Chapter 6
Table of Contents

6 SURFACE WATER SOURCES 6-1
6.1 INTAKE PROTECTION ZONES 6-3
6.1.1 What is an Intake Protection Zone? 6-3
6.1.2 Classification of Intakes 6-3
6.1.3 Delineation of Intake Protection Zones 6-4
6.1.4 Vulnerability Scoring 6-6

6.2 OUTSTANDING CONCERNS WITH THE VULNERABILITY SCORING METHODOLOGY 6-8

6.3 TYPE C: INLAND RIVER INTAKE PROTECTION ZONES IN THE MISSISSIPPI-RIDEAU SOURCE PROTECTION REGION 6-12
6.3.1 Delineation of Type C: Inland Rivers Intake Protection Zones 6-12
6.3.2 Vulnerability Scoring of Type C: Inland Rivers Intake Protection .... Zones 6-15
6.3.3 Managed Lands and Livestock Density 6-17
6.3.4 Impervious Surfaces 6-19

6.4 CARLETON PLACE WATER SUPPLY 6-20
6.4.1 Delineation of the Carleton Place Intake Protection Zones 6-21
6.4.2 Vulnerability Scoring – Carleton Place Intake Protection Zones 6-22
6.4.3 Managed Lands and Livestock Density – Carleton Place Intake Protection Zones 6-24
6.4.4 Impervious Surfaces – Carleton Place Intake Protection Zones 6-24
6.4.5 Water Quality Threat Assessment – Carleton Place Intake Protection Zones 6-25
6.4.6 Issues and Conditions – Carleton Place Intake Protection Zones 6-25

6.5 PERTH WATER SUPPLY 6-26
6.5.1 Delineation of the Perth Intake Protection Zones 6-27
6.5.2 Vulnerability Scoring – Perth Intake Protection Zones 6-27
6.5.3 Managed Lands and Livestock Density – Perth Intake Protection .... Zones 6-30
6.5.4 Impervious Surfaces – Perth Intake Protection Zones 6-30
6.5.5 Water Quality Threat Assessment – Perth Intake Protection Zones 6-31
6.5.6 Issues and Conditions – Perth Intake Protection Zones 6-31

6.6 SMITHS FALLS WATER SUPPLY 6-32
6.6.1 Delineation of the Smiths Falls Intake Protection Zones 6-33
6.6.2 Vulnerability Scoring – Smiths Falls Intake Protection Zones 6-33
6.6.3 Managed Lands and Livestock Density – Smiths Falls Intake Protection Zones 6-36
6.6.4 Impervious Surfaces – Smiths Falls Intake Protection Zones 6-36
6.6.5 Water Quality Threat Assessment – Smiths Falls Intake Protection Zones 6-37
6.6.6 Issues and Conditions – Smiths Falls Intake Protection Zones 6-37

6.7 TYPE C: OTTAWA RIVER INTAKE PROTECTION ZONES IN THE MISSISSIPPI-RIDEAU SOURCE PROTECTION REGION 6-38
6.7.1 Delineation of Type C: Ottawa River Intake Protection Zones 6-38
6.7.2 Vulnerability Scoring of Type C: Ottawa River Intake Protection Zones 6-41

6.8 OTTAWA WATER SUPPLY – BRITANNIA 6-44
6.8.1 Delineation of Britannia Intake Protection Zones 6-46
6.8.2 Vulnerability Scoring – Britannia Intake Protection Zones 6-46
6.8.3 Managed Lands and Livestock Density – Britannia Intake Protection Zones 6-51
6.8.4 Impervious Surfaces – Britannia Intake Protection Zones 6-51
6.8.5 Water Quality Threat Assessment – Britannia Intake Protection Zones 6-51
6.8.6 Issues and Conditions – Britannia Intake Protection Zones 6-52

6.9 OTTAWA WATER SUPPLY – LEMIEUX ISLAND 6-53
6.9.1 Delineation of Lemieux Island Intake Protection Zones 6-54
6.9.2 Vulnerability Scoring – Lemieux Island Intake Protection Zones 6-54
6.9.3 Managed Lands and Livestock Density – Lemieux Island Intake Protection Zones 6-59
6.9.4 Impervious Surfaces – Lemieux Island Intake Protection Zones 6-59
6.9.5 Water Quality Threat Assessment – Lemieux Island Intake Protection Zones 6-59
6.9.6 Issues and Conditions – Lemieux Island Intake Protection Zones 6-60

6 Surface Water Sources

Introduction

This chapter provides information on surface-water based municipal drinking water systems in the Mississippi-Rideau Source Protection Region (MRSPR). Information on the general process of determining intake protection zones (IPZs) for municipal surface water intakes is provided, followed by discussion on how each of the five municipal IPZs in the region was delineated. Significant threats, issues, and conditions are discussed where applicable for each of the intakes.

There are five municipal surface drinking water intakes in the MRSPR. Two are located in the Ottawa River, supplying the City of Ottawa, and three are in smaller inland rivers, supplying the Towns of Carleton Place, Perth, and Smiths Falls. The following table shows the locations and number of users for each of the drinking water systems.

Municipal Water Supply Location	Estimated Number of Users
Carleton Place	9,400
Perth	6,000
Smiths Falls	10,000
Britannia and Lemieux	814,000
Total	**839,400**

Surface Water Drinking Water Systems

IPZs have been delineated for each of the municipal intakes. The IPZ studies for Carleton Place, Perth and Smiths Falls drinking water systems were completed together and are referred to as Type C: Inland Rivers Intake Protection Zone studies.

The IPZ studies for Britannia and Lemieux Island (Ottawa) drinking water systems were completed together, and are referred to as Type C: Ottawa River Intake Protection Zone Studies. Although the MRSPR does not extend across the provincial border, which essentially runs down the centre of the Ottawa River, sufficient information was obtained from the Ville de Gatineau that permitted a preliminary assessment of the delineation of IPZ-2 into Quebec. The preliminary IPZ-2 shown for areas within the Province of Quebec is for information purposes only.

A preliminary IPZ-3 delineation for the Ottawa River municipal surface water intakes, which extends beyond the MRSPR boundary to include the Chalk River Nuclear Facility was also completed for discussion purposes. This is in response to concerns related to potential impacts on the Britannia and Lemieux water treatment plants if there were an accidental tritium release upstream at the Chalk River facility.

A number of lower or single tier municipalities have IPZs located within their boundaries. Table 6-3 lists which municipalities within the MRSPR have IPZs and the associated water intake.

Questions have been raised regarding how vulnerability scores were derived and Section 6.2 discusses concerns which have been identified with the approach taken for vulnerability scoring. As a result of these concerns no IPZ-3 vulnerability scores or threats counts are included in this Assessment Report. Once provincial technical guidance becomes available IPZ-3 vulnerability scoring will be completed.

A summary of vulnerability scores for IPZs-1s and IPZ-2s can also be found in Section 6.2.

Summary of Key Findings

There are no issues or conditions identified at any of the municipal surface water intakes in the MRSPR. A summary of key results is in Table 6-1.

There were 34 potentially significant threats identified in the MRSPR IPZs. Carleton Place has 10 potentially significant threats, Perth 13, Smiths Falls five, Britannia has six, and Lemieux Island did not have any potentially significant threats. Table 6-2 is a summary of potentially significant threats in the MRSPR.

Technical Studies

Five background technical studies were completed for the surface water sources chapter. The following table summarizes "who did what", including a peer review, if applicable. Further information about peer review is provided following the table.

Study & Completion Date	Lead Consultant	Peer Review
Inland Rivers (Carleton Place, Perth, Smiths Falls) Surface Water Intake Protection Zone Study, 2010	J.F. Sabourin and Associates Inc., and Water and Earth Science Associates	Baird & Associates Ltd.
Ottawa River Surface Water Intake Protection Zone Study, 2010	Baird & Associates Ltd.	J.F. Sabourin and Associates Inc.
Managed Lands and Livestock Density, 2010	Dillon Consulting	not peer reviewed
Impervious Surfaces, 2010	Mississippi-Rideau Conservation Authority Staff	not peer reviewed
Drinking Water Threats and Issues, 2010	Dillon Consulting	not peer reviewed

Surface Water Sources – Technical Reports

Peer Review

An independent consultant was retained to undertake a peer review of each IPZ study. The objectives of the IPZ study peer review were as follows:

- To ensure consistency with the expectations of the MOE Technical Guidance modules, which have since been replaced by the Technical Rules
- To validate the approach for development of surface water vulnerability studies
- To ensure scientifically defensible surface water vulnerability studies.

The table above lists the names of consultants who undertook the peer review for each study. Each technical study contains a peer review record.

This chapter is a summary of the MRSPR surface water studies' processes and results. Further information on threats and issues processes may be found in Chapter 4. Information on data gaps may be found in Chapter 8. A list of all Assessment Report technical reports and data source information may be found in Appendix A-1. For further information on the work completed in the MRSPR related to surface water sources, see the related technical report(s).

6.1 Intake Protection Zones

This section provides information on IPZs; how they are classified, delineated and scored for vulnerability within the MRSPR.

6.1.1 What is an Intake Protection Zone?

An IPZ is the land and water area that contributes water to a municipal surface water intake. Within this area it is important to monitor or regulate drinking water threats. IPZ studies aim to provide an understanding of local surface water flow conditions and potential sources of contamination surrounding one or more intakes that supplies a public drinking water system.

6.1.2 Classification of Intakes

The Technical Rules require classification of each municipal surface water intake into one of the following four categories:

- **Type A** intakes are located in a Great Lake;
- **Type B** intakes are located in a Great Lake Connecting Channel or River (such as the St. Lawrence River);
- **Type C** intakes are located in a smaller river where neither the direction nor flow rate at the intake is affected by a water impoundment structure (e.g. a dam); and
- **Type D** intakes are anything not classified as a Type A, B or C intake. Type D intakes are typically located in smaller inland lakes.

The classification of an intake determines how the related IPZs are developed and assessed. As discussed in Chapter 2, there are 5 municipal surface-water based drinking water systems in the MRSPR. The following table provides the source water and classification of each of the five systems.

Municipal Drinking Water System	Source Water	Intake Classification
Carleton Place	Mississippi River	Type C
Perth	Tay River	
Smiths Falls	Rideau River	
Britannia (Ottawa)	Ottawa River	
Lemieux Island (Ottawa)		

MRSPR Surface Water Intake Classification

The IPZ studies for Carleton Place, Perth and Smiths Falls drinking water systems were completed together and are referred to as Type C: Inland Rivers Intake Protection Zone studies. Information relevant to the three inland river systems is presented as Section 6.3 and the individual study results are presented in Sections 6.4 through 6.6.

The IPZ studies for Britannia and Lemieux Island (Ottawa) drinking water systems were completed together, and are referred to as Type C: Ottawa River Intake Protection Zone Studies. Information related to the Ottawa systems is presented in Section 6.7 and the individual study results are presented in Sections 6.8 and 6.9.

Although all municipal surface water intakes in the MRSPR are classified as Type C systems, the Technical Rules have different requirements for the delineation of IPZ-3s for the inland river intakes and Ottawa River intakes.

6.1.3 Delineation of Intake Protection Zones

An IPZ is made up of three separate zones: IPZ-1, IPZ-2, and IPZ-3. These areas are adjacent to one another, but do not overlap. The zones are made up of both water areas and land areas which have the potential to contribute contamination to a municipal surface water intake. A general description of how the three IPZs are delineated follows.

IPZ-1

The IPZ-1 represents the most vulnerable area immediately surrounding the municipal surface water intake. The size and shape of the IPZ-1 is set by the Technical Rules but may be modified to reflect local conditions. If the IPZ-1 delineation includes land, it may only extend onto the land by 120 m from the high water mark or the Conservation Authority Regulation Limit, whichever is greater. The general IPZ-1 requirements for each type of intake is shown in the following table.

Intake Type	Location	General Area Shape	Area Dimensions for IPZ-1
A	Great Lakes	Circle	One kilometre radius
B	Connecting Channels	Semi-Circle/Rectangle	One kilometre radius upstream of intake, rectangle two kilometres long and 100 m wide downstream
C*	Rivers	1) Circle, or 2) Semi-Circle/Rectangle	1) One kilometre radius, or 2) 200 m radius upstream of intake, rectangle 400 m long and ten m wide downstream
D	Other	Circle	One kilometre radius

IPZ-1 General Features
***MRSPR Municipal Surface Water Intake Type**

IPZ-2

The in-river portion of IPZ-2 is based on a specified Time of Travel (ToT) within the river. This is the period required for surface water to travel to the intake. Under the Technical Rules, the required ToT must be equal to or less than the time that is sufficient to allow operators to shut down the water treatment plant in the event of a spill, or 2 hours, whichever is greater.

The Technical Rules also require that all storm sewers that may contribute water to the intake within the 2 hour ToT or the water treatment shut down time (if the shut down time is greater than 2 hours) be included in IPZ-2.

The on-land portion of IPZ-2 adjacent to the river is based on a setback of 120 m from the high water mark or the Generic Regulation limit as maintained by the Mississippi Valley and Rideau Valley Conservation Authorities, whichever is greater.

IPZ-3

The IPZ-3 is an area where contaminants, if released, could be transported to the municipal surface water intake. For municipal surface water intakes located on inland rivers other than the Ottawa River, the standard approach is to buffer all rivers, streams, and lakes upstream of the intake by 120 m, or the generic regulation limit line.

The Technical Rules prescribe a different approach for municipal surface water intakes on the Ottawa River, called the event-based approach (EBA). This approach considers the dispersion of a contaminant spill within the watershed, and results in the delineation of an IPZ-3 that includes areas beyond IPZ-1 and IPZ-2 which could contribute contaminants to the intake in the case of an extreme weather event. For the work done in the MRSPR, extreme events have been defined as 1:100 year (also called one hundred year return) flood events.

Inclusion of Transport Pathways in IPZ Delineation

A transport pathway (TP) is anything that provides a direct route for contaminants to enter surface water. These are human-made or natural features such as drainage ditches, tile drains, roadways, or creeks and streams. Since these pathways can drain water from a larger area than the river's main channel alone, the intake protection zones must be expanded to include them.

Transport pathways are considered once a preliminary IPZ delineation has been completed. The IPZ-2 and/or IPZ-3 is expanded to include the transport pathways. In the case of the inland river municipal surface water intakes, a 120 m setback on both sides of the transport pathway was used to define the transport pathway area since not all information on conditions was known.

The delineation of the Type C: Inland Rivers IPZs in the MRSPR is presented in Section 6.3.1. This section provides information for the Carleton Place, Perth, and Smiths Falls municipal surface water intakes. The delineation of the Type C: Ottawa River IPZs in the MRSPR is presented in Section 6.7.1. The section provides information on the two municipal surface water intakes for the City of Ottawa located at Britannia and Lemieux Island.

6.1.4 Vulnerability Scoring

Once the IPZs are delineated, the next step is to assess how susceptible the surface water in these zones is to contamination. This is done in order to identify areas where extra care is needed to protect the water supply.

The Technical Rules set out a process for assessing the vulnerability for each intake protection zone. The final vulnerability score is based on the following equation:

$$\mathbf{V = B \times C}$$

Where:

V is the vulnerability score

B is the area vulnerability factor

C is the source vulnerability factor

These factors, and how their values were calculated, are described below.

Determining the Area Vulnerability Factor (B)

The first step in the evaluation of surface water vulnerability is to determine the area vulnerability factor (B) for each intake protection zone. The area vulnerability factor B must be a whole number (no decimal points), and the possible values range from 1 to 10, with 10 being the highest vulnerability.

IPZ-1

The area vulnerability factor for IPZ-1 is always 10, as required in the Technical Rules, since this zone is closest to the intake and encompasses the area of water and land to which the water intake is most vulnerable. It is assumed that if contaminants were released within IPZ-1 they would not be diluted or filtered before reaching the intake.

IPZ-2

The Technical Rules require that the area vulnerability factor for IPZ-2 can be 7, 8, or 9. One score must be assigned to the whole zone and the following factors must be taken into consideration:

- Percentage of area of IPZ-2 that is land. This factor reflects the assumption that as the percentage of land within an IPZ increases, the potential risk increases for a spill to occur that may impact water quality at the water intake.
- The land cover, soil type, permeability of the land and the slope of the land. This factor reflects the potential for overland water to flow into the zone. Whether vegetation is present, as well as the type of vegetation, affects how much of the water is overland water flow and how much of it soaks into the ground. Permeable soils allow for more infiltration. Slopes increase the percentage of overland flow compared to the amount of infiltration.
- The hydrological and hydrogeological conditions where transport pathways are located. This factor reflects the extent of the transport pathways including sewer systems that may exist in the zone and their influence on water (and potential contaminant) movement from land to rivers which are the source of water intakes.

IPZ-3

The area vulnerability factor for IPZ-3 is based on proximity to the municipal surface water intake as well as the three factors considered for IPZ-2, shown above. Unlike IPZ-2, the area vulnerability factor for IPZ-3 may differ by location throughout the area. According to the Technical Rules, no value in the IPZ-3 may be a higher value than the value assigned to IPZ-2.

Determining the Source Vulnerability Factor (C)

The second step is to assess the source vulnerability factor (C). This is an assessment of the location of the municipal surface water intake and how vulnerable it is to the impact of contaminants. The source vulnerability factor is assigned to each intake in accordance with the following table from the Technical Rules.

Intake Type	Location	Source Vulnerability Factor (C)
A	Great Lakes	0.5 to 0.7
B	Connecting Channels	0.7 to 0.9
C*	Rivers	0.9 or 1
D	Other	0.8 to 1

Source Vulnerability Factor Ranges for Surface Water Intakes
*** Intake Type for all MRSPR Municipal Surface Water Intakes**

In the MRSPR where there are only Type C intakes, a factor of 1 corresponds to a higher vulnerability and 0.9 indicates relatively less vulnerability.

The source vulnerability factor is based on:

- the depth of the intake below the water surface - the deeper the intake, the lower the vulnerability;
- the distance of the intake from land - the further away from shore, the lower the vulnerability; and
- the number of recorded drinking water quality issues at the intake, if any.

Calculating IPZ Vulnerability Scores

Once the area (B) and source (C) vulnerability factors have been finalized, the final step is to complete the calculation of the final vulnerability scores, according to the prescribed equation.

The following table summarizes the possible area vulnerability factors (B), source vulnerability factors (C) and vulnerability scores (V) for Type C intakes.

	Possible Area Vulnerability Factors (B)			Possible Source Vulnerability Factors (C)	Possible Vulnerability Scores (V) [B x C = V] *Expressed to a max. of one decimal point, depending on the value of C*		
Zone	**IPZ-1**	**IPZ-2**	**IPZ-3**		**IPZ-1**	**IPZ-2**	**IPZ-3**
Possible Values	*10*	*7 to 9*	*1 to 9*	*0.9 or 1*	*9 or 10*	*6.3 to 9*	*0.9 to 9*

Ranges of Possible Vulnerability Factors and Scores for Surface Water IPZs

6.2 Outstanding Concerns with the Vulnerability Scoring Methodology

There has been considerable debate in the MRSPR about how vulnerability scores should be determined for IPZs. While specific concerns have been documented in the record of public comments (*to be included in the Assessment Report submission package*), the intent of the following section is to:

- inform readers that concerns have been raised before they review the scores;
- document that the Committee considers the scores to be a reasonable first time assessment and can be updated at a later date; and
- demonstrate that the Province must develop strong Technical Guidance detailing how vulnerability scores should be derived for Intake Protection Zones.

First Time for Surface Water Studies

Professionals have been carrying out groundwater Wellhead Protection Studies since the late 1990s, providing experience and established best practices for the MOE to draw from for its development of the Technical Rules governing groundwater studies. The result is a fully prescribed approach for how to derive vulnerability scores for the Wellhead Protection Areas, discussed in Chapter 5, and an approach has been applied consistently across the province.

In contrast, surface water IPZ studies are being undertaken for the first time in Ontario. With little experience and few “lessons learned” to draw from, the Technical Rules for surface water studies did not prescribe how to carry out vulnerability scoring for Intake Protection Zones. The Technical Rules requires locally developed methodologies to be used.

Current Technical Rules for Surface Water Vulnerability Scores

The Technical Rules for surface water vulnerability scores rely on the determination of an area vulnerability factor (B) and a source vulnerability factor (C) to derive vulnerability scores (V), where V = B x C.

Specifically, the Technical Rules indicate that for the area vulnerability factor (B), one must consider:

- the percentage of area of IPZ-2 or IPZ-3 that is land;
- the land cover, soil type, permeability of the land and the slope of the land;
- the hydrological and hydrogeological conditions where transport pathways are located; and
- the proximity of the area of the IPZ-3 to the intake.

For the Source Vulnerability Factor (C), one must consider:

- the depth of the intake below the water surface;
- the distance of the intake from land; and
- the history of water quality concerns at the intake.

In addition to the above, the Technical Rules specify:

- the area vulnerability factor for IPZ-1 must be 10;
- the area vulnerability factor for IPZ-2 is not less than 7 and not more than 9;
- the area vulnerability factors for IPZ-3 are not less than 1 and not more than 9;
- the area vulnerability factor for IPZ-3 shall not be greater than the area vulnerability factor assigned to IPZ-2; and
- the source vulnerability factor shall be 0.9 or 1 for the municipal surface water intakes located in the Mississippi-Rideau Source Protection Region.

The Debate

The Technical Rules for surface water vulnerability scoring presented above set boundaries within which to derive vulnerability scores. The Rules allow enough flexibility that they may be applied in a number of different ways, each producing different results. The resulting vulnerability scores may be considered to be somewhat subjective due to the arbitrary decisions required in response to this flexibility. It also means the Rules can be applied differently across the Province.

In Source Protection Committee meetings and public open houses, an argument has been advanced that where there is flexibility, the Technical Rules should be applied in the most precautionary manner producing the highest vulnerability scores allowed under the Rules because the methodology used by the consultants is not scientifically defensible. Since the Technical Rules rely on the consideration of the simple indicators previously listed to derive vulnerability scores rather than a physics-based assessment of how a contaminant spill would behave, it is difficult to scientifically justify any methodology that applies the Technical Rules in a certain way. However, simply opting to produce the highest scores possible is also subjective. Additionally it carries with it the implication that this would allow the greatest number of land use activities to be regulated by the Source Protection Plan in the largest possible area, without the science-based rationale for doing so.

Committee members, staff, and the consultants clearly recognize that there is too much flexibility in the Technical Rules and the debate surrounding the surface water vulnerability scoring has helped identify particular concerns. However, the Committee considers the surface water vulnerability scores for IPZ-1 and IPZ-2 for the five surface water intakes in the MRSPR, derived by the method described in the next sections, as a reasonable first time assessment and understands that the scores can be adjusted in an updated Assessment Report if and when a more rigorous scientific methodology becomes available. The vulnerability scores are, in most instances, at or close to the highest possible values permissible in the Technical Rules and the vulnerability scores that are not reflect the individual river and intake characteristics.

As a result of too much flexibility in the Technical Rules, and after a considerable amount of effort by committee members, staff and the consultants, the Committee was not successful in developing a methodology for IPZ-3 vulnerability scoring that was locally supported. As a result, no IPZ-3 vulnerability scores are included in this Assessment Report. As noted below, it is recommended that provincial technical guidance be developed. Once developed, IPZ-3 vulnerability scoring can be completed.

	Zone	IPZ-1	IPZ-2	IPZ-3
	Possible Vulnerability Scores Values	9 or 10	6.3 to 9	0.9 to 9
	Vulnerability Scores Values Results			
Intake Protection Zones	Carleton Place	10	9	To be determined
	Perth	10	9	To be determined
	Smiths Falls	10	8	To be determined
	Britannia	9	8.1	To be determined
	Lemieux Island	9	8.1	To be determined

Summary of Possible and Final Vulnerability Scores for Intake Protection Zones in the MRSPR

The Solution – Provincial Technical Guidance Required

In order to address concerns raised by the public as well as staff, consultants and Committee members, it is suggested that a panel of experts be assembled to develop appropriate Technical Guidance, in order to ensure that scoring is carried out in a scientifically-based manner consistently across the province in the future. This could involve:

- an assessment of existing methodologies from other source protection areas and regions to derive vulnerability scores;
- the identification of a preferred scoring methodology; and
- the preparation of a Technical Guidance document for vulnerability scoring.

Timing

The development of a Technical Guidance document for surface water vulnerability scoring should be completed by the MOE in time to enable the MRSPR to complete IPZ-3 surface water vulnerability scoring and reassess their IPZ-1 and IPZ-2 vulnerability scoring. The Assessment Report, if required, would then be updated prior to the implementation of Source Protection Plan policies in 2013.

6.3 Type C: Inland River Intake Protection Zones in the Mississippi-Rideau Source Protection Region

This section provides information on inland river municipal intake protection zones. Three municipal intakes are included in this category; Carleton Place, Perth, and Smiths Falls.

6.3.1 Delineation of Type C: Inland Rivers Intake Protection Zones

The following describes the process which was undertaken to complete the IPZ delineation for the municipal intakes for Carleton Place, Perth, and Smiths Falls.

Collection and assembly of data and information

Local hydrology, water quality, and climate data was collected from federal, provincial, and municipal governments as well as other sources. Information collected includes the generic regulation limit lines for the study area, as maintained by the Rideau Valley and Mississippi Valley Conservation Authorities. Generic regulation areas identify land which could be unsafe for development due to naturally occurring processes associated with flooding, erosion, dynamic beaches or unstable soil or bedrock.

The characteristics of the municipal surface water intakes and identification of surrounding land uses were determined through site visits, discussions with municipal staff and review of available records and reports. Current and high-quality digital aerial photography and elevation data is an integral part of the analysis of Carleton Place, Perth and Smiths Falls. This data was acquired by the Mississippi-Rideau Source Protection Region in 2006.

Delineation of IPZ-1

As discussed in Section 6.1.3, the IPZ-1 surrounds the municipal surface water intake. The Technical Rules outline how to create IPZ-1. For Type C intakes, IPZ-1 can be created using a;

- one km radius (centred on the intake); or
- 200 m radius (centred on the intake) upstream of intake, plus a rectangle 400 m long and 10 m wide downstream of the intake.

The first method is more appropriate for intakes located in large surface water features such as lakes, where there is little or no flow. The second of the two methods listed above was selected for the three inland municipal water intakes in the MRSPR because, unlike a lake, the rivers have a continuous downstream flow.

Wherever the IPZ-1 intersects the shore, it was expanded to a setback of 120 m from the high water mark or the Conservation Authority generic regulation limit, whichever is greater.

It should be noted that the Smiths Falls IPZ-1 accommodates two intakes, the main intake and the auxiliary intake for the new water treatment plant. Delineation of the IPZ-1 for the Smiths Falls water intakes included some minor modifications to reflect local hydrodynamic conditions. The 10 m downstream limit for the intakes was extended approximately 23 m downstream to a structure that would prevent backflow from points downstream during lower flows. The 200 m upstream distance in the water was extended 10 m in a small part of the IPZ-1's northwest corner to completely encompass infrastructure located there rather than passing through the middle of the structures.

Development of a computer model

Aforementioned datasets were used to develop a general understanding of the local surface water system. Using the geometry from cross-sections at various points along each river, along with water flow data from a stream flow gauge, the HEC-RAS computer model was chosen to determine how quickly water flows towards the three intakes.

HEC-RAS models how water flows through natural rivers and channels. This modeling software is publicly available and has been peer reviewed. The model was used to determine the velocity with which water (at the various points) travels towards the intake in the river. This information was used to determine the IPZ-2 Time of Travel (ToT).

Delineation of IPZ-2

As discussed in Section 6.1.3, the IPZ-2 is based in part on the distance upstream from the intake that represents how far a contaminant in the water travels in a minimum of two hours.

Under the Technical Rules, the required ToT must be equal to or less than the time that is sufficient to allow operators to shut down the water treatment plant (WTP) in the event of a spill. The following table shows the approximate shut down time for the three inland municipal water intakes ranges from five to 15 minutes after detection or notification, so the ToT was set to the minimum two hour limit.

Municipal Surface Water System	Approximate Shut Down Time as Reported by Municipality
Carleton Place	5 minutes
Perth	5 minutes
Smiths Falls	15 minutes

Approximate Shut Down Time for MRSPR Inland Water Treatment Plants

In-river

The HEC-RAS model defined the upstream limits of IPZ-2 using the two hour ToT, as prescribed by the Technical Rules. The equivalent of each river's bankfull velocity was also required and this was represented by using the 2-year return period flow, which is considered to be representative of bankfull conditions.

The bankfull flow rate for each of the three rivers follows. The upstream limits of the IPZ-2s were extended to take into account wind effects on the ToT in the river.

Intake	Source Water	Bankfull flow (m^3/s)
Carleton Place	Mississippi River	144
Perth	Tay River	24.3
Smiths Falls	Rideau River	53

MRSPR Inland Rivers Bankfull Velocity

On-land

The next step involved determining the upstream limits of the storm sewer systems. Storm sewer outlets are located upstream of the intakes in Perth and Smiths Falls. No storm sewer outlets were identified upstream of the Carleton Place intake. The ToT in the Smiths Falls storm sewers was determined using flowing full velocities. Calculations were done to determine the distance up the storm sewer to be included in the IPZ-2. Storm sewers where the sum of the ToT in the river and the ToT in the storm sewer are less than or equal to two hours are included, with the delineation being at the two hour ToT. The entire upstream Perth storm sewershed was included in the IPZ-2 due to its location and extent. The identified on-land IPZ-2 areas were also extended to take into account wind effects on the ToT.

To complete the delineation, the outer boundaries of the zone, along the edges of the river, needed to be set. According to the Technical Rules, the outer boundary of the IPZ-2 on-land area along the river includes a setback of 120 m from the high water mark, or the generic regulation limits line (as developed and maintained by MVC and RVCA), whichever is greater.

Delineation of IPZ-3

The third intake protection zone (IPZ-3), was created by buffering all rivers, first order streams, and lakes upstream of IPZ-2 to include a setback of 120 m from the high water mark, or the generic regulation limits line, whichever is greater.

Inclusion of Transport Pathways

The final step in the IPZ delineation process was to expand the preliminary IPZ-2 and IPZ-3 zones where transport pathways are present. Transport pathways are natural or anthropogenic features such as natural tributaries, roadways and ditches. The ToT up the transport pathways was determined by either a ToT formula or by the drainage divides. When the ToT formula was used, the distance up the transport pathways was calculated so the sum of the ToT in the river and the ToT in the transport pathway was equal to two hours.

Mapped wetlands within the watershed that are contiguous to the IPZ-3 water courses were identified as potential transport pathways and were included in the preliminary delineation of the IPZ-3 along with a 120 m setback around the wetlands.

6.3.2 Vulnerability Scoring of Type C: Inland Rivers Intake Protection Zones

As presented in Section 6.1.4, the area vulnerability score is based on the following equation: **V = B x C,**

Where;

V is the vulnerability score
B is the area vulnerability factor
C is the source vulnerability factor

The Technical Rules identify the possible IPZ area vulnerability factor (B) values.

- **IPZ-1** is always 10
- **IPZ-2** may be 7, 8, or 9, same score throughout
- **IPZ-3** 1 to 9, must not be higher than IPZ-2, score varies but is always a whole number.

For Type C intake, the source vulnerability factor (C), can be either 0.9 or 1. The source vulnerability factor is the same for IPZ-1, IPZ-2 and IPZ-3.

The methodologies used to determine the area vulnerability factor for IPZ-2 and IPZ-3 follow. This is followed by the methodology used to determine source vulnerability factor.

Determination of Area Vulnerability Factor (B) for IPZ-2

At each of the three intakes, the area vulnerability factor (B) for IPZ-2 was established based on a numerical approach involving a weighted combination of the factors in the Technical Rules requirements:

- **Percentage of area of IPZ-2 that is land**. This factor reflects the assumption that as the percentage of land within an IPZ increases, the potential risk increases for a spill to occur that may impact water quality at the water intake.
- **The land cover, soil type, permeability of the land and the slope of the land.** This factor reflects the potential for overland water flow into the zone. Vegetation presence, as well as the type of vegetation, will affect the percentage of overland water flow which occurs and how much of the water infiltrates the ground. Permeable soils allow for increased infiltration. Slopes increase the percentage of overland flow compared to the amount of infiltration.
- **The hydrological and hydrogeological conditions where transport pathways are located**. This factor reflects the extent of the transport pathways and sewer systems that may exist in the zone and their influence on water (and potential contaminant) movement from land to rivers which are the source of water intakes.

As discussed, according to the Technical Rules the area vulnerability factor (B) may be a 7, 8 or 9. For each of the three factors shown above, circumstances were identified where, when combined and weighted, the area vulnerability factor (B) would be set at the minimum value of 7. This also was done to identify circumstances where there would be the maximum value of 9. From that, a number of different circumstances were identified to quantify a range in the vulnerability experienced locally in the study region.

Using a scenario where the channel is relatively wide compared to the land setback for that location, it was estimated that the minimum percentage of IPZ-2 land area would be 10%. This was set as the assumed minimum value of 7. Then, scenarios were identified to determine an approximate maximum value which would represent an area vulnerability factor (B) of 9. This would occur in a situation such as where the channel would be relatively narrow compared to the amount of land included in the setback. The maximum percentage of IPZ-2 land area was then set as 90% which became the assumed maximum value.

Similarly, scenarios related to the land characteristics were used to determine the curve number (CN) (discussion follows in #2 of Determination of Area Vulnerability Factor for IPZ-3), and slope, both of which help determine runoff potential on the lands adjacent to the river. From this, the minimum and maximum assumptions were determined for the curve number and slope.

Finally, scenarios on the extent or density of transport pathways were developed to determine the minimum and maximum numbers for the ratio of the total length of transport pathways over the length of the main channel in the IPZ-2.

All of these "assumptions" were reached by considering the physical characteristics of the waterway, the adjacent land, and transport pathways, combined with professional judgement.

Each of the three factors was then given an assumed weight, again based on consideration of the area and professional judgement, with the total weights summing to 100%. The assumed minimum and maximum vulnerability factor values for each of the three factors as well as the assumed weighting factors used at each of the three water intakes follows.

Three factors used for Area Vulnerability Factor (B)	Assumed Minimum Value (B = 7)	Assumed Maximum Value (B = 9)	Assumed Weighting
Percentage of Area Composed of Land	10 %	90%	30%
Runoff Potential based on land cover/soil type/permeability (CN) and slope	CN =36, Slope = 0.25%	CN =95, Slope = 2%	30%
Transport Pathways (total length / main channel length)	0	9	40%

Components of Area Vulnerability Factor and Assumed Weighting

In the final step, the actual or calculated value for each specific IPZ-2 was then converted, by interpolation, between the minimum and maximum values of B=7 and B=9. For example, an actual land area for IPZ-2 of 72% would result in a converted B value of B=8.55.

Appendix 6-1 provides additional details on the vulnerability scoring methodology for the Type C: Inland Rivers Intake Protection Zones.

Determination of Source Vulnerability Factor (C)

At each of the three intakes, the source vulnerability factor (C) was established based on a review of the following factors;

- the depth of the intake below the water surface (the deeper the intake, the lower the vulnerability);
- the distance of the intake from land (the further away from shore, the lower the vulnerability); and
- the number of recorded drinking water quality issues at the intake, if any, based on required water quality monitoring and a voluntary drinking water surveillance program.

The available information was considered adequate to assign the source vulnerability factor (C) a score of 0.9 (lower vulnerability) or 1 (higher vulnerability).

6.3.3 Managed Lands and Livestock Density

The percentage of managed lands and nutrient units are indicators of the degree of agricultural activity and other land management activities. In some cases the storage and application of pesticides, fertilizers, and other agricultural materials associated with agricultural activities may result in pathogen and chemical contamination of drinking water sources.

MRSPR studies on managed lands and livestock density have been completed in accordance with the MOE Technical Guidance Bulletin entitled “Proposed Methodology for Calculating Percentage of Managed Land and Livestock Density for Land Application of Agricultural Source of Material, Non-Agricultural Source of Material and Commercial Fertilizers” issued December 2009.

MOE lists a number of definitions for agricultural operations which fall under the Farm Unit. A summary of definitions follows and more information may be found at; http://www.ene.gov.on.ca/en/water/cleanwater/cwdocs/tbmanagedLandsAndLivestock.pdf.

Table 6-4 shows scoring for managed lands and livestock density for the three inland rivers IPZs.

Key Definitions

Managed lands are lands to which fertilizers and/or nutrient units are, or may be, applied. Managed lands can be broken into two subsets: agricultural managed land and non-agricultural managed land. Agricultural managed land includes areas of cropland, fallow, and improved pasture that may receive nutrients. Non-agricultural managed lands includes golf courses (turf), sports fields, lawns (turf) and other built-up grassed areas that may receive nutrients (primarily commercial fertilizer).

Nutrient Units (NU) are used to measure how much manure an animal produces annually. MOE has categorized different types of livestock. It uses beef cattle as a base (conversion factor of 1 or NU=1) and compares the number of animals in other species which would be required to produce an equal annual amount of manure. From this, nutrient units for livestock of any category can be calculated.

Livestock density is defined as the number of nutrient units over a given area and is generally measured in nutrient units per hectare (NU/ha) or nutrient units per acre (NU/ac). The Technical Rules require NU/ac be used here.

A farm unit is the area where nutrients generated must be at least the size of the property deed, the generating facility, or all land receiving nutrients. It should include all facilities on other deeds owned by the same person if the nutrients generated there are used on the land of the first deed, and can consist of separate farm units if nutrients are applied to different land bases. The size of a farm unit depends on whether or not the unit generates nutrients. If the farm unit does not generate nutrients, it must be at least the size a single field where nutrients are applied.

The Province defined thresholds, as shown in the following table, based on the area of managed lands in a vulnerable area to determine the risk of over-application of nutrients causing contamination of drinking water sources.

Land Use	Risk
<40% of vulnerable area is managed lands	Low potential
40-80% of vulnerable area is managed lands	Moderate potential
>80% of vulnerable area is managed lands	High potential

Risk Thresholds

MOE also defines thresholds based on livestock density in order to evaluate the risk of over-application of agriculturally sourced materials:

- If livestock density in the vulnerable area is less than 0.5 NU/acre, the area is considered to have a low potential for nutrient application exceeding crop requirements,
- If livestock density in the vulnerable areas is over 0.5 and less than 1.0 NU/acre, the area is considered to have a moderate potential for nutrient application exceeding crop requirements, and
- If livestock density in the vulnerable areas is over 1.0 NU/acre, the area is considered to have a high potential for nutrient application exceeding crop requirements.

Method used for Calculating Percentage of Managed Lands for IPZ-1 and IPZ-2

The areas of agricultural and non-agricultural lands were determined using land assessment and Municipal Property Assessment Corporation property classifications. The areas were confirmed through analysis of satellite imagery.

The percentage of managed lands within IPZ-1 and IPZ-2 was calculated by summing the total area of managed lands (both agricultural and non-agricultural) and dividing the result by the total land area.

Method for Calculating Livestock Density

Livestock Density is measured in Nutrient Units per acre (NU/ac) to estimate the generation, storage and application of nutrients from agricultural source material (ASM) in an area. The NU represents amount of manure and biosolids used to fertilize a Farm Unit either produced by animals on the farm or brought from the outside. A farm unit is a single field, the land base that generates nutrients or the land base that receives nutrients.

The calculation of livestock density within the intake protection areas was based on the calculation of Nutrient Units per acre (NU/ac) of agricultural managed lands. Two values for livestock density were calculated. The first value is the Land Application of Nutrients, which represents the nutrient units applied to crops or turf, and was computed for IPZ-1, IPZ-2 and IPZ-3. The second value reported is for livestock density associated with grazing or pasturing, and was computed for IPZ-1 and IPZ-2. This value was calculated using the estimated number of livestock in each farm unit or pasture area. The following method describes the calculation of each of these values.

Method used for Calculating Livestock Density in IPZ-1 and IPZ-2

The following steps were used to determine Livestock Density in IPZ-1 and IPZ-2.

1. Determine the number of animals on a farm unit and estimate how many of each type of animals (e.g. poultry – broiler, cattle - cow, or swine - sows) are present. Estimates of the number of animals on a farm were carried out based on building design and size.
2. Convert the number of each type of animals to nutrient units using nutrient unit conversion tables supplied by MOE.
3. Determine the area of managed lands that are within the intake protection zone. For the purposes of estimating the NUs required for the estimation of livestock density in a farm unit, where a portion of a farm unit falls within a vulnerable area, the NUs generated on the entire parcel of land should be factored into the calculations rather than the NUs generated within the portion of land that falls within a vulnerable area.
4. Determine the area of land used for pasturing or grazing associated with each farm unit.
5. Calculate the livestock density for the application of nutrients to land by dividing the total number of nutrient units by the area of managed lands that are within a vulnerable area.
6. Calculate the livestock density for pasturing/grazing by dividing the total number of nutrient units by the area available for pasturing/grazing for each farm unit.

6.3.4 Impervious Surfaces

Impervious surfaces are primarily constructed surfaces such as roads and parking lots that are covered by impenetrable materials such as asphalt, concrete and stone. These materials are a barrier to groundwater infiltration. Impervious surfaces also generate more runoff during melt or storm events.

Road salt applied to roads and walkways for winter maintenance is included in the list of Prescribed Drinking Water Threats, shown in Table 4-1. Impervious surface area calculations are required to determine if road salt application in the vulnerable areas could be a drinking water threat.

Method for Calculating the Percentage of Impervious Surfaces

The Southern Ontario Land Resource Information System (SOLRIS) was the primary data source used to identify impervious surfaces. SOLRIS is a landscape-level inventory of natural, rural, and urban areas. For the areas without SOLRIS coverage, a combination of the Ontario Road Network (ORN), Ministry of Natural Resources (MNR) built-up areas and some digitized areas were used (e.g. village boundaries).

Using GIS software, a 1000m x 1000m grid was created to cover the MRSPR. With permission from the MOE, the grid was then shifted so that one of the grid cell intersections overlapped the centroid (centre of mass) of the MRSPR. The use of one grid over the entire MRSPR was to eliminate grid overlap between the Mississippi and Rideau Source Protection Areas. The data sources listed above were then combined into one layer, impervious surfaces. For each grid cell, the amount of impervious surface area is divided by the area of the cell to determine the percentage of impervious surfaces. Appendix 6-2 provides information on the modifications.

6.4 Carleton Place Water Supply

The Mississippi River is 170 km in length, drains an area of approximately 3,750 km^2 and has an average annual flow rate of 40 m^3/s. Upstream of Carleton Place, the Mississippi River flows through a series of lakes (Crotch, Dalhousie, and Mississippi Lakes). It then flows past Carleton Place, Almonte, and turns north, where it flows into the Ottawa River.

The Carleton Place Water Treatment Plant (WTP) provides treated drinking water to the Town of Carleton Place for approximately 9,400 people each day. Figure 6-1 shows the town boundaries of Carleton Place and the location of the municipal surface water intake.

The Carleton Place WTP intake crib is located in the Mississippi River, approximately 48 m from shore and at 2.2 m below low flow water levels. A map showing the local setting of the Carleton Place WTP and municipal surface water intake is shown in Figure 6-2.

The natural water quality in the Mississippi River is characterized as having a high organic carbon content, which results in elevated colour levels. In general, the natural, or raw water exhibits relatively low turbidity levels (although elevated turbidity levels in the raw water have been measured on occasion). The natural water quality is generally soft, with hardness levels within the Ontario Drinking Water Standards, Objectives and Guidelines (ODWSOG) Operational Guideline range. Regular water quality testing is carried out by the Ontario Clean Water Agency, on behalf of the Town of Carleton Place, in both the untreated and treated water and the results are compared with the ODWSOG. *E. coli* and total coliforms are sometimes detected in the untreated source water samples at levels above the ODWSOG, which is typical for surface water, and are removed during treatment. A review of available untreated water quality results indicates that turbidity, colour and Dissolved Organic Carbon (DOC) exceed the ODWSOG aesthetic objectives.

Water from the Mississippi River is treated at the WTP by first pretreating and screening to remove solids. It is then mixed with a coagulant which binds with remaining solids. The coagulant forms into sticky particles (called 'floc'), which attract and trap suspended particles before settling out of the water in large settling tanks. The 'floc' collects at the bottom of each settling tank, while the clear water flows into collection troughs at the top. The clear water is then filtered through layers of sand and anthracite and is disinfected. Fluoride is added as the last step before it is distributed. The treated water quality is consistently compliant with the Ontario Drinking Water Standards.

6.4.1 Delineation of the Carleton Place Intake Protection Zones

The steps undertaken to complete the intake protection zone delineation for Carleton Place are presented in Section 6.3.1. The results of the delineation process are discussed below.

Figure 6-3 shows the various components that make up Carleton Place's IPZ-1 and IPZ-2. These components include:

- the default IPZ-1 shape which is a semi-circle (200m radius) upstream of the intake, plus a rectangle 400 m long and 10 m wide downstream of the intake
- the in-river IPZ-2 limit, with and without the wind extension
- the anthropogenic transport pathways, including a 120 m buffer
- a 120 m buffer on watercourses
- the Mississippi Valley Conservation Generic Regulation Limit line.

Figure 6-4 shows the complete delineation for the Carleton Place IPZ-1 and IPZ-2. IPZ-1 is approximately 0.09 km^2, and IPZ-2 is approximately 3.9 km^2. Figure 6-4 also shows a portion of the Carleton Place IPZ-3 which is adjacent to IPZ-2. The full IPZ-3 is shown in Figure 6-5. The IPZ-3 is approximately 1,525 km^2 and includes the 120 m on-land buffer. The total area covered by IPZs for the Carleton Place municipal surface water intake is 1529 km^2.

Municipalities which are located within the Carleton Place IPZs are shown in Table 6-3.

Uncertainty

The level of uncertainly associated with the delineation of the Carleton Place Intake Protection Zones is as follows;

- IPZ-1 delineation is assigned a low uncertainty;
- IPZ-2 has a high uncertainty due to the limitations of the numerical model and limited mapping and field data, especially for transport pathways; and
- IPZ-3 are assigned a high uncertainty due to the limited mapping and field data available, especially for transport pathways.

Further details regarding the uncertainty assessment are provided in Appendix 6-3.

6.4.2 Vulnerability Scoring – Carleton Place Intake Protection Zones

The approach used to complete the vulnerability scoring, including the area vulnerability factor (B) and the source vulnerability factor (C), for the Carleton Place intake protection zones is presented in Section 6.3.2. The specific vulnerability scoring inputs and results are discussed below.

Area Vulnerability Factor – IPZ-1

The IPZ-1 area vulnerability factor for the Carleton Place intake is 10 as defined in the Technical Rules.

Area Vulnerability Factor – IPZ-2

The area vulnerability factor for the IPZ-2 may range from 7 to 9. The following table summarizes the specific information, including assumed minimum and maximum values for area vulnerability factor (B) that were used in the analysis to quantify each criteria. For more information on the assumed values, please see Section 6.3.2.

Parameter	Assumed Minimum Value (B = 7)	Assumed Maximum Value (B = 9)	Calculated value for Carleton Place IPZ-2 (based on local data)
Percentage of Area Composed of Land	10 %	90%	72%
Runoff Potential based on land cover/soil type/permeability (CN) and slope	CN =36, Slope = 0.25%	CN =95, Slope = 2%	CN =83, Slope = 1.42%
Transport Pathways (total length / main channel length)	0	9	14.86 km/2.12 km = 7.0

Summary of Specific Information used to determine the Carleton Place IPZ-2 Area Vulnerability Factor (B)

It should be noted that all three calculated values fall well into the higher half of the ranges between the assumed minimum values and the assumed maximum values. The final area vulnerability scoring falls in the higher half (above 8 which is the midpoint) of the predetermined 7-9 range for B and close to the ¾ point in the range.

The table below summarizes the derivation of the IPZ-2 area vulnerability factor (B) for the Carleton Place IPZ-2. It includes the converted area vulnerability values between assumed minimum value (B=7) and assumed maximum value (B=9) for each of the three parameters, as well as the assumed weighting. The factor is then rounded to a whole number.

The final area vulnerability factor for the Carleton Place IPZ-2 is 9.

Parameter	Calculated value for Carleton Place IPZ-2 (based on local data)	Converted B values for Carleton Place IPZ-2 between assumed minimum value (B=7) and assumed maximum value (B=9)		
		$B_{\%LA}$	$B_{CN, Slope}$	B_{TP}
Percentage of Area Composed of Land	72%	8.55		
Runoff Potential based on land cover/soil type/permeability (CN) and slope	CN =83, Slope = 1.42%		8.88	
Transport Pathways (total length / main channel length)	14.86 km/2.12 km = 7.0			8.56
Assumed Weighting		30 %	30%	40%
Weighted Area Vulnerability Factor (B)	**8.65**			
Assigned Area Vulnerability Factor (B)	**9**			

Summary of Scoring for the IPZ-2 Area Vulnerability Factor (B)

Source Vulnerability Factor

As indicated in Section 6.1.4, the source vulnerability factor for Type C intakes, can be either 0.9 or 1. Although there have been no reported water quality incidences and there are no hydraulic structures in close proximity upstream of the intake, the source vulnerability factor was assessed to be 1 for Carleton Place due to the following:

- shallow depth of water intake, 2.2 m below surface at low water level; and
- moderate distance of the intake from shore, 48 m.

Final Vulnerability Scoring for Carleton Place Intake Protection Zones

As presented above, the Carleton Place source vulnerability factor (C) was assessed to be 1. Thus, the final vulnerability scores (V) for each of the zones are the same as the area vulnerability factors (B). Carleton Place's IPZ-1 has a final vulnerability score of 10, IPZ-2 has a score of 9. Figure 6-6 shows the final vulnerability scoring for Carleton Place's IPZ-1 and IPZ-2. Following are the summarized results.

	Area Vulnerability Factor (B) *Expressed as a whole number*			Source Vulnerability Factor (C)	Vulnerability Score (V) *Expressed to one decimal point or as whole number depending on the value of C*		
Zone	**IPZ-1**	**IPZ-2**	**IPZ-3**		**IPZ-1**	**IPZ-2**	**IPZ-3**
Possible Values	*10*	*7 to 9*	*1 to 9*	*0.9 or 1*	*9 or 10*	*6.3 to 9*	*0.9 to 9*
Carleton Place Scores	**10**	**9**	**To be Deter-mined**	**1**	**10**	**9**	**To be Deter-mined**

Summary of Carleton Place IPZ Vulnerability Scoring Results

Uncertainty

The Technical Rules require that uncertainty be categorized as low or high. The level of uncertainly associated with the vulnerability scoring for the Carleton Place Intake Protection Zones is as follows;

- IPZ-1 delineation is assigned a low uncertainty; and
- IPZ-2 is assigned a high uncertainty due to the data available for curve number and length of transport pathways.

Further details regarding the uncertainty assessment are provided in Appendix 6-3.

6.4.3 Managed Lands and Livestock Density – Carleton Place Intake Protection Zones

The method for calculating managed lands and livestock density is described in Section 6.3.3.

The Total Managed Lands for the Carleton Place IPZs are:

- 18.2% of the total IPZ-1 area; and
- 28.3% of the total IPZ-2 area.

The results are provided in Table 6-4 and shown in Figure 6-7.

6.4.4 Impervious Surfaces – Carleton Place Intake Protection Zones

Impervious surfaces are primarily constructed surfaces such as roads and parking lots that are covered by impenetrable materials such as asphalt, concrete and stone. These materials are a barrier to groundwater infiltration. Impervious surfaces also generate more runoff during melt or storm events.

The method for calculating impervious surfaces is described in Section 6.3.4. In the Carleton Place IPZs the percentage of land which has impervious surfaces ranges from 0-75%

6.4.5 Water Quality Threat Assessment – Carleton Place Intake Protection Zones

Water quality threats are existing conditions (e.g. contaminated sediment, soil or surface water) or existing or future land use activities that could contaminate a drinking water supply. A land use inventory was completed in 2008 for IPZ-1 and IPZ-2, and in 2010 for IPZ-3 areas that have a vulnerability score of 8.

It should be noted that a single land use activity can fall into multiple threat categories. For example, a crop farm may have fuel storage, may apply commercial fertilizer to land, and apply agricultural source material to land. Each of these activities is a separate threat category in the provincial table (see Section 4.3), and so therefore each is treated as a separate threat.

A land use activity and associated threats that occur where the vulnerability score is high may result in a determination that it is a significant threat. In many cases, the specific circumstances that apply to a threat category are unknown. Using the same example, a crop farm may have fuel storage, but the volume of fuel stored is unknown. Unless additional information was available, it was assumed that enough material was stored for that activity to be a significant threat.

A total of 10 potentially significant drinking water threats were identified in the Carleton Place IPZ-1 and IPZ-2. The list of identified potentially significant drinking water threats is provided in Table 6-5. The term “Poly” in the table refers to a polygon, or an area that may contain multiple threats. For example, a polygon may be a farm field, representing a single potential threat, or a residential area with an unknown number of septic systems, each which may be a potential threat. The term “Point” in the table refers to a point source. Figure 6-9 shows the areas containing potential significant threats in purple. The size of the area where significant threats may be present is approximately 4 km^2. See Section 4.3.3 for information on the full list of significant, moderate, and low threats.

Transportation Corridors

A number of transportation corridors exist within the Carleton Place IPZs where there may be the transportation of dangerous and/or hazardous goods and the potential for a spill exists. Spills within the IPZs have the potential to impair the surface water quality; however they are not included as threats in this report as they are not listed in the provincial drinking water threats categories issued by MOE, discussed in Section 4-3.

This Assessment Report provides this key information for municipalities and other agencies to assist in ensuring all available information is accessible for emergency response planning purposes. Transportation corridors (e.g. roads, railway lines) can be seen in Figure 6-4.

6.4.6 Issues and Conditions – Carleton Place Intake Protection Zones

As discussed in Chapter 4, issues are documented cases of water quality contamination approaching or exceeding acceptable provincial levels.

No issues were identified for the Carleton Place WTP. However, a number of parameters that exceed the Ontario Drinking Water Standards and Operational

Guidelines are noted below. For the Mississippi River raw water, the following parameters exceed the Ontario Drinking Water Standards and Operational Guidelines:

- aesthetic objectives for turbidity, colour, and DOC; and
- health-related criteria for *E. coli* and total coliforms.

None of the above parameters are considered to be issues as they are known to be naturally occurring and do not represent a problem for the water treatment plant operator. The presence of *E. coli* and total coliforms is not unusual in surface water sources and they are easily removed during the treatment processes.

A condition is a situation where past activities resulted in a drinking water threat in accordance with the criteria found in the Technical Rules. Based on the criteria, there are no confirmed conditions in the Carleton Place IPZs. However, there were two spills noted in the Drinking Water Threats and Issues Technical Report.

6.5 Perth Water Supply

The Tay River is 95 km in length, drains an area of approximately 800 km^2 and has an average annual flow rate of 7.4 m^3/s. A number of lakes are upstream of Perth (e.g. Long, Eagle, Elbow, Crow, Bobs, Christie). Control structures at Eagle Lake and at Bobs Lake are used for flood control and for maintaining summer water flow within the Rideau Canal system.

The Perth WTP is located in Perth, Ontario on the Tay River. It provides treated drinking water to the Town of Perth for approximately 6,000 people each day. Figure 6-10 shows the town boundaries and the location of the municipal surface water intake. The intake is located approximately 4 m from shore and 2 m below the water surface at low water level. Figure 6-11 shows the local setting of the Perth WTP and the municipal surface water intake.

The natural water quality in the Tay River is characterized as generally alkaline, attributed to the limestone bedrock upstream of the WTP intake, but with alkalinity values typically within the ODWSOG Operational Guideline range. Colour and turbidity in the raw water vary seasonally. Regular water quality testing is carried out by the Town of Perth, in both the untreated and treated water and the results are compared with the ODWSOG. *E. coli* and total coliforms are occasionally detected in the untreated source water samples at levels above the ODWSOG, which is common for surface water, and can be removed during treatment. A review of available water quality test results on untreated source water does not show any exceedances except for *E. coli* and total coliforms.

Water from the Tay River is treated at the WTP by first pretreating and screening to remove solids, then mixing it with a coagulant which binds with remaining solids. The coagulant forms into sticky particles (called 'floc'). The floc attracts and traps suspended particles before settling out of the water in large settling tanks. It then collects at the bottom of each settling tank, while the clear water is pumped from the top of the tank. The clear water is filtered through layers of activated carbon, sand and gravel and is disinfected with chlorine and lime is added to adjust for pH. Fluoride is added as the last step before it is distributed. The treated water quality is consistently compliant with the Ontario Drinking Water Standards.

6.5.1 Delineation of the Perth Intake Protection Zones

The steps undertaken to complete the intake protection zone delineation for Perth are presented in Section 6.2.1. The results of the delineation process are discussed below.

Figure 6-12 shows the various components that make up Perth's IPZ-1 and IPZ-2. These components include:

- the default IPZ-1 shape which is a semi-circle (200 m radius) upstream of intake, plus a rectangle 400 m long and 10 m wide downstream of the intake;
- the in-river IPZ-2 limit, with and without the wind extension;
- the anthropogenic transport pathways, including a 120 m buffer;
- a 120 m buffer on watercourses; and
- the Rideau Valley Conservation Generic Regulation Limit line.

Figure 6-13 shows the complete delineation for the Perth IPZ-1 and IPZ-2. The IPZ-1 is approximately 0.06 km^2, and IPZ-2 is approximately 2.9 km^2. Figure 6-14 also shows a part of the Perth IPZ-3 which is adjacent to IPZ-2. The full IPZ-3 is shown in Figure 6-14. The Perth IPZ-3 is approximately 364 km^2. The total area covered by IPZs for the Perth municipal surface water intake is 367 km^2.

Municipalities which are located within the Perth IPZs are shown in Table 6-3.

Uncertainty

The level of uncertainly associated with the delineation of the Perth IPZs is summarized below. The Technical Rules require that uncertainty be assigned as low or high.

- IPZ-1 is assigned a low uncertainty;
- IPZ-2 has a high uncertainty due to the limitations of the numerical model and available flow data; and
- IPZ-3 is assigned a high uncertainty due to the lack of certain digital and field data.

Further details regarding the uncertainty assessment are provided in Appendix 6-3.

6.5.2 Vulnerability Scoring – Perth Intake Protection Zones

The method used to complete the vulnerability scoring, including the area vulnerability factor (B) and the source vulnerability factor (C), for the Perth intake protection zones is presented in Section 6.3.2. The specific vulnerability scoring inputs and results are discussed below.

Area Vulnerability Factor – IPZ-1

The IPZ-1 area vulnerability factor for the Perth intake is 10 as predetermined by the Technical Rules.

Area Vulnerability Factor – IPZ-2

The area vulnerability factors for the IPZ-2 may range from 7 to 9.The table below summarizes the specific information, including assumed minimum and maximum values for area vulnerability factor (B) that were used in the analysis to quantify each criteria. For more information on the assumed values, please see Section 6.3.2.

Parameter	Assumed Minimum Value (B = 7)	Assumed Maximum Value (B = 9)	Calculated value for Perth IPZ-2 (based on local data)
Percentage of Area Composed of Land	10 %	90%	87%
Runoff Potential based on land cover/soil type/permeability (CN) and slope	CN =36, Slope = 0.25%	CN =95, Slope = 2%	CN =85, Slope = 1.26%
Transport Pathways (total length / main channel length)	0	9	13.84 km/2.95 km = 4.7

Summary of Specific Information used to determine the Perth IPZ-2 Area Vulnerability Factor (B)

It should be noted that two of the three calculated values fall well into the higher half of the ranges between the assumed minimum values and the assumed maximum values, with transport pathways falling just above the midpoint. Since weighting is fairly even with a slightly higher percentage given to transport pathways, the final area vulnerability scoring will fall in the higher half (above 8 which is the midpoint) of the predetermined 7-9 range for B.

The following table summarizes the derivation of the IPZ-2 area vulnerability factor (B) for the Perth IPZ-2. It includes the converted area vulnerability values between assumed minimum value (B=7) and assumed maximum value (B=9) for each of the three parameters, as well as the assumed weighting.

The final area vulnerability factor for the Perth IPZ-2 is 9.

Parameter	Calculated value for Perth IPZ-2 (based on local data)	Converted B values for Perth IPZ-2 between assumed minimum value (B=7) and assumed maximum value (B=9)		
		$B_{\%LA}$	$B_{CN, Slope}$	B_{TP}
Percentage of Area Composed of Land	87%	8.92		
Runoff Potential based on land cover/soil type/permeability (CN) and slope	CN =85, Slope = 1.26%		8.88	
Transport Pathways (total length / main channel length)	13.84 km/2.95 km = 4.7			8.04
Assumed Weighting		30 %	30%	40%
Weighted Area Vulnerability Factor (B)	**8.56**			
Assigned Area Vulnerability Factor (B)	**9**			

Summary of Scoring for Perth IPZ-2 Area Vulnerability Factor (B)

Source Vulnerability Factor

Although there have been no reported water quality incidences and there are no hydraulic structures in close proximity upstream of the intake, the source vulnerability factor was assessed to be 1.0 for Perth due to the:

- shallow depth of intake (2 m)
- short distance of the intake from shore (4 m).

Final Vulnerability Scoring for Perth IPZs

As presented above, the Perth source vulnerability factor (C) was assessed to be 1. Thus, the final vulnerability scores (V) for each of the zones are the same as the area vulnerability factors (B).

Perth's IPZ-1 has a final vulnerability score of 10, IPZ-2 a score of 9. The results are summarized below. Figure 6-15 shows the final vulnerability scoring for Perth's IPZ-1 and IPZ-2.

	Area Vulnerability Factor (B) *Expressed as a whole number*			**Source Vulnerability Factor (C)**	**Vulnerability Score (V)** *Expressed to one decimal point or as whole number depending on the value of C*		
Zone	**IPZ-1**	**IPZ-2**	**IPZ-3**		**IPZ-1**	**IPZ-2**	**IPZ-3**
Possible Values	*10*	*7 to 9*	*1 to 9*	*0.9 or 1*	*9 or 10*	*6.3 to 9*	*0.9 to 9*
Perth Scores	**10**	**9**	**To be deter-mined**	**1**	**10**	**9**	**To be deter-mined**

Summary of Perth IPZ Vulnerability Scoring Results

Uncertainty

The level of uncertainly associated with the vulnerability scoring of the Perth IPZs is summarized below. Further details regarding the uncertainty assessment are provided in Appendix 6-3.

- IPZ-1 vulnerability scoring for Perth is assigned low uncertainty as its value is predetermined by the Technical Rules.
- IPZ-2 is assigned a high uncertainty due to the data available for curve number and length of transport pathways.
- IPZ-3 is assigned a high uncertainty due to the available data on land use and soils.

6.5.3 Managed Lands and Livestock Density – Perth Intake Protection Zones

The method for calculating managed lands and livestock density is described in Section 6.3.3.

The Total Managed Lands for the Perth IPZs are:

- 35% of the total IPZ-1 area; and
- 42.4% of the total IPZ-2 area.

The results are provided in Table 6-4 and and shown in Figure 6-16, which also shows the various scores for IPZ-3.

6.5.4 Impervious Surfaces – Perth Intake Protection Zones

Impervious surfaces are primarily constructed surfaces such as roads and parking lots that are covered by impenetrable materials such as asphalt, concrete and stone. These materials are a barrier to groundwater infiltration. Impervious surfaces also generate more runoff during melt or storm events.

The method for calculating impervious surfaces is described in Section 6.3.4. Figure 6-17 shows the impervious surfaces for Perth. In the Perth IPZs the percentage of land which has impervious surfaces ranges from 0-81%.

6.5.5 Water Quality Threat Assessment – Perth Intake Protection Zones

Water quality threats are existing conditions (e.g. contaminated sediment, soil or surface water) or existing or future land use activities that could contaminate a drinking water supply. A land use inventory was completed in 2008 for IPZ-1 and IPZ-2.

It should be noted that a single land use activity could fall into multiple threat categories. For example, a crop farm may have storage of fuel, may apply commercial fertilizer to land, and apply agricultural source material to land. Each of these activities is a separate threat category in the provincial table, and so each is therefore a separate threat.

Land use activities and associated threats that occur where the vulnerability score is high may result in determining it to be a significant threat. In many cases, the specific circumstances that apply to a threat category are unknown. Using the same example, a crop farm may have fuel storage, but the volume of fuel stored is unknown. Unless additional information was available, it was assumed that enough material was stored for that activity to be a significant threat.

A total of 13 potentially significant drinking water threats were identified in the Perth IPZ-1 and IPZ-2. The list of identified potential significant drinking water threats is provided in Table 6-6. The term "Poly" in the table refers to a polygon, or an area that may contain multiple threats. For example, a polygon may be a farm field, representing a single potential threat, or a residential area with an unknown number of septic systems, each which may be a potential threat. The term "Point" in the table refers to a point source. Figure 6-18 shows the areas containing potentially significant threats in purple. The size of the area where significant threats may be present is approximately 3 km^2. See Section 4.3.3 for information on the full list of significant, moderate, and low threats.

Transportation Corridors

A number of transportation corridors exist within the Perth IPZs where there may be the transportation of dangerous and/or hazardous goods and the potential for a spill exists. Spills within the IPZs have the potential to impair the surface water quality however they are not included as threats as per the prescribed drinking water threats categories (see Section 4-3).

This Assessment Report provides this key information for municipalities and other agencies to assist in ensuring all available information is accessible for emergency response planning purposes. Transportation corridors are shown in Figure 6-13, Perth IPZ-1 and IPZ-2.

6.5.6 Issues and Conditions – Perth Intake Protection Zones

As discussed in Chapter 4, issues are documented cases of water quality contamination approaching or exceeding acceptable provincial levels. No issues were identified for the Perth WTP. However, parameters that exceed the Ontario Drinking Water Standards and Operational Guidelines are noted below. For the Tay River raw water, the following parameters exceed the Ontario Drinking Water Standards and Operational Guidelines:

- health-related criteria for *E. coli* and total coliforms.

The parameters are not considered to be issues as they are known to be naturally occurring and do not represent a problem for the water treatment plant operator. The presence of *E. coli* and total coliforms is not unusual in surface water sources and they are easily removed during the treatment processes.

A golf course located just upstream of the Perth municipal surface water intake, provides the Town of Perth with a list of chemicals that are applied on the golf course in the spring and fall of each year. The Town tests raw water samples for these potential contaminations immediately after each application. To date, none of the chemicals have been detected in the raw water samples.

A condition is a situation where past activities resulted in a drinking water threat in accordance with the criteria found in the Technical Rules. Based on the criteria, there are no confirmed conditions in the Perth IPZs. However, there were two spills noted in the Drinking Water Threats and Issues Technical Report.

6.6 Smiths Falls Water Supply

The Rideau River is 146 km in length, drains an area of approximately 4,100 km^2 and has an average annual flow rate of 14 m^3/s. The river is a ‘regulated’ waterway as it has several dams, operated by Parks Canada – Rideau Canal, which control water levels and flows in the river. The Rideau River flows north from Upper Rideau Lake and empties into the Ottawa River at Rideau Falls.

The Smiths Falls WTP is located in Smiths Falls, Ontario on the Rideau River. It provides treated drinking water to the Town of Smiths Falls for approximately 10,000 people each day. Figure 6-19 shows the town boundaries and the location of the municipal surface water intake. Smiths Falls WTP has two municipal surface water intakes (main and auxiliary). The main intake is located approximately 30 m from shore and 1.8 m below the top of the water surface during low flow levels. Figure 6-20 shows the local setting of the Smiths Falls WTP and the intake locations.

The natural water quality in the Rideau River is characterized as generally soft, with elevated colour levels and slightly elevated Dissolved Organic Carbon (DOC). Alkalinity of the raw water is usually within the ODWSOG Operational Guideline range. Regular water quality testing is carried out by the Town of Smiths Falls, in both the un-treated and treated water and the results are compared with the ODWSOG. *E. coli* and total coliforms are sometimes detected in the untreated samples at levels above the ODWSOG, which is common for surface water, and can be removed during treatment. A review of available untreated water quality results indicates that colour and DOC exceed the ODWSOG aesthetic objectives.

Raw water from the Rideau River is treated at the WTP by first screening the raw water as it enters the water intake to remove large solids and debris. Low lift pumps then pump the water to the AquaDAF which is a high rate dissolved air floatation clarifier. A coagulant & polymer are added to aid in the removal of particles. The clarified water from the AquaDAF flows to the filters which comprise of granular activated carbon (GAC) & sand. The treated water passes through ultraviolet reactors, at which point the water is chlorinated for disinfection purposes along with a chemical for pH adjustment. The water then flows to the in-ground reservoir where it is stored before it is pumped to the distribution system. Fluoride is added as it is pumped to the distribution system. The treated water quality is consistently compliant with the Ontario Drinking Water Standards.

6.6.1 Delineation of the Smiths Falls Intake Protection Zones

The steps undertaken to complete the intake protection zone delineation for Smiths Falls are presented in Section 6.3.1. The results of the delineation process are discussed below.

Figure 6-21 shows the various components that make up Smiths Falls IPZ-1 and IPZ-2. The components include:

- the default IPZ-1 shape which is a semi-circle (200 m radius) upstream of main intake with a 10 m extension in the water around the structures in the northwest corner of the IPZ-1, plus a rectangle 400 m long and 187 m wide downstream of the main intake and extending downstream of the auxiliary intake;
- the in-river IPZ-2 limit, with and without the wind extension;
- the anthropogenic transport pathways, including a 120 m buffer;
- a 120 m buffer on watercourses; and
- the Rideau Valley Conservation Generic Regulation Limit line.

Figure 6-22 shows the complete delineation for the Smiths Falls IPZ-1 and IPZ-2. The IPZ-1 is approximately 0.14 km^2, and IPZ-2 is approximately 3.5 km^2. Figure 6-24 also shows a part of the Smiths Falls IPZ-3 which is adjacent to IPZ-2. The full IPZ-3 is shown in Figure 6-23. The IPZ-3 is approximately 864 km^2 which includes the 120 m on-land buffer. The total area covered by IPZs for the Smiths Falls municipal surface water intake is 869 km^2.

Municipalities which are located within the Smiths Falls IPZs are shown in Table 6-3.

Uncertainty

The level of uncertainly associated with the delineation of the Smiths Falls Intake Protection Zones follows:

- IPZ-1 delineation for Smiths Falls has low uncertainty;
- IPZ-2 delineation has a high uncertainty due to the level of model precision and accuracy;
- IPZ-3 is assigned a high uncertainty due to a lack of certain digital and field data.

Further details regarding the uncertainty assessment are provided in Appendix 6-3.

6.6.2 Vulnerability Scoring – Smiths Falls Intake Protection Zones

The approach used to complete the vulnerability scoring, including the area vulnerability factor (B) and the source vulnerability factor (C), for the Smiths Falls intake protection zones is presented in Section 6.2.2. The specific vulnerability scoring inputs and results are discussed below.

Area Vulnerability Factor – IPZ-1

The IPZ-1 area vulnerability factor for the Smiths Falls intakes is 10 as predetermined by the Technical Rules.

Area Vulnerability Factor – IPZ-2

The area vulnerability factors for the IPZ-2 may range from 7 to 9. The table below summarizes the specific information, including assumed minimum and maximum values for area vulnerability factor (B) that were used in the analysis to quantify each criteria.

Parameter	Assumed Minimum Value (B = 7)	Assumed Maximum Value (B = 9)	Calculated value for Smiths Falls IPZ-2 (based on local data)
Percentage of Area Composed of Land	10 %	90%	47%
Runoff Potential based on land cover/soil type/permeability (CN) and slope	CN =36, Slope = 0.25%	CN =95, Slope = 2%	CN =91, Slope = 0.45%
Transport Pathways (total length / main channel length)	0	9	3.57 km/1.90 km = 1.9

Summary of Specific Information used to determine the IPZ-2 Area Vulnerability Factor

It should be noted that of the three calculated values the land area falls just below the midpoint between the assumed minimum values and the assumed maximum values. The curve number falls at the high end of the range while the slope is at the lower end. Transport pathways are much lower than those found at the two previously discussed inland WTPs and are much lower than the midpoint. Since weighting is fairly even with a slightly higher percentage given to transport pathways, the final area vulnerability scoring will likely fall in the lower half (below 8 which is the midpoint) of the predetermined 7-9 range for the area vulnerability factor.

The following table summarizes the derivation of the IPZ-2 area vulnerability factor (B) for the Smiths Falls IPZ-2. It includes the converted area vulnerability values between assumed minimum value (B=7) and assumed maximum value (B=9) for each of the three parameters, as well as the assumed weighting.

The final area vulnerability factor for the Smiths Falls IPZ-2 is 8.

Parameter	Calculated value for Smiths Falls IPZ-2 (based on local data)	Converted B values for Smiths Falls IPZ 2 between assumed minimum value (B=7) and assumed maximum value (B=9)		
		$B_{\%LA}$	$B_{CN,\ Slope}$	B_{TP}
Percentage of Area Composed of Land	47%	7.93		
Runoff Potential based on land cover/soil type/permeability (CN) and slope	CN =91, Slope = 0.45%		8.80	
Transport Pathways (total length / main channel length)	3.57 km/1.90 km = 1.9			7.42
Assumed Weighting		30 %	30%	40%
Weighted Area Vulnerability Factor (B)	**7.98**			
Assigned Area Vulnerability Factor (B)	**8**			

Summary of Scoring for the IPZ-2 Area Vulnerability Factor

Source Vulnerability Factor

Although there have been no reported water quality incidences and there are no hydraulic structures upstream of the main intake, the source vulnerability factor was assessed to be 1 for Smiths Falls due to:

- the shallow depth of the main intake (1.8 m);
- the moderate distance of the intake from shore (30 m); and
- the presence of a hydraulic structure upstream of the auxiliary intake.

Final Vulnerability Scoring for Smiths Falls IPZs

As presented above, the Smiths Falls source vulnerability factor (C) was assessed to be 1. Thus, the final vulnerability scores (V) for each of the zones are the same as the area vulnerability factors (B). Smiths Falls IPZ-1 has a final vulnerability score of 10 and IPZ-2 a score of 8. The results are summarized below. Figure 6-24 shows the final vulnerability scoring for Smiths Falls IPZ-1 and IPZ-2.

	Area Vulnerability Factor (B) *Expressed as a whole number*			**Source Vulnerability Factor (C)**	**Vulnerability Score (V)** *Expressed to one decimal point or as whole number depending on the value of C*		
Zone	**IPZ-1**	**IPZ-2**	**IPZ-3**		**IPZ-1**	**IPZ-2**	**IPZ-3**
Possible Values	*10*	*7 to 9*	*1 to 9*	*0.9 or 1*	*9 or 10*	*6.3 to 9*	*0.9 to 9*
Smiths Falls Scores	**10**	**8**	**1 to 7**	**1**	**10**	**8**	**1 to 7**

Summary of Smiths Falls IPZ Vulnerability Scoring Results

Uncertainty

The level of uncertainly associated with the vulnerability scoring of the Smiths Falls Intake Protection Zones is summarized below.

- IPZ-1 vulnerability scoring for Smiths Falls is assigned low uncertainty as its value is predetermined by the Technical Rules; and
- IPZ-2 is assigned a high uncertainty due to the uncertainty of the curve number value and length of transport pathways.

Further details regarding the uncertainty assessment are provided in Appendix 6-3.

6.6.3 Managed Lands and Livestock Density – Smiths Falls Intake Protection Zones

The method for calculating managed lands and livestock density is described in Section 6.3.3.

The Total Managed Lands for the Smiths Falls IPZs is:

- 23.8% of the total IPZ-1 area; and
- 13.4% of the total IPZ-2 area.

The results are provided in Table 6-4 and shown in Figure 6-25.

6.6.4 Impervious Surfaces – Smiths Falls Intake Protection Zones

Impervious surfaces are primarily constructed surfaces such as roads and parking lots that are covered by impenetrable materials such as asphalt, concrete and stone. These materials are a barrier to groundwater infiltration. Impervious surfaces also generate more runoff during melt or storm events.

The method for calculating impervious surfaces is described in Section 6.3.4. Figure 6-26 shows the impervious surfaces in Smiths Falls. In the Smiths Falls IPZs the percentage of land which has impervious surfaces ranges from 0-81%.

6.6.5 Water Quality Threat Assessment – Smiths Falls Intake Protection Zones

Water quality threats are existing conditions (e.g. contaminated sediment, soil or surface water) or existing or future land use activities that could contaminate a drinking water supply. A land use inventory was completed in 2008 for IPZ-1 and IPZ-2.

It should be noted that a single land use activity could fall into multiple threat categories. For example, a crop farm may have storage of fuel, may apply commercial fertilizer to land, and apply agricultural source material to land. Each of these activities is a separate threat category in the provincial threats table (see Section 4.3), and so each is therefore a separate threat.

Land use activities and associated threats that occur where the vulnerability score is high may result in determining it to be a significant threat. In many cases, the specific circumstances that apply to a threat category are unknown. Using the same example, a crop farm may have fuel storage, but the volume of fuel stored is unknown. Unless additional information was available, it was assumed that enough material was stored for that activity to be a significant threat.

A total of 5 potentially significant drinking water threats were identified in the Smiths Falls IPZ-1 and IPZ-2. The list of identified potential significant drinking water threats is provided in Table 6-7. The term “Poly” in the table refers to a polygon, or an area that may contain multiple threats. For example, a polygon may be a farm field, representing a single potential threat, or a residential area with an unknown number of septic systems, each which may be a potential threat. The term “Point” in the table refers to a point source. Figure 6-27 shows the areas containing potential significant threats in purple. The size of the area where significant threats may be present is approximately 3.6 km^2. See Section 4.3.3 for information on the full list of significant, moderate, and low threats.

Transportation Corridors

A number of transportation corridors exist within the Smiths Falls IPZs where there may be the transportation of dangerous and/or hazardous goods and the potential for a spill exists. Spills within the IPZs have the potential to impair the surface water quality however they are not included as threats as they are not included in the provincial drinking water threats categories (see Section 4-3).

This Assessment Report provides this key information for municipalities and other agencies to assist in ensuring all available information is accessible for emergency response planning purposes. Transportation corridors (e.g. roads and railway lines) are shown in Figure 6-20.

6.6.6 Issues and Conditions – Smiths Falls Intake Protection Zones

As discussed in Chapter 4, issues are documented cases of water quality contamination approaching or exceeding acceptable provincial levels. No issues were identified for the Smiths Falls WTP. However, a number of parameters that exceed the Ontario Drinking Water Standards and Operational Guidelines are noted below.

For the Rideau River raw water, the following parameters exceed the Ontario Drinking Water Standards and Operational Guidelines:

- aesthetic objectives for turbidity, colour, and DOC; and
- health-related criteria for *E. coli* and total coliforms.

None of the above parameters are considered to be issues as they are known to be naturally occurring and do not represent a problem for the water treatment plant operator. The presence of *E. coli* and total coliforms is not unusual in surface water sources and they are easily removed during the treatment processes.

Staff from the Town of Smiths Falls has indicated that there is a community concern with the taste and odour of the drinking water. Taste and odour become more pronounced during the summer months, most likely due to higher temperatures, increased organics concentrations and algae blooms. The Town has added granular activated carbon filters to address the taste and odour problems.

The drinking water has been tested for pesticides due to the presence of a golf course located approximately 0.5 km upstream of the intake. Pesticides have not been detected.

A condition is a situation where past activities resulted in a drinking water threat in accordance with the criteria found in the Technical Rules. Based on the criteria, there are no confirmed conditions in the Smiths Falls IPZs. However, there was one spill and one contaminated site noted in the Drinking Water Threats and Issues Technical Report.

6.7 Type C: Ottawa River Intake Protection Zones in the Mississippi-Rideau Source Protection Region

This section provides information on the two municipal surface water intakes in the Ottawa River which supply the City of Ottawa.

6.7.1 Delineation of Type C: Ottawa River Intake Protection Zones

The following steps were undertaken to complete the intake protection zone delineation for the municipal intakes at Britannia and Lemieux Island.

Collection and assembly of data and information

Local hydrology and climate data was collected from federal, provincial, and municipal governments as well as other sources. This included the generic regulation limit lines for the study area, as maintained by the Rideau Valley and Mississippi Valley Conservation Authorities. Areas within the generic regulation limit identify lands that could be unsafe for development due to naturally occurring processes associated with flooding, erosion, dynamic beaches or unstable soil or bedrock.

The characteristics of the surface water intakes and surrounding land uses were determined through site visits, discussions with municipal staff, and review of available records and reports. In the summer of 2007, a hydrographic survey was conducted to map the riverbed topography from the Deschênes

Rapids to the Chaudière Dam. Current measurements were also carried out to develop a better understanding of the river flow conditions around the intakes.

Delineation of IPZ-1

As discussed in Section 6.1.3, the IPZ-1 is directly adjacent to the surface water intake. The Technical Rules outline how to create IPZ-1. For Type C intakes, IPZ-1 can be created using a;

- one kilometre radius (centred on the intake) or
- 200 m radius (centered on the intake) upstream of intake, plus a rectangle 400 m long and ten m wide downstream of the intake.

The first method is more appropriate for intakes located in large surface water features such as lakes, where there is little or no flow. The second of the two methods listed above was selected for the Ottawa River municipal water intakes in the MRSPR because, unlike a lake, the river has a continuous downstream flow.

The Technical Rules also state that the dimensions of IPZ-1 may be modified to suite "local hydrodynamic conditions". For both the Britannia and Lemieux Island water intakes, IPZ-1 was modified from a semi-circle to a complete circle with a radius of 200 m. This was done to allow for the potential influence of winds on surface currents in the vicinity of the intakes. Where IPZ-1 intersected the shore, it was expanded to a setback of 120 ms from the high water mark or the Conservation Authority generic regulation limit, whichever was greater.

Development of computer models

A computer model was used to determine the flow rates upstream of the municipal water intake. The datasets collected were used to develop a general understanding of the local surface water system. Then, an appropriate surface water computer model was chosen to suit the conditions being modelled.

For both the Britannia and Lemieux Island intakes, the MIKE21 model was used to refine the river's bathymetry (the picture of the terrain of the river bed), and then another model, MISED, was used to delineate the in-river portion of IPZ-2. MISED is a three-dimensional numerical model that has the ability to handle the accelerated current speeds that occur in rapids. The MISED model was calibrated against measured current data collected in August 2007, and then utilized to determine the current patterns in the river and around the intakes.

Delineation of IPZ-2

As discussed in Section 6.1.3, the IPZ-2 was based, in part, on the distance upstream from the intake that represents how long a contaminant in the water takes to travel a minimum of two hours.

Under the provincial Technical Rules, the required ToT must be equal to or less than the time that is sufficient to allow operators to shut down the water treatment plant in the event of a spill. Since the Britannia and Lemieux Island plants both take less than 30 minutes to shut down after detection or notification, the time of travel was set to the minimum 2 hour limit.

In-river

The MISED model defined the outer limits of IPZ-2 using the two hour ToT, as defined by the Technical Rules. The equivalent of the river's bankfull velocity was also required and this was represented by using the two year return period flow, which is considered to be representative of bankfull conditions.

The bankfull flow for the Ottawa River is 3100 m^3/s. The outer limits of IPZ-2 were also extended to take into account wind effects on the time of travel in the river. Additional modeling was carried out at low flow conditions to investigate the potential effluent discharged from a large area of stormwater catchments located to the south of the Lemieux intake. The results of the additional modeling helped define the limits of IPZ-2 south of the Lemieux Island intake.

On-land

For both Britannia and Lemieux Island, the inland portion of IPZ-2 is governed by storm sewer systems. To include the drainage areas of these systems, the distances inland were calculated using established hydraulic formulations based on flows through the sewer pipe network. For nearby tributaries, the distance upstream was also calculated using an established hydrological formula.

According to the Technical Rules, the outer boundary of IPZ-2 is a setback of 120 m from the high water mark, or the generic regulation limits line (as developed and maintained by the RVCA), whichever is greater.

Québec and the Ottawa IPZ-2 Delineation

Although the MRSPR does not extend across the provincial border, which essentially runs down the centre of the Ottawa River, sufficient information was obtained from the Ville de Gatineau that permitted a preliminary assessment of the delineation of IPZ-2 into Quebec. The preliminary IPZ-2 shown for Quebec is for information purposes only.

Delineation of IPZ-3

For intakes located on the Ottawa River, the Technical Rules prescribe an Event-Based Approach (EBA) that considers the dispersion of a contaminant spill within the watershed. The EBA results in the delineation of an IPZ-3 which includes the areas beyond IPZ-1 and IPZ-2 that could contribute contaminants to the intake if a spill occurred during an extreme weather event. IPZ-3 zones for the Britannia and Lemieux Island intakes were delineated using a worst case scenario model. Under the Technical Rules IPZ-3 is delineated using the 1:100 year flow. This differs from the standard approach for other inland rivers, which is to include all rivers, streams, and lakes upstream of the intake by 120 m, or the generic regulation limit line.

The first step in the EBA is to delineate an IPZ-3 based on considerations of extreme high flow event conditions, in this case the 100 year flood conditions, and an understanding of how contaminants may be transported to the intake.

The EBA then allows activities to be identified as a significant drinking water threat if it can be shown through modeling that a release of a specific contaminant from an activity would result in an issue at the municipal water intake.

Potential contaminant spill threats were identified. Due to the large dilution potential of the Ottawa River, it was considered that only catastrophic large-volume contaminant releases would have a potential impact at the intakes. Thus, the "worst case" scenarios would result from spills on transportation corridors, such as rail and road crossings on the key waterways.

Approximately 65 road crossings and 10 rail crossings were identified upstream of the IPZ-2.

Using different spill scenarios, the concentrations at the Britannia and Lemieux Island drinking water intakes were estimated. The calculations started with potential spill sites directly at the Ottawa River, then proceeded up each major tributary until the point at which no significant impact on drinking water quality at the municipal intake was found. A setback of 120 m was applied to all tributaries.

Chalk River and the Ottawa IPZ-3 Delineation

The Chalk River Nuclear Laboratory is situated on the Ottawa River approximately 180 km upriver of the City of Ottawa. In December of 1988, a tritium spill occurred at the facility that eventually reached the Ottawa intakes approximately 16 days later with peak concentrations observed at the Britannia WTP 23 days later. Although no drinking water standards were exceeded at that time, provincial standards are currently being reviewed by the Ontario Drinking Water Advisory Council. If provincial standards for allowable levels for tritium are lowered significantly in the future, a similar spill could result in levels exceeding provincial limits at Ottawa’s municipal intakes. The Technical Rules state that IPZ-3 is to terminate at the edge of the Source Protection Region, which for the Ottawa River is near the mouth of the Mississippi River, but for discussion purposes a secondary IPZ-3 was extended beyond the Source Protection Region to include the Chalk River facility.

Inclusion of Transport Pathways

The final step in the IPZ delineation process was to expand the preliminary IPZ-2 and IPZ-3 zones where transport pathways are present. Transport pathways are natural or anthropogenic features such as natural tributaries, roadways and ditches. The ToT up the transport pathways was determined by either a ToT formula. The distance up the transport pathways was calculated so the sum of the ToT in the river and the ToT in the transport pathway was equal to two hours.

6.7.2 Vulnerability Scoring of Type C: Ottawa River Intake Protection Zones

As presented in Section 6.1.4, the vulnerability score is based on the following equation: **V = B x C**

Where:

V is the vulnerability score
B is the area vulnerability factor
C is the source vulnerability factor

The Technical Rules identify the possible IPZ area vulnerability score (B) values.

- **IPZ-1** is always 10;
- **IPZ-2** may be 7, 8, or 9, same score throughout; and
- **IPZ-3** 1 to 9, must not be higher than IPZ-2, score varies.

For a Type C intake, the source vulnerability factor, C can be either 0.9 or 1. The source vulnerability factor is the same for IPZ-1, IPZ-2 and IPZ-3.

The methodologies used to determine B for IPZ-2 and IPZ-3 are presented below. This is followed by the methodology used to determine C.

Determination of Area Vulnerability Factor (B) for IPZ-2

Similar to the three inland intakes, at each of the Ottawa River intakes the area vulnerability factor (B) for IPZ-2 was established based on a numerical approach involving a weighted combination of the factors required to be considered in the Technical Rules:

- Percentage of area of IPZ-2 that is land. This factor reflects the assumption that as the percentage of land within an IPZ increases, the potential risk increases for a spill to occur that may impact water quality at the water intake.
- The land cover, soil type, permeability of the land and the slope of the land. This factor reflects the potential for overland water flow into the zone. Vegetation presence, as well as the type of vegetation, will affect the percentage of overland water flow which occurs and how much of the water infiltrates the ground. Permeable soils allow for increased infiltration. Slopes increase the percentage of overland flow compared to the amount of infiltration.
- The hydrological and hydrogeological conditions where transport pathways are located. This factor reflects the extent of the transport pathways and sewer systems that may exist in the zone and their influence on water (and potential contaminant) movement from land to rivers which are the source of water intakes.

The following four parameters were developed to account for the three factors listed previously:

- Percentage of area composed of land;
- Type of land use;
- % imperviousness of the land; and
- Extent of transport pathways.

Four parameters used for Area Vulnerability Factor (B)	Assumed Minimum Value (B = 7)	Assumed Maximum Value (B = 9)	Assumed Weighting
Percentage of Area Composed of Land	10 %	90%	33.3%
Type of Land Use	- Natural land cover was scored as 7 - Agricultural, open space was scored as 8 - Mainly developed land was scored as 9		16.65%
% Imperviousness of the Land	0%	80%	16.65%
Extent of Transport Pathways	Transport pathways were classified on the basis of the percentage of the preliminary IPZ-2 land area that is drained by storm sewer systems. - <10% of the land area was scored as 7 - 10 to 50% of the land area was scored as 8 - >50% of the land area was scored as 9		33.3%

Determination of Area Vulnerability Factor

Appendix 6-4 provides additional details in the vulnerability scoring methodology for Type C: Ottawa River Intake Protection Zones.

Determination of Source Vulnerability Factor (C)

At each of the Ottawa River intakes, the source vulnerability factor (C) was established based on a numerical approach involving a weighted combination of the following factors:

- the depth of the intake below the water surface (the deeper the intake, the lower the vulnerability);
- the distance of the intake from land (the further away from shore, the lower the vulnerability); and
- the number of recorded drinking water quality issues at the intake, if any, based on required water quality monitoring and a voluntary drinking water surveillance program.

Each factor was assigned an equal weighting. The following assumptions were made in order to quantify the range of possible intake designs that might be encountered in practice.

Low Vulnerability

A deep water intake represents a low vulnerability scenario. Based on the provincial boundary line and the bathymetric features of the river within the study domain, an intake representing the lowest bracket of vulnerability would be located in water depths of less than 15 m, and up to 1000 m offshore.

High Vulnerability

An example of a high vulnerability within the source protection region might be a shallow intake located adjacent or close to the shore in a small river. Such an intake might have a depth of 2 m.

Factors used for Source Vulnerability Factor (C)	Assumed Minimum Value (C = 0.9)	Assumed Maximum Value (C = 1)	Assumed Weighting
Depth of Intake	15 metres	2 metres	33.3%
Distance of the Intake from land	1000 metres	0 metres	33.3%
Historical Water Quality Issues	A value of 0.9 was assumed if there were no water quality concerns at Intake	A value of 1 was assumed if persistent or chronic water quality concerns were present at Intake	33.3%

Source Vulnerability Weighting for Ottawa River Surface Water Intakes

The assumed minimum and maximum source vulnerability factor (C) values for each of the three factors as well as the assumed weighting factors used at each of the three intakes is presented below. The Technical Rules do not specify how weighting is to be determined so weighting was distributed equally for the Ottawa River municipal surface water intakes.

Source Vulnerability (C) Determination

The actual or calculated value for each of the factors (e.g., depth of intake = 7 ms) was converted between the minimum and maximum allowable values of C=0.9 and C=1. Results for the Britannia municipal surface water intake are shown in Section 6.7.2 and for the Lemieux Island municipal surface water intake in Section 6.8.2.

6.8 Ottawa Water Supply – Britannia

The Ottawa River is 1,130 km in length, drains an area of approximately 146,000 km^2 in both Ontario (35%) and Quebec (65%), and has an average annual flow rate of 1,200 m^3/s (near Britannia). The river originates northwest of Ottawa east of the Dozois Reservoir in Quebec. It then flows west into Lake Timiskaming and southeast before it discharges into the St. Lawrence River west of Montreal, Quebec. Over most of its length, the river forms the inter-provincial boundary between Ontario and Quebec.

The Britannia WTP is one of two water treatment plants in the City of Ottawa, Ontario on the Ottawa River. The Britannia and Lemieux Island WTPs provide treated drinking water to the City of Ottawa for approximately 814,000 people each day. The Britannia municipal surface water intake is located approximately 300 m from shore and seven m below the water surface in the Ottawa River. Figure 6-31 shows the location of the municipal surface water intake.

As shown on Figure 6-28, the Britannia WTP is situated along a section of the river that extends from the Chaudière Dam upstream to Lac Deschênes. This segment of the river is unique and hydraulically complex due to the presence of several sets of rapids, a number of islands, and the Chaudière Dam. These physical features make this section of the river non-navigable for most watercraft, although canoes and kayaks are often seen in this reach. Large cribs made of wood and rock are remnants of the logging industry and were used to anchor large log booms. These permanent mooring stations are scattered throughout this part of the river, some sitting only inches below the water surface making navigation very hazardous, even for small boats.

The natural water quality in the Ottawa River is characterized as soft water with a low alkalinity. Regular water quality testing is carried out by the City of Ottawa in both the untreated and treated water and the results are compared with the Ontario Drinking Water Standards (ODWS). Hardness is below the ODWS – Operational Guidelines range. *E. coli* is present in some of the untreated source water samples, which is common for surface water, and can be removed during treatment. A review of available untreated water quality results indicates that turbidity, colour and DOC exceed the ODWS aesthetic objectives and alkalinity also exceeds the ODWS – operational guidelines.

Raw water from the Ottawa River is treated at the Britannia WTP by screening the water at the intake to remove larger debris and then mixing the water with a coagulant which binds with suspended particles within the water. The coagulant forms into sticky particles (called ‘floc’), which attract and trap suspended particles before settling at the bottom of large settling tanks. The clear water from the top of the tank is then filtered through layers of anthracite, sand, and gravel. The filtered water is then disinfected, sodium hydroxide is added to adjust for pH (as well as to help reduce pipe corrosion), and fluoride is added before the water is ready for distribution. The treated water quality is consistently compliant with the Ontario Drinking Water Standards.

A tritium spill into the Ottawa River at the Chalk River nuclear laboratory in 1988 reached the City of Ottawa in approximately 16 days. Peak concentrations in the water were approximately 420 Bq/L which was below the ODWS maximum acceptable concentration of 7000 Bq/L. However, the allowable levels are currently being reviewed by the Ontario Drinking Water Advisory Council. It is possible that the allowable levels will be significantly reduced in the future. If a similar spill should occur, the peak concentrations in the water could be above the new standard. The City of Ottawa has indicated that untreated water is tested at least weekly for tritium and concentrations are usually below the laboratory detection limit of 5.0 Bq/L.

6.8.1 Delineation of Britannia Intake Protection Zones

The steps undertaken to complete the intake protection zone delineation for Britannia are presented in Section 6.7.1. The results of the delineation process are discussed below.

Figure 6-30 shows the various components that make up Britannia's IPZ-1 and IPZ-2. The components include:

- the default IPZ-1 shape which is circle (200 m radius) around the intake;
- the in-river IPZ-2 limit based on reverse particle tracking;
- the anthropogenic transport pathways (storm sewersheds) including a 120 m buffer; and
- the Mississippi Valley/Rideau Valley Conservation Generic Regulation Limit line.

Figure 6-31 shows the complete delineation for the Britannia IPZ-1 and IPZ-2. IPZ-1 is approximately 0.13 km^2, and IPZ-2 is approximately 31 km^2. Figure 6-32 shows the Britannia IPZ-1 and IPZ-2, including the Quebec side of the Ottawa River. The full extent of IPZ-3 within the MRSPR is shown in Figure 6-33 for the Britannia intake. The total area of the IPZ-3 within the MRSPR is 335 $km^{2.}$ Figure 6-34 illustrates the extent of the IPZ-3 if the Chalk River nuclear facility were to be considered. The total area covered by IPZs for the Britannia municipal surface water intake is 366 km^2.

Municipalities which are located within the Britannia IPZs are shown in Table 6-3.

Uncertainty

The level of uncertainly associated with the delineation of the Britannia IPZs is summarized below.

- Within the provincial regulation limits, the IPZ-1 and IPZ-2 delineation has been assigned a low uncertainty. Preliminary information was made available for the IPZ-2 delineation in Quebec but detailed work has not been completed.
- The IPZ-3 delineation, limited to Ontario, is assigned a high uncertainty due to the overall analytical methodology related to the Event Based Approach.

Further details regarding the uncertainty assessment are provided in Appendix 6-5.

6.8.2 Vulnerability Scoring – Britannia Intake Protection Zones

The approach used to complete the vulnerability scoring, including the area vulnerability factor (B) and the source vulnerability factor (C), for the Britannia intake protection zones is presented in Section 6.7.2. The specific vulnerability scoring inputs and results are discussed below.

Area Vulnerability Factor – IPZ-1

The IPZ-1 area vulnerability factor for the Britannia intake is 10 as predetermined by the Technical Rules.

Area Vulnerability Factor – IPZ-2

The area vulnerability factor for IPZ-2 ranges from 7 to 9.

The following table summarizes the specific information, including assumed minimum and maximum values for area vulnerability factor (B) that were used in the analysis to quantify each criterion.

Parameters used for Area Vulnerability Factor (B)	Assumed Minimum Value (B = 7)	Assumed Maximum Value (B = 9)	Calculated Value for Britannia IPZ-2 (based on local data)
Percentage of Area Composed of Land	10 %	90%	73%
Type of Land Use	- Natural land cover was scored as 7 - Agricultural, open space was scored as 8 - Mainly developed land was scored as 9		Developed =9
% Imperviousness of the Land	0%	80%	34%
Extent of Transport Pathways	Transport pathways were classified on the basis of the percentage of the IPZ-2 land area that is drained by storm sewer systems. - <10% of the land area was scored as 7 - 10 to 50% of the land area was scored as 8 - >50% of the land area was scored as 9		>50%

Summary of Specific Information used to determine the IPZ-2 Area Vulnerability Factor (B)

The estimated minimum and maximum values for percentage of area composed of land is discussed in Section 6.3.2 and found under assumed minimum and maximum values, while the measured values for Britannia are shown in the last column of the previous table. Similarly, the estimated range of minimum and maximum percentage of Imperviousness of the Land is found in the assumed minimum and maximum value columns, with the calculated value in the last column.

Parameter	Calculated value for Britannia IPZ 2 (based on local data)	Converted B values for Britannia IPZ-2 between assumed minimum value (B=7) and assumed maximum value (B=9)			
		$B_{\%LA}$	B_{land}	B_{Imp}	B_{TP}
Percentage Land Area ($B_{\%LA}$)	73%	8.6			
Type of Land Use (B_{land})	Developed		9.0		
% Imperviousness (B_{imp})	34%			7.9	
Percentage of Land Area Drained by Storm Sewer (B_{TP})	>50%				9.0
Assumed Weighting Factor		1/3	1/6	1/6	1/3
Weighted Factor	**8.66**				
Selected Area Factor	**9**				

Summary of Scoring for the IPZ-2 Area Vulnerability Factor (B)

The table summarizes the derivation of the IPZ-2 area vulnerability factor (B) for the Britannia IPZ-2. It includes the converted area vulnerability values between assumed minimum value (B=7) and assumed maximum value (B=9) for each of the four parameters, as well as the assumed weighting. The final area vulnerability factor for the Britannia IPZ-2 is 9.

Source Vulnerability Factor

The approach used to complete the source vulnerability factor for the Britannia intake protection zones is presented in Section 6.7.2. The specific vulnerability scoring inputs and results are discussed below.

The table below summarizes the specific information, including assumed minimum and maximum values for area vulnerability factor (B) that were used in the analysis to quantify each criteria.

Three Factors used for Source Vulnerability Factor (C)	Assumed Minimum Value (C = 0.9)	Assumed Maximum Value (C = 1)	Calculated value for Britannia (based on local data)
Depth of Intake (**C**$_{depth}$)	15 metres	2 metres	7 metres
Distance of the Intake from land (**C**$_{Dist}$)	1000 metres	0 metres	300 metres
Historical Water Quality Issues (**C**$_{DWI}$)	A value of 0.9 was assumed if there were no water quality concerns at Intake	A value of 1 was assumed if persistent or chronic water quality concerns were present at Intake	none

Summary of Specific Information used to determine the Source Vulnerability Factor (C)

The following table summarizes the derivation of the Britannia source vulnerability factor (C). It includes the converted source vulnerability values between assumed minimum value (C=0.9) and assumed maximum value (C=1) for each of the three parameters, as well as the assumed weighting. The final source vulnerability factor for the Britannia intakes is 0.9.

Parameter	Calculated value for Britannia (based on local data)	Converted B values for Britannia between assumed minimum value (C=0.9) and assumed maximum value (C=1)		
		(C_{depth})	(C_{Dist})	(C_{DWI})
Depth of Intake (C_{depth})	7 metres	0.96		
Distance of the Intake from land (C_{Dist})	300 metres		0.97	
Historical Water Quality Issues (C_{DWI})	none			0.9
Assumed Weighting Factor		1/3	1/3	1/3
Weighted Factor	**0.943**			
Selected Area Factor	**0.9**			

Summary of Scoring for the Source Vulnerability Factor (C)

Final Vulnerability Scoring for Britannia IPZs

As presented above, the Britannia source vulnerability factor (C) was assessed to be 0.9. Thus, the final vulnerability scores (V) for each of the zones is less than the area vulnerability factors (B).

As shown in the following table, Britannia's IPZ-1 has a final vulnerability score of 9 and IPZ-2 a score of 8.1.

Figure 6-35 shows the final vulnerability scoring for Britannia's IPZ-1 and IPZ-2. Following is a summary of results.

	Area Vulnerability Factor (B) *Expressed as a whole number*			Source Vulnerability Factor (C)	Vulnerability Score (V) *Expressed to one decimal point or as whole number depending on the value of C*		
Zone	**IPZ-1**	**IPZ-2**	**IPZ-3**		**IPZ-1**	**IPZ-2**	**IPZ-3**
Possible Values	*10*	*7 to 9*	*1 to 9*	*0.9 or 1*	*9 or 10*	*6.3 to 9*	*0.9 to 9*
Britannia Scores	**10**	**9**	**To be deter-mined**	**0.9**	**9**	**8.1**	**To be deter-mined**

Summary of Britannia IPZ Vulnerability Scoring Results

Uncertainty

The Britannia IPZs vulnerability scoring uncertainty levels are as follows:

- IPZ-1 vulnerability score is assigned a low uncertainty; and
- IPZ-2 vulnerability scores is also assigned a low uncertainty, however there is no scoring for the Quebec portion.

Further details regarding the uncertainty assessment are provided in Appendix 6-5.

6.8.3 Managed Lands and Livestock Density – Britannia Intake Protection Zones

The method for calculating managed lands and livestock density is described in Section 6.3.3.

The Total Managed Lands for the Britannia IPZs are:

- 0% of the total IPZ-1 area; and
- 27.8% of the total IPZ-2 area.

The results are also provided in Table 6-8 and shown Figure 6-36.

6.8.4 Impervious Surfaces – Britannia Intake Protection Zones

The method for calculating impervious surfaces is described in Section 6.3.4. Figure 6-37 shows the impervious surfaces within the Britannia IPZs. The percentage of impervious surfaces within the Britannia IPZs range from 0-98.3%.

6.8.5 Water Quality Threat Assessment – Britannia Intake Protection Zones

Water quality threats are existing conditions (e.g. contaminated sediment, soil or surface water) or existing or future land use activities that could contaminate a drinking water supply. A land use inventory was completed in 2010 within the MRSPR IPZs but not in Quebec.

It should be noted that a single land use activity could fall into multiple threat categories. For example, a crop farm may have storage of fuel, may apply commercial fertilizer to land, and apply agricultural source material to land. Each of these activities is a separate threat category in the provincial table, and so each is therefore a separate threat.

A land use activity and associated threats that occur where the vulnerability score is high may result in determining it to be a significant threat. In many cases, the specific circumstances that apply to a threat category are unknown. Using the same example, a crop farm may have fuel storage, but the volume of fuel stored is unknown. Unless additional information was available, it was assumed that enough material was stored for that activity to be a significant threat.

A total of six potentially significant drinking water threats, areas where the vulnerability score is 8 or greater, were identified in the Britannia IPZ-1 and IPZ-2. The list of identified potential significant drinking water threats is provided in Table 6-9. The term “Poly” in the table refers to a polygon, or an area that may contain multiple threats. For example, a polygon may be a farm field, representing a single potential threat, or a residential area with an unknown number of septic systems, each which may be a potential threat. The term “Point” in the table refers to a point source. Figure 6-38 shows the areas containing potential significant threats in purple. The size of the area where significant threats may be present is approximately 31 km^2. See Section 4.3.3 for information on the full list of significant, moderate, and low threats.

Transportation Corridors

A number of transportation corridors exist within the Britannia IPZs where there may be the transportation of dangerous and/or hazardous goods and the potential for a spill exists. Spills within the IPZs have the potential to impair the surface water quality however they are not included as threats as per the prescribed drinking water threats categories (see Section 4-3).

This Assessment Report provides this key information for municipalities and other agencies to assist in ensuring all available information is accessible for emergency response planning purposes. Transportation corridors are shown in Figure 6-31, Britannia IPZ-1 and IPZ-2.

6.8.6 Issues and Conditions – Britannia Intake Protection Zones

As discussed in Chapter 4, issues are documented cases of water quality contamination approaching or exceeding acceptable provincial levels. A condition is a situation where past activities resulted in a drinking water threat. No issues or conditions were identified for the Britannia WTP. However, a number of parameters that exceed the Ontario Drinking Water Standards and Operational Guidelines are noted below, including tritium which is identified as parameter that could potentially impact the Ottawa water supply.

For the Ottawa River raw water, there are numerous parameters that exceed the Ontario Drinking Water Standards and Operational Guidelines. The exceeding parameters include:

- aesthetic objectives of turbidity, colour, DOC and iron
- alkalinity, hardness and aluminum which are operational objectives
- health-related criteria for E. coli and total coliforms

None of the above parameters are considered to be issues as they are known to be naturally occurring and do not represent a problem for the water treatment plant operator. *E. coli* and total coliforms presence is usual in surface water sources and they are easily removed during the treatment processes.

The one parameter identified that could potentially impact the Ottawa water supply is tritium. The current maximum allowable concentration for tritium in the Ontario Drinking Water Standards is 7,000 Bq/L. In May 2009, the Ontario Drinking Water Advisory Council recommended that the guideline be revised to 20 Bq/L, applied as a running annual average. Chalk River Laboratories, the site of nuclear technology research and development, is located approximately 180 km upstream of the drinking water intakes.

In December 1988, a spill of heavy water containing tritium entered the Ottawa River. Personnel at the Britannia WPP were notified of the incident, and began monitoring raw water for tritium. Concentrations peaked at approximately 440 Bq/L, never exceeding the 7,000 Bq/L guideline set in the Ontario Drinking Water Standards. Increased tritium levels were observed from approximately Day 16 after the spill until Day 38 after the spill, with the peak occurring at Day 21.

The City of Ottawa currently tests raw water for tritium at least weekly and the concentrations are usually below the detection limit of 5.0 Bq/L. Between the year 2000 and August 2009, the highest (partial) annual average tritium concentration measured in the raw water at the Britannia WTP was 7.0 Bq/L (January to August 2009), with a maximum measured concentration of 22.8 Bq/L. While the annual average concentrations in recent years have been well below the current and proposed guidelines, an upstream heavy water release (similar to the 1988 incident) might have the potential to result in an annual average tritium concentration above the proposed guideline level.

Based on this information, tritium is currently not considered a drinking water issue in accordance with the Technical Rules. However tritium is considered to represent a potential concern that should continue to be tracked. It should be noted that municipal water treatment plants do not have the capacity to remove tritium from source water.

It is recommended that a reassessment of this parameter be carried out as part of a future Assessment Report update when and if the current tritium standard is revised.

6.9 Ottawa Water Supply – Lemieux Island

The Lemieux Island Water Treatment Plant (WTP) is located in Ottawa, Ontario on the Ottawa River, as shown in Figure 6-31. The Lemieux Island and Britannia WTPs provide treated drinking water to the City of Ottawa for approximately 814,000 people each day. For more background information on the Ottawa River source water supply, see Section 6.8.

The Lemieux Island WTP intake is located approximately 450 m from the mainland and 11 m from the shore of Lemieux Island, and 6 m below the water.

6.9.1 Delineation of Lemieux Island Intake Protection Zones

The steps undertaken to complete the intake protection zone delineation for Lemieux Island are presented in Section 6.7.1. Discussion on the results of the delineation process follow.

Figure 6-39 shows the various components that make up Lemieux Island's IPZ-1 and IPZ-2. The components include:

- the default IPZ-1 shape which is circle (200 m radius) around the intake;
- the in-river IPZ-2 limit based on reverse particle tracking;
- the anthropogenic transport pathways (storm sewersheds), including a 120 m buffer; and
- the Rideau Valley Conservation Generic Regulation Limit line.

Figure 6-40 shows the complete delineation for the Lemieux Island IPZ-1 and IPZ-2. IPZ-1 is approximately 0.07 km^2, and IPZ-2 is approximately 13 km^2. Figure 6-41 shows the Lemieux Island IPZ-1 and IPZ-2, including the Quebec side of the Ottawa River. The full extent of IPZ-3 within the MRSPR is shown On Figure 6-42 for the Lemieux Island intake. The total area of the IPZ-3 within the MRSPR is approximately 377 km^2. Figure 6-43 shows the extent of IPZ-3 if the Chalk River nuclear facility were to be considered. The total area covered by IPZs within the MRSPR for the Lemieux Island municipal surface water intake is 390 km^2.

Municipalities which are located within the Lemieux Island IPZs are shown in Table 6-3.

Uncertainty

The level of uncertainly associated with the delineation of the Lemieux Island Intake Protection Zones is summarized below. Further details regarding the uncertainty assessment are provided in Appendix 6-4.

- Within the provincial regulation limits, the IPZ-1 and IPZ-2 delineation has been assigned a low uncertainty. Preliminary information was made available for the IPZ-2 delineation in Quebec but detailed work has not been completed.
- The IPZ-3 delineation, limited to Ontario, is assigned a high uncertainty due to the overall analytical methodology related to the Event-Based Approach.

6.9.2 Vulnerability Scoring – Lemieux Island Intake Protection Zones

The approach used to complete the vulnerability scoring, including the area vulnerability factor (B) and the source vulnerability factor (C), for the Lemieux Island intake protection zones is presented in Section 6.7.2. The specific vulnerability scoring inputs and results are discussed below.

Area Vulnerability Factor – IPZ-1

The IPZ-1 area vulnerability factor for the Lemieux Island intake is 10 as predetermined by the Technical Rules.

Area Vulnerability Factor – IPZ-2

The area vulnerability factor for IPZ-2 ranges from 7 to 9.

The table summarizes the specific information, including assumed minimum and maximum values for area vulnerability factor (B) that were used in the analysis to quantify each criteria.

<table>
<tr><th>Four parameters used for Area Vulnerability Factor (B)</th><th>Assumed Minimum Value (B = 7)</th><th>Assumed Maximum Value (B = 9)</th><th>Calculated value for Lemieux Island IPZ-2 (based on local data)</th></tr>
<tr><td>Percentage of Area Composed of Land</td><td>10 %</td><td>90%</td><td>55%</td></tr>
<tr><td>Type of Land Use</td><td colspan="2">- Natural land cover was scored as 7
- Agricultural, open space was scored as 8
- Mainly developed land was scored as 9</td><td>Developed</td></tr>
<tr><td>% Imperviousness of the Land</td><td>0%</td><td>80%</td><td>42%</td></tr>
<tr><td>Extent of Transport Pathways</td><td colspan="2">Transport pathways were classified on the basis of the percentage of the IPZ-2 land area that is drained by storm sewer systems.
- <10% of the land area was scored as 7
- 10 to 50% of the land area was scored as 8
- >50% of the land area was scored as 9</td><td>>50%</td></tr>
</table>

Summary of Specific Information used to determine the IPZ-2 Area Vulnerability Factor (B)

The following table summarizes the derivation of the IPZ-2 area vulnerability factor (B) for the Lemieux Island IPZ-2. It includes the converted area vulnerability values between assumed minimum value (B=7) and assumed maximum value (B=9) for each of the four parameters, as well as the assumed weighting.

The final area vulnerability factor for the Lemieux Island IPZ-2 is 9.

Parameter	Calculated value for Lemieux Island IPZ-2 (based on local data)	Converted B values for Lemieux Island IPZ-2 between assumed minimum value (B=7) and assumed maximum value (B=9)			
		$B_{\%LA}$	B_{land}	B_{Imp}	B_{TP}
Percentage Land Area ($B_{\%LA}$)	55%	8.1			
Type of Land Use (B_{land})	Developed		9.0		
% Imperviousness (B_{imp})	42%			8.1	
Percentage of Land Area Drained by Storm Sewer (B_{TP})	>50%				9.0
Assumed Weighting Factor		1/3	1/6	1/6	1/3
Weighted Factor	**8.55**				
Selected Area Factor	**9**				

Summary of Scoring for the IPZ-2 Area Vulnerability Factor (B)

Source Vulnerability Factor

The approach used to complete the source vulnerability factor for the Lemieux Island intake protection zones is presented in Section 6.6.2. The specific vulnerability scoring inputs and results follow.

The following table summarizes the specific information, including assumed minimum and maximum values for area vulnerability factor (B) that were used in the analysis to quantify each criteria.

Three Factors used for Source Vulnerability Factor (C)	Assumed Minimum Value (C = 0.9)	Assumed Maximum Value (C = 1)	Calculated value for Lemieux Island (based on local data)
Depth of Intake (C_{depth})	15 metres	2 metres	6 metres
Distance of the Intake from land (C_{Dist})	1000 metres	0 metres	450 metres
Historical Water Quality Issues ($\mathbf{C}_{DWI}$)	A value of 0.9 was assumed if there were no water quality concerns at Intake	A value of 1 was assumed if persistent or chronic water quality concerns were present at Intake	none

Summary of Specific Information used to determine the Source Vulnerability Factor (C)

The following table summarizes the derivation of the Lemieux Island source vulnerability factor (C). It includes the converted source vulnerability values between assumed minimum value (C=0.9) and assumed maximum value (C=1) for each of the three parameters, as well as the assumed weighting.

The final source vulnerability factor for the Lemieux Island intakes is 0.9.

Parameter	Calculated value for Lemieux Island (based on local data)	Converted B values for Lemieux Island between assumed minimum value (C=0.9) and assumed maximum value (C=1)		
		(C_{depth})	(C_{Dist})	(C_{DWI})
Depth of Intake (C_{depth})	6 metres	0.97		
Distance of the Intake from land (C_{Dist})	450 metres		0.96	
Historical Water Quality Issues (C_{DWI})	none			0.9
Assumed Weighting Factor		1/3	1/3	1/3
Weighted Factor	**0.943**			
Selected Area Factor	**0.9**			

Summary of Scoring for the Source Vulnerability Factor (C)

Final Vulnerability Scoring for Lemieux Island IPZs

As presented above, the Lemieux Island source vulnerability factor (C) was assessed to be 0.9. Thus, the final vulnerability scores (V) for each of the zones is less than the area vulnerability factors (B).

As shown in the following table, Lemieux Island's IPZ-1 has a final vulnerability score of 9 and the IPZ-2 a score of 8.1. Figure 6-44 shows the final vulnerability scoring for Lemieux Island's IPZ-1 and IPZ-2.

	Area Vulnerability Factor (B) *Expressed as a whole number*			Source Vulnerability Factor (C)	Vulnerability Score (V) *Expressed to one decimal point or as whole number depending on the value of C*		
Zone	**IPZ-1**	**IPZ-2**	**IPZ-3**		**IPZ-1**	**IPZ-2**	**IPZ-3**
Possible Values	*10*	*7 to 9*	*1 to 9*	*0.9 or 1*	*9 or 10*	*6.3 to 9*	*0.9 to 9*
Lemieux Island Scores	**10**	**9**	**To be deter-mined**	**0.9**	**9**	**8.1**	**To be deter-mined**

Summary of Lemieux Island IPZ Vulnerability Scoring Results

Uncertainty

The level of uncertainly associated with the vulnerability scoring of the Lemieux Island IPZs is summarized below:

- IPZ-1 vulnerability score is assigned a low uncertainty; and
- IPZ-2 vulnerability score is assigned a low uncertainty.

Further details regarding the uncertainty assessment are provided in Appendix 6-5.

6.9.3 Managed Lands and Livestock Density – Lemieux Island Intake Protection Zones

The method for calculating managed lands and livestock density is described in Section 6.3.3.

The Total Managed Lands for the Lemieux Island IPZs are:

- 0% of the total IPZ-1 area; and
- 20.7% of the total IPZ-2 area.

The results are also provided in Table 6-8 and shown in Figure 6-45.

6.9.4 Impervious Surfaces – Lemieux Island Intake Protection Zones

The method for calculating impervious surfaces is described in Section 6.3.4. Figure 6-46 shows the impervious surfaces for Lemieux Island. The percentage of impervious surfaces within the Britannia IPZs range from 0-98.3%.

6.9.5 Water Quality Threat Assessment – Lemieux Island Intake Protection Zones

Water quality threats are existing conditions (e.g. contaminated sediment, soil or surface water) or existing or future land use activities that could contaminate a drinking water supply. A land use inventory was completed in 2010 within the MRSPR IPZs but not in Quebec.

It should be noted that a single land use activity could fall into multiple threat categories. For example, a crop farm may have fuel storage, may apply commercial fertilizer to land, and apply agricultural source material to land.

Each of these activities is a separate threat category in the provincial table, and so each is therefore a separate threat.

Land use activities and associated threats that occur where the vulnerability score is high may result in determining it to be a significant threat. In many cases, the specific circumstances that apply to a threat category are unknown. Using the same example, a crop farm may store fuel, but the volume of fuel stored is unknown. Unless additional information was available, it was assumed that enough material was stored for that activity to be a significant threat.

No potentially significant drinking water threats, areas where the vulnerability score is 8 or greater, were identified in the Lemieux Island IPZs. Even though no potentially significant threats were identified for the Lemieux Island IPZs, Figure 6-47 shows the areas where potential significant threats would be found if they existed. Please see Section 4.3.3 for information on the full list of significant, moderate, and low threats.

Transportation Corridors

A number of transportation corridors exist within the Lemieux Island IPZs where there may be the transportation of dangerous and/or hazardous goods and the potential for a spill exists. Spills within the IPZs have the potential to impair the surface water quality however they are not included as threats as per the prescribed drinking water threats categories (see Section 4-3).

This Assessment Report provides this key information for municipalities and other agencies to assist in ensuring all available information is accessible for emergency response planning purposes. Transportation corridors are shown in Figure 6-40, Lemieux Island IPZ-1 and IPZ-2.

6.9.6 Issues and Conditions – Lemieux Island Intake Protection Zones

As discussed in Chapter 4, issues are documented cases of water quality contamination approaching or exceeding acceptable provincial levels. A condition is a situation where past activities resulted in a drinking water threat. No issues or conditions were identified for the Lemieux Island WTP. However, a number of parameters that exceed the Ontario Drinking Water Standards and Operational Guidelines are noted below, including tritium which is identified as parameter that could potentially impact the Ottawa water supply.

For the Ottawa River raw water, there are numerous parameters that exceed the Ontario Drinking Water Standards and Operational Guidelines. The exceeding parameters include:

- aesthetic objectives of turbidity, colour, DOC and iron;
- alkalinity, hardness and aluminum which are operational objectives; and
- health-related criteria for E. coli and total coliforms.

None of the above parameters are considered to be issues as they are known to be naturally occurring and do not represent a problem for the water treatment plant operator. *E. coli* and total coliforms presence is usual in surface water sources and they are easily removed during the treatment processes.

The one parameter identified that could potentially impact the Ottawa water supply is tritium. Tritium is currently not considered a drinking water issue in accordance with the Technical Rules. However, tritium is considered to represent a potential concern that should continue to be tracked. It is recommended that a re-assessment of this parameter be carried out when and if the current tritium standard is revised. See Section 6.8.6 for more details.