FIGURES

TABLES

5.0 DRINKING WATER THREATS ASSESSMENT

5.1 OVERVIEW

5.1.1 Threats to Drinking Water Quantity

Stressed: A subwatershed is identified as stressed when the estimated water use is greater than 10% of the available groundwater or surface water supply.

Subwatershed: A portion of a watershed separated out for stress assessment calculations.

The majority of the technical work on threat identification and enumeration was based on the 2009 version of the Director's Technical Rules, but amendments to the Credit Valley Assessment Report, resulting in versions 2.0, 3.0 and 4.0, were made using the 2017 Director's Technical Rules and Tables of Drinking Water Threats. These amendments were completed for groundwater-based water systems in Peel Region.

The *Technical Rules* require that a Water Quantity Risk Assessment be completed for municipal drinking water supplies if they are considered *stressed* according to the water budget calculations described in **Chapter 3** of this Assessment Report. In the Credit Valley Source Protection Area (CVSPA), municipal water supplies are sourced from groundwater, and from Lake Ontario (**Chapter 2**). No municipal supplies are sourced from the Credit River. Stresses to water quantity have been identified for three municipal groundwater systems in Orangeville, Mono, Amaranth, Acton, and Georgetown (**Chapter 3**).

Note that the *Technical Rules* exempt Great Lakes sources from the water quantity threat assessment process, and that no municipal supplies within the CVSPA are sourced from the rivers or streams

A Tier 2 Water Budget was completed for the CVSPA, as per *Technical Rules (19–24)*. The screening results calculated groundwater and/or surface water *stresses* in 22 *subwatersheds,* but the only additional work necessary under the *Clean Water Act, 2006* (*CWA),* was a Tier 3 water budget for the Orangeville, Acton, and Georgetown water supplies, as discussed in **Chapter 3**. Under other programs within the conservation authority and municipalities, additional work is planned to examine the potential effects to the ecosystem in the other stressed subwatersheds. The CTC Source Protection Committee (SPC) has recommended to the conservation authority and municipality that additional work to assess the potential stresses to the ecosystem in these watersheds should be undertaken.

5.1.2 Threats to Drinking Water Quality

Site-specific verification of drinking water threats was not conducted as part of the original studies informing the 2012 Approved Assessment Report. Since 2012 however, preliminary effort aimed at the ground-truthing of significant threats in vulnerable zones around municipal wells has been undertaken. The findings of this work have been used to update the threats enumeration around the wells. Despite this, it is possible that threats identified in this document do not actually exist, and it is also possible that a non-documented threat exists that has not been enumerated. If a significant threat has been enumerated but does not exist, policies in a Source Protection Plan would not apply. Conversely, if a significant threat has not been enumerated but does exist, such policies would apply. A key implementation activity for the municipalities will be to confirm the existence of significant drinking water threats at the site scale.

In the Water Quality Risk Assessment process, the hazard rating and the vulnerability score are multiplied to produce a risk score. In place of having to complete these calculations for all threats, *Part XI* (*Rule 118*) of the *Technical Rules* under the *CWA* allows reference to activities in the Tables of Drinking Water Threats that may pose a potential threat to the quality and/or quantity of drinking water within each vulnerable area. The size and complexity of the Table of Drinking Water Threats precludes efficient reference and analysis. Therefore, in March 2010 the Ministry of the Environment and Climate Change (MOECC) developed a series of 76 Provincial Tables of Circumstances each of which lists every circumstance that makes an activity a low, moderate, or significant drinking water threat. The Provincial Tables of Circumstances that apply in the CVSPA are listed in **Table 5.1**.

The identification of threats to municipal drinking water sourced from Lake Ontario follows a different process, using event based modelling as described in **Section 5.7.6**.

No conditions were identified in the CVSPA, as per *Rule (126)* (conditions).

Table 5.1: Provincial Tables of Circumstances (2010)

Threat Type	Vulnerability Area	Vulnerability Score	Threat Classification and Provincial Table Reference Code		
			Significant	Moderate	Low
Chemical*	WHPA A,B,C,D	10	1(CW10S)	3(CW10M)	6(CW10L)
		8	2(CW8S)	4(CW8M)	7(CW8L)
		6	n/a	5(CW6M)	8(CW6L)
	WHPA-E, IPZ	7.2	n/a	27(CIPZWE7.2M)	35(CIPZWE7.2L)
		6	n/a	75(CIPZWEM6)	76(CIPZWEL6)
		5.4	n/a	n/a	40(CIPZWE5.4L)
		5	n/a	n/a	74(CIPZWEL5)
		4.8	n/a	n/a	42(CIPZWE4.8L)
		4.5	n/a	n/a	43(CIPZWE4.5L)
	SGRA, HVA	6	n/a	17(CSGRAHVA6M)	18(CSGRAHVA6L)
DNAPL	WHPA A,B,C	all	9(DWAS)	n/a	n/a
	WHPA-D, SGRA, HVA	6	n/a	10(DW6M)	11(DW6L)
Pathogen	WHPA A,B	10	12(PW10S)	13(PW10M)	n/a
		8	n/a	14(PW8M)	15(PW8L)
		6	n/a	n/a	16(PW6L)
	WHPA-E, IPZ	7.2	n/a	53(PIPZWE7.2M)	62(PIPZWE7.2L)
		6	n/a	57(PIPZ6M)	66(PIPZ6L)
		5.4	n/a	n/a	68(PIPZWE5.4L)
		5	n/a	n/a	69(PIPZ5L)
		4.8	n/a	n/a	71(PIPZWE4.8)
		4.5	n/a	n/a	72(PIPZWE4.5L)

Only Tables of Circumstances that apply within the CVSPA are included

n/a: does not apply

** In some Tables of Circumstances, both chemicals and DNAPLs are listed*

Current information that appears in the Provincial Tables of Circumstances can be generated by searching the Source Water Protection Threats Tool, accessible via http://swpip.ca/

5.2 THREATS ASSESSMENT METHODOLOGY

Under the *CWA*, a “prescribed threat” (hereafter referred to as “threat”) is defined as “an activity or condition that adversely affects or has the potential to adversely affect the quality or quantity of any water that is or may be used as a source of drinking water and includes an activity or condition that is prescribed by source protection regulation as a drinking water threat.” The *CWA* focuses on protecting municipal supplies of drinking water. Other legislation, such as the *Ontario Water Resources Act*, Ontario Reg. 903: Water Wells and Ontario Reg. 387/04: Permit to Take Water (PTTW), addresses threats to private drinking systems.

One of the responsibilities of the SPC is to evaluate threats to the sustainability of municipal drinking water supplies from both a quantity and quality perspective. Threats are classified as low, moderate, or significant, according to criteria provided by the Province that consider the natural vulnerability of the area as well as hazard scores assigned to the chemicals and pathogens associated with the various land-use activities.

Part X (Quantity Threats) of the *Technical Rules* outlines a process that endorses using the best science available and making continuous improvements. This process evaluates the ability of a water supply system to support a municipality’s current and planned drinking water needs. Under the *Technical Rules (2009)*, water quantity threats are associated with municipal groundwater and inland surface water systems. These threats are defined and assessed through the water budget process. The Great Lakes sources are exempt from water quantity threat assessment.

Under *Part XI* (Quality Threats) of the *Technical Rules,* the SPC must describe the circumstances associated with various activities or conditions under which the presence of a specified chemical or pathogen could threaten the water quality of a drinking water source now or in the future. **Figure 5.1** summarizes the processes for the identification of drinking water threats.

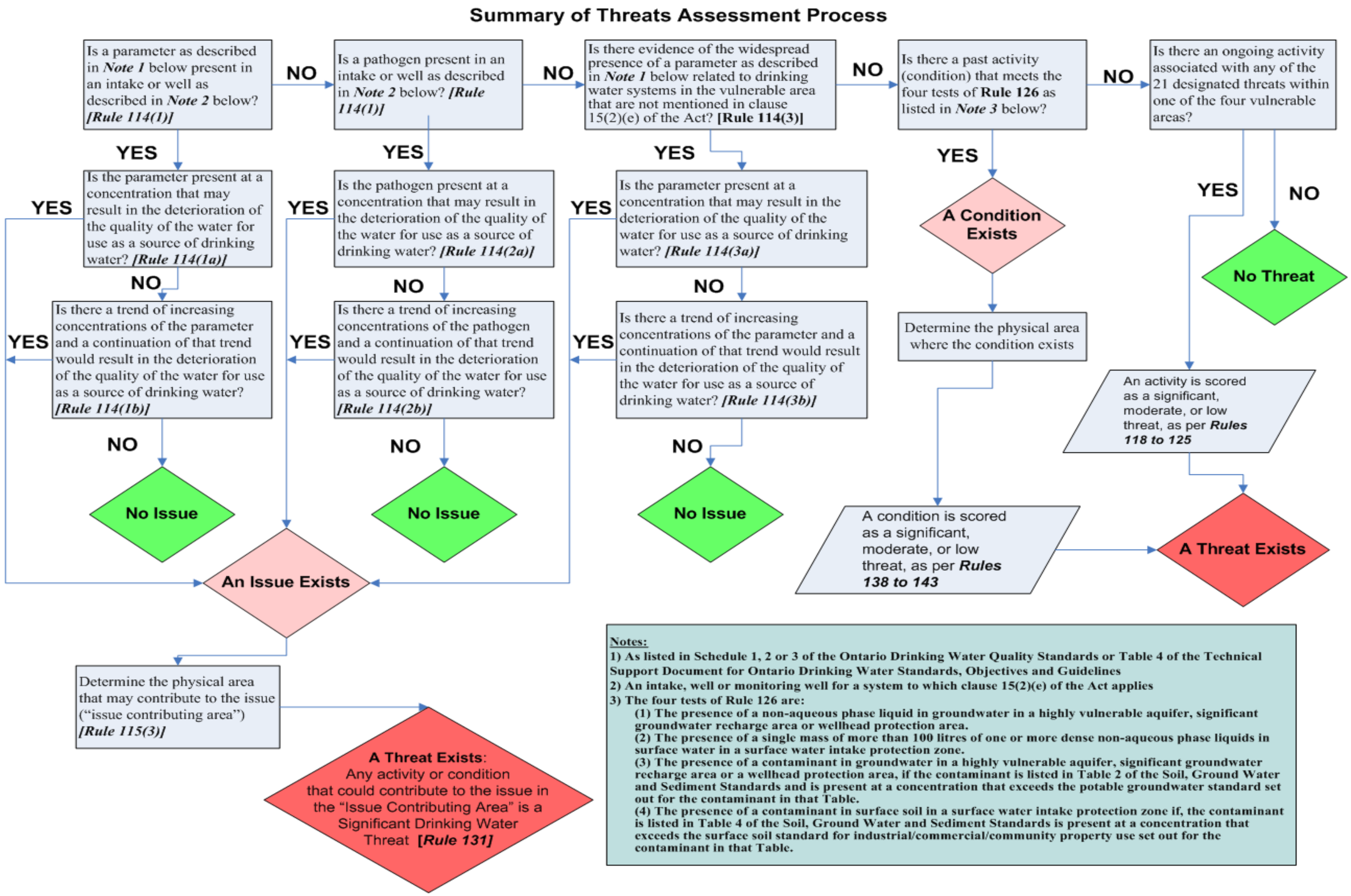


Figure 5.1: Summary of Threats Assessment Process

5.2.1 Threats from Activities

The province has identified 22 activities that, if they are present in vulnerable areas, now or in the future, could pose a threat (listed in Section 1.1 of O. Reg. 287/07). Twenty of these activities are relevant to drinking water quality threats while two relevant to drinking water quantity threats. The following list of these prescribed, ongoing activities was assembled by the MOECC using input from multiple stakeholder groups and committees:

1. The establishment, operation, or maintenance of a waste disposal site within the meaning of Part V of the *Environmental Protection Act* (*EPA*);
2. The establishment, operation, or maintenance of a system that collects, stores, transmits, treats, or disposes of sewage;
3. The application of agricultural source material to land;
4. The storage of agricultural source material;
5. The management of agricultural source material;
6. The application of non-agricultural source material (NASM) to land;
7. The handling and storage of non-agricultural source material (NASM);
8. The application of commercial fertilizer to land;
9. The handling and storage of commercial fertilizer;
10. The application of pesticide to land;
11. The handling and storage of pesticide;
12. The application of road salt;
13. The handling and storage of road salt;
14. The storage of snow;
15. The handling and storage of fuel;
16. The handling and storage of a dense non-aqueous phase liquid;
17. The handling and storage of an organic solvent;
18. The management of runoff that contains chemicals used in the de-icing of aircraft;
19. An activity that takes water from an aquifer or a surface water body without returning the water taken to the same aquifer or surface water body – (*Water Quantity Threat*);
20. An activity that reduces the recharge of an aquifer – (*Water Quantity Threat*);
21. The use of land as livestock grazing or pasturing land, an outdoor confinement area, or a farm-animal yard; and
22. The establishment and operation of a liquid hydrocarbon pipeline (per inclusion under 2017 Phase 1 Director's Technical Rules)*.

Dense Non-Aqueous Phase Liquids (DNAPLs): A group of chemicals that is insoluble and denser than the water portion of the shallowest aquifer.

Non-Aqueous Phase Liquid (NAPL): A group of Chemicals that is insoluble in water, including light and dense NAPLs.

*Note: In the development of the CTC Source Protection Plan, liquid hydrocarbon pipelines (containing benzene) were identified as a local threat. After approval of the Source Protection Plan, O. Reg. 287/07 was amended to include liquid hydrocarbon pipelines as a prescribed threat.

For each vulnerable area, the SPC lists and describes the threats and conditions related to drinking water, in accordance with Part XI of the *Technical Rules.* The SPC applied to the Director to include the following as local threats to Lake Ontario Drinking Water Sources in CVSPA:

- Pipeline transporting petroleum products (containing benzene) which crosses a tributary flowing into Lake Ontario; and
- Handling and storage of water and heavy water containing tritium at the Pickering Nuclear Generation Station.

The Director accepted inclusion of these local threats on July 5, 2011. The CTC SPC letter to the Director and the Director's response are included as **Appendix E7.**

5.2.2 Threats from Conditions

Conditions relate to past or historic activities. Conditions must pass one of the five tests set out in *Technical Rule (126)*. The following conditions are considered drinking water threats if they are located in vulnerable areas:

- The presence of a *non-aqueous phase liquid (NAPL)* in groundwater in a highly vulnerable aquifer (HVA), significant groundwater recharge area (SGRA), or wellhead protection area (WHPA);
- The presence, in surface water of a single mass of more than 100 litres, of one or more dense non-aqueous phase liquids (DNAPLs) in a surface water intake protection zone (IPZ);
- The presence of a contaminant in groundwater in an HVA, SGRA, or a WHPA, provided that the contaminant is listed in Table 2 of the "Soil, Groundwater and Sediment Standards" and is present at a concentration that exceeds the potable groundwater standard set for the contaminant in the table;
- The presence of a contaminant in surface soil in a surface water IPZ, provided that the contaminant listed in Table 4 of the "Soil, Groundwater and Sediment Standards" is present at a concentration that exceeds the surface soil standard for industrial/commercial/community property use set for the contaminant in the table; and
- The presence of a contaminant in sediment, provided that the contaminant is listed in Table 1 of the "Soil, Groundwater and Sediment Standards" and is present at a concentration that exceeds the sediment standard set out for the contaminant in the table.

To identify potential conditions, a review of available data regarding potential contamination within the WHPAs was completed. Data available included databases from the Ecolog ERIS results such as Record of Site Condition, MOECC Spills Database and Occurrence Reporting Information System and MOECC Historical Waste Disposal Sites. The review process also included information obtained during consultations with municipal staff.

5.2.3 Threats from Issues

An issue is defined under the *CWA* as an existing water quality problem associated with a drinking water source, or evidence of a trend that suggests a deterioration of water quality for one or more parameters on the MOECC prescribed list. Issues must result from the deterioration of the quality of water for use as drinking water and must be amply documented.

Municipal operators of water systems have been surveyed to identify issues affecting their intakes and wellheads. The survey involved referencing reports and communicating with intake/pump operators.

Where adequate documentation exists, drinking water issues are defined and described in compliance with Part XI.1 (*Technical Rules 114–117*). Basic requirements for identifying issues include the following:

- Issues can only be identified at the drinking water system. There must be data to support the identification of the issue.
- Issues under Rule (114) must result in the deterioration of the quality of the water for uses as a source of drinking water.
    - For systems included in SPA's "Source Water Protection Terms of Reference", issues can be identified for parameters in Schedules 1, 2, or 3 of the "Ontario Drinking Water Quality Standards" (ODWS), in Table 4 of the technical support document, or for any pathogen for which a microbial risk assessment is completed.
    - For systems not in the Terms of Reference, only chemical quality of drinking water may be included (Schedules 2 and 3 of ODWQ in Table 4 of the technical support document). The *Safe Drinking Water Act*, *2002* (*SDWA*) defines a drinking water system as any system that takes water for drinking water purposes.
- The documentation of a threat must meet the requirements of *Rule (115)* only if the issues meet the test in *Rule (114)* and the cause is fully or partly anthropogenic. If the issue does not meet the test in *Rule (114)*, the issue is documented as per *Rule (115.1)*.

The *Technical Rules* require that the following information be compiled:

- Parameter or pathogen of concern;
- Affected wells, intakes, or monitoring wells;
- Map of the area within which prescribed or local threats could contribute to the issue - the issue contributing area. Note that only the part of any issue contributing area located within one of the four vulnerable areas (HVA, SGRA, IPZ-1, IPZ-2, or WHPA (zone A to F)), should be addressed. The issue contributing area should be mapped as a polygon within the vulnerable area;
- List of activities, conditions from past activities, and natural conditions that are associated with the parameter or pathogen; and
- Circumstances under which the parameter or pathogen is considered.

The *Technical Rules* state that any activity or condition that can contribute to an issue is a significant drinking water threat within the issue contributing area. If the issue is located in a surface water source, all activities or conditions (linked to past activities) that could cause the parameter to be released into the surface water are considered threats. If the issue is within a groundwater source, all activities or conditions (linked to past activities) that could cause the parameter to be released into the groundwater are considered threats. Any natural conditions contributing to an issue must be documented, but these conditions do not become threats. Documentation (tables and text) is required for the activities or conditions that are considered threats, including their location. Where documentation is not clear or complete, but the data indicates that there may be an issue, data and information gaps are noted with the recommendation that they be addressed and incorporated in a future update of this Assessment Report.

Issue Contributing Areas

Issue contributing areas (ICA) were delineated for each issue identified as described in **Chapter 5.5**. In the case of sodium chloride and nitrate issues, a study was undertaken to assess the relative contribution from activities that may contribute to the identified issue. This study was intended to quantify the impacts of these activities, and to rank them in terms of their contribution to the overall issue.

The assessment was undertaken using the following methodology:

- Review of existing data and information from completed studies on drinking water threats in the CVSPA, including reports completed in 2010 for Source Protection, other documentation as well as databases and Geographic Information System (GIS) shapefiles. The documents were reviewed with specific attention to the methods and approaches used to delineate Significant Drinking Water Threats, particularly within the identified ICAs;
- Review and update of geodatabases as required to interface with the MOECC Threats Database Version 7.1.2 (the electronic equivalent of the Table of Drinking Water Threats (MOE, 2009));
- Communication with staff of the Region of Halton and the Town of Orangeville to secure additional data (e.g., land parcel data, road salt application rates, etc.), for advice and guidance, and to ensure that there was confidence and inclusion in the work being undertaken;
- Preparation of a list of the Drinking Water Threats associated with the chemical parameters identified as a Drinking Water Issue under *Technical Rule 115(4)*. These tables were prepared by searching and filtering the database for activities and circumstances that are associated with the chemical parameter identified as a drinking water issue;
- Identification and enumeration of existing land use activities within the ICA that could contribute to the drinking water issue;
- Creation of a list of the circumstances for each property, that are considered to be drinking water threats, and in particular significant drinking water threats. The list of significant threats for each ICA was presented in a tabular format as suggested by the MOECC;
- The updated lists of activities that are Significant Drinking Water Threats and the counts of Significant Drinking Water Threats in the ICA were subsequently reviewed with the municipal representatives and prioritized to assist the SPC in understanding relative priorities for considering policy options.

5.2.4 Assessing Threats from Activities

Once lists of threats have been compiled, the next step is to determine circumstances under which the threats may be low, moderate, or significant for each vulnerable area. The MOECC Provincial Tables of Circumstances show the threat for circumstances under which a given activity is classified as a low, moderate, or significant threat. These are provincial tables that list specific descriptions of situations where chemicals and pathogens pose threats to sources of drinking water.

The method for determining when an activity is a threat is based on a semi-quantitative risk assessment. The assessment considers both the nature of the activity or condition (the hazard rating) and the natural vulnerability of the affected area (WHPA-A to F, IPZ-1 and IPZ-2, SGRA, or HVA). Vulnerability scores are assigned in a process described in **Chapter 4**. The hazard ratings of various threats can be found in

MOECC Tables of Drinking Water Threats which is part of the *Technical Rules.* Both scores are then used to determine a risk score.

Water quantity threats are identified in **Chapter 5.3** and **Chapter 5.6**, while quality threats are discussed in **Chapters 5.4**, **5.5**, and **5.7**. If the drinking water threat is identified as significant, the SPC is required to identify where these activities are located and count the instances. If the drinking water threat is moderate or low, the province simply requires all the circumstances that could pose a drinking water threat be identified. It should be noted that these moderate or low threat circumstances are not counted or located in the assessment and may not actually exist in the vulnerable areas discussed. These are listed in Section 1.1 (1)—Appendix E.1 of Ontario Regulation 287/07 (*CWA*, *2006*).

For each vulnerable area (see **Chapter 4**), the SPC must list the threats in the Assessment Report and describe the conditions related to drinking water, in accordance with Part XI of the *Technical Rules (2009).* Additional local threats may be included per *Technical Rule (119)* and requires the SPC to seek permission from the Director to include them, provided that all of the following apply:

1. The SPC has identified the activity as a potential threat to a municipal source of drinking water;
2. In the opinion of the Director,
    - The chemical hazard rating of the activity is greater than 4; or
    - The pathogen hazard rating of the activity is greater than 4; and
3. The risk score for the activity in the vulnerable area is greater than 40, calculated according to *Rule (122).*

Hazard Rating

The following is a description of the approach used by the Province to determine specific drinking water threats. The application of the hazard rating system for activities and conditions is described in Parts XI.4 (*Rules 127–137*) and XI.5 (*Rules 138–143*) of the *Technical Rules*.

Hazard ratings for chemicals are based on the following factors:

- Toxicity of the parameter;
- Environmental fate of the parameter;
- Quantity of the parameter;
- Method of release of the parameter into the natural environment; and
- Type of vulnerable area in which the activity is located.

Hazard ratings for pathogens are based on the following factors:

- Frequency with which pathogens associated with the activity are present;
- Method of release of the pathogen into the natural environment; and
- Type of vulnerable area in which the activity is located.

A hazard rating is a science-based, numerical value, which represents the relative potential for a contaminant to impact drinking water sources at concentrations significant enough to cause human illness.

A description on how the ratings were calculated is included below. The MOECC Tables of Drinking Water Threats link threat activities by their North American Industry Classification System (NAICS) codes with the circumstances under which they occur to produce a hazard rating. The chemical hazard rating for all threats was computed using the following formula:

$$\text{Hazard Rating} = (0.25*T + 0.25*F + Q + RIM) / 2.5$$

Where:

T = Toxicity
F = Environmental Fate
Q = Quantity
RIM = Release to Environment (Release Impact Modifier)

Risk Score

Hazard scores and vulnerability scores separately range between 1 and 10 and are multiplied to determine the risk score for the threat. A threat posed by an activity or condition is classified as low, moderate, or significant, based on its risk score. The scale is as follows:

- Score greater than 40, but less than 60: low threat;
- Score equal to or greater than 60, but less than 80: moderate threat; and
- Score equal to or greater than of 80 and above: significant threat.

The *Technical Rules (2009)* require that the following information must be recorded about all significant threats to drinking water in a given vulnerable area:

- The significant threat and its location; and,
- The circumstances that render the threat low, moderate, or significant.

Other details should be recorded where possible, such as the associated chemicals and the volumes in use and/or the volumes stored.

All significant threats must be addressed in the source protection plans. The CTC SPC may choose to develop policies to address low or moderate drinking water threats.

5.2.5 Managed Lands

Managed lands are lands to which nutrients are or may be applied to the landscape. They include both agricultural and non-agricultural land uses. The agricultural uses are commonly found on the fringes of urban areas and on vacant Greenfield lands. Non-agricultural uses, including golf facilities, athletic fields, institutional greenspaces, and parks.

The Province developed a specific methodology for calculating the percentage of managed lands within each of the vulnerable areas discussed in **Chapter 4** (HVAs, SGRAs, WHPAs, and IPZ-1 and IPZ-2s). The nutrients can originate from chemical sources (e.g., non-agricultural source materials (NASMs) or from animal manure (e.g., agricultural source materials (ASMs)).

The percentage of managed land was calculated as set out in the MOECC *Draft Technical Bulletin: Proposed Methodology for Calculating Percentage of Managed Lands and Livestock Density for Land Application of Agricultural Source of Material, Non-Agricultural Source of Material and Commercial Fertilizers (*see **Appendix E1**).

The managed lands are divided into two categories:

- Agricultural Managed Lands, which includes cropland, fallow, and improved pastureland; and
- Non-Agricultural Managed Lands, which includes golf courses, sports fields, residential lawns, and other turf.

Where the vulnerability score of these managed lands is 6 or higher for groundwater (HVAs and WHPAs), or 4.4 or higher for surface water (including IPZs and WHPA-Es), there is a potential threat to drinking water. Per *Technical Rule (90)*, these analyses are NOT required for Great Lakes based IPZ-3s (Type A intakes).

The percentage of managed lands within a vulnerable area is calculated by dividing the sum of agricultural or non-agricultural managed lands by the total land area within the vulnerable area, and then multiplying that sum by 100. If only a part of a managed land falls within a vulnerable area, only that part of land should be factored into the total amount of managed land within that vulnerable area.

The following methods were used to define the percentages of managed land for these areas:

- Geographic information systems (GIS);
- Photo interpretation; and
- Windshield surveys, in the case of some WHPAs.

In HVAs with a vulnerability score of 6, no significant or moderate threats can be identified from managed lands; only low threat scores are possible. No amount of nutrient applied will result in a significant or moderate threat in these areas.

Managed land calculations rely heavily on the accuracy of the land cover data and the Municipal Property Assessment Corporation's (MPAC) parcel data. As a conservative estimate of risk, it was assumed that all managed lands receive some type of nutrient application. To evaluate the threat of over-application of nutrients in a vulnerable area (or in subsets of this area), the thresholds are defined as follows:

- If the total area of managed land makes up less than 40% of the vulnerable area (or subsets of this area), it is considered to have a low potential for nutrient application that would contaminate municipal drinking water sources;
- If the total area of managed land makes up 40%–80% of the vulnerable area (or subsets of this area), it is considered to have a moderate potential for nutrient application that would contaminate municipal drinking water sources; and
- If the total area of managed land makes up greater than 80% of the vulnerable area (or subsets of this area), it is considered to have a high potential for nutrient application that could contaminate municipal drinking water sources.

5.2.6 Livestock Density

For land application of ASMs, high livestock density suggests an increased potential for over-application of ASMs because the land base may not be large enough to properly utilize all the material; conversely, an area with low livestock density is more likely to have enough land base to properly utilize materials. It should be noted that there may be provincial legislation, agricultural/industrial standards, or other instruments that control the application of these materials that would reduce the actual threat, and that ground truthing was not conducted. This analysis does not consider whether or not such instruments are in place. This matter will be evaluated when the Source Protection Plan policies are developed by the SPC.

Growers will likely use commercial fertilizers to compensate for any undersupply of ASM based nutrients; however, the amounts applied will be limited. The rationale is that growers will want to minimize the use of commercial fertilizers and not exceed crop requirements, as they are a purchased crop input that increases the cost of crop production.

The livestock density was calculated using the methodology recommended by the MOECC, outlined in the *Draft Technical Bulletin: Proposed Methodology for Calculating Percentage of Managed Lands and Livestock Density for Land Application of Agricultural Source of Material, Non-Agricultural Source of Material and Commercial Fertilizers, November 2009* (see **Appendix E1**).

To evaluate the threat of over-application of ASMs, the thresholds are defined as follows:

- If livestock density in the vulnerable area has a value of less than 0.5 NUs/acre, the area has a low potential for nutrient application that exceeds crop requirements;
- If livestock density in the vulnerable area is greater than 0.5 and less than 1.0 NU/acre, the area has a moderate potential for nutrient application that exceeds crop requirements; and
- If livestock density in the vulnerable areas is greater than 1.0 NU/acre, the area has a high potential for nutrient application that exceeds crop requirements.

Where agricultural facilities were found within HVAs or SGRAs, the building footprints of structures within those facilities were digitized to calculate the area occupied by the structure. The Farm Operation Code based on the MPAC data was used to determine farm operation type and calculate its Nutrient Unit per acre (NU/ acre). All agricultural managed lands associated with an agricultural facility were added together and associated NU factor applied.

Livestock densities are considered with the natural vulnerability to determine the level of threat to drinking water sources. In HVAs with a vulnerability score of 6, no significant or moderate threats can be identified; only low threat scores are possible.

5.2.7 Impervious Surfaces

Impervious surfaces are defined by the *CWA* as the surface area of all highways and other impervious land surfaces used for vehicular traffic and parking, and all pedestrian paths. As per subsection 16 (11) in Part II of the *CWA*, for each vulnerable area, one or more maps of the percentage of the impervious surface area where road salt can be applied per square kilometre in the vulnerable area is required. This calculation is required in order to assist in determining the threat level associated with the application of road salt within each vulnerable area within the CVSPA jurisdiction.

The impervious surface analyses for the CVSPA study area were completed for HVAs, SGRAs, WHPAs, and IPZ-1s and IPZ-2s where they extend onto land. The analyses include all on-land areas where the vulnerability exceeds a score of 6 in HVAs and WHPAs, and 4.4 in IPZs. The impervious surfaces evaluation followed the steps outlined below.

The data sources required to complete the impervious area calculations, included the CVSPA HVA, SGRA, WHPA and IPZ delineations with their associated vulnerability scoring (**Chapter 4** and **Appendix D**), and mapping of the road network across the CVSPA. The information from these data sources was overlain so that the vulnerability mapping and road networks were presented on a single figure. Notably absent from the dataset were parking lots, driveways, or pedestrian pathways, which could receive salt application and thus, were NOT included in this assessment.

Credit Valley Conservation (CVC) staff developed and used a 1 km^2 grid net to perform the analysis. The percent impervious area within each grid was determined by calculating the total impervious surface area and dividing by the total area of the grid. For each road, the road width was determined using the following road conversion widths supplied by Genivar (2007):

- Arterial Road – 15 m;
- Collector Road – 12 m;
- Expressway/Highway – 12 m;
- Freeway – 25 m;
- Local Road – 10 m;
- Ramp/Service Road – 5 m; and
- Resource/Recreation Road – 8 m.

According to *Technical Rule 16 (11),* the percent impervious area calculated within each grid is grouped according to the following divisions:

- 1% to 8%;
- Greater than 8% but less than 80%; and
- Greater than or equal to 80%.

5.2.8 Uncertainty Assessment

Technical Rules (13), (14) and (15) require a discussion of uncertainty as it relates to the delineation of vulnerable areas and the calculation of the vulnerability scores. Uncertainty, as defined by the *Technical Rules*, has been discussed for each of the vulnerable areas in **Chapter 4**. The CTC SPC, however, considered another potential source of error that warrants mention; the level of confidence associated with the enumeration and location of threats.

Uncertainty analysis includes the effects of the lack of knowledge and other potential sources of error. For the threats assessment, a number of databases were used, each of which has elements of uncertainty associated with the location or nature of the activity. The accuracy of the databases used depends on the source, the age of the information, and the scale at which the spatial information was recorded. Windshield surveys were completed only for some WHPAs, but not for any other vulnerable area. Without in-depth assessment of each property, the potential exists for errors.

The uncertainty associated with the threat is related to knowledge and understanding of which chemical contaminants are present for a specific land use activity. To calculate the hazard rating for each land use activity, a series of assumptions were made that have an uncertainty associated with them.

The MOECC recognizes the preliminary nature of this inventory, and that the activities have not been verified in the field. However, under the *CWA,* if an activity exists that is not inventoried here, it is still a significant threat, and if an activity does not exist on the landscape but is inventoried here, it is not a significant threat. Source protection policies will apply only to specific activities in the respective vulnerable areas. If an activity does not exist on a property in a vulnerable area, there are no implications from the policy.

There are a number of other uncertainties related to enumerating threats at the regional scale. These uncertainties include, but are not limited to, the following:

- The vulnerable areas have been delineated using the best available numerical models, but these still involve uncertainty because of the complexity of the groundwater flow system and circulation patterns in Lake Ontario.

- Without field verification, it is not possible to assess if the threats actually exist.
- Each data source was assigned an uncertainty level of high, moderate, or low based on the age of the data, the source it was acquired from, the reliability of the source, and data maintenance.
- The use of the NAICs codes within the WHPA zones is a conservative approach and likely overestimates the number of threats because individual businesses may not store or use the chemicals involved. The uncertainty level associated with some WHPAs has however been reduced through limited site-specific verification undertaken since 2012. This is discussed further in **Section 5.5**.
- Using air photo interpretation to delineate livestock buildings means that operators can err in describing a structure and in determining what type of structure it is.
- Structures identified may or may not house animals at any point in time.
- Some managed lands do not have a calculated NU/acre number because they are crop fields without an associated farm unit, or they have an undefined operation code for the farm unit in the MPAC parcel data.
- The managed land analysis relies on the accuracy of the Ontario Parcel Alliance parcel data and the associated MPAC land use and Farm Operation Code and descriptions.
- The degree of uncertainty associated with the impervious area calculations, is considered low in the rural areas.
- In the highly urbanized areas, there is a moderate level of uncertainty. Except in the Issue Contributing Areas, the following data gaps and limitations were identified with respect to the application of road salt:
    - Impervious area calculations did not include pedestrian pathways, parking lots or driveways; and
    - Road salt application practices were not assessed.

5.3 GROUNDWATER QUANTITY THREATS

The province has identified in Section 1.1 (1) of O. Reg. 287/07 (*CWA*, *2006*) and in the *Technical Rules*, Part X.2 (*113*) two activities that, if present in vulnerable areas, could pose water quantity threats. These two threat activities are: taking water from an aquifer or surface water body without returning it to the same source; and reducing recharge to an aquifer. The SPC is required to identify where significant and moderate quantity threat activities are located and to report the circumstances that make an activity a water quantity threat. The analyses of these activities are documented in **Appendix E.1** of this report.

In the CVSPA, Tier 2 Water Budget analyses have identified three potentially stressed subwatersheds where municipal groundwater systems are located. These are:

- Subwatershed 19—groundwater-based municipal supplies to the Town of Orangeville, Mono and Township of Amaranth; and
- Subwatersheds 10 and 11—groundwater-based municipal supplies to the communities of Acton and Georgetown in the Town of Halton Hills.

Given these findings, the *Technical Rules* require that Tier 3 Water Budget assessments be undertaken for each of these areas.

The Tier 3 studies for Orangeville, Mono and Amaranth; and Acton and Georgetown have been completed and are described in **Chapter 3.8**. The threats identified to water quantity from each study are discussed separately below.

5.3.1 Water Quantity Threats – Orangeville, Mono and Amaranth

The local area risk assessment (see **Chapter 3.8**) undertaken for Subwatershed 19, through the Tier 3 water budget assessment for Orangeville, Mono and Amaranth, concludes that a significant level of risk exists in the Local Area A, shown in **Figure 5.2**. As such, the *Technical Rules* require that all consumptive demand occurring within this local area be classified as significant water quantity threats. Furthermore, the results indicate a need to manage the drinking water as a regional resource shared by the towns of Orangeville and Mono, and the Township of Amaranth.

A summary of the water quantities threats enumerated within the Local Area A is presented in **Table 5.2**. The table provides an estimate of the count of water quantity threats within the Local Area, by the municipalities and source protection areas in which they occur.

The table shows that there are approximately 305 significant water quantity threats within the Local Area in the CVSPA. Although neither East Garafraxa nor Peel (the one well in Caledon is an Orangeville supply well) have municipal water supplies in the Local Area, consumptive usage or recharge reduction taking place on their respective landscapes could pose potential water quantity threats to municipal supplies in the Local Area.

The CTC SPC is required to develop policies in the Source Protection Plan to manage or avoid these threats.

Table 5.2: Significant Threat Counts within Local Area A, Orangeville, Mono, and Amaranth

	Local Area A	CVSPA	NVSPA	GRSPA	Orange-ville	Mono	Amaranth	East Garafraxa	Town of Caledon
Municipal	**15**	14	1	-	8	3	3	-	1
Non-Municipal Permitted	**-**	-	-	-	-	-	-	-	-
Non-Municipal Non-Permitted	**391**	288	62	41	62	58	105	125	41
Recharge Reduction	**7**	3	2	2	1	1	3	2	-
Total	**413**	**305**	**65**	**43**	**71**	**62**	**111**	**127**	**42**

Consumptive Water Usage

The consumptive water users in this local area include the permitted water demands (e.g., municipal pumping) and non-permitted water demands (e.g., domestic water wells). These demands are shown in **Table 5.3** and **Figure 5.2** while the municipal demand associated with this local area is listed in **Table 5.3**.

Table 5.3: Consumptive Water Uses – Orangeville, Mono, and Amaranth

Local Area	Local Area Risk Level	Consumptive Demand (Threat)	Threat Classification
A	Significant	Well 2A	Significant
		Wells 5/ 5A	Significant
		Well 6	Significant
		Well 7	Significant
		Well 8B	Significant
		Well 8C	Significant
		Wells 9A/ 9B	Significant
		Well 11	Significant
		Well 12	Significant
		Pullen Well	Significant
		Cardinal Woods Well 1	Significant
		Cardinal Woods Well 3	Significant
		Cardinal Woods Well 4	Significant
B	Low	Island Lake PW1	-
		Island Lake TW1	-
C	Low	Coles Wells 1	-
		Coles Wells 2	-
D	Low	Orangeville Well 10	-

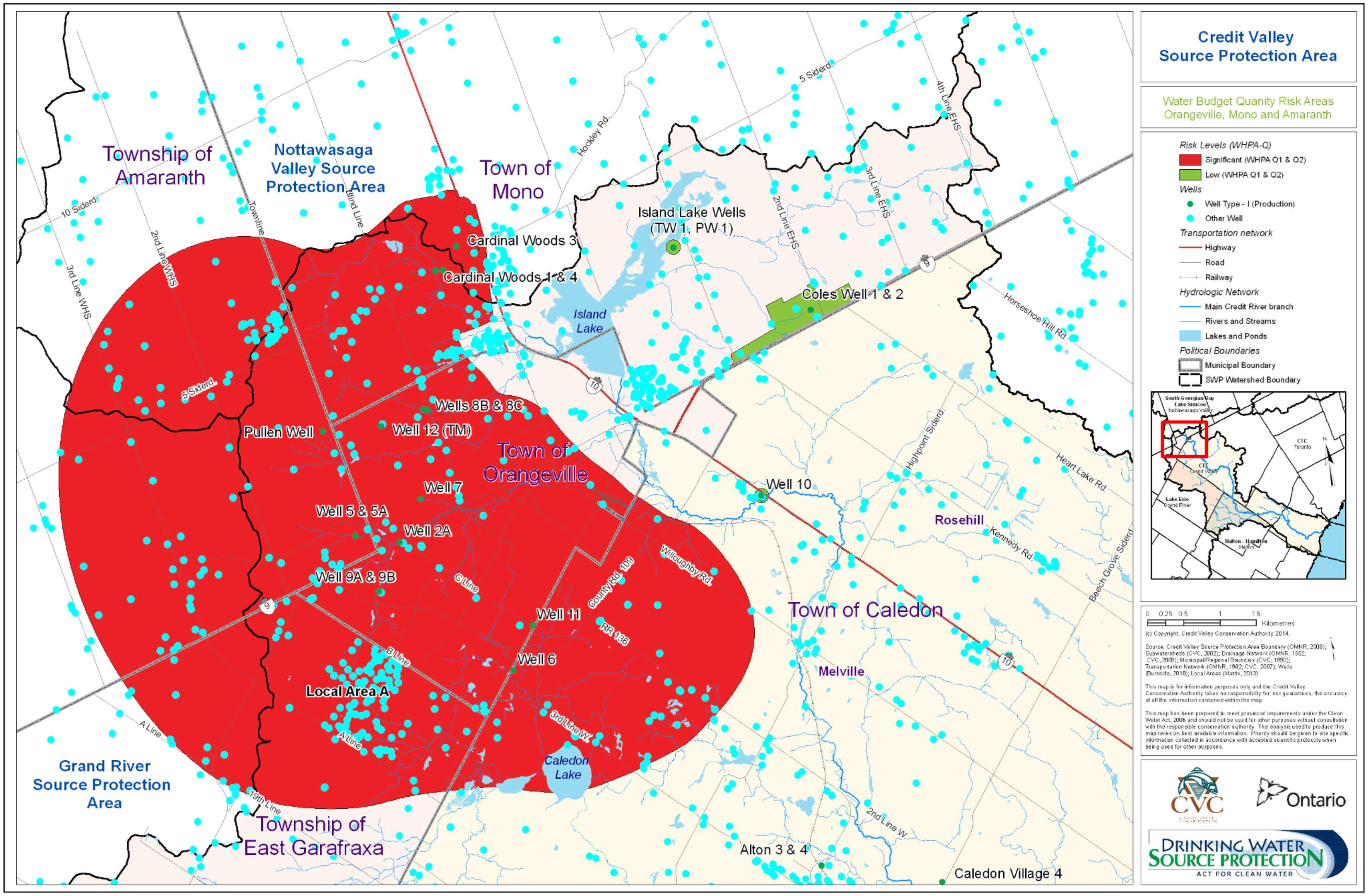


Figure 5.2: Water Budget Quantity Risk Areas – Orangeville, Mono and Amaranth

Since the risk level in the Local Areas B, C and D is low, there are no moderate or significant water quantity threats in those areas.

Recharge Reduction

The *Technical Rules* also specify that reduction in groundwater recharge is a potential water quantity threat activity within the Local Area. The Tier 3 water budget scenarios considered the impact of existing and future proposed land development on groundwater recharge and the resulting impact on water levels in the municipal aquifer at the wells. The proposed land use designations were based on approved Official Plans. The types of land use which were evaluated in assessing the potential reduction in recharge included commercial, high, and moderate density residential subdivisions, industrial (excluding aggregate extraction), institutional areas, and special suburban lands (**Table 3.15** and **Figure 5.2**).

Where a Local Area is assigned a significant risk level, all existing and future reductions in groundwater recharge within the Local Area are classified as significant water quantity threats. This significant risk level applies only to Local Area A identified in the Orangeville, Mono and Amaranth Tier 3 water budget.

5.3.2 Water Quantity Threats – Town of Halton Hills

The local area risk assessment (see **Chapter 3.8**) undertaken for Subwatersheds 10 and 11, through the Tier 3 water budget assessment for Halton Hills, concludes that a significant level of risk exists in the Local Area A and a moderate level of risk exists in Local Area C, shown in **Figure 5.3**. As such, the *Technical Rules* require that all existing and future consumptive demand and recharge reduction occurring within Local Area A and future consumptive demand and recharge reduction activities occurring within Local Area C be classified as significant water quantity threats. Existing consumptive demand and recharge reduction activities occurring within Local Area C are classified as moderate water quantity threats.

A summary of the water quantities threats enumerated within the Local Area A is presented in **Table 5.4**. The table provides an estimate of the count of water quantity threats within the Local Area, by the municipalities and source protection areas in which they occur.

All water quantity threats enumerated within Local Area A are identified as being consumptive in nature. The table shows that within the CVSPA, the vast majority of these threats originate from non-municipal non-permitted wells.

The CTC SPC is required to develop policies in the Source Protection Plan to manage or avoid the significant threats and may develop policies to address low or moderate threats.

Consumptive Water Usage

The consumptive water users in this local area include the permitted water demands (e.g., municipal pumping) and non-permitted water demands (e.g., domestic water wells). These demands are shown in **Table 5.5** and **Figure 5.3**. The municipal demand associated with these local areas is listed in **Table 5.5.**

Since the risk level in the Local Areas B and C are low and moderate, respectively, there are no existing significant water quantity threats in these areas.

Table 5.4: Existing Threat Counts within Local Area A, Town of Halton Hills

	Local Area A	CVSPA	GRSPA	HSPA	Town of Erin	Town of Halton Hills
Municipal	**3**	3	0	0	1	2
Non-Municipal						
Permitted	**0**	0	0	0	0	0
Non-Municipal	**93**	84	9	0	36	57
Non-Permitted						
Total	**96**	**87**	**9**	**0**	**37**	**59**

Table 5.5: Existing Consumptive Water Uses – Town of Halton Hills

Area	Risk Level	Permitted Consumptive Demand (Threat)	Threat Classification
Local Area A	Significant	Fourth Line Well A	Significant
		Davidson Well	Significant
Local Area B	Low	Prospect Park Well	-
Local Area C	Moderate	Lindsay Court Well 9	Moderate
		Princess Anne Well5	Moderate
		Princess Anne Well 6	Moderate
		Cedarvale Well 1A	Moderate
		Cedarvale Well 3A	Moderate
		Cedarvale Well 4	Moderate
		Cedarvale Well 4A	Moderate

Recharge Reduction

The *Technical Rules* also specify reduction in groundwater recharge as a potential water quantity threat within the Local Area. The Tier 3 Scenarios considered the impact of existing and future land development on groundwater recharge and the resulting impact on water levels in the municipal aquifer at the wells. Reductions in groundwater recharge within Local Areas A and C have the potential to be classified as significant water quantity threats. However, the analyses conclude that the vast majority of planned development is slated to occur outside of the areas of significant groundwater recharge, and as such will not significantly impact the municipal aquifers.

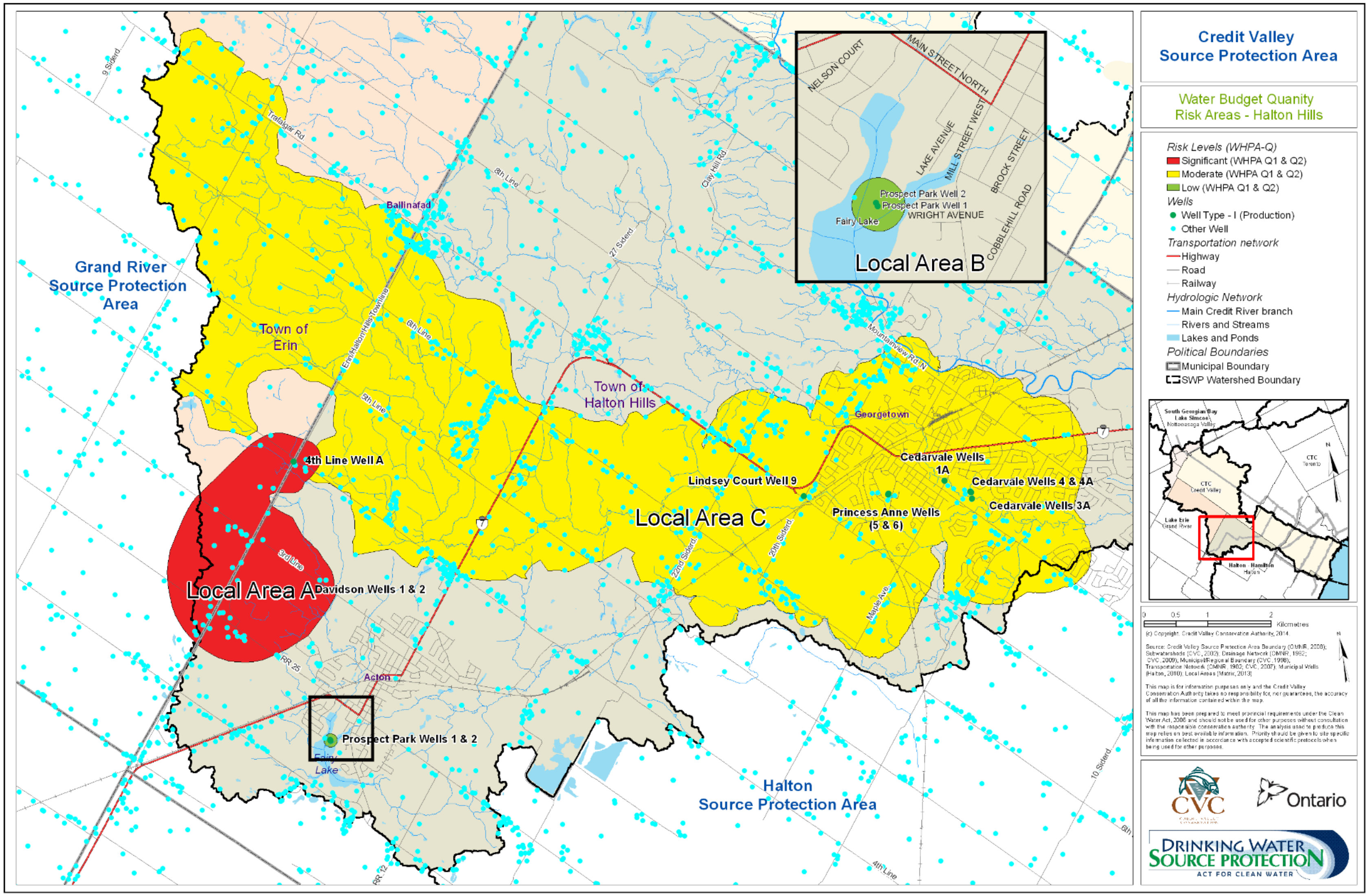


Figure 5.3: Water Budget Quantity Risk Areas – Halton Hills

5.4 GROUNDWATER QUALITY THREATS IN HIGHLY VULNERABLE AQUIFERS (HVA)

In HVAs, no significant threats can be identified using methodology associated with the scoring system for vulnerability and hazards as documented in the *Technical Rules*; only moderate or low threat scores are possible. The location and number of potential moderate and low threat activities do not need to be identified; only reference to Provincial Tables of Circumstances is required. It should be noted that the Provincial Tables of Circumstances list activities that could pose a threat under various circumstances (storage, transport, handling, use). Each possible circumstance is considered separately for each activity. The Provincial Tables of Circumstances reflect the full listing of activities under the various circumstances.

5.4.1 Threats from Conditions and Issues

No conditions or issues with respect to municipal drinking water quality have been identified in HVAs within the CVSPA. However, CVC staff will continue to monitor background ground water quality through the provincial groundwater monitoring network (PGMN).

5.4.2 Threats from Activities

According to the Provincial Tables of Circumstances within HVAs where the vulnerability score is 6 (high), there are eight circumstances on the chemical list that could pose a moderate threat to drinking water systems and 1,148 circumstances that could pose a low-level threat (see **Table 5.6**).

It should be noted that these moderate or low threat circumstances have not been counted or located in the assessment and may not actually exist in the vulnerable areas discussed. Within the Provincial Tables of Circumstances, Table 10 (DW6M DNAPLS) and Table 17 (CSGRAHVA6M Chemical) reflects the full listing of circumstances that represent moderate threats in HVAs, while Table 11 (DW6L DNAPLS) and Table 18 (CSGRAHVA6L Chemical) provides the listing of circumstances that represent low threats in HVAs. **Table 5.6** provides the number of threat circumstances for HVAs. The HVAs are shown on **Figure 4.2**.

Table 5.6: Number of Circumstances that Could Pose a Threat in HVAs

Vulnerable Area: HVA (Score = 6)	Number of Possible Circumstances with Threat Classification		
	Moderate	**Low**	**Total**
Pathogens	0	0	0
Chemical	5	1,126	1,131
DNAPL	3	22	25
TOTAL THREATS	**8**	**1,148**	**1,156**

5.4.3 Threats from Managed Lands in the Wider Landscape

The map of percent managed lands in HVAs is shown in **Figure 5.4**. The mapping shows significant clusters of managed land activities, notably in the mid- and upper areas of the CVSPA. The mapping shows that the majority of the HVAs are classified as managed lands with a moderate potential for nutrient application.

Table 5.7 shows the percent of HVAs which have high, moderate, or low risk score from potential application of nutrients. The drinking water threat in HVAs, originating from managed lands is observed to be moderate, affecting approximately 93% of the HVAs.

Table 5.7: Managed Lands in HVAs

Managed Lands (%)	Risk Score	% of Total HVAs	Threat
< 40	Low	5.8	Moderate
40–80	Moderate	93.2	
> 80	High	0.9	

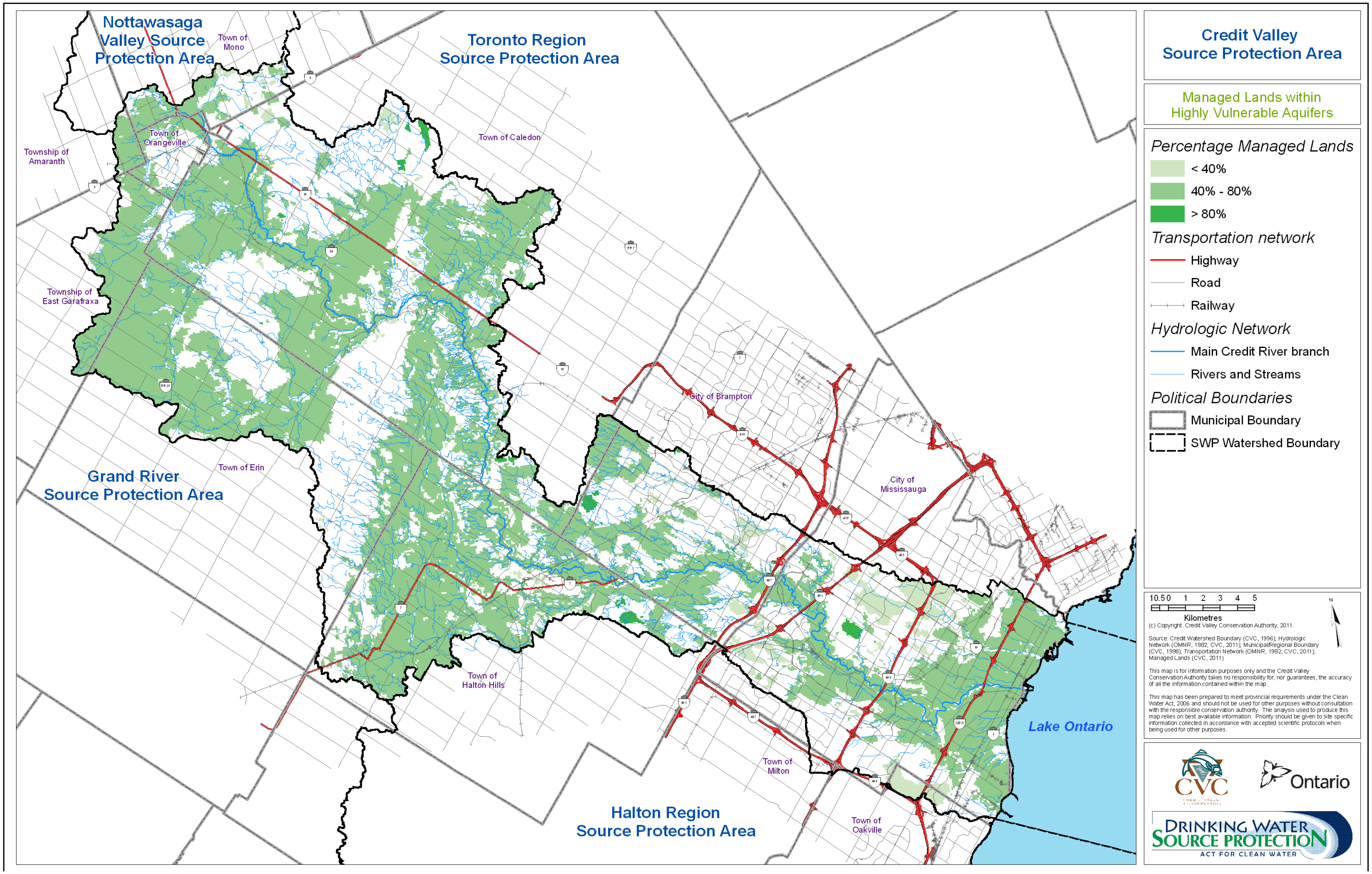


Figure 5.4: Managed Lands within Highly Vulnerable Aquifers

5.4.4 Threats from Estimated Livestock Density in the Wider Landscape

Only those areas of HVAs where livestock facilities were found are included in **Figure 5.6**. Note that the non-HVA areas are left unshaded on these maps because the methodology does not apply outside of the vulnerable areas.

Table 5.8 shows what percentage of the HVAs in these areas have significant, moderate, or low threat levels associated with the application of nutrients that exceed crop requirements. Less than 1% of HVAs have a moderate risk score, and less than 1% have significant risk score associated with the application of nutrients. In all cases the drinking water threat is low.

Table 5.8: Estimated Livestock Density in Highly Vulnerable Aquifers

Estimated Livestock Density	Risk Score	% of Total HVAs	Threat
< 0.5 NUs/acre	Low	99.20	Low
0.5–1.0 NU/acre	Moderate	0.66	
> 1.0 NU/acre	High	0.13	

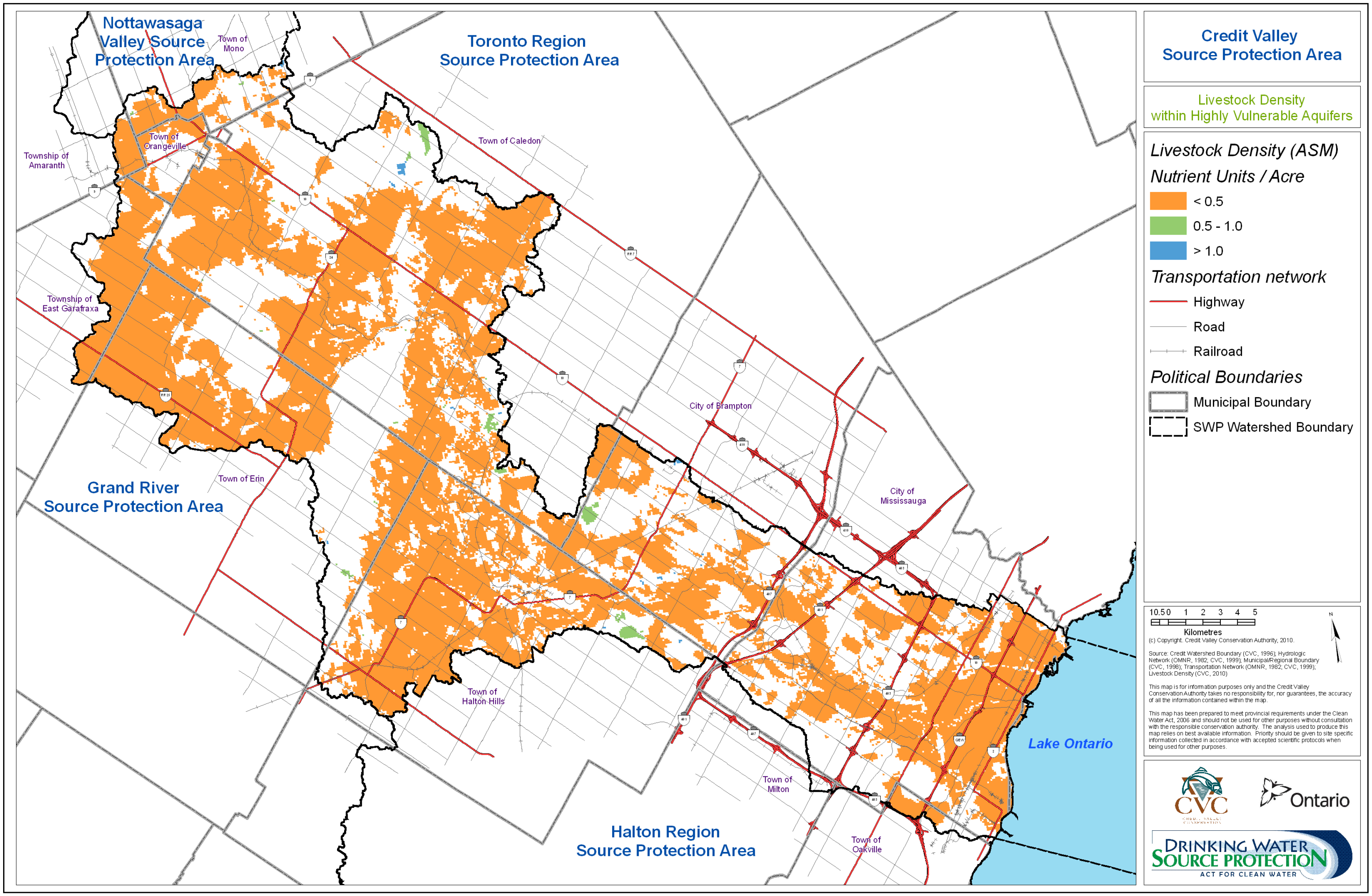


Figure 5.5: Livestock Density within Highly Vulnerable Aquifers

5.4.5 Threats for Impervious Surfaces in the Wider Landscape

Table 5.9 summarizes the percentages of impervious surfaces within HVAs. As expected, the areas with less than 1% impervious surfaces are found in rural areas. About 90% of HVAs within the CVSPA experience moderate levels of imperviousness (between 1 – 80%). These levels rise based on land use. The remaining 10% of the HVAs have less than 1% impervious surfaces where the threat on impervious surfaces is extremely limited.

Urban areas, which are made up of residential subdivisions, commercial developments, and roads, and other infrastructure and institutions that service these areas are, by their very nature, likely to have highly impervious surfaces—far more than the rural and agricultural areas of the CVSPA (see **Figure 5.8**). Note that the non-HVA areas are left unshaded on these maps because the methodology does not apply outside of the vulnerable areas.

Table 5.9: Impervious Surfaces in HVAs

Impervious Surfaces (%)	% of Total HVAs	Threat
Not more than 1	9.98	No Threat
More than 1, no more than 8	71.14	Low
More than 8, no more than 80	18.88	
80 or more	0	

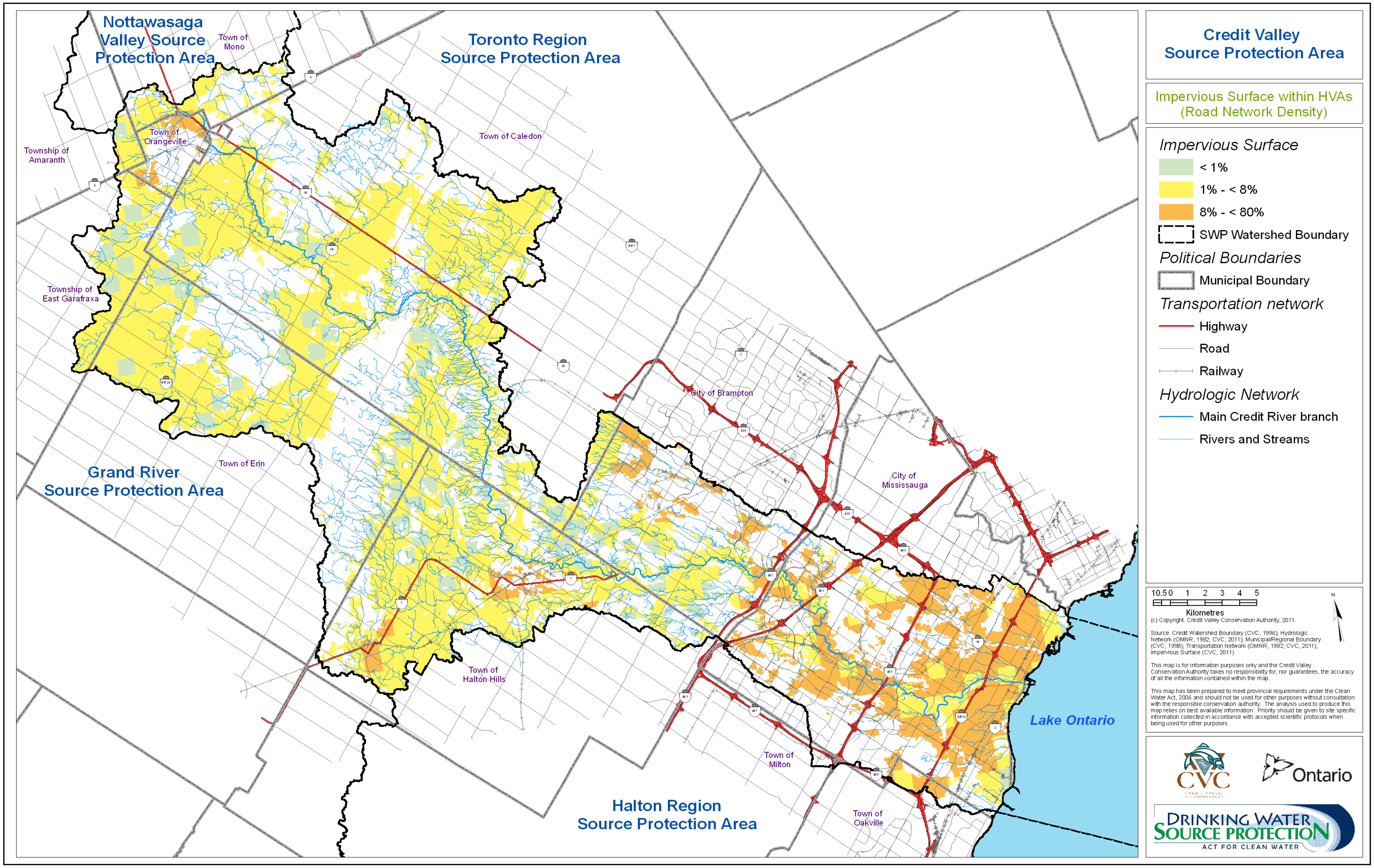


Figure 5.6: Impervious Surfaces within HVAs (Road Network Density)

5.5 GROUNDWATER QUALITY THREATS AND ISSUES IN WELLHEAD PROTECTION AREAS (WHPA)

Threats assessments have been completed by consultants working for each municipality except for wells in the Township of Amaranth and the Region of Halton, where the consultants were under the direction of CVC staff. Threats have been assessed for all municipal wells in the CVSPA as described in the following sections organized by municipality. Groundwater based municipal supplies in the CVSPA are currently delivered through nine active water systems plus two water systems that are currently off-line (**Table 2.6**). There are a total of 46 municipal drinking water wells in the CVSPA.

Table 5.10 shows the summary of the number significant drinking water threats identified within these WHPAs.

Table 5.10: Summary of Drinking Water Threats (Quality and Quantity) for the Credit Valley Source Protection Area

Municipality	Wells	Significant Drinking Water Threats	Total # of Parcels with Significant Drinking Water Threats
Town of Orangeville	Wells 2A, 5, 5A, 6, 7, 8B, 8C, 9A, 9B, 10, 11 and 12	2,728	2,495
Town of Mono	Cardinal Woods Wells 1, 3 and 4, Island Lake Wells TW1 and PW1, and Coles Wells 1 and 2	66	40
Township of Amaranth	Pullen Well	41	30
Town of Erin	Erin Wells 7 and 8	28	10
	Hillsburgh Wells H2 and H3	39	19
	Bel Erin Wells 1 and 2	223	104
Region of Halton	Acton 4th Line Well, Davidson Wells 1 and 2, and Prospect Park Wells 1 and 2	651	346
	Georgetown Lindsay Court Well 9, Princess Anne Wells 5 and 6, and Cedarvale Wells 1a, 3a, 4 and 4a	6,135	4,046
Region of Peel	Alton Wells 3 and 4A	13	12
	Caledon Village Wells 3 and 4	2	1
	Inglewood Wells 3 and 4	3	3
	Cheltenham Wells 1 and 2	16	6
	Total	**9,945**	**7,112**

Note that since the Pullen Well (Amaranth) and its WHPAs lie within the WHPAs for Orangeville Wells 8B, 8C and Well 12, a number of the threats and affected properties around the Pullen Well are also included in the threats count for Orangeville. Similar overlap occurs within Orangeville (WHPA & ICA), and between Mono's Coles wells and Orangeville Well 10 WHPAs. Given this, the total threat and parcel counts do not represent direct summations of the data shown for the individual municipalities.

To reduce inconsistencies in the approaches used by the various consultants undertaking the threats assessment work, staff in the CTC Source Protection Region participated, along with their consultants, in a series of meetings led by the South Georgian Bay Lake Simcoe Source Protection Region (SGBLS SPR), to develop a common approach to interpreting the provincial direction. The agreements emerging from this process are documented in the report *Reducing Inconsistencies in Threat Subcategory Enumeration* (May 2010), reproduced in **Appendix E2**, and referred to as the *SGBLS Accord*. The SGBLS Accord opted to apply a single threat for handling and storage of fuel in each WHPA with a vulnerability score of 10, unless there was a high probability that natural gas was the primary source of heating fuel. However, the CTC SPC requested that a single threat for handling and storage of fuel oil be assigned to each individual property, unless it could be shown that the property is not using fuel oil.

Prior to 2012, the analyses of threats were mainly restricted to desktop studies with limited field verification of significant threats through windshield surveys. Since then, initial effort aimed at the ground truthing of significant threats in vulnerable zones around municipal wells has been undertaken. The *Technical Rules* require the enumeration (counting, locating) of all significant threats to the quality of the water used as a source of drinking water, in a given vulnerable area. The location and number of moderate and low threats do not have to be reported; only referencing to the provincial tables is required. The *Technical Rules* require that each significant threat within the vulnerable areas be enumerated (identified and counted). As such, drinking water threats were analyzed within the WHPAs, as follows:

- Chemical threats—located within WHPA-A to WHPA-E;
- DNAPL threats—located in WHPA-A, WHPA-B, or WHPA-C/C1 regardless of the risk score, and in WHPA-D, where there is a vulnerability score of 6; and
- Pathogen threats—located within WHPA-A, WHPA-B, and WHPA-E.

5.5.1 County of Dufferin - Town of Orangeville

The Town of Orangeville has a municipal supply comprised of 12 wells. The WHPA delineation and vulnerability assessment processes around these wells are described in **Chapter 4.2**.

The original issues evaluation and threats identification for the town's wells are detailed in the report "Issues Evaluation and Threats Assessment, Town of Orangeville" (R.J. Burnside & Associates Limited, June 2010). This report was subjected to extensive peer review by municipal staff and by the CVC prior to acceptance by the CTC SPC, and inclusion in the Assessment Report. This document contains the foundation technical data and information upon which the summary below has been based.

Since the WHPAs of Orangeville's wells also traverse the land areas of Amaranth, East Garafraxa, Mono, and Caledon. Official Plan land-use maps for these municipalities were also consulted to evaluate the existing and planned land uses within them. Historical aerial photographs from 1951 and 1976 were reviewed to identify land-use changes and potential high-risk activities such as waste disposal sites within the well-capture zones. Aerial photography available to the Town of Orangeville based on 2002 and 2006 Ministry of Natural Resources and Forestry (MNRF) ortho-imagery was also utilized as part of this study.

Threats and Issues

The threats inventory was compiled using the data and information sources outlined in **Appendix E2**. Site-specific verification of drinking water threats was not conducted as part of the original study referenced above. Since 2012 however, initial effort aimed at the ground truthing of significant threats in vulnerable zones around municipal wells has been undertaken by both the Region of Peel and by CVC staff. The Region of Peel undertook the verification in the portions of the vulnerable zones that fall within the Town of Caledon, while the CTC conducted the assessment in the rest of the zones.

The region's findings are presented in the report "Region of Peel – Verification of Significant Drinking Water Quality Threats (Groundwater), for Orangeville Municipal Wells in Caledon" (R.J. Burnside & Associates Limited, April 2014). The CTC's findings are presented in the report "Drinking Water Quality, Preliminary Verification of Significant Threats - Town of Orangeville" (Credit Valley Conservation Authority & CTC Source Protection Region, January 2015).

The findings of both studies have been used to refine the threat counts in this report.

Table 5.11 through **Table 5.15** summarize the significant drinking water threats around the wellheads. No significant managed land threats were identified, except in WHPA-C Wells 8B/8C, and 12. Details of the evaluation of managed land threats are found in **Appendix E3**.

Table 5.11: Orangeville Water System, Wells 2A, 5, 5A, 7, 9A and 9B—Enumerated Drinking Water Threats

Activity (or Threat Type)	Threats			
	Significant	Moderate	Low	Total
1) The establishment, operation, or maintenance of a waste disposal site within the meaning of Part V of the *Environmental Protection Act*	0	n/a	n/a	n/a
2) The establishment, operation, or maintenance of a system that collects, stores, transmits, treats or disposes of sewage	21	n/a	n/a	n/a
3) The application of agricultural source material to land	2	n/a	n/a	n/a
4) The storage of agricultural source material	0	n/a	n/a	n/a
5) The management of agricultural source material to land	0	n/a	n/a	n/a
6) The application of non-agricultural source material (NASM) to land	2	n/a	n/a	n/a
7) The handling and storage of non-agricultural source material NASM	0	n/a	n/a	n/a
8) The application of commercial fertilizer	0	n/a	n/a	n/a
9) The handling and storage of commercial fertilizer	1	n/a	n/a	n/a
10) The application of pesticide to land	2	n/a	n/a	n/a
11) The handling and storage of pesticide	1	n/a	n/a	n/a
12) The application of road salt	990	n/a	n/a	n/a
13) The handling and storage of road salt	10	n/a	n/a	n/a
14) The storage of snow	0	n/a	n/a	n/a
15) The handling and storage of fuel	1	n/a	n/a	n/a
16) The handling and storage of a dense non-aqueous phase liquid	25	n/a	n/a	n/a
17) The handling and storage of an organic solvent	0	n/a	n/a	n/a
18) The management of runoff that contains chemicals used in the de-icing of aircraft	0	n/a	n/a	n/a
19) An activity that takes water from an aquifer or a surface water body without returning the water taken to the same aquifer or surface water body	110	n/a	n/a	n/a
20) An activity that reduces the recharge of an aquifer	1	n/a	n/a	n/a
21) The use of land as livestock grazing or pasturing land, an outdoor confinement area, or a farm-animal yard.	0	n/a	n/a	n/a
Total Threats	**1169**	**n/a**	**n/a**	**n/a**
Total Parcels	**1113**	**n/a**	**n/a**	**n/a**

n/a - not required by the MOECC

Table 5.12: Orangeville Water System, Wells 8B, 8C and 12-Enumerated Drinking Water Threats

Activity (or Threat Type)	Threats			
	Significant	Moderate	Low	Total
1) The establishment, operation, or maintenance of a waste disposal site within the meaning of Part V of the *Environmental Protection Act*	2	n/a	n/a	n/a
2) The establishment, operation, or maintenance of a system that collects, stores, transmits, treats or disposes of sewage	2	n/a	n/a	n/a
3) The application of agricultural source material to land	3	n/a	n/a	n/a
4) The storage of agricultural source material	0	n/a	n/a	n/a
5) The management of agricultural source material to land	0	n/a	n/a	n/a
6) The application of non-agricultural source material (NASM) to land	3	n/a	n/a	n/a
7) The handling and storage of non-agricultural source material NASM	0	n/a	n/a	n/a
8) The application of commercial fertilizer	0	n/a	n/a	n/a
9) The handling and storage of commercial fertilizer	1	n/a	n/a	n/a
10) The application of pesticide to land	3	n/a	n/a	n/a
11) The handling and storage of pesticide	1	n/a	n/a	n/a
12) The application of road salt	1	n/a	n/a	n/a
13) The handling and storage of road salt	0	n/a	n/a	n/a
14) The storage of snow	0	n/a	n/a	n/a
15) The handling and storage of fuel	0	n/a	n/a	n/a
16) The handling and storage of a dense non-aqueous phase liquid	2	n/a	n/a	n/a
17) The handling and storage of an organic solvent	0	n/a	n/a	n/a
18) The management of runoff that contains chemicals used in the de-icing of aircraft	0	n/a	n/a	n/a
19) An activity that takes water from an aquifer or a surface water body without returning the water taken to the same aquifer or surface water body	21	0	0	n/a
20) An activity that reduces the recharge of an aquifer	0	0	0	n/a
21) The use of land as livestock grazing or pasturing land, an outdoor confinement area, or a farm-animal yard.	1	n/a	n/a	n/a
Total Threats	**40**	**n/a**	**n/a**	**n/a**
Total Parcels	**27**	**n/a**	**n/a**	**n/a**

n/a- not required by the MOECC

Table 5.13: Orangeville Water System, Well 6 and 11-Enumerated Drinking Water Threats

Activity (or Threat Type)	Threats			
	Significant	Moderate	Low	Total
1) The establishment, operation, or maintenance of a waste disposal site within the meaning of Part V of the *Environmental Protection Act*	0	n/a	n/a	n/a
2) The establishment, operation, or maintenance of a system that collects, stores, transmits, treats or disposes of sewage	5	n/a	n/a	n/a
3) The application of agricultural source material to land	0	n/a	n/a	n/a
4) The storage of agricultural source material	0	n/a	n/a	n/a
5) The management of agricultural source material to land	0	n/a	n/a	n/a
6) The application of non-agricultural source material (NASM) to land	0	n/a	n/a	n/a
7) The handling and storage of non-agricultural source material NASM	0	n/a	n/a	n/a
8) The application of commercial fertilizer	0	n/a	n/a	n/a
9) The handling and storage of commercial fertilizer	0	n/a	n/a	n/a
10) The application of pesticide to land	0	n/a	n/a	n/a
11) The handling and storage of pesticide	0	n/a	n/a	n/a
12) The application of road salt	1037	n/a	n/a	n/a
13) The handling and storage of road salt	43	n/a	n/a	n/a
14) The storage of snow	1	n/a	n/a	n/a
15) The handling and storage of fuel	0	n/a	n/a	n/a
16) The handling and storage of a dense non-aqueous phase liquid	31	n/a	n/a	n/a
17) The handling and storage of an organic solvent	0	n/a	n/a	n/a
18) The management of runoff that contains chemicals used in the de-icing of aircraft	0	n/a	n/a	n/a
19) An activity that takes water from an aquifer or a surface water body without returning the water taken to the same aquifer or surface water body	95	0	0	208
20) An activity that reduces the recharge of an aquifer	0	0	0	1
21) The use of land as livestock grazing or pasturing land, an outdoor confinement area, or a farm-animal yard.	0	n/a	n/a	n/a
Total Threats	1212	n/a	n/a	n/a
Total Parcels	1138	n/a	n/a	n/a

n/a- not required by the MOECC

Table 5.14: Orangeville Water System, Well 10 Enumerated Drinking water threats

Activity (or Threat Type)	Threats			
	Significant	Moderate	Low	Total
1) The establishment, operation, or maintenance of a waste disposal site within the meaning of Part V of the *Environmental Protection Act*	1	n/a	n/a	n/a
2) The establishment, operation, or maintenance of a system that collects, stores, transmits, treats or disposes of sewage	6	n/a	n/a	n/a
3) The application of agricultural source material to land	1	n/a	n/a	n/a
4) The storage of agricultural source material	1	n/a	n/a	n/a
5) The management of agricultural source material to land	0	n/a	n/a	n/a
6) The application of non-agricultural source material (NASM) to land	0	n/a	n/a	n/a
7) The handling and storage of non-agricultural source material NASM	1	n/a	n/a	n/a
8) The application of commercial fertilizer	0	n/a	n/a	n/a
9) The handling and storage of commercial fertilizer	1	n/a	n/a	n/a
10) The application of pesticide to land	1	n/a	n/a	n/a
11) The handling and storage of pesticide	1	n/a	n/a	n/a
12) The application of road salt	216	n/a	n/a	n/a
13) The handling and storage of road salt	87	n/a	n/a	n/a
14) The storage of snow	0	n/a	n/a	n/a
15) The handling and storage of fuel	2	n/a	n/a	n/a
16) The handling and storage of a dense non-aqueous phase liquid	1	n/a	n/a	n/a
17) The handling and storage of an organic solvent	0	n/a	n/a	n/a
18) The management of runoff that contains chemicals used in the de-icing of aircraft	0	n/a	n/a	n/a
19) An activity that takes water from an aquifer or a surface water body without returning the water taken to the same aquifer or surface water body	0	0	0	208
20) An activity that reduces the recharge of an aquifer	0	0	0	1
21) The use of land as livestock grazing or pasturing land, an outdoor confinement area, or a farm-animal yard.	1	n/a	n/a	n/a
Total Threats	320	n/a	n/a	n/a
Total Parcels	219	n/a	n/a	n/a

n/a- not required by the MOECC

A total of 2,728 significant threats have been identified on 2,495 parcels in the vulnerable areas of the town's wellheads. 227 of these threats are related to water quantity, while the rest are related to water quality. 78 of the water quality threats originate on lands within the Region of Peel, 205 originate in the Township of East Garafraxa and 12 originate in the Township of Amaranth. These have been linked mainly to sodium and chloride issues from the application of road salts, handling, and storage of DNAPLs, sewage, the handling and storage of fuel, storage of snow, and handling, storage, and application of road salts.

The areas where the threats are or would be low, moderate, or significant for chemicals, DNAPLs and pathogens are shown in **Figure 5.10**, **Figure 5.11**, and **Figure 5.12**, respectively.

The issues evaluation was initially undertaken by R.J. Burnside & Associates Ltd in 2010. In June 2013, the SPC requested that a separate evaluation be undertaken utilizing updated criteria applied to an updated determination of issues around Halton Region's wellheads. This work resulted in the development of the report "Issues Determination, Town of Orangeville Wells" (CTC, 2013). It was subjected to review by the Town of Orangeville and approved by the SPC in October, 2013.

The recent work involved the review of parameter trends to assess how their concentration has varied over time, and whether statistical projection shows the potential for concentrations to increase above the Ontario Drinking Water Standard (ODWS) level within a thirty-year period. This time horizon was proposed by staff, as this is generally the planning horizon under the *Growth Management Plan for the Greater Golden Horseshoe,* which applies to most municipalities in the CVSPA. In determination of an Issue, consideration was also given to the frequency with which the half concentration of the ODWS (1/2 maximum allowable concentration (MAC)) was met or exceeded. Based on this assessment, the following issues were identified:

Based on the updated criteria, the following issues were identified:

- Sodium Issues – at Wells 6, 9A and 9B only. Sodium issues previously identified for Wells 2A,5/5A, 10 and 11, have been removed; and
- Chloride Issues – at Wells 6, 9A and 9B, 10 and 11 only. Chloride issues previously identified for Wells 2A and 5/5A have been removed.

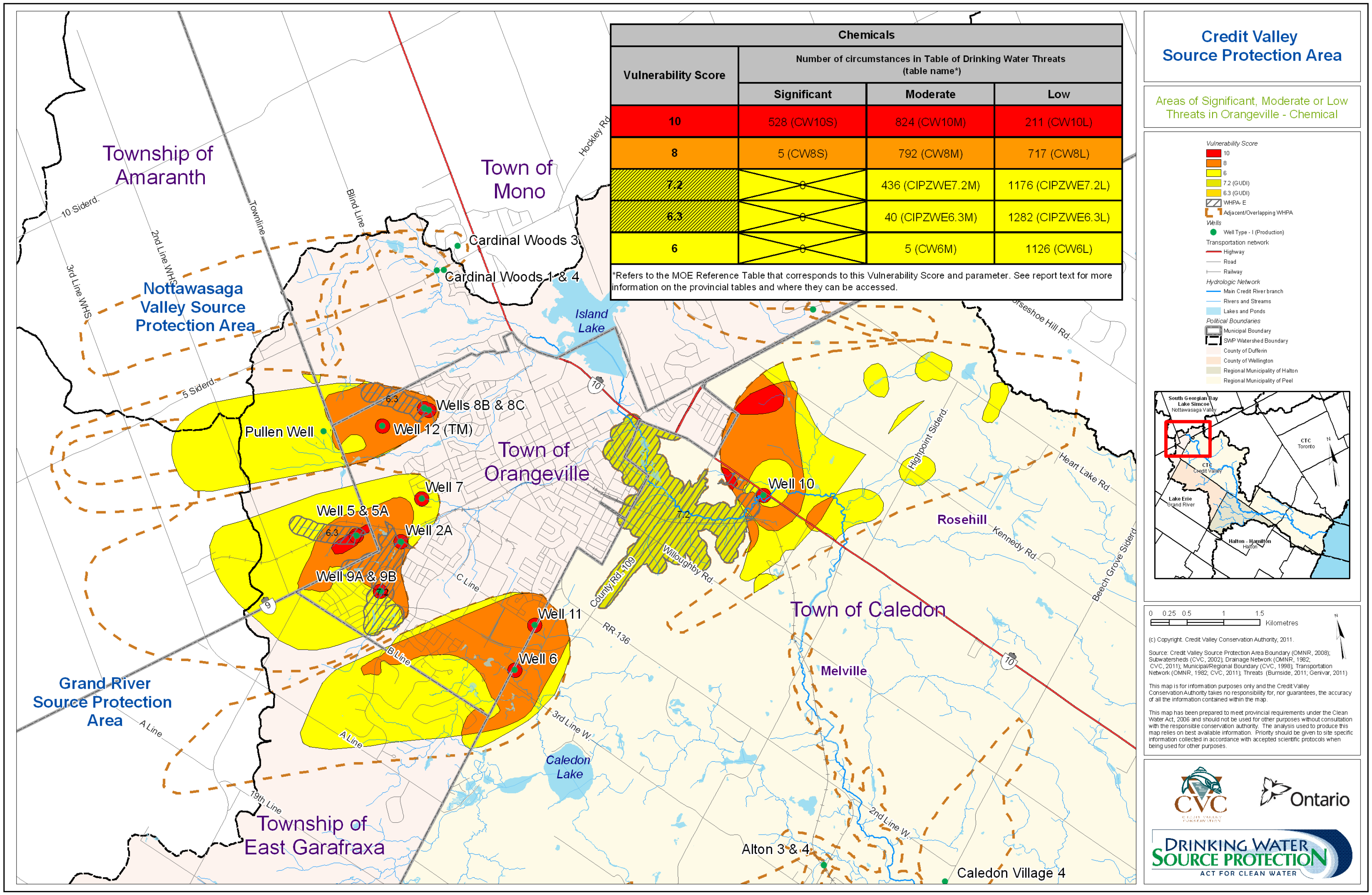
Figure 2.21 and **Figure 2.22** show concentrations of sodium and chloride from 1983 to 2012. The trend plots show a distinctive upward change in gradient between the periods, pre- and post-2000. Concentrations are below the ODWS for both Na (200 mg/L) and Cl (250 mg/L) but based on projections they are anticipated to exceed the respective standards within the next 30 years if the trends were to continue. Unless immediate action is taken to address these trends, it may not be possible to reverse the trend in rising levels. Mitigation actions will take time to implement, and improvements will not occur immediately. Without action, the quality of water in these wells could deteriorate beyond repair.

Issue Contributing Areas

ICAs for Orangeville's wells are shown in **Figure 5.13.** They remain unchanged from the 2010 evaluation, and have been delineated in accordance with the *Technical Rules*, and are based on the linkages between the issues noted and the history of land usage and development in the area:

- The WHPAs for Wells 2A, 5/5A, and 9A/9B are overlapping and mapped as a single WHPA. The ICA for the sodium and chloride for Well 9A/B is interpreted as being the extent of this WHPA. The WHPA features a number of subdivision developments that have been established since 2000. The WHPA also features the main east-west arterial road through the Town of Orangeville, as well as the new bypass.

- The WHPA defined for Wells 6 and 11 is regarded as the ICA for the chloride levels noted at these wells, and for sodium levels noted at Well 6. This WHPA encompasses the western edge of Orangeville which contains recently developed subdivisions. Alongside these developments are a number of major roadways including the existing Highway 9 and Townline.
- The WHPA for Well 10 is regarded as the ICA for the chloride levels noted at this well. This WHPA encompasses a large area to the south of Orangeville and includes a number of major roadways, such as Highway 10 which runs north to south within the WHPA-A. Well 10 is identified as a GUDI well, and runoff from parking lots, streets and storm water ponds, and discharge of treated sewage within the WHPA-E may also be contributing to the occurrence of the issue.

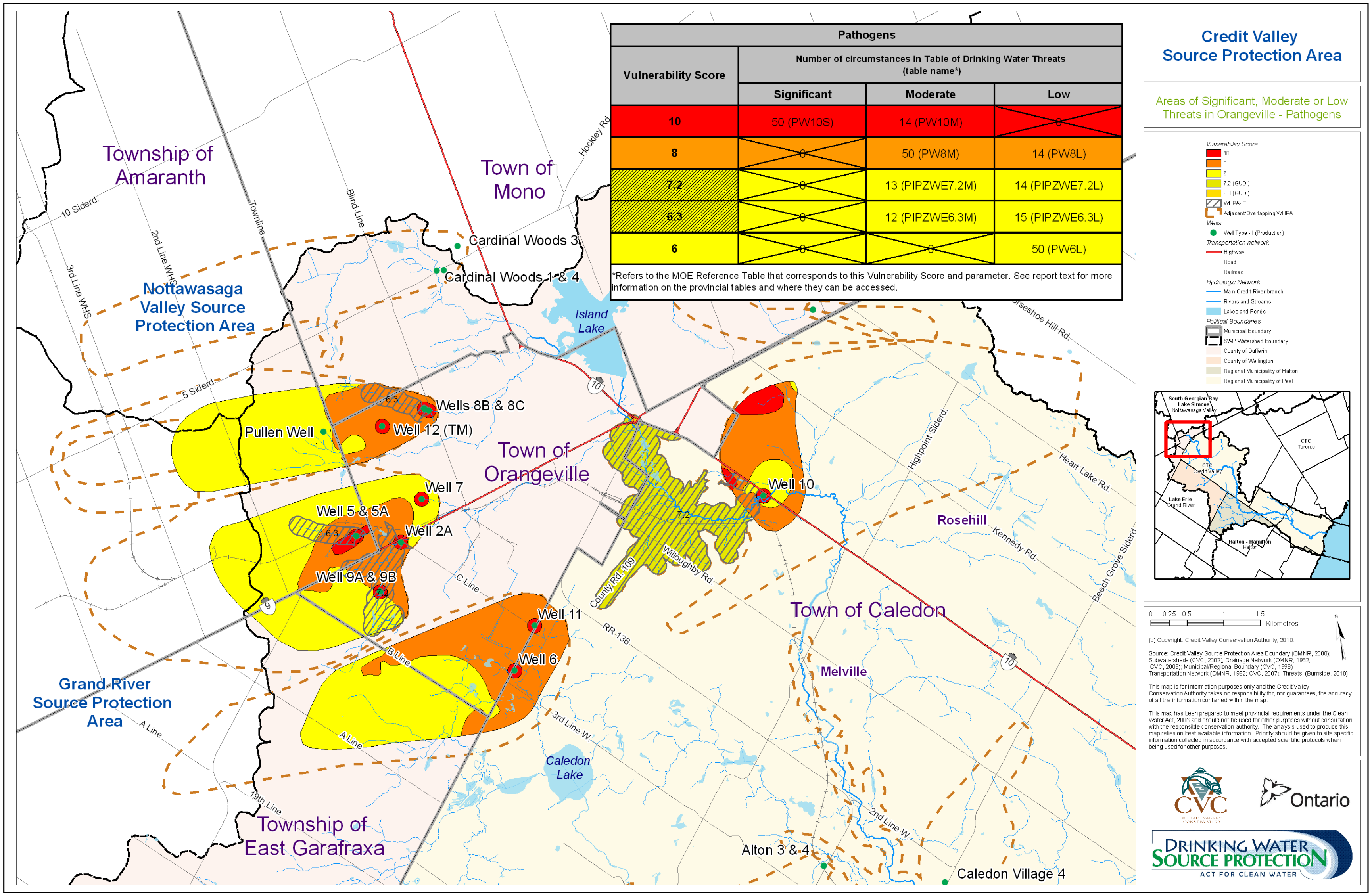


Chemicals			
Vulnerability Score	Number of circumstances in Table of Drinking Water Threats (table name*)		
	Significant	Moderate	Low
10	528 (CW10S)	824 (CW10M)	211 (CW10L)
8	5 (CW8S)	792 (CW8M)	717 (CW8L)
7.2	0	436 (CIPZWE7.2M)	1176 (CIPZWE7.2L)
6.3	0	40 (CIPZWE6.3M)	1282 (CIPZWE6.3L)
6	0	5 (CW6M)	1126 (CW6L)

*Refers to the MOE Reference Table that corresponds to this Vulnerability Score and parameter. See report text for more information on the provincial tables and where they can be accessed.

Figure 5.7: Areas of Significant, Moderate or Low threats in Orangeville – Chemical

The current Provincial Table of Drinking Water Threats can be accessed at http://swpip.ca/



Pathogens			
Vulnerability Score	Number of circumstances in Table of Drinking Water Threats (table name*)		
	Significant	Moderate	Low
10	50 (PW10S)	14 (PW10M)	0
8	0	50 (PW8M)	14 (PW8L)
7.2	0	13 (PIPZWE7.2M)	14 (PIPZWE7.2L)
6.3	0	12 (PIPZWE6.3M)	15 (PIPZWE6.3L)
6	0	0	50 (PW6L)

*Refers to the MOE Reference Table that corresponds to this Vulnerability Score and parameter. See report text for more information on the provincial tables and where they can be accessed.

Figure 5.8: Areas of Significant, Moderate or Low Threats in Orangeville – Pathogens

The current Provincial Table of Drinking Water Threats can be accessed at http://swpip.ca/

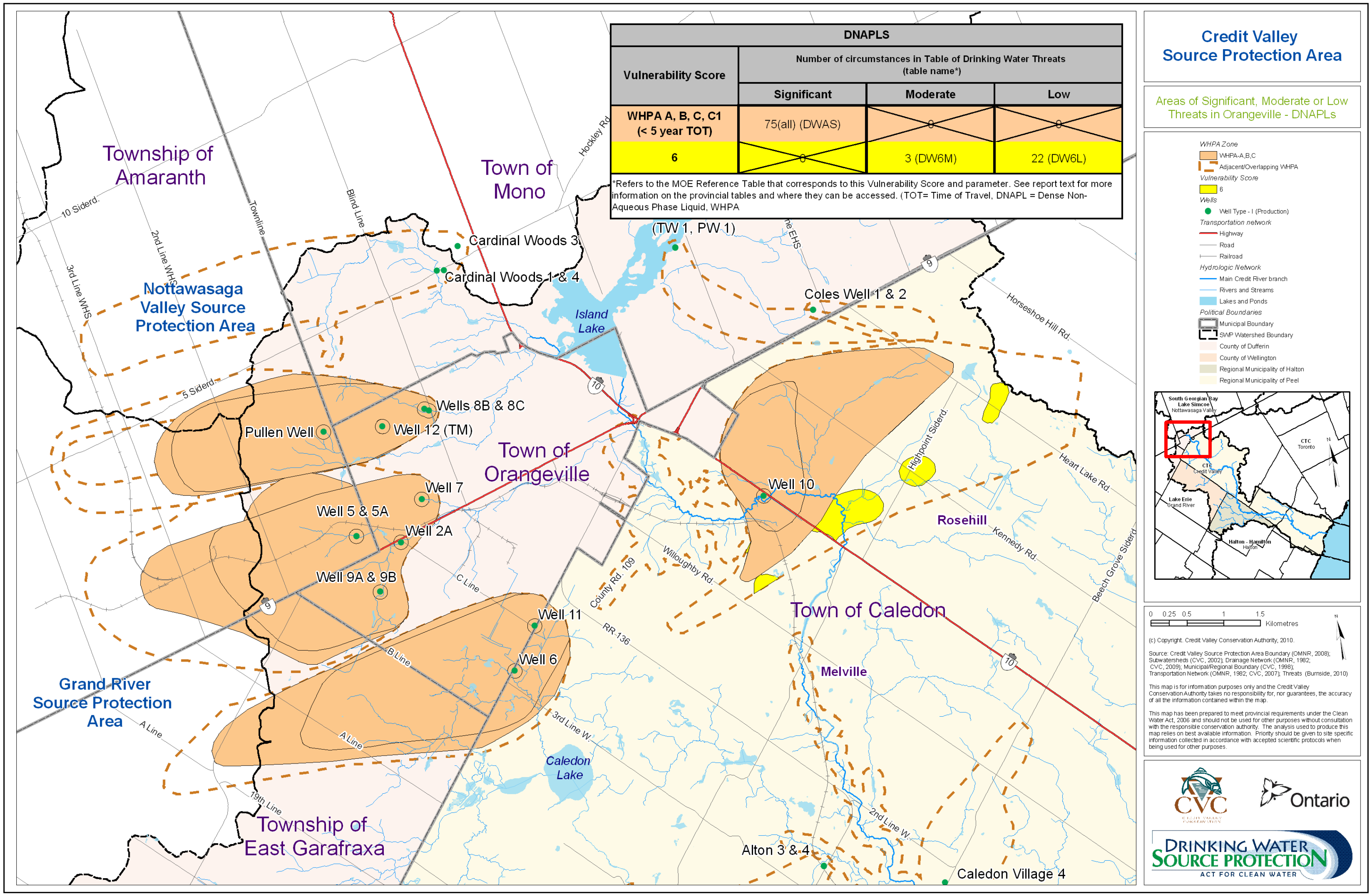


Figure 5.9: Areas of Significant, Moderate or Low Threats in Orangeville – DNAPLs

The current Provincial Table of Drinking Water Threats can be accessed at http://swpip.ca/

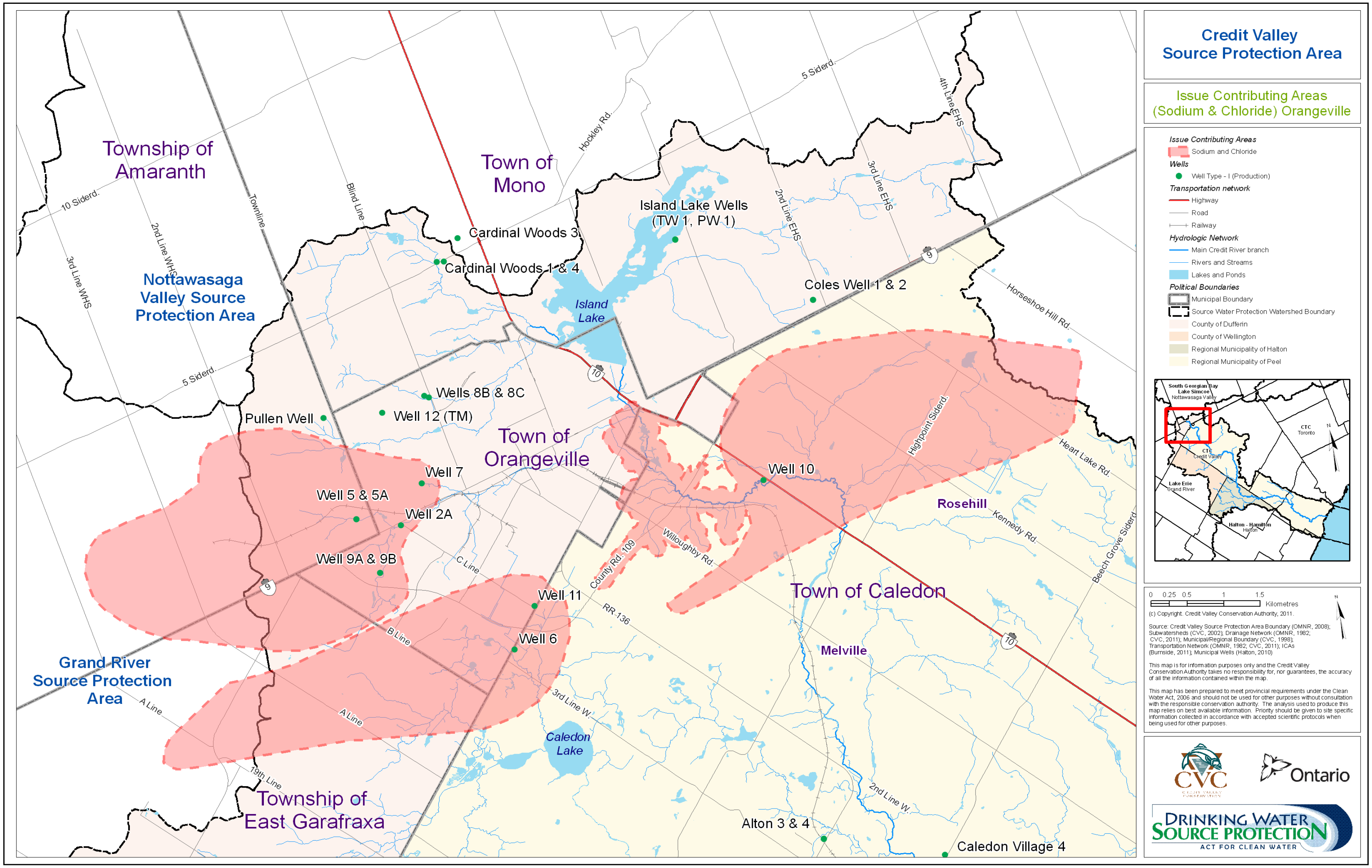


Figure 5.10: Issue Contributing Areas (Sodium &/or Chloride) in Orangeville

Sodium and chloride are thought to be linked to both point sources and non-point sources. Point sources include water softener backwash discharged to septic systems, while non-point sources are impacts from road salt application.

Any activity that utilizes or has the potential to generate sodium or chloride in an ICA would automatically be considered a significant drinking water threat, if included as a circumstance listed in the MOECC's Provincial Tables of Circumstances or if added as a local threat.

The ICAs for Orangeville's wells shown in **Figure 5.13** relate to three WHPAs for the following wells – Wells 2A, 5/5A, 7 and 9A/B; Wells 6 and 11; and Well 10. **Table 5.11** also shows the numbers of significant threats that are related to the issues in the ICA. The methodology outlined in **Chapter 5.2.3** was applied to the ICA to estimate the sodium and chloride loading to the environment from a given land activity, and to prioritize the various activities based on the loading that they generate. The activities were then ranked in terms of their comparative contribution to the identified issues.

The details of this study are contained in the report "Drinking Water Threats in Issue Contributing Areas" (Credit Valley Source Protection Area and Genivar, May 2011) and further information is found in **Appendix E6**.

The activities that are thought to contribute to the identified issues are as follows:

- Storage of road salt;
- Application of road salt;
- Septic systems;
- Storage of snow; and
- Sewage and Storm Management Systems.

The study results are shown in **Figure 5.14** and **Figure 5.15**. In the ICA for Wells 2, 5, 7, and 9; and 6 and 11, approximately 98% of the potential sodium and chloride loading is estimated to originate from salt application undertaken as part of winter road and parking lot maintenance. In the ICA for Well 10 the loading into WHPA-E from the discharge of the municipal sewage effluent was the largest source, accounting for 70% of the potential sodium and chloride loading. There is some uncertainty associated with this conclusion though, as the water pollution control plant (WPCP) outfalls directly into the Credit River, and the analysis was not able to ascertain how much of the effluent infiltrates through the ground, or how much travels towards Well 10. This is a data gap that requires further analysis.

The proportion of salt that comes from public and private road maintenance sources varies amongst ICAs. This is reasonable as each contains a different proportion of private parking lots, however private non-residential salt application can be a large part of the loading within an ICA. The percentage of the release of contaminants from the application of road salt by private residents and the release of sodium and chloride from private sewage, including the potential contribution from water softeners is quite small (combined less than 2%) although the total amount released in the area is in excess of 51.8 tonnes annually.

Under the *Building Code Act,* any septic system governed under this act that is identified as a significant drinking water threat is subject to mandatory re-inspections to ensure that the system is functioning properly of if corrective action is required. There are no corrective actions that can be taken to reduce the discharge of sodium or chloride. Thus, based on this analysis showing the relatively small estimated contribution of sodium and/or chloride from private septic systems, even those with water softeners discharging to the system, the CTC SPC decided in 2015 that the septic systems should not be considered as significant threat activities contributing to sodium/chloride issues in these wells pursuant to *Technical Rule* 115(4) and 131(2). It should be noted that the septic systems identified as significant threat as a result of the vulnerability scoring approach would not be impacted by this decision, i.e., remain significant threat.

The total average annual application of chloride is shown in **Figure 5.16** for public road de-icing, and de-icing on commercial, industrial, institutional, or multi-unit residential parcels, but there is a wide variation year-to-year depending upon weather events. Tabulated details on sodium and chloride loadings in Orangeville's WHPAs are provided in **Appendix E6** and can also be found in the foundation report referenced earlier.

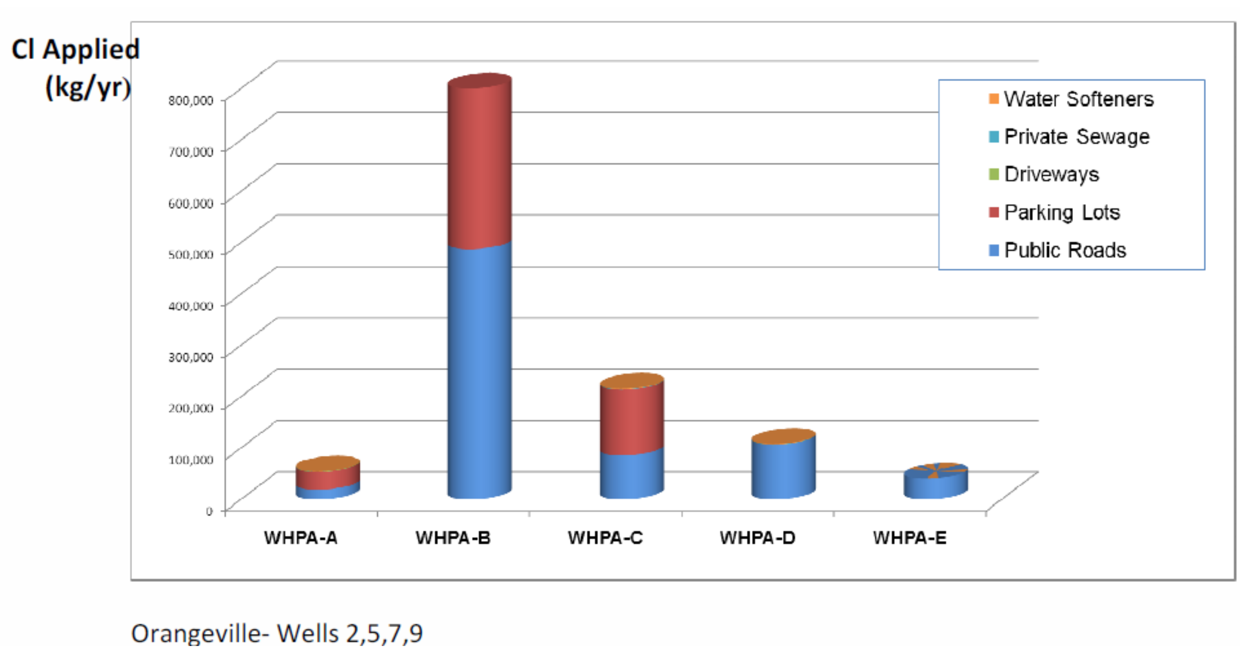


Figure 5.11: Sodium and Chloride Loadings in Issue Contributing Area – Wells 2, 5, 7, 9

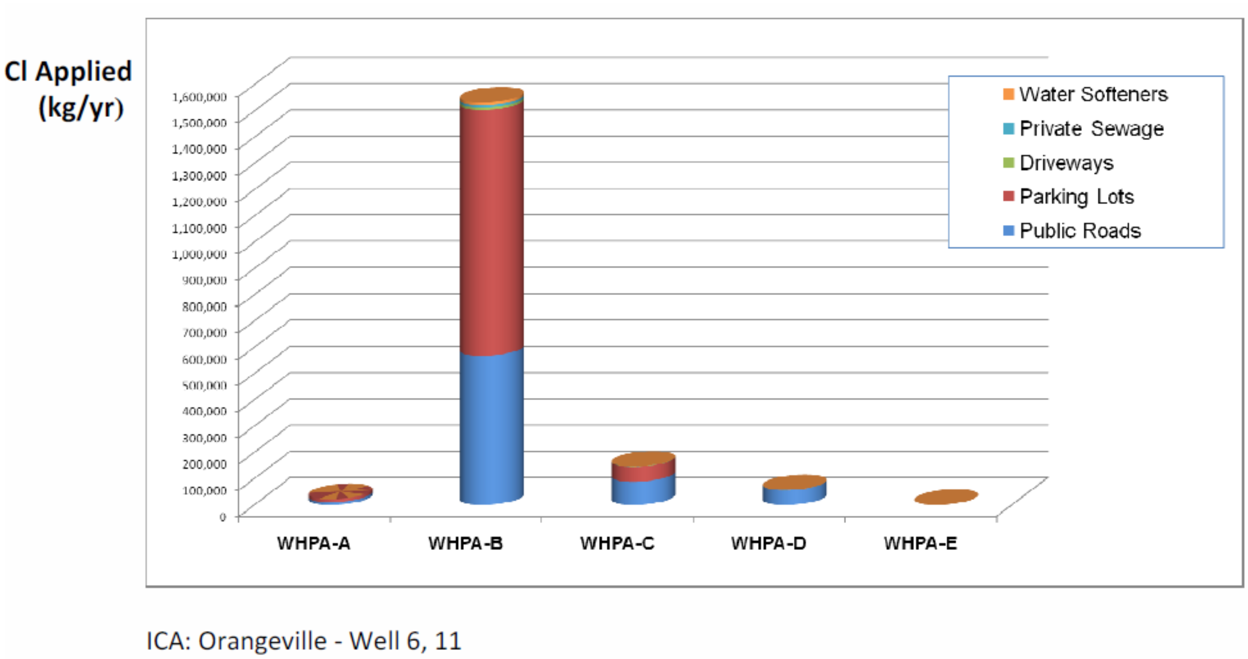
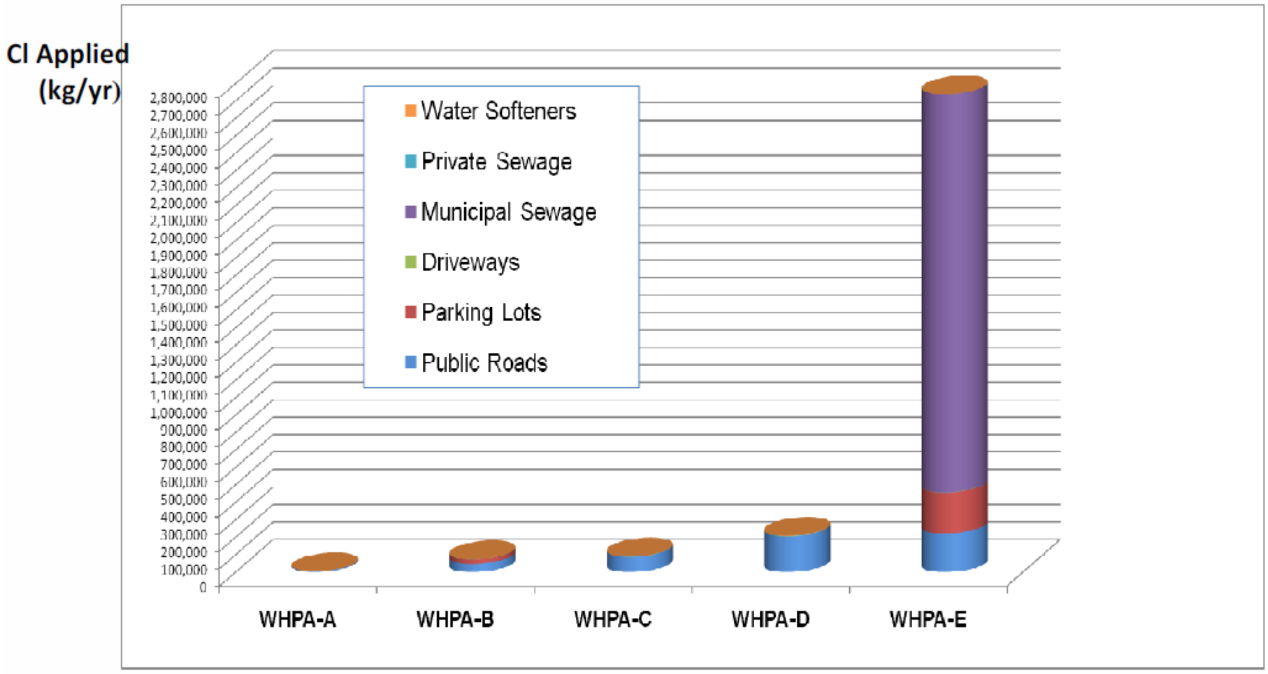


Figure 5.12: Sodium and Chloride Loadings in Issue Contributing Area – Wells 6, 11



Orangeville Well 10

Figure 5.13: Sodium and Chloride Loadings in Issue Contributing Area – Well 10

Conditions

A review of available documentation was conducted for potential contamination associated with past activities within the WHPAs of the town's municipal wells. Data available included databases from the Ecolog ERIS results such as Record of Site Condition, MOECC Spills Database and Occurrence Reporting Information System, and MOECC Historical Waste Disposal Sites. Based on the available data, no conditions have been identified within WHPAs of the town's municipal wells.

Cross-Boundary Threats

The threats enumeration provides an assessment of threats within the CVC's jurisdiction. However, the WHPAs of most Orangeville wells do cross the boundary into the Grand River Source Protection Area's (GRSPA) jurisdiction (**Figure 5.12**).

The results of the 2011 ICA study show that 79 significant threats related to sodium and chloride in the ICA of Wells 2, 5, 7, and 9, originate in the GRCA.

5.5.2 County of Dufferin - Town of Mono

The Town of Mono is located in the headwaters area of the CVSPA and provides municipal water supply though seven wells in three wellfields. The WHPA delineation and vulnerability assessment processes around these wells are described in **Chapter 4.2**.

The issues evaluation and threats identification originally undertaken within the WHPAs of the wells are detailed in the report "Issues Evaluation and Threats Assessment, Town of Mono" (R.J. Burnside & Associates Limited, June 2010). This report was subjected to extensive peer review by municipal staff and by the CVC prior to acceptance by the CTC SPC, and inclusion in the Assessment Report. This document contains the foundation technical data and information upon which the summary below has been based.

Threats and Issues

The threats inventory was compiled using the data and information sources outlined in **Appendix E2**. Site-specific verification of drinking water threats was not conducted as part of the original study referenced above. Since 2013 however, staff has undertaken initial work aimed at the ground truthing of significant threats in vulnerable zones around municipal wells. The findings are presented in the report "Drinking Water Quality, Preliminary Verification of Significant Threats - Town of Mono" (Credit Valley Conservation Authority & CTC Source Protection Region, January 2015). The results of this work have been used to refine the threat counts discussed below.

Tables 5.15 through **Table 5.17** summarize the number of significant, threats in the Mono water system. The areas where the threats are or would be low, moderate, or significant for chemicals, DNAPLs and pathogens are shown in **Figure 5.17**, **Figure 5.18**, and **Figure 5.19**, respectively. Details of the evaluation of managed land threats can be found in **Appendix E3**.

A total of 66 significant threats have been identified on 40 parcels in the WHPAs of these municipal wells.

- Cardinal Woods— 55 significant threats were identified, most of which are linked to water quantity threats, the rest to private septic systems and the handling and storage of fuel.
- Coles— a total of five significant threats have been identified, which are linked to the handling and storage of DNAPLs (1), the handling and storage of organic solvents (1), the application of road salts (1), the handling and storage of road salts (1), and private septic systems (1).
- Island Lake— a total of six significant threats have been identified and are linked to the handling and storage of fuel (1), the application of pesticides (1), the application of NASM (1), the handling and storage of organic solvents (1), and private septic systems (2).

All available water quality data for the Mono supply wells were collected and reviewed to identify any issues. This included hydrogeological studies, engineering reports, and MOECC annual reports for the water supply systems. An overview of water quality at the town's wellheads has been presented in **Chapter 2.4**.

The data sources were reviewed to assess whether any contaminants are impacting or have the potential to impact or degrade the quality of the town's groundwater-based drinking water sources. Based on this review, no issues have been identified in the WHPAs of the Town of Mono.

Table 5.15: Mono Water System, Cardinal Woods Wells 1, 3, and 4 —Enumerated Drinking Water Threats

Activity (or Threat Type)	Threats			
	Significant	Moderate	Low	Total
1) The establishment, operation, or maintenance of a waste disposal site within the meaning of Part V of the *Environmental Protection Act*	0	n/a	n/a	n/a
2) The establishment, operation, or maintenance of a system that collects, stores, transmits, treats or disposes of sewage	3	n/a	n/a	n/a
3) The application of agricultural source material to land	0	n/a	n/a	n/a
4) The storage of agricultural source material	0	n/a	n/a	n/a
5) The management of agricultural source material to land	0	n/a	n/a	n/a
6) The application of non-agricultural source material (NASM) to land	0	n/a	n/a	n/a
7) The handling and storage of non-agricultural source material NASM	0	n/a	n/a	n/a
8) The application of commercial fertilizer	0	n/a	n/a	n/a
9) The handling and storage of commercial fertilizer	0	n/a	n/a	n/a
10) The application of pesticide to land	0	n/a	n/a	n/a
11) The handling and storage of pesticide	0	n/a	n/a	n/a
12) The application of road salt	0	n/a	n/a	n/a
13) The handling and storage of road salt	0	n/a	n/a	n/a
14) The storage of snow	0	n/a	n/a	n/a
15) The handling and storage of fuel	3	n/a	n/a	n/a
16) The handling and storage of a dense non-aqueous phase liquid	0	n/a	n/a	n/a
17) The handling and storage of an organic solvent	0	n/a	n/a	n/a
18) The management of runoff that contains chemicals used in the de-icing of aircraft	0	n/a	n/a	n/a
19) An activity that takes water from an aquifer or a surface water body without returning the water taken to the same aquifer or surface water body	48	n/a	n/a	n/a
20) An activity that reduces the recharge of an aquifer	1	n/a	n/a	n/a
21) The use of land as livestock grazing or pasturing land, an outdoor confinement area, or a farm-animal yard.		n/a	n/a	n/a
Total Threats	**55**	**n/a**	**n/a**	**n/a**
Total Parcels	**35**	**n/a**	**n/a**	**n/a**

n/a not required by the MOECC

Table 5.16: Mono Water System, Island Lake Wells TW1 and PW 1 — Enumerated Drinking Water Threats

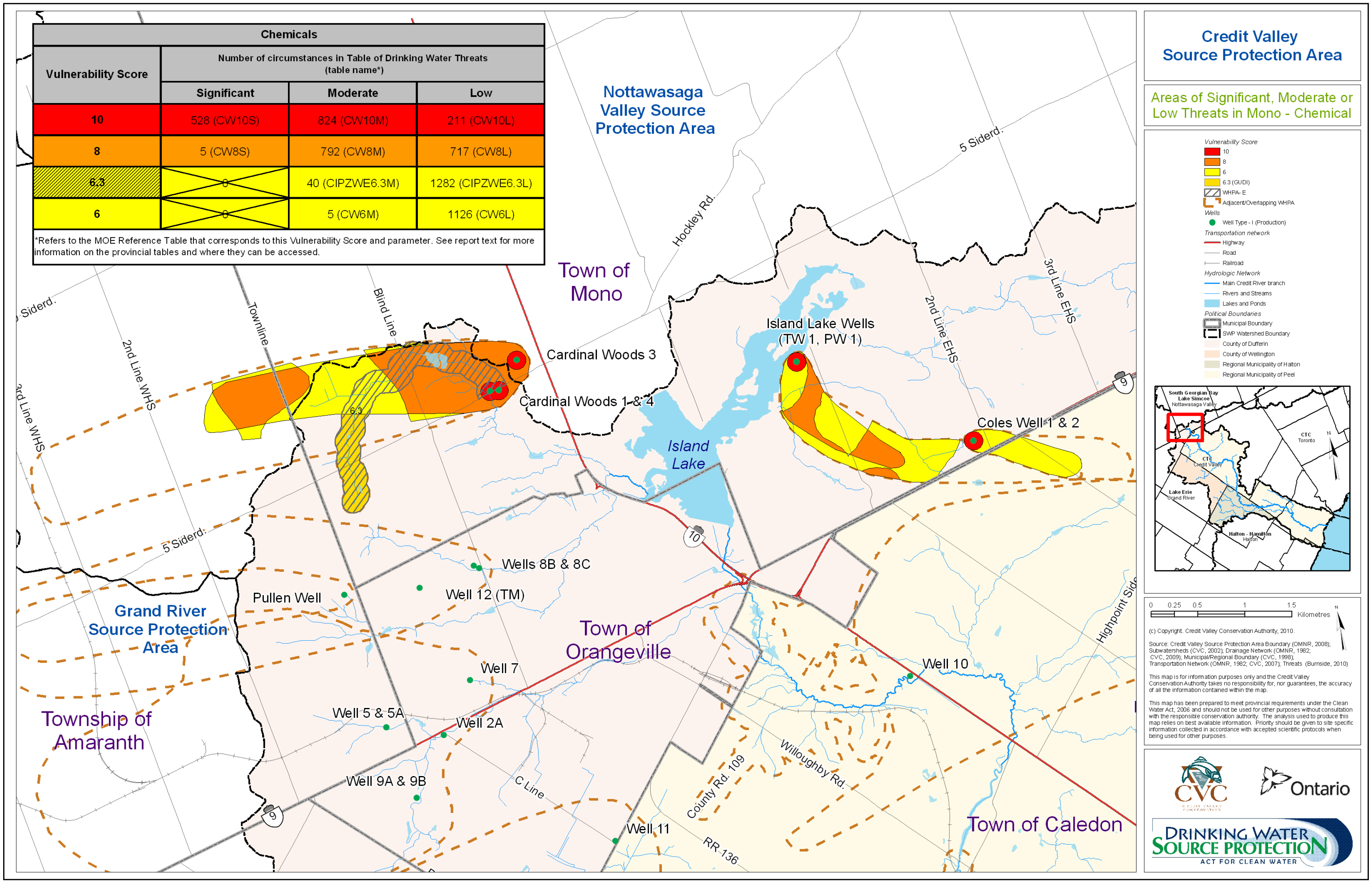
Activity (or Threat Type)	Threats			
	Significant	Moderate	Low	Total
1) The establishment, operation, or maintenance of a waste disposal site within the meaning of Part V of the *Environmental Protection Act*	0	n/a	n/a	n/a
2) The establishment, operation, or maintenance of a system that collects, stores, transmits, treats or disposes of sewage	2	n/a	n/a	n/a
3) The application of agricultural source material to land	1	n/a	n/a	n/a
4) The storage of agricultural source material	0	n/a	n/a	n/a
5) The management of agricultural source material to land	0	n/a	n/a	n/a
6) The application of non-agricultural source material (NASM) to land	1	n/a	n/a	n/a
7) The handling and storage of non-agricultural source material NASM	0	n/a	n/a	n/a
8) The application of commercial fertilizer	0	n/a	n/a	n/a
9) The handling and storage of commercial fertilizer	0	n/a	n/a	n/a
10) The application of pesticide to land	1	n/a	n/a	n/a
11) The handling and storage of pesticide	0	n/a	n/a	n/a
12) The application of road salt	0	n/a	n/a	n/a
13) The handling and storage of road salt	0	n/a	n/a	n/a
14) The storage of snow	0	n/a	n/a	n/a
15) The handling and storage of fuel	1	n/a	n/a	n/a
16) The handling and storage of a dense non-aqueous phase liquid	0	n/a	n/a	n/a
17) The handling and storage of an organic solvent	0	n/a	n/a	n/a
18) The management of runoff that contains chemicals used in the de-icing of aircraft	0	n/a	n/a	n/a
19) An activity that takes water from an aquifer or a surface water body without returning the water taken to the same aquifer or surface water body	0	n/a	n/a	n/a
20) An activity that reduces the recharge of an aquifer	0	n/a	n/a	n/a
21) The use of land as livestock grazing or pasturing land, an outdoor confinement area, or a farm-animal yard.	0	n/a	n/a	n/a
Total Threats	**6**	**n/a**	**n/a**	**n/a**
Total Parcels	**3**	**n/a**	**n/a**	**n/a**

n/a – not required by MOECC

Table 5.17: Mono Water System, Cole Wells 1 and 2 —Enumerated Drinking Water Threats

Activity (or Threat Type)	Threats			
	Significant	Moderate	Low	Total
1) The establishment, operation, or maintenance of a waste disposal site within the meaning of Part V of the *Environmental Protection Act*	0	n/a	n/a	n/a
2) The establishment, operation, or maintenance of a system that collects, stores, transmits, treats or disposes of sewage	1	n/a	n/a	n/a
3) The application of agricultural source material to land	0	n/a	n/a	n/a
4) The storage of agricultural source material	0	n/a	n/a	n/a
5) The management of agricultural source material to land	0	n/a	n/a	n/a
6) The application of non-agricultural source material (NASM) to land	0	n/a	n/a	n/a
7) The handling and storage of non-agricultural source material NASM	0	n/a	n/a	n/a
8) The application of commercial fertilizer	0	n/a	n/a	n/a
9) The handling and storage of commercial fertilizer	0	n/a	n/a	n/a
10) The application of pesticide to land	0	n/a	n/a	n/a
11) The handling and storage of pesticide	0	n/a	n/a	n/a
12) The application of road salt	1	n/a	n/a	n/a
13) The handling and storage of road salt	1	n/a	n/a	n/a
14) The storage of snow	0	n/a	n/a	n/a
15) The handling and storage of fuel	0	n/a	n/a	n/a
16) The handling and storage of a dense non-aqueous phase liquid	1	n/a	n/a	n/a
17) The handling and storage of an organic solvent	1	n/a	n/a	n/a
18) The management of runoff that contains chemicals used in the de-icing of aircraft	0	n/a	n/a	n/a
19) An activity that takes water from an aquifer or a surface water body without returning the water taken to the same aquifer or surface water body	0	n/a	n/a	n/a
20) An activity that reduces the recharge of an aquifer	0	n/a	n/a	n/a
21) The use of land as livestock grazing or pasturing land, an outdoor confinement area, or a farm-animal yard.	0	n/a	n/a	n/a
Total Threats	**5**	**n/a**	**n/a**	**n/a**
Total Parcels	**2**	**n/a**	**n/a**	**n/a**

n/a - not required by the MOECC

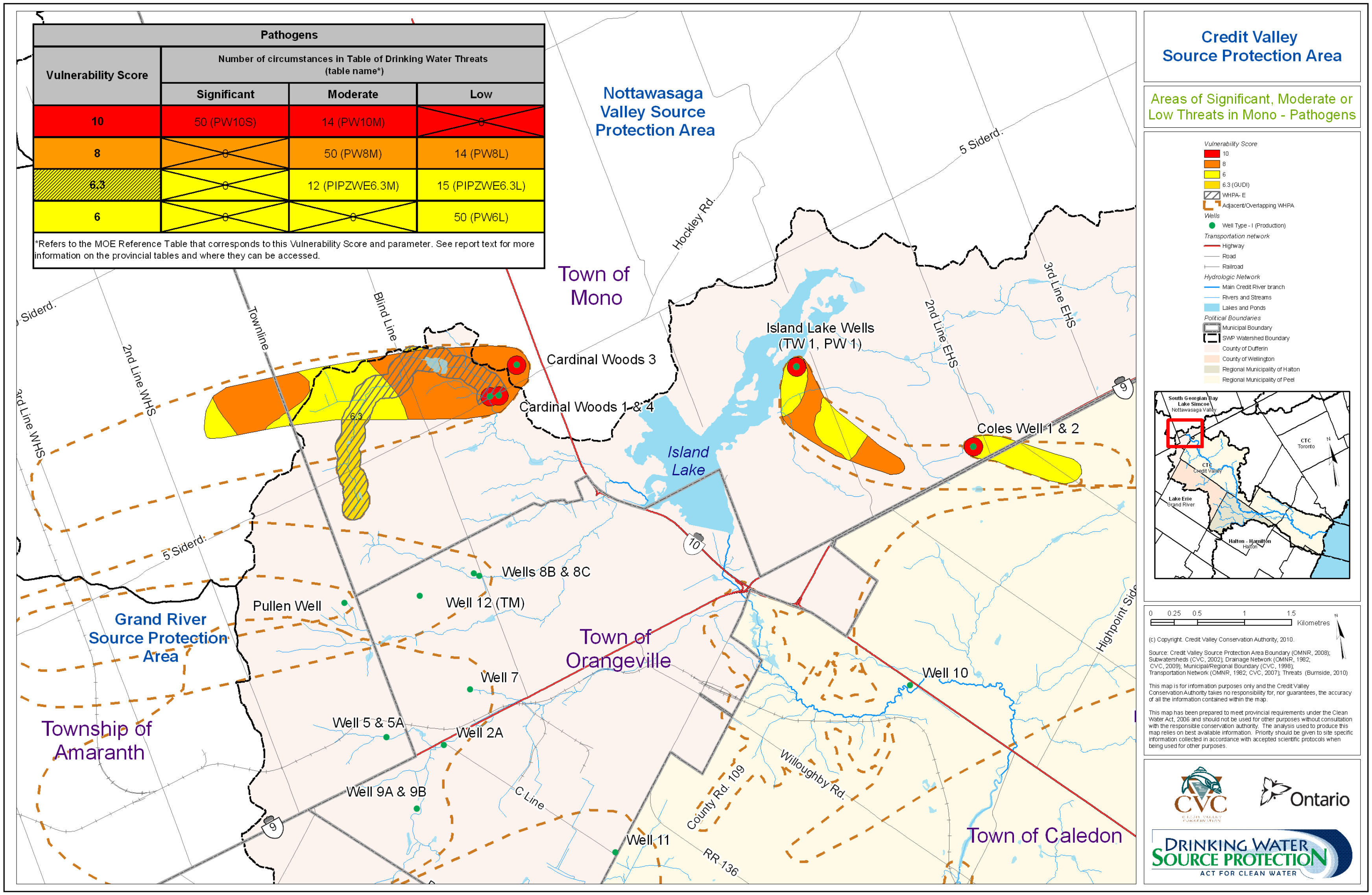


Chemicals			
Vulnerability Score	Number of circumstances in Table of Drinking Water Threats (table name*)		
	Significant	Moderate	Low
10	528 (CW10S)	824 (CW10M)	211 (CW10L)
8	5 (CW8S)	792 (CW8M)	717 (CW8L)
6.3	0	40 (CIPZWE6.3M)	1282 (CIPZWE6.3L)
6	0	5 (CW6M)	1126 (CW6L)

*Refers to the MOE Reference Table that corresponds to this Vulnerability Score and parameter. See report text for more information on the provincial tables and where they can be accessed.

Figure 5.14: Areas of Significant, Moderate or Low Threats in Mono – Chemical

The current Provincial Table of Drinking Water Threats can be accessed at http://swpip.ca/

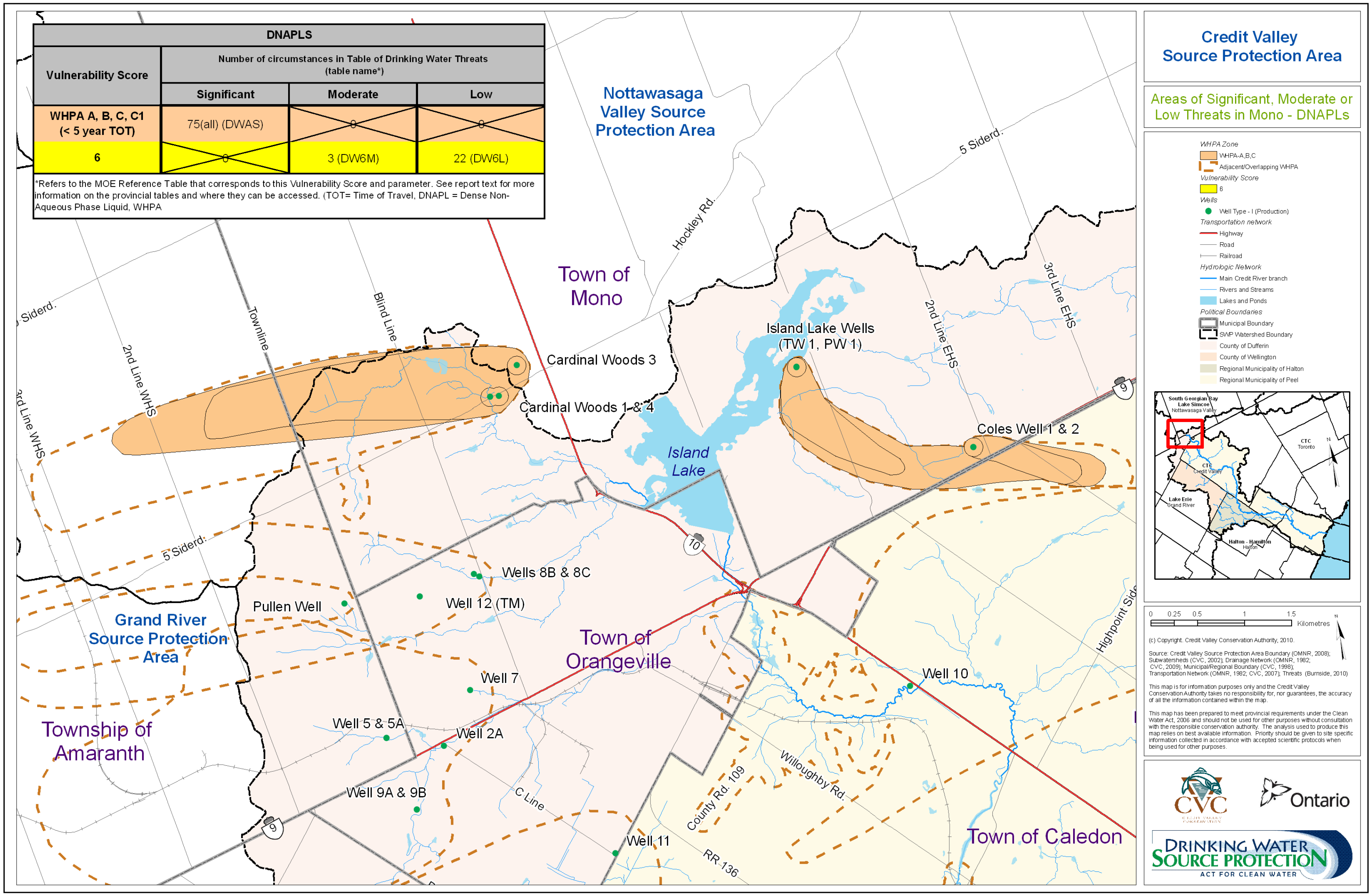


Pathogens			
Vulnerability Score	Number of circumstances in Table of Drinking Water Threats (table name*)		
	Significant	Moderate	Low
10	50 (PW10S)	14 (PW10M)	0
8	0	50 (PW8M)	14 (PW8L)
6.3	0	12 (PIPZWE6.3M)	15 (PIPZWE6.3L)
6	0	0	50 (PW6L)

*Refers to the MOE Reference Table that corresponds to this Vulnerability Score and parameter. See report text for more information on the provincial tables and where they can be accessed.

Figure 5.15: Areas of Significant, Moderate or Low Threats in Mono – Pathogens

The current Provincial Table of Drinking Water Threats can be accessed at http://swpip.ca/



DNAPLS			
Vulnerability Score	Number of circumstances in Table of Drinking Water Threats (table name*)		
	Significant	Moderate	Low
WHPA A, B, C, C1 (< 5 year TOT)	75(all) (DWAS)	0	0
6	0	3 (DW6M)	22 (DW6L)

*Refers to the MOE Reference Table that corresponds to this Vulnerability Score and parameter. See report text for more information on the provincial tables and where they can be accessed. (TOT= Time of Travel, DNAPL = Dense Non-Aqueous Phase Liquid, WHPA

Figure 5.16: Areas of Significant, Moderate or Low Threats in Mono – DNAPLs

The current Provincial Table of Drinking Water Threats can be accessed at http://swpip.ca/

Conditions

A review of available data and documents was conducted on potential contamination associated with past activities within the WHPAs of the town's municipal wells. Data available included databases from the Ecolog ERIS results such as Record of Site Condition and MOECC Spills Database and Occurrence Reporting Information System. Historical aerial photographs from 1978 were obtained from the University of Waterloo, Map and Design Library and reviewed to identify land-use changes and potential high-risk activities, such as waste disposal sites within the well-capture zones. Aerial photography available to the Town of Mono based on a 2002 Ministry of Natural Resources and Forestry (MNRF) survey was also utilized as part of this study.

Based on this review, no conditions have been identified within the WHPAs of the municipal water supply for the Town of Mono.

Cross-Boundary Threats

Since the WHPAs of Mono's wells also traverse the land areas of Amaranth and Caledon, Official Plan land use maps for these municipalities were also consulted to evaluate the existing and planned land uses within them. The significant threats reported above fall within the CVSPA's boundary, but the WHPAs of Cardinal Wood's wells do cross the boundary into the Nottawasaga Valley SPA's jurisdiction **Figure 5.17**), where a number of moderate and low threats were found to originate.

5.5.3 County of Dufferin - Township of Amaranth

The Township of Amaranth designated the Pullen Well as part of its planned municipal supply in 2008. The WHPA delineation and vulnerability assessment processes around the wellhead are described in **Chapter 4.2**.

The issues evaluation and threats identification originally undertaken within the WHPAs of the Pullen Well, are detailed in the report "Issues Evaluation and Threats Assessment—Pullen Well, Township of Amaranth" (R.J. Burnside & Associates Limited, June 2010). This document contains the foundation technical data and information upon which the summary below has been based. Historical aerial photographs from 1976 were reviewed to identify land-use changes and potential high-risk activities, such as waste disposal sites within the WHPAs. This report was subjected to extensive peer review by municipal staff and by the CVC prior to acceptance by the CTC SPC, and inclusion in the Assessment Report.

Threats and Issues

The threats inventory was compiled using the data and information sources outlined in **Appendix E2**. Site-specific verification of drinking water threats was not conducted as part of the original study referenced above. Since 2013 however, staff has undertaken initial work aimed at the ground truthing of significant threats in vulnerable zones around the Pullen well. The findings are presented in the report "Drinking Water Quality, Preliminary Verification of Significant Threats - Township of Amaranth" (Credit Valley Conservation Authority & CTC Source Protection Region, January 2015). The results of this work have been used to refine the threat counts discussed below.

Table 5.19 summarizes the number of significant threats in the Pullen wellhead. Details of the evaluation of managed land threats can be found in **Appendix E3**.

Table 5.18: Pullen Well, Township of Amaranth—Enumerated Drinking Water Threats

Activity (or Threat Type)	Threats			
	Significant	Moderate	Low	Total
1) The establishment, operation, or maintenance of a waste disposal site within the meaning of Part V of the *Environmental Protection Act*	2	n/a	n/a	n/a
2) The establishment, operation, or maintenance of a system that collects, stores, transmits, treats or disposes of sewage	1	n/a	n/a	n/a
3) The application of agricultural source material to land	2	n/a	n/a	n/a
4) The storage of agricultural source material	0	n/a	n/a	n/a
5) The management of agricultural source material to land	0	n/a	n/a	n/a
6) The application of non-agricultural source material (NASM) to land	2	n/a	n/a	n/a
7) The handling and storage of non-agricultural source material NASM	0	n/a	n/a	n/a
8) The application of commercial fertilizer	0	n/a	n/a	n/a
9) The handling and storage of commercial fertilizer	1	n/a	n/a	n/a
10) The application of pesticide to land	2	n/a	n/a	n/a
11) The handling and storage of pesticide	1	n/a	n/a	n/a
12) The application of road salt	0	n/a	n/a	n/a
13) The handling and storage of road salt	0	n/a	n/a	n/a
14) The storage of snow	0	n/a	n/a	n/a
15) The handling and storage of fuel	0	n/a	n/a	n/a
16) The handling and storage of a dense non-aqueous phase liquid	0	n/a	n/a	n/a
17) The handling and storage of an organic solvent	0	n/a	n/a	n/a
18) The management of runoff that contains chemicals used in the de-icing of aircraft	0	n/a	n/a	n/a
19) An activity that takes water from an aquifer or a surface water body without returning the water taken to the same aquifer or surface water body	28	n/a	n/a	28
20) An activity that reduces the recharge of an aquifer	1	n/a	n/a	n/a
21) The use of land as livestock grazing or pasturing land, an outdoor confinement area, or a farm-animal yard.	0	n/a	n/a	n/a
Total Threats	**41**	**n/a**	**n/a**	**n/a**
Total Parcels	**30**	**n/a**	**n/a**	**n/a**

n/a - not required by the MOECC

The areas where the threats are or would be low, moderate or significant for chemicals, DNAPLs and pathogens are shown in **Figure 5.20**, **Figure 5.21**, and **Figure 5.22**, respectively.

A total of 41 significant threats have been identified on 30 parcels in the vulnerable areas of the Pullen's wellhead; 28 of these are linked to water quantity threats, eight to managed land activities, while three are non-managed land related.

The Pullen Well is not currently online and has never been used. As a result, annual water quality data are not available to assess issues. The only data available were obtained in 2002 during a pumping test of the well. The sample results indicated that all parameters were below the ODWS (Burnside and Gartner Lee, 2004).

Water quality sampling in 2002 reported concentrations of 0.4 mg/L for nitrates and 9.2 mg/L for chlorides. These levels are comparable to levels in Orangeville Well 12, the closest municipal well to the Pullen Well of 0.2 mg/L and 0.5 mg/L for nitrates and chloride levels of 12 mg/reported in 2007 (Burnside, 2010). Based on this review of the available water quality data there are currently no issues for the Pullen Well.

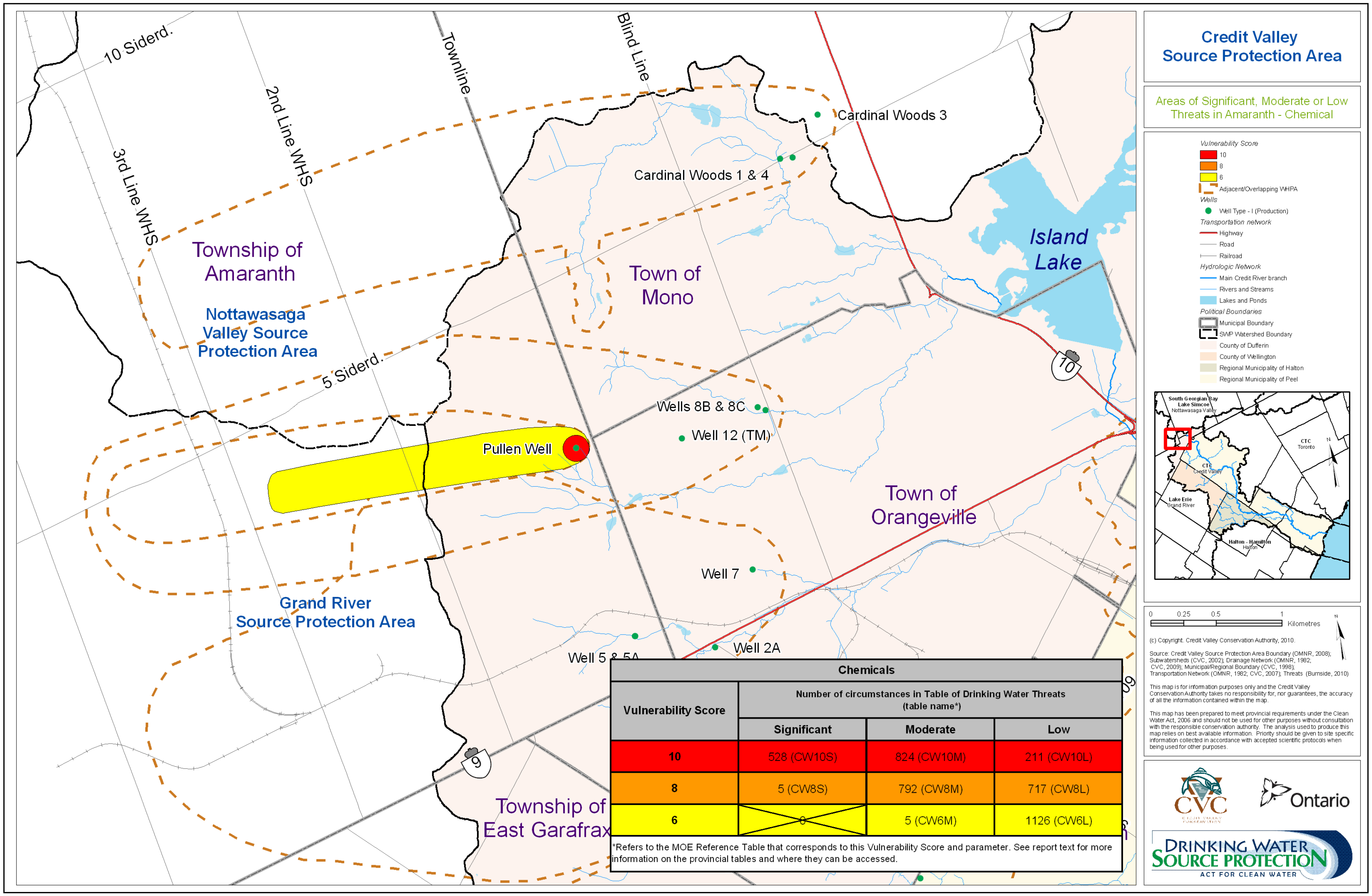
Conditions

A review of available documentation was conducted for potential contamination associated with past activities within the WHPAs of the Pullen Well. Data available included databases from the Ecolog ERIS results such as Record of Site Condition, MOECC Spills Database and Occurrence Reporting Information System, and the MOECC's Data Hound Files.

Based on this review, no conditions have been identified within the WHPAs of the Pullen Well.

Cross-Boundary Threats

The significant threats reported are within the CVSPA's boundary, but the WHPAs of the Pullen wells do cross the boundary into the GRSPA's jurisdiction (**Figure 5.20**), where a few low threats were found to originate.



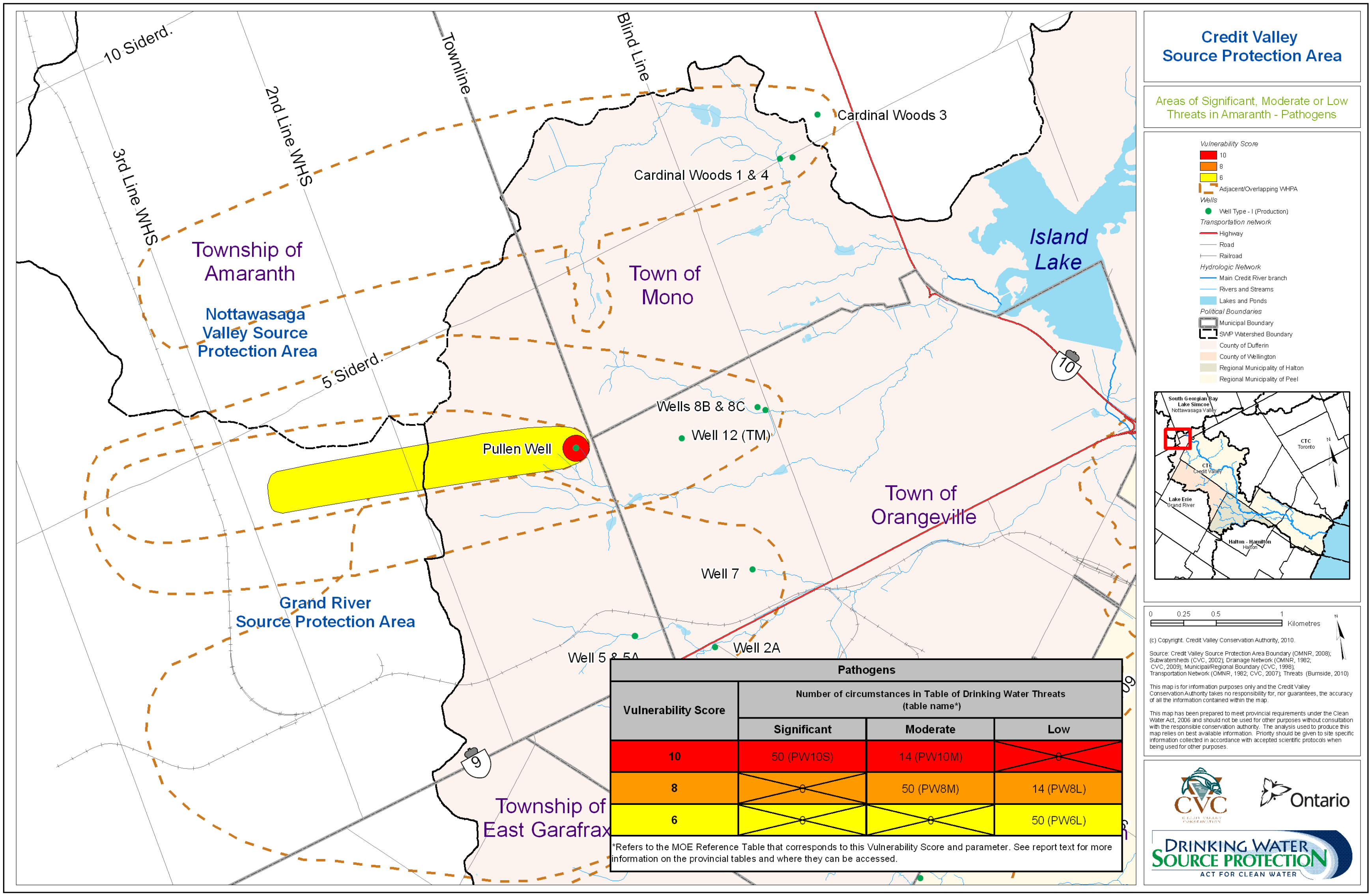
Chemicals

Vulnerability Score	Number of circumstances in Table of Drinking Water Threats (table name*)		
	Significant	Moderate	Low
10	528 (CW10S)	824 (CW10M)	211 (CW10L)
8	5 (CW8S)	792 (CW8M)	717 (CW8L)
6	0	5 (CW6M)	1126 (CW6L)

*Refers to the MOE Reference Table that corresponds to this Vulnerability Score and parameter. See report text for more information on the provincial tables and where they can be accessed.

Figure 5.17: Areas of Significant, Moderate or Low Threats in Amaranth – Chemical

The current Provincial Table of Drinking Water Threats can be accessed at http://swpip.ca/

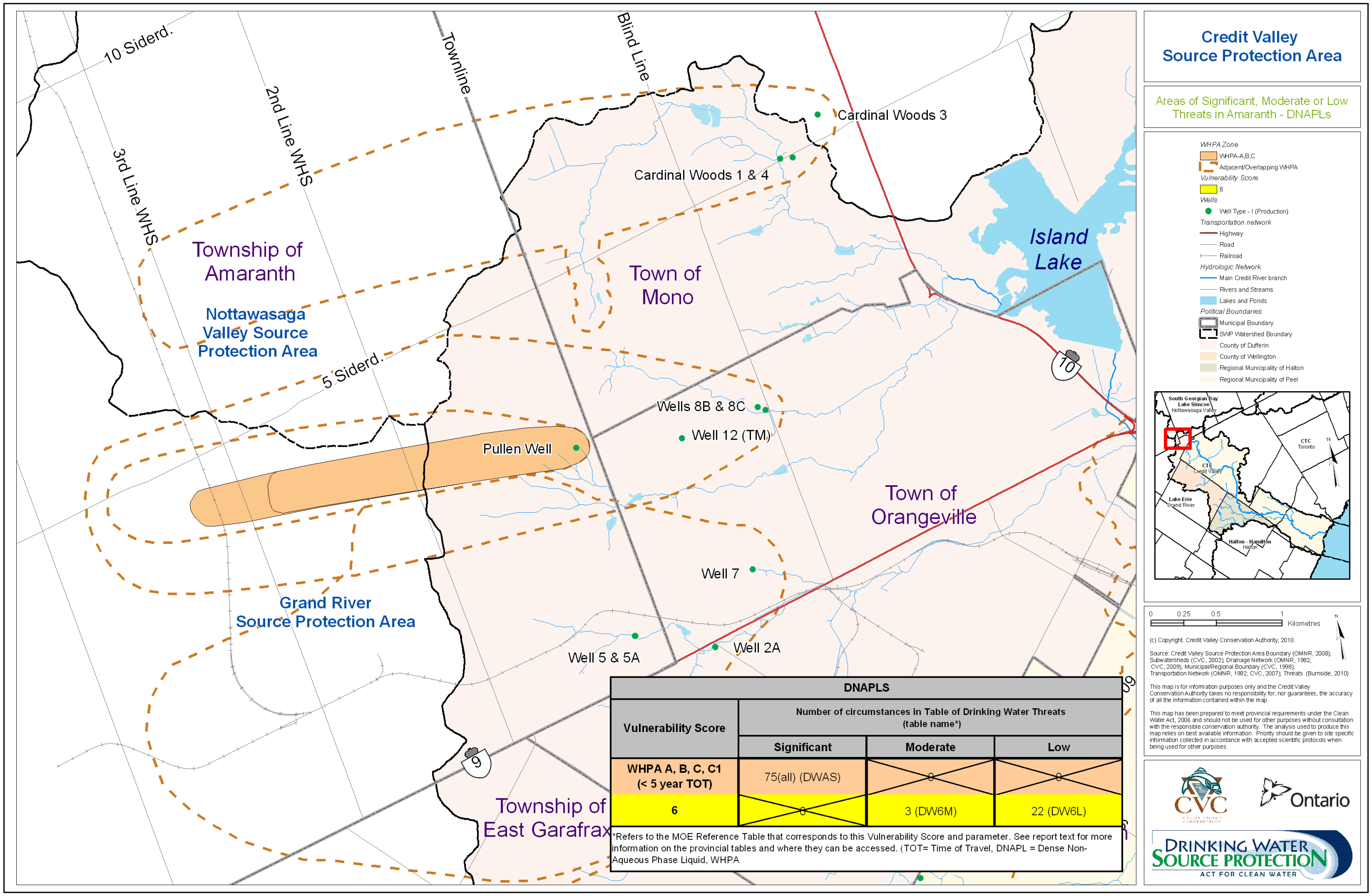


Pathogens			
Vulnerability Score	Number of circumstances in Table of Drinking Water Threats (table name*)		
	Significant	Moderate	Low
10	50 (PW10S)	14 (PW10M)	0
8	0	50 (PW8M)	14 (PW8L)
6	0	0	50 (PW6L)

*Refers to the MOE Reference Table that corresponds to this Vulnerability Score and parameter. See report text for more information on the provincial tables and where they can be accessed.

Figure 5.18: Areas of Significant, Moderate or Low Threats in Amaranth – Pathogens

The current Provincial Table of Drinking Water Threats can be accessed at http://swpip.ca/



DNAPLS

Vulnerability Score	Number of circumstances in Table of Drinking Water Threats (table name*)		
	Significant	Moderate	Low
WHPA A, B, C, C1 (< 5 year TOT)	75(all) (DWAS)	0	0
6	0	3 (DW6M)	22 (DW6L)

*Refers to the MOE Reference Table that corresponds to this Vulnerability Score and parameter. See report text for more information on the provincial tables and where they can be accessed. (TOT= Time of Travel, DNAPL = Dense Non-Aqueous Phase Liquid, WHPA

Figure 5.19: Areas of Significant, Moderate or Low Threats in Amaranth – DNAPLs

The current Provincial Table of Drinking Water Threats can be accessed at http://swpip.ca/

5.5.4 County of Wellington - Town of Erin

The Town of Erin has a municipal water supply composed of four wells in the Erin and Hillsburgh water systems. Another previously operated water system in the Bel-Erin subdivision was taken offline in 2002. Though unused, the wells retain active permits.

The issues evaluation and threats identification originally undertaken in the WHPAs of these wells are detailed in the report "Issues Evaluation and Threats Assessment, Town of Erin Municipal Wells" (Blackport Hydrogeology Inc., in association with Golder Associates Limited, June 2010). This report was subjected to extensive peer review by municipal staff and by the CVC prior to acceptance by the CTC SPC, and inclusion in the Assessment Report. This document contains the foundation technical data and information upon which the summary below has been based. The threats inventory was compiled using the data from the following sources:

- TSSA (Technical Standards and Safety Authority) database (2009), which includes all properties with registered underground fuel storage tanks (industrial and commercial);
- MOECC Certificates of Approval—last accessed May 2010, which lists all properties with certificates of approval for waste disposal sites;
- Hazardous Waste Information Network (HWIN) database (2009), which includes properties that are registered as generating, storing, or handling hazardous waste; and
- Golder Centre Wellington PCI database (2006), which was used to identify properties in the Erin and Hillsburgh WHPAs and included a compilation of databases such as Ecolog ERIS data, and NAICS property information, as well as the data listed above.

MPAC data 2010, used in Bel-Erin WHPA, and property codes for Erin and Hillsburgh WHPAs to assess threats adapted from the MOECC land-use look-up tables including fuel storage, DNAPL storage, pesticide application and storage, commercial fertilizer application and storage, agricultural source material application and storage, and livestock grazing/pasturing. The MPAC codes were also used to identify properties with managed lands. These data were used to develop a preliminary list of threats for each of the WHPA areas and a threats ID assigned to each threat, cross-referenced with property codes and/or MPAC codes. Additional information was collected through site reconnaissance (windshield surveys), air photo assessment, and discussions with town staff. This additional information was used to refine the threats table generated from the existing databases.

Threats and Issues

Site specific verification of drinking water threats was not conducted as part of the original study informing the *Approved Assessment Report: CVSPA*. Since 2013 however, CVC staff has undertaken initial work aimed at the ground truthing of significant threats in vulnerable zones around municipal wells. The findings are presented in the report "Drinking Water Quality, Preliminary Verification of Significant Threats - Town of Erin" (Credit Valley Conservation Authority & CTC Source Protection Region, January 2015). The results of this work have been used to refine the threat counts discussed below.

Table 5.19, **Table 5.20**, and **Table 5.21** summarize the number of significant threats around the wellheads of the three water systems. Significant managed land threats were identified for WHPAs-B and C in both Hillsburgh wells, and in Bel-Erin. Details of the evaluation of managed land threats are found in **Appendix E3**.

The areas where the threats are or would be low, moderate or significant for chemicals, DNAPLs and pathogens are shown on **Figure 5.23** through **Figure 5.31**.

A total of 290 significant threats have been identified on 133 parcels in the vulnerable areas of the wellheads.

- Hillsburgh—39 significant threats, which are linked mainly to private septic systems (17) and to handling and storage of fuel (16). Agricultural activities (6) account for the balance.
- Erin—28 significant threats, which are linked to agricultural activities (15), the handling and storage of DNAPLs (7), and fuel (2). The remainder are linked to private septic systems (3), and the handling and storage of organic solvents (1).
- Bel-Erin—223 significant threats, which are linked mainly to private septic systems (102), and to the handling and storage of fuel (100). The remainder relate to agricultural activities (14), the handling and storage of organic solvents (3), and DNAPLs (4).

All available water quality data for the municipal supply wells and the Bel-Erin wells were collected and reviewed to identify issues. This included hydrogeological studies, engineering reports, and ODWS O. Reg. 170/03 Reports (2002–2009); historic raw water quality data (from 1995) were also obtained directly from the town.

Based on this review, no issues have been identified in the WHPAs of the Town of Erin. Based on the quality trends, there is low uncertainty regarding the issues at Erin and Hillsburgh, but greater uncertainty exists for the Bel-Erin wellfield due to the limited long-term data and the relatively high vulnerability setting of the wells.

Conditions

A review of available documentation was conducted for potential contamination associated with past activities within the WHPAs of the town's municipal wells. Data available included databases from the Ecolog ERIS results such as Record of Site Condition, MOECC Spills Database and Occurrence Reporting Information System, and the MOECC's Data Hound Files.

Based on this review, no conditions have been identified within the WHPAs of the six wells in the Town of Erin.

Table 5.19: Town of Erin (Erin Water System)—Enumerated Drinking Water Threats

Activity (or Threat Type)	Threats			
	Significant	Moderate	Low	Total
1) The establishment, operation, or maintenance of a waste disposal site within the meaning of Part V of the *Environmental Protection Act*	0	n/a	n/a	n/a
2) The establishment, operation, or maintenance of a system that collects, stores, transmits, treats or disposes of sewage	3	n/a	n/a	n/a
3) The application of agricultural source material to land	2	n/a	n/a	n/a
4) The storage of agricultural source material	2	n/a	n/a	n/a
5) The management of agricultural source material to land	0	n/a	n/a	n/a
6) The application of non-agricultural source material (NASM) to land	2	n/a	n/a	n/a
7) The handling and storage of non-agricultural source material NASM	0	n/a	n/a	n/a
8) The application of commercial fertilizer	0	n/a	n/a	n/a
9) The handling and storage of commercial fertilizer	3	n/a	n/a	n/a
10) The application of pesticide to land	3	n/a	n/a	n/a
11) The handling and storage of pesticide	3	n/a	n/a	n/a
12) The application of road salt	0	n/a	n/a	n/a
13) The handling and storage of road salt	0	n/a	n/a	n/a
14) The storage of snow	0	n/a	n/a	n/a
15) The handling and storage of fuel	2	n/a	n/a	n/a
16) The handling and storage of a dense non-aqueous phase liquid	7	n/a	n/a	n/a
17) The handling and storage of an organic solvent	1	n/a	n/a	n/a
18) The management of runoff that contains chemicals used in the de-icing of aircraft	0	n/a	n/a	n/a
19) An activity that takes water from an aquifer or a surface water body without returning the water taken to the same aquifer or surface water body	n/a			
20) An activity that reduces the recharge of an aquifer	n/a			
21) The use of land as livestock grazing or pasturing land, an outdoor confinement area, or a farm-animal yard.	0	n/a	n/a	n/a
Total Threats	**28**	**n/a**	**n/a**	**n/a**
Total Parcels	**10**	**n/a**	**n/a**	**n/a**

n/a - not required by the MOECC

Table 5.20: Town of Erin (Hillsburgh Water System) —Enumerated Drinking Water Threats

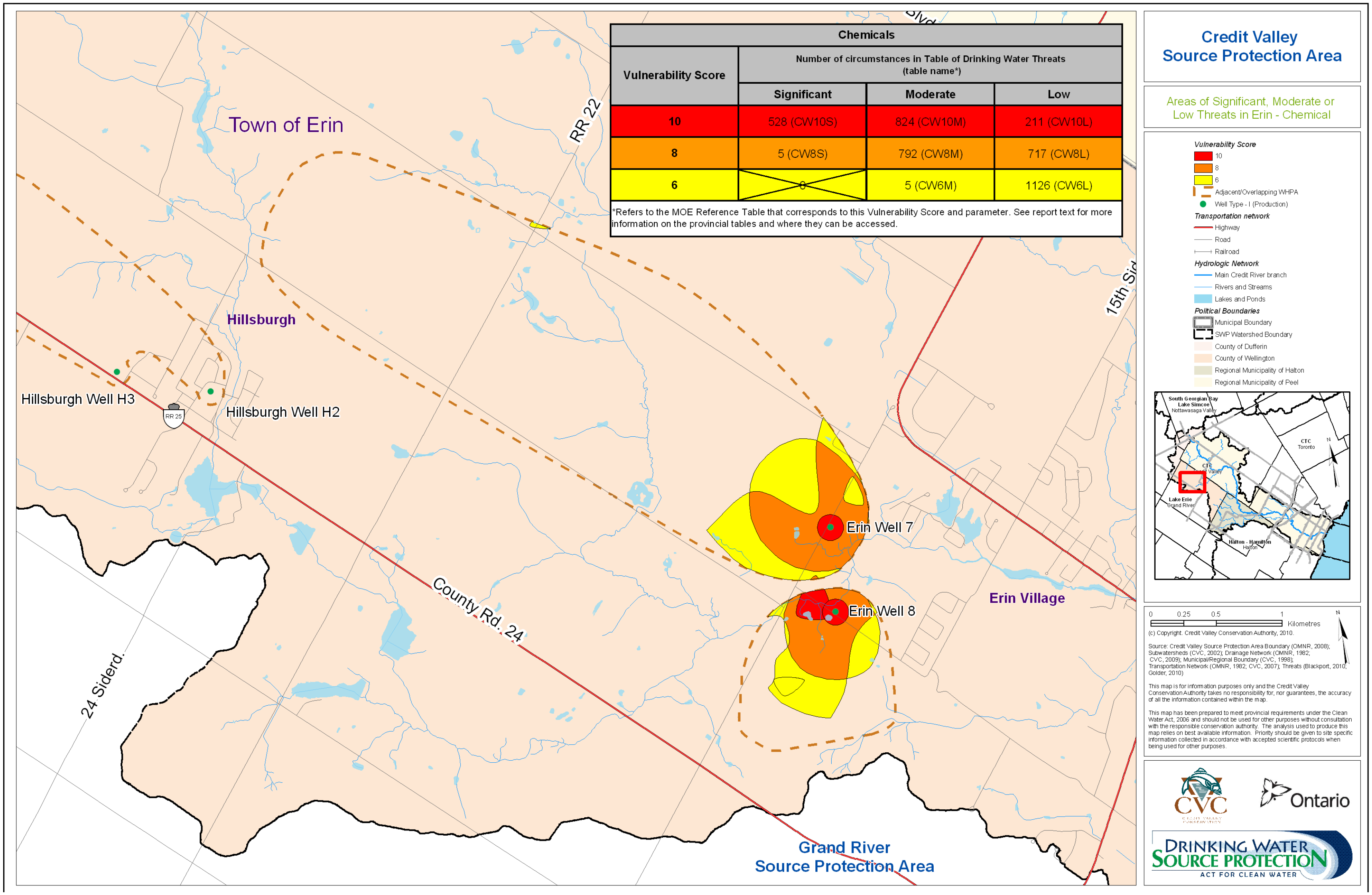
Activity (or Threat Type)	Threats			
	Significant	Moderate	Low	Total
1) The establishment, operation, or maintenance of a waste disposal site within the meaning of Part V of the *Environmental Protection Act*	0	n/a	n/a	n/a
2) The establishment, operation, or maintenance of a system that collects, stores, transmits, treats or disposes of sewage	17	n/a	n/a	n/a
3) The application of agricultural source material to land	1	n/a	n/a	n/a
4) The storage of agricultural source material	0	n/a	n/a	n/a
5) The management of agricultural source material to land	0	n/a	n/a	n/a
6) The application of non-agricultural source material (NASM) to land	1	n/a	n/a	n/a
7) The handling and storage of non-agricultural source material NASM	0	n/a	n/a	n/a
8) The application of commercial fertilizer	1	n/a	n/a	n/a
9) The handling and storage of commercial fertilizer	0	n/a	n/a	n/a
10) The application of pesticide to land	1	n/a	n/a	n/a
11) The handling and storage of pesticide	0	n/a	n/a	n/a
12) The application of road salt	0	n/a	n/a	n/a
13) The handling and storage of road salt	0	n/a	n/a	n/a
14) The storage of snow	0	n/a	n/a	n/a
15) The handling and storage of fuel	16	n/a	n/a	n/a
16) The handling and storage of a dense non-aqueous phase liquid	2	n/a	n/a	n/a
17) The handling and storage of an organic solvent	0	n/a	n/a	n/a
18) The management of runoff that contains chemicals used in the de-icing of aircraft	0	n/a	n/a	n/a
19) An activity that takes water from an aquifer or a surface water body without returning the water taken to the same aquifer or surface water body	n/a	n/a	n/a	n/a
20) An activity that reduces the recharge of an aquifer	n/a	n/a	n/a	n/a
21) The use of land as livestock grazing or pasturing land, an outdoor confinement area, or a farm-animal yard.	0	n/a	n/a	n/a
Total Threats	**39**	**n/a**	**n/a**	**n/a**
Total Parcels	**19**	**n/a**	**n/a**	**n/a**

n/a - not required by the MOECC

Table 5.21: Town of Erin (Bel-Erin Water System) — Enumerated Drinking Water Threats

Activity (or Threat Type)	Threats			
	Significant	Moderate	Low	Total
1) The establishment, operation, or maintenance of a waste disposal site within the meaning of Part V of the *Environmental Protection Act*	0	n/a	n/a	n/a
2) The establishment, operation, or maintenance of a system that collects, stores, transmits, treats or disposes of sewage	102	n/a	n/a	n/a
3) The application of agricultural source material to land	3	n/a	n/a	n/a
4) The storage of agricultural source material	2	n/a	n/a	n/a
5) The management of agricultural source material to land	0	n/a	n/a	n/a
6) The application of non-agricultural source material (NASM) to land	0	n/a	n/a	n/a
7) The handling and storage of non-agricultural source material NASM	0	n/a	n/a	n/a
8) The application of commercial fertilizer	0	n/a	n/a	n/a
9) The handling and storage of commercial fertilizer	2	n/a	n/a	n/a
10) The application of pesticide to land	3	n/a	n/a	n/a
11) The handling and storage of pesticide	2	n/a	n/a	n/a
12) The application of road salt	0	n/a	n/a	n/a
13) The handling and storage of road salt	0	n/a	n/a	n/a
14) The storage of snow	0	n/a	n/a	n/a
15) The handling and storage of fuel	100	n/a	n/a	n/a
16) The handling and storage of a dense non-aqueous phase liquid	4	n/a	n/a	n/a
17) The handling and storage of an organic solvent	3	n/a	n/a	n/a
18) The management of runoff that contains chemicals used in the de-icing of aircraft	0	n/a	n/a	n/a
19) An activity that takes water from an aquifer or a surface water body without returning the water taken to the same aquifer or surface water body	n/a	n/a	n/a	n/a
20) An activity that reduces the recharge of an aquifer	n/a	n/a	n/a	n/a
21) The use of land as livestock grazing or pasturing land, an outdoor confinement area, or a farm-animal yard.	2	n/a	n/a	9
Total Threats	**223**	**n/a**	**n/a**	**324**
Total Parcels	**104**	**n/a**	**n/a**	**148**

n/a - not required by the MOECC

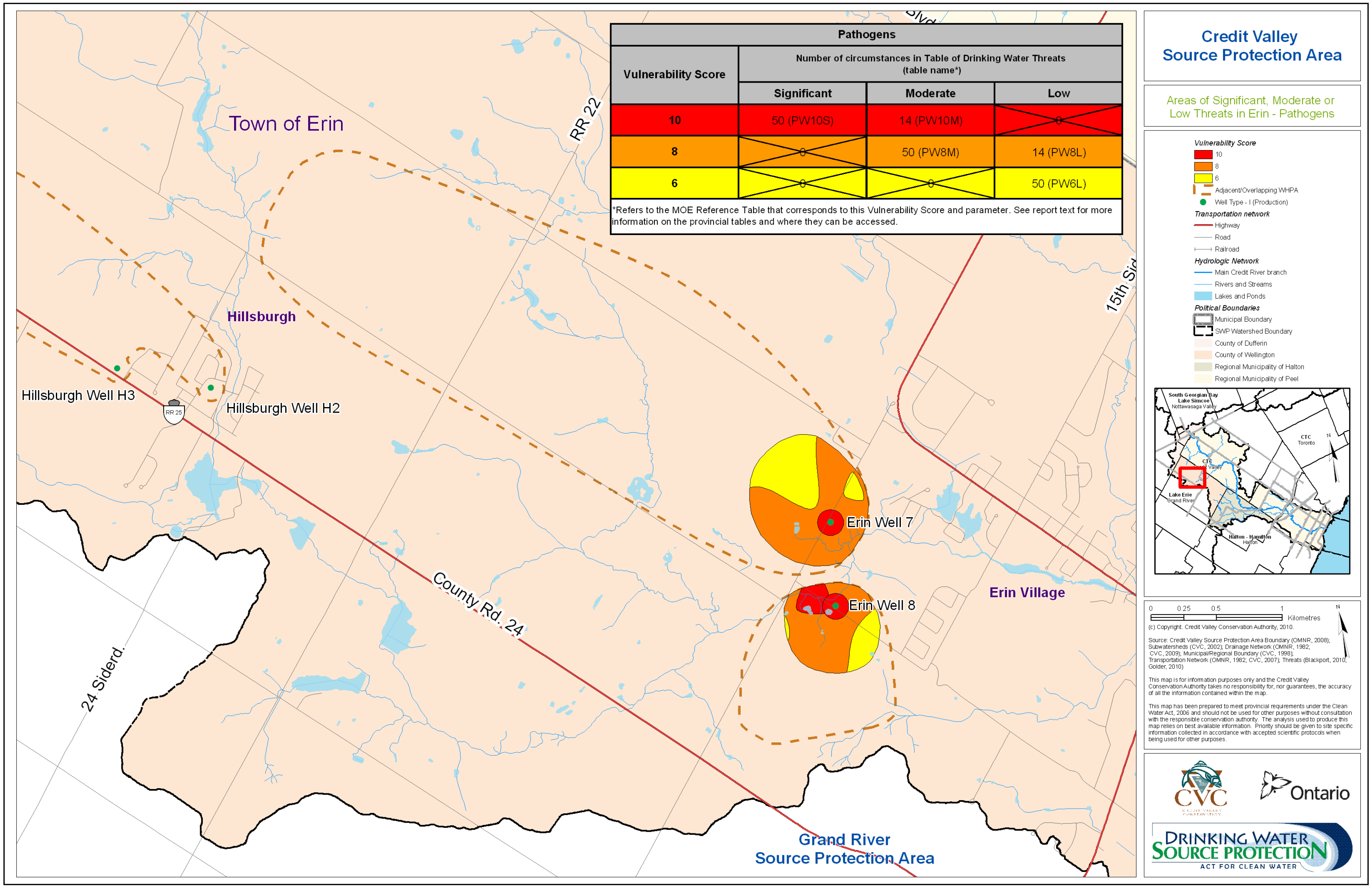


Chemicals			
Vulnerability Score	Number of circumstances in Table of Drinking Water Threats (table name*)		
	Significant	Moderate	Low
10	528 (CW10S)	824 (CW10M)	211 (CW10L)
8	5 (CW8S)	792 (CW8M)	717 (CW8L)
6	0	5 (CW6M)	1126 (CW6L)

*Refers to the MOE Reference Table that corresponds to this Vulnerability Score and parameter. See report text for more information on the provincial tables and where they can be accessed.

Figure 5.20: Areas of Significant, Moderate or Low Threats in Erin – Chemical

The current Provincial Table of Drinking Water Threats can be accessed at http://swpip.ca/

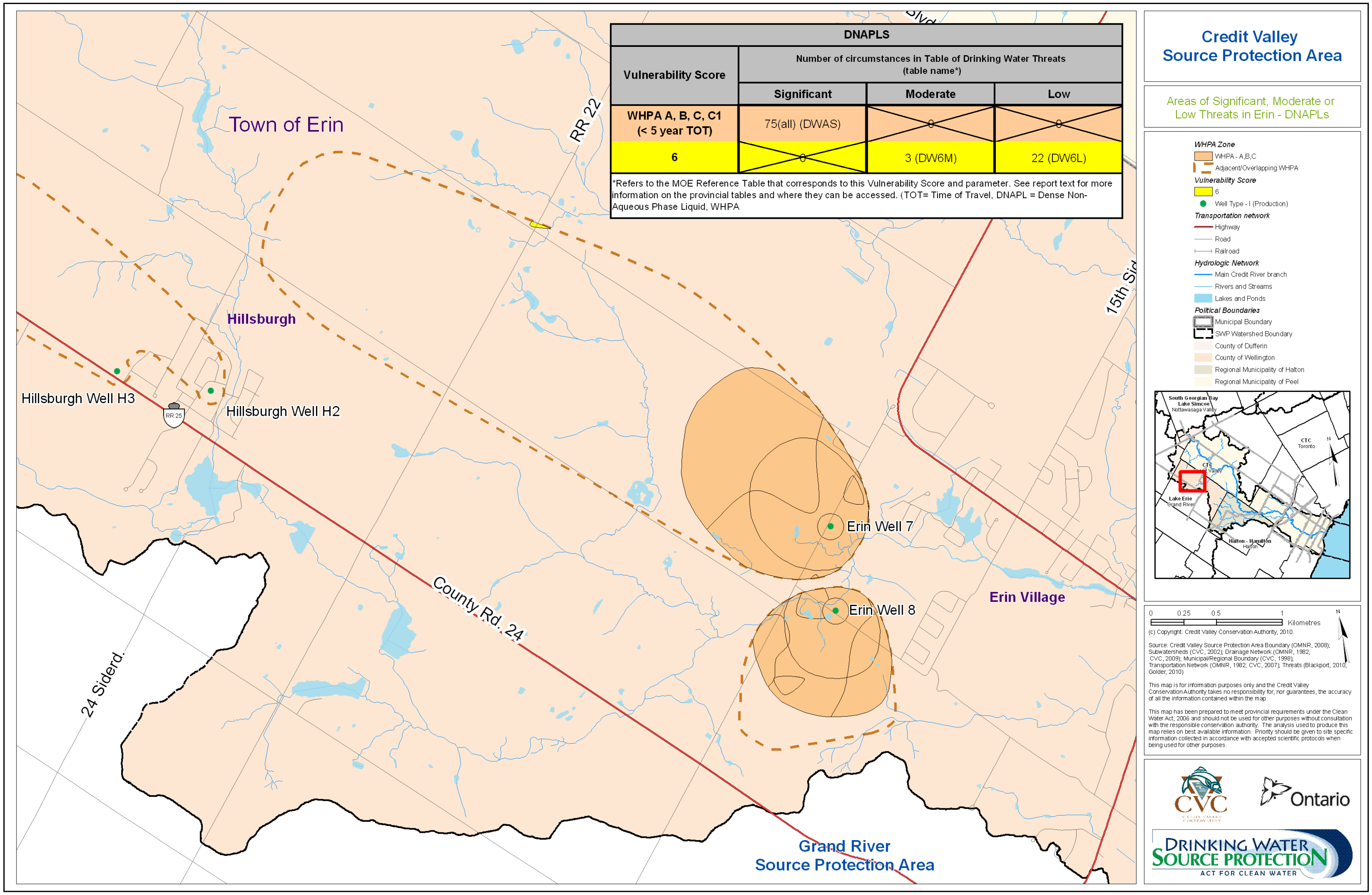


Pathogens			
Vulnerability Score	Number of circumstances in Table of Drinking Water Threats (table name*)		
	Significant	Moderate	Low
10	50 (PW10S)	14 (PW10M)	0
8	0	50 (PW8M)	14 (PW8L)
6	0	0	50 (PW6L)

*Refers to the MOE Reference Table that corresponds to this Vulnerability Score and parameter. See report text for more information on the provincial tables and where they can be accessed.

Figure 5.21: Areas of Significant, Moderate or Low Threats in Erin - Pathogen

The current Provincial Table of Drinking Water Threats can be accessed at http://swpip.ca/



DNAPLS

Vulnerability Score	Number of circumstances in Table of Drinking Water Threats (table name*)		
	Significant	Moderate	Low
WHPA A, B, C, C1 (< 5 year TOT)	75(all) (DWAS)	0	0
6	0	3 (DW6M)	22 (DW6L)

*Refers to the MOE Reference Table that corresponds to this Vulnerability Score and parameter. See report text for more information on the provincial tables and where they can be accessed. (TOT= Time of Travel, DNAPL = Dense Non-Aqueous Phase Liquid, WHPA

Figure 5.22: Areas of Significant, Moderate or Low Threats in Erin - DNAPLs

The current Provincial Table of Drinking Water Threats can be accessed at http://swpip.ca/

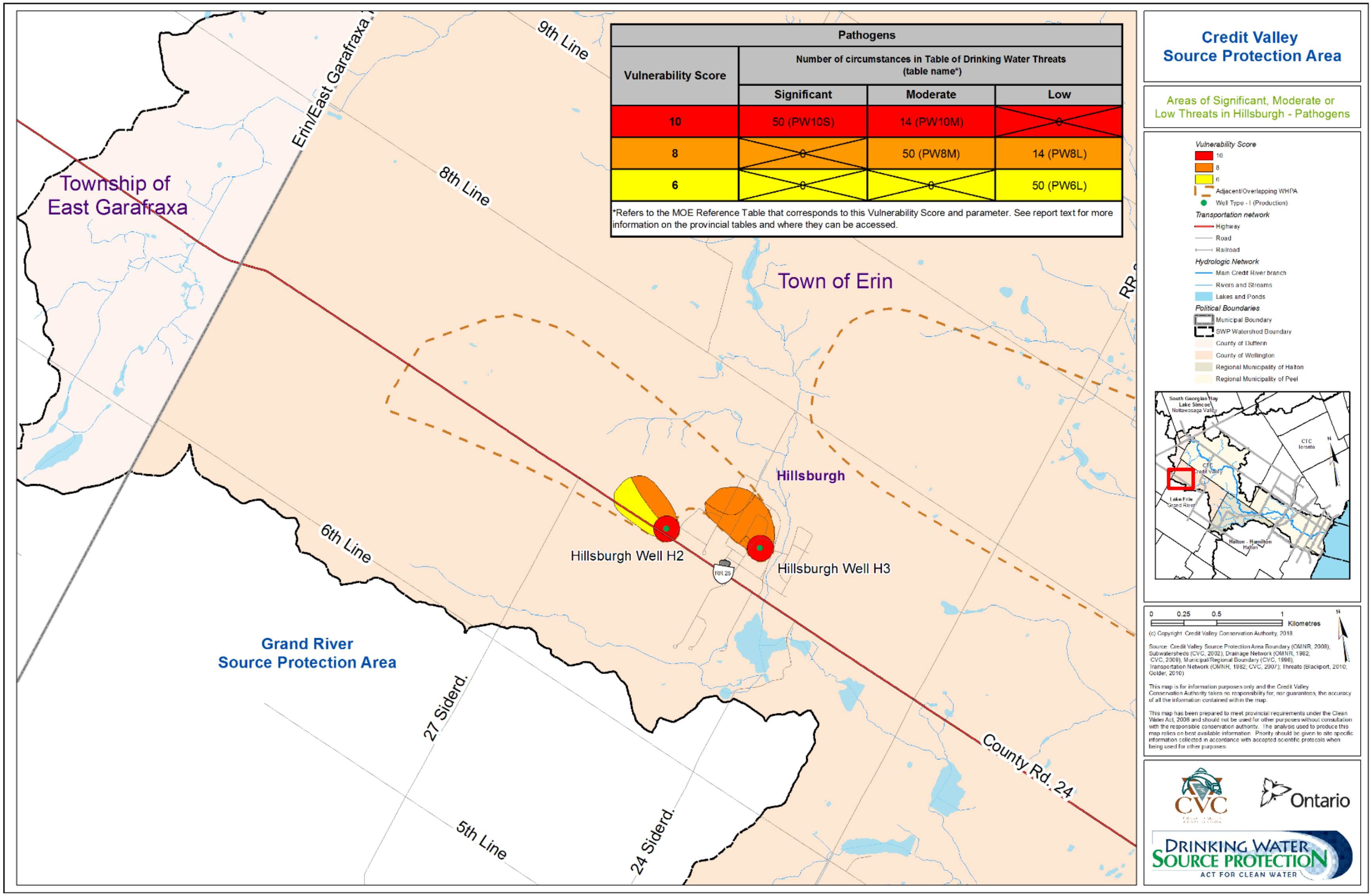
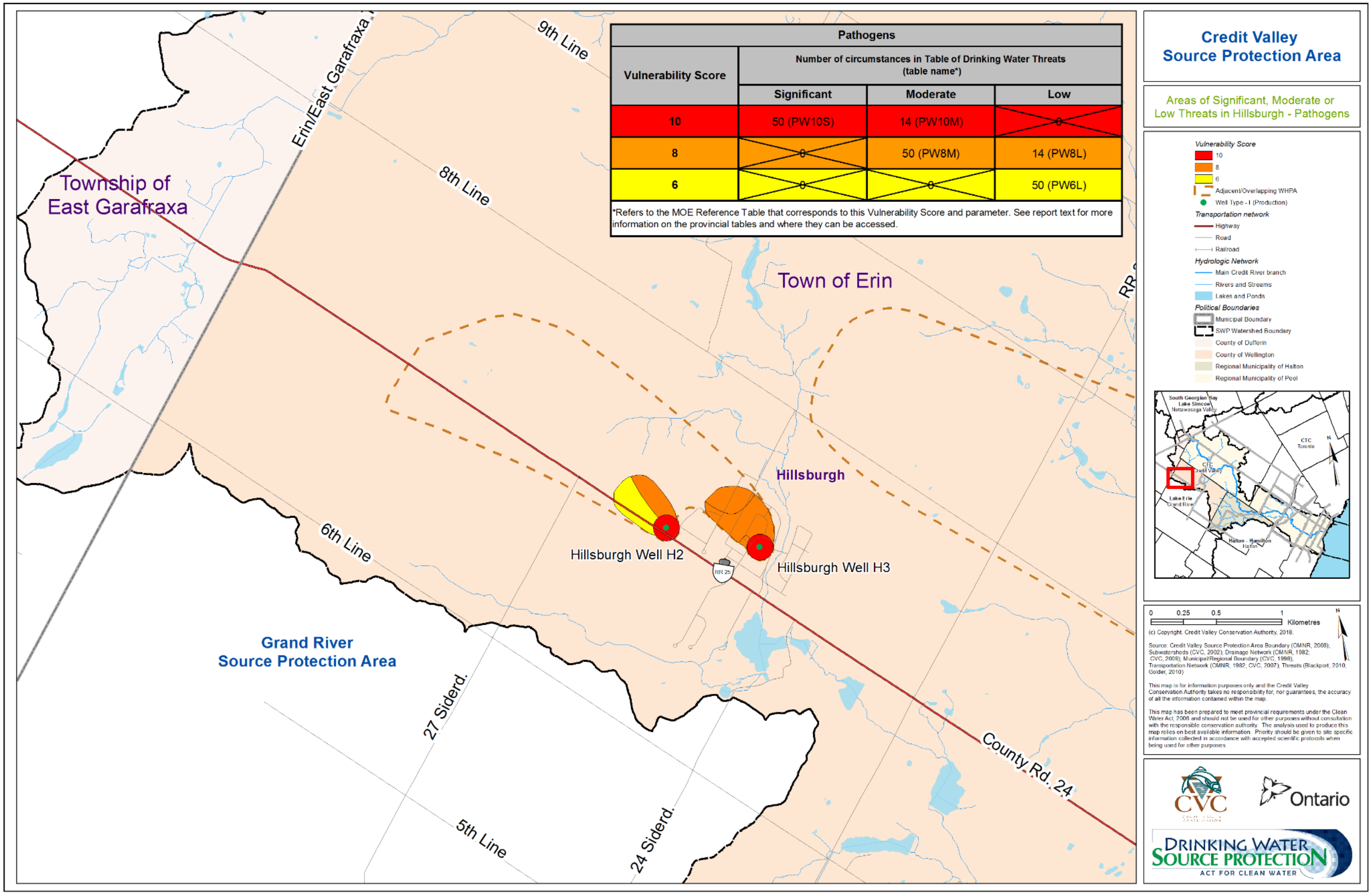


Figure 5.23: Areas of Significant, Moderate or Low Threats in Hillsburgh – Chemical

*The current **Provincial Table** of Drinking Water Threats **can be** accessed at http://swpip.ca/*

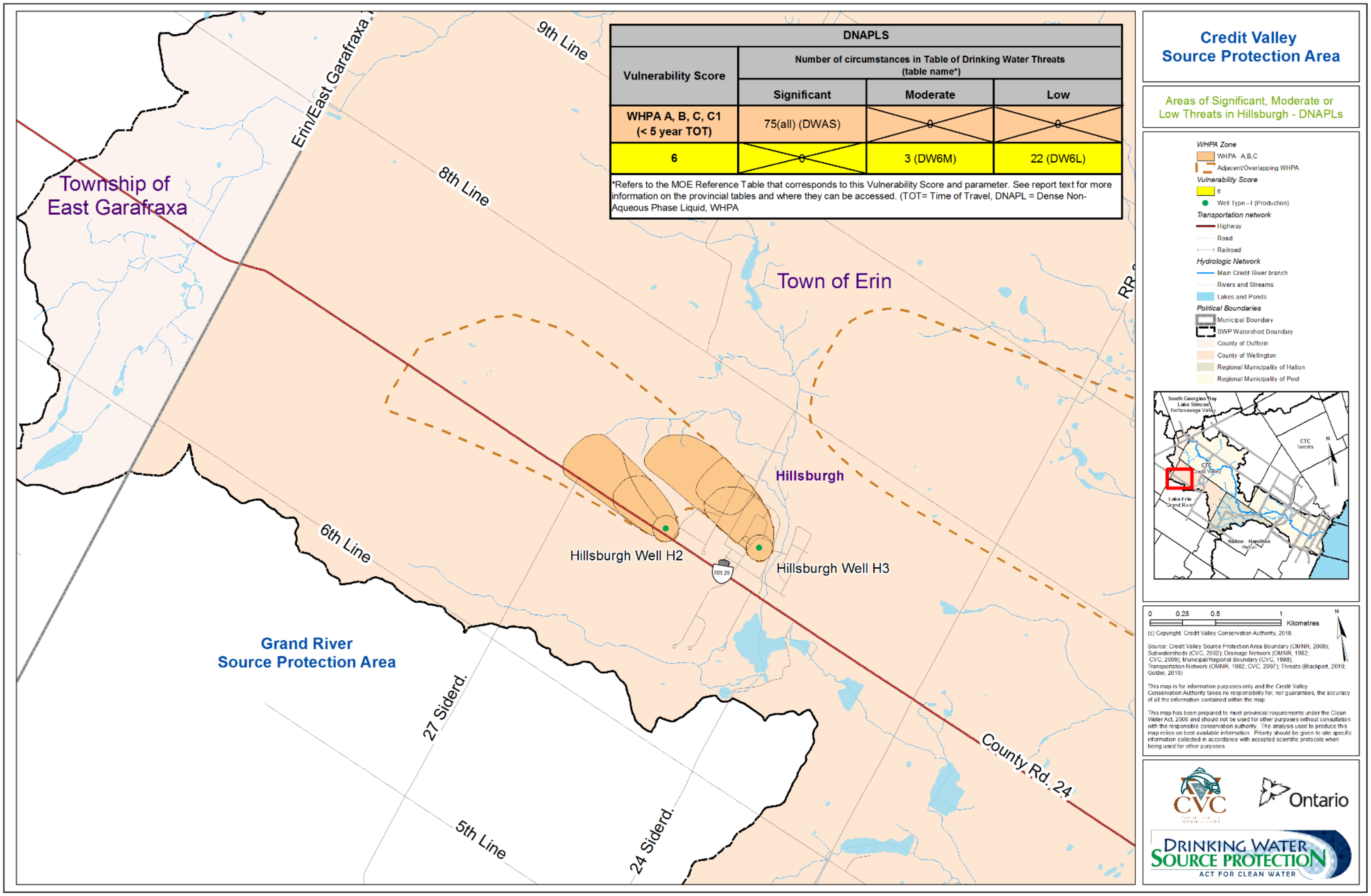


Pathogens			
Vulnerability Score	Number of circumstances in Table of Drinking Water Threats (table name*)		
	Significant	Moderate	Low
10	50 (PW10S)	14 (PW10M)	0
8	0	50 (PW8M)	14 (PW8L)
6	0	0	50 (PW6L)

*Refers to the MOE Reference Table that corresponds to this Vulnerability Score and parameter. See report text for more information on the provincial tables and where they can be accessed.

Figure 5.24: Areas of Significant, Moderate or Low Threats in Hillsburgh – Pathogens

The current ***Provincial Table*** *of Drinking Water Threats* ***can be*** *accessed at* [***http://swpip.ca/***](http://swpip.ca/)

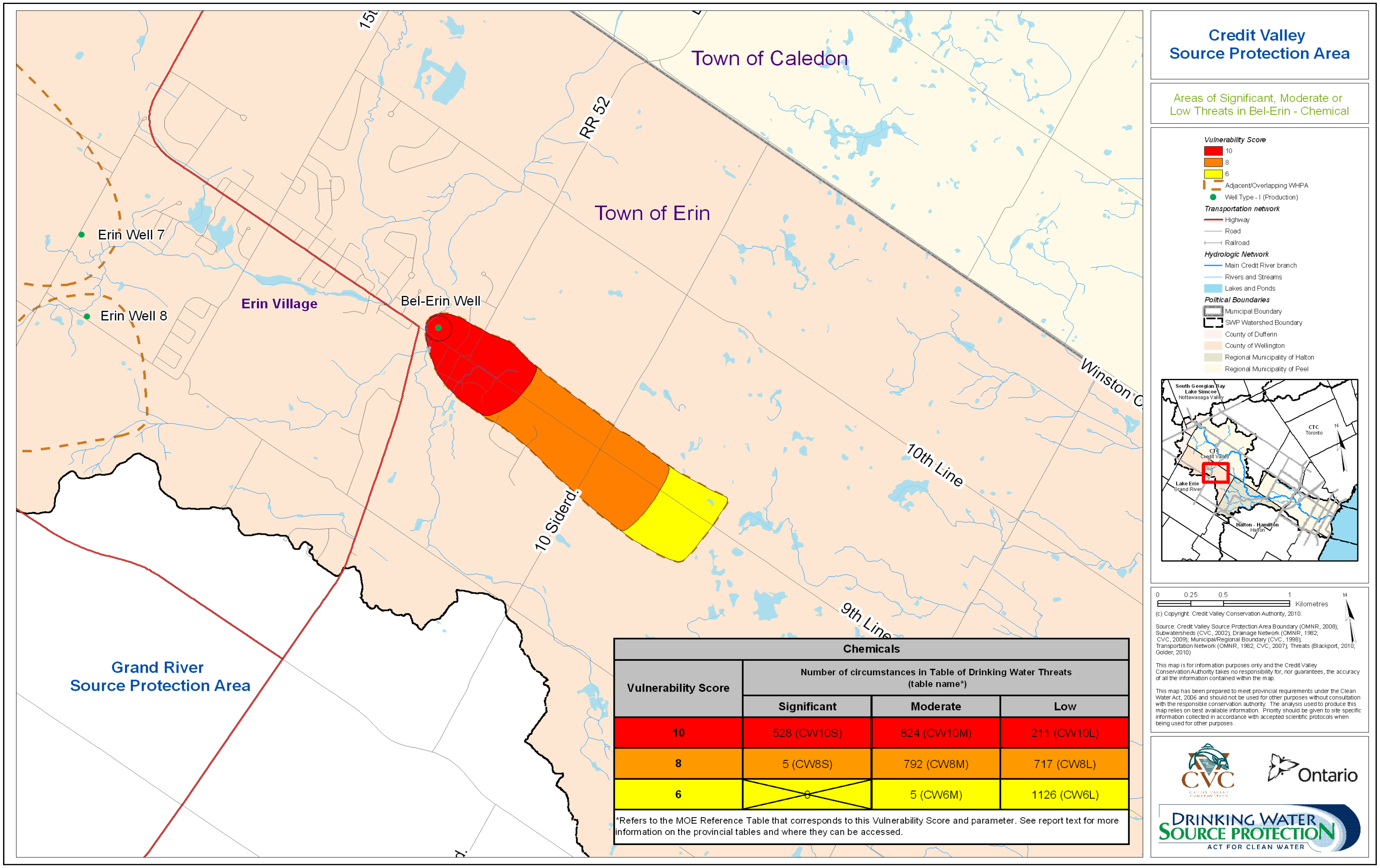


DNAPLS			
Vulnerability Score	Number of circumstances in Table of Drinking Water Threats (table name*)		
	Significant	Moderate	Low
WHPA A, B, C, C1 (< 5 year TOT)	75(all) (DWAS)	0	0
6	0	3 (DW6M)	22 (DW6L)

*Refers to the MOE Reference Table that corresponds to this Vulnerability Score and parameter. See report text for more information on the provincial tables and where they can be accessed. (TOT= Time of Travel, DNAPL = Dense Non-Aqueous Phase Liquid, WHPA

Figure 5.25: Areas of Significant, Moderate or Low Threats in Hillsburgh – DNAPLs

The current Provincial Table of Drinking Water Threats can be accessed at http://swpip.ca/

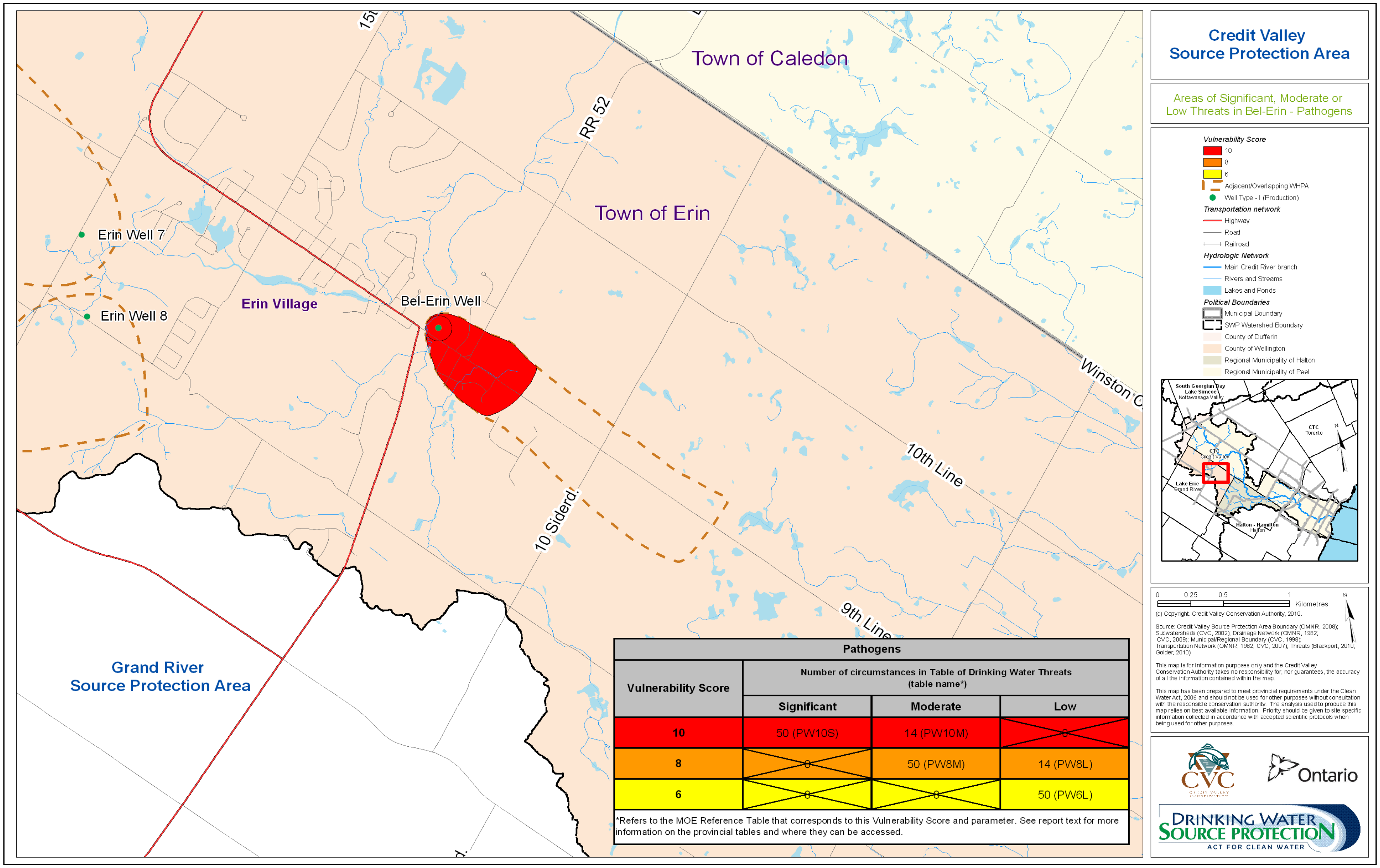


Chemicals			
Vulnerability Score	Number of circumstances in Table of Drinking Water Threats (table name*)		
	Significant	Moderate	Low
10	528 (CW10S)	824 (CW10M)	211 (CW10L)
8	5 (CW8S)	792 (CW8M)	717 (CW8L)
6	0	5 (CW6M)	1126 (CW6L)

*Refers to the MOE Reference Table that corresponds to this Vulnerability Score and parameter. See report text for more information on the provincial tables and where they can be accessed.

Figure 5.26: Areas of Significant, Moderate or Low Threats in Bel Erin – Chemicals

The current Provincial Table of Drinking Water Threats can be accessed at http://swpip.ca/



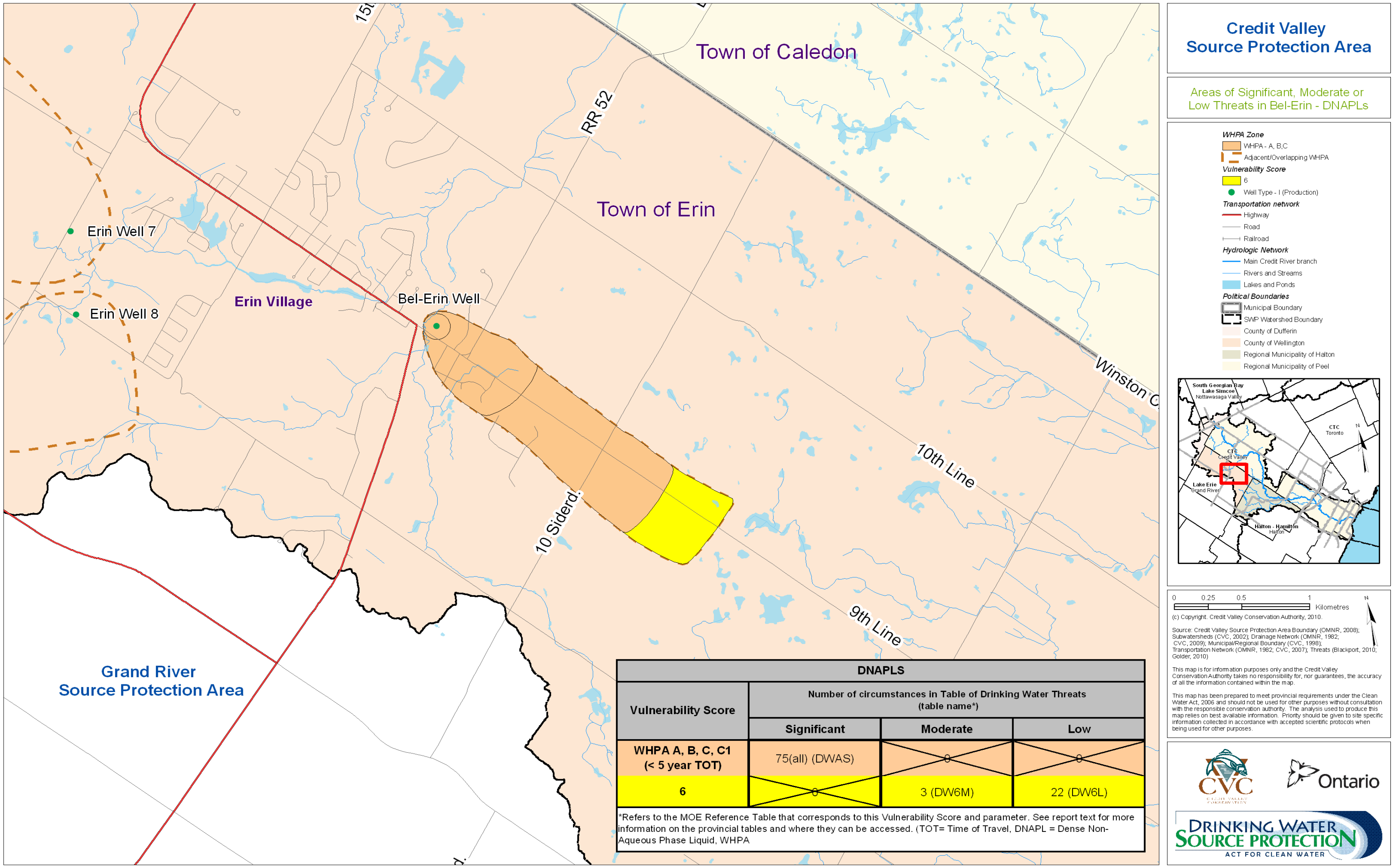
Pathogens

Vulnerability Score	Number of circumstances in Table of Drinking Water Threats (table name*)		
	Significant	Moderate	Low
10	50 (PW10S)	14 (PW10M)	0
8	0	50 (PW8M)	14 (PW8L)
6	0	0	50 (PW6L)

*Refers to the MOE Reference Table that corresponds to this Vulnerability Score and parameter. See report text for more information on the provincial tables and where they can be accessed.

Figure 5.27: Areas of Significant, Moderate or Low Threats in Bel Erin – Pathogens

The current Provincial Table of Drinking Water Threats can be accessed at http://swpip.ca/



DNAPLS			
Vulnerability Score	Number of circumstances in Table of Drinking Water Threats (table name*)		
	Significant	Moderate	Low
WHPA A, B, C, C1 (< 5 year TOT)	75(all) (DWAS)	0	0
6	0	3 (DW6M)	22 (DW6L)

*Refers to the MOE Reference Table that corresponds to this Vulnerability Score and parameter. See report text for more information on the provincial tables and where they can be accessed. (TOT= Time of Travel, DNAPL = Dense Non-Aqueous Phase Liquid, WHPA

Figure 5.28: Areas of Significant, Moderate or Low Threats in Bel Erin – DNAPLs

The current Provincial Table of Drinking Water Threats can be accessed at http://swpip.ca/

5.5.5 Regional Municipality of Halton - Town of Halton Hills

In the CVSPA, Halton Region provides municipal water supply to the Town of Halton Hills through the Acton and Georgetown water systems comprising twelve wells. The WHPA delineation and vulnerability scoring processes around the wellheads are described in **Chapter 4.2**.

The issues evaluation and threats identification studies for these water systems were originally undertaken by AMEC Earth and Environmental in 2010. In 2012, the threat enumerations were updated, following the CTC SPC's approval of the WHPA (**Section 4.7**) amendments for the municipal wells.

The threats inventory was compiled using the data and information sources outlined in **Appendix E2** and was undertaken based on the provisions of the SGBLS Accord. Site specific verification of drinking water threats was not included as part of either enumeration effort referenced above. Since 2013 however, staff has undertaken initial work aimed at the ground truthing of significant threats in vulnerable zones around municipal wells. The findings are presented in the report "Drinking Water Quality, Preliminary Verification of Significant Threats - Town of Halton Hills" (Credit Valley Conservation Authority & CTC Source Protection Region, January 2015). The results of this work have been used to refine the threat counts discussed below.

Additional assumptions include:

- Fertilizer application was assigned to commercial properties where landscaping was verified through aerial photography, and to residential properties;
- Data for natural gas service area were not available, so residences outside of the sewer and water serviced areas were assigned a fuel storage threat on a per parcel basis;
- Non-buildable land was inspected using aerial photography to determine a presence of storm water management pond. If there was no evidence of storm water management pond, the parcel was excluded from threats enumeration;
- Non-domestic land uses were assumed to have larger fuel capacity than residential land use;
- Livestock grazing threats were identified through aerial photography; and
- Industrial effluent discharges were assumed for heavy industrial facilities only (i.e., mills).

Threats and Issues

The issues evaluation was initially based on work undertaken by AMEC in 2010. In December 2012, Halton Region petitioned the MOECC for reconsideration of the issues, citing a concern that the original assessment may have been overly conservative and further that new data was available that should be considered. The MOECC requested that a fresh review of the datasets be undertaken by CVC staff and the region. This work resulted in the development of the report *Issues Determination, Halton Region Wells* prepared by CTC staff in 2013. This report was subjected to review by a working group of the SPC and approved by the SPC in June 2013.

The findings of this study provided context for 2013 field verification work referenced above, as it recommended the removal of certain issues that had been identified through the original study, and the reduction of the ICAs for the issues that were retained. The threats inventory was compiled using the data and information sources outlined in **Appendix E2.**

Table 5.22 and **Table 5.23** summarize the number of significant threats around Acton and Georgetown wellheads, respectively. Significant managed land threats were identified in both areas. Details of the evaluation of managed land threats are presented in **Appendix E4**.

The areas where the threats are or would be low, moderate, or significant for chemicals, DNAPLs and pathogens are shown on **Figure 5.32** through **Figure 5.37**. A total of 6,786 significant threats have been identified on 4,392 parcels in the vulnerable areas of the municipal wellheads of Halton Hills (in CVSPA). 27 of these threats originate on lands within the Town of Erin.

Acton— 651 significant threats, which are linked to agricultural activities (319), private septic systems (165), the handling and storage of fuel (41), the handling and storage of organic solvents (17), the handling and storage of DNAPLs (22), and consumptive groundwater usage (87).

Georgetown — 6,135 significant threats, which are linked to road salt (4,258), the handling and storage of fuel (128), private septic systems (1,350), the handling and storage of DNAPLs (144), agricultural activities (226), and the handling and storage of organic solvents (29).

Analysis was carried out by Genivar on behalf of the Region of Halton in 2013 which showed the relatively small estimated contribution of sodium and/or chloride from private septic systems within the ICA, even those with water softeners discharging to the system. Key details from the study, *Potential Salt and Nitrate Loadings from Activities in Revised Halton Region Wellhead Protection Areas, July 2013,* are presented in **Appendix E6.** The CTC SPC decided in 2015 that the septic systems should not be considered as significant threat activities contributing to chloride issues in these wells pursuant to *Technical Rule* 115(4) and 131(2). It should be noted that the septic systems identified as significant threats as a result of the vulnerability scoring approach would not be impacted by this decision, i.e., remain significant threat.

The wastewater is treated, and effluent eventually sent to the Black Creek and Silver Creek. The sewers and their connections that transport the wastewater are considered as threats as there is the potential for leaks to occur. For the enumeration of threats, only one threat has been counted for each wellfield to represent all sanitary sewers and connections within the highest scoring area of the WHPA.

Septic systems are assumed to be used at all rural homes and buildings outside of the town limits. Septic systems that are not properly maintained can contribute to pathogen and chemical contamination in surface and groundwater. MPAC data were used to identify properties that had a building and were not municipally serviced. These parcels were assumed to have a septic system.

With respect to the enumeration of fuel threats staff was able to access data from the natural gas provider to permit refinement of the previous assessment. This enabled a more accurate estimation of the number of properties that may use natural gas for heating and therefore would not have heating fuel storage tanks.

It should be noted that Source Protection Plan policies apply only to threat activities that are actually being engaged in or planned to be engaged in the future, whether or not they have been identified in this enumeration.

Conditions

A review of available documentation was conducted for potential contamination associated with past activities within the WHPAs of the town's municipal wells. The two main sources of information were the ERIS Ecolog Reports and data from the MOECC Regional offices.

Based on this review, no conditions have been identified within the WHPAs of the region's wells.

Cross-Boundary Threats

The threats enumeration discussed above, provides an assessment of threats within the CVC's jurisdiction. However, the WHPAs of Acton and Georgetown do cross the western boundary of the CVSPA into the GRSPA's jurisdiction, and the southern boundary into the Halton Source Protection Area (HSPA).

Table 5.22: Town of Halton Hills (Acton Water System) — Enumerated Drinking Water Threats

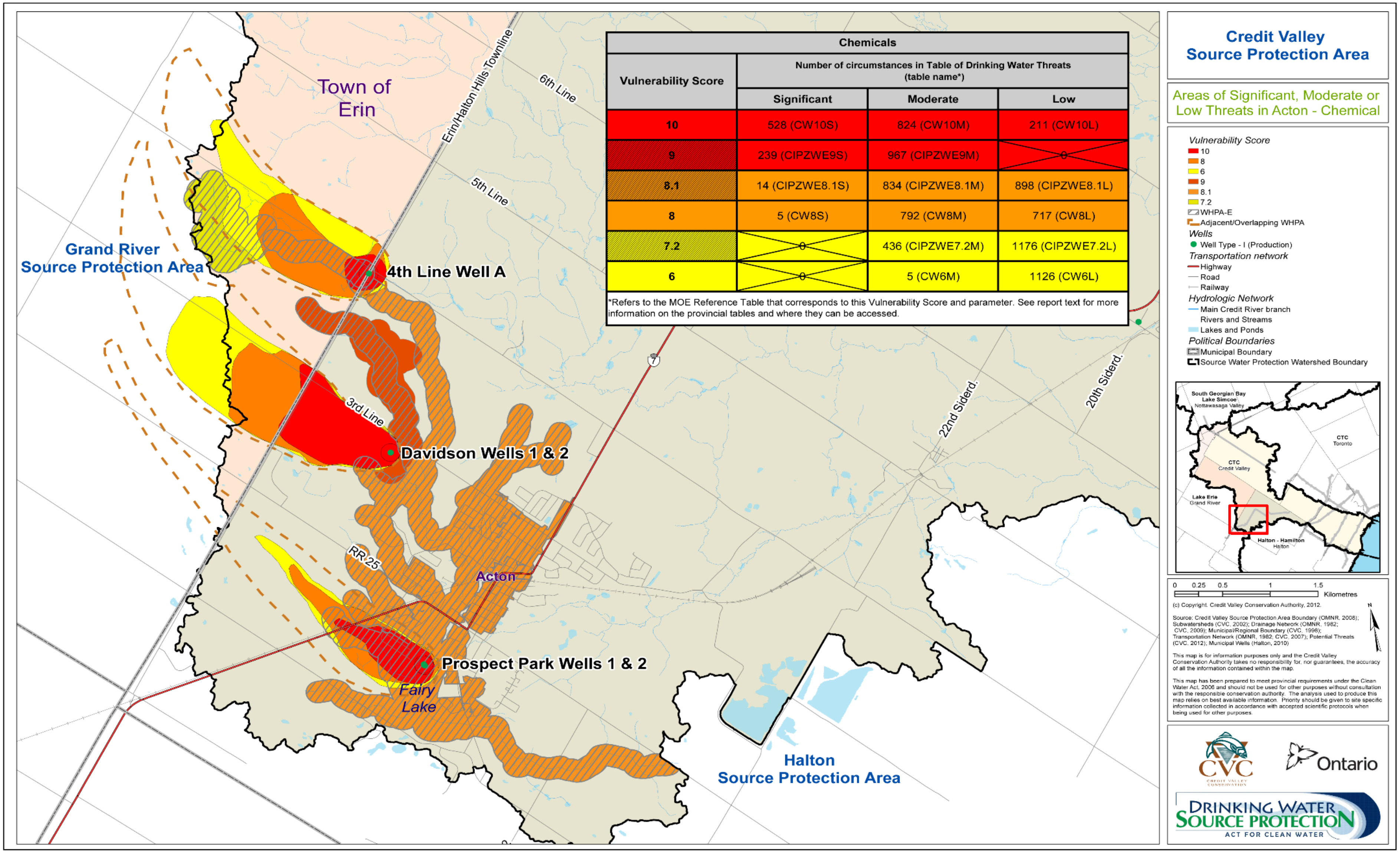
Activity (or Threat Type)	Threats			
	Significant	Moderate	Low	Total
1) The establishment, operation, or maintenance of a waste disposal site within the meaning of Part V of the *Environmental Protection Act*	0	n/a	n/a	n/a
2) The establishment, operation, or maintenance of a system that collects, stores, transmits, treats or disposes of sewage	165	n/a	n/a	n/a
3) The application of agricultural source material to land	36	n/a	n/a	n/a
4) The storage of agricultural source material	22	n/a	n/a	n/a
5) The management of agricultural source material to land	0	n/a	n/a	n/a
6) The application of non-agricultural source material (NASM) to land	0	n/a	n/a	n/a
7) The handling and storage of non-agricultural source material NASM	0	n/a	n/a	n/a
8) The application of commercial fertilizer	55	n/a	n/a	n/a
9) The handling and storage of commercial fertilizer	59	n/a	n/a	n/a
10) The application of pesticide to land	63	n/a	n/a	n/a
11) The handling and storage of pesticide	18	n/a	n/a	n/a
12) The application of road salt	0	n/a	n/a	n/a
13) The handling and storage of road salt	0	n/a	n/a	n/a
14) The storage of snow	0	n/a	n/a	n/a
15) The handling and storage of fuel	41	n/a	n/a	n/a
16) The handling and storage of a dense non-aqueous phase liquid	22	n/a	n/a	n/a
17) The handling and storage of an organic solvent	17	n/a	n/a	n/a
18) The management of runoff that contains chemicals used in the de-icing of aircraft	0	n/a	n/a	n/a
19) An activity that takes water from an aquifer or a surface water body without returning the water taken to the same aquifer or surface water body	87	n/a	n/a	n/a
20) An activity that reduces the recharge of an aquifer	0	n/a	n/a	n/a
21) The use of land as livestock grazing or pasturing land, an outdoor confinement area, or a farm-animal yard.	66	n/a	n/a	n/a
Total Threats	**651**	**n/a**	**n/a**	**n/a**
Total Parcels	**346**	**n/a**	**n/a**	**n/a**

n/a - not required by the MOECC

Table 5.23: Town of Halton Hills (Georgetown Water System)—Enumerated Drinking Water Threats

Activity (or Threat Type)	Threats			
	Significant	Moderate	Low	Total
1) The establishment, operation, or maintenance of a waste disposal site within the meaning of Part V of the *Environmental Protection Act*	0	n/a	n/a	n/a
2) The establishment, operation, or maintenance of a system that collects, stores, transmits, treats or disposes of sewage	1350	n/a	n/a	n/a
3) The application of agricultural source material to land	8	n/a	n/a	n/a
4) The storage of agricultural source material	5	n/a	n/a	n/a
5) The management of agricultural source material to land	0	n/a	n/a	n/a
6) The application of non-agricultural source material (NASM) to land	1	n/a	n/a	n/a
7) The handling and storage of non-agricultural source material NASM	0	n/a	n/a	n/a
8) The application of commercial fertilizer	0	n/a	n/a	n/a
9) The handling and storage of commercial fertilizer	18	n/a	n/a	n/a
10) The application of pesticide to land	44	n/a	n/a	n/a
11) The handling and storage of pesticide	73	n/a	n/a	n/a
12) The application of road salt	3299	n/a	n/a	n/a
13) The handling and storage of road salt	959	n/a	n/a	n/a
14) The storage of snow	0	n/a	n/a	n/a
15) The handling and storage of fuel	128	n/a	n/a	n/a
16) The handling and storage of a dense non-aqueous phase liquid	144	n/a	n/a	n/a
17) The handling and storage of an organic solvent	29	n/a	n/a	n/a
18) The management of runoff that contains chemicals used in the de-icing of aircraft	0	n/a	n/a	n/a
19) An activity that takes water from an aquifer or a surface water body without returning the water taken to the same aquifer or surface water body	0	n/a	n/a	n/a
20) An activity that reduces the recharge of an aquifer	0	n/a	n/a	n/a
21) The use of land as livestock grazing or pasturing land, an outdoor confinement area, or a farm-animal yard.	77	n/a	n/a	n/a
Total Threats	**6135**	**n/a**	**n/a**	**n/a**
Total Parcels	**4046**	**n/a**	**n/a**	**n/a**

n/a - not required by the MOECC

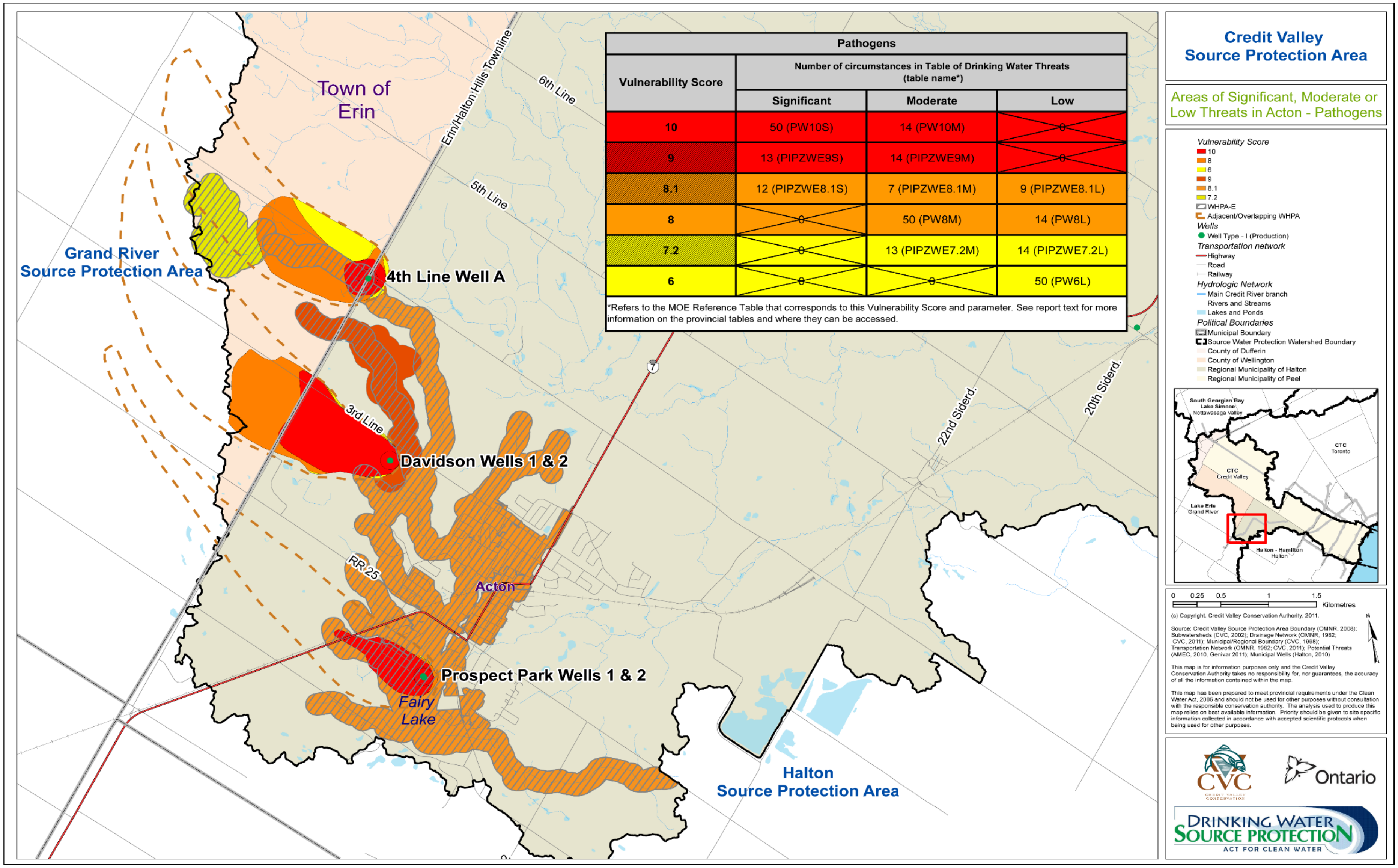


Chemicals			
Vulnerability Score	Number of circumstances in Table of Drinking Water Threats (table name*)		
	Significant	Moderate	Low
10	528 (CW10S)	824 (CW10M)	211 (CW10L)
9	239 (CIPZWE9S)	967 (CIPZWE9M)	0
8.1	14 (CIPZWE8.1S)	834 (CIPZWE8.1M)	898 (CIPZWE8.1L)
8	5 (CW8S)	792 (CW8M)	717 (CW8L)
7.2	0	436 (CIPZWE7.2M)	1176 (CIPZWE7.2L)
6	0	5 (CW6M)	1126 (CW6L)

*Refers to the MOE Reference Table that corresponds to this Vulnerability Score and parameter. See report text for more information on the provincial tables and where they can be accessed.

Figure 5.29: Areas of Significant, Moderate or Low Threats in Acton – Chemical

The current Provincial Table of Drinking Water Threats can be accessed at http://swpip.ca/

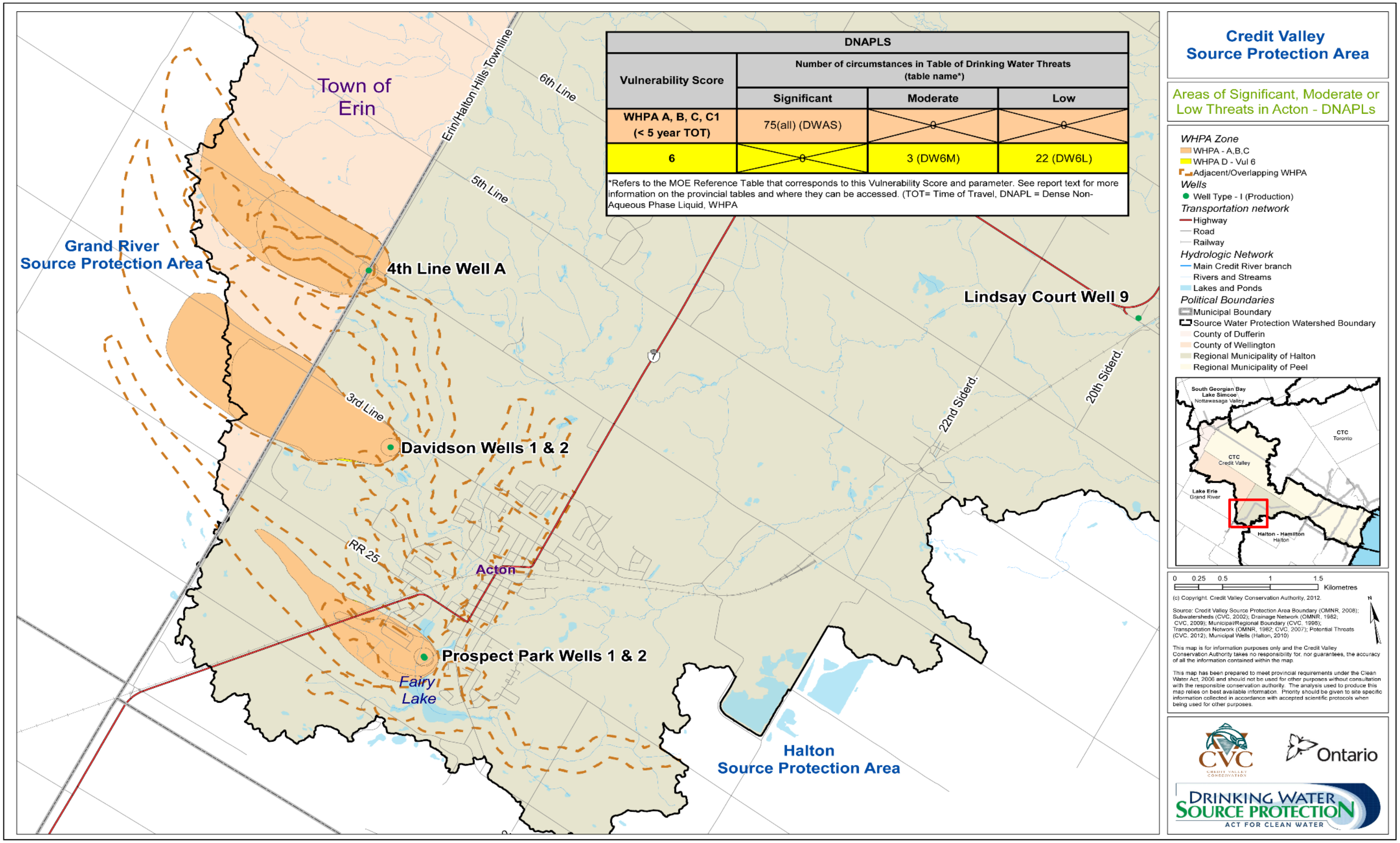


Pathogens			
Vulnerability Score	Number of circumstances in Table of Drinking Water Threats (table name*)		
	Significant	Moderate	Low
10	50 (PW10S)	14 (PW10M)	0
9	13 (PIPZWE9S)	14 (PIPZWE9M)	0
8.1	12 (PIPZWE8.1S)	7 (PIPZWE8.1M)	9 (PIPZWE8.1L)
8	0	50 (PW8M)	14 (PW8L)
7.2	0	13 (PIPZWE7.2M)	14 (PIPZWE7.2L)
6	0	0	50 (PW6L)

*Refers to the MOE Reference Table that corresponds to this Vulnerability Score and parameter. See report text for more information on the provincial tables and where they can be accessed.

Figure 5.30: Areas of Significant, Moderate or Low Threats in Acton – Pathogens

The current Provincial Table of Drinking Water Threats can be accessed at http://swpip.ca/

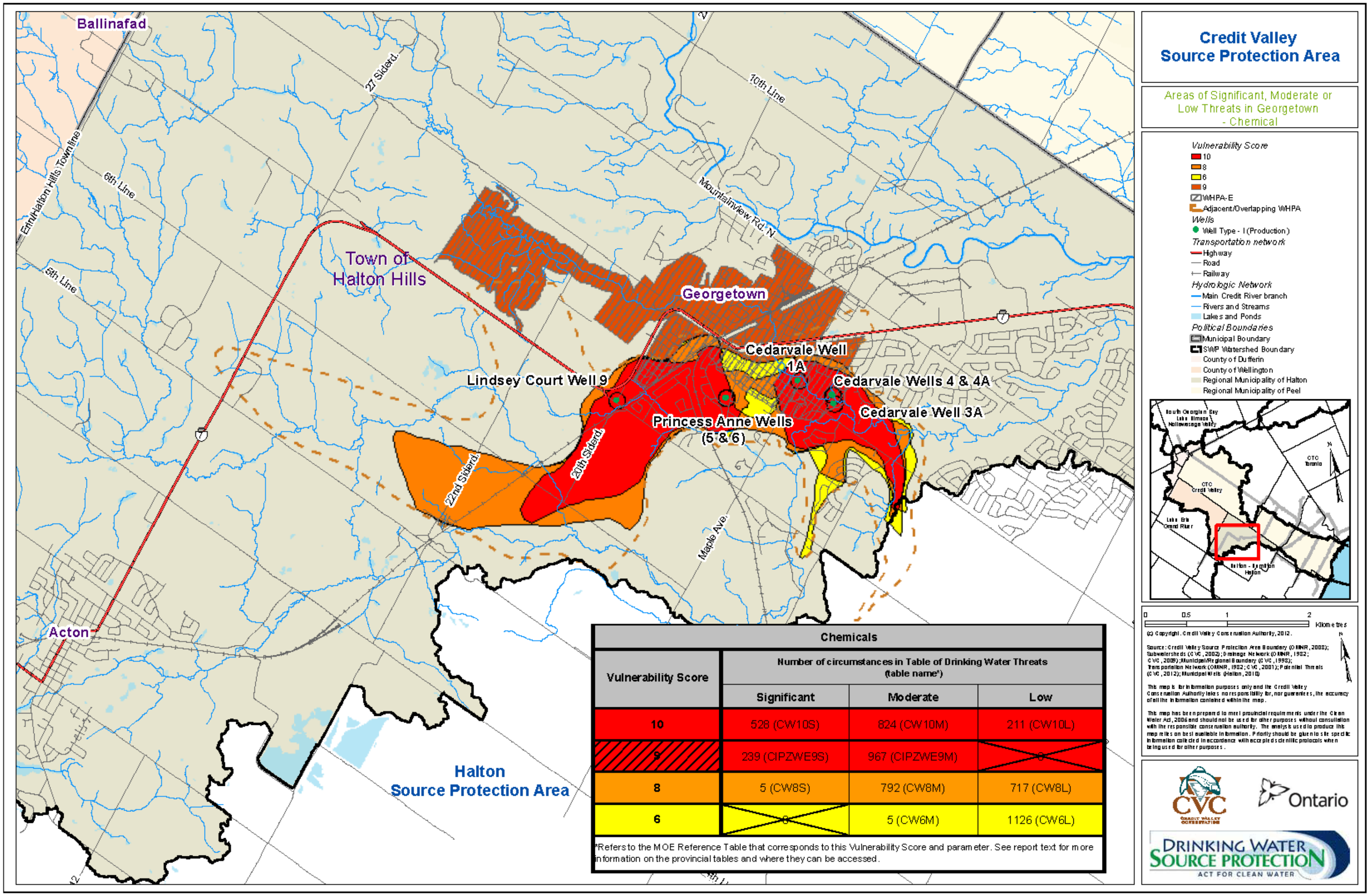


DNAPLS			
Vulnerability Score	Number of circumstances in Table of Drinking Water Threats (table name*)		
	Significant	Moderate	Low
WHPA A, B, C, C1 (< 5 year TOT)	75(all) (DWAS)	0	0
6	0	3 (DW6M)	22 (DW6L)

*Refers to the MOE Reference Table that corresponds to this Vulnerability Score and parameter. See report text for more information on the provincial tables and where they can be accessed. (TOT= Time of Travel, DNAPL = Dense Non-Aqueous Phase Liquid, WHPA

Figure 5.31: Areas of Significant, Moderate or Low Threats in Acton – DNAPLs

The current Provincial Table of Drinking Water Threats can be accessed at http://swpip.ca/

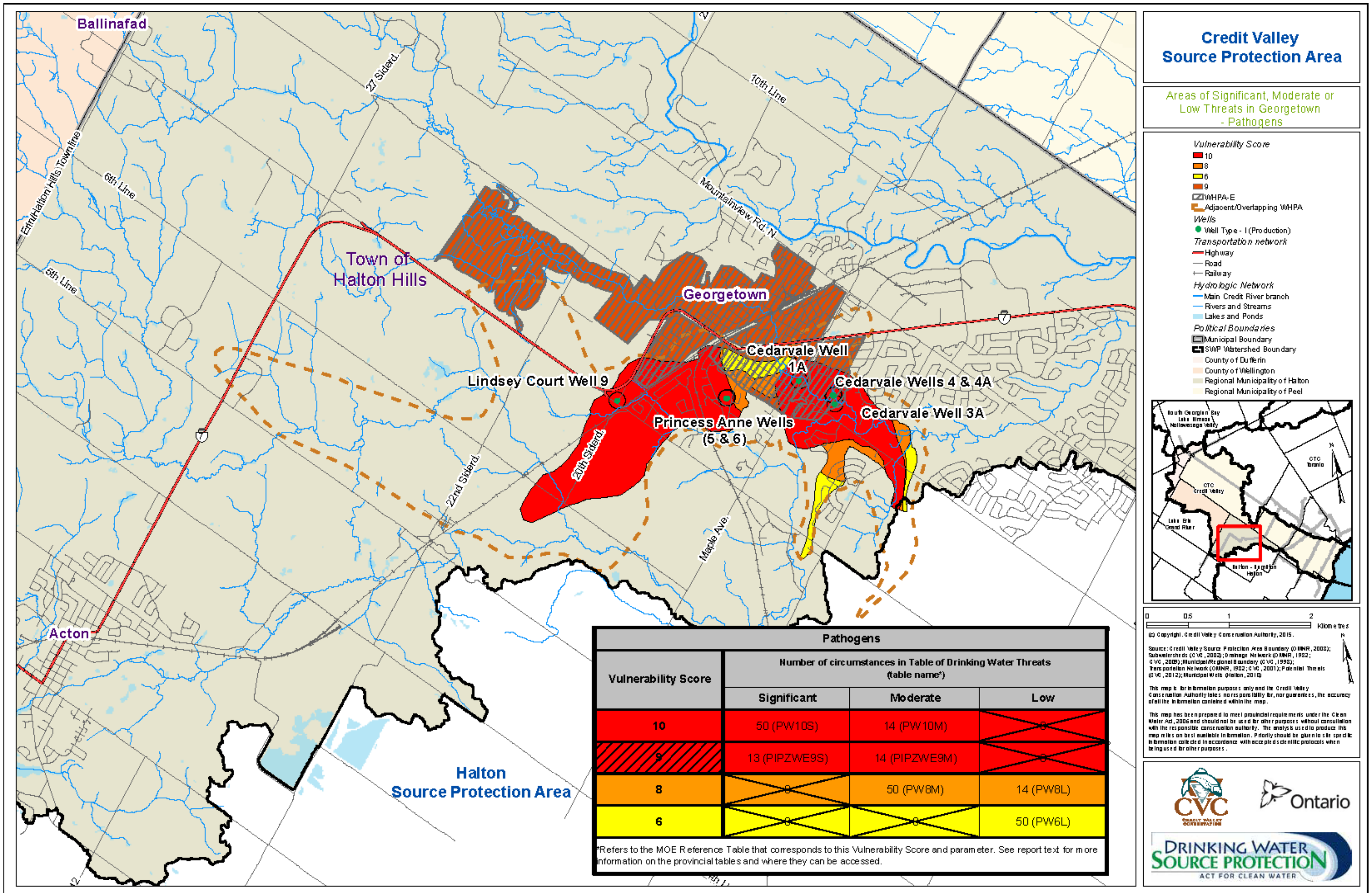


Chemicals			
Vulnerability Score	Number of circumstances in Table of Drinking Water Threats (table name*)		
	Significant	Moderate	Low
10	528 (CW10S)	824 (CW10M)	211 (CW10L)
9	239 (CIPZWE9S)	967 (CIPZWE9M)	0
8	5 (CW8S)	792 (CW8M)	717 (CW8L)
6	0	5 (CW6M)	1126 (CW6L)

*Refers to the MOE Reference Table that corresponds to this Vulnerability Score and parameter. See report text for more information on the provincial tables and where they can be accessed.

Figure 5.32: Areas of Significant, Moderate or Low Threats in Georgetown – Chemical

The current Provincial Table of Drinking Water Threats can be accessed at http://swpip.ca/

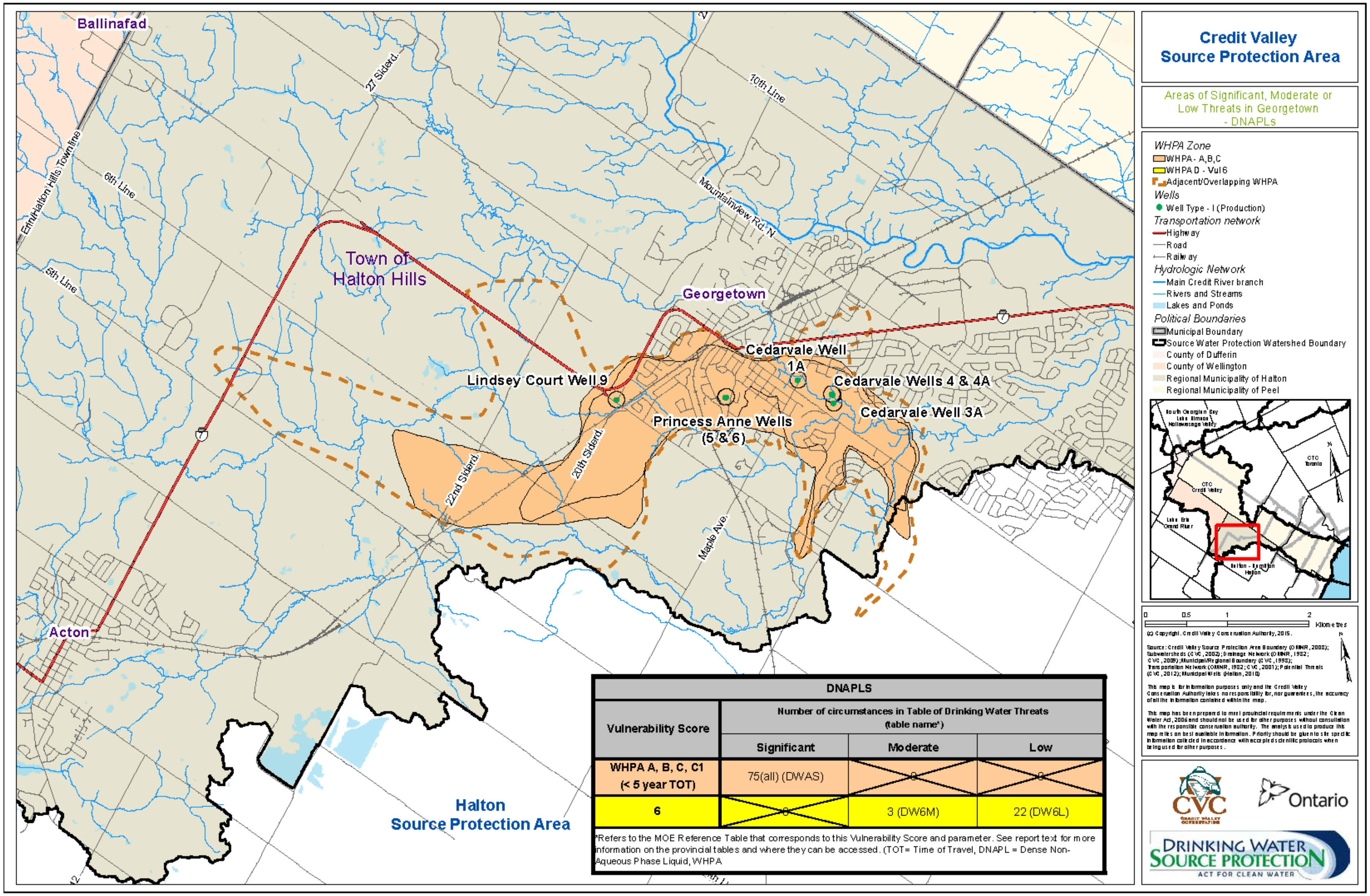


Pathogens			
Vulnerability Score	Number of circumstances in Table of Drinking Water Threats (table name*)		
	Significant	Moderate	Low
10	50 (PW10S)	14 (PW10M)	0
9	13 (PIPZWE9S)	14 (PIPZWE9M)	0
8	0	50 (PW8M)	14 (PW8L)
6	0	0	50 (PW6L)

*Refers to the MOE Reference Table that corresponds to this Vulnerability Score and parameter. See report text for more information on the provincial tables and where they can be accessed.

Figure 5.33: Areas of Significant, Moderate or Low Threats in Georgetown – Pathogens

The current Provincial Table of Drinking Water Threats can be accessed at http://swpip.ca/



DNAPLS			
Vulnerability Score	Number of circumstances in Table of Drinking Water Threats (table name*)		
	Significant	Moderate	Low
WHPA A, B, C, C1 (< 5 year TOT)	75(all) (DWAS)	0	0
6	0	3 (DW6M)	22 (DW6L)

*Refers to the MOE Reference Table that corresponds to this Vulnerability Score and parameter. See report text for more information on the provincial tables and where they can be accessed. (TOT= Time of Travel, DNAPL = Dense Non-Aqueous Phase Liquid, WHPA

Figure 5.34: Areas of Significant, Moderate or Low Threats in Georgetown – DNAPLs

The current Provincial Table of Drinking Water Threats can be accessed at http://swpip.ca/

Issues Evaluation – Halton Hills

Water quality data and information were accessed through ODWS O. Reg. 170/03 Reports (2003 and 2009), and through historic raw water quality records (from the mid-1980s) provided by Halton Region.

The data were reviewed to assess whether any contaminants are impacting or have the potential to impact the quality of the town's groundwater-based drinking water sources. The parameter trends were studied to assess how their concentration has varied over time, and whether statistical projections show the potential for concentrations to increase above the ODWS level within a thirty-year period. This time horizon was proposed by CVC staff in 2013, as this is generally the planning horizon under the *Growth Management Plan for the Greater Golden Horseshoe,* which applies to most municipalities in the CVSPA. In the determination of an issue, consideration was also given to the frequency with which the half concentration of the ODWS (1/2 MAC) was met or exceeded. Based on the updated criteria, the issues at the region's wells have been re-assessed, and are outlined below.

Acton - Sodium (Na) and Chloride (Cl)

The time series plots in **Figure 2.30** and **Figure 2.31** show the average annual sodium and chloride concentrations in raw water for each of Acton's wells. The ODWS standard for Na and Cl are 200 mg/L and 250 mg/L, respectively.

The plots show that over the last two decades, most wells, except for the Prospect Park wells, have exhibited a relatively slight increase in trends for both parameters. Na concentrations have ranged between 10 and 30 mg/L, and Cl concentrations have ranged between 0 and 50 mg/L.

Prospect Park Well 1—Na and Cl concentration have doubled between 1996 and 2012, and the trend plot shows a distinct rise over time. During this period, Na concentration increased from around 25 mg/L (1986) to current level of just under 50 mg/L. Similarly, Cl concentration increased from levels of 50 mg/L (1986) to a current level of just over 100 mg/L.

Given the trends, and the implications on the quality of water used for municipal drinking water supply, both Na and Cl were originally identified as issues at Prospect Park Well 1 (AMEC, 2010). However, based on the findings of the recent analyses (CTC, 2013), it was determined that sodium and chloride concentrations will not likely rise to the level of their respective ODWS within a thirty-year timeline. As such, a decision was taken to rescind both the sodium and chloride issues initially assigned to Prospect Park Well 1.

Prospect Park Well 2 (Acton)—This is a relatively new well (2004), and the available data series does not appear to indicate an increasing trend but shows Na and Cl concentrations fluctuating within relatively narrow ranges.

Sodium and chloride levels should be carefully monitored in the future.

Acton - Nitrates (NO_3)

The time series plots for NO_3 concentration at Acton are shown in **Figure 2.32**. They reflect average annual concentrations in raw water for each municipal well. The ODWS standard for NO_3 is 10 mg/L.

The plots show that over the last two decades, most of the wells, except for the Davidson wells, have exhibited relatively slight increase in trends for NO_3. At Prospect Park, concentrations have hovered around 0.1 mg/L since 2004, while the Fourth Line well has shown fluctuations between 2 and 3 mg/L, with a relative slight increase in trend over the two-decade period.

All wells show NO_3 concentrations below the ODWS, but concentrations at Davidson Wells 1 and 2 have remained elevated since 2000. In Well 1, the concentration generally varied between 2 mg/L and 4 mg/L between 1987 and 2000, rising to over 6mg/L in 2001. Since then, it has remained elevated, while exhibiting wider fluctuations most recently levels were 3 mg/L (2009). At Well 2, NO_3 concentrations rose sharply from around 2 mg/L in 2000 to over 6 mg/L in 2001. Since then, it has mimicked fluctuations observed at Well 1, and has decreased to a level of about 2.5 mg/L (2012). Variations in trends since 2000 at both wells appear to be related to pumping cycles.

The historical data for the Davidson Wellfield has shown a great deal of variability in the NO_3 concentration at the wells since 1985. The recent statistical analyses (CTC, 2013) conclude that for Well 1, the ODWS could be met as early as 2049. The NO_3 concentration in Well 2 is not expected to meet or exceed the criterion until much later (2127). In addition, the data for both wells exhibited repeated spikes over the 1/2 MAC throughout the 2000 to 2009 period. Between 2010 and 2012, a decreasing trend was observed, but it is not certain whether this trend will continue into the future, as similar decreases in past have been followed by periods of increase.

Since the future land use will revolve around rural/agricultural land usage with expected ongoing nutrient applications, the new study (CTC, 2013) recommends that the original nitrate issue assignment be retained only around Well 1 and reassessed as additional research and new data becomes available.

Fourth Line Well (Acton)—though the 20-year time series plot does not show an identifiable trend suggesting that NO_3 may pose a future threat to the use of the well for municipal supply, concentration levels over the last five years do seem to indicate the beginning of what can potentially become an increasing trend.

Additional data are required to make a clearer definition/pronouncement on this trend. The plot suggests a cyclical stress, but whether the variations are a result of pumping volume changes, seasonal or climatic variations, land-use changes, increased commercial fertilizer applications, or a combination of all four, or other stressors, should be further assessed.

Georgetown – Sodium (Na) and Chloride (Cl)

The time series plots in **Figure 2.33** and **Figure 2.34** show the average annual sodium and chloride concentrations in raw water for each of Georgetown's wells. The plots show that between 1986 and 2009, all wells, with the exception of Lindsay Court Well 9, have exhibited marked increases in concentration of both Na and Cl—doubling, or even tripling, during that interval.

Given the trends, and the implications on the quality of water used for municipal drinking water supply, Na was initially deemed an issue at each of Georgetown's wellfields, with the exception of Lindsay Court (AMEC, 2010). However, based on the findings of the recent statistical analyses (CTC, 2013), it was determined that Na concentration will not likely rise to the level of the ODWS at any of the wells within a thirty-year timeline. As such, a decision was taken to rescind the Na issue assignment from these wells. Cl was also initially deemed an issue at each of Georgetown's wellfields, with the exception of Lindsay Court (AMEC, 2010). However, based on the findings of the recent analyses (CTC, 2013), it was determined that Cl concentration will not likely rise to the level of the ODWS at the Princess Anne wells or at Cedarvale Well 3A, within a thirty-year timeline. As such, a decision was taken to rescind the Cl issue assignment from these wells, but to retain it at the Cedarvale 1A, 4 and 4A wells.

In conclusion, the 2013 analyses have determined that a Cl issue does exist at the Cedarvale 1A, 4, and 4A wells.

Georgetown-Nitrates (NO_3)

The time series plots for nitrate concentration at Georgetown are shown in **Figure 2.35**. They reflect average annual concentrations in raw water for each municipal well. The ODWS standard for NO_3 is 10 mg/L. The plots show that between 1989 and 2009, most of the wells have hovered within a relatively constant band, showing a slight increase in trends for NO_3.

No nitrate issue has been identified at Georgetown. All wells show nitrate concentrations below the ODWS, and most have never exceeded a concentration of 3 mg/L, with the exception of the Princess Anne wells, which have hovered around 4.0 mg/L for most of the last decade.

Georgetown-Cis 1, 2 dichloroethylene (1, 2 DCE)

Cedarvale wellfield (Georgetown) —the presence of the chemical cis 1, 2 dichloroethylene (1, 2 DCE) has been discussed in **Chapter 2.4**. This is an odourless, colourless organic liquid, which may occur in the environment as a result of the anaerobic degradation of chlorinated solvents, and may originate from industrial sources, as it is used as a refrigerant, in the extraction of rubber, oils, and fats in metal working, and in the production of pharmaceuticals and artificial pearls (EPA, 2010). 1, 2 DCE is also a common dry-cleaning solvent.

Halton Region is aware of the presence of the chemical and is actively engaged in an intensive monitoring program per the conditions of the PTTW for Cedarvale Well 4. This program is being undertaken as part of the long-term management of the water supply and attempts to identify the source area from which the chemical originates.

No maximum allowable concentration exists for 1, 2 DCE in the ODWS or Canadian Council of Ministers of the Environment, but the World Health Organization standard of 50 µg/L is utilized by the region, as a surrogate standard, in its current monitoring program for 1, 2 DCE. To ensure safety of its drinking water sources, the region applies 50% of this standard as its trigger threshold.

While the 1, 2 DCE concentrations at Cedarvale 4A are still relatively low (0.5–2.5 µg/L) (**Figure 2.39**), it is recommended that intensive monitoring be continued as part of the long-term management of the water supply. 1,2 DCE has not been identified as an issue.

Issue Contributing Areas – Acton and Georgetown

ICAs have been defined in accordance with the *Technical Rules* and are based on the linkages between the issues noted and the history of land usage and development in the area. The ICA for chloride at Georgetown is shown in **Figure 5.38** while the ICA for nitrate at Acton is shown in **Figure 5.39**. **Table 5.22** and **Table 5.23** show the numbers of significant threats that are related to these issues in Acton and Georgetown. All ICAs were delineated through consultation with the CVC and Regional Municipality of Halton.

Sodium (Na) and Chloride (Cl)

Since road and parking lot salting has most likely been occurring for the better proportion of the last 25 years, the Cl ICA for the municipal wells at Georgetown includes the entire well head protection areas (WHPAs A to E) for the Cedarvale 1A, 4 and 4A wells, as shown in **Figure 5.38.**

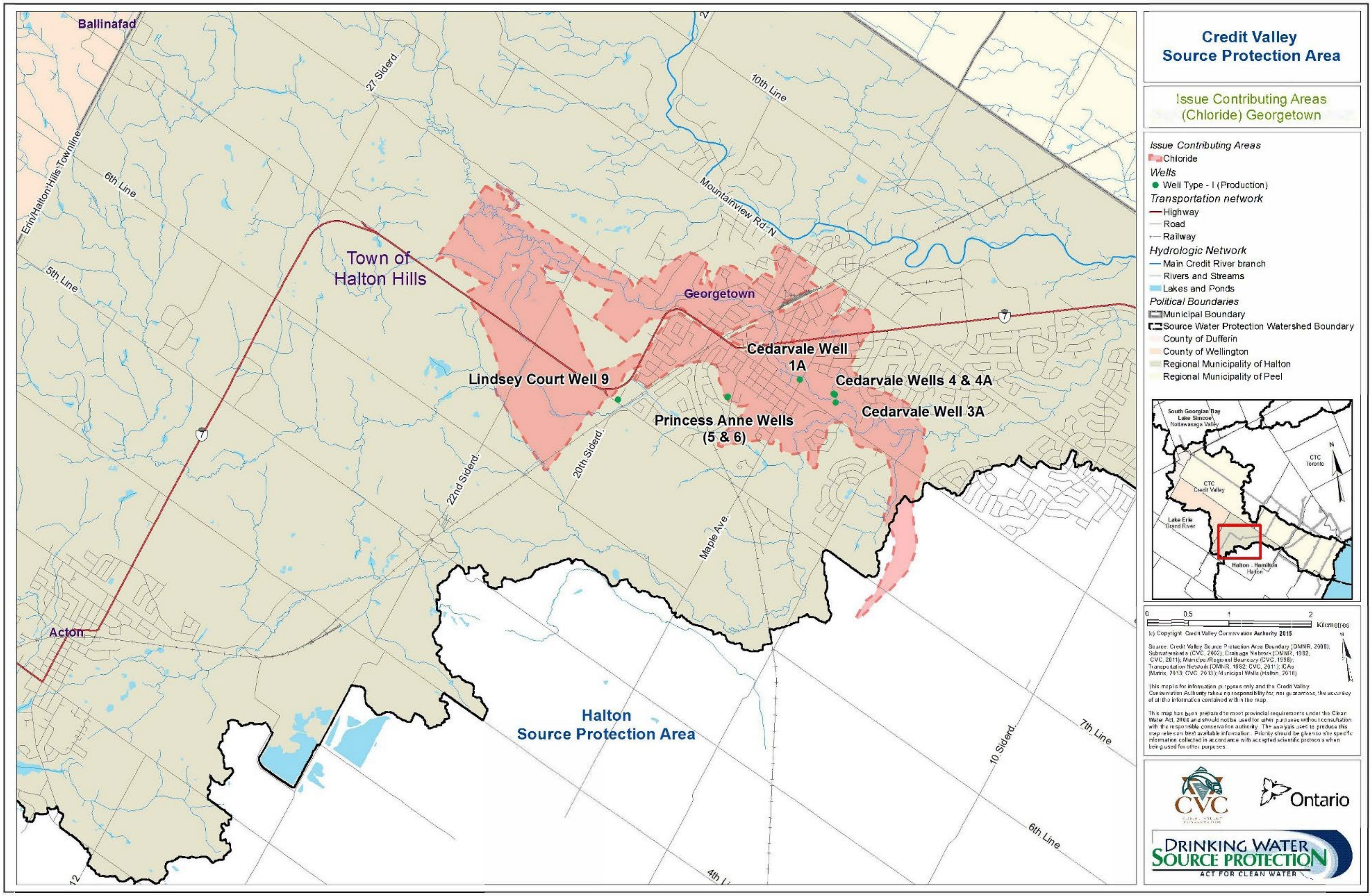


Figure 5.35: Chloride Issue Contributing Area (Chloride) Georgetown

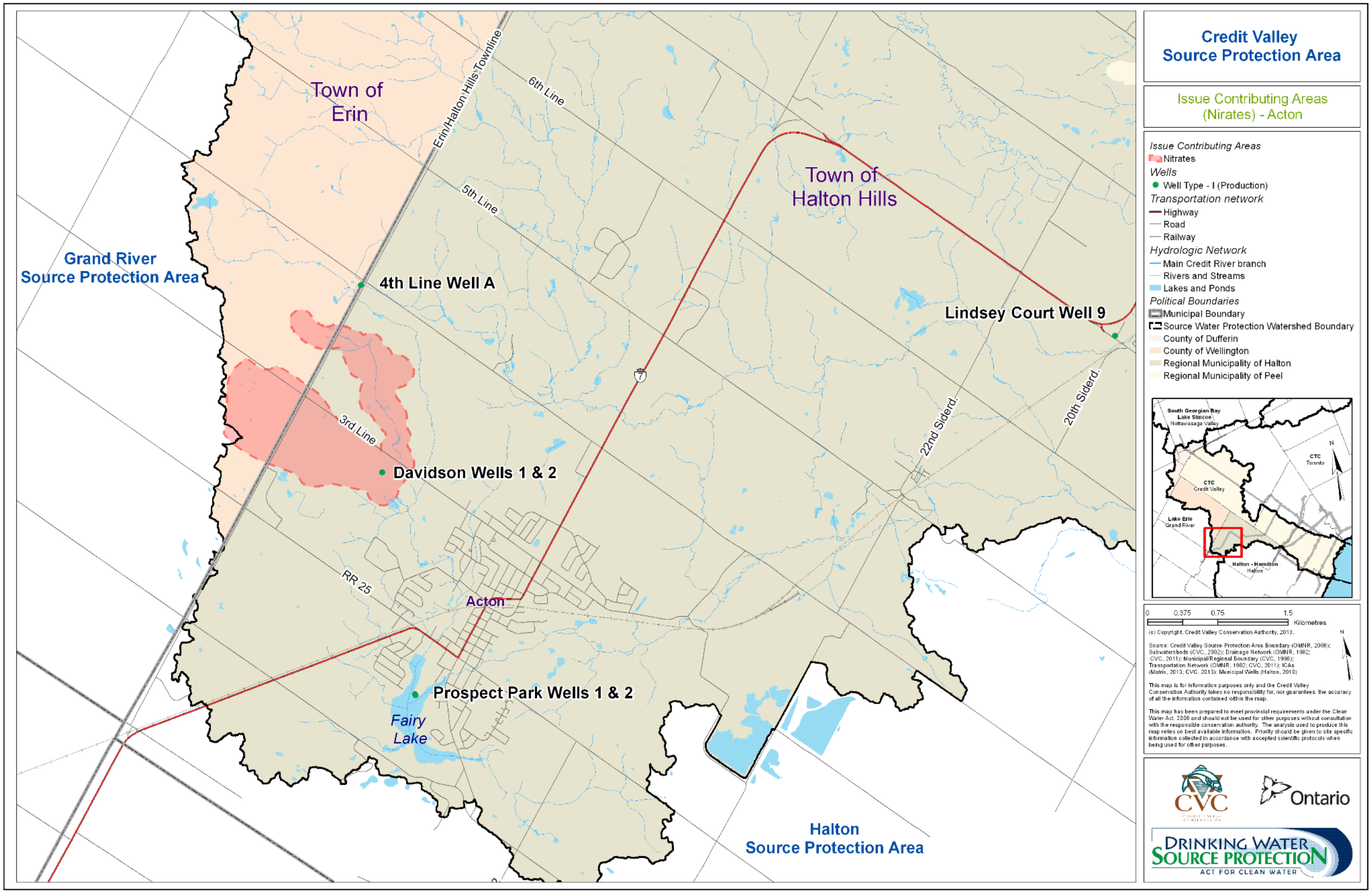


Figure 5.36: Nitrate Issue Contributing Areas (Nitrates) Acton

Any activity that utilizes or has the potential to generate chloride in an ICA is automatically deemed to be a significant drinking water threat, if the activity included as a circumstance listed in the MOECC Provincial Tables of Circumstances, or if added as a local threat. The MOECC Provincial Tables of Circumstances describe the circumstances under which a given activity is classified as low, moderate, or significant. These tables list specific descriptions of situations where chemicals and pathogens pose threats to sources of drinking water. Such activities that pose a threat to release chloride into the groundwater include:

- Storage of road salt;
- Application of road salt;
- Septic systems;
- Sewage and storm management systems; and
- Storage of snow.

The CTC SPC is required to develop policies in the Source Protection Plan to reduce or avoid the significant threat from such activities if they occur in an ICA for chloride. Under the *Building Code Act,* any septic systems governed under this act that are identified as a significant drinking water threat are subject to mandatory re-inspections to ensure that the systems are functioning properly or if corrective action is required. There are no corrective actions that can be taken to reduce the discharge of sodium or chloride. Thus, the CTC SPC has determined that due to the relatively small percentage of the loading of chloride within the ICA from the existing private septic systems (even if there is a water softener connected) that these septic systems should not be deemed significant drinking water threats contributing to the chloride Issue at these wells, pursuant to *Technical Rule* 115(4) and 131(2). The 2013 Genivar Inc. study referenced earlier, estimated that the contribution of sodium and/or chloride from private septic systems within the ICA, represented approximately 0.3% of the overall loadings.

Nitrates (NO_3)

The most probable sources of nitrates are the application of commercial fertilizer and agricultural source material (ASM), and septic systems. This being so, the ICA for $N0_3$ was originally (2010) delineated to extend over the entire Well Head Protection Area (WHPAs A-E) of the Davidson wells. This area included all managed lands and septic systems occurring within the 25-year time of travel, and the area where a connection between the surface and groundwater (GUDI connection) has been identified.

Given the cyclical nature of the NO_3 concentration observed, the recent study (CTC, 2013) suggests that the trends may be influenced by seasonal variation in agricultural practices at locations close to the wells, and in areas where a direct hydrological connection exists between the ground surface and the producing aquifer. As such, the ICA has been reduced to include only the WHPAs A, B and E of Davidson Well 1, as shown in **Figure 5.39**. Since Well 2 is located next to Well 1, and has the same WHPA boundary, this WHPA is also included in the ICA.

Any activity that utilizes or has the potential to generate nitrate in an ICA for nitrate would automatically be considered a significant drinking water threat, if included as a circumstance listed in the MOECC's Provincial Tables of Circumstances, or if added as a local threat. The CTC SPC is required to develop policies in the Source Protection Plan to mitigate against such activities, which include:

- Application of commercial fertilizer;
- Application of non-agricultural source material (NASM);

- Storage of NASM;
- Application of untreated septage to land;
- Management or handling of agricultural source material (ASM);
- Sewage system or sewage works—septic systems;
- Storage of ASM;
- Storage of commercial fertilizer;
- Storage of snow;
- Waste disposal; and
- The use of land as livestock grazing or pasturing land, an outdoor confinement area, or a farm-animal yard.

The CTC SPC is required to develop policies in the Source Protection Plan to reduce or avoid the threat from such activities if they occur in an ICA for nitrate.

5.5.6 Regional Municipality of Peel - Town of Caledon

The Region of Peel provides municipal water to Caledon through eight wells located at Alton, Caledon Village, Inglewood, and Cheltenham. The WHPA delineation and vulnerability assessment processes around the municipal wells are described in **Chapter 4.2**.

The issues evaluation and threats identification exercise originally undertaken within the WHPAs of the wells are detailed in the report "Issues Evaluation and Threats Assessment, Region of Peel" (R.J. Burnside & Associates Limited, May 2010). This report was subjected to extensive peer review by municipal and CVC staff prior to acceptance by the CTC SPC, and inclusion in this Assessment Report. Tables 5.25, 5.26 and 5.27 summarize the technical data and information provided in Burnside and Associates Limited (2010). In preparation for Inglewood Well 4 to be brought on-line in 2019, a desktop exercise to identify existing significant drinking water threats associated with the new drinking water well, was completed. This exercise involved a review of MPAC classification and aerial photography. This exercise added to the number of significant drinking water threats at the Inglewood Drinking Water System.

In July 2019, a desktop exercise was carried out to evaluate the existing significant drinking water threats in the WHPAs delineated for Alton Well 4A. This exercise primarily involved reviewing aerial photography to determine whether a property was residential, commercial/institutional, or agricultural. A list of potential existing significant drinking water threats was generated for use in carrying out a field verification exercise. During the public consultation period which took place between July 25 and September 11, 2019, Region of Peel staff contacted property owners to confirm whether particular activities were actively taking place.

Threats and Issues

The threats inventory was compiled using the data and information sources outlined in **Appendix E1**. Site specific verification of drinking water threats was not conducted as part of the original study by R.J. Burnside & Associates Limited, May 2010. Since 2012, the Region of Peel has undertaken work aimed at ground truthing significant drinking water threats in vulnerable areas around its municipal wells. This work has been detailed in the report "Region of Peel – Verification of Significant Drinking Water Quality

Threats (Groundwater)" (R.J. Burnside & Associates Limited, August 2012) and the findings have been used to refine the threat counts in this Assessment Report.

Table 5.24 to **Table 5.27** summarizes the number of significant threats around Peel's wellheads. Details of the evaluation of managed land threats are found in **Appendix E3**.

The areas where threats are or would be low, moderate, or significant for chemicals, DNAPLs and pathogens are shown on **Figure 5.40** through **Figure 5.48**.

- Alton – A total of thirteen significant threats have been identified, which are linked to the handling and storage of DNAPLs (1), sewage disposal systems (3), the application of agricultural source material (5), and livestock grazing/pasturing (4).
- Caledon Village—A total of two significant threats have been identified, which are linked to the handling and storage of DNAPLs (1), and the handling and storage of fuel (1).
- Inglewood—A total of 3 significant threats have been identified, and are linked to sewage (1), DNAPLs (1), and the handling and storage of fuel (1).
- Cheltenham—A total of 16 significant threats have been identified, and are linked to agricultural activities (10), waste disposal (2), and the handling and storage of fuel (4).

Septic systems are assumed to be used at all rural homes and buildings outside of the serviced areas of Inglewood. Septic systems that are not properly maintained can contribute to pathogen and chemical contamination in surface and groundwater. MPAC data were used to identify properties that had a building and were not municipally serviced. These parcels were assumed to have a septic system.

Septic effluent disposal systems may contribute nitrate to the groundwater. Many houses in the area may have water softeners due to the hardness of the groundwater. Backwashing softeners during maintenance can introduce high amounts of sodium chloride into septic systems that can also potentially contaminate the groundwater.

No record of status or inspections information for septic systems is available from the municipal records. It is known that septic systems are more likely to deteriorate in performance with age. In the absence of information on the status of these systems, it is assumed that water quality data from the area is indicative of the impact of these sources on the water supply.

The available water quality data (from 1982) were reviewed to assess whether contaminants are impacting or have the potential to impact the quality of water used as the source of the Region's municipal supply. A review of water quality data and information at Peel's wellheads has been presented in **Chapter 2.4**.

Although not identified as an issue under the *Clean Water Act, 2006,* a review of water quality data at the Alton Wells 3 and 4 (decommissioned in 2019) show that sodium (Na) and chloride (Cl) concentrations are generally elevated with respect to the ODWS, suggesting impacts from road salt in the aquifer (**Figure 2.31** and **Figure 2.32**). There is, however, no identifiable increasing trend that would suggest that the concentrations may threaten the use of the wells for water supply in the future. The trends are thought to be reflective of seasonal variations in concentrations.

Conditions

A review of available data and documents was conducted on potential contamination associated with past activities within the WHPAs of Alton, Caledon Village, Inglewood, and Cheltenham. Data available included databases from the Ecolog ERIS results such as Record of Site Condition, MOECC Spills Database and Occurrence Reporting Information System, and MOECC Historical Waste Disposal Sites.

Based on this review, no conditions have been identified within the Peel Region WHPAs.

Table 5.24: Town of Caledon (Alton Wellfield)—Enumerated Significant Drinking Water Threats

Activity (or Threat Type)	Threats			
	Significant	**Moderate**	**Low**	**Total**
1) The establishment, operation, or maintenance of a waste disposal site within the meaning of Part V of the *Environmental Protection Act*	0	n/a	n/a	n/a
2) The establishment, operation, or maintenance of a system that collects, stores, transmits, treats or disposes of sewage	3	n/a	n/a	n/a
3) The application of agricultural source material to land	5	n/a	n/a	n/a
4) The storage of agricultural source material	0	n/a	n/a	n/a
5) The management of agricultural source material to land	0	n/a	n/a	n/a
6) The application of non-agricultural source material (NASM) to land	0	n/a	n/a	n/a
7) The handling and storage of non-agricultural source material NASM	0	n/a	n/a	n/a
8) The application of commercial fertilizer	0	n/a	n/a	n/a
9) The handling and storage of commercial fertilizer	0	n/a	n/a	n/a
10) The application of pesticide to land	0	n/a	n/a	n/a
11) The handling and storage of pesticide	0	n/a	n/a	n/a
12) The application of road salt	0	n/a	n/a	n/a
13) The handling and storage of road salt	0	n/a	n/a	n/a
14) The storage of snow	0	n/a	n/a	n/a
15) The handling and storage of fuel	0	n/a	n/a	n/a
16) The handling and storage of a dense non-aqueous phase liquid	1	n/a	n/a	n/a
17) The handling and storage of an organic solvent	0	n/a	n/a	n/a
18) The management of runoff that contains chemicals used in the de-icing of aircraft	0	n/a	n/a	n/a
19) An activity that takes water from an aquifer or a surface water body without returning the water taken to the same aquifer or surface water body	n/a	n/a	n/a	n/a
20) An activity that reduces the recharge of an aquifer	n/a	n/a	n/a	n/a
21) The use of land as livestock grazing or pasturing land, an outdoor confinement area, or a farm-animal yard.	4	n/a	n/a	n/a
Total Threats	**13**	**n/a**	**n/a**	**n/a**
Total Parcels	**12**	**n/a**	**n/a**	**n/a**

n/a - not required by the MOECC

Table 5.25: Town of Caledon (Caledon Village Wellfield)—Enumerated Significant Drinking Water Threats

Activity (or Threat Type)	Threats			
	Significant	Moderate	Low	Total
1) The establishment, operation, or maintenance of a system that collects, stores, transmits, treats or disposes of sewage	0	n/a	n/a	n/a
2) The establishment, operation, or maintenance of a waste disposal site within the meaning of Part V of the *Environmental Protection Act*	0	n/a	n/a	n/a
3) The application of agricultural source material to land	0	n/a	n/a	n/a
4) The storage of agricultural source material	0	n/a	n/a	n/a
5) The management of agricultural source material to land		n/a	n/a	n/a
6) The application of non-agricultural source material (NASM) to land	0	n/a	n/a	n/a
7) The handling and storage of non-agricultural source material NASM	0	n/a	n/a	n/a
8) The application of commercial fertilizer	0	n/a	n/a	n/a
9) The handling and storage of commercial fertilizer	0	n/a	n/a	n/a
10) The application of pesticide to land	0	n/a	n/a	n/a
11) The handling and storage of pesticide	0	n/a	n/a	n/a
12) The application of road salt	0	n/a	n/a	n/a
13) The handling and storage of road salt	0	n/a	n/a	n/a
14) The storage of snow	0	n/a	n/a	n/a
15) The handling and storage of fuel	1	n/a	n/a	n/a
16) The handling and storage of a dense non-aqueous phase liquid	1	n/a	n/a	n/a
17) The handling and storage of an organic solvent	0	n/a	n/a	n/a
18) The management of runoff that contains chemicals used in the de-icing of aircraft	0	n/a	n/a	n/a
19) An activity that takes water from an aquifer or a surface water body without returning the water taken to the same aquifer or surface water body	n/a	n/a	n/a	n/a
20) An activity that reduces the recharge of an aquifer	n/a	n/a	n/a	n/a
21) The use of land as livestock grazing or pasturing land, an outdoor confinement area, or a farm-animal yard.	0	n/a	n/a	n/a
Total Threats	**2**	**n/a**	**n/a**	**n/a**
Total Parcels	**1**	**n/a**	**n/a**	**n/a**

n/a - not required by the MOECC

Table 5.26: Town of Caledon (Inglewood Water System)—Enumerated Significant Drinking Water Threats

Activity (or Threat Type)	Threats			
	Significant	Moderate	Low	Total
1) The establishment, operation, or maintenance of a system that collects, stores, transmits, treats or disposes of sewage	1	n/a	n/a	n/a
2) The establishment, operation, or maintenance of a waste disposal site within the meaning of Part V of the *Environmental Protection Act*	0	n/a	n/a	n/a
3) The application of agricultural source material to land	0	n/a	n/a	n/a
4) The storage of agricultural source material	0	n/a	n/a	n/a
5) The management of agricultural source material to land	0	n/a	n/a	n/a
6) The application of non-agricultural source material (NASM) to land	0	n/a	n/a	n/a
7) The handling and storage of non-agricultural source material NASM	0	n/a	n/a	n/a
8) The application of commercial fertilizer	0	n/a	n/a	n/a
9) The handling and storage of commercial fertilizer	0	n/a	n/a	n/a
10) The application of pesticide to land	0	n/a	n/a	n/a
11) The handling and storage of pesticide	0	n/a	n/a	n/a
12) The application of road salt	0	n/a	n/a	n/a
13) The handling and storage of road salt	0	n/a	n/a	n/a
14) The storage of snow	0	n/a	n/a	n/a
15) The handling and storage of fuel	1	n/a	n/a	n/a
16) The handling and storage of a dense non-aqueous phase liquid	1	n/a	n/a	n/a
17) The handling and storage of an organic solvent	0	n/a	n/a	n/a
18) The management of runoff that contains chemicals used in the de-icing of aircraft	0	n/a	n/a	n/a
19) An activity that takes water from an aquifer or a surface water body without returning the water taken to the same aquifer or surface water body	n/a	n/a	n/a	n/a
20) An activity that reduces the recharge of an aquifer	n/a	n/a	n/a	n/a
21) The use of land as livestock grazing or pasturing land, an outdoor confinement area, or a farm-animal yard.	0	n/a	n/a	n/a
Total Threats	**3**	**n/a**	**n/a**	**n/a**
Total Parcels	**3**	**n/a**	**n/a**	**n/a**

n/a - not required by the MOECC

Table 5.27: Town of Caledon (Cheltenham Water System)—Enumerated Significant Drinking Water Threats

Activity (or Threat Type)	Threats			
	Significant	Moderate	Low	Total
1) The establishment, operation, or maintenance of a system that collects, stores, transmits, treats or disposes of sewage	0	n/a	n/a	n/a
2) The establishment, operation, or maintenance of a waste disposal site within the meaning of Part V of the *Environmental Protection Act*	2	n/a	n/a	n/a
3) The application of agricultural source material to land	2	n/a	n/a	n/a
4) The storage of agricultural source material	2	n/a	n/a	n/a
5) The management of agricultural source material to land	0	n/a	n/a	n/a
6) The application of non-agricultural source material (NASM) to land	2	n/a	n/a	n/a
7) The handling and storage of non-agricultural source material NASM	0	n/a	n/a	n/a
8) The application of commercial fertilizer	1	n/a	n/a	n/a
9) The handling and storage of commercial fertilizer	0	n/a	n/a	n/a
10) The application of pesticide to land	0	n/a	n/a	n/a
11) The handling and storage of pesticide	1	n/a	n/a	n/a
12) The application of road salt	0	n/a	n/a	n/a
13) The handling and storage of road salt	0	n/a	n/a	n/a
14) The storage of snow	0	n/a	n/a	n/a
15) The handling and storage of fuel	4	n/a	n/a	n/a
16) The handling and storage of a dense non-aqueous phase liquid	0	n/a	n/a	n/a
17) The handling and storage of an organic solvent	0	n/a	n/a	n/a
18) The management of runoff that contains chemicals used in the de-icing of aircraft	0	n/a	n/a	n/a
19) An activity that takes water from an aquifer or a surface water body without returning the water taken to the same aquifer or surface water body	n/a	n/a	n/a	n/a
20) An activity that reduces the recharge of an aquifer	n/a	n/a	n/a	n/a
21) The use of land as livestock grazing or pasturing land, an outdoor confinement area, or a farm-animal yard.	2	n/a	n/a	n/a
Total Threats	**16**	**n/a**	**n/a**	**n/a**
Total Parcels	**6**	**n/a**	**n/a**	**n/a**

n/a - not required by the MOECC

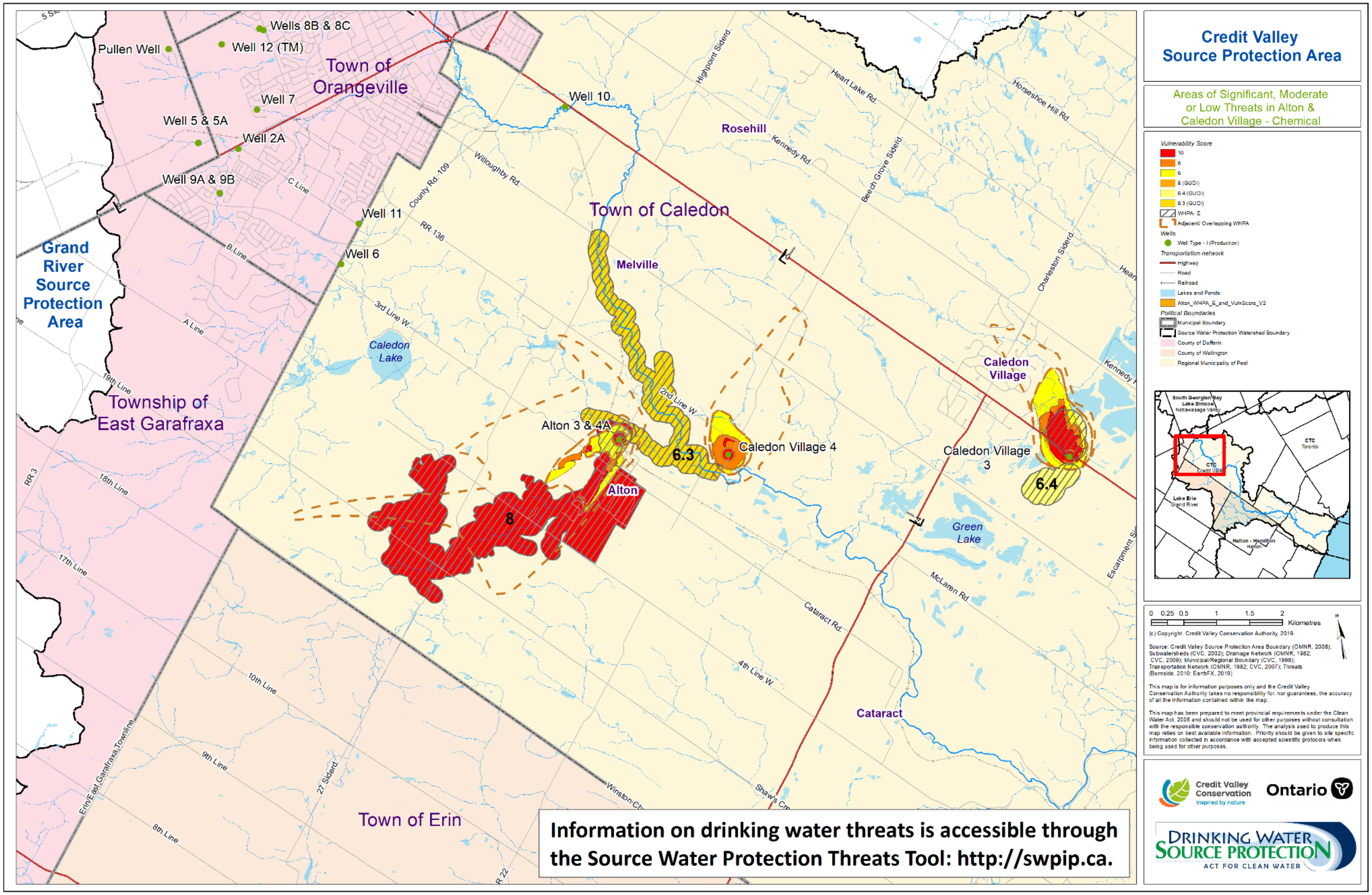


Figure 5.37: Areas of Significant, Moderate or Low Threats at Caledon Village – Alton Drinking Water Systems – Chemicals

The current Provincial Table of Drinking Water Threats can be accessed at http://swpip.ca/

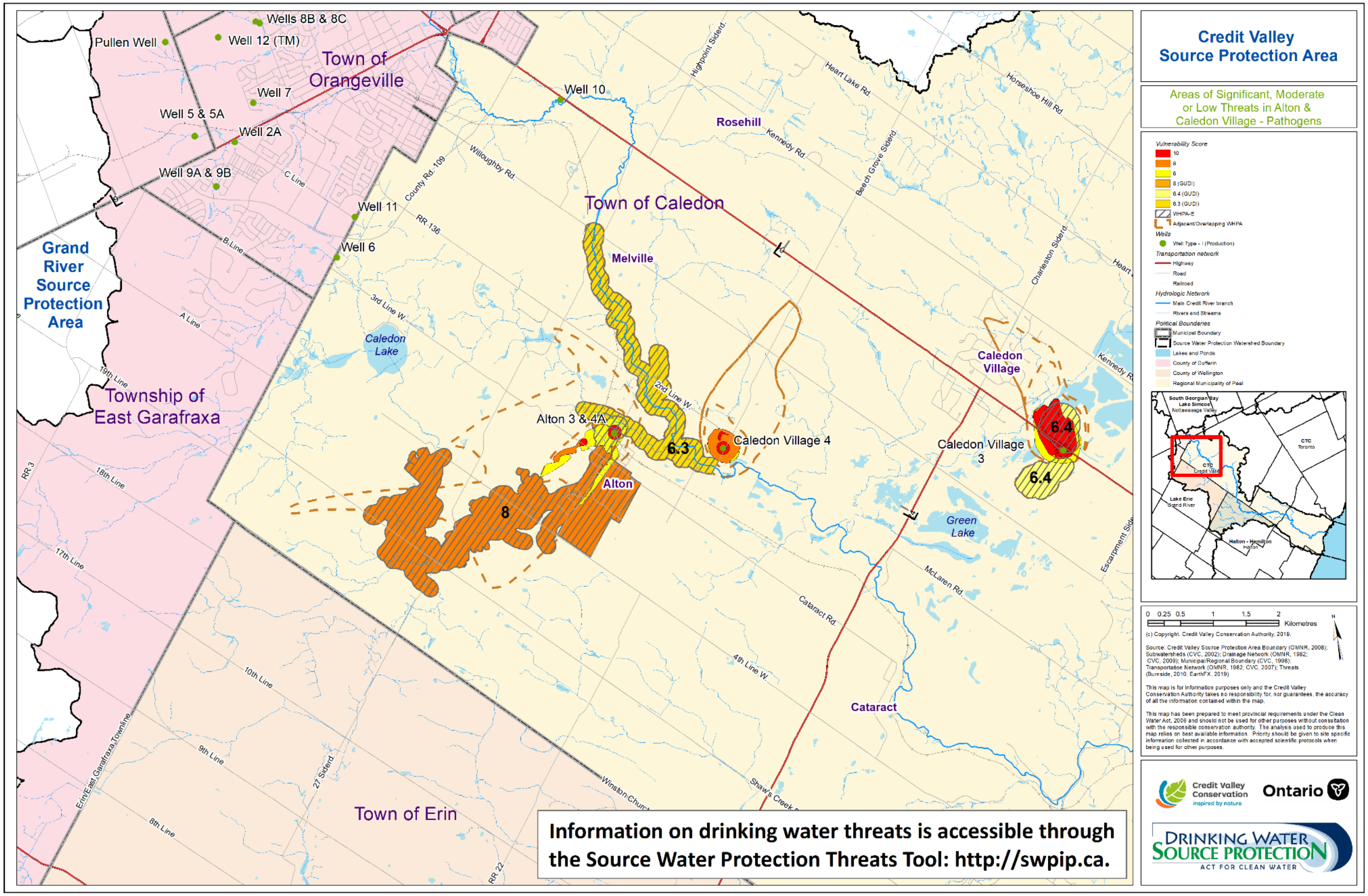


Figure 5.38: Areas of Significant, Moderate or Low Threats at Caledon Village - Alton Drinking Water Systems – Pathogens

The current Provincial Table of Drinking Water Threats can be accessed at http://swpip.ca/

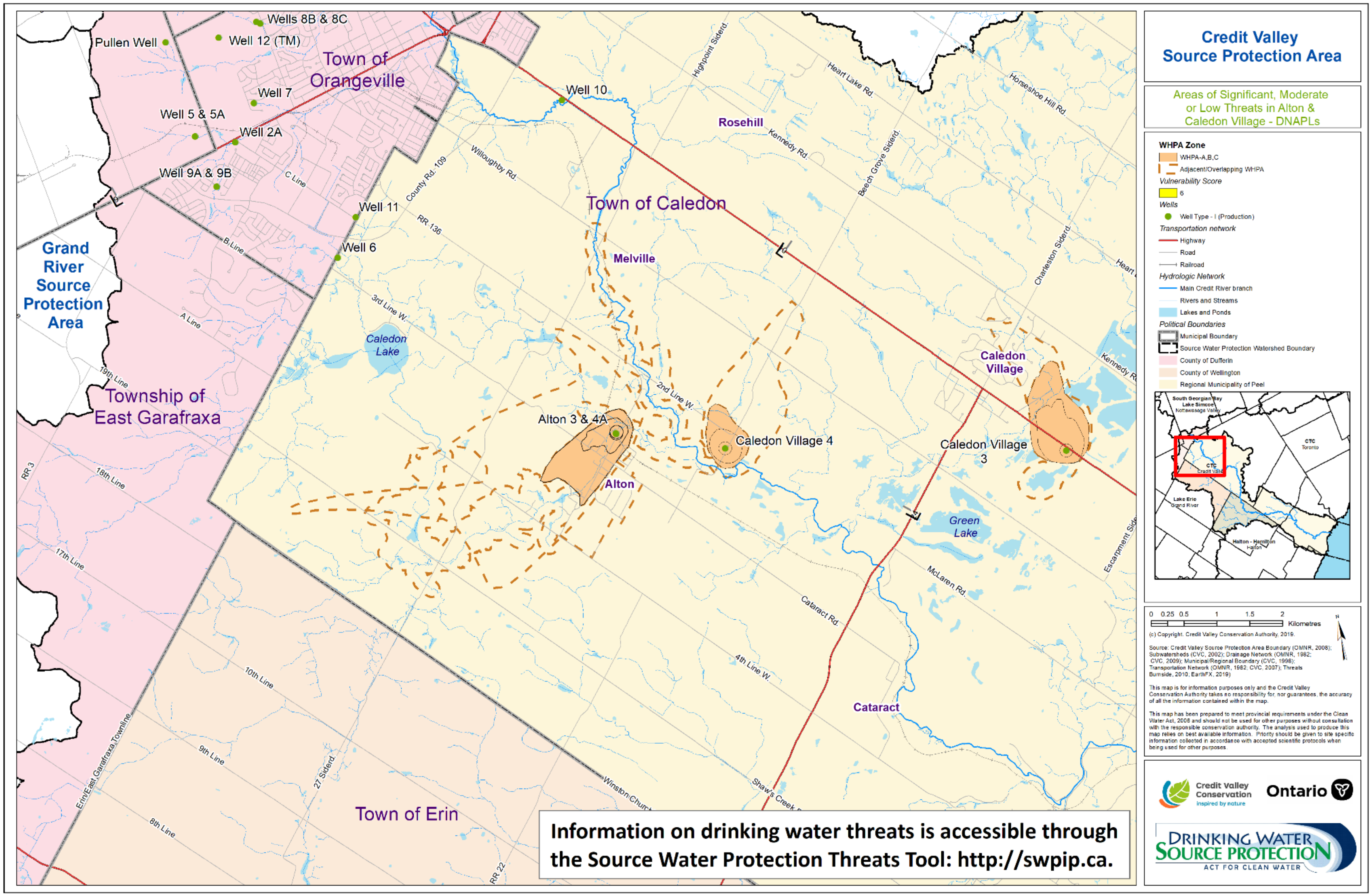
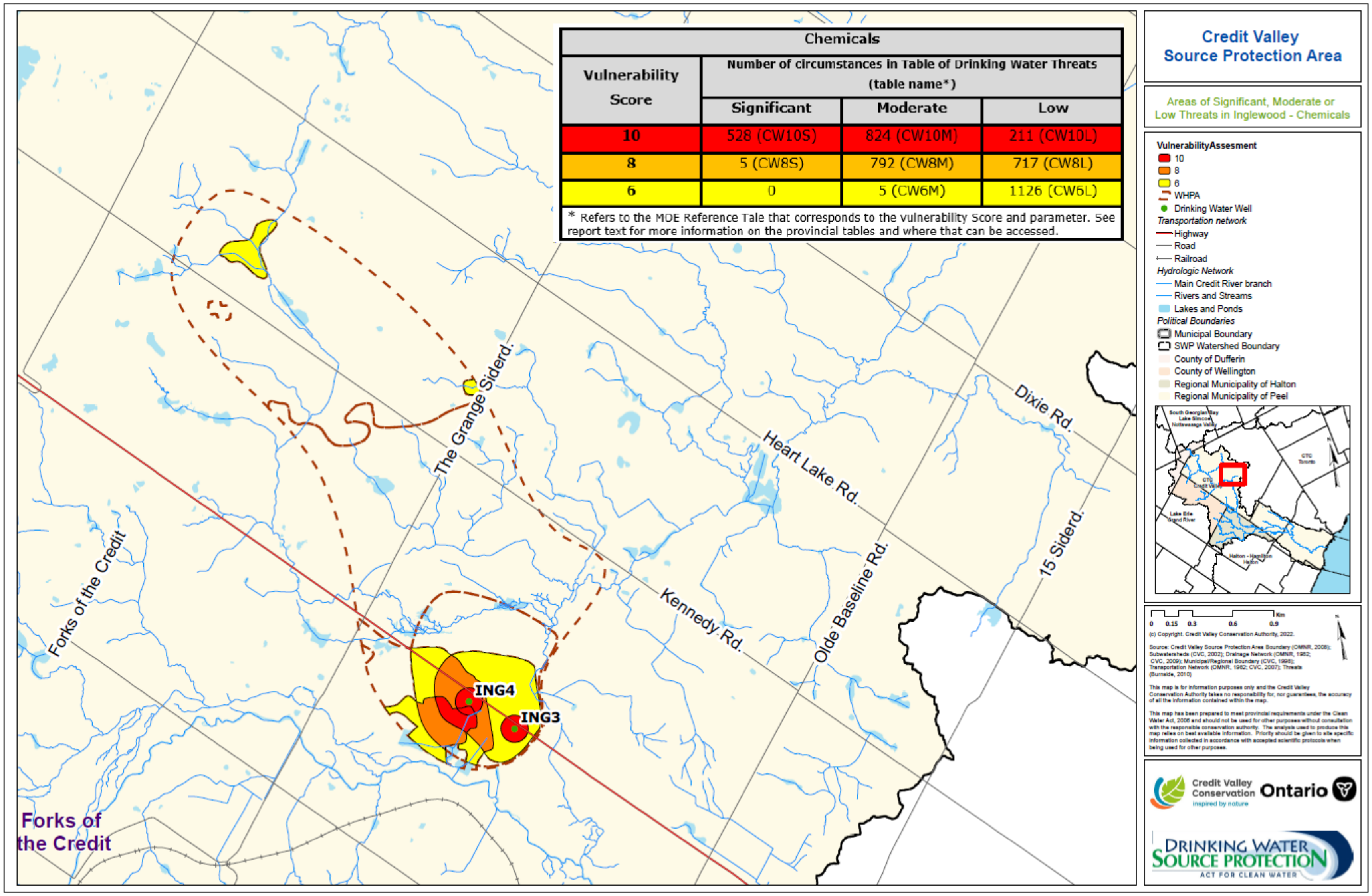


Figure 5.39: Areas of Significant, Moderate or Low Threats at Caledon Village – Alton Drinking Water Systems – DNAPLs

The current Provincial Table of Drinking Water Threats can be accessed at http://swpip.ca/

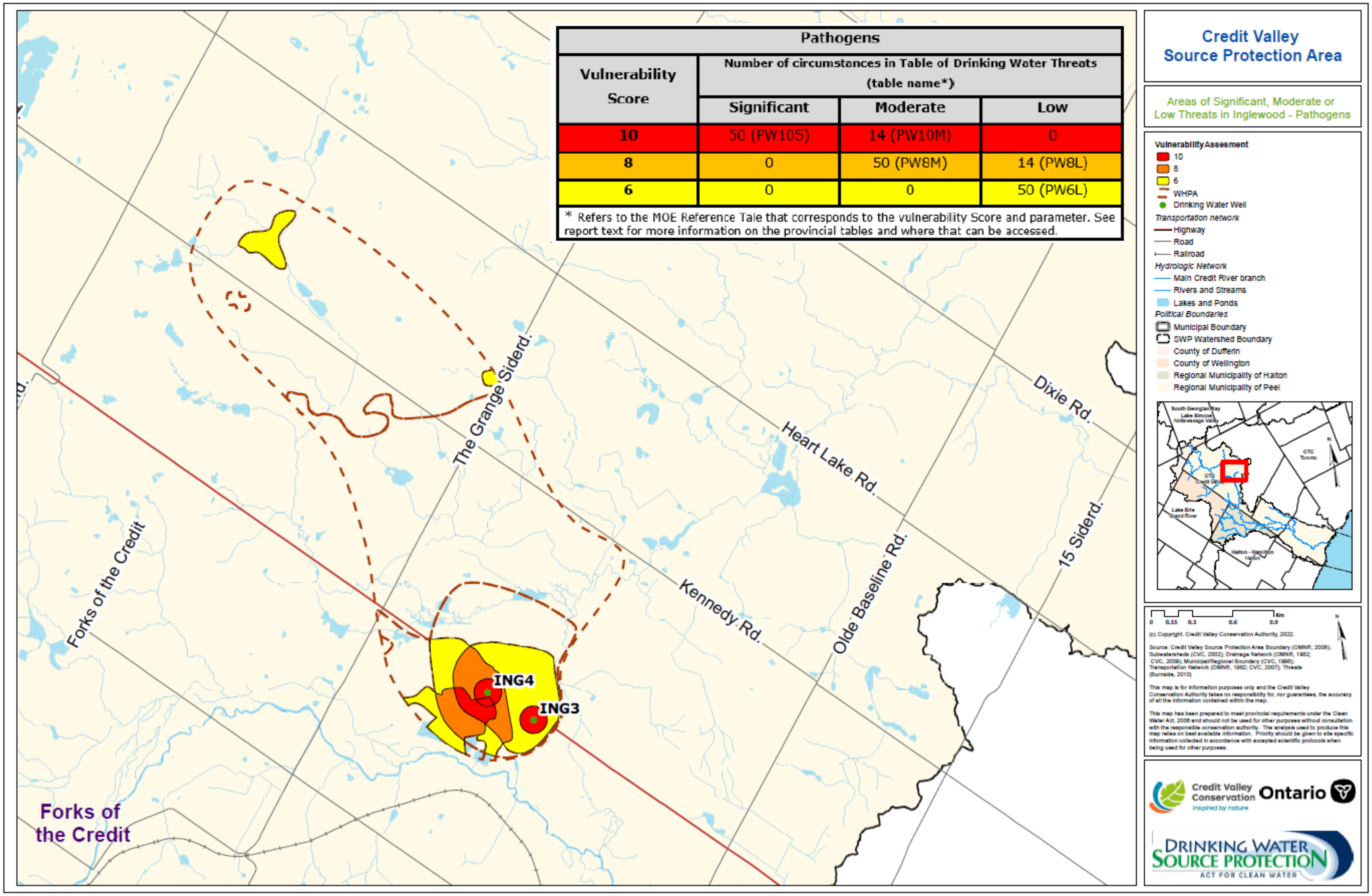


Chemicals			
Vulnerability Score	Number of circumstances in Table of Drinking Water Threats (table name*)		
	Significant	Moderate	Low
10	528 (CW10S)	824 (CW10M)	211 (CW10L)
8	5 (CW8S)	792 (CW8M)	717 (CW8L)
6	0	5 (CW6M)	1126 (CW6L)

* Refers to the MOE Reference Tale that corresponds to the vulnerability Score and parameter. See report text for more information on the provincial tables and where that can be accessed.

Figure 5.40: Areas of Significant, Moderate or Low Threats in Inglewood – Chemicals

The current Provincial Table of Drinking Water Threats can be accessed at http://swpip.ca/

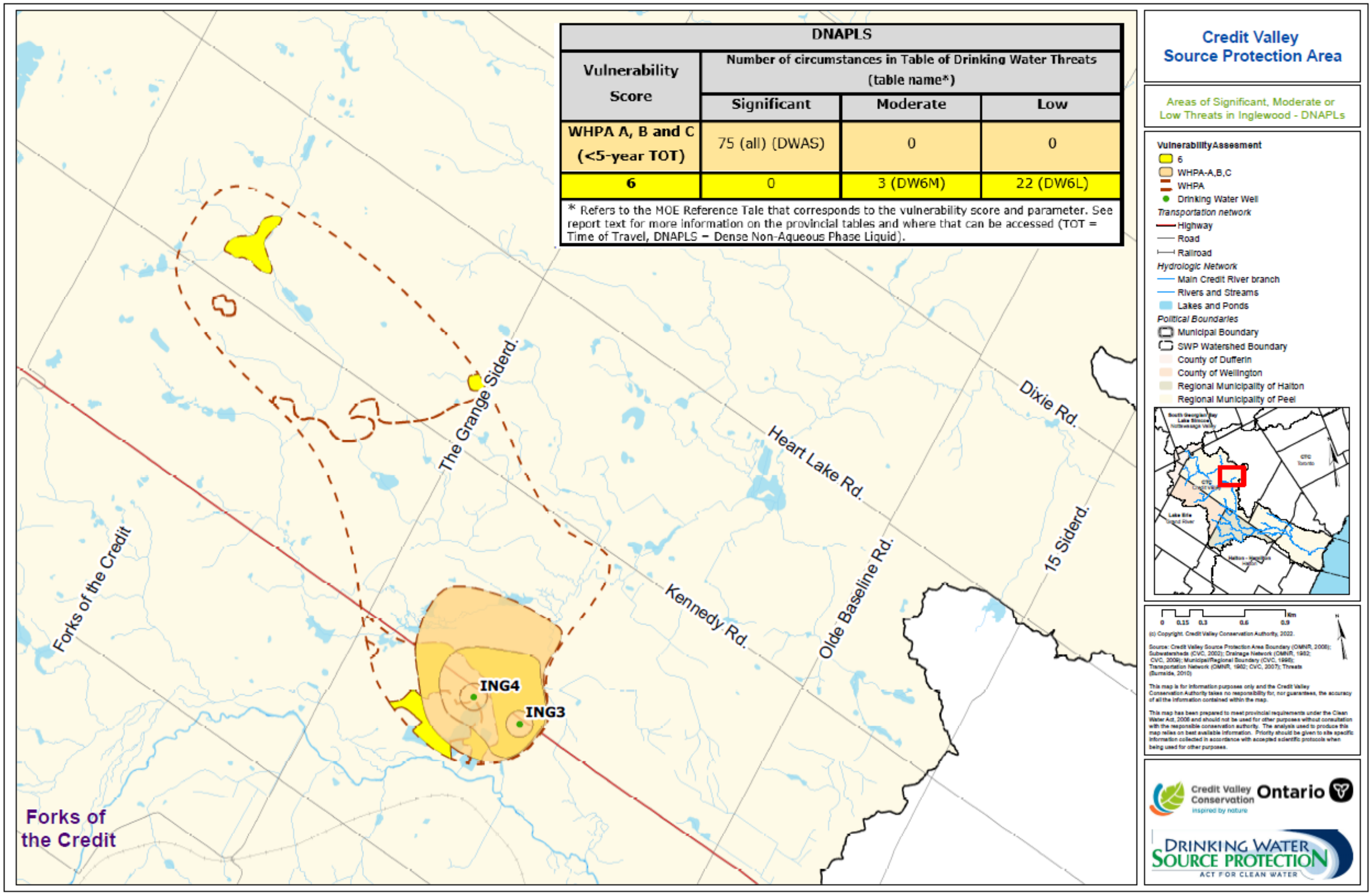


Pathogens			
Vulnerability Score	Number of circumstances in Table of Drinking Water Threats (table name*)		
	Significant	Moderate	Low
10	50 (PW10S)	14 (PW10M)	0
8	0	50 (PW8M)	14 (PW8L)
6	0	0	50 (PW6L)

* Refers to the MOE Reference Tale that corresponds to the vulnerability Score and parameter. See report text for more information on the provincial tables and where that can be accessed.

Figure 5.41: Areas of Significant, Moderate or Low Threats in Inglewood – Pathogens

The current Provincial Table of Drinking Water Threats can be accessed at http://swpip.ca/

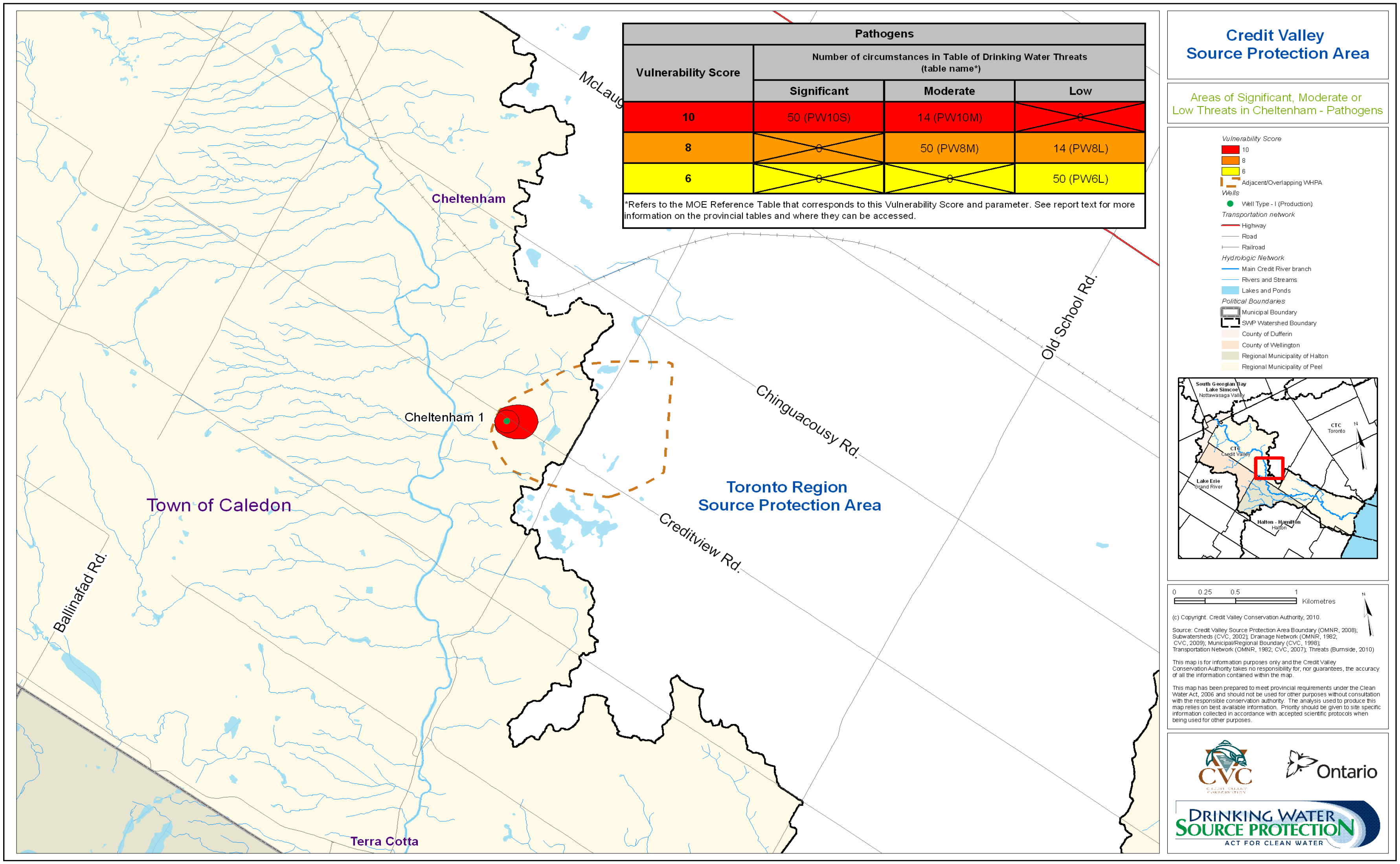


DNAPLS			
Vulnerability Score	Number of circumstances in Table of Drinking Water Threats (table name*)		
	Significant	Moderate	Low
WHPA A, B and C (<5-year TOT)	75 (all) (DWAS)	0	0
6	0	3 (DW6M)	22 (DW6L)

* Refers to the MOE Reference Tale that corresponds to the vulnerability score and parameter. See report text for more information on the provincial tables and where that can be accessed (TOT = Time of Travel, DNAPLS – Dense Non-Aqueous Phase Liquid).

Figure 5.42: Areas of Significant, Moderate and Low Threats in Inglewood – DNAPLs

The current Provincial Table of Drinking Water Threats can be accessed at http://swpip.ca/

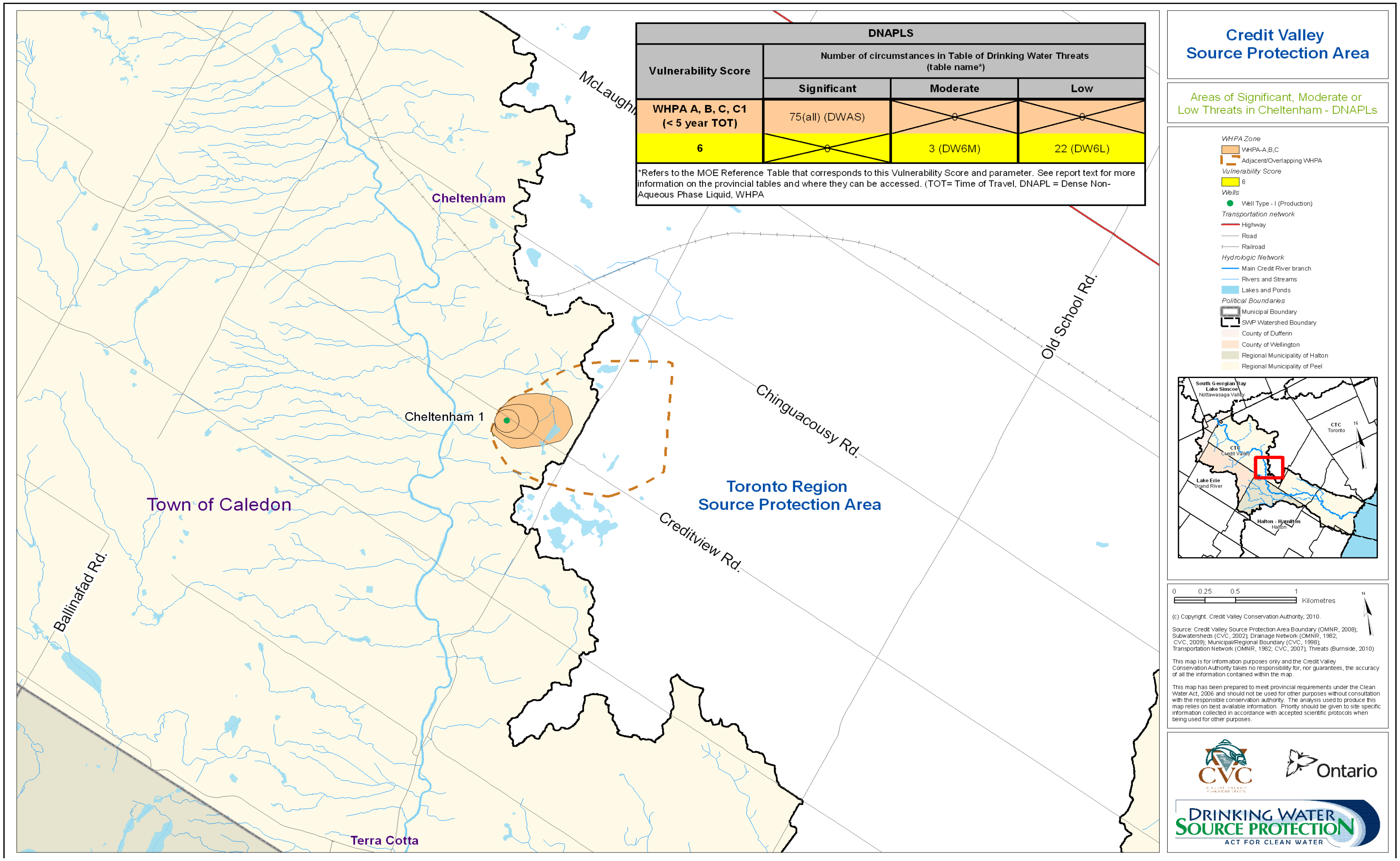


Pathogens			
Vulnerability Score	Number of circumstances in Table of Drinking Water Threats (table name*)		
	Significant	Moderate	Low
10	50 (PW10S)	14 (PW10M)	0
8	0	50 (PW8M)	14 (PW8L)
6	0	0	50 (PW6L)

*Refers to the MOE Reference Table that corresponds to this Vulnerability Score and parameter. See report text for more information on the provincial tables and where they can be accessed.

Figure 5.43: Areas of Significant, Moderate or Low Threats in Cheltenham – Pathogens

The current Provincial Table of Drinking Water Threats can be accessed at http://swpip.ca/



DNAPLS			
Vulnerability Score	Number of circumstances in Table of Drinking Water Threats (table name*)		
	Significant	Moderate	Low
WHPA A, B, C, C1 (< 5 year TOT)	75(all) (DWAS)	0	0
6	0	3 (DW6M)	22 (DW6L)

*Refers to the MOE Reference Table that corresponds to this Vulnerability Score and parameter. See report text for more information on the provincial tables and where they can be accessed. (TOT= Time of Travel, DNAPL = Dense Non-Aqueous Phase Liquid, WHPA

Figure 5.44: Areas of Significant, Moderate or Low Threats in Cheltenham – DNAPLs

The current Provincial Table of Drinking Water Threats can be accessed at http://swpip.ca/

5.6 SURFACE WATER QUANTITY THREATS

Under the *Technical Rules*, water quantity threats must be defined and assessed through the water budget process. The Great Lakes are exempt from such assessment, and there are no surface water intakes on the Credit River.

With respect to municipal groundwater-based systems (wells), the Tier 3 Water Budget studies completed on the municipal water systems for the towns of Orangeville, Mono, Acton, Georgetown, and the Township of Amaranth have identified significant water quantity threats related to consumptive usage and to recharge reduction.

In the case of the headwaters municipalities (Orangeville, Mono and Amaranth), the results indicate a need to manage the drinking water as a shared regional resource.

5.7 SURFACE WATER QUALITY THREATS

Technical Rules (118, 125, and 126) require that significant municipal drinking water threats be listed and described in the vulnerable areas around surface water intakes (IPZ-1 and IPZ-2), including those in Lake Ontario. A description of the approach used in vulnerability assessment for IPZs is presented in **Chapter 4**. It should be noted that all of the activities listed in the provincial threats tables are land based and do not apply in Lake Ontario. There are no threat activities included which occur only within the lake itself, such as those related to shipping.

5.7.1 Threats from Conditions and Issues in Intake Protection Zones (IPZ-1s and 2s)

No conditions or issues with respect to municipal drinking water quality have been identified for any of the lake based municipal water supplies within the CVSPA. However, staff from the regional municipalities of Peel and Halton, and the City of Toronto will continue to monitor the municipal raw water quality in accordance with the *Safe Drinking Water Act* (2002) as to ensure that no issues occur in the future without immediate corrective action.

5.7.2 Threats from Activities in Intake Protection Zone (IPZ-1s and 2s)

The four CVSPA Lake Ontario intakes (including the Oakville water treatment plant (WTP), and the R.L. Clark WTP of Toronto) associated with the CVSPA jurisdiction, have vulnerability scores of either 5 (Arthur P. Kennedy, Lorne Park, Clark WTP), or 6 (Oakville WTP). There are a number of circumstances where an activity could pose a low risk to the intakes where they exist, according to the Provincial Tables of Circumstances. **Table 5.28** shows the count of potential activities that pose threats in vulnerable IPZ-1s.

Table 5.28: List of Possible Activities that are Threats in Intake Protection Zone-1s

Threat Category	Number of Possible Activities/Conditions with Threat Risk Classification			Total
	Significant	Moderate	Low	
Vulnerability Score = 5 (Arthur P. Kennedy, Lorne Park, Clark WTPs)				
Pathogens	0	0	13	13
Chemical (including DNAPLs	0	0	558	558
Total	**0**	**0**	**271**	**571**
Vulnerability Score = 6 (Oakville WTP)				
Pathogens	0	12	15	27
Chemical (including DNAPLs)	0	13	1,193	1,206
Total	**0**	**25**	**1,208**	**1,233**

Figure 5.50 shows the area of low and moderate threats in the IPZ-2s. All of the CVSPA IPZ-1s are fully within Lake Ontario. None of the potential activities, therefore, pose any level of threat within the IPZ-1s, which are the most vulnerable areas around the intakes. Tables 41 (CIPZWE4.9L), 44 (CIPZWE4.2L), 69 (PIPZ5L), and 73 (PIPZWE4.2L) of the Provincial Tables of Circumstances apply to these areas.

In an IPZ-2 with vulnerability score greater than 4 (e.g., Oakville, Lorne Park, Arthur P. Kennedy, and R.L. Clark), a number of possible activities pose a low risk to the intakes, according to the following Provincial Tables of Circumstances:

- Table 43 (CIPZWE4.5L);
- Table 42 (CIPZWE4.8L);
- Table 40 (CIPZWE5.4L);
- Table 72 (PIPZWE4.5L);
- Table 71 (PIPZWE4.8L); and
- Table 68 (PIPZWE5.4L).

Table 5.29 shows the count of potential activities that pose threats in vulnerable IPZ-2s. For IPZ-2 areas with a vulnerability score of 4 or less, no activities listed pose even a low level of risk to the intakes, according to the Provincial Tables of Circumstances.

Figure 5.50 shows the area of low and moderate threats in the IPZ-2s.

Table 5.29: Summary of Threats, Intake Protection Zone-2s

Threat Category	Number of Possible Activities/Conditions with Threat Risk Classification			Total
	Significant	Moderate	Low	
Vulnerability Score = 4.8 (Oakville WTP)				
Pathogens	0	0	13	13
Chemical (including DNAPLs)	0	0	436	436
Total	**0**	**0**	**449**	**449**
Vulnerability Score = 4.5 (Arhur P. Kennedy, Lorne Park and R.L. Clark WTP)				
Pathogens	0	0	13	13
Chemical (including DNAPLs)	0	0	239	239
Total	**0**	**0**	**252**	**252**

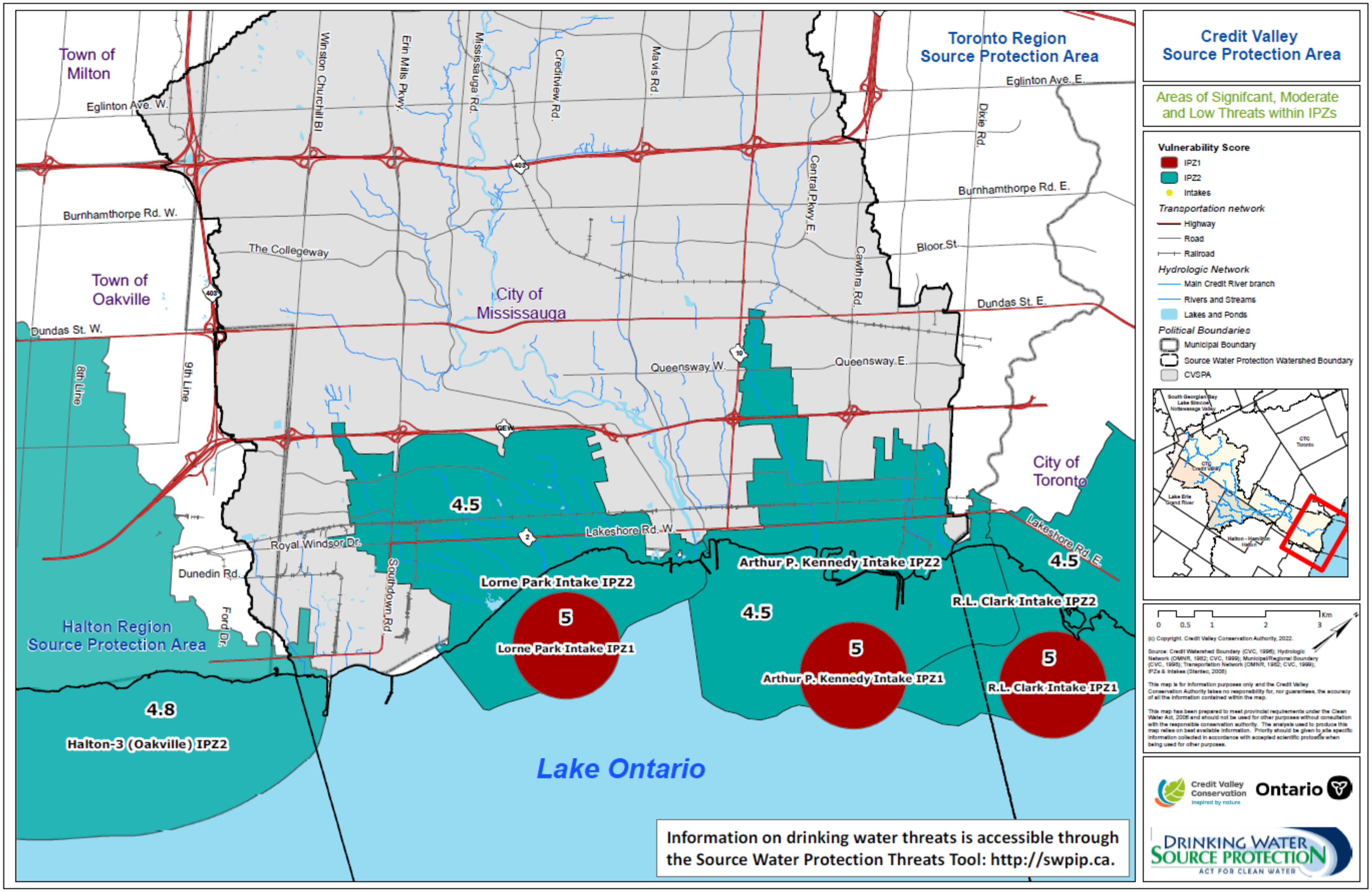


Figure 5.45: Areas of Significant, Moderate and Low Threats within IPZs

5.7.3 Threats from Managed Lands in Intake Protection Zone (IPZ-1s and 2s)

The vulnerability of the area is considered in the Provincial Tables of Circumstances along with the low, moderate or high score for nutrient application in the managed lands analyses to determine the level of threat to drinking water. If an IPZ-1 or IPZ-2 extends onto land and has a vulnerability score higher than 4.4, the managed lands must be mapped as a threat to municipal drinking water sources as a surrogate in the determination of risk associated with the application of nutrients to the land. In the land areas where there is overlap with neighbouring IPZs with vulnerability scores higher than 4.4, managed land analyses are also required for these IPZs.

Much like the HVAs and SGRAs, the IPZ-2s in CVSPA have a low-risk score associated with the application of nutrients due to managed land activities. There is a mix of land uses along the Lake Ontario waterfront in the CVSPA, ranging from urban residential, employment areas, marinas and ports, agricultural and coastal wetlands. There are no agricultural activities within the IPZ land areas in the CVSPA.

Table 5.30 to **Table 5.33** shows percent managed lands for the IPZ-2s of Arthur P. Kennedy, Lorne Park WTP, Oakville, and R.L. Clark WTPs, respectively. These areas are shown in **Figure 5.51**.

Table 5.30: Managed Land in Arthur P. Kennedy Water Treatment Plant Intake Protection Zone in CVSPA

Managed Lands (%) in IPZ	% of Total IPZ	Potential Risk Score	Threat Score
< 40%	100.00%	Low	Low
40–80%	0.00%	Moderate	
> 80%	0.00%	High	

Table 5.31: Managed lands in Lorne Park Water Treatment Plant Intake Protection Zone in CVSPA

Managed Lands (%) in IPZ	% of Total IPZ	Potential Risk Score	Threat Score
< 40%	100.00%	Low	Low
40–80%	0.00%	Moderate	
> 80%	0.00%	High	

Table 5.32: Managed Lands in Oakville Water Treatment Plant Intake Protection Zone in the CVSPA

Managed Lands (%) in IPZ	% of Total IPZ	Potential Risk Score	Threat Score
< 40%	100.00%	Low	Low
40–80%	0.00%	Moderate	
> 80%	0.00%	High	

Table 5.33: Managed Lands in R.L. Clark's Water Treatment Plant Intake Protection Zones in the CVSPA

Managed Lands (%) in IPZ	% of Total IPZ	Potential Risk Score	Threat Score
< 40%	100.00%	Low	Low
40–80%	0.00%	Moderate	
> 80%	0.00%	High	

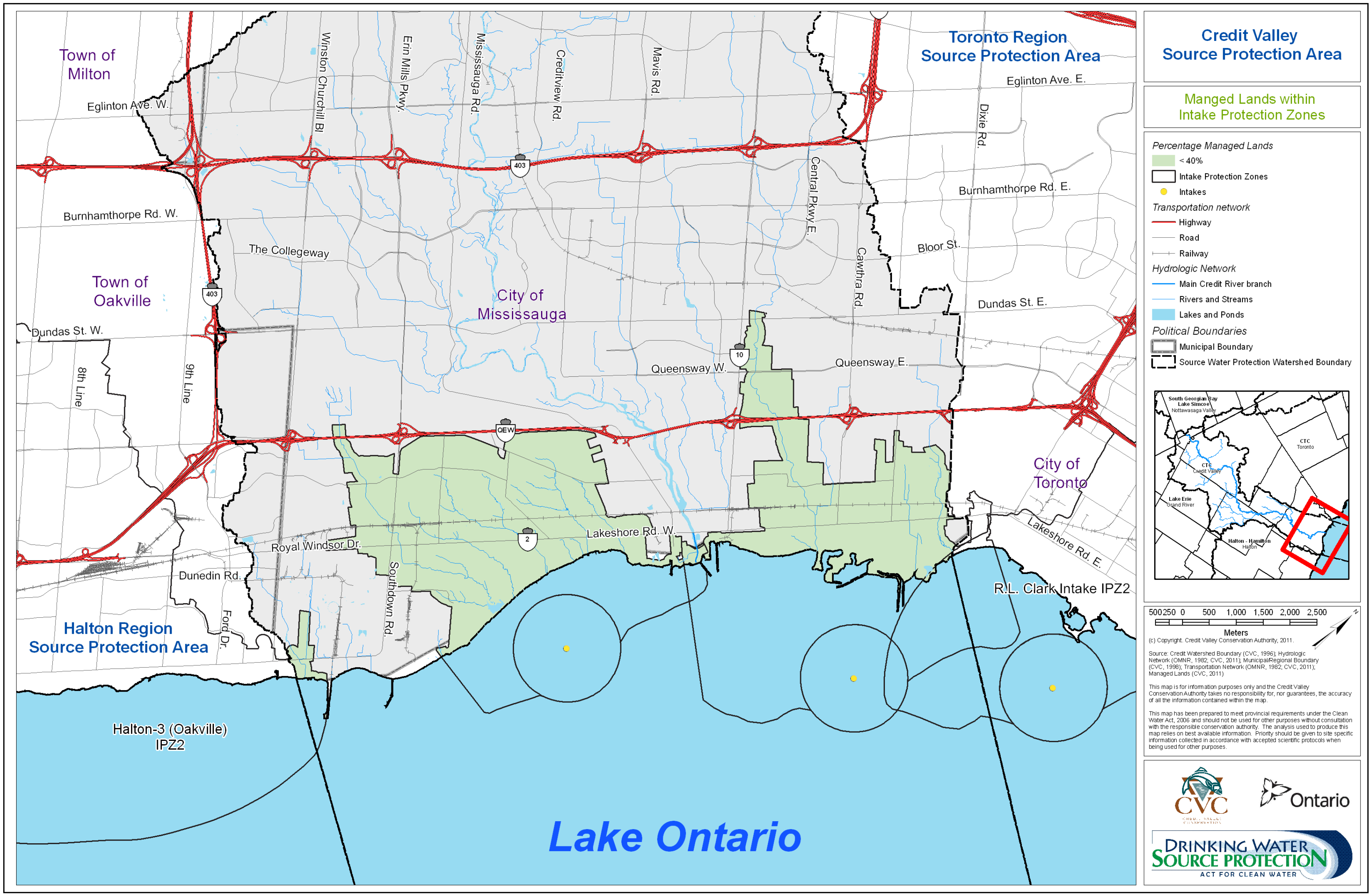


Figure 5.46: Managed Lands within Intake Protection Zones

5.7.4 Threats from Estimated Livestock Density in Intake Protection Zone (IPZ-1s and 2s)

Due to the urbanized nature of the fields, there is no livestock activity in the areas where the neighbouring IPZs touch the land.

5.7.5 Threats for Impervious Surfaces in Intake Protection Zone (IPZ-1s and 2s)

The vulnerability score of surface water vulnerability zones (IPZ) must be 4.4 or higher for the impervious surfaces analysis to be undertaken per the *Technical Rules*. The IPZ-1s for both the Arthur P. Kennedy and Lorne Park WTPs have vulnerability scores of 5, but they do not touch land. Therefore, impervious surface analyses are not required. Since each of their IPZ-2s has a vulnerability score of 4.5, impervious surface analyses are required for these areas. Since the vulnerability scores for IPZ-2s for Oakville and R.L. Clark WTPs are 4.8 and 4.5 respectively, the analyses are likewise required for them.

In the land areas where there is overlap with neighbouring IPZs, with vulnerability scores higher than 4.4, impervious cover analyses are also required for these IPZs.

Table 5.34 to **Table 5.37** shows percent impervious surface for the IPZ-2s of Arthur P. Kennedy, Lorne Park WTP, Oakville, and R.L. Clark WTPs, respectively. These areas are shown in **Figure 5.52**.

Table 5.34: Imperviousness in Arthur P. Kennedy Water Treatment Plant Intake Protection Zone within the CVSPA

Impervious Surfaces (%) in IPZ	% of Total IPZ	Threat Score
Not more than 1	0.89%	No Threat
More than 1, not more than 8	18.13.%	Low
More than 8, not more than 80%	80.99%	
80 or more	0.00%	

Table 5.35: Imperviousness in Lorne Park Water Treatment Plant Intake Protection Zone within the CVSPA

Impervious Surfaces (%) in IPZ	% of Total IPZ	Threat Score
Not more than 1	4.25%	No Threat
More than 1, not more than 8	33.81.%	Low
More than 8, not more than 80%	61.94%	
80 or more	0.00%	

Table 5.36: Imperviousness in Oakville Water Treatment Plant Intake Protection Zone within the CVSPA

Impervious Surfaces (%) in IPZ	% of Total IPZ	Threat Score
Not more than 1	1.65%	No Threat
More than 1, not more than 8	98.35%	Low
More than 8, not more than 80%	0.00%	
80 or more	0.00%	

Table 5.37: Imperviousness in R.L. Clark Water Treatment Plant Intake Protection Zone within the CVSPA

<table>
<tr><th>Impervious Surfaces (%) in IPZ</th><th>% of Total IPZ</th><th>Threat Score</th></tr>
<tr><td>Not more than 1</td><td>61.47%</td><td>No Threat</td></tr>
<tr><td>More than 1, not more than 8</td><td>38.53%</td><td rowspan="3">Low</td></tr>
<tr><td>More than 8, not more than 80%</td><td>0.00%</td></tr>
<tr><td>80 or more</td><td>0.00%%</td></tr>
</table>

The vast majority of the land portion of the IPZ-2 of the Arthur P. Kennedy and Lorne Park WTPs fall within the 8–80% range, while those of the Oakville and R.L. Clark fall within the less than 8% range. Given the vulnerability scoring of all IPZ-2s, they were found to have a low potential for threats associated with the impervious surfaces.

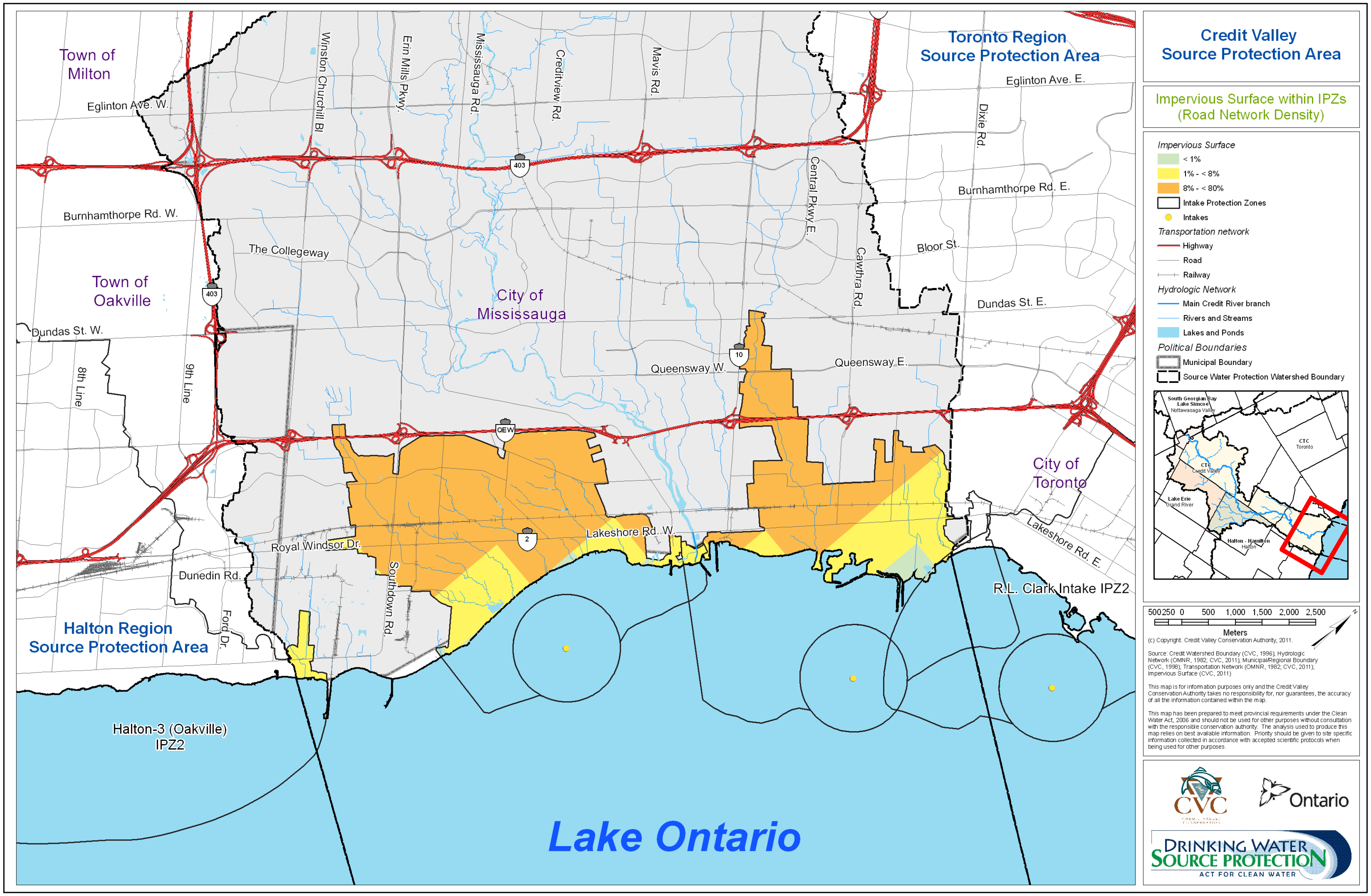


Figure 5.47: Impervious Surfaces within Intake Protection Zones (Road Network Density)

5.7.6 Threats from Activities in Intake Protection Zones

The *Technical Rules* stipulate that event based modelling can be used to identify whether spills from existing facilities, such as bulk petroleum storage facilities, wastewater treatment plants (WWTP), and industrial chemical facilities, are significant threats to nearby WTP intakes.

Threshold: A contaminant concentration above which the raw water quality could be considered to be impaired. A description of the individual thresholds that were used is provided in **Appendix E7**.

A number of spill scenarios were modelled as part of the Lake Ontario Collaborative (LOC) project to determine if certain land based activities could pose a potential drinking water threat to these intakes. Any scenario that identifies conditions under which a contaminant could exceed a *threshold* in the raw water is identified as a significant drinking water threat.

The *Technical Rules* require an IPZ-3 to be delineated if modelling demonstrates that contaminants may be transported to an intake and result in deterioration of the raw water quality of a drinking water supply. The key *Technical Rules* and the *MOECC's Technical Bulletin: Delineation of Intake Protection Zone 3 Using Event Based Approach (EBA)*, dated July 2009, describes the process for delineating the IPZ-3. These are described below:

- *Rule (68)*: If … modelling or other methods demonstrate that contaminants … may be transported to a Type A intake … an area known as IPZ-3 shall be delineated;
- *Rule (69)*: the area delineated shall not exceed the area that may contribute water during or as a result of an extreme event;
- *Rule (130)*: An activity is or would be a significant drinking water threat in an IPZ, if modelling demonstrates that a release of a chemical parameter or pathogen would be transported to the intake and result in deterioration of the water as a drinking water source;
- Guidance from the MOE identified that *Rule (68)* prescribes that an IPZ-3 must be delineated if a spill may result in deterioration of the water supply; and
- The intent of *Rules (68)* and (*130)* was to identify the location and type of activity of concern and based on an understanding of that type of activity, contaminants of concern, and potential spill volume. This was referred to as an Events Based Approach, which may be used to determine whether or not an IPZ-3 should be delineated.

Modelling Approach

The LOC developed a list of existing land use activities near and along the shoreline of Lake Ontario that were of concern if a spill from each location were to occur. The spill characteristics for each modelling scenario (volume, release mechanism, release rate, concentration, and other variables) were determined by the LOC modelling team with input from industry and municipal representatives.

Where concentrations predicted at an intake exceeded the threshold, the land use activity was identified as a significant threat and an IPZ-3 was delineated to identify the contaminant travel path to the intake.

If spill scenario modelling results indicate that a spill/release from an existing facility has the potential to impact a WTP (basically reach an intake) at a level that a WTP needs to shut down, then that facility is automatically identified as a significant drinking water threat activity. There is no limitation based on the time of travel within the event based modelling methodology.

A list of proposed spill scenario simulations for existing facilities was developed in concurrence with municipal partners, source protection committees, and MOECC. The following criteria were used:

- The location and possible materials released under normal operation and spill scenarios;
- Conditions under which contaminants could reach drinking water intakes;
- Predicted concentration of key parameters at the intake*;* and
- Evaluation of historical raw water analyses at drinking water plants to assess whether there are observed elevations of parameters that may be linked to storm events or past spill or weather conditions

Based on the criteria above, the following list of preliminary scenarios was modelled:

- Disinfection failure at each Lake Ontario WWTP to evaluate the potential effects to nearby WTPs;
- Release of *E. coli* from an industrial processing facility into the Credit River;
- Combined Sewer Overflow (CSO) release in the City of Toronto to evaluate the potential effects to the Toronto WTPs (this did not impact any CVSPA intakes);
- Sanitary Trunk Sewer (STS) breaks within Toronto area creeks;
- Spill of gasoline/refined product from large pipelines located under major tributaries to Lake Ontario (e.g., Credit River, Humber River, etc.);
- Release of gasoline from a bulk petroleum fuel storage and handling facilities in the Keele/Finch area of Toronto and in the Mississauga – Oakville area; and
- Discharge of tritium from nuclear generating plants at Pickering and Darlington (this did not impact any CVSPA intakes).

The selected LOC spill scenarios are based on real events that have occurred in the past and, as such, are not representative of extreme events. For example, the pipeline spill scenario events used for the LOC is based on the Enbridge pipeline rupture event that occurred near Kalamazoo, Michigan during the summer of 2010. Details on the spill scenario characteristics and how the model (MIKE-3) was calibrated and validated are provided in **Appendix E5**. The MIKE-3 model uses the full three-dimensional representation of water motion. It simulates the seasonal temperature conditions and summer stratification that affects the circulation pattern in Lake Ontario, which is required for accurate predictions of water currents.

The identification of significant threats did not consider any regulated risk management requirements. Current risk management measures and the adequacy of existing regulatory requirements will be considered in the development of the Source Protection Plan. Source protection plans are required to reduce or eliminate threats to drinking water.

The spill scenarios that were modelled for the Lake Ontario intakes are summarized in **Table 5.38** below and described in the text following the table. **Table 5.39** presents all of the scenarios that were modelled for the CTC Source Protection Region.

Table 5.38: Lake Ontario Model Spill Scenarios

Spill Scenario Details			Contaminant of Concern
Type	**Location**	**Volume and Duration of Spill**	
Disinfection Failure at WWTP	Mid-Halton WWTP S.W. Halton WWTP S. E. Halton WWTP Clarkson WWTP G.E. Booth WWTP Humber WWTP Ashbridges Bay WWTP Highland Creek WWTP Duffins Creek WWTP Wellington WWTP Corbett Creek WWTP Harmony Creek WWTP Courtice WWTP	Disinfection failure at the plant, leading to a release of *E. coli* at a level of 5,000,000/100mL for a two-day period between April and August.	*E. coli*
Sanitary Trunk Sewer (STS) Breaks	Sanitary trunk sewer breaks from pipes located within 120 meters or regulated limit of the main tributaries along the Toronto Waterfront (Etobicoke Creek, Humber River, Highland Creek and Don River) up to and including location of first lateral sewer connection upriver from the mouth	Actual density of *E. coli* (1,000,000 CU/100ml) measured downstream of the Aug. 19, 2005 event in Highland Creek was used to model impact. Simulated spills to each of the other tributaries assumed release of 50% of their design flow at an *E. coli* density of 5,000,000 CFU/100ml; all simulated for 24-hour spill duration.	*E. coli*
Combined sewer overflow (CSO)	Toronto Inner Harbour	Continuous simulation of actual conditions April 1, 2007 to October 31, 2008.	*E. coli*
Lagoon Spill	Industrial Processing Facility on the Credit River	52,800$m^{3,}$ with *E. coli* concentration at 5,000, 000/100mL, 24-hour duration.	*E. coli*
Petroleum (gasoline) Pipeline Break	16 Mile Creek Joshua Creek Credit River Etobicoke Creek Humber River Don River Highland Creek Rouge River Petticoat Creek Duffins Creek Carruthers Creek Lynde Creek Oshawa Creek Bowmanville Creek Wilmot Creek Graham Creek Ganaraska River Cobourg Creek	Spill of 2,700 m^3 of gasoline containing 1% benzene, 6-hour duration.	Benzene

Spill Scenario Details			Contaminant of Concern
Type	Location	Volume and Duration of Spill	
Bulk Petroleum (gasoline) Release	Bulk petroleum storage and handling facilities in Oakville and North York	260,000 litre benzene spill under easterly and westerly wind conditions, 6 hour duration. Three, 15-minute spills, volume ranging from 200 to 1000 litres of benzene under a variety of meteorological conditions.	Benzene
Tritium Release	Pickering Nuclear Facility	2900 kg of tritiated water discharged over a period of 6 hours at a concentration of 7.9 $\times 10^{11}$ Bq/L (i.e., the estimated total amount of tritium activity released was 2.3×10^{15} Bq).	Tritium
Tritium Release	Darlington Nuclear Facility	2900 kg of tritiated water discharged over a period of 6 hours at a concentration of 7.9 $\times 10^{11}$ Bq/L (i.e., the estimated total amount of tritium activity released was 2.3×10^{15} Bq).	Tritium

Wastewater Treatment Plant Disinfection Failure

Modelling scenarios were undertaken to determine if disinfection failures at wastewater treatment plants would cause deterioration of the quality of raw water for drinking water purposes for the CVSPA WTPs. The modelled parameter of concern for these scenarios was *E. coli* and the recreational standard for *E. coli* of 100 CFU/100ml was used as the threshold to assess deterioration of the quality of water. Normally the measured *E. coli* levels in the raw water in the vicinity of these intakes is less than 1 CFU/100 ml. The simulation date for this modelling was April 25 to August 31, 2008, using wind data from the Pearson Airport. Note that these weather conditions were not extreme event conditions, but daily conditions that occurred within the simulation period window. Each WWTP was simulated at the Certificate of Approval flow rate, and *E. coli* levels within the discharge were set constant at 5,000,000 CFU/100 ml. The decay of *E. coli* was taken into consideration for the modelling. The Lake Ontario version of MIKE-3 was used to model the contaminant pathway within Lake Ontario and determine the concentrations of the contaminant at the intakes.

Sanitary Trunk Sewer Breaks

A series of scenarios were modelled to determine if simultaneous trunk sewer breaks near Lake Ontario across the Toronto shoreline would cause deterioration of the quality of water at the CVSPA intakes. Although there are trunk sewers near Lake Ontario in other municipalities within the CTC that may be threats, these have not been assessed to date.

Four trunk sewer break locations were modelled during this exercise. The sewer breaks were considered to occur where the trunk sewer was located within the tributary valley out to the greater of the regulated limit, or 120 metres of the top of bank and between the WWTP upriver to the first lateral connection to the trunk sewer. Within this area, the maximum amount of wastewater would be present in the pipe and the time of travel to the lake would be less than two hours. The trunk sewer flow was estimated at 50% of the design flow of each WWTP.

The Highland Creek sewer break was modelled based on measurements taken during an actual event (August 2005). Water quality was sampled downstream of the actual break, where mixing with Highland

Creek itself had already diluted the sewage effluent. In the other three cases the breaks in the other streams (Etobicoke Creek, Humber River, Don River) were modelled by adding sewer flows to the tributary flows at the river mouths to account for dilution that would occur before the sewage reached Lake Ontario. The simulation for *E. coli* assumed the ambient level was 1000 CFU/100ml in each tributary. During the trunk sewer break in Highland Creek, the measured level downstream was 1,000,000 CFU/100mL. In the other cases it was assumed that the level of *E. coli* in the raw, undiluted sewage was 5,000,000 CFU/100ml prior to dilution with the tributary. This level is consistent with regularly observed levels in raw sewage. The ambient lake conditions were assumed to have zero CFU and first order decay of *E. coli* was applied. The first order decay means that the population of bacterial pathogens (*E. coli* in this case), is estimated to reduce at a constant rate over time. The time is the modelled travel time to the intake.

Combined Sewer Overflow

A number of combined sewers flow into the Toronto Inner Harbour. The modelling for this scenario comprised a continuous simulation of actual conditions between April 1, 2007 and October 31, 2008. The 2007 data were used to calibrate the model and the 2008 data were used to assess the impacts to the drinking water intakes.

Lagoon Spill

A lagoon spill from an industrial food processing facility on the Credit River was modelled to determine the effects of a release of 52,800$m^{3,}$ of water containing *E. coli* concentration at 5,000,000/100mL over a 24-hour period.

Petroleum Pipeline Breaks

Modelling scenarios were undertaken to determine if gasoline containing benzene spilled from an oil pipeline rupture as it crosses the Credit River, Humber River, Don River, Highland Creek, Rouge River or Duffins Creek would reach any of the CVSPA intakes and cause deterioration of the quality of raw water. The modelled parameter of concern for these scenarios was benzene and the raw water quality threshold used for assessing the threat from benzene was the ODWS (0.005 mg/l).

The pipeline flow was based on the daily average flow rate of 0.125 cubic metres of fuel per second (m^3/s), with a spill duration of 6-hours. Therefore, the spill volume was 2,700 m^3 of fuel (at 1% benzene, for a benzene volume of 27 m^3). The pipeline flow was mixed with the river flow, and it was assumed that the benzene in the gasoline would fully mix in the river water. The temperature in the tributaries was set at 20˚C, as was the gasoline temperature in the pipeline. The daily flow volumes in the rivers were obtained from the Canada Water Survey database, and the flow rates in the rivers were simulated by conservation authority staff using in-house HEC-RAS models. Similar to the modelling scenarios described above, the MIKE-3 model was used to simulate the contaminant pathway within Lake Ontario and the concentrations at the intakes.

Petroleum pipeline break scenarios were not previously simulated for Joshua and Etobicoke creeks in the Assessment Report but were identified as significant drinking water threats because they are located between two other tributaries where significant threats were simulated and identified.

In 2013, the CTC Source Protection Region had the consultant run the simulation for these creeks using the same models, but with less conservative assumptions applied to the petroleum pipeline break scenarios previously executed. Despite these assumptions, the modelled spill of the pipeline still resulted in a significant drinking water threat. The results of these model runs are also presented in **Appendix E5**.

Bulk Petroleum Storage and Handling Spills

Two modelling scenarios were undertaken to determine if the release of gasoline containing benzene from bulk petroleum storage and handling facilities in Oakville and North York would reach water treatment plant intakes and cause deterioration of the quality of raw water. The first scenario was based on the release of 26 million litres (volume of a large fuel storage tank) of gasoline containing 1% benzene over a period of 6-hours. The resulting release was the equivalent to 260,000 litres of benzene.

The second scenario simulated three small (mini tank) spills of 15-minute duration from a ship unloading at the Oakville pier. These spills of 20,000, 50,000, and 100,000 litres of gasoline are estimated to contain 200, 500, and 1,000 litres of benzene.

The spill scenarios were simulated using the Lake Ontario version of MIKE-3 using easterly and westerly wind events as described above. The modelled parameter of concern for these scenarios was benzene and the raw water quality threshold for benzene is 0.005 mg/l - the ODWS. The simulation period for the modelling was between April 15 and July 7, 2006. The wind direction and velocity data were obtained from various sources, including Pearson Airport. These represent daily conditions (i.e., not extreme events) that occurred within the chosen simulation period.

Tritium Release

Model scenarios were undertaken to determine if the release of tritium in water from the Pickering or Darlington nuclear power plants would cause deterioration of the quality of raw water for the intakes located in Lake Ontario. The modelled parameter of concern was tritium and the threshold used was the ODWS for tritium (7,000 Bq/L). The model also simulated a threshold of 350 Bq/L and 20 Bq/L. The value of 20 Bq/L has been recommended by the Minister of the Environment and Climate Change's Ontario Drinking Water Advisory Council as a revised drinking water standard based on a running annual average.

The scenario was based on a 1992 spill event when heavy water leaked into the cooling water stream. This resulted in the release of 2,900 kg of tritiated water at a concentration of 7.9×10^{11} Bq/L. The modelled duration of the spill event was 6-hours, as if it were released on May 17, 2006 during a period of easterly currents. This was not an extreme weather period. Similar to the modelling scenarios described above, the MIKE-3 model was used to simulate the contaminant pathway within Lake Ontario and the concentrations at the intakes.

Modelling Results

The modelling runs produced concentration plumes that cover the areas where the contaminant travels during the time period based on weather conditions used in the model run. The extent of the contaminant plume is based on the hydrodynamic conditions in the lake. The model runs identify the extent of the area where contamination is above the threshold level. This area encompasses not only the area to the intake but also beyond. In some cases, the area is quite extensive. Contaminant plumes may also move to and past an intake and then back again, especially where the contaminant concentration persists above the threshold for up to several weeks. The currents in the nearshore area in the lake are complex and not one-directional. Further details regarding these points are included in **Appendix E5**.

The modelling results for the event-based modelling are summarized below. **Table 5.39** shows all of the modelled scenarios that result in significant drinking water threats to the CVSPA intakes, as well as spill scenarios located in CVSPA that result in significant drinking water threats in adjacent source protection areas. Further details are provided in the **Appendix E5**. **Table 5.38** outlines the results where the model scenarios predict that an activity will be a significant drinking water threat, including:

- Threats located within the CVSPA that are a significant threat to intakes located within the CVSPA (three unique threats to two intakes); and
- Threats located outside of the CVSPA that are a significant threat to intakes located within the CVSPA (eighteen unique threats to two intakes).

Table 5.39: Modelling Results Identifying Significant Drinking Water Threats Affecting CVSPA

SPR/SPA	WTP	Spill Model Scenario	Spill Location	Parameter of Concern	Water Quality Threshold	Concentration at the Intake	Significant Threat
Halton-Hamilton/ Halton SPA	Burlington	Clarkson WWTP Disinfection failure	IPZ-3 CVSPA	*E. coli*	100 cfu/100 mL	623	yes
	Burloak	Clarkson WWTP Disinfection failure	IPZ-3 CVSPA	*E. coli*	100 cfu/100 mL	889	yes
		G.E. Booth WWTP disinfection failure	IPZ-2 CVSPA	*E. coli*		1,000	yes
	Oakville	Clarkson WWTP Disinfection failure	IPZ-3 CVSPA	*E. coli*	100 cfu/100 mL	9950	yes
		G.E. Booth WWTP disinfection failure	IPZ-2 CVSPA	*E. coli*		3,070	yes
CTC/CVSPA	Lorne Park	S.W. Halton WWTP disinfection failure	IPZ-2 HSPA	*E. coli*	100 cfu/100 mL	216	yes
		Mid-Halton WWTP disinfection failure	IPZ-2 HSPA	*E. coli*		248	yes
		S.E. Halton WWTP Disinfection failure	IPZ-2 HHSPA	*E. coli*		539	yes
		Clarkson WWTP Disinfection failure	IPZ-3 CVSPA	*E. coli*		5600	yes
		G.E. Booth WWTP disinfection failure	IPZ-2 CVSPA	*E. coli*		38,000	yes
		Humber River WWTP disinfection failure	IPZ-3 TRSPA	*E. coli*		734	yes
		Ashbridges Bay WWTP disinfection failure	IPZ-3 TRSPA	*E. coli*		756	yes
		Etobicoke Creek STS break	IPZ-3 TRSPA	*E. coli*	100 cfu/100 mL	367	yes
		16 Mile Creek pipeline break	IPZ-3 HSPA	Benzene	0.005 mg/L	0.42	yes

SPR/SPA	WTP	Spill Model Scenario	Spill Location	Parameter of Concern	Water Quality Threshold	Concentration at the Intake	Significant Threat
CTC/CVSPA	Lorne Park	Joshua Creek pipeline break	IPZ-3 HSPA	Benzene	0.005 mg/L	0.065	yes
		Credit River pipeline break	IPZ-3 CVSPA	Benzene		2.4	yes
		Etobicoke Creek pipeline break	IPZ-3 TRSPA	Benzene		0.006	yes
		Humber River pipeline break	IPZ-3 TRSPA	Benzene		0.15	yes
		Don River pipeline break	IPZ-3 TRSPA	Benzene		0.014	yes
		Highland Creek pipeline break	IPZ-3 TRSPA	Benzene		0.01	yes
		Rouge River pipeline break	IPZ-3 TRSPA	Benzene		0.008	yes
		Duffins Creek pipeline break	IPZ-3 TRSPA	Benzene		0.009	yes
		Bulk storage spill, Oakville facility*	IPZ-2 HSPA	Benzene		1.25	yes
		Small (mini tank) Spills -15 min duration	IPZ-2 HSPA	Benzene		0.0068	yes
		North York Petroleum Storage Spill via Humber River	IPZ-3 TRSPA	Benzene		0.078	yes

SPR/SPA	WTP	Spill Model Scenario	Spill Location	Parameter of Concern	Water Quality Threshold	Concentration at the Intake	Significant Threat
CTC/CVSPA	Arthur P. Kennedy	Clarkson WWTP Disinfection failure	IPZ-3 CVSPA	*E. coli*	100 cfu/100 mL	1,426	yes
		G.E. Booth WWTP disinfection failure	IPZ-2 CVSPA	*E. coli*		83,800	yes
		Humber River WWTP disinfection failure	IPZ-3 TRSPA	*E. coli*		2,906	yes
		Ashbridges Bay WWTP disinfection failure	IPZ-3 TRSPA	*E. coli*		780	yes
		Etobicoke Creek STS break	IPZ-3 TRSPA	*E. coli*		183	yes
		Humber River STS break	IPZ-3 TRSPA	*E. coli*		110	yes
		16 Mile Creek pipeline break	IPZ-3 HSPA	Benzene	0.005 mg/L	0.146	yes
		Joshua Creek pipeline break	IPZ-3 HSPA	Benzene		0.007	yes
		Credit River pipeline break	IPZ-3 CVSPA	Benzene		0.37	yes
		Etobicoke Creek pipeline break	IPZ-3 TRSPA	Benzene		0.0057	yes
		Humber River pipeline break	IPZ-3 TRSPA	Benzene		0.30	yes
		Don River pipeline break	IPZ-3 TRSPA	Benzene		0.023	yes
		Highland Creek pipeline break	IPZ-3 TRSPA	Benzene		0.012	yes
		Rouge River pipeline break	IPZ-3 TRSPA	Benzene		0.009	yes
		Duffins Creek pipeline break	IPZ-3 TRSPA	Benzene		0.011	yes
		Bulk storage spill, Oakville facility*	IPZ-2 HSPA	Benzene		0.5	yes
		North York Petroleum Storage Spill via Humber River	IPZ-3 TRSPA	Benzene		0.31	yes

SPR/SPA	WTP	Spill Model Scenario	Spill Location	Parameter of Concern	Water Quality Threshold	Concentration at the Intake	Significant Threat
CTC/TRSPA	R.L. Clark	G.E. Booth WWTP disinfection failure	IPZ-2 CVSPA	*E. coli*	100 cfu/100 mL	55,600	yes
		Clarkson WWTP Disinfection failure	IPZ-3 CVSPA	*E. coli*		1,400	yes
		Credit River Pipeline Break	IPZ-3 CVSPA	Benzene	0.005 mg/L	0.15	yes
	R.C. Harris	G.E. Booth WWTP disinfection failure	IPZ-2 CVSPA	*E. coli*	100 cfu/100 mL	110	yes

The modelling scenario for the Oakville bulk fuel storage assumed that the spill would reach Lake Ontario via Bronte Creek. The Halton-Hamilton Source Protection Committee has determined that a spill may take another route to reach the lake. Further assessment will be undertaken in the future when funding is available, but it is most likely that modelled results would still be a significant drinking water threat.

The following maps highlight the location of a potential threat, with a "connector" line that highlights the shortest path to the affected intake. Note that the paths shown are not representative of any particular date or current direction. Each scenario is shown in a different colour to best represent the variety and extent of the potential threats. See **Figure 5.53** through **Figure 5.59** for spills scenarios where there are threat activities located in CVSPA or municipal intakes located in CVSPA are affected by threat activities located within other source protection areas.

Significant Threats Enumeration

Table 5.40 provides the number of significant drinking water threats located in CVSPA, extracted from the information found in **Table 5.39**. Note that **Table 5.39** includes multiple references to a single significant drinking water threat location. There are three significant threat locations in CVSPA (note that a threat may affect more than one intake and that some of the affected intakes are outside the CVSPA).

The Source Protection Plan for CTC SPR must have policies to address these significant drinking water threats that are located within the source protection area. In addition, CVSPA has identified significant drinking water threats from activities located outside the CVSPA. These activities affect water treatment plants located in CVSPA that must be addressed through source protection plan policies developed in adjacent source protection areas where the threat activities are located. These locations are documented in **Table 5.41** but are not enumerated as part of the CVSPA threat inventory, since they are located outside of the CVSPA. CVSPA staff has brought this information to the attention of the source protection staff of the neighbouring source protection areas to ensure that policies are developed for them.

Table 5.40: Number of Significant Threat Locations in CVSPA

Number of Significant Threat Locations in CVSPA		
Threat Locations	**Parameter of Concern**	**WTP Affected**
G.E. Booth WWTP bypass	*E. coli*	Burloak (in HSPA), Oakville (in HSPA), Lorne Park, Arthur P. Kennedy, R. L. Clark (in TRSPA), R.C. Harris (in TRSPA)
Clarkson WWTP bypass	*E. coli*	Burlington(in HSPA), Burloak, (in HSPA), Oakville (in HSPA), Lorne Park, Arthur P. Kennedy, R. L. Clark (in TRSPA)
Credit River pipeline break	Benzene	Lorne Park, Arthur P. Kennedy, R. L. Clark (in TRSPA)
Total Number of Significant Threat Locations		**3**

Note: The actual pipeline break location break at each watercourse is the land use activity that is identified as a significant threat.

Table 5.41: Significant Threat Locations in Neighbouring SPAs Impacting CVSPA Intakes

Lake Ontario Intake Significant Threat Location	Source Protection Area where Threat is Located	Parameter of Concern	CVSPA WTP Affected
S.W. Halton WWTP disinfection failure	*HSPA*	*E. coli*	Lorne Park
Mid-Halton WWTP disinfection failure	*HSPA*	*E. coli*	Lorne Park
S.E. Halton WWTP disinfection failure	*HSPA*	*E. coli*	Lorne Park
16 Mile Creek pipeline break	*HSPA*	Benzene	Lorne Park
Joshua Creek pipeline break	*HSPA*	Benzene	Lorne Park, Arthur P. Kennedy
Bulk storage spill, Oakville facility	*HSPA*	Benzene	Lorne Park Arthur P. Kennedy
Small (mini tank) Spills – 15 minute duration	*HSPA*	Benzene	Lorne Park
Humber River WWTP disinfection failure	*TRSPA*	*E. coli*	Lorne Park, Arthur P. Kennedy
Ashbridges Bay WWTP disinfection failure	*TRSPA*	*E. coli*	Lorne Park, Arthur P. Kennedy
Etobicoke Creek STS break	*TRSPA*	*E. coli*	Lorne Park, Arthur P. Kennedy
Humber River STS break	*TRSPA*	*E. coli*	Arthur P. Kennedy
Etobicoke Creek pipeline break	*TRSPA*	Benzene	Lorne Park, Arthur P. Kennedy
Humber River pipeline break	*TRSPA*	Benzene	Lorne Park Arthur P. Kennedy
Don River pipeline break	*TRSPA*	Benzene	Lorne Park, Arthur P. Kennedy
Highland Creek pipeline break	*TRSPA*	Benzene	Lorne Park, Arthur P. Kennedy
Rouge River pipeline break	*TRSPA*	Benzene	Lorne Park, Arthur P. Kennedy
Duffins Creek pipeline break	*TRSPA*	Benzene	Lorne Park, Arthur P. Kennedy
North York Petroleum Storage Spill	*TRSPA*	Benzene	Lorne Park, Arthur P. Kennedy

Note: The actual pipeline break location at each watercourse is the land use activity that is identified as the significant threat.

IPZ-3 Delineation

As discussed above, an IPZ-3 is delineated where modelling demonstrates that a contaminant released during an event may be transported to the intake resulting in an unacceptable deterioration in the quality of water rendering it unsuitable as a source of drinking water. The modelled results outlined in **Table 5.39** shows where spill events would lead to concentrations of contaminants at the respective intakes in CVSPA that exceed the selected thresholds. Therefore, an IPZ-3 must be delineated for each of these scenarios, where the significant drinking water threat activity is located outside IPZ-1 or IPZ-2. Where the spill scenario was within IPZ-1 or IPZ-2, no IPZ-3 was delineated for that related activity. The Director's Rule (68) guides the delineation of IPZ-3s, which requires that setbacks from tributaries where the modelled contaminant could travel to reach Lake Ontario be determined based on the greater of the area of land measured from the high water mark (not exceed 120 metres) or the Conservation Authority regulation limit. The term 'high water mark' under the Director's Technical Rules is consistent with the definition of 'ordinary high water mark' as defined by DFO-Fact Sheet T-6, Fisheries and Ocean Canada, as the usual or average level to which a body of water rises at its highest point and remains for sufficient time so as to change the characteristics of the land. The measured high water mark is based on the CGVD28 (Canadian Geographical Vertical Datum) converted from the IGLD (International Great Lakes Datum 1985). The high water mark was delineated and the setback extended from this datum.

Once a contaminant is modelled to reach an intake, an event based area within the IPZ-1, 2 or 3 was delineated using the required setbacks, from the point of its release in the tributary to a point representing the maximum landward extent of the IPZ-2. The event based area is the spatial component of the IPZ-1, 2 or 3 required for database and policy application purposes. A dashed line is also drawn from the point of entry at the lake to the affected intake. This line is termed the "spill collector" and represents the shortest transport path between the shoreline and the affected intakes. An IPZ-3 that falls in the lake, such as a spill at a WWTP is represented by a spill collector dashed line only. The following maps (**Figure 5.60** to **Figure 5.62**) show the IPZ-1, IPZ-2 and IPZ-3 for each municipal intake located in the CVSPA.

The spill scenarios modelled are illustrated in **Figure 5.53** through **Figure 5.60**. It should be noted that the IPZs shown in **Figure 5.60** and **Figure 5.61**, additionally present the IPZ-3s delineated for intakes in neighbouring SPAs (HSPA, TRSPA) shown in **Figure 5.60** and **Figure 5.61**, respectively, and these may overlap with existing IPZ-1s and 2s of these SPAs. Where this occurs, the IPZ-3 should be truncated at the boundary of the IPZ-1s or IPZ-2s in the mapping provided by those SPAs (i.e., there should be no overlap). The delineation of the STS break IPZ-3s and associated event based areas were revised in 2015. A technical addendum is presented in **Appendix E5.4.3**.

The CTC SPC is required to develop source protection policies to address the significant drinking water threats identified in the Assessment Report.

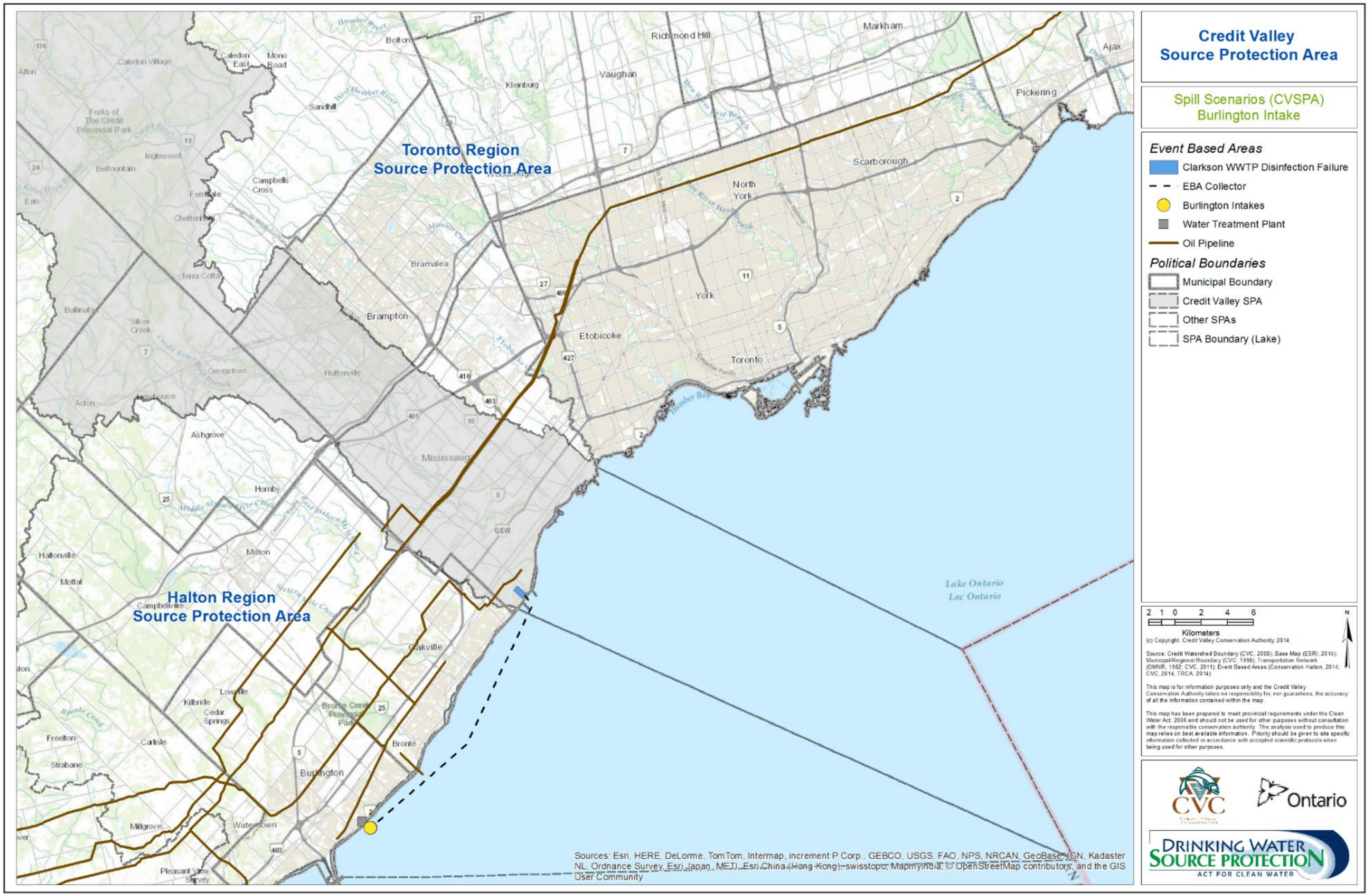


Figure 5.48: Spill Scenarios (CVSPA) Burlington Intake

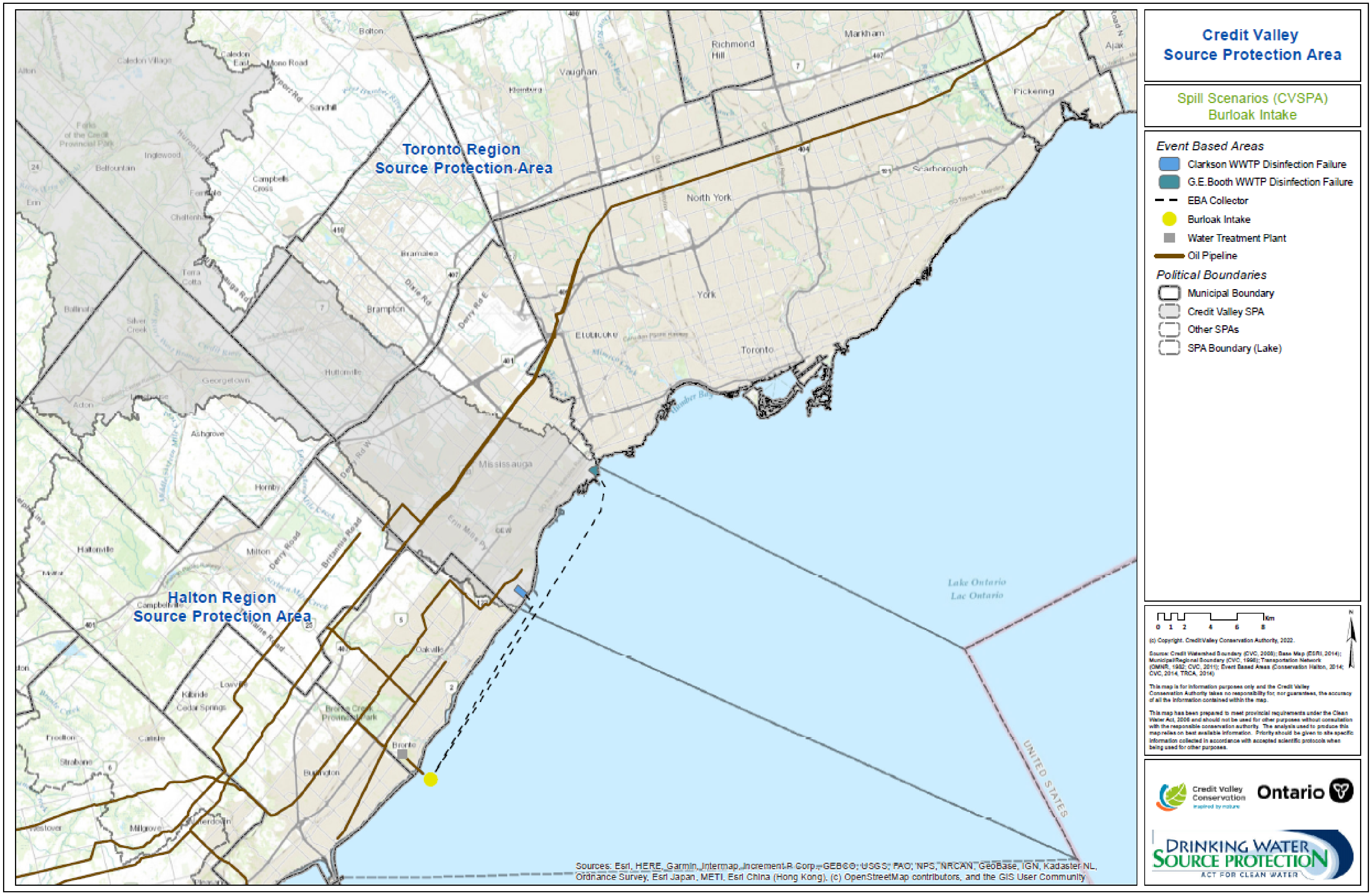


Figure 5.49: Spill Scenarios (CVSPA) Burloak Intake

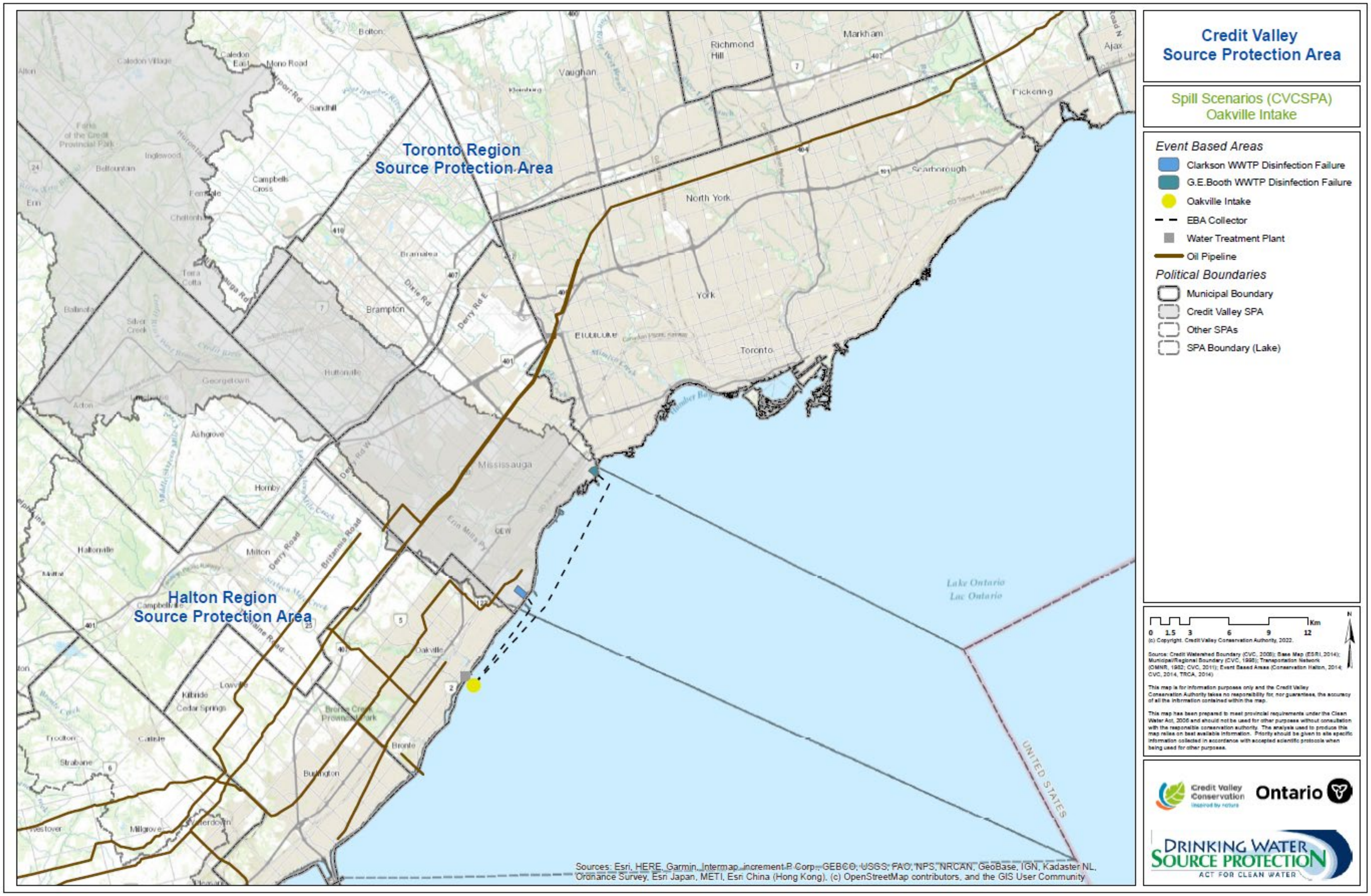


Figure 5.50: Spill Scenarios (CVSPA) Oakville Intake

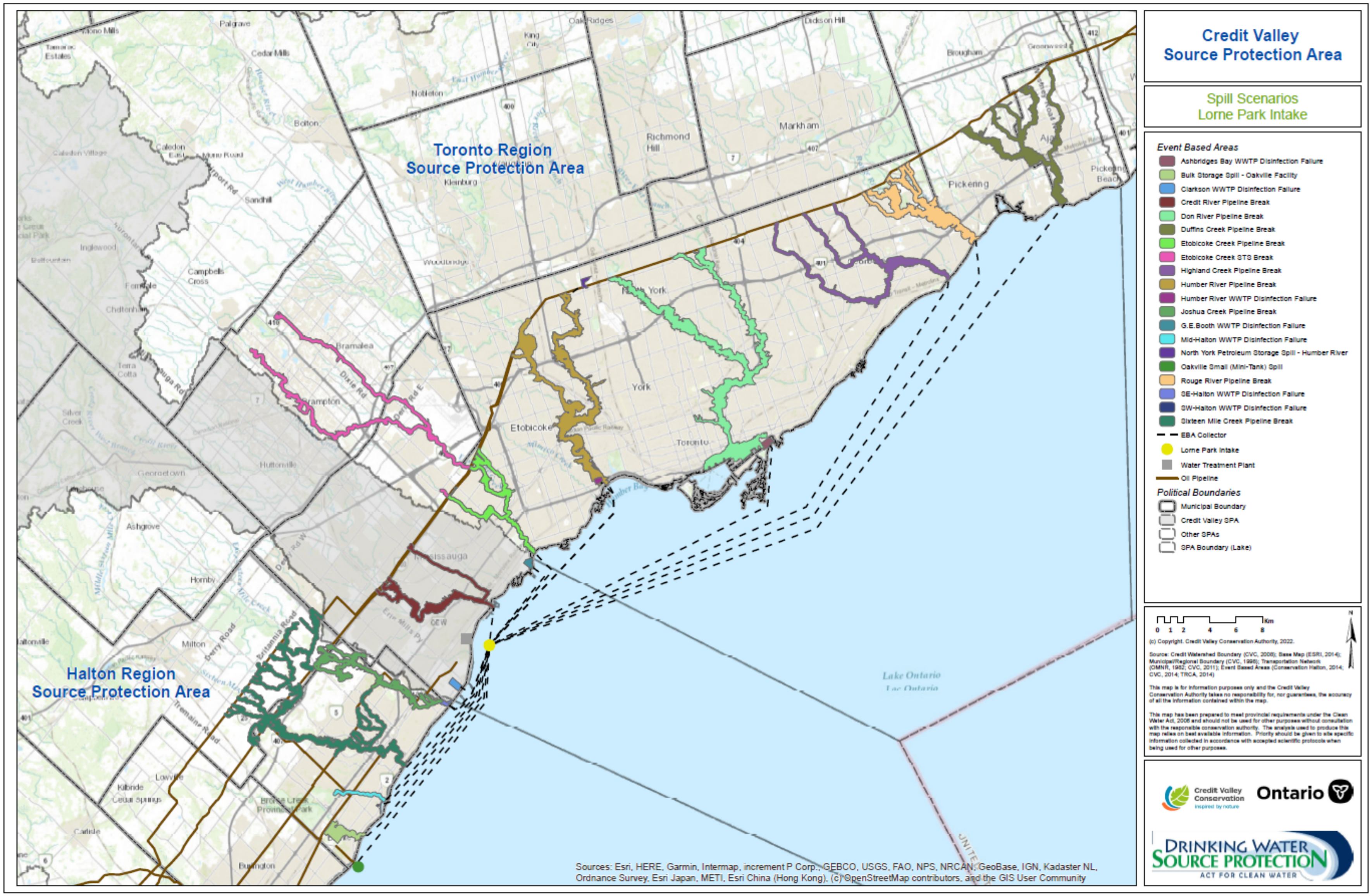


Figure 5.51: Spill Scenarios Lorne Park Intake

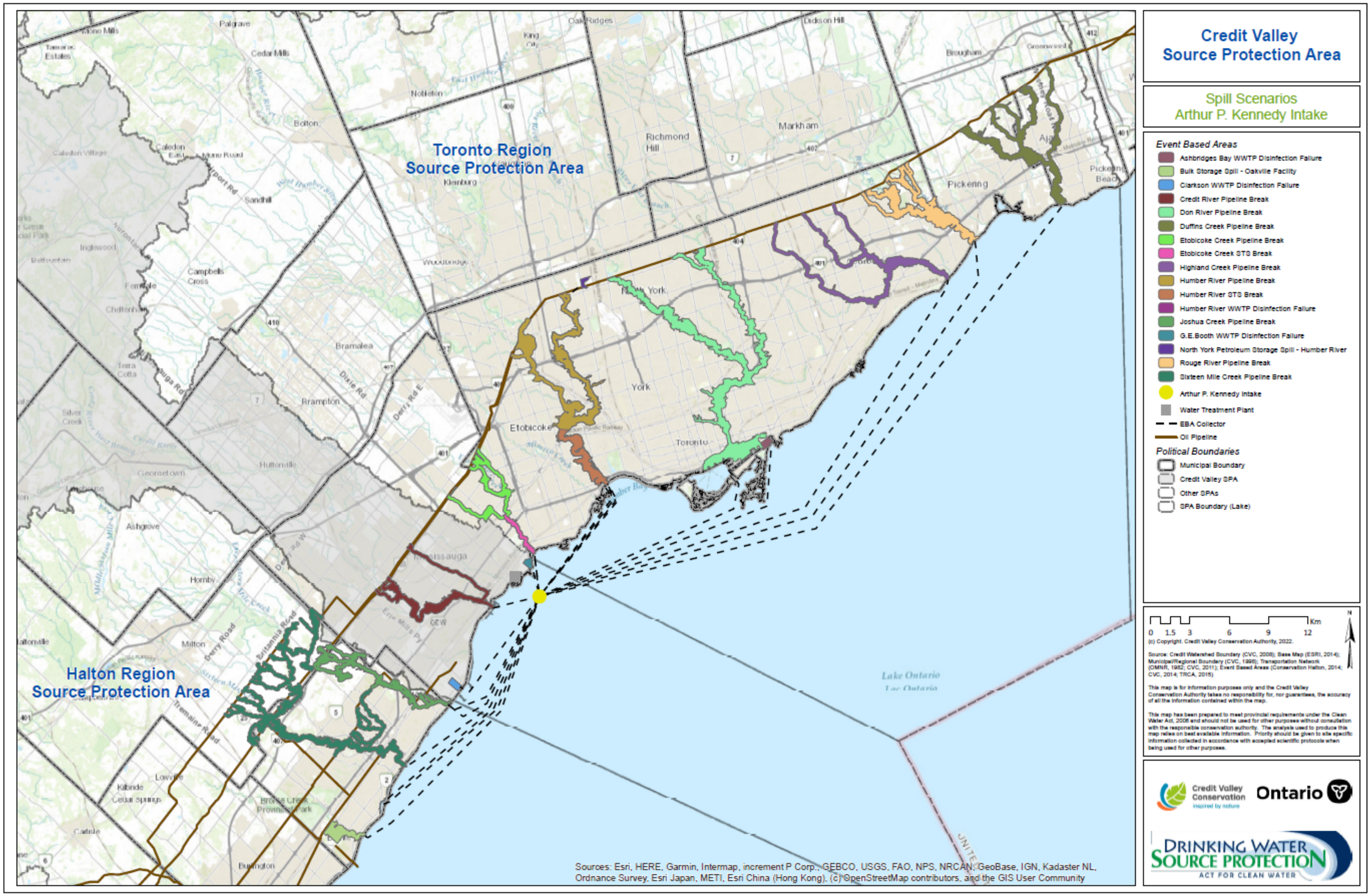


Figure 5.52: Spill Scenarios Arthur P. Kennedy (formerly Lakeview) Intake

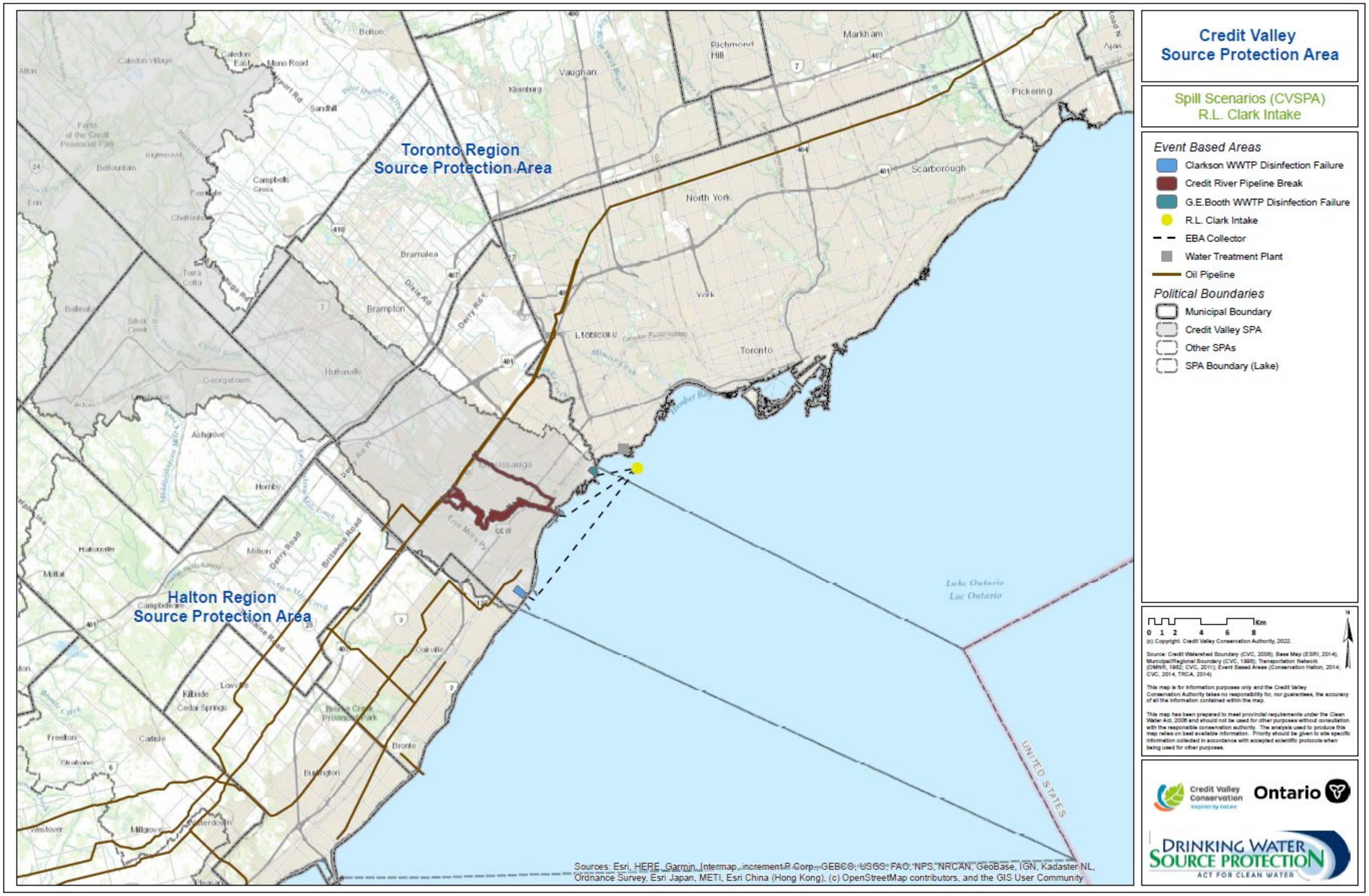


Figure 5.53: Spill Scenarios (CVSPA) R. L. Clark Intake

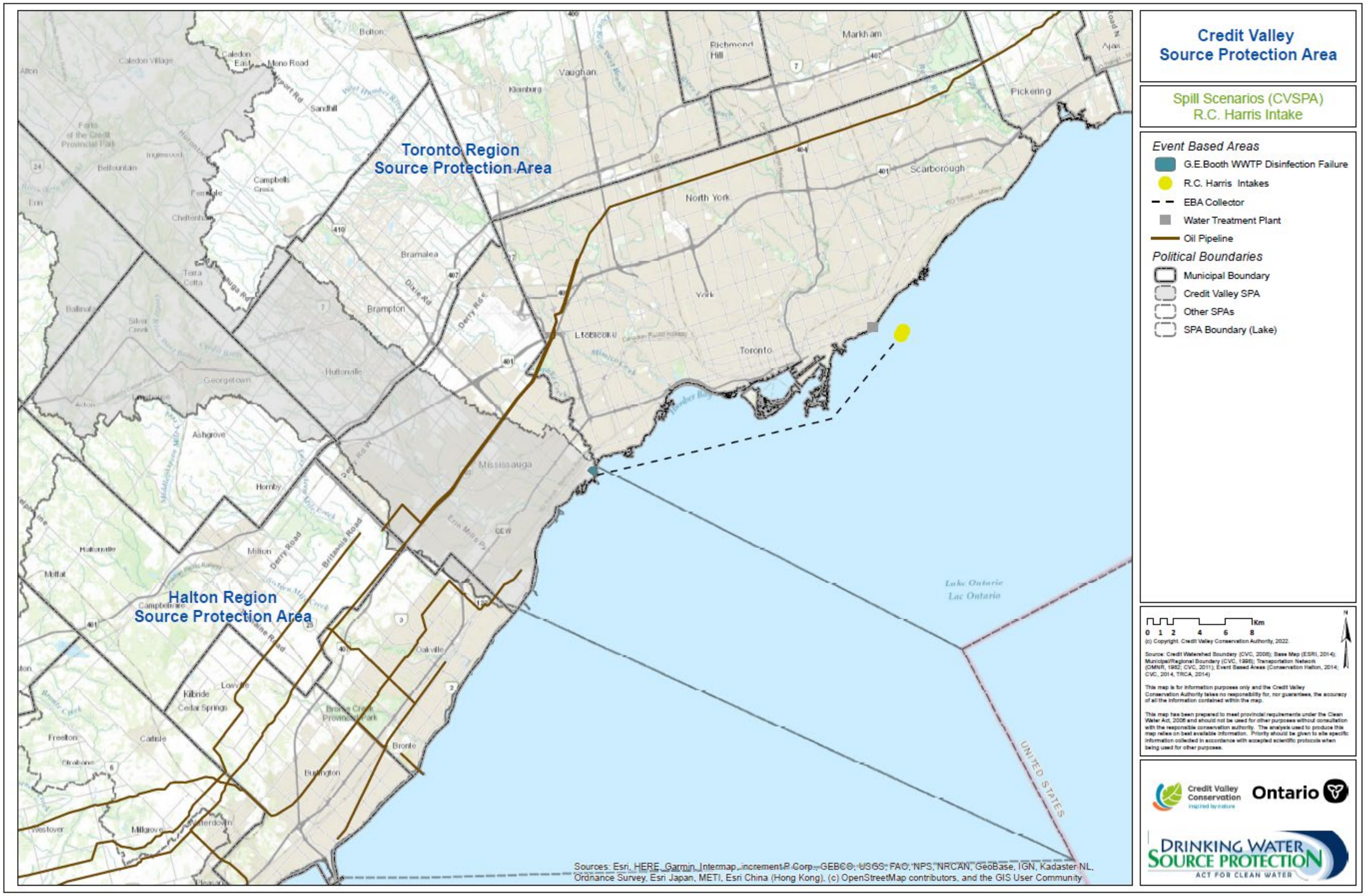


Figure 5.54: Spill Scenarios (CVSPA) R. C. Harris Intake

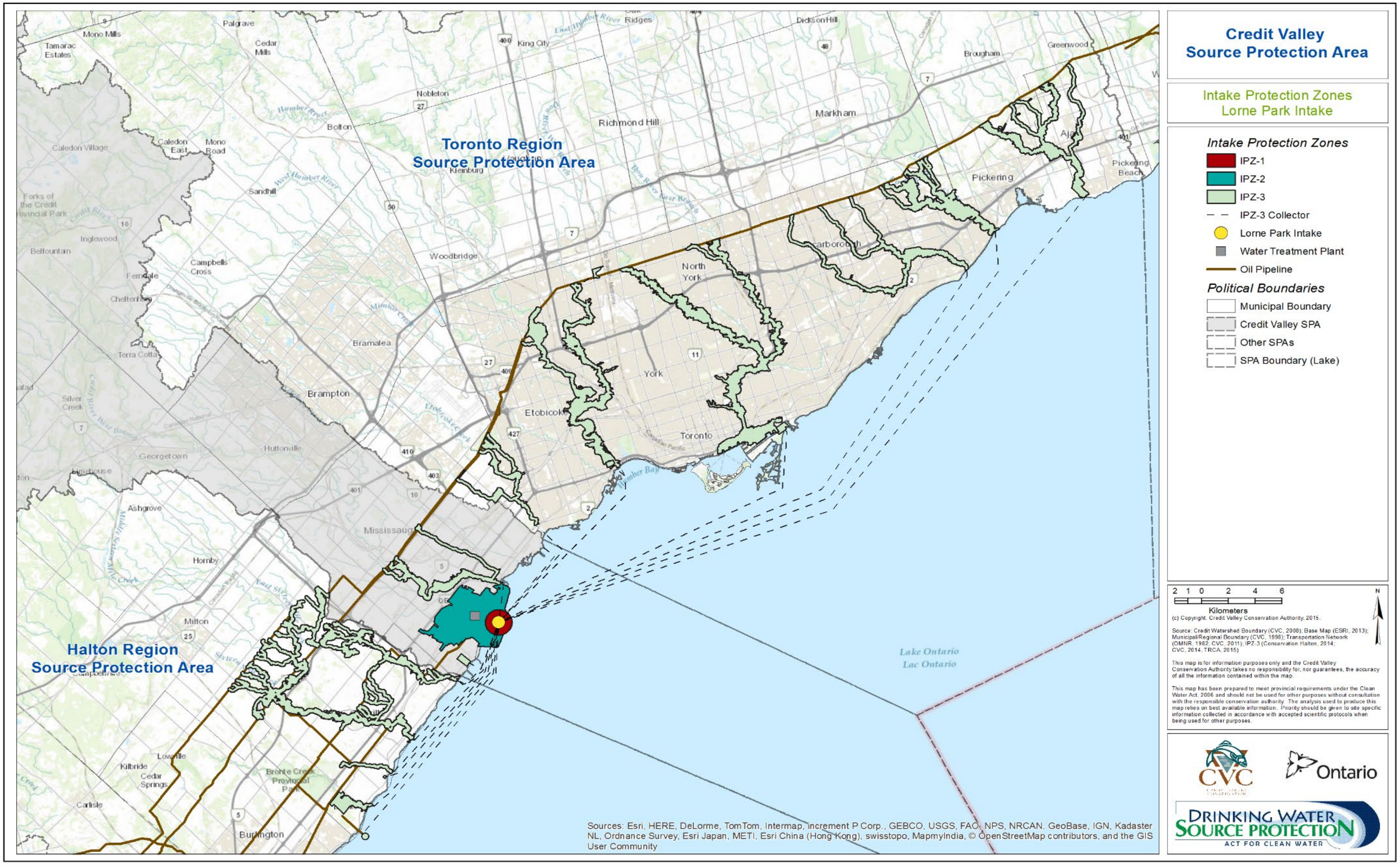


Figure 5.55: Intake Protection Zone Lorne Park Intake

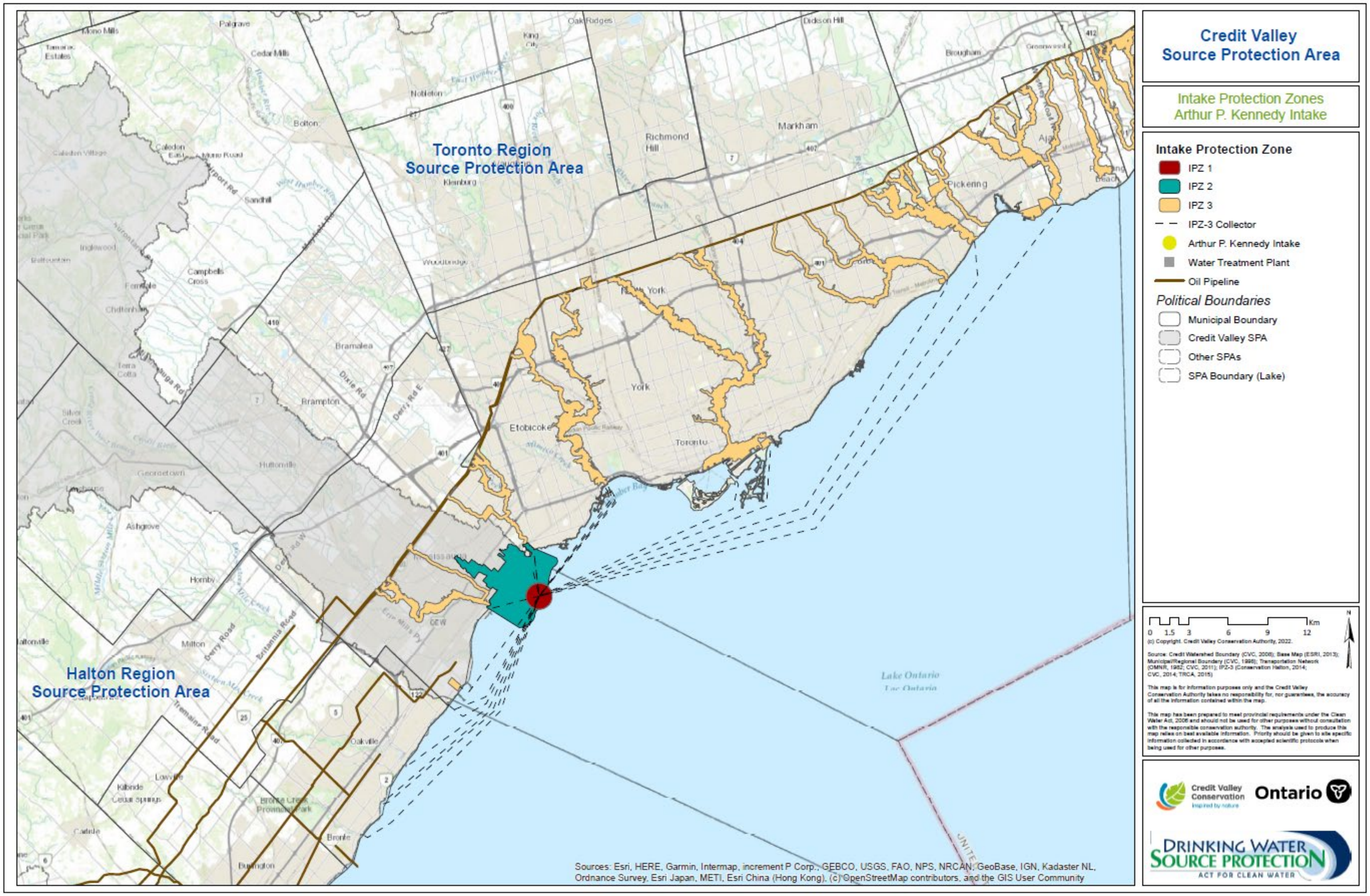


Figure 5.56: Intake Protection Zone Arthur P. Kennedy Intake

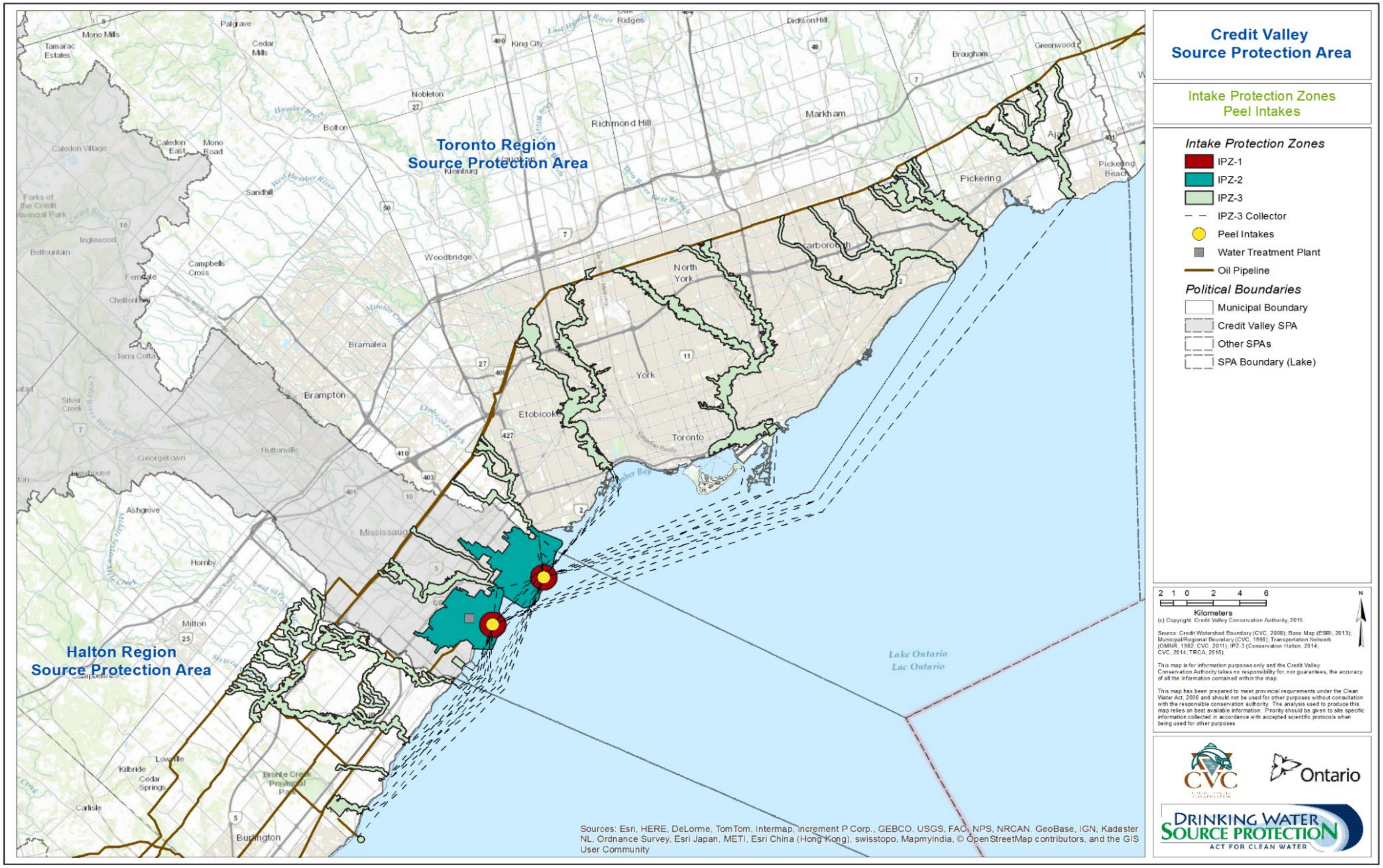


Figure 5.5.57: Intake Protection Zones Peel Intakes

Uncertainty Assessment

IPZ-3 delineation was undertaken in accordance with the Director's Rule 68 of the CWA 2006. The delineation does contain inherent uncertainty that is associated with input data, the ability of a model to accurately reflect the hydrologic system and model calibration. These factors are discussed below and reflected in **Table 5.42**.

Table 5.42: Uncertainty Associated with IPZ-3 Delineation

Spill Source	Lake Hydrodynamic Model		Source Term (as Lake Input)	
	Uncertainty Level	Comment	Uncertainty Level	Comment
Tritium	Low	Model calibrated to specific event	Low	Measured discharge
E. coli @ WWTP	Low	Model calibrated to both hydrodynamics and decay	Low	Evidence – based Discharge
E. coli from STS break	High	Model calibrated to general hydrodynamics	Low	Evidence – based Discharge
E. coli from CSO spill	Low	Based on calibrated Inner Harbour model for both hydrodynamics and *E. coli* decay	Low	Based on calibrated rainfall-runoff model
Rural industrial spill of *E. coli*	High	Model calibrated to general hydrodynamics	Low	Evidence – based Discharge, transformed by river modelling
Benzene spill from Storage Farm	High	Model calibrated to general hydrodynamics	Low	Evidence – based Discharge
Pipeline break of Benzene	High	Model calibrated to general hydrodynamics	High	Evidence – based Discharge without river modelling

The modelling runs produced concentration plumes that capture the areas that the contaminant travels during the run. The concentration plume travels to the intake and beyond and is therefore quite extensive in size. It could not be stated with certainty that all areas within these plumes would reach a particular intake given the dynamic nature of currents and wind. In addition, the modelling completed (concentration plumes) did not necessarily have a contour for the selected thresholds that would indicate deterioration of the quality of water and pose a significant threat to supplies.

In order to produce an IPZ-3 with greater certainty, the extent of the on-land IPZ-3 was determined by applying a setback from the tributaries per Director’s Rule (68). A straight dashed line marks the connection from the shoreline to the affected intakes and is labelled a “spill collector” to show the association between the threat activity and the intake. The dashed line remains as a component of the IPZ-3. This approach has been reviewed by the LOC technical working group and from the perspective of the MOECC, meets the requirements of the *Technical Rules*.

Pipeline spill scenarios were not completed for each tributary where the oil pipeline crosses. In order to assess the potential threat, additional hydraulic modelling work was done by CVC staff using HEC-RAS software to determine if it would be reasonable to include other creeks not modelled in the oil pipeline break scenario in delineating an IPZ-3. Watercourses that were not included in the original pipeline rupture scenarios were reviewed to determine if similar contaminant transport characteristics were apparent. Where the oil pipeline crossed these additional watercourses, and they were located between other modelled tributaries and a particular intake, it was assumed that these watercourses may be delineated as an IPZ-3 for that intake. This greatly reduced the amount of hydrodynamic modelling required.

The actual location of travel of a contaminant will depend on the prevailing weather conditions at the time along with the characteristics of the spill and the contaminant which is released. The modelling work done to date does not reflect all of the conditions that might exist nor do the scenarios systematically assess the full array of potential threat activities.

The model assumed that each contaminant did not undergo any transformation during the time period for the model run. This assumption is reasonable in the case of tritium but will likely overestimate the concentrations of benzene over time which may evaporate or be chemically changed. *E. coli* are living organisms naturally found in the intestines of humans and warm-blooded animals and will die sometime after they have been released into the environment. The rate that *E. coli* will die is dependent on time, environmental conditions such as temperature, whether they are shielded by being attached to suspended particles or exposed to disinfecting chemicals. In general terms, *E. coli* survives for about 4-12 weeks in water at a temperature of 15-18°C. Normally wastewater treatment plants disinfect the sewage prior to discharge to reduce the concentrations of pathogens, although this is not possible during a disinfection failure event.

Data Gaps

In developing policies to address these significant threats, the CTC SPC and other SPCs in the Lake Ontario Collaborative must take into consideration the dynamic nature of the nearshore water quality in Lake Ontario. As shown in the modelled scenarios, contaminants released in one source protection area can travel to intakes throughout that area and beyond.

Additional work on assessing other spill scenarios and conditions is needed. The analyses done to date, while providing valuable and robust results, do not provide a complete identification of potential threats. What has been achieved is the calibration and validation of a model which can be used to assess nearshore impacts from the Region of Niagara in the west, to Prince Edward County in the east. Peer review on the model calibration and validation process could not be completed within the time frame for finalization of the Assessment Report. The peer review results will be considered when future updates of this Assessment Report are undertaken.

Furthermore, there is the need to be able to do real-time modelling when a spill or other potential threat circumstance arise in order to predict where the contamination may travel and the expected peak concentrations and duration in order to provide municipal water treatment plant operators with the information needed to respond and determine their treatment options, including whether to stop taking water from the intake during the spill.

Further work is required to characterise the potential threats posed by water-borne pathogens other than *E. coli.* Preliminary work to identify the quantity and distribution of pathogens such as *Cryptosporidium* and *Giardia* was not sufficient to characterize the situation and identify where land-based activities are introducing these contaminants into the nearshore. However, based on the results of the *E. coli* scenarios, further work is required to identify the extent and sources of other pathogens to assess whether a threat exists in the source water.

The analysis undertaken does not address any threats due to cumulative releases of contaminants under non-spill situations to Lake Ontario water quality. The quality of the water at drinking water intakes within the CVSPA is generally very good based on the information provided by municipal plant operators. The water quality in Lake Ontario may be affected by changes in climate. As the population of the Lake Ontario basin continues to grow, there will likely be more water taken for drinking water along with more discharges of municipal sewage and possibly more industrial use of water and industrial discharges. Lake Ontario is the single most important source of drinking water for the people of Ontario.

5.8 POTENTIAL IMPACTS OF CLIMATE CHANGE

The *Technical Rules (2009)* require that the study team considers the impact of climate change (especially the risks it poses to the sustainability of drinking water supplies) as part of the threats assessment component of the Assessment Report. A provincial report called *Adaptation to Climate Change* includes a chapter that discusses risks to drinking water supplies associated with climate change in Ontario (Chiotti and Lavender, 2008). The report does not discuss climate change in detail, but it recognizes that more frequent extreme rainfalls resulting from climate change may have long-term effects on the quality and quantity of drinking water sources in Ontario (O'Connor, 2002a; Chiotti and Lavender, 2008).

Ontario's *CWA* provides an opportunity to assess an area's vulnerability to climate change. The guidance document related to characterizing watersheds focuses on past and current trends, but teams preparing these characterizations are also expected to consult appropriate climate change models. Using the information from the climate change models and other projected changes to the watershed (such as population growth, and land-use or intensification change), the teams should be able to identify all vulnerable areas. Potential climate change impacts will likely be further addressed in future versions of the CVSPA Assessment Report. As required by the Province, some general points about the potential effects follow.

5.8.1 Water Resources Supply Management

Water resources management is complex, balancing the demands of many different users with rapidly increasing urbanization and economic growth, and in-stream flow needs. Most communities in the province rely on surface water, although 90% of rural inhabitants rely solely on groundwater for their potable water supply (MOE, 2001; MOE 2006b; Chiotti and Lavender, 2008*).* Although total annual runoff is projected to decrease as a result of future climate change, flows are expected to increase during the winter and decrease significantly during the summer, when demand is highest (Chiotti and Lavender, 2008). It is generally accepted that rainfall events throughout the year are likely to be more intense, localized events rather than widespread, evenly distributed storms (Chiotti and Lavender, 2008). These higher intensity storms can have equally significant but more acute impacts on the CVSPA watersheds.

Despite the general abundance of freshwater supplies, seasonal water shortages have been documented (Chiotti and Lavender, 2008). Many shallow wells are sensitive to low water or drought conditions, and wells in some areas may go dry (Chiotti and Lavender, 2008). Several of the areas identified as most vulnerable to water shortages have been included as part of the Greenbelt Area in the Growth Plan for the Greater Golden Horseshoe Region, which places limits on urbanization, among other things (MPIR, 2006; Chiotti and Lavender, 2008).

Several studies have investigated the effects of climate change on water resources in areas surrounding the Great Lakes basin (e.g., Mortsch *et al*., 2000, 2003; Bruce *et al*., 2003; Kling *et al*., 2003; Chiotti and Lavender, 2008). **Table 5.43** identifies projected changes in regional hydrology that have implications for water quality and quantity**.** Of particular concern are areas already under stress from non-climatic factors. Communities accessing water from the Great Lakes via shallow water intakes or pipelines designed for relatively high historical water levels may experience problems in the future, resulting from more frequent low water levels. In conjunction with increased algal growth, low water levels will likely cause problems for water supply, odour, and taste (Chiotti and Lavender, 2008).

Hydrogeological Parameter	Expected Changes to Water Resources in the 21st Century Great Lakes Basin
Runoff	Decreased annual runoff, but increased winter runoff
	Earlier and lower spring freshet (the flow resulting from melting snow and ice)
	Lower summer and fall low flow
	Longer duration low flow periods
	Increased frequency of high flows due to extreme precipitation events
Lake Levels	Lower net basin supplies and declining levels due to increased evaporation and timing of precipitation
	Increased frequency of low water levels
Groundwater Recharge	Decreased groundwater recharge, with shallow aquifers being especially sensitive
Groundwater Discharge	Changes in amount and timing of baseflow to streams, lakes, and wetlands
Ice Cover	Ice cover season reduced or eliminated completely
Snow Cover	Reduced snow cover (depth, areas, and duration)
Water Temperature	Increased water temperatures in bodies of surface water
Soil Moisture	Soil moisture may increase by as much as 80% during winter in the basin, but decrease by as much as 30% in the summer and fall

Table 5.43: Expected Changes to Water Resources in the 21st Century Great Lakes Basin (from de Loë and Berg, 2006; Adaptation to Climate Change, 2007)

In general, communities dependent on surface water systems other than the Great Lakes will become increasingly susceptible to more frequent water shortages (Chiotti and Lavender, 2008*).* The impacts of climate change projected for 2020 are likely to be more significant than changes arising from projected urban development, in terms of both magnitude of peak flows and total loads of nitrogen and phosphorous (Chiotti and Lavender, 2008). The same study concluded that subwatersheds are sensitive to different stressors and respond differently to similar stressors. As a result, communities within these subwatersheds may need to respond and adapt in different ways (Chiotti and Lavender, 2008).

The ability to access water in the Great Lakes through deepwater intakes reduces the water supply's vulnerability to drought, as do the interconnected water treatment and distribution systems, which allow sharing between plants during shortages (Chiotti and Lavender, 2008).

With the potential for more summer drought periods, contamination of Lake Ontario intakes may increase. Reduced sediment transport from watersheds due to lower flows increases clarity in near shore Lake Ontario, and this in turn can create conditions for algae blooms, which have historically been significant enough to disrupt municipal lake supplies (Bowen and Booty, 2011). If water levels drop in the Great Lakes however, this can affect the operation of intakes which depend on the pressure of the water column above the intake to help move water into the plant. Decreasing water levels may require augmented pumping to draw water from the lake into the water treatment plant.

Extreme events can temporarily raise the levels in Lake Ontario which can lead to increased shoreline erosion, and transport additional pathogens to the lake, especially when rainfall occurs when the ground is snow-covered (pers. comm Bowen G). In areas reliant on groundwater, deeper sources are more protected from climate variability and are used, as shallow sources become compromised (Environment Canada, 2004).

Climate change and future climate variability are expected to increase the frequency and magnitude of low water level conditions on the Great Lakes. A real possibility is that Lake Ontario monthly still water levels could drop below historical record low elevations under future climate change/climate variation conditions by three to four tenths of a metre.

When assessing the impacts of extreme low Lake Ontario water levels on municipal water intakes in the lake, the depth of water over the intakes will affect the hydraulic intake pumping capacity and the quality of raw intake water as determined by seasonal variations in water depth and surface water quality (see **Table 2.6** for summary of water treatment plants information on the intake depth and intake distance from shoreline).

Overall, water levels in Lake Ontario may decrease by 0.4 m as the result of climate change (Mortsch, 2004). Because the Lake Ontario intakes are gravity-based, declines in lake levels will reduce the hydraulic capacity of the intake structure. This would result in an overall decrease in plant capacity (up to 10%).

5.8.2 Flooding

Most flood emergencies reported in this area between 1992 and 2003 happened in January and May and were caused by rain-on-snow conditions. Increasing winter temperatures will mean that the spring freshet is likely to occur earlier and, because of more frequent winter thaws, will likely be lower, possibly resulting in decreased risk of spring flooding (Chiotti and Lavender, 2008).

Historical trends and climate change projections discussed in **Chapter 3** suggest that there will be an increase in the incidence of drought and extreme weather patterns that could result in more frequent and more severe flooding events in the study area. Adaptive management will be increasingly required to manage water resources.

5.8.3 Climate Change Scenario—CVSPA

In 2008, the Ministry of Natural Resources and Forestry (MNRF), in association with Environment Canada and CVC, undertook a review of available meteorological and hydrological data, and attempted to develop methodologies for assessing future climate change. This joint effort culminated in a report entitled "Guide for Assessment of Hydrologic Effects of Climate Change in Ontario" (EbnFlo Environmental and AquaResource Inc., December 2009).

The objective of the study was to establish a standard procedure for conducting climate change assessments of hydrologic systems in Ontario and, thus, facilitate the mainstreaming of climate change assessment. It also attempts to establish a standard procedure for conducting assessments of the effects of climate change on water resources in Ontario to inform management and adaptation decision making.

Hydrological and meteorological data from the CVSPA were analyzed and future climate change projections were assessed as part of this work. This assessment is summarized in **Chapter 3** of this Assessment Report.

Test Case Study—Orangeville (Subwatershed 19)

The case study to examine the impact of future climate scenarios on the findings of the Tier 2 water budget stress assessment for Orangeville is described in **Chapter 3.6.4**. This study attempted to understand how the results of the Subwatershed 19 stress assessment might vary or be affected by the potential impacts of climate change. It considered a total of twelve climate scenarios (including the current), each of which estimates an average annual groundwater recharge rate as needed to complete percent water demand. The surface water flow model was run to estimate groundwater recharge for each of the twelve scenarios.

The Hydrologic Simulation Program Fortran (HSP-F) streamflow generation model was run using each of the developed future climates scenarios. Simulated streamflow and water budget parameters (i.e., precipitation, runoff, recharge, and evapotranspiration) from each climate change scenario were output from HSP-F at the daily time step.

To determine climate change impacts to the groundwater flow system, MODFLOW (a three-dimensional finite-difference groundwater flow model) was run using a monthly stress period. For each month, the simulated mean monthly recharge rates from the HSP-F model for each climate change scenario were input in the MODFLOW groundwater model. MODFLOW was run with seven-time steps per month, with simulated groundwater discharge output for each month. All simulated data were compiled in a relational database for analysis.

Streamflow regimes are a function of climate, geology, vegetation, topography, land use and hydraulic infrastructure (e.g., dams). In this assessment, only the climate was varied, all other factors remain unchanged from the current conditions. This was done to isolate impacts due to climate change. Groundwater reserve and consumptive demand were assumed to be constant in order to compute a new percent water demand for each climate scenario.

Percent water demand for each climate scenario was found to range between 11% and 17% as compared to 14%, estimated in the current climate (base line) scenario. A subwatershed is classified as having a moderate potential for hydrologic stress if the percent water demand for groundwater ranges from 10% to 20%. The water demands estimated for the future scenarios remain within this range, so the subwatershed stress ratings for these scenarios remain unchanged from the current one.

The case study did not consider impacts from land development or increased water demand. There are currently no municipal surface water takings in Subwatershed 19; therefore, climate change impacts were not completed for the Credit River.

5.9 SUMMARY

The *Technical Rules* require a risk assessment of certain prescribed activities (of both water quantity and water quality threats) that occur in the other vulnerable areas (HVAs, SGRAs, WHPAs, and IPZs) surrounding municipal water supply abstraction points. These threats may be associated with activities, conditions (past activities), or issues. The threats present in these areas are assessed using a combination of the area's natural vulnerability ranking and a hazard score for the activity per the Provincial Tables of Circumstances. Significant threats must be identified and counted in the Assessment Report and addressed in the Source Protection Plan. The SPC may also choose to address moderate and low threats within the Source Protection Plan. The SPC is not aware of any current conditions or issues affecting any groundwater or surface water drinking water source in the CVSPA study area.

Threats to Water Quantity

Under the *Technical Rules*, water quantity threats are associated with municipal groundwater and inland surface water systems. These threats are defined and assessed through the water budget process. The Great Lakes are exempt from such assessment, and there are no surface water intakes on the Credit River.

With respect to municipal groundwater-based systems (wells), a Tier 3 Water Budget study completed for the municipalities of Orangeville, Mono and Amaranth has identified 305 significant water quantity threats related to consumptive usage and to recharge reduction.

A Tier 3 Water Budget study completed for the municipalities of Acton and Georgetown has similarly identified 87 significant water quantity threats related to consumptive usage.

Threats to Water Quality – Surface Water

Under the *Technical Rules*, water quality issues, conditions, and threats must be defined and assessed through approved methodologies. The analysis for the CVSPA resulted in no significant water quality issues, conditions, or threats being identified in any of the HVAs, SGRAs, or IPZs to date.

A number of spill scenarios were modelled as part of the Lake Ontario Collaborative (LOC) project to determine if certain land-based activities could pose a potential drinking water threat to these intakes. Any scenario that identifies conditions under which a contaminant could exceed a threshold in the raw water is identified as a significant drinking water threat. The scenarios considered included:

- Disinfection failure at each Lake Ontario Wastewater Treatment Plant to evaluate the potential effects to nearby Water Treatment Plants;
- Release of *E. coli* from an industrial processing facility into the Credit River;
- Combined sewer overflow release in the City of Toronto to evaluate the potential effects of the Toronto WTPs (this did not impact any CVSPA intakes);
- Sanitary Trunk Sewer breaks within Toronto area creeks;
- Spill of gasoline/refined product from large pipelines located under major tributaries to Lake Ontario (e.g., Credit River, Humber River, etc.);

- Release of gasoline from a bulk petroleum fuel storage facility in the Oakville area and in the Keele/Finch Area of Toronto; and
- Discharge of tritium from nuclear generating facilities at Pickering and Darlington (this did not impact any CVSPA intakes).

The Technical Rules require an IPZ-3 is to be delineated if modelling demonstrates that contaminants may be transported to an intake and result in deterioration of the raw water quality of a drinking water supply above a specific threshold, based on the ODWS.

The selected LOC spill scenarios were based on "real" events that have occurred in the past and were not based on extreme weather condition events at the time of the spill. The IPZ-3 for each threat activity was delineated by drawing a line from the location of the threat activity on shore where the contaminant is released to the affected intake along the shortest path within the area where concentrations were modelled to exceed the threshold for that contaminant.

The identification of significant threats does not consider any risk management measures that may be in place. Source Protection Plan policies when implemented are intended to reduce or eliminate threats to drinking water. The Lake Ontario modelling identified three locations of significant drinking water quality threats for Lake Ontario intakes within the CVSPA. The Source Protection Plan for CTC SPR must have policies to address these significant drinking water threats that are located within the source protection area.

In addition, CVSPA has identified significant drinking water threats located outside of the CVSPA. These activities, although not enumerated in this Assessment Report, affect water treatment plants located in CVSPA, and must be addressed through source protection plan policies developed in adjacent source protection areas. CVSPA staff has brought this information to the attention of the source protection staff of the neighbouring source protection areas to ensure that policies are developed for them.

Threats to Water Quality – Groundwater

With respect to the groundwater, water quality issues relating to sodium (Na) and chloride (Cl) were identified in WHPAs of several municipal wells servicing the Town of Orangeville; issues relating to chloride (Cl) were identified for municipal wells servicing Georgetown; and issues relating to Nitrates ($N0_3$) were identified in one municipal well servicing Acton. No conditions were identified in any of the WHPAs of municipal wells within the CVSPA. A total of 9,553 significant threats related to water quality have been identified in WHPAs in the CVSPA. They are located on 6,725 parcels of land as shown in **Table 5.44**.

Most of the significant threats in the CVSPA are related to issues identified in municipal wells serving the most populated urban centres: Acton, Georgetown, and Orangeville. These are areas in the middle and upper zones of the Credit River watershed where sizeable populations receive municipal water supplies sourced solely from groundwater.

Table 5.44: Significant Water Quality Threats Count in the CVSPA

Municipality	Wells	Significant Drinking Water Threats	Total # of Parcels with Significant Drinking Water Threats
Town of Orangeville	Wells 2A, 5, 5A, 6, 7, 8B, 8C, 9A, 9B, 10, 11 and 12	2,501	2,268
Town of Mono	Cardinal Woods Wells 1, 3 and 4, Island Lake Wells TW1 and PW1, and Coles Wells 1 and 2	17	8
Township of Amaranth	Pullen Well	12	2
Town of Erin	Erin Wells 7 and 8	28	10
	Hillsburgh Wells H2 and H3	39	19
	Bel Erin Wells 1 and 2	223	104
Region of Halton	Acton 4th Line Well, Davidson Wells 1 and 2, and Prospect Park Wells 1 and 2	564	246
	Georgetown Lindsay Court Well 9, Princess Anne Wells 5 and 6, and Cedarvale Wells 1a, 3a, 4 and 4a	6,135	4,046
Region of Peel	Alton Wells 3 and 4A	13	12
	Caledon Village Wells 3 and 4	2	1
	Inglewood Wells 3 and 4	3	3
	Cheltenham Wells 1 and 2	16	6
	Total	**9,553**	**6,725**

Note that since the Pullen Well (Amaranth) and its WHPAs lie within the WHPAs for Orangeville Wells 8B, 8C and Well 12, a number of the threats and affected properties enumerated around the Pullen Well are also included in the threats count for Orangeville. Similar overlap occurs within Orangeville (WHPA & ICA), and between Mono's Coles wells and Orangeville Well 10 WHPAs. Given this, the total threat and parcel counts do not represent direct summations of the data shown for the individual municipalities.

Climate Change

Although total annual runoff is projected to decrease as a result of future climate change, flows are expected to increase during the winter and decrease significantly during the summer, when demand is highest. The overall effect on the Great Lakes is expected to be a net decline in water levels, but the system is complex, especially with water level controls in place for the St. Lawrence Seaway system (Chiotti and Lavender, 2008).

In general, communities dependent on surface water systems other than the Great Lakes will become increasingly susceptible to more frequent water shortages. However, the ability to access water in the Great Lakes through deep water intakes reduces the water supply's vulnerability to drought, as do the interconnected water treatment and distribution systems, which allow sharing between plants during shortages.

CVC staff is actively engaging consultants to minimize the effects of urbanization and climate change on the hydrology and hydrogeology across the CVSPA. Such work includes pilot projects for a wide variety of innovative stormwater management practices, including rainwater harvesting, green roofs, and infiltration enhancements (e.g., pervious pavement, infiltration galleries).

Uncertainty and Data Gaps

Considerable uncertainty is involved in the threats inventory for this study. The uncertainty level associated with the WHPAs has however been reduced through limited field verification undertaken since 2012, to support the early work that was done. It is anticipated that the continual collection of information over time (field surveys, verification) will allow for further reduction in the uncertainty associated with the threats inventory. The MOECC recognizes the preliminary nature of this inventory, and that the activities have not been fully verified in the field. However, under the *CWA,* if an activity exists that is not inventoried here, it is still a significant threat, and if an activity does not exist on the landscape but is inventoried here, it is not a significant threat.

Source protection policies will apply only to specific activities in the respective vulnerable areas. If an activity does not exist on a property in a vulnerable area, there are no implications from the policy.

In developing policies to address these significant threats, the CTC SPC and other SPCs in the Lake Ontario Collaborative must take into consideration the dynamic nature of the nearshore water quality in Lake Ontario. As shown in the modelled scenarios, contaminants released in one source protection area can travel to intakes throughout that area and beyond.

The threat count reflects the various circumstances associated with a particular activity (as presented in the Provincial Tables of Circumstances. A source protection committee may also choose to address potential moderate and low threats within the source protection plan.