Updated Assessment Report

Sault Ste. Marie Region

Source Protection Area

CHAPTER 6

WATER QUALITY RISK ASSESSMENT

With Support Provided By

Approved April 12, 2021

The Assessment Report was initially approved on November 25, 2011.
Amendments were made in 2014 to include Chapter 2c.
Updated Assessment Report February 5, 2015.
Updated Assessment Report January 2017.

Prepared as per Ontario Regulation 287/07, *Clean Water Act, 2006*

ASSESSMENT REPORT
WATER QUALITY RISK ASSESSMENT

Table of Contents

Table of Contents
List of Figures
List of Tables
Appendices
List of Acronyms
Glossary

EXECUTIVE SUMMARY x
1.0 INTRODUCTION 1
1.1 Objective 1
1.2 SSM Source Protection Area 2
2.0 VULNERABLE AREAS 2
2.1 Vulnerability Score 2
3.0 THREATS IDENTIFICATION AND ASSESSMENT 4
3.1 Summary of Results 5
3.1.1 Threats in IPZs 5
3.1.1.1 Threats Approach - Potential Activities & Circumstances 5
3.1.2 Threats in SGRAs 7
3.1.3 Threats in HVAs 8
3.1.4 Threats in WHPAs 8
3.1.4.1 Threats Approach - Existing Significant, Moderate and Low Threats 11
3.1.4.2 Issues Approach to Threat Identification 12
4.0 CONDITIONS 12
5.0 UNCERTAINTY ANALYSIS 13
6.0 SUMMARY AND CONCLUSIONS 14
7.0 REFERENCES 16

List of Figures

Figure 1: SSM SP Area
Figure 2: Sault Ste. Marie Gros Cap IPZ-1
Figure 3: Sault Ste. Marie Gros Cap IPZ-2
Figure 4: Significant Groundwater Recharge Areas (SGRAs)
Figure 5: Highly Vulnerable Aquifers (HVAs)
Figure 6: Wellhead Protection Areas (WHPAs)
Figure 7: Vulnerability Scores in IPZs
Figure 8: Vulnerability Scores in HVAs and SGRAs
Figure 9: Vulnerability Score in WHPAs
Figure 10: Threat Risk Classification in Wellhead Protection Areas

List of Tables

Table 1: Vulnerability Score 3

Table 2: Summary of Risk Classifications 5

Table 3: Areas within Gros Cap Intake Protection Zone where Activities are or would be Significant, Moderate and Low Drinking Water Threats... 6

Table 4: Numbers of Potential Significant (S), Moderate (M) and Low (L) Threats related to Activities in the Vulnerable Area of the Gros Cap Intake 6

Table 5: Summary of Tables of Circumstances related to Threat Levels and Vulnerability Scores 7

Table 6: Area within HVAs where Activities Are or Would be Significant, Moderate and Low Drinking Water Threats. 8

Table 7: Summary of Tables of Circumstances Related to HVAs 8

Table 8: Areas Within Sault Ste. Marie Wellhead Protection Area Where Activities Are or Would be Significant, Moderate and Low Drinking Water Threats 9

Table 9: Number of Potential Significant (S), Moderate (M) and Low (L) Threats Related to Activities in the Vulnerable Areas of the Sault Ste. Marie Wellhead....................................... 9

Table 10 Summary of Tables of Circumstances Related to Threat Levels and Vulnerability Scores. 10

Table 11: List of Potential Drinking Water Threats Related to the Sault Ste. Marie Municipal Groundwater System that Are or Would be Significant. 11

Table 12: Existing Threats Within Sault Ste. Marie Source Protection Area......................... 12

Table 13: Summary of WHPAs delineation uncertainty 13

APPENDICES

Appendix A
Table A-1: Threat Activities and Risk Score within IPZ-1 (Chemicals) for VS=5

Appendix B
Table B-1: Assumptions Used For Hazard Ratings

Appendix C
Summary Work Sheets

Appendix D
Formal Request of the Addition of a Local Threat Along Transportation Corridor Within the IPZ-2.

Director's Approval Letter to Include a Local Threat Along Transportation Corridor Within the IPZ-2.

List of Acronyms

CWA	*Clean Water Act, 2006*
DNAPL	Dense Non-Aqueous Phase Liquids
DWSP	Drinking Water Source Protection
DWSPP	Drinking Water Source Protection Process
GIS	Geographic Information System
GW	Groundwater
GWVA	Groundwater Vulnerability Analysis
HVA/'s	Highly Vulnerable Aquifer/Aquifers
IPZ/'s	Intake Protection Zone/Zones
km	kilometre
km^2	square kilometre
m	metre
m^3/s	cubic metres per second
MOE	Ministry of the Environment
MECP	Ministry of Environment, Conservation and Parks (formerly MOE and MOECC)
PTTW	Permit to Take Water
SGRA	Significant Groundwater Recharge Area
SPC	Source Protection Committee
SPA	Source Protection Area
SSM	Sault Ste. Marie
SSMR SPA	Sault Ste. Marie Region Source Protection Area
WHPAs	Wellhead Protection Areas
WTP	Water Treatment Plant

Glossary

Items included in the glossary of definitions are found in *ITALICS* in the main text.

Agricultural Source Material
Material(s) applied to land as 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).

Non-agricultural Source Material
Material(s) applied 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).

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.

Assessment Report
The report that is to be produced by Source Protection Committees according to the Technical Rules that will be used as a basis to prepare the Source Protection Plans.

Census Consolidated Subdivisions
A census consolidated subdivision (CCS) is a group of adjacent census subdivisions. Generally, the smaller, more urban census subdivisions (towns, villages, etc.) are combined with the surrounding, larger, more rural census subdivision, in order to create a geographic level between the census subdivision and the census division.

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.

Clean Water Act
The *Clean Water Act, 2006* was passed as Bill 43 to protect drinking water at the source. The Act requires the development of a watershed based source protection plan.

Cosmetic Pesticide Ban Act
The *Cosmetic Pesticide Ban Act, 2008* (*Act*) recognizes that the cosmetic use of pesticides to improve the appearance of lawns and gardens presents health and environmental risks. The *Act* restricts the use and sale of specific pesticides for cosmetic purposes on specific land uses.

Dense Non-Aqueous Phase Liquid
An organic chemical in concentrations greater than its aqueous solubility and is more dense than water. Such a chemical will sink in groundwater and accumulate in depressions in an aquifer.

Drinking Water Condition
A substantiated, through scientific means, a condition relating to the quality of water that interferes or is anticipated to interfere with the use of a drinking water source by a municipal residential system or designated system.

Drinking Water Threat
A threat is defined as a chemical or pathogen contaminant that poses a potential risk to the drinking water sources.

Freedom of Information and Protection of Privacy Act (FIPPA)
The FIPPA was created for the following purposes:

- To provide a right of access to information under the control of institutions in accordance with the principals that information should be available to the public, necessary exemptions from the right of access should be limited and specific, and decisions on the disclosure of government information should be reviewed independently of the government.
- To protect the privacy of individuals with respect to personal information about themselves held by institution and to provide individuals with a right of access to that information (R.S.O. 1990, c. F31, s1.)

Hazard Rating
A numeric value that 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.

Highly Vulnerable Aquifers (HVA)
An aquifer on which, external sources have or are likely to have a significant adverse effect; and includes the land above the aquifer (*Clean Water Act, 2006*).

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.

Intake Protection Zones (IPZs)
Areas as described in the *Clean Water Act, 2006*, that are related to a surface water intake and within which it is desirable to regulate or monitor drinking water threats.

Livestock Density
The number of farm animals grown, produced or raised per square kilometre of an area, separated by type of farm animals specified in section 3.1 of the Nutrient Management Protocol.

Managed Land
Land where materials are applied as nutrients.

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*).

Parcel
A parcel is 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.

Pathogenic Contaminant
A microscopic organism that is capable of producing infection or infectious disease in humans.

Pesticides
Chemicals include insecticides, fungicides, and herbicides that are used to kill living organisms.

Regulatory Limit
The "Regulatory Limit" is the area defined by the Conservation Authority for floodplain mapping purposes. Regulated areas are those areas for which Conservation Authorities delineate and restrict land uses by making regulations under subsection 28(1) of the *Conservation Authority Act*. This subsection applies to water courses, streams, lakes, valleys, flood plains, and wetlands in Ontario.

Safe Drinking Water Act (SDWA)
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.

Significant Groundwater Recharge Areas (SGRA)
An area within which it is desirable to regulate or monitor drinking water threats that may affect the recharge of an aquifer (*Clean Water Act, 2006*). These are delineated as the area that 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. For the purposes of the current study, these areas also need to have a water supply source within them.

Transport / Preferential Pathways
Any structure, 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.

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 Ministry of the Environment (15(2) (e) (IV)).

Vulnerable Areas
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.

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*).

Watershed Characterization Report
The Watershed Characterization Report is the foundation for subsequent steps in the Assessment Report and pulls together all available information on the watershed including natural characteristics, land uses, water quality, location of municipal drinking water systems, and preliminary list of drinking water threats.

Wellhead Protection Area
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 well field.

Definitions Used for Land Use Classifications:

Within the report land use was classified using the definitions outlined below. Each land use definition is based primarily on classifications of the North American Industry Classification System (NAICS) with some refinements and amalgamations to suit the purposes of the report. These definitions should be used to identify land uses outlined in the Issues Evaluation and Threats Inventory Report for the Sault Ste. Marie Region Conservation Authority and the City of Sault Ste. Marie.

Agricultural
This is assigned to land use that is associated with crop or animal production and any associated activities. For the purposes of the study forestry and logging, hunting, fishing and trapping are also included in this category.

Commercial
Activities involving the trade and exchange of goods and services in the retail, wholesale and services sectors are assigned to this category. The category also includes transportation services.

Manufacturing
This category refers to land uses that are associated with the mechanical, physical or chemical transformation of materials, substances or components into new products. Facilities within this classification are often referred to as plants, factories or mills.

Utilities
Establishments engaged in the provision of utility services such as electric power, natural gas, water supply and sewage removal. Storm water management infrastructure is also included in this category.

Waste Management
Land uses in this category are engaged in the collection, treatment and disposal of waste materials. This category also includes the modification, recycling or reuse of these materials. It is noted that this category does not include household or private septic systems.

EXECUTIVE SUMMARY

The Ontario Government passed Bill 43, the *Clean Water Act, 2006* to protect drinking water at the source as part of an overall commitment to human health and the environment. A key focus of the legislation is the production of locally-developed, science-based assessment report and source protection plan. The Sault Ste. Marie Region Source Protection Committee (SSMR SPC) in conjunction with the Drinking Water Source Protection (DWSP) staff and the City of Sault Ste. Marie is working to complete the required technical studies in compliance with the *Clean Water Act*. The Assessment Report will be used to develop the source water protection plan and establish the measures to protect the sources of drinking water within the Sault Ste. Marie Region watershed.

As part of the requirement under the *Clean Water Act* is the development of a *Watershed* based *Assessment Report* that presents the status of water resources and water use throughout the watershed. The *Water Quality Risk Assessment* is part of the required *Assessment Report*, which determines the risk of specific threats entering the municipal drinking water system. A drinking water threat is an existing or future activity or existing condition that results from a past activity that is impacting or has the potential to impact a drinking water source.

In this report, a review of the threats list generated in the threats inventory (Issues Evaluation and Threats Inventory Report) has been carried out. The threats inventory is focused within vulnerable areas identified in the previous chapters *Groundwater Vulnerability Analysis* and the *Surface Water Vulnerability Analysis*. For groundwater, the threats within the wellhead protection area (WHPA) were taken in to account. For surface water, threats in Intake Protection Zones (IPZs) were assessed. Threats inventoried within other vulnerable areas, such as highly vulnerable aquifer (HVA) areas and significant recharge areas (SGRA) were also assessed for the risk analysis. These analyses were carried out according to the Technical Rules: Assessment Report, November 2009. It is concluded that threats within IPZs scored as low risk activities. There are three threats within WHPAs categorized as having significant risk. Threats within HVAs and SGRAs are assessed as low to moderate risk based on threats risk scoring process.

1.0 INTRODUCTION

The City of Sault Ste. Marie is located at the south-east corner of the Lake Superior. Sault Ste. Marie is dependent both on surface and groundwater for municipal drinking water supply source and obtains its water from Lake Superior (Gros Cap) and six (6) wells located within the City of Sault Ste. Marie ***(Figure 1)***. Wells for the Municipal Water Supply System are located in deep bedrock aquifers.

The Ministry of the Environment (MOE) initiated the Municipal Groundwater Studies program in 2001 to support groundwater management throughout the Province of Ontario. The program was undertaken at a regional scale across the Sault Ste. Marie (SSM) watershed and built on previous work to improve the understanding of groundwater resources in the watershed. Capture zones up to the 25 year time of travel for all four groundwater wellheads (includes six supply wells) were delineated as part of the study.

In 2005, the MOE initiated the Source Water Protection Program to protect drinking water sources throughout Ontario. The program was developed to protect the source water quality and sustainability of municipal drinking water supplies. Source protection plans will be developed for the municipal drinking water systems of the City of Sault Ste. Marie based on the outcome of the Assessment Report technical studies and updated as new data is available and evaluated.

As a requirement of the *Clean Water Act 2006*, an Issues Evaluation and Threats Inventory was completed for the Sault Ste. Marie municipal groundwater supply system including the Gros Cap Intake.

This report, Water Quality Risk Assessment, was developed based on the Issues Evaluation and Threats Inventory. This report presents the results and categorization of the threats, their significance and scientifically based risk score for the threats located within the SSM municipal well fields and surrounding area. The study was undertaken in general accordance with the *Technical Rules: Assessment Report*, *Clean Water Act, 2006,* (November 2009).

1.1 Objective

The main objective of this chapter is to classify and prioritize the threats and conditions that were identified in the Issues Evaluation and Threats Inventory Report within the Sault Ste. Marie Region Source Protection Area. The assessment is based on existing provincial groundwater studies, field evaluation/surveys, existing reports/data and recent studies of the Gros Cap IPZs. Specifically, the current report sets out to provide:

- A list of drinking water threats located in vulnerable areas of the watershed classified according to risk (Significant, Moderate, Low); and
- Maps and summary worksheets of the above information.

It should be noted that this study was completed in conjunction with the Issues Evaluation and Threats Inventory and both reports should be read together. Based on previous and present studies, gaps have been identified throughout the study and the results of assessment process. Continuous improvement is a key component of the Source Water Planning cycle. The MECP acknowledges that approaches selected to complete the assessment report will be unique to each community and will be based on local factors including the hydrological/hydrogeological conditions and land use activities.

1.2 SSMR Source Protection Area

The study area consists of the Sault Ste. Marie Region Source Protection Area (SSMR Source Protection Area) which is shown in ***Figure 1***. Within this Area, the major residential settlements are the City of Sault Ste. Marie, Prince Township, Garden River First Nation and the Batchewana First Nation. The SSMR Source Protection Area covers approximately 775 square kilometres (km^2) including a land area of 522 km^2 and a water area of 253 km^2.

The City of Sault Ste. Marie is located at the southern portion of the watershed. Prince Township is located at the west side of the planning area. People living outside the City of Sault Ste. Marie urban service line and within Prince Township rely on private well systems. With a population of approximately 80,000, the City of Sault Ste. Marie is a major regional center for business, institutional, commercial and industrial services.

2.0 VULNERABLE AREAS

Based on the current requirements of the *Technical Rules*, vulnerable areas were delineated for the SSMR Source Protection Area in previous studies. These vulnerable areas include Significant Recharge Areas (*SGRA*), Highly Vulnerable Aquifers (*HVA*), Wellhead Protection Areas (*WHPA*) and Intake Protection Zones (*IPZ*).

The vulnerable areas assessed as part of this study are IPZs for the SSM Water Treatment Plant (WTP), SGRAs and HVAs with the SSMR Source Protection Area, and WHPAs for all the four Wellheads which include six groundwater wells. The locations of these vulnerable areas are shown in ***Figures 2 to 6****.*

The delineation of the IPZ-1 and IPZ-2 was completed as part of the Surface Water Vulnerability Analysis (Baird and CRA 2008-2009) as per the Technical Rules: Assessment Report (December, 2008). SGRAs and HVAs were delineated based on the work that had been completed by SSMR Source Protection Authority staff and peer reviewed by Breen GeoSciences as part of the Groundwater Vulnerability Analysis (SSMRCA, 2008).

2.1 Vulnerability Score

Vulnerability scores are assigned to vulnerable areas based on the anticipated vulnerability to contamination in the area. Vulnerability scores are developed on a scale of 1 – 10 with a 10 representing the highest vulnerability and 1 representing the lowest vulnerability. The vulnerability scores assigned under the current study were based on SSMR Source Protection Area's "Groundwater Vulnerability Assessment Report". The guidance was taken from the Technical Rules: Assessment Report (November, 2009). A summary of the vulnerability score within SSMR Source Protection Area is presented in Table 1 below:

Table 1: Vulnerability Score

Vulnerable Area	Vulnerability Score
IPZ-1	5
IPZ-2	4
SGRAs	2 to 6
HVAs	6
WHPA-A	10
WHPA-B	6 to 8
WHPA-C	4 to 6
WHPA-D	2 to 6

A vulnerability score of 6 is assigned to *HVAs* as outlined in Technical Rule Part VII(i), Rule 79. The vulnerability scores for *SGRAs* are determined based on the areas of groundwater vulnerability identified in accordance with Part IV Rule 38 and provided in the Groundwater Vulnerability Assessment (SSMRCA, 2008). A score of 6 is assigned to an *SGRA* where the underlying groundwater vulnerability is high, a score of 4 where the groundwater vulnerability is medium and a score of 2 where the groundwater vulnerability is low.

For the *IPZs*, vulnerability scores were assigned as part of the Surface Water Vulnerability Analysis (Baird & CRA 2008-2009). Scores were assigned according to the Technical Rules: Assessment Report (November, 2009). The *IPZ* vulnerability scores used in this study are therefore based on guidance provided by the MOE and on professional judgment. The IPZ studies indicate that for the SSM surface water intake, vulnerability could range from 4 – 5 in *IPZ-1*. Within *IPZ-2* vulnerability could range from 3 – 4. Professional judgment was used in the determination of the specific value for each intake protection zone (IPZ-1 and IPZ-2).

It is noted from the map of *HVAs* and *SGRAs* that vulnerability scores of 6 dominate the *vulnerable areas* of the watershed. Within the *SGRAs* there are also areas that scored values of 2 and 4. The vulnerability scores within the *IPZs* are seen to range from 4 to 5. The vulnerability of *IPZ-1* and *IPZ-2* (5 and 4 respectively) indicate a medium vulnerability than that for the *HVAs* and *SGRAs*. The details of the vulnerability scoring for these areas are described in the Surface Water Vulnerability Analysis Report (Baird 2009).

Vulnerability scores for the *SGRAs, HVAs, WHPAs* and *IPZs* within the SSMR SPA are shown in ***Figures 7 and 8***. Vulnerability Scores of 2 to 10 were assigned for all the WHPAs for different captures zones (100m, 2 year – 25 year time of travel).

3.0 THREATS IDENTIFICATION AND ASSESSMENT

The *Technical Rules: Assessment Report (*November, 2009) requires that all potential land use activities that are or would be classified as significant risks are identified in the *Assessment Report*. The guidance provided by the MOE, indicates a relationship between vulnerability scores and the final risk category. Based on this relationship, vulnerability scores that may result in a categorization as a significant *threat* must be 8 or greater. Within the study area, areas for which significant *threats* are identified based on their vulnerability scores are *WHPA–A and WHPA-B*. In Appendix A, the original *Tables of Drinking Water Threats* has been reduced to include only the activities that may be significant for this study.

The tables were produced from the MOE Table of Drinking Water Threats Database V7.1.2 (January 2010)[1]. These tables of threats outline the circumstances in which a potential activity would become significant threat. The tables includes the information regarding the reference no., quantity and type of contaminant, amount of contributing area and other screening criteria to assess the level of significance of each activity. It is noted that there are 44 circumstances within *WHPA-A* (Provincial Table 1)[1] for storage of different chemicals in relation to quantity and land use. When any of the land use as mentioned in these tables would be allowed in the specific vulnerable area, the threats will have significant potential to impact the drinking water sources. There are four circumstances (Provincial Table 2)[1] pose a significant risk for those WHPAs having vulnerability score of 8 (*WHPA-B*). DNAPL's as indicated in Provincial Table 9[1] having significant risk to drinking water sources if they would allowed within *WHPA- A, B*, and *C* (with any vulnerability score).

An inventory of *threats* was completed as part of the Issues Evaluation and Threats Inventory Report, to identify the current activities within the study's *vulnerable areas*. The *threats* inventory process has identified *threats* within the *IPZs* of the SSM WTP as well as threats located in *HVAs, SGRAs and WHPAs* across the study area.

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 used in the identification of threats within the transportation corridor along the IPZ-2.

[1] The 76 Provincial Tables of Circumstances are not longer available from Ontario.ca. These 76 Tables are derived entirely from the Tables of Drinking Water Threats, which are accessible via the source protection homepage of Ontario.ca. The information that appears in the 76 Provincial Tables of Circumstances (i.e., drinking water threats that are significant in a given vulnerable zone and score) can also be generated by searching the Source Water Protection Threats Tool, accessible via http://swpip.ca/. Alternative formats of these two sources are available upon request from the local conservation authority.

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.

3.1 Summary of Results

All *threats* identified in the SSMR SPA including *IPZs*, *SGRAs* and *HVAs* have been classified as significant, moderate or low risk. A summary of the threat risk classifications is shown in Table 2. Each point represents a land use activity. The land use activity may have more than one *threat* activity associated to it and subsequently more than one risk classification. The highest risk classification of the *threat* activities taking place at that location has been reported.

Table 2: Summary of Risk Classifications

Release Impact Modifier	**Threat Risk Classifications**		
	Significant	**Moderate**	**Low**
IPZ-1	0	0	12
IPZ-2	0	0	89
SGRA	0	46	1585
HVAs	0	18	2648
WHPA-A	3	0	0
WHPA-B	0	5	0
WHPA-C	0	10	6
WHPA-D	0	2	8

3.1.1 Threats in IPZs

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 Gros Cap intake.

3.1.1.1 Threats Approach - Potential Activities & Circumstances

Based on the resulting vulnerability scores (Table 1) the possible threat levels (Table 2) were identified for each of the vulnerable areas. Due to the vulnerability scores within the IPZs, only IPZ-1 may contain potential low chemical or pathogen threats. Refer to ***Figures 7 to 9*** for further support of the vulnerable areas where activities are or would be significant, moderate or low drinking water threats.

While Table 2 lists the IPZs where significant, moderate and low threats could be found in the Gros Cap IPZs, Table 3 lists the number of chemical and pathogen threats which could be significant, moderate or low within each of the IPZ according to the MOE Tables of Drinking Water Threats. There are 543 potential low chemical threats and 41 Low potential pathogen threats in the Gros Cap IPZ-1.

Table 3: Areas within Gros Cap 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**	**5**	**NA**	**NA**	**Yes**
	IPZ-2	**4**	**NA**	**NA**	**NA**
	IPZ-3	**-**	**NA**	**NA**	**NA**
Pathogen	**IPZ-1**	**5**	**NA**	**NA**	**Yes**
	IPZ-2	**4**	**NA**	**NA**	**NA**
	IPZ-3	**-**	**NA**	**NA**	**NA**

Table 4: Numbers of Potential Significant (S), Moderate (M) and Low (L) Threats related to Activities in the Vulnerable Area of the Gros Cap Intake

Vulnerable Area	Vulnerability Score	Chemical Threats			Pathogen Threats		
		S	M	L	S	M	L
IPZ-1	5	-	-	543	-	-	41
IPZ-2	4	-	-	-	-	-	-
IPZ-3	-	-	-	-	-	-	-

The circumstances related to the threats listed in Table 3 above can be found in the Provincial tables listed in Table 4[1]. The table headings within Table 4 (i.e. CIPZWE5L) represent the MOE Provincial Tables of Circumstances. These provincial tables outline the specific circumstances related to potential chemical and pathogen threats. The MOE Provincial Tables of Circumstances can be found on the Ontario Ministry of the Environment website[1].

The table headings are acronym for a list of circumstances utilizing the following identifiers:

Acronym	Definition
C	**Chemical**
P	**Pathogen**
W	**Wellhead protection area**
IPZ	**Intake protectio0n zone**
IPZWE	**IPZ and WHPA-E**
(number)	**Vulnerability score**
S	**Significant**
M	**Moderate**
L	**Low**

For example: CIPZWE5L is a table of:
C - **C**hemical Threats in an
IPZ - **I**ntake **P**rotection **Z**one or
WE- **W**ellhead Protection Area-**E** with a vulnerability score of
5 - **Five**, categorized as a

L - **L**ow threat

Table 5: Summary of Tables of Circumstances related to Threat Levels and Vulnerability Scores

Vulnerability Score	Significant	Moderate	Low
5	-	-	CIPZWE5L PIPZ5L
4	-	-	-

There are 543 low chemical drinking water threats that are or would be low in the IPZ-1 of the Gros Cap of Sault St. Marie intake, all of which are related to circumstances with "the establishment, operation or maintenance of a system that collects, stores, transmits, or treats or disposes of sewage, storage and handling of fuel". There are 41 threats related to pathogens that are or would be low threats in the IPZ-1 of the Gros Cap intake. There are no threats that are or would be significant in the IPZ-1, IPZ-2 or IPZ-3 due to the low vulnerability of those areas.

The Source Protection Authority has modeled a spills scenario as per Technical Rule 68 and the spill threats are determined to be potassic fertilizer and fuel oil. Using the Ontario Drinking Water Standards the concentrations of the chemical components were anticipated to be above the acceptable standards (Baird, 2010).

Under the provisions of Technical Rules 119 - 125, the Sault Ste. Marie Region Source Protection Committee (SPC) submitted a formal request to MOE to add this activity as a local threat and, as of September 02, 2011, the Director has approved the SPC's request to include the transportation of hazardous substances along transportation corridors within the IPZ-2 as a local, non-prescribed threat. It is important that the transportation of hazardous substances in areas of close proximity to municipal drinking water sources be considered a significant threat to enable the inclusion of appropriate policies in the Source Protection Plan. The Director's letter can be found in Appendix D.

3.1.2 Threats in SGRAs

Figure 4 illustrates the SGRAs for the Source Protection Area.

In accordance with the Technical Rules a water quality issue in the SGRA may be identified if the presence of a parameter listed in the Ontario Drinking Water Quality Standards is shown to deteriorate the quality of the 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. There are a total of 2 Provincial Groundwater Monitoring wells located in the SGRA. A review of the water quality data from these wells indicate that there are no known issues associated with these areas.

3.1.3 Threats in HVAs

The intrinsic susceptibility index (ISI) method was used to assess groundwater vulnerability in the SSMR SPA, 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 SSMR SPA are shown in ***Figure 5***, while ***Figure 8*** shows HVAs with the corresponding vulnerability scores.

Areas where significant, moderate or low drinking water threats can exist, within the HVAs, are summarized in Table 9, and further supported by the HVA ***Figure 13***.

The table headings within Table 9 (CSGRAHVA6M and CSGRAHVA6L) represent the MOE Provincial Tables of Circumstances[1] which apply to HVAs. These provincial tables outline the specific circumstances related to potential chemical threats (note that pathogen threats cannot exist for an HVA). The actual provincial tables can be found on the Ontario Ministry of the Environment website.

Table 6: Area 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	NA	yes	yes

Table 7: Summary of Tables of Circumstances Related to HVAs[1]

Vulnerability Score	Significant	Moderate	Low
6	NA	CSGRAHVA6M	CSGRAHVA6L

In accordance with the Technical Rules 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. A review of this information indicates that there are no known issues associated with these areas.

3.1.4 Threats in WHPAs

Based on the resulting vulnerability scores the possible threat levels were identified for each of the vulnerable areas (Table 10). Due to the vulnerability scores within the WHPAs, only WHPA-A, B and C may contain potential significant chemical threats, and only WHPA-A may contain significant chemical threats. Refer to ***Figure 10*** for further support of the vulnerable areas where activities are significant water threats.

Table 8: Areas Within Sault Ste. Marie 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	8	✓	✓	✓
	WHPA-C	6	-	✓	✓
	WHPA-D	4, 2	-	-	-
Pathogen	WHPA-A	10	✓	✓	-
	WHPA-B	8	-	✓	✓
	WHPA-C	6	-	-	-
	WHPA-D	4, 2	-	-	-

While Table 10 lists the WHPAs where significant, moderate and low threats could be found in the Sault Ste. Marie WHPA's, Table 11 lists the number of chemical and pathogen threats which could be significant, moderate or low within each of the WHPAs according to the MECP Tables of Drinking Water Threats[1]. There are 603 potential significant chemical threats and 50 potential pathogen threats in the Sault Ste. Marie WHPA.

Table 9: Number of Potential Significant (S), Moderate (M) and Low (L) Threats Related to Activities in the Vulnerable Areas of the Sault Ste. Marie Wellhead.

Vulnerable Area	Vulnerability Score	Chemical Threats			Pathogen Threats		
		S	**M**	**L**	**S**	**M**	**L**
WHPA-A	10	528	824	211	50	14	0
WHPA-B	8	5	792	717	0	50	14
WHPA-C	6	0	5	1126	0	0	0

The circumstances related to the threats listed in Table 11 above can be found in the Provincial Tables of Circumstances[1]; summary lists of circumstances relevant to each vulnerable area in SSM are shown in Table 13. The number of circumstances related to potential significant drinking water threats are found in Table 5-11.

The table headings within Table 12 (i.e. CW10S) represent the MECP Provincial Tables of Circumstances[1]. These provincial tables outline the specific circumstances related to potential chemical and pathogen threats. The MECP Provincial Tables of Circumstances can be found on the Ontario Ministry of the Environment, Conservation and Parks website[1].

The table headings are acronym for a list of circumstances utilizing the following identifiers:

Acronym	Definition
C	Chemical
P	Pathogen
W	Wellhead protection area
IPZ	Intake protection zone
IPZWE	IPZ and WHPA-E
(number)	Vulnerability score
S	Significant
M	Moderate
L	Low

For example: CW10S is a table of:
C - **C**hemical Threats in a
W- **W**ellhead Protection Area with a vulnerability score of
10 - **10,** categorized as a
S - **S**ignificant threat

Table 10 Summary of Tables of Circumstances Related to Threat Levels and Vulnerability Scores.[1]

Vulnerability Score	Threat Level Possible		
	Significant	Moderate	Low
10	CW10S PW10S	CW10M PW10M	CW10L NA
8	CW8S NA	CW8M PW8M	CW8L PW8L
6	NA NA	CW6M NA	CW6L NA

Note: The table reference refer to the Provincial Tables of Circumstances[1]

Table 11: List of Potential Drinking Water Threats Related to the Sault Ste. Marie Municipal Groundwater System that Are or Would be Significant.

Activities Prescribed to be Drinking Water Threats	# of Significant Threats	
	Chemicals	Pathogens
The application of agricultural source material to land.	5	5
The application of commercial fertilizer to land.	5	
The application of non-agricultural source material to land.	5	5
The application of pesticide to land.	11	
The application of road salt.	2	
The establishment, operation or maintenance of a system that collects, stores, transmits, treats or disposes of sewage.	133	6
The establishment, operation or maintenance of a waste disposal site within the meaning of Part V of the Environmental Protection Act.	241	1
The handling and storage of a dense non-aqueous phase liquid.	75	
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	21
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	10
Number of circumstances under which the threat is or would be significant	603	50

3.1.4.1 Threats Approach - Existing Significant, Moderate and Low Threats

The identification of specific groundwater quality threats in the SSMR SPA vulnerable areas was based on inputs from several sources including published environmental and land-use databases (maintained, for example, by the Ministry of the Environment, Technical Standards and Safety Authority and the Municipality), field reconnaissance work by Sault Ste. Marie Region 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[1].

Based on a review of the above information, the field work and a subsequent review of initial findings, four occurrences relating to three (3) activities prescribed by MECP were confirmed as a significant (S) threats (Table 14). The four significant threats within the Sault Ste. Marie vulnerable area are related to handling & storage fuel and storage of snow in close proximity to the WHPA-A areas.

A total of 17 activities were identified as posing a moderate threat and 14 were identified as low.

Table 12: Existing Threats Within Sault Ste. Marie Source Protection Area

Activity Prescribed to be a Threat	WHPA-A	WHPA-B			WHPA_C		WHPA-D	Circumstance Reference #
	VS=10	VS=8	VS=6	VS=4	VS=6	VS=4	VS=4,2	
The handling and storage of fuel.	S(2)	M(8)	M(5)	L(2)	L(12)	-	-	192-203 282-321
The storage of snow	S(1)	M(4)	-	-	-	-	-	1459-1532
Sanitary Sewers and related pipes	S(1)	-	-	-	-	-	-	893-918

3.1.4.2 Issues Approach to Threat Identification

There are no drinking water issues, in accordance with Rule 114 and 115 in the Sault Ste. Marie Wellhead Protection area.

4.0 CONDITIONS

There are no known conditions that exist in the vulnerable areas of the Sault Ste Marie.

5.0 UNCERTAINTY ANALYSIS

The vulnerability scores are based on the Intrinsic Susceptibility Index (ISI) and the wellhead protection areas. Therefore, the uncertainty associated with each score is a function of these two variables.

A number of components of the modeling process have a low to high degree of uncertainty. The uncertainty in the WHPA-A and WHPA-B delineations is low. Generally, the uncertainty in delineating the WHPAs decreases closer to the wellhead as there is less compounding of errors. The overall uncertainty for the WHPA-C and WHPA-D was assessed to be high. The modeling approach involves a number of assumptions that limit the accuracy of their final size and shape. Two of these assumptions include are the equivalent porous medium concept used to represent bedrock layers, and the simplification of the overburden model layers.

Most of area over the low lands covered by thick clay and silt deposits has been identified as having low ISI. Also, artesian flowing well conditions exits over parts of this low land area, which effectively protecting the deeper aquifer. There is a great amount of reliability in this information; therefore the uncertainty of this score is low.

Table 13: Summary of WHPAs delineation uncertainty

Geological factors	Depth to aquifer, thickness of overburden	Sufficient data from MECP, WWIS, City of SSM, and Previous Groundwater Management Studies databases
	Soil and Rock Characteristics	Sand and gravel layers logged in the MECP water well Records were used.
Hydrogeological Factors	Hydraulic Parameters	Calculated hydraulic conductivity was in the range of value assigned in the model.
	Hydraulic Head Measurements	High variability and large uncertainity of the MECP data (WWIS).
	Recharge	The total volume of water distributed over the gravel area adjacent to the bedrock
	Boundary Conditions	Vertical recharge through the upper layer of the model, rivers and lakes at the ground surface
Methodological Factors	Model Used for WHPA Delineation	MODFLOW / MODPATH are industry standards. Steady-state capture zones determined to represent the ultimate source of water for each well based on the long term, average pumping rates for the well
	Model Calibration and Sensitivity Analysis	High degree of accuracy to the steady-state solutions. PEST model was used to evaluate parameter sensitivity. The sensitivity analysis showed that model calibration was sensitive to the conductivity of the overburden, the sandstone units, and recharge.
	Pump Rate Used for Model	A constant pumping rate was used for all wells, which is considered as conservative approach
	Capture Zones Delineation	The capture zone for all four supply wells extend to the source of groundwater to the north where high recharge occur.

Uncertainty Level

High Uncertainty | Medium Uncertainty | Low Uncertainty

6.0 SUMMARY AND CONCLUSIONS

A water quality threats assessment was completed for Wellhead Protection Area A for all municipal wells. Results of the analysis indicated the presence of 3 potential significant threats within the two Wellhead Protection Areas.

A spills scenario as per Technical Rule 68 has been modeled and the spill threats are determined to be potassic fertilizer and fuel oil. The concentrations of the chemical components were anticipated to be above the Ontario Drinking Water Standards. The transportation of hazardous substances along the transportation corridors within the IPZ-2 is a significant threat.

Aquifer vulnerability was assessed using the AVI method within all areas of the watershed.

The resulting analysis showed areas of high and medium aquifer vulnerability across the northern extents of the watershed. These areas generally correspond to the Precambrian Uplands. The southern extents of the watershed have been found to have predominantly low vulnerability. The aquifer is underlying the thick clay layer, which provides protection to the deeper, confined aquifers.

Areas mapped as highly vulnerable are considered Highly Vulnerable Aquifer (HVAs). These areas received a vulnerability score of 6.

Managed lands were calculated to be below 40% of the total land area within the Highly Vulnerable Aquifers.

Livestock density was calculated to be <0.5 Nutrient Units per acre within the Highly Vulnerable Aquifers.

Given that the maximum vulnerability score a Highly Vulnerable Aquifer can receive is a 6, activities cannot become significant threats within Highly Vulnerable Aquifers.

To date, no drinking water issues have been identified in the Highly Vulnerable Aquifers.

Significant Groundwater Recharge Areas that coincided with areas of high groundwater vulnerability were given a score of 6. Significant Groundwater Recharge Areas that coincided with medium and low areas of aquifer vulnerability were given scores of 4 and 2 respectively.

Managed lands were calculated to be below 40% of the total land area within the Significant Groundwater Recharge Areas with a vulnerability score of 6.

Livestock density was calculated to be <0.5 Nutrient Units per acre within the Significant Recharge Areas with a vulnerability score of 6.

No significant threats can occur within a Significant Groundwater Recharge Area since the maximum vulnerability score is 6.

To date, no drinking water issues have been identified in the Highly Vulnerable Aquifers.

Four Wellhead Protection Areas were delineated for each well: a 100 metre proximity zone and three time-related (2-year, 5-year and 25-year) capture zones generated through a groundwater model.

An issues-based threats analysis was also completed through a review of water quality data collected from the municipal wells. No issue-based threats were identified within the municipal groundwater system.

.

7.0 REFERENCES

Burnside 2003: Sault Ste. Marie Area Groundwater Management and Protection Study. R.J Burnside and Associates Limited.

Burnside 2005. Vulnerability of Municipal Groundwater Study, Sault Ste. Marie PUC. R.J Burnside and Associates Limited.

Baird January 2008. Gros Cap Intake Protection Zone Study. W.F. Baird & Associates Coastal Engineers Ltd.

Baird October 2008. Gros Cap Intake Protection Zone Study, Numerical Modeling in Support of IPZ-2 Delineation. W.F. Baird & Associates Coastal Engineers Ltd.

Baird 2010. Gros Cap Intake Source Water Protection Studies: Numerical Modeling in Support of IPZ-3 Delineation. W.F. Baird & Associates Coastal Engineers Ltd.

CRA July 2009 (final March 2016). Gros Cap Intake Issues Evaluation and Threats Inventory (within IPZs 1 and 2). CONESTOGA-ROVERS & ASSOCIATES.

City of Sault Ste. Marie Planning Department. Official Planning Document 1996.

Government of Ontario. O.Reg. 385/08 as part of the *Clean Water Act 2006*.

Groundwater Vulnerability Analysis, SSMRCA, March 2009.

Issues Evaluation and Threats Inventory Report for the Sault Ste. Marie Source Protection Area, SSM SPC, October 2009.

Ministry of the Environment. Government of Ontario. Technical Rules: Assessment Report, Clean Water Act, 2006, November 2009.

Sault Ste. Marie SPC Watershed Characterization. June 2008

Upper Thames River Conservation Authority's On-line SWP Threats Analysis Tool. https://swpip.ca/Threats, UTRCA, 2009