

The area considered within the North Bay-Mattawa SP Area measures 3,963 km^2, with 2,295 km^2 (58%) draining to the Mattawa River and 930 km^2 (23%) draining to South River. The remaining smaller watersheds comprise 738 km^2 (19%). These watersheds, along with the South River, drain to Lake Nipissing. Only the Mattawa River and its contributing watersheds drain to the Ottawa River.

A portion of Lake Nipissing is included within the North Bay-Mattawa SP Area. As per Technical Rule 4, where the source is a Great Lake or other very large water body (i.e., Lake Nipissing), a water budget assessment is not required. Therefore, it is not mentioned in the Conceptual Water Budget.

These watersheds are characterized largely by shallow soils over bedrock particularly in the southern and eastern parts of the region. The overburden is mostly sand and gravel, which readily accepts infiltration of precipitation. The underlying Precambrian bedrock is comparatively impermeable and locally deflects groundwater flow laterally to the streams, wetlands and lakes. South of North Bay, there is an area of deeper soils lying in a geologic basin where the bedrock is lower due to prehistoric faulting. These deeper soils host the most extensive agricultural area in the SP Area and have many private wells. The thickest overburden has been reported on the north and south side of the Mattawa River in Olrig Township and Boyd Township, respectively. In Mattawa and Powassan, there are limited sand and gravel aquifers that supply water to these villages.

In the north end of the SP Area, the City of North Bay obtains all of its drinking water from Trout Lake. This is important, because treated wastewater is discharged to Lake Nipissing, effectively transferring water from one watershed to another (i.e., inter-basin transfer). Mattawa and Powassan obtain their drinking water from two municipal groundwater wells at each location. The well configuration consists of one active well and one standby well in each town.

The water balance was calculated based on historical data from 13 meteorological stations within the vicinity of the SP Area. The analysis considered water surplus, soils, topography, and vegetation. The results were verified against the average annual streamflow of four gauging stations within the SP Area from 1971 to 2000, when the meteorological records were most coincident with existing streamflow records. Measured meteorological data and related calculations (i.e., actual evapotranspiration) were interpolated for the SP Area from values measured (or calculated) at the 13 meteorological stations. Individual monthly and annual interpolations were made using ordinary Kriging techniques.

The interpolated average annual precipitation for the study area during this period was 972 mm/yr. The interpolated actual evapotranspiration was estimated to be 535 mm/yr, leaving a surplus of 437 mm/yr. This surplus is available for runoff and groundwater recharge. The average recharge for the area was 208 mm/yr and average runoff was 229 mm/yr. Since the recharge ultimately reaches the watercourses in this shallow flow system, it generates baseflow. The combination of runoff and baseflow compares well with measured streamflow at selected subwatersheds over the 30 years of record, with a difference of just 11%. This is considered to be in very close agreement, given the variability of the supporting information, and provides some independent assurance of the final conclusions.

When considering water volumes for the entire SP Area, annual consumptive surface and groundwater takings equal 33.6 million m^3 and 1.5 million m^3, respectively, for a total of 35.1 million m^3 per year. This represents approximately 2% of the available annual surplus, which is about 1,732 million m^3. Therefore, there appears to be ample drinking water supplies within the SP Area, and on a basin-wide basis there is no apparent water quantity issue.

2.5.3 Watershed Overview

For management purposes, the SP Area is divided into quaternary watersheds of appropriate size. The natural independent watersheds are far more variable in size, and for developing an understanding of the movement of water through a system at the conceptual level, it is the independent watersheds that were considered.

The six independent watersheds in the North Bay-Mattawa SP Area (Table 2-17 and Figure 2-33) include:

1. Mattawa River watershed – the largest watershed within the jurisdiction of North Bay–Mattawa SP Area. It is composed of nine subwatersheds including: Mattawa River, North River, Trout/Turtle Lake, Kaibuskong River, Sharpes Creek, Amable du Fond River, Pautois Creek, Boom Creek, and Upper South-Upper Amable du Fond Rivers.
2. Duchesnay ~~River~~ Creek watershed.
3. LaVase River watershed.
4. Wistiwasing River watershed (referred to locally as the Wasi River).
5. Bear-Boileau Creeks watershed.
6. South River watershed, including Reserve-Beatty and Wolf Creeks.

The last five watersheds discharge flow westward into Lake Nipissing separately. Therefore, they were considered as five independent watersheds for the purpose of hydrologic analysis.

Table 2-17. Independent Watersheds with Corresponding Drainage Areas

Independent Watershed	Drainage Area (km^2)
Mattawa River Watershed	2,295
South River Watershed	930
Wistiwasing River Watershed	234
La Vase River Watershed	182
Bear-Boileau Creeks Watershed	178
Duchesnay River Watershed	144
Total	**3,963 km^2**

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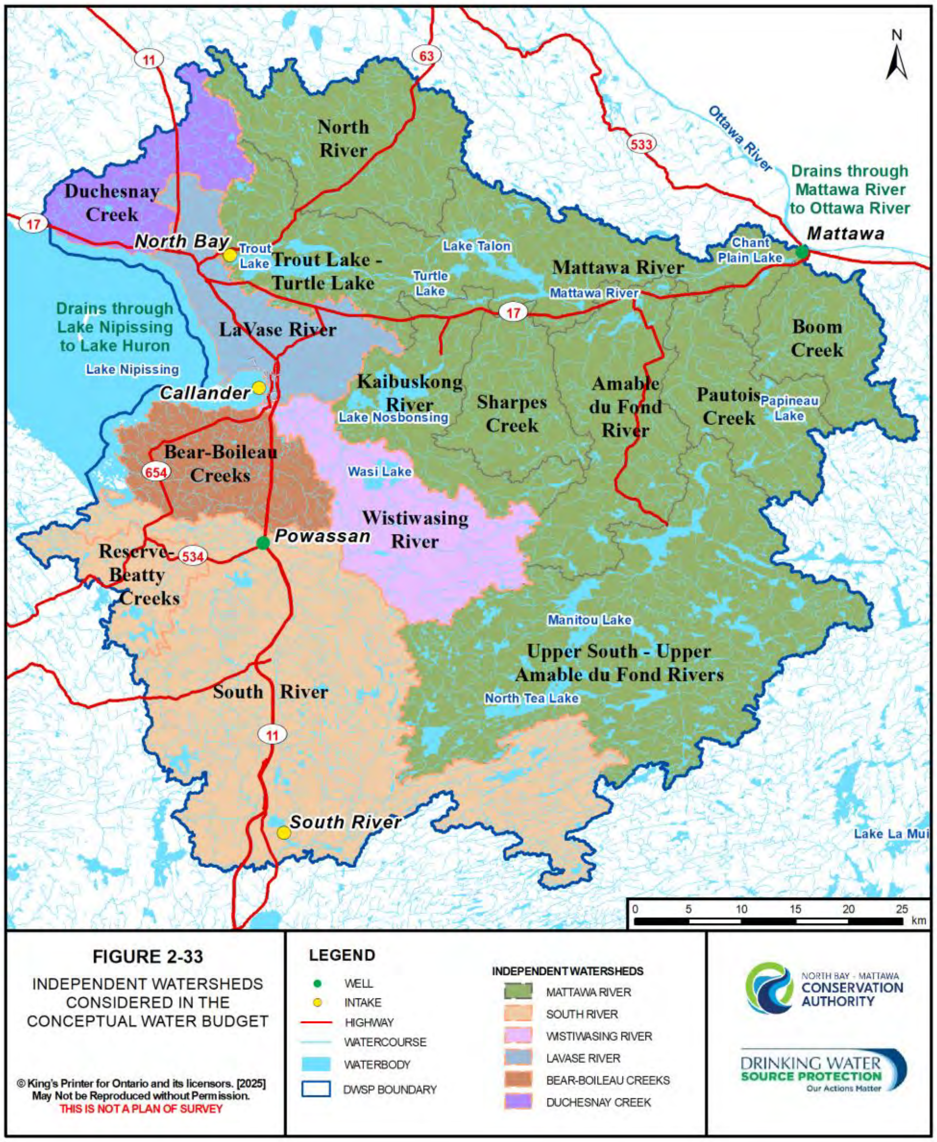
Figure 2-33. Independent Watersheds Considered in the Conceptual Water Budget



Municipal Drinking Water System
Highways
Lakes
Rivers/Streams
Source Protection Subwatersheds
Drains through Mattawa to Ottawa River
Drains through Nipissing to Huron
North River
Duchesnay River
Trout Lake Turtle Lake
Mattawa River
La Vase River
Boom Creek
Kaibuskong River
Sharpes Creek
Pautois Creek
Bear-Boleau Creeks
Wistiwasing River
Amable du Fond River
Reserve-Beatty Creeks
Upper South-Upper Amable du Fond Rivers
South River
North Bay
Mattawa
Callander
Powassan
South River
0 5 10 20 Kilometers

Two major river systems are the Mattawa River and the South River. The location of the dams and the water level profile of the Mattawa River are depicted on Figure 2-34. The control structures on the Mattawa River include Turtle Lake, Talon Lake and Hurdman Dams. The Trout Lake control structure is a spill dam located at the outlet of Turtle Lake, at the border of Bonfield and Phelps Townships. The primary purpose of the dam is to control the water level of Trout Lake for recreational and navigational purposes, at an elevation of 202.2 mASL. Talon Lake Dam is located at the outlet of Talon Lake, directly downstream of Boivin Lake on the border of Olrig and Calvin Townships. The water level upstream of the dam is maintained at 193.8 mASL. Hurdman Dam is a spill dam with the capacity to generate hydroelectric power. This dam is located 3.2 km upstream of the Town of Mattawa and backs water up for approximately 6 km, forming the narrow water body known as Chant Pl~~a~~ein Lake.

The South River also holds multiple control structures and related generating stations, including Craig, Sausage, and Smyth Lake Dams, as well as the Nipissing, Elliot Chute and Bingham Chute Generating Stations (GS). The water level profile of the South River and its dams and generating stations are shown on Figure 2-35. The Craig Lake control dam is located approximately 36 km east of the Village of South River~~,~~ and maintains the upstream water elevation of the headwater lake of South River at 386 mASL. The South River Dam is located at the outlet of the South River Reservoir, adjacent to the Village of South River, and maintains a water level elevation of 354 mASL.

The Truisler Chute GS is located approximately 15 km downstream of the South River Reservoir. Downstream of this dam are the Geisler Chute GS and Corkery Falls GS, followed by the Elliot Chute GS (264 mASL) and Bingham Chute GS (263 mASL). The Sausage and Smyth Lake Dams are approximately 5.6 km and 9.5 km east of the Village of Trout Creek, respectively. The most downstream control structure on South River is the Nipissing GS, located 3 km east of the Village of Nipissing, with an upstream water elevation of 239 mASL.

There are also three water control structures in the Amable Du Fond River basin. Recreation spill dams are located on Moore Lake in Samuel de Champlain Provincial Park, at the outlet of Lake Kioshkokwi in Kiosk and on Club Lake in Algonquin Provincial Park.

The following table (Table 2-18) summarizes the water levels along the Mattawa and South River systems.

Table 2-18. Water Levels of the Major River Systems

Name of River	Lake/Dam	Water Level (mASL)
Mattawa River	Trout Lake	202
	Turtle Lake	202
	Whitethroat Lake	199
	Bigfish Lake	198
	Tilliard Lake	197
	Talon Lake	194
	Pimisi Bay	178
	Bouillon Lake	163
	Mattawa River	161
	Chant Plaein Lake at Hurdman Dam	159
	Boom Lake	154
	Ottawa River	152
South River	Craig Lake	386
	Twenty Seven Lake	367
	South River	354
	Forest Lake	353
	South River Reservoir	351
	Elliott Chute	264
	South River	263
	Bingham Chute	252
	South River	245
	South River	244
	Nipissing GS	239
	Outlet – Lake Nipissing	197

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Figure 2-34. Water Level Profile for the Mattawa River System

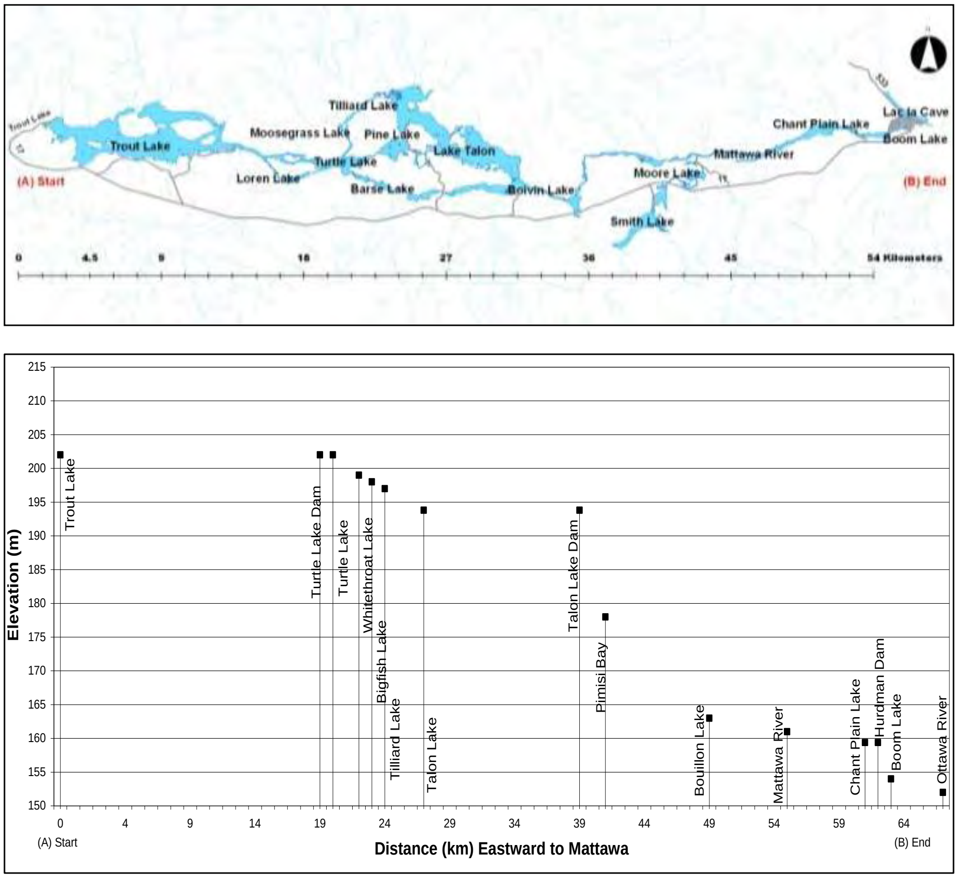
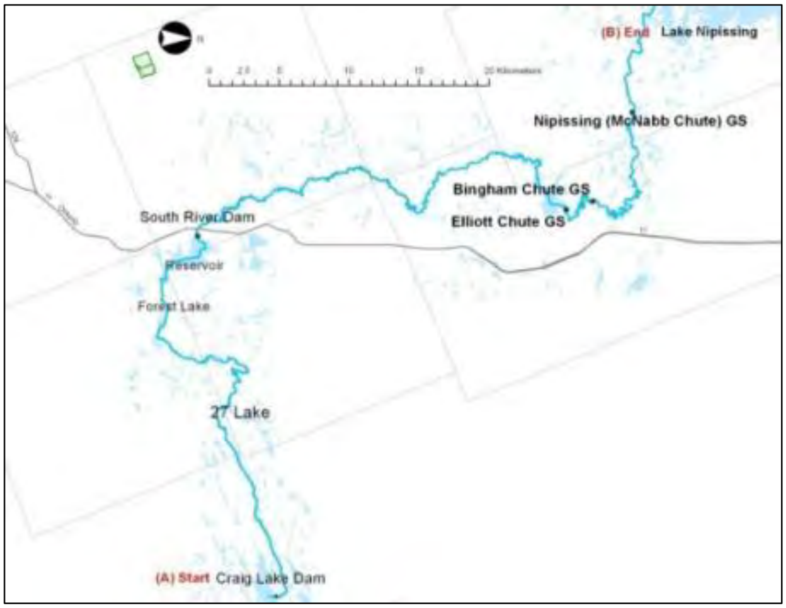
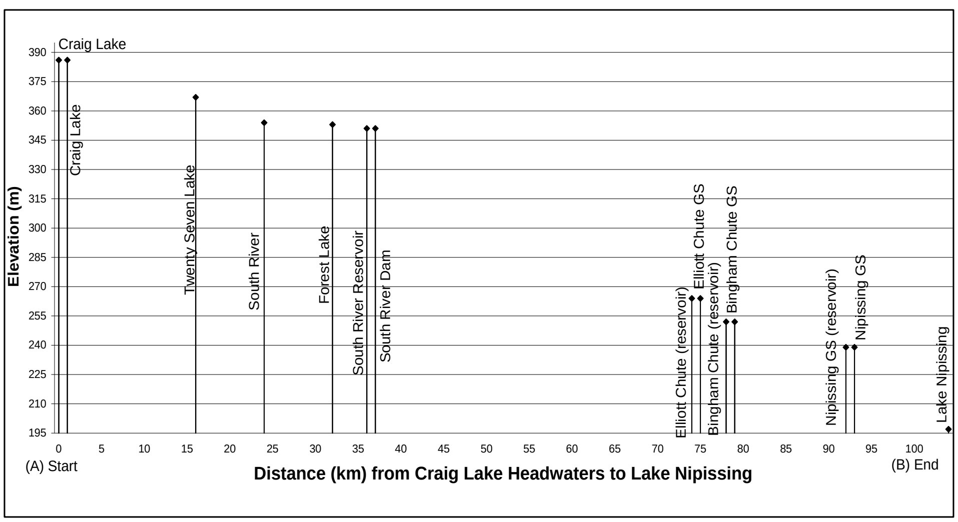


Figure 2-35. Water Level Profile for the South River System





2.5.4 Climate Data

The first step was to prepare a water budget for existing conditions from the meteorological data at each meteorological station. The average annual precipitation for the period 1971 to 2000 was selected, as it could be directly compared to the available period of streamflow record.

Using the method of Thornthwaite and Mather (1957) the actual evapotranspiration (AET) was calculated for each station. This method uses precipitation, temperature, site latitude, surficial geology, and vegetation cover to calculate the AET. The water surplus was determined by subtracting this from the average annual precipitation.

Soil moisture storage is defined as the amount of water that is stored in the soil within the plant root zone and used to buffer evapotranspirative losses. The value for soil moisture storage was assumed to be 100 mm based on the generally sandy soil type.

The results of this analysis are presented in Table 2-19.

Table 2-19. Summary of Water Balance for Selected Meteorological Stations (1971-2000)

	Meteorological Station	Precipitation (mm/yr)	AET (mm/yr)	Water Surplus (mm/yr)
Stations North of the Study Area	Belleterre (QUE)	996	513	483
	Remigny (QUE)	916	507	409
	Sudbury A (ON)	899	507	392
	Earlton A (ON)	785	482	303
Stations Directly in the Study Area	North Bay Airport	1008	534	474
	Powassan (ON)	936	539	397
Stations Inland of the East of the Study Area	Combermere (ON)	869	511	358
	Madawaska (ON)	843	512	331
	Chalk River (ON)	860	542	318
Stations South of the Study Area	Dwight (ON)	1183	526	657
	Dunchurch (ON)	1114	523	591
	Muskoka A (ON)	1099	533	566
	Minden (ON)	1045	533	512

2.5.5 Surplus, Runoff and Recharge

Water surplus was determined throughout the area using a GIS analysis. Precipitation was extrapolated to the entire SP Area, as was evapotranspiration. GIS analysis was then performed to subtract the actual evapotranspiration from the precipitation to generate water surplus.

The next step in determining recharge is to partition the surplus between runoff and recharge, using the following MECP methodology (MOEE, 1995). (Note: Ministry of Environment and Energy or MOEE is a previous name of the Ministry of Environment, Conservation and Parks or MECP) The partitioning of the water surplus between runoff and recharge depends on four main factors: 1) topography; 2) soil texture, 3) cover type, and 4) available water.

The MECP method relies on calculating "Infiltration Factors" composed of the first three factors that are applied to the fourth factor, average annual water surplus. These factors are tabulated in the MECP manual (Table 2) on pages 4-62, and are reproduced here as Table 2-20 for the reader's convenience.

The MECP method is based on the principle that water will recharge more easily through:

- sands compared to clays;
- on flat slopes compared to steep slopes; and
- through vegetated soils compared to areas that do not intercept runoff.

Runoff is greater on slopes than on flat ground. Topographic factors were calculated based on actual slopes derived from the digital elevation model using a grid-based GIS method. Application of the generalized Infiltration Factors recommended by MECP was refined by developing a relationship between Infiltration Factor and degrees of slope.

For the categories where slope ranges were given, the appropriate slope (in degrees) was calculated for the mid-point of the range. The resulting relationship is shown in Figure 2-36.

The table of example infiltration factors (Table 2-20) provides an indication of the effects of topography, soil and land cover on runoff. Woodlands provide twice the infiltration of agricultural crops.

Table 2-20. Infiltration Factors Used for Estimating Runoff and Recharge

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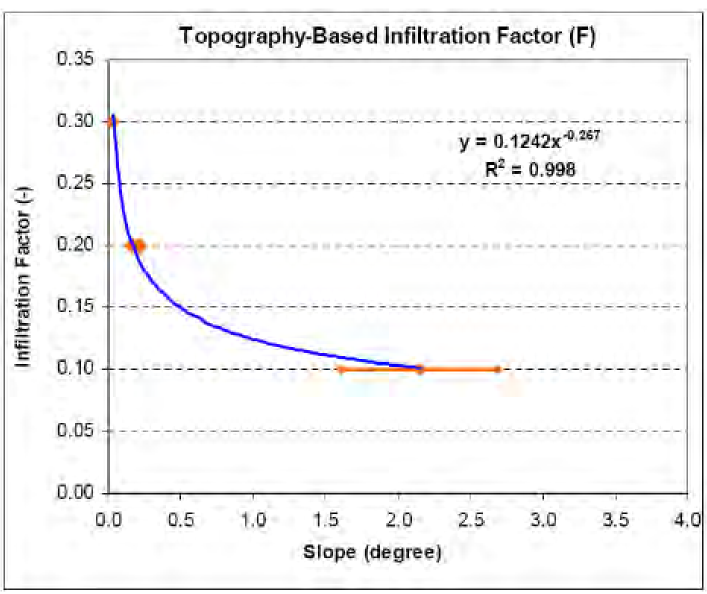
Description of Area/Development Site	Infiltration Factor
TOPOGRAPHY	
Flat and average slope not exceeding 0.6 m per km	0.30
Rolling land, average slope of 2.8 m to 3.8 m per km	0.20
Hilly land, average slope of 28 m to 47 m per km	0.10
SOIL	
Tight impervious clay	0.10
Medium combinations of clay and loam	0.20
Open sandy loam	0.40
COVER	
Cultivated lands	0.10
Woodlands	0.20

Note: Reproduced from MOEE (1995), Technical Guidelines for the Preparation of Hydrogeological Studies for Land Development Application (Note: Ministry of Environment and Energy or MOEE is a previous name of the Ministry of Environment, Conservation and Parks or MECP)

Figure 2-36. Relationship between Infiltration Factor (F) and Slope



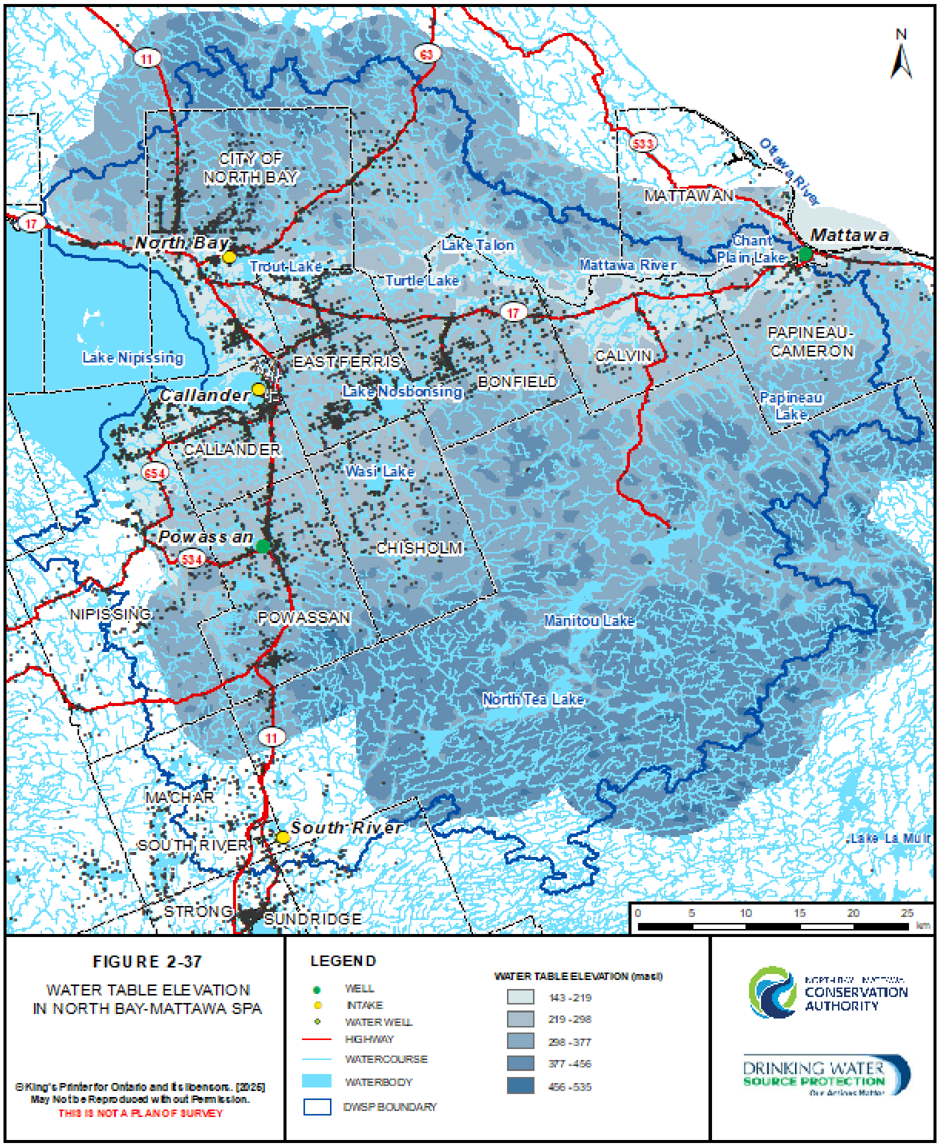
2.5.6 Baseflow Separation

As the watershed region is composed of numerous rivers, lakes and wetlands, and is mostly of silt, sand and gravel soils, there is a significant interaction between surface and groundwater in terms of baseflow contribution to the streams. Baseflow is defined as that portion of the total streamflow that occurs when there is no contribution from rainfall or runoff. In addition, any precipitation that does not runoff and infiltrates into the ground, and later returns to the watercourse, would be referred to as ‘baseflow’. Generally, infiltrated water that returns to the stream rapidly (say in less than 24 hours) is referred to as ‘subsurface flow’, ~~and~~ sometimes as ‘interflow’, and is usually considered as part of the ‘storm flow’. In agricultural watersheds that are drained by subsurface tiles, the flow in the tiles (hence, ‘tile flow’) is considered part of the ‘rapid subsurface flow’ (or the ‘slow’ storm flow). Water that infiltrates deeper into the ground, and returns to the stream much later, would be considered as the ‘baseflow’.

Therefore, baseflow comprises the accumulated subsurface or groundwater discharge to the watercourses. These are important for the natural function of the ecosystem, providing clean water and sustaining streamflow and wetlands in dry periods. In particular, it supplies the cold water that provides thermal buffering in headwater streams and sustains fish habitat. Figure 2-8 in Section 2.1 Watershed Characterization categorizes the temperature regimes of various streams and water bodies as indicated by the species of fish. The accumulation of baseflow throughout the watershed sustains the river system and lakes. From a source water protection aspect, this is an important component of Trout Lake, which is the main source of water for North Bay. The escarpment highlands are an important landscape feature contributing baseflow to Trout Lake.

The water table for the SP Area is presented in Figure 2-37. Water level elevations range from 404 ~~-~~m in the north and south, to 120 m near Lake Nipissing and the Mattawa and Ottawa Rivers. Lateral groundwater movement will also occur in the shallow bedrock where fractures exist. Groundwater recharge can be defined as the supplementation of the groundwater by the infiltration of rainfall and snowmelt, which is not returned to the atmosphere by evapotranspiration. This provides the driving force that causes groundwater to flow, and ultimately discharge as baseflow to wetlands, watercourses and lakes.

Figure 2-37. Water Table in the North Bay-Mattawa SP Area



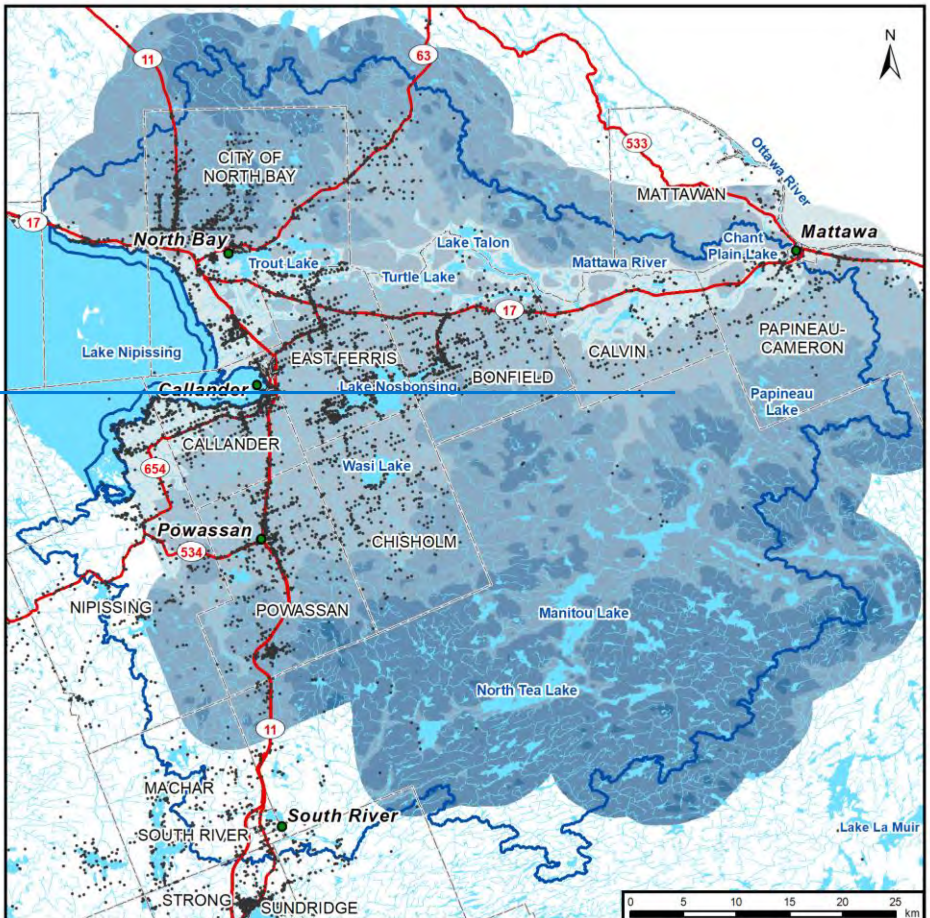


FIGURE 2-37
WATER TABLE ELEVATION IN NORTH BAY-MATTAWA SPA

2.5.7 Water Use

Water use in the SP Area is typically focused around developed areas and is used for municipal drinking water, irrigation, industry, and recreation. This water comes from both groundwater and surface water sources. Water use greater than 50,000 litres per day falls under the Permit to Take Water Process. Table 2-21 and Table 2-22 summarize the surface water takings (values are maximum allowed by each permit) and groundwater allotted takings according to the Permit to Take Water database.

A rural population of approximately 19,173 lives in the study area and most residents use water from private groundwater wells for domestic supply. Therefore, rural groundwater use has been estimated to be approximately 2.34 Mm^3/yr. This is based on an assumed consumption of 335 L/person/day.

An overview of agricultural water use is provided in Table 2-23. The Permit to Take Water database indicates that there are no groundwater permits for agricultural use and that all agricultural water use is satisfied through surface water takings.

The volume of consumptive surface and groundwater demand within the watershed is summarized in Table 2-24 below. Consumptive water use is water that is taken from a groundwater aquifer or surface waterbody and is not returned to the same aquifer or surface waterbody in a reasonable time frame. Consumptive surface water takings total about 33.6 Mm^3/yr, which is only about 10.2% of the amounts allotted in the PTTW database. Similarly, the consumptive groundwater takings from the watershed is approximately 1.49 Mm^3/yr, which is 35.5% of the amounts allotted in the PTTW database.

Table 2-21. Maximum Permitted Surface Water Takings According to PTTW Database (2006)

Permit No	Easting	Northing	Water Use	Source (River, Lake, Creek)	Takings * (Mm^3/yr)
03-P-5011	615190	5105850	Agriculture (Field and Pasture Crops)	South River	1.43
03-P-5018	664730	5129230	Campgrounds	Long Lake	0.03
74-P-5011	653900	5125200	Other – Industrial	Pimisi Lake	0.05
8315-6ADM8M	640600	5146150	Aquaculture	Balsam Creek	1.47
81-P-5226	624100	5098800	Agriculture (Field and Pasture Crops)	Unnamed Creek	0.01
89-P-5762	639900	5117300	Other – Commercial	Unnamed Creek	0.02
94-P-5025	626450	5118750	Municipal	Callander Bay	1.10
90-P-5838	622300	5131250	Municipal	Trout Lake	29.02
94-P-5011	622800	5131750	Other – Institutional	Trout Lake	0.08
98-P-5023	668099	5129680	Manufacturing	Mattawa River	0.36
99-P-5010	627650	5077650	Municipal	Forest Lake	0.61
00-P-5052	629536	5133188	Field and Pasture Crops	Four Mile Creek	0.02
0251-6ADRGZ	623200	5123800	Golf Course Irrigation	La Vase River	0.12
01-P-5006	673388	5131071	Power Production	Mattawa River	*293.28*
92-P-5988	Not Available	Not Available	Agriculture (Field and Pasture Crops)	Boulder Creek	0.80
00-P-5002	625244	5075778	Golf Course Irrigation	Irrigation Ponds	0.35
01-P-5008	624718	5121441	Golf Course Irrigation	Irrigation Ponds	0.40
Total					**329.15**
Non-consumptive (Power Generation)					*293.28*
Consumptive (Municipal, Irrigation, Other-Industrial, Campgrounds etc.)					35.86
Municipal					30.73
Irrigation					4.60
Other-Industrial, Campgrounds etc.					0.53

Table 2-22. Maximum Permitted Groundwater Takings According to PTTW Database (2006)

Permit No	Easting	Northing	Source Name	Water Use	Takings (Mm^3/yr)
02-P-5059	676210	5131526	Well # 1 (Mattawa)	Municipal	1.67
02-P-5059	676210	5131526	Well # 2 (Mattawa)	Municipal	0.72
04-P-5008	619528	5136736	Leachate Collection System & Pump Station	Groundwater-Remediation	0.44
92-P-5975	617750	5136650	Well Other	Industrial	0.03
04-P-5027	Not available	Not Available	Well #1	Campgrounds	0.03
04-P-5027	622900	5123700	Well #2	Campgrounds	0.001
82-P-5292	625900	5104350	Well #1 (Powassan)	Municipal	0.48
82-P-5292	625900	5104350	Well #2 (Powassan)	Municipal	0.48
93-P-5026	618300	5100550	Springs #1	Bottled Water	0.05
93-P-5026	618300	5100550	Springs #2	Bottled Water	0.07
93-P-5026	618300	5100550	Springs #3	Bottled Water	0.09
00-P-5002	625244	5075778	Dug Well	Golf Course Irrigation	0.04
02-P-5002	631550	5124340	Well #1	Other-Institutional	0.03
02-P-5002	631550	5124340	Well #2	Other-Institutional	0.02
02-P-5002	631550	5124340	Well #3	Other-Institutional	0.01
02-P-5002	631550	5124340	Well #4	Other-Institutional	0.02
03-P-5018	664750	5128520	Well #1	Campgrounds	0.03
Total					**4.20**
Municipal					3.35
Irrigation					0.04
Other-Industrial, Campgrounds etc.					0.81

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Table 2-23. Agricultural Water Use (m^3/yr) (2006)

Quaternary Watershed	No. of Farms	Livestock	Field	Vegetable	Specialty	Total
North River (2JE-09)	0	0	0	0	0	0
Duchesnay Creek (2DD-19)	0	0	0	0	0	0
La Vase River (2DD-20)	13	3,497	13	4,501	4,209	12,220
Mattawa River (2JE-02)	18	4,612	32	2,000	1,866	8,511
Bear-Boileau Creeks (2DD-21)	13	5,580	27	197	1,996	7,799
Reserve-Beatty Creeks (2DD-25)	10	2,597	13	174	4,491	7,275
South River (2DD-23)	59	26,261	116	633	4,986	31,995
Wistiwasing River (2DD-22)	36	11,301	86	1,113	1,002	13,500
Upper Amable Upper South Rivers (2JE-04)	0	81	1	0	0	82
Amable du Fond River (2JE-03)	19	4,612	34	18	0	4,663
Pautois Creek (2JE-05)	7	1,591	11	7	0	1,609
Sharpes Creek (2JE-06)	11	2,975	28	0	0	3,003
Kaibuskong River and Depot Creek (2JE-07)	19	5,255	40	1,556	1,449	8,300
Boom Creek (2JE-17)	0	0	0	0	0	0
Total	**205**	**68,362**	**401**	**10,199**	**19,998**	**98,957**

Table 2-24. Consumptive Surface and Groundwater Use/Demand in the SP Area According to PTTW Database (2006)

Water Use		Water Takings (Mm^3/yr)	Consumptive Factor	Consumptive Use
Surface Water				
Total Surface Water Takings according to PTTW		329.15		
Permitted Takings: Power Generation		293.28	0.0	0.0
Permitted Takings: Other- Industrial		0.53	0.25	0.13
Permitted Takings: Municipal Water Supply	*Trout Lake*	29.02	1.0	29.02
	Callander Bay	1.10	0.2	0.22
	South River Reservoir	0.61	0.2	0.12
Permitted Takings: Agriculture (Irrigation)		4.60	0.9	4.14
Total Consumptive Surface Water Use/Demand				**33.63**
Groundwater				
Total Groundwater Takings according to PTTW		4.20		
Permitted Takings: Other- Industrial		0.81	0.25	0.20
Permitted Takings: Municipal Water Supply		3.35	0.20	0.67
Permitted Takings: Agriculture (Irrigation)		0.04	0.90	0.04
Water Takings: Private wells		2.34	0.25	0.58
Total Consumptive Groundwater Use/Demand				**1.49**

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2.5.8 SP Area Water Budget Calculations

Precipitation

It was noted previously that climate normal~~s~~ data for 13 stations within and surrounding the SP Area were available for the period 1971 to 2000 (see Table 2-19). The mean annual precipitation for each of these 13 stations was computed for that time period to agree with the time frame for streamflow records available in the SP Area.

The point observations of mean annual precipitation for the 13 climatic stations were entered into the GIS database and mean annual precipitation was interpolated over the entire study area with ordinary Kriging techniques. Table 2-26 below presents annual average precipitation estimated by this method for the different watersheds (above four specific stream gauges) in the SP Area. Among the 13 selected meteorological stations, precipitation ranges from 785 mm/yr to 1,183 mm/yr with an arithmetic average annual precipitation of 965.6 mm/yr.

The ~~areally~~spatially-weighted, interpolated annual average for the entire study area is 972 mm/yr and this value is shown in Table 2-27.

Evapotranspiration

Actual evapotranspiration (AET) losses were calculated using the Thornthwaite and Mather (1957) method, which takes into consideration the average monthly temperature and the hours of daylight, as well as soil moisture storage. This method is very widely used in water balance estimates and was chosen here for its simplicity and its ability to directly utilize the available climate data. The Thornthwaite and Mather method produces an estimate of the potential evapotranspiration (PET), which is adjusted to yield AET by considering soil moisture storage. Based on the application of this method, AET estimated for the 13 stations ranges from 481 mm to 542 mm (Table 2-20) with an arithmetic average of 520.2 mm annually.

An ~~areally~~spatially-weighted, mean annual AET total of 535 mm is derived and used in Table 2-27.

Streamflow

In the North Bay-Mattawa SP Area, there are records from 11 streamflow gauges/hydrometric stations. Complete flow records are available at these gauges for the period stated in Table 2-25. Among these stations there are four stations, highlighted in Table 2-26, which have periods of record that match closely with the climatic stations. The annual flow volumes (expressed as depth) for the four stations are provided in Table 2-26.

The mean, maximum and minimum stream flows in this exercise for the entire watershed were calculated on a pro rata basis. For example, the flow rate of each individual subwatershed was divided by the corresponding subwatershed area, averaging it out and finally multiplying it with the total area of the watershed.

Table 2-25. Summary of Continuous Streamflow Gauge Stations within Study Area

Station Name	Station ID	Drainage Area (km²) [1]	Latitude	Longitude	Period of Records	Number of Years	Max Annual Flow Rate (m³/s)	Mean Annual Flow Rate (m³/s)	Min Annual Flow Rate (m³/s)
Duchesnay River Near North Bay	02DD008	90.4	46°19’53”N	79°30’20”W	(1956-1982)	26	2.32	1.65	0.93
Chippewa Creek at North Bay	**02DD014**	**37.3 (32.4)**	**46°18’42”N**	**79°26’54”W**	**(1974-2003)**	**29**	**0.821**	**0.62**	**0.444**
La Vase River Near North Bay	**02DD013**	**70.4 (69.2)**	**46°15’48”N**	**79°23’42”W**	**(1974-2003)**	**29**	**1.33**	**0.93**	**0.559**
South River Near Nipissing	02DD005	787	46°05’49”N	79°28’45”W	(1937-1984)	47	17.9	11.8	6.36
South River Near Powassan	02DD001	761 (783)	46°5’40”N	79°23’45”W	(1914-1936)	22	23.2	12	6.57
South River Above Truisler Chute	02DD002	420	45°57’48”N	79°24’21”W	(1919-1952)	33	13.3	6.7	3.33
South River at South River Prov-Terr-State	02DD009	316 (326.3)	45°50’54”N	79°22’46”W	(1956-1991)	35	7.33	5.34	2.93
Kaibuskong River At Bonfield	02JE008	174	46°14’5”N	79°09’0”W	1915	1	ND	ND	ND
Mattawa River Near Rutherglen	02JE014	2040	46°18’7”N	78°52’51”W	(1962-1971)	9	35.2	25.6	14.4
Amable Du Fond River at Samuel de Champlain Provin	**02JE019**	**1130 (1140)**	**46°18’0”N**	**78°52’45”W**	**(1972-1995)**	**23**	**22.6**	**16.1**	**9.05**
Mattawa River Below Bouillon Lake	**02JE020**	**909 (951.5)**	**46°17’56”N**	**78°54’26”W**	**(1971-1998)**	**27**	**20.6**	**15.4**	**9.31**

Note: 1. Drainage areas are from Hydat database; Drainage areas in parentheses were calculated using Archydro; ND: No data; Streamflow gauge stations marked with a shaded area were used for water budget analyses as they closely match with climatic stations data (see also discussion in Section 2.5.4).

2.5.9 Summary of the SP Area Water Budget

Table 2-26 provides a summary of the water budget for the four watersheds with gauges and includes the surficial area (in square kilometres) draining past each gauge. The selection of these watersheds was based on the consistent period of records (1971-2000) between streamflow and climatic data.

Table 2-26. Summary of Water Budget on Subwatershed Basis

Catchment Name (Gauge #)	Area (km^2)	Average Annual Precip. (mm)	Average Annual Actual ET (mm)	Surplus (mm)	Runoff (mm)	Recharge (mm)	Streamflow (mm)	Baseflow (mm)*
Chippewa Creek (02DD014)	32.4	1005	533	472	193	279	621	256
La Vase River (02DD013)	69.2	967	536	431	265	166	438	127
Amable Du Fond River (02JE019)	1140	961	535	426	235	191	439	215
Mattawa River Below Bouillon Lake (02JE020)	951.5	966	535	431	225	206	500	227

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Note: * Baseflow was calculated using an automated baseflow separation program described by Arnold and Allen, 1994

Examination of Table 2-26 yields some interesting observations. The surplus value (comprised of runoff and recharge) theoretically should match the streamflow value (correspondingly comprised of storm runoff and baseflow). There is excellent agreement for La Vase and Amable Du Fond watersheds at their respective gauges. The Mattawa River is out by only 14%, which is near the accuracy of streamflow measurement. Only Chippewa Creek was significantly different (by 31%), which may have more to do with the urbanized character of this smaller watershed. An urbanized watershed will have less transpiration, shorter water retention times and, thus, less evaporation. This means that there is a greater surplus, which generally ends up as runoff. Hence, the measured streamflow value is greater than the theoretical surplus.

Table 2-27 below provides a summary of the integrated water budget for the entire SP Area. The description column of the table provides some insight as to assumptions and limitations of the analysis. To simplify the interpretations of Table 2-27, the following narrative is meant to assist the reader. It is expressed solely in terms of average annual amounts. All values are expressed in terms of a volume of water, expressed in million cubic metres per year (Mm^3/yr).

A total of 3,852 Mm^3/yr falls as precipitation, of which 2,120 Mm^3/yr is returned to the atmosphere by evapotranspiration (or about 55% is lost). This leaves 1,732 Mm^3/yr as a surplus, available for runoff or recharge. By way of comparison the average streamflow out of the watershed is 1,951 Mm^3/yr which is made up of both runoff and baseflow. There is about an 11% difference in these values, with the measured streamflow being higher than the calculated surplus. This difference is considered to be an acceptable margin of error, given the uncertainties in parameter estimation, measurement error and meteoric distribution of precipitation.

Table 2-27. Summary of the Conceptual Water Budget (Total Drainage Area: 3,963 km^2)

Parameters	Annual Depth (mm)	Annual Volume (10^6 m^3)	Description
Precipitation	972	3,852	Interpolated from an area-averaged annual mean precipitation. Precipitation calculated by arithmetic average of the 13 stations is 965.6 mm
Actual ET	535	2,120	Interpolated from an area-averaged annual average actual ET. (Arithmetic average of AET calculated using Thornthwaite and Mather (1957) is 520.2 mm)
Surplus	437	1,732	Spatially distributed average value. (Arithmetic average value is 445.4 mm)
Recharge	208	824	Determined in GIS platform
Runoff	229	908	Determined in GIS platform
Max Streamflow	721.4	2,859	Area weighted maximum annual streamflow
Mean Streamflow	492.4	1,951	Area weighted mean annual streamflow
Min Streamflow	294.4	1,166	Area weighted minimum annual streamflow
Consumptive Surface Water Takings	8.5	33.63	According to PTTW Database
Non-Consumptive Surface Water Takings	74	293.3	According to PTTW Database
Consumptive Groundwater Takings	0.38	1.49	According to PTTW database and include water takings from private wells for about 19,173 people consuming water at a rate of 335 L/day/capita
Non--Consumptive Groundwater Takings	0.76	3.01	According to PTTW Database

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The surplus of 1,732 Mm^3/yr was partitioned between runoff and recharge in the following way. A total of 52.4% of the surplus, or 908 Mm^3/yr, directly runs off, while 824 Mm^3/yr goes to recharge the water table (to later appear as baseflow).

Maximum permitted surface water and groundwater takings total 333.35 Mm^3/yr, or about 19.2% of the overall surplus. Of this, approximately 296 Mm^3/yr is comprised of non-consumptive uses. For the purpose of this summary, both surface water and groundwater sources are considered together. As previously defined, non-consumptive uses involve the use of the water that is returned to the local watershed of origin in a reasonable timeframe. In the context of the source water protection water budget, consumptive uses refer to the amount of water removed from a hydrological system and not returned back to the same system in a reasonable time period. The consumptive use, including North Bay's maximum permitted withdrawal from Trout Lake, is about 34.83 Mm^3/yr, or about 2.01% of the surplus.

2.5.10 Trends in Water Quantity

When considering water volumes for the entire SP Area, annual consumptive surface water and groundwater takings equal 33.6 Mm^3/yr and 1.5 Mm^3/yr, respectively, for a total of 35.1 Mm^3/yr. When compared with the available annual surplus, which is about 1,732 Mm^3/yr, there appears to be ample drinking water supplies within the SP Area. Given the large watershed and renewable nature of the water supply, there are no serious concerns in water availability. Annual fluctuations are significant enough to cause local stresses, however these generally have been temporary.

Further discussion on trends in water demand is provided in the individual Municipal sections below.

2.5.11 Limitations

Although more than 40 meteorological stations have operated within and in the vicinity of the North Bay-Mattawa SP Area over the years, most of them have only recorded daily precipitation (as rainfall and snowfall depths), with a handful of them including daily maximum and minimum air temperatures. There have been no pan evaporation measurements in the study area from which to estimate lake evaporation, which constitutes a data gap in the present analysis. Few stations were in operation for more than 25 years, although a sufficient number have been open long enough to make some general conclusions about the overall climate of the region. The only long-term climate stations location still collecting data areis at the North Bay Airport, though the station has changed and one located near Powassan.

The geology surrounding the municipal wells in Mattawa and Powassan indicates aquifers of potential limited local extent. Therefore, on a SP Area basis, the percent consumptive groundwater use value may be misleading, and likely underestimates the stress placed on the local aquifers. Also, overburden thickness may be subdued due to the limited amount of water well data used in this assessment.

Finally, total actual water takings are probably lower based on the fact that MECP's PTTW database currently does not report actual takings, only maximum permitted amounts. This would be reflected in the overall surface water or groundwater takings portion of the water budget. Likewise, information on the amounts of water taken without a PTTW was not made available within this analysis.

2.6 Water Quantity Stress Assessment

2.6.1 Tier One Water Quantity Analysis

The Tier One Water Budget and Subwatershed Stress Assessment require a quantitative analysis at the subwatershed level. This type of analysis looks at the ratio of water demand to the available water supply (termed the "Percent Water Demand") within a specific subwatershed. Subwatersheds with Percent Water Demand values above the specified Provincial thresholds are classified as having a Moderate or Significant potential for stress. The Tier One analysis largely utilizes available data collected and analyzed in the Conceptual Understanding phase, and evaluates the potential for water taking related impacts within a subwatershed.

Initially, Tier One Assessments were focused on subwatersheds that provided a municipal supply of drinking water. Tier One Assessments were completed for the subwatersheds containing the groundwater supply for the Town of Mattawa and the Municipality of Powassan (WESA, 2010), and for the surface water supply for the City of North Bay (Gartner Lee, 2008b) and the Village of South River (WESA, 2010). A Tier One Assessment was not required for the subwatershed supplying the Municipality of Callander as per Technical Rule 4 where the source is a Great Lake or other very large water body (i.e., Lake Nipissing).

As per the Technical Rules (MECP, 2009), a Tier One Water Budget and Water Quantity Stress Assessment is required for each subwatershed within a Source Protection Area, not just those subwatersheds that provide municipal supply. This report summarizes the Tier One Water Budget and Stress Assessment for all subwatersheds in the North Bay – Mattawa Source Protection Area. More detailed summaries of the subwatersheds supplying municipal systems are found in the relevant municipal Sections later in the report.

2.6.2 Tier One Watersheds

The subwatersheds used in the Tier One Assessment are generally based on the quaternary watersheds in the North Bay-Mattawa SP Area. In total, 15 subwatersheds were considered for this assessment, as shown on Figure 2-38 and summarized in Table 2-28 below.

Table 2-28. North Bay-Mattawa Source Protection Area Watersheds

Watershed I.D.	Quaternary Watershed	Estimated Drainage Area (km²)
2DD-19	Duchesnay River	144
2DD-20	La Vase River	182
2DD-21	Bear-Boileau Creeks	178
2DD-23	South River	827
2JE-04	Upper South - Upper Amable du Fond River	706
2JE-02	Mattawa River	273
2JE-03	Amable du Fond River	258
2JE-09	North River	248
2DD-22	Wistiwasing River	234
2JE-07	Kaibuskong River	182
2JE-01	Trout / Turtle Lake	177
2JE-05	Pautois Creek	176
2JE-17	Boom Creek	138
2JE-06	Sharpes Creek	137
2DD-25	Reserve-Beatty Creeks	102
Total	**North Bay – Mattawa SP Area**	**3962**

Figure 2-38. North Bay-Mattawa Source Protection Area Tier One Subwatersheds

FIGURE 2-38

TIER 1 WATERSHEDS IN NORTH BAY-MATTAWA SPA

LEGEND

- MUNICIPAL DRINKING WATER SYSTEM
- HIGHWAY
- WATERCOURSE
- WATERBODY
- DWSP BOUNDARY
- TIER 1 WATERSHED
- WATERSHED DIVIDE (Lake Nipissing - Ottawa River)

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DRINKING WATER SOURCE PROTECTION Our Actions Matter

2.6.3 Water Budget Elements

Water Supply

For surface water sources, the estimated monthly water supply was calculated as the monthly median streamflow. The monthly median value is a typical monthly baseflow or low flow value (MECP, 2009). Seven streamflow gauges located throughout the SP Area were used to estimate streamflow. The location of the seven streamflow gauges is shown on Figure 2-39, as well as the locations of dam structures.

Streamflow records were obtained from the Water Survey of Canada website. A summary of stream gauge information is presented in Table 2-29.

Streamflow gauges are located in five subwatersheds. The remaining 10 subwatersheds are ungauged. Therefore in order to provide a reliable estimate of the water supply in each subwatershed, the total streamflow was estimated using a simple proportional analysis. For ungauged subwatersheds, streamflow stations closest to the subwatershed in question and with similar physiography were chosen to pro-rate the drainage area. The stream gauging stations selected for each subwatershed and the applied scaling factors are listed in Table 2-30.

Table 2-29. Streamflow Gauging Stations used in the Tier One Assessment

Station Name	Station ID	Drainage Area (km^2)	Latitude	Longitude	Period of Records	Number of Years	Max Annual Flow Rate (m^3/s)	Mean Annual Flow Rate (m^3/s)	Min Annual Flow Rate (m^3/s)
Duchesnay River Near North Bay	02DD008	90.4	46°19'53"N	79°30'20"W	(1956-1982)	26	2.32	1.65	0.93
Chippewa Creek at North Bay	02DD014	37.3	46°18'42"N	79°26'54"W	(1974-2003)	29	0.82	0.62	0.44
La Vase River Near North Bay	02DD013	70.4	46°15'48"N	79°23'42"W	(1974-2003)	29	1.33	0.93	0.56
South River Near Nipissing	02DD005	787	46°05'49"N	79°28'45"W	(1937-1984)	47	17.9	11.8	6.36
South River at South River Prov-Terr-State	02DD009	316	45°50'54"N	79°22'46"W	(1956-1991)	35	7.33	5.34	2.93
Amable Du Fond River at Samuel de Champlain Provin	02JE019	1130	46°18'0"N	78°52'45"W	(1972-1995)	23	22.6	16.1	9.05
Mattawa River Below Bouillon Lake	02JE020	909	46°17'56"N	78°54'26"W	(1971-1998)	27	20.6	15.4	9.31

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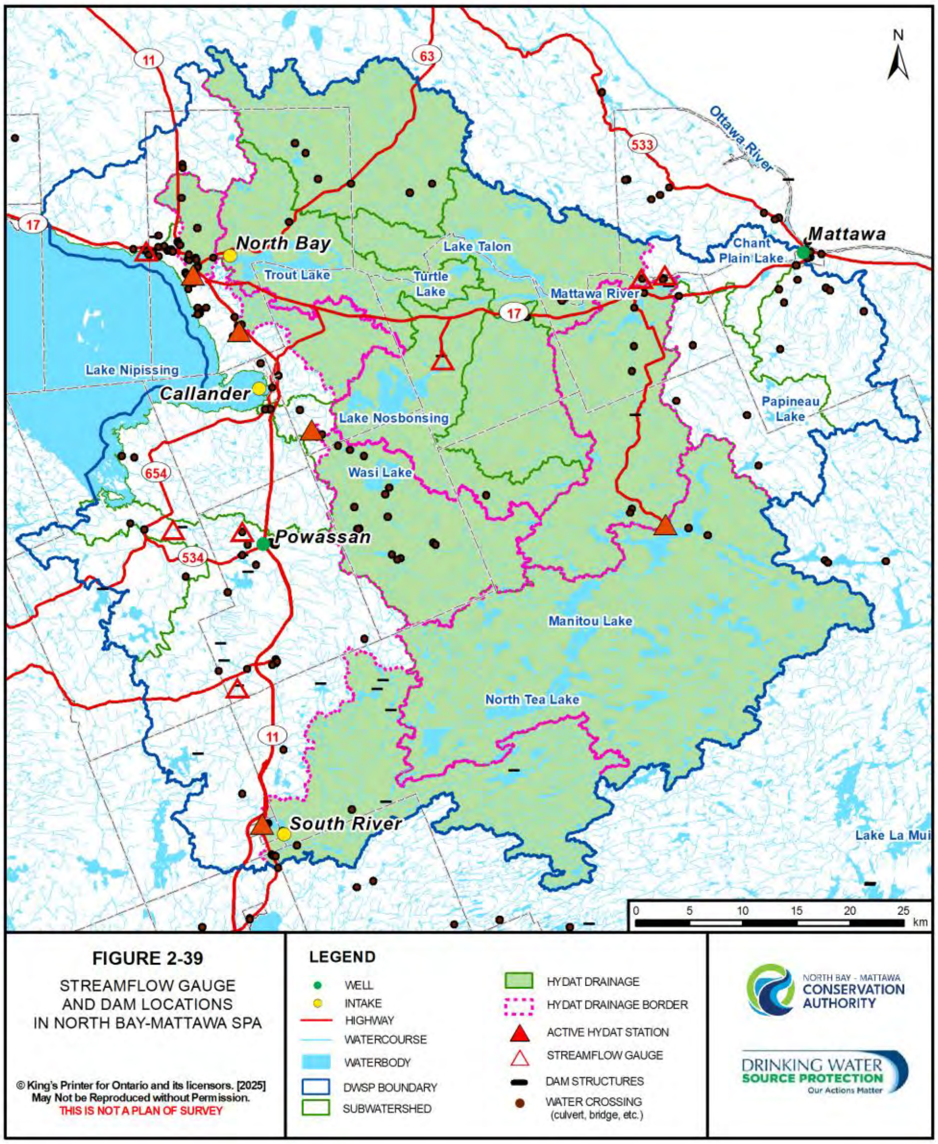
Figure 2-39. Streamflow Gauge Locations and Dam Structures



Water Crosing (culvert, bridge, etc.)
Dam Structures
Active HYDAT Stations
Streamflow Gauge
Municipal Water Services
Organized Township
Highways
Lakes
Rivers/Streams
HYDAT Drainage Border
HYDAT Drainage
Subwatersheds
Mattawa
North Bay
Callander
Powassan
South River
NORTH BAY
EAST FERRIS
BONFIELD
CALVIN
PAPINEAU-CAMERON
CALLANDER
CHISHOLM
POWASSAN
NIPISSING
LAURIER
MACHAR
JOLY
SUNDRIDGE
STRONG
0 5 10 20 Kilometers

Table 2-30. Streamflow Gauging Stations and Scaling Factors used to Prorate

HYDAT Station Used to Prorate		Quaternary Subwatershed Prorated		Scaling Factor
HYDAT Station Name	**HYDAT station ID**	**Subwatershed Name**	**Subwatershed ID**	
Mattawa River Below Bouillon Lake	02JE020	North River	2JE-09	3.665
		Trout/Turtle Lake	2JE-01	5.136
		Mattawa River (excluding Trout/Turtle contributing area)	2JE-02	3.33
Amable Du Fond River at Samuel de Champlain Provincial Park	02JE019	Boom Creek	2JE-17	8.188
		Amable Du Fond River	2JE-03	4.38
		Pautois Creek	2JE-05	6.42
		Sharpes Creek	2JE-06	8.248
		Kaibuskong River	2JE-07	6.209
		Upper South-Upper Amable Du Fond Rivers	2JE-04	1.601
		Wasi River	2DD-22	4.829
South River Near Nipissing	02DD005	South River	2DD-23	0.952
		Reserve-Beatty Creeks	2DD-25	7.716
		Bear-Boileau Creeks	2DD-21	4.421
Duchesnay River Near North Bay	02DD008	Duchesnay Creek	2DD-19	0.628
La Vase River at North Bay, Chippewa Creek at North Bay	02DD013, 02DD014	La Vase River	2DD-20	0.592

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For groundwater sources, the estimated monthly water supply for each subwatershed was the calculated annual recharge rate divided evenly over 12 months. The Tier One analysis for groundwater supplies does not consider aquifer storage, so the water supply terms are assumed to be constant on an average annual basis (MECP, 2009). The annual recharge distribution for the entire SP Area was determined in the Conceptual Water Budget (Map 14a) (Gartner Lee, 2008a). Through GIS, this information was used to estimate annual recharge rates for each subwatershed under consideration. Due to the regional nature of the subwatersheds investigated at this scale, it is unlikely that groundwater divides differ significantly from surface water divides. Based on this, groundwater inflow was assumed to be negligible, and was not considered as part of the groundwater supply component.

Water Reserve

Water reserve is an estimate of the amount of water that needs to be reserved to support other uses of water within the watershed, including both ecosystem requirements as well as other human uses. For surface water, the reserve was estimated as the stream flow that was exceeded 90% of the time (Q_{P90}). Data from stream gauges assigned to each subwatershed, as discussed above, were used to calculate Q_{P90}.

For groundwater, water reserve was estimated as 10% of the monthly calculated groundwater recharge.

Water Demand

Water demand relates to water that is taken as a result of an anthropogenic activity, such as municipal supply, private water takings or agricultural use, and that is a partial or total consumptive use. Water Demand was derived from the maximum permitted takings as noted in the Ministry of Environment's Permit to Take Water (PTTW) database (MOE, 2009a) (see Tables 2-31 and 2-32). Consumptive water demand refers to water that is taken from a source and not returned locally in a reasonable time frame.

Consumptive water demand was determined through analysis of the Ministry of Environment's Permit to Take Water (PTTW) database (MOE, 2009a). The analysis considered the seasonality of pumping, and applied consumptive use coefficients, based on the type and purpose of taking. Surface water and groundwater consumptive demand were estimated for each permit. The procedure followed meets the intent of Appendix ~~D~~C (Water Use) of Guidance Module #7: Water Budget and Water Quantity Risk Assessment (MOE, 2007).

(Note: Ministry of Environment or MOE is a previous name of the Ministry of Environment, Conservation and Parks or MECP)

Table 2-31. Permitted Surface Water Takings According to PTTW Database (MOE, 2009a)

Permit No.	Source	Watershed	Category	Period of Taking (days)	Maximum Permitted Takings (L/day)
03-P-5018	Long Lake	Mattawa River	Water Supply: Campgrounds	150	220,000
3030-5Z4NMS	Long Lake	Mattawa River	Water Supply: Municipal	365	220,000
98-P-5023	Mattawa River	Mattawa River	Industrial: Manufacturing	365	975,000
6565-7T6PTN	Trout Lake	Trout Lake	Water Supply: Municipal	365	79,500,000
4187-6P2HR4	Trout Lake	Trout Lake	Industrial: Cooling Water	365	10,682,784
4187-6P2HR4	Trout Lake	Trout Lake	Water Supply: Communal	365	54,504
0251-6ADRGZ	La Vase River	La Vase River	Commercial: Golf Course Irrigation	183	654,240
4755-72DQRV	10 Inter-Connected Ponds	La Vase River	Commercial: Golf Course Irrigation	184	981,936
7615-7G8KQR	C1 / Culvert	La Vase River	Dewatering: Construction	20	4,665,600
7615-7G8KQR	C2 / Culvert	La Vase River	Dewatering: Construction	20	9,676,800
7615-7G8KQR	Surface Water Management Pond / Excavation Area	La Vase River	Dewatering: Construction	20	400,000
81-P-5226	Beaver Dam	South River	Agricultural: Field & Pasture Crops	10	378,500
0121-6GWG8B	South River	South River	Commercial: Golf Course Irrigation	182	1,022,000
99-P-5010	South River	South River	Water Supply: Municipal	365	1,680,000
8634-7FKH55	South River	South River	Construction: Road Building	215	1,728,000
03-P-5011	South River	South River	Agricultural: Field & Pasture Crops	30	3,928,000
3111-5WVLPX	South River	South River	Agricultural: Field & Pasture Crops	30	3,928,000
8315-6ADM8M	Headwater Spring of Balsam Creek	North River	Commercial: Aquaculture	365	4,032,000

(Note: Ministry of Environment or MOE is a previous name of the Ministry of Environment, Conservation and Parks or MECP)

Table 2-32. Permitted Groundwater Takings According to PTTW Database (2009)

Permit No.	Source	Watershed	Category	Period of Taking (days)	Maximum Permitted Takings (L/day)
02-P-5002	Well No. 1	La Vase River	Water Supply: Communal	365	59,803
02-P-5002	Well No. 2	La Vase River	Water Supply: Communal	365	59,803
02-P-5002	Well No. 3	La Vase River	Water Supply: Irrigation	122	13,075
02-P-5002	Well No. 4	La Vase River	Water Supply: Communal	365	59,803
2265-6KXLMZ	Well 1	La Vase River	Industrial: Power Production	365	80,000
5182-63SS2B	Well #1	La Vase River	Water Supply: Campgrounds	365	91,368
5182-63SS2B	Well #2	La Vase River	Water Supply: Campgrounds	365	91,368
4458-7DRQ7C	Dewatering System	La Vase River	Dewatering	30	160,000
2654-7LHMP6	1 Wellpoint System / 40-50 Wellpoints	La Vase River	Dewatering: Construction	30	400,000
04-P-5008	Leachate Collection & Pump Station	La Vase River	Remediation: Groundwater	365	1,200,000
1136-63CRCK	Leachate Collection & Pump Station	La Vase River	Remediation	365	1,200,000
03-P-5018	Well #1	Pautois Creek	Water Supply: Campgrounds	365	69,120
3030-5Z4NMS	Well #1	Pautois Creek	Water Supply: Municipal	365	69,120
82-P-5292	Well #1 (Powassan)	South River	Water Supply: Municipal	365	1,313,280
82-P-5292	Well #2 (Powassan)	South River	Water Supply: Municipal	365	1,313,280
02-P-5059	Well # 1 (Mattawa)	Mattawa River	Water Supply: Municipal	365	4,582,080
02-P-5059	Well # 2 (Mattawa)	Mattawa River	Water Supply: Municipal	365	1,964,160

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To generate monthly consumptive water demand estimates, the permitted values were distributed to the month in which they were most likely to be active (e.g., golf course irrigation May-Oct), while also considering the number of days the permit is authorized to be active. A sector specific consumptive use factor, which estimates how much water is not returned to the original source, is then applied. The consumptive use factors are included in Table 2-33. This calculation results in monthly estimates of consumptive water demand. This is seen as a conservative approach and is consistent with Guidance Module 7 (MOE, 2007). Reporting pumping rates were not made available to this study.

Table 2-33. Consumptive Water Use Factors

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Category of Water Taking	Groundwater	Surface Water*
Agricultural: Field and Pasture Crops	0.85	0.85
Commercial: Aquaculture	NA	0.008
Commercial: Golf Course Irrigation	NA	0.70
Construction: Road Building	NA	0.90
Dewatering	1	0.008
Industrial: Cooling	NA	0.02
Industrial: Manufacturing	NA	0.10
Industrial: Power Production	1	NA
Remediation	1	0.25
Water Supply: Campground	0.20	0.20
Water Supply: Communal	1	0.20
Water Supply: Municipal	1	0.20

Note: *Assumes water is discharged back to original source. Where this is not the case, factor is 1.

The North Bay- Mattawa SP Area Conceptual Water Budget (Gartner Lee, 2008a) estimated the rural population of the SP Area to be approximately 19,000. This population would be reliant on a combination of groundwater and surface water supplies for domestic use, although the division of supply is not known. Applying a per capita domestic use rate of 175 L/day/capita (MOE, 2001), yields a total unserviced demand of 3,325 m^3/day. This demand, expressed in terms of depth over the SP Area is about 0.3 mm/yr. However, for the purpose of this report, consumptive water demand from rural users was considered to be minimal since this water is likely returned to the groundwater system through septic tanks and tile drains, and therefore not considered.

Agriculture is a comparatively minor land use in terms of its extent within the SP Area, comprising only 6% of the land area. Due to this relatively minor proportion of agricultural land, it is assumed that consumptive water demand associated with livestock watering, and other agricultural practices, is negligible.
(Note: Ministry of Environment or MOE is a previous name of the Ministry of Environment, Conservation and Parks or MECP)

2.6.4 Subwatershed Stress Assessment

Overview

The Tier One Stress Assessment is a screening exercise to determine whether or not the ratio of consumptive water demand to available water supply is greater than Provincial thresholds, on a subwatershed basis. This exercise indicates where there is a higher likelihood of water taking related impacts and-, thus, whether further study is required. The assessment is completed using the Percent Water Demand calculation. As outlined in the MOE Guidance Module for Water Budgets (MOE, 2007), and the Technical Rules (MECP, 2009), the Percent Water Demand is calculated using the following formula:

$$\textit{Percent Water Demand} = \frac{Q_{DEMAND}}{Q_{SUPPLY} - Q_{RESERVE}} \times 100$$

where Q_{DEMAND} is the consumptive demand, Q_{SUPPLY} is the water supply, and $Q_{RESERVE}$ is the water reserve.

The Percent Water Demand was evaluated independently for groundwater and surface water supplies in each subwatershed. As indicated in the Technical Rules (MECP, 2009), groundwater sources are evaluated for both average annual and monthly conditions, whereas surface water sources are evaluated monthly. Based on the Percent Water Demand and the thresholds listed in Table 2-34, each subwatershed was assigned a level of potential stress for groundwater and for surface water. Those subwatersheds receiving a low level of potential stress require no further water budgeting work. Those subwatersheds experiencing a moderate or significant level of potential stress, and which have a municipal water supply, are subject to further water budget evaluation at the Tier Two level.

Table 2-34. Surface Water and Groundwater Stress Thresholds

Stress Level Assignment	Surface Water	Groundwater	
	Maximum Monthly % Water Demand	Average Annual % Water Demand	Monthly Maximum % Water Demand
Significant	≥ 50%	≥ 25%	≥ 50%
Moderate	> 20% and < 5 0%	> 10% and < 25%	> 25% and < 50%
Low	≤ 20%	≤ 10%	≤ 25%

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The Technical Rules (MECP, 2009) require that the subwatershed stress be estimated for current and future municipal water demands. This section only discusses current demands. Tier One studies completed specifically for subwatersheds supplying municipal systems investigated the impact of future municipal demands, and are discussed separately in sections to follow. (Note: Ministry of Environment or MOE is a previous name of the Ministry of Environment, Conservation and Parks or MECP)

Stress Assessment

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Utilizing the water supply and demand components previously quantified, a stress assessment was carried out for every subwatershed in the SP Area. Water demands in the subwatershed were determined through the PTTW database (MOE, 2009a). Of the 15 subwatersheds studied, only six have active Permits to Take Water. Stress assessments for these six subwatersheds are described in the following sections. Without a permit the percent demand is zero, which constitutes a low potential for stress. (Note: Ministry of Environment or MOE is a previous name of the Ministry of Environment, Conservation and Parks or MECP)

La Vase River

Surface Water

There are five permitted surface water takings located in the La Vase River subwatershed. Two of the takings are associated with golf course irrigation, and are active May to October. The other three takings are associated with construction dewatering, and are authorized to be active for 20 days per year. It is assumed that these takings would be active during the month of April.
The maximum monthly consumptive water demand is 13 L/s and occurs throughout the months of May to October. For the remaining months, the consumptive water demand is zero, or less than 0.1 L/s.

The maximum monthly percent water demand calculated for La Vase River is 6%, well below the Moderate threshold of 20% for surface water (Table 2-35). As such, the La Vase River subwatershed is classified as having a low potential for stress.

Table 2-35. La Vase River Surface Water Stress Assessment

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Month	Water Supply (m^3/s)	Water Reserve (m^3/s)	Water Demand (m^3/s)	% Water Demand	Stress Level Assigned
Jan	0.64	0.39	0.00	0	Low
Feb	0.48	0.00	0.00	0	Low
Mar	1.34	0.39	0.00	0	Low
Apr	5.04	1.29	0.001	0.03	Low
May	1.99	0.57	0.013	0.92	Low
Jun	0.74	0.26	0.013	2.71	Low
Jul	0.45	0.19	0.013	5	Low
Aug	0.39	0.16	0.013	5.65	Low
Sep	0.62	0.19	0.013	3.02	Low
Oct	1.36	0.44	0.013	1.41	Low
Nov	2.02	0.71	0.00	0	Low
Dec	1.08	0.58	0.00	0	Low

Groundwater

There are 11 groundwater withdrawals permitted within the La Vase River subwatershed. Four withdrawals are for communal water supplies; two are for campground water supplies; two are for dewatering; two are for groundwater remediation; one withdrawal is for irrigation; and one withdrawal is for power production purposes. The average annual consumptive water demand associated with these permits is 30 L/s, with a maximum monthly demand of 36 L/s.

The maximum monthly percent water demand for La Vase River is 4% (Table 2-36), indicating a low potential for stress.

Table 2-36. La Vase River Groundwater Stress Assessment

Month	Water Supply (m^3/s)	Water Reserve (m^3/s)	Water Demand (m^3/s)	% Water Demand	Stress Level Assigned
Jan	1.19	0.12	0.03	2.8	Low
Feb	1.19	0.12	0.03	2.8	Low
Mar	1.19	0.12	0.03	2.8	Low
Apr	1.19	0.12	0.04	3.8	Low
May	1.19	0.12	0.03	2.8	Low
Jun	1.19	0.12	0.03	2.8	Low
Jul	1.19	0.12	0.03	2.8	Low
Aug	1.19	0.12	0.03	2.8	Low
Sep	1.19	0.12	0.03	2.8	Low
Oct	1.19	0.12	0.03	2.8	Low
Nov	1.19	0.12	0.03	2.8	Low
Dec	1.19	0.12	0.03	2.8	Low

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South River

Surface Water

There are six surface water takings within the South River subwatershed. Three of the water takings are for agricultural purposes, along with a construction withdrawal, a golf course irrigation permit, and a municipal supply. The municipal supply permit is associated with the Village of South River. It is estimated that the total maximum consumptive demand reaches 110 L/s during the month of July, then declines to a stable consumptive demand of 4 L/s throughout the winter months. The maximum monthly percent water demand is calculated to be 4% (Table 2-37), and indicates that the subwatershed has a low potential for stress.

Table 2-37. South River Surface Water Stress Assessment

Month	Water Supply (m^3/s)	Water Reserve (m^3/s)	Water Demand (m^3/s)	% Water Demand	Stress Level Assigned
Jan	8.37	4.40	0.00	0	Low
Feb	8.04	4.64	0.00	0	Low
Mar	9.41	5.36	0.00	0	Low
Apr	31.36	11.01	0.02	0.1	Low
May	14.82	7.69	0.03	0.42	Low
Jun	7.50	3.76	0.03	0.8	Low
Jul	4.75	1.93	0.11	3.9	Low
Aug	4.34	1.69	0.03	1.13	Low
Sep	5.57	2.31	0.03	0.92	Low
Oct	6.98	3.36	0.03	0.83	Low
Nov	10.08	4.43	0.02	0.35	Low
Dec	8.77	4.46	0.00	0	Low

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Groundwater

There are two groundwater takings located in South River subwatershed, both being associated with Powassan's municipal supply. Consumptive demand is assumed to be constant throughout the year at a rate of approximately 15 L/s. This consumptive demand corresponds to a percent water demand of less than one percent (Table 2-38), indicating a low potential for stress.

Table 2-38. South River Groundwater Stress Assessment

Demand Scenario	Water Supply (m^3/s)	Water Reserve (m^3/s)	Water Demand (m^3/s)	% Water Demand	Stress Level Assigned
Average Demand	7.5	0.75	0.02	0.3	Low
Maximum Demand	7.5	0.75	0.02	0.3	Low

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The subwatersheds contributing to the water supplies for the Municipality of Powassan and Village of South River are contained within the South River watershed. A separate Tier One investigation into these subwatersheds was conducted to refine the percent water demand calculations and stress identification. A summary of these findings is provided in Section 7 for the Powassan subwatershed and in Section 8 for the South River subwatershed.

Trout / Turtle Lake

Surface Water

There are three surface water takings from Trout Lake: a taking to supply water to the City of North Bay, and two takings for industrial cooling purposes. As wastewater from the City of North Bay is not returned to Trout/Turtle Lake, 100% of the municipal supply taking is consumptive and, therefore, dominates the subwatershed total consumptive demand. The consumptive demand for the subwatershed results in the percent water demand being above 20% in January through March, and June through September. This results in the subwatershed being identified as having a Moderate potential for stress (Table 2-39). Further details on the Tier One Assessment are found in Section 6.

If stress levels are shown to be either moderate or significant, a more robust Tier Two Subwatershed Stress Assessment is completed and, similarly if that reveals moderate or significant stress, a Tier Three Local Area Risk Assessment must be undertaken. The Tier Two and Tier Three assessments for the Trout/Turtle Lake subwatershed are presented in Section 6.

Table 2-39. Trout Lake Surface Water Stress Assessment

Month	Water Supply (m^3/s)	Water Demand (m^3/s)	% Water Demand	Stress Level Assigned
Jan	1.781	0.5483	31	Moderate
Feb	1.651	0.5549	34	Moderate
Mar	2.742	0.5543	20	Moderate
Apr	8.545	0.5443	6	Low
May	5.063	0.5893	12	Low
Jun	2.242	0.6435	29	Moderate
Jul	1.565	0.6154	39	Moderate
Aug	1.389	0.6396	46	Moderate
Sep	1.698	0.5657	33	Moderate
Oct	2.670	0.5256	20	Low
Nov	3.728	0.5256	14	Low
Dec	2.750	0.5069	18	Low

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Groundwater

There are no permitted groundwater takings from the Trout/Turtle Lake subwatershed. This results in a percent water demand of zero, and indicates a low potential for stress.

Mattawa River

Surface Water

There are a total of three water takings within the Mattawa River subwatershed. Two of these takings are for water supplies, with the third being for industrial manufacturing. The total consumptive demand is 2 L/s and is dominated by the industrial manufacturing taking. The maximum monthly percent water demand is less than 1% (Table 2-40), indicating a low potential for stress.

Table 2-40. Mattawa River Surface Water Stress Assessment

Month	Water Supply (m^3/s)	Water Reserve (m^3/s)	Water Demand (m^3/s)	% Water Demand	Stress Level Assigned
Jan	2.44	1.87	0.002	0.35	Low
Feb	2.03	1.59	0.002	0.45	Low
Mar	2.73	1.55	0.002	0.17	Low
Apr	12.93	3.78	0.002	0.02	Low
May	6.19	2.80	0.002	0.06	Low
Jun	2.70	0.74	0.002	0.1	Low
Jul	1.54	0.56	0.002	0.2	Low
Aug	1.33	0.41	0.002	0.22	Low
Sep	1.94	0.70	0.002	0.16	Low
Oct	3.19	1.25	0.002	0.1	Low
Nov	4.73	2.19	0.002	0.08	Low
Dec	3.48	2.09	0.002	0.14	Low

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Groundwater

One groundwater permit with two sources is located within the Mattawa River subwatershed and is associated with the municipal supply of Mattawa. There is not a significant difference in water demand between months as municipal/communal and industrial/commercial water use is consistent throughout the year. There is a slight increase in demand in July and August as a result of water used for crop irrigation.

The average annual percent water demand is 0.6%, indicating a low potential for stress. The maximum percent water demand is also 0.6%, indicating a low potential for stress (Table 2-41). Further details on this Tier One Assessment are found in Section 5.

Table 2-41. Mattawa River Groundwater Stress Assessment

Month	Water Supply (m^3/s)	Water Reserve (m^3/s)	Water Demand (m^3/s)	% Water Demand	Stress Level Assigned
Jan	17.9	1.79	0.09	0.58	Low
Feb	17.9	1.79	0.08	0.53	Low
Mar	17.9	1.79	0.09	0.58	Low
Apr	17.9	1.79	0.09	0.56	Low
May	17.9	1.79	0.09	0.58	Low
Jun	17.9	1.79	0.09	0.56	Low
Jul	17.9	1.79	0.10	0.64	Low
Aug	17.9	1.79	0.10	0.64	Low
Sep	17.9	1.79	0.09	0.59	Low
Oct	17.9	1.79	0.09	0.58	Low
Nov	17.9	1.79	0.09	0.56	Low
Dec	17.9	1.79	0.09	0.58	Low
Annual	215	21.5	1.12	0.58	Low

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Pautois Creek

Surface Water
There are no permitted surface water takings from the Pautois Creek subwatershed. This results in a percent water demand of zero, and indicates a low potential for stress.

Groundwater
There are two groundwater takings located within Pautois Creek subwatershed. The permits are for a campground water supply and a municipal water supply. The average annual and maximum monthly consumptive demand is 1 L/s. Both demand scenarios result in a percent water demand less than one percent, indicating a low potential for stress (Table 2-42).

Table 2-42. Pautois Creek Groundwater Stress Assessment

Demand Scenario	Water Supply (m^3/s)	Water Reserve (m^3/s)	Water Demand (m^3/s)	% Water Demand	Stress Level Assigned
Average Demand	1.05	0.10	0.001	0.11	Low
Maximum Demand	1.05	0.10	0.001	0.11	Low

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North River

Surface Water

There is a single aquaculture surface water taking located within North River. The consumptive demand associated with this taking is 0.4 L/s throughout the year. The percent water demand associated with this consumptive demand is less than one percent, indicating a low potential for stress (Table 2-43).

Table 2-43. North River Surface Water Stress Assessment

Month	Water Supply (m^3/s)	Water Reserve (m^3/s)	Water Demand (m^3/s)	% Water Demand	Stress Level Assigned
Jan	2.21	1.70	0.0004	0.08	Low
Feb	1.84	1.44	0.0004	0.1	Low
Mar	2.48	1.41	0.0004	0.04	Low
Apr	11.74	3.44	0.0004	0.005	Low
May	5.62	2.54	0.0004	0.01	Low
Jun	2.45	0.67	0.0004	0.02	Low
Jul	1.40	0.51	0.0004	0.04	Low
Aug	1.21	0.37	0.0004	0.05	Low
Sep	1.77	0.64	0.0004	0.04	Low
Oct	2.90	1.14	0.0004	0.02	Low
Nov	4.30	1.99	0.0004	0.02	Low
Dec	3.16	1.90	0.0004	0.03	Low

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Groundwater

There are no permitted groundwater takings within the North River subwatershed. This results in a percent water demand of zero, and indicates a low potential for stress.

Other Subwatersheds

The remaining subwatersheds which were not mentioned above do not have any known active PTTWs. As such, these subwatersheds have a water demand and percent water demand of zero for both surface water and groundwater. The water supply and reserve for these surface water and groundwater sources are presented in Tables 2-44 and 2-45, respectively.

Table 2-44. Subwatersheds with Zero Percent Water Demand – Surface Water

Subwatershed (Supply & Reserve in m^3/s)		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Duchesnay River	Supply	0.65	0.53	0.68	8.10	2.71	1.02	0.61	0.48	0.99	1.94	2.17	1.26
	Reserve	0.34	0.25	0.32	1.00	0.92	0.36	0.14	0.12	0.18	0.61	0.95	0.59
Bear-Boileau Creeks	Supply	1.80	1.73	2.02	6.75	3.19	1.61	1.02	0.93	1.20	1.50	2.17	1.89
	Reserve	0.95	1.00	1.15	2.37	1.66	0.81	0.42	0.36	0.50	0.72	0.95	0.96
Upper South - Upper Amable du Fond River	Supply	6.72	5.40	6.31	24.61	19.15	9.56	4.85	3.17	3.91	5.21	9.78	8.68
	Reserve	3.61	3.72	3.56	8.82	10.11	4.82	2.37	1.68	1.76	2.18	3.39	3.89
Amable du Fond River	Supply	2.46	1.97	2.31	8.99	7.00	3.49	1.77	1.16	1.43	1.90	3.58	3.17
	Reserve	1.32	1.36	1.30	3.22	3.7	1.76	0.87	0.61	0.64	0.80	1.24	1.42
Wistiwasing River	Supply	2.21	1.77	2.07	8.09	6.29	3.14	1.59	1.04	1.29	1.71	3.21	2.85
	Reserve	1.19	1.22	1.17	2.90	3.32	1.58	0.78	0.55	0.58	0.72	1.11	1.28
Kaibuskong River	Supply	1.73	1.39	1.63	6.34	4.94	2.47	1.25	0.82	1.01	1.34	2.52	2.24
	Reserve	0.93	0.96	0.92	2.27	2.61	1.24	0.61	0.43	0.45	0.56	0.87	1.00
Pautois Creek	Supply	1.68	1.35	1.57	6.14	4.77	2.38	1.21	0.79	0.98	1.30	2.44	2.16
	Reserve	0.90	0.93	0.89	2.20	2.52	1.2	0.59	0.42	0.44	0.54	0.85	0.97
Boom Creek	Supply	1.31	1.06	1.23	4.81	3.74	1.87	0.95	0.62	0.76	1.02	1.91	1.70
	Reserve	0.71	0.73	0.69	1.72	1.98	0.94	0.46	0.33	0.34	0.43	0.66	0.76
Sharpes Creek	Supply	1.30	1.05	1.22	4.78	3.72	1.86	0.94	0.62	0.76	1.01	1.9	1.68
	Reserve	0.70	0.72	0.69	1.71	1.96	0.94	0.46	0.33	0.34	0.42	0.66	0.75
Reserve-Beatty Creeks	Supply	1.03	0.99	1.16	3.88	1.83	0.93	0.59	0.54	0.69	0.86	1.25	1.08
	Reserve	0.54	0.57	0.66	1.36	0.95	0.46	0.24	0.21	0.29	0.42	0.55	0.55

Note: Surface Water Demand/Percent Water Demand is 0 for all months within each subwatershed listed above. Surface Water Stress Level is Low for all months within each subwatershed listed above.

Table 2-45. Subwatersheds with Zero Percent Water Demand – Groundwater

Subwatershed	Average/Maximum Monthly Supply and Reserve (m^3/s)		Water Demand/ % Demand	Stress Level
Duchesnay River	Supply	1.36	0	Low
	Reserve	0.14		
Bear-Boileau Creeks	Supply	1.24	0	Low
	Reserve	0.12		
Upper South - Upper Amable du Fond River	Supply	5.49	0	Low
	Reserve	0.55		
Amable du Fond River	Supply	1.55	0	Low
	Reserve	0.16		
North River	Supply	2.18	0	Low
	Reserve	0.22		
Wistiwasing River	Supply	1.68	0	Low
	Reserve	0.168		
Kaibuskong River	Supply	1.2	0	Low
	Reserve	0.12		
Trout / Turtle Lake	Supply	2.44	0	Low
	Reserve	0.244		
Boom Creek	Supply	0.88	0	Low
	Reserve	0.09		
Sharpes Creek	Supply	0.87	0	Low
	Reserve	0.09		
Reserve-Beatty Creeks	Supply	0.82	0	Low
	Reserve	0.08		

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2.6.5 Limitations

A data gap exists in that streamflow gauges are located in only five of the 15 subwatersheds. Regardless, total streamflow was estimated using a simple proportional analysis. For ungauged subwatersheds, streamflow stations closest to the subwatershed in question and with similar physiography were chosen to pro-rate the drainage area.

Similar to the Conceptual Water Budget, total actual water takings are probably lower based on the fact that the MECP PTTW database currently does not report actual takings, only maximum permitted amounts. Likewise, information on the amounts of water taken without a PTTW was not available within this analysis.

2.6.6 Uncertainty

The Technical Rules (MECP, 2009) require that an uncertainty classification of either "High" or "Low" be assigned to each subwatershed undergoing a stress assessment. Given that the low water demand associated with each subwatershed was calculated using the PTTW maximum permitted rates, which tend to overestimate the amount of use, the uncertainty level assigned to each subwatershed is low.

2.6.7 Summary

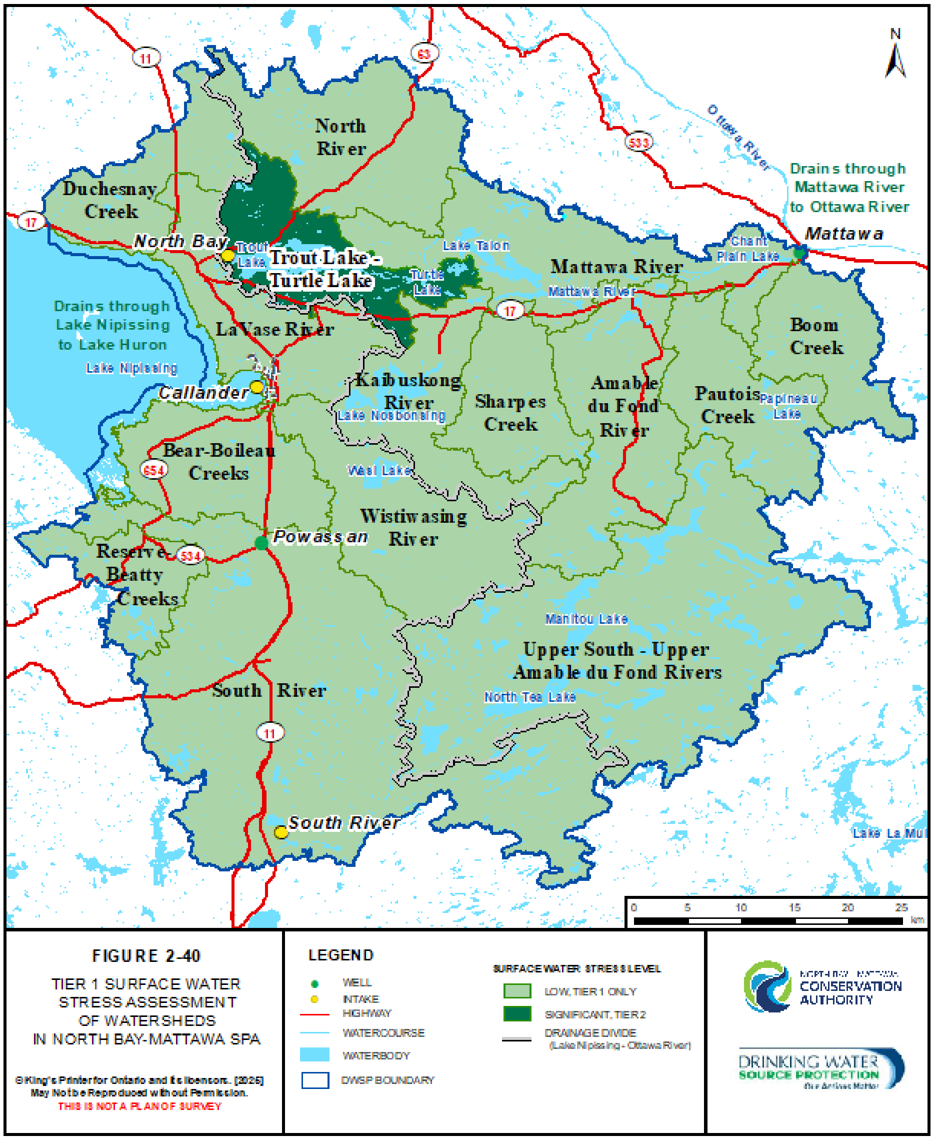
As per the requirements of the *Clean Water Act (2006)*, a Tier One Water Quantity Stress Assessment has been completed for all subwatersheds within the North Bay-Mattawa SP Area. Water supply and reserve estimates have been generated by available streamflow data, as well as estimates of groundwater recharge produced as part of the Conceptual Water Budget Study. Consumptive water demand estimates have been generated by applying seasonal use and consumptive use factors to information in the Province's PTTW database (MOE, 2009a).

Surface water subwatershed stress is illustrated in Figure 2-40. Results of the Surface Water Stress Assessment indicate that only the Trout/Turtle Lake Subwatershed has percent water demands that are above the Provincial thresholds. The identification of Trout/Turtle Lake as being potentially stressed confirms the assessment carried out by Gartner Lee (2008b).

Based on the groundwater stress assessment, all subwatersheds were assigned a low level of stress. Groundwater subwatershed stress is illustrated by Figure 2-41.

(Note: Ministry of Environment or MOE is a previous name of the Ministry of Environment, Conservation and Parks or MECP)

Figure 2-40. Surface Water Stress Assessment in the North Bay-Mattawa SP Area




Drainage Divide
Rivers/Streams
Highways
Lakes
Surface Water
Stress Level
Low, Tier 1 Only
Significant, Tier 2
North River
Duchesnay River
Mattawa River
La Vase River
Boom Creek
Kaibuskong River
Sharpes Creek
Amable du Fond River
Pautois Creek
Bear-Boileau Creeks
Wistiwasing (Wasi) River
NIPISSING
Upper South-Upper Amable
South River
LAURIER
0 5 10 20 Kilometers

Figure 2-41. Groundwater Stress Assessment in the North Bay-Mattawa SP Area

N
W
E
S
Drainage Divide
Rivers/Streams
Highways
Lakes
Groundwater Stress Level
Low, Tier 1 Only
North River
Duchesnay River
Trout Lake-Turtle Lake
Mattawa River
La Vase River
Boom Creek
Kaibuskong River
Sharpes Creek
Amable du Fond River
Pautois Creek
Bear-Boileau Creeks
Wistiwasing (Wasi) River
Reserve-Beatty Creeks
NIPISSING
Upper South-Upper Amable
South River
LAURIER
0 5 10 20 Kilometers

2.7 Climate Change

There is broad international scientific agreement that human activities are primarily responsible for recently documented climate change (see for example IPCC, 2014a). This has largely been attributed to the release of greenhouse gases (GHGs) into the atmosphere, which have caused warming temperatures, which in turn have changed precipitation regimes and increased extreme weather events. Since the Intergovernmental Panel on Climate Change (IPCC) released its first report in 1990, average global temperature increases of about 0.1 °C per decade have been observed, contributing to an average global temperature increase of between 0.62 °C and 1.06 °C over the period 1880 to 2012 (IPCC, 2014a).

Long-term changes to temperature and precipitation are expected as a result of climate change. Under low GHG emissions scenarios, the IPCC (2014a) predicts global average temperature is likely to increase by 0.3 °C to 1.7 °C by 2100 relative to 1986–2005. In their worst case GHG emissions scenarios, however, the IPCC (2014a) predicts that average global temperatures could increase as much as 4.8 °C by 2100 relative to 1986–2005.

While these trends are expected to continue well into the future, the extent of climate change will largely depend on the level of GHG emissions mitigation around the world. Failure to reduce international GHG emissions will lead to more significant changes and increased risk of impacts. However, even if GHGs were dramatically reduced today, anthropogenic warming, atmospheric carbon levels and other impacts would continue for centuries due to the time scales associated with climate processes and feedbacks. These predictions point to the need for adaptation to climate change as well as for reducing sources of GHG emissions.

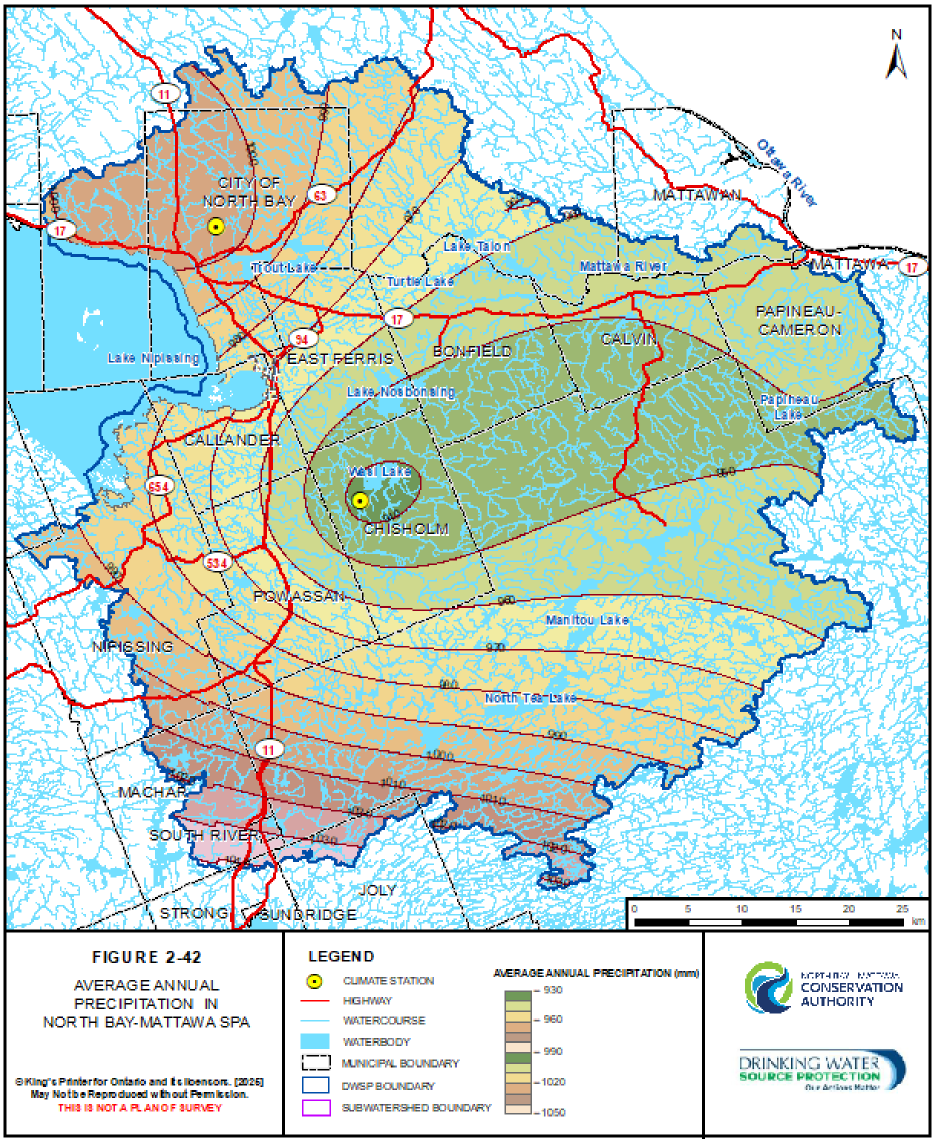
2.7.1 Overview

Existing Climate Data

Existing climate data for the Source Protection Area (SP Area) have been provided by Gartner Lee (2008a). From a climate change perspective, these data are valuable for the climate baseline they provide and for comparing observed climate trends against projected trends.

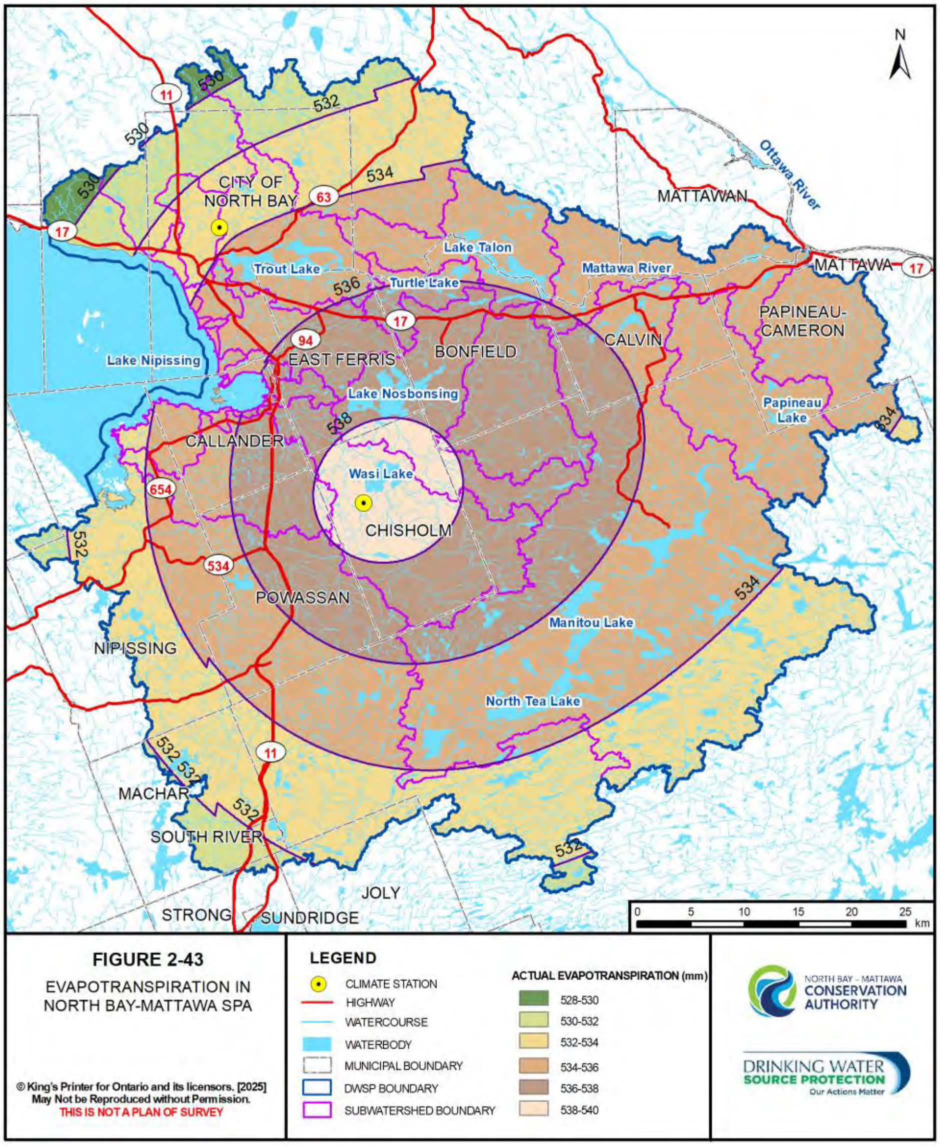
For the SP Area, Gartner Lee (2008a) has provided data on climate stations, average annual precipitation, precipitation distribution, metrological zones, evapotranspiration, and long-term historic temperature and precipitation trends and averages. This information is contained within the Section 2.5 Conceptual Water Budget of this document. Estimated annual precipitation and evapotranspiration within the SP Area is provided in Figures 2-42 and 2-43, respectively.

Figure 2-42. Precipitation in the North Bay-Mattawa SP Area



Average Annual Precipitation
(mm)
785 - 885
885 - 985
985 - 1,085
1,085 - 1,185
Precipitation Contour
Snow Course Location
Climate Station
Municipal Drinking Water System
Highways
Lakes
Rivers/Streams
Organized Township
Subwatersheds
North Bay Psychiatric Hospital
North Bay A
NORTH BAY
North Bay
MATTAWAN
Mattawa
Corbeil Conservation Area
BONFIELD
CALVIN
PAPINEAU-CAMERON
EAST FERRIS
Callander
NIPISSING
CALLANDER
Powassan
CHISHOLM
NIPISSING
POWASSAN
South River
MACHAR
South River
JOLY
SUNDRIDGE
STRONG
0 5 10 20 Kilometers

Figure 2-43. Evapotranspiration in the North Bay-Mattawa SP Area



Actual Evapotranspiration (mm)
482 - 494
494 - 506
506 - 518
518 - 530
530 - 542
Climate Station
Municipal Drinking Water System
Evapotranspiration Contour
Highways
Lakes
Organized Township
Rivers/Streams
Subwatersheds
North Bay
Mattawa
Callander
Powassan
South River
MATTAWAN
BONFIELD
CALVIN
PAPINEAU-CAMERON
EAST FERRIS
CALLANDER
CHISHOLM
POWASSAN
NIPISSING
MACHAR
JOLY
SUNDRIDGE
STRONG
0 5 10 20 Kilometers

These data will be useful for conducting region-specific analyses of climate change scenarios, which is beyond the scope of this report. For example, using temperature and precipitation data from the North Bay weather station, OCCIAR (2010) found that annual mean temperature in the North Bay area increased over the period 1938 to 2008, and that total annual precipitation increased by 110 mm during this same time period.

Future climate change projections

Using global climate models (GCMs), scientists are able to produce climate change projections for various regions of the earth. An ensemble approach of running many models together reduces the uncertainty associated with any individual model by minimizing individual model biases. When evaluated using historical empirical data, ensemble results also come closest to replicating historical climate conditions. Although not a guarantee, the results of an ensemble model collection are most likely to represent future climate conditions (CCSN, 2009).

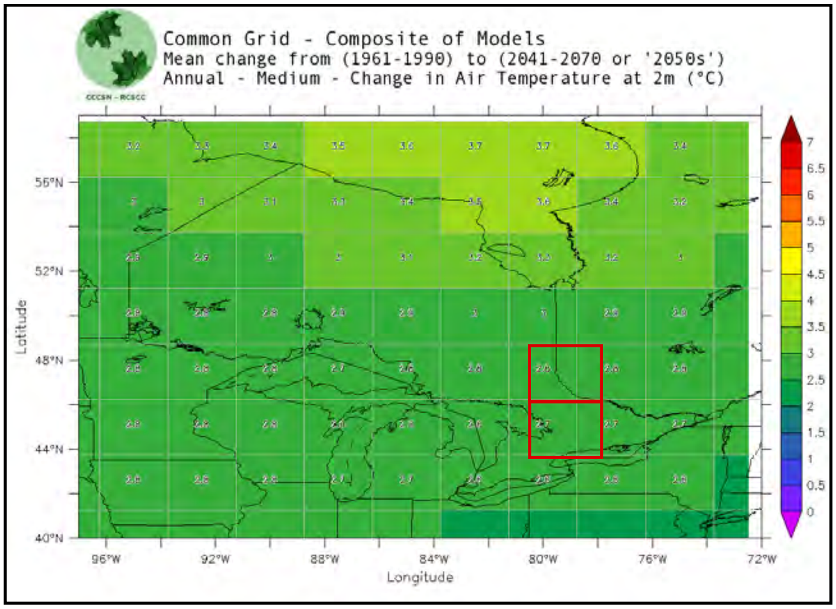
The climate projections for the SP Area discussed below are derived from models developed by 24 international climate modelling centres. These models have been combined by Environment Canada scientists, working as members of the Canadian Climate Change Scenarios Network (CCSN), to compute projections for different regions of Ontario (CCSN, 2009). These projections have been based on different assumptions about future volumes of GHG emissions and have been grouped into low, medium, and high scenarios. These models provide a generalized projection of expected changes in a given region, but do not provide detailed projections that consider local influences on climate (e.g., effects of local water bodies and changes in relief).

Climate change projections for the SP Area have been assembled using the CCSN model data. The '2050s' is a term used by the CCSN to describe the period from 2041-2070. All CCSN projections used in this report are for the 2050s period. Furthermore, all data are presented as a mean change from 1961-1990 climate averages. Because the SP Area straddles two grid cells in the model (highlighted in red on Figure 2-44), the mean of these two cell values is used in the following discussion.

In the SP Area, average annual temperatures are expected to rise 2.4 °C (under a low emissions scenario) to 3.1 °C (under a high emissions scenario) by the 2050s. Winter temperature projections are the most striking, as these expected changes are measurably larger than for other seasons. They are expected to rise 2.7 °C (low emissions) to 3.7 °C (high emissions) by the 2050s.

Model projections for total precipitation in the 2050s indicate that a 5.7% (low emissions) to 6.3% (high emissions) increase in annual average precipitation is expected. The greatest seasonal increase in precipitation will occur in the winter with increases of 10.5% (low emissions) to 12.2% (high emissions) projected. Relatively large precipitation increases are also projected for the SP Area during the spring season, with increases of 9.7% (low emissions) to 10.5% (high emissions). Changes in summer and autumn precipitation are much smaller by comparison.

Figure 2-44. Example output from a CCSN model for the region that includes the North Bay-Mattawa SP Area (CCSN, 2009)



2.7.2 Anticipated Changes in Water Quantity and Quality Due to Climate Change

In Ontario, climate change is expected to affect water quality, stream flow, lake levels, groundwater infiltration, and patterns of groundwater recharge to streams (de Lo~~e~~ë and Berg, 2006~~,~~; Chiotti and Lavender, 2008~~,~~; Pearson and Burton, 2009). More specifically, changes to the hydrologic cycle as a result of climate change may influence the vulnerability and reliability of source water for drinking. For example, changes in seasonal and annual flow variability may alter the groundwater recharge, which is critical to the supply of drinking water. Increased water temperature, reduced stream flow and changing lake levels may also influence the water quality of a surface water source (~~Ontario Ministry of Environment~~MOE, 2006).

Generally, annual runoff is expected to decrease, although increased winter runoff and high flows due to extreme precipitation events throughout the year are expected. Lake levels are expected to decline and groundwater recharge is expected to decrease. There will be changes to groundwater discharge in the amount and timing of baseflow to streams, lakes and wetlands. Ice cover on lakes is expected to be reduced or eliminated completely over time. Snow cover will also be reduced and water temperature in surface water bodies will increase. Finally, it is expected that soil moisture will increase in the winter, but decrease in the summer and autumn.

2.7.3 Impacts on Source Protection Planning

Potential impacts from climate change (Table 2-46) that may be pertinent to source water protection planning in Ontario have been summarized by de Loë and Berg (2006). They draw on a number of previous studies (e.g., Lavender et al., 1998; Bruce et al., 2000; Great Lakes Water Quality Board, 2003; Kling et al., 2003; Auld et al., 2004; Bruce et al., 2006) with a focus primarily on the Great Lakes Basin.

Table 2-46. Potential Impacts of Climate Change

Type of Change	Potential Impacts of Change
Frequency of extreme rainfall events	• greater frequency of waterborne diseases • increased transportation of contaminants from the land surface to water bodies
Runoff	• increased stress on fish habitat due to reduced streamflow • reduced water quality because less water is available for dilution of sewage treatment plant effluents and runoff from agricultural and urban land • increased erosion from flashier streamflow • increased water treatment costs due to decreased water quality • increased competition and conflict over reduced water supplies during drought periods • increased frequency of flooding-related damage due to more high intensity storms
Lake levels	• changes to coastal wetland form and function because of declining lake levels • decreased water quality resulting from lower water volume, increased non-point source pollution, and increased chemical reactions between water, sediments and pollutants • increased water treatment costs due to reduced lake water quality • increased costs associated with moving water supply intakes • increased need for dredging of harbours and channels • reduced hydropower production due to lower flows between connecting channels
Ice cover	• longer navigation season due to reduced ice thickness and shorter ice cover season • increased shore erosion and sedimentation • increased water temperatures due to decreased ice cover

Type of Change	Potential Impacts of Change
Water temperature	• increased stress on fish habitat due to increases in water temperature • reduced water quality (e.g., increased algae production) as water temperature increases • greater frequency of taste and odour problems in drinking water supplies
Groundwater recharge and discharge	• changes to wetland form and function as discharge decreases • greater costs for groundwater-dependent communities, industries and rural residents associated with deepening wells • increased conflict because of additional competition for scarcer supplies • increased frequency of shallow wells drying up in rural areas • greater frequency of low flows in streams dependent on baseflow, causing increased competition and conflict, and increased stress on aquatic ecosystems
Soil moisture	• increased stress on plants due to decreased summer soil moisture • increased demand for irrigation to supplement soil moisture on drought prone soils

The findings presented in Table 2-46 are also consistent with more recently published work on climate change and water resources in Ontario (e.g., Chiotti and Lavender, 2008; Pearson and Burton, 2009). However, in some cases, other studies provide additional context and information. For example, the Expert Panel on Climate Change Adaptation (2009) notes that streams flowing in and out of some small lakes may also dry up for as long as several weeks in the summer. More frequent spring, summer and fall rainstorms will increase the risk of flooding and will increase the erosion of riverbanks and the turbidity of drinking water sources. Increased lake effect precipitation is also likely to occur in the lee of the Great Lakes because of more ice-free, open water in winter. Along with an earlier spring, this may in turn lead to a greater volume of spring run-off.

2.7.4 Intake Vulnerability under Climate Change Scenario

The literature review and climate change forecasting completed for the North Bay-Mattawa SP Area suggests that three major trends are expected:

1. Lake levels will decline as a result of decreased snowpack and longer dry periods.
2. Groundwater levels will decline, especially as intense storms produce rapid surface saturation and, therefore, increased runoff. Low groundwater levels may also reduce stream baseflow.
3. Intense storms carrying the bulk of total precipitation will produce large runoff events, which could lead to flooding, property destruction, and transportation of contaminant materials.

Considerations of source vulnerability for surface water intakes include: depth of the intake from the water's surface; the distance of the intake from the shoreline; and the history of water quality concerns at the surface water intake. Conditions for area vulnerability relate to the delineation of the intake protection zones, and consider for IPZ-2 and IPZ-3: the percentage of the zone which is land; the land cover, soil type and permeability; hydrological and hydrogeological conditions of a transport pathway area; and for IPZ-3, the distance of the zone from the intake (can be in increments; Rules 88-96).

Based on declining lake levels, there is a potential for each intake to have a decreased distance from the water surface to the intake crib. This would increase vulnerability, though the other factors that influence the intake score have a moderating effect and, thus, there might be little change to any of the intake vulnerability scores.

Groundwater systems rely on a different analysis which uses a combination of an intrinsic susceptibility index (ISI), aquifer vulnerability index (AVI), surface to aquifer advection time (SAAT), or surface to well advection time (SWAT). The consultant for the Powassan and Mattawa groundwater systems used the ISI method, which utilizes available Water Well Information System (WWIS) database records to produce an index or numerical score. The index considers the overburden soil type and thickness above the aquifer, and the static water level in the well. This index value is then interpolated between the well locations to produce a complete spatial assessment (map) of the intrinsic vulnerability of the aquifer(s) (Guidance Modules Groundwater, 2006).

Local impacts to groundwater systems would likely be similar across the two communities of interest. The changes to vulnerability resulting from a climate change scenario will come from the likelihood of decreased water tables. The increase in depth to aquifer has the potential to raise the ISI, as there is increased material between the ground level and the water table. This may also result in a need for new wells. Drilling activity for these wells would create more pockets of increased vulnerability, as it is possible that the wells may become transport pathways if they are not drilled and sealed properly. The existing wells will require proper decommissioning to prevent the same issue.

Drought conditions present a probability of increased distance that particles are able to travel in relation to the modelled time of travel. There is potential in certain situations for this to create broader wellhead protection areas (WHPAs), as those delineations are directly derived from time of travel calculations (except for WHPA-A).

Geophysical events could also be an outcome of the decrease in a water table level, combined with infrequent and intense precipitation events. It is possible for a combination of these factors to create localized subsidence. Subsidence is the process of compaction of soils which had previously been highly saturated. The effect is normally a gradual shift in the height of land, with compaction occurring over a long time period.

2.7.5 Assessment of Water Quantity

The stress placed on surface water and groundwater supplies increases as resources are depleted. The current water budget process identified the stress placed on the North Bay drinking water source due to the return of the water taken from the Trout/Turtle Lake subwatershed to another watershed (Lake Nipissing). The actual stress on the drinking water source is not a concern following a Tier Three water quantity analysis of the North Bay source as described in Section 5.

The Mattawa River and South River demonstrated Low stress conditions, which may be elevated under climate change scenarios. Therefore, it would be beneficial to monitor the stress of the various subwatersheds as time progresses and more signs of the predicted scenarios are noticed. Results of the Trout/Turtle Lake Tier Two and Tier Three studies will likely also be impacted by a climate change scenario, most obviously due to a decline in the streamflow contributions to the lakes and, thus, a decline in overall lake levels.

2.7.6 Future Work

As the resources become available, it would be beneficial for the North Bay-Mattawa Conservation Authority and its partners to become engaged in the local study of climate change impacts. The initial Climate Change report (Trailhead Consulting and P. Quinby Consulting, 2010) addresses the need to study the impacts of climate change on infrastructure systems, especially as the intensity of hydrometeorological events increases. For a full analysis of the local implications, the consultants recommend a scientific downsampling of climate data which would give a better understanding of the conditions specific to the North Bay-Mattawa SP Area.

2.8 Great Lakes Agreements

With respect to Great Lakes agreements, the *Clean Water Act (2006)* includes the following Section:

14. (1) If a source protection area contains water that flows into the Great Lakes, the terms of reference for the preparation of the assessment report and source protection plan for the source protection area shall be deemed to require consideration of

- The Great Lakes Water Quality Agreement of 1978 between Canada and the United States of America, signed at Ottawa on November 22, 1978, including any amendments made before or after this Section came into force.
- The Great Lakes Charter signed by the premiers of Ontario and Quebec and the governors of Illinois, Indiana, Michigan, Minnesota, New York, Ohio, Pennsylvania and Wisconsin on February 11, 1985, including any amendments made before or after this Section comes into force.
- The Canada-Ontario Agreement Respecting the Great Lakes Basin Ecosystem 2002 entered into between Her Majesty the Queen in Right of Canada and Her Majesty the Queen in Right of Ontario, effective March 22, 2002, including any amendments made before or after this Section comes into force.

- Any other agreement to which the Government of Ontario or the Government of Canada is a party that relates to the Great Lakes Basin and that is prescribed by the regulations.

All of the watersheds that make up the North Bay-Mattawa Source Protection Area drain ultimately to either Lake Huron or the St. Lawrence River.

The Great Lakes Water Quality Agreement (GLWQA) is a commitment by Canada and the United States to address the pollution of the Great Lakes. The Agreement was amended in 2012 with a new focus on nearshore areas and recognizes "… the importance of taking action, resolving existing environmental issues and anticipating and preventing future problems" (Environment Canada, 2020). There are a series of 10 'Annexes' that outline the objectives, actions and expected outcomes for addressing the following topics:

Annex 1: Areas of concern

Annex 2: Lakewide management

Annex 3: Chemicals of mutual concern

Annex 4: Nutrients

Annex 5: Discharges from vessels

Annex 6: Aquatic invasive species

Annex 7: Habitat and species

Annex 8: Groundwater

Annex 9: Climate change impacts

Annex 10: Science

In order to implement the GLWQA, a subsequent agreement between the governments of Canada and Ontario known as the Canada-Ontario Great Lakes Agreement (2014) has also been adopted. It sets out how the governments of Canada and Ontario will cooperate and coordinate their efforts toward five main priorities, which serve to:

- protect waters;
- improve wetlands, beaches and coastal areas;
- protect habitats and species;
- enhance understanding and adaptation; and
- promote innovation and engage communities

The agreement contributes to meeting Canada's obligations under the GLWQA (Ontario, 2020c~~0c~~). No aspects or recommendations of this assessment report compromise the objectives of the GLWQA.

The Great Lakes St. Lawrence River Basin Sustainable Water Resources Agreement was signed in 2005 between the provinces of Ontario, Quebec, and the eight Great Lakes states. The Water

Resources Agreement sets out broad principles for the joint management of the Great Lakes with respect to quantity. It carries on from the original Great Lakes Charter which was developed in 1985 in response to the growing use of water and proposals to divert large quantities out of the Great Lakes basin (~~Ministry of Natural Resources~~MNR, ~~(~~2005). The agreement recognizes that:

- Protecting, conserving, restoring, and improving these waters is the foundation of water resource management in the basin and essential to maintaining the integrity of the basin ecosystem;
- Managing to conserve and restore these waters will improve them as well as the water dependent natural resources of the basin;
- Continued sustainable, accessible and adequate water supplies for the people and economy of the basin are of vital importance;
- The States and Provinces must balance economic development, social development and environmental protection as interdependent and mutually reinforcing pillars of sustainable development;
- (Ontario, 2020d)

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Chapter 2 of the Great Lakes St. Lawrence River Basin Sustainable Water Resources Agreement addresses the "Prohibition of diversions, exceptions and management and regulation of withdrawals." The Water Resources Agreement contains a statement that reaffirms the "principles and findings of the Great Lakes Charter and the commitments and directives of the Great Lakes Charter Annex 2001." (Ontario, 2020d). Any diversions which would individually or cumulatively have significant adverse impacts on lake levels, in-basin uses, or the Great Lake ecosystem will not be allowed. Exceptions are rare and tightly regulated and are primarily for communities that straddle the Great Lakes-St. Lawrence divide. The North Bay diversion is one of these exceptions and it is important that the City demonstrate sensitivity to the terms of the Water Resources Agreement.

Within the North Bay-Mattawa Source Protection Area, only the North Bay municipal water supply is relevant to the Great Lakes Charter or its Annex. North Bay draws its municipal water from the Ottawa River watershed and discharges the treated sewage to the Lake Huron watershed constituting an intra-basin transfer. Future expansions of the North Bay water taking would have to be compliant with the terms of the Water Resources Agreement.

3.0 Explanation of Delineation and Assessment Methodology

The following Section describes the methodology used to delineate vulnerable areas and assess threats for all municipal drinking water supplies.

3.1 Surface Water Systems Methodology

The Municipality of Callander, City of North Bay and the Village of South River all utilize surface water sources for their municipal drinking water. Each was the subject of a detailed technical study in accordance with the Technical Rules set out in the Assessment Report: Technical Rules (December 12, 2008) as amended November 16, 2009 under the *Clean Water Act (2006)*. The findings for each municipal system are summarized in the relevant Sections later in this report (Sections 4, 6 and 8 respectively).

The procedure for assessing a surface water supply consists of:

- intake characterization (including water treatment plant and raw water quality);
- intake protection zone (IPZ) delineations and vulnerability scoring;
- uncertainty analysis of IPZ delineations and vulnerability scores;
- drinking water issues evaluation;
- threat identification and assessment; and
- gap analysis and recommendations.

3.1.1 Intake Characterization

Characterization of the water treatment plant in the technical studies includes details on location, type, capacity, population serviced, storage capacity, and pumping rates (both average and peak demand) for the plant. The description of the intake includes location, depth, diameter, and any other relevant details. The response time to shut down the plant should an emergency occur outside of normal hours of operation was determined. In all cases this meets or is less than the two-hour standard for delineating the Intake Protection Zone 2. During hours when the plants are staffed, shutdown can be completed in a matter of minutes.

The hydrodynamics and hydrological conditions of the supply source itself were also characterized for each system. North Bay and Callander draw from inland lakes. The Village of South River draws from an impounded (dammed) section of the South River and has dominant characteristics of a lake for the purposes of this assessment. Hydrodynamics play an important role in contaminant movement in these systems. For example, deep lakes can stratify into two non-mixing layers which dramatically reduce the risk of surface contaminants reaching an intake located at depth. Since the intake for the Village of South River is located in an impounded river, water levels and flows are regulated, necessitating a review of the operating plan for the dam.

General water chemistry and other water quality parameters were characterized for each source. All available data were reviewed. Raw water quality was assessed to identify potential issues (see below).

3.1.2 Delineation and Scoring of Vulnerable Areas

Defining Vulnerable Areas (Intake Protection Zones – Surface Water Systems)

Source protection planning specifies that three intake protection zones be identified and protected to maintain water quality at the surface water intake. The nature of the waterbody determines the shape and size of these vulnerable areas. All municipal surface water systems in this source protection area were classified as Type D intakes in accordance with Technical Rule 55; each is located in an impoundment or a lake other than a Great Lake. Of the three protection zones, Intake Protection Zone-1 (IPZ-1) is considered the most vulnerable to contamination. If a contaminant enters this zone, there may be little potential for dilution and limited time to respond before the contaminant reaches the intake.

For all three surface water systems, IPZ-1 was delineated according to Technical Rule 61. IPZ-1 is generally defined as the surface area of the waterbody within a 1 km radius centered on the intake and, where this area abuts land, a maximum setback of 120 m inland from the high water mark. However, for the intake for the Village of South River, located in the east basin of the South River Reservoir, the opening under the causeway effectively serves as the outlet of the basin and defines the downstream boundary of the IPZ-1.

Intake Protection Zone-2 (IPZ-2) is the secondary protection zone. If a spill or other event were to occur in the IPZ-2 that may impair water quality at the intake, the plant operator should have sufficient time to respond. IPZ-2 does not include land or water that lies within IPZ-1.

Delineation of IPZ-2 requires consideration of operator response time and potential contaminant flow in the vicinity of the intake. Therefore, the delineation of IPZ-2 is unique for each intake and specific details are provided in the relevant Section for each municipality. The presence of transport pathways, which are natural or constructed drainage routes (including storm water systems) that have the potential to facilitate the movement of contaminants, may expand the vulnerable areas. In all cases, the IPZs were surveyed to identify potential contaminant transport pathways. Where the IPZ-2 abuts land, a 120 m setback is included.

Intake Protection Zone 3 (IPZ-3) is intended to incorporate the area of each surface waterbody within the Source Protection Area that could contribute water to the intake. Where these areas abut land, a 120 m setback is included.

Vulnerability Scoring

Vulnerability scores provide a comparative assessment of the likelihood that a contaminant originating within an intake protection zone could reach the intake. They consider both the vulnerability of the intake protection zone (area vulnerability) and the inherent vulnerability of the intake based on factors such as depth, distance from shore and history of water quality concerns (source vulnerability). The two factors are multiplied together to give a vulnerability score up to 10.

Vulnerability Score =	**Area Vulnerability Factor** x	**Source Vulnerability Factor**
Maximum value of 10	Value up to 10	Value up to 1.0

Vulnerability scores were determined for each intake and used to assess the likelihood of a contaminant originating at any given point within the intake protection zones reaching the intake. These scores were based on:

- the percentage of the area that is composed of land;
- land cover, soil type, permeability of the land, and the slope of setbacks;
- hydrological and hydrogeological conditions in the area that contributes water to transport pathways;
- depth of the intake from the surface;
- distance of the intake from land; and
- history of water quality concerns at the intake.

3.1.3 Uncertainty Analysis

As identified in the Technical Rules, the process of delineation of each vulnerable area will carry a degree of uncertainty depending on the quality of the data used in the assessment and the professional judgment and skills of the analyst. Rule 13 in Part I.4 requires that an analysis of uncertainty, characterized as high or low, be made in respect of the vulnerability of the surface water throughout the vulnerable area.

3.1.4 Issues Identification

Drinking water issues, as defined in Part XI.1 of the Technical Rules relate to the presence of a “listed parameter" in water at the intake if:

- 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
- 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 that has been identified in water at a surface water intake that is not one of the "listed parameters". However, this requires a microbial risk assessment to be conducted with respect to that pathogen. The only pathogens considered in the issues evaluation for each system were total coliforms and *E. coli*, which are listed parameters.

Drinking water issues were identified by comparing all listed parameters for raw and treated water to the applicable Ontario Drinking Water Quality Standards, Aesthetic Objectives and Operational Guidelines. The chemical and physical attributes of raw water were also assessed.
Parameters in raw water that had exceeded the applicable benchmark or that had come within 25% of the benchmark were identified and evaluated for trends. Those parameters that had exceeded the applicable benchmark are considered drinking water issues. As well, a parameter would be considered an issue if an increasing trend was observed and a continuation of that trend would result in the inability of the water treatment plant to treat that parameter. If an issue is determined to be the result of natural causes, then no further action need be taken.

3.1.5 Threats Identification and Assessment

Threats are defined as those activities or conditions that could cause contamination of drinking water by a chemical or pathogen within one of the three Intake Protection Zones (IPZs). Activities must be assessed and reported whether or not they currently occur within the vulnerable areas. O.Reg. 287/07 Section 1.1 (1) under the *Clean Water Act (2006)* lists 20 activities that may result in threats to drinking water quality. (Two additional prescribed activities pose threats to water quantity.) See Table 3-1 below.

Table 3-1. Activities Prescribed to be Drinking Water Threats in O.Reg. 287/07 (General) of the *Clean Water Act (2006)*

O.Reg. 287/07 s. 1.1(1)	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

O.Reg. 287/07 s. 1.1(1)	Activity
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
19	An activity that takes water from an aquifer or a surface water body without returning the water taken to the same aquifer or surface water body
20	An activity that reduces the recharge of an aquifer
21	The use of land as livestock grazing or pasturing land, an outdoor confinement area or a farm-animal yard
22	The establishment and operation of a liquid hydrocarbon pipeline.

Note: "agricultural source material", "application", "commercial fertilizer", "livestock", "non-agricultural source material" and "outdoor confinement area" have the same meanings as in O.Reg. 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.

Conditions are drinking water threats resulting from past activities. **No conditions were identified in any of the surface water vulnerable areas.** As defined by Part XI.3 of the Technical Rules (MECP, ~~2017~~2021), conditions refer to past activities that have produced contaminants that may result in significant drinking water threats and include the presence of:

- a non-aqueous phase liquid in groundwater in a highly vulnerable aquifer, significant groundwater recharge area or wellhead protection area;
- 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 intake protection zone;
- a contaminant in groundwater in a highly vulnerable aquifer, significant groundwater recharge area or wellhead protection area, if the contaminant is listed in Table 2 of the Soil, Ground Water and Sediment Standards, is present at a concentration that exceeds the potable groundwater standard set out for the contaminant in that Table, and the presence of the contaminant in groundwater could result in the deterioration of the groundwater for use as a source of drinking water;

- a contaminant in surface soil in a surface water intake protection zone, if the contaminant is listed in Table 4 of the Soil, Ground Water and Sediment Standards, is present at a concentration that exceeds the surface soil standard for industrial/commercial/community property use set out for the contaminant in that Table and the presence of the contaminant in surface soil could result in the deterioration of the surface water for use as a source of drinking water;
- a contaminant in sediment in an intake protection zone, if the contaminant is listed in Table 1 of the Soil, Ground Water and Sediment Standards and is present at a concentration that exceeds the sediment standard set out for the contaminant in that Table, and the presence of the contaminant in sediment could result in the deterioration of the surface water for use as a source of drinking water; or
- a contaminant in groundwater that is discharging into an intake protection zone, if the contaminant is listed in Table 2 of the Soil, Ground Water and Sediment Standards, the concentration of the contaminant exceeds the potable groundwater standard set out for that contaminant in the Table, and the presence of the contaminant in groundwater could result in the deterioration of the surface water for use as a source of drinking water.

In accordance with Technical Rule 9(ix) areas where activities that are or would be significant, moderate or low drinking water threats were identified and are presented in the relevant municipal Sections.

An activity is deemed a significant, moderate or low threat dependent upon:

- specific circumstances that influence the risk presented by a chemical or pathogen associated with that activity,
- the Intake Protection Zone in which the activity is or would be located, and
- the area's vulnerability score (Vs).

The Ministry of the Environment, Conservation and Parks provides reference tables of significant, moderate and low drinking water threats related to activities (MECP ~~2018~~2021). The Technical Rules Part XII - ~~Table 1 and Table 2 of the~~ Tables of Drinking Water Quality Threats list drinking water threats related to chemicals and pathogens~~, respectively~~. Further, an activity is also deemed to be a significant or moderate threat if it contributes to a drinking water issue as per Technical Rules 131 and 134.1. The Threats Tables can be downloaded from the MECP webpage (https://www.ontario.ca/page/2021-technical-rules-under-clean-water-act).

An on-line searchable version of the Threats Tables can be accessed at swpip.ca.

~~Table 3-2 below provides an example using the Excel version of the MECP Tables of Drinking Water Threats for chemicals (MECP, 2018). There are nine columns marked A through I. Columns A and B indicate the threat category and subcategory, respectively. Columns C, D, E, and F provide the circumstances related to the activity, such as quantity and relative location. Column G indicates the vulnerable zone(s) and the vulnerability score involved, while Column G lists the specific chemicals of concern. Lastly, Column I indicates if the activity is considered a significant, moderate or low~~

drinking water threat based upon the set of circumstances and the associated vulnerability score and vulnerable area.

The on-line version of the Threats Tables can be filtered to outline the specific circumstances related to potential chemical threats. After the webpage is opened, click on the "Search" menu tab and then "Zone and Score". By applying the filter values in sequence, as shown in Table 3-2 below, it is possible to narrow the results to those activities matching certain circumstances.

In the first example from the Excel file shown in Table 3-2, the main search values are the prescribed drinking water threat of "handling and storage of an organic solventfuel", where the risk is "significant" for "chemical" parameters. The results show the vulnerable areas and vulnerability scores where these values are found. By expanding the row for a particular vulnerability score, a list of activities is shown. is The second example in Table 3-2 uses "Search by Zone Score" to perform a search by selecting the zone "IPZ-2", where the risk is "significant for "chemical parameters and the vulnerability score is "8". further defined by the volume of solvent stored above ground (between 250 L and 2500 L). Depending on the vulnerable area score within an intake protection zone, certain chemicals are considered to be at different threat levels (Colum I). A significant threat (row 195) only occurs where one particular chemical is used and only in an IPZ-1 where the vulnerability score is 10. TheThese examples illustrate example illustrates that the threat level for a certain type of activity can be different depending on its location and the vulnerability score.

Table 3-2. Example of search results for IPZ-2 using from Excel on-linefile version of MECP's Tables of Drinking Water Threats (Chemical)

Search by Threat Subcategory	Search Result	
	Circumstance 1	**Circumstance 2**
• **Threat Subcategory:** Fuel – Handling and Storage • **Risk:** Significant • **Parameter of Concern:** Chemical • **Vulnerable Areas Score:** IPZ-1 (9)	Liquid fuel storage in a tank at or above grade at a facility as defined in section 1 of O. Reg. 213/01, a facility as defined in section 1 of O. Reg. 217/01, or a facility that manufactures or refines fuel.	Fuel stored or handled in a quantity that is >2,500 litres.
	Liquid fuel storage in a tank partially below grade at a facility as defined in section 1 of O. Reg. 213/01, a facility as defined in section 1 of O. Reg. 217/01, or a facility that manufacturers or refines fuel.	Fuel stored or handled in a quantity that is >2,500 litres.

Search by Zone Scores	Search Result
	Threat Sub Category
• **Zones**: IPZ-2 • **Risk:** Significant • **Parameter of Concern:** Chemical • Vulnerable Areas Score: 8	Industrial Effluent Discharges Overflow - CSO or SSO Snow - Storage Storm Water - Outfall (Industrial/Commercial) Transfer/Processing Site - Hazardous Waste or LIW WWTF and Associated Parts

	~~A~~	~~B~~	~~C~~	~~D~~	~~E~~	~~F~~	~~G~~	~~H~~	~~I~~
~~Table Row~~	~~Prescribed Drinking Water Threat~~	~~Threat Sub Category~~	~~Summary of Chemical Quantity Circum-stance~~	~~Chemical Quantity Circumstance Legal Wording~~	~~Description of the Threat Legal Wording~~	~~Summary of the Description of the Threat~~	~~Vulner-able Zones that the Circum-stances Apply~~	~~Chemicals Associated with the Circum-stances~~	~~Risk Associated with the Circum-stances and Vulnerable Zones~~
~~195~~	~~The handling and storage of an organic solvent.~~	~~Storage Of An Organic Solvent~~	~~where the quantity stored is >250-2500 L~~	~~The quantity of organic solvent stored is more than 250, but not more than 2,500 litres.~~	~~The organic solvent is stored in a container at or above grade.~~	~~Where an organic solvent is stored at or above grade.~~	~~IPZ-1, WHPA-A, WHPA-B with a score of 10~~	~~Carbon Tetrachloride~~	~~Significant~~
~~878~~	~~The handling and storage of an organic solvent.~~	~~Storage Of An Organic Solvent~~	~~where the quantity stored is >250-2500 L~~	~~The quantity of organic solvent stored is more than 250, but not more than 2,500 litres.~~	~~The organic solvent is stored in a container at or above grade.~~	~~Where an organic solvent is stored at or above grade.~~	~~IPZ-1, IPZ-2, IPZ-3, WHPA-B, WHPA-C, WHPA-E with a score of 8~~	~~Carbon Tetrachloride, Chloroform, Methylene chloride (Dichloromethane)~~	~~Moderate~~
~~879~~	~~The handling and storage of an organic solvent.~~	~~Storage Of An Organic Solvent~~	~~where the quantity stored is >250-2500 L~~	~~The quantity of organic solvent stored is more than 250, but not more than 2,500 litres.~~	~~The organic solvent is stored in a container at or above grade.~~	~~Where an organic solvent is stored at or above grade.~~	~~IPZ-1, IPZ-2, IPZ-3, WHPA-E with a score of 9~~	~~Carbon Tetrachloride, Chloroform, Methylene chloride (Dichloromethane), Pentachlorophenol~~	~~Moderate~~
~~880~~	~~The handling and storage of an organic solvent.~~	~~Storage Of An Organic Solvent~~	~~where the quantity stored is >250-2500 L~~	~~The quantity of organic solvent stored is more than 250, but not more than 2,500 litres.~~	~~The organic solvent is stored in a container at or above grade.~~	~~Where an organic solvent is stored at or above grade.~~	~~IPZ-1, WHPA-A, WHPA-B with a score of 10~~	~~Chloroform, Methylene chloride (Dichloromethane), Pentachlorophenol~~	~~Moderate~~

	A	B	C	D	E	F	G	H	I
Table Row	Prescribed Drinking Water Threat	Threat Sub Category	Summary of Chemical Quantity Circum-stance	Chemical Quantity Circumstance Legal Wording	Description of the Threat Legal Wording	Summary of the Description of the Threat	Vulner-able Zones that the Circum-stances Apply	Chemicals Associated with the Circum-stances	Risk Associated with the Circum-stances and Vulnerable Zones
2590	The handling and storage of an organic solvent.	Storage Of An Organic Solvent	where the quantity stored is >250-2500 L	The quantity of organic solvent stored is more than 250, but not more than 2,500 litres.	The organic solvent is stored in a container at or above grade.	Where an organic solvent is stored at or above grade.	IPZ-1, IPZ-2, IPZ-3, WHPA-B, WHPA-C, WHPA-E with a score of 8	Pentachlorophenol	Low

Note: Table generated by using the filter features in Excel to select: only "the handling and storage of an organic solvent" from column A; "where the quantity stored is >250-2500 L" from column C; and "The organic solvent is stored in a container at or above grade" from Column E.
Excerpt from Table 1 of Tables of Drinking Water Threats version 1.1 (MECP, 2018)

Lists of significant, moderate and low drinking water threats related to chemicals and pathogens were compiled for each of the vulnerable areas in North Bay-Mattawa Source Protection Area using the MECP Tables of Drinking Water Threats. These tables provide a list of circumstances for each prescribed activity which could pose as a drinking water threat. The vulnerability score for each vulnerable area then determines the corresponding threat level for each circumstance. The total number of significant, moderate and low threats in vulnerable areas was summarized based on these tables.

Technical Rules 9.(1) (e) and (f) require that an Assessment Report include the number of locations at which:

- a significant drinking water threat activity is being engaged in; and
- a condition resulting from a past activity is a significant drinking water threat.

These are identified in the Sections that follow for each individual municipal water source.

3.1.6 Gap Analysis and Recommendations

This report is organized by municipal water system. Each section contains a gap analysis and recommendations pertinent to that system.

3.2 Groundwater Systems Methodology

The Town of Mattawa and Municipality of Powassan rely on groundwater sources for their municipal drinking water systems.

Each of these two systems was the subject of a detailed technical study in accordance with the Technical Rules set out in the Assessment Report: Technical Rules (December 12, 2008) as amended November 16, 2009 under the *Clean Water Act (2006)*. The technical studies revealed thirteen significant threats in Mattawa and two in Powassan.

Broadly speaking, the objectives consist of the following steps:

- identify the areas which contribute water to the aquifer (or aquifers) being used by the system;
- determine the time that it takes for water to move to the wells, and
- identify any relevant land use activities (current, historical or possible in the future) which may threaten the quality of the source(s).

Objective 1: Identifying the areas which contribute water to the aquifer(s) is essential to understanding which areas need to be protected from contamination. Those closest to the wellhead are considered most vulnerable. Groundwater generally moves very slowly; distances that surface water would travel in minutes or hours, typically take years for groundwater. Over that time chemical contaminants in groundwater are subject to various fates; some break down, some get adsorbed onto soil particles and are immobilized, and those that remain become more and more dilute.
Objective 2: Most bacteria that are pathogenic to humans die off within a matter of months in travelling groundwater. However, some toxic chemicals are highly persistent and in some cases are heavier than water. The latter can be highly problematic if a spill occurs that is not detected and cleaned up promptly. Therefore, the time it would take for contaminated water to reach the wellhead from any location is also important to consider.
Objective 3: The third objective relates to identifying all land use activities that could pose a threat so that they can be managed to reduce the risk. These include historic activities that may have left contaminated conditions. The slow movement of contaminants in groundwater permits far more time to respond to spills than in surface water, but it also means that contaminants do not tend to get flushed out of groundwater sources. Clean-ups, when necessary, can be very costly.

Although water underground can travel in three dimensions, the procedure for delineating vulnerable areas based on time-of-travel only considers horizontal flow in the aquifer to the well. Distances are projected upwards to create a map of vulnerable areas on the surface. It is a conservative approach in that it does not consider the time it may take water to reach the aquifer from the surface.

When technical studies commenced in 2006, the Ministry of Environment provided Source Protection Technical Studies Draft Guidance Modules to guide the work. These modules were updated in March 2007 (MOE 2007). (Note: Ministry of Environment or MOE is a previous name of the Ministry of Environment, Conservation and Parks or MECP). These provided far more detailed information than the subsequent Technical Rules. Guidance modules 3 to 6 were utilized in identifying vulnerable areas and assessing threats for these three systems.

The procedure for assessing a groundwater supply consists of:

- wellhead system characterization (including water treatment plant, relevant local geology and water quality);
- wellhead protection area (WHPA) delineation through computer modelling and vulnerability scoring;
- uncertainty analysis of WHPA delineations and vulnerability scores;
- drinking water issues evaluation;
- threat identification and assessment; and
- gap analysis and recommendations.

3.2.1 Water Supply Overview

The technical studies reviewed details on location, type, capacity, population serviced, and pumping rates (both average and peak demand) for each municipal system.

Treatment of municipal groundwater in Mattawa and Powassan consists simply of chlorination to ensure adequate contact time prior to distribution and a chlorine residual as water flows through the distribution system. Details of well construction, water demand and the population served are pertinent to understanding the movement of groundwater and to planning for future demand. The rate of pumping affects the speed at which water travels and therefore the size of the vulnerable area (Wellhead Protection Area).

Landscape features, such as elevations, types and depths of soil layers, and depth to bedrock are essential to:

- identify recharge areas where water supplying the aquifer first enters the ground;
- determine how fast water can be expected to travel; and
- identify any natural protective features that are barriers to contaminant movement.

A review of water quality, both raw and treated, is used to identify any existing issues with the supply.

3.2.2 Delineation and Scoring of Vulnerable Areas

Defining Vulnerable Areas (Wellhead Protection Areas)

The availability and movement of water hidden underground in aquifers is not readily apparent. Various information sources and techniques, such as computer based three-dimensional ground water flow modelling, are used to develop an understanding. Well records, which are produced when a well is drilled, provide valuable information on the type of soils encountered at various depths during well construction and the depth(s) at which water was found. The depths at which particular layers were encountered can then be joined mathematically to describe the structure of the ground in three dimensions. The nature of the various layers of soil largely determines the rate at which the water can move, along with any contaminants they might contain.

Water moves readily through soils dominated by large particles such as course sand, whereas fine particle soils like tightly packed clay impede the movement of water through them. Since groundwater flows so slowly, computer modelling was used to predict the direction and speed of water-borne contaminants instead of chemical tracers. It would take at least 25 years to run an appropriate experiment using chemical tracers.

Groundwater tends to flow in a specific direction due to the gradient of the water table. The gradient can be determined by considering the static water level in various wells. Presence of a heavily drawing well such as one supplying a municipal system will affect the speed and direction of flow as well as the water table gradient; To what extent depends on both the rate of extraction and the ease of water movement through the soil.

The movement of contaminants through the soil depends on the nature of the soils between the surface and the aquifer and the thickness of the soils. The hydraulic conductivity of each type of soil can be described by its K-factor as shown in Table 3-3 below. The Intrinsic Susceptibility Index (ISI) is then calculated for each location within the vulnerable area considering the degree of protection provided by the various layers of soil and the thickness of each. Susceptibility of the aquifer at each location is then rated as high, medium or low.

Table 3-3. Representative K-Factors for Selected Geological Materials

Geological Material	K-Factor
Sand and gravel aquifer	1
Sandy till	2
Silty sand	3
Sandy silt	4
Alluvium	4
Clay	8
Bedrock	3

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Regional groundwater studies conducted throughout Ontario between 2002 and 2006 included the areas of the North Bay-Mattawa Source Protection Area relevant to the Mattawa and Powassan systems.

The scale of that study (Waterloo Hydrogeologic, 2006) was large, but information collected and analyzed for them was still highly valuable in completing the current technical studies. An application called Visual MODFLOW was used at that time. In the current studies, a more recent version (4.3) was used and the model domain and characteristics were modified to reflect the input of additional hydrogeologic data sources. Details on the development of each model may be found in the relevant groundwater technical studies, all of which were completed by Waters Environmental Geosciences Ltd.

Once each model was developed it would be run in steady state mode at the average pumping rates for the system. The regions of the aquifer which contribute flow to the wellhead area were identified by an analysis method known as “particle tracking”. Particle tracking is a feature within the groundwater model which allows the movement of individual particles of water to be traced (on a map view) from the point where recharge enters the groundwater flow system to the point where the water is extracted at the well. The exact pathway that the water particles follow depends on the subsurface soil and rock types, and the directions of groundwater flow in the aquifer. Within Visual MODFLOW, particle tracking is performed by a sub-program called MODPATH.

By using MODPATH, several dozen particles can be tracked simultaneously as they move through the groundwater flow system being modelled. The position of each particle can be described by the time it takes to travel a fixed distance in the groundwater flow system. Therefore, particle tracking is the basis for developing the wellhead protection areas (WHPA) using their respective time-of-travel (TOT) characteristics. As previously explained, contaminants released closer to the wellhead are considered to pose more risk than those originating further away; the time it takes contaminants to reach the wellhead is an important factor in managing risk.

The following capture zones were established for municipal wellheads:

- WHPA-A is the area within 100 m of wellhead
- WHPA-B extends beyond the 100 m zone to a line marking the 2-year TOT
- WHPA-C extends from the WHPA -B limit out to the 5-year TOT
- WHPA-D extends from the WHPA-C limit out to the 25-year TOT

If a municipal well system is classified as obtaining groundwater under the direct influence of surface water (or a GUDI system), additional consideration must be given to the identification of the potential interactions between the groundwater system and the nearby surface water.

Vulnerability Scoring

As well as time-of-travel within the aquifer to the wellhead, the vulnerability of the aquifer to surface contamination was assessed using the Intrinsic Susceptibility Index (ISI). This method considers the soil characteristics (resistance to flow) and depth to the aquifer and rates the susceptibility of each location as high, medium or low. Final vulnerability scores were established for various locations within the vulnerable area based on both the WHPA and the susceptibility in accordance with Table 2(a) in Rule 83.

3.2.3 Uncertainty Analysis

As identified in the Technical Rules, the process of delineation of each vulnerable area will carry a degree of uncertainty depending on the quality of the data used in the assessment and the professional judgment and skills of the analyst. Rule 13 in Part I.4 requires that an analysis of uncertainty, characterized as high or low, be made in respect of the vulnerability of the surface water throughout the vulnerable area.

3.2.4 Issues Identification

Drinking water issues, as defined in Part XI.1 of the Technical Rules, relate to the presence of a "listed parameter‟ in water at the wellhead if:

- 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
- there is an increasing trend of the parameter that would result in the deterioration of water quality for use as drinking water.

Issues can also relate to the presence of a pathogen. The intention of issues identification is to link observed water quality problems to specific threats where possible, so that the appropriate measures can be taken to eliminate the source of the problem. However, water quality issues may be due to natural sources. These are still listed as issues but no action is required.

The assessment process also has a provision to consider drinking water concerns. These are potential issues which are believed to exist but for which there is no data substantiating the presence of the contaminant. They are generally identified during public consultation.

3.2.5 Threats Identification and Assessment

A groundwater threat is a land use activity (either existing or historical), within the vulnerable area which may impair water quality if managed improperly.

O.Reg. 287/07 Section 1.1 (1) under the *Clean Water Act (2006)* lists 20 activities that may result in threats to drinking water quality (see Table 3-1 above). (Two additional prescribed activities pose threats to water quantity.)

Conditions are drinking water threats resulting from past activities. As defined by Part XI.3 of the Technical Rules (MECP, 2017), conditions refer to past activities that have produced contaminants that may result in significant drinking water threats and include the presence of:

- a non-aqueous phase liquid in groundwater in a highly vulnerable aquifer, significant groundwater recharge area or wellhead protection area;
- 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 intake protection zone;
- a contaminant in groundwater in a highly vulnerable aquifer, significant groundwater recharge area or wellhead protection area, if the contaminant is listed in Table 2 of the Soil, Ground Water and Sediment Standards, is present at a concentration that exceeds the potable groundwater standard set out for the contaminant in that Table, and the presence of the contaminant in groundwater could result in the deterioration of the groundwater for use as a source of drinking water;
- a contaminant in surface soil in a surface water intake protection zone, if the contaminant is listed in Table 4 of the Soil, Ground Water and Sediment Standards, is present at a concentration that exceeds the surface soil standard for industrial/commercial/community property use set out for the contaminant in that Table and the presence of the contaminant in surface soil could result in the deterioration of the surface water for use as a source of drinking water;
- a contaminant in sediment in an intake protection zone, if the contaminant is listed in Table 1 of the Soil, Ground Water and Sediment Standards and is present at a concentration that exceeds the sediment standard set out for the contaminant in that Table, and the presence of the contaminant in sediment could result in the deterioration of the surface water for use as a source of drinking water; or
- a contaminant in groundwater that is discharging into an intake protection zone, if the contaminant is listed in Table 2 of the Soil, Ground Water and Sediment Standards, the concentration of the contaminant exceeds the potable groundwater standard set out for that contaminant in the Table, and the presence of the contaminant in groundwater could result in the deterioration of the surface water for use as a source of drinking water.

In accordance with Technical Rule 9(ix), areas where activities that are or would be significant, moderate or low drinking water threats were identified and are presented in the relevant municipal Sections.

An activity is deemed a significant, moderate or low threat dependent upon:

- specific circumstances that influence the hazard presented by a chemical or pathogen associated with that activity;
- the vulnerable area in which the activity is or would be located; and
- the area's vulnerability score.

The Ministry of the Environment, Conservation and Parks provides reference tables of significant, moderate and low drinking water threats related to activities (MECP 2021). The Technical Rules Part XII - Tables of Drinking Water Threats list drinking water threats related to chemicals and pathogens. Further, an activity is also deemed to be a significant or moderate threat if it contributes to a drinking water issue as per Technical Rules 131 and 134.1. The Threats Tables can be downloaded from the MECP webpage (https://www.ontario.ca/page/2021-technical-rules-under-clean-water-act).

An on-line searchable version of the Threats Tables can be accessed at swpip.ca. The on-line version of the Threats Tables can be filtered to outline the specific circumstances related to potential chemical threats. After the webpage is opened, click on the "Search" menu tab and then "Zone and Score". By applying the filter values in sequence, as shown in Table 3-2 below, it is possible to narrow the results to those activities matching certain circumstances.

In the first example shown in Table 3-4, the main search values are the prescribed drinking water threat of "handling and storage of fuel", where the risk is "significant" for "chemical" parameters. The results show the vulnerable areas and vulnerability scores where these values are found. By expanding the row for a particular vulnerability score, a list of activities is shown. The second example in Table 3-4 uses "Search by Zone Score" to perform a search by selecting the zone "WHPA-B", where the risk is "significant for "chemical parameters and the vulnerability score is "8". These examples illustrate that the threat level for a certain type of activity can be different depending on its location and the vulnerability score.

Table 3-4. Example of search results for WHPA-B using on-line version of MECP's Table of Drinking Water Threats

Search by Threat Subcategory	Search Result: Circumstance 1	Search Result: Circumstance 2
• **Threat Subcategory:** Fuel – Handling and Storage • **Risk:** Significant • **Parameter of Concern:** Chemical • **Vulnerable Areas Score:** WHPA-A (10)	Liquid fuel storage in a tank at or above grade at a facility as defined in section 1 of O. Reg. 213/01, a facility as defined in section 1 of O. Reg. 217/01, or a facility that manufactures or refines fuel.	Fuel stored or handled in a quantity that is >2,500 litres.
	Liquid fuel storage in a tank partially below grade at a facility as defined in section 1 of O. Reg. 213/01, a facility as defined in section 1 of O. Reg. 217/01, or a facility that manufacturers or refines fuel.	Fuel stored or handled in a quantity that is >2,500 litres.
	Liquid fuel storage in a tank entirely below grade at a facility as defined in section 1 of O. Reg. 213/01, a facility as defined in section 1 of O. Reg. 217/01, or a facility that manufactures or refines fuel.	Fuel stored or handled in a quantity that is >2,500 litres.
	Liquid fuel storage in a tank at or above grade at a facility as defined in section 1 of O. Reg. 213/01, a facility as defined in section 1 of O. Reg. 217/01, or a facility that manufactures or refines fuel.	Fuel stored or handled in a quantity that is more than 250, but not more than 2,500 litres.
	Liquid fuel storage in a tank partially below grade at a facility as defined in section 1 of O. Reg. 213/01, a facility as defined in section 1 of O. Reg. 217/01, or a facility that manufacturers or refines fuel.	Fuel stored or handled in a quantity that is more than 250, but not more than 2,500 litres.
	Liquid fuel storage in a tank entirely below grade at a facility as defined in section 1 of O. Reg. 213/01, a facility as defined in section 1 of O. Reg. 217/01, or a facility that manufactures or refines fuel.	Fuel stored or handled in a quantity that is more than 250, but not more than 2,500 litres.

Search by Zone Scores	Search Result: Threat Sub Category
• **Zones:** WHPA-B • **Risk:** Significant • **Parameter of Concern:** Chemical • Vulnerable Areas Score: 8	DNAPL - Handling & Storage Landfilling (Hazardous Waste or LIW) Landfilling (Municipal Waste) Storm Water - Outfall (Industrial/Commercial) LIW Injection into a well Transfer/Processing Site - Hazardous Waste or LIW Transfer/Processing Site - Municipal Waste

The Ministry of the Environment, Conservation and Parks (MECP) provides reference tables of significant, moderate and low drinking water threats related to activities. Table 1 and Table 2 of the Tables of Drinking Water Threats list drinking water threats related to chemicals and pathogens, respectively. Further, an activity is also deemed to be a significant or moderate threat if it contributes to a drinking water issue as per Technical Rules 131 and 134.1.

Table 3-4 below provides an example using the Excel version of the MECP Tables of Drinking Water Threats for pathogens. There are five columns marked A through E. Columns A and B indicate the threat category and subcategory, respectively. Column C provides the circumstances related to the activity, such as quantity and relative location. Column D indicates the vulnerable zone(s) and the vulnerability score involved. Lastly, Column E indicates if the activity is considered a significant, moderate or low drinking water threat based upon the set of circumstances and the associated vulnerability score and vulnerable area.

In the example from the Excel file shown in Table 3-4, the prescribed drinking water threat of “application of agricultural source material” is further defined “any quantity and the potential release of pathogens. Depending on the vulnerable area score within a wellhead protection area, the activity is considered to be at different threat levels (Colum E). A significant threat (row 4) only occurs where the activity occurs in a WHPA- or WHPA-B and the vulnerability score is 10. The example illustrates that the threat level for a certain type of activity can be different depending on its location and the vulnerability score.

Table 3-4. Example from the Excel file version of MECP's Tables of Drinking Water Threats (Pathogen)

Row #	Prescribed Drinking Water Threat	Threat Sub Category	Description of the Threat Legal Wording	Vulnerable Zones that the Circumstances Apply	Risk Associated with the Circumstances and Vulnerable Zones
4	The application of agricultural source material to land.	Application Of Agricultural Source Material (ASM) To Land	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, WHPA-A, WHPA-B with a score of 10	Significant
50	The application of agricultural source material to land.	Application Of Agricultural Source Material (ASM) To Land	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.	WHPA-B with a score of 8	Moderate
133	The application of agricultural source material to land.	Application Of Agricultural Source Material (ASM) To Land	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.	WHPA-B with a score of 6	Low

Note: Table generated by using the filter features in Excel to select only: "The application of agricultural source material to land" from column A.
Excerpt from Table 2 of Tables of Drinking Water Threats version 1.1 (MECP, 2018)

Lists of significant, moderate and low drinking water threats related to chemicals and pathogens were compiled for each of the vulnerable areas in North Bay-Mattawa Source Protection Area using the MECP's Tables of Drinking Water Threats. These tables provide a list of circumstances for each prescribed activity which could pose ~~as~~ a drinking water threat. The vulnerability score for each vulnerable area then determines the corresponding threat level for each circumstance. The total number of significant, moderate and low threats in vulnerable areas was summarized based on these tables.

Technical Rules 9.(1) (e) and (f) require that an Assessment Report include the number of locations at which:

- a significant drinking water threat activity is being engaged in; and
- a condition resulting from a past activity is a significant drinking water threat.

These are identified in the Sections that follow, relevant to each individual municipal water source.

No conditions were identified in any of the groundwater vulnerable areas.

3.2.6 Gap Analysis and Recommendations

This report is organized by municipal water system; each section contains a gap analysis and recommendations pertinent to that system.

4.0 Callander

4.1 Introduction and Summary of Findings

This Section includes analyses of vulnerability with respect to both water quantity and water quality for the surface water intake for the Municipality of Callander. General methodology for the water quality portion is described in Section 3.1 of this report. The information in this Section is based on the Callander Drinking Water Source Protection Technical Studies Update, 2010, prepared by Hutchinson Environmental Services (HESL) and subsequent monitoring conducted by the NBMCA and other organizations (e.g., Nipissing University). This section includes the following:

- intake characterization (including water treatment plant and raw water quality)
- intake protection zone (IPZ) delineations
- uncertainty analysis of IPZ delineations and vulnerability scores
- drinking water issues evaluation
- threat identification and assessment, and
- gap analysis and recommendations.

A technical advisory committee oversaw the technical aspects of the report; local knowledge was solicited from the community at large as well as the Callander Bay Watershed Advisory Committee on several occasions during the process. The findings were presented to the public and comments were received. Additional peer review was not conducted because the technical challenges posed by the assessment were considered well within the expertise of the consultant. The full technical report is available at ~~www.actforcleanwater.ca~~http://www.nbmca.ca/ or directly from the North Bay-Mattawa Conservation Authority.

Field Code Changed

The water treatment plant for the Municipality of Callander is located on Part Lot 2, Concession 26 in the Municipality of Callander. Water is drawn from Callander Bay, a relatively isolated bay connected to the extreme east end of Lake Nipissing. The intake pipe is 400 mm in diameter and extends approximately 1,000 m from the shoreline (Figure 4-1) where the intake is located at a depth of approximately 8 m.

A water budget and water quantity stress assessment is usually required to determine whether the water supply within a subwatershed is adequate to meet both the current and long-term demands of the municipality and other users. However, such an assessment is not needed where the source is a Great Lake or other very large water body which would provide a substantial source water supply. Because Callander draws its water from Lake Nipissing, a water budget was not required as per Technical Rule 4 (MECP ~~2017~~2021).

Threats in the identified vulnerable areas were assessed utilizing the "threats approach" and it was determined there are no existing significant drinking water threats in the vulnerable area of the Callander drinking water intake.

Figure 4-1. Callander Intake on Callander Bay of Lake Nipissing


Callander Lagoons
N
W
E
S
Water Treatment Facility
D
Intake Type D
Water Treatment Facility
Roads
Highways
Streams/Creeks
Water
Wetland
Municipal Services
0
1 km

The issues approach for identification of threats determined that microcystin, a toxin sometimes produced by some cyanobacteria (blue-green algae), is a drinking water issue for the Callander drinking water supply. Because phosphorus contributes to the production of cyanobacteria, any activity that occurs in the Issue Contributing Area (Figure 4-6) which can result in the input of phosphorus to Callander Bay is considered a significant threat regardless of the score of the vulnerable area in which it occurs.

Lake Nipissing, the drinking water source for the Municipality of Callander, is the third largest lake entirely within Ontario and has a surface area of 874 km^2. Lake Nipissing is shallow, with water depths mostly less than 10 m and exceeding 20 m only near the outflow of the lake to the French River.

Lake Nipissing supports a productive, warm water fishery. Given the shallow nature of the lake and its 60 km length, the water column is easily mixed to the bottom by wind and wave action preventing thermal stratification in all but a very small portion of the lake. Water levels are controlled by three dams near the headwaters of the French River, which are used to gradually lower lake levels over the winter by approximately 1.3 m to accommodate spring runoff. The watershed area for the lake is large (12,047 km^2) with drainage from 26 quaternary watersheds. However, only a small portion, approximately 300 km^2 (2.5% of that area), contributes to Callander Bay including Wistiwasing (Wasi) River, Burford Creek, Cranberry Creek, Windsor Creek, and several small, unnamed watercourses.

4.2 Water Budget and Water Quantity Stress Assessment

A water budget and water quantity stress assessment is usually required to determine whether the water supply in a subwatershed is adequate to meet both the current and long-term demands of the municipality and other users. However where the source is a Great Lake or other very large water body, such an assessment is not needed. Because Callander draws its water from Lake Nipissing, a water budget was not required. Technical Rule 4 states the following:

> An area represented by a conceptual water budget or water budget prepared in accordance with rule 3 shall not include any part of a surface water body that is a Great Lake, a connecting channel, Lake Simcoe, Lake Nipissing, Lake St. Clair or the Ottawa River. (Technical Rule 4; MECP ~~2017~~2021)

4.3 Intake Characterization

4.3.1 Source Water

Like the main body of Lake Nipissing, Callander Bay is shallow and generally the water column is easily mixed to the bottom by wind and wave action. However, weak stratification, which prevents mixing, sometimes occurs and oxygen concentrations in the lower portions of the water column subsequently drop. This happens because oxygen is consumed by microbial processes, such as the mineralization of organic carbon compounds (i.e., cellular respiration) and the oxidation of ammonium (i.e., nitrification).

Sediment oxygen depletion has important implications for phosphorus cycling in Callander Bay. If periods of stratification are maintained for a sufficient duration, there is a risk of complete oxygen depletion (anoxia) at the sediment surface. Phosphorus that is bound to cations such as iron (Fe^{3+}) in sediments under oxygenated conditions is released into the water column under anoxic conditions. A flux of phosphorus from the sediments is called internal phosphorus loading. Because the water column of Callander Bay undergoes complete vertical mixing frequently over the summer months the phosphorus from internal loading can be introduced into the surface waters at the height of the growing season, promoting additional phytoplankton production.

General water chemistry surveys have been conducted for Callander Bay by the Ministry of the Environment (MOE) from 1988 to 1990 and again from 2003 to 2004, and the results were compared to applicable Ontario Drinking Water Quality Standards, Objectives and Guidelines (O.Reg. 169/03; MOE, 2006g). Water quality data have been collected by NBMCA for the Wasi River (2003-present) through the MECP's Provincial Water Quality Monitoring Network (PWQMN)), and for Callander Bay (2002-present) through MECP's Lake Partner Program (LPP).

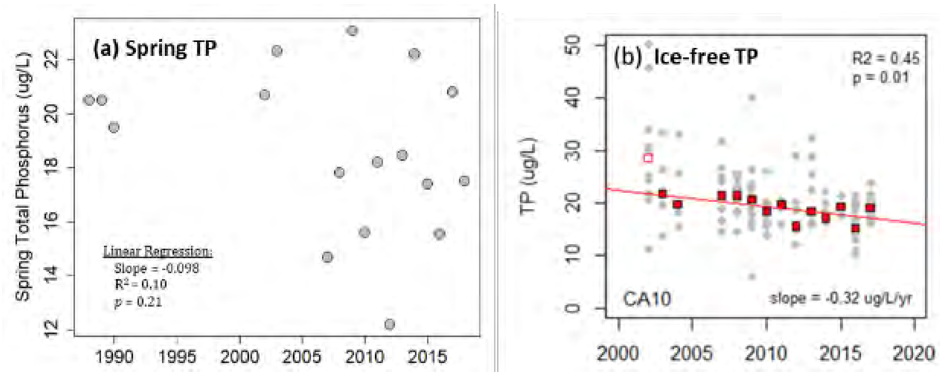
Based on available water quality surveys, the lake water is circumneutral (pH = 7.4), has low alkalinity (18.4 mg/L) and is ionically dilute with a conductivity of 82.5 µS/cm. Callander Bay has slightly greater ionic strength than most Shield lakes and, hence, higher pH and alkalinity values that are likely due to: the slightly thicker soils and glacial deposits in the catchment, the large size of the catchment area, and the influence of abundant wetlands in the catchment. In addition, the bay supports large aquatic plant communities that would contribute to the relatively higher pH and alkalinity. All measured raw water parameters for Callander Bay are within applicable Ontario Drinking Water Standards, Objectives and Guidelines, but aluminum and iron concentrations exceeded the guidelines in the Wasi River, a primary tributary to Callander Bay, in 2007. Aluminum concentrations are further discussed in Section 4.5 as they relate to potential drinking water issues for source protection planning.

In most Ontario lakes, phosphorus is the nutrient that limits the biomass of phytoplankton (suspended algae and cyanobacteria). Callander Bay would be classified as meso-eutrophic based on its mean total phosphorus concentration of 20.6 µg/L for the ice-free period (2002-2018).

Figure 4-2(a) shows there is no statistically significant trend in spring (May) TP concentration in Callander Bay from 1988 to 2018 (site CA10). The annual median TP concentration for the ice-free season (May-Oct; red squares), as illustrated in Figure 4-2(b), has shown a significant decline since 2002 (even when the high value (open square) from 2002 is excluded from the trend analysis). Monitoring data prior to this period may not be reliable due to analytical constraints and, therefore, longer-term changes in phosphorus concentrations in Callander Bay are uncertain based on measured data.

(Note: Ministry of Environment or MOE is a previous name of the Ministry of Environment, Conservation and Parks or MECP)

Figure 4-2. Total Phosphorus (TP) concentration in Callander Bay (1998 to 2018)

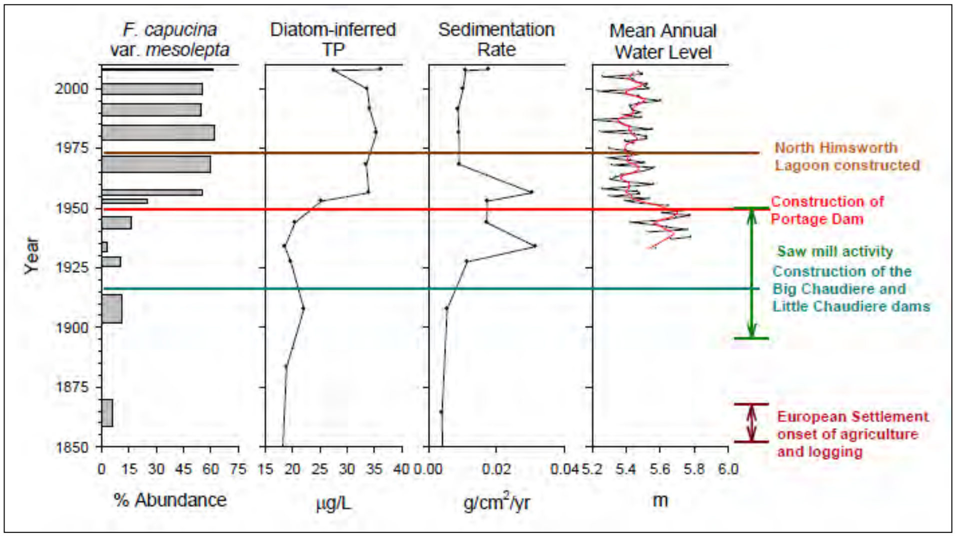


To determine long-term changes in phosphorus concentrations in Callander Bay, a paleolimnological study was completed by AECOM for the NBMCA (AECOM, 2009). This study estimated historic total phosphorus concentrations by analyzing fossil diatom assemblages preserved in a dated sediment core from the bay. Diatoms are a unicellular group of algae with cell walls that are composed of silica and preserve well in the sediments. They are abundant in most freshwater environments and can be used as indicators of environmental conditions because they have well-defined ecological preferences. Total phosphorus concentrations were estimated by applying a model developed from Ontario lakes to the fossil diatom assemblages in Callander Bay to estimate changes that have occurred over the past ~ 400 years.

This study estimated that total phosphorus concentrations have remained relatively stable in recent decades, but that a significant increase occurred coincident with construction of the Portage Dam in 1949-1950 at the westerly outlet of Lake Nipissing (Figure 4-3) (Hutchinson Environmental Sciences Ltd, 2010; and AECOM, 2009).

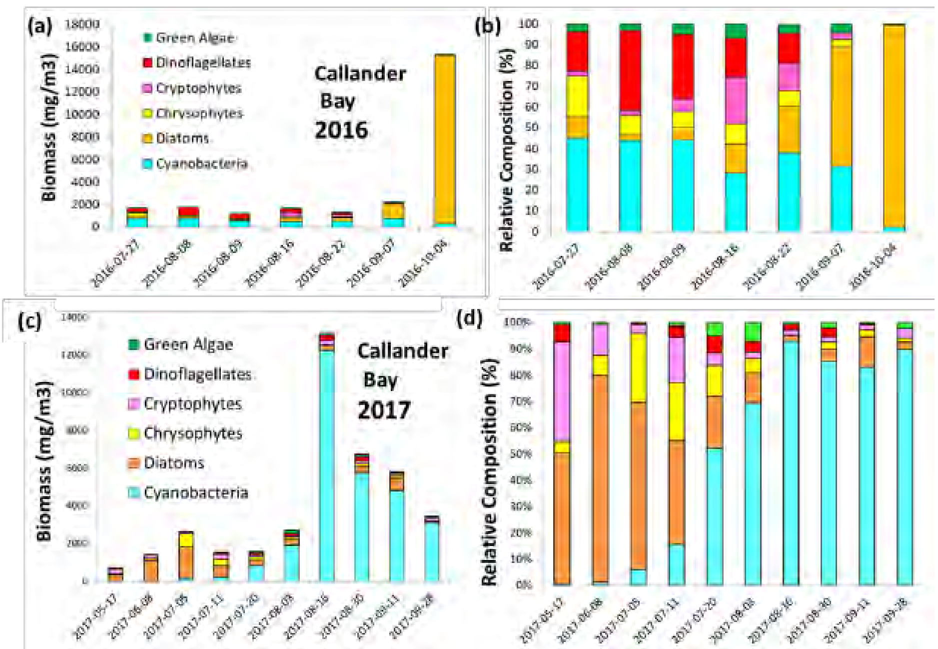
Blasting of the channel and subsequent operation of the dam resulted in an overall decrease in water levels in Lake Nipissing, particularly during the spring melt period. The influence of this hydrological change may have resulted in a combination of physical changes to Callander Bay including an altered mixing regime, changes in flushing rates and mixing with waters in the main basin of Lake Nipissing, exposure of productive low lying areas, and expansion of the shallow littoral zone, all of which could contribute to increased phosphorus concentrations. While the exact mechanism of change cannot be determined without further study, it was estimated that phosphorous concentrations in Callander Bay were sensitive to this major hydrological change. Other factors related to post-war activities in the watershed may also have played a part in the proposed ecological change in the state of Callander Bay at this time.

Figure 4-3. Paleoenvironmental Summary of Callander Bay (1850 to 2008)



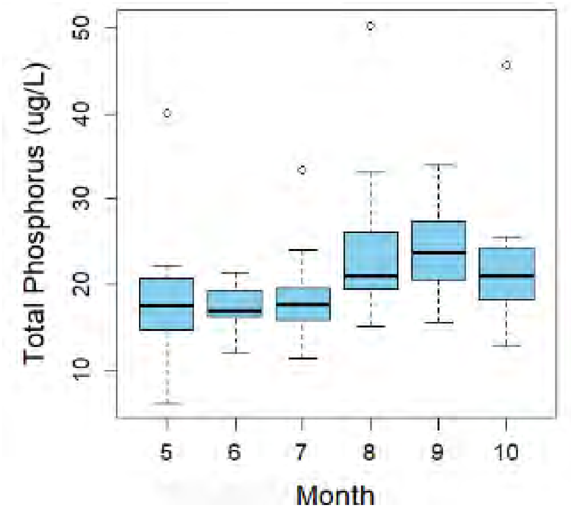
Due to the concern about algal productivity in Callander Bay, the NBMCA conducted sampling in 2007 to characterize the phytoplankton community composition and biomass over the open-water (ice-free) season. As the summer progressed, the phytoplankton assemblages became strongly dominated by cyanobacteria, representing between 66% and 96% of the total phytoplankton biomass in Callander Bay. Additional phytoplankton biovolume data were collected by Nipissing University researchers in 2016 and 2017 (Figure 4-4). In 2017, the phytoplankton community composition became increasingly dominated by cyanobacteria through the ice-free period, as was observed in 2007. However, based on the data collected from late-July to early-October of 2016, it is apparent that cyanobacteria do not dominate the phytoplankton community of Callander Bay in all years.

Figure 4-4. Phytoplankton biovolume and community composition of Callander Bay in 2016 and 2017.



Similar to results previously reported by the MECP (Neary and Clark, 1992), NBMCA monitoring results (2002-2018) show that total phosphorus concentrations in Callander Bay are generally higher in August and September than during other months of the ice-free season (Figure 4-5).

Figure 4-5. Seasonality in the total phosphorus concentration of Callander Bay from May to October (2002–2018).

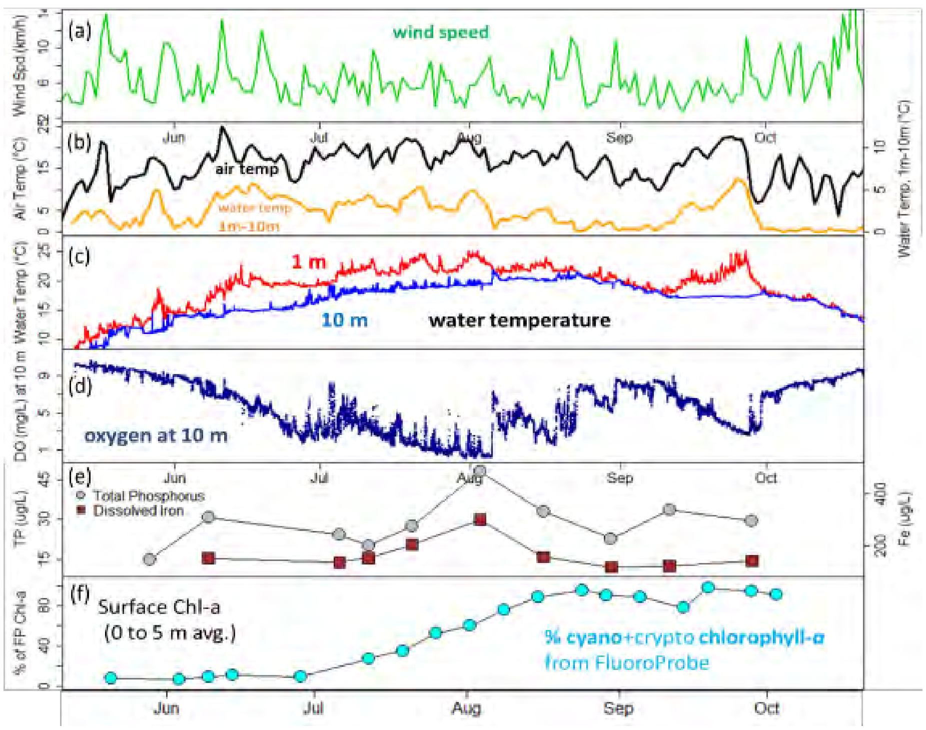


Note: Boxes represent data between the 25th and 75th percentiles, horizontal black lines represent medians, and whiskers represent max and min values (exclusive of outliers).

The MECP attributed increased phosphorus concentrations in the late fall (1988-1990) to decomposition of abundant aquatic plants. More recently, research led by Dan Walters of Nipissing University has demonstrated that under certain meteorological conditions, Callander Bay can undergo vertical density (thermal) stratification for sufficient duration to induce sediment anoxia and, consequently, internal loading of phosphorus and ferrous iron that appear to trigger cyanobacteria blooms (Figure 4-6). If weather conditions (which are inherently variable) are an important factor in triggering the blooms, this would help explain why blooms occur irregularly in Callander Bay (i.e. are severe in some years and minor or absent in others).

In 2017, the vertical water temperature gradient in Callander Bay was largely a function of air temperature (Figure 4-6 b, c) and showed little correlation with wind speed (Figure 4-6 a). Dissolved oxygen near the bottom reached a minimum in early August (Figure 4-6 d) at which time Fe and P concentrations peaked (Figure 4-6 e). Cyanobacterial chlorophyll-a peaked shortly after, in late August (Figure 4-6 f).

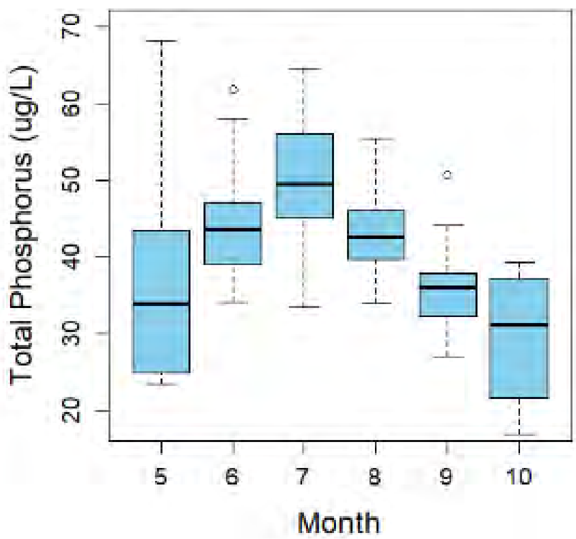
Figure 4-6. Water parameters in Callander Bay (2017)



Note: Source: Dan Walters, Nipissing University. Wind speed and air temperature data are courtesy of Paul Caccamo (Callander volunteer weather station operator). Water temperature and dissolved oxygen data were collected at the Nipissing University monitoring buoy. Nutrient data were provided by Dan Walters (Nipissing University).

Phosphorus loads from the Wistiwasing (Wasi) River, the largest tributary to Callander Bay, may also contribute to the observed increase in phosphorus concentrations in Callander Bay over the ice-free season. Monitoring data collected by the NBMCA from 2009 to 2017 indicate that phosphorus concentrations at the outlet of the Wasi River are generally highest in July (Figure 4-7), prior to the August increase in TP noted in the bay. This seasonal pattern in riverine water quality is common, at least in part because there is little dilution occurring during the mid-summer (i.e., relative to seasons when precipitation is greater and/or snow is melting).

Figure 4-7. Total Phosphorus Concentrations at the Wasi River Outlet to Callander Bay during the Ice-Free Season



Note: A value of 125 µg/L on 16 Oct 2017 is not visible.

With respect to drinking water quality, there is no Ontario standard, objective or guideline for phosphorus, because at the levels present in lake water, consumption of phosphorus poses no known human health risk. However, high phytoplankton productivity resulting from high phosphorus concentrations can impair the aesthetic quality of drinking water by reducing water clarity (increasing turbidity and colour) and by producing compounds that cause taste and odour problems (e.g., geosmin). In addition, certain types of cyanobacteria can produce toxins, notably microcystin, that are potentially harmful to human health.

Cyanobacterial blooms in Callander Bay have been confirmed by the MECP in most years since 2009 (Table 4-1; Claire Holeton (MECP), personal communication). When blooms are present, the North Bay Parry Sound District Health Unit is notified. The Health Unit posts signs and issues media releases warning the public with respect to appropriate precautions.

Table 4-1. Cyanobacteria blooms in Callander Bay that were reported to and confirmed by the MECP.

Year	Month & Day
2000	July 25th
2009	August 12th
2010	August 3rd
2011	August 29th
2012	August 8th
2015	June 22nd
2016	June 27th
2017	August 18th
2018	August 17th
2019	June 28th

4.3.2 Sediment Characterization

NBMCA sampled the sediments of Callander Bay on March 9, 2010 at four locations (Figure 4-8 and Table 4-2). Sediment sampling has also been conducted by researchers at Nipissing University, but no findings have been published to date.

Figure 4-8. Sampling locations of Callander Bay sediments in March 2010.

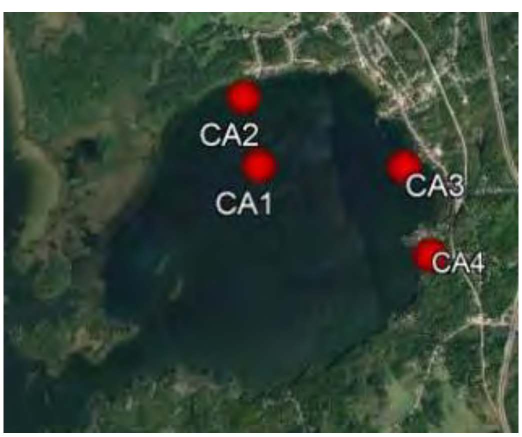


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Table 4-2. Moisture content and organic carbon, nitrogen and phosphorus concentrations of Callander Bay sediments at 4 sampling locations in March 2010.

Parameter	AVG.	CA1	CA2	CA3	CA4
Moisture (%)	73.8	53	75	84	83
Total Organic Carbon (g/kg)	38.5	16	41	49	48
Total Kjeldahl Nitrogen (µg/g)	3595	1270	3500	4900	4800
Acid Extractable Phosphorus (µg/g)	963	770	880	1100	1100

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In several areas of Callander Bay, there is substantial accumulation of sawmill debris and, potentially, contaminants in the sediments from historic practices in the watershed as well as urban drainage including lagoon discharges. There is direct evidence for sediment resuspension from a sediment core collected from near the centre of Callander Bay in August, 2007. The sediments were highly organic and flocculent in the top 5 cm of the core, and sediment particles were suspended in the water of the core tube above the sediment-water interface.

Due to the shallow nature of the bay and its susceptibility to complete mixing, sediments are easily resuspended, potentially releasing nutrients and contaminants into the water column and influencing water quality near the intake. The high phytoplankton productivity in the bay results in a high rate of accumulation of sediment. The municipality participates in the Drinking Water Surveillance Program whereby raw water is analyzed on a regular basis for numerous parameters and the presence of various contaminants.

4.3.3 Hydrology

There are six tributaries that drain to Callander Bay, including: the Wistiwasing (Wasi) River ; Burford Creek; Windsor Creek; and three unnamed tributaries. A hydrological study performed in October 1993 determined that the dominant flow in the Main Channel connecting Callander Bay to Lake Nipissing is toward the main basin of the lake (Northland Engineering Limited, 1993) (Table 4-3). These flows were observed to be greatest coincident with the lowering of Lake Nipissing water levels to accommodate spring runoff inputs, but also with a high wind event that occurred on October 21, 1993. However, lowering of the lake level during the sampling interval of the study would be unlikely to cause the elevated flows because levels are lowered only by approximately 1 cm per month (beginning in October). It is more likely that the high wind event, potentially in combination with a seiche on Lake Nipissing, caused the high flow. (A seiche is a long standing wave that affects the motion of the entire water mass of a lake. Seiches are most commonly created by wind-induced tilting of the water surface. Wind pushes water to one end of the lake and as the wind stress is removed, the tilted water surface flows back. Once established, these waves have great momentum and continue to rock back and forth.)

Frequent, but minor flow reversals into Callander Bay via the Main Channel appear to occur as a result of seiche events on the main basin of the lake (Northland Engineering Limited, 1993). These findings indicate that there is only limited mixing of waters from the main basin of Lake Nipissing with waters in Callander Bay. This conclusion is also supported by water quality characteristics of the bay that are distinct from those of the main lake (Neary and Clark, 1992).

Table 4-3. Water Currents in Callander Bay, October 1993 (from Northland Engineering, 1993)

Parameter	Units	Main Channel	North Shore	East Shore
Latitude	N	46° 12' 04"	46° 13' 34"	46° 13' 05"
Longitude	W	79° 25' 00"	79° 23' 18"	79° 22' 17"
Resultant Current	cm/s	0.92	0.53	0.30
Resultant Current Direction	° from Magnetic North	276	337	221
Mean Current Speed	cm/s	2.52	2.35	2.02
Maximum Current	cm/s	20.0	15.4	14.9
Minimum Current	cm/s	1.5	0.5	1.1

Based on the observed currents in 1993 in Callander Bay (Table 4-3), the minimum time for water to move 1 km is approximately 1.4 to 1.9 hours at maximum current speeds and 11.0 to 13.8 hours at mean current speeds, respectively (assuming constant speed and direction). Delineation of Intake Protection Zone 2 (IPZ-2) must encompass a minimum two-hour travel time for contaminants to reach the intake (see Section 3.1). As the current speeds observed in the main channel of Callander Bay reflect channelized flow from Callander Bay to the main basin of Lake Nipissing, the maximum current speeds observed at the North Shore more appropriately depict maximum speeds that would be generated within Callander Bay. Therefore, the current speeds at North Shore are more appropriate for calculating time-of-travel for the purposes of the IPZ-2 delineation. At the maximum current speed observed along the North Shore of Callander Bay of 0.154 m/s, water would travel 1.11 km in two hours.

Wind can affect wave patterns and currents on lakes, which in turn can influence water quality conditions and the movement of contaminants. Dominant winds in the Lake Nipissing region are from the southwest throughout most of the year with north winds prevailing in winter and early spring (February to April) based on meteorological data from the North Bay Airport (Table 4-4). Mean wind speeds are 13 km/h with maximum hourly speeds ranging from 51 to 72 km/h between 1971 and 2000. The maximum wind speed observed in October 1993 during the Callander Bay hydrological study (Northland Engineering, 1993) was 54 km/h, which is within the range of the 1971-2000 maximum hourly speeds. This suggests that the current speeds observed in the Northland Engineering (1993) study reflect the current speeds that can occur under maximum wind conditions in Callander Bay.

Table 4-4. Wind Pattern Normals (1971-2000) at the North Bay Airport (WMO Station 71731), Environment Canada

Month	Speed (km/h)	Most Frequent Direction	Max. Hourly Speed (km/h)	Max. Gust Speed (km/h)	Direction of Max. Gust	Days with Winds >= 52 km/h	Days with Winds >= 63 km/h
Jan	13.6	SW	58	100	S	0.7	0.1
Feb	13.6	N	64	90	NE	0.4	0
Mar	14.8	N	**72**	89	E	0.7	0.2
Apr	14.8	N	59	97	SW	0.5	0.2
May	13.5	SW	64	93	w	0.3	0.1
Jun	12.2	S.W	64	**115**	SW	0.1	0
Jul	11.5	SW	56	82	NW	0.3	0.1
Aug	10.7	SW	56	91	S	0	0
Sep	11.8	SW	51	89	S	0	0
Oct	13.1	SW	70	96	S	0.4	0.1
Nov	13.9	w	68	96	SW	0.5	0.2
Dec	13.2	E	59	85	SW	0.6	0.1
Year	**13.1**	**SW**			**SW**	**4.6**	**1.1**
Oct 1993	13.8	SW	54				

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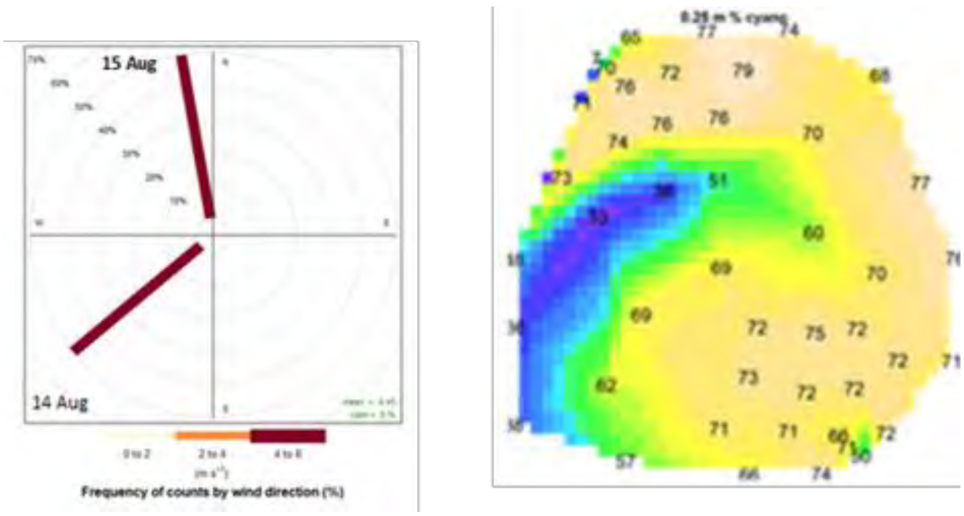
There are no known hydrological studies related to wind and wave action for the main basin of Lake Nipissing. Given the long fetch of the lake across an east-west axis and dominant winds from the southwest, seiche events are likely common in the main basin of the lake. (Fetch is the distance over which wind can blow uninterrupted by land.) This supports the observations of Northland Engineering for frequent flow reversals in the Main Channel that direct flow from the main lake basin into Callander Bay (Northland Engineering, 1993).

In a 1988 study of bacterial concentrations in the lagoon effluent draining through the wetland into Callander Bay, fecal coliforms reached 70,000 counts per 100 mL (Lake 1988). The Northland Engineering report's analysis of circulation was used to determine maximum current speeds in the bay and the potential two-hour travel distance of a contaminant near the intake. Findings also indicated that there is only limited mixing of waters from the main basin of Lake Nipissing with the waters in Callander Bay. This conclusion is consistent with the significant water quality differences observed between the main body and the bay. It should be noted, however, that flows may be affected by high wind events. Indeed, fluorescence data, collected in 2017 by NBMCA (using a

FluoroProbe) the day after only a moderate (~20 km/hr) SW wind, appear to show the movement of water from the Main Channel toward the centre of Callander Bay (Figure 4-9).

Figure 4-9. Surface fluorescence readings from Callander Bay (2017).



Note: Surface fluorescence readings were taken from Callander Bay the day following a SW wind in 2017.

4.3.4 System Details

Treatment of raw water at the Callander Water Treatment Plant includes filtration, coagulation, sedimentation, and disinfection by chlorination. The gravity flow filters use granulated activated carbon to treat for taste and odour problems caused by algae in Callander Bay. Backwash from the wastewater is decanted to the storm sewer and sludge is pumped to the sanitary sewer. There is one elevated water storage tank (standpipe) with a capacity of 2,272 m^3, providing water reserves for approximately three days at maximum daily flow demands or six days at average demand. Based on available flow data from 2001 to 2007, water demand averaged 400 m^3/day with a maximum of approximately 844 m^3/day representing 28% of the rated capacity for the plant (3,000 m^3/day). Daily flows vary over the course of the year with the highest average demand occurring in the summer months. Average daily flow rates have been increasing since 2001. The response time to shut down the plant outside of hours that it is normally staffed is between one and two hours.

4.4 Delineation and Scoring of Vulnerable Areas

4.4.1 Defining the Vulnerable Areas (Intake Protection Zones)

The vulnerable area for the Callander drinking water intake includes three Intake Protection Zones (IPZs) following Part VI of the Technical Rules for a Type D intake. Of the three protection zones, Intake Protection Zone 1 (IPZ-1) is considered the most vulnerable to contamination. If a contaminant enters this zone, there may be little potential for dilution and limited time to respond before the contaminant reaches the intake. IPZ-1 was delineated as the surface area of Callander Bay within a 1 km radius centered on the drinking water intake in Callander Bay and, where this area abuts land, a maximum setback of 120 m inland from the high water mark (Figure 4-10).

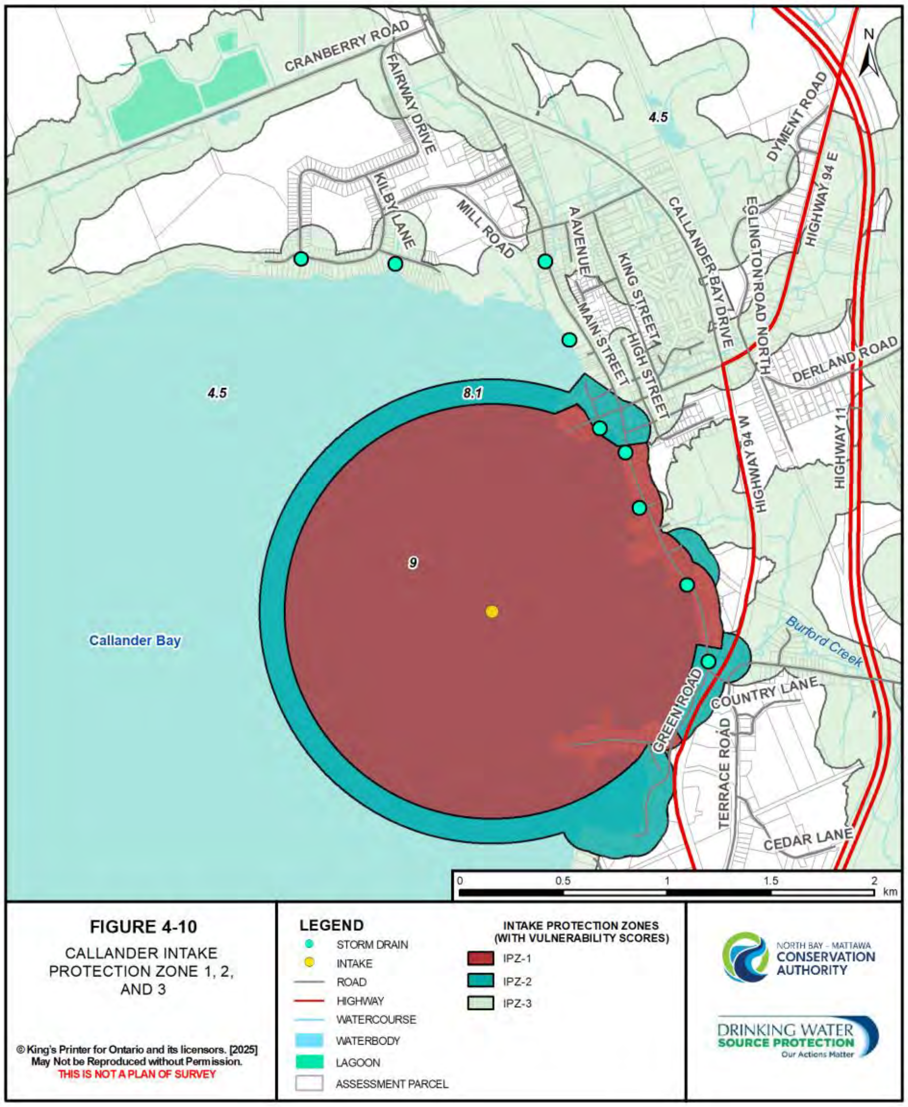
Intake Protection Zone 2 (IPZ-2) is the secondary protection zone. If a spill or other event were to occur in the IPZ-2 that may impair water quality at the intake, the plant operator should have sufficient time to respond. IPZ-2 did not include land or water that lies within IPZ-1 and was delineated using the following criteria:

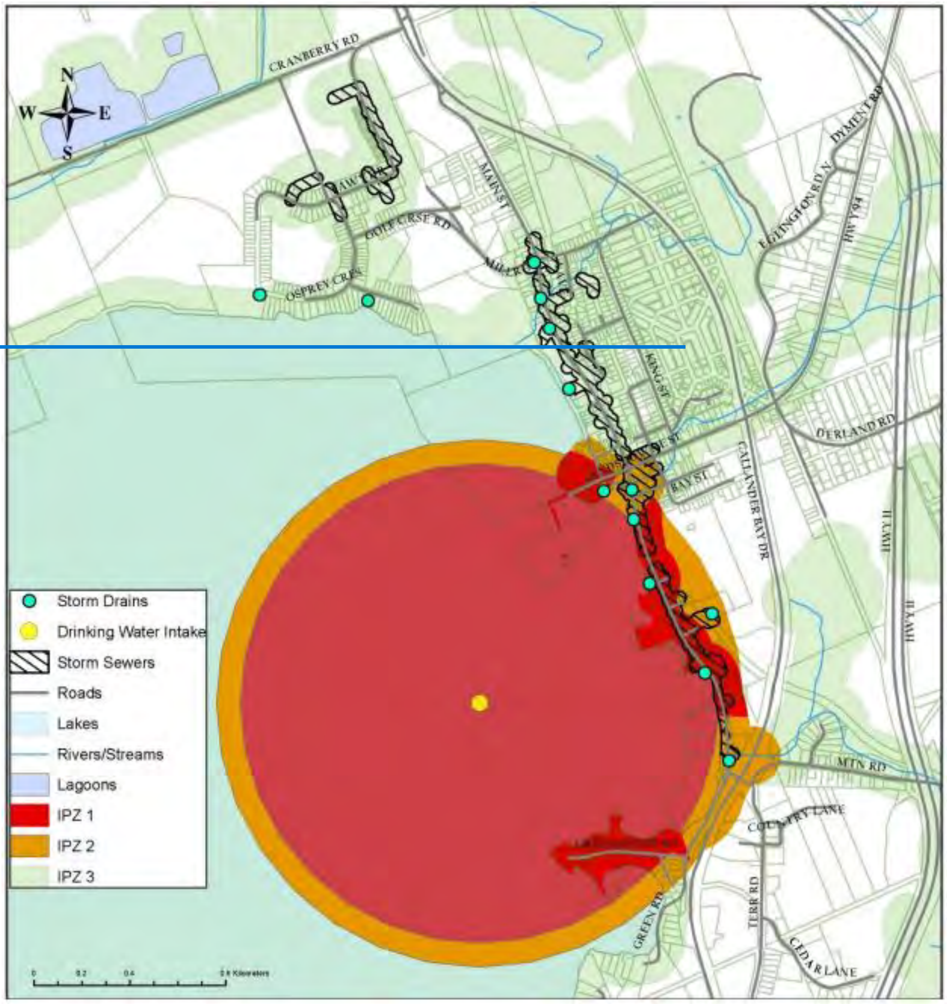
- the surface area of Callander Bay within 1.11 km of the drinking water intake, which represents a two-hour time-of-travel to the intake based on research presented in the Northland Engineering Study (1993) as summarized in the Hydrology section above; and
- where this area abuts land, a maximum setback of 120 m along the abutted land measured from the high water mark; and
- the area of the stormwater system that discharges into Callander Bay within 1.11 km of the drinking water intake; and
- the surface area and associated 120 m land buffer of tributaries to Callander Bay that lie within 1.11 km of the drinking water intake and extending upstream along the tributaries to encompass a two-hour time-of-travel.

The Northland Engineering Study (1993), cited above, measured current speed and direction at various locations within the bay. The maximum current speed of 0.154 m/s along the North Shore was judged to be most representative of maximum current speed within the bay. This corresponds to a travel distance of 1.11 km in the required two-hour target response period.

IPZ-2 is extended to include any storm sewersheds which drain within the IPZ-2 (Figure 4-10). To identify the area of storm sewer contribution, sewer and sewershed mapping was obtained from the Municipality. The area of the stormwater sewershed draining to Callander Bay that lies within 1.11 km of the intake was included to approximate a two-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 slower than that which occurs due to wind driven surface currents in Callander Bay. The 1.11 km distance to the intake is, therefore, a conservative estimate to approximate the necessary distance to encompass a two-hour time-of-travel to the intake from the sewershed area. Further evaluation would be required to determine the exact area of the sewershed within the residual time of travel that may contribute water to the intake.

Figure 4-10. Callander Intake Protection Zone 1 and 2




CRANBERRY RD
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DYMENT RD
HWY 94
KING ST
DERLAND RD
BAY ST
CALLANDER BAY DR
HWY 11
MTN RD
COUNTRY LANE
TERR RD
CEDAR LANE
GREEN RD
Storm Drains
Drinking Water Intake
Storm Sewers
Roads
Lakes
Rivers/Streams
Lagoons
IPZ 1
IPZ 2
IPZ 3

The IPZ-2 is also extended 205 m upstream of Burford Creek and 130 m upstream of Creek 323 to encompass a two-hour time-of-travel to the intake. This extension of the IPZ-2 is considered to be very conservative as the Wistiwasing River is a larger river with substantially greater flow velocities than that which would be observed in the smaller creeks. The IPZ-2, therefore, may require modification in subsequent phases of Source Water Protection planning if measured velocities are obtained for Burford Creek and Creek 323 that differ from those found in Wistiwasing River.

It was noted, however, that the creeks discharge to Callander Bay at some distance to the intake, requiring that the IPZ-2 only be extended to include a time-of-travel of 6.8 minutes for Burford Creek and 4 minutes for Creek 323. Use of measured flow velocities for these creeks would result in minimal change to the delineation of 205 m for Burford Creek and 130 m for Creek 323. This flow data was collected from these creeks over the 2009 ice-free season and could be used to assess the validity of the delineations. There is an on-going monitoring plan in place for the collection of flow data; however, the 2009 data was not received until after the production of the technical report which formed the basis of this assessment.

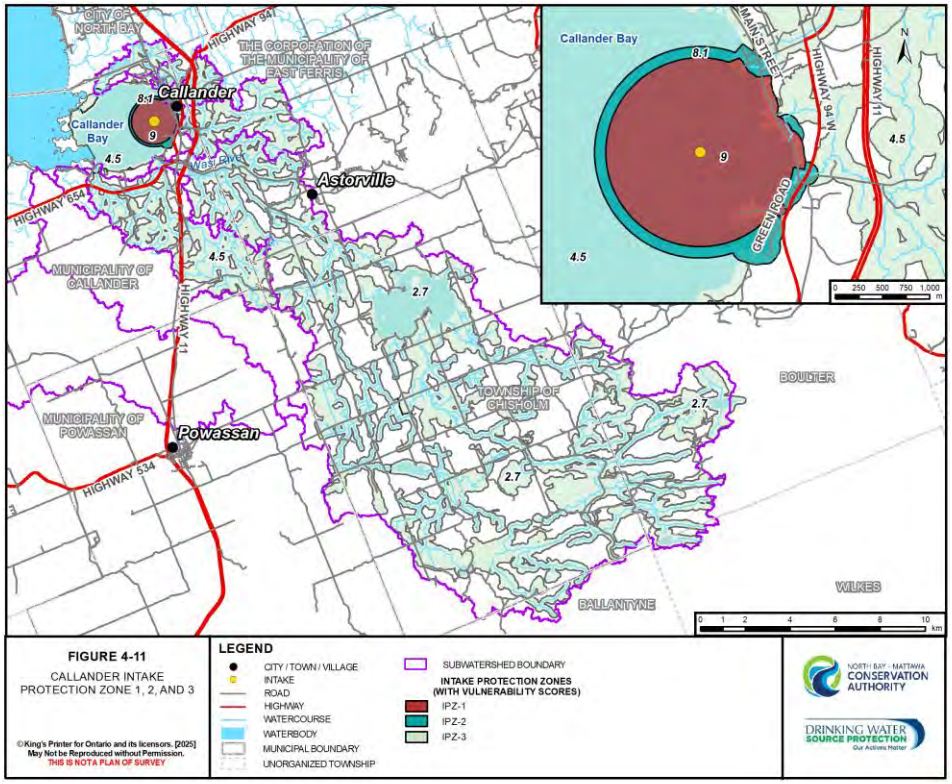
Intake Protection Zone 3 (IPZ-3) is intended to incorporate the area of each surface water body within the Source Protection Area for the Callander intake that could contribute water to the intake. Where these areas abut land, a 120 m setback is included. The IPZ-3 was extended to include the portion of the Callander sewer system that drains to Callander Bay outside of IPZ-2.

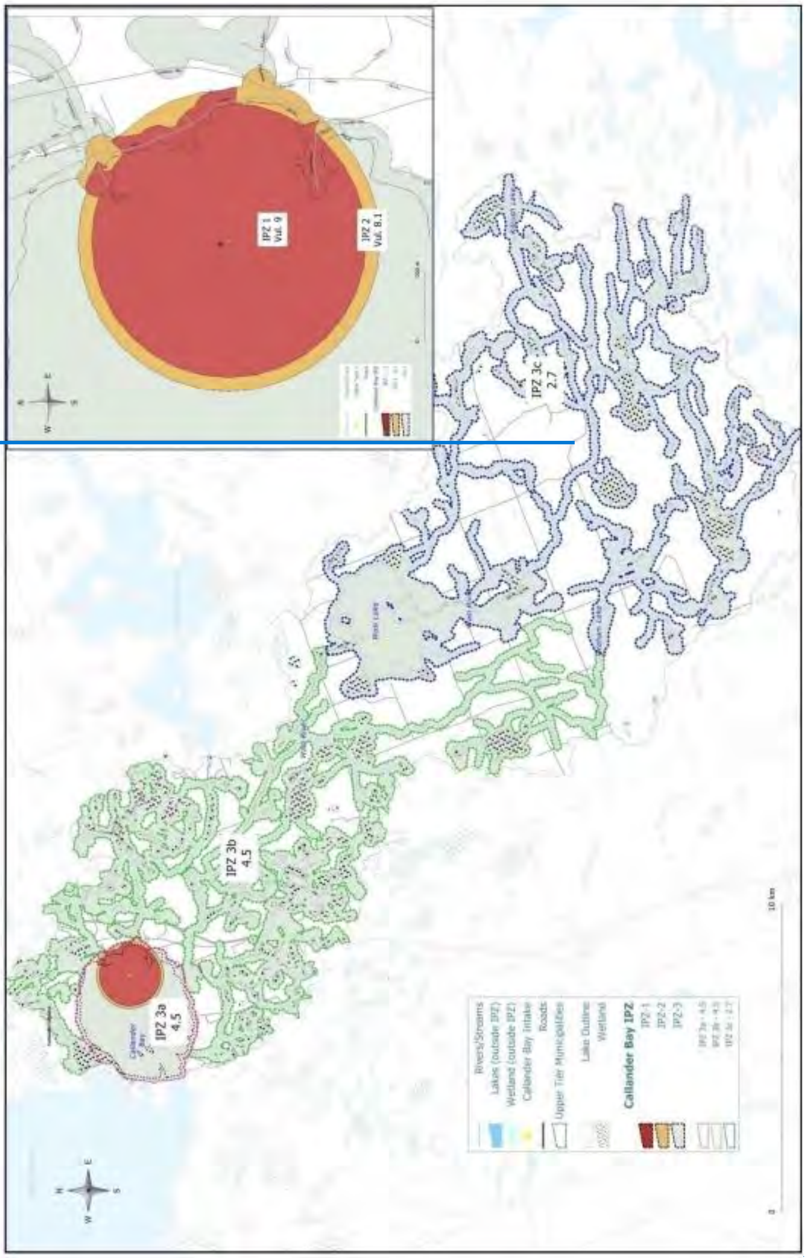
The Callander intake is classified as a Type D, inland water intake. As the Callander intake is located in Lake Nipissing, Rule 68 requires that IPZ-3 be delineated to include the area within each surface water body through which modelling or other methods demonstrate that contaminants released during an extreme event may be transported to the intake. However, based on an analysis of available data regarding measured flows during extreme wind events, the configuration of Callander Bay and distinct differences in water quality between the bay and the main body of the lake, application was made to the Director under Rule 15.1 to permit the use of Rule 70 rather than Rule 68 for the delineation of IPZ-3. Following review by the Ministry and their concurrence that potential for contaminants in the main body of the lake to reach the intake during an extreme storm event was very low, approval was granted by the Director on July 28, 2010 and a copy of same is included in Appendix E to this Assessment Report.

Transport pathways are natural or constructed drainage routes that have the potential to facilitate the movement of contaminants to the water intake. The Intake Protection Zones were surveyed to identify potential contaminant transport pathways. Several were identified and are described in Section 4.6.2.

For easy reference, Figure 4-11 below depicts the vulnerable areas for the Callander intake and their scores. A larger format is included in Appendix A of this report.

Figure 4-11. Callander Intake Protection Zone 1, 2 and 3





Note: larger 11" x 17" version of Figure 4-11 is available in Appendix A as Figure A-1.

4.4.2 Vulnerability Scoring

Vulnerability scores were used to assess the likelihood that a contaminant originating within the intake protection zones would reach the Callander intake. These scores were based on:

- the percentage of the area that is composed of land;
- land cover, soil type, permeability of the land, and the slope of setbacks;
- hydrological and hydrogeological conditions in the area that contribute water to transport pathways;
- depth of the intake from the surface;
- distance of the intake from land; and
- history of water quality concerns at the intake.

Vulnerability scores are calculated by multiplying the Source Vulnerability Factor by the Area Vulnerability Factor (Rule 87). Guidance for calculating these vulnerability factors is provided in Part VIII.2 and Part VIII.3 of the Technical Rules.

The Source Vulnerability Factor (SVF) is based on characteristics of the intake and ranges between 0.8 and 1.0. Scoring the SVF considers the following:

- depth of the intake from the surface of the water (deeper scores lower);
- distance of the intake from land (further from land scores lower); and
- history of drinking water concerns relating to the intake (no history of concerns scores lower).

The Callander Bay intake is assigned a Source Vulnerability Factor of 0.9. The following characteristics contribute to the vulnerability of the source:

- the intake is relatively shallow (~8 m deep) and the water of the bay mixes frequently over the open water season, thus allowing potential contaminants from surface waters to move to the depth of the intake; and
- there have been past instances of drinking water concerns related to the intake including seven drinking water issues identified under Rule 114.

The source vulnerability is moderated in Callander Bay because the intake is located relatively far from shore (the closest distance to land from the intake is ~0.7 km) and, while drinking water issues exist, these are all primarily the result of natural causes. The vulnerability scores for all IPZ are outlined in Table 4-5.

Area Vulnerability Factors (AVF) were assigned to the IPZs in accordance with Technical Rules 88-93. The area vulnerability is a fixed value of 10 for the IPZ-1. For the IPZ-2 and IPZ-3, the area vulnerability factors consider the following aspects:

- the percentage of area that is composed of land, where a greater land area increases vulnerability;
- land cover, soil type, permeability of the land, and the slope of any setbacks (attributes that reduce runoff reduce score);
- hydrological and hydrogeological conditions in the area that contribute water to the area through transport pathways (few transport pathways scores lower); and
- in respect of the IPZ-3, the proximity of the IPZ-3 area to the intake (increased distance scores lower).

The specific methodology for assigning area vulnerability factors for each of the surface water intakes is provided in Section 3.1.2. For each of the subzones, the Area Vulnerability Factor was calculated as the sum of individual scores (0, 1 or 2) assigned for each of the four aspects listed above. This procedure weighted all factors equally. The maximum aspect score that could be generated is 6 for the IPZ-2 (three aspects times maximum score of 2) and 8 for the IPZ-3 subzones (four aspects times maximum score of 2). The aspect score was then pro-rated to determine the AVF for each zone.

The IPZ-2 was assigned an AVF of 9 (possible range of 7 to 9, see Table 4-5) based on the following:

- land area consists primarily of urban and residential lands with a relatively high percentage of cleared area and impermeable surfaces (69%) that create high potential for runoff;
- the setback areas along the southwest shore of Callander Bay have steep slopes, enhancing water movement toward the bay; and
- there are several transport pathways that drain urban and residential lands facilitating the transport of potential contaminants to Callander Bay. These include the Green Road transport pathway, two stormwater outfalls that drain areas of the stormwater system and two intermittent creeks that drain areas of the Municipal yard.

Rule 90 allows for different Area Vulnerability Factors (AVF) to be assigned to different subzones within the IPZ-3, but these values must be lower than those of the IPZ-2, and so must range between 1 and 8 for this intake. The IPZ-3 was initially subdivided into 6 subzones, IPZ3a-f, based on differences in physical characteristics of each area including distance to the intake. Once the calculation of vulnerability scores revealed identical scores for subzones b, c, d, and e, the four subzones were consolidated into subzone IPZ-3b for this report. The breakdown of the scoring is provided in Table 4-5 and the rationale for the scoring follows.

Table 4-5. Callander Bay IPZ-2 and IPZ-3 Area Vulnerability Factors

Aspect	IPZ-2	IPZ-3a	IPZ-3b	IPZ-3c
% land area	1	0	1	1
Land cover, soils, permeability, slope of setbacks	2	1	0	0
Transport pathways	2	2	2	1
Proximity to the intake	NA	2	1	0
Total Aspect Score	5/6 = 83%	5/8 = 63%	4/8 =50%	2/8 = 25%
Possible AVF range	7 to 9	1 to 8	1 to 8	1 to 8
Area Vulnerability Factor (AVF) calculated as: (%Aspect score x difference between maximum and minimum AVF range) + minimum possible AVF value	**9** ((83% x 2) + 7)	**5** ((63% x 7) + 1)	**5** ((50% x 7) + 1)	**3** ((25% x 7) + 1)

Note: AVF value is rounded up to nearest whole number.

Subzone IPZ-3a includes the surface area of Callander Bay and the associated 120 m setbacks on land. The AVF for this subzone was calculated at 5. The area is comprised primarily of water, reducing vulnerability. There are numerous transport pathways draining land areas (stormwater outlets, stormwater pond drainage, the inlet of the lagoon discharge channel) and the area lies in close proximity to the intake. Both of these characteristics increase the vulnerability of the area. Land cover of the setback area is variable with some cleared areas with low density residential/cottage development, moderate amounts of impermeable surface area where roads are present, and some greatly sloping areas, particularly along the east shoreline south of the low lift station pump house. Therefore, this factor was assessed at 1 out of a possible range of 0 to 2.

Subzone IPZ-3b was assigned an AVF of 5. While this area comprises more land, and that increases vulnerability, it is considered less vulnerable than the IPZ-3a subzone, as the setbacks on land have less impermeable surfaces (<2%) and cleared area, and the subzones are more distant from the intake.

Subzone IPZ-3c encompasses the surface area of Wasi Lake and upstream waterbodies, and associated 120 m setbacks on land. This subzone was assigned a low Area Vulnerability Factor of 3. As with IPZ-3b, IPZ-3c is comprised of nearly equal amounts of land and water. Land cover in the subzone is primarily natural (89% forest and wetland). There is little impermeable area in the subzone and slopes within the setback are low. Vulnerability of this zone is greatly reduced due to its distance from the intake. Transport pathways were not identified in this zone, but given the agricultural land use in the subzone, there are likely constructed pathways that could increase vulnerability.

The resulting vulnerability scores for the vulnerable area of the Callander intake are summarized in Table 4-6 below and illustrated in Figure 4-11 above (a larger version of this figure is provided in Appendix A). Some changes were made to the IPZ delineation in 2023 using recent mapping updates: Conservation Authority's approximate regulated area; wetland mapping project; watercourse layer; replotting of subwatershed boundaries; and digital elevation model. Although there are many small, localized shifts in the delineation, the overall characteristics used to determine the area vulnerability factor did not change appreciable. The values shown in Table 4-5 are unchanged from the 2015 approved Assessment Report.

Potential locations for significant, moderate and low drinking water threats are presented in Table 4-6 of section 4.6.1. Low threats can occur in any area with a vulnerability score greater than 4; moderate threats can only occur in areas where the vulnerability score is 6 or greater; and significant threats can only occur in areas where the vulnerability is greater than or equal to 8.

Table 4-6. Vulnerability Scores (Vs) for the Callander Vulnerable Areas

Area	Source Vulnerability Factor	Area Vulnerability Factor	Vulnerability Score
IPZ-1	0.9	10	9.0
IPZ-2	0.9	9	8.1
IPZ-3a	0.9	5	4.5
IPZ-3b	0.9	5	4.5
IPZ-3c	0.9	3	2.7

The IPZ-3a, IPZ-3b, and IPZ-3c are shown in other tables and maps simply as IPZ-3 with different vulnerability scores shown as required.

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4.4.3 Uncertainty Analysis

Part I.4 of the Technical Rules requires that an uncertainty rating 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, including:

- distribution, variability, quality and relevance of data used in the preparation of the assessment report,
- ability of the methods and models used to accurately reflect the flow processes in the hydrological system,
- quality assurance and quality control procedures applied,

- extent and level of calibration and validation achieved for models used or calculations or general assessments completed, and
- accuracy to which the Area Vulnerability Factor and the Source Vulnerability Factor effectively assesses the relative vulnerability of the hydrological features.

In general, the distribution, variability, quality, and relevance of the data were adequate to confidently delineate the IPZs and assign vulnerability scores, resulting in an uncertainty rating of "low".

Geographical information available from the Ministry of Natural Resources provided the data necessary to identify waterbodies and watercourses to delineate watershed areas. This delineation was used to characterize setback areas for the vulnerability scoring. The position of the intake is accurate having been confirmed by divers.

A degree of uncertainty exists for the delineation of the IPZ-2 due to the lack of a recent hydrodynamic model to estimate time-of-travel in Callander Bay and two creeks (Burford Creek and Creek 323). The vulnerability assessment that was used measured current information from a 1993 study and based time-of-travel calculations on maximum observed velocities in October of that year assuming constant current direction toward the intake. This method of calculating time-of-travel is conservative based on the available data, but is unable to provide confident time-of-travel estimates under storm conditions (such as a 20-year storm event). Despite this uncertainty, time-of-travel estimates derived using the 1993 data are consistent with time-of-travel estimates using general limnological principles for maximum surface water current speeds, lending confidence to the calculations for the Callander intake.

Some uncertainty exists for the delineation of the IPZ-2 as there were no known available flow or modelling data to calculate flow velocities in Burford Creek or Creek 323 at the time of the study. The IPZ-2 was extended upstream of these creeks to capture a two-hour time-of-travel under the flow velocity for a 100-year flood event of 0.5 m/s. The flow velocity was based on the rate determined for the nearby Wasi River in the Wasi River Management Study (A. J. Robinson and Associates, Inc., 1986). More recently, discharge measurements were taken for Burford Creek between 2009 and 2016. Of the 56 discharge measurements, most were taken between May and September, and none were taken in April during the spring freshet when flow is greatest. The values obtained were: min discharge 0.005 m^3/s, median discharge 0.027 m^3/s, mean discharge 0.063 m^3/s, and max discharge 0.470 m^3/s.

A low level of uncertainty exists for the vulnerability scoring of the IPZ-3. Transport pathways were not identified by site investigations for this large area. However, given the great distance of the IPZ-3 to the intake, the existence of transport pathways in this vulnerable area would not significantly influence the vulnerability scoring of this zone.

While there is some uncertainty in the IPZ-2 delineation and vulnerability scoring for IPZ-3, as described above, this uncertainty is considered to be low and additional data to reduce the uncertainty would not likely result in significant changes to the delineations or the vulnerability scores. In summary, an overall ‘low’ uncertainty is given to all of the IPZ delineations and the associated vulnerability scores.

4.5 Issues Identification

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

- 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
- there is an increasing trend of the parameter that would result in the deterioration of water quality for use as drinking water.

Listed parameters are those included in Schedule 1, 2 or 3 of the Ontario Drinking Water Quality Standards.

The analysis of raw water quality was based on:

- a single sampling date (March 28, 2001);
- available Monthly Process Reports for colour, turbidity, pH, and iron (2000-2002, 2006-2007 (January to July));
- DWIS data for *E. coli* (2005, 2006) and total coliform (2003-2004).

Information pre-dating 2001 was obtained from the Engineers' Report for Water Works by RAL Engineering Limited (2001).

Based on a detailed assessment of raw and treated water quality records from the Callander Water Treatment Plant (WTP) and an evaluation of potential cyanotoxin production in Callander Bay, seven listed parameters were identified as drinking water issues as per Rule 114 under clause 15(2)(f) of the *Clean Water Act (2006)* in accordance with Rule 115 (Table 4-7). With the exception of *E. coli*, these are also considered as drinking water issues in respect of drinking water systems not mentioned in clause 15(2)(e) of the *Clean Water Act* that draw water from Callander Bay (Rule 114 (3)).

It should be noted that, with the exception of turbidity, none of the listed drinking water issues in the source water exceeded applicable guidelines in treated water (note that microcystin has not been measured in treated water). This suggests that the water treatment plant has effectively treated these parameters at the concentrations at which they occur in raw water. There are presently insufficient long-term data, however, to assess whether there is an increasing trend in any of these parameters that may affect the ability of the plant to treat them. The determination of drinking water issues should consider treatment capabilities of the plant. These parameters should continue to be monitored for any significant increase in concentrations that would affect treatment capability and indicate potential reassessment of these parameters as listed drinking water issues.

Table 4-7. List of Drinking Water Issues for the Callander Drinking Water Supply

Issue	Water Source
Turbidity	Treated and Raw
Aluminium	Raw
Colour	Raw
Organic Nitrogen	Raw
E. coli	Raw
Iron	Raw
Microcystin	Raw*

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Note: * Based on documented bloom activity dominated by toxin-producing cyanobacteria taxa

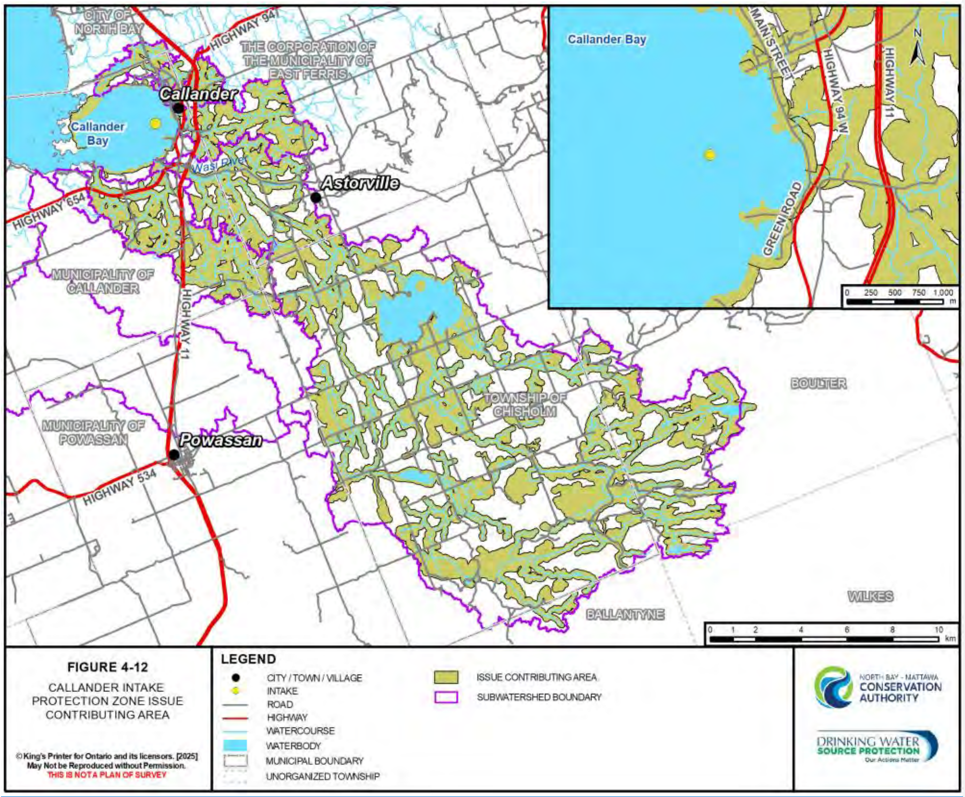
All of the drinking water issues with the exception of microcystin LR were considered to be primarily a result of natural causes. A further description of these issues under Rule 115 (identification of an issue contributing area and drinking water threats that contribute or may contribute to the issue) is not required as this rule only applies to drinking water issues that result or partially result from anthropogenic, not natural, causes.

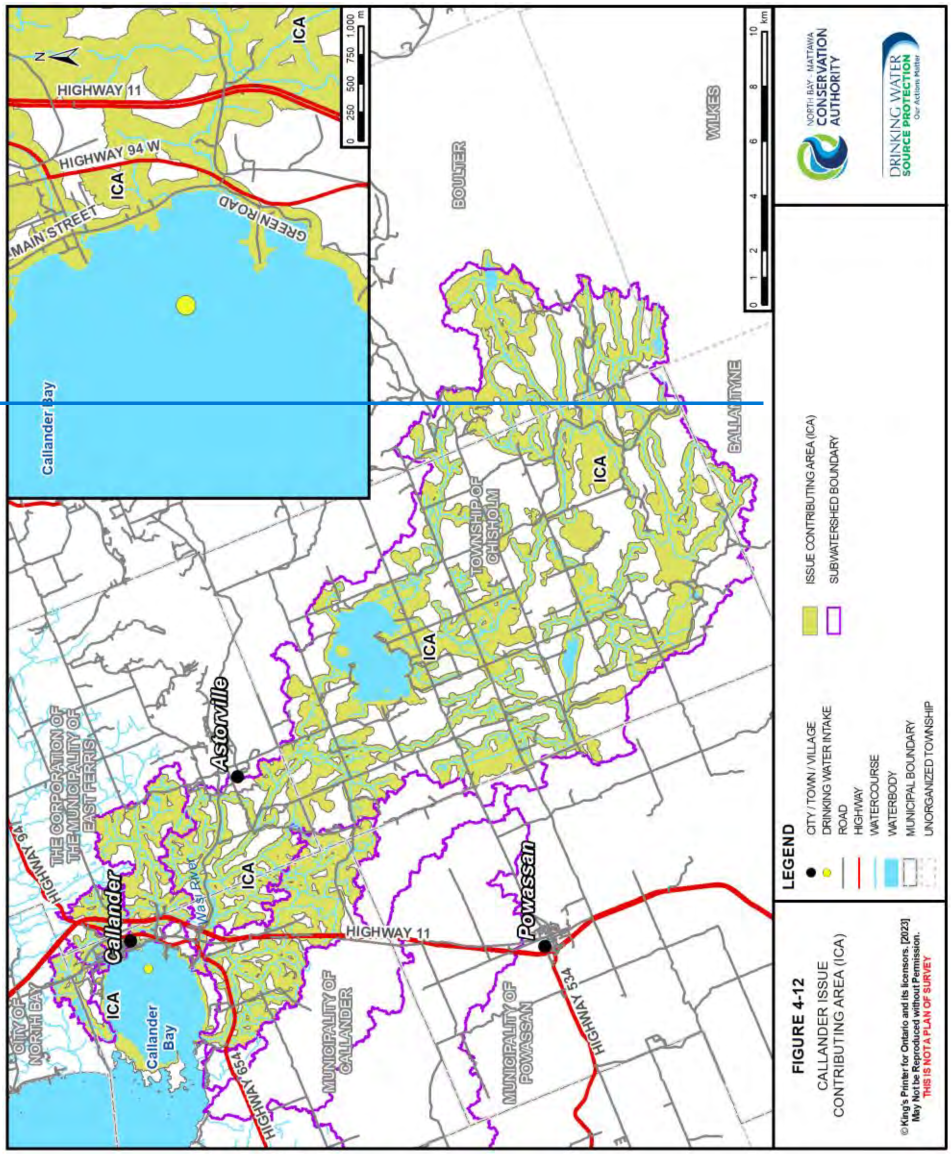
Microcystin-producing cyanobacteria are likely naturally occurring in Callander Bay. However, anthropogenic sources of phosphorus to the bay are probably contributing to cyanobacterial production and the recent bloom activity (see Section 4.3). Identification of an issue contributing area and drinking water threats that contribute or may contribute to microcystin production are therefore required under Rule 115.

Activities, conditions resulting from past activities and naturally occurring conditions may all contribute to the phosphorus concentration in Callander Bay. A detailed phosphorus budget was completed in 2011 to assess human sources of phosphorus in the Callander Bay watershed and to evaluate the appropriateness of the Issue Contributing Area (~~IPZ~~ ICA) for phosphorus. The phosphorus budget concluded that the Issue Contributing Area captures the primary sources of phosphorus to Callander Bay from human activities and recommended that the Issue Contributing Area ~~(ICA)~~ remain as defined in the Technical Study. In 2022, the Source Protection Committee reviewed information about the movement of phosphorus and concluded that the Issue Contributing Area should continue to be delineated as the entire Intake Protection Zone for the Callander municipal drinking water supply. A recent update to the background map layers, such as wetlands, did result in changes to the mapped extent of the Callander ~~IPZ~~ ICA. The area of the ~~IPZ~~ ICA changed from a total of 149.13 km^2 in 2015 to a total of 172.77 km^2 in 2022. Figure 4-12 shows the extent of the Callander Issue Contributing Area.

Drinking water threats that contribute or may contribute to phosphorus concentration in Callander Bay in accordance with Technical Rules 118, 119 and 126 are described in Section 4.6.2.

Figure 4-12. Callander Issue Contributing Area (IPZ-ICA)





Note: larger 11" x 17" version of Figure 4-12 is available in Appendix A as Figure A-2.

4.6 Threats Identification and Assessment

Threats are defined as those activities or conditions that could cause contamination of drinking water by a chemical or pathogen within one of the three Intake Protection Zones (IPZs). Activities must be assessed and reported whether or not they currently occur within the vulnerable areas. O.Reg. 287/07 Section 1.1 (1) under the *Clean Water Act (2006)* lists 20 activities (see Table 3-1) that may result in threats to drinking water quality. (Two additional prescribed activities pose threats to water quantity.)

Conditions, as defined by Part XI.3 of the Technical Rules, refer to past activities that have produced contaminants that may result in significant drinking water threats. A more detailed definition can be found in the discussion under section 3.1.5 above.

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

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

Further, it is required that areas be identified where activities and/or conditions are or would be significant, moderate or low threats. To interpret how the vulnerability of an area relates to the potential for threats, readers first must consult the map (Figure 4-11) to determine the vulnerability score of the area of interest, and then check the table (Table 4-8) to see what levels of threats could occur based on that vulnerability score. Then, if more information is desired with respect to the specific nature of activities of concern and how they pose a threat, that information can be found through the Tables of Circumstances.

4.6.1 Threats Approach

There were two approaches used to identifying threats; the *threats approach*, which is based on the vulnerability scores of the vulnerable areas, and the *issues approach*, which is based on activities or conditions that contribute to existing drinking water issues listed under Rule 114. A third approach, the *events-based approach*, is based on modelling that demonstrates a chemical or pathogen release from an activity that could result in the deterioration of source drinking water. This approach was not used in the identification of threats.

Part XI.4 of the Technical Rules describes the methods for identifying significant, moderate and low drinking water threats related to activities in the vulnerable area of a drinking water intake.

A threat is deemed significant, moderate or low depending on:

1. the vulnerable area in which the activity occurs or would occur;
2. the vulnerability score of the vulnerable area; and
3. a set of prescribed activities and corresponding circumstances that constitute a threat

The Technical Rules require activities that would be a significant, moderate or low drinking water threat within the vulnerable areas to be listed in the Assessment Report, *regardless of whether or not the activities presently exist in the vulnerable area*.

Lists of significant, moderate and low drinking water threats related to chemicals and pathogens were compiled for each of the vulnerable areas of the Callander drinking water intake based on the MECP Tables of Drinking Water Quality Threats (MECP ~~2018~~2021).

Threats Approach - Potential Activities and Circumstances

Based on the resulting vulnerability scores the possible threat levels for Callander (Table 4-8) were identified for each of the vulnerable areas shown in Figure 4-11. Due to the vulnerability scores within the IPZs, only IPZ-1 and IPZ-2 may contain potential significant chemical or pathogen threats. Other vulnerable areas score below the threshold of 8 and no significant threats are listed in the Table of Drinking Water Quality Threats.

Table 4-8. Areas within Callander Intake Protection Zone where Activities are or would be Significant, Moderate and Low Drinking Water Threats

Threat Type	Vulnerable Area	Vulnerability Score	Threat Level Possible		
			Significant	Moderate	Low
Chemical	IPZ-1	9	✓	✓	✓
	IPZ-2	8.1	✓	✓	✓
	IPZ-3~~a~~	4.5			✓
	~~IPZ-3b~~	~~4.5~~			~~✓~~
	IPZ-3~~c~~	2.7			
Pathogen	IPZ-1	9	✓	✓	✓
	IPZ-2	8.1	✓	✓	✓
	IPZ-3~~a~~	4.5			✓
	~~IPZ-3b~~	~~4.5~~			~~✓~~
	IPZ-~~3c~~	2.7			

The Technical Rules Part XII - Tables of Drinking Water Quality Threats (MECP ~~2018~~2021) provide the detailed sets of circumstances for identifying if an activity meets the criteria for a significant, moderate or low drinking water threat. The Threats Tables can be downloaded from the MECP

webpage (https://www.ontario.ca/page/2021-technical-rules-under-clean-water-act)(Ontario.ca/page/source-protection) in an Excel file format..
An on-line searchable version of the Threats Tables can be accessed at swpip.ca. The on-line version Excel file of the Threats Tables can be filtered to outline the specific circumstances related to potential chemical or pathogen threats. After the file is downloaded andwebpage is opened, click on the "DataSearch" menu tab and then "FilterZone and Score". By applying the filter values in sequence, as shown in Table 4-7 below, it is possible to narrow the results to those activities considered at a threat level within the particular vulnerable area and vulnerability score.

Table 4-9. Summary of Circumstances in the Provincial Threats Tables Related to Callander IPZ

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Vulnerable Area	Vulnerability Score	Risk	Parameter of Concern	# of Sets of Circumstances
IPZ-1	9	Significant	Chemical	58
IPZ-1	9	Moderate	Chemical	138
IPZ-1	9	Low	Chemical	41
IPZ-2	8.1	Significant	Chemical	9
IPZ-2	8.1	Moderate	Chemical	145
IPZ-2	8.1	Low	Chemical	77
IPZ-3	4.5	Low	Chemical	58
IPZ-3	2.7	Low	Chemical	0
IPZ-1	9	Significant	Pathogen	16
IPZ-1	9	Moderate	Pathogen	11
IPZ-1	9	Low	Pathogen	2
IPZ-2	8.1	Significant	Pathogen	14
IPZ-2	8.1	Moderate	Pathogen	8
IPZ-2	8.1	Low	Pathogen	7
IPZ-3	4.5	Low	Pathogen	16
IPZ-3	2.7	Low	Pathogen	0

Note: n/a indicates there are no matching circumstances where an activity is considered a drinking water threat

There are 16 17 prescribed activities that are or would be significant drinking water threats if they occurred in the Callander Intake Protection Zone. A breakdown of the prescribed activities and the number of circumstances under which those activities would be significant is provided in Table 4-10.

Vulnerable Area	Vulnerability Score	Threat Level Possible		
		Significant	Moderate	Low
IPZ-1	9	CIPZWE9S PIPZWE9S	CIPZWE9M PIPZWE9M	CIPZWE9L PIPZWE9L
IPZ-2	8.1	CIPZWE8.1S PIPZWE8.1S	CIPZWE8.1M PIPZWE8.1M	CIPZWE8.1L PIPZWE8.1L
IPZ-3a	4.5	NA NA	NA NA	CIPZWE4.5L PIPZWE4.5L
IPZ-3b	4.5	NA NA	NA NA	CIPZWE4.5L PIPZWE4.5L
IPZ-3c	2.7	NA	NA	NA

Note: NA indicates that there are no threats of that level using the threats approach.

Activity Prescribed To be a Threat	IPZ-1	IPZ-2	IPZ-3b	Circumstance Reference #
	Vs=9	Vs=8.1	Vs=4.5	
	L	L		656
	L	L		657
	L			658
	L	L		660
	L	L		661
	L	L		662
	L	L		663
establishment, operation or maintenance of a system that collects, stores, transmits, treats or disposes of sewage	L	L		664
	L	L		665
	L			666
	L	L		667
	L			668
	L	L		695
	L	L		696
	L	L		697
	L	L		698
	L	L		699
	L	L		700
	L	L		701
	M	L		702
	L	L		703
establishment, operation or maintenance of a system that collects, stores, transmits, treats or disposes of sewage	M	L		704
	M	L		705
	M	L		706
handling and storage of a pesticide			L	73
application of road salt	M	M		92
	M	M		93
				90
				91
handling and storage of road salt		L		1435
		L		1436

Activity Prescribed To be a Threat	IPZ-1 Vs=9	IPZ-2 Vs=8.1	IPZ-3b Vs=4.5	Circumstance Reference #
handling and storage of fuel		L (2)		1364
		L (2)		1365
		L (2)		1366
		L (2)		1367
		L (2)		1368
		L (2)		152
		L (2)		153
		L (2)		154
		L (2)		155
		L (2)		156
	M (4)	L (2)		1349
	L (4)	L (2)		1350
	L (4)	L (2)		1351
	L (4)	L (2)		1352
	L (4)	L (2)		1353
	M (4)	L (2)		152
	L (4)	L (2)		153
	L (4)	L (2)		154
	L (4)	L (2)		155
	L (4)	L (2)		156
establishment, operation or maintenance of a system that collects, stores, transmits, treats or disposes of sewage				1949
	M (67)	M (43)		1956
	M	M		1958
			L	1959

Notes: Circumstance Reference Numbers refer to those provided in Table 1 or Table 2 of the Tables of Drinking Water Threats. Vs refers to vulnerability score; numbers in brackets refer to the number of occurrences of the threat if greater than 1

Table 4-10. Enumeration of Circumstances under which Prescribed Activities are or would be Significant Threats in the Vulnerable Area of the Callander Drinking Water Intake

Activities Prescribed to be Drinking Water Threats	Chemical	Pathogen
The establishment, operation or maintenance of a waste disposal site within the meaning of Part V of the Environmental Protection Act	15	4
The establishment, operation or maintenance of a system that collects, stores, transmits, treats or disposes of sewage	11	5
The application of agricultural source material to land	3	1
The storage of agricultural source material	3	2
The application of non-agricultural source material to land	3	1

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Activities Prescribed to be Drinking Water Threats	Chemical	Pathogen
The handling and storage of non-agricultural source material.	2	1
The application of commercial fertilizer to land	3	0
The application of pesticide to land	2	0
The handling and storage of pesticide.	1	0
The application of road salt.	1	0
The handling and storage of road salt.	1	0
The storage of snow	4	0
The handling and storage of fuel	2	0
The handling and storage of a dense non-aqueous phase liquid	2	0
The management of runoff that contains chemicals used in the de-icing of aircraft	1	0
The use of land as livestock grazing or pasturing land, an outdoor confinement area or a farm-animal yard	2	2
The establishment and operation of a liquid hydrocarbon pipeline.	2	0
Number of circumstances under which the threat is or would be significant	**58**	**16**

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Activities Prescribed to be Drinking Water Threats	# of Significant Threat Circumstances	
	Chemical	Pathogen
The application of agricultural source material to land.	6	1
The application of commercial fertilizer to land.	6	
The application of non-agricultural source material to land.	6	1
The application of pesticide to land.	11	
The establishment, operation or maintenance of a system that collects, stores, transmits, treats or disposes of sewage.	172	5
The establishment, operation or maintenance of a waste disposal site within the meaning of Part V of the Environmental Protection Act.	20	1
The handling and storage of non-agricultural source material.	6	1
The handling and storage of pesticide.	2	
The handling and storage of road salt.	2	
The management of runoff that contains chemicals used in the de-icing of aircraft.	2	
The storage of agricultural source material.	6	2
The storage of snow.	8	
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.	4	2
Number of circumstances under which the threat is or would be significant	**253**	**13**

Threats Approach - Existing Significant, Moderate and Low Threats

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Specific threats relating to drinking water within vulnerable areas for the Callander intake were identified primarily using a desktop research approach, which included review of data from the following sources of information:

- Occurrence Reporting Information System (ORIS)
- National Pollutant Release Inventory (NPRI)
- Technical Standards & Safety Authority (TSSA) (data provided by the Ministry of the Environment)
- Hazardous Waste Information System (HWIS)
- Federal Contaminated Sites Inventory (FCSI)
- Lands Information Ontario (LIO) (e.g., land cover, permeability)
- North Himsworth ~~Waste Water~~Wastewater Treatment annual reports
- Discussions with the Technical Advisory Committee

In addition, the presence of several threats was confirmed during field investigations (July 2007; May 2008; February 2010) and by telephone inquiries to the Municipality of Callander and numerous local businesses.

Based on a review of the above information and several site investigations, numerous occurrences related to six prescribed drinking water threat activities were confirmed to exist in the vulnerable areas of the Callander drinking water intake (Table 4-11). [Drinking water threats as prescribed in Paragraphs 1 through 18 and paragraphs 21 to 22 subsection 1.1(1) of O.Reg. 287/07 (General)]

Each occurrence of an activity prescribed to be a drinking water threat was evaluated as significant, moderate or low based on the circumstances of that occurrence and using the MECP Tables of Drinking Water Threats (MECP ~~2018~~2021).

Based on this evaluation and using the "threats approach" to identifying threats, there are no existing significant drinking water threats in the vulnerable area of the Callander drinking water intake.

There are several occurrences of activities that have circumstances which cause them to be moderate or low threats (Table 4-11). No significant, moderate or low threats presently exist in subzones IPZ-3a and IPZ-3c.

Table 4-11. Existing Moderate (M) and Low (L) Threats in the Vulnerable Area of the Callander Drinking Water Intake

Activity Prescribed to be a Threat	IPZ-1	IPZ-2	IPZ-3b	Circumstance Reference # and type
	Vs=9	Vs=8.1	Vs=4.5	
The establishment, operation or maintenance of a system that collects, stores, transmits, treats or disposes of sewage.	ML	L		C2.2.3(Chemical)1742 (Chemical)
	L	LL		C2.2.4 (Chemical)1747 (Chemical)
	L (1)M (67)	L (1)		C2.5.3(Chemical)77 (Pathogen)
	M (67)	M (43)M (43)		P2.2.1 (Pathogen)78 (Pathogen)
	M (1)M	M (1)		P2.5.1 (Pathogen)506 (Chemical)
	L		L (1)	P2.8.1 (Pathogen)1732 (Chemical)
		L		1737(Chemical)
The establishment, operation or maintenance of a system that collects, stores, transmits, treats or disposes of sewage.	L (1)			1767 (Chemical)
		L (1)		1769 (Chemical)
	M (1)			74 (Pathogen)
		M (1)		75 (Pathogen)
			L (1)	180 (Pathogen)
The application of a pesticide to land			L (1)	1616 C10.1.2 (Chemical)
The handling and storage of fuel.	M (4)	M (2)		942 C15.1.7(Chemical) 1008 (Chemical)
		M (2)M (2)		C15.1.8(Chemical)944 (Chemical) 1010 (Chemical)
		L (2)		2785 (Chemical) 2945 (Chemical)

Activity Prescribed to be a Threat	IPZ-1	IPZ-2	IPZ-3b	Circumstance Reference # and type
	Vs=9	Vs=8.1	Vs=4.5	
The application of road salt	M (1)	M (2)		458 C12.1.2 (Chemical)
	M (1)	M (1)		462 C12.1.3 (Chemical)
		M (1)		464 (Chemical)
The handling and storage of road salt	M (3)	M (10)L (1)		C13.2.3 (Chemical)3277 (Chemical)
		L (1)		C13.3.2 (Chemical)

Note: * Occurrences in columns with bold boxes represent one parcel with multiple circumstances.
Vs = vulnerability score; S = Significant threat; M = Moderate threat; L = Low threat

All existing and potential significant drinking water threats are required to be addressed with mandatory compliance policies in the source protection plan. As previously stated, there are currently no significant drinking water threats for the Callander intake other than those related to the microcystin issue.

4.6.2 Issues Approach to Threat Identification

In addition to the above noted threats related to activities, Rule 115 requires that threats be listed for those drinking water issues listed under Rule 114 that result from, or partially result from, human activities (anthropogenic).

Microcystin is a toxin which is sometimes produced by certain species of cyanobacteria (blue-green algae) and is listed as a parameter in the Ontario Drinking Water Quality Standards. Therefore, if it occurs in excess of the maximum acceptable level, it constitutes a drinking water issue. The fact that there have been several recorded incidents of toxic cyanobacteria blooms in Callander Bay is adequate evidence of exceedances of microcystin. Phosphorus contributes to the production of cyanobacteria. Therefore, any activity that occurs in the Issue Contributing Area (Figure 4-13) which can result in the input of phosphorus to Callander Bay is considered a threat. Moreover, these threats are automatically considered to be significant threats regardless of the vulnerability scores of the vulnerable areas.

The activities that could contribute phosphorus to Callander Bay, as well as the number of circumstances related to those activities that constitute a significant threat, are listed in Table 4-12. Details of circumstances are presented in Appendix F.

Table 4-12. Enumeration of Circumstances that are or would be Significant Drinking Water Threats Related to Prescribed Activities that Contribute Phosphorus to Callander Bay

Activity (Related to Phosphorus Loading)	# of Significant Threat Circumstances
The application of agricultural source material to land.	9
The application of commercial fertilizer to land.	9
The application of non-agricultural source material to land.	9
The establishment, operation or maintenance of a system that collects, stores, transmits, treats or disposes of sewage.	~~27~~53
The establishment, operation or maintenance of a waste disposal site.	73
The handling and storage of commercial fertilizer.	~~8~~1
The handling and storage of non-agricultural source material.	~~12~~8
The storage of agricultural source material.	11~~2~~
The use of land as livestock grazing or pasturing land, an outdoor confinement area or a farm-animal yard.	6
Total	**~~99~~179**

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Issues Approach - Activities and Circumstances

As listed in Table 4-13 below, there are existing occurrences of five activities (out of nine listed in Table 4-12) that are Prescribed Drinking Water Threats related to phosphorus in the Issue Contributing Area (equal to the vulnerable area of the Callander intake) for microcystin. As anthropogenic sources of phosphorus contribute to cyanobacteria production and hence microcystin production, these threats are considered to be significant drinking water threats regardless of the vulnerability scores.

The existing significant threats related to phosphorus and the number of occurrences of those threats are listed in Table 4-13 and explained further in Table 4-14. The locations of significant threats within the Callander Issue Contributing Area are provided in Figure 4-12. Note that in Table 4-13 the total number of occurrences is summarized based on the prescribed drinking water threat, while Table 4-14 separates the number of occurrences by threat subcategory.

Information on the existing septic systems within the Callander subwatershed was derived from an in-house database. This data is comprised of permits issued by NBMCA and formerly by MECP originally provided by MECP, and is used for the Sewage/Septic program as well as Drinking Water Source Protection at NBMCA.

Parcels with agricultural activity were determined through site investigations conducted during the summer of 2013 to reflect current conditions. There was a great degree of uncertainty in a previous 2011 assessment, which used Municipal Property Assessment Corporation (MPAC) data. The available MPAC data at the time of the assessment was outdated and did not necessarily reflect current conditions of the area. It was deemed necessary to undertake site investigations to improve upon the dataset.

Table 4-13. Enumeration of Significant Threats Related to Phosphorus and Contributing to the Issue, Microcystin

Prescribed Drinking Water Threat	IPZ	Number of Occurrences
The establishment, operation or maintenance of a system that collects, stores, transmits, treats or disposes of sewage.	IPZ-1	~~39~~32
	IPZ-2	~~4~~10
	IPZ-3~~a~~	~~684~~7718
	~~IPZ-3b~~	~~295~~449
	~~IPZ-3c~~	~~189~~222
The application of agricultural source material to land.	IPZ-3	44
The storage of agricultural source material.	IPZ-3	6
The application of commercial fertilizer to land.	IPZ-3	16
Handling and storage of commercial fertilizer	IPZ-2	4
	IPZ-3	16
The use of land as livestock grazing or pasturing land, an outdoor confinement area or a farm-animal yard.	IPZ-3	~~44~~50
TOTAL		~~705~~896

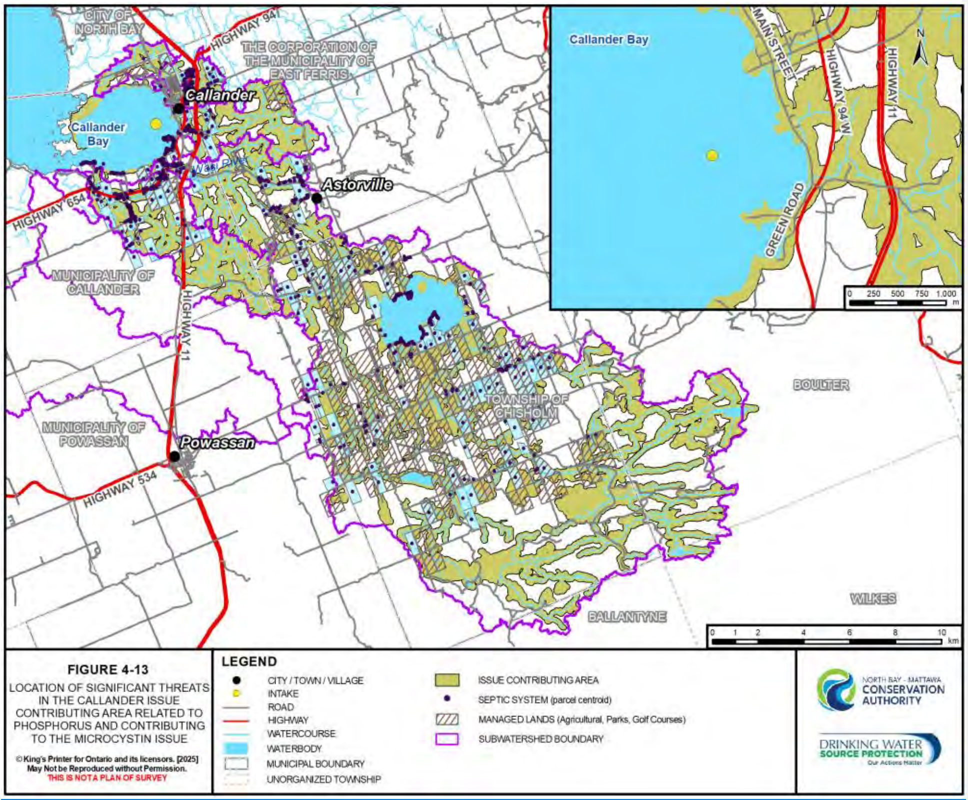
Table 4-14. Existing Significant Drinking Water Threats Related to Phosphorus and Contributing to the Drinking Water Issue, Microcystin

Prescribed Drinking Water Threat	Threat Subcategory	Quantity Circumstance	Chemical Circumstance	# of Occurrences
The establishment, operation or maintenance of a system that collects, stores, transmits, treats or disposes of sewage.	2.2 Onsite sewage works~~Septic system~~	~~Septic system that is subject to the Building Co~~The system is subject to the Ontario Building Code Act, 1992, or the system is a sewage works within the meaning of the Ontario Water Resources Act. ~~de~~	The system is an earth pit privy, privy vault, greywater system, cesspool, or a leaching bed system and its associated treatment unit.~~Sewage system that is defined in Section 8.1.2.1 of O.Reg. 350, except a holding tank, that may discharge to groundwater or surface water~~, or the system requires or uses a holding tank for the retention of hauled sewage.~~.~~	~~589~~755 (~~37~~ 31 in IPZ-1, ~~3~~ 9 in IPZ-2, ~~66~~ 45715 in IPZ-~~3a, 294~~ 448 ~~in IPZ-3b, 189~~ 222 ~~in IPZ-3c~~)
	2.3 Storm Water Management Facilities and Drainage Systems: Outfall~~Sewage System or Sewage Works - Stormwater Management Facility (including storm sewers)~~	~~Where the drainage area is 1 to < 10 ha and the predominant land use is rural, agricultural, or low density residential~~Any quantity	A storm water management facility outfall or a storm water drainage system outfall~~The system is a storm water management facility designed to discharge storm water to groundwater or surface water.~~	2 in IPZ-3~~a~~

Prescribed Drinking Water Threat	Threat Subcategory	Quantity Circumstance	Chemical Circumstance	# of Occurrences
	2.5 Wastewater collection facilities and associated parts: Sanitary sewers~~Sanitary Sewers and related wastewater collection systems~~	~~Sanitary sewer with a conveyance of >1,000 - 10,000~~> 250 m^3/day~~d~~	A gravity sanitary sewer, forcemain or rising main that forms part of a wastewater collection facility, not including its appurtenances.~~The system is part of a wastewater collection facility moving human waste, but does not include a sewage storage tank or a designed bypass.~~	2 (1 in IPZ-1, 1 in IPZ-2)
	2.8.1 - 2.8.5 Wastewater Treatment Facilities and Associated Parts: final effluent outfall or a sewage treatment plant overflow outfall~~Sewage treatment plant effluent discharges (includes lagoons)~~	Sewage Treatment Plants that discharge treated effluent > 2,500 m3/d or < 17,500 m3/d on an annual average	The system is a wastewater treatment facility that discharges directly to land or surface water through a means other than a designed bypass.	1 in IPZ-3~~b~~
	~~Sewage holding tank~~	~~Septic System holding tank is subject to the OWRA~~	~~The system requires or uses a holding tank for the retention of hauled sewage at the site where it is produced before its collection by a hauled sewage system.~~	~~1 in IPZ-1~~
The application of agricultural source material to land.	3.1 Application of Agricultural Source Material (ASM) to land~~Application Of Agricultural Source Material (ASM) To Land~~	~~Dependent upon % managed lands and NU/acre of managed lands~~Any quantity	The agricultural source material is applied to land~~Land application of agricultural source material~~	44 in IPZ-3

Prescribed Drinking Water Threat	Threat Subcategory	Quantity Circumstance	Chemical Circumstance	# of Occurrences
The storage of agricultural source material.	4.1 Storage of Agricultural Source Material (ASM)~~Storage Of Agricultural Source Material (ASM)~~	~~Dependent upon the weight or volume of manure stored annually on a Farm Unit~~Any quantity	The agricultural source material is stored ~~partially below grade, or at or above grade,~~ in a ~~structure that is a~~ permanent nutrient storage facility or temporary field nutrient storage site as defined under the *Nutrient Management Act* (O.Reg 267).	6 possible in IPZ-3
The application of commercial fertilizer to land.	8.1 Application of commercial fertilizer to land~~Application Of Commercial Fertilizer To Land~~	~~Dependent upon % managed lands and NU/acre of managed lands~~Any quantity	Commercial fertilizer is applied to land. ~~and may result in a release to groundwater or surface water~~	16 in IPZ-3
The handling and storage of commercial fertilizer to land	9.1 Handling and storage of commercial fertilizer	Any quantity	Storage of commercial fertilizer on a site.	20 (4 in IPZ-2 16 in IPZ-3)
The use of land as livestock grazing or pasturing land, an outdoor confinement area or a farm-animal yard.	~~21.1~~21.1 Agricultural source material (ASM) generation - livestock grazing or pasturing	~~Dependent upon NU/acre~~Any quantity	The use of land as livestock grazing or pasturing land~~, where agricultural source material may be generated, and may result in a release to land or water~~.	44 in IPZ-3
	~~21.2~~21.2 Agricultural source material (ASM) generation - outdoor confinement area (OCA) or farm animal yard	Any quantity	The use of land as an outdoor confinement area or a farm-animal yard.	6 in IPZ-3

Figure 4-13. Location of Significant Threats in the Callander Issue Contributing Area (IPZ-ICA) Related to Phosphorus and Contributing to the Microcystin Issue



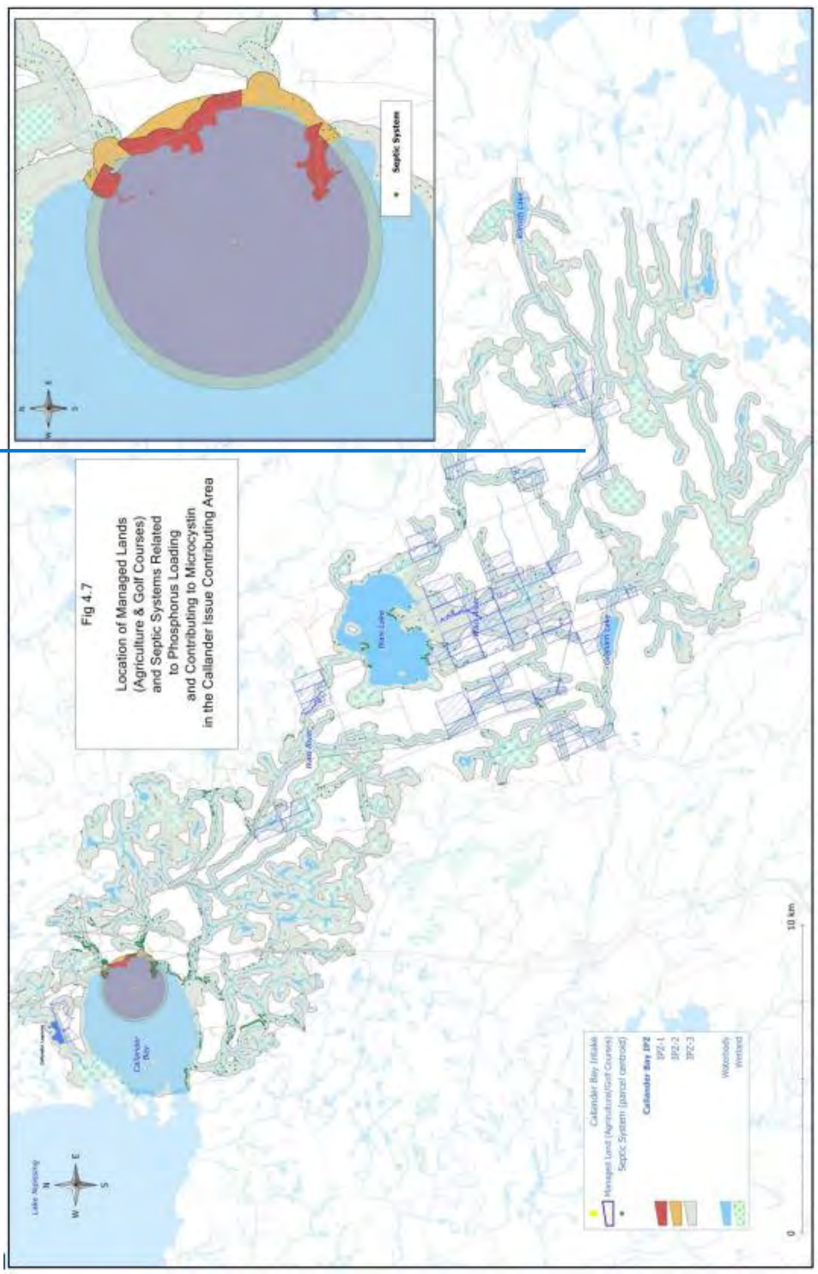


Fig 4.7
Location of Managed Lands (Agriculture & Golf Courses) and Septic Systems Related to Phosphorus Loading and Contributing to Microcystin in the Callander Issue Contributing Area

4.6.3 Conditions

There are presently no known conditions that exist in the vulnerable areas of the Callander intake.

Despite this, further evaluation of anthropogenic sources of phosphorus in sediments of Callander Bay is warranted as it relates phosphorus loading to the bay and its potential to contribute to microcystin-producing cyanobacteria. Phosphorus in lake sediments is not a listed parameter in Table 1 of the Soil, Ground Water and Sediments Standards and, therefore, is not considered a condition contributing to cyanobacteria biomass and the production of microcystin under the Technical Rules. As described in Section 4.3, however, phosphorus contained in sediments of Callander Bay may in fact contribute to internal phosphorus loading and this loading may represent a large portion of the total phosphorous load to the bay. If the results of a nutrient budget confirm that internal phosphorus loading is a significant component of the total phosphorus load to Callander Bay, then the Source Protection Committee should consider requesting that sediments in Callander Bay be classified as a condition under Rule 15.1.

4.6.4 Local Threat Considerations

The North Bay-Mattawa Source Protection Committee is concerned about the threat posed by the transportation of hazardous substances along a number of roadways within the Callander Intake Protection Zone which creates the potential for a spill to occur in the vulnerable area.

Although there is no prescribed threat activity related to the transportation of hazardous substances under the *Clean Water Act*, Technical Rule 119 allows Source Protection Committees to request that an activity be listed as a drinking water threat if:

1. The activity has been identified by the Source Protection Committee as an activity that may be a drinking water threat; and
2. The Director indicates that the chemical or pathogen hazard rating for the activity is greater than 4.

The Source Protection Committee submitted a formal request to the Ministry of Environment for the addition of transportation of hazardous substances as a non-prescribed (local) drinking water threat in the SP Area. This request was approved by the Director on February 8, 2011 (Appendix G). Included in the approval are the circumstances and hazard ratings for the activities considered.

Table 4-15 shows where significant, moderate and low threats relating to the transportation of hazardous substances are located in the Callander IPZs. There is one circumstance in which the threat is significant for the Callander intake. This occurs in IPZ-1 (Figure 4-11) and relates to a pathogen threat from the transportation of septage, for which a spill of any quantity may result in the presence of pathogens in surface water. No significant chemical threats relating to transportation exist for this intake.

Table 4-15. Areas within the Callander Intake Protection Zone where Transportation of Hazardous Substances is Considered a Significant, Moderate or Low Drinking Water Threat

Threat Type	Vulnerable Area	Vulnerability Score	Threat Level Possible		
			Significant	Moderate	Low
Chemical	IPZ-1	9		✓	✓
	IPZ-2	8.1		✓	✓
Pathogen	IPZ-1	9	✓		
	IPZ-2	8.1		✓	
	IPZ-3a	4.5			✓
	IPZ-3b	4.5			✓

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4.7 Gap Analysis and Recommendations

Primary information gaps that create uncertainty in the evaluation of drinking water issues and threats noted in this study include:

A. Lack of sufficient long-term data to assess trends in parameters for the evaluation of drinking water issues.

The Municipality of Callander is participating in the MECP's Drinking Water Surveillance Program (DWSP) and additional data collected under this program may be used, in time, to assess trends in parameters of concern. Once sufficient data become available, parameters that are presently listed as drinking water issues should be reassessed to determine if there is evidence of increasing trends that could affect the treatment capability of the plant. If not, the Source Protection Committee may consider their removal as drinking water issues.

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5.0 Mattawa

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5.1 Introduction and Summary of Findings

The Town of Mattawa is situated at the confluence of the Mattawa and Ottawa Rivers at the extreme eastern boundary of the North Bay-Mattawa Source Protection Area (SP Area). The Town of Mattawa draws its municipal drinking water from two wells located on the northern shore of the Mattawa River. The entire study area was assigned a high susceptibility to surficial contamination due to the predominance of higher hydraulic conductivity sands and gravels, and a shallow water table in an unconfined aquifer setting. There are no significant or moderate stresses to the quantity of water.

A Wellhead Protection Area (WHPA) with four zones was delineated using computer modelling, based on the time it would take contaminants in the water to reach the wellhead. Times of travel range from two years to 25 years.

No issues or conditions were identified with the Mattawa municipal water supply. A municipal sewer line passing through the Wellhead Protection Area (WHPA) generates four pathogen threats classified as “significant”.

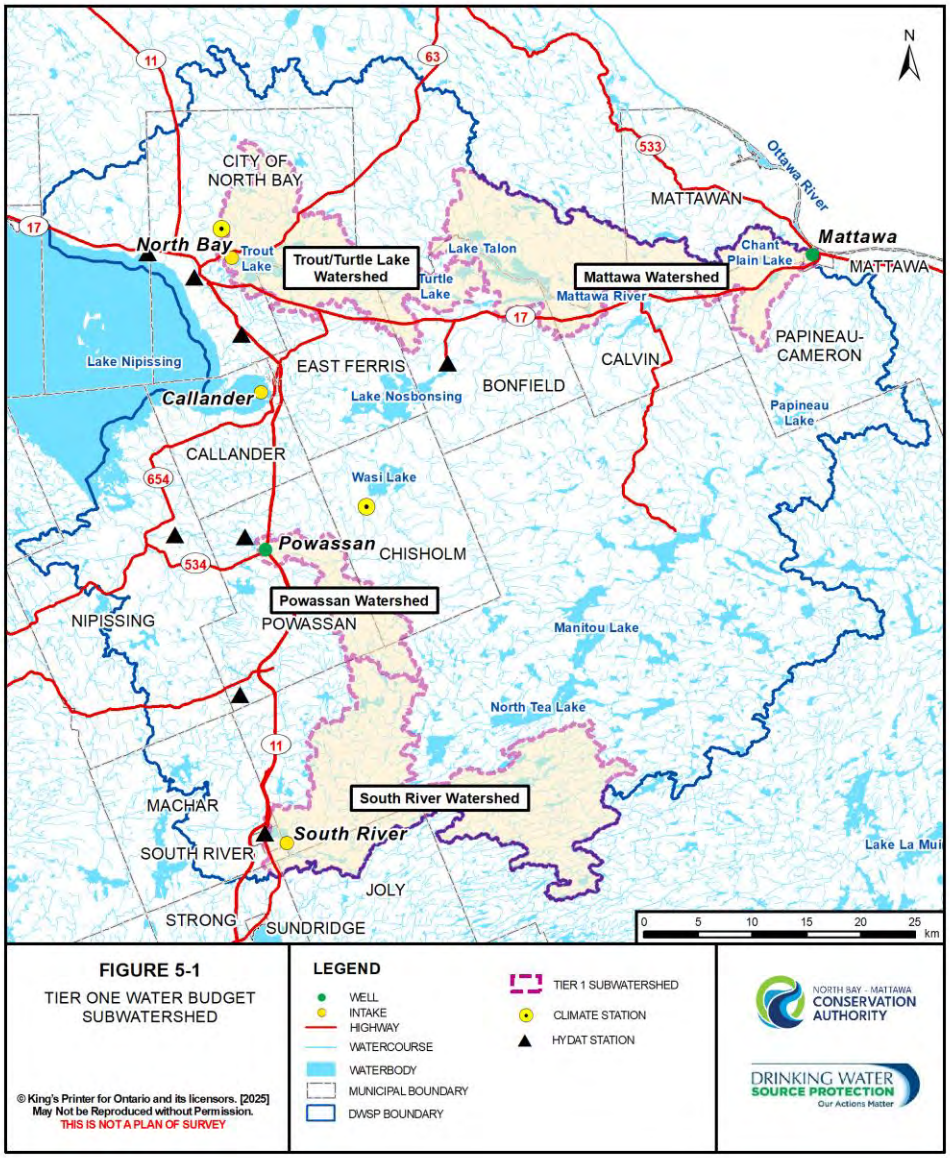
5.2 Water Budget and Water Quantity Stress Assessment

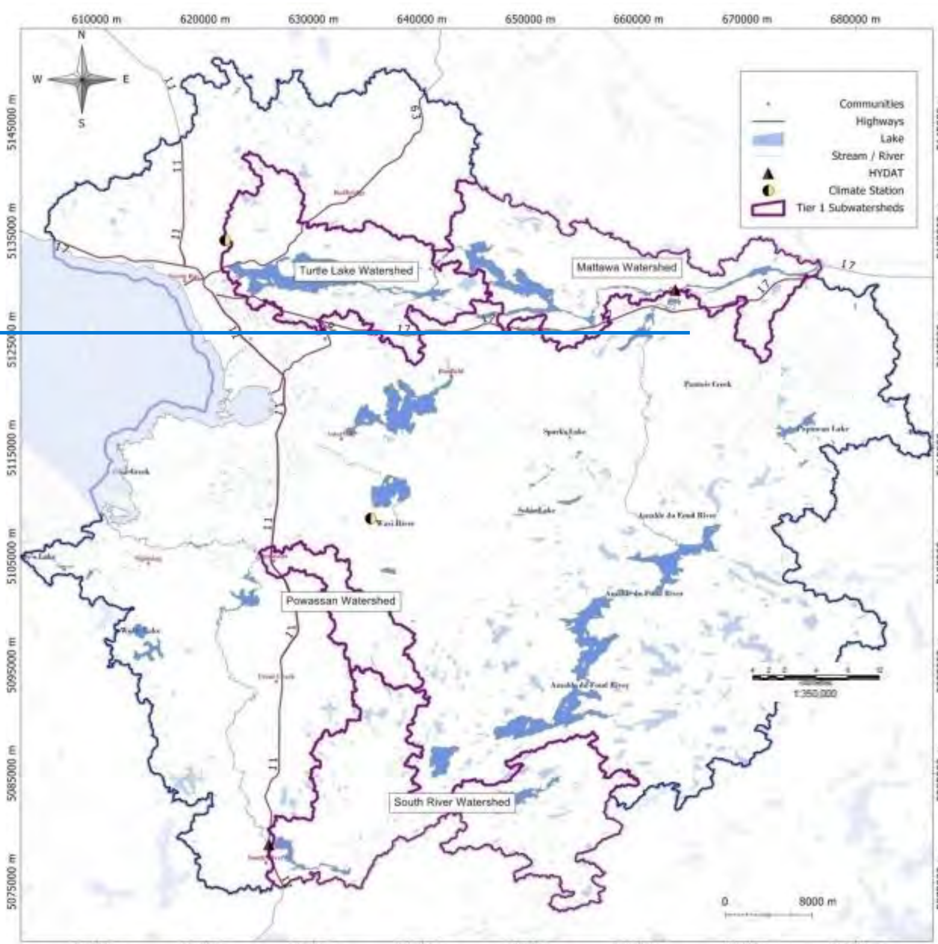
A water budget and water quantity stress assessment for each subwatershed is required by the *Clean Water Act (2006)* to determine whether the subwatershed will be able to meet current and future demands of all users.

General principles were explained earlier in Section 2.5 Conceptual Water Budget (Regional Analysis). The methodology specified in the Technical Rules Part III describes a tiered approach whereby all subwatersheds are subjected to a Tier One assessment and, if stress is low during all months of the year, no further assessment is required (MECP 2009). If stress levels are shown to be either moderate or significant, a more robust Tier Two assessment is completed and, similarly if that reveals moderate or significant stress, a Tier Three Local Risk Assessment must be undertaken. The information for this Section is based primarily on the Tier One Water Budget and Stress Assessment for the subwatershed supplying the Mattawa municipal groundwater supply (WESA, 2010). A Tier One assessment for the remainder of the subwatersheds in the SP Area is presented in Section 2.6.

The Mattawa River Quaternary subwatershed was split at the Turtle Dam such that the Town of Mattawa groundwater supply watershed was delineated extending from Turtle Dam east to the Town of Mattawa for a contributing area of 240 km^2. The portion of the Mattawa River Watershed that contributes to the groundwater intake is depicted along with the contributing subwatersheds for the municipal supplies for the Town of Powassan and the Village of South River in Figure 5-1.

Figure 5-1. Tier One Water Budget Subwatershed





Communities
Highways
Lake
Stream / River
HYDAT
Climate Station
Tier 1 Subwatersheds
Turtle Lake Watershed
Mattawa Watershed
Powassan Watershed
South River Watershed
1:350,000
0
8000 m
610000 m
620000 m
630000 m
640000 m
650000 m
660000 m
670000 m
680000 m
5145000 m
5135000 m
5125000 m
5115000 m
5105000 m
5095000 m
5085000 m
5075000 m

The town is serviced by two overburden wells that tap into a gravel aquifer. Although Mattawa experienced almost a 12% decline in population between 2001 and 2006 (Statistics Canada, 2007), no significant change in population is expected in the upcoming years (Waterloo Hydrogeologic, 2006). The population assumption remains valid, as the change in population from 2006 to 2016 was a decline of just 0.5% (Statistics Canada, 2017). Therefore, future water demand and land use change are expected to be minimal and have minimal impact on the subwatershed water budget parameters. As a result, additional assessment into future scenarios is not necessary.

Water budget elements include precipitation, actual evapotranspiration (AET), surplus, recharge, and runoff. All are expressed in mm to make them comparable to precipitation figures. The resulting water budget for the Mattawa subwatershed is shown below in Table 5-1.

Table 5-1. Estimated Water Budget Elements (Mattawa)

Month	Precipitation (mm)	Actual ET (mm)	Surplus (mm)	Recharge mm	Runoff (mm)
January	64.8	0.0	64.8	1.8	2.0
February	49.8	0.0	49.8	0.9	1.0
March	64.7	0.0	64.7	0.5	0.5
April	64.9	20.7	44.2	27.2	29.7
May	81.5	76.2	5.3	80.4	87.8
June	88.4	106.4	0.0	40.2	43.9
July	95.4	117.1	0.0	20.1	21.9
August	94.3	99.9	0.0	10.0	11.0
September	109.5	67.0	0.0	5.0	5.5
October	92.5	29.9	59.7	16.8	18.3
November	92.7	0.0	92.7	8.4	9.2
December	70.7	0.0	70.7	3.6	4.0
Annual Total	**969.1**	**517.2**	**451.9**	**214.9**	**234.6**
Gartner Lee (2007)	966	535	431	206	225

Note: ET = Evapotranspiration

The resultant values are very similar (+/- 5%) to those estimated in Gartner Lee Ltd. (2007a) for the same regions. The total annual surplus should theoretically equal streamflow (Gartner Lee Ltd., 2007a). Analysis of continuous streamflow data collected at Environment Canada / Water Survey of Canada gauge 02JE020 (Mattawa River below Bouillon Lake) (Figure 5-1) yields a total annual surplus of 452 mm. The total surplus predicted by the Thornthwaite-Mather soil moisture budget conducted by WESA also yielded a total surplus of 452 mm. The extremely close agreement between these two methods, as well as the close correlation between results obtained by WESA and Gartner Lee Ltd. (2007a), provides a high level of confidence in the water balance.

The groundwater supply is the water available for a subwatershed's groundwater users. Module 7 of the MECP Assessment Report Guidance Modules (MOE, 2007), which was the guidance at the time of the WESA study, recommends against using baseflow separation to determine groundwater supply if there are significant streamflow regulation structures in the watershed of interest. The Mattawa subwatershed contains three such structures: Turtle Lake Dam, Talon Lake Dam and the Hurdman Dam. Consequently, groundwater supply was estimated to equal recharge as determined using a soil moisture model described in the WESA report. Annual recharge was estimated to be 214.6 mm, which results in an average monthly recharge of 17.9 mm. Considering the area of the watershed (240 km^2), the average groundwater supply is 1.63 m^3/s. Lateral groundwater flow was assumed to be negligible. Water reserve was set at 10% of the recharge.

Water use (demand) was calculated considering available datasets for the study area and the results compiled on monthly and annual scales. Municipal and communal use was determined using the Environment Canada Municipal Water and Wastewater Survey (Environment Canada, 2004b) as well as the Permit to Take Water (PTTW) database (MOE, 2009a). The only communal PTTW other than the Town of Mattawa is for the Samuel de Champlain Park. Water takings and returns were divided between deep groundwater, shallow groundwater and surface water. The following assumptions were made:

- Most private wells are completed in bedrock, while municipal wells are completed in the overburden (Waterloo Hydrogeologic, 2006); therefore, it was assumed that takings are from deep groundwater and shallow groundwater, respectively;
- 2004 actual municipal water use values were used (753,572 m^3/yr) to be consistent with other values in the Municipal Water and Wastewater Survey and provide a conservative estimate of use (average use between 1997 and 2007 was 703,432 m^3/yr);
- Municipal water consumed includes water from population with sewage haulage;
- Municipal system losses are returned to shallow groundwater through infiltration;
- Communal water returns are to shallow groundwater by infiltration through septic beds and infiltration of surface runoff; and
- Environment Canada (2004b) states that 99% of serviced residents are on sewers and 0.8% are on septic. The remaining 0.2% was assumed to return to surface water.

(Note: Ministry of Environment or MOE is a previous name of the Ministry of Environment, Conservation and Parks or MECP)

Datasets included the following:

- Municipal and communal use (as specified above);
- Domestic use from private water supplies (based on Statistics Canada 2006);
- Agricultural use (livestock and irrigation).

Domestic use was calculated based on the population of Mattawa of 2,003 and an estimate that 0.1% of those are supplied by private wells with a total gross water taking of 128 m^3/yr (consumptive factor 0.2 assuming rest of water returned via septic systems to shallow groundwater).

Gross water takings for agricultural purposes are estimated at 52,517 m^3/yr, where livestock irrigation and crop irrigation are 46,748 and 5,759 m^3/yr. Total agricultural demand comprises approximately 4% of the total water takings and 18% of the total consumed.

The water use results developed for each of the sectors were amalgamated to estimate the cumulative water use for each of the systems (surface water, shallow groundwater and deep groundwater). Results from all sectors are summarized on an annual scale in Tables 5-2a, 5-2b and 5-2c and graphically on Figure 5-2.

Table 5-2a. Annual Water Use Results - Gross Takings (Mattawa)

Gross Annual Taking (m^3)						
Reservoir	**Permitted Takings**			**Non-Permitted**		**TOTAL**
	Municipal and Communal[a]	**Industrial and Commercial**[b]	**Other Permitted**	**Private Domestic**	**Agricultural**[c]	
Surface Water	33,000					33,000
Shallow Groundwater	665,765	468,911				1,134,676
Deep Groundwater				128	52,517	52,645
TOTAL	**698,765**	**468,911**	**0**	**128**	**52,517**	**1,220,321**

Table 5-2b. Annual Water Use Results - Consumption (Mattawa)

Annual Consumed (m^3)						
Reservoir	Permitted Takings			Non-Permitted		TOTAL
	Municipal and Communal[a]	Industrial and Commercial[b]	Other Permitted	Private Domestic	Agricultural[c]	
Surface Water	6,600					6,600
Shallow Groundwater	72,867	145,487				218,354
Deep Groundwater				26	51,363	51,389
TOTAL	**79,467**	**145,487**	**0**	**26**	**51,363**	**276,343**

Table 5-2c. Annual Water Use Results - Returns (Mattawa)

Annual Returned (m^3)						
Reservoir	Permitted Takings			Non-Permitted		TOTAL
	Municipal and Communal[a]	Industrial and Commercial[b]	Other Permitted	Private Domestic	Agricultural[c]	
Surface Water	269,116	323,424				592,540
Shallow Groundwater	350,182			102	1,154	351,438
Deep Groundwater						0
TOTAL	**619,298**	**323,424**	**0**	**102**	**1,154**	**943,977**

Notes:
a: Includes system losses, which are assumed to return to surface water
b: Assume industrial and commercial water comes from shallow groundwater and returns to SW through sewer service
c: Assume agricultural water comes from deep groundwater, since assuming source is same as private wells, and most private domestic wells are in deep bedrock
d: Assume remaining 0.2% returns to surface water (99% on sewer and 0.8% on septic)
e: Assume returns from private domestic wells discharges through septic systems to shallow groundwater

Of the gross annual water takings within the study area, 97% are from groundwater, being comprised of 93% from shallow groundwater and 4% from deep groundwater. The remaining 3% of takings are from surface water. Municipal/communal takings account for 57% of gross water takings while industrial/commercial accounts for 38%, and agricultural for 4%.

For total water consumed, 79% comes from shallow groundwater, being comprised of 19% from deep groundwater and 2% from surface water. Surface water receives 63% of water returns, while shallow groundwater receives 37%, which is assumed to be primarily through infiltration and septic systems (it is assumed that water lost to the system is lost through leakage and returns to the shallow groundwater through infiltration). This is consistent with the mostly rural nature of the region. Returns to surface water are concentrated in the areas serviced by sewers.

Figure 5-2. Annual Water Use (Mattawa)

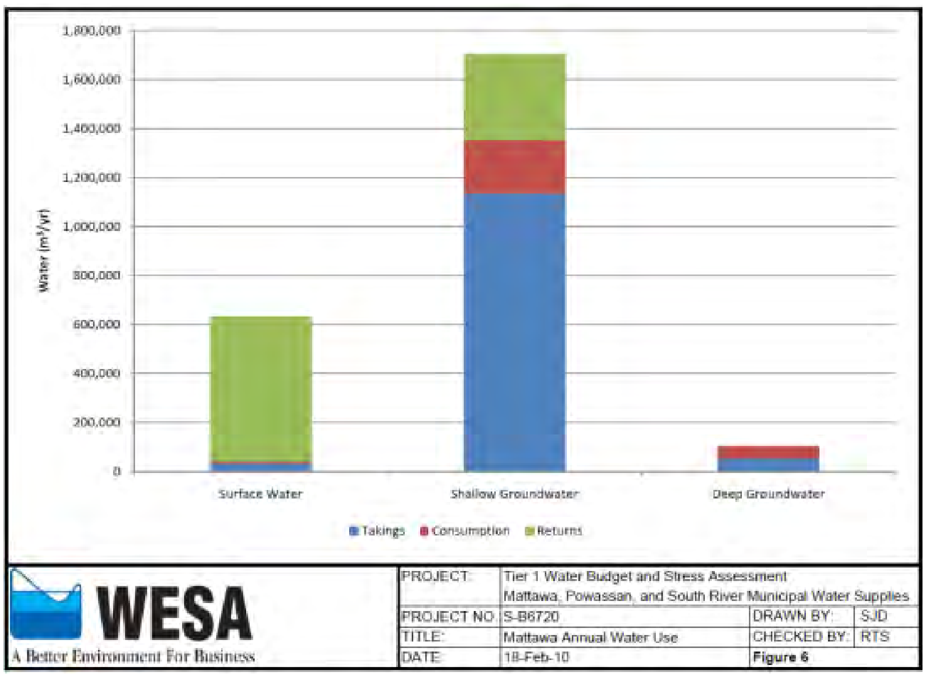


Table 5-3 compiles net water takings for each of the systems. Positive values indicate that returns exceed takings. This is the case for surface water where an excess of 559,540 m^3 are returned annually. Both the shallow and deep groundwater systems have more water taken than returned: 783,238 and 52,645 m^3/yr, respectively. The net water takings exceed returns by 276,343 m^3/yr.

Table 5-3. Net Water Taking (Mattawa)

Reservoir	Net Water Takings (m^3)
Surface Water	559,540
Shallow Groundwater	- 783,238
Deep Groundwater	- 52,645
TOTAL	**- 276,343**

Note: Positive values indicate that returns exceed takings.

Monthly water use results, including gross, consumed and returned water, were compiled for each month and show details for each system (surface water, shallow groundwater and deep groundwater). There is not a significant difference in water demand between months as municipal/communal and industrial/commercial water use is consistent throughout the year. There is a slight increase in demand in July and August as a result of water used for crop irrigation.

5.2.1 Groundwater Stress Assessment

Groundwater stress is determined by examining the ratio of water demand (water takings) to water supply, while considering the reserve water required to maintain ecosystem function (MECP, 2017). The percent water demand is compared to a stress threshold (Table 5-4) to determine the stress level.

Table 5-4. Groundwater Stress Thresholds Based on Annual and Monthly Percent Water Demand

Groundwater Quantity Stress Level Assignment	Average Annual (%) Water Demand	Maximum Monthly (%) Water Demand
Significant	≥ 25%	≥ 50%
Moderate	> 10% and < 25%	> 25% and < 50%
Low	≤ 10%	≤ 25%

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The annual and maximum monthly percent groundwater demands for the Town of Mattawa supply subwatershed are 0.58% and 0.64%, respectively. Table 5-5 presents the monthly and annual demand, supply and reserve values used to calculate the percent demand.

Table 5-5. Percent Groundwater Demand (Mattawa)

Month	Consumption	Supply	Reserve	%Demand
January	0.09	17.9	1.79	0.58
February	0.08	17.9	1.79	0.53
March	0.09	17.9	1.79	0.58
April	0.09	17.9	1.79	0.56
May	0.09	17.9	1.79	0.58
June	0.09	17.9	1.79	0.56
July	***0.10***	***17.9***	***1.79***	***0.64***
August	***0.10***	***17.9***	***1.79***	***0.64***
September	0.09	17.9	1.79	0.56
October	0.09	17.9	1.79	0.58
November	0.09	17.9	1.79	0.56
December	0.09	17.9	1.79	0.58
Total	**1.12**	**215**	**21.5**	**0.58**

Note: ***Bold italics*** indicate months with maximum monthly percent demand.

A subwatershed is considered low stress if the average annual percent demand is less than or equal to 10% and if the maximum monthly percent demand is less than or equal to 25%. As a result, the Town of Mattawa municipal supply subwatershed is considered low stress and does not require a Tier Two Assessment.

5.2.2 Uncertainty

The limitations inherent to each dataset individually, combined with the discrepancies between datasets, all introduce various levels of uncertainty which are ultimately compounded into the results.

Because this study is conducted at the regional scale, results must be interpreted in their context and would require confirmation and refinement through further investigation at the local scale. Also, the various datasets used in the analysis are a 'snapshot in time': population census is as of 2006, while municipal water use data is current as of 2004. Obtaining more up to date data would reduce the error associated with the combination of datasets from varying dates.

The greatest source of uncertainty in estimating water use comes from the Provincial Permits to Take Water (PTTW) database. Determining permit validity from information contained in the database (expiry date, whether a permit has been revoked, etc.) is challenging, and would require review of individual permits to increase confidence in the data. Only water takings greater than

50,000 L/d are included in the PTTW database, while water use from smaller users is unknown. The PTTW database only contains information on maximum allowable withdrawals, while actual takings are unknown with the exception of a municipal water supply. However, the uncertainty associated from this limitation was reduced in part by applying the monthly and consumptive use factors specified in the provincial guidance document (MOE, 2007) and AquaResource (2005).

Other sources of uncertainty include limited information available for some sectors. There may be an unaccounted number of smaller industrial and commercial users. Water taking for livestock is exempt from the permitting requirements, regardless of the volume taken. Similarly, no information is available for recreational or ecological users.

Considering the significant sources of uncertainty, the uncertainty associated with the Tier One Water Budget and Stress Assessment is considered high. However, the percent demand for this system is well below the defined thresholds, and as such no additional work is likely required to address the uncertainty.

5.3 Groundwater System Characterization

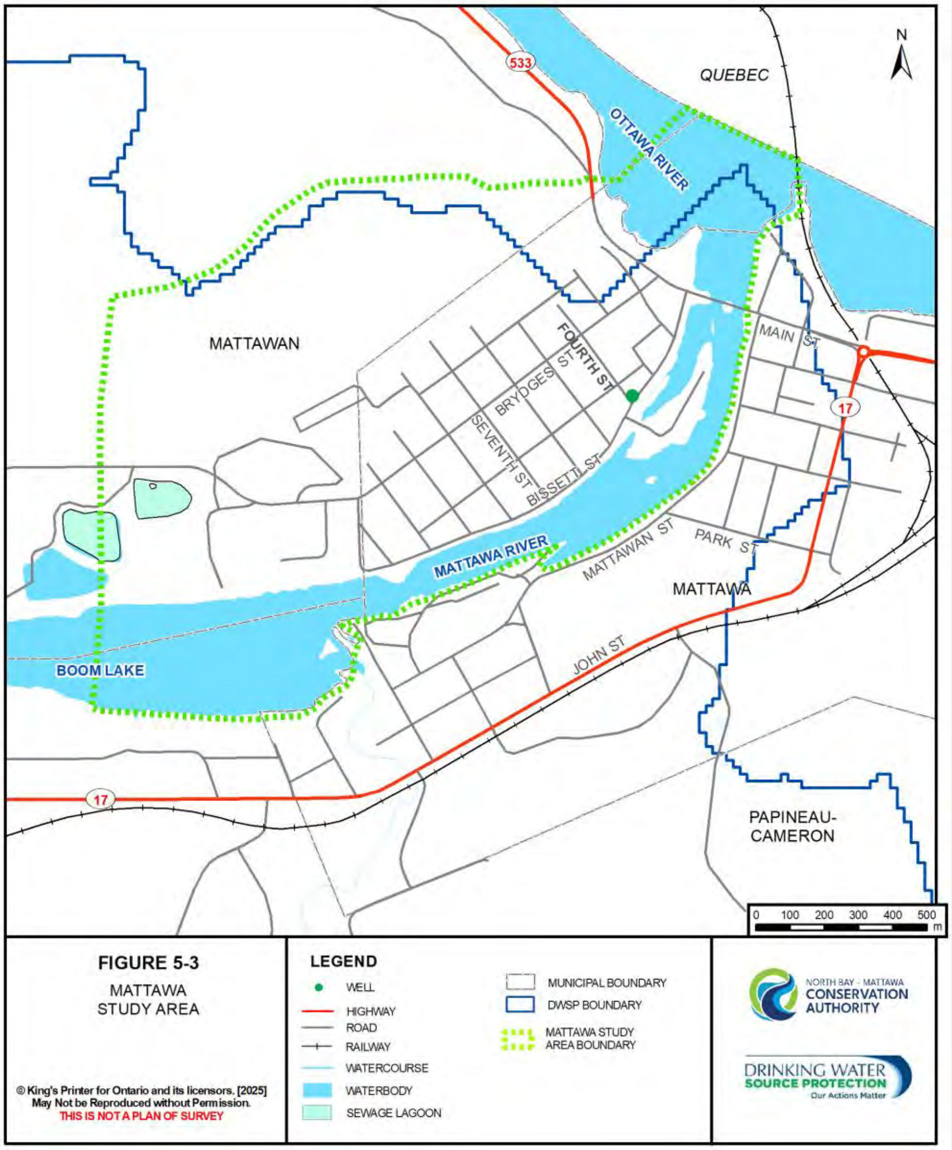
The information contained in the following Sections assessing the water quality component of the vulnerability and threats to the Mattawa system was taken primarily from the two 2009 Technical Assessment Reports on the Municipality of Mattawa prepared by Waters Environmental Geosciences entitled:

- Groundwater Vulnerability Analysis and (2009d); and
- Groundwater Risk Assessment (2009b).

The Town of Mattawa well field consists of two municipal wells, housed in a single structure, located on the northeast corner of the intersection of Bisset Street and Fourth Street in the Town of Mattawa (Figure 5-3). The Mattawa River flows east, then bends to the northeast before it enters the Ottawa River. The well field is located on the north shore of the Mattawa River, approximately 60 m from the riverbank, and the site is elevated approximately 5 m above the river level. The UTM co-ordinates of the well building (in *NA*D83) are 676227 mE and 5131742 mN (Ministry of the Environment, 2008). The system services the entire population of 2,270 (2006 census). Table 5-6 below summarizes the construction details of the wells. The sand and gravel soils are typical of the area.

(Note: Ministry of Environment or MOE is a previous name of the Ministry of Environment, Conservation and Parks or MECP)

Figure 5-3. Mattawa Study Area



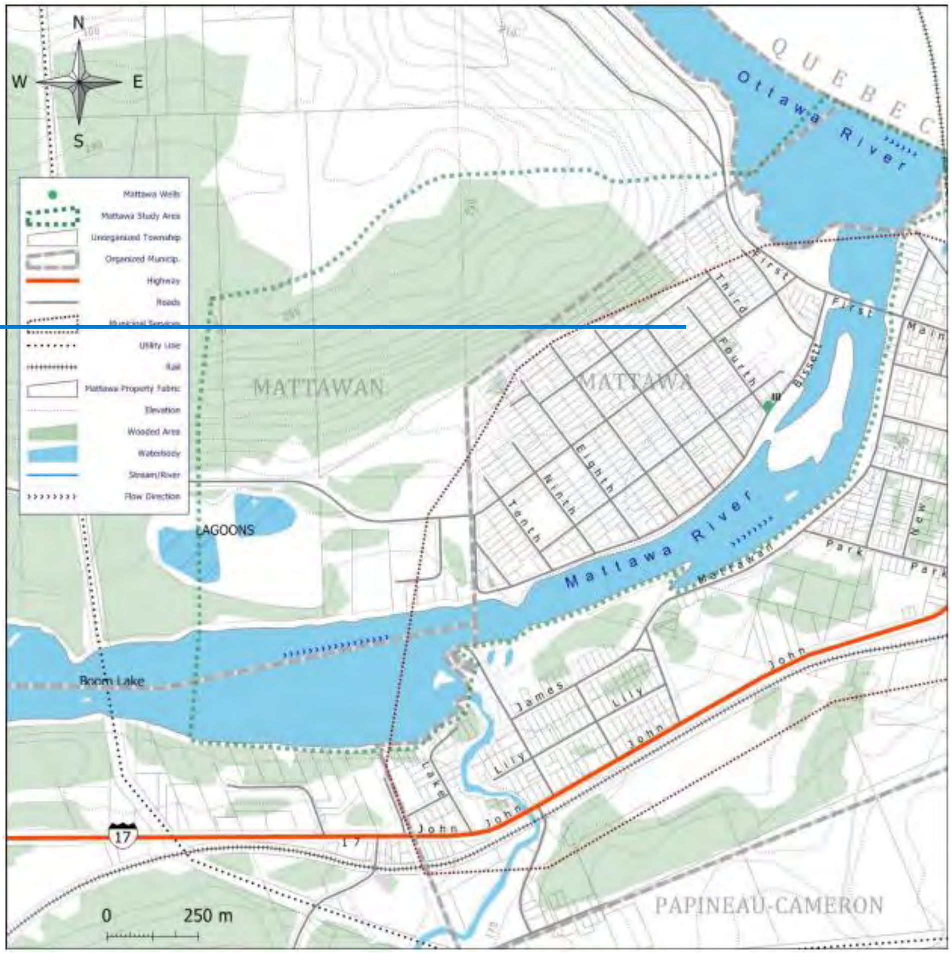

N
W
E
S
Mattawa Wells
Mattawa Study Area
Unorganized Township
Organized Municip.
Highway
Roads
Municipal Services
Utility Line
Rail
Mattawa Property Fabric
Elevation
Wooded Area
Waterbody
Stream/River
Flow Direction
QUEBEC
Ottawa River
MATTAWAN
MATTAWA
LAGOONS
Mattawa River
Boom Lake
PAPINEAU-CAMERON
0 250 m

Table 5-6. Specifications for the Two Mattawa Municipal Wells

Specification	Well No. 1	Well No. 2
Year drilled	1958	1949
Drilling Company	International Water Supply Ltd. (London)	International Water Supply Ltd. (London)
Depth Below Grade	26.5 m	23.6 m
Steel Casing - Diameter - Depth	 406 mm (16 inch) 22.0 m	 305 mm (12 inch) 20.6 m
Stainless Steel Screen - Slot Size - Diameter - Length - Depth	 No. 6 406 mm (16 inch) 4.6 m 26.4 m	 No. 6 305 mm (12 inch) 3.0 m 23.6 m
Packing	Gravel Packed	Gravel Packed
Outer Working Casing - Diameter - Depth	 660 mm (26 inch) 18.8 m	 560 mm (22 inch) 18.6 m
Static Water Level at Completion (Below grade)	5.2 m	5.4 m
Registration No.	43-00581	43-00579
Formation encountered during drilling	Sand and gravel, with boulders	Sand and gravel, with occasional boulders

Water consumption data were obtained from the Municipality, for the time period January 1997 to December 2007, and examined for overall trends. Although there is a degree of scatter in the plot (attributed to some seasonal effects coupled with well maintenance activities), an overall trend towards lower consumption was noted. The highest total consumption was for May 1998, averaging 2,907 m^3/day (900 m^3/day being taken from Well No. 1 and 2,007 m^3/day being taken from Well No. 2). This was about 50% higher than the long-term average over the entire period, 1,940 m^3/day. These values are well below the maximum permitted pumping rate for both wells combined of 6,546 m^3/day (Permit to Take Water No. 02-P-5059; MOE, 2009a). For the present wellhead protection modelling analysis, the average consumption rate of 1,940 m^3/day was used. Since the wells are only a few metres apart, the simulation used a single well pumping at this combined rate.

The review of available information indicated that there is no proposed expansion to the water distribution system. (Note: Ministry of Environment or MOE is a previous name of the Ministry of Environment, Conservation and Parks or MECP)

Despite their close proximity to the Mattawa River, the municipal wells have not been classified as being groundwater under the direct influence of surface waters (GUDI). There have been no problems detected with water quality.

5.4 Delineation and Scoring of Vulnerable Areas

5.4.1 Defining the Vulnerable Areas (Wellhead Protection Areas)

As explained in the Groundwater Methodology Section 3.2.2, delineation of the vulnerable area for a Type I drinking water system under the *Clean Water Act (2006)* is based on the time it takes water to travel in the aquifer to the wellhead. Four subzones of the wellhead protection area (WHPA) were identified; tome-of-travel (TOT) was determined using computer based three-dimensional groundwater flow modelling:

- WHPA-A is the area within 100 m
- WHPA-B extends beyond the 100 m zone to a line marking the 2-year TOT
- WHPA-C extends from the WHPA -B limit out to the 5-year TOT
- WHPA-D extends from the WHPA-C limit out to the 25-year TOT

Several years previous, a regional groundwater study was conducted (Waterloo Hydrogeologic, 2006) which also used computer modelling to delineate a wellhead protection area. The current study used a more recent version of the same software, local mapping and additional data to create a revised model. The resulting vulnerable areas with scores are illustrated in Figure 5-4.

5.4.2 Vulnerability Scoring

Water well records for the area are limited, so available data regarding subsurface conditions was supplemented using local knowledge to determine the susceptibility of the aquifer (to contamination from the surface). Since the wellheads are located in a residential area, the municipality is familiar with ground conditions from construction of sewer lines and roads. The Intrinsic Susceptibility Index (ISI) for a location is based on soil characteristics and the depth to water. The entire study area was assigned a high susceptibility to surficial contamination due to the predominance of higher hydraulic conductivity sands and gravels, and high water table, in an unconfined aquifer setting. Shallow bedrock exposure over the upland portions of the site also contributes to high susceptibility, although it is not a factor in the ISI calculation. Therefore, the vulnerability scores for each WHPA as per Technical Rule 83, Table 2(a) are listed in Table 5-7.

Table 5-7. Vulnerability Scores for the Mattawa Vulnerable Areas

WHPA	Vulnerability Score
A	10
B	10
C	8
D	6

Wellhead protection areas and their vulnerabilities are depicted in Figure 5-4. Since the entire vulnerable area is already scored as highly susceptible to contamination, the existence of any surface conditions or transport pathways that could enhance contaminant flow would be irrelevant to scoring and so were not considered.

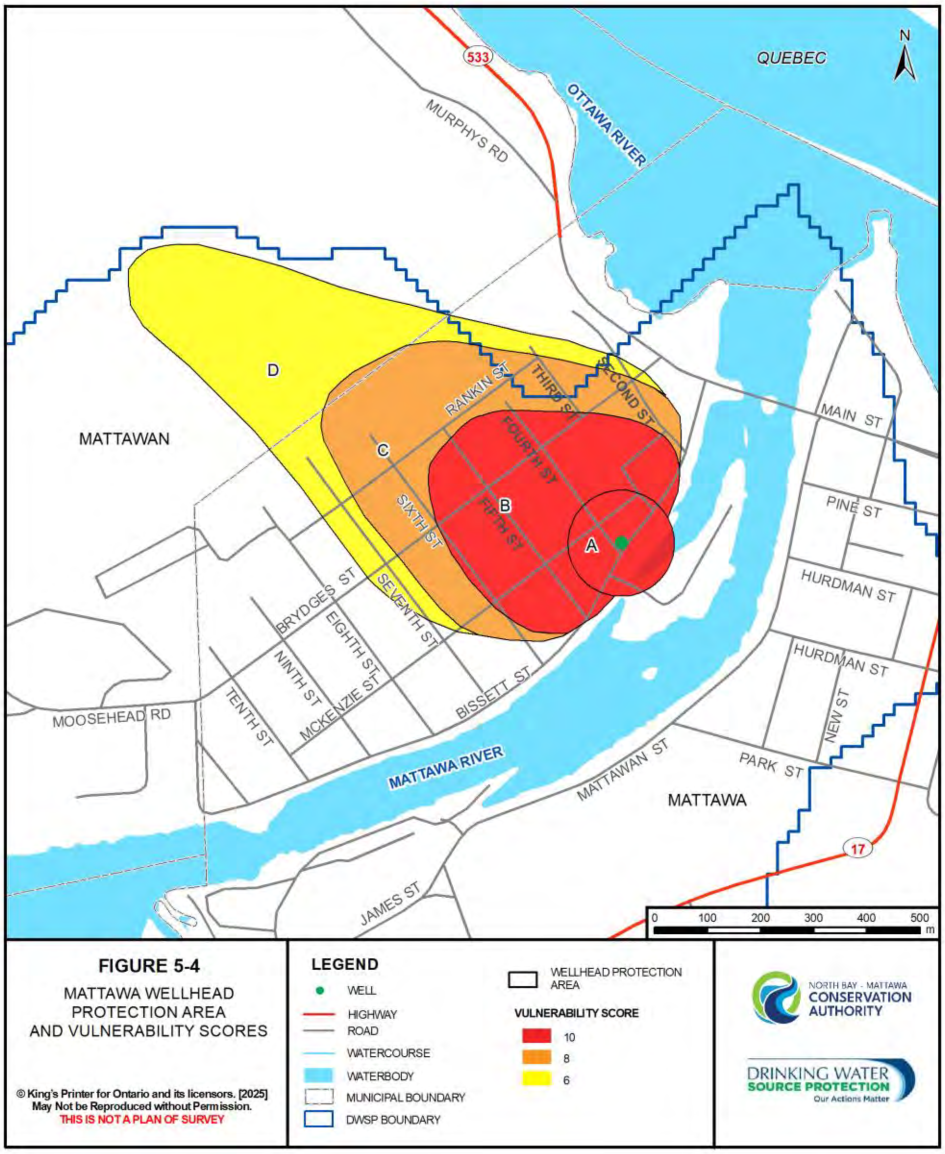
5.4.3 Uncertainty Analysis

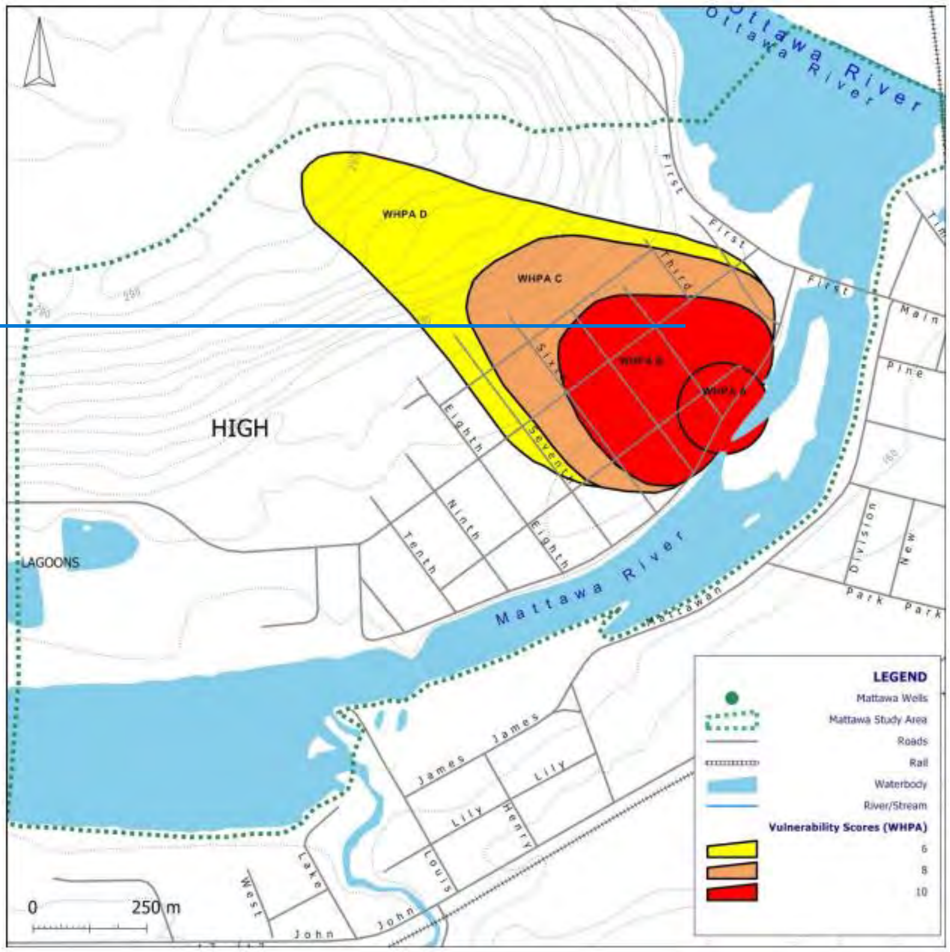
The uncertainty associated with the delineation and scoring of each vulnerable area must be reviewed and then rated as either high or low. This study used a new conceptualization of the groundwater model but came up with similar results to the 2006 NBMCA Groundwater Study (Waterloo Hydrogeologic).

When the vulnerable areas derived by modelling for each study are compared, there is reasonably close agreement suggesting uncertainty is low. Overall, however, a lack of detailed subsurface information was an issue for the broad landscape within the model domain. In some areas the geological conditions were extrapolated based on marginal data, and reliance was placed on published geological interpretations by others. Therefore, Waters Environmental Geosciences Ltd. (2009b) assessed the uncertainty of the delineations of the WHPA zones delineated by modelling as high except for the WHPA-A, which is simply defined by a circle extending 100 m around the wellhead, so the uncertainty for that area is low.

Any discrepancies are not expected to have significant implications on the usefulness of the findings for the intended purpose, source protection planning. Although there is some question as to where exactly to draw the lines defining the vulnerable area and its zones, the differences are not large and the broad area was determined to be highly susceptible to infiltration of water-borne contaminants. This assessment of vulnerability is low uncertainty.

Figure 5-4. Mattawa Wellhead Protection Area and Vulnerability Scores





Note: larger 11” x 17” version of Figure 5-4 is available in Appendix A as Figure A-6.

5.5 Issues Identification

Based on a review of available data for raw and treated water and discussions with the Ministry of Environment, it was determined that there were no issues associated with the Mattawa groundwater supply. It is acknowledged that raw water quality data is relatively limited because regular analysis is not required.

5.6 Threats Identification and Assessment

Threats are defined as those activities or conditions that could cause contamination of drinking water by a chemical or pathogen within one of the Wellhead Protection Areas (WHPA). Activities must be assessed and reported whether or not they currently occur within the vulnerable areas. O.Reg. 287/07 Section 1.1 (1) under the *Clean Water Act (2006)* lists 20 activities that may result in threats to drinking water quality (see Table 3-1) (two additional prescribed activities pose threats to water quantity).

Conditions, as defined by Part XI.3 of the Technical Rules, refer to past activities that have produced contaminants that may result in significant drinking water threats. A more detailed definition can be found in the discussion under section 3.2.5 above.

In addition to identification and assessment of conditions, there are two additional components within the Threats Approach to addressing drinking water threats to comply with the Technical Rules. These involve:

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

Since no conditions were identified, the assessment of the Mattawa system involved the *threats approach*, which is based on listing the prescribed activities that are or would be drinking water threats within the vulnerable areas, and the *issues approach*, which is based on activities or conditions that contribute to existing drinking water issues listed under Rule 114.

5.6.1 Threats Approach

Part XI.4 of the Technical Rules describes the methods for identifying significant, moderate and low drinking water threats related to activities in the vulnerable area of a drinking water intake.

A threat is deemed significant, moderate or low depending on:

1. the vulnerable area in which the activity occurs or would occur;
2. the vulnerability score of the vulnerable area; and
3. a set of prescribed activities and corresponding circumstances that constitute a threat.

The Technical Rules require activities that would be a significant, moderate or low drinking water threat within the vulnerable areas to be listed in the Assessment Report, *regardless of whether or not the activities presently exist in the vulnerable area.*

Lists of significant, moderate and low drinking water threats related to chemicals and pathogens were compiled for each of the vulnerable areas of the Mattawa wellhead protection area based on the MECP Tables of Drinking Water Quality Threats (MECP 2021).

Existing activities were compared to the MECP Tables of Drinking Water Quality Threats, where the prescribed activities that pose a threat were classified as significant, moderate or low based on their circumstances.

Threats Approach - Potential Activities and Circumstances

Based on the resulting vulnerability scores, the possible threat levels were identified for each of the vulnerable areas (Table 5-8). Due to the vulnerability scores within the WHPAs, only WHPA-A, B and C may contain potential significant chemical threats, and only WHPA-A and WHPA-B may contain significant pathogen threats. Refer to Figure 5-4 above for further support of the vulnerable areas where activities are or would be significant, moderate or low drinking water threats.

Table 5-8. Areas within Mattawa Wellhead Protection Area where Activities are or would be Significant, Moderate and Low Drinking Water Threats

Threat Type	Vulnerable Area	Vulnerability Score	Threat Level Possible		
			Significant	Moderate	Low
Chemical	WHPA-A	10	✓	✓	✓
	WHPA-B	10	✓	✓	✓
	WHPA-C	8	✓	✓	✓
	WHPA-D	6		✓	✓
Pathogen	WHPA-A	10	✓	✓	
	WHPA-B	10	✓	✓	

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Note: Pathogen threats are not considered in WHPA-C or WHPA-D.

The Technical Rules Part XII - Tables of Drinking Water Quality Threats (MECP 2021) provide the detailed sets of circumstances for identifying if an activity meets the criteria for a significant, moderate or low drinking water threat. The Threats Tables can be downloaded from the MECP webpage (https://www.ontario.ca/page/2021-technical-rules-under-clean-water-act).

An on-line searchable version of the Threats Tables can be accessed at swpip.ca. The on-line version of the Threats Tables can be filtered to outline the specific circumstances related to potential chemical or pathogen threats. After the webpage is opened, click on the "Search" menu tab and then "Zone and Score". By applying the filter values in sequence, as shown in Table 5-8 below, it is possible to narrow the results to those activities considered at a threat level within the particular vulnerable area and vulnerability score.

Table 5-9. Summary of Circumstances in the Provincial Threats Tables Related to Mattawa WHPA

Vulnerable Area	Vulnerability Score	Risk	Parameter of Concern	# of Sets of Circumstances
WHPA-A	10	Significant	Chemical	129
WHPA-A	10	Moderate	Chemical	99
WHPA-A	10	Low	Chemical	12
WHPA-B	10	Significant	Chemical	129
WHPA-B	10	Moderate	Chemical	99
WHPA-B	10	Low	Chemical	12
WHPA-C	8	Significant	Chemical	11
WHPA-C	8	Moderate	Chemical	155
WHPA-C	8	Low	Chemical	70
WHPA-D	6	Significant	Chemical	n/a
WHPA-D	6	Moderate	Chemical	8
WHPA-D	6	Low	Chemical	203
WHPA-A	10	Significant	Pathogen	23
WHPA-A	10	Moderate	Pathogen	6
WHPA-A	10	Low	Pathogen	n/a
WHPA-B	10	Significant	Pathogen	23
WHPA-B	10	Moderate	Pathogen	23
WHPA-B	10	Low	Pathogen	6

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Threat Type	Vulnerable Area	Vulnerability Score	Threat Classification and Provincial Table Reference Code		
			Significant	Moderate	Low
Chemical	WHPA-A, B	**10**	CW10S	CW10M	CW10L
	WHPA-C	**8**	CW8S	CW8M	CW8L
	WHPA-D	**6**	NA	CW6M	CW6L
Dense Non-Aqueous Phase Liquids (DNAPLs)	WHPA-A,B,C	**Any**	DWAS	NA	NA
	WHPA-D	**6**	NA	DWHVASGRA6M	DWHVASGRA6L
Pathogen	WHPA-A, B	**10**	PW10S	PW10M	NA
	WHPA-C	**8**	NA	PW8M	PW8L
	WHPA-D	**6**	NA	NA	PW6L

Note: n/a indicates there are no matching circumstances where an activity is considered a drinking water threat

Pathogen threats are not considered in WHPA-C or WHPA-D.

There are ~~18~~ 19 prescribed activities that are or would be significant drinking water threats if they occurred in the Mattawa Wellhead Protection Area. A breakdown of the prescribed activities and the number of circumstances under which those activities would be significant is provided in Table 5-10.

Table 5-10. Enumeration of Circumstances under which Prescribed Activities are or would be Significant Threats to the Mattawa Municipal Groundwater System

Activities Prescribed to be Drinking Water Threats	# of Significant Threat Circumstances	
	Chemical	Pathogen
The establishment, operation or maintenance of a waste disposal site within the meaning of Part V of the *Environmental Protection Act*.	~~33~~43	~~1~~4
The establishment, operation or maintenance of a system that collects, stores, transmits, treats or disposes of sewage.	~~20~~23	~~6~~5
The application of agricultural source material to land.	1	1
The storage of agricultural source material.	6	~~3~~2
The application of non-agricultural source material to land.	1	1
The handling and storage of non-agricultural source material.	~~6~~5	~~2~~1
The application of commercial fertilizer to land.	1	n/a
The handling and storage of commercial fertilizer.	1	n/a
The application of pesticide to land.	2	n/a
The handling and storage of pesticide.	~~3~~2	n/a
The application of road salt	0	n/a
The handling and storage of road salt.	~~1~~2	n/a
The storage of snow.	~~6~~5	n/a
The handling and storage of fuel.	~~12~~6	n/a

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Activities Prescribed to be Drinking Water Threats	# of Significant Threat Circumstances	
	Chemical	Pathogen
The handling and storage of a dense non-aqueous phase liquid.	~~25~~3	n/a
The handling and storage of an organic solvent.	8	n/a
The management of runoff that contains chemicals used in the de-icing of aircraft.	1	n/a
The use of land as livestock grazing or pasturing land, an outdoor confinement area or a farm-animal yard.	2	2
The establishment and operation of a liquid hydrocarbon pipeline.	3	n/a
Number of circumstances under which the threat is or would be significant	**~~132~~129**	**16**

Note: n/a indicates there are no matching circumstances where an activity is considered a drinking water threat

Threats Approach - Existing Significant, Moderate and Low Threats

The identification of specific groundwater quality threats in the Mattawa vulnerable areas was based on inputs from several sources including: published environmental and land use databases (maintained by, for example: the Ministry of the Environment, Conservation and Parks; Technical Standards and Safety Authority; and the Municipality; field reconnaissance work by North Bay-Mattawa Conservation Authority staff; air photo interpretation; and land use mapping reviews).

Each occurrence of an activity prescribed to be a drinking water threat was evaluated as significant, moderate or low based on the circumstances of that occurrence and using the MECP Tables of Drinking Water Threats.

Based on a review of the above information, the field work and a subsequent review of initial findings, ~~13~~ 17 occurrences relating to two activities prescribed by the Threats Tables were confirmed as a significant (S) threat (Table 5-12). ~~Nine~~ Thirteen of the significant threats are chemical threats related to the storage of home heating fuel oil in WHPA-B. Four of the significant threats within the Mattawa vulnerable area are pathogen threats related to the location of the municipal sewage infrastructure in close proximity to the WHPA-A and WHPA-B areas.

A total of ~~29~~ 25 activities were identified as posing a moderate threat and ~~13~~ 9 were identified as a low threat.

Table 5-11. Existing Threats within Mattawa Wellhead Protection Area

Activity Prescribed to be a Threat	WHPA-A	WHPA-B	WHPA-C	WHPA-D	Circumstance Reference # and type
	Vs=10	Vs=10	Vs=8	Vs=6	
The establishment, operation or maintenance of a system that collects, stores, transmits, treats or disposes of sewage.	M (2)	M (2)	L (2)		C2.3.4 (Chemical)
	M (2)	M (2)	M (1)	L (1)	C2.5.8 (Chemical)
	S (2)	S (2)			P2.5.1 (Pathogen)
The handling and storage of road salt – potentially exposed to precipitation or runoff		S(1)	M(1)		C.13.2.3 (Chemical)
The handling and storage of fuel.		S (9)	M (16)	L (6)	C15.1.7 (Chemical)
		S (4)			C15.1.9 (Chemical)

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Activity Prescribed to be a Threat	WHPA-A	WHPA-B			WHPA-C		WHPA-D	Circumstance Reference #
	Vs=10	Vs=10	Vs=8	Vs=6	Vs=8	Vs=6	Vs=6	
		S (9)						1359 1360 1369 1370
The handling and storage of fuel.		M (4)			M (16)		L (6)	1354
The establishment, operation or maintenance of a system that collects, stores, transmits, treats or disposes of sewage.	S (2)	S (2)						1958
	M (2)	M (2)			M (1)		L (1)	663

** Occurrences in columns with bold boxes represent one parcel with multiple circumstances*

Note: * Occurrences in columns with bold boxes represent one parcel with multiple circumstances.
Vs = vulnerability score; S = Significant threat; M = Moderate threat; L = Low threat

5.6.2 Issues Approach to Threat Identification

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There are no drinking water issues, in accordance with Rule 114 and 115 in the Mattawa Wellhead Protection Area.

5.6.3 Conditions

There are no known conditions that exist in the vulnerable areas of the Mattawa Wellhead Protection Area.

5.6.4 Local Threat Considerations

The North Bay-Mattawa Source Protection Committee is concerned about the threat posed by the transportation of hazardous substances along a number of roads within the Mattawa Wellhead Protection Area (WHPA) which creates the potential for a spill to occur.

Although there is no prescribed threat activity related to transportation of hazardous substances under the *Clean Water Act*, Technical Rule 119 allows Source Protection Committees to request that an activity be listed as a drinking water threat if:

1. The activity has been identified by the Source Protection Committee as an activity that may be a drinking water threat; and
2. The Director indicates that the chemical or pathogen hazard rating for the activity is greater than 4.

The Source Protection Committee submitted a formal request to the Ministry of Environment for the addition of the transportation of hazardous substances as a non-prescribed (local) drinking water threat in the SP Area. This request was approved by the Director on February 8, 2011 (Appendix G). Included in the approval are the circumstances and hazard ratings for the activities considered.

Table 5-12 shows where significant, moderate and low threats relating to the transportation of hazardous substances are located in the Mattawa WHPA. Both chemical and pathogen significant threats exist within Mattawa WHPA-A and WHPA-B (Figure 5-4). The pathogen threat relates to the transportation of septage, for which a spill may result in the presence of pathogens in groundwater. Significant chemical threats relate to the transportation of sulphuric acid or sodium hydroxide in quantities greater than 2,500 litres, for which a spill may decrease or increase, respectively, the pH of groundwater beyond acceptable limits.

Table 5-12. Areas within Mattawa Wellhead Protection Area where Transportation of Hazardous Substances and Transportation of Septage is Considered a Significant, Moderate or Low Drinking Water Threat

Threat Type	Vulnerable Area	Vulnerability Score	Threat Level Possible		
			Significant	Moderate	Low
Chemical	WHPA-A	10	✓	✓	
	WHPA-B	10	✓	✓	
	WHPA-C	8		✓	✓
	WHPA-D	6			✓
Pathogen	WHPA-A	10	✓		
	WHPA-B	10	✓		

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Note: Pathogen threat is related to transportation of septage.
Pathogen threats are not considered in WHPA-C or WHPA-D.

5.7 Gap Analysis and Recommendations

With respect to issues identification, data on raw water quality is largely unavailable because there are no requirements to collect it. However, since the only treatment provided in the Mattawa system is chlorination, most parameters analyzed for treated water would not be reduced during treatment. Therefore, data on treated water quality should generally be adequate to identify issues.

From a scientific viewpoint, additional supplemental analysis of the water chemistry would be of benefit in tracking any long-term trends in water quality for those parameters not mandated by the Certificate of Approval for the water system. As a suggestion, it has been recommended (Waters Environmental Geosciences Ltd., 2009b, Groundwater Risk Assessment) that a complete water quality scan of the raw water characteristics (major ion analysis, heavy metals analysis, nutrient indicators, and general water chemistry parameters) be undertaken annually, complementing the analysis required by the Certificate of Approval.

Uncertainty scores were assigned to the various vulnerable areas. In many instances, high uncertainties were assigned because of a lack of detailed subsurface information. In the interest of continuous improvement, as new subsurface data become available, it is recommended that they be periodically assessed against the current conceptual model of the local geological setting so that any anomalous information is corrected for future planning cycles.

Although the Town of Mattawa has provided municipal sewage collection to all residences in the vulnerable area for more than fifty years, there was never a by-law requiring hook-up and there are no records available to verify hook up. Therefore, confirmation has not been made that there are no on-site septic systems still in operation. Such a system would be classified as a significant threat in WHPA-A or WHPA-B.

6.0 North Bay

6.1 Introduction and Summary of Findings

This Section includes analyses of vulnerability with respect to both water quantity and water quality for the surface water intake for the City of North Bay. General methodology for water quality vulnerability assessments for surface water systems is described in Section 3 of this report. The information specific to water quality vulnerability in this Section is based primarily on the Surface Water Vulnerability and Threats Assessment for Drinking Water Source Protection for the City of North Bay, 2010a, prepared by AECOM Canada, and includes the following:

- intake characterization (including water treatment plant and raw water quality);
- intake protection zone (IPZ) delineations;
- uncertainty analysis of IPZ delineations and vulnerability scores;
- drinking water issues evaluation;
- threat identification and assessment; and
- gap analysis and recommendations.

The primary purpose is to identify existing and potential activities that could negatively impact the quality of drinking water. To that end, the conclusions must summarize all circumstances that could pose either chemical or pathogen threats based on the MECP Tables of Drinking Water Threats (MECP 2018).

Water quantity assessments were reviewed by a peer review committee as well as by the Manager of Environmental Services for the City of North Bay. Technical review of the water quality assessment was provided by a technical advisory committee, which consisted primarily of members of the Trout Lake Watershed Advisory Committee, a multi-stakeholder committee including representatives of various ministries, institutions, associations, and municipalities. Local knowledge was solicited and comments received at two public meetings, one early in the process and another when the draft findings were presented. Additional peer review was not conducted because the technical challenges posed by the assessment were considered well within the expertise of the consultant. The full report is available at www.actforcleanwater.ca or directly from the North Bay-Mattawa Conservation Authority.

Based on this evaluation, there are no existing significant drinking water threats related to either chemicals or pathogens for the City of North Bay.

However, the North Bay-Mattawa Source Protection Committee (SPC) received approval in 2011 from the MECP to add, as a local threat, the transportation of hazardous substances along the rail line and highway that run through the Intake Protection Zone-1 (adjacent to Delaney Bay where the source water intake is located). These transportation activities are considered moderate or low threats for the North Bay IPZ.

6.2 Water Budget and Water Quantity Stress Assessment

General principles were explained earlier in Section 2.5 Conceptual Water Budget. The methodology specified in the Technical Rules Part III describes a tiered approach whereby all subwatersheds are subjected to a Tier One Subwatershed Stress Assessment and, if stress is low during all months of the year, no further assessment is required. If stress levels are shown to be either moderate or significant, a more robust Tier Two Subwatershed Stress Assessment is completed and, similarly if that reveals moderate or significant stress, a Tier Three Local Area Risk Assessment must be undertaken.

The subwatershed used to assess quantity stress related to the City of North Bay supply is a combination of the contributing areas to both Trout Lake and Turtle Lake, herein referred to as the Trout/Turtle Lake subwatershed.

The channel between the two lakes was previously lowered by blasting and the outlet of Turtle Lake is controlled by a stop-log dam such that the water surface of both lakes is contiguous. The Trout/Turtle Lake subwatershed from which the City of North Bay draws its water underwent all three tiers of analysis for water quantity. The Tier One Subwatershed Stress Assessment was completed by Gartner Lee Ltd (2008b). The Tier Two Subwatershed Stress Assessment and Tier Three Local Area Risk Assessment were undertaken by AquaResource (2010).

For the Tier Two and Tier Three studies, in addition to a surface water flow model, a reservoir routing model was developed enabling verification of model results to a secondary dataset to increase confidence. Since there are no hydrometric gauges on the Trout/Turtle Lake outflow, the adjacent La Vase River and Chippewa Creek subwatersheds were both modelled and the water budget components applied as appropriate to model the Trout/Turtle Lake subwatershed. Further detail is provided below, while a comprehensive description of the approach used for water budget modelling is provided in Appendix B of the Trout/Turtle Lake Tier Two Subwatershed Stress Assessment and Tier Three Local Area Risk Assessment report, available at www.actforcleanwater.ca.

To further understand the nature of the hydrologic flows within a subwatershed and protect vulnerable areas, there is also a need to identify Significant Groundwater Recharge Areas (SGRAs). These are areas which typically facilitate the transmission of precipitation to recharge the aquifer. SGRAs for the Trout/Turtle Lake subwatershed were identified using the threshold of 115% as per Rule 44, further described below.

The purpose of this analysis is to make sure that the dynamics of the system area are well enough understood to ensure the water supply is well managed now and into the future. O. Reg. 287/07 Section 1.1(1) identifies 22 prescribed drinking water threats for the purpose of defining “drinking water threat” under the *Clean Water Act (2006)* subsection 2(1).

Two of these relate to water quantity threats as follows:

- an activity that takes water from an aquifer or surface water body without returning the water taken to the same aquifer or surface water body; and
- an activity that reduces the recharge of an aquifer.

The City of North Bay withdraws drinking water from Trout Lake in the Ottawa River watershed and returns the treated wastewater to Lake Nipissing in the Great Lakes watershed. This practice significantly predates the Great Lakes Charter Annex (2001) (see Section 2.8 Great Lakes Agreements) and is permitted under Ontario Permit to Take Water 6565-7T6PTN.

All such inter-basin transfers do constitute a prescribed threat as per clause 19 above. Further, Trout Lake is located in the headwaters of the Mattawa River and it depends on a relatively small basin to capture precipitation to maintain lake levels. This makes it more vulnerable to over-exploitation; however, the City of North Bay has policies and practices in place intended to minimize over-use and loss.

Historically, the Trout Lake water level has never dropped below the drinking water intake. The intake is located in Delaney Bay of Trout Lake at a depth of 21.5 m. The lake can function as a reservoir for significant periods continuing to provide water to the North Bay system even if the level of the lake is dropping. Therefore, the tiered assessments focus on scenario two and three: percent water demand under normal conditions and the drought assessment scenario as necessary.

A subwatershed's potential for stress is estimated by comparing the amount of water consumed to the amount of water flowing through the subwatershed. Estimated consumptive demand, when divided by the available water supply, minus a reserve term (to allow for other users and ecological demands), and expressed as a percentage, results in a value known as Percent Water Demand. If the moderate or low threshold is surpassed at the Tier One level, a Tier Two assessment is required. The Provincial Thresholds are shown in Table 6-1 below.

Table 6-1. Thresholds for Stress Levels based on Percent Water Demand

Surface Water Potential Stress Level Assignment	Maximum Monthly (%) Water Demand
Significant	≥ 50%
Moderate	> 20% and < 50%
Low	≤ 20%

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The percent water demand calculations and threshold values in a Tier Two Subwatershed Stress Assessment are the same as a Tier One Subwatershed Stress Assessment. However, the Tier Two assessment uses more refined water demand estimates as well as a more advanced water budget model, including both a continuous surface flow model and a groundwater flow model. For the Trout/Turtle Lake subwatershed there are no permitted groundwater takings and the sole municipal water supply is from Trout Lake. As such, a groundwater flow model was not considered.

Municipal water supplies within a confirmed Moderate or Significant potential for stress at the Tier Two level proceed to a locally focused Tier Three Local Area Risk Assessment. The object of the Tier Three Assessment is to estimate the likelihood that municipalities will be able to meet current and future water quantity requirements, while meeting the needs of other water uses. Water budget modelling at the Tier Three level is even more sophisticated than the other Tiered Assessments.

The tasks required to assess the Risk level of each Local Area within a Tier Three Local Area Risk Assessment are listed below:

1. Local Area Delineation. The Local Area for a surface water intake is referred to as an intake protection zone for water quantity, abbreviated as “IPZ-Q”. IPZ-Qs are delineated by determining the total drainage area that provides water to a municipal intake located within subwatersheds identified through a Tier Two Subwatershed Stress Assessment as having a Moderate or Significant potential for stress.
2. Assign Tolerance Level. Tolerance is defined as the municipal system’s ability to meet peak water demands. If the municipal system is able to meet peak water demands, a Tolerance level of “High” is assigned. If the municipal system is not able to meet the peak water demands, a Tolerance level of “Low” is assigned.
3. Assign Exposure Level. Exposure evaluates whether a Local Area can supply sufficient water to meet the demands of the municipal system and other water users. Four scenarios are tested to determine the resiliency of the Local Area to drought conditions, increased municipal takings and potential future changes in land use. If the Local Area can supply sufficient water to the municipal system without causing adverse effects on other water users, an Exposure level of “Low” is assigned. If the Local Area cannot supply sufficient water without causing adverse effects to other water users, an Exposure level of “High” is assigned.
4. Assign Risk Level. The Risk level is essentially the potential that a municipal water supply will not be able to meet its planned pumping rates. Based on the classification of Tolerance and Exposure, the Risk level is assigned to the Local Area. The Risk level for the Local Area may be classified as “Low”, “Moderate” or “Significant”.

The Risk level of the Local Area is a combination of the Tolerance and Exposure levels. The Technical Rules (MECP, 2017) outline how Tolerance and Exposure are used to assign Risk. As per Part IX.1 Rule 98, a Local Area related to a surface water intake is assigned a Risk level in accordance with the following:

- Significant, if the local area has an Exposure level of High and the system has a Tolerance level of Low;
- Moderate, if the local area has an Exposure level of High and the system has a Tolerance level of High;
- Moderate, if the local area has an Exposure level of Low and the system has a Tolerance level of Low; or
- Low, if the local area has an Exposure level of Low and the system has a Tolerance level of High.

6.2.1 Municipal System Description

The MECP has granted the City of North Bay a Permit to Take Water for a maximum taking of 79.5 ML/d from Trout Lake for its municipal water supply. Lake water is supplied to the water treatment plant through a 1.2 m diameter intake pipe extending into Delaney Bay of Trout Lake (City of North Bay 2019). The 300 m long inlet pipe terminates at an intake crib, which is placed at an elevation of 180.3 mASL (21.5 m below the low lake level).

The City of North Bay's estimated service-based population is 54,000 (City of North Bay 2019). A new water treatment facility, completed in October 2009 and in operation since early 2010, has capacity to supply water to over 80,000 people (Veritec 2008a), with a maximum production flow rate of 78.7 ML/d based on the maximum permitted taking of 79.5 ML/d (City of North Bay 2019). A new Permit to Take Water would be needed to provide the additional supply necessary to service the additional people. The water treatment facility consists of membrane filtration combined with ultraviolet light disinfection and chlorination.

The City's water distribution system has 14,800 connections, servicing residential and industrial/commercial/institutional (ICI) water users. In 2010 North Bay City Council approved the installation of water meters for the serviced population as a measure to reduce consumption. The average daily volume of water processed by the treatment plant is 20 ML/d (City of North Bay 2020). There are an estimated 1,000 North Bay residents on private systems that are not serviced by municipal water.

Municipal water use can be divided into the following categories: residential water demand, ICI water demand, distribution system losses, distribution system flushing, and water meter under-reporting. This breakdown, as estimated by Veritec (2008a), is included in Table 6-2.

Table 6-2. Estimated Breakdown of Water Use for City of North Bay for 2006

Water Use Category	Estimated Water Volume (ML/yr)	Per Capita Rate based on 54,000 population (L/p/day)	Percent of Total (%)
Industrial/commercial/institutional (ICI)	3,582	182	27%
Residential	4,569	232	34%
System Flushing	1,468	74	11%
Leakage and Losses	3,661	186	27%
Water Meter Under-Reporting	126	6	1%
Total	**13,406**	**680**	**100%**

The estimated breakdown of water use for the City of North Bay, as presented in Table 6-2 above, may contain uncertainties. To estimate the water use, Veritec relied upon empirical relationships because of limited availability of metering data. To estimate the residential portion of water use, meters were installed on a small number (10) of residential connections. These meters were monitored and the results were scaled up to estimate the total City residential water demand. Due to this extrapolation, the values reported in Table 6-2 may have significant uncertainties associated with them, and should be considered estimates.

Veritec estimated that residential and ICI water demand comprises approximately 34% and 27%, respectively, of the total pumped water. The remaining 39% is considered "Non-Revenue Water", as it is not provided to a customer. This Non-Revenue Water is comprised of water meter under-reporting (1%), flushing required for distribution system maintenance (11%), and distribution system losses (27%). The City of North Bay is continuously working on measures to identify and minimize system leakage and losses.

6.2.2 Stress Assessment Results

Tier One and Tier Two Subwatershed Stress Assessments and a Tier Three Local Area Risk Assessment were completed for the Trout/Turtle Lake subwatershed following the Technical Rules (MOE, 2009b) in effect at the time and Guidance Module #7 (MOE, 2007). (Note: Ministry of Environment or MOE is a previous name of the Ministry of Environment, Conservation and Parks or MECP)

6.2.2.1 Tier One Subwatershed Stress Assessment Results

This Tier One Subwatershed Stress Assessment utilizes available data, first collected and analyzed in the Conceptual Water Budget, to evaluate the cumulative stress within a subwatershed. The screening assessment includes estimating a monthly percentage of the consumptive amount of a water supply that is demanded by water users (Percent Water Demand). In accordance with Part III.3 of the Technical Rules, results of the Percent Water Demand calculations for an existing system will assign a surface water stress level of significant, moderate or low, and determine whether or not to proceed to a further Tier Two Subwatershed Stress Assessment.

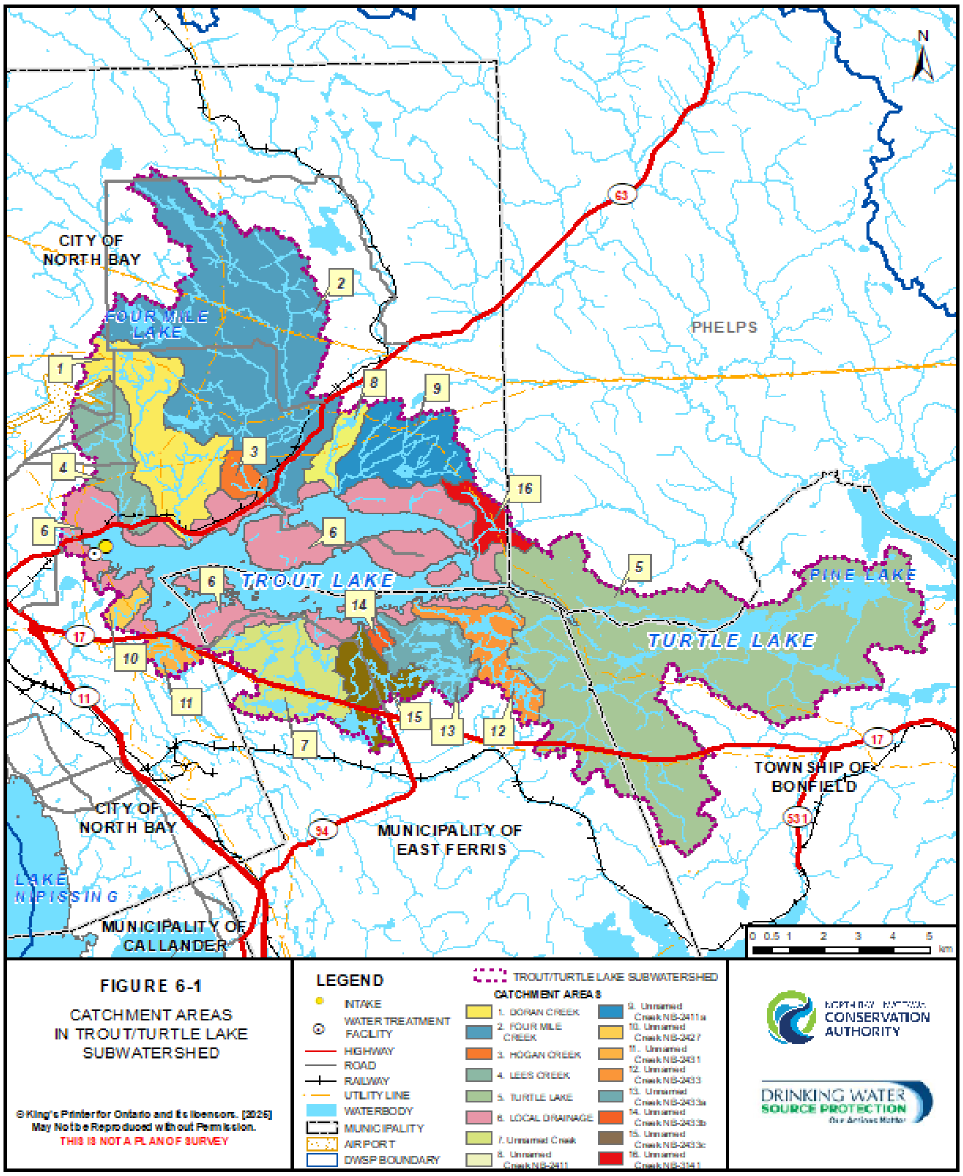
Trout/Turtle Lake subwatershed includes the water that falls within the catchment area feeding both Trout and Turtle Lakes (Figure 6-1), which comprises approximately 181 km^2. In the Trout/Turtle Lake subwatershed, water pathways are essentially surface driven. That is, the low permeability bedrock outcrops drive much of the water to runoff to the watercourses. Water that does infiltrate recharges the shallow, more permeable soil and then follows short groundwater pathways discharging to the watercourses as baseflow. Hence, over a long period of time the change in groundwater storage is essentially zero, and the surface watercourses eventually receive and convey all the water which is not evaporated or transpired.

The Tier One Subwatershed Stress Assessment used an approach that estimated the various components of the hydrologic cycle, including precipitation (P) and evapotranspiration (ET). These were calculated using available precipitation and temperature data (1971-2000) collected during the North Bay–Mattawa Conceptual Water Budget (see Section 2.5 for more details). The calculations were conducted on a monthly basis. Water surplus (precipitation minus actual evapotranspiration) was calculated using the methodology of Thornthwaite and Mather (1957), which took into account mean monthly temperature and precipitation for climate stations within or near the North Bay–Mattawa SP Area.

In addition, the Tier One Subwatershed Stress Assessment takes into account the seasonal variability in streamflow and is, therefore, evaluated using expected monthly values. Since none of the contributing streams in Figure 6-1 are gauged, nor is the outlet of Trout or Turtle Lakes, an assessment of the total discharge was made assuming that the watershed was in balance (i.e. inputs = outputs). Downstream on the Mattawa River, below Bouillon Lake is the nearest long-term HYDAT gauging station (Number 02JE020). This station relates to a 951.5 km^2 total catchment area which includes the areas of the Trout/Turtle Lake subwatershed. Assuming that the physiography of these areas is quite similar, a proportional analysis of the HYDAT data was done to estimate the outflow characteristics of the subwatershed.

Water reserve is an estimate of the amount of streamflow or lake water that needs to be reserved to support other uses of water within the watershed, including both ecosystem requirements as well as other human uses. Typically the MECP requires considering a 10% reserve for surface water systems to provide supply to the downstream users of the surface water system. However, the outlet of Turtle Lake is always observed to be flowing even when there is no overflow from the dam. That is, the leakage from the dam through the stop logs is significant and is driven by the total head behind the dam, and not the incremental change at the crest. Likewise, the watershed that supplies Trout and Turtle Lakes is upstream of the water taking and, therefore, is not affected by the reserve. As a result, reserve was not considered in the percent water demand calculation. NBMCA acknowledges that the Technical Rules require consideration of water reserve, but since the Trout/Turtle Lake subwatershed was determined to proceed to a further and more detailed Tier Two assessment, the current analysis within this Tier One level was considered acceptable.

Figure 6-1. Trout/Turtle Lake Subwatersheds



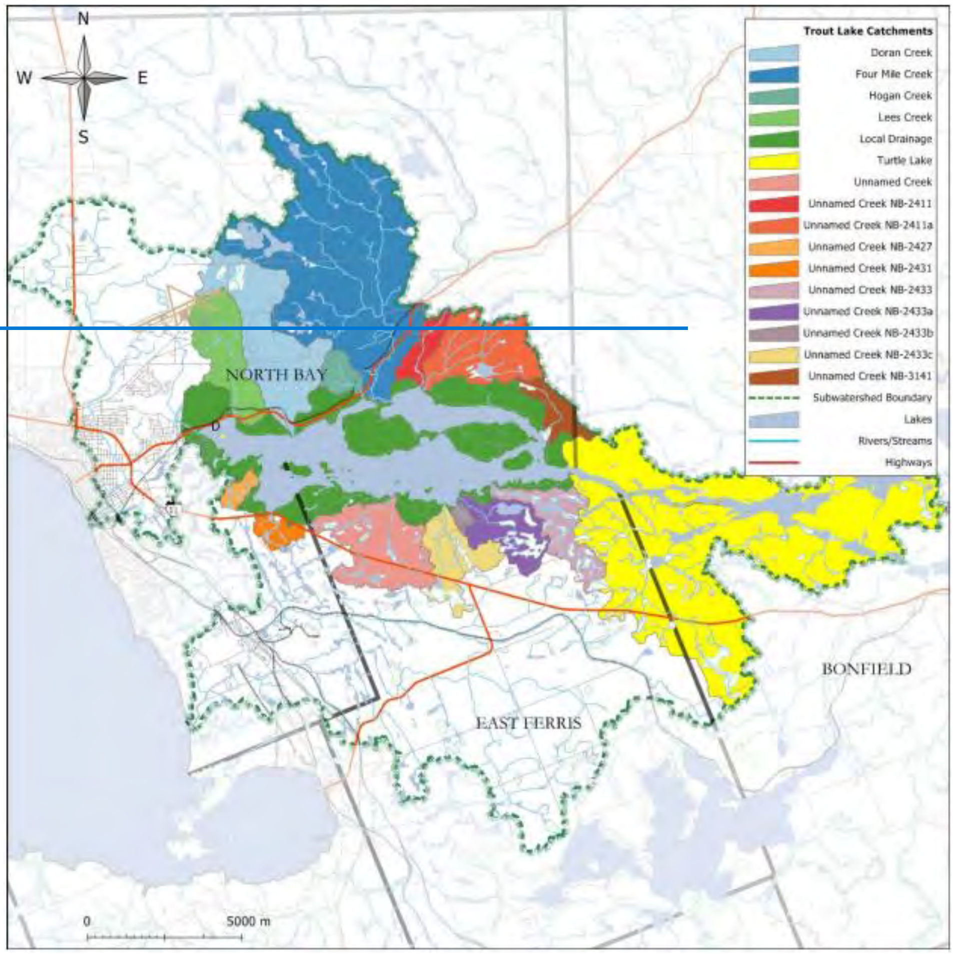

N
W
E
S
Trout Lake Catchments
Doran Creek
Four Mile Creek
Hogan Creek
Lees Creek
Local Drainage
Turtle Lake
Unnamed Creek
Unnamed Creek NB-2411
Unnamed Creek NB-2411a
Unnamed Creek NB-2427
Unnamed Creek NB-2431
Unnamed Creek NB-2433
Unnamed Creek NB-2433a
Unnamed Creek NB-2433b
Unnamed Creek NB-2433c
Unnamed Creek NB-3141
Subwatershed Boundary
Lakes
Rivers/Streams
Highways
NORTH BAY
BONFIELD
EAST FERRIS
0
5000 m

Table 6-3 shows the precipitation, evapotranspiration, surplus, and streamflow results for the Trout/Turtle Lake subwatershed. The average annual precipitation falling on the Trout/Turtle Lake subwatershed is 5.64 m^3/s. Approximately 3.05 m^3/s (or approximately 54% of annual precipitation) is lost through evapotranspiration and 2.59 m^3/s (or approximately 46% of annual precipitation) of water remains as surplus. The amount of surplus is assumed to reach the lake more quickly through runoff and more slowly through groundwater pathways. The total streamflow should theoretically be equal to the surplus, given that groundwater storage changes are negligible over longer periods of time. In this subwatershed, estimated surplus matches with streamflow within about 11%, which is reasonable given the variability of precipitation volumes.

Table 6-3. Monthly and Annual Water Budget Components of Trout/Turtle Lake Subwatershed

Month	Precipitation (m^3/s)	Actual ET (m^3/s)	Surplus (m^3/s)	Streamflow (m^3/s)
January	4.59	0	4.59	1.78
February	3.86	0	3.86	1.65
March	4.46	0	4.46	2.74
April	4.59	1.51	3.07	8.55
May	5.59	5.24	0.35	5.06
June	6.23	7.56	Deficit (-1.33)	2.24
July	6.77	8.32	Deficit (-1.56)	1.57
August	6.42	7.17	Deficit (-0.75)	1.39
September	7.88	4.75	3.14	1.7
October	6.41	2.06	4.36	2.67
November	6.12	0	6.12	3.73
December	4.76	0	4.76	2.75
Annual Average	**5.64**	**3.05**	**2.59**	**2.99**

Note: ET = evapotranspiration

Percent Water Demand calculations require a quantitative assessment of both the water supply and demand. Water demand was quantified based on the Ministry of Environment Permit to Take Water (PTTW) database for the North Bay-Mattawa SP Area (Table 6-4). The database revealed permit holders located within the Trout/Turtle Lake subwatershed, including the City of North Bay's municipal water supply, the Department of National Defense for industrial cooling water, a small communal water supply, and an agricultural permit for irrigation.

The quantities of permitted water taking as reported in the PTTW database are generally presented as maximum allowable takings over a period of time and do not usually reflect the actual taking, which is usually lower. As a result, using permitted water takings to estimate water demand typically overestimates the actual demand. Actual water takings for the North Bay Water Treatment Plant were available and, therefore, were used in this assessment, while the maximum permitted values for the remaining Permits were used as a conservative approach towards estimating water demand.

Table 6-4. Total Water Demand (Takings) of Trout/Turtle Lake Subwatershed

Month	Water Treatment Plant (m^3/s)	Industrial Cooling (m^3/s)	Communal Water Supply (m^3/s)	Agriculture (m^3/s)	Total Demand (m^3/s)
January	0.424	0.1236	0.0006	0	**0.5483**
February	0.4306	0.1236	0.0006	0	**0.5549**
March	0.43	0.1236	0.0006	0	**0.5543**
April	0.42	0.1236	0.0006	0	**0.5443**
May	0.465	0.1236	0.0006	0	**0.5893**
June	0.5117	0.1236	0.0006	0.0075	**0.6435**
July	0.4836	0.1236	0.0006	0.0075	**0.6154**
August	0.5078	0.1236	0.0006	0.0075	**0.6396**
September	0.4414	0.1236	0.0006	0	**0.5657**
October	0.4013	0.1236	0.0006	0	**0.5256**
November	0.4013	0.1236	0.0006	0	**0.5256**
December	0.3826	0.1236	0.0006	0	**0.5069**
Annual Average	**0.4416**	**0.1236**	**0.0006**	**0.0019**	**0.5678**

The Percent Water Demand calculation is as follows:

$$\textit{Percent Water Demand} = \frac{Q_{DEMAND}}{Q_{SUPPLY} - Q_{RESERVE}} \times 100$$

where Q_{DEMAND} is the consumptive demand, Q_{SUPPLY} is the water supply, and $Q_{RESERVE}$ is the water reserve.

As already mentioned, water reserve was not included in this assessment.

Surface water stress levels are determined using assigned threshold values based on the maximum monthly Percent Water Demand calculations, where:

1. % Water Demand >=50% is Significant stress
2. % Water Demand 20-50% is Moderate stress
3. % Water Demand <=20 is Low stress

Based on the Percent Water Demand calculations, the findings of the Tier One water budget for the Trout/Turtle Lake subwatershed, as shown in Table 6-5 below, indicated Moderate levels of hydrologic stress in January through March and June through September. This resulted in a classification of the system as Moderate potential for stress and warranted proceeding to a Tier Two Subwatershed Stress Assessment without the need to model a drought scenario.

Table 6-5. Tier One Level Percent Water Demand and Stress Level of Trout/Turtle Lake Subwatershed

Month	Total Supply (Streamflow) (m^3/s)	Total Demand (takings) (m^3/s)	% Water Demand	Stress Level Assignment
January	1.781	0.5483	31	Moderate
February	1.651	0.5549	34	Moderate
March	2.742	0.5543	20	Moderate
April	8.545	0.5443	6	Low
May	5.063	0.5893	12	Low
June	2.242	0.6435	29	Moderate
July	1.565	0.6154	39	Moderate
August	1.389	0.6396	46	Moderate
September	1.698	0.5657	33	Moderate
October	2.670	0.5256	20	Low
November	3.728	0.5256	14	Low
December	2.750	0.5069	18	Low

6.2.2.2 Tier One Uncertainty

The Tier One Subwatershed Stress Assessment for North Bay is considered to have a high uncertainty, due to:

- Precipitation varies as much as 25% between meteorological stations in the North Bay–Mattawa SP Area
- Streamflow data was pro-rated to calculate water supply in the lake based on a gauge (02JE020 on the Mattawa River) some 28 km downstream of Trout Lake

Regardless, the decision to proceed to a Tier Two Subwatershed Stress Assessment further refines this analysis with greater details and precision and, as such, reduces the uncertainty posed within this Tier One assessment.

6.2.2.3 Tier Two Subwatershed Stress Assessment Results

The Tier Two Subwatershed Stress Assessment is meant to be a confirmation of the Tier One Subwatershed Stress Assessment results, using more refined water demand estimates and a more advanced water budget model than those used for the Tier One Assessment. As noted above, the Tier Two assessment was completed using the version of the Technical Rules in effect at the time (MOE, 2009b). (Note: Ministry of Environment or MOE is a previous name of the Ministry of Environment, Conservation and Parks or MECP)

Tier Two Subwatershed Stress Assessments are developed at the subwatershed scale, similar to the Tier One, and use a continuous surface water model and, where necessary, a groundwater flow model in their development (where the latter was not the case for the Trout/Turtle Lake subwatershed). Municipal water supplies located within subwatersheds that are confirmed to have a Moderate or Significant potential for stress proceed to a locally-focused Tier Three Local Area Risk Assessment.

The Tier Two Stress Assessment described herein was completed using a numerical surface water flow model and a reservoir routing model. These modelling tools provide a physical means of quantifying flow through the Trout/Turtle Lake subwatershed for use in the Stress Assessment calculations. The Stress Assessment includes consideration of the following conditions:

1. Existing System Average - Percent Water Demand calculations;
2. Planned System Demand - Percent Water Demand calculations;
3. Existing System Future Demand - Percent Water Demand calculations; and
4. Existing or Planned System Drought Conditions.

Any one of the above conditions that determines the subwatershed to be at a moderate or significant degree of stress is sufficient to identify that subwatershed as requiring a Tier Three Local Area Risk Assessment.

The Tier Two Subwatershed Stress Assessment begins with the collection and interpretation of maps and data relating to the hydrological system. These data include geologic mapping, land use and vegetation mapping, topographic data, and surface water drainage maps.

The hydrological information is then used to develop and calibrate the hydrologic model. Continuous hydrologic flow models are typically used to describe and quantify water budget components including evapotranspiration, overland runoff, groundwater recharge, and total streamflow. As part of this project, the Guelph All-Weather-Sequential-Events Runoff (GAWSER) model was chosen to simulate the hydrology of the Trout/Turtle Lake subwatershed. As there are no surface water stream gauges within the Trout/Turtle Lake subwatershed, the hydrologic model also included the adjacent La Vase River and Chippewa Creek subwatersheds. Observed streamflows from Water Survey of Canada stream gauges on the La Vase River and Chippewa Creek were used to calibrate and verify the hydrologic model. The location of these two subwatersheds in relation to the Trout/Turtle Lake subwatershed is shown in Figure 6-2.

Following model calibration, hydrologic parameters for these watercourses were transferred to hydrologically similar areas in the Trout/Turtle Lake subwatershed, allowing the representation of the hydrology using physical parameters that represent local conditions as accurately as possible. As an additional measure of model performance, inflows to Trout/Turtle Lake generated through a reservoir routing model were used to estimate lake levels, which allowed comparison against MNR observed lake levels. Verifying model results to a secondary dataset increases the confidence associated with model results.

The Percent Water Demand calculation methods are the same as those used in the Tier One Subwatershed Stress Assessment, where:

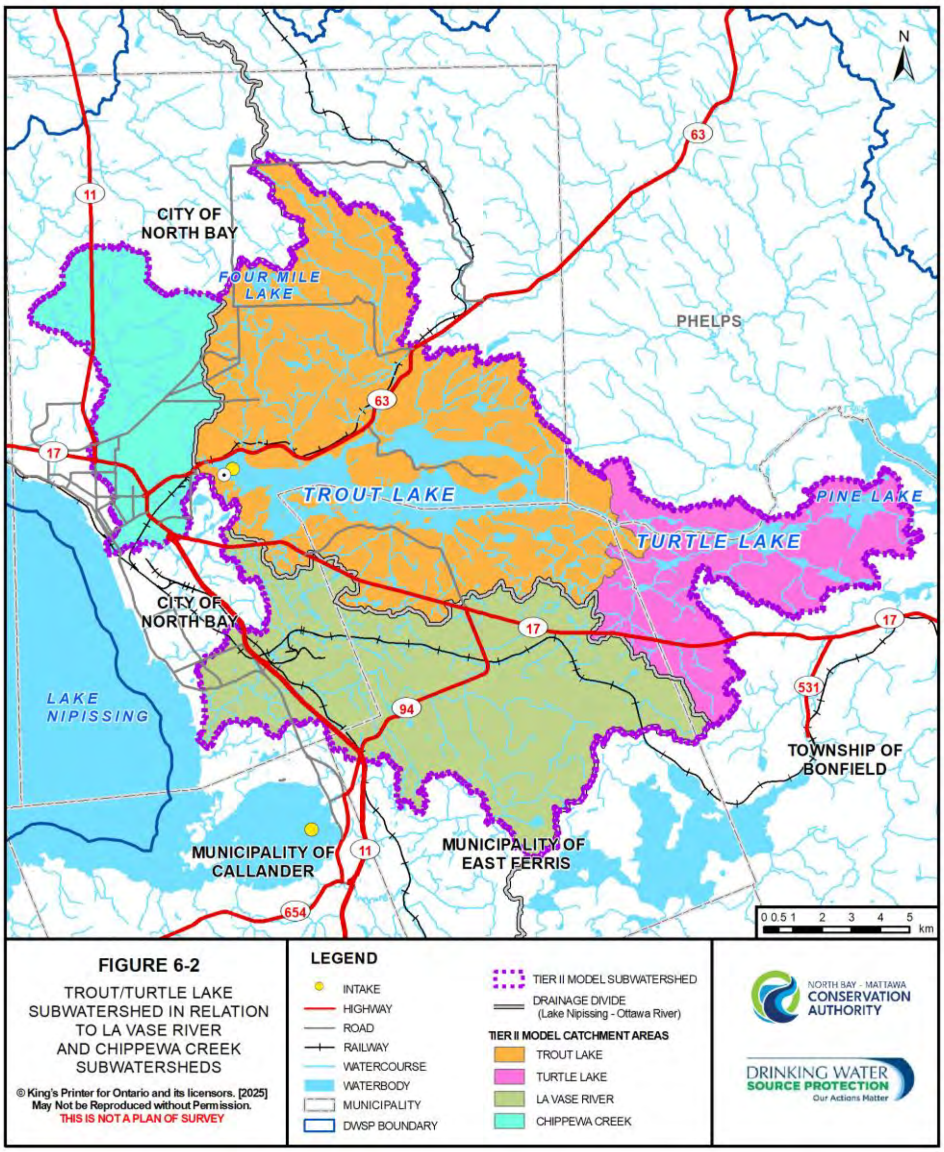
$$\textbf{\textit{Percent Water Demand}} = \frac{Q_{DEMAND}}{Q_{SUPPLY} - Q_{RESERVE}} \times 100$$

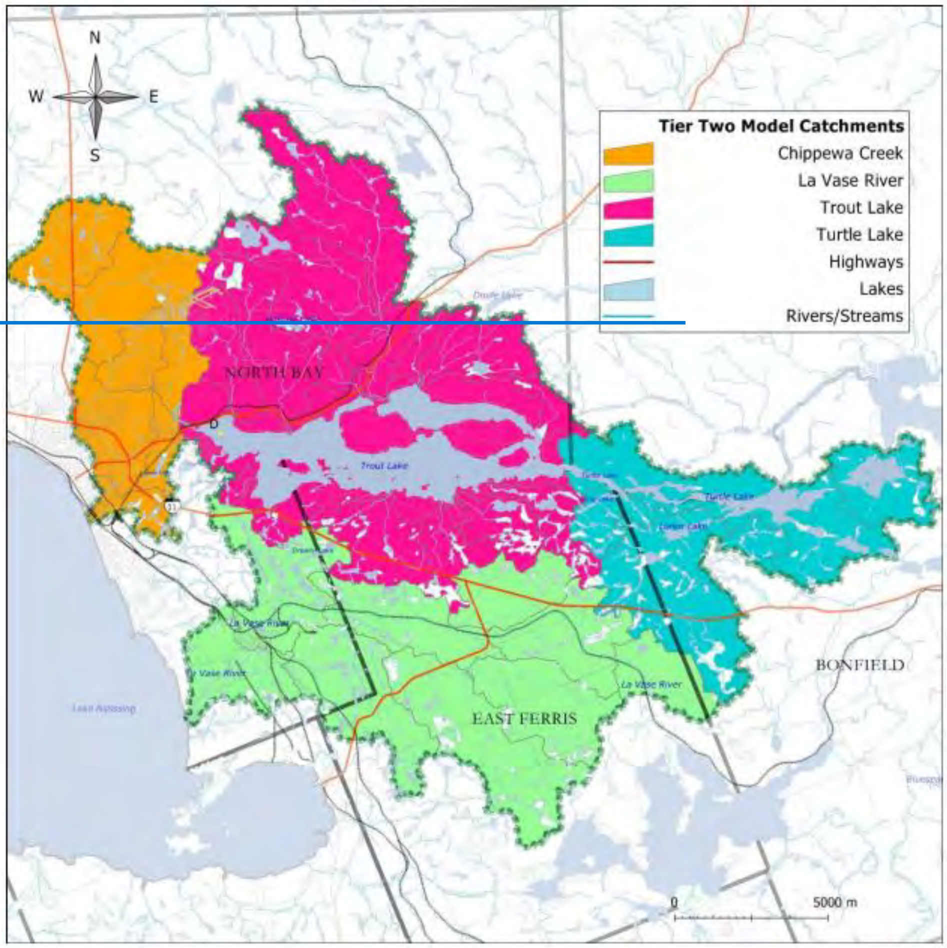
where Q_{DEMAND} is the consumptive demand, Q_{SUPPLY} is the water supply, and $Q_{RESERVE}$ is the water reserve.

Similarly, surface water stress levels are determined using the same threshold values as in the Tier One level. The stress levels are assigned based on the maximum monthly Percent Water Demand calculations, where:

1. % Water Demand >=50% is Significant stress;
2. % Water Demand 20-50% is Moderate stress; and
3. % Water Demand <=20 is Low stress

Figure 6-2. Trout/Turtle Lake Subwatershed in Relation to La Vase River/Chippewa Creek Subwatersheds




Tier Two Model Catchments
Chippewa Creek
La Vase River
Trout Lake
Turtle Lake
Highways
Lakes
Rivers/Streams
N
S
W
E
NORTH BAY
EAST FERRIS
BONFIELD
Trout Lake
La Vase River
0
5000 m

Hydrologic Modelling

As already mentioned, there are no surface water stream gauges within the Trout/Turtle Lake subwatershed. In turn the hydrologic model included the adjacent La Vase River and Chippewa Creek subwatersheds. The Trout/Turtle Lake subwatershed covers an area of 176 km^2 (further refined from the Tier One Subwatershed Stress Assessment). Annual and mean annual precipitation as recorded at the North Bay Airport station from 1950-2005 was used in the modeling; this climate station is located in the Chippewa Creek subwatershed, adjacent to the Trout/Turtle Lake subwatershed. An upward trend in precipitation is evident, with a mean annual precipitation of 1,070 mm over the last 30 years (1975-2005).

Land cover is one of the primary factors that influence how a subwatershed will respond to a precipitation event and, as such, is a critical component of the modelling. Land cover for the study area was taken from the 2000 Edition of the Ontario Provincial Land Cover Database (Table 6-6). As there have been no significant land use changes over the last decade, it is assumed this data is representative of current conditions. Approximately 70% of the Trout/Turtle Lake and the La Vase River subwatersheds are forested. These subwatersheds also contain numerous small lakes and wetlands. Approximately half of Chippewa Creek subwatershed is forested with the remaining half being urban lands associated with the City of North Bay.

Table 6-6. Land Cover as a Percentage of Total Area for Trout/Turtle Lake, Chippewa Creek and La Vase River Subwatersheds

Land Cover	Trout/Turtle Lake	Chippewa Creek	La Vase River
Water	17%	1%	1%
Settlement/Infrastructure	4%	49%	6%
Bedrock	0%	1%	0%
Forest Sparse	6%	5%	14%
Forest Dense Deciduous	27%	14%	15%
Forest Dense Mixed	30%	24%	37%
Forest Dense Coniferous	6%	5%	5%
Bog - Treed	2%	0%	3%
Agriculture - Pasture	6%	1%	12%
Cloud/Unknown	2%	0%	7%

Note: Based on 2000 Ontario Provincial Land Cover Database (Spectranalysis, 2004)

Surficial geology is another crucial component of the watershed characterization and subsequent modelling, as it determines the rate and volume of water that penetrates the soil surface. The surficial geology illustrates two main geologic regions within the study area. The regions are separated by the North Bay Escarpment, which runs along the north shore of Trout/Turtle Lake. The area above the Escarpment, that is the northern half of Chippewa Creek subwatershed and the area northwest of Trout/Turtle Lake, has a thicker overburden characterized by coarser grained materials, such as sands and gravels, deposited as till and glaciofluvial outwash. The area below the Escarpment, that is the area south and east of Trout/Turtle Lake, consists of bedrock with very thin overburden. There are pockets of glaciolacustrine and organic deposits throughout the study area, which are comprised of finely grained materials such as clays.

Hydrologic modelling is required to estimate streamflow, reservoir water levels and major water budget components, such as evapotranspiration, direct overland runoff and groundwater recharge. Model calibration involves adjusting hydrologic parameters to best reflect the observed hydrologic conditions. Following calibration, the model is then tested to confirm that the parameter adjustments are representative of major hydrologic processes; this modeling procedure is called verification.

The results of the calibration and verification phase demonstrated that the model reasonably replicates the major hydrologic processes in the Chippewa Creek and the La Vase River subwatersheds. As such, the model parameters for Chippewa Creek and the La Vase were transferred to the Trout/Turtle Lake subwatershed with confidence that natural conditions were being reasonably replicated. The model parameters applied to Trout/Turtle Lake subwatershed were validated by comparing simulated streamflow at five locations in Trout/Turtle Lake subwatershed against observed spot flow measurements taken by NBMCA in May, June, July, and August 2008.

A reservoir routing model was created to validate estimated inflows to Trout/Turtle Lake. This routing model considers inflows, withdrawals, evaporative losses, and level-storage-discharge relationships to generate a daily time series of Trout/Turtle Lake water levels. The 1995-2005 time period used for this analysis coincides with the calibration period used for the hydrologic model. The reservoir routing model produced simulated reservoir levels generally consistent with observations of the Trout/Turtle Lake water levels recorded at the Turtle Lake Dam; this can also be considered a secondary validation of the simulated Trout/Turtle Lake inflows.

The mean annual water budget (precipitation, evapotranspiration, runoff, and recharge) based on the GAWSER model was calculated on a subwatershed basis for the 1975-2005 study period (Table 6-7). The four water budget components are described below:

1. Precipitation – Depth of water that reaches the ground surface via rainfall or snowmelt, based on reported climate data.
2. Evapotranspiration – Depth of water that leaves the subwatershed via evaporation, transpiration and sublimation.
3. Direct Overland Runoff – Depth of water that does not infiltrate the soil, but reaches the surface water system via overland flow.

4. Groundwater Recharge – Depth of water that infiltrates into and past the evaporative root zone and enters the groundwater flow system. This water is returned to the surface water system via groundwater discharge, and sustains dry weather streamflow (baseflow).

Table 6-7. Mean Annual Water Budget on a Subwatershed Basis

Subwatershed	Mean Annual Water Budget for 1975-2005 (mm/yr and (% of Precipitation))			
	Precipitation	Evapo-transpiration	Overland Runoff	Groundwater Recharge
Trout/Turtle Lake	953	568 (60%)	246 (26%)	139 (15%)
Chippewa Creek	1,027	523 (51%)	316 (31%)	188 (18%)
LaVase River	924	549 (59%)	282 (31%)	93 (10%)

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Water Demand

Two surface water permits are located within the Trout/Turtle Lake subwatershed: the City of North Bay permit with a maximum rate of 79.5 ML/d (920 L/s); and the Canadian Forces Base industrial cooling permit with a maximum rate of 10.7 ML/d (124 L/s). There are no permitted groundwater takings within the subwatershed. These two water takings result in an annual average rate of water withdrawal from Trout/Turtle Lake subwatershed of 44.9 ML/d (520 L/s); representing about half of the maximum permitted water withdrawal rate. Applying a consumptive factor (percentage based on the net amount of water taken from a source and not returned to the source in a reasonable time) of 2% to the cooling taking, and 100% to the municipal supply (since water withdrawn from Trout Lake is diverted into Lake Nipissing), yields a consumptive withdrawal of 34.6 ML/d (398 L/s) from the subwatershed.

Using output from the hydrologic model and reported water withdrawals from the City of North Bay, the Tier Two Subwatershed Stress Assessment was completed by comparing the consumptive water demand within the subwatershed to the total streamflow entering the subwatershed, on a monthly basis (Table 6-8). This comparison results in the Percent Water Demand, which when compared to Provincial thresholds, determines if the subwatershed has a Significant, Moderate or Low potential for stress.

Table 6-8. Existing Conditions Tier Two Assessment for Trout/Turtle Lake Subwatershed

Term	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Consumptive Water Demand (m^3/s) [1]	0.39	0.39	0.38	0.38	0.39	0.41	0.42	0.42	0.44	0.39	0.38	0.39
Water Supply (m^3/s) [2]	0.74	0.64	2.39	5.97	2.81	1.95	1.65	1.37	1.81	2.09	2.48	1.47
Water Reserve (m^3/s) [3]	0.43	0.33	0.38	1.12	0.92	0.78	0.43	0.42	0.51	0.62	0.85	0.84
Water Supply - Reserve (m^3/s)	0.31	0.30	2.01	4.85	1.89	1.17	1.21	0.95	1.31	1.47	1.63	0.63
Percent (%) Water Demand [4]	**128**	**129**	**19**	**8**	**21**	**35**	**35**	**44**	**34**	**27**	**23**	**62**

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Note: Shaded boxes for Percent (%) Water Demand indicate months where the threshold was exceeded for Moderate or Significant stress

Definitions:

1- 2008 Mean Monthly Municipal Water Demand + Permitted Industrial Cooling Consumptive Demand

2- Median Monthly Streamflow (1975-2005)

3- 90th Percentile Exceedance Streamflow (1975-2005)

4- Percent Water Demand = Consumptive Demand / (Supply-Reserve) x 100%

The Tier Two Subwatershed Stress Assessment results for the Trout/Turtle Lake subwatershed indicated that the subwatershed has a **Significant** potential for stress in January, February and December, and a **Moderate** potential for stress from May to November. The *Clean Water Act* Technical Rules (MECP, 2017) require any municipal system located within a subwatershed that has a Moderate or a Significant potential for stress at the Tier Two level to undergo a Tier Three Local Area Risk Assessment.

As the Trout/Turtle Lake subwatershed is classified as having a **Significant** potential for stress under existing system demand conditions, the Percent Water Demand for planned or future system conditions did not need to be calculated. Likewise, consideration of existing or planned drought system conditions for the Trout/Turtle Lake subwatershed was not necessary.

6.2.2.4 Tier Two Uncertainty

The uncertainty assigned to this classification by AquaResource (2010) was Low, mostly based on the facts that:

1. Consumptive demand was determined using actual pumping data from the City of North Bay rather than maximum permitted amounts;
2. High quality local meteorological data was available from the weather station at the North Bay Jack Garland Airport; and
3. The findings of the reservoir routing model were consistent with those of the surface flow model.

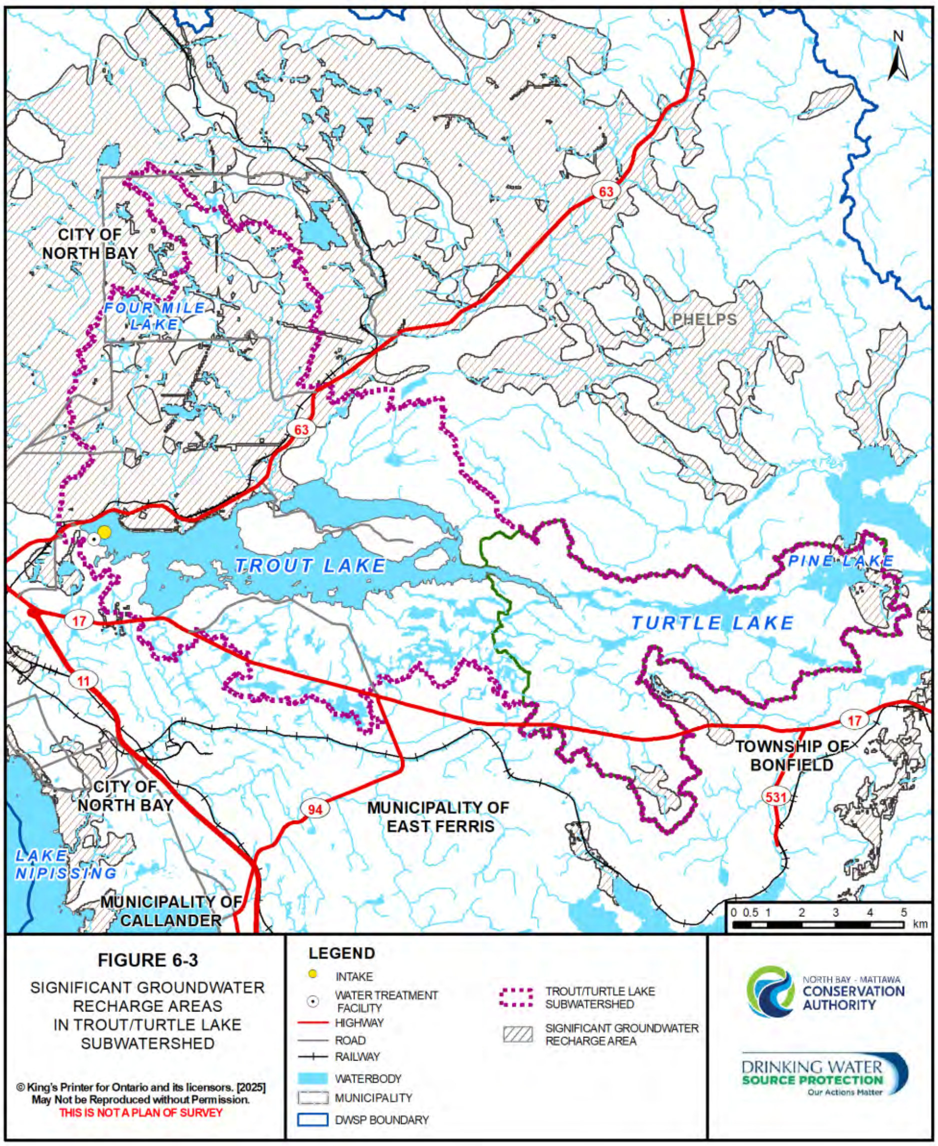
6.2.2.5 Significant Groundwater Recharge Areas (SGRA)

Significant Groundwater Recharge Areas (SGRA), as delineated using the methodology prescribed by Technical Rule 44(1), are presented in Figure 6-3. Large portions of the Four Mile Creek and Doran Creek subwatersheds are identified as SGRAs. Plans for aggregate and other resource extraction, and development in those areas will need to consider its vulnerability with respect to maintenance of the aquifer and baseflow to Trout/Turtle Lake.

It should be noted, however, that when relying on the SGRA map to support water quantity or water quality protection activities, there is a need to consider some of the assumptions and limitations associated with the delineated SGRAs. They are as follows:

1. Significant volumes of groundwater recharge may occur in areas that are not classified as SGRAs. Estimated groundwater recharge rates in some areas may be high, but just below the SGRA threshold.
2. The hydrologic model is calibrated to achieve the best overall fit to measured streamflow. Within a specific watershed, there is a wide range of estimated groundwater recharge rates depending on local geologic type and land cover. While the calibration process addresses the confidence of the hydrologic simulation within a subwatershed, the water budget parameters for a specific Hydrologic Response Unit are not calibrated and the results should only be considered as a relative measure of hydrologic processes.

Figure 6-3. Significant Groundwater Recharge Areas (SGRA) in the Trout/Turtle Lake Subwatershed



6.2.2.6 Tier Three Local Area Risk Assessment Results

The objective of the Tier Three Local Area Risk Assessment is to estimate the likelihood that municipalities will be able to meet current and future water quantity requirements. The Tier Three Assessment is a more detailed study carried out on all municipal water supplies located in subwatersheds that were classified in the Tier Two Subwatershed Stress Assessment as having a Moderate or Significant potential for hydrologic stress. The goal of this assessment is to determine significant or moderate threats to water quantity, so to prioritize the risk management measures that should be applied to reduce the level of risk associated with a municipal water supply system not being able to meet current or future water demands.

As noted above, the Tier Three assessment was conducted using the version of the Technical Rules in effect at the time (MOE, 2009b). (Note: Ministry of Environment or MOE is a previous name of the Ministry of Environment, Conservation and Parks or MECP). The tasks required to assess the Risk level of each Local Area include:

1. Determine Local Area Delineation;
2. Assign Tolerance Level;
3. Assign Exposure Level; and
4. Assign Risk Level

Local Area Delineation (IPZ-Q)

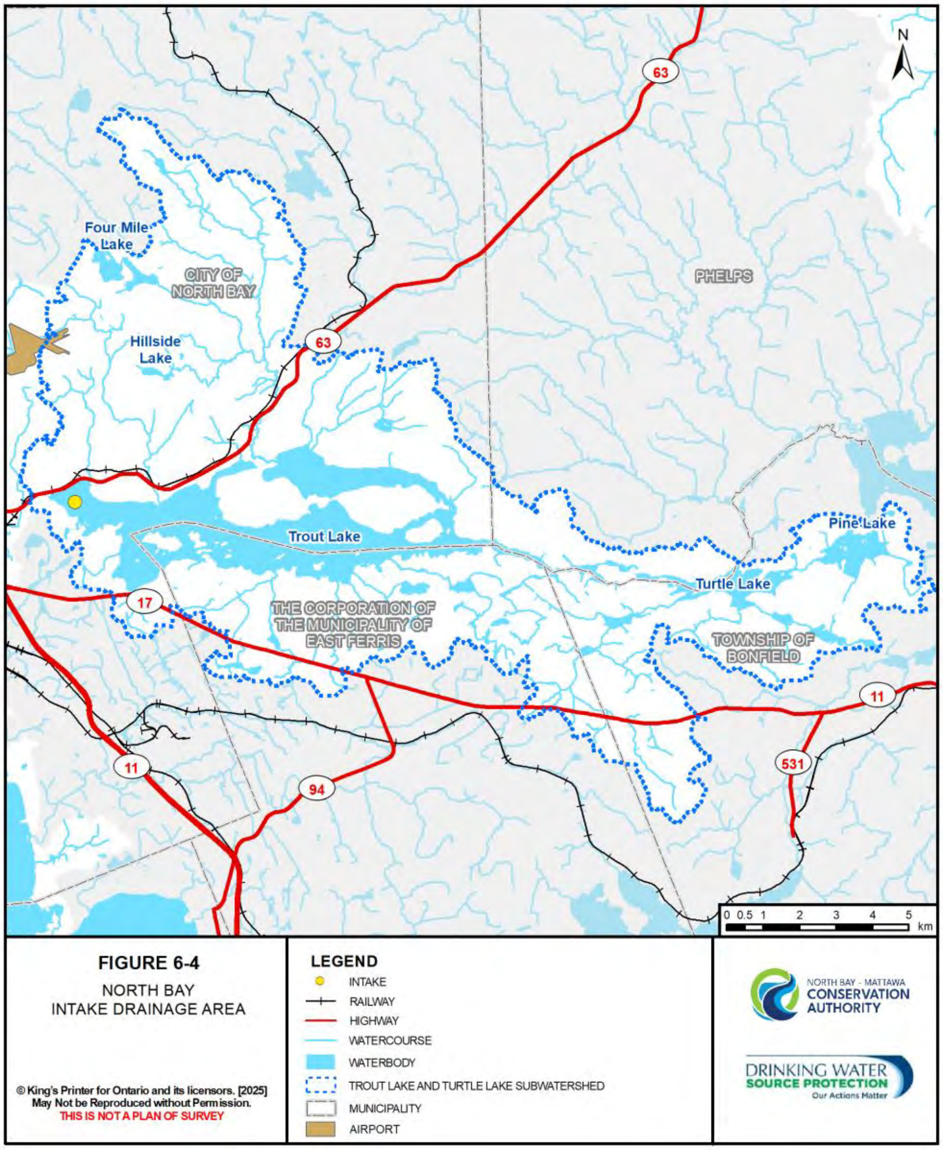
The first task in the Tier Three Local Area Risk Assessment is determining the total drainage area that provides water to the municipal intake, or the local area delineation (IPZ-Q). In the case of the North Bay intake, the drainage area contributing to the intake includes the entire Trout/Turtle Lake subwatershed. This is shown in Figure 6-4.

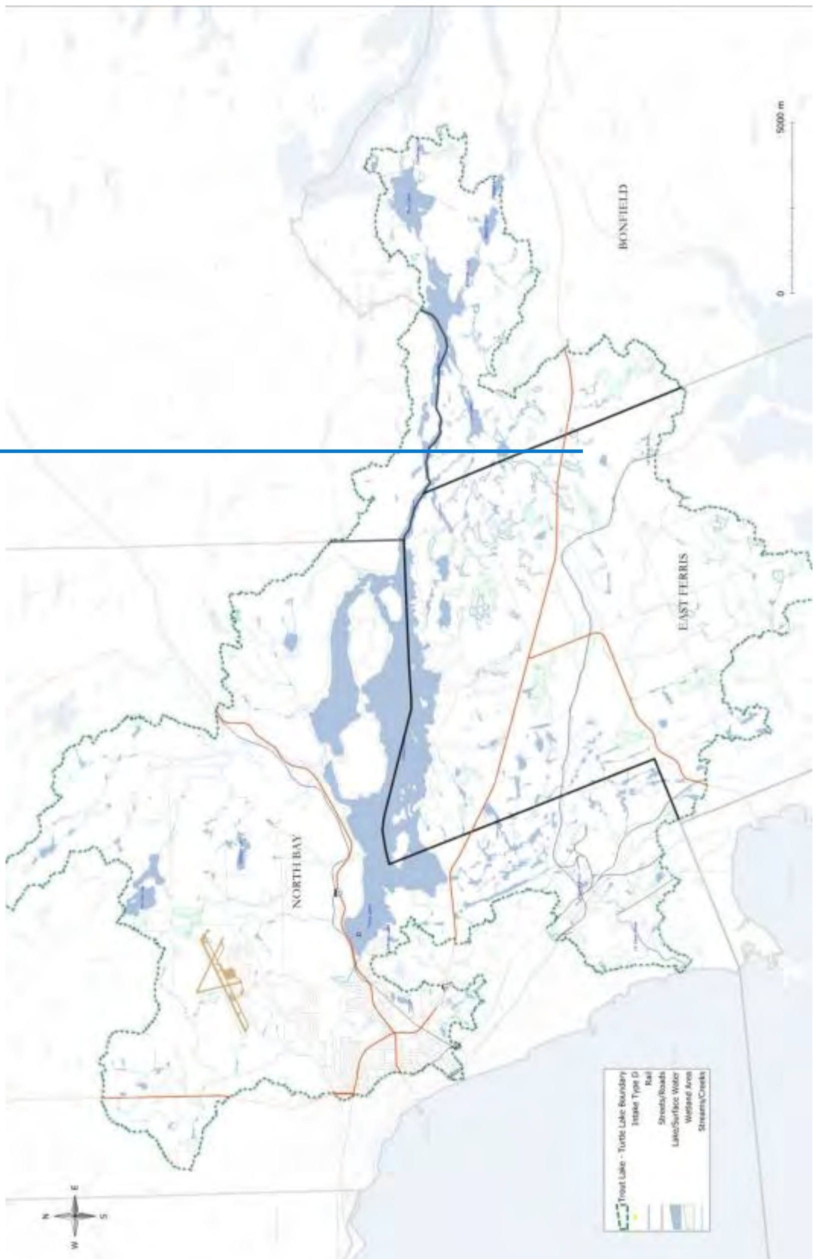
Assigning Tolerance Level

The Tolerance level of a municipal drinking water supply system is defined as its ability to meet peak demands. A municipal system within a Local Area (IPZ-Q) is classified as having either a Low or High tolerance level depending on the municipal water supply system's ability to supply water to users during peak demand periods. Specifically, Part IX.3 Rule 107 of the Technical Rules (MOE, 2009b) outlines how Tolerance is assigned to a municipal drinking water system. (Note: Ministry of Environment or MOE is a previous name of the Ministry of Environment, Conservation and Parks or MECP).

The North Bay intake is located 23 m below the observed Trout Lake low water level elevation (201.8 masl). Considering the volume of Trout Lake alone, it is estimated that the volume of water contained between the intake elevation and the standard operating level is 270,000 ML. Conservatively, assuming no inflow to the lake at all, this volume of water would sustain the City of North Bay's 2008 average withdrawal (~425 L/s, or 37 ML/d) for approximately 20 years.

Figure 6-4. North Bay Intake Total Drainage Area




BONFIELD
EAST FERRIS
NORTH BAY
0
5000 m
Trout Lake - Turtle Lake Boundary
Intake Type D
Rail
Streets/Roads
Lake/Surface Water
Wetland Area
Streams/Creeks

While the storage held in the lake below the standard operating level is sufficient to sustain the municipal taking for a significant period of time with zero inflow, the severe impacts of such a situation occurring should be recognized. In addition to discharge from Turtle Dam ceasing and affecting downstream lakes and rivers, recreational use, aquatic and wetland habitats within Trout/Turtle Lake would be significantly impacted as lake levels are drawn down. It is recommended that the City of North Bay continue to manage municipal water demand with the aim to maintain lake levels within historical ranges.

To assess the City's ability to withdraw sufficient water to meet peak demands, while remaining within PTTW restrictions, peak municipal demands were compared to the maximum permitted withdrawal rate associated with the water treatment plant. The City of North Bay experienced a peak day demand in the summer of 2001 that was approximately 90% of the City's maximum permitted withdrawal rate (North Bay, 2003). As a result of this event, the City instituted an outdoor water use by-law to restrict outdoor water use to every other day. Water withdrawal reports from the City of North Bay indicate that following implementation of the outdoor water use bylaw, 2002-2008, the maximum daily demand between 2002 and 2008 has been less than 70% of the permitted withdrawal rate. This indicates that the water treatment plant is able to withdraw sufficient water from Trout Lake to meet peak demands, while remaining in compliance with the PTTW.

Due to the volume of water stored within Trout/Turtle Lake, and the ability of this storage to supply sufficient water to the municipal intake to meet peak demands, as well as the ability of the City to withdraw peak demands within their current PTTW, a Tolerance classification of **High** is assigned to the North Bay municipal drinking water system.

Assigning Exposure Level

The next step is to determine Exposure Levels. When assessing the Exposure level, Part IX.2 of the Technical Rules (MOE, 2009b) requires that four circumstances for a surface water intake be considered as follows:

- Long term average climate period, existing/current system, average daily pumping;
- Drought period, existing/current system, average daily pumping;
- Long term average climate period, committed/future demand, average daily pumping during period of committed/future demand; and
- Drought period, committed/future demand, average daily pumping during period of committed/future demand.

Note that the Technical Rules require an assessment of future demand as either a planned system or an existing system with a committed demand. Through consultation with the City of North Bay, there are no planned systems associated with the North Bay municipal system; any references to a "planned system" within this Tier Three assessment actually refers to an existing system with a committed/future demand. (Note: Ministry of Environment or MOE is a previous name of the Ministry of Environment, Conservation and Parks or MECP).

The following Sections document each of the components of the above four scenarios. Assumptions related to each component are also documented.

1. Long Term Average Climate Period

Similar to the Conceptual Water Budget and Tier Two Subwatershed Stress Assessment, the Tier Three assessment used a 30-year period from 1975-2005. Simulated stream flow into Trout/Turtle Lake, estimated by the GAWSER model over this time period, was used when determining lake levels (AquaResource, 2010).

2. Drought Period

The Tier Three Local Area Risk Assessment requires consideration of a drought scenario. The drought scenario is meant to evaluate the possibility of short-term climate variability triggering an Exposure exceedance. The Technical Rules specify that the drought period considered for surface water systems is the continuous ten-year period with the lowest mean annual precipitation; however, MNR subsequently provided direction that a shorter two-year period is more appropriate to evaluate drought impacts on surface water bodies. As such, a two-year period was used to evaluate drought impacts.

An in-filled dataset for the North Bay Airport, distributed by the Ministry of Natural Resources, was used for this Assessment (as developed by Schroeter and Associates, 2007). The period of record associated with this station is 1950-2005, and through this period there were two major drought periods (as seen on Figure 6-5); one in the 1960's, and the second during the late 1990's/early 2000's.

A two-year running average was applied to the North Bay climate dataset to determine the period for use in the drought scenario. The lowest continuous two-year period within the 1950-2005 period was 1962-1963, with an average total precipitation of 654 mm/yr, which represents 64% of the long term (1970-2005) average precipitation. Inflows to Trout/Turtle Lake estimated by the GAWSER model for this time period were used to determine corresponding lake levels.

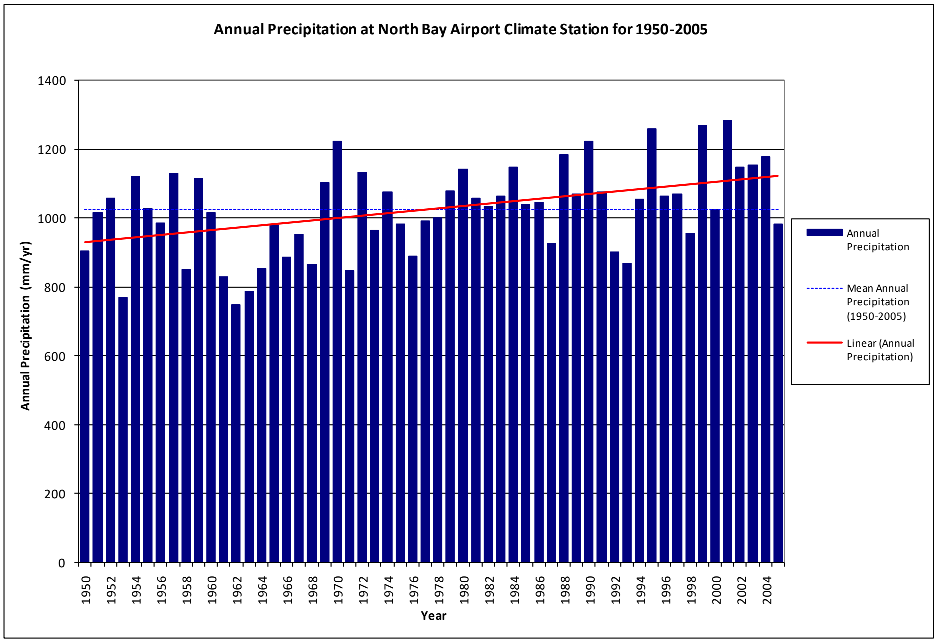
3. Existing Pumping

Consistent with the Tier Two Assessment, reported withdrawal rates from 2008 were used at the Tier Three level for the existing pumping scenario.

4. Committed/Future Pumping

Planned system rates are defined as the groundwater or surface water pumping rates used for a drinking water system that is planned to be established, with one of the following approvals: an individual Environmental Assessment (EA) approval; or if the system has been identified as the preferred solution within a completed planning process with an approved Class EA; or the system would serve a First Nation Community as defined in the *Indian Act*, Canada (O.Reg. 287/07, s.1(1)). According to this definition, and through consultation with the City of North Bay, there are no planned systems associated with the North Bay municipal system.

Figure 6-5. Annual Precipitation Recorded at North Bay Airport Meteorological Station for 1950-2005



The current drinking water treatment plant and permit to take water have sufficient capacity to provide drinking water to the City of North Bay now and into the foreseeable future. As such, the future pumping scenarios within this assessment apply to an existing system with a committed demand, as per the Technical Rules. The committed water demand is associated with planned or approved developments which will be serviced by the municipal drinking water supply. The City of North Bay has estimated the number of building lots which have been approved for development to be approximately 1,400. It should be noted that this may include lots within developments already under construction, which would be already accounted for in the 2008 population estimate. As such, 1,400 additional building lots are considered a conservatively high estimate. Statistics Canada has reported an average of 2.4 people per dwelling for the City of North Bay (Statistics Canada, 2007), resulting in a committed population increase of 3,360 people.

To evaluate the impacts of planned population growth on Trout/Turtle Lake water levels, and to determine if lake levels will remain above the Exposure threshold, the approved population increase, along with the future per capita rate of 680 L/p/day (litres per person per day) was used. As the City of North Bay is currently implementing a number of conservation measures that will reduce water consumption, future estimates evaluated in the Exposure scenarios also included the effects of these measures. Although the consideration of conservation measures is beyond the requirements of the *Clean Water Act*, these factors are expected to be in place during the time period of the committed/future demand scenario described below. For this reason, conservation measures are included within this assessment as a more representative prediction of future pumping rates. A second scenario, not considering the impact of the infrastructure upgrades, was also included. The pumping rates for the two scenarios are included in Table 6-9.

Table 6-9. Planned Pumping Scenarios

	Per Capita Rate without Conservation (680 L/d)	Per Capita Rate with Conservation (458 L/d)
	Average Taking ML/d (L/s)	
Committed Serviced Population (58,360)	40 (459)	27 (309)

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Planned Land Use

When evaluating Exposure, the Technical Rules (MOE, 2009b) require consideration of future land use developments, as well as committed pumping. (Note: Ministry of Environment or MOE is a previous name of the Ministry of Environment, Conservation and Parks or MECP). Land use changes, particularly urban development, have the potential to impact the hydrologic cycle, and will often result in changes to available water, both in terms of total volume of streamflow, as well as the seasonal distribution of streamflow.

The North Bay Official Plan (North Bay, 2012) describes and outlines how and where future development will be accommodated. The City of North Bay recognized the importance of Trout Lake, both for recreational and water supply aspects, and incorporated policies into the Official Plan that aimed to protect the Lake. The following text was taken from Sections 3.5.1 and 3.5.2 of the Official Plan, and describes the development controls placed on lands within the Trout/Turtle Lake subwatershed.

> "3.5.1 This Official Plan recognizes that Trout Lake is a valuable community resource in that it is the sole source of drinking water for the City of North Bay as well as for private systems which draw their water directly from the lake; that this water body is a significant recreational resource at the fringe of the urban area which offers unique opportunities not found in such close proximity to most Canadian communities; that the shoreline of this water body has a special aesthetic appeal for the development of seasonal and permanent residential uses; and that the general population of North Bay wishes to see that special care is taken through strict lake and watershed development controls to maintain or improve its existing level of water, aesthetic and fishery quality.
>
> 3.5.2 This Plan recognizes that all lands located within the Trout Lake watershed are connected to Trout Lake by surface and ground water drainage, and that all uses in the watershed directly or indirectly influence Trout Lake. **It is the intent of this Plan to strictly control or limit the nature and extent of development** along the shoreline of Trout Lake, including second tier or back lot development, development on islands in Trout Lake, development

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along major inflowing streams to Trout Lake, and development in the Trout Lake watershed in general."

This intent by the City to limit development within the Trout Lake watershed is evident by the land area where urban services are provided. Serviced land is typically required for urban development. Only a small portion of the urban serviced area lies within the Trout/Turtle Lake subwatershed. This area is located in the easternmost portion of the City, adjacent to Delaney Bay, and is 0.9 km^2 in area. As this area is currently fully developed, and no other lands within the Trout/Turtle Lake subwatershed are serviced, it is expected there will be negligible land use change within the City of North Bay portion of the Trout/Turtle Lake subwatershed.

Municipalities lying adjacent to Trout or Turtle Lakes include the Municipality of East Ferris, Township of Bonfield and Phelps Township. These are predominantly rural townships, with no urban areas within the Trout/Turtle Lake subwatershed. Due to the lack of urban centres, it is expected that there will be no significant land use change within these municipalities.

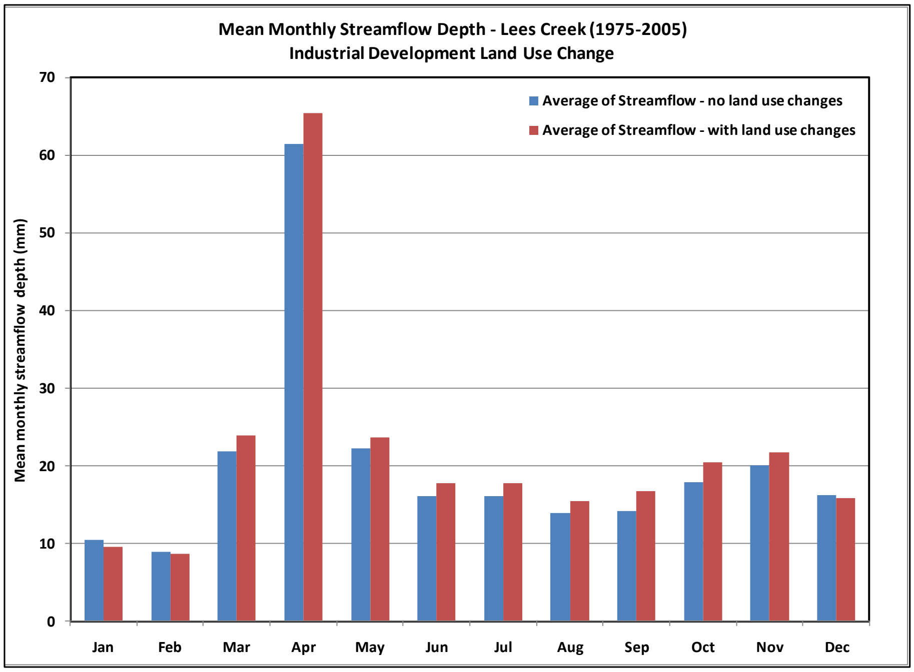
Despite the measures outlined above, some minor land use change is expected within the Trout/Turtle Lake subwatershed. These anticipated land use changes include a 45 ha (112 acres) industrial development within Lees Creek subwatershed (City of North Bay, 2009), as well as a 0.2 ha (0.5 acres) peat extraction site and a 6.5 ha (16 acres) aggregate extraction site, both of which are within Doran Creek subwatershed (North Bay-Mattawa Conservation Authority, 2009). These developments represent approximately 0.3% of the Trout/Turtle Lake drainage area.

These developments were considered within the GAWSER model by modifying the hydrologic response unit (HRU) classification for the affected subwatersheds (Lees and Doran Creeks). The industrial development was represented by assuming a typical impervious percentage for industrial developments (90%) and increasing the impervious HRU class by the corresponding area. The peat extraction site was represented by transferring land area from the wetland class to the open water class. The aggregate extraction site was simulated by utilizing a high infiltration, low storage, low evapotranspiration HRU class, which supplies infiltrated water quickly to the watercourse. As the Technical Rules require no mitigative measures to be considered when assessing the level of Risk, no best management measures, such as maintaining recharge volumes, were considered during this analysis.

Included in Figure 6-6 and Figure 6-7 is the mean monthly flow under pre-development and post-development conditions for Lees and Doran Creeks, respectively.

As shown on Figure 6-6, the industrial development in Lees Creek results in increases in streamflow for most months. This is due to the impervious area added by the industrial development causing the majority of rainfall or snowmelt to become overland runoff, reducing the amount of infiltration, and subsequently reducing evapotranspiration. The industrial development also reduces the amount of groundwater recharge generated and, therefore, lowers streamflow during months that experience limited overland runoff (e.g. December-February). The industrial development would also impact streamflow during drought periods, where the majority of streamflow would be derived from groundwater discharge. As the volume of groundwater recharge is reduced by impervious land cover, groundwater discharge would be reduced.

Figure 6-6. Planned Land Use Scenario - Lees Creek

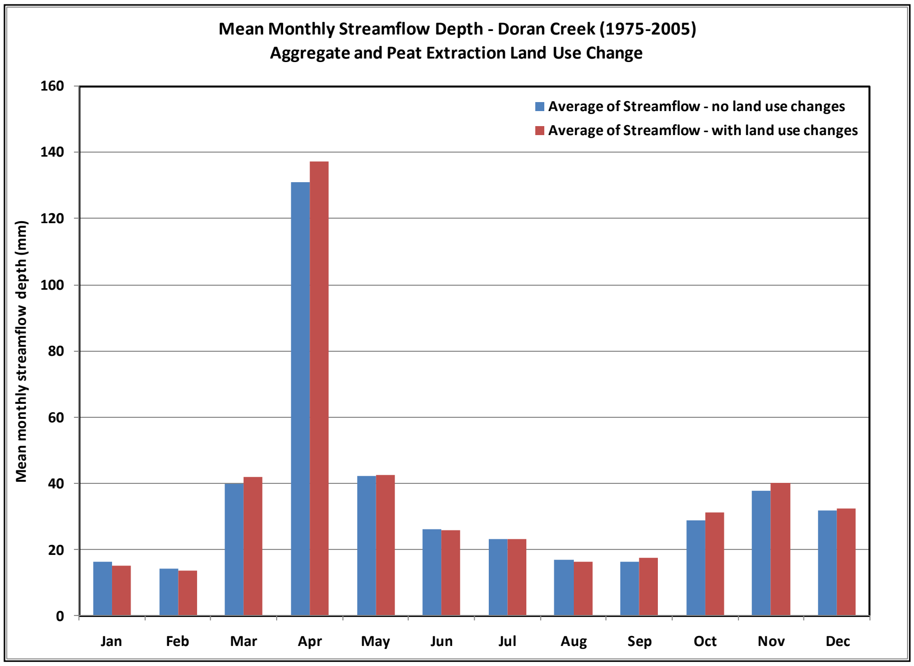


The impact of the aggregate and peat extraction land use scenario on Doran Creek generally results in a quicker responding system (Figure 6-7). Streamflow during the spring months is generally higher as water is routed through to the watercourse faster, with lower summertime streamflow. Streamflow recovers quicker in the fall from the traditional summertime lows; however, streamflow during the months of January and February will be lower.

Land use policies contained within the City of North Bay Official Plan will limit or control land development within the Trout/Turtle Lake subwatershed. Despite these controls, a small number of developments have previously been approved. To maintain Trout/Turtle Lake levels, these developments should be required to implement best management practices, such as maintaining groundwater recharge volumes and managing storm runoff to maintain, or even enhance, dry weather streamflow.

Trout/Turtle Lake simulated inflow hydrographs from the planned land use scenario were used to represent the changes in hydrology that could be expected given approved developments.

Figure 6-7. Planned Land Use Scenario - Doran Creek



Results of Exposure Scenarios

Using the reservoir routing model, lake levels for each of the four Exposure scenarios were estimated using pumping records from City of North Bay and simulated inflows calculated by the GAWSER model. Recorded stop log settings for Turtle Dam were used to specify dam operations where records existed (1991-2005).

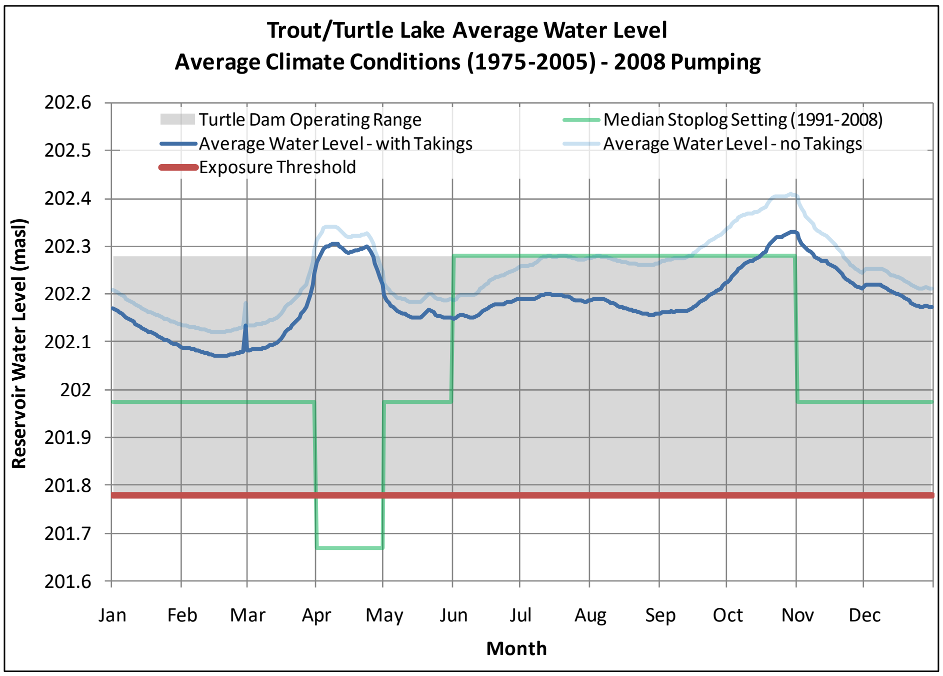
Scenario 1: Average climate conditions, existing pumping

Figure 6-8 illustrates the simulated average daily water levels for the 1975-2005 period. Also included in the figure is the operating range of Turtle Dam, as well as the median stop log setting for Turtle Dam.

Average water levels, with municipal pumping, remain below the Exposure threshold of 201.78 mASL (metres Above Sea Level). As a result, an Exposure classification of “Low” was assigned to the Local Area for Scenario 1.

To assess the impact of municipal pumping on lake levels, another scenario was investigated with water withdrawals turned off. Comparison of the simulated water levels for the two series on Figure 6-8 shows the maximum impact of the water withdrawal is approximately 10 cm, and is seen in the late summer/fall months. This difference is largely reduced through the late fall and winter months as higher inflows replenish reservoir storage.

Figure 6-8. Exposure Scenario #1 Results



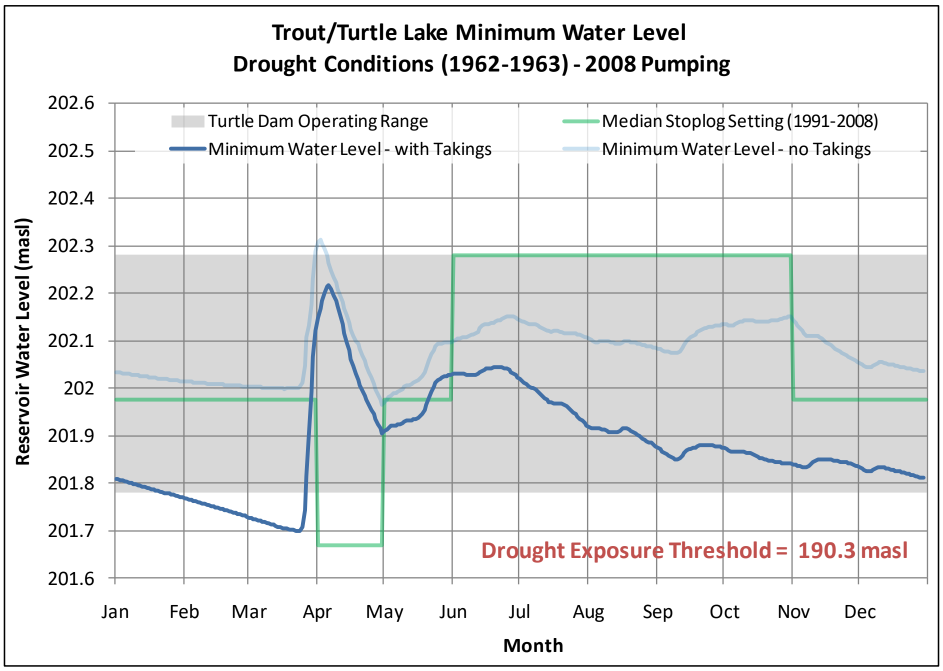
Scenario 2: Drought climate conditions, existing pumping

Figure 6-9 illustrates the minimum simulated daily water level over the 1962-1963 drought period. Minimum, rather than the average, lake levels are considered for the drought scenarios. This is due to the threshold for drought scenarios being the ability of the North Bay intake to withdraw water. Should the intake, at any time in the two-year drought period, be exposed or otherwise unable to withdraw water, an Exposure classification of High would be assigned.

Using inflows simulated to occur using climate data from 1962-1963, minimum lake levels are predicted to drop to approximately 201.78 mASL, approximately 11 m above the drought Exposure threshold of 190.3 mASL. Based on this analysis, an Exposure level of “Low” was assigned to the Local Area for Scenario 2.

Similar to Scenario 1, a separate analysis was conducted to determine the impact of municipal takings during a drought period. In the absence of municipal pumping, the minimum water level generally remains above 202.0 mASL. A difference of up to 30 cm is noted in the fall months between the simulated water levels with and without municipal pumping. When compared to the impact as shown in Figure 6-8, this indicates that the municipal water taking has a larger impact on water levels during a drought year than an average year.

Figure 6-9. Exposure Scenario #2 Results

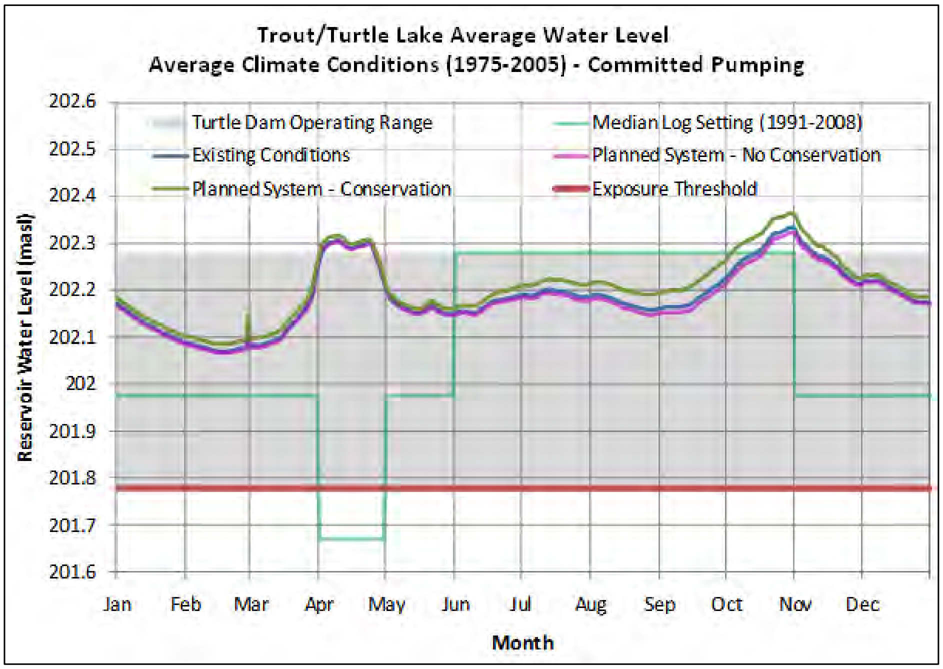


Scenario 3: Average climate conditions, committed pumping and planned land use

Figure 6-10 illustrates the results of Scenario 3. Simulated water levels include existing pumping, planned land use, as well as the existing system with a committed demand (shown as a "Planned System" within the figure), with and without conservation measures which include anticipated reductions due to metering and the associated ability to detect and address system leakage. Simulated water levels under both committed/planned pumping scenarios are comparable to water levels with existing municipal pumping; the maximum difference is approximately 3 cm, and all water levels remain above 201.78 mASL during all months. Based on results of this analysis, an Exposure classification of "Low" was assigned to the Local Area for Scenario 3.

For long term average conditions, it is estimated that the conservation measures currently being implemented by the City of North Bay will result in Trout/Turtle Lake water levels being up to five centimetres higher than future water levels without the planned upgrades. This increase in water levels would occur primarily during the late summer/fall months, and would be a benefit to the recreational use of Trout/Turtle Lake. It is recommended that the City of North Bay continue to implement aggressive water conservation measures, as reducing water withdrawals from Trout Lake will result in higher and more stable Trout/Turtle Lake water levels.

Figure 6-10. Exposure Scenario #3 Results

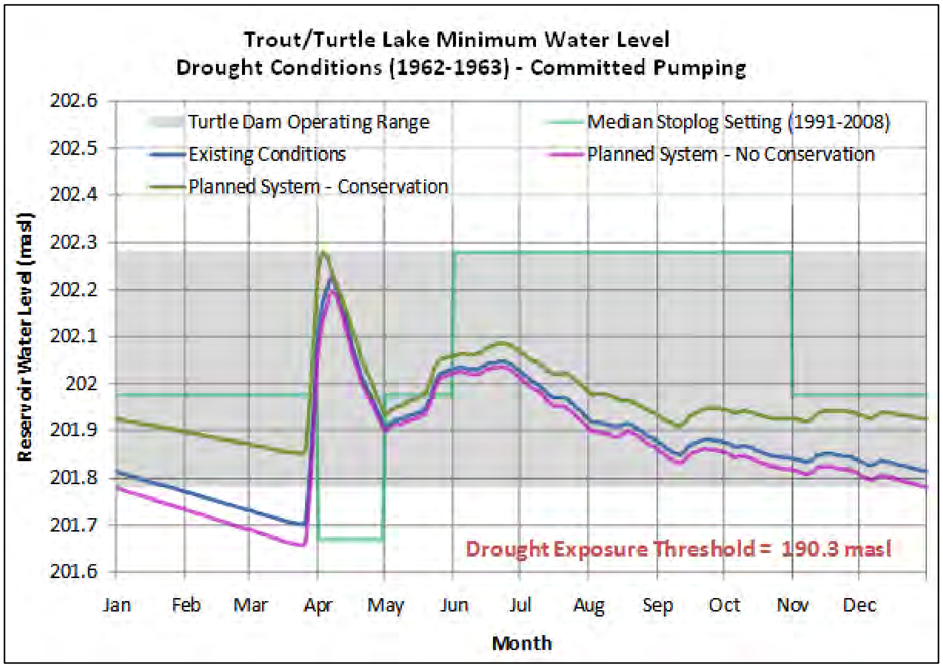


Scenario 4: Drought climate conditions, committed pumping and planned land use

Simulated water levels for committed pumping under drought conditions are illustrated on Figure 6-11. Water levels for existing pumping, planned land use, and the existing system with a committed demand (shown as a “Planned System” within the figure), are presented (Figure 6-11). Scenarios with and without conservation measures are also available in this figure. As with the drought scenario for existing pumping, water levels remain well above the drought Exposure threshold of 190.3 mASL. Consequently, an Exposure classification of “Low” was assigned to the Local Area for Scenario 4.

For drought conditions, the impact of reduced pumping caused by the conservation measures is more pronounced than for average annual conditions. Simulated water levels under committed/planned pumping (with conservation) are approximately 10 cm higher than water levels under existing pumping. The higher water levels caused by water conservation measures would typically be observed in the late summer, fall and winter months.

Figure 6-11. Exposure Scenario #4 Results



Exposure Summary

All four scenarios, required by the Technical Rules (MOE, 2009b), result in an Exposure classification of "Low". These results are due to the large volume of water held in storage by Turtle Dam, and the ability of this storage to buffer the impacts of municipal withdrawals, as well as extreme droughts. (Note: Ministry of Environment or MOE is a previous name of the Ministry of Environment, Conservation and Parks or MECP).

Based on the results of all four scenarios, the Exposure classification assigned to the City of North Bay municipal intake is **Low**.

6.2.2.7 Tier Three Water Quantity Risk Determination

The Risk Level of the Local Area is a combination of the Tolerance and Exposure levels. The Technical Rules (MOE, 2009b) outline how Tolerance and Exposure are used to assign risk. (Note: Ministry of Environment or MOE is a previous name of the Ministry of Environment, Conservation and Parks or MECP). As per Part IX.1 Rule 98, a Local Area related to a surface water intake is assigned a risk level in accordance with the following:

1. Significant, if the local area has an Exposure level of High and the system has a Tolerance level of Low;
2. Moderate, if the local area has an Exposure level of High and the system has a Tolerance level of High;
3. Moderate, if the local area has an Exposure level of Low and the system has a Tolerance level of Low; or
4. Low, if the local area has an Exposure level of Low and the system has a Tolerance level of High.

Results of the Risk Score calculations are shown in Table 6-10. Due to the ability of Trout/Turtle Lake to meet the peak demands placed on the municipal intake, a **High** Tolerance was assigned to the City of North Bay municipal system. Simulated water levels within Trout/Turtle Lake were analyzed within four scenarios required by the Technical Rules for a surface water intake; all scenarios resulted in a **Low** Exposure level.

Table 6-10. Results of Tier Three Water Quantity Risk Scenarios

Water Quantity Risk Determination	Tolerance Level	Exposure Level	Risk Level
Scenario 1: Average climate, existing pumping	High	Low	Low
Scenario 2: Drought climate, existing pumping	High	Low	Low
Scenario 3: Average climate, committed pumping and planned land use	High	Low	Low
Scenario 4: Drought climate, committed pumping and planned land use	High	Low	Low

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Based on the results of the four scenarios, a **High** Tolerance level and **Low** Exposure level results in a **Low** Risk level for the Local Area, and the City of North Bay municipal system. Due to the Local Area having a Low Risk Level, there are **no** water quantity threats identified with the North Bay system.

6.2.2.8 Tier Three Uncertainty

Similar to the Tier Two Subwatershed Stress Assessment, the Technical Rules require that the Tier Three Assessment results be examined with regard to uncertainty. This qualitative assessment considers four factors:

1. the available input data;
2. the ability of the model to replicate major hydrologic processes;
3. the quality assurance and quality control procedures; and
4. the extent and level of model calibration achieved.

Uncertainty associated with each of the four factors with respect to the Tier Two Assessment and tools produced an uncertainty rating of "Low" for the Tier Two Assessment. Since the tools developed for the Tier Two Subwatershed Stress Assessment were applied in the Tier Three Local Area Risk Assessment, the rationale is applicable to the uncertainty associated with the Tier Three Assessment.

An additional source of uncertainty associated with the Tier Three Assessment is the selection of the Exposure threshold. The Technical Rules prescribe the methodology for determining the Exposure threshold as the amount of water used by other water users within the time period of 2003-2007. Water level records for Trout/Turtle Lake facilitated the Exposure threshold to be estimated, and related directly to water surface elevation. The availability of historical water levels reduces the uncertainty associated with the Exposure threshold, and subsequently the Exposure analysis.

Due to the above considerations, the uncertainty associated with the Tier Three Assessment is **Low**.

6.2.3 Water Quantity Conclusions and Recommendations

The methodology followed in this report is consistent with the Technical Rules prepared by the Ministry of Environment (MOE, 2009b) for the preparation of Assessment Reports under the *Clean Water Act (2006)*. (Note: Ministry of Environment or MOE is a previous name of the Ministry of Environment, Conservation and Parks or MECP). The relevant Sections in the Technical Rules can be found in:

- Part III.3 – Subwatershed stress levels – Tier One Water Budget;
- Part III.4 – Subwatershed Stress Levels – Tier Two Water Budgets: and
- Part IX.1 – Risk level, local area.

To meet the requirements of the *Clean Water Act (2006)*, a Tier One Subwatershed Stress Assessment, Tier Two Subwatershed Stress Assessment and a Tier Three Local Area Risk Assessment were each completed for the Trout/Turtle Lake subwatershed. The Trout/Turtle Lake subwatershed, which contains the City of North Bay municipal water intake, was identified as having a Moderate potential for stress in the Trout/Turtle Lake Tier One Subwatershed Stress Assessment (Gartner Lee, 2008b). Similarly, a further refined Tier Two Subwatershed Stress Assessment identified the Trout/Turtle Lake subwatershed as having both a Significant and Moderate potential for water quantity stress in certain months (AquaResources, 2010). As such, a Tier Three level of assessment was required.

The required Tier Three Local Area Risk Assessment was meant to assess the risk of a water source not being able to meet the demands of the municipal system, as well as other water users. Using the tools generated as part of the Tier Two Subwatershed Stress Assessment, a Tier Three Local Area Risk Assessment was completed for the City of North Bay municipal water intake. The assessment involved determining if water takings could cause Trout/Turtle Lake water levels to drop below water level thresholds. As per the requirements of the *Clean Water Act (2006)* Technical Rules, four scenarios were investigated.

All four scenarios indicated that Trout/Turtle Lake has sufficient storage volume to meet the current demands and committed/future demands of the North Bay municipal system, while maintaining critical lake levels. As a result of this analysis, the Trout/Turtle Lake subwatershed, and the City of North Bay municipal intake has a Water Quantity Risk level of **Low**. As such, there are no Moderate or Significant water quantity threats within the Trout/Turtle Lake subwatershed.

As part of the Tier Two Subwatershed Assessment and Tier Three Local Area Risk Assessment, the Technical Rules (MECP, 2017) specifies that Significant Groundwater Recharge Areas (SGRAs) be delineated. This study follows a straightforward and reproducible procedure for delineating SGRAs as described in the Technical Rules (MECP, 2017). The Technical Rules allow two methodologies for identifying SGRAs. Based on consultation with the Water Budget Peer Review Committee, the 115% of average groundwater recharge was selected for delineating SGRAs. SGRAs present a good opportunity to address the need to protect groundwater quantity within the source protection planning process, but this opportunity needs to address both the value of total groundwater recharge across a subwatershed as well as those areas having higher than average values.

6.2.4 Data Gaps/Limitations

The primary data gaps identified through the Trout/Turtle Lake Tier Two and Tier Three investigation was the lack of continuous records for both flow (lake inflow and outflow) and lake level. Through use of data collected from adjacent watersheds, and measurements collected as part of the NBMCA's spot flow program as well as the MNR's operational records for Turtle Dam, this data gap was managed. Specific recommendations for addressing this data gap are included below.

6.2.5 Recommendations

The following recommendations are taken from the Trout/Turtle Lake Tier Two Subwatershed Stress Assessment and Tier Three Local Area Risk Assessment Report by AquaResource (2010).

Continued Use and Improvement of Numeric Models

As part of the study, numeric models were created that are able to quantify water budget components for the Trout/Turtle Lake subwatershed, as well as estimate changes to lake levels given changes in inflow, water withdrawals or land use change. These numeric models can, and should, be used for a variety of other water management investigations. Such investigations include, but are not limited to:

- impact assessment and analysis;
- support for permit to take water applications;
- subwatershed studies; lake studies; and
- supporting water quality investigations.

As additional data is collected through current, or expanded, monitoring programs, the numeric models should be verified/validated and, if necessary, revised. These additional verification/validation exercises would improve the model over time and result in an overall increased confidence in simulated results.

Additional Monitoring

Model calibration within the Trout/Turtle Lake subwatershed was limited due to the lack of observed water level and flow data. Due to the importance of Trout and Turtle Lakes to the City of North Bay, both for water supply and recreational purposes, it is recommended that existing data collection programs be continued or expanded into the future. Specific recommendations are included below:

1. Continuous water levels should be collected for Trout/Turtle Lake. This recommendation could be met by the installation of a low cost level logger on the upstream face of Turtle Dam.
2. The NBMCA should continue, and if possible expand, the spot flow monitoring program for Trout/Turtle Lake tributaries. This monitoring program is currently the sole source of information on inflow characteristics to Trout/Turtle Lake, and is critical to understanding the volume and spatial distribution of inflow to Trout/Turtle Lake.
3. Should site conditions allow, it is recommended that a stream gauge station be constructed downstream of Turtle Dam. Having continuous time series for both lake levels and dam discharge would greatly assist water managers in making effective water management decisions.

Water Conservation Measures

The municipal drinking water system for the City of North Bay is responsible for 99.5% of all consumptive withdrawals from Trout/Turtle Lake. The analysis indicated that reducing the per capita water consumption rate to 450 L/d from the current 680 L/d could result in significant increases in lake levels, particularly during drought periods. It is expected that this reduction could be obtained by fully implementing the following conservation measures:

- outdoor water use restrictions;
- installation of water meters on all connections; and
- adoption of a volumetric billing approach.

The City of North Bay has completed the installation of water meters on all connections. It is strongly recommended that the City of North Bay continue to implement these water conservation measures. Furthermore, it is recommended that the City of North Bay investigate the feasibility of additional measures to further reduce water withdrawals from Trout Lake, such as an aggressive leak detection and water fixture (e.g. toilet) retrofit programs.

Land Development within Trout/Turtle Lake Subwatershed

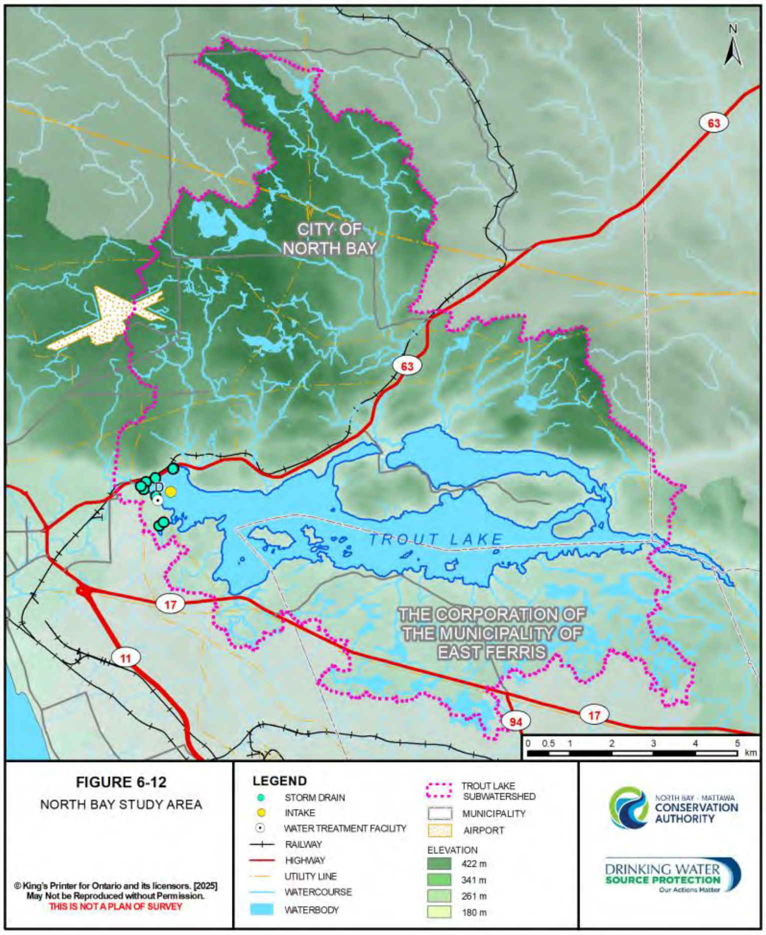
Land use policies contained within the City of North Bay Official Plan will strictly limit or control land development within the Trout/Turtle Lake subwatershed. Despite these controls, a small number of developments have previously been approved. These developments include an industrial subdivision and peat/aggregate extraction sites. To maintain lake levels within Trout/Turtle Lake, it is recommended that these developments be required to implement best management practices, such as maintaining groundwater recharge volumes and managing storm runoff to maintain, or even enhance, dry weather streamflow.

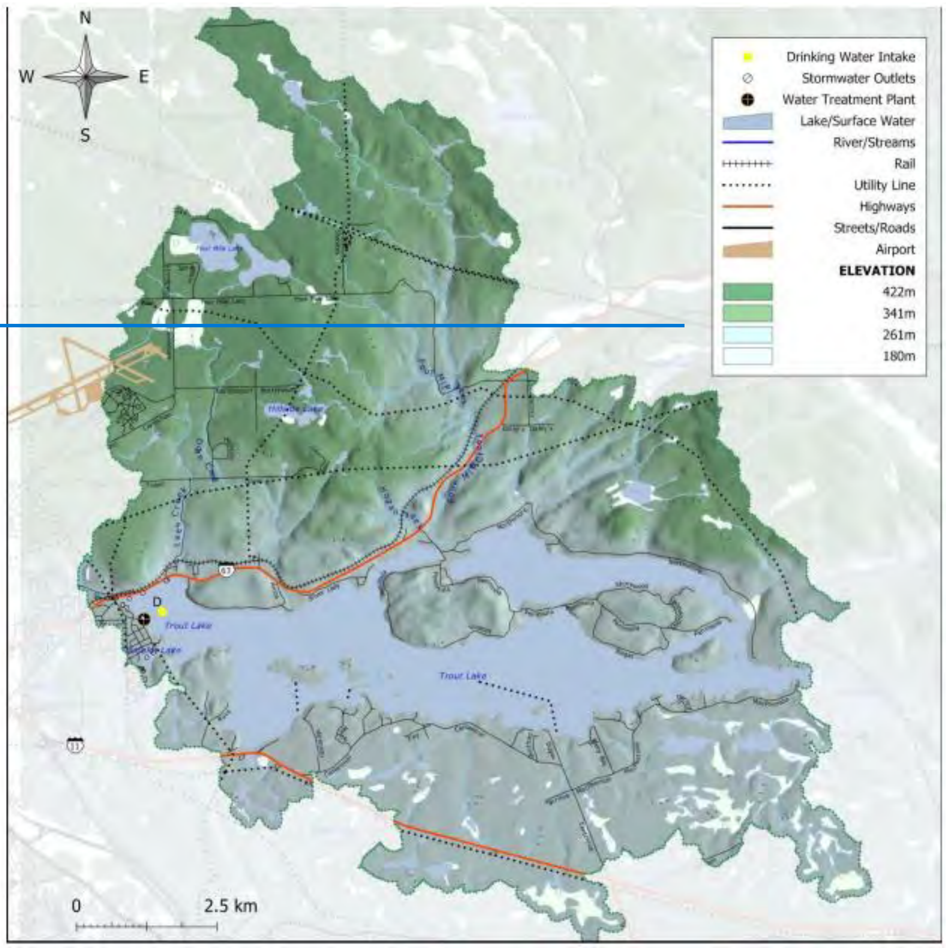
6.3 Intake Characterization

6.3.1 Source Water

The North Bay municipal drinking water intake is classified as Type D, inland water intake. The intake is located near the centre of Delaney Bay, 314 m from the treatment plant, in the western basin of Trout Lake. It is set at a depth of about 22 m and is raised 3.4 m above the bottom. The Trout Lake watershed is 106 km^2 in size and includes 14 stream subwatersheds (Figure 6-12).

Figure 6-12. North Bay Study Area





N
W
E
S
Drinking Water Intake
Stormwater Outlets
Water Treatment Plant
Lake/Surface Water
River/Streams
Rail
Utility Line
Highways
Streets/Roads
Airport
ELEVATION
422m
341m
261m
180m
D
Trout Lake
0
2.5 km

6.3.2 Hydrology

Most of the watershed is forested, with some urban/residential and agricultural areas in the west and northwest portions. Trout Lake is made up of three sub-basins including: Four Mile Bay; One Mile Bay; and the 'main basin', which includes Delaney Bay located at the extreme west end of Trout Lake. For the most part, limnological conditions of Trout Lake are typical of large, deep Precambrian Shield lakes. It is oligotrophic: biologically unproductive with low concentrations of nutrients. Mean annual concentrations of total phosphorus for the main basin and Delaney Bay averaged 0.0056 mg/L from 1996 to 2005. (Provincial Water Quality Objectives target an upper limit of 0.020 mg/L to limit the excessive proliferation of algae.) Spring overturn concentrations collected under the MECP Lake Partner Program from 1975 to 2005 are similar and display no directional trends over time. As with most deep, northern temperate lakes, Trout Lake undergoes thermal stratification during the open water season.

The upper layer (epilimnion) averages about 20°C and the lower layer (hypolimnion), about 15 m below, averages between 5° and 7°C. Following the melting of ice on Trout Lake in early to mid-April, spring turnover (mixing) begins and usually extends into May until surface waters warm sufficiently to cause the lake to stratify. Once this happens the two layers do not mix until fall turnover. This provides the intake with a significant degree of protection from surface contaminants.

6.3.3 Water System Details

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 original treatment plant was built in 1929 and upgraded in 1972. In August 2002, the primary disinfectant was changed to ultraviolet sterilization instead of chlorine and the chlorination point was moved to the outer end of the intake to increase contact time. The treated water is chlorinated again just prior to entering the distribution system in order to maintain a chlorine residual. A new water treatment plant has been completed and has been online since early 2010. This 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, taste and odour compounds, or soluble chemicals which could originate from spills.

Plant capacity is rated at 79,500 m^3/day. The intake features an on-line turbidity monitor that samples from the bell chamber ahead of the first chlorination point via a separate sampling line that also serves to collect raw water for chemical analyses (City of North Bay 2019). Travel time for raw water from the intake to reach the chamber of the water treatment plant ranges from approximately 15 to 30 minutes, averaging about 20 minutes. In case of emergency, the drinking water plant can be shut down within 15 minutes.

6.4 Delineation and Scoring of Vulnerable Areas

As described in Section 3.1 Surface Water Methodology, source protection planning specifies that three intake protection zones should be identified and protected in order to maintain water quality at the intake location. The zones for the North Bay intake were delineated in accordance with Part VI of the Technical Rules for a Type D intake.

6.4.1 Defining the Vulnerable Areas (Intake Protection Zones)

Intake Protection Zone 1 (IPZ-1) for the North Bay intake is defined as the surface area of Trout Lake within a 1-km radius of the drinking water intake in Delaney Bay and, where this area abuts land, includes a setback of 120 m inland measured from the high water mark (Figure 6-13).

Of the three protection zones, IPZ-1 is the most vulnerable to contamination. If a contaminant entered this zone, there would be relatively little time to respond and limited potential for the contaminant to be diluted before it reached the intake

The IPZ-2 is intended to provide a minimum two-hour response time to shut down the treatment plant in case of an emergency. At the time of the study, there were no known hydrodynamic studies of water flow or measurements of surface currents in Trout Lake. Therefore, time-of-travel to the intake was estimated using major limnological principals guiding wind-driven surface water current speeds using the maximum wind speed recorded by the North Bay Airport weather station during the period 1971-2000. This analysis indicated that it would take longer than two hours for a contaminant released at the outer limit of IPZ-1 to reach the intake, so the IPZ-2 within Trout Lake does not extend beyond the IPZ-1 (with the exception of the transport pathways described below).

The IPZ-2 must also consider transport pathways extending inland from the shoreline. The IPZ-2 for the North Bay drinking water intake (Figure 6-14) consists of the following areas:

- Lees Creek and associated buffer of 120 m 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 two hour time-of-travel distance to the intake. No known data exist for Lees Creek to calculate flow velocities under storm conditions, but the suggested IPZ-2 delineation most likely encompasses the necessary minimum two hour time-of-travel requirements set out in the Technical Rules. Under maximum estimated wind driven surface currents, the time-of-travel from the outlet of Lees Creek to the intake would be approximately 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 two hours.
- The portion of the natural transport pathway, Armstrong Creek and associated setback of 120 m that lies within 846 m of the intake, which approximates the maximum two hour time-of-travel to the intake (as described below).
- The extent of two transport pathways that drain to Lees Creek near its outlet to Delaney Bay in Trout Lake (as described below).

- The area of the stormwater system draining to Delaney Bay that lies within 864 m of the intake (to approximate a two hour time-of-travel to the intake in accordance with Rule 65(2)). Time-of-travel in the stormwater system 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 using the maximum current speed that would occur in Delaney Bay, is therefore a conservative estimate to approximate the necessary two hour time-of-travel to the intake from the stormwater system area.

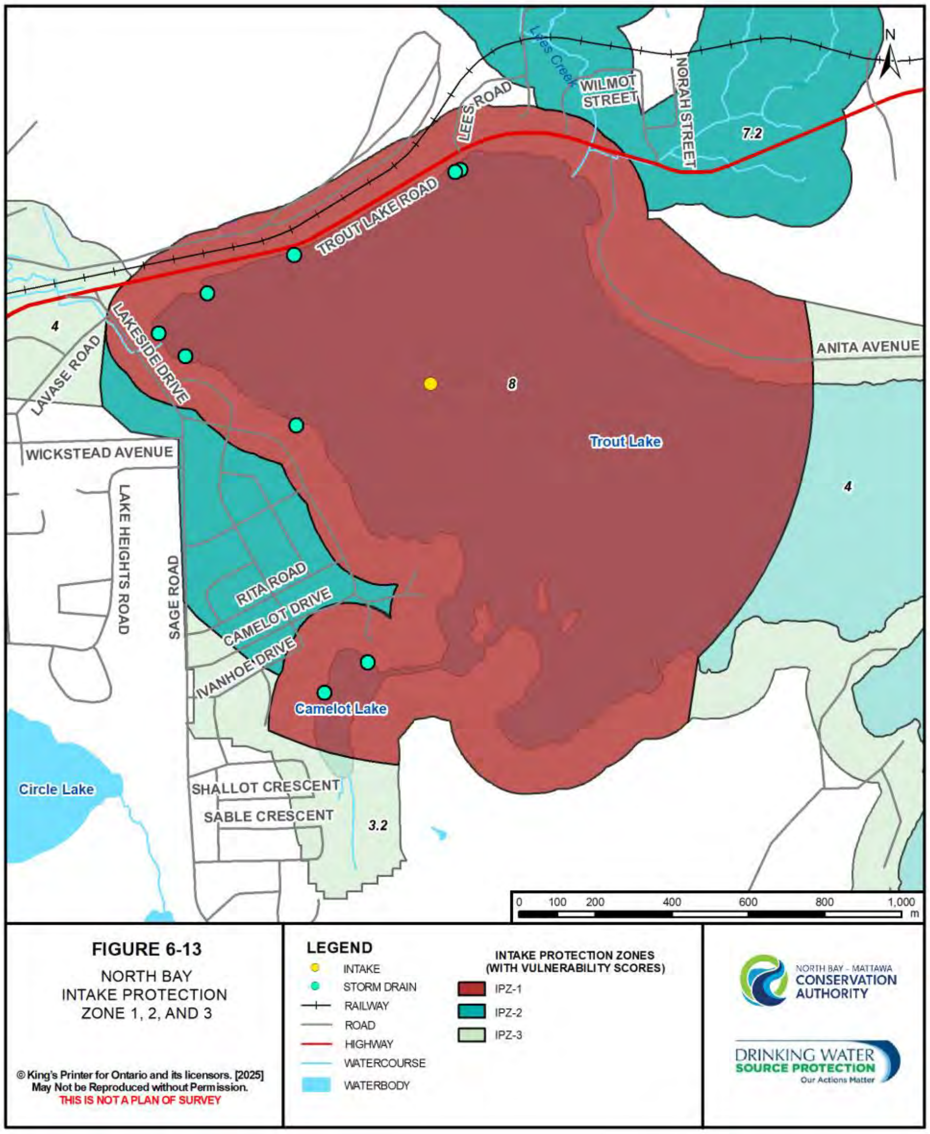
The IPZ-3 protects water quality of the drinking water source from long-term chronic exposure of contaminants and other materials that can have a negative impact on drinking water quality at the intake. The IPZ-3 is defined by the Technical Rules (Part VI.5) as the area within each surface water body that may contribute water to the intake. This includes 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 lie within an IPZ-1 or IPZ-2. The IPZ-3 for North Bay, therefore, includes the surface area of Trout Lake, all waterbodies draining to Trout Lake and associated setbacks of 120 m on land exclusive of those areas encompassed by the IPZ-1 and IPZ-2 as illustrated in Figure 6-14.

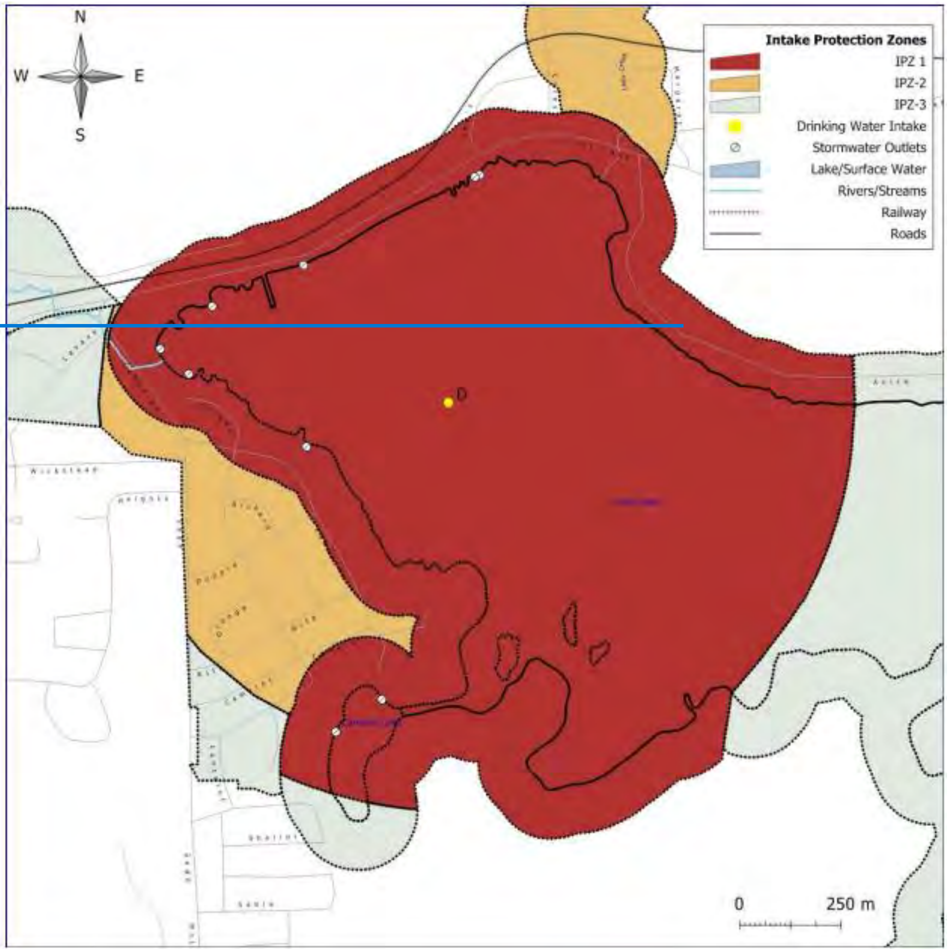
Transport pathways are natural or constructed pathways that facilitate the transport of contaminants to the intake. The shoreline area of Delaney Bay and the area surrounding the lower reaches of Lees Creek were surveyed during two site visits in the summer of 2007 to identify transport pathways. The 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 6-13).

Constructed transport pathways include:

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

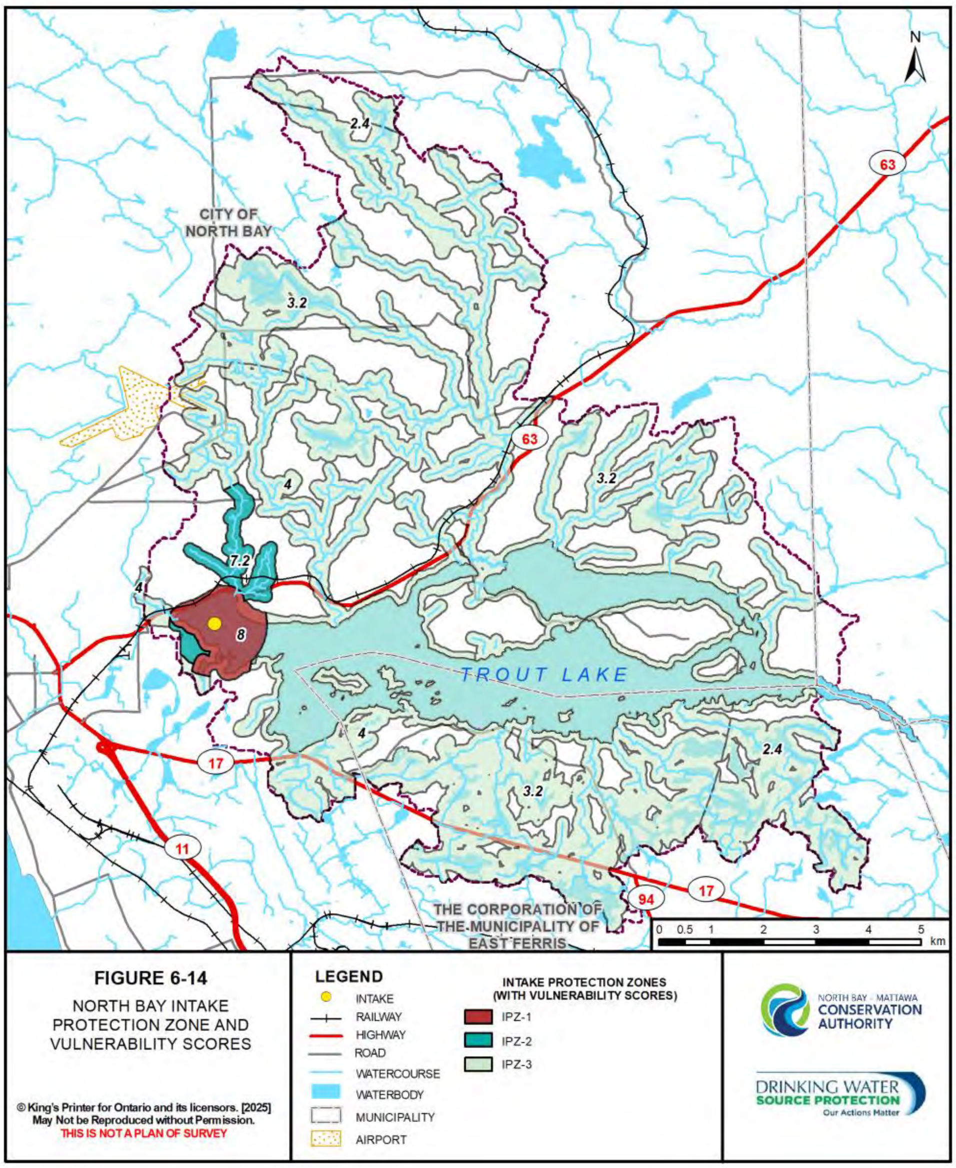
Figure 6-13. North Bay Intake Protection Zone-1

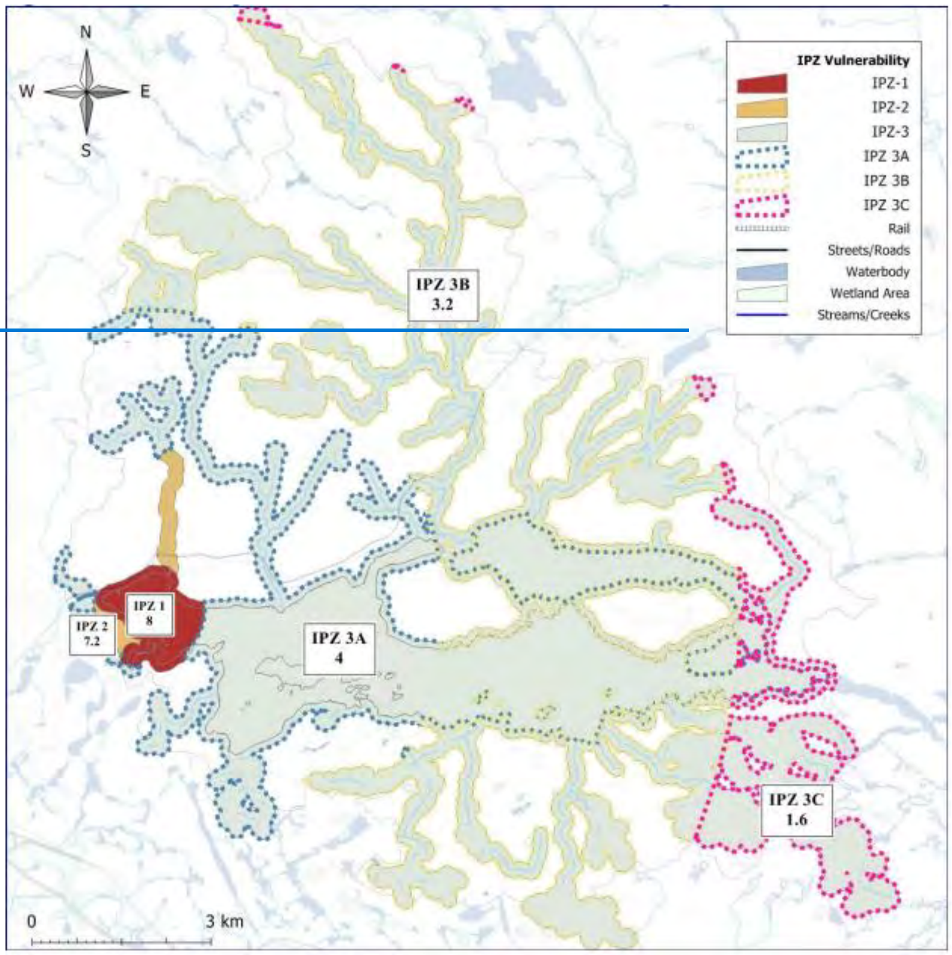




N
W
E
S
Intake Protection Zones
IPZ 1
IPZ-2
IPZ-3
Drinking Water Intake
Stormwater Outlets
Lake/Surface Water
Rivers/Streams
Railway
Roads
0
250 m

Figure 6-14. North Bay Intake Protection Zone and Vulnerability Scores





Note: larger 11" x 17" version of Figure 6-14 is available in Appendix A as Figure A-5.

Natural preferential pathways to Trout Lake include the 14 inlet creeks identified from GIS mapping (MNR base mapping, resolution = 20 m). Three additional creeks, Armstrong Creek and Margaret Creek and an unnamed creek that drains to Lees Creek (which drains into the north shore of Delaney Bay), had the routes and outlets confirmed by GPS during field site visits (June 22 and 29, 2007).

Armstrong Creek enters Trout Lake at the extreme westerly end of the lake within Delaney Bay at Olmsted Beach. It is an intermittent watercourse, which drains portions of Ski Hill Road and crosses under the ONR line, Highway 63 (Trout Lake Road) and Lakeside Drive. The IPZ-2 was extended to include this natural pathway and associated maximum setback of 120 m within a two-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 system. The remaining upstream portion of Armstrong Creek was included as part of the IPZ-3 delineation.

Margaret Creek drains to Lees Creek near its outlet into 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 setbacks of 120 m.

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 by road and land development (Lees Creek was used historically to transport logs down the escarpment during forestry operations). 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 during 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.

6.4.2 Vulnerability Scoring

Vulnerability scores were used to assess the likelihood that a contaminant originating within the intake protection zones would reach the intake. These scores were based on:

- the percentage of the area that is composed of land;
- land cover, soil type, permeability of the land, and the slope of setbacks;
- hydrological and hydrogeological conditions in the area that contributes water to transport pathways;
- depth of the intake from the surface;
- distance of the intake from land; and
- history of water quality concerns at the intake.

Vulnerability scores provide a comparative assessment of the likelihood that a contaminant originating within the Intake Protection Zones could reach the North Bay intake. Vulnerability scores are calculated by multiplying the Source Vulnerability Factor by the Area Vulnerability Factor (Rule

87). Guidance for calculating these vulnerability factors is provided in Part VIII.2 and Part VIII.3 of the Technical Rules.

Source Vulnerability Factor

The Source Vulnerability Factor is based on characteristics of the intake and ranges between 0.8 and 1.0. Scoring of the Source Vulnerability Factor considers the following:

- the depth of the intake from the surface of the water;
- the distance of the intake from land; and
- the history of drinking water concerns relating to the intake.

The North Bay intake is relatively far from shore (approximately 314 m) and deep (22 m), drawing water for most of the ice-free season from the hypolimnion and, thereby, reducing the potential for contaminants at the surface to reach the intake. Trout Lake provides excellent quality raw water. Any potential concerns regarding turbidity have been effectively addressed by the new chemically assisted membrane filtration system which came online in early 2010. Given these considerations, the lowest source vulnerability factor of 0.8 was assigned for the North Bay drinking water intake.

Area Vulnerability Factor

Area Vulnerability Factors were assigned to the IPZs in accordance with Technical Rules 88 to 93 (MECP, 2017). The area vulnerability factor is fixed at a value of 10 for the IPZ-1. For the IPZ-2 and IPZ-3, the Area Vulnerability Factors consider the following aspects:

1. the percentage of the area of the IPZ-2 or IPZ-3, as the case may be, 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 of the area where the transport pathway is located ; and
4. in respect of an IPZ-3, the proximity of the area of the IPZ-3 to the intake.

The specific methodology for assigning area vulnerability factors for each of the surface water intakes is provided in section 3.1. For each of the subzones, the Area Vulnerability Factor was calculated as the sum of individual scores (0, 1 or 2) assigned for each of the four aspects listed above. This procedure weighted all factors equally. The maximum aspect score that could be generated is 6 for the IPZ-2 (three aspects times maximum score of 2) and 8 for the IPZ-3 subzones (four aspects times maximum score of 2). The aspect score was then prorated to determine the Area Vulnerability Factor for each zone.

An Area Vulnerability Factor of 9 was assigned for IPZ-2 from a possible range of 7 to 9. This score reflects that each aspect scored the top value based on the following:

- most of the IPZ-2 is comprised of land;
- a large portion of the area in the stormwater system draining into Delaney Bay is comprised of urban and residential lands that have high runoff generation potential; setback areas along Lees Creek and tributaries north of Trout Lake Road include steep-sided riverbanks; and
- there are numerous transport pathways that direct drainage to the IPZ-1 including stormwater drains and ditches (Figure. 6-13).

Given the large area encompassed by the IPZ-3, different Area Vulnerability Factors were assigned to areas within the IPZ-3 dependent upon their distance to the intake. With increasing distance from the intake there is reduced potential for contamination and thus a lower vulnerability score is warranted. Area Vulnerability Factors for North Bay were assessed for three subzones of the IPZ-3 using each of the four aspects listed above. The breakdown and rationale for the scoring is provided in Table 6-11. An Area Vulnerability Factor of was assigned to each of the IPZ-3 subzones from a possible range of 1 to 9. The resulting Vulnerability Scores are listed in Table 6-12 and illustrated in Figure 6-14.

Some changes were made to the IPZ delineation in 2023 using recent mapping updates: Conservation Authority's approximate regulated area; wetland mapping project; watercourse layer; replotting of subwatershed boundaries; and digital elevation model. Although there are many small, localized shifts in the delineation, the overall characteristics used to determine the area vulnerability factor did not change appreciable. The values shown in Table 6-11 are unchanged from the 2015 approved Assessment Report.

Table 6-11. North Bay IPZ-3 Area Vulnerability Factors

Factors to Consider	IPZ-3 Factor Scores			Rationale
	Areas within 5 km of the intake	Areas more than 5 km but 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	IPZ-3 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
% Aspect Score	4/8 = 50%	3/8 = 37.5 %	2/8 = 25%	(calculated as: total of individual aspect scores divided by total available value)
Area Vulnerability Factor	5 ((50%x8) +1)	4 ((37.5%x8) +1)	3 ((25%x8) +1)	(calculated as: % aspect score x difference between maximum and minimum AVF range + minimum possible AVF score

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Table 6-12. Vulnerability Scores for the North Bay 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	5	4
IPZ-3 more than 5 km but within 10 km of the intake	0.8	4	3.2
IPZ-3 beyond 10 km of the intake	0.8	3	2.4

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6.4.3 Uncertainty Analysis

Part I.4 of the Technical Rules requires that an uncertainty rating of high or low be provided 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 – The location of the intake is known within a few metres because the direction of the pipe can be seen in aerial photographs a substantial distance from shore and the length is known based on engineering reports. Because the intake is less than 1 km from shore in most directions, only the downstream 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. 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 (with the exception of the transport pathways, all of which have been considered).

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 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. Since a conservative approach was used, refinement could reduce the extent of the IPZ-2 along Lees Creek.

Water Quality Data – The vulnerability scoring requires knowledge of water quality as it relates to drinking water issues (see Section 6.5). Raw water records and treated water records from the Water Treatment Plant did not encompass the entire operational history of the plant. 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 (Ontario Drinking Water Quality Standards).

6.5 Issues Identification

Details on methodology are provided in Section 3.1 of this report. Additionally, readers are referred to the AECOM (2010a) report as referenced in Section 6.1 above.

Drinking water issues, as defined in Part XI.1 of the Technical Rules, relate to the presence of a listed parameter in water at the intake either at a concentration that may affect the use of the water as a drinking water source, or there is evidence of an increasing trend. Chemical contaminants and pathogens must both be considered. The investigation for issues affecting source water at the North Bay intake included reviews of the following:

- Drinking Water Surveillance Program (DWSP) Monitoring Data;
- Drinking Water Information System (DWIS) Monitoring Data;
- O.Reg. 170/03 Annual Reports (2006-2008); and
- Trout Lake Parasite Study (Miller Environmental Services Inc., 2000)

All potential issues were identified and further investigated. Chemical parameters requiring follow-up included colour, a single high reading of antimony, detection of 2,4-dichlorophenol above aesthetic objectives, and turbidity.

Although colour consistently exceeded the aesthetic objective in the raw water between 1990 and 2005, there is no increasing trend, colour has been maintained below the objective in treated water, and the cause of the colour is considered to be natural due to moderately high concentrations of dissolved organic carbon (DOC) and naturally occurring iron concentrations. The single high antimony reading was most likely due to laboratory error.

Chlorophenols can cause an unpleasant taste or odour. The five times between 1994 and 1996 that 2,4-dichlorophenol was measured in raw water above the aesthetic objectives of 0.0003 mg/L but well below the drinking water standard (ODWQS) of 0.9 mg/L were suspected to be incorrectly recorded and actually intended to reflect the laboratory detection limit at the time. The Technical Advisory Committee for the 2010 study summarized herein concluded that there is insufficient evidence to list 2,4-dichlorophenol as a drinking water issue under Rule 114.

Turbidity levels in raw water had to be very low, below 1 NTU, to ensure effective disinfection with either ultraviolet light or chlorine when the City of North Bay did not have filtration. There were several incidents where reported turbidity levels became a concern; however, there was no trend in mean turbidity for the 1990 to 2005 period. The new plant which came online in 2010 includes membrane filtration and is capable of yielding water with a maximum turbidity of 0.3 NTU, which is sufficient to delist turbidity as a drinking water issue.

6.6 Threats Identification and Assessment

There were two approaches used to identifying threats: the *threats approach*, which is based on the vulnerability scores of the vulnerable areas; and the *issues approach*, based on activities or conditions that contribute to existing drinking water issues listed under Rule 114. A third approach, the *events-based approach*, is based on modelling that demonstrates a chemical or pathogen release from an activity that could result in the deterioration of source drinking water. This approach was not used in the identification of threats.

Threats are defined as those activities or conditions that could cause contamination of drinking water by a chemical or pathogen within one of the Wellhead Protection Areas (WHPA). Activities must be assessed and reported whether or not they currently occur within the vulnerable areas. O.Reg. 287/07 Section 1.1 (1) under the *Clean Water Act (2006)* lists 20 activities that may result in threats to drinking water quality (see Table 3-1). (Two additional prescribed activities pose threats to water quantity.)

Conditions, as defined by Part XI.3 of the Technical Rules, refer to past activities that have produced contaminants that may result in significant drinking water threats. A more detailed definition can be found in the discussion under section 3.1.5 above.

Part XI.4 of the Technical Rules describe the methods for identifying significant, moderate and low drinking water threats related to activities in the vulnerable area of a drinking water intake. A threat is deemed significant, moderate or low depending on:

- the vulnerable area in which the activity occurs or would occur;
- the vulnerability score of the vulnerable area; and
- a set of prescribed activities and corresponding circumstances that constitute a threat

The Technical Rules require activities that would be a significant, moderate or low drinking water threat within the vulnerable areas to be listed in the Assessment Report, *regardless of whether or not the activities presently exist in the vulnerable area.*

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 drinking water intake based on the MECP Tables of Drinking Water Quality Threats (MECP 2021).

Evaluation of threats posed by pathogens were limited to *E. coli* and total coliforms. ODWQS for total coliforms and *E. coli* are that there should be none detectable in treated water, but both are naturally occurring bacteria in surface water. They are typically detected in raw water samples at the North Bay intake, therefore exceeding the ODWQS for treated water. Based on available data, there are no apparent trends in maximum or mean annual *E. coli* counts. *E. coli* and total coliforms are not considered to be drinking water issues for the North Bay intake, because:

- they have maintained relatively low levels in raw water at the intake without evidence of an increasing trend, and
- 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.

6.6.1 Threats Approach

The threats evaluation for source protection planning involves the identification of activities or conditions within vulnerable areas that could cause contamination of drinking water by a chemical or pathogen. As previously stated, there are no known conditions relevant to the North Bay intake.

Threats Approach - Potential Activities and Circumstances

Based on the resulting vulnerability scores (Table 6-12) the possible threat levels (Table 6-13) were identified for each of the vulnerable areas. Due to the vulnerability scores within the IPZs, only IPZ-1 may contain potential significant chemical or pathogen threats. Refer to Figure 6-14 above for further support of the vulnerable areas where activities are or would be significant, moderate or low drinking water threats.

Table 6-13. Areas within North Bay Intake Protection Zone where Activities are or would be Significant, Moderate and Low Drinking Water Threats

Threat Type	Vulnerable Area	Vulnerability Score	Threat Level Possible		
			Significant	Moderate	Low
Chemical	IPZ-1	8	✓	✓	✓
	IPZ-2	7.2		✓	✓
	IPZ-3~~a~~	4.0			
	IPZ-3~~b~~	3.2			
	IPZ-3~~c~~	2.4			
Pathogen	IPZ-1	8	✓	✓	✓
	IPZ-2	7.2		✓	✓
	IPZ-3~~a~~	4.0			
	IPZ-3~~b~~	3.2			
	IPZ-3~~c~~	2.4			

Whereas Table 6-13 lists the IPZs where significant, moderate and low threats could be found in the North Bay IPZs, Table 6-14 lists the number of chemical and pathogen threats which could be significant, moderate or low within each of the IPZs according to the MECP Tables of Drinking Water Quality Threats. There are ~~5~~ 8 potential significant chemical threat circumstances and ~~12~~ 14 potential significant pathogen threat circumstances in the North Bay IPZ-1.

The Technical Rules Part XII - Tables of Drinking Water Quality Threats (MECP 2021) ~~The Tables of Drinking Water Threats (MECP 2018)~~ provide the detailed sets of circumstances for identifying if an activity meets the criteria for a significant, moderate or low drinking water threat. The Threats Tables can be downloaded from the MECP webpage (https://www.ontario.ca/page/2021-technical-rules-under-clean-water-act)~~(Ontario.ca/page/source-protection) in an Excel file format~~.

An on-line searchable version of the Threats Tables can be accessed at swpip.ca. ~~The actual provincial Threat Tables can be found at: https://files.ontario.ca/2017_2018_chemical_and_pathogen_tables_of_threats_12_v2.xlsx~~

The on-line version ~~Excel file~~ of the Threats Tables can be filtered to outline the specific circumstances related to potential chemical or pathogen threats. After the webpage is ~~file is downloaded and~~ opened, click on the "Search~~Data~~" menu tab and then "Zone and Score~~Filter~~". By applying the filter values in sequence, as shown in Table 6-14 below, it is possible to narrow the results to those activities considered at a threat level within the particular vulnerable area and vulnerability score.

Table 6-14. Summary of Circumstances in the Provincial Threats Tables Related to North Bay IPZ

North Bay IPZ		Filter Threats Tables by:				# of Sets of Circumstances
Vulnerable Area	Vulnerability Score	Zone	Risk	Parameter of Concern	Score	
IPZ-1	8	IPZ	Significant	Chemical	8	8
IPZ-1	8	IPZ	Moderate	Chemical	8	146
IPZ-1	8	IPZ	Low	Chemical	8	76
IPZ-2	7.2	IPZ	Significant	Chemical	7.2	0
IPZ-2	7.2	IPZ	Moderate	Chemical	7.2	100
IPZ-2	7.2	IPZ	Low	Chemical	7.2	123
IPZ-1	8	IPZ	Significant	Pathogen	8	14
IPZ-1	8	IPZ	Moderate	Pathogen	8	8
IPZ-1	8	IPZ	Low	Pathogen	8	7
IPZ-2	7.2	IPZ	Significant	Pathogen	7.2	n/a
IPZ-2	7.2	IPZ	Moderate	Pathogen	7.2	16

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North Bay IPZ		Filter Threats Tables by:				# of Sets of Circumstances
Vulnerable Area	Vulnerability Score	Zone	Risk	Parameter of Concern	Score	
IPZ-2	7.2	IPZ	Low	Pathogen	7.2	12

Vulnerability Score	~~Significant~~	~~Moderate~~	Low
8	CIPZWE8S PIPZWE8S	CIPZWE8M PIPZWE8M	CIPZWE8L PIPZWE8L
7.2	NA NA	CIPZWE7.2M PIPZWE7.2M	CIPZWE7.2L PIPZWE7.2L
4.0	NA	NA	NA
3.2	NA	NA	NA
2.4	NA	NA	NA

Note: n/a indicates there are no matching circumstances where an activity is considered a drinking water threat

Table 6-15 provides the activities and total number of circumstances relating to significant drinking water threats in the City of North Bay. There is one prescribed activity, with ~~5~~ 7 associated circumstances, that is or would be a significant chemical drinking water threat in the IPZ-1 of the North Bay intake: "the establishment, operation or maintenance of a system that collects, stores, transmits, or treats or disposes of sewage". There are 7 prescribed activities, with ~~12~~ 15 associated circumstances, that are or would be a significant pathogen threat in the IPZ-1 of the North Bay intake. There are no threats that are or would be significant in the IPZ-2 or IPZ-3 due to the low vulnerability score of those areas.

Table 6-15. Enumeration of Circumstances under which Prescribed Activities are or would be Significant Threats to the North Bay Drinking Water Intake

Activities Prescribed to be Drinking Water Threats	# of Significant Threat Circumstances	
	Chemical	Pathogen
The establishment, operation or maintenance of a waste disposal site within the meaning of Part V of the *Environmental Protection Act*.	2	~~1~~4
The establishment, operation or maintenance of a system that collects, stores, transmits, treats or disposes of sewage.	~~5~~4	~~4~~3
The application of agricultural source material to land.		1
The storage of agricultural source material.		2
The application of non-agricultural source material to land.		1

Activities Prescribed to be Drinking Water Threats	# of Significant Threat Circumstances	
	Chemical	Pathogen
The handling and storage of non-agricultural source material.		1
The storage of snow	2	
The use of land as livestock grazing or pasturing land, an outdoor confinement area or a farm-animal yard.		2
Number of circumstances under which the threat is or would be significant	~~5~~8	~~12~~14

Threats Approach - Existing Significant, Moderate and Low Threats

Rule 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. A comprehensive threats list was compiled in a draft report by Gartner Lee Limited (2007b). This list was based on a desktop research approach, including the following sources:

- Class Environmental Assessment to Service Anita Avenue, North Bay, Ontario with Sanitary Sewer Servicing. City of North Bay, 1993;
- Trout Lake Parasite Study (Miller Environmental Services Inc., 2000);
- Delaney Bay Spills Contingency Plan (Aquafor Beech Limited, 2001);
- Lees Creek and Golf Club Creek Tributary: Subwatershed/Stormwater Management Plans. (Aquafor Beech Limited, 2001);
- Ontario Base Mapping;
- North Bay (31 L/6) 1:50,000 National Topographic Series map;
- Federal Contaminated Sites Inventory;
- National Priority Release Inventory;
- Ontario Environmental Registry;
- Ontario PCB database;
- Ontario Environmental Compliance Reports;
- Department of National Defense;
- Ontario Ministry of the Environment, North Bay;
- City of North Bay; and
- Personal communications

In addition, site investigations were conducted in July and August, 2007, as well as discussions with the Source Protection Committee. Since the vulnerability scores of the IPZ-2 and IPZ-3 are all below 8, no activities in these areas would be significant threats based on the MECP's Tables of Drinking Water Quality Threats (MECP 2021).

In the draft report by Gartner Lee Limited (2007b), 61 possible drinking water threats were identified for the North Bay intake based on previous Ministry guidance for source protection planning. The threats identified in the 2007 Gartner Lee draft report were re-evaluated as threats based on the current Technical 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 and the storage and handling of road salt.

None of the potential threats inventoried in the Gartner Lee (2007b) report met the circumstances that would result in a significant threat in the IPZ-1. Given the low vulnerability scores assigned to the IPZ-2 and IPZ-3, there are no activities that could be considered as significant in these zones.

Based on this evaluation, there are no existing significant drinking water threats related to either chemicals or pathogens for the City of North Bay.

6.6.2 Issues Approach to Threat Identification

In addition to the above noted threats related to activities, Rule 115 requires that threats be listed for those drinking water issues listed under Rule 114 that result from, or partially result from, human activities. There are no known issues in the North Bay IPZ.

6.6.3 Conditions

Three potential sites with contaminants 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 MECP guidance (Gartner Lee Limited, 2007b; Table 6-13). 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 (MECP, 2017). If at some point a site evaluation does determine the presence of contaminants, then a risk score would be calculated based on Technical Rules Part XI.5.

Based on the data gap about these activities, no conditions that would be significant threats have been identified in the vulnerable areas for the City of North Bay intake as defined by Rule 140 (MECP, 2017).

Table 6-16. Potential Sites for Evaluation as Conditions within North Bay Intake Protection Zone

Past Activity	Contaminant of Concern	Location Within the Vulnerable Area	Vulnerability Score
Copper Ore Spill from Train Derailment	Copper	IPZ-2	7.2
Milne Lumber Company Mill	NAICS various chemicals	IPZ-1	8
Montreal Smelting and Reduction Refinery	NAICS various chemicals	IPZ-1	8

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6.6.4 Local Threat Considerations

The North Bay-Mattawa Source Protection Committee is concerned about the threat posed by the transportation of hazardous substances along highway and rail corridors within the City of North Bay Intake Protection Zone which creates the potential for a spill to occur in the vulnerable area.

Although there is no prescribed threat activity related to the transportation of hazardous substances under the *Clean Water Act*, Technical Rule 119 allows Source Protection Committees to request that an activity be listed as a drinking water threat if:

1. The activity has been identified by the Source Protection Committee as an activity that may be a drinking water threat; and
2. The Director indicates that the chemical or pathogen hazard rating for the activity is greater than 4.

The Source Protection Committee submitted a formal request to the Ministry of Environment for the addition of transportation of hazardous substances as a non-prescribed (local) drinking water threat in the SP Area. This request was approved by the Director on February 8, 2011 (Appendix F). Included in the approval are the circumstances and hazard ratings for the activities considered.

Table 6-17 shows where significant, moderate and low threats relating to the transportation of hazardous substances are located in the North Bay IPZs. There are no significant threats relating to the transportation of hazardous substances for the North Bay intake.

Table 6-17. Areas within North Bay Intake Protection Zone where Transportation of Hazardous Substances are Considered a Significant, Moderate or Low Drinking Water Threat

Threat Type	Vulnerable Area	Vulnerability Score	Threat Level Possible		
			Significant	Moderate	Low
Chemical	IPZ-1	8		✓	✓
	IPZ-2	7.2			✓
Pathogen	IPZ-1	8		✓	
	IPZ-2	7.2		✓	

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6.7 Gap Analysis and Recommendations

As stated in the Uncertainty Analysis, there are data gaps that result in some uncertainty, but improved data are unlikely to result in any significant changes in either the delineation or scoring of the IPZs.

The use of a hydrodynamic model and flow data from Lees Creek would refine the IPZ-2 delineation. A conservative approach was used to delineate the IPZ-2 using 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.

The vulnerability scoring requires knowledge of water quality as it relates to drinking water issues. 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 assessment. Despite this, available records were adequate to evaluate the tested parameters as drinking water issues in relation to the ODWQS (Ontario Drinking Water Quality Standards).

The investigation of existing activities was adequate to confirm the conclusions that there are no existing significant threats to the North Bay intake related to either chemicals or pathogens.

7.0 Powassan

7.1 Introduction and Summary of Findings

The Municipality of Powassan draws its municipal drinking water from two wells near Genesee Creek. There is a clay aquitard throughout much of the study area that provides significant protection to the aquifer from surface contaminants. There are no significant or moderate stresses to the quantity of water.

A Wellhead Protection Area (WHPA) divided into areas of varying vulnerability was identified for the municipal supply. The procedure used computer modelling to determine the length of time it would take a waterborne contaminant to reach the wellhead and then assessed the degree of protection provided by the soil from contaminants moving down from the surface.

The only potential issue identified for the Powassan groundwater supply is the presence of elevated sodium in the water, but this was determined to be due to natural sources within the aquifer.

There are two septic systems located on properties within 100 m of the wellhead which are automatically classified as posing significant pathogen threats.

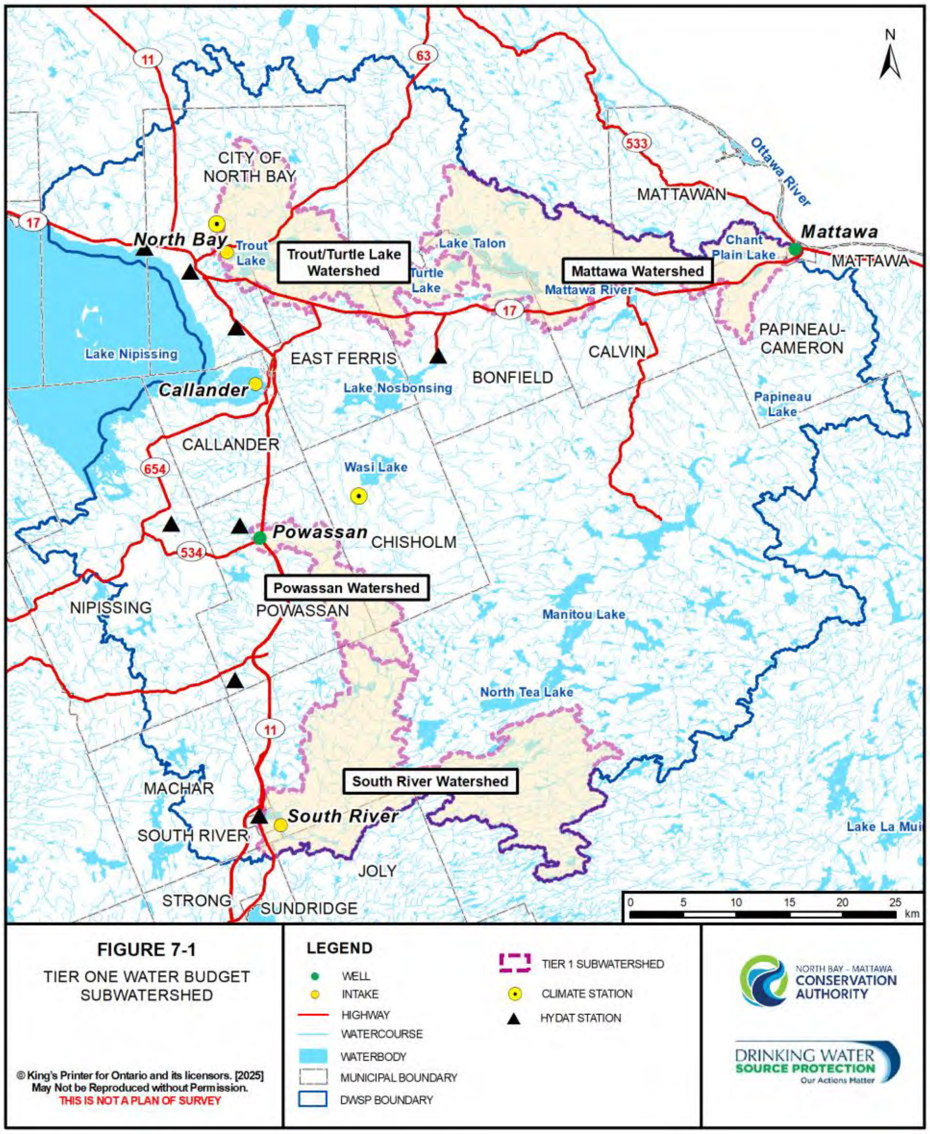
7.2 Water Budget and Water Quantity Stress Assessment

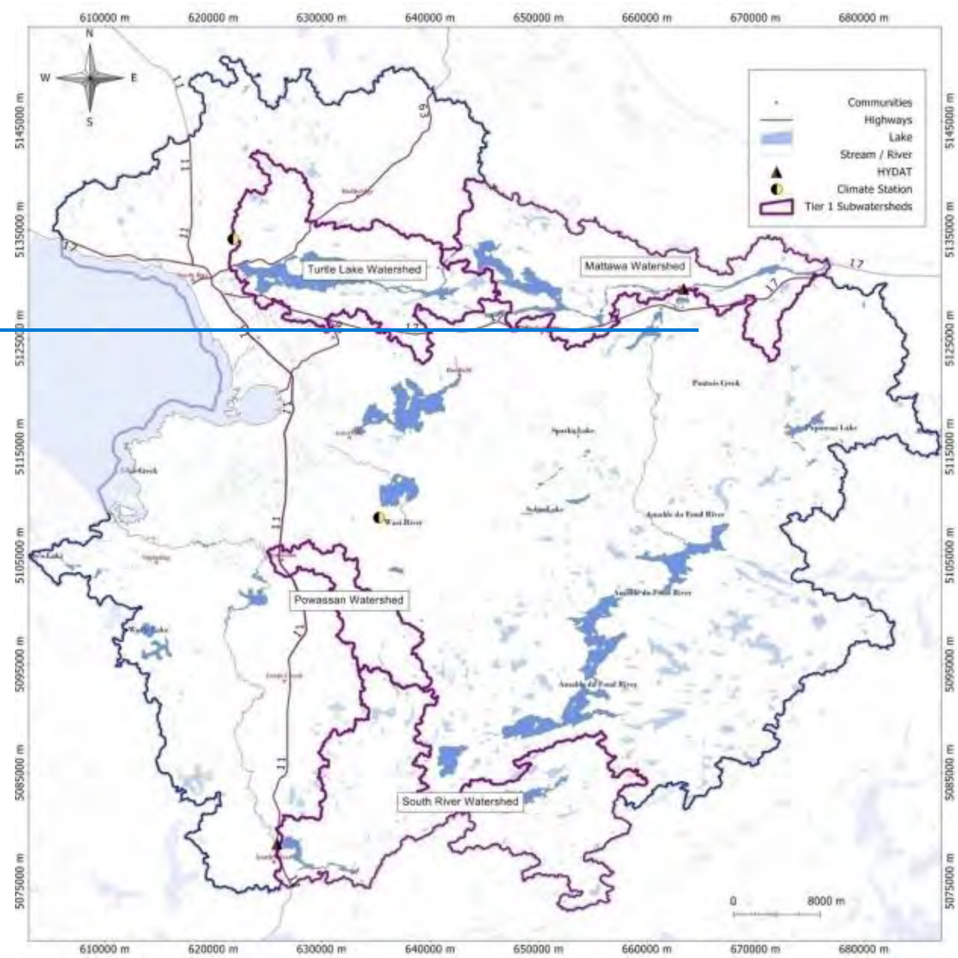
A water budget and water quantity stress assessment for each subwatershed is required by the *Clean Water Act (2006)* to determine whether the subwatershed will be able to meet current and future demands of all users.

General principles were explained earlier in Section 2.5 Conceptual Water Budget. The methodology specified in the Technical Rules Part III describes a tiered approach whereby all subwatersheds are subjected to a Tier One assessment and if stress is low during all months of the year, no further assessment is required. If stress levels are shown to be either moderate or significant, a more robust Tier Two assessment is completed and, similarly if that reveals moderate or significant stress, a Tier Three Local Risk Assessment must be undertaken. The information for this Section is based primarily on the Tier One Water Budget and Stress Assessment for the subwatersheds supplying the South River, Powassan and Mattawa Municipal Water Supplies (WESA, 2010). A Tier One Assessment for the remainder of the subwatersheds in the SP Area is presented in Section 2.6.

The portion of the South River Watershed that contributes to the groundwater intake for Powassan is approximately 70.1 km^2 and is depicted along with the contributing subwatersheds for the municipal supplies for the Town of Mattawa and the Village of South River in Figure 7-1.

Figure 7-1. Tier One Water Budget Subwatershed




Communities
Highways
Lake
Stream / River
HYDAT
Climate Station
Tier 1 Subwatersheds
Turtle Lake Watershed
Mattawa Watershed
Powassan Watershed
South River Watershed
0
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680000 m
5145000 m
5135000 m
5125000 m
5115000 m
5105000 m
5095000 m
5085000 m
5075000 m

Municipal drinking water for the Municipality of Powassan is provided by two overburden wells that tap into a gravel aquifer. The Municipality of Powassan experienced a population decline of 1.8% between 1996 and 2001, but then experienced an equivalent increase during the period between 2001 and 2006, resulting in a stable population over those ten years. (NBMCA, 2007; Statistics Canada, 2007). In addition, the municipality does not anticipate a significant change in population or in pumping rates in the upcoming years (Waterloo Hydrogeologic, 2006). The population has continued to increase slowly and was 3,455 in the 2016 census, a growth rate of 6.24% since 2001 (Statistics Canada 2016). Therefore, future water demand and land use change are expected to be minimal and have minimal impact on the subwatershed water budget parameters. As a result, additional assessment into future scenarios is not necessary.

Water budget elements include precipitation, actual evapotranspiration (AET), surplus, recharge, and runoff. All are expressed in mm to make them comparable to precipitation figures. The resulting water budget for Powassan is shown below in Table 7-1.

While total annual surplus should theoretically equal stream flow (Gartner Lee Ltd., 2007b), there is no recent stream flow data within the Powassan municipal supply subwatershed. Data from gauge 02DD001 (South River at Powassan) ends in 1936 so is not necessarily representative of current flow conditions. Instead, data from another gauge, Environment Canada/Water Survey of Canada gauge 02DD009 (South River at South River), was used to approximate conditions within the Powassan subwatershed.

Table 7-1. Estimated Water Budget Elements (Powassan)

Month	Precipitation (mm)	Actual ET (mm)	Surplus (mm)	Recharge mm	Runoff (mm)
January	64.9	0.0	68.5	1.7	2.5
February	51.9	0.0	53.0	0.8	1.2
March	62.9	0.0	63.4	0.4	0.6
April	66.1	24.9	41.6	22.3	33.1
May	82.8	76.9	6.2	67.5	99.9
June	89.0	106.5	0.0	33.7	50.0
July	99.5	119.6	0.0	16.9	25.0
August	94.6	103.9	0.0	8.4	12.5
September	112.3	68.8	0.8	4.4	6.5
October	95.6	32.0	64.9	15.3	22.6
November	86.7	0.0	89.2	7.6	11.3
December	64.3	0.0	67.3	3.8	5.7
Annual Total	**970.7**	**532.7**	**454.9**	**182.8**	**270.8**
Gartner Lee (2007)	936	539	430	173	257

Analysis of continuous stream flow data collected at this gauge yielded a total annual surplus of 435 mm. By comparison the total surplus predicted by the Thornthwaite-Mather soil moisture budget conducted by WESA on the Powassan subwatershed yielded a total annual surplus of 455 mm. Gartner Lee Ltd. (2007a) estimated the surplus in a comparable location to be 430 mm. The primary cause for the difference is that the precipitation predicted by the WESA GIS model was 34 mm greater than that predicted by Gartner Lee Ltd. (2007a). All water budget parameters estimated by WESA are within 6% of those estimated by Gartner Lee Ltd. (2007a). The close agreement between the results obtained by WESA and Gartner Lee Ltd. (2007a) provides a high level of confidence in the water balance.

The groundwater supply is the water available for a subwatershed's groundwater users. The Powassan municipal supply subwatershed contains two such structures: Elliot Chute and Bingham Chute. Elliot Chute and Bingham Chute host small hydroelectric generating stations (Gartner Lee Ltd., 2007a). It is assumed that groundwater flow into the subwatershed is negligible as the Powassan municipal supply subwatershed is bounded by the South River Reservoir on the downstream side and flow divides on the upstream sides. Consequently, groundwater supply was estimated to equal recharge as determined using a soil moisture model described in the WESA report.

Annual recharge was estimated to be 183 mm, which results in an average monthly recharge of 15.2 mm. Considering the area of the subwatershed (70.1 km^2), the average groundwater supply is 0.406 m^3/s. Lateral groundwater flow was assumed to be negligible. Water reserve was set at 10% of the recharge.

Water use (demand) was calculated considering available datasets for the study area, and the results compiled on monthly and annual scales. Municipal and communal use was determined using the Environment Canada Municipal Water and Wastewater Survey (Environment Canada, 2004b) as well as the Permit to Take Water (PTTW) database (MOE, 2009a). (Note: Ministry of Environment or MOE is a previous name of the Ministry of Environment, Conservation and Parks or MECP). There were no permitted communal water takings located in the Powassan subwatershed.

Water takings and returns were divided between deep groundwater, shallow groundwater and surface water. The following assumptions were made:

- most private wells are completed in bedrock, while municipal wells are completed in the overburden (Waterloo Hydrogeologic, 2006); therefore, it was assumed that takings are from deep groundwater and shallow groundwater, respectively;
- municipal water consumed includes water from population with sewage haulage; and
- municipal system losses are returned to shallow groundwater through infiltration.

Gross takings for municipal/communal use are approximately 164,219 m^3/yr. Of the gross municipal/communal takings, approximately 162,047 m^3/yr (99%) is consumed. The high percentage of consumption is due to the fact that municipal water is returned to a lagoon that discharges to Lake Nipissing via the South River downstream of the Powassan municipal watershed and therefore, is lost from the watershed (i.e. consumed). Municipal and communal water takings make up approximately 68% of the total gross water takings in the subwatershed and 68% of the water consumed. Environment Canada (2004b) states that 99% of serviced residents are on municipal sewers and 0.8% are on septic. The remaining 0.2% was assumed to return to surface water.

Datasets included the following:

- municipal and communal use (as specified above);
- domestic use from private water supplies (based on Statistics Canada 2006);
- agricultural use (livestock and irrigation from Statistics Canada, 2007).

Domestic use was calculated based on the population of the Municipality of Powassan of 3,309 and an estimate that 46% of those were supplied by private wells (Statistics Canada, 2007) with a total gross water taking of 97,227 m^3/yr (consumptive factor 0.2 assuming rest of water returned via septic systems to shallow groundwater).

Reported gross water takings for agricultural purposes are entirely for livestock because crop irrigation data are suppressed to meet confidentiality requirements of the *Statistics Act* and assumed negligible. Water for livestock is assumed to be taken entirely from deep groundwater wells and returned to shallow groundwater by infiltration. Gross water takings are estimated at 75,760 m^3/yr. Total agricultural demand comprises approximately 32% of the total water takings and total consumption.

The water use results developed for each of the sectors were amalgamated to estimate the cumulative water use for each of the systems (surface water, shallow groundwater and deep groundwater). Results from all sectors are summarized on an annual scale in Tables 7-2a, 7-2b and 7-2c and graphically on Figure 7-2.

Table 7-2a. Annual Water Use Results - Gross Takings (Powassan)

Reservoir	Gross Annual Takings (m^3)					TOTAL
	Permitted Takings			Non-Permitted		
	Municipal and Communal[a]	Industrial and Commercial[b]	Other Permitted	Private Domestic	Agricultural[c]	
Surface Water						0
Shallow Groundwater	164,219					164,219
Deep Groundwater				97,227	75,760	172,987
TOTAL	164,219	0	0	97,227	75,760	337,206

Table 7-2b. Annual Water Use Results - Consumption (Powassan)

Reservoir	Annual Consumed (m^3)					TOTAL
	Permitted Takings			Non-Permitted		
	Municipal and Communal[a]	Industrial and Commercial[b]	Other Permitted	Private Domestic	Agricultural[c]	
Surface Water						0
Shallow Groundwater	162,047					162,047
Deep Groundwater				19,445	75,760	95,205
TOTAL	**162,047**	**0**	**0**	**19,445**	**75,760**	**257,252**

Table 7-2c. Annual Water Use Results - Returns (Powassan)

Reservoir	Annual Returned (m^3)					TOTAL
	Permitted Takings			Non-Permitted		
	Municipal and Communal[d]	Industrial and Commercial[b]	Other Permitted	Private Domestic[e]	Agricultural	
Surface Water						0
Shallow Groundwater	2,201			77,782		79,983
Deep Groundwater						0
TOTAL	**2,201**	**0**	**0**	**77,782**	**0**	**79,983**

Notes. a: Includes system losses, which are assumed to return to surface water
b: Assume industrial and commercial water comes from shallow groundwater and returns to SW through sewer service
c: Assume agricultural water comes from deep groundwater, since assuming source is same as private wells, and most private domestic wells are in deep bedrock
d: Assume remaining 0.2% returns to surface water (99% on sewer and 0.8% on septic)
e: Assume returns from private domestic wells discharges through septic systems to shallow groundwater

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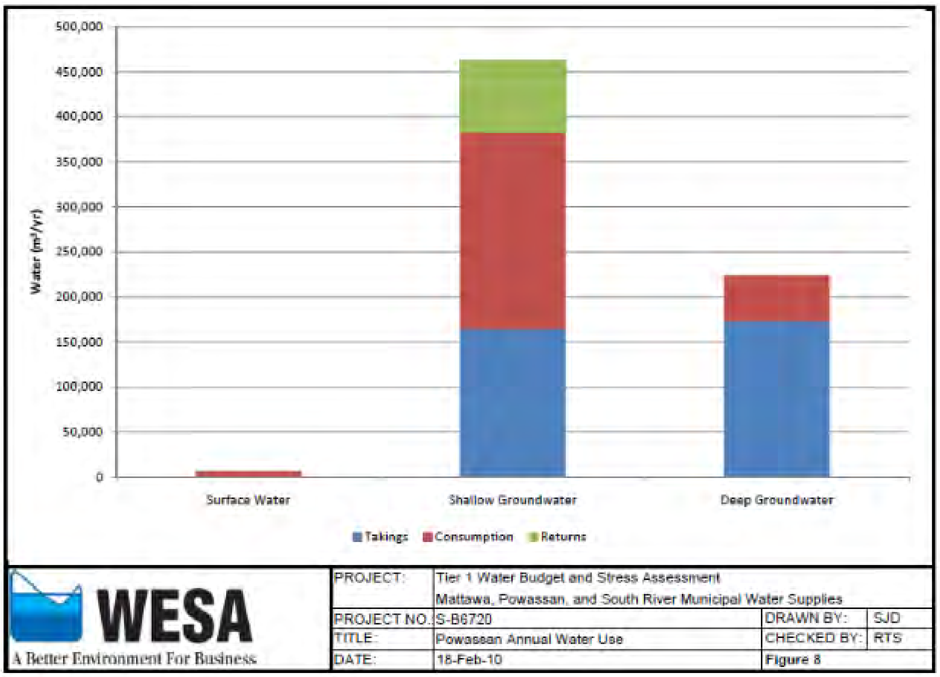
All of the gross annual water takings within the study area are from groundwater: 49% from shallow groundwater (municipal takings); and 51% from deep groundwater (private domestic and agricultural takings).

Figure 7-2. Annual Water Use (Powassan)



Of total water consumed, 63% comes from shallow groundwater and the remaining 37% from deep groundwater. Municipal water to serviced residents is 100% consumed with respect to the subwatershed of interest. Water not consumed through the "consumptive factor" is returned to a lagoon for treatment that discharges to Lake Nipissing, which is downstream of the Powassan municipal supply watershed; therefore, it is considered lost to the watershed in question (i.e., consumed). All water that is not consumed is assumed to be returned to shallow groundwater through infiltration and septic systems; it is assumed that leakage from the municipal system returns to the shallow groundwater through infiltration. This is consistent with the mostly rural nature of the region. Table 7-3 compiles the net water takings for each of the systems. There is a net taking from groundwater of approximately 257,224 m^3/yr. Both the shallow and deep groundwater systems have more water taken than returned; 84,237 m^3/yr and 172,987 m^3/yr, respectively.

Table 7-3. Net Water Takings (Powassan)

Reservoir	Net Water Takings (m^3)
Surface Water	0
Shallow Groundwater	- 84,236
Deep Groundwater	- 172,987
TOTAL	**- 257,223**

Note: Positive values indicate that returns exceed takings

Monthly water use was nearly constant between months (differing only due to the number of days in each month), since there are no seasonal uses. Monthly takings from shallow groundwater range from 12,598 m^3 to 13,947 m^3, while takings from deep groundwater range from 13,270 m^3 to 14,692 m^3.

7.2.1 Groundwater Stress Assessment

Groundwater stress is determined by examining the ratio of water demand (water takings) to water supply, while also considering the reserve required to maintain ecosystem function (MOE, 2007). (Note: Ministry of Environment or MOE is a previous name of the Ministry of Environment, Conservation and Parks or MECP). The percent water demand is compared to a stress threshold (Table 7-4) to determine the stress level.

Table 7-4. Groundwater Stress Thresholds Based on Annual and Monthly Percent Water Demand

Groundwater Quantity Stress Level Assignment	Average Annual (%) Water Demand	Maximum Monthly (%) Water Demand
Significant	≥ 25%	≥ 50%
Moderate	> 10% and < 25%	> 25% and < 50%
Low	≤ 10%	≤ 25%

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The annual and maximum monthly percent groundwater demand for the Municipality of Powassan supply subwatershed are 2.23% and 2.27%, respectively. Table 7-5 below presents the monthly and annual demand, supply and reserve values used to calculate the percent demand.

A subwatershed is considered low stress if the average annual percent demand is between 0 and 10% and if the maximum monthly percent demand is between 0 and 25%. As a result, the Municipality of Powassan municipal supply subwatershed was considered low stress and did not require a Tier Two Water Budget.

Table 7-5. Percent Groundwater Demand (Powassan)

Month	Consumption	Supply	Reserve	%Demand
January	***0.312***	***15.2***	***1.52***	***2.27***
February	0.282	15.2	1.52	2.05
March	***0.312***	***15.2***	***1.52***	***2.27***
April	0.302	15.2	1.52	2.20
May	***0.312***	***15.2***	***1.52***	***2.27***
June	0.302	15.2	1.52	2.20
July	***0.312***	***15.2***	***1.52***	***2.27***
August	***0.312***	***15.2***	***1.52***	***2.27***
September	0.302	15.2	1.52	2.20
October	***0.312***	***15.2***	***1.52***	***2.27***
November	0.302	15.2	1.52	2.20
December	***0.312***	***15.2***	***1.52***	***2.27***
Total	**3.67**	**182.4**	**18.24**	**26.74**

Note: ***Bold italics*** indicate months with maximum monthly percent demand.

7.2.2 Uncertainty

The limitations inherent to each dataset individually, combined with the discrepancies between datasets, all introduce various levels of uncertainty which are ultimately compounded into the results.

Because this study is conducted at the regional scale, results must be interpreted in their context and would require confirmation and refinement through further investigation at the local scale. Also, the various datasets used in the analysis are a 'snapshot in time', as population census is as of 2006, while municipal water use data is current as of 2004. Obtaining contemporary, more up-to-date data would reduce the error associated with the combination of datasets from varying dates.

Only water takings greater than 50,000 L/d are included in the Permit to Take Water (PTTW) database, while water use from smaller users is unknown. There were no PTTW records available for Powassan.

Other sources of uncertainty include how very little information is available for some sectors; for instance, there may be a number of smaller industrial and commercial users that are not accounted for. Water taking for livestock is exempt from the permitting requirements, regardless of the volume taken. Similarly, no information is available for recreational or ecological users.

Considering the significant sources of uncertainty, the uncertainty associated with the Tier 1 Water Budget and Stress Assessment is considered high. However, the percent demand for this system is well below the defined thresholds and, as such, no additional work is likely required to address the uncertainty.

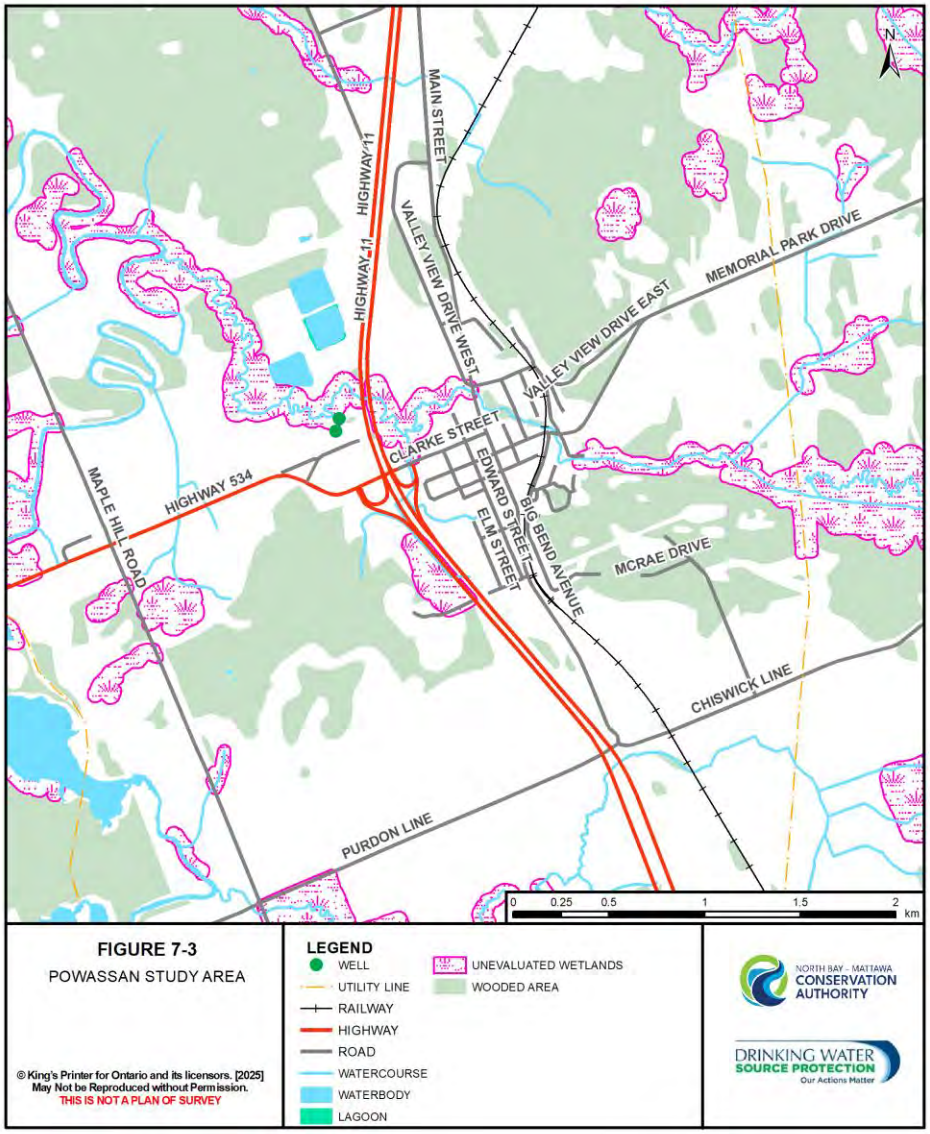
7.3 Groundwater System Characterization

The information contained in the following Sections assessing the water quality component of the vulnerability and threats to the Powassan system was taken primarily from the two 2009 Technical Assessment Reports on the Municipality of Powassan prepared by Waters Environmental Geosciences Ltd. (WEGL) entitled:

- Groundwater Vulnerability Analysis, and (2009c); and
- Groundwater Risk Assessment (2009a).

The Municipality of Powassan well field consists of two municipal wells, located on the north side of Highway 534 and west of the Highway 11 corridor, in Powassan (Figure 7-3). The well field is located on a gently sloping topography between Highway 534 and Genesee Creek, with both wells being located above the creek level. The UTM co-ordinates of the two municipal wells (in NAD83) are 625874 mE and 5104525 mN (Well No. 1) and 625890 mE and 5104590 mN (Well No. 2). The system services approximately 1,025 people (2006 census).

Figure 7-3. Powassan Study Area




N
W
E
S
Main
Memorial
Memorial park
LAGOONS
Chiswick
Purdon
Maple Hill
0
1000 m
Powassan Wells
Roads
Railway
Lakes
Wetland
Rivers/Streams
Utility Line
Wooded Areas
Study Area

Table 7-6 below summarizes the construction details of the Powassan wells. The sand and gravel soils are typical of the area.

Table 7-6. Specifications for the Two Powassan Municipal Wells

Specification	Well No. 1	Well No. 2
Year Drilled	1981	1983
Drilling Company	Crowley Groundwater Ltd. (Dundas)	Crowley Groundwater Ltd. (Dundas)
Depth Below Grade	23.2 m	18.6 m
Steel Casing - Diameter - Depth	160 mm (6 1/4 in) 19.3 m	305 mm (12 inch) 11.0 m
Stainless Steel Composite Screen	3.8 m screened interval 140 mm (5 1/2 inch) diameter screen with two 0.9 m long No. 10 slot screens over top of one 1.2 m long No. 50 slot screen	7.6 m screened interval 250 mm (10 inch) diameter composite screen with a 2.7 m long No. 30 slot screen atop 4.0 m of No. 40 slot screen over top 0.9 m of No. 35 screen
Gravel Packing	No indication of any	No indication of any
Static Water Level at Completion (Below grade)	5.9 m	0.4 m (approximately at elevation of nearby Genesee Creek)
Registration No.	Not Registered	
Formation encountered during drilling	Fine brown sand to a depth of 10.7 m; over brown layered silty clay and fine sand to a depth of 15.2 m; over coarse sand and gravel with occasional cobbles to completion depth of 24.1 m	Brown dirty sand to a depth of 3.4 m, over clay with streaks of sand to a depth of 10.4 m; over gravel and sand to a depth of 18.9 m (with a partially cemented layer from 12.3 m to 12.8 m); over clay, gravel and sand to completion depth of 22.0 m

Water consumption data were obtained from the Municipality, for the time period January 2003 to December 2008, and examined for overall trends. Although there is a degree of scatter in the plot (attributed to some seasonal effects coupled with well maintenance activities), there is no distinct trend in total water use over the period. The highest total consumption was for December 2008, averaging 613 m^3/day (402 m^3/day being taken from Well No. 1 and 211 m^3/day from Well No. 2). Over the total time period for which the records were obtained, the average total daily consumption was 508 m^3/day, with an average of 208 m^3/day being taken from Well No. 1 and 300 m^3/day being taken from Well No. 2.

These values are well below the maximum permitted pumping rate (both wells combined) of 1,313 m^3/day (Permit to Take Water No. 82-P5292). For the present analysis, the allocated quantity of water to be used in the wellhead protection analysis was assumed to be equal to 508 m^3/day, which is the average for the period reviewed. The individual rates used in the capture zone assessment were set at 208 m^3/day for Well No. 1 and 300 m^3/day for Well No. 2. A review of available information indicated that there is no proposed expansion to the water distribution system.

Despite the close proximity of the wells to Genesee Creek, particularly Well No. 2, the Powassan well field has not been flagged as groundwater under the direct influence of surface water (GUDI); however, a review of the initial pumping test data suggested that at higher pumping rates, the area of influence of the pumping wells may extend outwards far enough to capture a portion of surface water via recharge. A supplemental analysis was undertaken to investigate the specific pumping conditions which could lead to the conversion of the water supply from non-GUDI to GUDI (Groundwater Under Direct Influence) status. This information was identified as being of value to future watershed planning and, as well, would provide a sensitivity analysis of the model itself to future changes in groundwater withdrawals. Findings are discussed in Section 7.4.

The area is characterized by rolling hills and bedrock outcrops. Because the bedrock is fractured, it transmits water readily enough that the upper portions had to be included as part of the groundwater flow system beneath the well field in the model. Overburden (soil covered) areas exhibit soil layers of varying hydraulic conductivity (rate at which water can pass through soil) above the aquifer. In the areas of lower elevation the uppermost layer tended to be primarily clay which would impede the infiltration of water. However, this was not consistent over the study area. In the valley and floodplain of Genesee Creek, a layer of silty sand alluvium, which conducts water more readily, penetrates the clay layer offering a “window” for surface water recharge to the underlying sand and gravel till aquifer. The alluvium is still relatively fine grained and its hydraulic conductivity is low relative to the sand and gravel aquifer.

This means that there is a clay aquitard over much of the study area that provides significant protection to the aquifer from surface contaminants.

Using the Visual MODFLOW groundwater flow model, the amount of time needed for the water “particles” to travel through the aquifer to the well field can be determined, allowing the contributing areas to be defined by their respective travel times (or time of travel values). During the model calibration process, the soil properties and recharge values were adjusted manually until a close match of the water table surface and the water levels in the wells and creeks were obtained.

Table 7-7 shows the final calibrated parameters used in the model. In Table 7-7, "na" indicates that there is no recharge value applicable to the sand and gravel aquifer because the unit is not in the uppermost layer (i.e. recharge only applies to the uppermost layer of the model). "k" refers to the hydraulic conductivities, with the subscripts indicating the direction in which the parameter is measured (corresponding to the x, y and z axes). "S_s" refers to the specific storage, "S_y" refers to the specific yield and "$n_{eff} = n_{tot}$" refers to the effective and total porosity (set equal to each other in this case). With the exception of the bedrock unit, an anisotropy ratio of 1:10 was used for the vertical to horizontal hydraulic conductivity values.

Table 7-7. Powassan Model Parameters at Calibration

Zone	Material	$k_x = k_y$ (cm/sec)	k_z (cm/sec)	Recharge (mm/year)	S_s (1/m)	S_y	$n_{eff} = n_{tot}$
1	basal till	4×10^{-3}	4×10^{-4}	180	6×10^{-5}	0.24	0.35
2	bedrock	9×10^{-4}	9×10^{-4}	150	1×10^{-6}	0.04	0.10
3	alluvium	1×10^{-4}	1×10^{-5}	80	6×10^{-7}	0.18	0.25
4	clay	1×10^{-6}	1×10^{-7}	10	3×10^{-4}	0.05	0.45
5	sandy silt	9×10^{-5}	9×10^{-6}	80	1×10^{-4}	0.18	0.40
6	silty sand	3×10^{-4}	3×10^{-5}	110	1×10^{-4}	0.18	0.40
7	sand and gravel aquifer	3×10^{-2}	3×10^{-3}	na	6×10^{-5}	0.24	0.35

Note: na = no applicable value; k = hydraulic conductivity; S_s = specific storage; S_y = specific yield; n_{eff} = effective porosity; n_{tot} = total porosity

7.4 Delineation and Scoring of Vulnerable Areas

The procedure for delineating and scoring the vulnerable area of a Type One Drinking Water System under the *Clean Water Act (2006)* is outlined in detail in Section 7.4.1. Identifying the vulnerable area is based largely on the time it takes water to travel in the aquifer to the wellhead.

7.4.1 Defining the Vulnerable Areas (Wellhead Protection Areas)

Four subzones of the wellhead protection area (WHPA) were identified. Time-of-travel (TOT) was determined using computer based three-dimensional groundwater flow modelling:

- WHPA-A is the area within 100 m;
- WHPA-B extends beyond the 100 m zone to a line marking the 2-year TOT;
- WHPA-C extends from the WHPA -B limit out to the 5-year TOT;
- WHPA-D extends from the WHPA-C limit out to the 25-year TOT.

Several years previous, a regional groundwater study was conducted (Waterloo Hydrogeologic, 2006), which also used computer modelling to delineate a wellhead protection area. The current study used a more recent version of the same software, local mapping and a substantial amount of additional data to create a revised model at a finer scale resulting in the delineation of vulnerable areas as shown in Figure 7-4a.

The shape of the Powassan wellhead protection area is due to the direction that the groundwater flows in the aquifer. Flow tends to run from the east and southeast toward the well. Accordingly, the vulnerable area does not include lands to the west or north.

The municipal sewage treatment lagoons are located outside of the vulnerable area and discharge downstream of the wells.

A supplemental GUDI analysis was performed as part of the assessment. Wells that draw all or some of their water supply from a surface water body, and have less than 50 days time-of-travel from the surface water to the well intake, are classified as groundwater under the direct influence of surface water (or GUDI), and once classified require additional levels of water treatment before distribution to the public.

The Powassan well field has not been flagged as having any interaction with the nearby surface water feature (Genesee Creek), as was indicated in the First Engineers' Report (Totten Sims Hubicki Associates, 2001), and is considered to be a non-GUDI supply under the *Clean Water Act (2006)*. However, a review of the initial pumping test data suggested that at higher pumping rates, the area of influence of the pumping wells may extend outwards far enough to capture a portion of surface water via recharge. The purpose of this analysis was to determine if there are pumping conditions under which surface water could reach the well in less than 50 days.

Municipal Well No. 1, by this analysis, receives no surface water inputs from Genesee Creek at the allocated pumping rate. Municipal Well No. 2 does receive a portion of its intake from Genesee Creek under the allocated pumping rate, but the location of this surface water input is approximately 1 km east of the well field area, and the associated time-of-travel to the well is in the range of 30 to 40 years. A second scenario simulated the entire allocation being drawn from Well No. 2 which could be required during maintenance of the other well. The surface water recharge location and time-of-travel did not change.

An additional scenario was run simulating one well pumping at the maximum permitted rate which is two and a half times the normal rate. Under these conditions, some water infiltrates from a closer location, but the time-of-travel is still on the order of 100 days and the well field remains non-GUDI. It should be noted that there is some uncertainty associated with any model, so caution is advised in interpretation of these findings at rates exceeding the allocated quantity.

7.4.2 Vulnerability Scoring

The other factor in determining the vulnerability score is how easily contaminants could travel through the soils and down to the aquifer (hydraulic conductivity). This depends on the nature and thickness of the soils between the surface and the aquifer.

The hydraulic conductivity of each type of soil can be described by its K-factor as shown in Section 3, Table 3-4.

The Intrinsic Susceptibility Index (ISI) is then calculated for each location within the vulnerable area considering the degree of protection provided by the type and thickness of various soil layers. Susceptibility of the aquifer at each location is then rated as high, medium or low (Figure 7-4b). The mapping of the susceptibility (ISI) (Figure 7-4b) shows the extent of the clay aquitard, described previously, which reduces the risk of contamination (ISI - Low). Beyond that the overburden consists of sandy silt above till; the susceptibility of that type of soil is rated as medium (ISI - Medium). There are a couple of gravel deposits fairly distant from the wells and the susceptibility in those areas is high (ISI – High).

The vulnerability score can be modified if there is concern that transport pathways within the WHPA may increase the vulnerability of the aquifer beyond that which was originally mapped. In two transport pathway locations along the highway corridor, two lens-shaped areas of higher susceptibility (8 and 10) are shown in Figure 7-4b. The ISI rating in these areas was increased due to the documented existence of several deep abandoned geotechnical boreholes drilled during highway construction. Review of the subsurface logs indicates that many of the drill holes penetrated lower permeability (clay) horizons, in which case it is likely that the boreholes would not have remained open for any length of time. Unfortunately, a clay unit was not always encountered, and it is considered possible that a constructed pathway from the surface to the aquifer may have been created within the identified geotechnical test areas. At the time of the completion of the technical study, there was no information available as to how the boreholes had been decommissioned (filled and capped) and the date of the drilling predates more recent policies relating to borehole abandonment and sealing in accordance with the requirements of O.Reg. 903 (water well regulation).

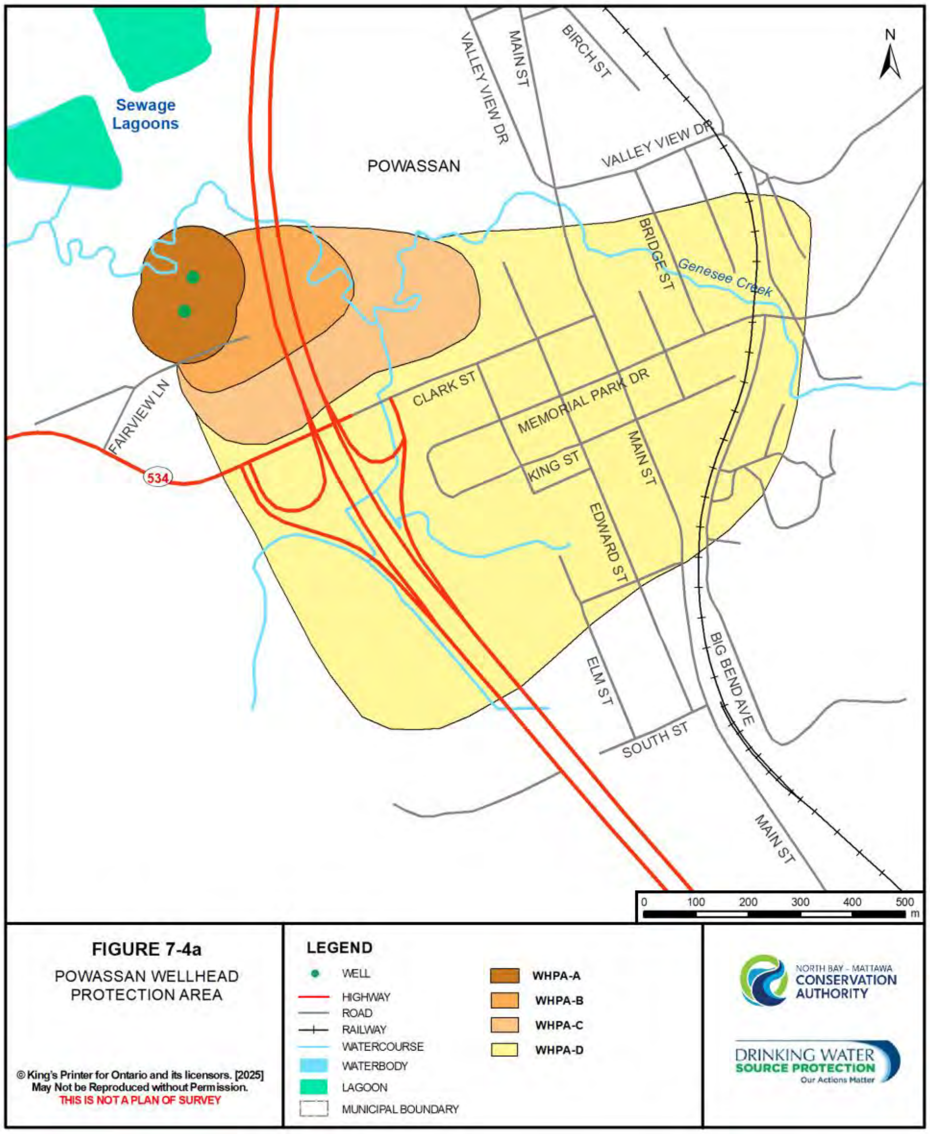
Technical Rule 83 provides the appropriate vulnerability scores based on the WHPA zone and the susceptibility of the aquifer at a particular location in the zone as shown below in Table 7-8. Once the WHPA and its subzone areas were delineated (Figure 7-4a), and the susceptibility of the aquifer throughout that area was determined (Figure 7-4b), these two factors were combined to provide the vulnerability score for the Powassan WHPA (Figure 7-4c and Figure 7-6).

Figure 7-4c (below) shows the resultant vulnerability scores for the entire vulnerable area once the WHPA zone and susceptibility factors are combined. An enlarged and detailed map of the modified vulnerable areas is provided in Figure 7-5 with reference to vulnerability scores shown on Figure 7-6.

Table 7-8. Vulnerability Scores (Vs) for Powassan Vulnerable Area

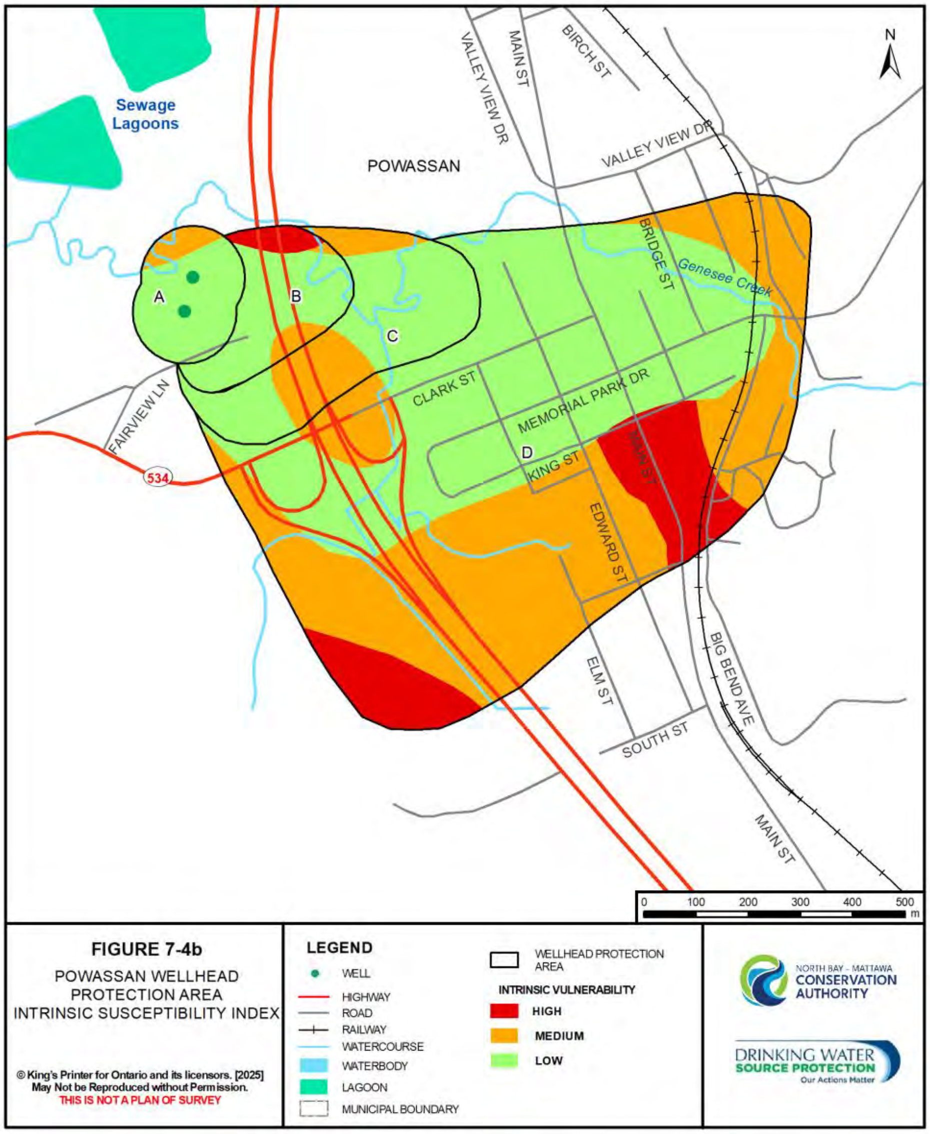
Intrinsic Susceptibility Index	Vulnerability Scores within Wellhead Protection Area			
	WHPA-A	WHPA-B	WHPA-C	WHPA-D
High	10	10	8	6
Medium	10	8	6	4
Low	10	6	4	2

Figure 7-4a. Powassan Wellhead Protection Area




Powassan Wells
Roads
Railway
Lakes
Wetland
Rivers/Streams
Utility Right of Way
Powassan WHPA
WHPA A
WHPA B
WHPA C
WHPA D
WHPA A
WHPA C
WHPA D
0
500 m

Figure 7-4b. Powassan Wellhead Protection Area - Intrinsic Susceptibility Index



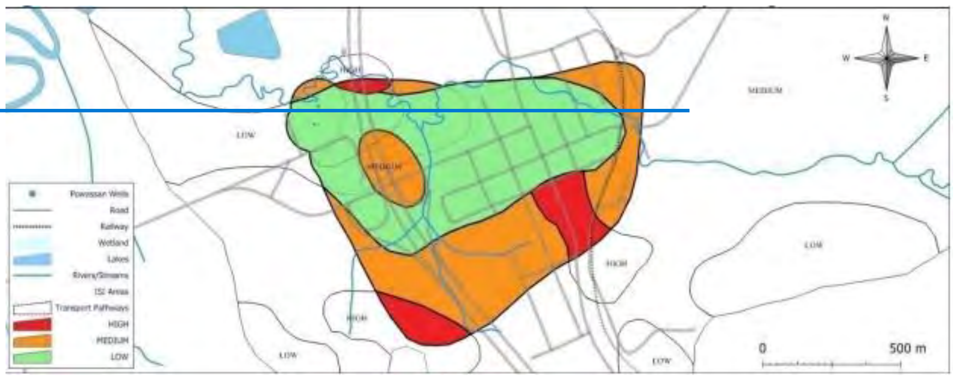
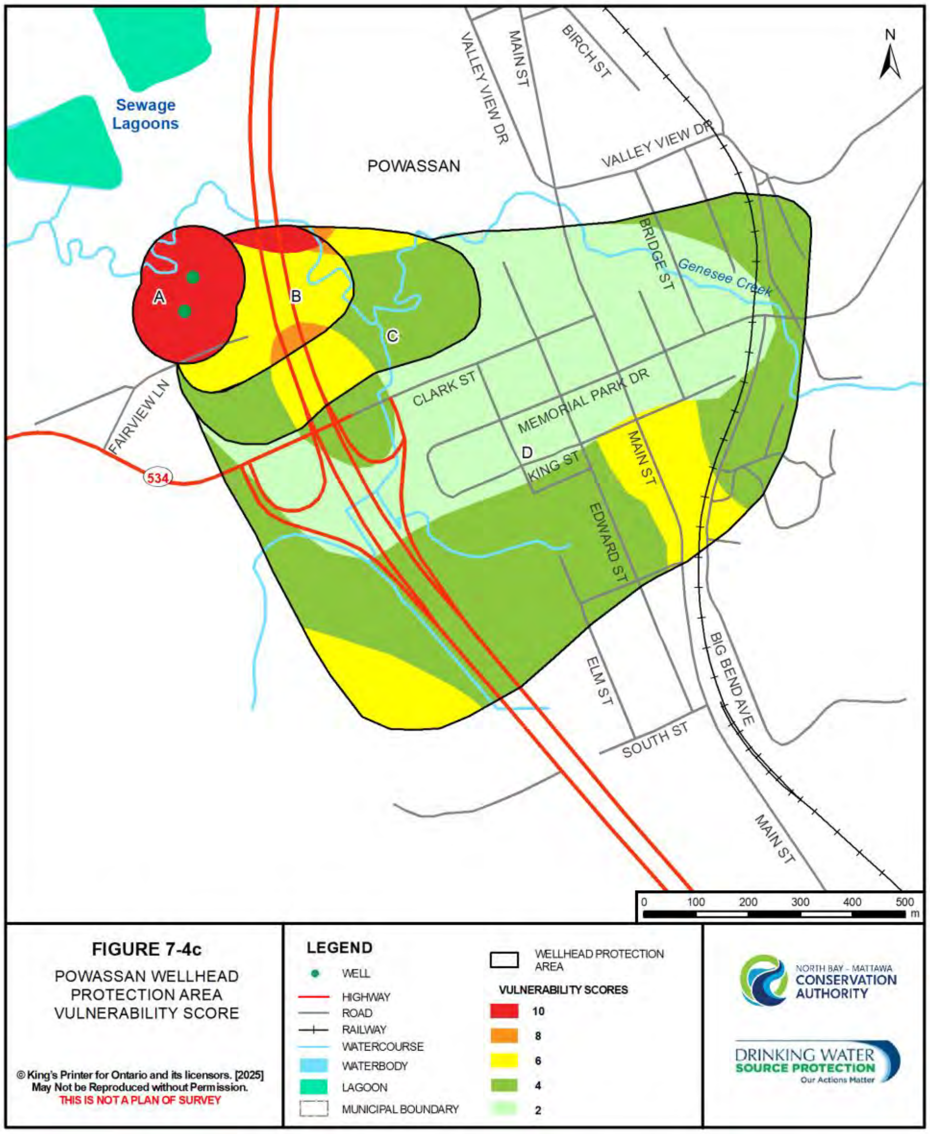
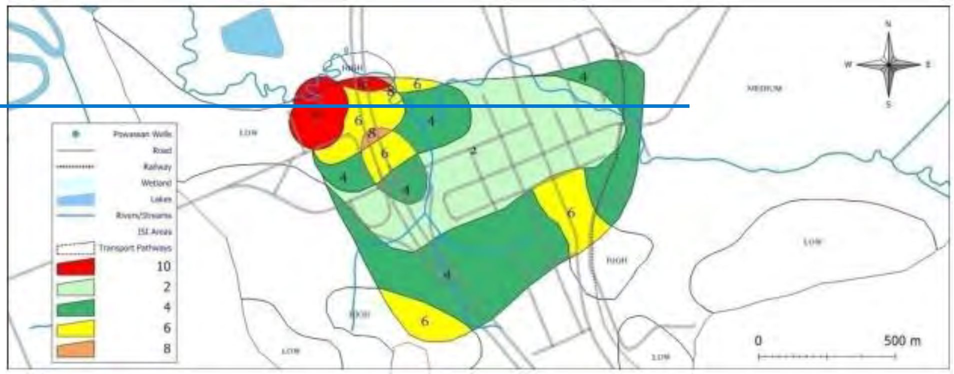

Powassan Wells
Road
Railway
Wetland
Lakes
Rivers/Streams
ISI Areas
Transport Pathways
HIGH
MEDIUM
LOW
N
W
E
S
MEDIUM
LOW
HIGH
0
500 m

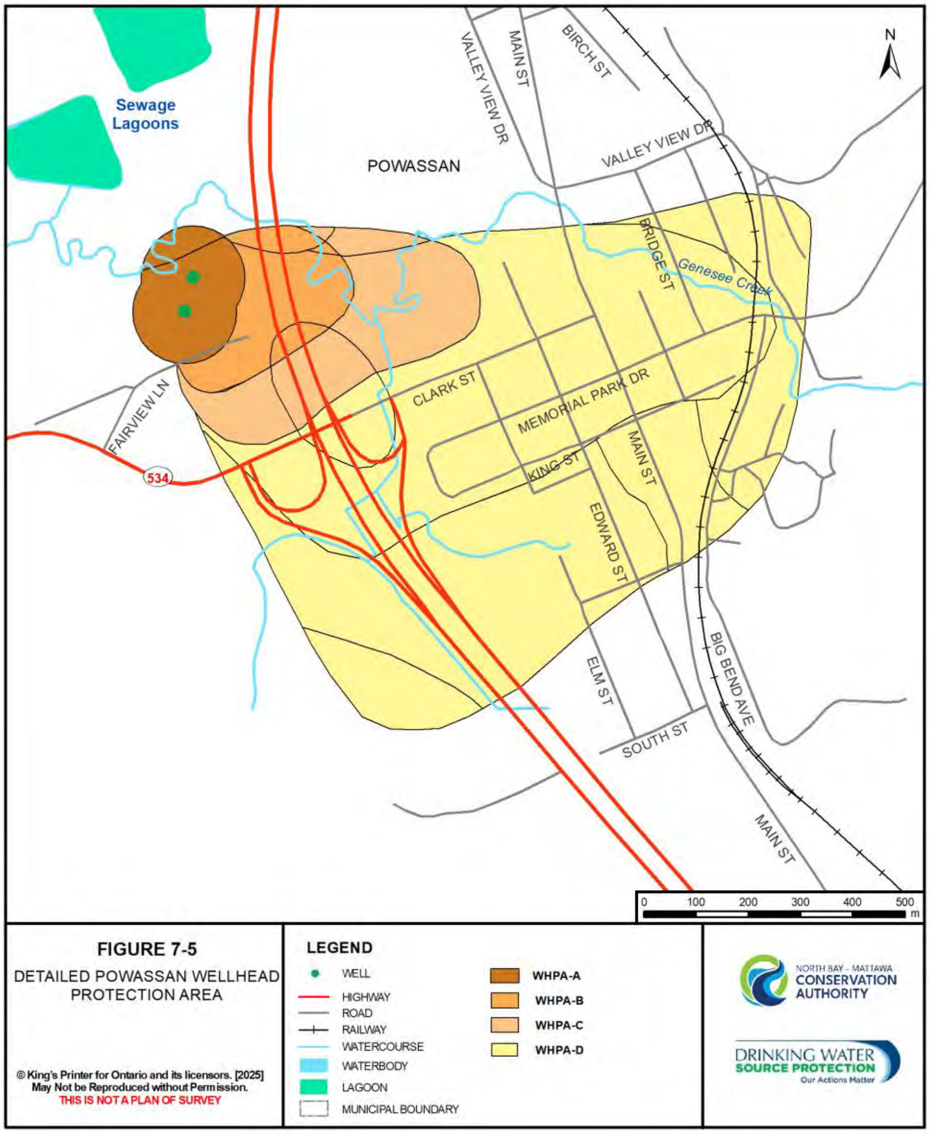
Figure 7-4c. Powassan Wellhead Protection Area - Vulnerability Score





Note: 7-4a.Vulnerability + 7-4b.Intrinsic Susceptibility = 7-4c. Vulnerability Score

Figure 7-5. Detailed Powassan Wellhead Protection Area



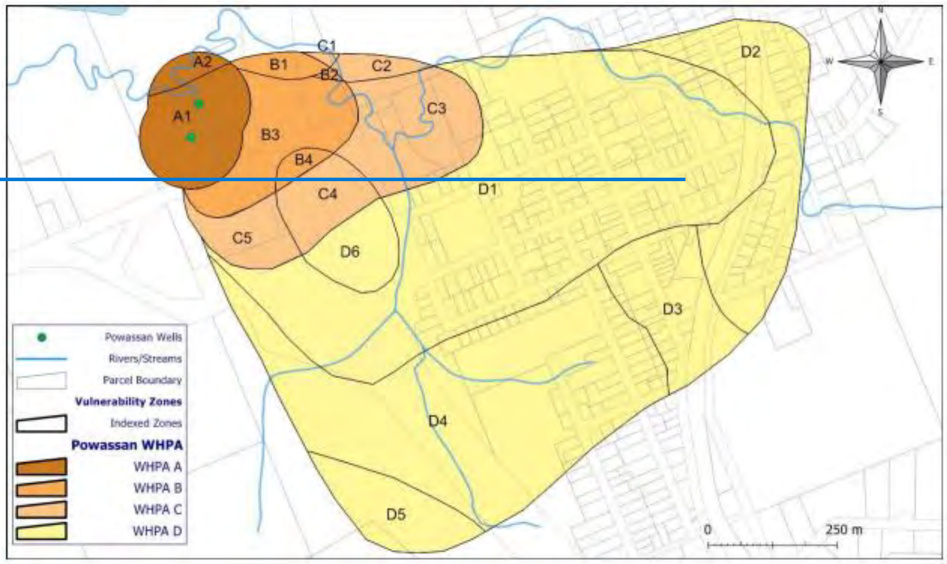
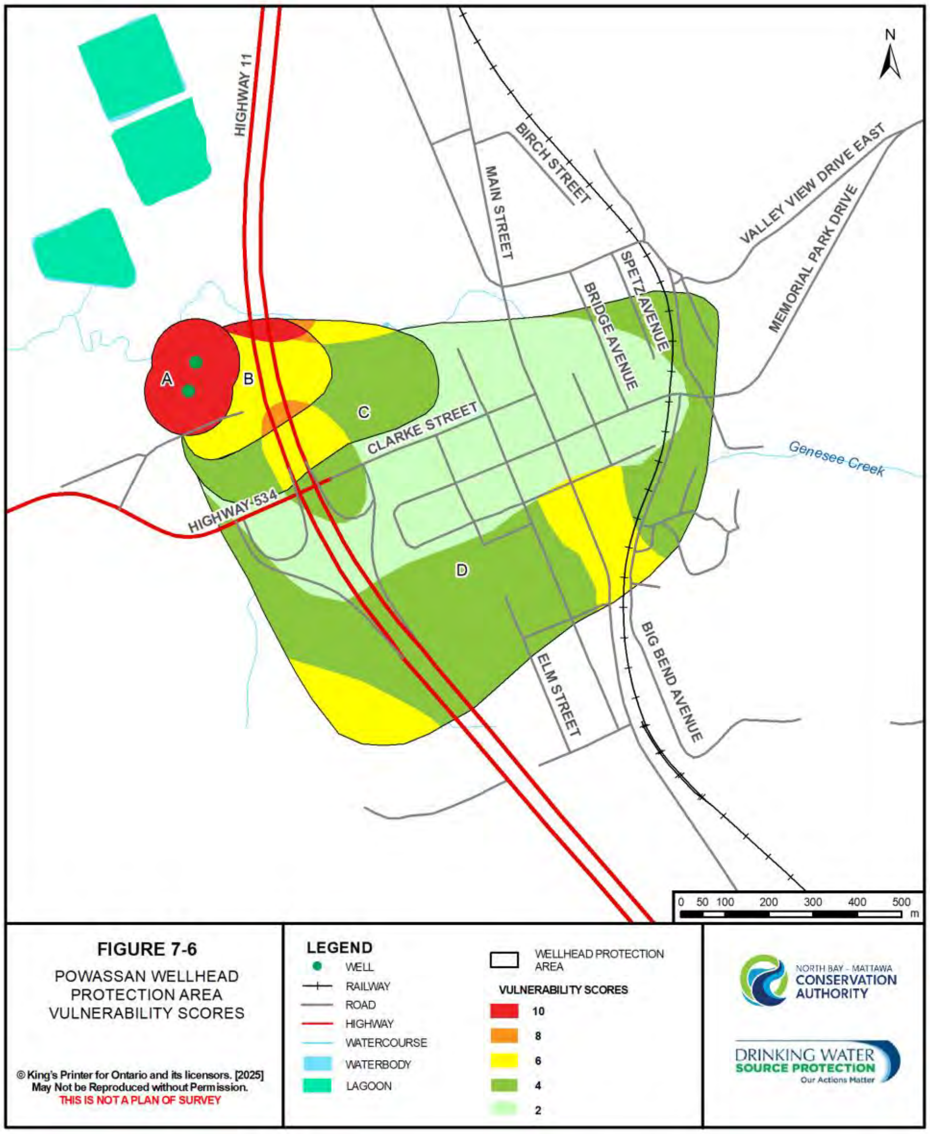
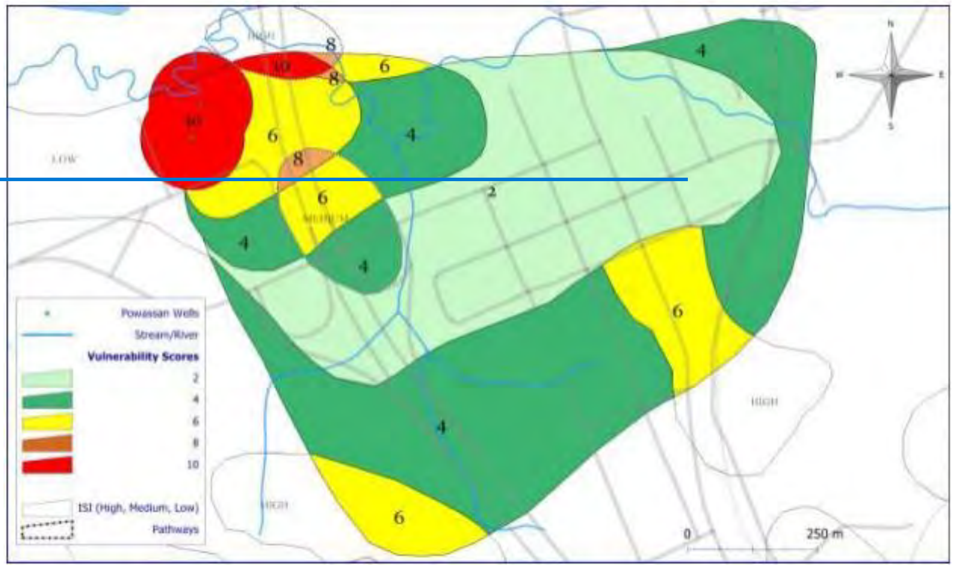

A2
A1
B1
C1
B2
C2
C3
B3
B4
C4
C5
D6
D1
D2
D3
D4
D5
Powassan Wells
Rivers/Streams
Parcel Boundary
Vulnerability Zones
Indexed Zones
Powassan WHPA
WHPA A
WHPA B
WHPA C
WHPA D
0
250 m

Figure 7-6. Powassan Wellhead Protection Area Vulnerability Scores





Note: larger 11” x 17” version of Figure 7-6 is available in Appendix A as Figure A-3.

7.4.3 Uncertainty Analysis

Delineation of the vulnerable areas within the WHPA will carry a degree of uncertainty, depending upon the quality of the data used in the assessment and the professional judgment skills of the analyst. The uncertainty of the vulnerability scoring of each area must be rated as either high or low (Table 7-9).

Table 7-9. Uncertainty Assessment - Powassan Groundwater Vulnerability Analysis

WHPA Zone	Vulnerable Area Designation	Intrinsic Vulnerability Category	Vulnerability Score	Uncertainty Factor	Explanation
A	A-1	low	10	low	fixed radius was applied, no hydrogeological interpretation required
	A-2	medium	10	low	fixed radius was applied, no hydrogeological interpretation required
B	B-1	high	10	high	status of abandoned geotechnical boreholes are unknown in this area
	B-2	medium	8	low	detailed modelling indicates stable capture zone close to the wellhead multiple scenario modelling indicates similar capture zone configuration
	B-3	low	6	low	detailed modelling indicates stable capture zone close to the wellhead multiple scenario modelling indicates similar capture zone configuration
	B-4	medium	8	high	status of abandoned geotechnical boreholes are unknown in this area
C	C-1	high	8	high	status of abandoned geotechnical boreholes are unknown in this area
	C-2	medium	6	low	detailed modelling indicates stable capture zone close to the wellhead multiple scenario modelling indicates similar capture zone configuration

WHPA Zone	Vulnerable Area Designation	Intrinsic Vulnerability Category	Vulnerability Score	Uncertainty Factor	Explanation
C	C-3	low	4	low	detailed modelling indicates stable capture zone close to the wellhead multiple scenario modelling indicates similar capture zone configuration
	C-4	medium	6	high	status of abandoned geotechnical boreholes are unknown in this area
	C-5	low	4	high	low density of subsurface information in this area
D	D-1	low	2	high	low density of subsurface information in the west half of this area multiple scenario modelling indicates variable capture zone configuration
	D-2	medium	4	high	low density of subsurface information in this area multiple scenario modelling indicates variable capture zone configuration
	D-3	high	6	low	sufficient density of subsurface information in this area
	D-4	medium	4	low	multiple scenario modelling indicates similar capture zone configuration
	D-5	high	6	high	low density of subsurface information in this area
	D-6	medium	4	high	status of abandoned geotechnical boreholes are unknown in this area

For the most part, there was adequate data available to achieve low uncertainty with respect to both the delineation of the WHPA and the assignment of susceptibility ratings using the ISI method. There is a small portion within each of WHPA-C and WHPA-D where there was less subsurface information available, so uncertainty has been rated as high for those areas. However, the delineation and scoring are consistent with adjacent areas. There are two other portions of WHPA-D where subsurface information is limited, and the multiple scenarios showed some shifting of capture zone configuration.

However, it should be noted that the current results are consistent with the findings of the previous NBMCA Groundwater Study (Waterloo Hydrogeologic, 2006). As well, they are consistent with the accepted geological interpretation of the area. The increased susceptibility assigned to areas where technical boreholes had been drilled in the early 1980s prior to construction of the interchange and bridge on Highway 11 is a conservative approach based on a lack of information available to confirm that appropriate decommissioning procedures were followed. It is the opinion of the consultant that the noted lack of information means the uncertainty for the susceptibility of the borehole area must be rated as high.

7.5 Issues Identification

Discussions with the MECP identified that the only potential issue associated with the Powassan groundwater supply is the presence of elevated sodium in the water. Sodium levels for the time interval of 2003 to 2006 ranged from 27 mg/L to 31 mg/L (Ministry of the Environment, 2008/2009 Inspection Report for the Powassan Water Well Supply). Under the current Ontario Drinking Water Quality Standards (ODWQS) (O.Reg. 169/03; Amended 2006) sodium levels above 20 mg/L constitute a notification level. The local Medical Officer of Health must be notified so that the information may be passed onto local physicians. The focus of such a notification is to provide warning to persons on a sodium-restricted diet of the presence of sodium in the water supply. As indicated in the ODWQS, sodium is not toxic.

Further investigations compared incidents of road salt contamination to water chemistry data for the Powassan well field. The levels of sodium observed at the Powassan well field have been seen at other locations in the North Bay area~~,~~ and are usually attributed to naturally occurring sodium levels in the bedrock formations of the region. Road salt impacted wells generally have a much higher concentration of sodium (and chloride) than has been reported for the Powassan well field. Therefore, the presence of the indicated sodium levels in the Powassan well supply is interpreted to be due to natural sources within the aquifer.

Public consultation identified a potential concern regarding historic use of the area adjacent to the wells for grazing livestock. However, available information suggests that this activity ceased in about 2000; further, in 2003 the Municipality adopted a by-law that restricts such land usage within 200 m of the wellhead. Given the passage of time and current land use restrictions, the risk of pathogens in the area due to former agricultural land use practices is not elevated.

Based on a review of these discussions and review of available data it was determined that there were no issues associated with the Powassan groundwater supply.

7.6 Threats Identification and Assessment

Threats are defined as those activities or conditions that could cause contamination of drinking water by a chemical or pathogen within one of the Wellhead Protection Areas (WHPA). Activities must be assessed and reported whether or not they currently occur within the vulnerable areas. O.Reg. 287/07 Section 1.1 (1) under the *Clean Water Act (2006)* lists 20 activities that may result in threats to drinking water quality (see Table 3-1). (Two additional prescribed activities pose threats to water quantity.)

Conditions, as defined by Part XI.3 of the Technical Rules, refer to past activities that have produced contaminants that may result in significant drinking water threats. A more detailed definition can be found in the discussion under section 3.2.5 above.

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

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

Of the three approaches used to identify threats, this system involved the *threats approach*, which is based on listing the prescribed activities that are or would be drinking water threats within the vulnerable areas, and the *issues approach*, which is based on activities or conditions that contribute to existing drinking water issues listed under Rule 114. The third approach, the *events-based approach*, is based on modelling that demonstrates a chemical or pathogen release from an activity that could result in the deterioration of source drinking water. The *events-based approach* was not used in the identification of threats for the Municipality of Powassan.

7.6.1 Threats Approach

Part XI.4 of the Technical Rules describes the methods for identifying significant, moderate and low drinking water threats related to activities in the vulnerable area of a drinking water intake.

A threat is deemed significant, moderate or low depending on:

1. the vulnerable area in which the activity occurs or would occur;
2. the vulnerability score of the vulnerable area;
3. a set of prescribed activities and corresponding circumstances that constitute a threat

The Technical Rules require activities that would be a significant, moderate or low drinking water threat within the vulnerable areas to be listed in the Assessment Report, *regardless of whether or not the activities presently exist in the vulnerable area.* For an activity to pose even a low threat, the vulnerability score of the area in which it occurs must be greater than or equal to 6 for a groundwater system.

Lists of significant, moderate and low drinking water threats related to chemicals and pathogens were compiled for each of the vulnerable areas of the Powassan drinking water intake based on the MECP Tables of Drinking Water Quality Threats (MECP ~~2018~~2021).

Existing activities were compared to the MECP Tables of Drinking Water Quality Threats, where the prescribed activities that pose a threat were classified as significant, moderate or low based on their circumstances.

Threats Approach - Potential Activities and Circumstances

Based on the resulting vulnerability scores, the possible threat levels were identified for each of the vulnerable areas (Table 7-10). Due to the vulnerability scores within the WHPAs, only WHPA-A, WHPA-B and WHPA-C may contain potential significant chemical threats, while WHPA-A and WHPA-B may contain significant pathogen threats (only WHPA-A and B for all wellheads in Ontario may contain pathogen threats). Refer to Figure 7-5b above for further support of the vulnerable areas where activities are significant, moderate or low.

Table 7-10. Areas within Powassan Wellhead Protection Area where Activities are or would be Significant, Moderate and Low Drinking Water Threats

Threat Type	Vulnerable Area	Vulnerability Score	Threat Level Possible		
			Significant	Moderate	Low
Chemicals	WHPA-A~~1, A2~~	10	✓	✓	✓
	WHPA-B~~1~~	10	✓	✓	✓
	WHPA-B~~2, B4~~	8	✓	✓	✓
	WHPA-B~~3~~	6	✓	✓	✓
	WHPA-C~~1~~	8	✓	✓	✓
	WHPA-C~~2, C4~~	6	✓	✓	✓
	WHPA-C~~3, C5~~	4	✓		
	WHPA-D~~3, D5~~	6		✓	✓
	WHPA-D~~2, D4, D6~~	4			
	WHPA-D~~1~~	2			
Pathogens	WHPA-A~~1, A2~~	10	✓	✓	
	WHPA-B~~1~~	10	✓	✓	
	WHPA-B~~2, B4~~	8		✓	✓
	WHPA-B~~3~~	6			✓

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Note: Pathogen threats are not considered in WHPA-C or WHPA-D.

The Tables of Drinking Water Quality Threats (MECP ~~2018~~2921) provide the detailed sets of circumstances for identifying if an activity meets the criteria for a significant, moderate or low drinking water threat. The Threats Tables can be downloaded from the MECP webpage (https://www.ontario.ca/page/2021-technical-rules-under-clean-water-act)~~(Ontario.ca/page/source-protection) in an Excel file format~~.

An on-line searchable version of the Threats Tables can be accessed at swpip.ca. ~~The actual provincial Threat Tables can be found at: https://files.ontario.ca/2017_2018_chemical_and_pathogen_tables_of_threats_12_v2.xlsx~~

The on-line version ~~Excel file~~ of the Threats Tables can be filtered to outline the specific circumstances related to potential chemical or pathogen threats. After the webpage is ~~file is downloaded and~~ opened, click on the "Search~~Data~~" menu tab and then "Zone and Score~~Filter~~". By applying the filter values in sequence, as shown in Table 7-11 below, it is possible to narrow the results to those activities considered at a threat level within the particular vulnerable area and vulnerability score.

Table 7-11. Summary of Circumstances in the Provincial Threats Tables Related to Powassan WHPA

Vulnerable Area	Vulnerability Score	Risk	Parameter of Concern	# of Sets of Circumstances
WHPA-A~~1, A2~~	10	Significant	Chemical	129
WHPA-A~~1, A2~~	10	Moderate	Chemical	99
WHPA-A~~1, A2~~	10	Low	Chemical	12
WHPA-B~~1~~	10	Significant	Chemical	129
WHPA-B~~1~~	10	Moderate	Chemical	99
WHPA-B~~1~~	10	Low	Chemical	12
WHPA-B~~2, B4~~	8	Significant	Chemical	11
WHPA-B~~2, B4~~	8	Moderate	Chemical	155
WHPA-B~~2, B4~~	8	Low	Chemical	70
WHPA-B~~3~~	6	Significant	Chemical	3
WHPA-B~~3~~	6	Moderate	Chemical	8
WHPA-B~~3~~	6	Low	Chemical	200
WHPA-C~~1~~	8	Significant	Chemical	11
WHPA-C~~1~~	8	Moderate	Chemical	155
WHPA-C~~1~~	8	Low	Chemical	70
WHPA-C~~2, C4~~	6	Significant	Chemical	3

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Vulnerable Area	Vulnerability Score	Risk	Parameter of Concern	# of Sets of Circumstances
WHPA-C2, C4	6	Moderate	Chemical	8
WHPA-C2, C4	6	Low	Chemical	200
WHPA-C3, C5	4	Significant	Chemical	3
WHPA-C3, C5	4	Moderate	Chemical	n/a
WHPA-C3, C5	4	Low	Chemical	n/a
WHPA-D3, D5	6	Moderate	Chemical	8
WHPA-D3, D5	6	Low	Chemical	203
WHPA-D2, D4, D6	4	Moderate	Chemical	n/a
WHPA-D2, D4, D6	4	Low	Chemical	n/a
WHPA-D1	2	Moderate	Chemical	n/a
WHPA-D1	2	Low	Chemical	n/a
WHPA-A1, A2	10	Significant	Pathogen	23
WHPA-A1, A2	10	Moderate	Pathogen	6
WHPA-A1, A2	10	Low	Pathogen	n/a
WHPA-B1	10	Significant	Pathogen	23
WHPA-B1	10	Moderate	Pathogen	6
WHPA-B1	10	Low	Pathogen	n/a
WHPA-B2, B4	8	Moderate	Pathogen	23
WHPA-B2, B4	8	Low	Pathogen	6
WHPA-B3	6	Moderate	Pathogen	n/a
WHPA-B3	6	Low	Pathogen	23

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Threat Type	Vulnerable Area	Vulnerability Score	Threat Classification and Provincial Table Reference Code		
			Significant	Moderate	Low
Chemical	WHPA-A, B1	**10**	CW10S	CW10M	CW10L
	WHPA-B2, B4, C-1	**8**	CW8S	CW8M	CW8L
	WHPA-B3, C2, C4, D3, D4, D6	**6**	NA	CW6M	CW6L
	WHPA-C3, C5, D2, D4, D6	**4**	NA	NA	NA
	WHPA-D1	**2**	NA	NA	NA
Dense Non-Aqueous Phase Liquids (DNAPLs)	WHPA-A,B,C	**Any**	DWAS	NA	NA
	WHPA-D	**6**	NA	DWHVASGRA6M	DWHVASGRA6L
Pathogen	WHPA-A, B1	**10**	PW10S	PW10M	NA
	WHPA-B2, B4, C-1	**8**	NA	PW8M	PW8L
	WHPA-B3, C2, C4, D3, D4, D6	**6**	NA	NA	PW6L
	WHPA-C3, C5, D2, D4, D6	**4**	NA	NA	NA
	WHPA-D1	**2**	NA	NA	NA

Note: n/a indicates there are no matching circumstances where an activity is considered a drinking water threat

Pathogen threats are not considered in WHPA-C or WHPA-D.

There are ~~18~~ 19 prescribed activities that are or would be significant drinking water threats if they occurred in the Powassan Wellhead Protection Area. A breakdown of the prescribed activities and the number of circumstances under which those activities would be significant is provided in Table 7-12.

Table 7-12. Enumeration of Circumstances under which Prescribed Activities are or would be Significant Threats to Powassan Municipal Groundwater System

Activities Prescribed to be Drinking Water Threats	# of Significant Threat Circumstances	
	Chemical	Pathogen
The establishment, operation or maintenance of a waste disposal site within the meaning of Part V of the *Environmental Protection Act*.	~~33~~43	~~1~~5
The establishment, operation or maintenance of a system that collects, stores, transmits, treats or disposes of sewage.	~~20~~24	~~6~~9
The application of agricultural source material to land.	1	1
The storage of agricultural source material.	6	3
The application of non-agricultural source material to land.	1	1
The handling and storage of non-agricultural source material.	~~6~~5	2
The application of commercial fertilizer to land.	1	n/a
The handling and storage of commercial fertilizer.	1	n/a
The application of pesticide to land.	2	n/a
The handling and storage of pesticide.	~~3~~2	n/a
The application of road salt	0	n/a
The handling and storage of road salt.	~~1~~2	n/a
The storage of snow.	~~6~~5	n/a
The handling and storage of fuel.	~~12~~6	n/a
The handling and storage of a dense non-aqueous phase liquid.	~~25~~3	n/a

Activities Prescribed to be Drinking Water Threats	# of Significant Threat Circumstances	
	Chemical	Pathogen
The handling and storage of an organic solvent.	8	n/a
The management of runoff that contains chemicals used in the de-icing of aircraft.	1	n/a
The use of land as livestock grazing or pasturing land, an outdoor confinement area or a farm-animal yard.	2	2
The establishment and operation of a liquid hydrocarbon pipeline.	3	n/a
Number of circumstances under which the threat is or would be significant	~~132~~129	~~16~~23

Activities Prescribed to be Drinking Water Threats	# of Significant Threat Circumstances	
	Chemical	Pathogen
The application of agricultural source material to land.	5	1
The application of commercial fertilizer to land.	5	
The application of non-agricultural source material to land.	5	1
The application of pesticide to land.	11	
The establishment, operation or maintenance of a system that collects, stores, transmits, treats or disposes of sewage.	135	6
The establishment, operation or maintenance of a waste disposal site within the meaning of Part V of the Environmental Protection Act.	244	1
The handling and storage of a dense non-aqueous phase liquid.	28	
The handling and storage of an organic solvent.	20	
The handling and storage of commercial fertilizer.	1	
The handling and storage of fuel.	36	
The handling and storage of non-agricultural source material.	6	2
The handling and storage of pesticide.	13	
The handling and storage of road salt.	2	
The management of runoff that contains chemicals used in the de-icing of aircraft.	2	
The storage of agricultural source material.	6	3
The storage of snow.	38	
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.	2	2
Number of circumstances under which the threat is or would be significant	**561**	**16**

Note: n/a indicates there are no matching circumstances where an activity is considered a drinking water threat

Threats Approach - Existing Significant, Moderate and Low Threats

The identification of specific groundwater quality threats in the Powassan vulnerable areas was based on inputs from several sources. The process included a local field survey of properties in the WHPA previously delineated by the NBMCA Groundwater Study (Waterloo Hydrogeologic, 2006), a search of publicly available databases through Ecolog ERIS, a review of the NBMCA database of *on-site* septic systems, and public consultation. The Threats of Drinking Water Tables were then used to rate the level of significance of each activity. [Drinking water threats as prescribed in Paragraphs 1 through 18 and Paragraphs 21 to 22 of subsection 1.1(1) of O.Reg. 287/07 (General)]

Based on a review of the above information, there are septic systems located on two properties that extend into the WHPA-A and are automatically classified as posing significant (S) pathogen threats (see Table 7-13).

The Powassan Threat Assessment report completed by WEGL (2009) identified the application of pesticides along the Highway 11 corridor as a significant threat in an area where the aquitard may have been compromised by previous technical borehole drilling. However, it was subsequently determined through consultation with Ministry of Transportation that MTO has not applied pesticides in that area in at least fifteen years, so the application of pesticides is not considered an existing activity.

Fuel storage at the wellhead for the standby generator was identified as a moderate threat.

Table 7-13. Existing Threats within Powassan Wellhead Protection Area

Activity Prescribed to be a Threat	WHPA-A	WHPA-B			WHPA-C		WHPA-D	Circumstance Reference # and type
	Vs=10	Vs=10	Vs=8	Vs=6	Vs=8	Vs=6	Vs=6	
The establishment, operation or maintenance of a system that collects, stores, transmits, treats or disposes of sewage.	~~S (2)~~			L (1)	M (1)	L (1)	L (1)	C2.2.4 (Chemical)~~16 (Pathogen)~~
	S (2)				~~M (1)~~			P2.2.1 (Pathogen)~~507 (Chemical)~~
The application of road salt		M (1)	L (1)	L (1)		L (1)	L (1)	~~463~~ C12.1.2 (Chemical)
The handling and storage of fuel.	~~M~~ S (2)			L (1)		L (1)	L (13)	~~1018 (Chemical)~~C15.1.7 (Chemical)

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Activity Prescribed to be a Threat	WHPA-A	~~WHPA-B~~			~~WHPA-C~~		WHPA-D	Circumstance Reference #
	Vs=10	Vs=10	Vs=8	Vs=6	Vs=8	Vs=6	Vs=6	
The handling and storage of fuel.	M (2)			L (1)		L (1)	L (13)	1354
The establishment, operation or maintenance of a system that collects, stores, transmits, treats or disposes of sewage.	S (2)			M (1)				1956
					M (1)	L (1)	L (1)	663
The application of road salt.		M (1)	L (1)	L (1)		L (1)	L (1)	92 93

Note: * Occurrences in columns with bold boxes represent one parcel with multiple circumstances.
Vs = vulnerability score; S = Significant threat; M = Moderate threat; L = Low threat

7.6.2 Issues Approach to Threat Identification

There are no drinking water issues, in accordance with Rule 114 and 115, in the Powassan Wellhead Protection Area.

7.6.3 Conditions

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There are no known conditions that exist in the vulnerable areas of the Powassan drinking water intake.

7.6.4 Local Threat Considerations

The North Bay-Mattawa Source Protection Committee is concerned about the threat posed by the transportation of hazardous substances along highway and rail corridors within the Powassan Wellhead Protection Area (WHPA) which creates the potential for a spill to occur.

Although there is no prescribed threat activity related to the transportation of hazardous substances under the *Clean Water Act*, Technical Rule 119 allows Source Protection Committees to request that an activity be listed as a drinking water threat if:

1. The activity has been identified by the Source Protection Committee as an activity that may be a drinking water threat; and
2. The Director indicates that the chemical or pathogen hazard rating for the activity is greater than 4.

The Source Protection Committee submitted a formal request to the Ministry of Environment for the addition of transportation of hazardous substances as a non-prescribed (local) drinking water threat in the SP Area. This request was approved by the Director on February 8, 2011 (Appendix G). Included in the approval are the circumstances and hazard ratings for the activities considered.

Table 7-14 shows where significant, moderate and low threats relating to the transportation of hazardous substances and the transportation of septage are located in the Powassan WHPA. Both chemical and pathogen significant threats exist within Powassan WHPA-A and WHPA-B1 (Figure 7-4a). The pathogen threat relates to the transportation of septage, for which a spill may result in the presence of pathogens in groundwater. Significant chemical threats relate to the transportation of sulphuric acid or sodium hydroxide in quantities greater than 2,500 litres, for which a spill may decrease or increase, respectively, the pH of groundwater beyond acceptable limits.

Table 7-14. Areas within Powassan Wellhead Protection Area where Transportation of Hazardous Substances is Considered a Significant, Moderate or Low Drinking Water Threat

Threat Type	Vulnerable Area	Vulnerability Score	Threat Level Possible		
			Significant	Moderate	Low
Chemical	WHPA-A~~1, A2~~	10	✓	✓	
	WHPA-B~~1~~	10	✓	✓	
	WHPA-B~~2, B4~~	8		✓	✓
	WHPA-B~~3~~	6			✓

Threat Type	Vulnerable Area	Vulnerability Score	Threat Level Possible		
			Significant	Moderate	Low
	WHPA-C~~1~~	8		✓	✓
	WHPA-C~~2, C4~~	6			✓
	WHPA-C~~3, C5~~	4			
	WHPA-D~~3, D5~~	6			✓
	WHPA-D~~2, D4, D6~~	4			
	WHPA-D~~1~~	2			
Pathogen	WHPA-A~~1, A2~~	10	✓		
	WHPA-B~~1~~	10	✓		
	WHPA-B~~2, B4~~	8		✓	
	WHPA-B~~3~~	6			✓

Note: Pathogen threat is related to transportation of septage.
Pathogen threats are not considered in WHPA-C or WHPA-D.

7.7 Gap Analysis and Recommendations

The present analysis was based on the information available at the time of reporting. Due to on-going changes in land use in Powassan, some of the information obtained in the 2007 data collection phases may no longer be accurate and, therefore, constitute a potential knowledge or data gap in the present interpretation. Since on-going land use changes are a characteristic of most municipalities, the suggested improvement to the database will be through periodic review and updating of the drinking water threats.

The present analysis of groundwater quality issues was limited by a lack of detailed raw water chemistry results for the municipal wells. However, the lack of this information does not compromise the validity of the findings.

From a scientific viewpoint, additional supplemental analysis of the water chemistry would be of benefit in tracking any long-term trends in water quality for those parameters not mandated by the Certificate of Approval for the water system. As a suggestion, it is recommended that a complete water quality scan of the raw water characteristics (major ion analysis, heavy metals analysis, nutrient indicators, and general water chemistry parameters) be undertaken annually, complementing the analysis required by the Certificate of Approval.

Uncertainty scores were assigned to the various vulnerable areas in this assessment, being flagged as either “high” or “low”. In many instances, high uncertainties were assigned because of a lack of detailed subsurface information. In the case of the municipally-serviced areas of Powassan, it is unlikely that any new deep well constructions will occur, and so the future subsurface information gathered in these areas may be limited to relatively shallow road work excavations and shallow geotechnical boreholes. In the interest of continuous improvement, as new subsurface data become available, it is recommended that they be periodically assessed against the current conceptual model of the local geological setting so that any anomalous information is corrected for future planning cycles.

Potential data gaps were identified where the Ecolog and Conservation Authority search areas did not sufficiently cover the newer WHPAs (2009). These gaps were unforeseen at the time of the initial data collection, and with the presently-defined WHPAs it is recommended that the search areas be re-visited to determine if any additional threats can be identified. It should be noted that the identified area of concern lies within the boundaries of a WHPA-D zone, and it is not possible to locate a “significant” threat in a WHPA-D zone (because of the scoring conventions presented in the Tables of Drinking Water Threats). However, for completeness, it is recommended that these areas be investigated and the table of existing threats revised (if appropriate).

8.0 South River

8.1 Introduction and Summary of Findings

This section includes analyses of vulnerability with respect to both water quantity and water quality for the surface water intake for the Village of South River. General methodology for water quality vulnerability assessments for surface water systems is provided in Section 3.1 of this report.

Technical work supporting this section was completed during two studies, which are available online at www.nbmca. ca under the Drinking Water Source Protection tab or www.actforcleanwater.ca or directly from the North Bay-Mattawa Conservation Authority:

- WESA, 2009: Drinking Water Source Protection Studies for the Village of South River: Surface Water Vulnerability Study, Threats Inventory and Issues Evaluation, Water Quality Risk Assessment. Draft final report prepared for the North Bay-Mattawa Conservation Authority, Project No. SB5904, March 2009; and
- AECOM, 2010b: Surface Water Vulnerability Study for the Village of South River Drinking Water Intake, Final report prepared for the North Bay-Mattawa Conservation Authority, Project No. 113616, January 6, 2010.

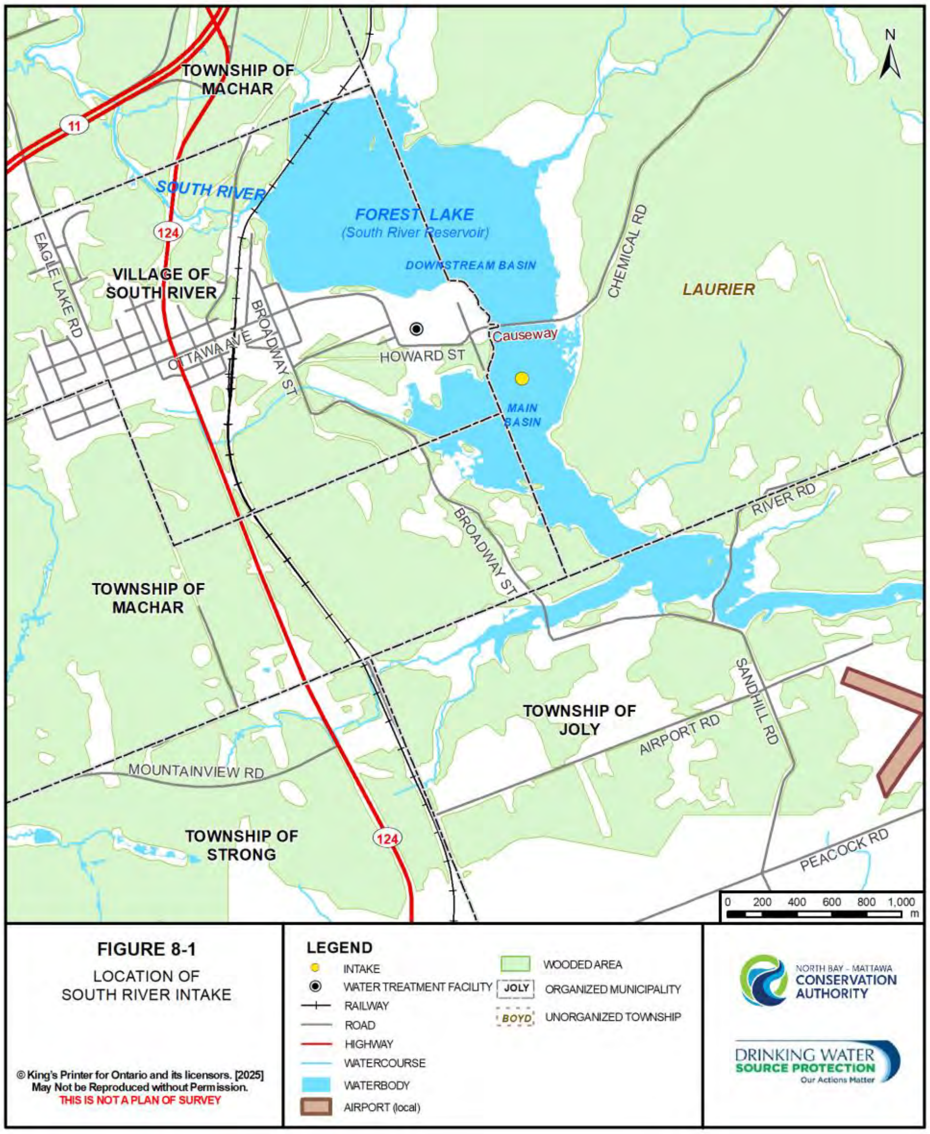
The two studies include the following:

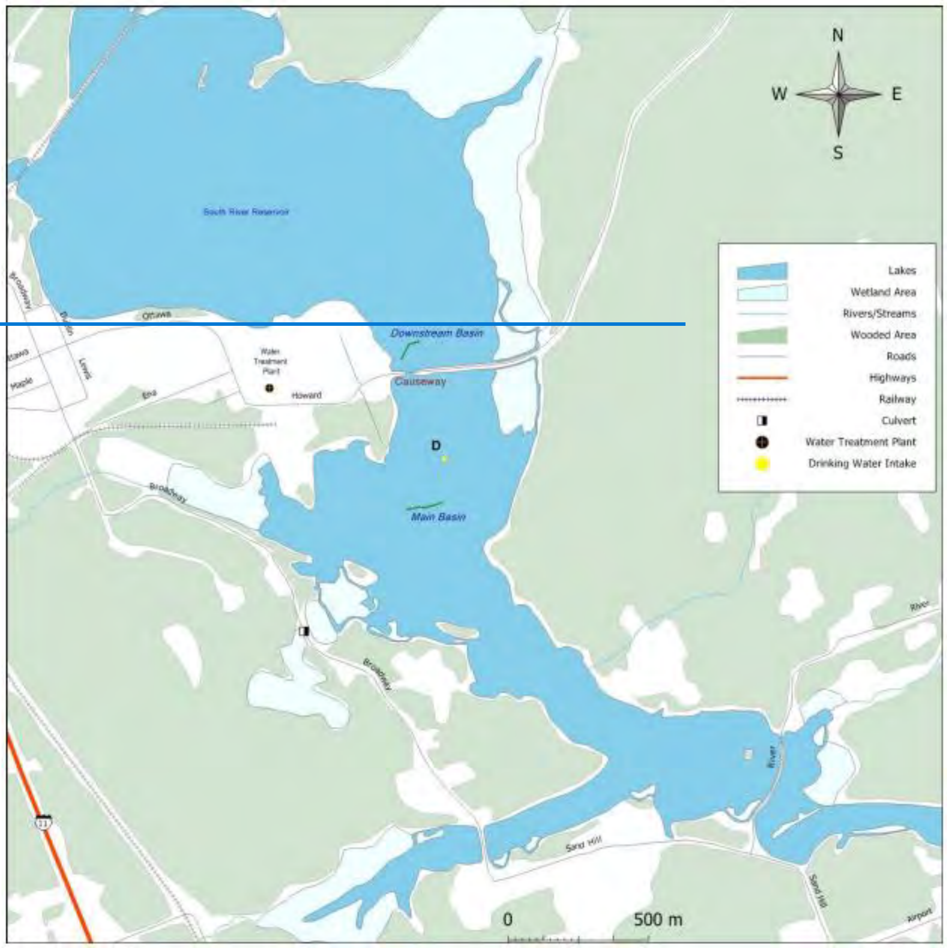
- intake characterization (including water treatment plant and raw water quality);
- intake protection zone (IPZ) delineations;
- uncertainty analysis of IPZ delineations and vulnerability scores;
- drinking water issues evaluation;
- threat identification and assessment; and
- gap analysis and recommendations.

A technical advisory committee oversaw the technical aspects of the report and local knowledge was solicited from the community at-large at two public meetings. Study findings were presented to the public and comments received. Peer review was conducted during the first study by WESA, and it was determined that additional flow data was required to verify the designation of the intake type. This work was subsequently undertaken by AECOM and a summary report was provided to meet all requirements for technical information for completion of the Assessment Report.

The intake for the Village of South River draws water from an impounded section of the South River (Figure 8-1). An analysis of flow conditions comparing the influence of the river current to wind effects at the surface confirmed that the most appropriate designation for the intake was Type D as an impoundment rather than a river.

Figure 8-1. South River Intake




N
W
E
S
Lakes
Wetland Area
Rivers/Streams
Wooded Area
Roads
Highways
Railway
Culvert
Water Treatment Plant
Drinking Water Intake
Downstream Basin
Causeway
D
Main Basin
Broadway
Sand Hill
River
0
500 m

A large portion of the watershed, upstream of the Village of South River, is in the Algonquin Highlands; the Village marks the uppermost area of settlement in the watershed. There are no significant or moderate stresses to the quantity of water.

The South River intake is located at a shallow depth of only 4.5 m from the surface and is relatively close to land (232 m). Both of these factors contribute to higher source vulnerability for the South River intake, because they increase the risk of a contaminant reaching the intake. The fact that there have been no documented concerns with water quality at the intake reduces the scoring of the source vulnerability from what it would be otherwise. The water treatment plant has full treatment (chemical assisted coagulation, flocculation and filtration).

Manganese concentrations have exceeded provincial drinking water standards. Therefore, manganese, which can cause excessive colour in water, was investigated as a drinking water issue for the South River intake. The source of manganese was determined to be natural, likely released from sediments when a beaver dam was removed, but manganese remains a drinking water issue under Rule 114. There are no other chemical parameters that are confirmed drinking water issues for the South River intake.

There are no known significant drinking water threats that presently exist in the vulnerable areas of the South River drinking water intake.

O.Reg. 287/07 Section 1.1 (1) under the *Clean Water Act (2006)* lists 20 activities that may result in threats to drinking water quality (see Table 3-1). (Two additional prescribed activities pose threats to water quantity.). Conditions, as defined by Part XI.3 of the Technical Rules, refer to past activities that have produced contaminants that may result in significant drinking water threats.

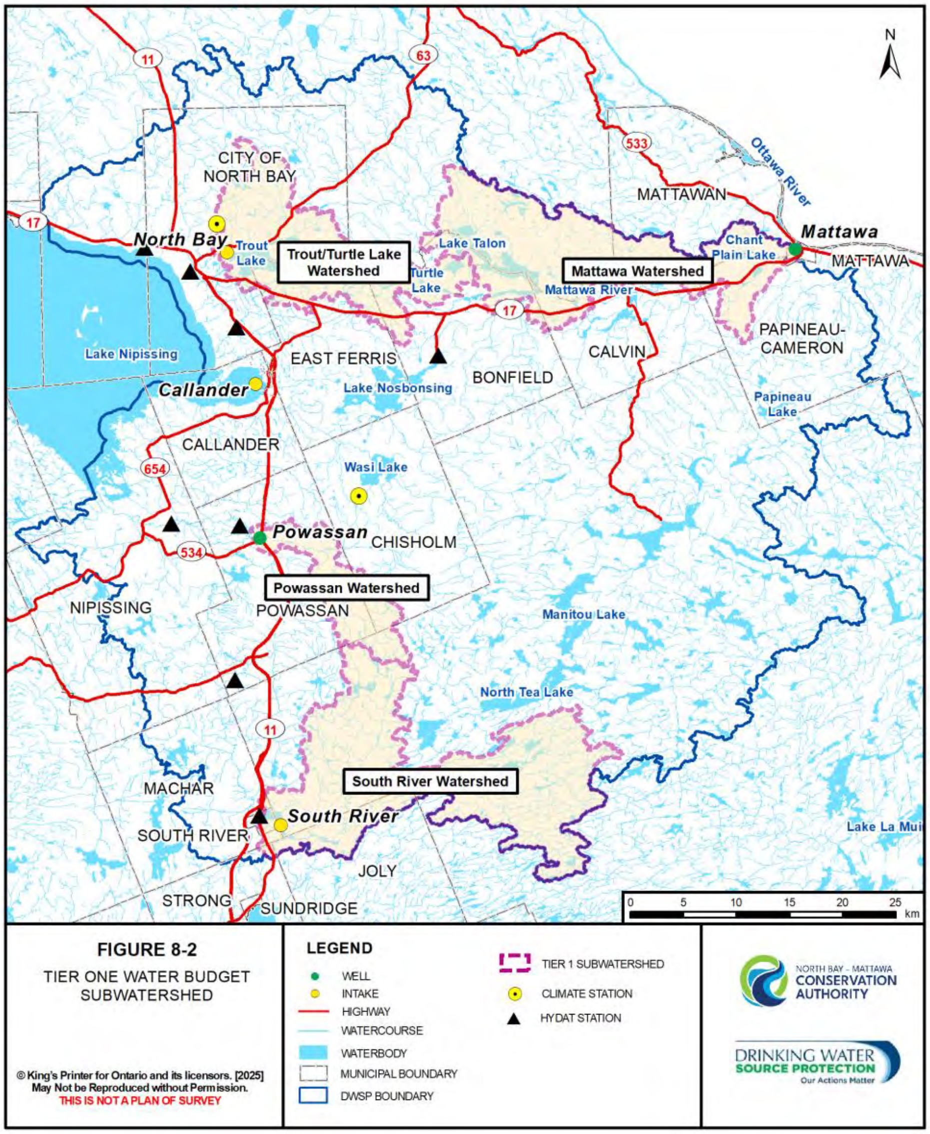
Related to the 20 prescribed activities, there are 239 circumstances that could be identified as chemical threats and 41 circumstances that could be identified as producing pathogen threats that would be significant if they occurred in the most vulnerable area – Intake Protection Zone -1 (IPZ-1).

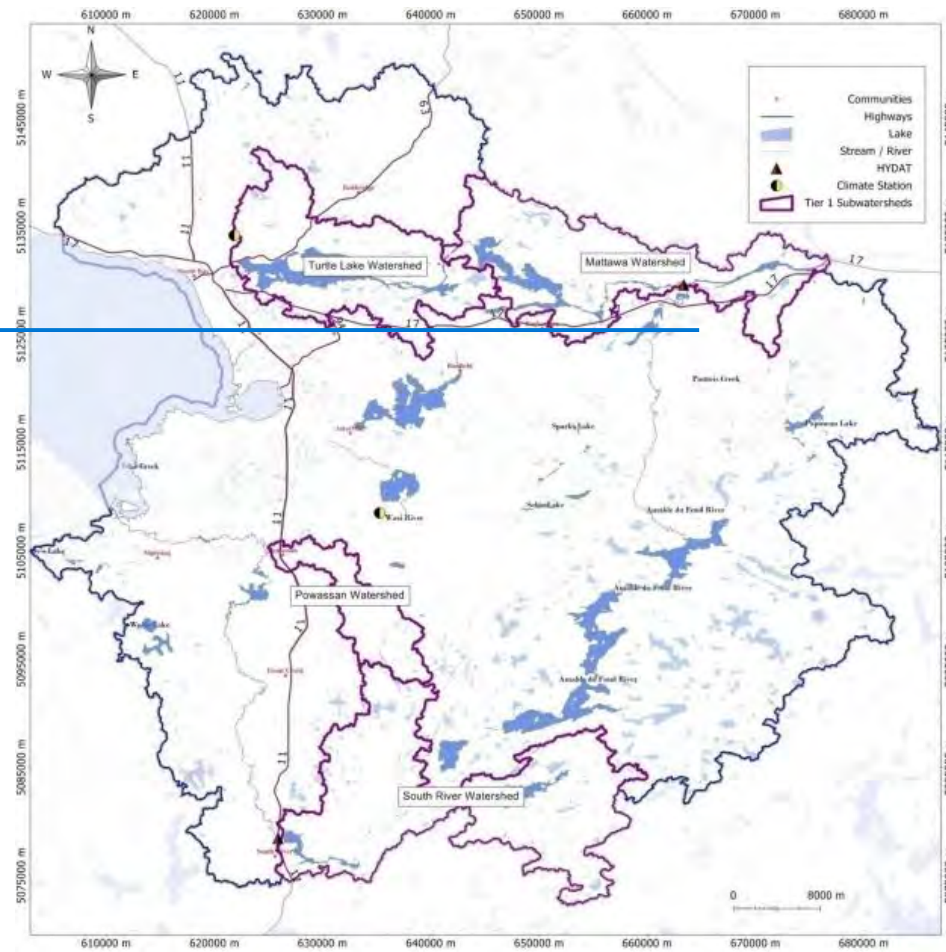
8.2 Water Budget and Water Quantity Stress Assessment

A water budget and water quantity stress assessment for each subwatershed is required by the *Clean Water Act (2006)* to determine whether the subwatershed will be able to meet current and future demands of all users. General principles were explained earlier in Section 2.5 Conceptual Water Budget.

The methodology specified in the Technical Rules Part III describes a tiered approach whereby all subwatersheds are subjected to a Tier One assessment and, if stress is low during all months of the year, no further assessment is required. If stress levels are shown to be either moderate or significant, a more robust Tier Two assessment is completed and, similarly, if that reveals moderate or significant stress, a Tier Three Local Risk Assessment must be undertaken. The information for this section is based primarily on the Tier One Water Budget and Stress Assessment for the South River, Powassan and Mattawa Municipal Water Supplies (WESA, 2010). A Tier One assessment for the remainder of the subwatersheds in the SP Area is presented in Section 2.6.

Figure 8-2. Tier One Water Budget Subwatershed

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Climate Station
Tier 1 Subwatersheds
Turtle Lake Watershed
Mattawa Watershed
Powassan Watershed
South River Watershed
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63
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8000 m

The subwatershed containing the Village of South River surface water supply is comprised of the South River watershed upstream of the South River Dam (Figure 8-2). Municipal drinking water for the Village of South River is currently serviced by a surface water intake that draws water from the South River reservoir. The Village of South River experienced an increase in population of 2.8%, between 2001 and 2006 (Statistics Canada, 2007), but had previously experienced a decline of 5.3% between 1996 and 2001, resulting in a net decline of 2.6% over the 10-year period. As a result, the Tier One Water Budget has been conducted using 2006 population estimates. The population has continued to increase slowly and was 1,114 in the 2016 census, a growth rate of 7.12% since 2001 (Statistics Canada 2016).

Water budget elements, including precipitation, actual Evapotranspiration (AET), surplus, recharge, and runoff were estimated using the methodology described in Section 2-5. Table 8-1 summarizes these parameters.

Table 8-1. Estimated Water Budget Elements (South River)

Month	Precipitation (mm)	Actual ET (mm)	Surplus (mm)	Recharge (mm)	Runoff (mm)
January	74.1	0.0	74.1	1.4	1.6
February	54.7	0.0	54.7	0.7	0.8
March	64.5	0.0	64.5	0.4	0.4
April	67.2	20.7	46.5	28.4	31.2
May	83.5	76.2	7.3	84.4	92.9
June	88.2	106.4	0.0	42.2	46.4
July	95.7	117.2	0.0	21.1	23.2
August	92.6	99.1	0.0	10.5	11.6
September	113.1	67.0	0.0	5.3	5.8
October	98.5	29.9	68.5	18.9	20.9
November	93.4	0.0	93.4	9.5	10.4
December	72.8	0.0	72.8	4.1	4.6
Annual Total	**998.3**	**516.4**	**481.9**	**226.9**	**249.8**

Note: ET = evapotranspiration

Total annual surplus should theoretically equal stream flow (Gartner Lee Ltd., 2007a). Analysis of continuous stream flow data collected at Environment Canada/Water Survey of Canada gauge 02DD009 (South River at South River) yields a total annual surplus of 435 mm. The total surplus predicted by the Thornthwaite-Mather soil moisture budget conducted by WESA on the South River subwatershed yielded a total annual surplus of 482 mm; a difference of approximately 11% compared to EC/WSC stream flow data. The primary cause for the difference is likely that the precipitation predicted by the WESA GIS model was greater than that predicted by Gartner Lee Ltd. (2007a), as was the case with the Powassan subwatershed. There is still a high level of confidence in the water balance despite the difference between surplus predicted by WESA and Gartner Lee Ltd. (2007a).

Total surplus was partitioned into recharge and runoff using the average partitioning coefficient for the NBMCA Source Protection Area (0.478; Gartner Lee Ltd., 2007a). This resulted in annual recharge and runoff of 227 mm and 250 mm, respectively. It should be noted that the sum of the recharge and runoff total 477 mm, while the total annual surplus is 482 mm. This discrepancy is due to rounding errors in the spreadsheet model during the calculation of monthly recharge and runoff.

The surface water supply is the water available for a subwatershed's surface water users. The South River water supply was estimated using Environment Canada/Water Survey of Canada (EC/WSC) HYDAT stream gauge data from gauge 02DD009 (South River at South River). The dataset spans from 1962 through 1991. Parametric statistics (median and Q_{P50}) were calculated for these data. Table 8-2 presents these results.

Table 8-2. Surface Water Flow Statistics for HYDAT Station 02DD009

Month	Flow (m^3/s)		
	Median	Supply (Q_{P50})	Reserve (Q_{P90})
January	4.1	4.0	3.0
February	4.0	3.9	3.1
March	4.6	4.7	3.3
April	10.9	10.5	5.6
May	6.3	6.5	3.7
June	3.6	3.5	2.0
July	2.4	2.3	1.4
August	2.3	2.3	1.3
September	2.4	2.3	1.3
October	3.6	3.6	1.7
November	4.9	4.8	2.0
December	4.9	5.1	2.8

Note: Q_{P50} = 50th percentile flow; Q_{P90} = 10th percentile flow

The 50th percentile flow (Q_{P50}) ranges from a minimum of 2.3 m^3/s (July through September) to a maximum of 10.5 m^3/s (April). The average total annual water supply based on the streamflow gauge is 435 mm. This is in close agreement with the total surplus predicted using the soil moisture budget spreadsheet (482 mm).

As described in Section 2.6, surface water reserve was estimated as the Q_{P90} (10th percentile) of the gauged stream flow (MOE, 2007). (Note: Ministry of Environment or MOE is a previous name of the Ministry of Environment, Conservation and Parks or MECP). Average annual water reserve based on continuous streamflow data from EC/WSC gauge 02DD009 is 25.3 mm and monthly water reserve is 2.10 mm, or 2.58 m^3/s (based on a subwatershed area of 322,598,800 m^2). Table 8-2 presents monthly reserve (Q_{P90}) based on median monthly flows.

Water use was estimated from the relevant datasets available for the study area and the results compiled on monthly and annual scales.

Municipal and communal use was determined using the 2004 Environment Canada Municipal Water and Wastewater Survey (Environment Canada, 2004b) as well as the PTTW database (MOE, 2009a). (Note: Ministry of Environment or MOE is a previous name of the Ministry of Environment, Conservation and Parks or MECP). Municipal and communal water takings include the municipal surface water intake (for which actual water use data are available) and other permitted communal takings contained in the PTTW database, such as campgrounds. There were no permitted takings for communal use in the South River municipal supply subwatershed.

Water takings and returns were divided between deep groundwater, shallow groundwater and surface water. The following assumptions were made:

- 2004 actual municipal water use values used in order to be consistent with other values in the Municipal Water and Wastewater Survey;
- municipal water consumed includes water from populations with sewage haulage; and
- municipal system losses are returned to shallow groundwater through infiltration.

Gross takings for municipal/communal use are approximately 207,316 m^3/yr. Of the gross municipal/communal takings, approximately 37,275 m^3/s (14%) is consumed. Municipal and communal water takings make up approximately 31% of the total gross water takings in the subwatershed and 10% of the water consumed.

Municipal and communal water takings are comprised of:

- surface water takings from the municipal intake in the South River Reservoir that reach serviced residents (186,377 m^3/yr); and
- water that is lost to the system (20,939 m^3/yr).

Table 8-3 summarizes these results. 100% of municipal and communal takings (207,316 m^3/yr) are from surface water. All of the municipal water not consumed is returned to shallow groundwater, as 100% of the serviced population uses septic systems for water treatment (Environment Canada, 2004b).

Table 8-3. Municipal and Communal Takings (South River)

General Use	Specific Source/Use	Gross Takings (m^3/yr)	Consumed (m^3/vr)	% Consumed
Municipal Communal	Municipal surface water to serviced residents	186,377	37,275	18.0
Municipal	System Losses	20,939	0	0.0
Total		**207,316**	**37,275**	**18.0**

Water use results for the industrial and commercial sectors were estimated from the 2004 Environment Canada Municipal Water and Wastewater Survey (Environment Canada, 2004b) and through review of the PTTW database.

The PTTW database yielded one result for the commercial sector (golf course irrigation; permit number 00-P-5002; MOE, 2009a). The gross water taking for this permit was 396,097 m^3/yr, being comprised of 354,315 097 m^3 from surface water and 41,782 m^3 from groundwater. It is assumed that the groundwater takings are from shallow groundwater as the permit information states that water is withdrawn from a dug well. The surface water taking is allowed for 260 days per year (assumed to extend between March 1 through November 15), while the groundwater taking is allowed year-round. The maximum allowable taking for this permit accounts for 60% of the gross water takings, 63% of gross surface water takings, and 100% of the gross takings from shallow groundwater.

A consumptive factor of 0.70 was used to determine consumption (MOE, 2007), which resulted in annual consumption of 248,021 m^3 and 29,247 m^3 from the surface water and groundwater takings, respectively. This accounts for 87% of the consumption from surface water and 100% of the consumption from shallow groundwater. The total consumption of 277,268 m^3 accounts for 74% of total consumption. Commercial water use results in consumption of 42% of gross water takings in the subwatershed. It was assumed that water returns (118,829 m^3/yr) are to shallow groundwater via septic systems and infiltration of irrigation water.

(Note: Ministry of Environment or MOE is a previous name of the Ministry of Environment, Conservation and Parks or MECP).

There are no additional permits for the Village of South River municipal water supply subwatershed in the PTTW database.

Statistics Canada data indicates the population of the Village of South River was 1,069 in

2006. Of this population, 1% of residents are supplied by private wells, with a total gross water taking of 683 m^3/yr. It is assumed that domestic use from outside the Village of South River is negligible.

Using a consumptive factor of 0.2, it was estimated that 137 m^3/yr is consumed. It is assumed that the remaining water is returned via septic systems to the shallow groundwater.
The following assumptions were made during the analysis of agricultural water use:

- water use for livestock consumption is constant throughout the year, while water taken for crop irrigation is isolated to July and August (MOE, 2007);
- 100% of the water taken for livestock consumption is consumed, while 80% of water used for crop irrigation is consumed (MOE, 2007);
- water taking is from deep groundwater (to be consistent with private domestic wells); and
- water not consumed is assumed to return to shallow groundwater through infiltration.

(Note: Ministry of Environment or MOE is a previous name of the Ministry of Environment, Conservation and Parks or MECP).

Gross water takings for agricultural purposes are used entirely for livestock irrigation (as crop data was suppressed to meet confidentiality requirements of the *Statistics Act* and are therefore assumed negligible) and are estimated at 61,778 m^3/yr. Total agricultural demand comprises approximately 9% of the total water takings and 16% of total consumption.

The water use results developed for each of the sectors and presented above were amalgamated to estimate the cumulative water use for each of the systems (surface water, shallow groundwater and deep groundwater). Results from South River are summarized on an annual scale in Table 8-4a, Table 8-4b, and Table 8-4c, and graphically on Figure 8-3.

Of the gross annual water takings within the study area, 84% are from surface water, 6% from shallow groundwater and 9% from deep groundwater.

Of the gross water takings, 57% are consumed, where 76% of water consumed comes from surface water, 8% from shallow groundwater and 16% from deep groundwater. All water that is not consumed is assumed to be returned to shallow groundwater through infiltration and septic systems. Since 100% of serviced residents use septic systems for treatment (Environment Canada, 2004b), it is assumed that returns from other users are also treated via septic systems. It is assumed that water lost to the system is lost through leakage and returns to the shallow groundwater through infiltration.

Table 8-4a. Annual Water Use Results - Gross Takings (South River)

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Reservoir	Gross Annual Takings (m^3)					TOTAL
	Permitted Takings			Non-Permitted		
	Municipal and Communal[a]	Industrial and Commercial[b]	Other Permitted	Private Domestic	Agricultural[c]	
Surface Water	207,316	354,315				561,631
Shallow Groundwater		41,782				41,782
Deep Groundwater				683	61,778	62,461
TOTAL	**207,316**	**396,097**	**0**	**683**	**61,778**	**665,874**

Table 8-4b. Annual Water Use Results - Consumption (South River)

Reservoir	Annual Consumed (m^3)					TOTAL
	Permitted Takings			Non-Permitted		
	Municipal and Communal	Industrial and Commercial	Other Permitted	Private Domestic	Agricultural	
Surface Water	37,275	248,021				285,296
Shallow Groundwater		29,247				29,247
Deep Groundwater				137	61,778	61,915
TOTAL	**37,275**	**277,268**	**0**	**137**	**61,778**	**376,458**

Table 8-4c. Annual Water Use Results - Returns (South River)

Reservoir	Annual Returned (m^3)					TOTAL
	Permitted Takings			Non-Permitted		
	Municipal and Communal[d]	Industrial and Commercial[b]	Other Permitted	Private Domestic[e]	Agricultural	
Surface Water						0
Shallow Groundwater	170,040	118,829		546		289,416
Deep Groundwater						0
TOTAL	**170,040**	**118,829**	**0**	**546**	**0**	**289,416**

Notes: a Includes system losses, which are assumed to return to surface water

b Assume industrial and commercial water comes from shallow groundwater and returns to SW through sewer service

c Assume agricultural water comes from deep groundwater, since assuming source is same as private wells, and most private domestic wells are in deep bedrock

d Assume remaining 0.2% returns to surface water (99% on sewer and 0.8% on septic)

e Assume returns from private domestic wells discharges through septic systems to shallow groundwater

Figure 8-3. Annual Water Use (South River)

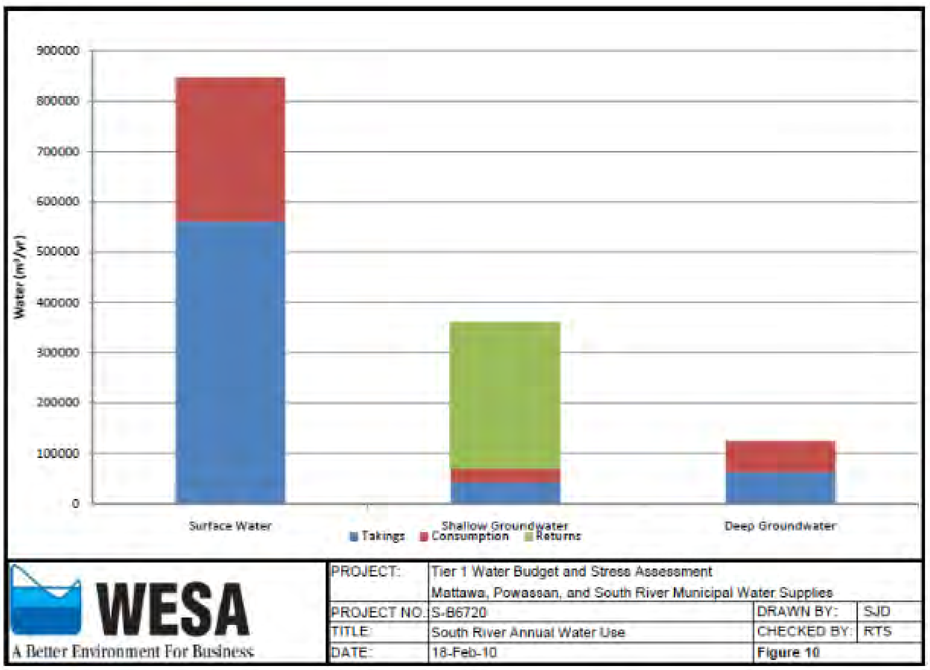

Table 8-5 summarizes the net water takings for South River. Positive values indicate that returns exceed takings. This is the case for shallow groundwater where an excess of 247,634 m^3 are returned annually. Both the surface water and deep groundwater systems have more water taken than returned; 561,631 m^3/yr and 62,461 m^3/yr, respectively. The net water takings exceed returns by 376,458 m^3/yr.

Table 8-5. Net Water Takings (South River)

Reservoir	Net Water Takings (m^3)
Surface Water	- 561,631
Shallow Groundwater	247,634
Deep Groundwater	- 62,461
TOTAL	- 376,458

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Note: Positive values indicate that returns exceed takings

Monthly takings from surface water range from 15,904 m^3 to 59,853 m^3. The large range is due to the seasonal water takings used for golf course irrigation, which occur between March 1 and November 15. Takings from shallow groundwater range between 3,205 m^3 and 3,549 m ^{3}, while takings from deep groundwater range from 4,792 m^3 to 5,305 m^3. Table 8-6a, Table 8-6b and Table 8-6c present monthly water use results, including gross, consumed and returned water.

Table 8-6a. Monthly Water Use Results - Gross Takings (South River)

Reservoir	Monthly Gross Water Takings (m^3)												Annual Gross Water Takings (m^3/yr)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Surface Water	17,608	15,904	59,853	57,922	59,853	59,853	57,922	59,853	57,922	59,853	37,481	17,608	561,631
Shallow Groundwater	3,549	3,205	3,549	3,434	3,549	3,434	3,549	3,549	3,434	3,549	3,434	3,549	41,782
Deep Groundwater	5,305	4,792	5,305	5,134	5,305	5,136	5,303	5,305	5,134	5,305	5,134	5,305	62,461

Table 8-6b. Monthly Water Use Results - Consumption (South River)

Reservoir	Monthly Consumptive Water Takings (m^3)												Annual Consumptive Water Takings (m^3/yr)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Surface Water	3,166	2,859	32,738	31,681	32,738	32,738	31,681	32,738	31,681	32,738	17,373	3,166	285,296
Shallow Groundwater	2,484	2,244	2,484	2,404	2,484	2,404	2,484	2,484	2,404	2,484	2,404	2,484	29,247
Deep Groundwater	5,259	4,750	5,259	5,089	5,259	5,089	5,258	5,259	5,089	5,259	5,089	5,259	61,915

Table 8-6c. Monthly Water Use Results - Returns (South River)

Reservoir	Monthly Water Returns (m³)												Annual Water Returns (m³/yr)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Surface Water	0	0	0	0	0	0	0	0	0	0	0	0	0
Shallow Groundwater	15,553	14,048	28,226	27,316	28,226	28,192	27,350	28,226	27,316	28,226	21,183	15,553	289,416
Deep Groundwater	0	0	0	0	0	0	0	0	0	0	0	0	0

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8.2.1 Surface Water Stress Assessment

Surface water stress is determined by examining the ratio of water demand (water takings) to water supply, while considering in the reserve required to maintain ecosystem function (MOE, 2007). (Note: Ministry of Environment or MOE is a previous name of the Ministry of Environment, Conservation and Parks or MECP). The percent water demand is compared to a stress threshold (Table 8-7) to determine the stress level.

Table 8-7. Surface Water Stress Thresholds Based on Maximum Monthly % Water Demand

Surface Water Stress Level Assignment	Maximum Monthly (%) Water Demand
Significant	≥ 50%
Moderate	> 20% and < 50%
Low	≤ 20%

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The maximum monthly percent surface water demand for the Village of South River municipal supply subwatershed is 1.2 %. Table 8-8 presents the demand, supply and reserve values used to calculate the percent demand. A subwatershed is considered low stress if the maximum monthly percent demand is less than 20%. As a result, the Village of South River municipal supply subwatershed is considered low stress and does not require a Tier Two Assessment.

Table 8-8. Percent Water Demand (South River)

Month	Consumption	Supply	Reserve	%Demand
January	0.010	33.2	24.91	0.118
February	0.009	29.2	23.25	0.148
March	0.101	39.0	27.40	0.873
April	0.098	84.4	44.99	0.249

Month	Consumption	Supply	Reserve	%Demand
May	0.101	54.0	30.72	0.437
June	0.101	28.1	16.07	0.842
July	0.098	19.1	11.62	1.314
August	***0.101***	***19.1***	***10.79***	***1.222***
September	***0.098***	***18.5***	***10.45***	***1.222***
October	0.101	29.9	14.11	0.643
November	0.054	38.6	16.07	0.239
December	0.02	42.3	23.25	0.126
Total	**0.90**	**435**	**253.6**	**0.494**

Note: ***Bold italics*** indicate months with maximum monthly percent demand.

8.2.2 Uncertainty

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The limitations inherent to each dataset individually, combined with the discrepancies between datasets, all introduce various levels of uncertainty which are ultimately compounded into the results.

Because this study is conducted at the regional scale, results must be interpreted in their context and would require confirmation and refinement through further investigation at the local scale. Also, the various datasets used in the analysis are a 'snapshot in time', as population census is as of 2006, while municipal water use data is current as of 2004. Obtaining contemporary, more up-to-date data would reduce the error associated with the combination of datasets from varying dates.

The greatest source of uncertainty in estimating water use comes from the Provincial Permits to Take Water (PTTW) database. Permit validity determined from information contained in the database (expiry date, whether a permit has been revoked, etc.) is challenging, and would require review of individual permits to increase confidence in the data. Only water takings greater than 50,000 L/d are included in the PTTW database, while water use from smaller users is unknown.

The PTTW database only contains information on maximum allowable withdrawals, while actual takings are unknown with the exception of a municipal water supply. However, the uncertainty associated from this limitation was reduced in part by applying the monthly and consumptive use factors specified in the provincial guidance document (MOE, 2007) and AquaResource (2005).

Other sources of uncertainty include how very little information is available for some sectors; for instance, there may be a number of smaller industrial and commercial users that are not accounted for. Water taking for livestock is exempt from the permitting requirements, regardless of the volume taken. Similarly, no information is available for recreational or ecological users.

Considering the significant sources of uncertainty, the uncertainty associated with the Tier One Water Budget and Stress Assessment is considered high. However, the percent demand for this system is well below the defined thresholds and, as such, no additional work is likely required to address the uncertainty.

(Note: Ministry of Environment or MOE is a previous name of the Ministry of Environment, Conservation and Parks or MECP).

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8.3 Intake Characterization

8.3.1 Source Water

The intake is located in the South River Reservoir, an impoundment of the South River, between two earthen berms that presently serve as causeways (Chemical Road and Brennan Road causeways) for the crossing of vehicles (Figure 8-1). The intake pipe has a diameter of 300 mm and extends 232 m from the shoreline to the intake crib, which lies at a depth of 4.5 m from the surface.

The South River is approximately 90 km long extending from its headwaters in the rocky uplands of the west end of Algonquin Provincial Park to its outlet in Lake Nipissing. The total drainage area of the river is 830 km^2. There are six hydro generating stations along the length of the South River and water levels are regulated on eight lakes in the upper watershed including the South River Reservoir according to the South River Water Management Plan (OPGI, draft report 2005). The Plan includes a detailed review of the hydrology of the South River.

Water levels in the South River Reservoir are regulated by MNR’s Forest Lake Dam located at the outlet of the reservoir. Forest Lake Dam is commonly known as Kootchie Dam and has often been referred to as the South River Dam. For consistency, the dam is referred to as the Forest Lake Dam in this report. The area impounded upstream of the Forest Lake Dam has often been referred to as ‘Forest Lake’ and/or the ‘South River Reservoir’. In this report, the South River Reservoir includes the basin between the Forest Lake Dam and the causeway at Brennan Road. Forest Lake is considered as the basin upstream of the Brennan Road causeway.

A privately-owned generating station that operated at the Forest Lake Dam provided electricity to the residents of South River until the mid-1960s when Ontario Hydro connected the village to the provincial grid. The generating station was redeveloped in 2010 to produce 650 kW of power as a run-of-the-river facility.

Water quality data for the period 1973-1991 are available from a Provincial Water Quality Monitoring Network Station (PWQMN) located in the South River downstream of the Forest Lake Dam near Highway 11. Monitoring at the station was reinstated in 2007 and a summary comparing the 1973-1991 and 2007-2009 data is presented in Table 8-9. The water quality measured at this location is generally typical of rivers on the Precambrian Shield. Values for most parameters tend to vary with flow rates and turbidity, but these are moderated somewhat by the influence of the dam and reservoir.

Several parameters that are typically correlated to water contact time with soils, e.g. aluminum, iron, copper, cadmium, and phosphorus, exceeded the Provincial Water Quality Objectives (PWQO) on several occasions. These parameters often increase naturally with turbidity.

Two parameters that are typically associated with anthropogenic (human) sources, lead and phenolics, have exceeded the PWQOs. Lead exceeded the objective of 5 µg/L twice in 2009 (May 26 and June 29) but was reported below detection limits on 14 of 20 sampling occasions between 2007 and 2009. The primary human source of lead is typically from industrial emissions, but historic uses of lead in paint and gasoline can also still contribute to lead concentrations. Phenolics exceeded the PWQO of 1 µg/L on a single occasion in May, 1991. No exceedances of either lead or phenolics have been reported in raw water or treated water at the South River water treatment plant. It is possible that inputs of these parameters to the river occurred downstream of the water intake; therefore, no additional action was recommended.

For most parameters monitored at the South River PWQMN, levels in 2007 to 2009 were similar to those observed between 1973 and 1991, and there is no indication that there is an increasing trend in any of the parameters. Direct comparison using statistical techniques is precluded, however, due to changes in analytical methods and detection limits over the period of the monitoring record.

Table 8-9. Water Quality in South River (Provincial Water Quality Monitoring Network Station 03013302302), 1973-1991; 2007-2009

Parameter[a]	1973-1991				2007-2009				Provincial Water Quality Objective (PWQO)[b]
	n	Maximum	Mean	Standard Deviation	n	Maximum	Mean	Standard Deviation	
Acidity, total	3	3.00	2.67	0.58					
Alkalinity, total	17	22.8	10.5	4.5	21		9.2	2.4	
Aluminum, unfiltered total (µg/L)	3[c]	93	70.3	20.2	21	117	62.4	25.0	75
Ammonium, total filtered reactive	102	0.25	0.04	0.04	20	0.048	0.022	0.013	
Arsenic, unfiltered total (µg/L)	14	0.03	0.00	0.01					5
Biological oxygen demand (BOD), 5 day	66	3.20	0.89	0.61					
Cadmium, unfiltered total (µg/L)	1	0.01	0.01		21	1	0.5	0.3	0.1
Calcium, unfiltered reactive	8	3.8	3.5	0.3	21	3.66	2.97	0.62	
Chloride, unfiltered reactive	101	29.0	2.3	2.9	21	2.9	1.7	0.4	
Colour, apparent (HCU)	3	40.0	33.3	5.8					
Conductivity (µohms/cm)	102	161	50	14	20	45	34.8	5.3	
Copper, unfiltered total (µg/L)	4[c]	5.50	1.85	2.4	20	1.32	0.45	0.38	1
Dissolved oxygen (mg/L)	76	13.00	8.70	2.02	20	9.6	6.3	1.3	
Hardness, total	11	20	14	3	20	14.2	10.4	2.6	

Parameter[a]	1973-1991				2007-2009				Provincial Water Quality Objective (PWQO)[b]
	n	Maximum	Mean	Standard Deviation	n	Maximum	Mean	Standard Deviation	
Iron, unfiltered total (µg/L)	4[c]	1000	525	351	20	717	402	151	300
Lead, unfiltered total (µg/L)[d]	4[c]	2.50	2.0	0.69	6	11.1	5.9	2.9	5
Magnesium, filtered reactive	8	1.35	1.03	0.21	20	1.24	0.99	0.23	
Manganese, unfiltered total	1	0.02	0.02		20	0.0817	0.0347	0.0188	
Nickel, unfiltered total (µg/L)	4[c]	2.50	1.3	0.50	20	1.95	0.61	0.50	25
Nitrate, filtered reactive	87	0.41	0.11	0.09	20	0.101	0.035	0.030	
Nitrates total, filtered reactive	1	0.12	0.12						
Nitrogen, total, Kjeldahl, unfiltered reactive	97	0.99	0.42	0.17	20	0.51	0.33	0.09	
pH (unit)	19	7.60	6.98	0.36	20	7.38	7.09	0.21	6.5-8.5
Phenolics, unfiltered reactive (µg/L)	13	2.80	1.15	0.60					1
Phosphate, filtered reactive	101	0.65	0.01	0.07	18	0.0055	0.0013	0.0012	
Phosphorus, unfiltered total	102	0.95	0.04	0.12	20	0.031	0.012	0.006	0.30
Sulphate, unfiltered reactive	1	6.1	6.1						
Temperature, water (°C)	100	26.0	10.6	8.8	4	20.1	13.2	4.8	
Turbidity (FTU)	98	9.00	1.82	1.27					
Zinc, unfiltered total (µg/L)	4[c]	7.8	2.7	1.9	20	3.81	2.87	0.974	20

Note: **a**: units are in mg/L unless otherwise noted; **b**: shaded cells indicate that the parameter has exceeded the PWQO; **c**: data for 1991 only; **d**: significant changes in analytical detection limits occurred beginning in 1991; data pre-1991 exist but are not included in the assessment

8.3.2 Hydrology

The South River Reservoir has a surface area of 2.5 km^2 and drainage area of 327.6 km^2, which represents the upper 39% of the South River watershed. The reservoir is bound upstream by the Brennan Road causeway and downstream by the Forest Lake Dam that serves as the outlet of the reservoir to the South River. A 20 m wide opening in the Brennan Road Causeway serves as the inlet to the reservoir from Forest Lake. The reservoir is divided into two hydrologically distinct basins by the Chemical Road Causeway located downstream of the intake and flow between the basins is restricted to a 20 m wide opening in the causeway. Due to a strong current through that opening, back-flow of water from the downstream basin toward the intake is unlikely.

The South River Reservoir is shallow with a mean depth of approximately 1.2 m and volume of approximately 3.9 x 10^6 m^3 (Totten Sims Hubricki Associates, 1998). There are isolated deep spots located in the former riverbed reaching a maximum depth of approximately 9 m. Because of the shallow depth of the reservoir, the water column does not thermally stratify and water is able to mix to the bottom by wind.

8.3.3 System Details

The South River water treatment plant is located at 28 Howard Street in the Village of South River. It is owned by the Village and operated by the Ontario Clean Water Agency (OCWA). The plant came online in 2000 and services 99% of the population of the village (Environment Canada, 2001). The population of South River was 1,114 in 2016, a 7.12% increase from the 2001 population of 1,040 (Statistics Canada, 2016).

Water treatment is by chemically assisted coagulation with 2x Napier Ried filtration (one anthracite filter and one granular activated carbon filter) and disinfection by sodium hypochlorite. Standby emergency power is provided by a 135 kW cooled diesel generator (MECP, 2021b). There is no water storage reservoir for the village and so the distribution system is pressurized. Upon notification of a spill or other event that may impair the quality of water at the intake, the time to shut down the plant is less than 1 hour.

The plant has a rated capacity of 1,680 m^3/day. Presently, the plant operates well below its capacity with an average water taking of 590 m^3/day and a maximum taking of 854 m^3/day in 2008. The total water taking in 2008 was 215,539 m^3.

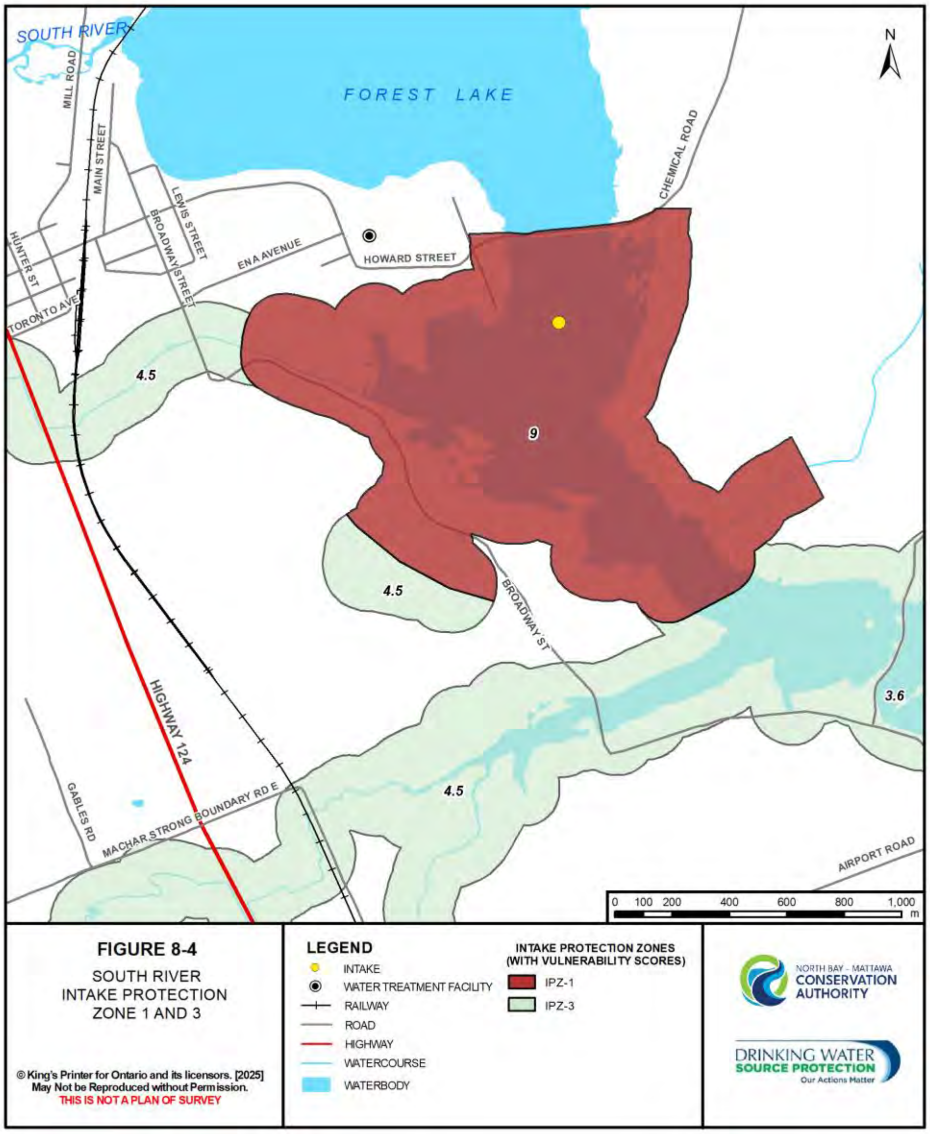
8.4 Delineation and Scoring of Vulnerable Areas

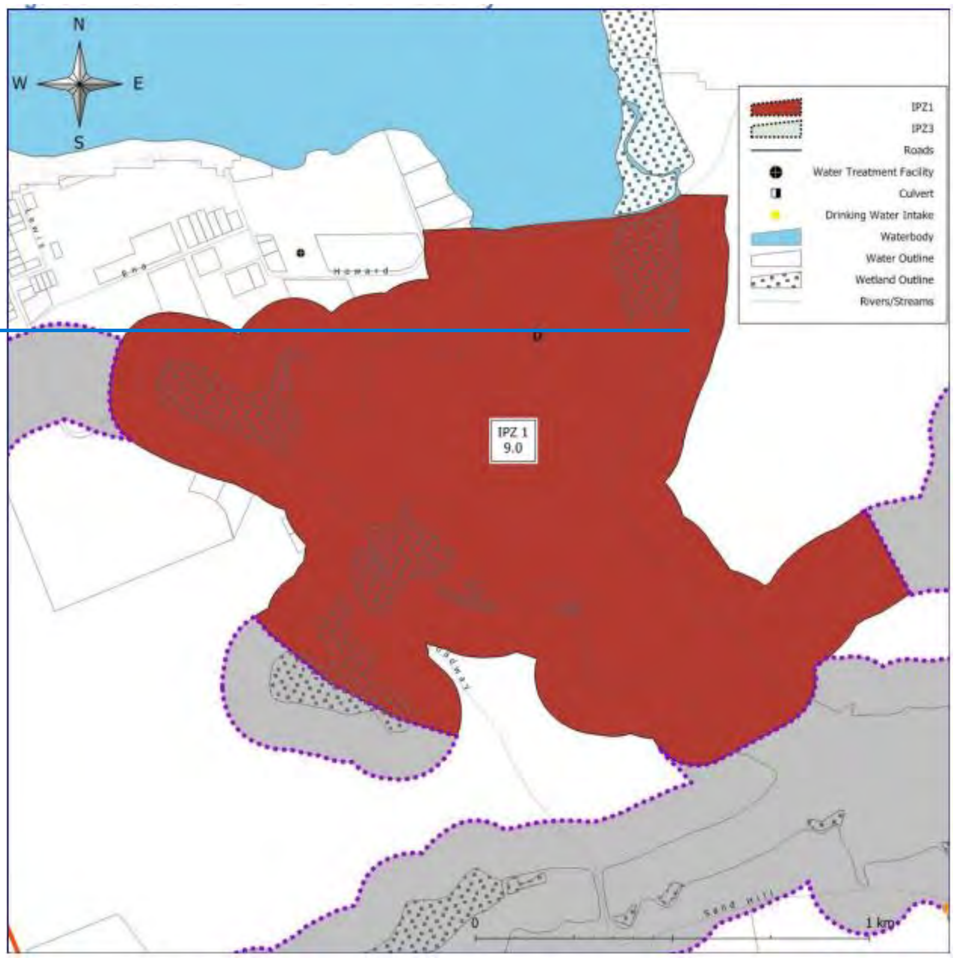
8.4.1 Defining the Vulnerable Areas (Intake Protection Zones)

A vulnerable area includes areas of land and/or water that contribute water to the drinking water intake and where the release of a contaminant could cause a deterioration of water quality for use as a drinking water source. The vulnerable area for the South River drinking water intake is comprised of three zones, called Intake Protection Zones (IPZs). Delineation of these zones was completed in accordance with Parts VI.2 to VI.6 of the Technical Rules for a Type D intake. In some cases, a zone may lie entirely within another zone, and in those cases only the most vulnerable zone will be indicated.

Intake Protection Zone 1 (IPZ-1) is the most vulnerable of the vulnerable areas for an intake and the procedure for delineation is specified by Technical Rules 61-64. If contaminants were released in this area, the drinking water plant operators would have little time to respond. IPZ-1 for the South River intake includes the surface area of the east basin of the South River Reservoir within 1 km of the drinking water intake and abutting lands that drain to this area to a maximum setback of 120 m from the high water mark (Figure 8-4). As described in Section 8.3, the basin of the reservoir in which the intake is located is hydrologically separated from the downstream basin by the Chemical Road Causeway. The opening under the causeway effectively serves as the outlet of the basin in which the intake is located. The decision to include some wetland areas in the IPZ-1 was based on an assessment of local site conditions made during field investigations.

Figure 8-4. South River IPZ-1 and Vulnerability




N
W
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IPZ1
IPZ3
Roads
Water Treatment Facility
Culvert
Drinking Water Intake
Waterbody
Water Outline
Wetland Outline
Rivers/Streams
IPZ 1
9.0
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Intake Protection Zone 2 (IPZ-2) is the secondary protection zone, delineated according to Technical Rules 72-74. If a spill or other event that may impair water quality at the intake were to occur in the IPZ-2, the plant operator would have sufficient time to respond. Although response time for operators of the South River water treatment plant is estimated at less than one hour, a minimum two hour response time must be provided. IPZ-2 therefore includes the area where a contaminant could reach the intake within two hours, but does not include any areas already in the IPZ-1. IPZ-2 is also extended to include applicable areas draining to stormwater management works. Establishing the time it takes for water borne contaminants to reach the intake is a key step in the process. The following paragraphs describe the process undertaken which concluded that the IPZ-2 would lie entirely within the IPZ-1.

In 2009, WESA used a HEC-RAS model to simulate flow velocities in the reservoir, and predicted velocities of only 0.01 m/s to 0.02 m/s near the intake at bank-full conditions. These appear quite reasonable considering the shallow and broad nature of the basin near and upstream of the intake. In this type of setting, wind-driven surface current velocities would exceed river generated flow velocities. This was observed by AECOM during a site visit on August 19, 2009, when measured surface water velocities ranged from 0.01 m/s to 0.10 m/s in the reservoir upstream of the intake under wind speeds ranging from 15 km/h to 24 km/h.

In the absence of a hydrodynamic model or measured surface water currents during high wind conditions, maximum surface water current velocity in the reservoir was estimated using major limnological principals guiding wind-driven surface water current speeds. There is no weather station in South River, but maximum wind speeds often exceed 21.6 km/h in the region. The maximum wind speed from the 1971-2000 climate normals recorded at the Muskoka (Station 6115525) and the North Bay Airport (Station 6085700) weather stations is 66 km/h (recorded February 19, 1972) and 72 km/h (recorded March 8, 1956), respectively.

At the critical wind speed, the maximum surface water velocity is 0.12 m/s and the distance from the intake to encompass a minimum two-hour time of travel 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. Therefore the two-hour time-of-travel area in the South River Reservoir is already included in the IPZ-1.

There is one tributary that enters the intake basin within the two-hour time-of-travel distance. Flows in the tributary are intermittent and there was no visible flow at the Broadway Street culvert during either of two site visits on August 19, 2009 and September 14, 2009. The inlet of this tributary is located 700 m from the intake on the west shore of the reservoir. Travel time from the inlet to the intake is approximately 1.6 hours based on a maximum surface water current speed of 0.432 km/h. The IPZ-1 extends 325 m upstream in the tributary from the inlet. Assuming the same wind-driven surface current speed, this distance represents a 0.75 hour time-of-travel in the tributary. This time-of-travel is considered a conservative estimate given the intermittent nature of flow in the tributary and the attenuation of flows in the tributary as it passes through extensive wetland area before reaching the reservoir. The total time-of-travel for water to reach the intake from where the IPZ-1 boundary crosses the tributary is 2.35 hours, which is greater than the two hour time of travel necessitated for the IPZ-2.

There are no land areas outside of the IPZ-1 that drain water to stormwater management works and contribute water to the intake where the time-of-travel to the intake would be two hours or less. The property along the east shore near the IPZ-1 is not developed and has no stormwater management.

Based on this evaluation, the IPZ-1 encompasses all areas that contribute water to the intake within a two-hour time-of-travel including drainage to stormwater management works, such that there is no IPZ-2 for the South River drinking water intake.

Intake Protection Zone 3 (IPZ-3) is the third vulnerable area and Technical Rules 72, 73 and 75 direct how it is to be delineated. IPZ-3 includes: the area of all surface water bodies contributing water to the intake including areas that contribute water via a transport pathway: and adjacent lands (setback area) where overland flow drains to the surface water bodies to a maximum setback of 120 m. The IPZ-3 for the South River intake and the corresponding Vulnerability Scores is illustrated in Figure 8-5 and further discussed below.

Figure 8-5. South River IPZ 1 and -3 ~~Subzones~~ and Vulnerability

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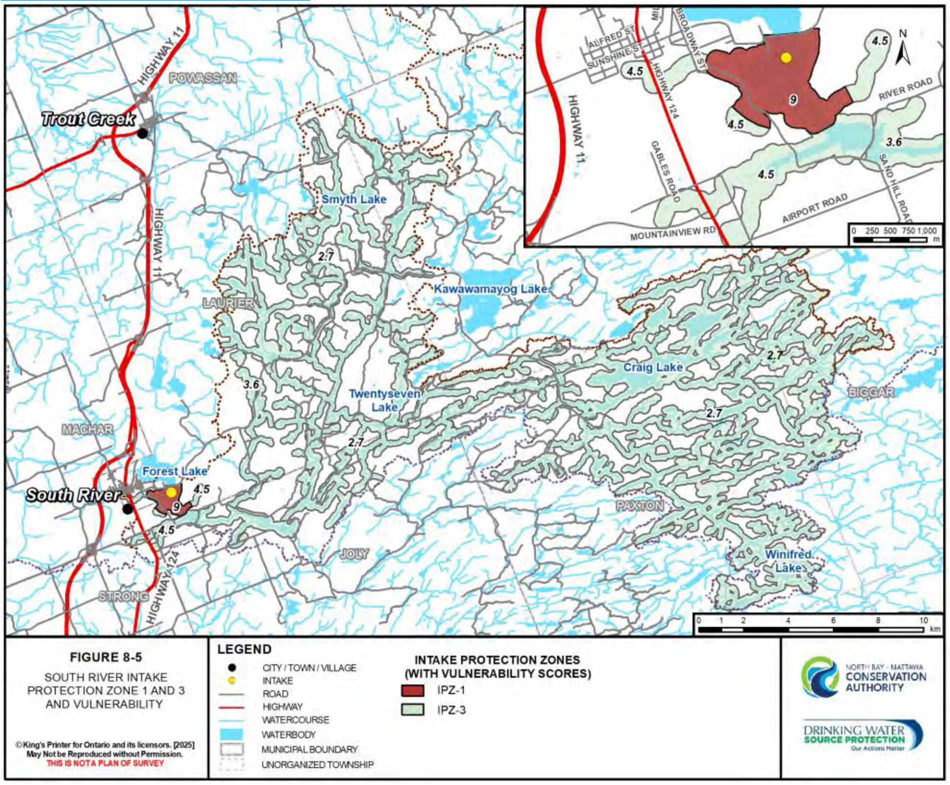

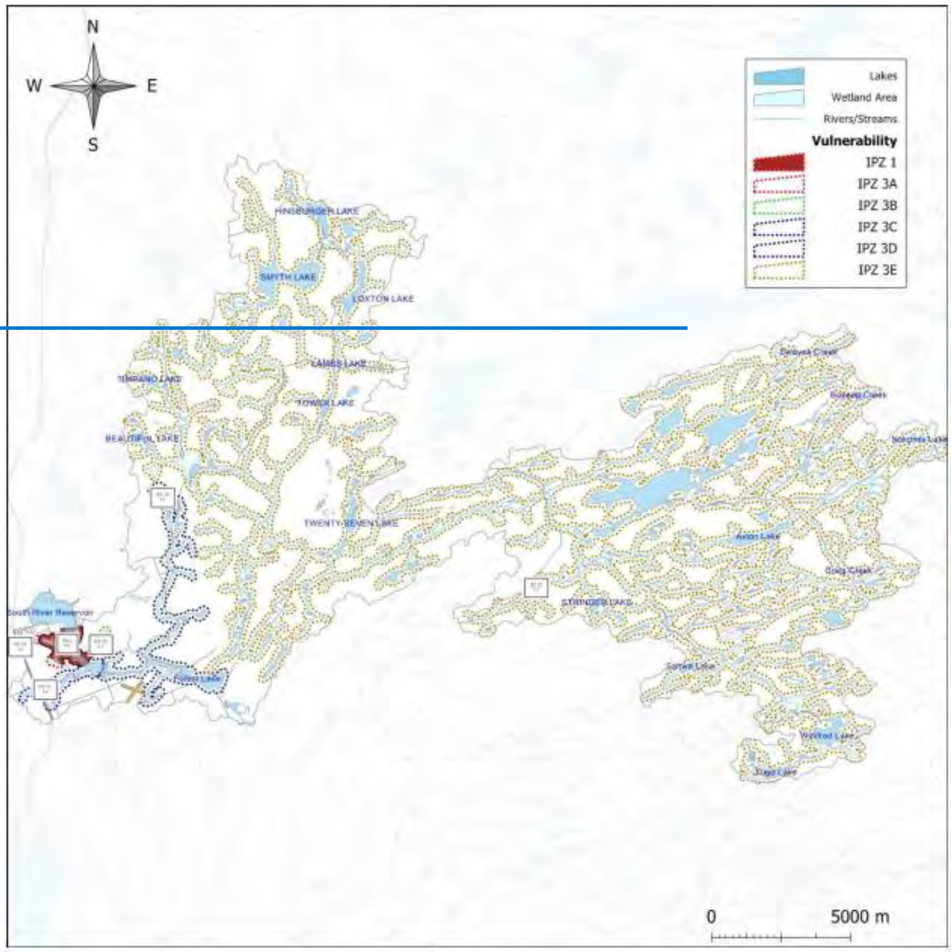

Note: larger 11” x 17” version of Figure 8-5 is available in Appendix A as Figure A-4.

8.4.2 Vulnerability Scoring

Vulnerability scores are calculated as the Area Vulnerability Factor multiplied by the Source Vulnerability Factor. Guidance for calculating these vulnerability factors is provided in Part VIII.2 and Part VIII.3 of the Technical Rules.

Area Vulnerability Factor

The IPZ-1 is assigned a set area vulnerability factor of 10 (Rule 88). The vulnerable area for South River's municipal intake did not contain an IPZ-2.

Area Vulnerability Factors assigned to areas within the IPZ-3 can range from 1 to 9, where a higher vulnerability factor results in greater vulnerability. Area Vulnerability Factors for an IPZ-3 were based on the following aspects:

- Percentage of the area that is composed of land;

  score of 2 >75% land

  score of 1 25–75% land

  score of 0 <25% land

- Land cover, soil type, permeability of the land and the slope of setbacks (each factor was given a score of 0.5 if the criteria below was met, then added to a maximum score of 2);

  score of 0.5 <85% forested

  score of 0.5 Variable soils

  score of 0.5 >25% impervious area

  score of 0.5 Setback slopes >20%

- Hydrological and hydrogeological conditions in the area that contributes water to the area through transport pathways;

  score of 2 Many transport pathways

  score of 1 Few transport pathways

  score of 0 No transport pathways

- The proximity of the area to the intake;

  score of 2 <2 km from intake

  score of 1 2-5 km from intake

  score of 0 >5 km from intake

The specific methodology for assigning Area Vulnerability Factors for each of the surface water intakes is provided in Section 3.1. For each subzone, the Area Vulnerability Factor was calculated as the sum of individual scores (0, 1 or 2) assigned for each of the four aspects listed above. This procedure weighted all factors equally. The maximum aspect score that could be generated is 8 for the IPZ-3 subzones (four aspects times maximum score of 2). The aspect score was then pro-rated to determine the Area Vulnerability Factor for each zone.

Different Area Vulnerability Factors were assigned for five areas within the IPZ-3 (Figure 8-5) based on differences in physical characteristics of each area, including distance to the intake. The areas include:

- IPZ-3~~a~~ (west tributary) - the tributary (and setback area) that crosses Broadway Street and outlets to the South River Reservoir at the west shore;
- IPZ-3~~b~~ (east tributary) - the tributary (and setback area) that outlets to the South River Reservoir at the east shore;
- IPZ-3~~c~~ - area downstream of the Brennan Road Causeway;
- IPZ-3~~d~~ - Forest Lake (upstream of the Brennan Road Causeway) and tributaries draining to Forest Lake within 5 km of the intake, and
- IPZ-3~~e~~ - area upstream of Forest Lake and its tributaries mentioned above (i.e. >5 km from the intake)

Based on this analysis, IPZ-3a, IPZ-3b and IPZ-3c have an area vulnerability of 5, which is the mid-value of the possible Range of area vulnerability score (1 to 9). IPZ-3d has an area vulnerability of 4 and IPZ-3e has and area vulnerability of 3. Area vulnerability scoring is summarized in Table 8-10.

Table 8-10. Area Vulnerability Scoring for Vulnerable Areas in IPZ-3 for South River Intake

Factor Affecting Area Vulnerability and Scoring	West tributary	East tributary	Downstream of Brennan Rd. Causeway	Forest Lake and tributaries within 5 km of intake	Area upstream of Forest Lake and tributaries (>5 km from intake)
% area composed of land Scoring: <25% = 0 25-75% = 1 >75% = 2	9% (0)	51% (1)	25% (1)	50% (1)	50% (1)
Land cover, soil type, permeability, slope of setbacks Scoring: <85% forested = 0.5 variable soils = 0.5 >25% impervious area = 0.5 Setback slopes >20% = 0.5	69% forested (0.5) Variable Soils (0.5) 31% impervious surface (0.5) Very low setback slopes (<20%) (0)	100% forested (0) Variable soils (0.5) 0% impervious surface (0) Variable setback slopes (>20%) (0.5)	32% forested (0.5) Variable soils (0.5) 2% impervious surface (0) Variable setback slopes (>20%) (0.5)	86% forested (0) Variable soils (0.5) 0% impervious surface (0) Variable setback slopes (>20%) (0.5)	85% forested (0) Variable soils (0.5) 0% impervious surface (0) Variable setback slopes (>20%) (0.5)
Transport Pathways	none known (0)	none known (0)	none known (0)	none known (0)	none known (0)
Proximity to intake Scoring: <2 km = 2 2 to 5 km = 1 >5 km = 0	Within ~2 km of the intake (2)	Within ~2 km of the intake (2)	Within ~2.5 km of the intake (1)	Within ~5 km of the intake (1)	greater than 5 km from the intake (0)
Total Aspect Score	3.5/8 = 44% ~~3.5/9=39%~~	4/8 = 50% ~~4/9 = 44%~~	3.5/8 = 44% ~~3.5/9 = 39%~~	3/8 = 38% ~~3/9 = 33%~~	2/8 = 25% ~~2/3 = 22%~~
Possible AVF range	1-9	1-9	1-9	1-9	1-9
Area Vulnerability Factor Scoring: 1 + sum of individual factor scores	5 (1+(44%x8)) ~~4~~ ~~(1+(39%x8))~~	5 (1+(50%x8)) ~~5~~ ~~(1+(44%x8))~~	5 (1+(44%x8)) ~~4~~ ~~(1+(39%x8))~~	4 (1+(38%x8)) ~~4~~ ~~(1+(33%x8))~~	3 (1+(25%x8)) ~~3~~ ~~(1+(22%x8))~~

Note: Scores for component factors affecting vulnerability are provided in brackets

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Source Vulnerability Factor

The Source Vulnerability Factor can range from 0.8 to 1.0 for a Type D intake and the following must be considered in assigning the score:

- depth of the intake from the surface;
- distance of the intake from land; and
- history of water quality concerns at the intake.

The South River intake is located at a shallow depth of only 4.5 m from the surface and is relatively close to land (232 m). Both of these factors contribute to higher source vulnerability for the South River intake, because they increase the risk of a contaminant reaching the intake. There have been no known documented concerns with water quality at the intake, and so this does not add to the source vulnerability. If each consideration is weighted equally, the source vulnerability factor is 0.9 (calculated as 0.8 + (0.2*2/3) = 0.9).

Vulnerability Scores

Vulnerability scores are calculated as the product of the area and source vulnerability factors. Vulnerability scores for each vulnerable area of the South River drinking water intake are provided in Table 8-11. The final vulnerability score for IPZ-1 is 9 from a possible range of 8 to 10. Vulnerability scores for the IPZ-3 range from 4.5 for subzone IPZ-3b to 2.7 for IPZ-3e. These scores are used to assess the risk of contamination of the drinking water source at the intake from threats.

Table 8-11. Vulnerability Scores for Vulnerable Areas of South River Intake

Vulnerable Area	Area Vulnerability Factor	Source Vulnerability Factor	Vulnerability Score
IPZ-1	10	0.9	9.0
IPZ-3a	5~~4~~		~~3.6~~4.5
IPZ-3b	5		4.5
IPZ-3c	5~~4~~		~~3.6~~4.5
IPZ-3d	4		3.6
IPZ-3e	3		2.7

8.4.3 Uncertainty Analysis

Part I.4 of the Technical Rules requires than an uncertainty rating of "high" or "low" be made with respect to the delineation of intake protection zones (IPZs) and vulnerability scores based on:

1. The distribution, variability, quality and relevance of data used in the preparation of the assessment report.
2. The ability of the methods and models used to accurately reflect the flow processes in the hydrological system.
3. The quality assurance and quality control procedures applied.
4. The extent and level of calibration and validation achieved for models used or calculations or general assessments completed.
5. The accuracy to which the area vulnerability factor and the source vulnerability factor effectively assesses the relative vulnerability of the hydrological features.

In consideration of the above factors, a "low" uncertainty is assigned to the delineation of the IPZ-1 and IPZ-3 and the associated vulnerability scores.

The IPZs were delineated in accordance with the Technical Rules, which are highly prescribed such that uncertainty of the delineations is greatly reduced. Watershed delineations and the identification of waterbodies and setbacks were completed by a qualified GIS specialist using geographical information available from the Ministry of Natural Resources, providing a high degree of certainty in the final IPZ delineations. There is some uncertainty with respect to the delineation of the IPZ-1 as the exact position of the intake was not field-verified. The intake location was determined from engineering design documents and is believed to be accurate to within a few metres.

The area and source vulnerability factors were assigned using a semi-quantitative approach to provide a consistent means of assessing relative vulnerability of the IPZs. Quantitative GIS data including land cover, slope characteristics, permeability, etc. were considered in the scoring. This approach was also used for the surface water intakes in Callander and North Bay providing a consistent means of vulnerability scoring across the North Bay-Mattawa Source Protection Area. Uncertainty was reduced by field reconnaissance investigations of the setback areas around the South River reservoir.

8.5 Issues Identification and Assessment

The issues identification process reviews records of pathogens and chemicals in the source water that may indicate a cause for concern. Drinking water issues relate to the presence of a 'listed parameter' in water at the intake if:

- 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
- 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 is not one of the 'listed parameters', but requires that a microbial risk assessment be conducted with respect to that pathogen. For the South River 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 Technical Rules do not specifically define 'deterioration of the quality of water for use as a source of drinking water'. Therefore, AECOM assessed water quality parameters as issues using the following approach:

- all listed parameters in raw and treated water were compared to the applicable Ontario Drinking Water Quality Standard (ODWQS), Aesthetic Objective (AO) or Operational Guideline (OG);
- any parameter in treated water that has exceeded the applicable benchmark (ODWQS, AO, OG) is considered a drinking water issue;
- any parameter in raw water that has exceeded the applicable benchmark or that has come within 25% of the benchmark is identified and is further evaluated as a drinking water issue based on the ability of the water treatment plant to treat the parameter.

It is noted that insufficient data exist to identify trends in raw and treated water quality parameters for the South River intake. If sufficient data existed, these would be assessed for trends. A parameter would be considered a drinking water issue 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 following sources of data were assessed to identify potential drinking water quality issues for the South River intake:

Drinking Water Information System (DWIS) Monitoring Data
Drinking Water Systems Regulation (O.Reg. 170/03) parameters analyzed in treated and raw water at the South River Water Treatment Plant from 2003 to 2006 were available at the time of production of the vulnerability report. For raw water, only bacteria (*E. coli* and total coliform) data are included in the DWIS database. There are chemical and bacteriological data for treated water;

however, most of the chemical parameters were only sampled on one occasion in 2004. If additional DWIS data exist for 2007 to present, these should be assessed for drinking water issues.

O.Reg. 170/03 (s.11) Annual Report – 2009 (for the period of Jan. 1 to Dec. 31, 2008)
This report was reviewed at the Village of South River Town Office (September 14, 2009). Previous annual reports, if available, should be provided to confirm AECOM's assessment of drinking water quality issues. Overall, there are minimal data available for raw water from the South River intake to evaluate drinking water issues. It is recommended that the drinking water issues be reassessed as new data become available.

8.5.1 Issues Related to Chemicals

Based on the available DWIS data, all measured chemical parameters in treated water at the point of entry to the distribution system of the South River Drinking Water Plant have been below detection limits with the exception of nitrogen (nitrate and nitrite), sodium and chromium (Table 8-9). Of these, only chromium exceeded the applicable ODWQS, aesthetic objectives and operational guidelines. A concentration of 1.3 mg/L was reported for chromium on March 1, 2004, which greatly exceeds the ODWQS of 0.05 mg/L. Based on discussions with the water treatment plant operator and the Technical Advisory Committee for the study, there is no apparent source of chromium to the South River Reservoir and it is suspected that the 2004 reported value for chromium is anomalous. Therefore, chromium is not considered a drinking water issue as defined by the Technical Rules.

No chemical parameters were reported to exceed applicable ODWQS, aesthetic objectives or operational guidelines in 2008 in the O.Reg. 170/11 Annual Report – 2009 for the South River WTP.

The drinking water plant operator investigated the source of elevated apparent colour at the point of entry of the WTP in the summer of 2009. Beginning on June 25th, apparent colour increased from the normal 50-70 range to a maximum of 97 on June 26th, and then returned to normal levels by July 2nd. Using a manganese reagent set, the manganese concentration of 0.105 mg/L was measured on July 2nd and 0.09 mg/L on July 3rd at the point of entry, which exceed the aesthetic objective of 0.05 mg/L for manganese. Given that iron concentrations at that time were low (0.01 mg/L), manganese was considered to be the source of discolouration of the water at that time. The timing of the colour increase was coincident with the removal of a beaver dam on June 23rd, upstream from the intake where Broadway/Sandhill Road crosses a tributary arm of the reservoir. It is suspected that the release of manganese-rich waters from upstream of the beaver dam resulted in the elevated manganese and colour observed at the intake.

AECOM agrees that the removal of the beaver dam is the most likely cause of the elevated manganese concentrations observed at the intake in the summer of 2009. Manganese is naturally occurring in sediments and can be released into overlying waters during periods of anoxia (lack of oxygen) in the water column. The occurrence of anoxia is common in still waters where there is an abundance of aquatic vegetation. At night, oxygen is depleted in the water due to the respiration of aquatic plants. Anoxic conditions can also occur due to the decomposition of aquatic vegetation. Oxygen levels can be replenished with oxygen from the atmosphere when the water column mixes.

It is therefore most likely that the source of manganese at the intake was natural, released from sediments upstream of the beaver dam.

Given that measured manganese concentrations exceeded the ODWQSOG, manganese is considered as a drinking water issue for the South River intake under Rule 114. There are no other chemical parameters that are confirmed drinking water issues for the South River intake.

8.5.2 Issues Related to Pathogens

E. coli and total coliforms should not be 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). However, total coliforms and *E. coli* are naturally occurring bacteria in surface water and are typically detected in raw water samples at the South River intake, therefore exceeding the ODWQS. *E. coli* and total coliform were detected at >10 cfu/100 mL in 43% and 96% of the raw water samples analyzed between 2003 and 2006, respectively (see Table 8-12). In 2008, *E. coli* ranged from 1 cfu/100 mL to 140 cfu/100 mL and total coliform ranged from 10 cfu/100 mL to 510 cfu/100 mL in raw water.

The observed levels of these bacteria are expected in the South River Reservoir because of its shallow nature which allows mixing of surface waters containing these bacteria and their transport to the intake. Moreover, large littoral and wetland areas provide abundant habitat for wildlife, a primary source of *E. coli* and other coliform bacteria to surface water. Despite naturally occurring levels, *E. coli* and total coliform have not been detected in treated water from the South River Water Treatment Plant in 2003-2006 or in 2008.

Statistical analysis of trends in *E. coli* and total coliform was precluded due to the large number of values below analytical detection (detection limit was 10 cfu/100 mL for the DWIS data) and the limited data availability (only two full years of data were available at the time of report production). If additional data become available, trends will be assessed.

Based on this evaluation of available pathogen data, *E. coli* and total coliform are not considered to be drinking water issues for the South River intake.

(Note: Ministry of Environment or MOE is a previous name of the Ministry of Environment, Conservation and Parks or MECP).

Table 8-12. *E. coli* and Total Coliform in Raw and Treated Water from South River Water Treatment Plant (2003-2006)

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Parameter		Raw Water	Treated Water
E. coli	Maximum (cfu)	60	0
	Minimum (cfu)	4	0
	n	92	93
	n > detection of 10 cfu	36	0
Total coliform	Maximum (cfu)	2000	0
	Minimum (cfu)	10	0
	n	91	93
	n > detection of 10 cfu	87	0

Note: cfu = colony-forming units

8.6 Threats Identification and Assessment

Threats are defined as those activities or conditions that could cause contamination of drinking water by a chemical or pathogen within one of the three Intake Protection Zones (IPZs). Activities must be assessed and reported whether or not they currently occur within the vulnerable areas. O.Reg. 287/07 section 1.1 (1) under the *Clean Water Act (2006)* lists 20 activities that may result in threats to drinking water quality (see Table 3-1). (Two additional prescribed activities pose threats to water quantity.)

Conditions, as defined by Part XI.3 of the Technical Rules, refer to past activities that have produced contaminants that may result in significant drinking water threats. A more detailed definition can be found in the discussion under section 3.2.5 above.

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

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

Rule 9 (ix) requires that areas within vulnerable areas where activities that are or would be a significant, moderate or low drinking water threats be listed in the Assessment Report; that is, regardless of whether or not the activities presently exist in the vulnerable area.

8.6.1 Threats Approach

Part XI.4 of the Technical Rules describe the methods for identifying significant, moderate and low drinking water threats related to activities in the vulnerable area of a drinking water intake (MECP, 2017).

A threat is deemed significant, moderate or low depending on:

1. the vulnerable area in which the activity occurs or would occur;
2. the vulnerability score of the vulnerable area;
3. a set of prescribed activities and corresponding circumstances that constitute a threat.

The Technical Rules require activities that would be a significant, moderate or low drinking water threat within the vulnerable areas to be listed in the Assessment Report, *regardless of whether or not the activities presently exist in the vulnerable area.* For an activity to pose even a low threat, the vulnerability score of the area in which it occurs must be greater than or equal to 4.2 for a surface system.

Lists of significant, moderate and low drinking water threats related to chemicals and pathogens were compiled for each of the vulnerable areas of the South River drinking water intake based on the MECP Tables of Drinking Water Quality Threats (MECP 2021). Existing activities were compared to the MECP Tables of Drinking Water Quality Threats, where the prescribed activities that pose a threat were classified as significant, moderate or low based on their circumstances.

Threats Approach - Potential Activities and Circumstances

Based on the resulting vulnerability scores, the possible threat levels were identified for each of the vulnerable areas (Table 8-13). Only the IPZ-1 for the South River intake has drinking water threats related to activities that would be significant due to contamination by chemicals or pathogens, and is further considered for enumeration of existing significant threats (Section 8.6.2). Refer to Figure 8-5 above for further support of the vulnerable areas where activities are or would be significant, moderate or low drinking water threats.

Table 8-13. Areas within South River Intake Protection Zone where Activities are or would be Significant, Moderate and Low Drinking Water Threats

Threat Type	Vulnerable Area	Vulnerability Score	Threat Level Possible		
			Significant	Moderate	Low
Chemical	IPZ-1	9	✓	✓	✓
	IPZ-3a	4.5			✓
	IPZ-3d	3.6			
	IPZ-3e	2.7			
Pathogen	IPZ-1	9	✓	✓	✓
	IPZ-3a	4.5			✓
	IPZ-3d	3.6			
	IPZ-3e	2.7			

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The Technical Rules Part XII - The Tables of Drinking Water Quality Threats (MECP 20182021) provide the detailed sets of circumstances for identifying if an activity meets the criteria for a significant, moderate or low drinking water threat. The Threats Tables can be downloaded from the MECP webpage (https://www.ontario.ca/page/2021-technical-rules-under-clean-water-act)(Ontario.ca/page/source-protection) in an Excel file format.

-An on-line searchable version of the Threats Tables can be accessed at swpip.ca.

The actual provincial Threat Tables can be found at:
https://files.ontario.ca/2017_2018_chemical_and_pathogen_tables_of_threats_12_v2.xlsx

The on-line version Excel file of the Threats Tables can be filtered to outline the specific circumstances related to potential chemical or pathogen threats. After the on-line version file is downloaded and opened, click on the "SearchData" menu tab and then "Zone and ScoreFilter". By applying the filter values in sequence, as shown in Table 8-14 below, it is possible to narrow the results to those activities considered at a threat level within the particular vulnerable area and vulnerability score.

Table 8-14. Summary of Circumstances in the Provincial Threats Tables Related to South River IPZ

Vulnerable Area	Vulnerability Score	Risk	Parameter of Concern	# of Sets of Circumstances
IPZ-1	9	Significant	Chemical	58
IPZ-1	9	Moderate	Chemical	138
IPZ-1	9	Low	Chemical	41
IPZ-3a	4.5	Low	Chemical	58
IPZ-1	9	Significant	Pathogen	16
IPZ-1	9	Moderate	Pathogen	11
IPZ-1	9	Low	Pathogen	2
IPZ-3a	4.5	Low	Pathogen	16

Vulnerability Score	Significant	Moderate	Low
9	CIPZWE9S PIPZWE9S	CIPZWE9M PIPZWE9M	CIPZWE9L PIPZWE9L
4.5	NA NA	NA NA	CIPZWE4.5L PIPZWE4.5L
3.6	NA	NA	NA
2.7	NA	NA	NA

Note: n/a indicates there are no matching circumstances where an activity is considered a drinking water threat

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The Technical Rules require that the number of locations within vulnerable areas be enumerated at which:

- an activity that is a significant drinking water threat is being engaged in, and
- any conditions resulting from a past activities that are a significant drinking water threat.

There are 14 prescribed activities that would be significant drinking water threats if they occurred in the IPZ-1 of the South River intake. A breakdown of the prescribed activities and the number of circumstances under which those activities would be significant is provided in Table 8-15.

Table 8-15. Enumeration of Circumstances in which Prescribed Activities would be Significant Threats to South River Drinking Water Intake

Activities Prescribed to be Drinking Water Threats	# of Significant Threat Circumstances	
	Chemical	Pathogen
The establishment, operation or maintenance of a waste disposal site within the meaning of Part V of the *Environmental Protection Act*.	~~8~~15	~~1~~4
The establishment, operation or maintenance of a system that collects, stores, transmits, treats or disposes of sewage.	~~159~~11	5
The application of agricultural source material to land.	0	1
The storage of agricultural source material.	3	2
The application of non-agricultural source material to land.	0	1
The handling and storage of non-agricultural source material.	~~3~~2	1
The application of commercial fertilizer to land.	0	n/a
The handling and storage of commercial fertilizer.	0	n/a
The application of pesticide to land.	2	n/a
The handling and storage of pesticide.	1	n/a
The application of road salt	0	n/a
The handling and storage of road salt.	1	n/a
The storage of snow.	~~2~~4	n/a
The handling and storage of fuel.	~~6~~2	n/a
The handling and storage of a dense non-aqueous phase liquid.	~~0~~2	n/a
The handling and storage of an organic solvent.	0	n/a
The management of runoff that contains chemicals used in the de-icing of aircraft.	1	n/a
The use of land as livestock grazing or pasturing land, an outdoor confinement area or a farm-animal yard.	2	2
The establishment and operation of a liquid hydrocarbon pipeline.	2	n/a
Number of circumstances under which the threat is or would be significant	~~42~~58	~~13~~16

Note: n/a indicates there are no matching circumstances where an activity is considered a drinking water threat

Threats Approach - Existing Significant, Moderate and Low Threats

Based on a desktop search, field investigations conducted August 19, 2009 and September 14, 2009 by AECOM staff, and information contained in previous threats assessments for the area (WESA, 2009), there are no known significant drinking water threats that presently exist in the vulnerable areas of the South River drinking water intake.

8.6.2 Issues Approach to Threat Identification

Manganese is the only confirmed drinking water issue (in accordance with Rule 114 (1)) for the South River intake. Manganese was considered to be naturally occurring and, therefore, Rule 131 does not apply for the determination of significant threats associated with drinking water issues.

8.6.3 Conditions

Based on a desktop search, there are no known conditions that exist in the vulnerable areas of the South River drinking water intake.

8.6.4 Local Threat Considerations

The North Bay-Mattawa Source Protection Committee is concerned about the threat posed by the transportation of hazardous substances along a number of transportation corridors within the South River Intake Protection Zone which creates the potential for a spill to occur in the vulnerable area.

Although there is no prescribed threat activity related to the transportation of hazardous substances under the *Clean Water Act*, Technical Rule 119 allows Source Protection Committees to request that an activity be listed as a drinking water threat if:

1. The activity has been identified by the Source Protection Committee as an activity that may be a drinking water threat; and
2. The Director indicates that the chemical or pathogen hazard rating for the activity is greater than 4.

The Source Protection Committee submitted a formal request to the Ministry of Environment for the addition of transportation of hazardous substances as a non-prescribed (local) drinking water threat in the SP Area. This request was approved by the Director on February 8, 2011 (Appendix G). Included in the approval are the circumstances and hazard ratings for the activities considered.

Table 8-15 shows where significant, moderate and low threats relating to the transportation of hazardous substances and the transportation of septage are located in the South River IPZs. There is one circumstance in which the threat is significant for the South River intake. This occurs in IPZ-1 (Figure 8-4) and relates to a pathogen threat from the transportation of septage, for which a spill of any quantity may result in the presence of pathogens in surface water. No significant chemical threats relating to transportation exist for this intake.

Table 8-16. Areas within South River Intake Protection Zone where Transportation of Hazardous Substances is Considered a Significant, Moderate or Low Drinking Water Threat

Threat Type	Vulnerable Area	Vulnerability Score	Threat Level Possible		
			Significant	Moderate	Low
Chemical	IPZ-1	9		✓	✓
Pathogen	IPZ-1	9	✓		
	IPZ-3~~a~~	4.5			✓

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8.7 Gap Analysis and Recommendations

This study uses Drinking Water Systems Regulation (O.Reg. 170/03) parameters analyzed from 2003 to 2006 at the South River Water Treatment Plant. For raw water, only bacteria data are included in the DWIS database. In treated water, chemical and bacteriological data exists, but most of the chemicals were only sampled on one occasion in 2004. Overall, there is minimal data available for raw water from the South River intake to evaluate drinking water issues. It is recommended that the drinking water issues evaluation be reassessed as new data becomes available.

Statistical analysis of trends in *E. coli* and total coliform was precluded due to the large number of values below analytical detection limits, as well as the limited data availability consisting of only two full years of data. Additional data would serve as beneficial towards analyzing for trends in pathogens.

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Key Documents

Acts and Regulations

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O.Reg. 284/07 under the *Clean Water Act*, 2006. Source Protection Areas and Regions.

O.Reg. 287/07 under the *Clean Water Act*, 2006. General.

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Technical Guidance Documents

Ministry of the Environment. 2006. *Assessment Report: Guidance Modules (draft).* October 2006.

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Local Background Reports

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Waters 2009d. Groundwater Vulnerability Analysis for the Town of Mattawa.

Note: Ministry of Environment or MOE and Ministry of Environment and Energy or MOEE are previous names of the Ministry of Environment, Conservation and Parks or MECP.

Glossary

100-Year Monthly Mean Lake Level (Great Lakes-St. Lawrence River system and large inland lakes) – the monthly mean lake level having a total probability of being equaled or exceeded during any year of one per cent. Monthly mean level refers to the average water level occurring during a month computed from a series of readings in each month.

100 Year Storm – a frequency based storm that on average will occur once every hundred years; however, has a one percent chance of occurring or being exceeded in any given year.

100-Year Wind Setup (Great Lakes-St. Lawrence River system and large inland lakes) – the wind setup having a total probability of being equaled or exceeded during any year of one percent. Wind setup refers to the vertical rise above the normal static water level on the leeward side of a body of water caused by wind stresses on the surface of the water.

Abandoned Well – a well that is deserted because it is dry, contains non-potable water, was discontinued before completion, has not been properly maintained, was constructed poorly, or it has been determined that natural gas may pose a hazard.

Absorption – a physical or chemical process in which atoms, molecules or ions enter a solid, liquid or gas bulk phase.

Activity – one or a series of related processes, natural or anthropogenic, that occurs within a geographical area and may be related to a particular land use.

Adsorption – the adhesion in an extremely thin layer of molecules (as of gases, solutes, or liquids) to the surfaces of solid bodies or liquids with which they are in contact.

Adverse Environmental Impacts – those physical, biological and environmental changes which are of long-term duration: where the rate of recovery is low; where there is a high potential for direct and/or indirect effects; and/or where the area is considered to be critical habitat or of critical significance to the protection, management and enhancement of the ecosystem.

Adverse Water Quality Incident (AWQI) – an event in which a municipal or private drinking water system receives an adverse test result. This can trigger a process of notification and corrective measures.

Aggregate – refers to gravel which is any loose rock that is at least two millimeters in its largest dimension (about 1/12 of an inch), and no more than 75 millimeters (about 3 inches). Sometimes gravel is restricted to rock in the 2-4 millimeter range, with pebble being reserved for rock 4-75 millimeters (some say 64 millimeters). The next smaller size class in geology is sand, which is 0.063 mm to 2 mm in size. The next larger size is cobble, which is 75 (64) millimeters to 256 millimeters (about ten inches).

Agricultural Managed Land – managed land that is used for agricultural production purposes including areas of cropland, fallow land and improved pasture where agricultural source material (ASM), commercial fertilizer or non-agricultural source material (NASM) is applied or may be applied.

Agricultural Source Material – material used for land application of nutrients that originate from agricultural activities such as livestock operations. May include manure, livestock bedding, runoff water from animal yards or manure storage and compost (*see Nutrient Management Act, 2002* for legal description).

Algal Bloom – refers to rapid growth of small aquatic plants on the surface of lakes and rivers, usually as a result of excessive nutrients.

Alkalinity – of, relating to, containing, or having the properties of an alkali or alkali metal. Having a pH of more than 7.

Alluvium Deposits – sediments consisting of silt, sand, clay, and gravel in varying proportions that are deposited by flowing water.

Alteration to a Watercourse – any watercourse, whether flowing all year or not, requires a Conservation Authority permit to be altered. Typical alterations include bridge or culvert installations, channelization and diversion.

Anthracite-Sand Filtration – filter sand used to separate suspended matter from the water. Anthracite is a type of “hard” coal, with a high percentage of fixed carbon.

Anthropogenic – influenced by human activity or of human origin.

Aphotic Zone – the depth of a waterbody that is not exposed to sunlight. The depth of the aphotic zone can be greatly affected by such things as turbidity and the season of the year. The benthic layer is located here. The aphotic zone generally underlies the photic zone, which is that portion of the waterbody directly affected by sunlight.

Aquiclude – a confining bed and/or formation composed of rock or sediment that is impermeable and prevents the flow of water to or from an adjacent aquifer.

Aquifer – a water-bearing layer (or several layers) of rock or sediment capable of yielding supplies of water; typically consists of unconsolidated deposits of sandstone, limestone or granite, and can be classified as confined, unconfined or perched. The water in an aquifer is called groundwater.

Aquifer System – a group of two or more aquifers that are separated by aquitards or aquicludes.

Aquifer Vulnerability Index (AVI) – a numerical indicator of an aquifer’s intrinsic or inherent vulnerability to contamination expressed as a function of the thickness and permeability of overlying layers.

Aquitard – a confining bed and/or formation composed of rock or sediment that retards but does not prevent the flow of water to or from an adjacent aquifer. It does not readily yield water to wells or springs, but stores ground water.

Area of Influence of a Well – the area covered by the drawdown curves of a given well or combination of wells at a given time when pumped.

Assessment Report – the Assessment Report is a science based report generated locally for each Source Protection Area to comply with the “*Clean Water Act, 2006*”. The Report identifies the watersheds and the vulnerable areas within the Source Protection Area. Threats to the vulnerable areas are assessed and determined whether they pose a significant threat to Municipal residential drinking water systems.

Attenuation – the soil's ability to lessen the amount of, or reduce the severity of, groundwater contamination. During attenuation the soil holds essential plant nutrients for uptake by agronomic crops, immobilizes metals that might be contained in municipal sewage sludge, and removes bacteria contained in animal or human wastes.

Average Annual Recession Rate – refers to the average annual linear landward retreat of a shoreline or river bank.

Bankfull Discharge – the formative flow of water that characterizes the morphology (shape) of a fluvial channel. In a single channel stream, bankfull is the discharge which just fills the channel without flowing onto the floodplain.

Baseflow – the sustained flow (amount of water) in a stream that comes from groundwater discharge or seepage. Groundwater flows underground until the water table intersects the land surface and the flowing water becomes surface water in the form of springs, streams/rivers, lakes, and wetlands. Baseflow is the continual contribution of groundwater to watercourses and is important for maintaining flow in streams and rivers between rainstorms and in winter conditions.

Basin – the area drained by a river or a watershed with a common outlet.

Batholith – a very large mass of igneous rock (e.g. granite) formed deep within the earth.

Beach – a geological formation consisting of loose rock particles, such as sand, gravel, shingle, pebbles, cobble, or even shell, along the shoreline of a body of water.

Bedrock – solid or fractured rock usually underlying unconsolidated geologic materials; bedrock may be exposed at the land surface.

Benthic Organisms – organisms that occur at the bottom of a body of water.

Benthic Region – the bottom of a body of water, supporting the benthos.

Benthos – the plant and animal life whose habitat is the bottom of a body of water.

Berm – a narrow shelf or ledge which can be used at the bottom of a slope to reinforce and stabilize it against slumping and erosion or to direct overland flow.

Best Management Practices (BMPs) – structural, non-structural and managerial techniques that are recognized to be the most effective and practical means to control non-point source pollutants yet are compatible with the productive use of the resource to which they are applied. BMPs are used in both urban and agricultural areas.

Bioaccumulation – continuous build-up of chemicals in the body tissues resulting from direct ingestion or ingestion of contaminated food sources. Chemicals are not flushed from the body, but rather remain in the tissues throughout the lifetime of the individual.

Biochemical Oxygen Demand (BOD) – is a measure of the quantity of oxygen used by micro-organisms (e.g. aerobic bacteria) in the decomposition (oxidation) of organic solids.

Biodegradation – decomposition of a substance into more elementary compounds by the action of micro-organisms such as bacteria.

Bog – peatland with the water table at or near the surface. The surface of the bog may often be raised above the surrounding terrain. Bogs are isolated from mineral-rich soil waters; therefore, nutrient input is from atmospheric deposition. They are strongly acidic and nutrient poor. Peat is usually greater than 40 centimetres deep. Groundcover is usually moss, *Sphagnum spp*. and ericaceous shrubs and may be treed or treeless. Bog water is derived from groundwater or precipitation.

Bored Well – a well drilled with a large rig-mounted boring auger, usually 3658 millimetres or more in diameter and seldom deeper than 30 metres.

Boulder – a sedimentary rock fragment that is usually rounded and has a diameter over 256 millimetres.

Calibration – the process whereby a numerical model is adjusted so that the calculated and observed parameters converge. When the parameters converge, the calibration process is complete.

Capillary Action – the movement of water in the interstices of a porous medium due to capillary forces.

Capillary Forces – the forces between water molecules and the clay (or any soil particle) surfaces. Capillary flow refers to water that moves in response to differences in capillary forces.

Capture Zone – a term used to represent an area where water originates and moves to a water well. Typically, capture zones are a two-dimensional representation of a three-dimensional space.

Carbonate – a compound(s) containing CO_3(2), also known as a salt of carbonic acid. When heated, yields the gas carbon dioxide (calcite, dolomite and siderite are examples of carbonates).

Channel Capacity – the ability of a watercourse at a given cross-section to convey flows of water, or how much water can be carried at a particular place; floods occur when the channel capacity is exceeded.

Channelization – the smooth realignment and regrading of a creek or streambed; implies modification of the watercourse to increase channel capacity; channelized banks are often reinforced with stone, concrete or rip-rap.

Chemical Contaminant – a substance used in conjunction with, or associated with, a land use activity or a particular entity, and with the potential to adversely affect water quality.

Chlorine Disinfection – the destruction or elimination of disease-carrying micro-organisms through the use of a chlorinated solution.

Chlorite – a rock-forming mineral, usually greenish in colour and platy (like mica). A hydrous silicate of aluminium, iron and magnesium.

Circumneutral – term applied to solutions (normally water) with a pH of 5.5 (acidic) to 7.4 (alkaline).

***Clean Water Act* –** the "*Clean Water Act, 2006"* was passed as Bill 43 to protect drinking water at the source. The *Clean Water Act* requires the development of a watershed-based Source Protection Plan.

Coagulation-Flocculation – a term used to describe a process where water is purified at a water treatment plant.

Coliforms – bacteria found only in human and animal wastes; presence in a river may indicate pollution by sewage or farmyard runoff.

Conceptual Water Budget – a written description of the overall system flow dynamics for each watershed in the Source Protection Area, taking into consideration surface water and groundwater features, land cover (e.g. proportion of urban vs. rural uses), man-made structures (e.g. dams, channel diversions, water crossings), and water takings.

Condition – the presence of a substance in a vulnerable area that results from a past activity and that also constitutes a drinking water threat.

Cone of Depression – the zone (around a well in an unconfined aquifer) that is normally saturated but becomes unsaturated as a well is pumped; an area where the water table dips down forming a "V" or cone shape due to a pumping well.

Confined Aquifer – also commonly called an artesian aquifer. A confined aquifer is bounded above and perhaps below by layers of geological material that do not transmit water readily. It is the saturated formation between impermeable layers that restrict movement of water vertically into or out of the saturated formation. In this layer, water is confined under pressure, similar to water in a pipeline. Drilling a well into this type of aquifer is similar to puncturing a pressurized pipeline. If the pressure is great enough, the well will flow, and this is called a flowing artesian well.

Confining Layer (aquitard) – a layer of geologic material with little to no permeability or hydraulic conductivity that functions as a container for an aquifer. Water does not rapidly pass through this layer or the rate of movement is extremely slow.

Conservation Authorities – local watershed management agencies that deliver services and programs that protect and manage water and other natural resources in partnership with government, landowners and other organizations.

Consumptive Use – the portion of water withdrawn or withheld from the water source and assumed to be lost or otherwise not returned to the water source due to evaporation, incorporation into products, or other processes.

Contaminant (pollutant) – an undesirable substance that makes water unfit for a given use when found in sufficient concentration.

Contaminant of Concern – a chemical or pathogen that is or may be discharged from a Drinking Water Threat; a chemical or pathogen that is or may become a Drinking Water Threat as identified by the Ontario Ministry of Environment.

Control Structure – a structure that serves to control the flow of water, generally a dam or weir.

Corrective Action – steps that must be taken following an adverse water quality incident as specified by O.Reg. 170/03, Schedules 17 & 18, or O.Reg. 252/05, Schedule 5 and/or as directed by the local Medical Officer of Health or drinking water inspector that are necessary to protect human health.

***Cosmetic Pesticide Ban Act* –** the "*Cosmetic Pesticide Ban Act, 2008"* recognizes that the cosmetic use of pesticides to improve the appearance of lawns and gardens presents health and environmental risks. The *Clean Water Act* restricts the use and sale of specific pesticides for cosmetic purposes on specific land uses.

Cumulative Effects (water quality) – the consequence of multiple threats sources, in space and time, which affect the quality of drinking water sources.

Cumulative Effects (water quantity) – the consequence of multiple threats sources, in space and time, which affect the quantity of drinking water sources.

DDT (dichlorodiphenyltrichloroethane) – a pesticide once widely used to control insects in agriculture and insects that carry diseases such as malaria. DDT is a white, crystalline solid with no odour or taste. Since the 1970's, use of DDT as a pesticide has been banned in North America.

Dam – structure used to hold back water.

Data Gaps – the lack of site specific information for a geological area and/or specific type of information.

Decommissioned Wells – decommissioned wells are capped, plugged and sealed in compliance with regulatory requirements by the Ministry of the Environment.

Dense Non-Aqueous Phase Liquid (DNAPL) – an organic chemical in concentrations greater than its aqueous solubility and more dense than water. Such a chemical will sink in groundwater and accumulate in aquifer depressions.

Designated System – a drinking water system that is included in a Terms of Reference, pursuant to resolution passed by a municipal council under subsection 8(3) of the proposed "*Clean Water Act, 2006"*.

Discharge – the flow of surface water in a stream or canal, or the outflow of groundwater to a well, ditch or spring. It is the volume of water in cubic metres per second (m3/s) running in a watercourse.

Discharge Area – an area where groundwater emerges at the surface; an area where upward pressure or hydraulic head moves groundwater towards the surface to escape as a spring, seep, or base flow of a stream.

Disposal Well – a well used for the disposal of waste into a subsurface stratum.

Diversion – a redirection of water from one drainage or watercourse to another.

Drainage Area – the area which supplies water to a particular point.

Drainage Basin – the area of land, surrounded by divides, that provides runoff to a fluvial network that converges to a single channel or lake at the outlet.

Drainage Well – a well pumped in order to lower the water table; a vertical shaft to a permeable substratum into which surface and subsurface drainage is channeled.

Drawdown – lowering of the water level of a lake or reservoir.

Drilled Well – a well usually 10 inches or less in diameter, drilled with a drilling rig and cased with steel or plastic pipe. Drilled wells can be of varying depth.

Drinking Water – 1. Water intended for human consumption. 2. Water that is required by an Act, regulation, order, municipal by-law or other document issued under the authority of an Act, (a) to be potable, or (b) to meet or exceed the requirements of the prescribed drinking water quality standards.

Drinking Water Concern – a purported drinking water issue that has not at this time been substantiated by monitoring, or other verification methods. Concerns may be identified through consultations with the public, stakeholder groups, and technical experts (e.g. water treatment plant operators).

Drinking Water Issue – a substantiated condition relating to the quality or quantity of water that interferes or is anticipated to soon interfere with the use of a drinking water source by a municipality. As defined in *Technical Rule 114*, regarding the quality of water in a vulnerable area:
1) The presence of a parameter in water at a surface water intake or well, at a concentration that may result in deterioration of the water quality or where there is a trend of increasing concentrations of a parameter.
2) The presence of a pathogen at a concentration that may result in deterioration of the water quality or there is a trend of increasing concentrations of the pathogen.

Drinking Water Source Protection – a program of education, stewardship, planning, infrastructure, and regulation activities that together serve to help prevent the contamination or overuse of source water.

Drinking Water System – a system of works, excluding plumbing, that is established for the purpose of providing users of the system with drinking water and that includes, (a) anything used for the collection, production, treatment, storage, supply or distribution of water, (b) anything related to the management of residue from the treatment process or the management of the discharge of a substance into the natural environment from the treatment system, and (c) a well or intake that serves as the source or entry point of raw water supply for the system.

Drinking Water Threat – Has the same meaning as in the "*Clean Water Act, 2006*." An existing activity, possible future activity or existing condition that results from a past activity,
(a) that adversely affects or has the potential to adversely affect the quality or quantity of any water that is or may be used as a source of drinking water, or
(b) that results in or has the potential to result in the raw water supply of an existing or planned drinking-water system failing to meet any standards prescribed by the regulations respecting the quality or quantity of water, and includes an activity or condition that is prescribed by the regulations as a drinking water threat.

Drought – a complex term that has various definitions, depending on individual perceptions. For the purposes of low water management, drought is defined as weather and low water conditions characterized by one or more of the following:
a) below normal precipitation for an extended period of time (for instance three months or more), potentially combined with high rates of evaporation that result in lower lake levels, streamflows or baseflow, or reduced soil moisture or groundwater storage;
b) streamflows at the minimum required to sustain aquatic life while only meeting high priority demands for water, water wells becoming dry, surface water in storage allocated to maintain minimum streamflows;
c) socio-economic effects occurring on individual properties and extending to larger areas of a watershed or beyond. As larger areas are affected and as low water and precipitation conditions worsen, the effects usually become more severe.

Dug Well – a large diameter well dug by hand, excavator or by an auguring machine, often cased by concrete or hand-laid bricks.

E. coli – an enterobacterium (*Escherichia coli*) that is used in public health as an indicator of fecal pollution (as of water or food) and in medicine and genetics as a research organism and that occurs in various strains that may live as harmless inhabitants of the human lower intestine or may produce a toxin causing intestinal illness.

Ecology – an interdependent community of plants and animals living in a recognizable area; humans are a major part of most Ontario ecosystems.

Effluent – the discharge of a pollutant in a liquid form, often from a pipe into a stream or river.

***Environmental Protection Act* –** the purpose of this *Act* is to provide for the protection and conservation of the natural environment. R.S.O. 1990, c. E.19, s. *3.*

Erosion – a physical process causing the deterioration and transport of soil surfaces and river channel materials by the force of flowing water or wind, ice or other geological agents, including such processes as gravitational creep. Geological erosion is naturally occurring erosion over long periods of time.

Esker – a ridge of glacial sediment deposited by a stream flowing in and under a melting glacier.

Euphotic Zone – the lighted region of a body of water that extends vertically from the water surface to the depth at which photosynthesis fails to occur because of insufficient light penetration.

Eutrophication – a means of aging lakes whereby aquatic plants are abundant and waters are deficient in oxygen. The process is usually accelerated by enrichment of waters with surface runoff containing nitrogen and phosphorus.

Eutrophic Lakes – lakes that are rich in nutrients and organic materials, therefore highly productive for plant growth. These lakes are often shallow and seasonally deficient in oxygen in the hypolimnion.

Evaporation – the process by which water or other liquids change from liquid to vapour; evaporation can return infiltrated water to the atmosphere from upper soil layers before it reaches groundwater or surface water, and occur from leaf surfaces (interception), water bodies (lakes, streams, wetlands, oceans), and small puddled depressions in the landscape.

Evapotranspiration – the combined loss of water from a given area and during a specific period of time by evaporation from the soil surface and by transpiration from plants.

Event – an occurrence of an incident (isolated or frequent) with the potential to promote the introduction of a threat into the environment. An event can be intentional, as in the case of licensed discharge or accidental, as in the case of a spill.

Existing Drinking Water Source – the aquifer or surface water body from which municipal residential systems or other designated systems currently obtain their drinking water. This includes the aquifer or surface water body from which back-up wells or intakes for municipal residential systems or other designated systems obtain their drinking water when their current source is unavailable or an emergency occurs.

Exposure – the extent to which a contaminant or pathogen reaches a water resource. Exposure, like a drinking water threat, can be quantified based on the intensity, frequency, duration and scale. The degree of exposure will differ from that of a drinking water threat dependent on the nature of the pathway or barrier between the source (threat) and the target (receptor) and is largely dependent on the vulnerability of the resource.

Fault – a fracture in the crust of the earth accompanied by a displacement of one side of the fracture with respect to the other usually in a direction parallel to the fracture.

Feldspar – common rock-forming minerals (e.g., orthoclase, microline, plagioclase). Aluminum silicates of one or more of calcium, sodium and potassium.

Fen – peatland with the water table at or just above the surface. Very slow internal drainage by seepage and usually enriched by nutrients from upslope mineral water, therefore more nutrient- and oxygen-rich than bogs. Peat substrate is usually greater than 40 centimetres deep. Can sometimes be a floating mat, with vegetation consisting of sedges, mosses, shrubs and sometimes a sparse tree layer.

Field Capacity – the capacity of soil to hold water at atmospheric pressure. It is measured by soil scientists as the ratio of the weight of water retained by the soil to the weight of the dry soil.

Fill – rubble, earth, rocks or other imported material that is used to raise or alter the existing elevation.

Filtering – the soil's ability to attenuate substances, which includes retaining chemicals or dissolved substances on the soil particle surface, transforming chemicals through microbial biological processing, retarding movement and capturing solid particles.

Flood – an overflow or inundation that comes from a river or other body of water and causes or threatens damage. It can be any relatively high streamflow overtopping the natural or artificial banks in any reach of a stream. It is also a relatively high flow as measured by either gauge height or discharge quantity.

Floodplain – a strip of relatively level land bordering a stream or river. It is built of sediment carried by the stream and dropped when the water has flooded the area. It is called a water floodplain if it is overflowed in times of high water, or a fossil floodplain if it is beyond the reach of the highest **flood**.

Floodway – the channel of a river and those parts of the adjacent floodplain which are required to carry and discharge flood water.

Flow – the volumetric rate of water discharged from a source, given in volume with respect to time. Measured in cubic metres per second (m3/s); see also "discharge".

Flow Regime – the basin's flow magnitude and duration given a particular precipitation event (amount and intensity) and also the frequency of the events. Given the temporal component of frequency, a basin's flow regime would encompass baseflow, low magnitude (high frequency events) and high magnitude (low frequency events).

Flow System – groundwater flow from the recharge area to a discharge area; three levels - regional, intermediate, and local. In a regional flow system, the recharge area is at the basin or watershed divide and the discharge area is at a river in the valley bottom. In a local flow system, the recharge area is at a topographical high spot and the discharge area is at a nearby topographical low spot.

Fluvial – pertaining to rivers and streams or to features produced by the actions of rivers and streams.

Food Chain – the passing of nutrients and energy through an ecosystem by animals eating other animals and plants.

Forest Management – the intelligent use and control of the forest and its products for a specific purpose; may be for wood production, wildlife habitat, maple syrup, nature trails or any combination of these uses and others.

Fractures – cracks in bedrock that may result in high permeability values.

Fresh Water - water that contains less than 1,000 milligrams per litre (mg/L) of dissolved solids; generally more than 500 milligrams per litre is undesirable for drinking and many industrial uses.

Freshet – the occurrence of a water flow resulting from sudden rain or melting snow. Most commonly used to describe a spring thaw resulting from snow and ice melt.

Future Municipal Water Supply Areas – an area corresponding to a wellhead protection area or a surface water intake protection zone, or an aquifer or groundwater area identified for future municipal water supply infrastructure (either a well or a surface water intake pipe).

Gauging Station – a site on a **stream**, lake or canal where hydrologic data is collected.

Geology – the study of science dealing with the origin, history, materials and structure of the earth, together with the forces and processes operating to produce change within and on the earth.

GIS (Geographic Information System) – an electronic map-based database management system which uses a spatial reference system for analysis and mapping purposes.

Glacial Drift – all material transported and deposited by glacial ice and glacial meltwater.

Glacial Lake – a lake created when glacial meltwaters are ponded in a basin scoured out by glacial ice, or from the damming of natural drainage by glacial materials such as till.

Glacial Outwash – well-sorted sand, or sand and gravel deposited by water melting from a glacier.

Glacial Till – nonsorted, nonstratitified sediment deposited or transported by glacial activity.

Glaciofluvial – pertaining to rivers and streams flowing from, on or under melting glacial ice, or to sediments deposited by such rivers and streams.

Glaciolacustrine – a term used to describe fine-grained glacial materials deposited in glacial lake environments.

Gneiss – a type of rock containing bands rich in granular materials alternating with bands rich in platy or micaceous minerals.

Gradient – the rate of change of elevation between one section of a river and another section further downstream.

Granite – a course-textured igneous rock made up of quartz, feldspar, and one or both of mica and hornblende; usually found in batholiths. It is an acid rock with a high content of silica.

Great Lakes Basin – refers to the watershed of the Great Lakes and the St. Lawrence River upstream from Trois-Rivieres, Quebec.

Greywacke – a variety of sandstone with tiny fragments of rock and rock minerals (quartz and feldspar), resulting from rapid erosion and sedimentation.

Grey Water – domestic wastewater other than that containing human excrete, such as sink drainage, washing machine discharge or bath water.

Groundwater – the water below the water table contained in void spaces (pore spaces between rock and soil particles, or bedrock fractures). Water occurring in the zone of saturation in an aquifer or soil.

Groundwater Barrier – rock or artificial material with a relatively low permeability that occurs (or is placed) below ground surface, where it impedes the movement of groundwater and thus may cause a pronounced difference in the hydraulic head on opposite sides of the barrier.

Groundwater Basin – the underground area from which groundwater drains. The basins could be separated by geologic or hydrologic boundaries.

Groundwater Divide – the boundary between two adjacent groundwater basins, which is represented by a high point in the water table.

Groundwater Flow – the rate of groundwater movement through the subsurface.

Groundwater Recharge – inflow of water to a ground water reservoir from the surface. Infiltration of precipitation and its movement to the water table is one form of natural recharge.

Groundwater Recharge Area – the area where an aquifer is replenished from: (a) natural processes, such as the infiltration of rainfall and snowmelt and the seepage of surface water from lakes, streams and wetlands, (b) from human interventions, such as the use of storm water management systems, and; (c) whose recharge rate exceeds a specified threshold.

Groundwater Reservoir – an aquifer or aquifer system in which groundwater is stored. The water may be placed in the aquifer by artificial or natural means.

Groundwater Storage – the storage of water in **groundwater reservoirs**.

Groundwater Vulnerability – the probability of contaminants propagating to a specified region in the groundwater system after introduction at some location above the uppermost aquifer.

Hardness – a characteristic of water that contains various dissolved salts, calcium, magnesium and iron (e.g. bicarbonates, sulfates, chlorides and nitrates).

Hazard – a contaminant and/or pathogen threat.

Hazard Lands – areas designated unsuitable for commercial or residential development because of some natural limitation such as flooding, unstable soil or high ground water levels.

Hazard Rating – the numeric value which represents the relative potential for a contaminant of concern to impact drinking water sources at concentrations significant enough to cause human illness. This numeric value is determined for each contaminant of concern in the Threats Inventory and Issues Evaluation of the Assessment Report.

Headwater – the source of a river or water immediately upstream of a structure. The source waters of a stream or river.

Heavy Metals – a general term used to describe more than a dozen metallic elements. Some heavy metals, such as zinc, copper and iron, although harmful at high concentrations are essential parts of our diets at trace levels. Others, like lead and mercury, have no known health benefits and can have harmful effects on human health and the environment at very low concentrations.

Herbicide – chemicals used to kill undesirable vegetation.

Heterotrophs – those microorganisms that use organic compounds for most or all of their carbon requirements. Most bacteria, including many of the bacteria associated with drinking water systems, are heterotrophs.

Heterotrophic Plate Count [HPC] – is a microbial method that uses colony formation on culture media to approximate the levels of heterotrophic flora.

High Magnitude – an event that is of great importance in terms of its impacts.

Highly Vulnerable Aquifer [HVA] – an aquifer that can be easily changed or affected by contamination from both human activities and natural process as a result of: a) its intrinsic susceptibility, as a function of the thickness and permeability of overlaying layers, or; b) by preferential pathways to the aquifer.

Hummocky – landscape terrain that is characterized by numerous small hills and ridges. Frequently found at the edges of glaciers or in areas of landslide deposits or glacial deposition.

Hydraulic Conductivity – the term used to describe the rate at which water moves through a medium; a controlling factor on the rate at which water can move through a permeable medium.

Hydraulic Flow – the flow of water in a channel as determined by such variables as velocity, discharge, channel roughness and shear stress.

Hydraulic Gradient – rate of change of pressure head per unit of distance of flow at a given point and in a given direction.

Hydraulic Head (Head) – the energy that causes groundwater to flow; the total mechanical energy per unit weight; the sum of the elevation head and the pressure head.

Hydrodynamics – the study of fluid in motion

Hydrogeologic Conditions – conditions stemming from the interaction of groundwater and the surrounding soil and rock.

Hydrogeologic Cycle – the circulation of water in and on the earth and through the earth's atmosphere through **evaporation**, **condensation**, **precipitation**, **runoff**, groundwater storage and seepage and re-evaporation into the atmosphere.

Hydrologic Cycle – the cycle of water movement from the atmosphere to the earth and it's return to the atmosphere through various stages, such as precipitation, interception, runoff, infiltration, percolation, storage, evaporation, and transpiration.

Hydrology – Scientific study of the properties, distribution and effects of water on the Earth's surface, in the soil, underlying rocks and in the atmosphere.

Hydropower – power produced by falling water.

Hypolimnion – the lowermost, non-circulating layer of water in a thermally stratified lake.

Igneous Rock – a rock formed by the crystallization of molten or partially molten matter or magna.

Impact – often considered the consequence or effect. The impact should be measurable and based on an agreed set of parameters. In the case of Drinking Water Source Protection, the parameters may be an acceptable list of standards which identify maximum raw water levels of contaminants and pathogens of concern. In the case of water quantity, the levels may relate to a minimum annual flow, piezometric head or lake level.

Impermeable – not allowing water to pass through.

Impervious – a term denoting the resistance to penetration by water or plant roots.

Impoundment – a body of water, such as a pond, confined by a dam, dyke, floodgate or other barrier. It is used to collect and store water for future use or treatment.

Indicator Graph – plot of monthly values of streamflow or precipitation vs. time at a station that has been designated as an indicator of conditions in that geographical location.

Infiltration – the process of water moving from the ground surface vertically downward into the soil.

Infiltration Capacity – the maximum rate at which a given soil in a given condition can absorb rain as it falls.

Infiltration Rate – the quantity of water that enters the soil surface in a specified time interval. Often expressed in volume of water per unit of soil surface area per unit of time (e.g., centimetres per hour, cm/hr).

Inflow – the water that flows into a lake, reservoir or forebay.

Inland Lake – a body of standing water, usually fresh water, larger than a pool or pond or a body of water filling a depression in the earth's surface.

Inland Rivers – a creek, stream, brook and any similar watercourse inland from the Great Lakes that is not a connecting channel between two Great Lakes.

Input Parameters – a term used in groundwater modelling to describe a number of physical parameters used to generate the numerical model.

Interception Loss – precipitation that is intercepted by trees, vegetation, and/or buildings and evaporates quickly back into the atmosphere before reaching the ground.

Interflow (subsurface stormflow) – water that travels laterally or horizontally through the zone of aeration (vadose zone) during or immediately after a precipitation event and discharges into a stream or other body of water.

Intrinsic Susceptibility – a measure of the natural protection of an aquifer from overlying layers with low permeability.

Intrinsic Susceptibility Index (ISI) – a numerical indicator of an aquifer's intrinsic susceptibility to contamination expressed as a function of the thickness and permeability of overlying layers.

Intrinsic Vulnerability – the potential for the movement of a contaminant(s) through the subsurface based on the properties of natural geological materials.

Irrigation – the controlled application of water for agricultural purposes through man-made systems to supply water requirements not satisfied by **rainfall**.

Kame – a steep-sided hill of stratified glacial drive. Distinguished from a drumlin by lack of unique shape and by stratification.

Karst – areas that have underlying dissolvable bedrock such as limestone or dolomite. There is generally much more interaction between groundwater and surface water in karst regions than in non-karst regions.

Knowledge Gaps – lack of referenced materials or expertise to assess certain characteristics of the specific watershed that can be adequately described without tabular or spatial data.

Lacustrine – pertaining to lakes, or to sediments that have either settled from suspension in standing bodies of fresh water or have accumulated at their margins through wave action.

Lagoon – water impoundment in which organic wastes are stored or stabilized, or both.

Land Use – a particular use of space at or near the earth's surface with associated activities, substances and events related to the particular land use designation.

Leachate – liquid formed by water percolating through contaminated soil or soluble waste as in a landfill.

Leaching – the downward transport of dissolved or suspended minerals, fertilizers and other substances by water passing through a soil or other permeable material.

Limnetic Zone – the open water area away from the shore of a lake or pond. In this zone, there is less light penetration and fewer producers.

Listed Parameter – sampled substances or conditions, as listed in the Ontario Drinking Water Quality Standards, O.Reg. 169/03 under the *Safe Drinking Water Act, 2002.*

Littoral – along and close to the shore, particularly describing aquatic plants, animals, currents and water deposits.

Livestock Density – the number of nutrient units over a given area, and is expressed by dividing the nutrient units by the number of acres in the same area, where, (a) in respect of land used for the application of nutrients, the number of acres of agricultural managed land in the vulnerable area; and (b) in respect of land that is part of a farm unit and that is used for livestock, grazing or pasturing, the number of acres that is used for those purposes.

Loam – a rich soil containing sand, silt, and clay.

Macroinvertebrates – aquatic animals without backbones, visible to the naked eye, that are monitored as indicators of environmental conditions.

Manganese – a gray-white or silvery brittle, metallic element which resembles iron but is not magnetic. It is found abundantly in the ores pyrolusite, manganite, and rhodochrosite and in nodules on the ocean floor. Manganese is alloyed with iron to form ferromanganese, which is used to increase strength, hardness, and wear resistance of steel.

Marsh – standing or slow-moving water with emergent plants covering greater than 25%. Permanently flooded, intermittently exposed, or seasonally flooded. Nutrient-rich water generally remains within the rooting zone for most of the growing season. Substrate is mineral soil or well-decomposed sedimentary organic material, often held together by a root mat.

Mass Balance – a term used to describe a process of inputs and outputs, which must equal in quantity.

Measure – a tangible direction or course of action. For example, a measure associated with the "risk management plan" policy approach may be one of the specific required actions set out in the risk management plan. In the "education and outreach" policy approach, a measure may be an educational pamphlet or training course that sets out best practices. In "incentive programs"**,** a measure may be the financial incentives provided toward the purchase of low-flow toilets or water restricting showerheads.

Membrane Filtration – process where semi-permeable membranes let water through while catching even sub-micron size suspended solids.

Meteorology – the science of the atmosphere; the study of atmospheric phenomena.

Metamorphic Rock – a rock that has undergone chemical or structural changes. Heat, pressure, or a chemical reaction may cause such changes.

Metamorphism – the process by which conditions within the Earth, below the zone of diagenesis, alter the mineral content, chemical composition, and structure of solid rock without melting it. Igneous, sedimentary, and metamorphic rocks may all undergo metamorphism. This gives rise to the terms metavolcanic, metasedimentary, etc.

Micrograms per Litre (ug/Ll) – a measure of the amount of dissolved solids in a solution in terms of micrograms of solid per litre of solution; Equivalent to part per billion in water or 1µg/Ll=1ppb.

Milligrams per Litre (mg/Ll) – a measure of the amount of dissolved solids in a solution in terms of milligrams of solid per litre of solution; equivalent to part per million in water or 1µg/Ll=1ppm .

Minimum Streamflow – the specific amount of water required to support aquatic life, minimize pollution and support recreational use.

Model – an assembly of concepts in the form of mathematical equations or statistical terms that portrays the behaviour of an object, process or natural phenomenon.

Model Calibration – the process for generating information over the life cycle of the project that helps to determine whether a model and its analytical results are of a quality sufficient to serve as the basis of a decision.

Model Validation – a test of a model with known input and output information that is used to adjust or estimate factors for which data are not available.

Moisture – water diffused in the atmosphere or the ground.

Monitoring Well – a non-pumping well, generally of small diameter, that is used to measure the elevation of a water table or water quality. A piezometer is one type of monitoring well.

Moraine – an accumulation of earth and stones carried by a glacier which is usually deposited into a high point like a ridge.

Municipal Residential System – all municipal drinking-water systems that serve or are planned to serve a major residential development (i.e. six or more private residences).

Municipal Well (Public or Community Well) – a pumping well that serves five or more residences.

Natural Flow – the rate of water movement past a specified point on a natural **stream**. The flow comes from a drainage area in which there has been no stream diversion caused by storage, import, export, return flow, or change in consumptive use caused by man-controlled modifications to land use. Natural flow rarely occurs in a developed area.

Nitrate (NO_3) – a chemical formed when nitrogen from ammonia (NH_3), ammonium (NH_4) and other nitrogen sources combine with oxygenated water. An important plant nutrient and type of inorganic fertilizer (most highly oxidized phase in the nitrogen cycle). In water, the major sources of nitrates are septic tanks, livestock feed lots and fertilizers.

Nitrite (NO_2) – product in the first step of the two-step process of conversion of ammonium (NH_4) to **nitrate (NO_3)**.

Non-Agricultural Source Materials – used to apply to land as nutrients that do not originate from agricultural activities. Includes pulp and paper biosolids, sewage biosolids, non-agricultural compost and any other material capable of being applied to land as a nutrient that is not from an agricultural source (see *Nutrient Management Act, 2002* for legal description).

Non-Municipal Year-Round Residential Systems – non-municipal drinking water systems that serve a major residential development (more than five private residences) or a trailer park or campground that has more than five service connections.

Non-Point Source Pollution – pollution of the water from numerous locations that are hard to identify as point source, like agricultural activities, urban runoff and atmospheric deposition.

Normal Operating Range – this is a specified range that lake elevations would be regulated to during typical conditions.

***Nutrient Management Act* –** the purpose of this *Act* is to provide for the management of materials containing nutrients in ways that will enhance protection of the natural environment and provide a sustainable future for agricultural operations and rural development. 2002, c. 4, s. 1.

Nutrients – chemicals (particularly phosphorus) which stimulate the growth of aquatic plants; the nutrients act as fertilizers and contribute to heavy weed growth and algae blooms.

Nutrient Unit – the amount of nutrients that give the fertilizer replacement value of the lower of 43 kg of nitrogen or 55 kg of phosphate as nutrient as established by reference to the Nutrient Management Protocol (*Nutrient Management Act, 2002*).

Official Plan – a land use policy document adopted by a municipality to guide the wise and logical development of its area for the benefit of its citizens.

Oligotrophic Lakes – deep lakes that have a low supply of nutrients, thus they support very little organic production. Dissolved oxygen at or near saturation throughout the lake during all seasons of the year.

Ontario Drinking Water Quality Standards – regulated standards (O.Reg. 169/03, Ontario Drinking Water Quality Standards made under the *Safe Drinking Water Act*, 2002) for microbiological, chemical and radiological parameters that, when present above certain concentrations in drinking water, have known or suspected adverse health effects and require corrective action.

Organic Compounds – natural or synthetic substances based on carbon.

Operational Plan – a document based on the requirements of the Drinking Water Quality Management Standard. The plan will document the owner and operating authority's quality management system.

Organic Soil – soil materials that have developed predominately from organic deposition (i.e., containing >17 percent organic carbon or approximately 30 percent organic matter by weight).

Organism – an individual form of life that includes bacteria, protozoa, fungi, viruses and algae.

Orthophoto Mapping – the ortho process corrects distortions caused by the terrain, the orientation of the airplane and the camera lens. In simplest terms, an ortho image is like a photo that has been draped over the ground similar to spreading a blanket over an uneven surface.

Outflow – the flow out of or through a waterpower facility, control structure, pond, reservoir or lake.

Outwash – sediments deposited by glacial meltwater creating stratified layers of gravel, sand and fines. The terms fluvial and outwash are used interchangeably.

Overburden – used to describe the soil and other material that lies above a specific geologic feature.

Paleolimnology – studies concerned with reconstructing the history (from the Greek: old lake study) of inland waters, especially changes associated with climate change, human impacts, and internal processes.

Parcel Level – a conveyable property, in accordance with the provisions of the *Land Titles Act*. The parcel is the smallest geographic scale at which risk assessment and risk management are conducted.

Pathogen – an organism capable of producing disease.

Part Per Billion (ppb) – a measure of the amount of dissolved matter in a solution in terms of a ratio between the number of parts of matter to a billion parts of total volume; equivalent to microgram per litre in water or one part per billion = one microgram per litre (µg /Ll).

Part Per Million (ppm) – a measure of the amount of dissolved matter in a solution in terms of a ratio between the number of parts of matter to a million parts of total volume; equivalent to milligram per litre in water or one part per million = one milligram per litre (µg /Ll).

Peak Flow – the greatest rate of flow of water (highest recorded level) in a river within a defined time interval (e.g. annual peak flow, daily peak flow).

Percolation – the actual movement of subsurface water either horizontally or vertically; lateral movement of water in the soil subsurface toward a nearby surface drainage feature (e.g., stream) or vertical movement through the soil to the groundwater zone.

Permeable – a porous surface through which water passes quickly.

Permeability – the property or capacity of a soil or rock for transmitting a fluid, usually water; the rate at which a fluid can move through a medium. The definition only considers the properties of the soil or rock, not the fluid. See also hydraulic conductivity.

Permit to Take Water – any person that takes more than 50,000 litres of water per day from any source requires a permit issued by the Ministry of the Environment Director under the *Ontario Water Resources Act*, unless they meet the criteria for certain exempted water takings.

Pesticides – chemicals including insecticides, fungicides, and herbicides that are used to kill living organisms.

pH – a numerical measure of acidity, or hydrogen ion activity used to express acidity or alkalinity. Neutral value is pH 7.0, values below pH 7.0 are acid, and above pH 7.0 are alkaline.

Physiography – the study of the landforms – form and process.

Pluton – an intrusive rock, as distinguished from the pre-existing rock that surrounds it.

Point Source Pollution – pollution from a distinct source, such as an industrial discharge pipe, underground storage tank, septic system, or spills.

Policy – a statement of intention. A policy may be designed to guide current and future actions and decisions, and to achieve a desired goal or outcome. A policy may refer to the policy approaches or the measures that will be used to achieve it.

Policy Approach – the approach a threat policy relies upon to reduce the risk posed by drinking water threats. The various policy approaches provided in the *Clean Water Act* are: education and outreach activities; incentive programs; land use planning approaches (e.g., official plans, zoning by-laws, site plan controls); new or amended provincial instruments (e.g., Environmental Compliance Approvals); risk management plans; prohibition; restricted land uses.

Porosity – the ratio of the volume of void or air spaces in a rock or sediment to the total volume of the rock or sediment.

Potable Water – water that is safe for drinking.

Precambrian Shield – rocks formed during the Precambrian era of earth's history, which have become exposed to the surface in what are called shield areas.

Precipitation – moisture falling from the atmosphere in the form of rain, snow, sleet or hail.

Precipitation Indicators – precipitation is the most important and convenient indicator. Reviewing the precipitation data and comparing it to trends will warn of an impending water shortage. Two precipitation indicators are used: Percent of average = 100 X total monthly precipitation/total average precipitation for those months. Average precipitation for the month is calculated by summing the monthly precipitation amounts for each year they were recorded at that station and dividing by the total number of years. The percent of average will be calculated for each month and indicators will be determined for the previous 18 months (long term) and the previous three months (seasonal). Under a Level I condition or higher, the previous month (short-term) will also be used, with weekly updates. If a watershed is under a Level I or Level II condition, MNR will add up the number of consecutive readings that register no rain (less than 7.6 mm).

Precipitation Indicator Graph – each month the actual and average monthly precipitation in millimetres (mm) are plotted for the previous 18 months. One plot shows the monthly total amounts and the other plots show the accumulated monthly totals, month by month over the 18 month period.

Preferential Pathway – any structure of land alteration or condition resulting from a naturally occurring process or human activity which would increase the probability of a contaminant reaching a drinking water source. Formerly known as transport pathway.

Private Well – groundwater that serves one home or is maintained by a private owner.

Quality Assurance – the procedural and operational framework used by modellers to assure technically and scientifically adequate execution of the tasks included in the study to assure that all analysis is reproducible and defensible.

Quaternary Geology – the study of all geologic activity and events which took place during the Quaternary geologic period (the last 1.8 million years).

Rainfall – the quantity of water that falls as rain only.

Rain Gauge – any instrument used for recording and measuring time, distribution and the amount of **rainfall**.

Raw Water – water in its natural state, prior to any treatment; not the same as 'pure' water which does not exist in nature. Raw water is water that is in a drinking-water system or in plumbing that has not been treated in accordance with: (a) the prescribed standards and requirements that apply to the system, or (b) such additional treatment requirements that are imposed by the license or approval for the system.

Raw Water Supply – water outside a drinking water system that is a source of water for the system (see source water).

Recharge Area – an area in which water infiltrates and moves downward into the zone of saturation of an aquifer; area that replenishes groundwater.

Recharge Zone – the area of land, including caves, sinkholes, faults, fractures and other permeable features, that allows water to replenish an **aquifer**. This process occurs naturally when rainfall filters down through the soil or rock into an aquifer.

Regulated Area – is the area near a watercourse which is subject to Conservation Authority regulations (Development, Interference with Wetlands and Alterations to Shorelines and Watercourses Regulation).

Reserve Amounts – minimum flows in streams that are required for the maintenance of the ecology of the ecosystem**.**

Reservoir – a water body, either natural or artificial, for the storage, regulation and control of water. Large bodies of groundwater are called groundwater reservoirs or aquifers; water behind a dam is also called a reservoir.

Riparian – situated along the bank of a stream or other body of water.

Riparian Area – the area that lies as a transition zone between upland areas such as fields and streams, wetlands, lakes, rivers, etc. The zone is intermittently inundated and usually supports wet meadow, marshy or swampy vegetation, and prevents erosion or scouring of a structure or embankment.

Riparian Buffers – a relatively narrow strip of land that borders a stream or river, often coincides with the maximum water surface elevation of the one-hundred year storm.

Risk – the likelihood of a drinking water threat: (a) rendering an existing or planned drinking water source impaired, unusable or unsustainable, or; (b) compromising the effectiveness of a drinking water treatment process, resulting in the potential for adverse human health effects.

River – a natural stream of water of considerable volume.

River and Stream System – a system that includes all watercourses, rivers, streams and small inland lakes (lakes with a surface area of less than 100 square kilometres) that have a measurable and predictable response to a single runoff event.

River Basin – a term used to designate the area drained by a river and its tributaries.

Root Zone – the depth of soil penetrated by crop roots.

Runoff – the portion of precipitation which is not absorbed by the ground surface and finds its way into surface stream channels and becomes the flow of water from the land to oceans or interior basins by overland flow and stream channels.

Runoff-Direct – the sum of surface runoff and interflow.

Runoff-Total – includes the sum of surface runoff (overland flow), baseflow, and interflow that moves across or through the land and enters a stream or other body of water.

***Safe Drinking Water Act* –** the "*Safe Drinking Water Act, 2002"* provides for the protection of human health and prevention of drinking water health hazards through the control and regulation of drinking water systems and drinking water testing.

Saturation – occurs when all pore spaces in a soil are filled with water.

Saturation Zone – the portion that's saturated with water is called the zone of saturation. The upper surface of this zone, open to atmospheric pressure, is known as the water table (phreatic surface).

Scarps – a steep slope, especially one formed by erosion or faulting (escarpment).

Scour – removal of soil material by waves and currents especially at the base or toe of a shore structure or bluff.

Sediment – transported and deposited particles derived from rocks, soil or biological material. Sediment is also referred to as the layer of soil, sand and minerals at the bottom of surface water, such as streams, lakes and rivers.

Sedimentary Peat – peat that is formed beneath a body of standing water. It is primarily derived from aquatic mosses, plant and algae. The material is slightly sticky, dark brown to black and is usually well decomposed (humic).

Sedimentation – silt and other suspended particles in a stream settling to the bottom. A natural river line process that creates point bars.

Seepage – the appearance and disappearance of water at the ground surface. Seepage designates the type of movement of water in saturated material. It is different from percolation, which is the predominant type of movement of water in unsaturated material.

Semi-Permeable – partially permeable.

Semi-Quantitative – an approach or methodology that uses measurable or ranked data, derived from both quantitative and qualitative assessments, to produce numerical values for articulating results.

Sensitivity Analysis – evaluates the effect of changes to input values or assumptions on a model's results.

Septic System (Conventional) – used to treat household sewage and wastewater by allowing solids to decompose and settle in a tank, then flow by gravity or pump/siphon to a drainage or tile field for soil absorption.

Serviced Area – area where municipal water and/or sewage systems are provided by a local board or municipality.

Setback Requirement – a distance measured inland from an edge of a slope or watercourse where construction is prohibited except for purpose of erosion, flood or pollution control.

Significant Groundwater Recharge Area – an area in which (a) there is a high volume of water moving from the surface into the ground and (b) groundwater serves either as source water or the water that supplies a coldwater ecosystem such as a brook trout stream.

Significant Threat Policy – defined in the *Clean Water Act* to mean: (a) a policy set out in a source protection plan that, for an area identified in the assessment report as an area where an activity is or would be a significant drinking water threat, is intended to achieve an objective referred to in paragraph 2 of subsection 22 (2), or (b) a policy set out in a source protection plan that, for an area identified in the assessment report as an area where a condition that results from a past activity is a significant drinking water threat, is intended to achieve the objective of ensuring that the condition ceases to be a significant drinking water threat.

Snow Course – an established, standard course of stations where the water content of the average snowpack can be determined; used to forecast spring flooding potential.

Snow Cover – a general term for the presence of snow on the surface of a watershed. Use of the term should include acknowledgement of the area and temporal variation of snowpack amounts on the watershed surface.

Snow Depth – the vertical distance between the upper surface of a snowpack and the ground surface beneath.

Snowfall – the amount of snow, hail, sleet or other precipitation occurring in solid form which reaches the earth's surface. It may be expressed in depth in inches after it falls, or in terms of inches or millimetres in depth of the equivalent amount of water.

Snowmelt – conversion of water from solid (ice) to liquid in the snowpack.

Snowpack – the seasonal accumulation of snow on the ground surface.

Snow Water Equivalent (also equivalent water content, or total water content) – depth of water layer produced, after melting of snow at a given place.

Soil Moisture – water diffused in the soil and remaining as a measurable quantity, as the volume of water divided by the total volume.

Soil Moisture Storage – water diffused in the soil. It is found in the upper part of the zone of aeration from which water is discharged by transpiration from plants or by soil **evaporation**.

Source Area – an area of land which absorbs and transmits surface and groundwater into nearby streams.

Source Protection Area – those lands and waters that have been defined under O.Reg. 284/07 as the "study area" for an Assessment Report and a Source Protection Plan under the "*Clean Water Act, 2006".*

Source Protection Authority – A Conservation Authority or other person or body that is required to exercise powers and duties under the "*Clean Water Act, 2006*".

Source Protection Committee – a group of individuals who have been appointed under the *"Clean Water Act"* by a Source Protection Authority to coordinate source protection planning activities for a Source Protection Area. The North Bay-Mattawa Source Protection Committee is composed of a provincially appointed Chair plus nine other members who were appointed from within the watershed by the North Bay-Mattawa Source Protection Authority.

Source Protection Plan – a document that is prepared by a Source Protection Committee under Section 22 of the "*Clean Water Act, 2006"* and O.Reg. 287/07 to direct Source Protection activities in a Source Protection Area. Each Source Protection Plan is approved by the Minister of the Environment.

Source Protection Region – two or more Source Protection Areas that have been grouped together under O.Reg. 284/07.

Source Water – untreated water in streams, rivers, lakes or underground aquifers which is used for the supply of raw water for drinking water systems (see raw water supply).

Source Water Protection – action taken to prevent the pollution and overuse of municipal drinking water sources, including groundwater, lakes, rivers and streams. Source water protection involves developing and implementing a plan to manage land uses and potential contaminants.

Specific Conductance – a measure of conductivity of liquids.

Spring Runoff – snow melting in the spring causes water bodies to rise. This, in streams and rivers, is called "spring runoff".

Static Water Level – the water level in a well that is not being pumped or influenced by pumping.

Storm – a change in the ordinary conditions of the atmosphere, which may include any or all meteorological disturbances such as wind, rain, snow, hail or thunder.

Stormwater Management – planning for the effective discharge of stormwater without causing harmful effects on surface features, river levels or water quality.

Stratification – formation or deposition of layers, as of rocks or sediments, or a layered configuration. Also may be used to describe the process of hydrological layering (of warmer water over colder water in a lake system).

Stream – a general term for a body of flowing water. In hydrology , the term is generally applied to the water flowing in a natural channel as distinct from a canal. More generally, it is applied to the water flowing in any channel, natural or artificial.
Some types of streams are: 1. Ephemeral: A stream which flows only in direct response to precipitation, and whose channel is at all times above the water table. 2. Intermittent or seasonal: A stream which flows only at certain times of the year when it receives water from spring(s) or rainfall, or from surface sources such as melting snow. 3. Perennial: A stream which flows continuously. 4. Gaining: A stream or reach of a stream that receives water from the zone of saturation. 5. Insulated: A stream or reach of a stream that neither contributes water to the zone of saturation nor receives water from it.

Stream Flow – the discharge that occurs in a natural channel. The term streamflow is more general than runoff , as streamflow may be applied to discharge whether or not it is affected by diversion or regulation.

Stream Flow Indicators – gauges in streams measure stream flow and are used to provide indicators to show there is enough stream flow in the river to meet basic needs of the ecosystem and to show that water is available for other uses such as recreation, hydropower generation or irrigation. One stream flow indicator will be used, percentage of lowest average summer month flow. The average monthly flow for July, August and September for the stream flow station is determined and the lowest of these 3 values is the lowest average summer month flow. Monthly flow for each stream-gauge station will be compared with the lowest average summer month flow for the station to determine the stream flow indicator.

Stream Flow Indicator Graph – each month the average flow in cubic meters per second (m^3/sec) for that month is plotted on a 1-year graph.

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Stream Gauge – a measuring device for water elevation at selected points; the water elevation is then changed into flow measurements by the use of a conversion table.

Sub-Catchment – secondary or subordinate area for catching water, reservoir or basin developed for flood control or water management.

Subwatershed – a watershed subdivision of unspecified size that forms a convenient natural unit.

Surface Runoff (overland flow) – precipitation that cannot be absorbed by the soil because the soil is already saturated with water (soil capacity); precipitation that exceeds infiltration; the portion of rain, snow melt, irrigation water, or other water that moves across the land surface and enters a wetland, stream, or other body of water (overland flow). Overland flow usually occurs in urban settings (pavement, roofs, etc.) or where the soils are very fine textured or heavily compacted.

Surface to Well Advection Time (SWAT) – the average time required by a water "particle" to travel from a point at the ground surface to the well, including both vertical and horizontal movement.

Surface Water – all water above the surface of the ground including, but not limited to lakes, ponds, reservoirs, artificial impoundments, streams, rivers, springs, seeps and wetlands.

Surface Water Intake Protection Zone (IPZ) – the contiguous area of land and water immediately surrounding a surface water intake, which includes: the distance from the intake; a minimum travel time of the water associated with the intake of a municipal residential system or other designated systems, based on the minimum response time for the water treatment plant operator to respond to adverse conditions or an emergency; the remaining watershed area upstream of the minimum travel time area (also referred to as the Total Water Contributing Area), applicable to inland watercourses and inland lakes only.

Surficial (Geology) – pertaining to or occurring on or near the earth's surface.

Sustainable Development – development that meets the needs of the present without compromising the ability of future generations to meet their own and future needs.

Swamp – wooded mineral wetland or peatland with standing or gently flowing water in pools or channels, or subsurface flow. The water table may drop below the rooting zone of vegetation, creating aerated conditions at the surface. The substrate is often woody, well decomposed peat, or a mixture of mineral and organic material. Vegetation includes deciduous or coniferous trees or shrubs, herbs and mosses.

Systems Serving Designated Facilities – drinking water systems that serve designated facilities such as schools (elementary and public), universities, colleges, children and youth care facilities (including day nurseries), health care facilities, children's camps and delivery agent care facilities (including certain hostels).

Table of Drinking Water Threats – a document released by the MECP that contains a listing of all threat activities and circumstances under which these activities may be considered to be significant, moderate or low risks to water supply sources in the province of Ontario.

Targets – in the context of draft technical guidance documents, targets are detailed goals that are often expressed as numeric goals (e.g., to reduce contaminant X in this aquifer by X per cent by 2112).

Terms of Reference – the work plan and budget, as approved by the Minister of Environment, for the preparation of Assessment Report and Source Protection, as defined by the "*Clean Water Act*". The Terms of Reference outlines the responsibilities assigned to the Source Protection Committee, Source Protection Authority, Conservation Authority and Member Municipalities in each Source Protection Area, in order to produce the Assessment Report and Source Protection Plan.

Thornthwaite Method – a method to estimate soil water budget, based on air temperature, latitude and date.

Threat Assessment - Tier 1 – preliminary examination of drinking water threats based on readily accessible information.

Threat Assessment - Tier 2 – advanced examination of drinking water threats through accessing more detailed information, interviews and perhaps when warranted, additional monitoring, modeling or studies.

Threat Policies – policies in a source protection plan that address a drinking water threat of any risk level (significant, moderate or low), including policies that address activities and conditions.

Tier 1, 2 and 3 Water Budgets – numerical analysis at the watershed (Tier 1), subwatershed (Tier 2) or local (Tier 3) level considering existing and anticipated amounts of water taken from the watershed, as well as quantitative flow between components such as recharge/discharge areas and rates.

Till – glacier deposits composed primarily of unsorted sand, silt, clay and boulders laid down directly by the melting ice.

Time Lag – the time required for processes and control systems to respond to a signal or to reach a desired level. (Also referred to as lag time.)

Time of Travel – the length of time it takes groundwater or surface water to travel a specified horizontal distance. For the purposes of source protection planning, a timeframe of 2, 5 and 25 years is used for groundwater and a 2-hour timeframe is used for surface water.

Topography – the contour of the land surface; the configuration of the land surface including its relief and the position of its natural and man-made features.

Total Water Contributing Area – the area around a water source that includes all the surface and groundwater that provides recharge to that water source. The total water contributing area can be calculated for an entire watershed or on a sub-watershed basis.

Transmissivity – the capacity of a material to transmit radiant energy.

Transpiration – the process by which plants take up water through their roots and then give off water vapour through their leaves (open stomata). This water then enters the atmosphere.

Transport Pathways – any structure of land alteration or condition resulting from a naturally occurring process or human activity which would increase the probability of a contaminant reaching a drinking water source.

Transportation Corridors – established vehicle infrastructure, including roadways, highways and railways, which have the potential to be routes for transporting commercial loads of hazardous chemicals or other anthropogenic substances, including waste.

Tributary – any stream that contributes water to another water body.

Trophic State – measure of nitrogen, phosphorous, and other biologically useful nutrients which are present in a Lake.

Turbidity – a measure of water cloudiness caused by suspended solids.

Turnover (mixing) – an in-lake process brought on by a cooling of the upper water layer, especially in a deep body of water, which makes the layer more dense and heavier. This heavier layer will gradually sink, displacing the lower level which is forced to rise.

Type I, Type II and Type III Systems – water supply systems as described in the *Clean Water Act*, 2006. Type I systems are municipal residential drinking water systems that serve a major residential development (15(2)(e)(ii)). Type II systems are water supply systems that have been included in the source protection planning process by Municipal or Band Council Resolution (15(2)(e)(iii)). Type III systems are water supply systems that are included in the Source Protection Process by the Minister of Environment (15(2)(e)(iv)).

Ultraviolet Disinfection – commonly used, non-chemical method of disinfection by applying ultraviolet light (UV) to water. UV rays are able to destroy bacteria, parasite cysts and most viruses in water that is free of large particles, turbidity and colour.

Unconfined Aquifer (water table aquifer) – an aquifer with continuous layers of permeable soil and rock that extends from the land surface to the base of the aquifer. The water table forms the upper boundary of the aquifer and is directly affected by atmospheric pressure.

Undercutting – erosion of material at the foot of a cliff or bank.

Unstable Slopes – banks or sloping land with the potential for landslides or slumping due to steepness of the slope, erosion at the bottom, type of soil or proposed use of the land.

Vertical Hydraulic Conductivity – vertical measure of the ratio of flow velocity to driving force for viscous flow under saturated conditions of a specified liquid in porous medium.

Vulnerable Area – areas related to a water supply source that are susceptible to contamination and for which it is desirable to regulate or monitor drinking water threats that may affect the water supply source. Vulnerable areas are (a) a significant groundwater recharge area, (b) a highly vulnerable aquifer, (c) a surface water intake protection zone, or (d) a wellhead protection area.

Waste Disposal Site – any land upon, into, in or through which, or building or structure in which waste is deposited, disposed of, handled, stored, transferred, treated or processed, and any operation carried out or machinery or equipment used in connection with the depositing, disposal, handling, storage, transfer, treatment or processing of the waste (*Environmental Protection Act*, R.S.O. 1990).

Water Balance – the accounting of water input and output and change in storage of the various components of the hydrologic cycle.

Water Budget – a description and analysis of the overall movement of water within each watershed in the Source Protection Area, taking into consideration surface water and groundwater features, land cover (e.g., proportion of urban versus rural uses), human-made structures (e.g., dams, channel diversions, water crossings), and water takings.

Water (Hydraulic) Conductivity – a property of plants, soil or rock that describes the ease with which water can move through pore spaces or fractures.

Watercourses – depressions formed by runoff moving over the surface of the earth; any natural course that carries water.

Water Cycle (Hydrologic Cycle) – the continuous circulation of water from the atmosphere to the earth and back to the atmosphere including condensation, precipitation, runoff, groundwater, evaporation, and transpiration.

Water Diversion – redirecting part of a stream flow to a location where the water will be used (e.g., to a site where it is convenient to build a water treatment plant).

Water Quality – a term used to describe the chemical, physical and biological characteristics of water, usually in respect to its suitability for a particular purpose, such as drinking.

Watershed – the land area from which surface water and groundwater drains into a stream system; the area of land that generates total runoff (surface flow, interflow, and baseflow) for a particular stream system. Also referred to as drainage area, basin or catchment area for a watercourse.

Watershed Characterization – a characterization of the physical geography and human geography of the watershed and the characterization of the interactions between the physical geography and human geography.

Water Supply – any quantity of available water.

Water Table – the point where the unsaturated zone meets the zone of saturation is known as the water table. Water table levels fluctuate naturally throughout the year based on seasonal variations and are the reason why some wells go dry in the summer. In addition, the depth to the water table varies. For example, in (select an area in the watershed or community) the water table is "x" metres below the surface. The water table is the surface below which the soil is saturated with water.

Water Table Aquifer – an aquifer whose upper boundary is the water table; also known as an unconfined aquifer.

Water Table Contour – a line in a groundwater map that connects points of equal groundwater elevation.

Weir – a small dam, often temporary and removable, which raises the water level upstream for aesthetic, recreational or industrial uses.

Well – a vertical bore hole in which a pipe-like structure is inserted into the ground in order to discharge (pump) water from an aquifer.

Wellhead – the structure built above a well.

Wellhead Protection Area (WHPA) – the surface and subsurface area surrounding a water well or well field that supplies a municipal residential system or other designated system through which contaminants are reasonably likely to move so as to eventually reach the water well or wells. Wellhead Protection Area (WHPA) is the surface and subsurface area within which the Municipal well's groundwater sources are vulnerable to surface threats.

Well Yield – the volume of water that can be pumped from a well during a specific period.

Wetlands – lands such as a swamp, marsh, bog or fen (not including land that is being used for agricultural purposes and no longer exhibits wetland characteristics) that, (a) is seasonally or permanently covered by shallow water or has the water table close to or at the surface, (b) has hydric soils and vegetation dominated by hydrophytic or water-tolerant plants, and (c) has been further identified, by the Ontario Ministry of Natural Resources (MNR) or by any other person, according to evaluation procedures established by the Ontario Ministry of Natural Resources , as amended from time to time.

Wetland Complex – an area consisting of several kinds of wetlands potentially including open water marsh, marsh, swamp, bogs and fens.

Withdrawal – the removal or taking of water from surface water bodies or groundwater sources.

Winter Drawdown – the water level reduction in a lake or reservoir during the winter.

Yield – the quantity of water expressed either as a continuous rate of flow (cubic feet per second, etc.) or as a volume per unit of time. It can be controlled for a given use, or uses, from surface water or groundwater sources in a watershed.

Zone of Aeration (vadose zone or unsaturated zone) – the zone between the land surface and the water table in which the pore spaces between soil and rock particles contain water, air, and/or other gases.

Zone of Saturation (saturated zone) – the zone in which the pore spaces between soil and rock particles are completely filled with water. The water table is the top of the zone of saturation. Water in the zone of saturation is called groundwater.

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APPENDICES

Appendix A – Selected Maps

Appendix B – Provincial Tables of Drinking Water Threats

Appendix ~~D~~C – Director Approval for use of Alternate Method for the Delineation of IPZ-3

Appendix ~~E~~D – Enumeration of Circumstances Relating to Phosphorus in Callander in which Prescribed Activities would be Significant Threats

Appendix ~~F~~E – Director Approval of Transportation of Hazardous Substances as a Local Drinking Water Threat

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Appendix A – Selected Maps

The following maps are reprinted here in larger format for ease of view. If you have any problems viewing these maps, please contact the Source Protection Team at dwsp~~.comments~~@nbmca.ca or 705 474-5420. Hard copies are also available.

- Figure A-1. Callander Intake Protection Zone (IPZ)
- Figure A-2. Callander Issue Contributing Area (ICA)
- Figure A-3. Powassan Wellhead Protection Area (WHPA)
- Figure A-4. South River Intake Protection Zone (IPZ)
- Figure A-5. North Bay Intake Protection Zone (IPZ)
- Figure A-6. Mattawa Wellhead Protection Area (WHPA)
- Figure A-7. Significant Groundwater Recharge Areas (SGRA)
- Figure A-8. Highly Vulnerable Aquifers (HVA)

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Figure A-1. Callander Intake Protection Zone (IPZ)

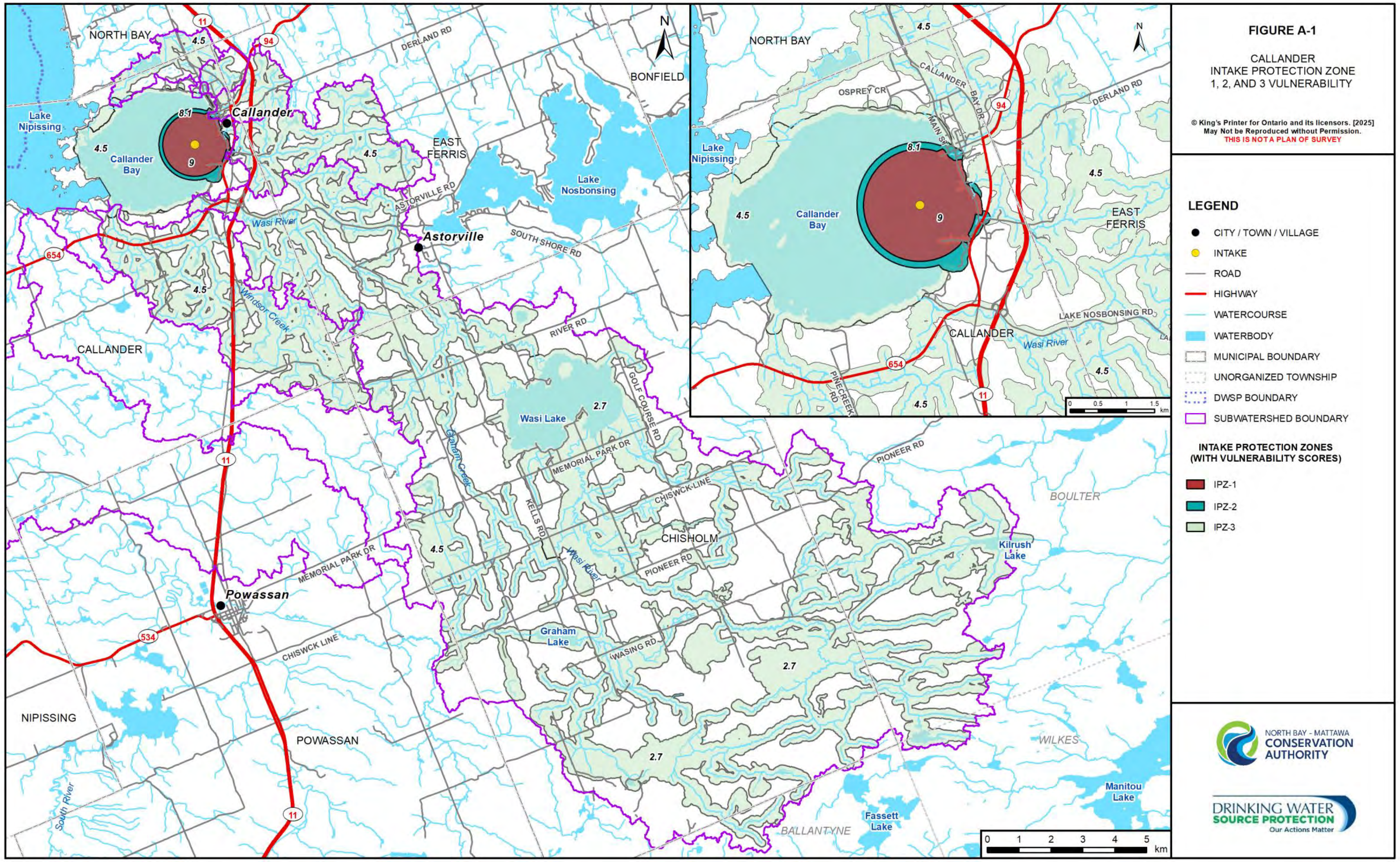

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Figure A-2. Callander Issue Contributing Area (ICA)

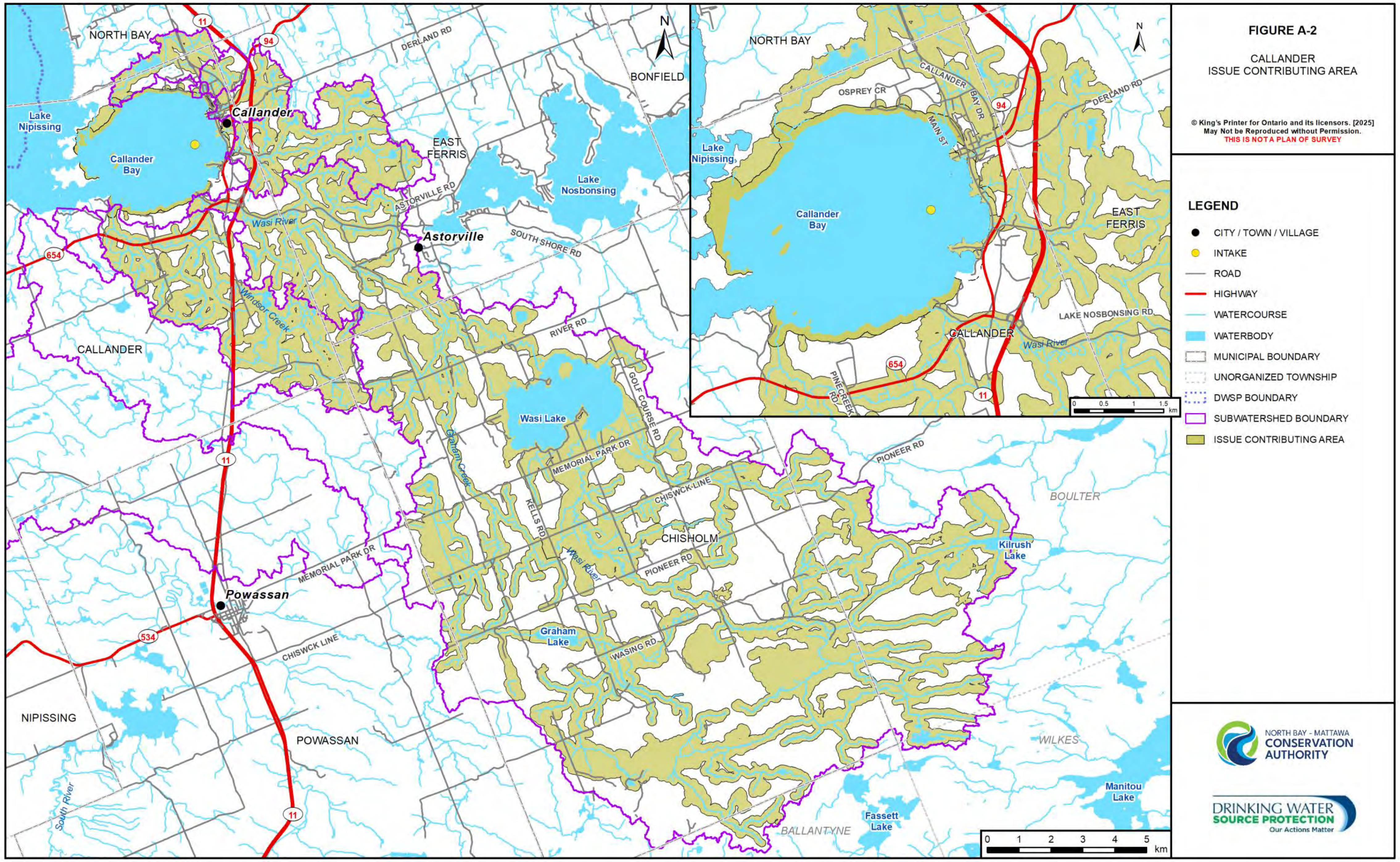

Figure A-3. Powassan Wellhead Protection Area (WHPA)

Figure A-4. South River Intake Protection Zone (IPZ)

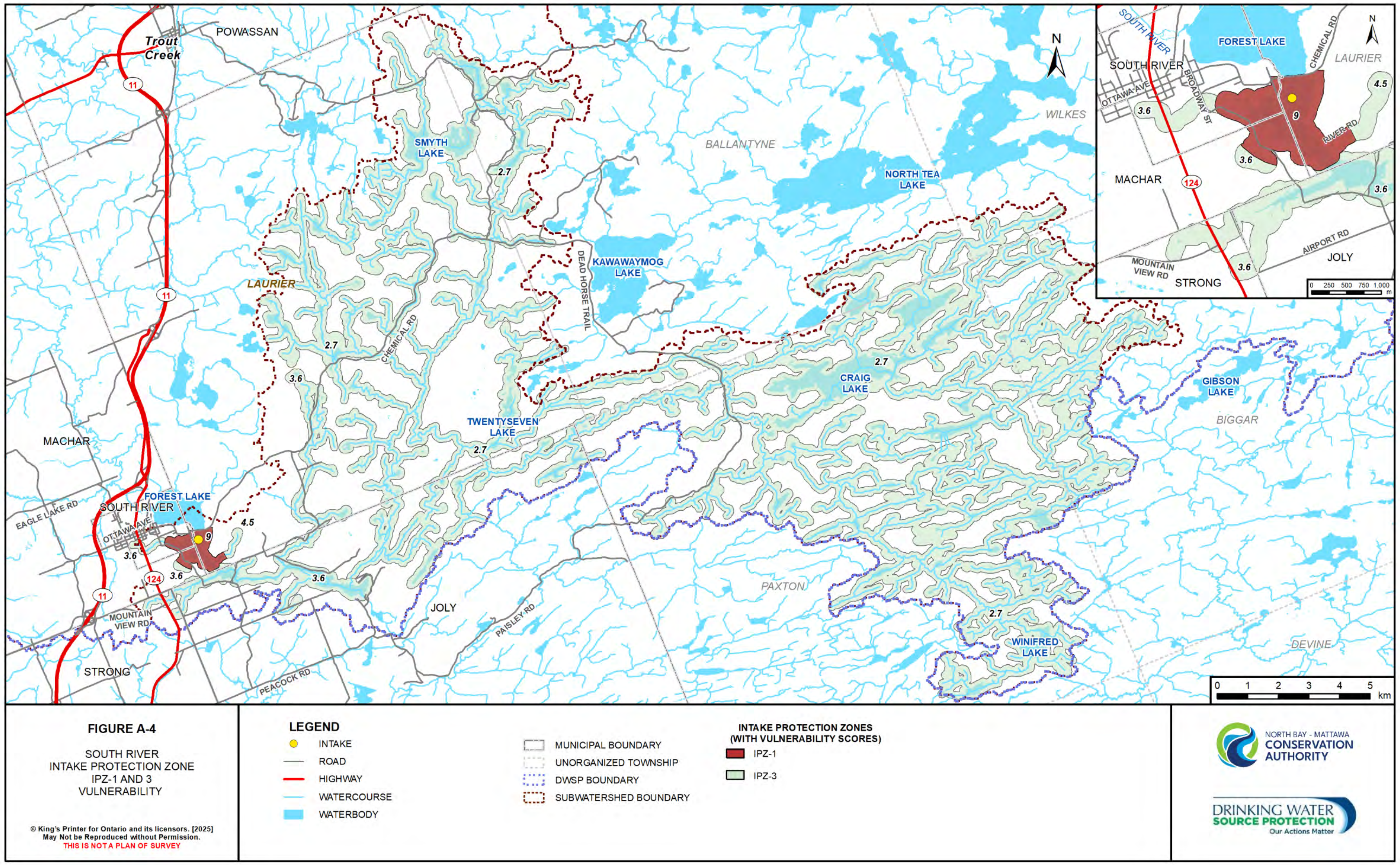

Figure A-5. North Bay Intake Protection Zone (IPZ)

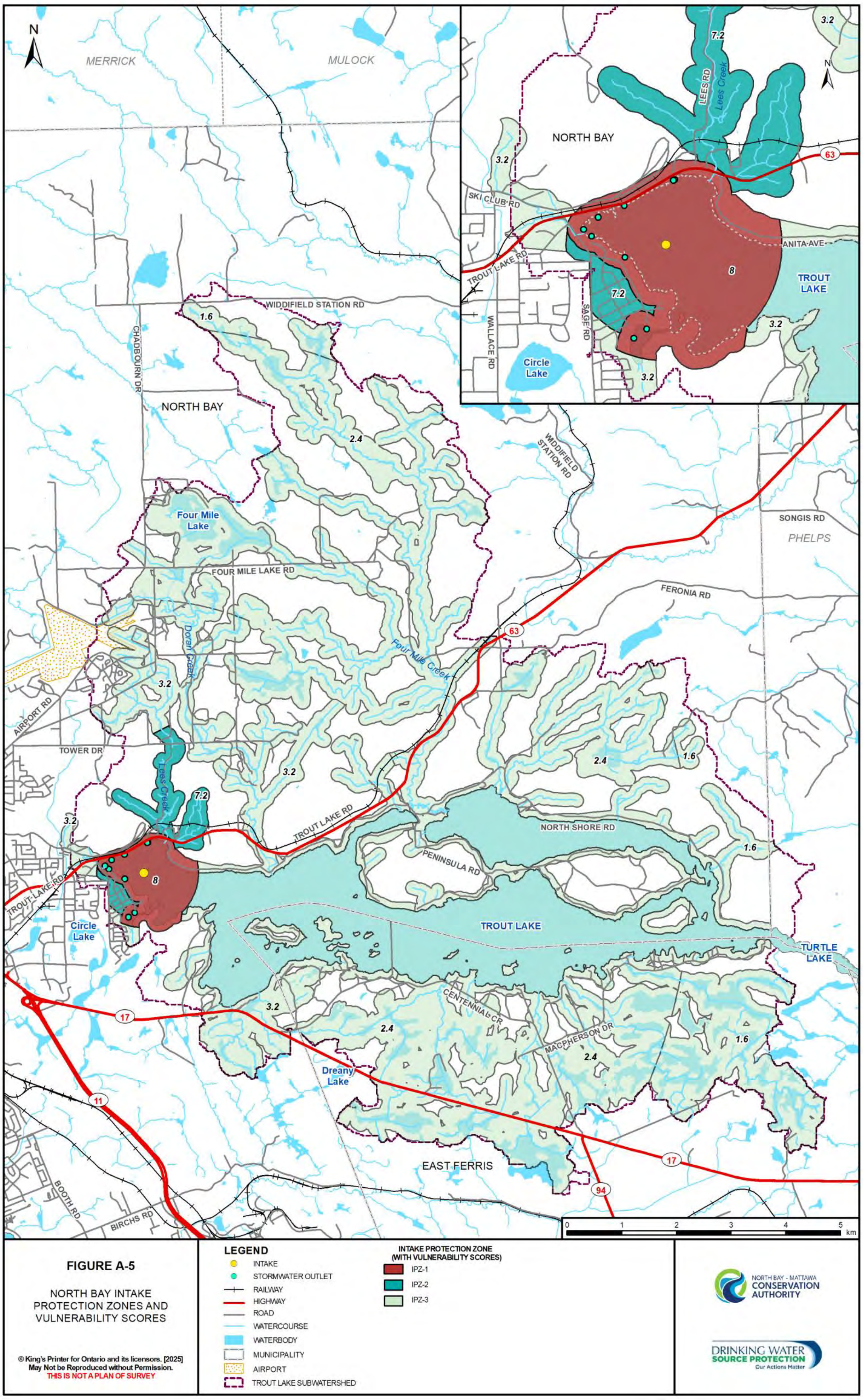

Figure A-6. Mattawa Wellhead Protection Area (WHPA)

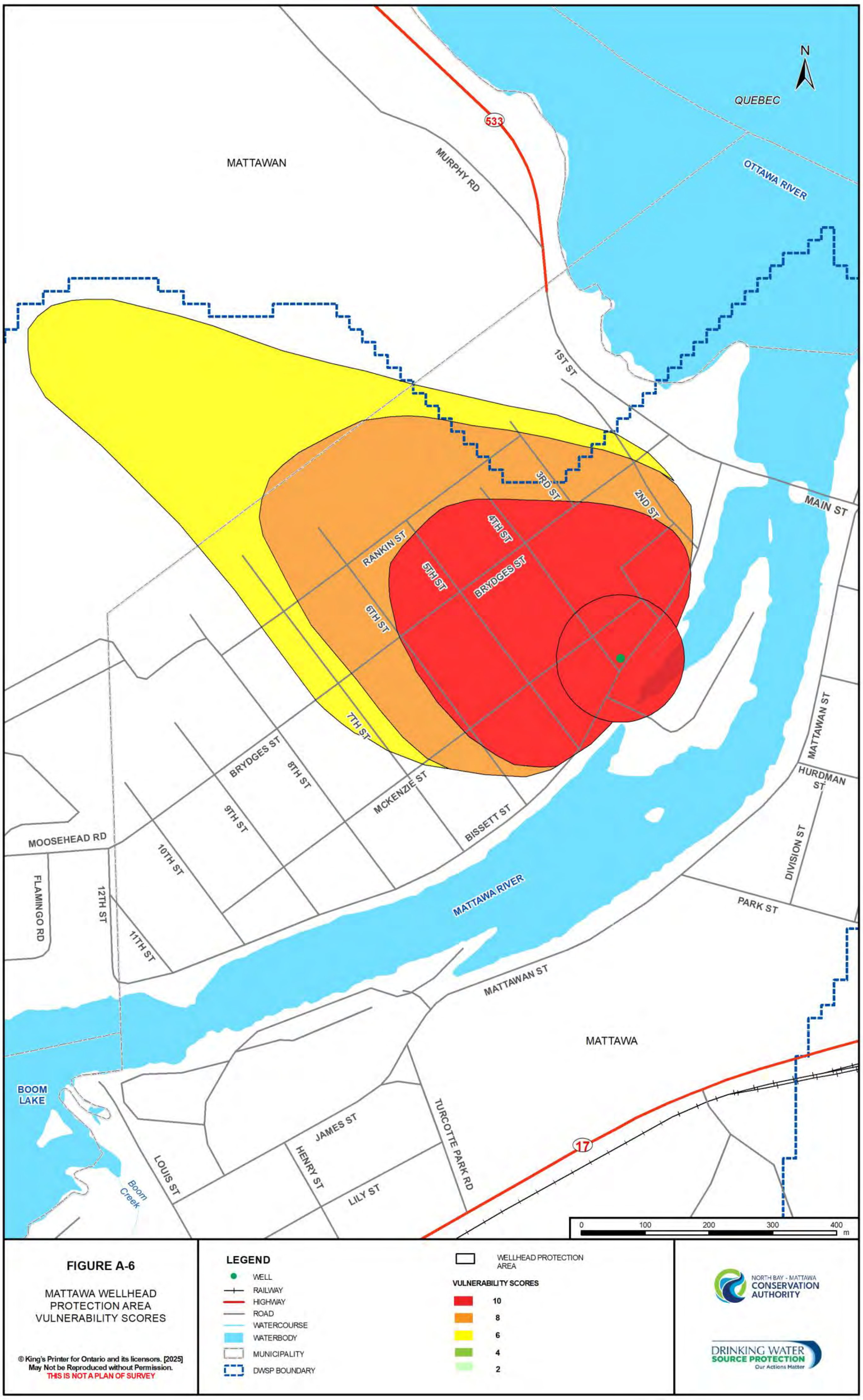

Figure A-7. Significant Groundwater Recharge Areas (SGRA) in the North Bay-Mattawa Source Protection Area

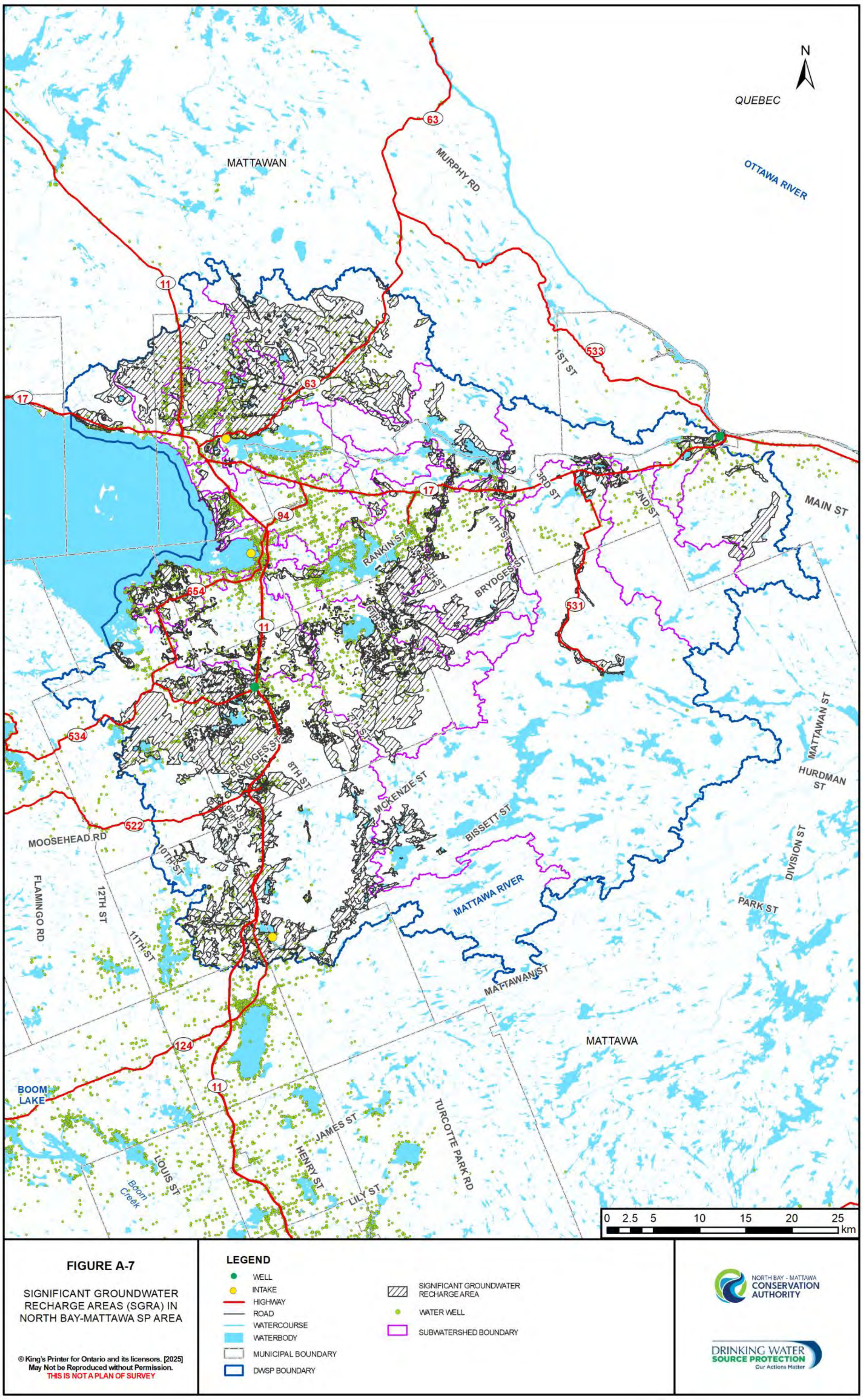

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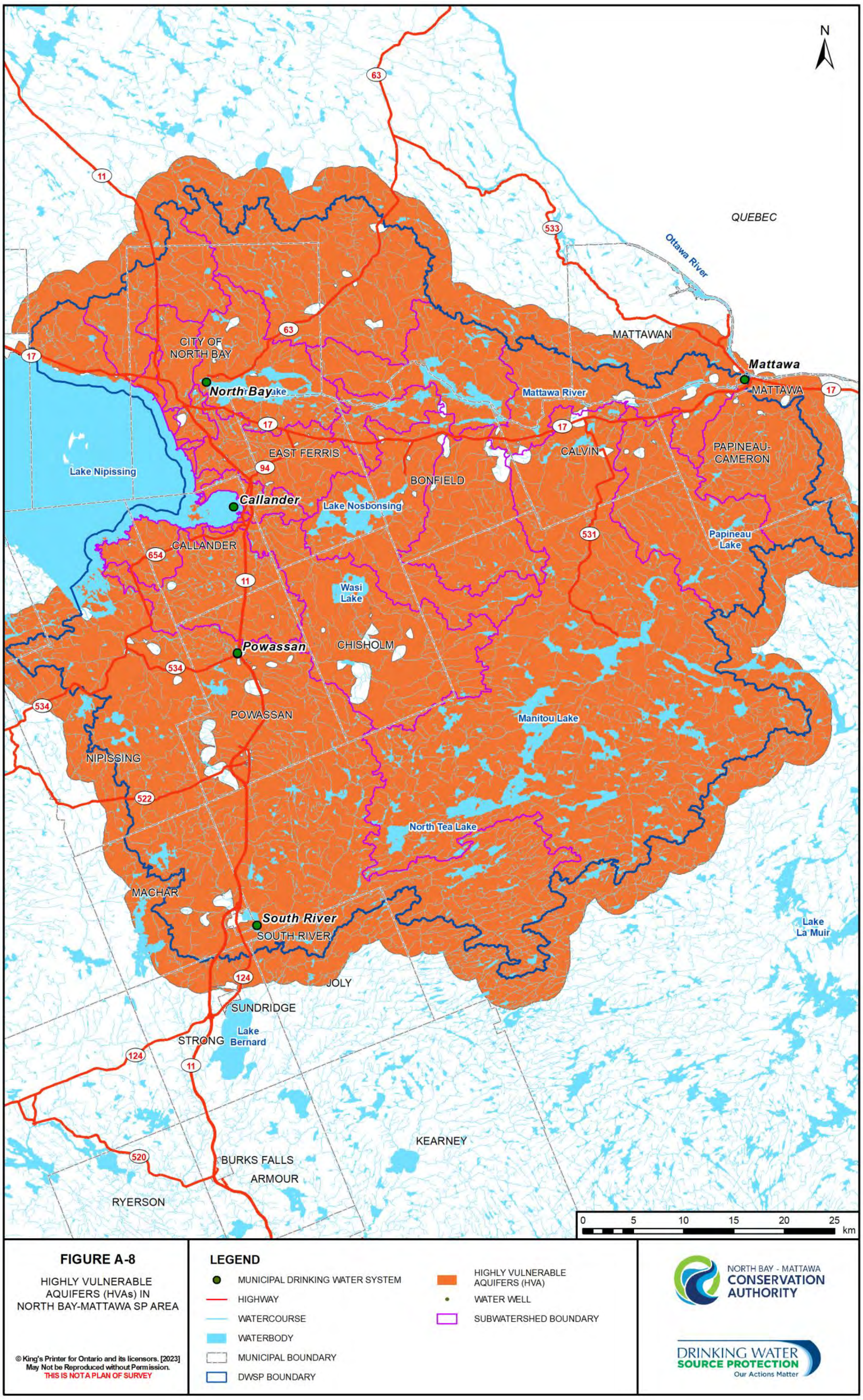
Figure A-8. Highly Vulnerable Aquifers (HVA) in the North Bay-Mattawa Source Protection Area



Appendix B – Provincial Tables of Drinking Water Threats

The Provincial Tables of Drinking Water Quality Threats are created by the Ministry of the Environment, Conservation and Parks to support the 22 Prescribed Threats of O.Reg. 287/07 Section 1.1(1) under the *Clean Water Act, 2006.* The Threats Tables outline the sets of circumstances under which an activity may be considered a significant, moderate or low drinking water threat.

Landowners can access this essential reference material on-line. For landowners within identified vulnerable areas who would appreciate assistance in determining their local circumstances please contact the Drinking Water Source Protection team at dwsp.comments@nbmca.on.ca. Please provide contact information where staff can best reach you to follow up on your request.

The current ~~and past~~ version of the Tables of Drinking Water Quality Threats can be accessed online:

> https://www.ontario.ca/page/2021-technical-rules-under-clean-water-act~~tables-drinking-water-threats~~

Past versions of the Tables of Drinking Water Threats can be accessed at:

> https://www.ontario.ca/page/tables-drinking-water-threats

A searchable on-line database of the Threats Tables can be accessed at:

> https://swpip.ca/Threats

Note that the drinking water threats assessment contained in the North Bay-Mattawa Source Protection Plan has been completed using the 2017/2018 2021 version ~~1.1~~ of the Tables of Drinking Water Quality Threats as published ~~July~~ December 3, 2021~~1, 2018~~ (MECP ~~2018~~2021).

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Appendix ~~D~~C – Director Approval for use of Alternate Method for the Delineation of IPZ-3

Ministry of the Environment
Source Protection Programs Branch
8th Floor
2 St. Clair Ave. West
Toronto ON M4V 1L5

Ministère de l'Environnement
Direction des programmes de protection des sources
8e étage
2, avenue St. Clair Ouest
Toronto (Ontario) M4V 1L5

Ontario

Log: ENV1174IT-2010-185

July 28, 2010

Ms. Barbara Groves
Chair
North Bay-Mattawa Source Protection Committee
15 Janey Avenue
North Bay ON P1C 1N1

Dear Ms. Groves:

I am responding to your July 27, 2010 letter regarding your request for Director's approval to use an alternate method for the delineation of IPZ-3 for the Municipality of Callander Intake, under Rule 15.1 of the Director's Technical Rules (Rules) for the completion of the assessment report under the *Clean Water Act* (CWA) for the North Bay-Mattawa source protection area.

Rule 70 - IPZ-3 Delineation for the Type-D Intake for the Municipality of Callander Intake

As set out in your correspondence, the Callander intake is classified as Type D, inland water intake, located in the relatively isolated Callander Bay which is separated from the main basin of Lake Nipissing by a narrow channel.

Your letter states that the flow direction of Callander Bay is predominantly towards the west (i.e. into Lake Nipissing with little mixing of waters between the Bay and Lake Nipissing due to minor reversal flow). Due to the bathymetry of the Bay and shoreline configuration, the water movement is constrained from Lake Nipissing to the Bay. Also, your letter states that during high speed wind events the main flow direction is towards Lake Nipissing through the main channel and not from the Lake to the Bay.

The supporting documentation, including modeling exercises and water quality analysis for both Lake Nipissing and the Bay, indicates the water quality of Callander Bay is different from that of the Lake Nipissing.

We agree with your opinion that the vulnerable area for the Callander intake should be delineated according to Rule 70, as Callander Bay behaves as an inland lake with an outflow to the main body of Lake Nipissing.

Ms. Groves
Page 2.

In accordance with my authority under Rule 15.1, I hereby provide Director's approval for the use of this alternate method for the Municipality of Callander Intake in the North Bay-Mattawa source protection area.

Your rationale for the use of this alternative method and how it was applied must be included in your assessment report. You must also attach a copy of this letter to assessment report.

We thank you for your efforts in completing the technical studies in support of the assessment report under the CWA. If you have any questions or require additional information, please contact our office.

Sincerely,

Ian Smith, Director
Source Protection Programs Branch
Ministry of the Environment

cc: Sue Miller, Project Manager
Heather Malcolmson, Manager, Source Protection Planning
Keith Willson, Manager, Source Protection Approvals
Neil Gervais, Liaison Officer, Source Protection Implementation

Appendix D – Enumeration of Circumstances Relating to Phosphorus in Callander in which Prescribed Activities would be Significant Threats

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Prescribed Drinking Water Threat	Threat Subcategory	Chemical Quantity Circumstance	Chemical Method of Release Circumstance	Number of Significant Threat Circumstances
The application of agricultural source material to land.	Application Of Agricultural Source Material (ASM) To Land	In a vulnerable area where % of Managed Land <40% and Livestock Density <0.5 NU/acre.	Agricultural source material is applied to land and may result in a release to groundwater or surface water	**9**
		In a vulnerable area where % of Managed Land <40% and Livestock Density 0.5-1.0 NU/acre.		
		In a vulnerable area where % of Managed Land <40% and Livestock Density >1.0 NU/acre.		
		In a vulnerable area where % of Managed Land 40%-80% and Livestock Density <0.5 NU/acre.		
		In a vulnerable area where % of Managed Land 40%-80% and Livestock Density 0.5-1.0 NU/acre.		
		In a vulnerable area where % of Managed Land 40%-80% and Livestock Density >1.0 NU/acre.		
		In a vulnerable area where % of Managed Land >80% and Livestock Density < 0.5 NU/acre.		
		In a vulnerable area where % of Managed Land >80% and Livestock Density 0.5-1.0 NU/acre.		
		In a vulnerable area where % of Managed Land >80% and Livestock Density >1.0 NU/acre.		

Prescribed Drinking Water Threat	Threat Subcategory	Chemical Quantity Circumstance	Chemical Method of Release Circumstance	Number of Significant Threat Circumstances
The application of commercial fertilizer to land.	Application Of Commercial Fertilizer To Land	In a vulnerable area where % of Managed Land <40% and Livestock Density <0.5 NU/acre.	Commercial fertilizer is applied to land and may result in a release to groundwater or surface water	**9**
		In a vulnerable area where % of Managed Land <40% and Livestock Density 0.5-1.0 NU/acre.		
		In a vulnerable area where % of Managed Land <40% and Livestock Density >1.0 NU/acre.		
		In a vulnerable area where % of Managed Land 40%-80% and Livestock Density <0.5 NU/acre.		
		In a vulnerable area where % of Managed Land 40%-80% and Livestock Density 0.5-1.0 NU/acre.		
		In a vulnerable area where % of Managed Land 40%-80% and Livestock Density >1.0 NU/acre.		
		In a vulnerable area where % of Managed Land >80% and Livestock Density <0.5 NU/acre.		
		In a vulnerable area where % of Managed Land >80% and Livestock Density 0.5-1.0 NU/acre.		
		In a vulnerable area where % of Managed Land >80% and Livestock Density >1.0 NU/acre.		
The application of non-agricultural source material to land.	Application of Non-Agricultural Source Material (NASM) or Biosolids to Land	In a vulnerable area where % of Managed Land <40% and Livestock Density <0.5 NU/acre.	Non-agricultural source material is applied to land and may result in a release to groundwater or surface water	**9**
		In a vulnerable area where % of Managed Land <40% and Livestock Density 0.5-1.0 NU/acre.		
		In a vulnerable area where % of Managed Land <40% and Livestock Density >1.0 NU/acre.		
		In a vulnerable area where % of Managed Land 40%-80% and Livestock Density <0.5 NU/acre.		
		In a vulnerable area where % of Managed Land 40%-80% and Livestock Density 0.5-1.0 NU/acre.		
		In a vulnerable area where % of Managed Land 40%-80% and Livestock Density >1.0 NU/acre.		
		In a vulnerable area where % of Managed Land >80% and Livestock Density <0.5 NU/acre.		
		In a vulnerable area where % of Managed Land >80% and Livestock Density 0.5-1.0 NU/acre.		
		In a vulnerable area where % of Managed Land >80% and Livestock Density >1.0 NU/acre.		

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Prescribed Drinking Water Threat	Threat Subcategory	Chemical Quantity Circumstance	Chemical Method of Release Circumstance	Number of Significant Threat Circumstances
The establishment, operation or maintenance of a system that collects, stores, transmits, treats or disposes of sewage.	Sewage System Or Sewage Works – Stormwater Management Facility	Where the drainage area is <=1 ha and the predominant land use is rural, agricultural, or low density residential.	The system is a storm water management facility designed to discharge storm water to land or surface water.	**12**
		Where the drainage area is >1 but <=10 ha and the predominant land use is rural, agricultural, or low density residential.		
		Where the drainage area is >10 but <=100 ha and the predominant land use is rural, agricultural, or low density residential.		
		Where the drainage area is >100 ha and the predominant land use is rural, agricultural, or low density residential.		
		Where the drainage area is <=1 ha and the predominant land use is high density residential.		
		Where the drainage area is >1 but <=10 ha and the predominant land use is high density residential.		
		Where the drainage area is >10 but <=100 ha and the predominant land use is high density residential.		
		Where the drainage area is >100 ha and the predominant land use is high density residential.		
		Where the drainage area is <=1 ha and the predominant land use is industrial/commercial		
		Where the drainage area is >1 but <=10 ha and the predominant land use is industrial/commercial		
		Where the drainage area is >10 but <=100 ha and the predominant land use is industrial/commercial		
		Where the drainage area is >100 ha and the predominant land use is industrial/commercial		
The establishment, operation or maintenance of a system that collects, stores, transmits, treats or disposes of sewage.	Sewage System Or Sewage Works - Industrial Effluent Discharges	Discharger is not a facility required to report through Environment Canada's National Pollutant Release Inventory for the parameter	A system that collects, transmits or treats industrial sewage and discharges the effluent to surface water	**2**
		Discharger is a facility required to report through Environment Canada's National Pollutant Release Inventory for the parameter		

Prescribed Drinking Water Threat	Threat Subcategory	Chemical Quantity Circumstance	Chemical Method of Release Circumstance	Number of Significant Threat Circumstances
The establishment, operation or maintenance of a system that collects, stores, transmits, treats or disposes of sewage.	Sewage System Or Sewage Works - Sanitary Sewers and related pipes	Sanitary sewer with a conveyance of >250 but <=1,000 m3/d	The system is part of a wastewater collection facility moving human waste, but does not include a sewage storage tank or a designed bypass.	**4**
		Sanitary sewer with a conveyance of >1,000 but <=10,000 m3/d		
		Sanitary sewer with a conveyance of >10,000 but<=100,000 m3/d		
		Sanitary sewer with a conveyance of >100,000 m3/d		
The establishment, operation or maintenance of a system that collects, stores, transmits, treats or disposes of sewage.	Sewage System Or Sewage Works – Onsite Sewage Systems	Septic system that is subject to the Building Code.	Sewage system that is defined in Section 8.1.2.1 of O.Reg. 350, except a holding tank, that may discharge to groundwater or surface water.	**2**
		Septic System is subject to the OWRA		
The establishment, operation or maintenance of a system that collects, stores, transmits, treats or disposes of sewage.	Sewage System Or Sewage Works – Onsite Sewage Systems Holding Tanks	Septic system holding tank that is subject to the Building Code.	Sewage system is a holding tank for the retention of hauled sewage at the site where it is produced before its collection by a hauled sewage system.	**2**
		Septic System holding tank is subject to the OWRA		
The establishment, operation or maintenance of a system that collects, stores, transmits, treats or disposes of sewage.	Sewage System Or Sewage Works - Sewage Treatment Plant Effluent Discharges (Includes Lagoons)	Sewage Treatment Plant that discharge treated effluent <=500 m3/d on an annual average	A wastewater treatment facility effluent discharge, and the discharge is not a bypass.	**5**
		Sewage Treatment Plant that discharge treated effluent >500 m3/d but <=2,500 m3/d on an annual average		
		Sewage Treatment Plant that discharge treated effluent >2,500 m3/d but <=17,500 m3/d on an annual average		
		Sewage Treatment Plant that discharge treated effluent >17,500 m3/d but <=50,000 m3/d on an annual average		
		Sewage Treatment Plant that discharge treated effluent >50,000 m3/d on an annual average		

Prescribed Drinking Water Threat	Threat Subcategory	Chemical Quantity Circumstance	Chemical Method of Release Circumstance	Number of Significant Threat Circumstances
The establishment, operation or maintenance of a waste disposal site within the meaning of Part V of the *Environmental Protection Act.*	The Application of Hauled Sewage to Land	Total application area < 1 ha	Hauled sewage is applied to land and may result in a release to groundwater or surface water	**3**
		Total application area 1 - 10 ha		
		Total application area > 10 ha		
The establishment, operation or maintenance of a waste disposal site within the meaning of Part V of the *Environmental Protection Act.*	Storage And Discharge of Tailings From Mines	Discharger is not a facility required to report through Environment Canada's National Pollutant Release Inventory for the parameter	The mine tailings are stored in a pit	**4**
			The mine tailings are stored using a surface impoundment structure	
		Discharger is a facility required to report through Environment Canada's National Pollutant Release Inventory for the parameter	The mine tailings are stored in a pit	
			The mine tailings are stored using a surface impoundment structure	
The handling and storage of commercial fertilizer.	Storage Of Commercial Fertilizer	where the quantity stored is <=25 kg	The commercial fertilizer is stored at a facility to retail sale or in relation to its application, excluding storage where it is manufactured, distributed, or processed.	**8**
			The commercial fertilizer is stored at a facility where it is manufactured, distributed, or processed, excluding storage related solely to retail sale or in relation to its application.	
		where the quantity stored is >25 but <=250 kg	The commercial fertilizer is stored at a facility to retail sale or in relation to its application, excluding storage where it is manufactured, distributed, or processed.	
			The commercial fertilizer is stored at a facility where it is manufactured, distributed, or processed, excluding storage related solely to retail sale or in relation to its application.	
		where the quantity stored is >250 but <=2500 kg	The commercial fertilizer is stored at a facility to retail sale or in relation to its application, excluding storage where it is manufactured, distributed, or processed.	
			The commercial fertilizer is stored at a facility where it is manufactured, distributed, or processed, excluding storage related solely to retail sale or in relation to its application.	
		where the quantity stored is >2500 kg	The commercial fertilizer is stored at a facility to retail sale or in relation to its application, excluding storage where it is manufactured, distributed, or processed.	
			The commercial fertilizer is stored at a facility where it is manufactured, distributed, or processed, excluding storage related solely to retail sale or in relation to its application.	

Prescribed Drinking Water Threat	Threat Subcategory	Chemical Quantity Circumstance	Chemical Method of Release Circumstance	Number of Significant Threat Circumstances
The handling and storage of non-agricultural source material.	Storage of Non-Agricultural Source Material (NASM)	Mass of nitrogen in NASM < 0.5 tonnes	The non-agricultural source material is stored at or above grade in or on a permanent nutrient storage facility as defined under the *Nutrient Management Act* (O.Reg 267).	12
			The non-agricultural source material is stored at or above grade in temporary field nutrient storage site as defined under the *Nutrient Management Act* (O.Reg. 267).	
			The non-agricultural source material is stored below grade in or on a permanent nutrient storage facility as defined under the *Nutrient Management Act* (O.Reg. 267).	
			The non-agricultural source material is stored partially below grade in a permanent nutrient storage facility as defined under the *Nutrient Management Act* (O.Reg 267).	
		Mass of nitrogen in NASM is 0.5 to 5 tonnes	The non-agricultural source material is stored at or above grade in or on a permanent nutrient storage facility as defined under the *Nutrient Management Act* (O.Reg 267).	
			The non-agricultural source material is stored at or above grade in temporary field nutrient storage site as defined under the *Nutrient Management Act* (O.Reg. 267).	
			The non-agricultural source material is stored below grade in or on a permanent nutrient storage facility as defined under the *Nutrient Management Act* (O.Reg. 267).	
			The non-agricultural source material is stored partially below grade in a permanent nutrient storage facility as defined under the *Nutrient Management Act* (O.Reg 267).	
		Mass of nitrogen in NASM >5 tonnes	The non-agricultural source material is stored at or above grade in or on a permanent nutrient storage facility as defined under the *Nutrient Management Act* (O.Reg 267).	
			The non-agricultural source material is stored at or above grade in temporary field nutrient storage site as defined under the *Nutrient Management Act* (O.Reg. 267).	
			The non-agricultural source material is stored below grade in or on a permanent nutrient storage facility as defined under the *Nutrient Management Act* (O.Reg. 267).	
			The non-agricultural source material is stored partially below grade in a permanent nutrient storage facility as defined under the *Nutrient Management Act* (O.Reg 267).	

Prescribed Drinking Water Threat	Threat Subcategory	Chemical Quantity Circumstance	Chemical Method of Release Circumstance	Number of Significant Threat Circumstances
The storage of agricultural source material.	Storage Of Agricultural Source Material (ASM)	The weight or volume of manure stored annually on a Farm Unit is sufficient to annually land apply nutrients at <=0.5 NU per acre of the farm units	The agricultural source material is stored at or above grade in a structure that is a permanent nutrient storage facility as defined under the *Nutrient Management Act* (O.Reg. 267)	**12**
			The agricultural source material is stored at or above grade using a temporary field nutrient storage site as defined under the *Nutrient Management Act* (O.Reg. 267).	
			The agricultural source material is stored below grade in a structure that is a permanent nutrient storage facility as defined under the *Nutrient Management Act* (O.Reg. 267)	
			The agricultural source material is stored partially below grade in a structure that is a permanent nutrient storage facility as defined under the *Nutrient Management Act* (O.Reg. 267)	
		The weight or volume of manure stored annually on a Farm Unit is sufficient to annually land apply nutrients at >0.5 and < =1 NU per acre of the farm	The agricultural source material is stored at or above grade in a structure that is a permanent nutrient storage facility as defined under the *Nutrient Management Act* (O.Reg. 267)	
			The agricultural source material is stored at or above grade using a temporary field nutrient storage site as defined under the *Nutrient Management Act* (O.Reg. 267).	
			The agricultural source material is stored below grade in a structure that is a permanent nutrient storage facility as defined under the *Nutrient Management Act* (O.Reg. 267)	
			The agricultural source material is stored partially below grade in a structure that is a permanent nutrient storage facility as defined under the *Nutrient Management Act* (O.Reg. 267)	
		The weight or volume of manure stored annually on a Farm Unit is sufficient to annually land apply nutrients at >1 NU per acre of the farm units	The agricultural source material is stored at or above grade in a structure that is a permanent nutrient storage facility as defined under the *Nutrient Management Act* (O.Reg. 267)	
			The agricultural source material is stored at or above grade using a temporary field nutrient storage site as defined under the *Nutrient Management Act* (O.Reg. 267).	
			The agricultural source material is stored below grade in a structure that is a permanent nutrient storage facility as defined under the *Nutrient Management Act* (O.Reg. 267)	
			The agricultural source material is stored partially below grade in a structure that is a permanent nutrient storage facility as defined under the *Nutrient Management Act* (O.Reg. 267)	

Prescribed Drinking Water Threat	Threat Subcategory	Chemical Quantity Circumstance	Chemical Method of Release Circumstance	Number of Significant Threat Circumstances
The use of land as livestock grazing or pasturing land, an outdoor confinement area or a farm-animal yard.	Management Or Handling Of Agricultural Source Material - Agricultural Source Material (ASM) Generation (Grazing and pasturing)	Where livestock density in the farm unit is <0.5 Nutrient Units per acre. Where livestock density in the farm unit is 0.5-1.0 Nutrient Units per acre. Where livestock density in the farm unit is >1.0 Nutrient Units per acre.	The use of land as livestock grazing or pasturing land.	**3**
The use of land as livestock grazing or pasturing land, an outdoor confinement area or a farm-animal yard.	Management Or Handling Of Agricultural Source Material - Agricultural Source Material (ASM) Generation (Yards or confinement)	Number of animals confined at any time can generate <120 NU/hectare of the area annually. Number of animals confined at any time can generate >=120 and <=300 NU/hectare of the area annually. Number of animals confined at any time can generate >300 NU/hectare of the area annually.	The use of land as an outdoor confinement area or a farm-animal yard.	**3**
Total number of circumstances relating to significant drinking water threats that may contribute to phosphorus loading in Callander Bay:				**99**

Note: Circumstances described from 2018 version of Tables of Drinking Water Threats (MECP 2018)

Appendix ~~F~~E – Director Approval of Transportation of Hazardous Substances as a Local Drinking Water Threat

Ministry of
the Environment
Source Protection Programs Branch
14th Floor
40 St. Clair Ave. West
Toronto ON M4V 1M2

Ministère de
l'Environnement
Direction des programmes de protection des sources
14e étage
40, avenue St. Clair Ouest
Toronto (Ontario) M4V 1M2

Ontario

Log: ENV1174IT-2010-248

February 8, 2011

Ms. Barbara Groves
Chair, North Bay-Mattawa Source Protection Committee
15 Janey Avenue
North Bay ON P1C 1N1

Dear Ms. Groves,

We are in receipt of your letter dated October 20, 2010. You have requested a Director's opinion regarding the addition of the transportation of hazardous substances as a local drinking water threat under Rule 119 of the technical rules. Table 1 provides details on activities that were considered.

In accordance with my authority under Rules 119 and 120 or 121, I hereby provide the following Director's opinion on the hazard rating related to the proposed activities and circumstance as per Table 2. The activity has been approved as a local threat in the North Bay-Mattawa Source Protection Area.

Your rationale for the inclusion of this local threat along with a copy of this letter must be included in your assessment report.

Sincerely,

Ian Smith, Director
Source Protection Programs Branch
Ministry of the Environment

c: Keith Willson, Manager, Source Protection Approvals
Paul Heeney, Manager, Source Protection Implementation
Heather Malcolmson, Manager, Source Protection Planning
Katie Fairman, Supervisor, Source Protection Implementation
Melanie Ward, Team Lead, Source Protection Approvals
Neil Gervais, Liaison Officer, CRCA, Source Protection Implementation

14-075

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Table 1:
ACTIVITY AND SUBCATEGORY

Applicable to the North Bay-Mattawa Source Protection Area

Activity being added as a Local Threat: Transportation of hazardous substances. Chemicals concern:

1. Ammonium Nitrate
2. Ammonia
3. Formaldehyde
4. Hydrogen Peroxide
5. Methanol
6. Sodium Hydroxide
7. Sulphuric acid
8. Sulphur Dioxide
9. Copper
10. BTEX (includes aviation fuel, gasoline, fuel oil)
11. Petroleum hydrocarbons (includes aviation fuel, gasoline, fuel oil)

Activity being added as a Local Threat: Transportation of Septage.
12. Pathogens

Table 2:
CIRCUMSTANCES AND HAZARD RATINGS

1) TRANSPORTATION OF AMMONIUM NITRATE

Activity	Vulnerability Score to produce a Significant DWT		Vulnerability Score to produce a Moderate DWT		Vulnerability Score to produce a Low DWT	
	IPZ-1,2,3, WHPA-E	WHPA-A, B, C, C1, D	IPZ-1,2,3, WHPA-E	WHPA-A, B, C, C1, D	IPZ-1,2,3, WHPA-E	WHPA-A, B, C, C1, D
1. The transportation of Ammonium Nitrate. 2. The Ammonium Nitrate is transported in a quantity that is more than 2,500 litres. 3. A spill may result in the release of Ammonium Nitrate to groundwater or surface water.			8 - 10	8 - 10	5.4 - 7.2	6

2) TRANSPORTATION OF AMMONIA

Ammonia is a gas and therefore, there is no chemical hazard rating related to drinking water.

3) TRANSPORTATION OF FORMALDEHYDE

Activity	Vulnerability Score to produce a Significant DWT		Vulnerability Score to produce a Moderate DWT		Vulnerability Score to produce a Low DWT	
	IPZ-1,2,3, WHPA-E	WHPA-A, B, C, C1, D	IPZ-1,2,3, WHPA-E	WHPA-A, B, C, C1, D	IPZ-1,2,3, WHPA-E	WHPA-A, B, C, C1, D
1. The transportation of Formaldehyde 2. The Formaldehyde is transported in a quantity that is more than 2,500 litres. 3. A spill may result in the release of Formaldehyde to groundwater or surface water.			8.1 - 10	10	5.6 - 8	6 - 8

4) TRANSPORTATION OF HYDROGEN PEROXIDE

No chemical hazard score was calculated for hydrogen peroxide as it dissociates readily to water and oxygen therefore, there is no chemical hazard rating related to drinking water.

5) TRANSPORTATION OF METHANOL

Activity	Vulnerability Score to produce a Significant DWT		Vulnerability Score to produce a Moderate DWT		Vulnerability Score to produce a Low DWT	
	IPZ-1,2,3, WHPA-E	WHPA-A, B, C, C1, D	IPZ-1,2,3, WHPA-E	WHPA-A, B, C, C1, D	IPZ-1,2,3, WHPA-E	WHPA-A, B, C, C1, D
1. The transportation of Methanol. 2. The Methanol is transported in a quantity that is more than 2,500 litres. 3. A spill may result in the release of Methanol to groundwater or surface water.			9-10	8 - 10	5.6 - 8.1	6

6) TRANSPORTATION OF SODIUM HYDROXIDE

Activity	Vulnerability Score to produce a Significant DWT		Vulnerability Score to produce a Moderate DWT		Vulnerability Score to produce a Low DWT	
	IPZ-1,2,3, WHPA-E	WHPA-A, B, C, C1, D	IPZ-1,2,3, WHPA-E	WHPA-A, B, C, C1, D	IPZ-1,2,3, WHPA-E	WHPA-A, B, C, C1, D
1. The transportation of Sodium Hydroxide. 2. The Sodium Hydroxide is transported in a quantity that is more than 2,500 litres. 3. A spill of Sodium Hydroxide may increase the pH of groundwater or surface water to above the acceptable range of 6.5-8.5, as specified in Table 4 of the Technical Support Document for Ontario Drinking Water Standards, Objectives and Guidelines.	10	10	8-9	8	5.4-7.2	6

CIRCUMSTANCES AND HAZARD RATINGS

7) TRANSPORTATION OF SULPHURIC ACID

Activity	Vulnerability Score to produce a Significant DWT		Vulnerability Score to produce a Moderate DWT		Vulnerability Score to produce a Low DWT	
	IPZ-1,2,3, WHPA-E	WHPA-A, B, C, C1, D	IPZ-1,2,3, WHPA-E	WHPA-A, B, C, C1, D	IPZ-1,2,3, WHPA-E	WHPA-A, B, C, C1, D
1. The transportation of sulphuric acid. 2. The sulphuric acid is transported in a quantity that is more than 2,500 litres. 3. A spill of sulphuric acid may decrease the pH of groundwater or surface water to below the acceptable range of 6.5-8.5, as specified in Table 4 of the Technical Support Document for Ontario Drinking Water Standards, Objectives and Guidelines.	10	10	8-9	8	5.4-7.2	6

8) TRANSPORTATION OF SULPHUR DIOXIDE

This is a gas, therefore, there is no chemical hazard rating related to drinking water

9) TRANSPORTATION OF COPPER

Activity	Vulnerability Score to produce a Significant DWT		Vulnerability Score to produce a Moderate DWT		Vulnerability Score to produce a Low DWT	
	IPZ-1,2,3, WHPA-E	WHPA-A, B, C, C1, D	IPZ-1,2,3, WHPA-E	WHPA-A, B, C, C1, D	IPZ-1,2,3, WHPA-E	WHPA-A, B, C, C1, D
1. The transportation of Copper. 2. The Copper is transported in a quantity that is more than 2,500 litres. 3. A spill may result in the release of Copper to groundwater or surface water.			8 - 10	10	5.4 - 7.2	6 - 8

10) TRANSPORTION OF LIQUID FUELS

Activity	Vulnerability Score to produce a Significant DWT		Vulnerability Score to produce a Moderate DWT		Vulnerability Score to produce a Low DWT	
	IPZ-1,2,3, WHPA-E	WHPA-A, B, C, C1, D	IPZ-1,2,3, WHPA-E	WHPA-A, B, C, C1, D	IPZ-1,2,3, WHPA-E	WHPA-A, B, C, C1, D
1. The transportation of liquid fuel. 2. The fuel is transported in a quantity that is more than 250, but not more than 2,500 litres. 3. A spill of the fuel may result in the presence of BTEX in groundwater or surface water.			9 - 10	10	6 – 8.1	6 - 8
1. The transportation of liquid fuel. 2. The fuel is transported in a quantity that is more than 250, but not more than 2,500 litres. 3. A spill of the fuel may result in the presence of Petroleum Hydrocarbons F1 (nC6-nC10) in groundwater or surface water.			10	10	6.4 - 9	8
1. The transportation of liquid fuel. 2. The fuel is transported in a quantity that is more than 250, but not more than 2,500 litres. 3. A spill of the fuel may result in the presence of Petroleum Hydrocarbons F2 (>nC10-nC16) in groundwater or surface water.			10	10	6.3 - 9	8
1. The transportation of liquid fuel. 2. The fuel is transported in a quantity that is more than 250, but not more than 2,500 litres. 3. A spill of the fuel may result in the presence of Petroleum Hydrocarbons F3 (>nC16-nC34) in groundwater or surface water.			9 - 10	10	6 – 8.1	8
1. The transportation of liquid fuel. 2. The fuel is transported in a quantity that is more than 250, but not more than 2,500 litres. 3. A spill of the fuel may result in the presence of Petroleum Hydrocarbons F4 (>nC34) in groundwater or surface water.			10	10	6.3 - 9	8

11) TRANSPORTION OF LIQUID FUELS

Activity	Vulnerability Score to produce a Significant DWT		Vulnerability Score to produce a Moderate DWT		Vulnerability Score to produce a Low DWT	
	IPZ-1,2,3, WHPA-E	WHPA-A, B, C, C1, D	IPZ-1,2,3, WHPA-E	WHPA-A, B, C, C1, D	IPZ-1,2,3, WHPA-E	WHPA-A, B, C, C1, D
1. The transportation of liquid fuel. 2. The fuel is transported in a quantity that is more than 2,500 litres. 3. A spill of the fuel may result in the presence of BTEX in groundwater or surface water.			8 – 10	8 - 10	5.4 – 7.2	6
1. The transportation of liquid fuel. 2. The fuel is transported in a quantity that is more than 2,500 litres. 3. A spill of the fuel may result in the presence of Petroleum Hydrocarbons F1 (nC6-nC10) in groundwater or surface water.			9 – 10	10	6 – 8.1	6 - 8
1. The transportation of liquid fuel. 2. The fuel is transported in a quantity that is more than 2,500 litres. 3. A spill of the fuel may result in the presence of Petroleum Hydrocarbons F2 (>nC10-nC16) in groundwater or surface water.			8.1 – 10	10	5.6 - 8	6 - 8
1. The transportation of liquid fuel. 2. The fuel is transported in a quantity that is more than 2,500 litres. 3. A spill of the fuel may result in the presence of Petroleum Hydrocarbons F3 (>nC16-nC34) in groundwater or surface water.			8 – 10	8 - 10	5.4 – 7.2	6 - 8
1. The transportation of liquid fuel. 2. The fuel is transported in a quantity that is more than 2,500 litres. 3. A spill of the fuel may result in the presence of Petroleum Hydrocarbons F4 (>nC34) in groundwater or surface water.			8.1 – 10	10	5.6 - 8	6 - 8

12) TRANSPORTATION OF SEPTAGE

Activity	Vulnerability Score to produce a Significant DWT		Vulnerability Score to produce a Moderate DWT		Vulnerability Score to produce a Low DWT	
	IPZ-1,2,3, WHPA-E	WHPA-A, B	IPZ-1,2,3, WHPA-E	WHPA-A, B	IPZ-1,2,3, WHPA-E	WHPA-A, B,
1. The transportation of septage. 2. The septage is transported in any quantity. 3. A spill of the septage may result in the presence of pathogens in groundwater or surface water.	9 - 10	10	7 – 8.1	8	4.5 – 6.4	6