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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 Technical Rules outline the legislated content for assessment reports across Ontario. The Technical Rules report was posted on the MOECC's website in December 2008 and further amended in November 2009. The 2017 version of the document can be found at: https://www.ontario.ca/page/2017-technical-rules-under-clean-water-act. Amendments to the Central Lake Ontario Source Protection Area Assessment Report resulting in version 2 were made using the 2017 Director's Technical Rules and Tables of Drinking Water Threats. Sections of the Assessment Report that were not updated as part of those amendments refer to the 2009 edition of the Director's Technical Rules and Tables of Drinking Water Threats.

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 Toronto and Region Source Protection Area (TRSPA), municipal water supplies are sourced from groundwater and from Lake Ontario (**Chapter 2**). Stresses to water quantity have been identified with part of the Toronto and Region Conservation (TRCA) watersheds through the York Tier 3 Water Budget process (**Chapter 3**).

Note that the *Technical Rules* exempt Great Lakes sources from the water quantity threat assessment process.

Conceptual and Tier 1 Water Budgets were completed for the TRSPA study area, as per *Technical Rules (19–24)*. The screening results calculated groundwater and/or surface water *stresses* in 21 *subwatersheds,* but the only additional work necessary under the *Clean Water Act, 2006* (*CWA)* was a Tier 3 Water Budget for the Whitchurch–Stouffville and Uxville drinking 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

It should be noted that the site-specific verification of threats was not conducted as part of this study. Therefore, 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. However, 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 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 Table 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 make an activity a low, moderate, or significant drinking water threat. The Provincial Tables of Circumstances that apply in the TRSPA 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 issues or conditions were identified in the TRSPA, as per *Rules (114) and (115)* (issues) and *Rule (126)* (conditions), although a small part of the issue contributing area (chloride) for Orangeville Well 10 extends into the northwest corner of the TRSPA.

Table 5.1: Provincial Tables of Circumstances (2010)

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

Notes: *Only Tables of Circumstances that apply within the TRSPA 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 *Ontario Water Resources Act*, Ontario Regulation 903: Water Wells and Ontario Regulation 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 quality and quantity 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* 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 process for the identification of drinking water quality threats.

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 are relevant to drinking water quantity threats. The following list of these prescribed, ongoing activities was assembled by the MECP 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 (DNAPL);*

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.

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 operations of a liquid carbon pipeline (per inclusion under 2017 Phase 1 Director's Technical Rules)*.

*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.

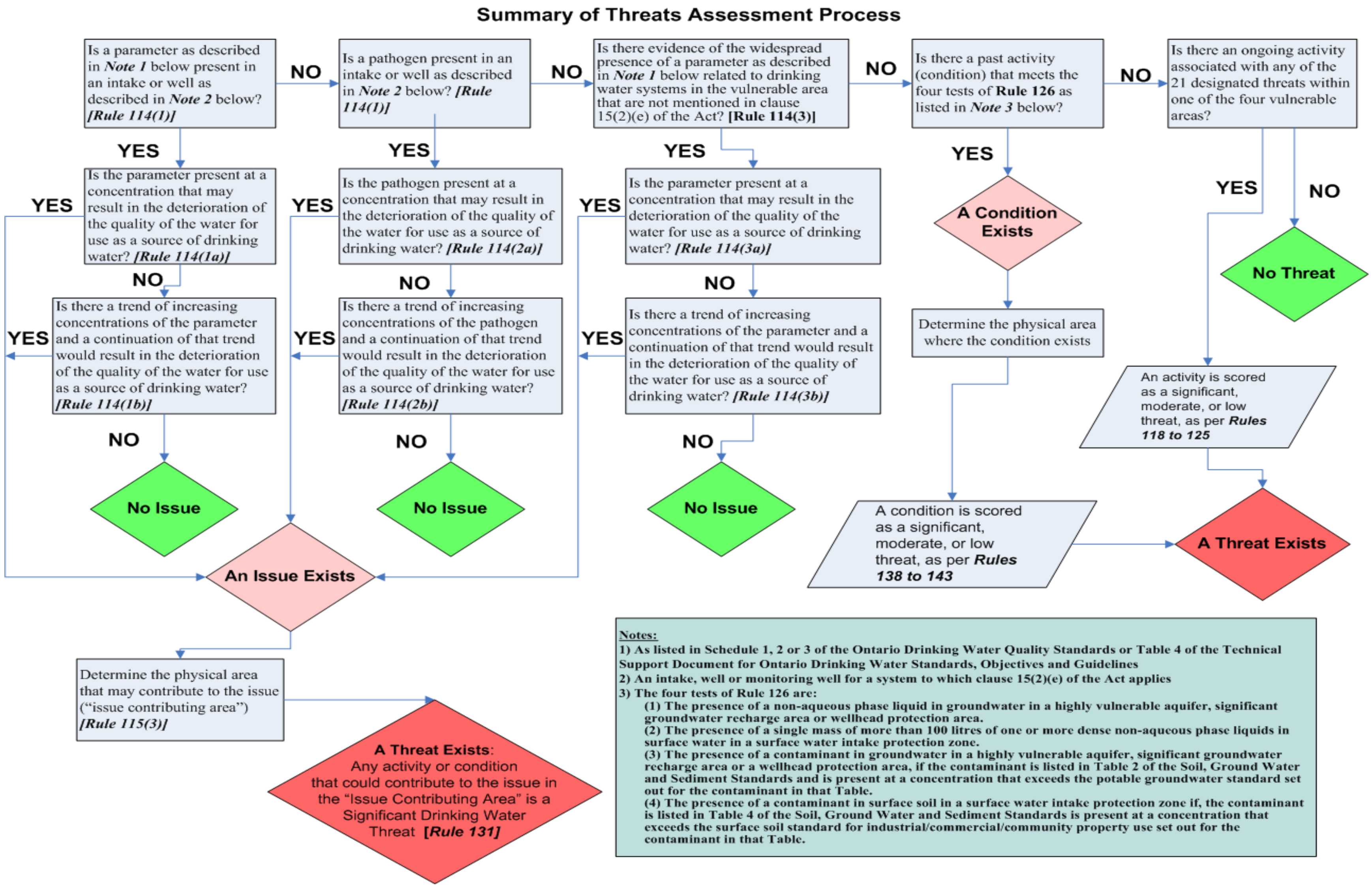


Figure 5.1: Summary of Threats Assessment Process

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 TRSPA:

- Pipe line 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 Water Use and Recharge Reduction

The water quantity threats assessment process is documented in **Chapter 3** of this document. A summary of the findings are presented in **Section 5.3**. Only future significant water quantity threats have been identified in TRSPA, existing moderate water quantity threats were identified through the York Tier 3 water budget project. Water quantity threats are discussed in **Section 5.3 and Section 5.6**.

5.2.3 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.
- 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.

5.2.4 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 were 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 *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 the 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 ODWS or 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 indicate 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.

Although no issues have been identified for TRSPA drinking water systems, the issue contributing area for Orangeville Well #10 extends into the northwest corner of the TRSPA.

5.2.5 Assessing Threats from Activities

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 drinking water source;
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 *Technical Rule (122).*

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

Hazard Ratings

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 Table 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:

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 of equal to or greater than 80 and above: significant.

The *Technical Rules* 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 Plan. The CTC SPC may choose to develop policies to address low or moderate drinking water threats.

5.2.6 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 land uses are commonly found on the fringes of urban areas and on vacant Greenfield lands. Non-agricultural uses include 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-1s 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 pasture land; 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 (SGRAs, HVAs, and WHPAs), or 4.4 or higher for surface water (including IPZs and WHPA-E), 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 and SGRAs 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.

5.2.7 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 (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.

5.2.8 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 TRSPA jurisdiction (IPZs, SGRAs and HVAs).

The impervious surfaces analyses for the TRSPA study area were completed for HVAs, SGRAs, WHPAs, and IPZ-1s and IPZ-2s (where they extend onto the land). The analyses include all on-land areas where the vulnerability exceeds a score of 6 in HVAs, SGRAs, 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 TRSPA HVA, SGRA, WHPA, and IPZ delineations with their associated vulnerability scoring (**Chapter 4** and **Appendix D**), and mapping of the road network across the TRSPA. 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.

TRCA 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 in 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%.

5.2.9 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 for only some WHPAs, and not for any other vulnerable areas. 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.

As mentioned in **Chapter 4**, the Tables of Circumstances assume that any possible threats associated with an activity is present and that all potential chemicals are present based on typical storage practices, typical chemical quantities, and typical waste disposal practices for that particular land use activity. The inventory and enumeration of threats for the most part was done as a desktop exercise, for which the level of uncertainty regarding the site specific existence of the threats is classified as high. This level of uncertainty is expected in a desktop study. It is anticipated that additional information collected over time will allow for the uncertainty related to the threats inventory to be reduced. 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.
- 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 uncertainty. 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.
- 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.

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 analysis of these activities are documented in **Appendix E.1** of this

Assessment Report. As described in **Chapter 3**, the vulnerable area for water quantity in the TRSPA has been assigned a moderate risk level which results in existing threat activities being moderate water quantity threats while future (new) activities are considered significant water quantity threats. The following existing moderate water quantity threats related to taking water were identified:

- 15 municipal wells;
- 62 permitted, non-municipal wells; and
- 5506 non-permitted wells.

5.4 GROUNDWATER QUALITY THREATS IN HIGHLY VULNERABLE AQUIFERS (HVA)

In HVAs, no significant threats can be identified using the methodology associated with the scoring system for vulnerability and/or 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 the 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 have been identified in HVAs within the TRSPA. However, TRCA staff will continue to monitor background groundwater quality through the Provincial Groundwater Monitoring Network (PGMN).

5.4.2 Threats from Activities

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

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. 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 and SGRAs, while Table 11 (DW6L DNAPLS) and Table 18 (CSGRAHVA6L Chemical) provides the listing of circumstances that represent low threats in HVAs and SGRAs. **Table 5.2** provides the number of threat circumstances for HVAs and SGRAs. The maps of HVAs is provided on **Figure 5.2**.

Table 5.2: Number of Circumstances that Could Pose a Threat in HVAs and SGRAs

Vulnerable Area: HVA/ SGRA (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	1148	1156

**Note Low and moderate threat numbers are subject to revision following changes to the technical rules.*

5.4.3 Threats from Managed Lands in HVAs

The mapping shows significant clusters of managed land activities in the southwest portion of Caledon, in Rouge Park, and in north Pickering. In localized parts of these areas, managed lands exceed 80% of the area of an HVA, which results in greater potential risk to the aquifers in these local areas.

Table 5.3 shows the percentage of the HVAs having low threat levels due to managed lands. About 37% of the HVAs in the TRSPA (mostly in Caledon and the northeast portion of the jurisdiction) have a moderate risk due to managed lands, while about 15% have a high risk score. **Figure 5.2** shows significant clusters of agricultural activities throughout the rural northern part of the TRSPA. Note that the non-HVA areas are left unshaded on these maps because the methodology does not apply outside of the vulnerable areas.

Table 5.3: Managed Lands in Highly Vulnerable Aquifers

Managed Lands (%)	Risk Score	% of Total HVAs		Threat
< 40	Low	51.2		
40–80	Moderate	34.5		Low
> 80	High	14.3		

5.4.4 Threats from Estimated Livestock Density in HVAs

Only those areas of HVAs where livestock facilities were found are included in Figure 5.3. Note that the non-HVA areas are left unshaded on this map because the methodology does not apply outside of the vulnerable areas. **Table 5.4** 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. Only about 4% of HVAs, and less than 1% has high risk score for this vulnerable area.

Table 5.4: Estimated Livestock Density in Highly Vulnerable Aquifers

Estimated Livestock Density	Risk Score	% of Total HVAs		Threat
< 0.5 NUs/acre	Low	96.4		
0.5 to 1.0 NU/acre	Moderate	3.4		Low
> 1.0 NU/acre	High	0.2		

Note: *Approximately 50% (47.5%) of < 0.5 NU are actually zero*

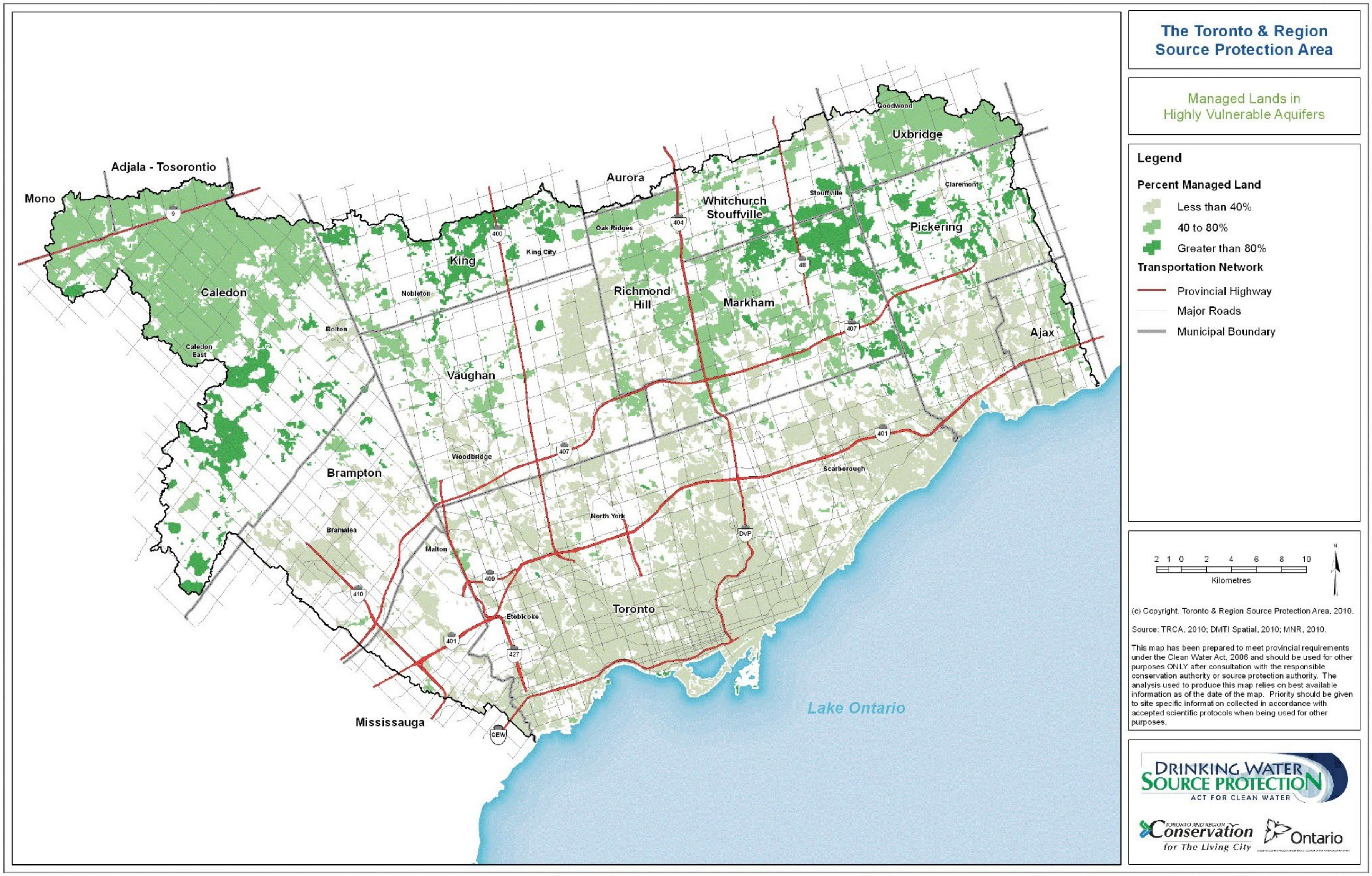


Figure 5.2: Managed Lands in Highly Vulnerable Aquifers

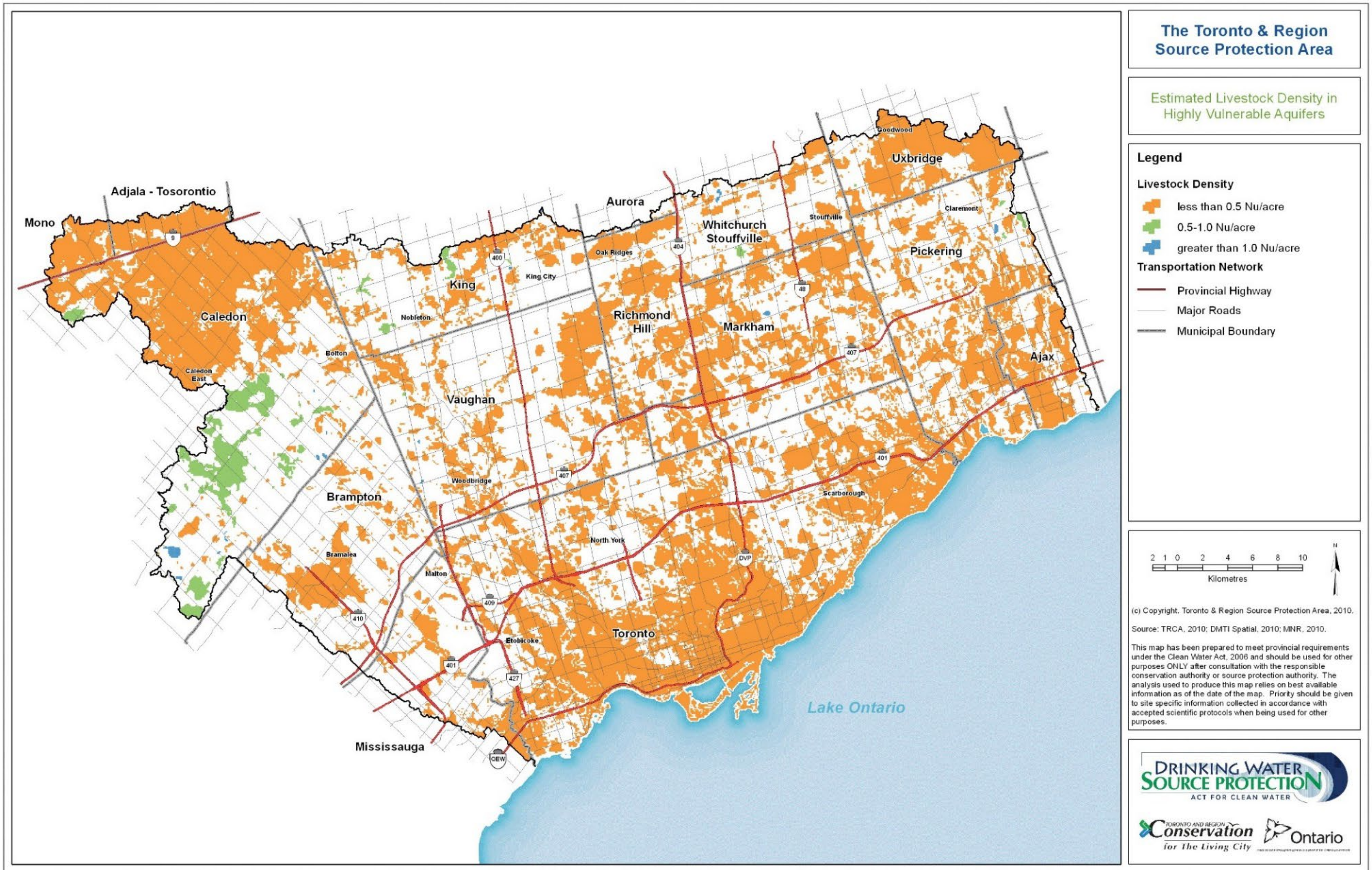


Figure 5.3: Estimated Livestock Density in Highly Vulnerable Aquifers

5.4.5 Threats for Impervious Surfaces in HVAs

Table 5.5 summarizes the percentages of impervious surfaces within the HVAs. About 90% of the HVAs within the TRSPA watershed experience moderate levels of imperviousness (between 1% and 80%). This level rises based on land use. The remaining 10% of the HVAs have less than 1% impervious surfaces where the threat due to salt application on impervious surfaces is extremely limited.

Urban areas, which are made up of residential subdivisions, commercial developments, 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 TRSPA (see Figure 5.4). Note that the non-HVA areas are left unshaded on these maps because the methodology does not apply outside of the vulnerable areas.

Table 5.5: Impervious Surfaces in HVA

Impervious Surfaces (%)	% of Total HVAs		Threat
not more than 1	9.7		No Threat
more than 1; not more than 8	39.1		Low
more than 8; not more than 80	51.2		
80 or more	0.0		

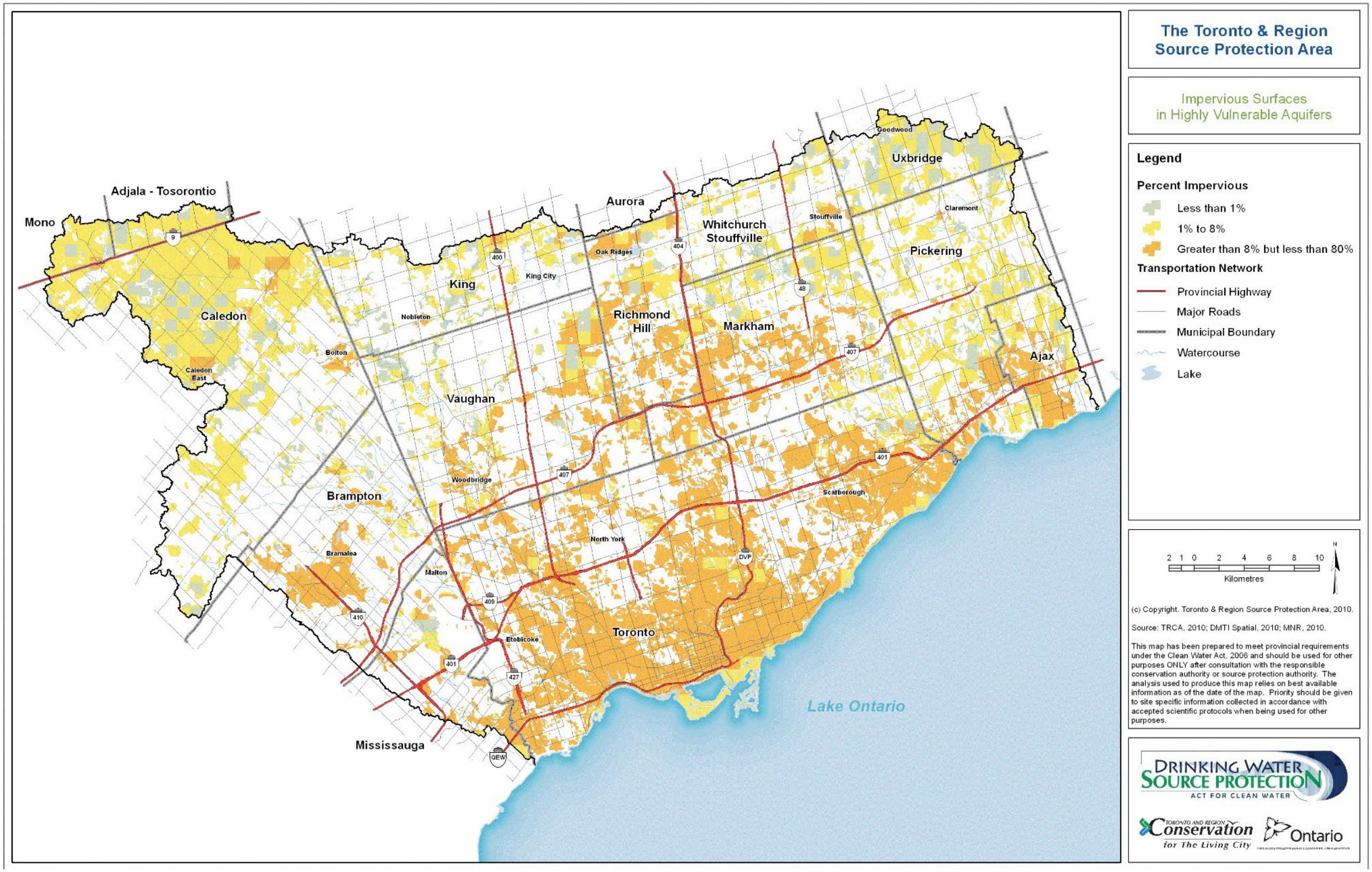


Figure 5.4: Impervious Surfaces in Highly Vulnerable Aquifers

5.5 GROUNDWATER QUALITY THREATS IN WELLHEAD PROTECTION AREAS (WHPA)

The threats assessment and inventories within the WHPAs were completed by consultants retained respectively by the regional municipalities of Peel (**Appendix E3**), York (**Appendix E4**), and Durham (**Appendix E5**). **Table 5.6** summarizes the significant threats identified in the WHPAs across the TRSPA, and the following sections provide details organized by well field. No issues were identified in any wellhead protection area in the TRSPA. Issues pertaining municipal residential drinking water systems whose WHPAs extend into TRSPA are outlined in the Assessment Report for their respective SPAs. **Appendices E3, E4,** and **E5** contains additional information on the approach and mapping products.

Table 5.6: Summary of Significant Drinking Water Threats to Groundwater Quality for the Toronto and Region Source Protection Area

Region	Well(s)	Significant Drinking Water Threats	Total # of Parcels with Significant Drinking Water Threats
Region of Peel	Caledon East 3	4	3
	Caledon East 4 & 4A	3	2
	Palgrave 2	1	1
	Palgrave 3	2	2
	Palgrave 4	1	1
York Region	Kleinburg 3	34*	14*
	Kleinburg 4		
	Nobleton 2	138	74
	Nobleton 3		
	Nobleton 5		
	King City 2	19	10
	King City 3		
	Whitchurch–Stouffville 2	243	80
	Whitchurch–Stouffville 3		
	Whitchurch–Stouffville 5		
	Whitchurch–Stouffville 6		
Durham Region	Uxville 1 and 2	17	8
	Total**	**462**	**195**

**Note threat counts NOT adjusted for the removal of Kleinberg Well 2. Threats verification underway by York Region staff.*

***Note threat counts NOT adjusted for the Orangeville ICA extending into TRSPA, as no significant threats were identified there beyond what is stated in the Credit Valley SPA Assessment Report.*

5.5.1 Drinking Water Threats - Region of Peel

Caledon East - Threats and Issues

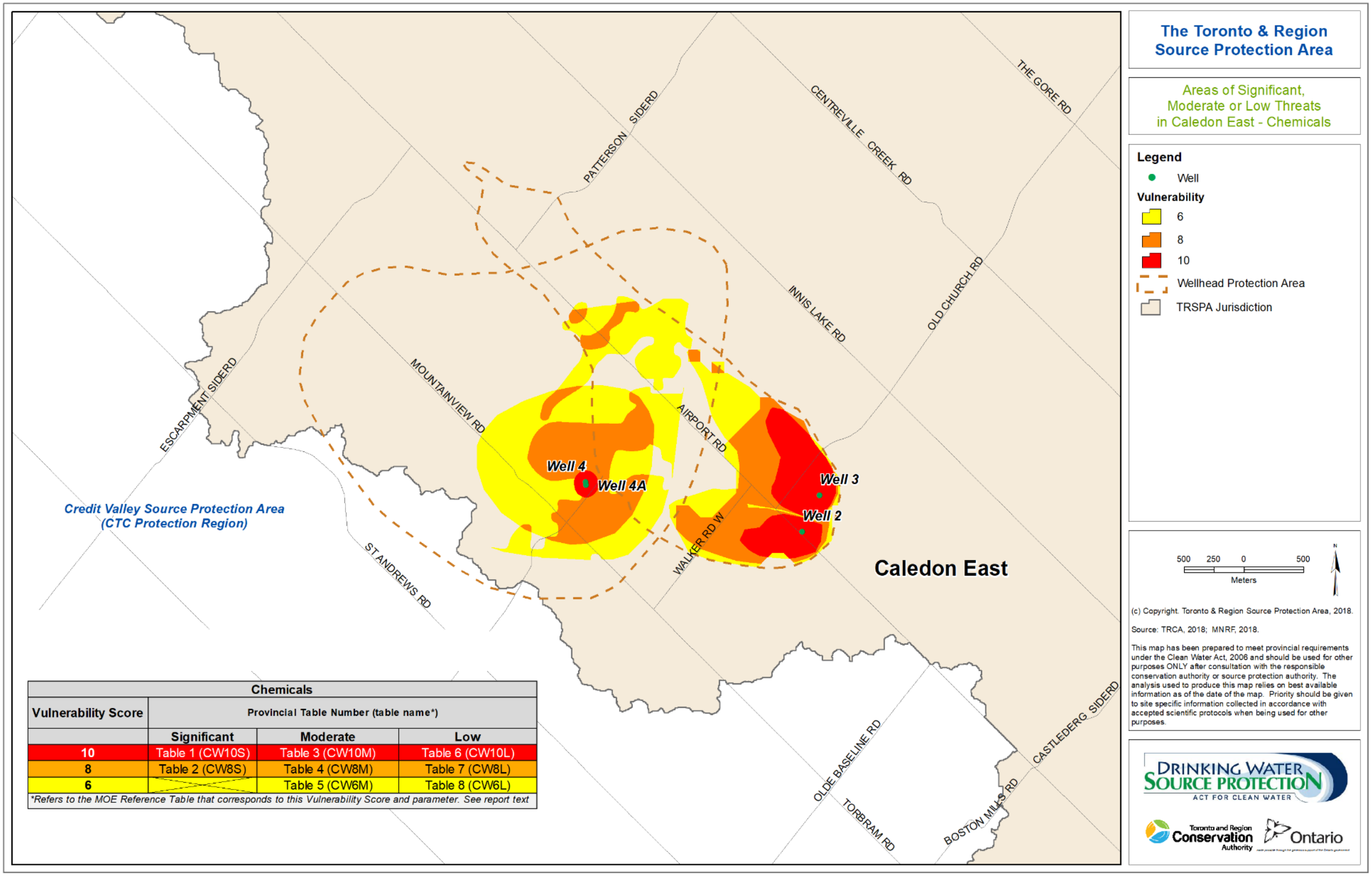
Caledon East Well 3 is located off of Airport Road in the centre of the Village of Caledon East, while Caledon East 4 and 4A are located across from a park in a residential area. The WHPAs for Caledon East 3 intersect and extend northwest along Airport Road. Land uses within the WHPAs include commercial, residential, agricultural, and recreation.

The threats inventory for Caledon East wells 3 and 4 was conducted by R.J. Burnside and Associates (Burnside, 2010), and by Matrix Solutions Inc. for Well 4A (Matrix, 2018). The summary of potential threats identified for this well field is provided in **Table 5.7**. No significant managed lands threats were identified for this area. No conditions or issues were identified for this water system. The areas where the threats are or would be low, moderate, and significant for chemicals, DNAPLs, and pathogens are shown on **Figure 5.8**, **Figure 5.9**, and **Figure 5.10**, respectively.

Table 5.7: Significant Threats Identified in Caledon East

Activity (or Threat Type)	Threats			
	Sig.	Mod.	Low	Total
1. The establishment, operation, or maintenance of a waste disposal site within the meaning of Part V of the *Environmental Protection Act* (*EPA*)	0			
2. The establishment, operation, or maintenance of a system that collects, stores, transmits, treats, or disposes of sewage	0			
3. The application of agricultural source material to land	0			
4. The storage of agricultural source material	0			
5. The management of agricultural source material	0			
6. The application of non-agricultural source material (NASM) to land	0			
7. The handling and storage of non-agricultural source material NASM	0			
8. The application of commercial fertilizer to land	0			
9. The handling and storage of commercial fertilizer	0			
10. The application of pesticide to land	0			
11. The handling and storage of pesticide	0			
12. The application of road salt	0			
13. The handling and storage of road salt	0			
14. The storage of snow	0			
15. The handling and storage of fuel	2			
16. The handling and storage of a dense non-aqueous phase liquid	4			
17. The handling and storage of an organic solvent	1			
18. The management of runoff that contains chemicals used in the de-icing of aircraft	0			
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			
20. An activity that reduces the recharge of an aquifer	0			
21. The use of land as livestock grazing or pasturing land, an outdoor confinement area, or a farm-animal yard	0			
Total Threats	7			
Total Parcels	5			

**Note in 2018, well 4A was brought on-line, at this time low and moderate drinking water threats were not re-evaluated, and so the enumeration of moderate and low threats were removed from this summary.*

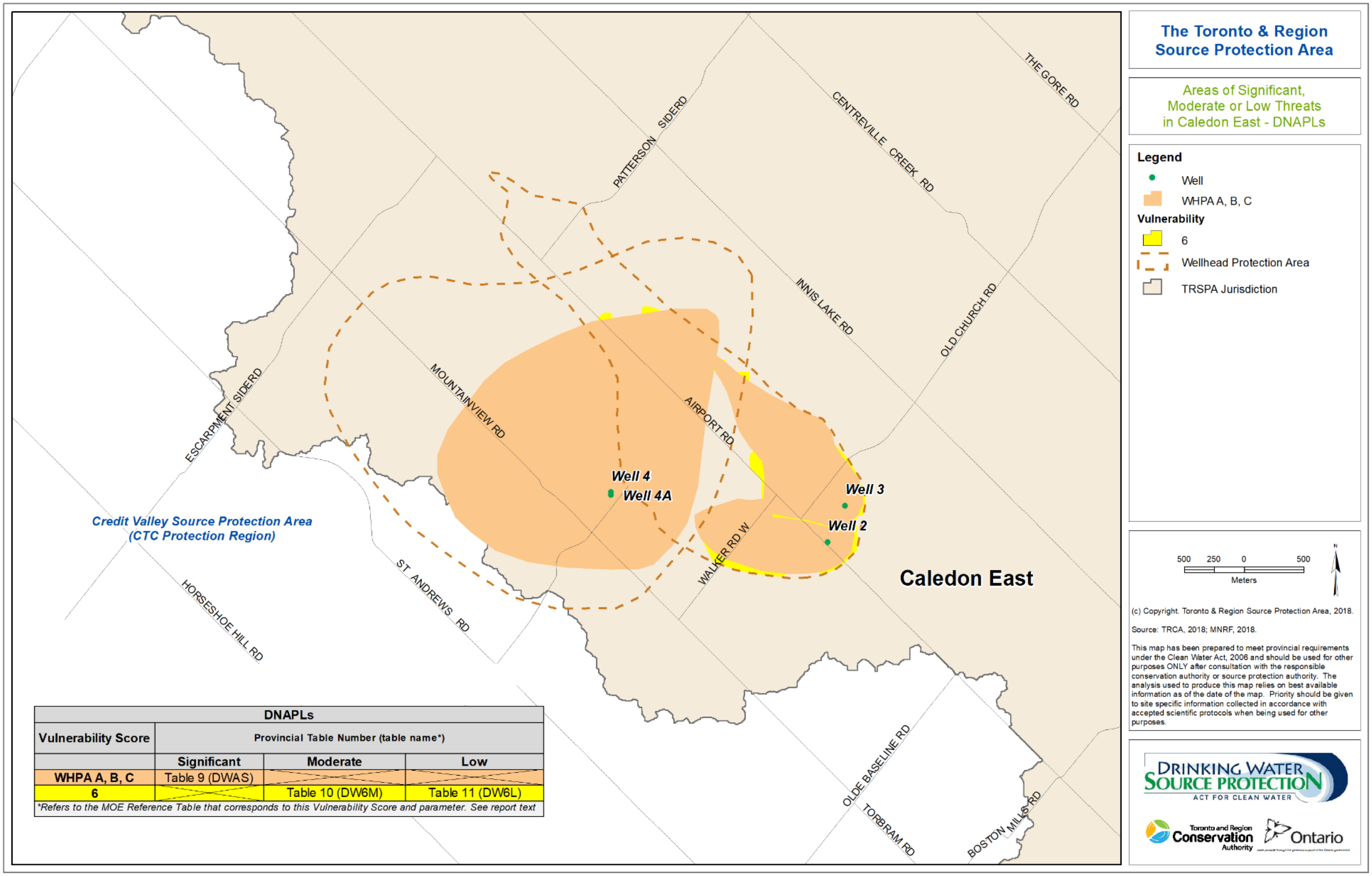


Chemicals			
Vulnerability Score	Provincial Table Number (table name*)		
	Significant	Moderate	Low
10	Table 1 (CW10S)	Table 3 (CW10M)	Table 6 (CW10L)
8	Table 2 (CW8S)	Table 4 (CW8M)	Table 7 (CW8L)
6		Table 5 (CW6M)	Table 8 (CW6L)

*Refers to the MOE Reference Table that corresponds to this Vulnerability Score and parameter. See report text

Figure 5.5: Areas of Significant, Moderate and Low Threats in Caledon East – Chemicals

The 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/

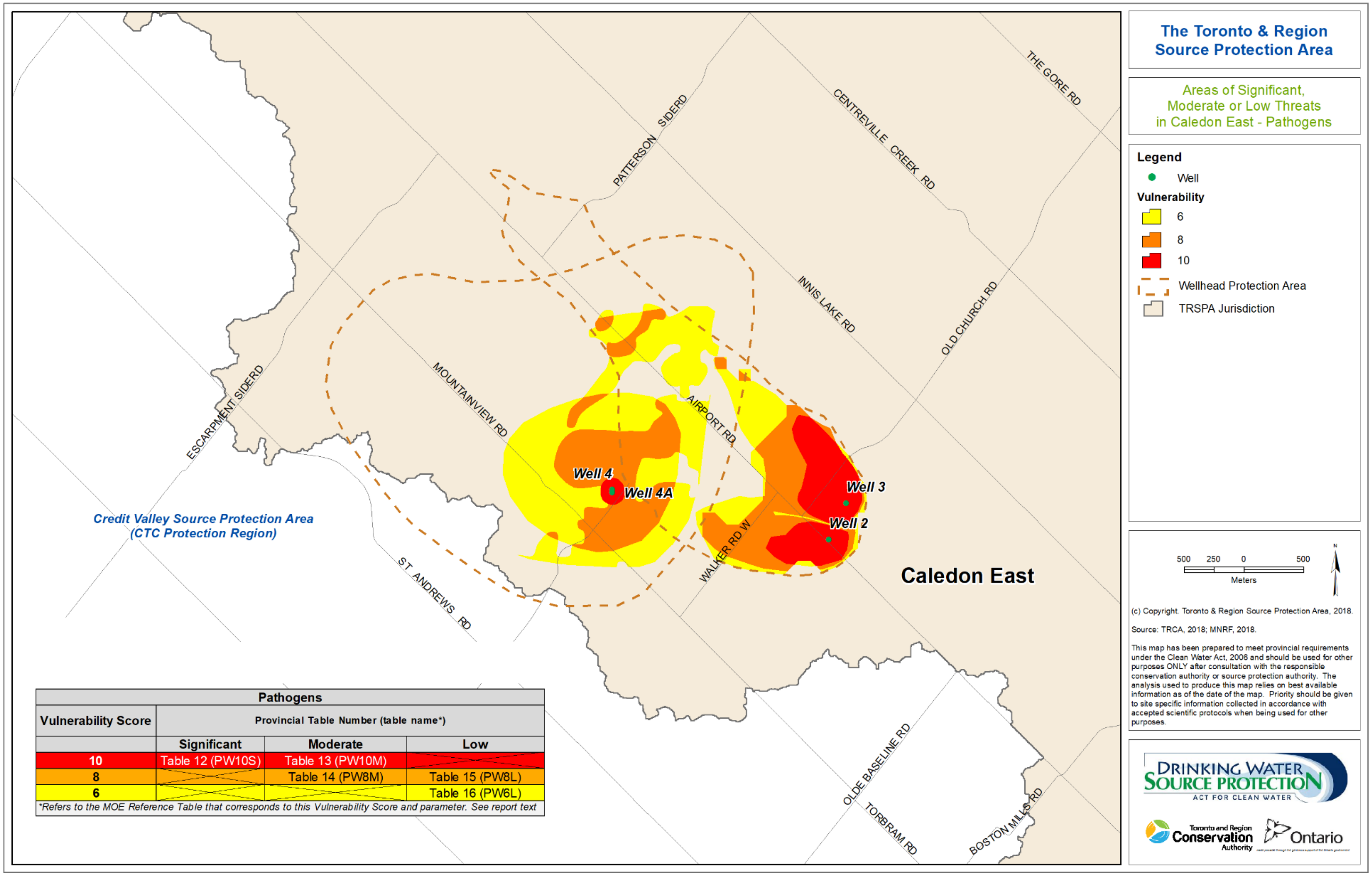


DNAPLs			
Vulnerability Score	Provincial Table Number (table name*)		
	Significant	Moderate	Low
WHPA A, B, C	Table 9 (DWAS)		
6		Table 10 (DW6M)	Table 11 (DW6L)

*Refers to the MOE Reference Table that corresponds to this Vulnerability Score and parameter. See report text

Figure 5.6: Areas of Significant, Moderate and Low Threats in Caledon East - DNAPLs

The 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/



Pathogens			
Vulnerability Score	Provincial Table Number (table name*)		
	Significant	Moderate	Low
10	Table 12 (PW10S)	Table 13 (PW10M)	
8		Table 14 (PW8M)	Table 15 (PW8L)
6			Table 16 (PW6L)

*Refers to the MOE Reference Table that corresponds to this Vulnerability Score and parameter. See report text

Figure 5.7: Areas of Significant, Moderate and Low Threats in Caledon East - Pathogens

The 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/

Palgrave - Threats and Issues

The WHPAs of the Palgrave wells cover land north of the Village of Palgrave up to Highway 9. Palgrave well 2 is located on Mount Hope Road beside a large wetland area, Palgrave well 3 is located beside a baseball field on Mount Hope Road, and Palgrave well 4 is located on a wooded property east of County Road 50. Land uses within the Palgrave WHPAs include natural and open space, agricultural, and residential. No conditions or issues were identified for this water system.

The threats inventory for Palgrave was conducted by R.J. Burnside and Associates (Burnside, 2010). The summary of potential low, moderate, and significant threats for this well field is tabulated in **Table 5.8.** No significant managed lands threats were identified for this area. No conditions or issues were identified for this water system. The areas where the threats are or would be low, moderate, and significant for chemicals, DNAPLs, and pathogens are shown on **Figure 5.11, Figure 5.12,** and **Figure 5.13**, respectively.

Table 5.8: Threats Identified in Palgrave

Activity (or Threat Type)	Threats			
	Sig.	Mod.	Low	Total
1. The establishment, operation, or maintenance of a waste disposal site within the meaning of Part V of the *Environmental Protection Act* (*EPA*)	0	0	0	**0**
2. The establishment, operation, or maintenance of a system that collects, stores, transmits, treats, or disposes of sewage	0	25	36	**61**
3. The application of agricultural source material to land	0	0	2	**2**
4. The storage of agricultural source material	0	2	0	**2**
5. The management of agricultural source material	0	0	0	**0**
6. The application of non-agricultural source material (NASM) to land	0	1	2	**3**
7. The handling and storage of non-agricultural source material NASM	0	0	0	**0**
8. The application of commercial fertilizer to land	0	3	2	**5**
9. The handling and storage of commercial fertilizer	0	1	1	**2**
10. The application of pesticide to land	0	1	1	**2**
11. The handling and storage of pesticide	0	1	1	**2**
12. The application of road salt	0	0	0	**0**
13. The handling and storage of road salt	0	0	0	**0**
14. The storage of snow	0	0	0	**0**
15. The handling and storage of fuel	4	9	4	**17**
16. The handling and storage of a dense non-aqueous phase liquid	0	0	0	**0**
17. The handling and storage of an organic solvent	0	0	0	**0**
18. The management of runoff that contains chemicals used in the de-icing of aircraft	0	0	0	**0**
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	**0**
20. An activity that reduces the recharge of an aquifer	0	0	0	**0**
21. The use of land as livestock grazing or pasturing land, an outdoor confinement area, or a farm-animal yard	0	2	0	**2**
Total Threats	**4**	**45**	**49**	**98**
Total Parcels	**4**	**35**	**40**	**79**

Notes: Sig. = Significant; Mod. = Moderate

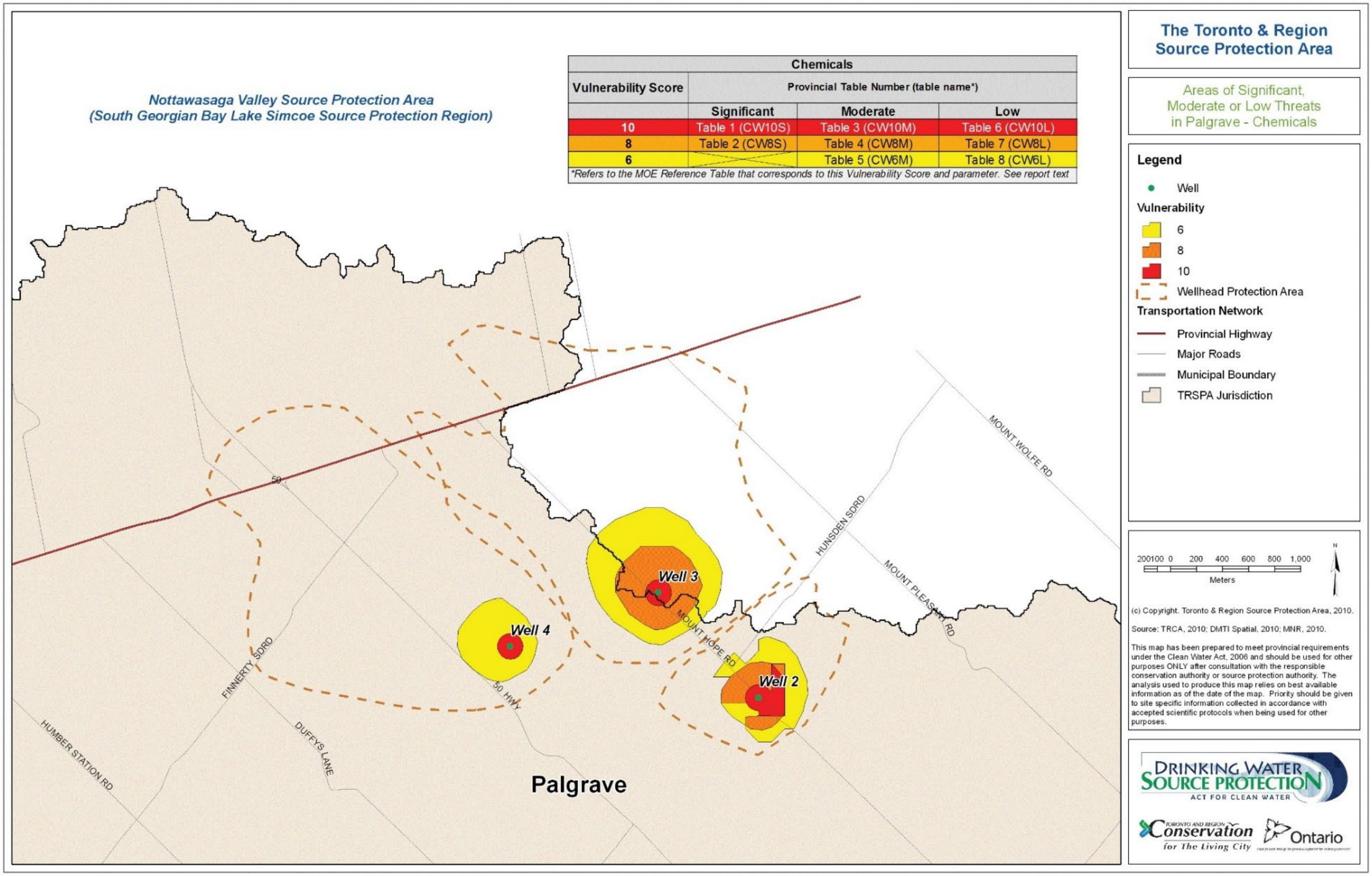


Figure 5.8: Areas of Significant, Moderate and Low Threats in Palgrave - Chemicals

The 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/

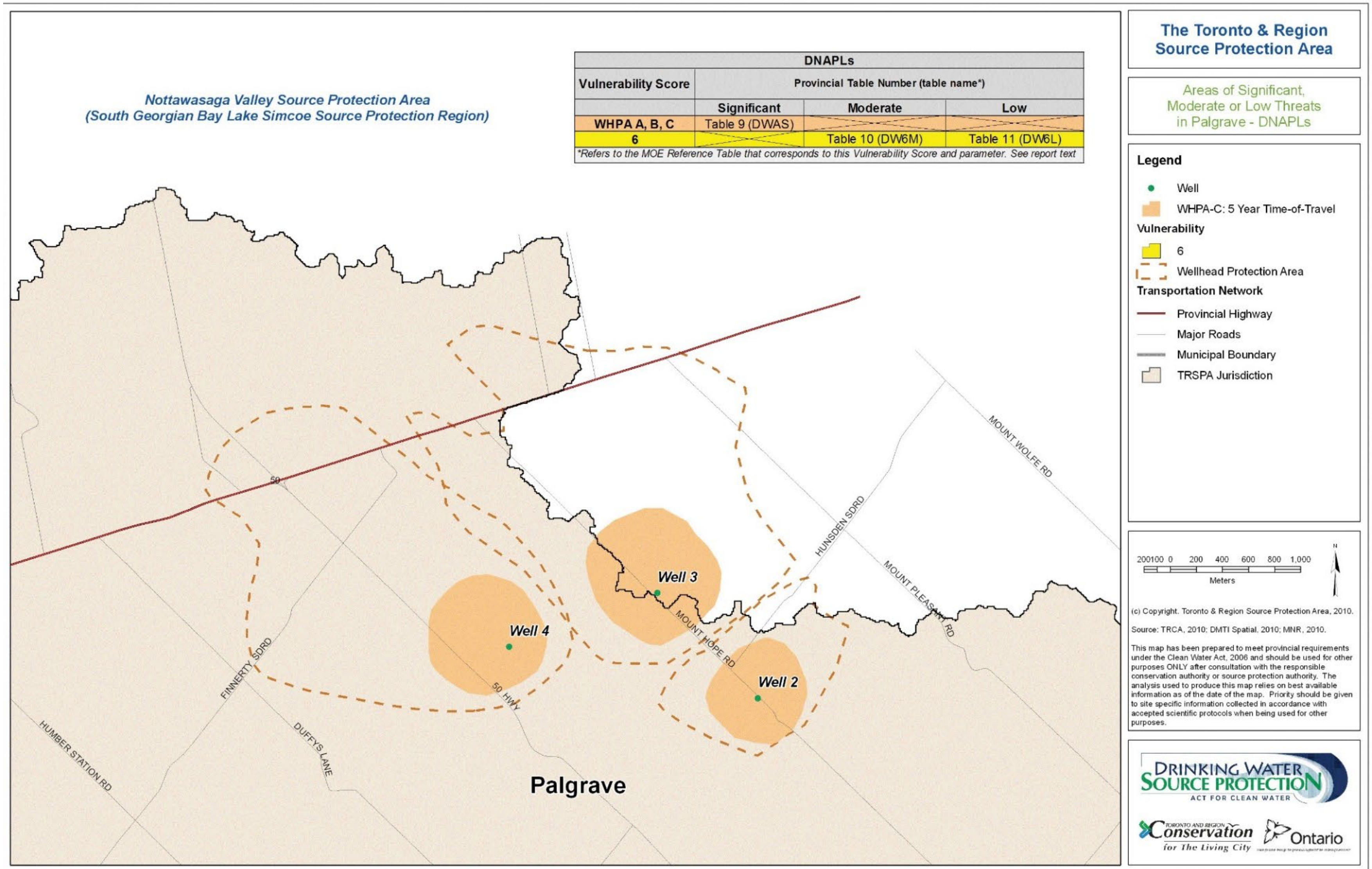


Figure 5.9: Areas of Significant, Moderate and Low Threats in Palgrave - DNAPLs

The 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/

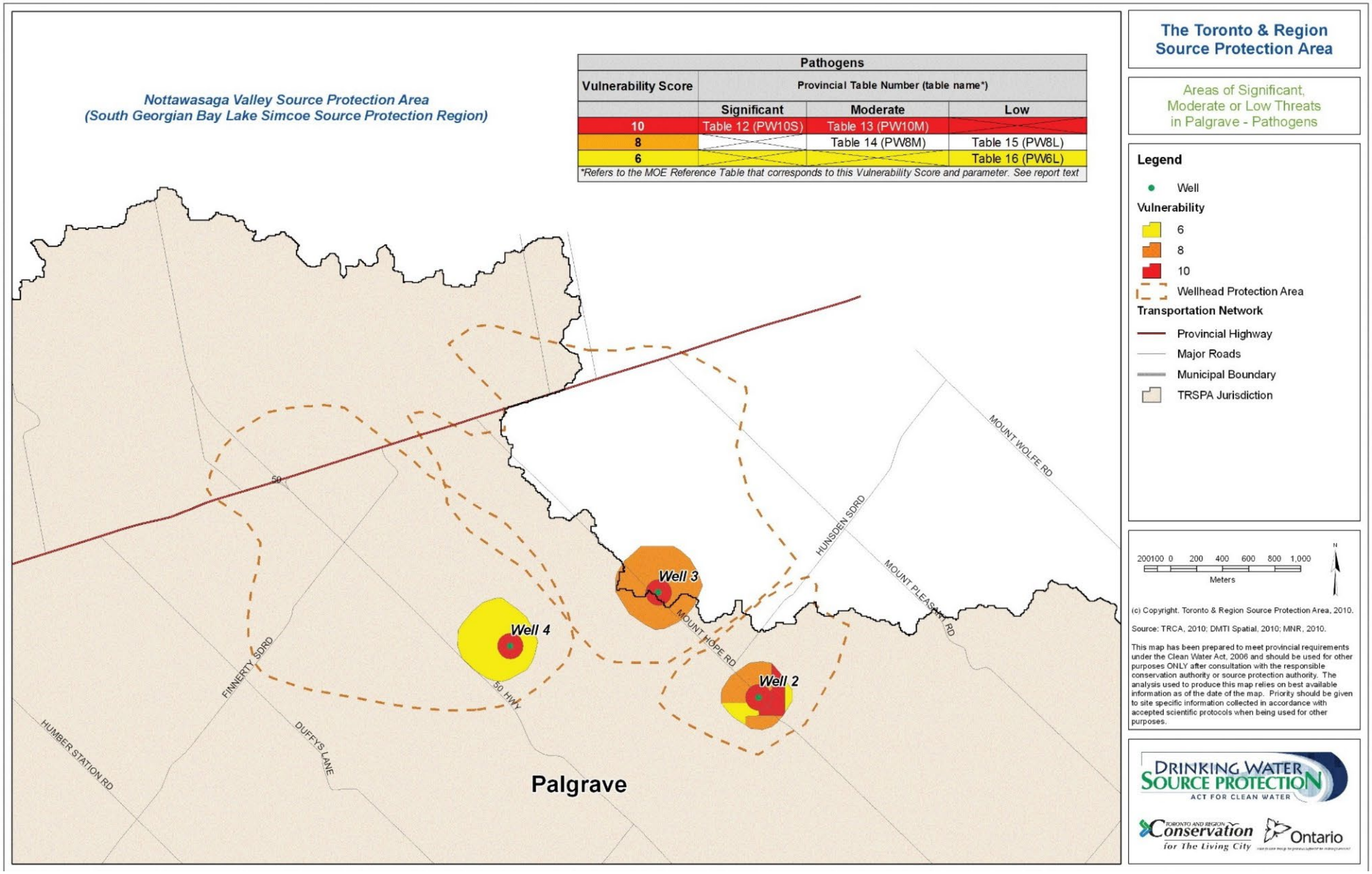


Figure 5.10: Areas of Significant, Moderate and Low Threats in Palgrave - Pathogens

The 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/

5.5.2 Drinking Water Threats - York Region

Kleinburg - Threats and Issues

The WHPAs of the Kleinburg wells 3 and 4 cover land west of the village, roughly centred on Nashville Road between Albion–Vaughan Road and Islington Avenue. The Kleinburg 2 well is located on the north side of Teston Road, on the edge of the Humber River. Land uses within the Kleinburg WHPAs include natural and open space, agricultural, residential, and commercial.

During the threats assessment process, the difficulty of enumerating domestic fuel storage threats (home heating oil) was identified by the consultants. *The Accord* (see **Appendix E2**) specified applying a single threat count for handling and storage of fuel in each WHPA vulnerable area, unless there was a high probability that natural gas was the primary source of heating fuel. However, the CTC SPC Working Group opted to diverge from this aspect of *The Accord*, requesting that a threat count 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.

For the York Region WHPAs within TRSPA, it was assumed that unserviced private lots (i.e., those parcels with private septic systems) have fuel oil tanks. Therefore, the numbers from Threat Activity 2 (the establishment, operation, or maintenance of a system that collects, stores, transmits, treats, or disposes of sewage) as identified by Stantec were added to Threat Activity 15 (the handling and storage of fuel).

In Kleinburg, most homes appear to be serviced with natural gas and municipal water/ wastewater, although some are on private wastewater disposal systems. The threats inventory for Kleinburg was conducted by Stantec (2010). The maps showing the areas of low, moderate, and significant threats for chemicals, DNAPLs, and pathogens are shown on **Figure 5.14**, **Figure 5.15** and **Figure 5.16**, respectively. The summary of potential significant, moderate, and low threats is tabulated in **Table 5.9**. No significant managed lands threats were identified for this area. No conditions or issues were identified for this water system. Note that the threat counts have not been adjusted to account for the decommissioning of Well 2. York Region staff are currently verifying threats for wells in their jurisdiction. Based on consultation between TRCA and York Region a decision was made to NOT adjust the threat counts at this time. These numbers will be revised in future updates to this Assessment Report.

Table 5.9: Threats Identified in Kleinburg

Activity (or Threat Type)	Threats			
	Sig.	Mod.	Low	Total
1. The establishment, operation, or maintenance of a waste disposal site within the meaning of Part V of the *Environmental Protection Act* (*EPA*)	0	1	0	1
2. The establishment, operation, or maintenance of a system that collects, stores, transmits, treats, or disposes of sewage	10	58	52	120
3. The application of agricultural source material to land	3	2	3	8
4. The storage of agricultural source material	0	0	0	0
5. The management of agricultural source material	0	0	0	0
6. The application of non-agricultural source material (NASM) to land	0	0	0	0
7. The handling and storage of non-agricultural source material NASM	0	0	0	0
8. The application of commercial fertilizer to land	0	3	6	9
9. The handling and storage of commercial fertilizer	1	1	0	2
10. The application of pesticide to land	2	4	3	9
11. The handling and storage of pesticide	1	1	0	2
12. The application of road salt	0	2	4	6
13. The handling and storage of road salt	0	0	0	0
14. The storage of snow	0	0	0	0
15. The handling and storage of fuel	14	59	53	126
16. The handling and storage of a dense non-aqueous phase liquid	3	0	0	3
17. The handling and storage of an organic solvent	0	0	0	0
18. The management of runoff that contains chemicals used in the de-icing of aircraft	0	0	0	0
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	0
20. An activity that reduces the recharge of an aquifer	0	0	0	0
21. The use of land as livestock grazing or pasturing land, an outdoor confinement area, or a farm-animal yard	0	0	0	0
Total Threats	**34**	**131**	**121**	**286**
Total Parcels	**14**	**67**	**61**	**142**

Notes:
Sig. = Significant; Mod. = Moderate
NA means Not Available

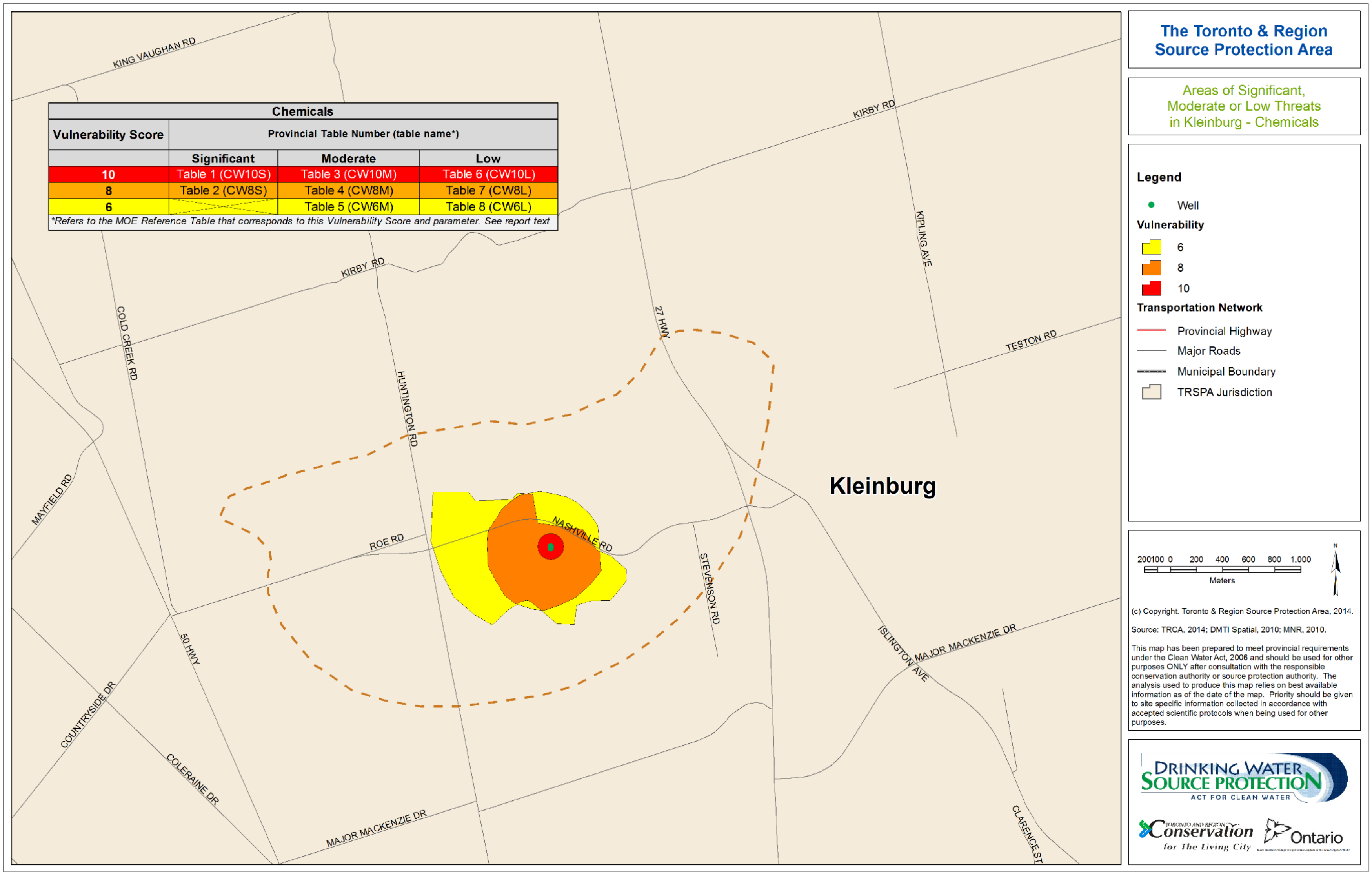
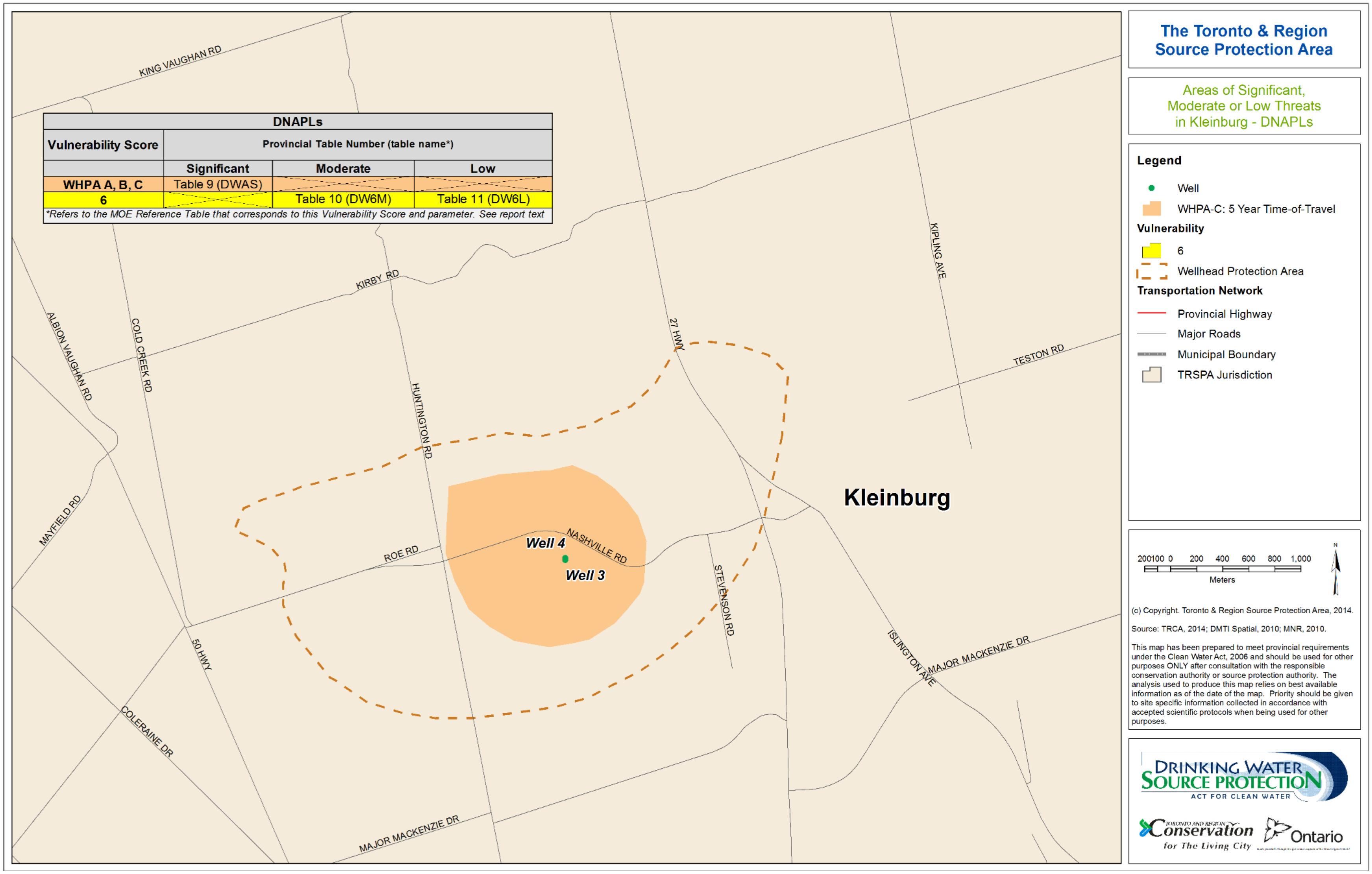


Figure 5.11: Areas of Significant, Moderate and Low Threats in Kleinburg – Chemicals

The 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/



DNAPLs

Vulnerability Score	Provincial Table Number (table name*)		
	Significant	Moderate	Low
WHPA A, B, C	Table 9 (DWAS)		
6		Table 10 (DW6M)	Table 11 (DW6L)

*Refers to the MOE Reference Table that corresponds to this Vulnerability Score and parameter. See report text

Figure 5.12: Areas of Significant, Moderate and Low Threats in Kleinburg – DNAPLs

The 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/

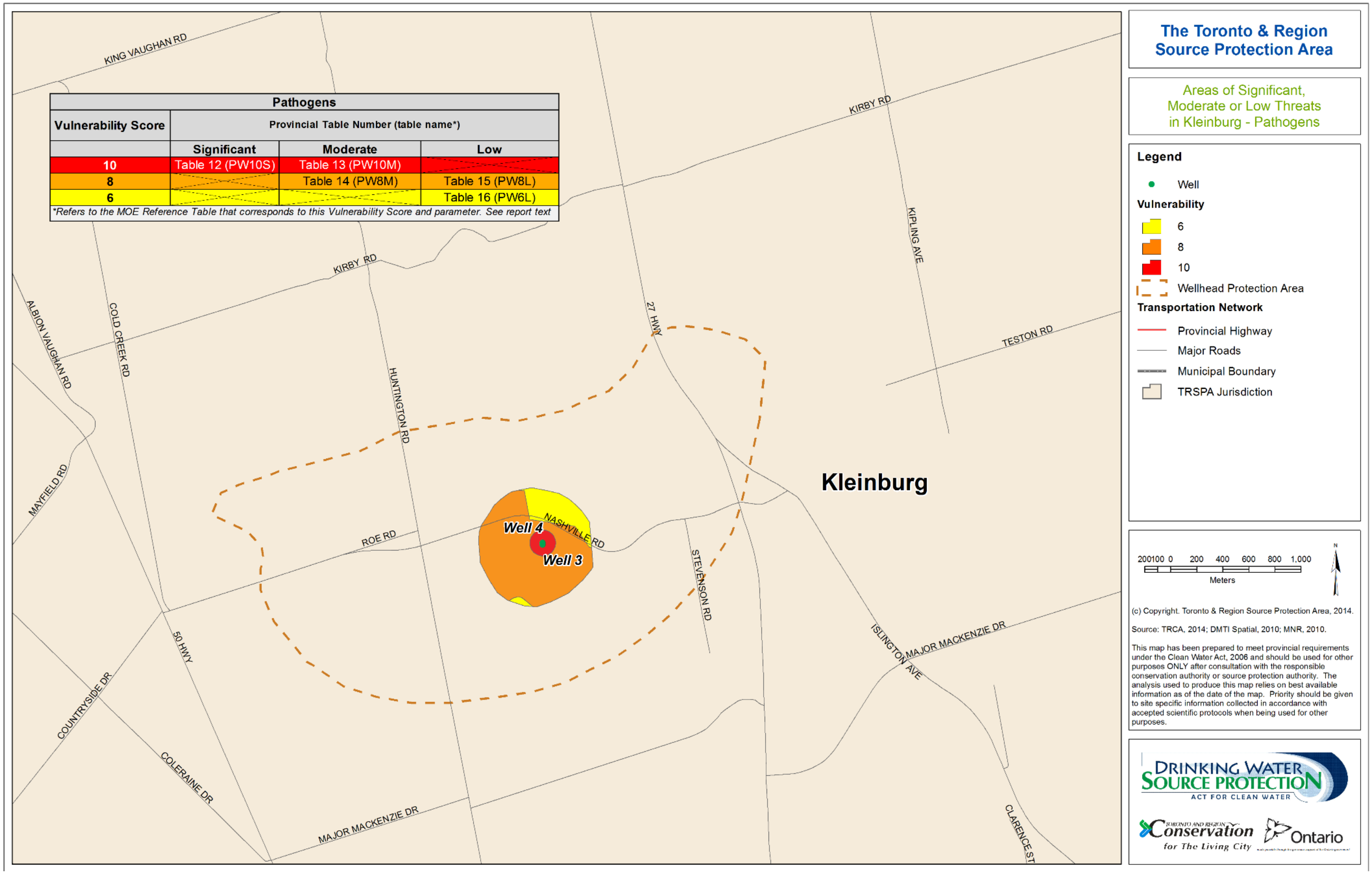


Figure 5.13: Areas of Significant, Moderate and Low Threats in Kleinburg - Pathogens

The 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/

Nobleton - Threats and Issues

The three wells in Nobleton are located near the intersection of Regional Road #27 (formerly Highway 27) and King Road. The WHPA zones extend northward to just south of the 16th Side Road, and therefore encompass most of the community. Land uses include a mix of commercial and residential, with agricultural to the north of the village.

During the threats assessment process, the difficulty of enumerating domestic fuel storage threats (home heating oil) was identified by the consultants. *The Accord (*see **Appendix E2**) specified applying a single threat count for handling and storage of fuel in each WHPA vulnerable area, unless there was a high probability that natural gas was the primary source of heating fuel. However, the CTC SPC Working Group opted to diverge from this aspect of *The Accord*, requesting that a threat count 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.

For the York Region WHPAs within TRSPA, it was assumed that unserviced private lots (i.e., those parcels with private septic systems) have fuel oil tanks. Therefore, the numbers from Threat Activity 2 (the establishment, operation, or maintenance of a system that collects, stores, transmits, treats, or disposes of sewage) as identified by Stantec were added to Threat Activity 15 (the handling and storage of fuel).

In Nobleton, most homes appear to be serviced with natural gas and municipal water/ wastewater, although some are on private wastewater disposal systems. The threats inventory for Nobleton was conducted by Stantec (2010). The threats inventory for Nobleton was conducted by Stantec (2010). The maps showing the areas of low, moderate, and significant threats for chemicals, DNAPLs, and pathogens are shown on **Figure 5.17**, **Figure 5.18** and **Figure 5.19**, respectively. The summary of potential significant, moderate, and low threats is tabulated in **Table 5.10**. No conditions or issues were identified for this water system.

Table 5.10: Threats Identified in Nobleton

Activity (or Threat Type)	Threats			
	Sig.	Mod.	Low	Total
1. The establishment, operation, or maintenance of a waste disposal site within the meaning of Part V of the *Environmental Protection Act* (*EPA*)	0	4	0	**4**
2. The establishment, operation, or maintenance of a system that collects, stores, transmits, treats, or disposes of sewage	59	0	356	**415**
3. The application of agricultural source material to land	1	0	1	**2**
4. The storage of agricultural source material	0	0	0	**0**
5. The management of agricultural source material	0	0	0	**0**
6. The application of non-agricultural source material (NASM) to land	0	0	0	**0**
7. The handling and storage of non-agricultural source material NASM	0	0	0	**0**
8. The application of commercial fertilizer to land	0	1	1	**2**
9. The handling and storage of commercial fertilizer	0	0	1	**1**
10. The application of pesticide to land	1	0	1	**2**
11. The handling and storage of pesticide	0	0	1	**1**
12. The application of road salt	0	2	2	**4**
13. The handling and storage of road salt	0	0	0	**0**
14. The storage of snow	0	0	0	**0**
15. The handling and storage of fuel	60	0	371	**431**
16. The handling and storage of a dense non-aqueous phase liquid	17	0	0	**17**
17. The handling and storage of an organic solvent	0	0	3	**3**
18. The management of runoff that contains chemicals used in the de-icing of aircraft	0	0	0	**0**
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	**0**
20. An activity that reduces the recharge of an aquifer	0	0	0	**0**
21. The use of land as livestock grazing or pasturing land, an outdoor confinement area, or a farm-animal yard	0	0	0	**0**
Total Threats	**138**	**7**	**737**	**882**
Total Parcels	**74**	**7**	**359**	**440**

Notes:
Sig. = Significant; Mod. = Moderate
NA means Not Available

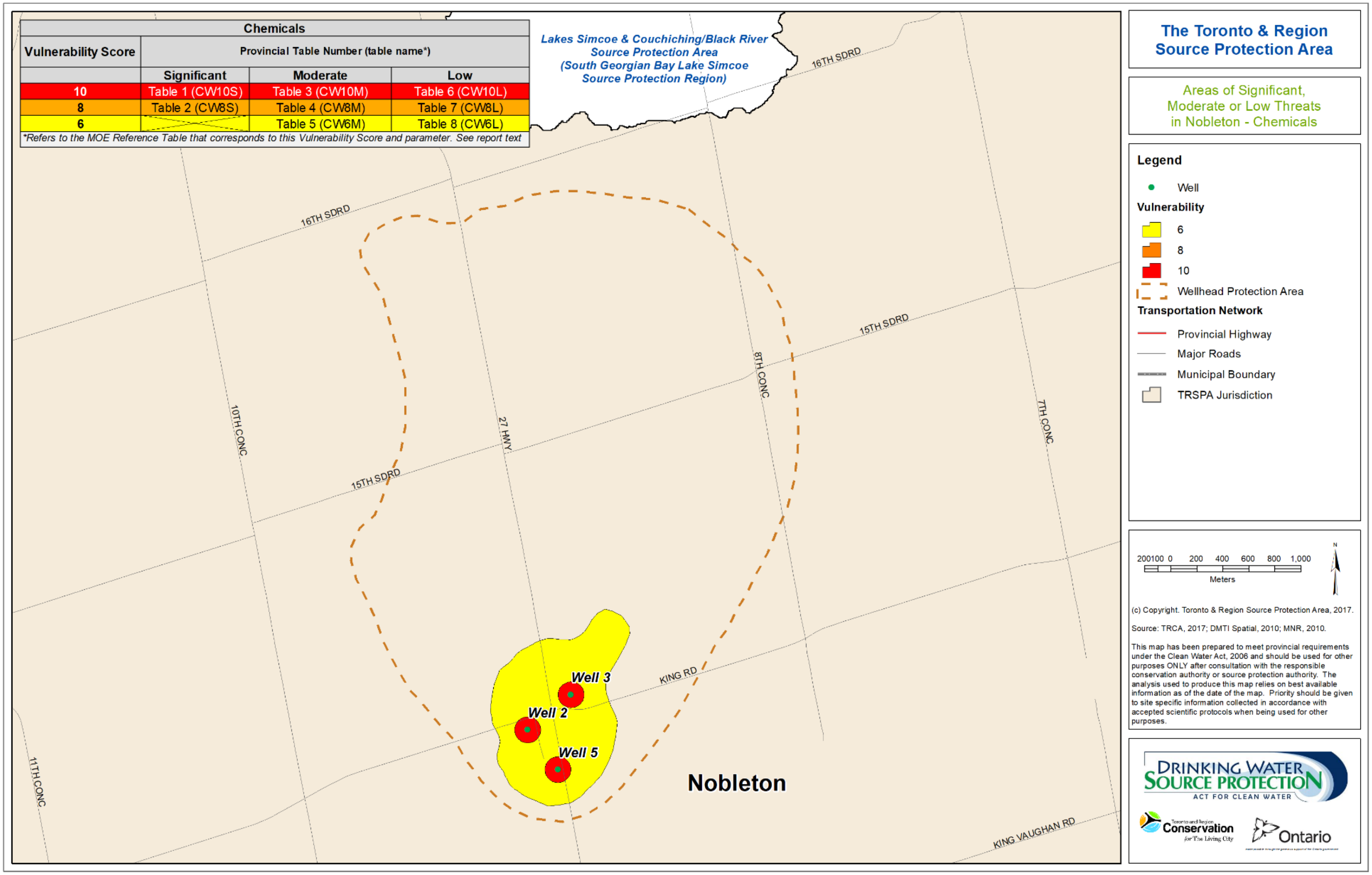
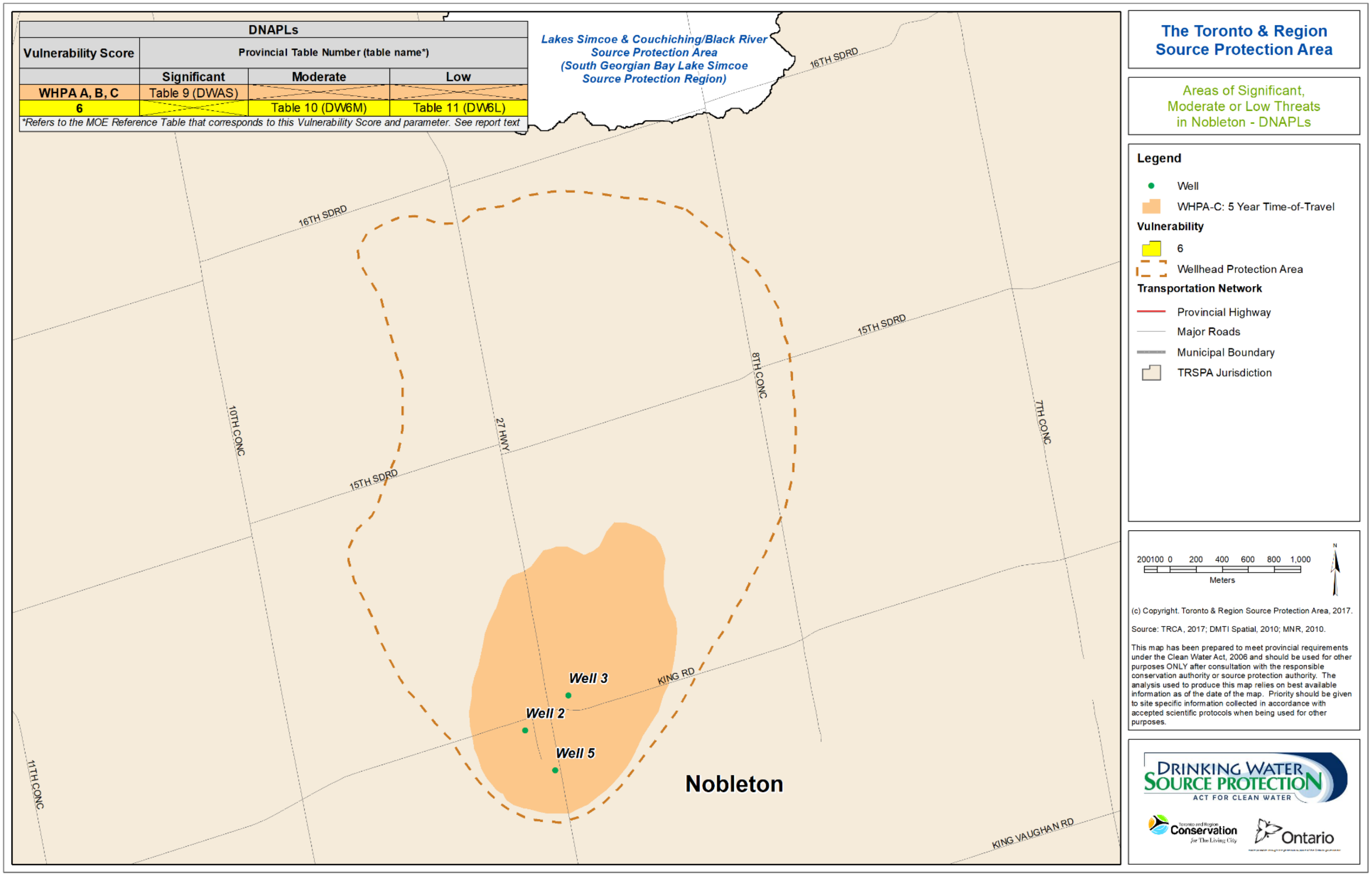


Figure 5.14: Areas of Significant, Moderate and Low Threats in Nobleton – Chemicals

The 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/



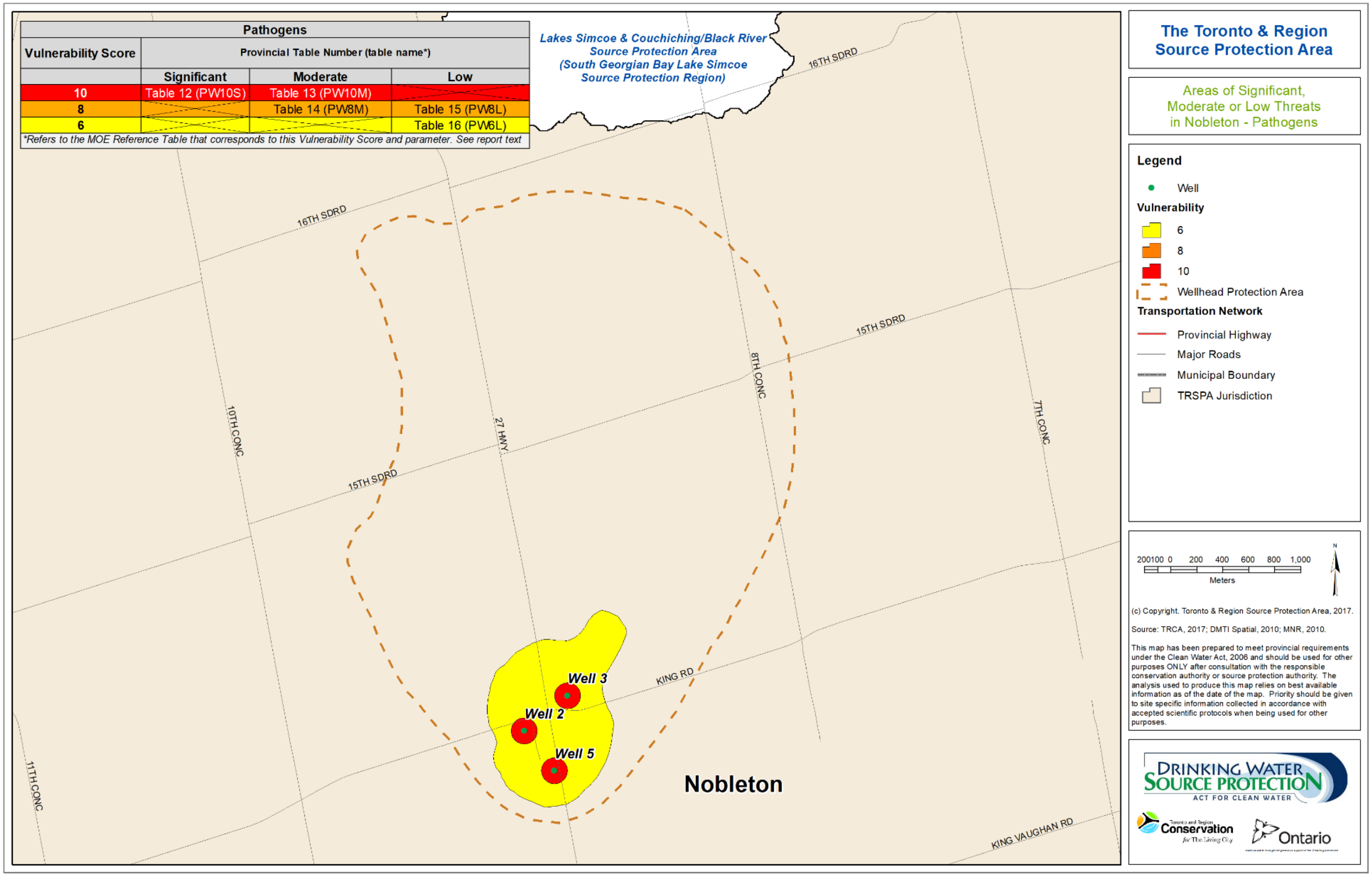
DNAPLs

Vulnerability Score	Provincial Table Number (table name*)		
	Significant	Moderate	Low
WHPA A, B, C	Table 9 (DWAS)		
6		Table 10 (DW6M)	Table 11 (DW6L)

*Refers to the MOE Reference Table that corresponds to this Vulnerability Score and parameter. See report text

Figure 5.15: Areas of Significant, Moderate and Low Threats in Nobleton - DNAPLs

The 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/



Vulnerability Score	Provincial Table Number (table name*)		
	Significant	Moderate	Low
10	Table 12 (PW10S)	Table 13 (PW10M)	
8		Table 14 (PW8M)	Table 15 (PW8L)
6			Table 16 (PW6L)

*Refers to the MOE Reference Table that corresponds to this Vulnerability Score and parameter. See report text

Figure 5.16: Areas of Significant, Moderate and Low Threats in Nobleton - Pathogens

The 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/

King City - Threats and Issues

The King City well field is located in the Humber River valley northeast of the intersection of Keele Street and King Road. The WHPAs for the two existing wells cover a large percentage of the village, including a mix of estate homes on larger lots and higher density residential.

During the threats assessment process, the difficulty of enumerating domestic fuel storage threats (home heating oil) was identified by the consultants. *The Accord (*see **Appendix E2**) specified applying a single threat count for handling and storage of fuel in each WHPA vulnerable area, unless there was a high probability that natural gas was the primary source of heating fuel. However, the CTC SPC Working Group opted to diverge from this aspect of *The Accord*, requesting that a threat count 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.

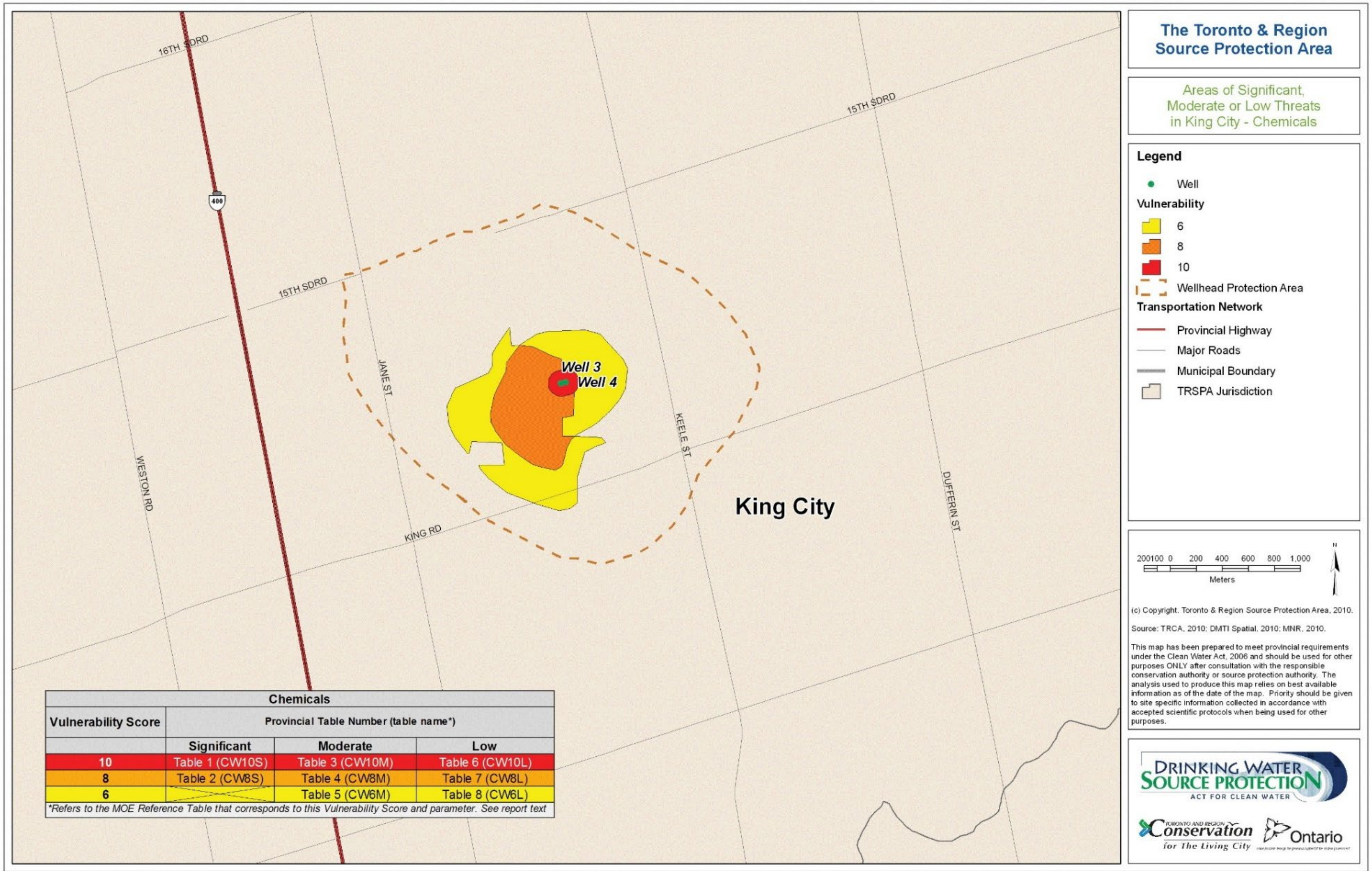
For the York Region WHPAs within TRSPA, it was assumed that unserviced private lots (i.e., those parcels with private septic systems) have fuel oil tanks. Therefore, the numbers from Threat Activity 2 (the establishment, operation, or maintenance of a system that collects, stores, transmits, treats, or disposes of sewage) as identified by Stantec were added to Threat Activity 15 (the handling and storage of fuel).

In King City, most homes appear to be serviced with natural gas and municipal water/wastewater, although a number have not yet connected to the municipal sewer system. The threats inventory for King City was conducted by Stantec (2010). The maps showing the areas of low, moderate, and significant threats for chemicals, DNAPLs, and pathogens are shown on **Figure 5.20, Figure 5.21** and **Figure 5.22**, respectively. The summary of potential significant, moderate, and low threats is tabulated in **Table 5.11**. No significant managed lands threats were identified for this area. No conditions or issues were identified for this water system.

Table 5.11: Threats Identified in King City

Activity (or Threat Type)	Threats			
	Sig.	Mod.	Low	Total
1. The establishment, operation, or maintenance of a waste disposal site within the meaning of Part V of the *Environmental Protection Act* (*EPA*)	1	0	0	**1**
2. The establishment, operation, or maintenance of a system that collects, stores, transmits, treats, or disposes of sewage	9	28	32	**69**
3. The application of agricultural source material to land	0	1	0	**1**
4. The storage of agricultural source material	0	0	0	**0**
5. The management of agricultural source material	0	0	0	**0**
6. The application of non-agricultural source material (NASM) to land	0	0	0	**0**
7. The handling and storage of non-agricultural source material NASM	0	0	0	**0**
8. The application of commercial fertilizer to land	0	0	1	**1**
9. The handling and storage of commercial fertilizer	0	0	0	**0**
10. The application of pesticide to land	0	1	2	**3**
11. The handling and storage of pesticide	0	0	0	**0**
12. The application of road salt	0	1	5	**6**
13. The handling and storage of road salt	0	0	0	**0**
14. The storage of snow	0	0	0	**0**
15. The handling and storage of fuel	9	30	32	**71**
16. The handling and storage of a dense non-aqueous phase liquid	0	0	0	**0**
17. The handling and storage of an organic solvent	0	0	0	**0**
18. The management of runoff that contains chemicals used in the de-icing of aircraft	0	0	0	**0**
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	**0**
20. An activity that reduces the recharge of an aquifer	0	0	0	**0**
21. The use of land as livestock grazing or pasturing land, an outdoor confinement area, or a farm-animal yard	0	0	0	**0**
Total Threats	**19**	**61**	**72**	**152**
Total Parcels	**10**	**29**	**39**	**78**

Notes:
Sig. = Significant; Mod. = Moderate
NA means Not Available

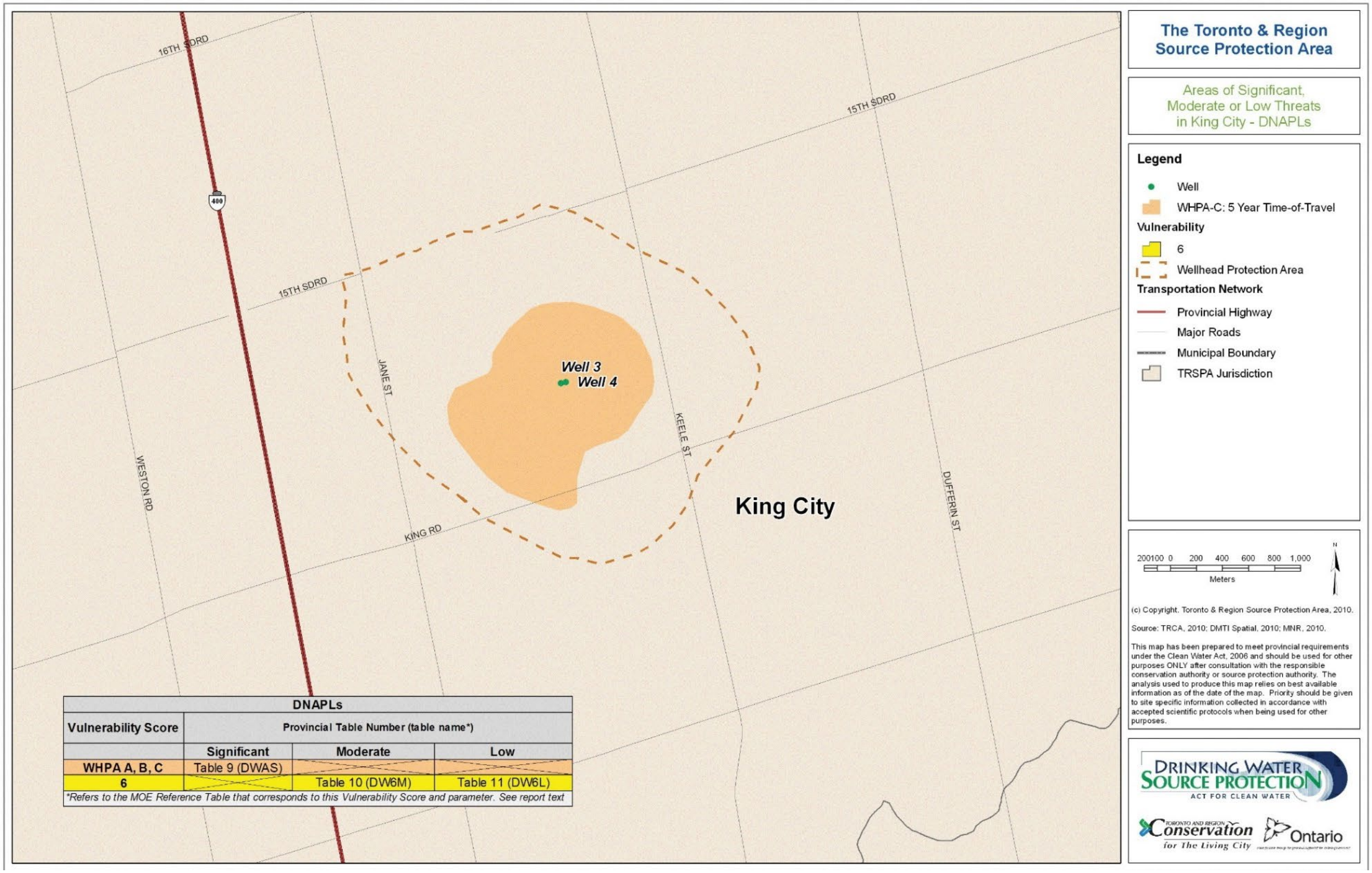


Chemicals			
Vulnerability Score	Provincial Table Number (table name*)		
	Significant	Moderate	Low
10	Table 1 (CW10S)	Table 3 (CW10M)	Table 6 (CW10L)
8	Table 2 (CW8S)	Table 4 (CW8M)	Table 7 (CW8L)
6		Table 5 (CW6M)	Table 8 (CW6L)

*Refers to the MOE Reference Table that corresponds to this Vulnerability Score and parameter. See report text

Figure 5.17: Areas of Significant, Moderate and Low Threats in King City - Chemicals

The 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/

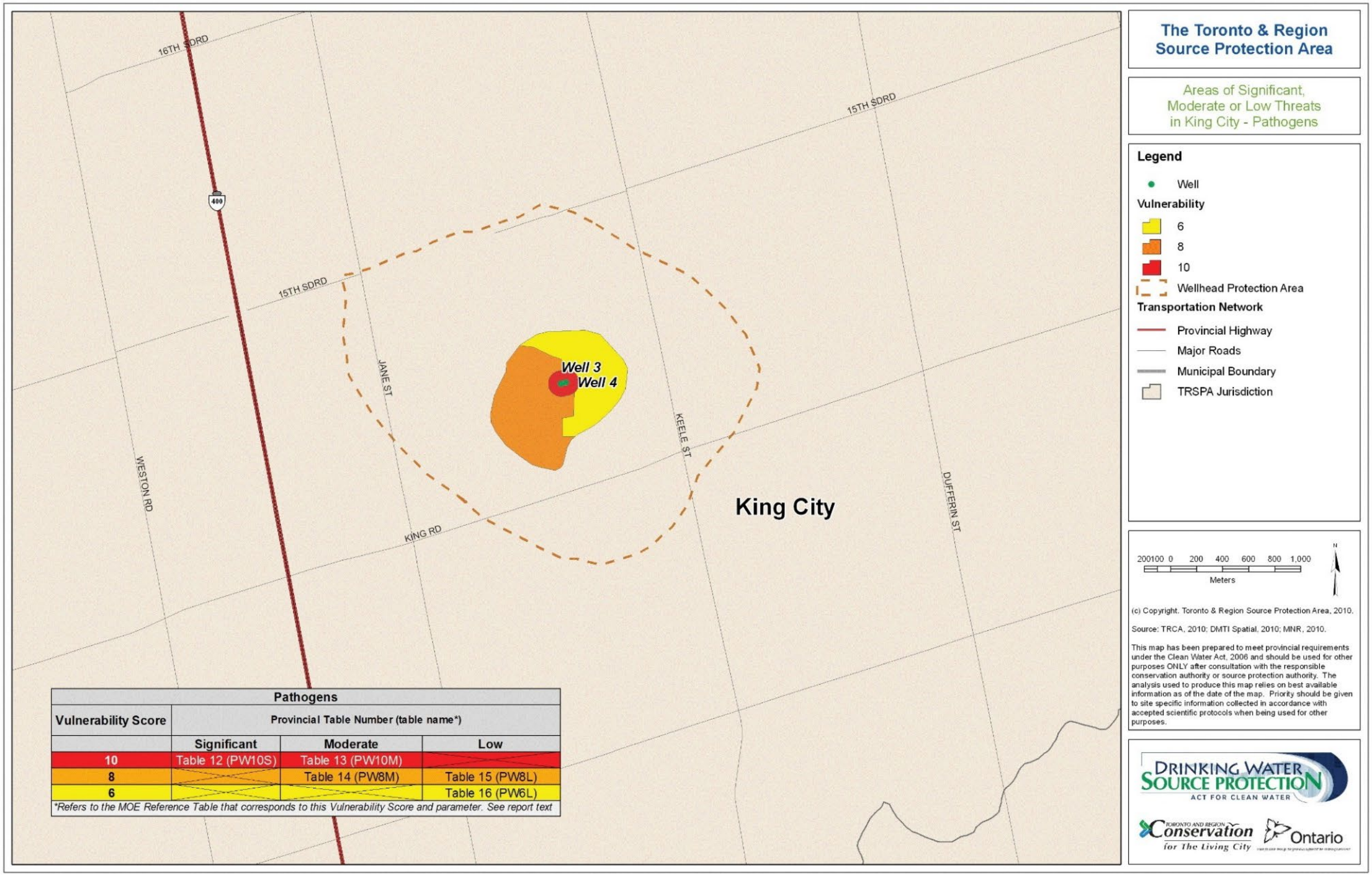


DNAPLs			
Vulnerability Score	Provincial Table Number (table name*)		
	Significant	Moderate	Low
WHPA A, B, C	Table 9 (DWAS)		
6		Table 10 (DW6M)	Table 11 (DW6L)

**Refers to the MOE Reference Table that corresponds to this Vulnerability Score and parameter. See report text*

Figure 5.18: Areas of Significant, Moderate and Low Threats in King City - DNAPLs

The 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/



Pathogens			
Vulnerability Score	Provincial Table Number (table name*)		
	Significant	Moderate	Low
10	Table 12 (PW10S)	Table 13 (PW10M)	
8		Table 14 (PW8M)	Table 15 (PW8L)
6			Table 16 (PW6L)

*Refers to the MOE Reference Table that corresponds to this Vulnerability Score and parameter. See report text

Figure 5.19: Areas of Significant, Moderate and Low Threats in King City - Pathogens

The 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/

Whitchurch–Stouffville - Threats and Issues

The Whitchurch–Stouffville water system comprises two distinct well fields: one near the centre of the village east of 10th Line (Wells 1, 2, and 3), and the other northwest of the community south of Bloomington Side Road (Wells 5 and 6). The WHPAs for Wells 1, 2, and 3 cover the eastern end of the community and include a mix of residential and commercial land uses. The WHPAs for Wells 5 and 6 are in a primarily agricultural area.

During the threats assessment process, the difficulty of enumerating domestic fuel storage threats (home heating oil) was identified by the consultants. *The Accord (*see **Appendix E2**) specified applying a single threat count for handling and storage of fuel in each WHPA vulnerable area, unless there was a high probability that natural gas was the primary source of heating fuel. However, the CTC SPC Working Group opted to diverge from this aspect of *The Accord*, requesting that a threat count 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.

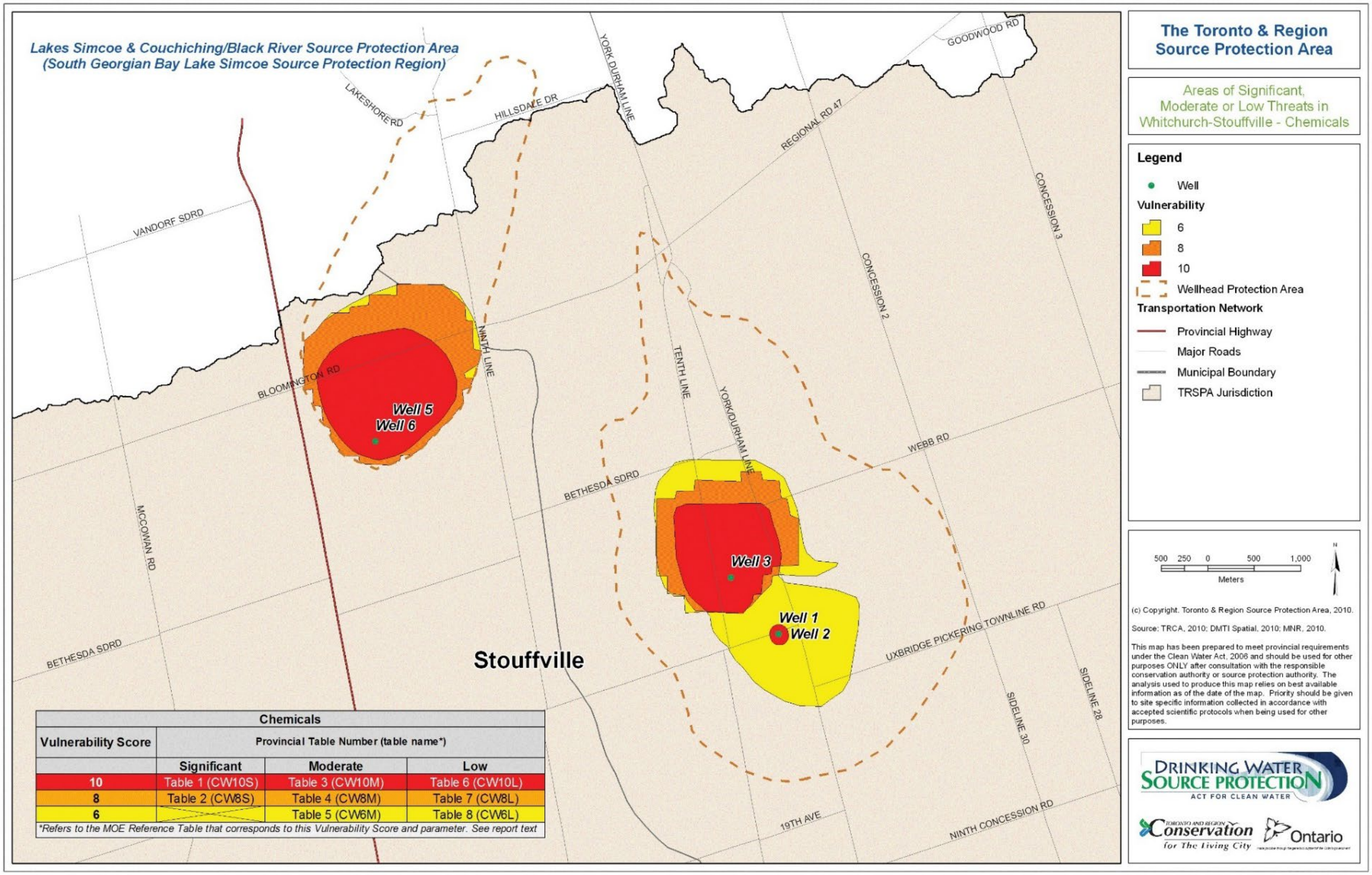
For the York Region WHPAs within TRSPA, it was assumed that unserviced private lots (i.e., those parcels with private septic systems) have fuel oil tanks. Therefore, the numbers from Threat Activity 2 (the establishment, operation, or maintenance of a system that collects, stores, transmits, treats, or disposes of sewage) as identified by Stantec were added to Threat Activity 15 (the handling and storage of fuel).

In Whitchurch-Stouffville, most homes appear to be serviced with natural gas and municipal water/ wastewater, although some are on private wastewater disposal systems. The threats inventory for Whitchurch–Stouffville was conducted by Stantec (2010). The maps showing the areas of low, moderate, and significant threats for chemicals, DNAPLs, and pathogens are shown on **Figure 5.23, Figure 5.24** and **Figure 5.25**, respectively and the summary of significant, moderate, and low threats is tabulated in **Table 5.12**. No significant managed lands threats were identified for this area. No conditions or issues were identified for this water system.

Table 5.12: Threats Identified in Whitchurch–Stouffville

Activity (or Threat Type)	Threats			
	Sig.	Mod.	Low	Total
1. The establishment, operation, or maintenance of a waste disposal site within the meaning of Part V of the *Environmental Protection Act* (*EPA*)	3	0	0	**3**
2. The establishment, operation, or maintenance of a system that collects, stores, transmits, treats, or disposes of sewage	62	55	72	**189**
3. The application of agricultural source material to land	22	4	20	**46**
4. The storage of agricultural source material	4	1	1	**6**
5. The management of agricultural source material	4	0	1	**5**
6. The application of non-agricultural source material (NASM) to land	0	0	0	**0**
7. The handling and storage of non-agricultural source material NASM	0	0	0	**0**
8. The application of commercial fertilizer to land	16	16	20	**52**
9. The handling and storage of commercial fertilizer	10	2	4	**16**
10. The application of pesticide to land	20	12	14	**46**
11. The handling and storage of pesticide	11	2	4	**17**
12. The application of road salt	0	5	8	**13**
13. The handling and storage of road salt	0	0	0	**0**
14. The storage of snow	0	0	0	**0**
15. The handling and storage of fuel	79	65	77	**221**
16. The handling and storage of a dense non-aqueous phase liquid	6	0	0	**6**
17. The handling and storage of an organic solvent	2	2	0	**4**
18. The management of runoff that contains chemicals used in the de-icing of aircraft	0	0	0	**0**
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	0
20. An activity that reduces the recharge of an aquifer	0	0	0	0
21. The use of land as livestock grazing or pasturing land, an outdoor confinement area, or a farm-animal yard	4	0	2	**6**
Total Threats	**243**	**164**	**223**	**630**
Total Parcels	**80**	**78**	**99**	**257**

Notes:
Sig. = Significant; Mod. = Moderate
NA means Not Available

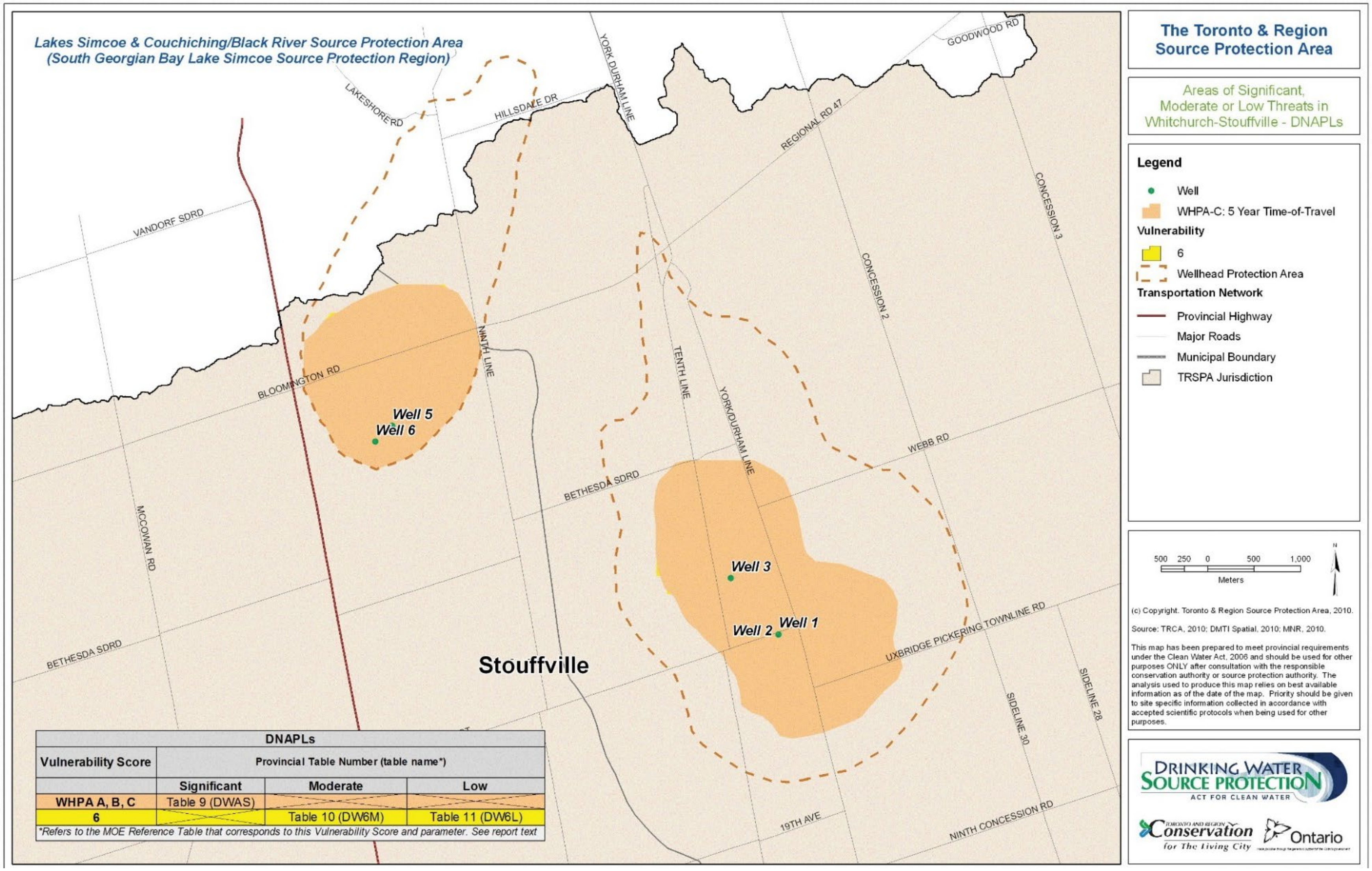


Chemicals			
Vulnerability Score	Provincial Table Number (table name*)		
	Significant	Moderate	Low
10	Table 1 (CW10S)	Table 3 (CW10M)	Table 6 (CW10L)
8	Table 2 (CW8S)	Table 4 (CW8M)	Table 7 (CW8L)
6		Table 5 (CW6M)	Table 8 (CW6L)

*Refers to the MOE Reference Table that corresponds to this Vulnerability Score and parameter. See report text

Figure 5.20: Areas of Significant, Moderate and Low Threats in Whitchurch-Stouffville - Chemicals

The 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/*](http://swpip.ca/)

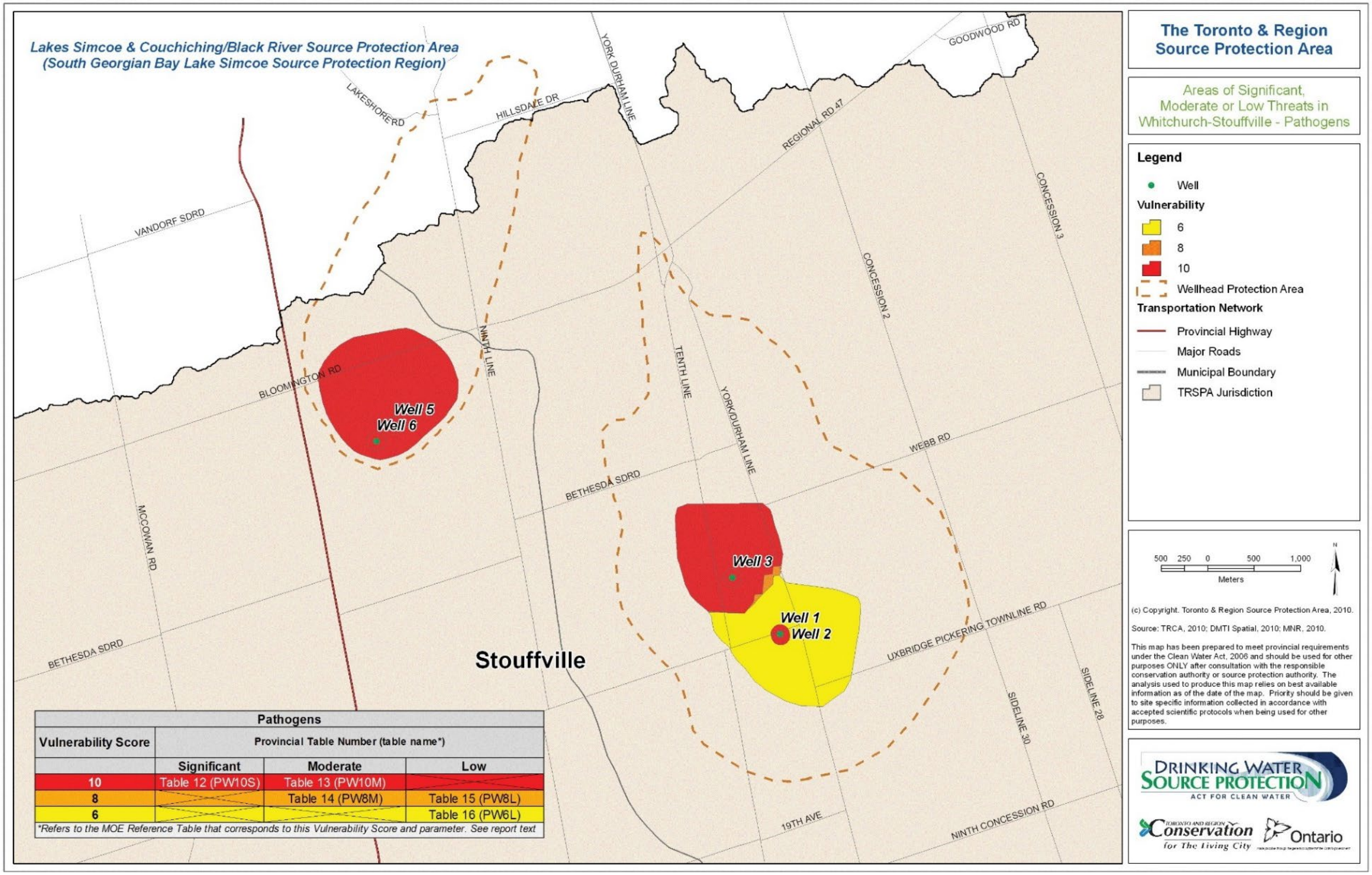


DNAPLs			
Vulnerability Score	Provincial Table Number (table name*)		
	Significant	Moderate	Low
WHPA A, B, C	Table 9 (DWAS)		
6		Table 10 (DW6M)	Table 11 (DW6L)

*Refers to the MOE Reference Table that corresponds to this Vulnerability Score and parameter. See report text

Figure 5.21: Areas of Significant, Moderate and Low Threats in Whitchurch-Stouffville - DNAPLs

The 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/



Pathogens			
Vulnerability Score	Provincial Table Number (table name*)		
	Significant	Moderate	Low
10	Table 12 (PW10S)	Table 13 (PW10M)	
8		Table 14 (PW8M)	Table 15 (PW8L)
6			Table 16 (PW6L)

*Refers to the MOE Reference Table that corresponds to this Vulnerability Score and parameter. See report text

Figure 5.22: Areas of Significant, Moderate and Low Threats in Whitchurch-Stouffville - Pathogens

The 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/

5.5.3 Drinking Water Threats - Durham Region

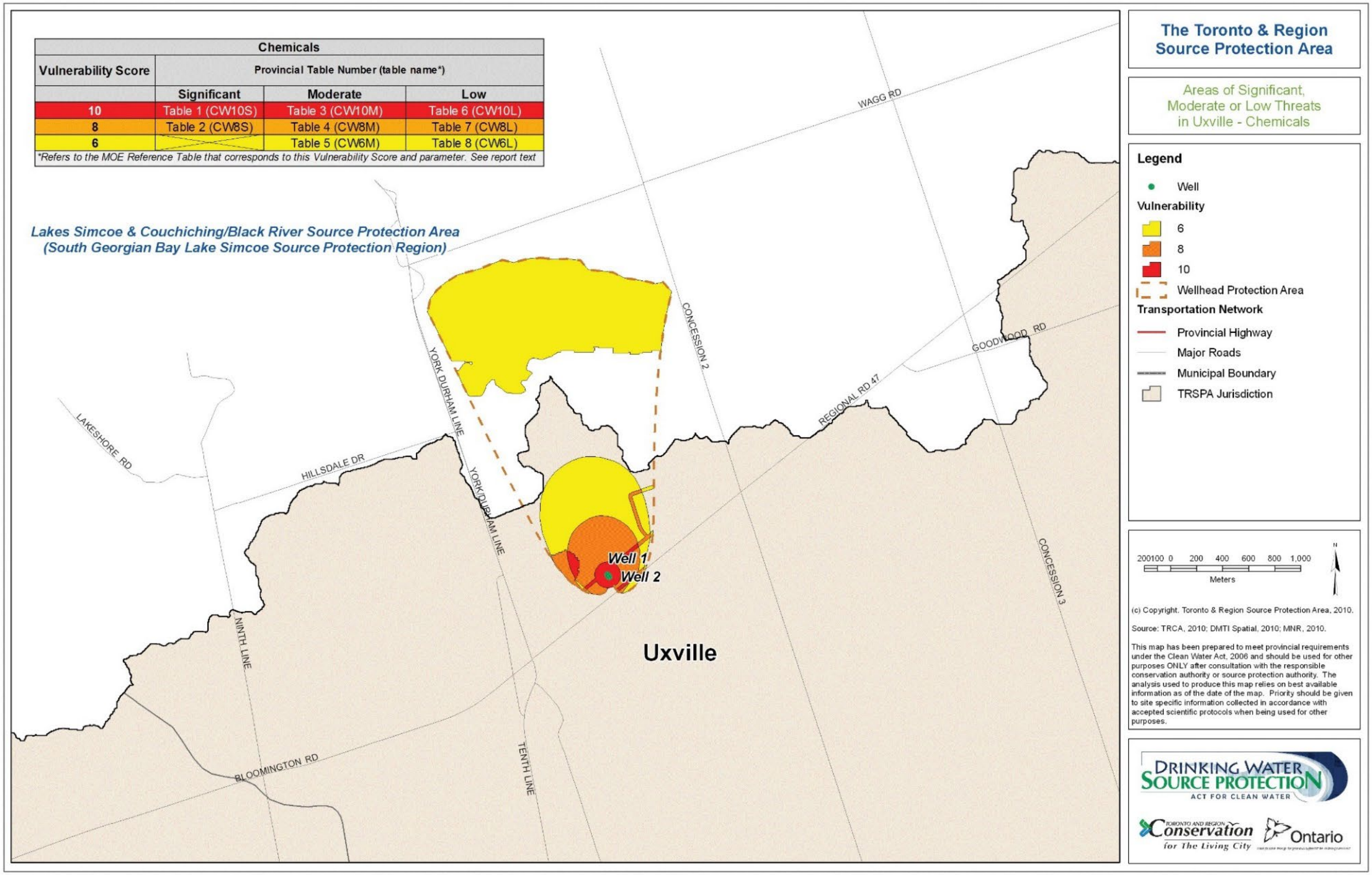
Uxville - Threats and Issues

The Uxville water system is located at the south end of the industrial park. The land use is dry industrial, meaning that water cannot be used in the on-site processes. The threats inventory for Uxville was conducted by AECOM (2010) and the Durham Region (Durham, 2010). The map showing the significant threats is presented in **Figure 5.26, Figure 5.27** and **Figure 5.28,** and the summary of potential significant, moderate, and low threats is tabulated in **Table 5.13**. No significant managed lands threats were identified for this area. No conditions or issues were identified for this water system. Note that the low and moderate threats for this water system were not enumerated.

Table 5.13: Threats Identified in Uxville

Activity (or Threat Type)	Threats			
	Sig.	Mod.	Low	Total
1. The establishment, operation, or maintenance of a waste disposal site within the meaning of Part V of the *Environmental Protection Act* (*EPA*)	4	0	0	**4**
2. The establishment, operation, or maintenance of a system that collects, stores, transmits, treats, or disposes of sewage	5	12	19	**36**
3. The application of agricultural source material to land	1	3	7	**11**
4. The storage of agricultural source material	0	1	3	**4**
5. The management of agricultural source material	0	1	2	**3**
6. The application of non-agricultural source material (NASM) to land	0	1	8	**9**
7. The handling and storage of non-agricultural source material NASM	0	0	0	**0**
8. The application of commercial fertilizer to land	0	1	11	**12**
9. The handling and storage of commercial fertilizer	0	2	6	**8**
10. The application of pesticide to land	1	3	9	**13**
11. The handling and storage of pesticide	0	0	8	**8**
12. The application of road salt	0	9	2	**11**
13. The handling and storage of road salt	0	0	0	**0**
14. The storage of snow	0	0	0	**0**
15. The handling and storage of fuel	1	6	24	**31**
16. The handling and storage of a dense non-aqueous phase liquid	4	0	0	**4**
17. The handling and storage of an organic solvent	1	2	2	**5**
18. The management of runoff that contains chemicals used in the de-icing of aircraft	0	0	0	**0**
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	0
20. An activity that reduces the recharge of an aquifer	0	0	0	0
21. The use of land as livestock grazing or pasturing land, an outdoor confinement area, or a farm-animal yard	0	1	3	**4**
Total Threats	**17**	**42**	**104**	**163**
Total Parcels	**8**	**18**	**32**	**58**

Notes:
Sig. = Significant; Mod. = Moderate
NA means Not Available



Chemicals			
Vulnerability Score	Provincial Table Number (table name*)		
	Significant	Moderate	Low
10	Table 1 (CW10S)	Table 3 (CW10M)	Table 6 (CW10L)
8	Table 2 (CW8S)	Table 4 (CW8M)	Table 7 (CW8L)
6		Table 5 (CW6M)	Table 8 (CW6L)

*Refers to the MOE Reference Table that corresponds to this Vulnerability Score and parameter. See report text

Figure 5.23: Areas of Significant, Moderate and Low Threats in Uxville - Chemicals

The 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/

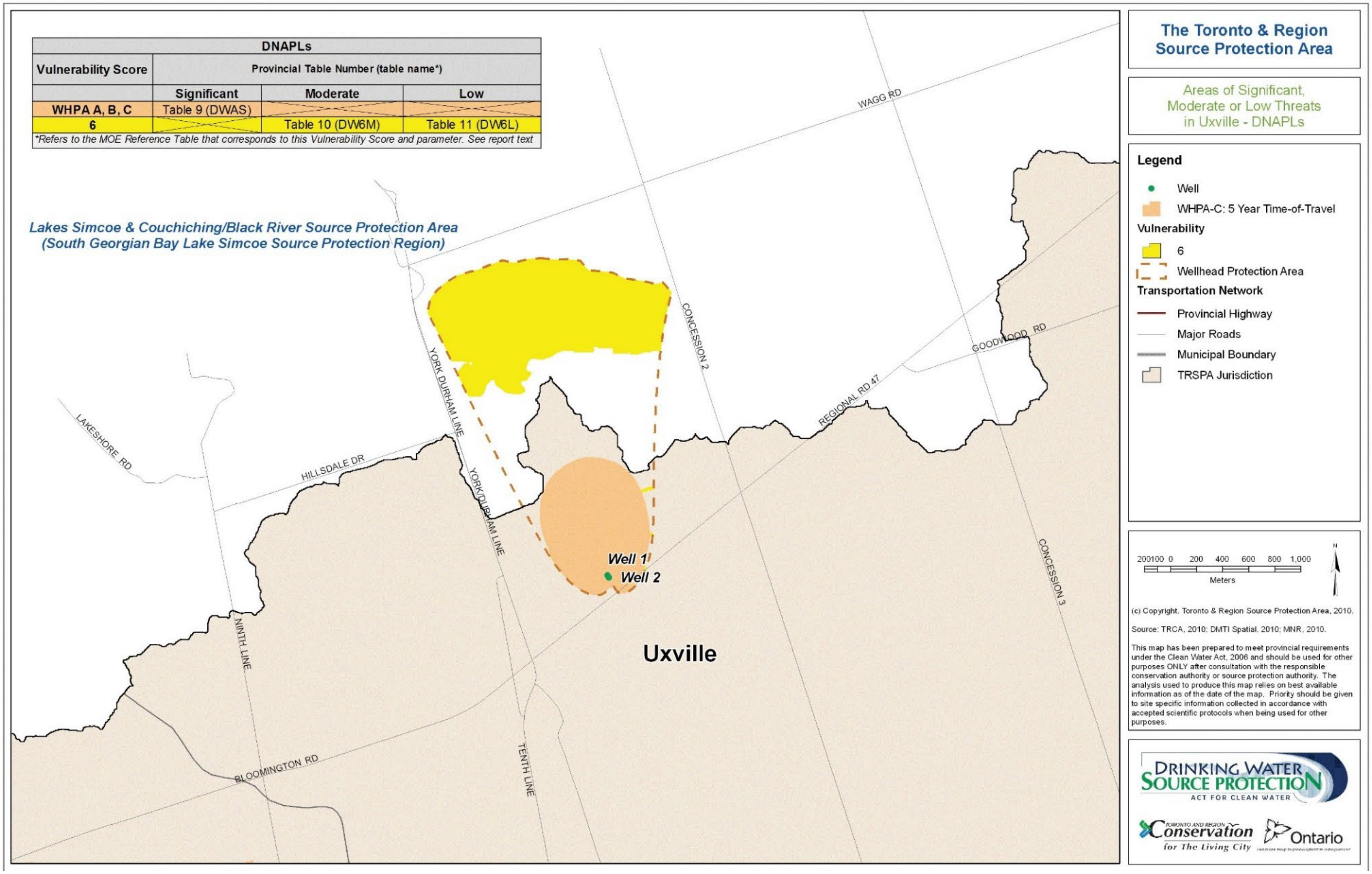


Figure 5.24: Areas of Significant, Moderate and Low Threats in Uxville - DNAPLs

The 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/

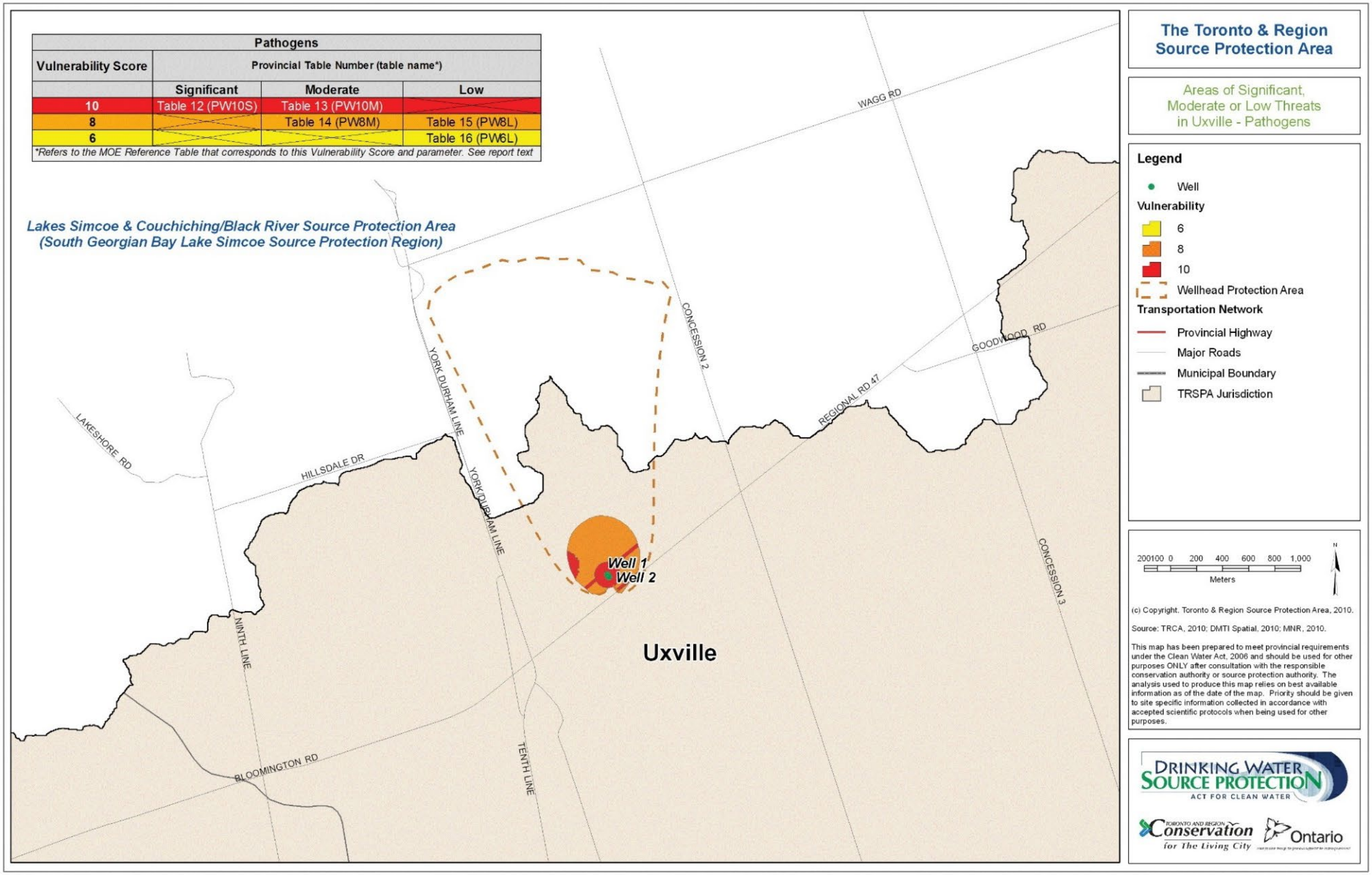


Figure 5.25: Areas of Significant, Moderate and Low Threats in Uxville - Pathogens

The 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/

5.6 SURFACE WATER QUANTITY THREATS

There are no inland surface water intakes in the TRSPA. The only surface water intakes are located in Lake Ontario. Since the *Technical Rules* exclude consideration of water quantity stress in the Great Lakes, no surface water quantity threats have been identified in TRSPA.

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-2s), 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 TRSPA. However, staff from the regional municipalities of Peel, York, Durham, 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 Zones (IPZ-1s and 2s)

The six TRSPA Lake Ontario intakes (including two for the Toronto Island facility, which has both shallow and deep intakes) have vulnerability scores of either 5 (Ajax, Toronto Island—deep, and F.J. Horgan), or 6 (R.C. Harris, R.L. Clark, and Toronto Island—shallow). There are a number of circumstances where an activity could pose a low risk to the intakes where it exists, according to the Provincial Tables of Circumstances.

Figure 5.29 and **Table 5.14** show the count of potential activities that pose threats in vulnerable IPZ-1.

Table 5.14: 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 (Ajax, F.J. Horgan, and Toronto Island—deep intakes)				
Pathogens	0	0	13	13
Chemical (including DNAPLs)	0	0	558	558
Total	**0**	**0**	**571**	**571**
Vulnerability Score = 6 (R.C. Harris, R.L. Clark, and Toronto Island—shallow intakes)				
Pathogens	0	12	15	27
Chemical (including DNAPLs)	0	13	1,193	1,206
Total	**0**	**25**	**1,208**	**1,233**

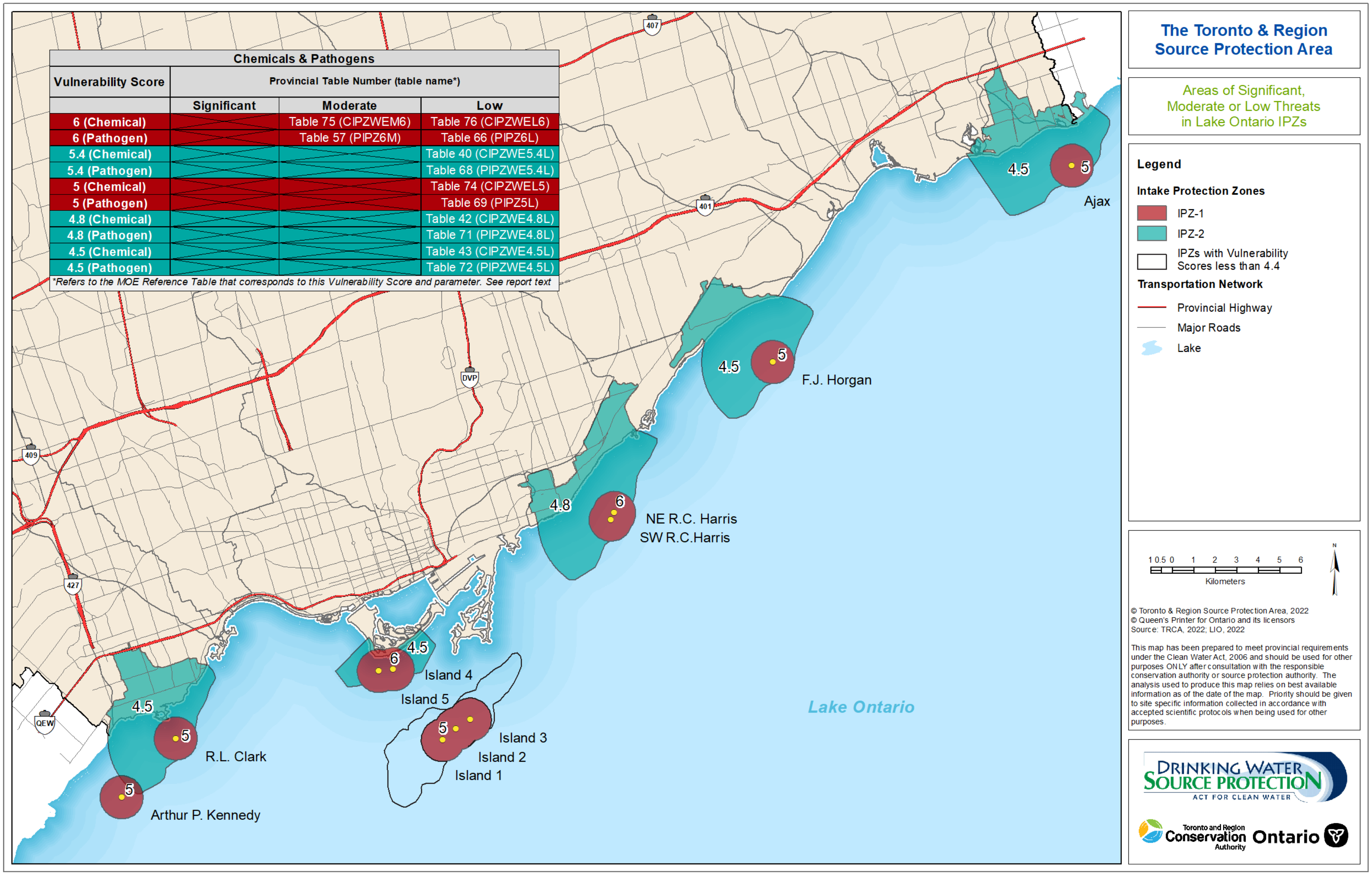


Figure 5.26: Areas of Significant, Moderate and Low Threats in Lake Ontario in IPZ-1s and 2s

The 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/

All of the TRSPA IPZ-1, with the exception of the shallow Toronto Island Intakes (which cover part of the land area of Toronto Island), 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. Where the IPZ-1 for the Toronto Island Treatment Plant extends onto the shore (approximately 150 m), some activities are considered low-level threats. 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 a vulnerability score greater than 4 (e.g., R.L. Clark, R.C. Harris, F.J. Horgan, and Toronto Island—shallow intakes), 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).

The numbers of low threats for these intakes are summarized in **Table 5.15.** For IPZ-2 areas with a vulnerability score of 4 or less (e.g., Toronto Island-deep intakes), no activities listed pose even a low level of risk to the intakes, according to the Provincial Tables of Circumstances.

Table 5.15: 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 (R.C. Harris)				
Pathogens	0	0	13	13
Chemical (including DNAPLs)	0	0	436	436
Total	**0**	**0**	**449**	**499**
Vulnerability Score = 4.5 (Ajax, Arthur P Kennedy, F.J. Horgan, R.L. Clark, Toronto Island Shallow)				
Pathogens	0	0	13	13
Chemical (including DNAPLs)	0	0	239	239
Total	**0**	**0**	**252**	**252**

5.7.3 Threats from Managed Lands in Intake Protection Zones (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 TRSPA, all of the IPZ-2s have a low risk score associated with the application of nutrients due to managed land activities (see **Table 5.16** and **Figure 5.30**). There are a mix of land uses along the Lake Ontario waterfront in the TRSPA, ranging from urban residential, employment areas, quarries, marinas and ports, parks, agriculture, and coastal wetlands. There are no agricultural activities within the IPZ-2 land areas in the TRSPA.

Table 5.16: Managed Lands (%) in Intake Protection Zones

Managed (%) in IPZs	Risk Score	% of Total IPZs Managed Lands	Threat
< 40	Low	70.9	Low
40–80	Moderate	29.1	
> 80	High	0	

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

The land area within this IPZ is urban parkland and there is no livestock activity within this vulnerable area, as shown on **Figure 5.31**.

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

The impervious surfaces were calculated based on the land area only. IPZ-2s within the TRSPA were mapped according to *Technical Rule 16 (11).* The *Technical Rules* require that only those areas in an IPZ-2 with impervious surfaces greater than 8% be mapped. Areas with less than 8% impervious surfaces are not mapped (see **Table 5.17**). The vast majority of the land portion of IPZ-2s falls within the 8%–80% range. This is a direct result of the land uses and transportation network along TRSPA's Lake Ontario waterfront.

Table 5.17: Impervious Surfaces in Intake Protection Zones

Impervious Surfaces (%) in IPZs	% of Total IPZs	Threat
not more than 1	1.7	No Threat
more than 1; not more than 8	10.0	Low
more than 8; not more than 80	88.3	
80 or more	0.0	

Generally, in IPZ-2s in the study area, areas with less than 8% imperviousness are associated with lakefront parks, conservation areas, and provincially significant coastal wetlands. For example, in these areas, the road network is limited, as is development (see **Figure 5.32**). Where agricultural facilities were found within vulnerable SGRAs and HVAs of the TRSPA, the building footprint of any structure within those facilities must be digitized to calculate the area occupied by the structure.

Figure 5.27: Managed Lands in Intake Protection Zones

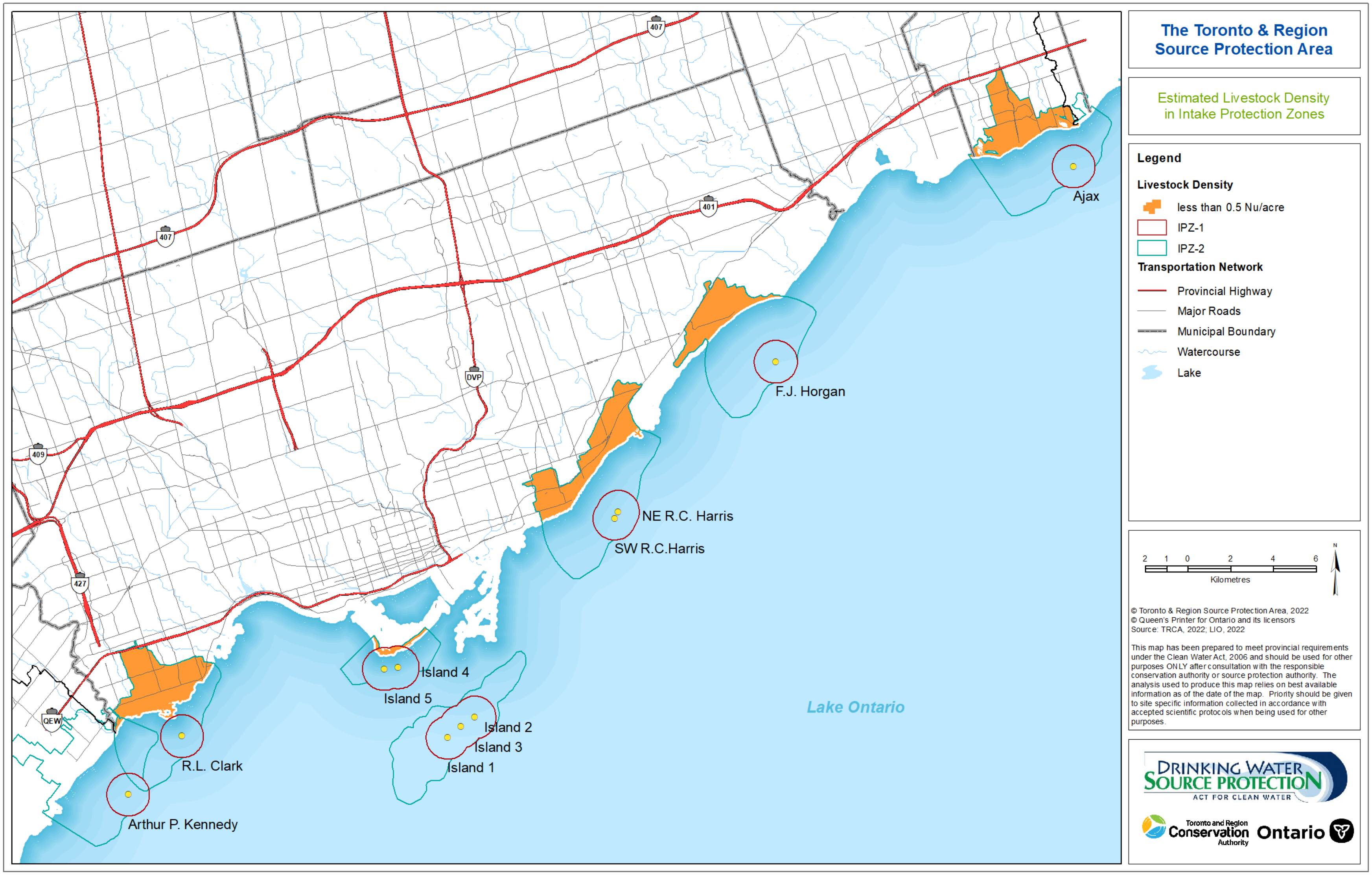


Figure 5.28: Estimated Livestock Density in Intake Protection Zones

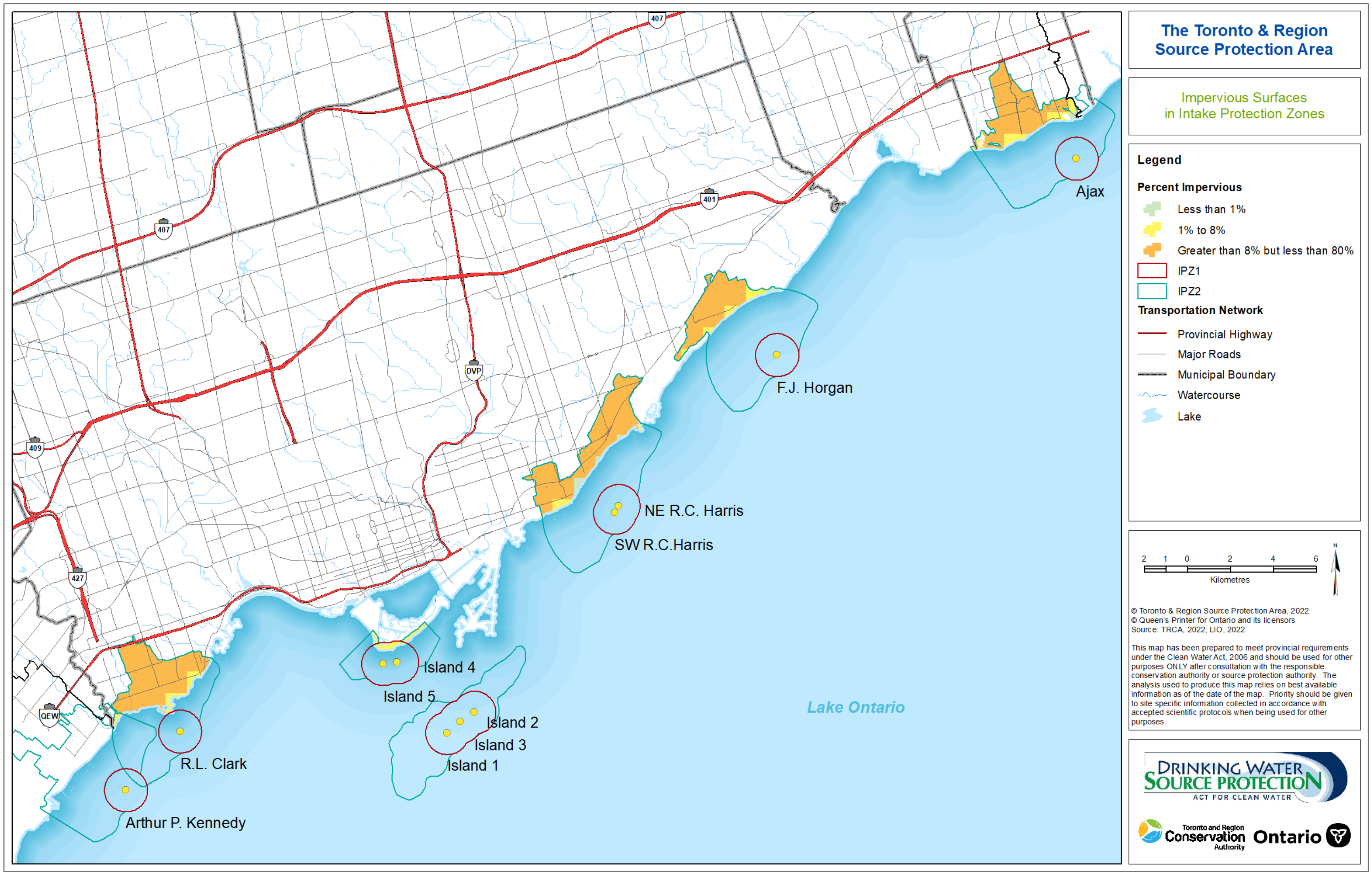


Figure 5.29: Impervious Surface in Intake Protection Zones

5.7.6 Threats from Activities in Intake Protection Zones

> **Threshold:** A contaminant concentration above which raw water quality could be considered to be impaired. A description of individual thresholds is provided in **Appendix E6**.

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 water treatment plant (WTP) intakes.

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 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. 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 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 MOECC 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 intakes; 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;
- Sanitary Trunk Sewer (STS) breaks within some Toronto area tributaries;
- 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 plants at Pickering or Darlington.

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 5.18**, below, and described in the text following the table. 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 regarding the spill scenario characteristics and how the model (MIKE-3) was calibrated and validated are provided in **Appendix E6**. MIKE-3 model uses the full three-dimensional representation of water motion. It simulates the seasonal temperature conditions and summer stratification that affects the circulations patterns in Lake Ontario, which is required for accurate predictions of water currents.

Table 5.19 presents all of the scenarios that were modelled for the CTC Source Protection Region while **Table 5.20** shows all of the modelled scenarios that result in significant drinking water threats to the TRSPA intakes, as well as spill scenarios located in TRSPA that result in significant drinking water threats in adjacent source protection areas. Further details are provided in **Appendix E6**.

Table 5.18: Lake Ontario Intake Model Spill Scenarios

Lake Ontario Intake Model Spill Scenario Details			Contaminant of Concern
Type	Location	Volume and Duration of Spill	
Disinfection Failure at WWTP	Mid-Halton 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*
	SW-Halton WWTP		
	SE-Halton WWTP		
	Clarkson WWTP		
	GE Booth (formerly Lakeview) WWTP		
	Humber WWTP		
	Ashbridges Bay WWTP		
	Highland Creek WWTP		
	Duffins Creek WWTP		
	Wellington WWTP		
	Corbett Creek WWTP		
	Harmony Creek WWTP		
	Courtice WWTP		
	Port Darlington WWTP		
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, Don River, Highland Creek) up to and including the location of the 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 to each tributary, all simulated for 24 hour spill duration	*E. coli*
Combined Sewer Overflow Spill	Toronto Inner Harbour	Continuous simulation of actual conditions from April 1, 2007 to Oct 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	2,700 m^3 of fuel, 6 hour duration	Benzene
	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		

Lake Ontario Intake Model Spill Scenario Details			Contaminant of Concern
Type	Location	Volume and Duration of Spill	
	Ganaraska River		
	Cobourg Creek		
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 $x10^{11}$ Bq/L (e.g., the estimated total amount of tritium activity released was $2.3x10^{15}$ 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 $x10^{11}$ Bq/L (e.g., the estimated total amount of tritium activity released was $2.3x10^{15}$ 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 TRSPA WTPs. The modelled parameter of concern for these scenarios was *E. coli* and the recreational standard for *E. coli* of 100 CFU/100 ml 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 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 TRSPA 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 up river to the first lateral connection to the trunk sewer. Within this area, the maximum amount of waste water would be present in the pipe and the time of travel to the lake would be less than two hours. Trunk sewer flow was estimated at about 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 and 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 assumed the ambient level of *E. coli* was 1000 CFU/100 ml 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/100 ml 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 bacterial population (*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 Spill

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 to 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 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* at a 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 TRSPA 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.

As shown in **Table 5.18**, 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 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.

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 Ontario Drinking Water Standard (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 to the quality of raw water for the intakes located in Lake Ontario. The modeled parameter of concern was tritium and the threshold used was the ODWS for tritium (7000 Bq/L). The model also simulated a threshold of 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 concentration of 7.9×10^{11} Bq/L. The modelled duration of the spill event was 6-hours, as if it were released 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 identified 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 near shore area in the lake are complex and not one-directional. Further details regarding these points are included in **Appendix E6**.

The Lake Ontario modelling identified 19 locations of significant drinking water quality threats for Lake Ontario intakes within the TRSPA. The Source Protection Plan for CTC SPR must have policies to address the significant drinking water threat activities that are located within the source protection area (SPA).

In addition, TRSPA has identified significant drinking water threat activities located outside of the TRSPA. These activities, although not enumerated in this Assessment Report, affect water treatment plants located in TRSPA, and must be addressed through source protection plan policies developed in adjacent source protection areas. TRSPA 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.

The modelling results for the event-based modelling are summarized below. **Table 5.19** outlines the results where the model scenarios predict that an activity will be a significant drinking water threat, including:

- Threats located within the TRSPA that are a significant threat to intakes located within the TRSPA (nineteen unique threats to five intakes); and
- Threats located outside of the TRSPA that are a significant threat to intakes located within the TRSPA (fifteen unique threats to five intakes).

Table 5.19 shows all of the modelled spills scenarios that result in significant drinking water threats to the TRSPA intakes, as well as spill scenarios located in TRSPA that result in significant drinking water threats in adjacent Source Protection Areas.

Table 5.19: Modelling Results of Significant Drinking Water Threats to Lake Ontario Intakes

SPR/SPA	Intake Affected	Spill Scenario	Activity Location	Parameter of Concern	Water Quality Threshold	Concentration at the Intake (benzene - mg/L; *E. coli* - CFU/100mL)	Significant Threat
Halton-Hamilton/ Halton SPA	Oakville	Ashbridges Bay WWTP disinfection failure	IPZ-3 TRSPA	*E. coli*	100 CFU/ 100 mL	108	Yes
		Etobicoke Creek STS break				144	Yes
CTC/ CVSPA	Lorne Park	Humber River WWTP disinfection failure	IPZ-3 TRSPA	*E. coli*	100 CFU/ 100 mL	734	Yes
		Ashbridges Bay WWTP disinfection failure				756	Yes
		Etobicoke Creek STS break				367	Yes
		North York Petroleum Storage Spill via Humber River	IPZ-3 TRSPA	Benzene	0.005 mg/L	0.078	Yes
		Etobicoke Creek pipeline break				*	Yes
		Humber River pipeline break				0.15	Yes
		Don River pipeline break				0.014	Yes
		Highland Creek pipeline break				0.01	Yes
		Rouge River pipeline break				0.008	Yes
		Duffins Creek pipeline break				0.009	Yes
	Arthur P. Kennedy (formerly Lakeview)	Humber River WWTP disinfection failure	IPZ-3 TRSPA	*E. coli*	100 CFU/ 100 mL	2,906	Yes
		Ashbridges Bay WWTP disinfection failure				780	Yes
		Etobicoke Creek STS break				183	Yes
		Humber River STS break				109	Yes
		Etobicoke Creek pipeline break	IPZ-3 TRSPA	Benzene	0.005 mg/L	*	Yes
		Humber River pipeline break				0.30	Yes

SPR/SPA	Intake Affected	Spill Scenario	Activity Location	Parameter of Concern	Water Quality Threshold	Concentration at the Intake (benzene - mg/L; *E. coli* - CFU/100mL)	Significant Threat
CTC/ CVSPA	Arthur P. Kennedy (formerly Lakeview)	Don River pipeline break	IPZ-3 TRSPA	Benzene	0.005 mg/L	0.023	Yes
		Highland Creek pipeline break				0.12	Yes
		Rouge River pipeline break				0.009	Yes
		Duffins Creek pipeline break				0.011	Yes
		North York Petroleum Storage Spill via Humber River				0.32	Yes
CTC/ TRSPA	R.L. Clark	Clarkson WWTP disinfection failure	IPZ-3 CVSPA	*E. coli*	100 CFU/ 100 mL	1400	Yes
		GE Booth WWTP disinfection failure	IPZ-3 CVSPA			55600	Yes
		Humber River WWTP disinfection failure	IPZ-3 TRSPA			11688	Yes
		Ashbridges Bay WWTP disinfection failure	IPZ-3 TRSPA			2671	Yes
		Etobicoke Creek STS break	IPZ-3 TRSPA			1013	Yes
		Humber River STS break	IPZ-3 TRSPA			343	Yes
		16 Mile Creek pipeline break	IPZ-3 HHSPA	Benzene	0.005 mg/L	0.19	
		Credit River pipeline break	IPZ-3 CVSPA			0.15	Yes
		Etobicoke Creek pipeline break	IPZ-3 TRSPA			*	Yes
		Humber River pipeline break				0.79	Yes
		Don River pipeline break				0.035	Yes
		Highland Creek pipeline break				0.013	Yes
		Rouge River pipeline break				0.01	Yes
		Duffins Creek pipeline break				0.011	Yes
		Bulk storage spill, Oakville facility				0.014	Yes

SPR/SPA	Intake Affected	Spill Scenario	Activity Location	Parameter of Concern	Water Quality Threshold	Concentration at the Intake (benzene - mg/L; *E. coli* - CFU/100mL)	Significant Threat
CTC/ TRSPA (Cont'd)	R.L. Clark (cont'd)	North York Petroleum Storage Spill via Humber River	IPZ-3 TRSPA	Benzene	0.005 mg/L	0.55	Yes
	Toronto Island (Shallow)	16 Mile Creek pipeline break	IPZ-3 CVSPA	Benzene	0.005 mg/L	0.008	Yes
		Humber River pipeline break	IPZ-3 TRSPA			0.40	Yes
		Don River Pipeline break				1.0	Yes
		Highland Creek pipeline break				0.015	Yes
		Rouge River pipeline break				0.014	Yes
		Duffins Creek pipeline break				0.015	Yes
	Toronto Island (Deep)	Humber River pipeline break	IPZ-3 TRSPA	Benzene	0.005 mg/L	0.01	Yes
		Don River Pipeline break				0.01	Yes
		North York Petroleum Storage Spill via Humber River				0.015	Yes
		North York Petroleum Storage Spill via Don River				0.009	Yes
	R.C. Harris	GE Booth WWTP disinfection failure	IPZ-3 CVSPA	*E. coli*	100 CFU/ 100 mL	110	Yes
		Humber River WWTP disinfection failure	IPZ-3 TRSPA			216	Yes
		Highland Creek WWTP disinfection failure				1, 308	Yes
		Ashbridges Bay WWTP disinfection failure				4,911	Yes
		Duffins Creek WWTP disinfection failure				450	Yes
		Don River STS break				127	Yes

SPR/SPA	Intake Affected	Spill Scenario	Activity Location	Parameter of Concern	Water Quality Threshold	Concentration at the Intake (benzene - mg/L; *E. coli* - CFU/100mL)	Significant Threat
CTC/ TRSPA (Cont'd)	R.C. Harris (Cont'd)	16 Mile Creek pipeline break	IPZ-3 HHSPA	Benzene	0.005 mg/L	0.005	Yes
		Humber River pipeline break	IPZ-3 TRSPA			0.101	Yes
		Don River pipeline break				0.31	Yes
		Highland Creek pipeline break				0.088	Yes
		Rouge River pipeline break				0.045	Yes
		Duffins Creek pipeline break				0.047	Yes
		North York Petroleum Storage Spill via Humber River				0.0055	Yes
		North York Petroleum Storage Spill via Don River				0.059	Yes
	F.J. Horgan	Humber River WWTP disinfection failure	IPZ-3 TRSPA	*E. coli*	100 CFU/ 100 mL	100	Yes
		Highland Creek WWTP disinfection failure	IPZ-3 TRSPA			10,471	Yes
		Ashbridges Bay WWTP disinfection failure	IPZ-3 TRSPA			1,373	Yes
		Duffins Creek WWTP disinfection failure	IPZ-3 TRSPA			2,470	Yes
		Highland Creek STS Break	IPZ-3 TRSPA			288	Yes
		16 Mile pipeline break	IPZ-3 HHSPA	Benzene	0.005 mg/L	0.005	Yes
		Humber River pipeline break	IPZ-3 TRSPA			0.065	Yes
		Don River Pipeline Break	IPZ-3 TRSPA			0.25	Yes
		Highland Creek pipeline break	IPZ-3 TRSPA			0.29	Yes
		Rouge River pipeline break	IPZ-3 TRSPA			0.27	Yes
		Duffins Creek pipeline break	IPZ-3 TRSPA			0.075	Yes
		North York Petroleum Storage Spill via Don River	IPZ-3 TRSPA			0.038	Yes

SPR/SPA	Intake Affected	Spill Scenario	Activity Location	Parameter of Concern	Water Quality Threshold	Concentration at the Intake (benzene - mg/L; *E. coli* - CFU/100mL)	Significant Threat
CTC/ TRSPA (Cont'd)	Ajax	Highland Creek WWTP disinfection failure	IPZ-3 TRSPA	*E. coli*	100 CFU/ 100 mL	1225	Yes
		Ashbridges Bay WWTP disinfection failure	IPZ-3 TRSPA			423	Yes
		Duffins WWTP disinfection failure	IPZ-3 TRSPA			7,320	Yes
		Corbett Creek WWTP disinfection failure	IPZ-3 CLOSPA			479	Yes
		Harmony Creek WWTP disinfection failure	IPZ-3 CLOSPA			210	Yes
		Courtice WWTP disinfection failure	IPZ-3 CLOSPA			353	Yes
		Don River Pipeline Break	IPZ-3 TRSPA	Benzene	0.005 mg/L	0.01	Yes
		Highland Creek pipeline break	IPZ-3 TRSPA			0.01	Yes
		Rouge River pipeline break	IPZ-3 TRSPA			0.011	Yes
		Petticoat Creek pipeline break	IPZ-3 TRSPA			*	Yes
		Duffins Creek pipeline break	IPZ-3 TRSPA			0.061	Yes
		Carruthers Creek pipeline break	IPZ-3 TRSPA			*	Yes
		Lynde Creek pipeline break	IPZ-3 CLOSPA			*	Yes
		Oshawa Creek pipeline break	IPZ-3 CLOSPA			0.14	Yes

SPR/SPA	Intake Affected	Spill Scenario	Activity Location	Parameter of Concern	Water Quality Threshold	Concentration at the Intake (benzene - mg/L; *E. coli* - CFU/100mL)	Significant Threat
CTC/ CLOSPA	Whitby	Highland Creek WWTP disinfection failure	IPZ-3 TRSPA	*E. coli*	100 CFU/ 100 mL	1064	Yes
		Ashbridges Bay WWTP disinfection failure	IPZ-3 TRSPA			422	Yes
		Duffins Creek WWTP disinfection failure	IPZ-3 TRSPA			6480	Yes
		Highland Creek pipeline break	IPZ-3 TRSPA	Benzene	0.005 mg/L	0.008	Yes
		Rouge River pipeline break				0.006	Yes
		Petticoat Creek pipeline break				*	Yes
		Duffins Creek pipeline break				0.011	Yes
		Carruthers Creek pipeline break				*	Yes
		Pickering Nuclear wastewater release	IPZ-3 TRSPA	Tritium	7000 Bq/L	12,000 Bq/L	Yes
	Oshawa	Pickering Nuclear wastewater release	IPZ-3 TRSPA	Tritium	7000 Bq/L	20,000 Bq/L	Yes

Note:

* Due to time constraints, the in-lake portion of this scenario was not run. However, this tributary lies between two other modelled tributaries which had significant threats from the same activity

The following maps highlight the location of the threat activities, 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 5.33** through **Figure 5.42** for the spills scenarios where there are threat activities located within TRSPA or municipal intakes located in TRSPA are affected by threat activities located within other source protection areas.

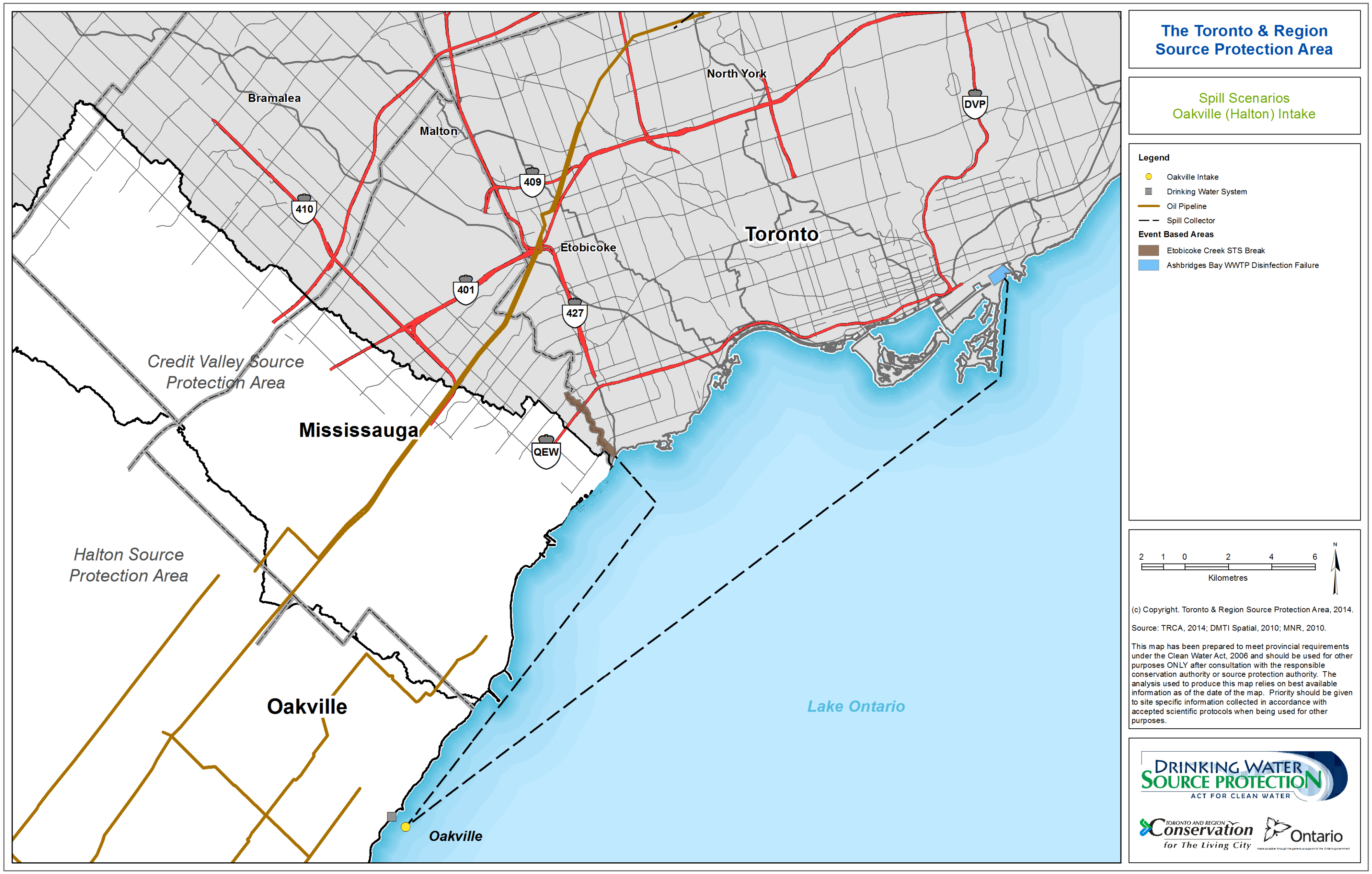


Figure 5.30: Spill Scenarios - Oakville (Halton) Intake

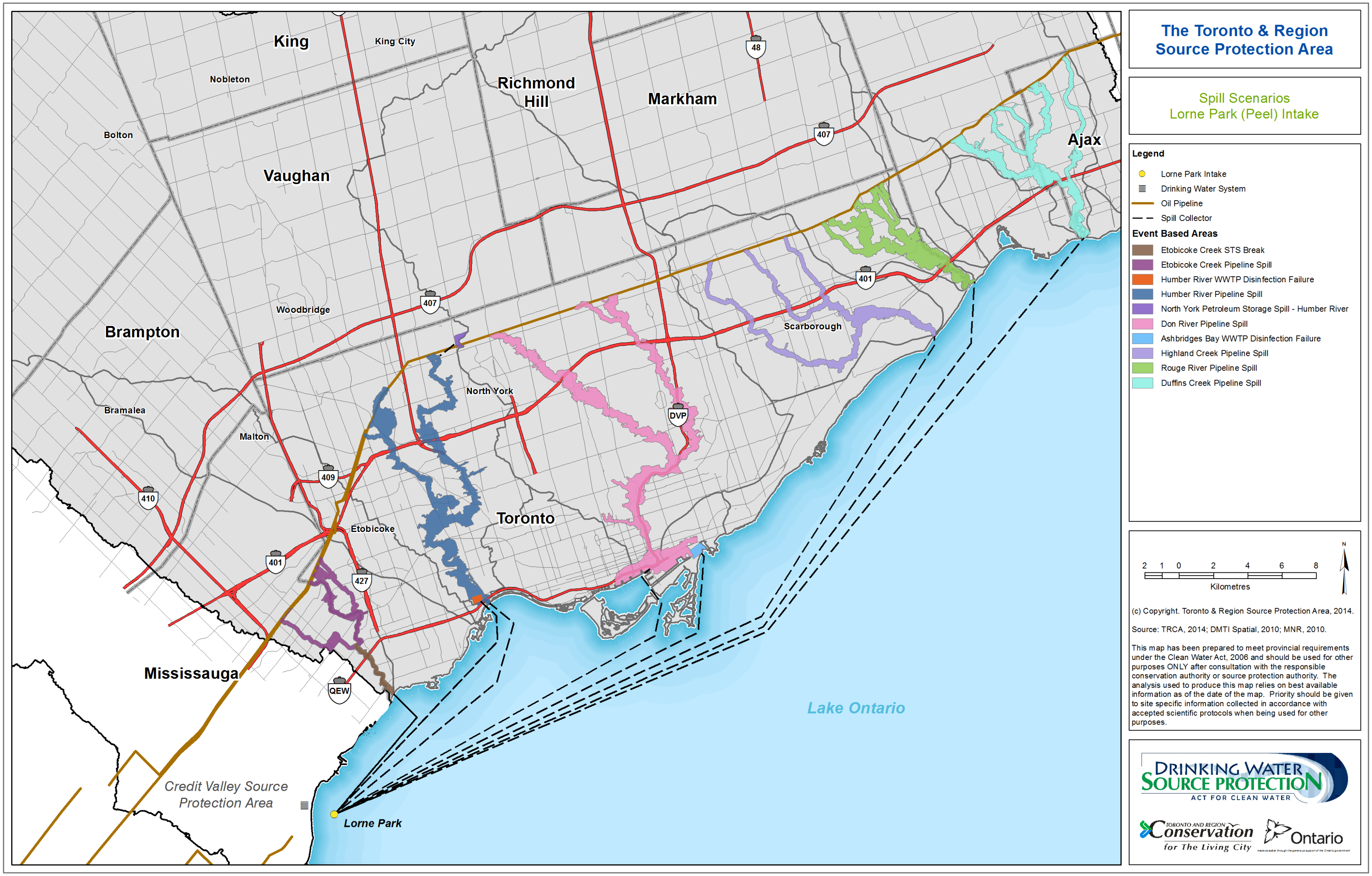


Figure 5.31: Spill Scenarios - Lorne Park (Peel) Intake

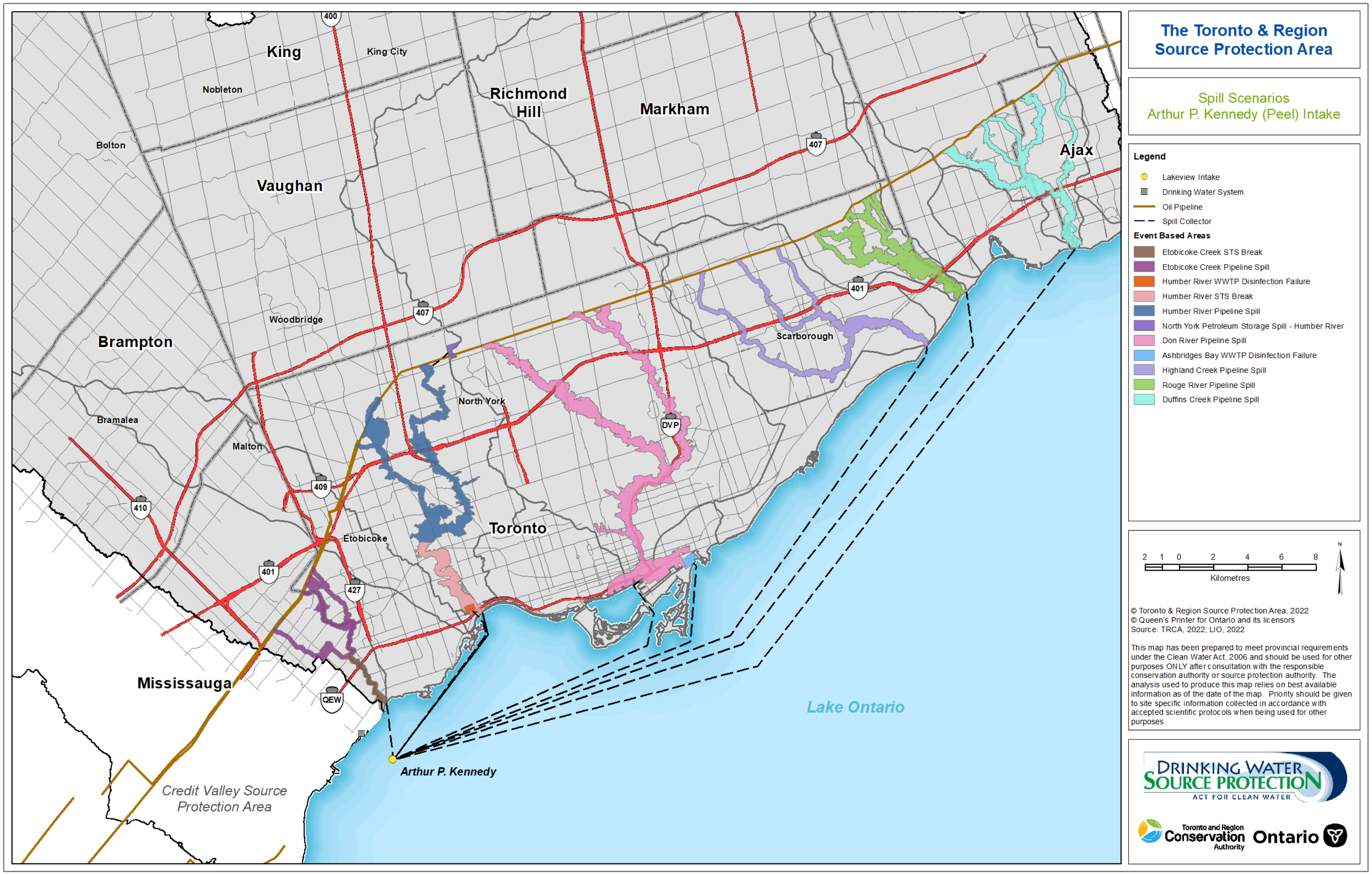


Figure 5.32: Spill Scenarios - Arthur P. Kennedy (Peel) Intake

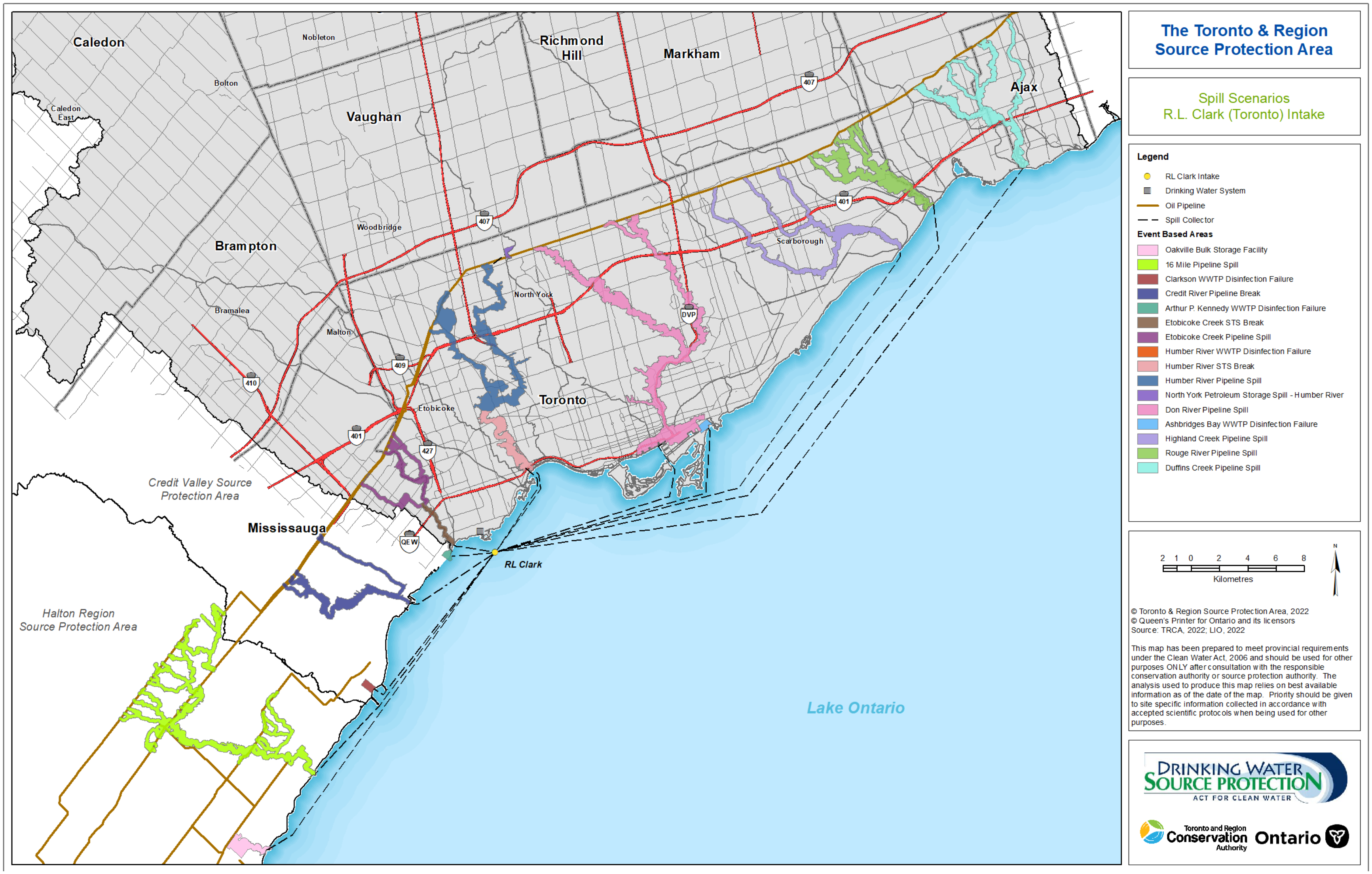


Figure 5.33: Spill Scenarios – R. L. Clark (Toronto) Intake

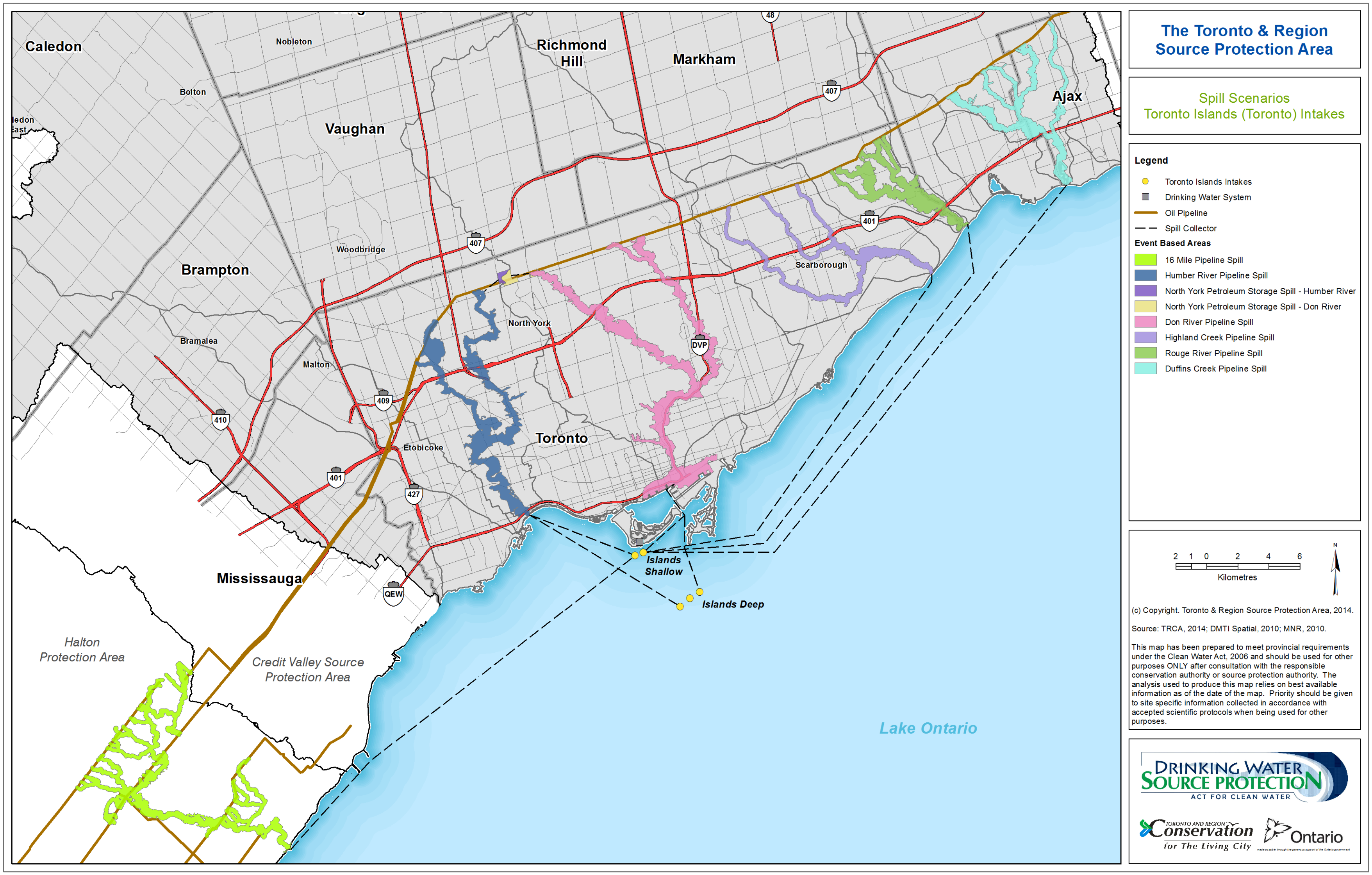


Figure 5.34: Spill Scenarios - Toronto Island (Toronto) Intakes

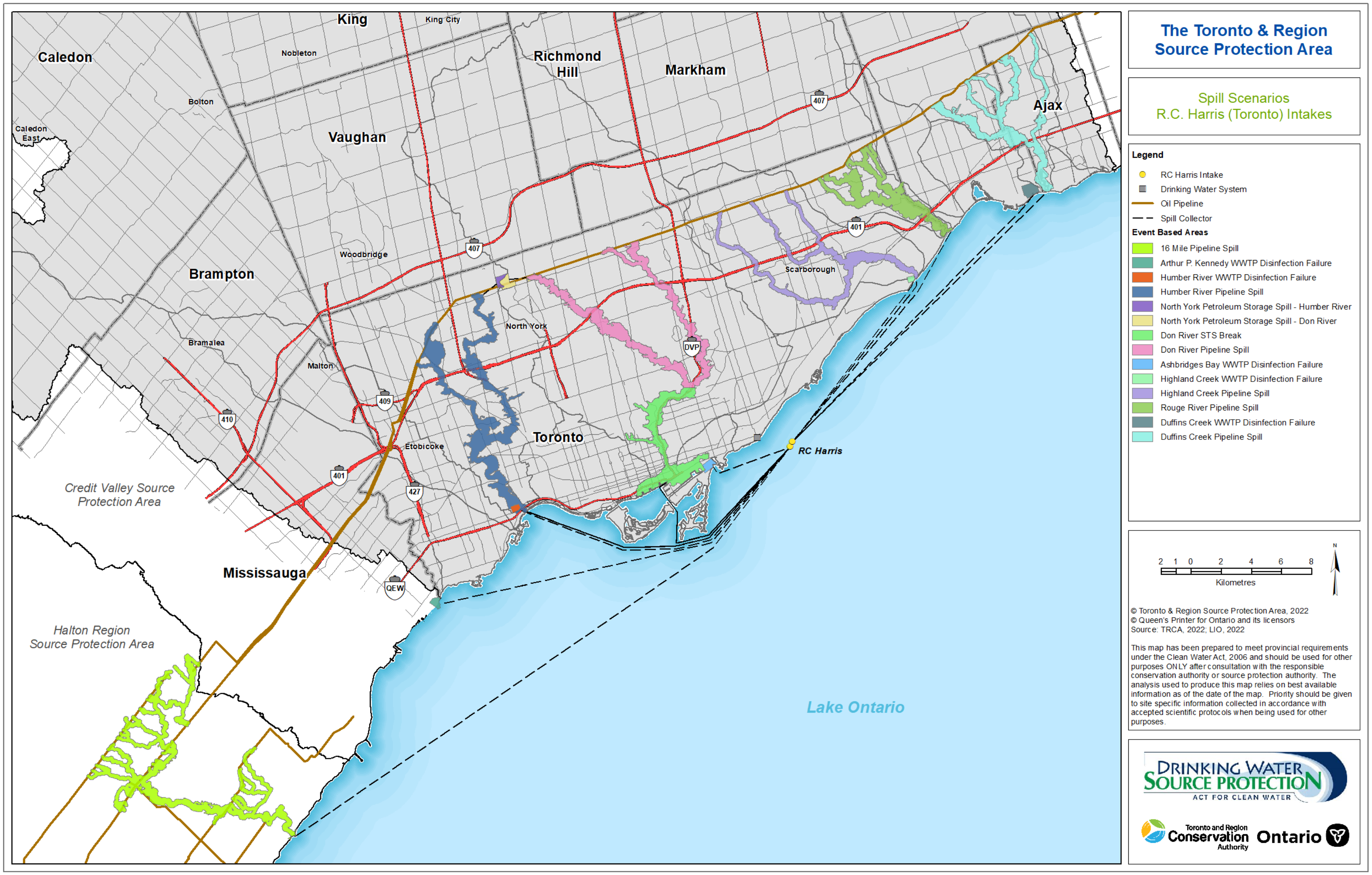


Figure 5.35: Spill Scenarios – R. C. Harris (Toronto) Intakes

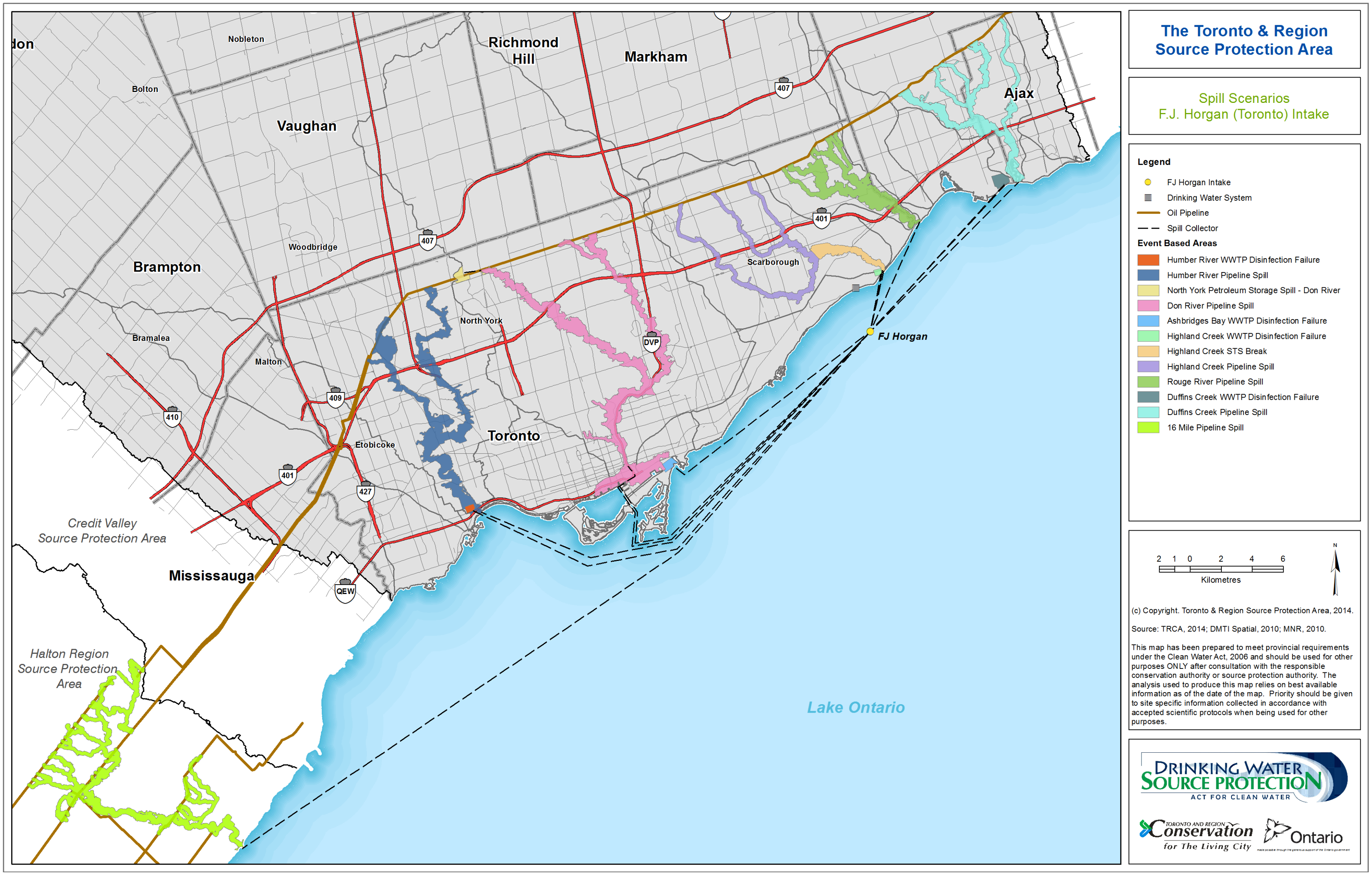


Figure 5.36: Spill Scenarios – F. J. Horgan (Toronto) Intake

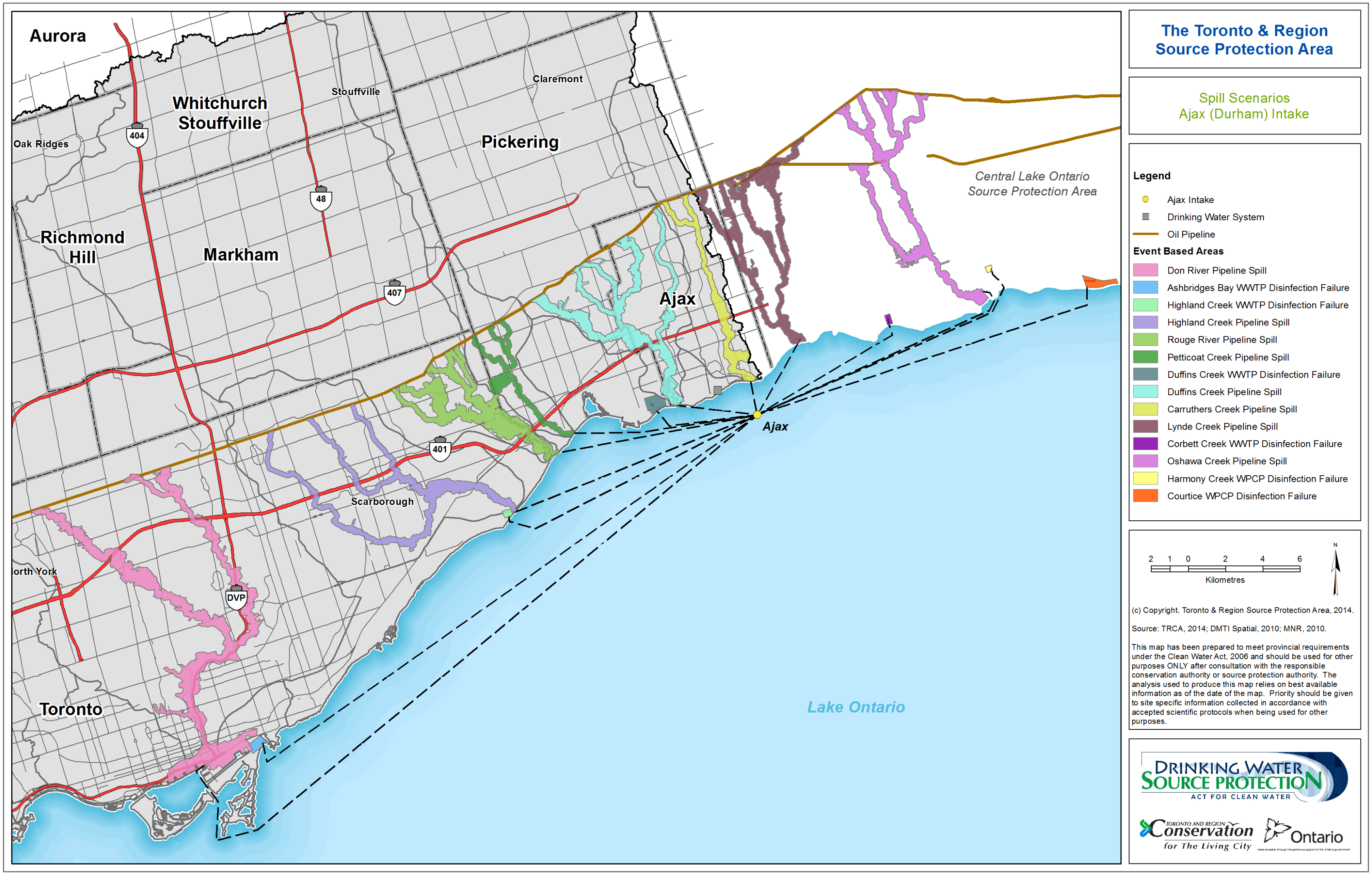


Figure 5.37: Spill Scenarios - Ajax (Durham) Intake

Figure 5.38: Spill Scenarios - Whitby (Durham) Intake

Figure 5.39: Spill Scenario - Oshawa (Durham) Intake

Significant Threats Enumeration

Table 5.20 provides the number of significant drinking threats located in TRSPA, extracted from the information found in **Table 5.19**. Note that **Table 5.19** includes multiple references to a single significant drinking water threat location. There are 19 significant threat locations within the TRSPA (note that a threat may affect more than one intake and that some of the affected intakes are outside the TRSPA).

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 TRSPA has identified significant drinking water threats from activities located outside the TRSPA. These activities affect water treatment plants located in TRSPA 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 5.19**, but are not enumerated as part of the TRSPA threat inventory, since they are located outside of the TRSPA. TRSPA 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 5.20: Significant Threats for the TRSPA WTPs

Number of Significant Threat Locations in TRSPA		
Threat Locations	**Parameter of Concern**	**WTP Affected (includes Intakes outside the TRSPA)**
Ashbridges Bay WWTP disinfection failure	*E. coli*	Ajax, R.L. Clark, R.C. Harris, F.J. Horgan, Arthur P. KennedyLorne Park, Oakville, Whitby
Carruthers Creek pipeline break	benzene	Ajax, Whitby, Oshawa, Whitby
Don River pipeline break	benzene	R.L. Clark, R.C. Harris, F.J. Horgan, Arthur P. Kennedy, Lorne Park, Toronto Island (Shallow and Deep), Ajax
Don River STS break	*E. coli*	R.C. Harris
Duffins Creek pipeline break	benzene	Ajax, R.C. Harris, F.J. Horgan, Arthur P. Kennedy, Lorne Park, Whitby, R.L. Clark, Toronto Island (shallow)
Duffins Creek WWTP disinfection failure	*E. coli*	Ajax, R.C. Harris, F.J. Horgan Whitby
Etobicoke Creek STS break	*E. coli*	R.L. Clark, Arthur P. Kennedy, Lorne Park, Oakville
Etobicoke Creek pipeline break	benzene	R.L. Clark, Arthur P. Kennedy, Lorne Park
GE Booth (formerly Lakeview)	E. coli	R.L. Clark, R.C. Harris
Highland Creek pipeline break	benzene	Ajax, R.C. Harris, F.J. Horgan, Arthur P. Kennedy, Lorne Park, Whitby, R.L. Clark, Toronto Island (shallow)
Highland Creek STS Break	*E. coli*	F.J. Horgan
Highland Creek WWTP disinfection failure	*E. coli*	Ajax, R.C. Harris, F.J. Horgan, Whitby
Humber River pipeline break	benzene	R.L. Clark, R.C. Harris, Arthur P. Kennedy, Lorne Park, Toronto Island (Shallow and Deep), F.J. Horgan
Humber River STS break	*E. coli*	R.L. Clark, Arthur P. Kennedy
Humber River WWTP disinfection failure	*E. coli*	R.L. Clark, R.C. Harris, F.J. Horgan, Arthur P. Kennedy, Lorne Park
North York Petroleum Storage Spill via Don River	benzene	R.C. Harris, F.J. Horgan, Toronto Island (Deep)
North York Petroleum Storage Spill via Humber River	benzene	R.L. Clark, R.C. Harris, Arthur P. Kennedy, Lorne Park, Toronto Island (Deep)
Petticoat Creek pipeline break	benzene	Ajax, Whitby
Rouge River pipeline break	benzene	Ajax, R.C. Harris, F.J. Horgan, Arthur P. Kennedy, Lorne Park, Whitby, R.L. Clark, Toronto Island (shallow)
Pickering Nuclear wastewater release	tritium	Oshawa, Whitby
Number of Significant Threat Locations	**19**	

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 modeled results outlined in **Table 5.19** show where spill events would lead to concentrations of contaminants at the respective intakes in TRSPA that exceed the selected thresholds. Therefore an IPZ-3 must be delineated for each of these scenarios, where the Significant Drinking Water Threat (SDWT) 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 Geographic Vertical Datum) converted from the IGLD (International Great Lakes Datum 1985). The high water mark was delineated and setback extended from this datum.

Once a contaminant is modelled to reach an intake, an Event Based Area (EBA) 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 EBA 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 with a spill at a WWTP is represented by a spill collector dashed line only. The following maps (**Figure 5.43** to **Figure 5.47** show the (IPZ-1, IPZ-2 and IPZ-3) for each of the municipal intakes located within TRSPA. The delineation of the STS break IPZ-3s and associated Event Based Areas (EBAs) were revised in 2015. A technical addendum discussion these revisions is presented in **Appendix E 6.3.3**.

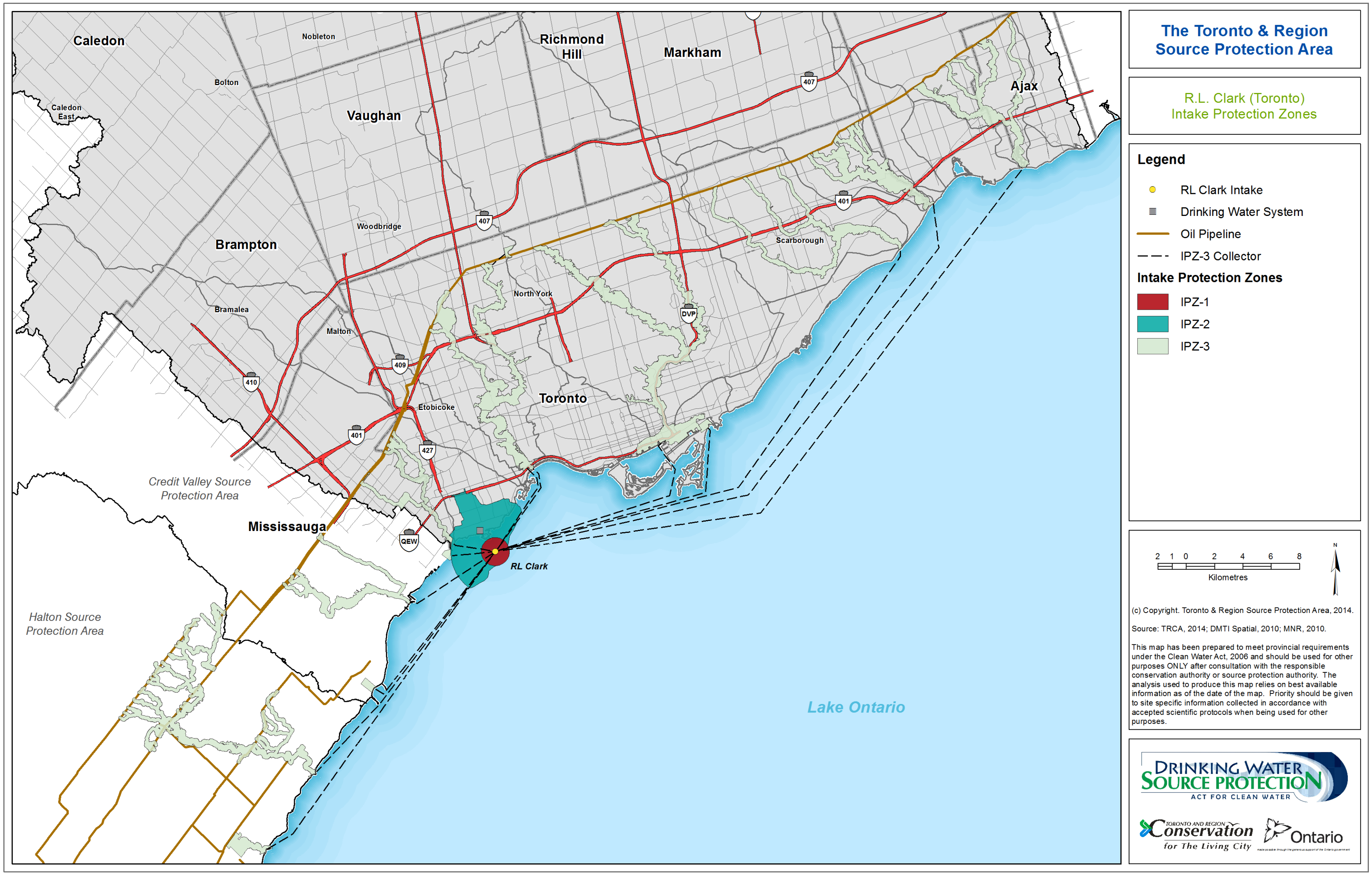


Figure 5.40: R. L. Clark (Toronto) Intake Protection Zones

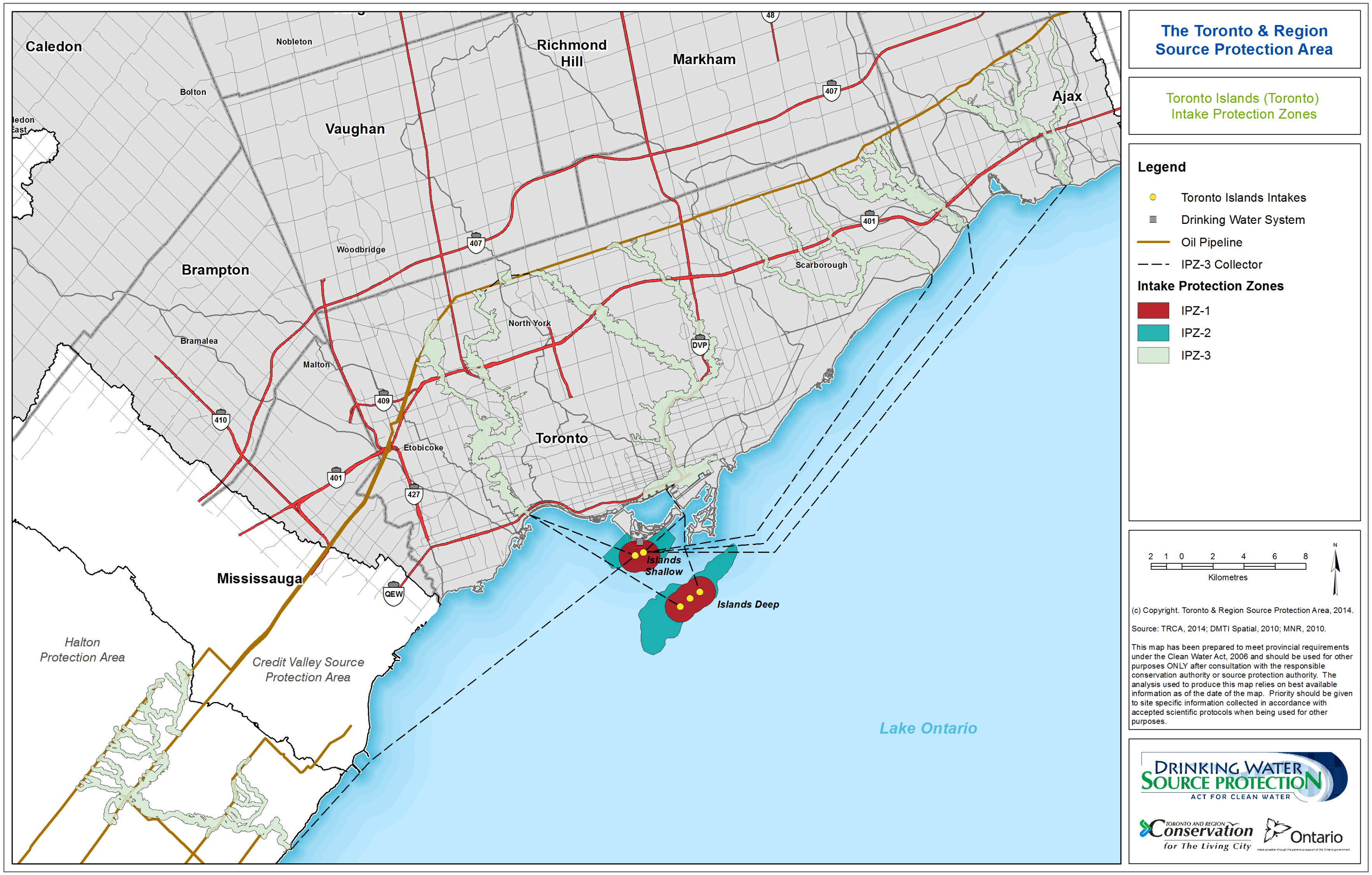


Figure 5.41: Toronto Islands (Toronto) Intake Protection Zones

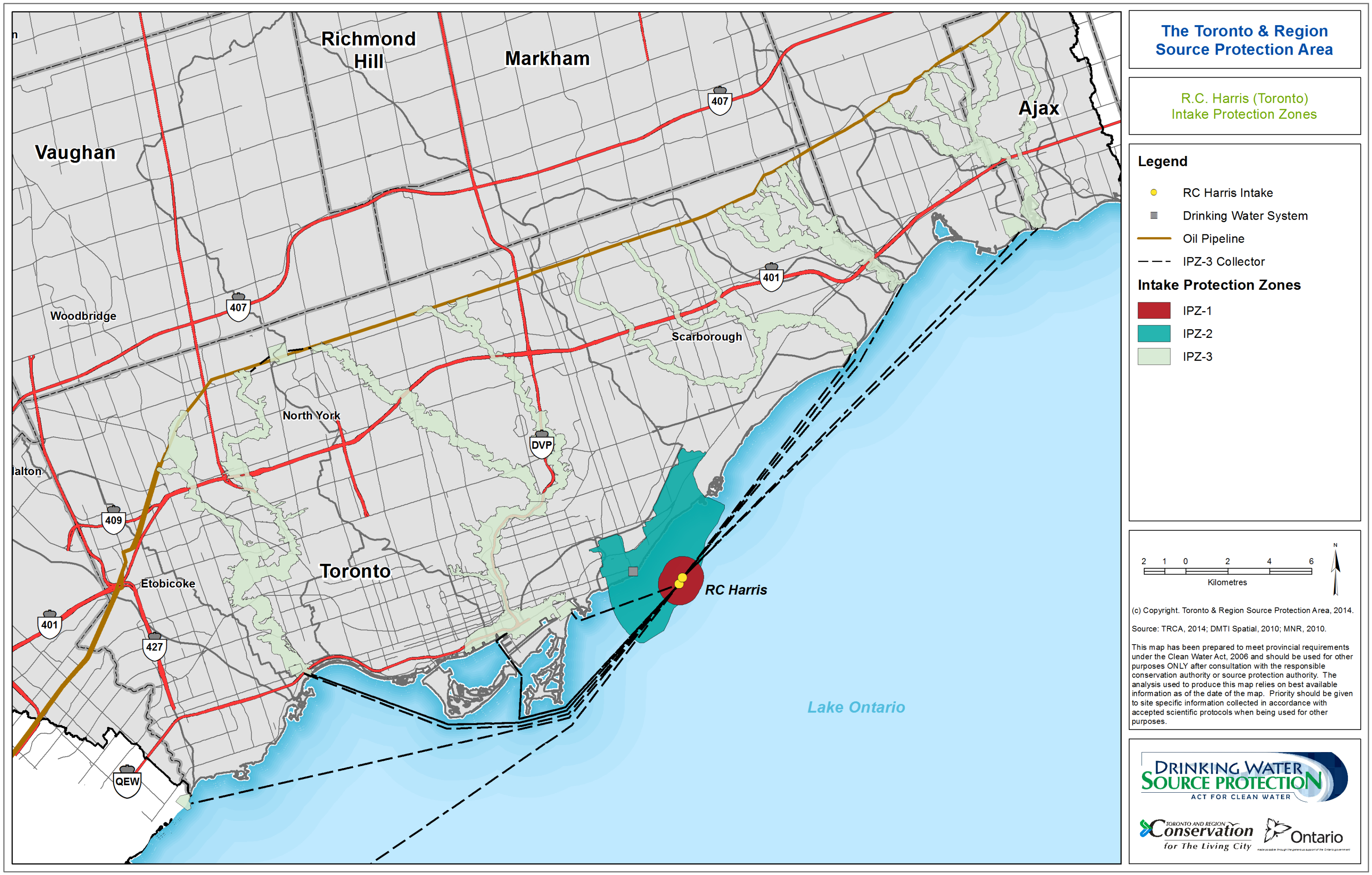


Figure 5.42: R. C. Harris (Toronto) Intake Protection Zones

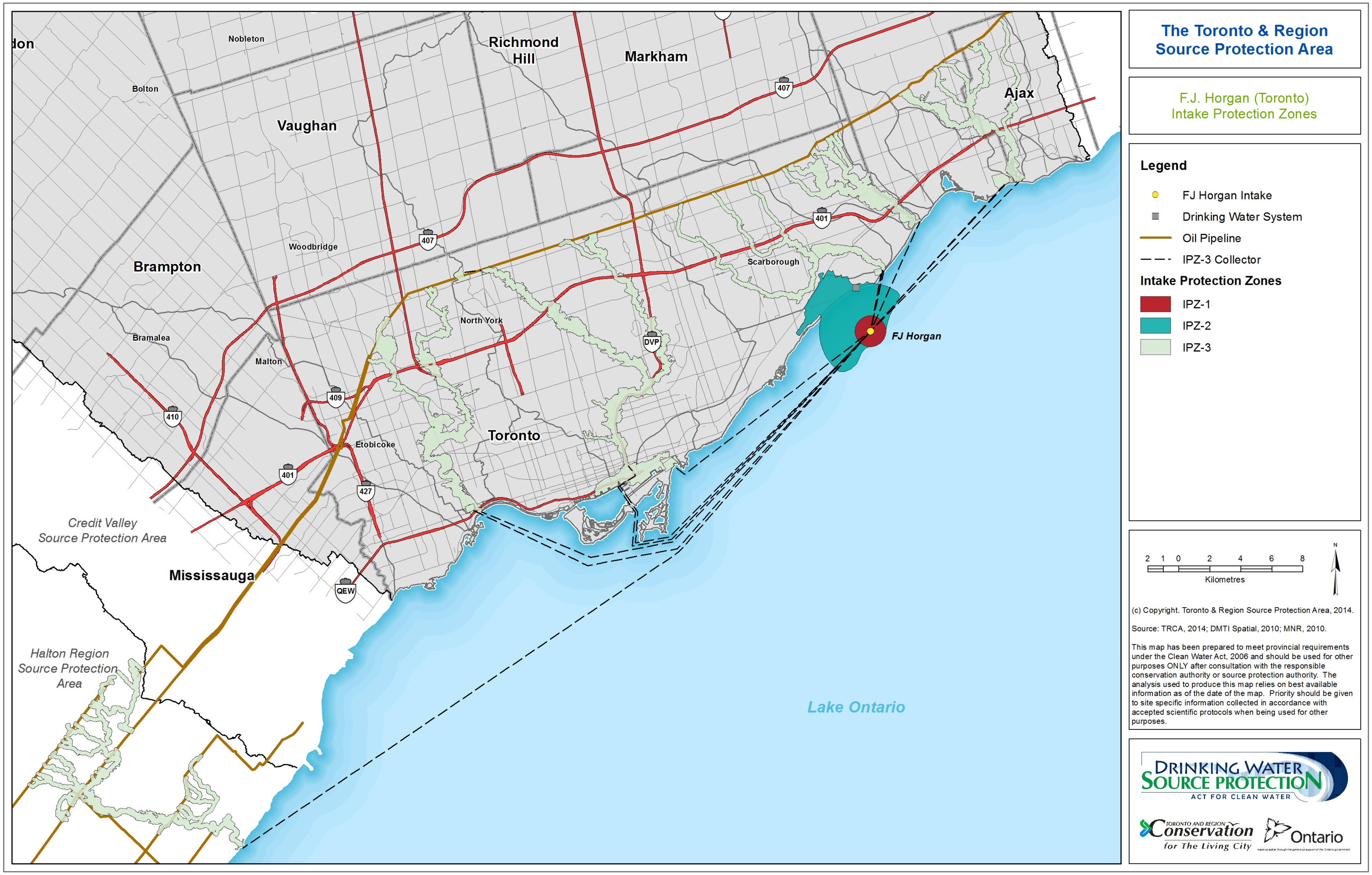


Figure 5.43: F. J. Horgan (Toronto) Intake Protection Zones

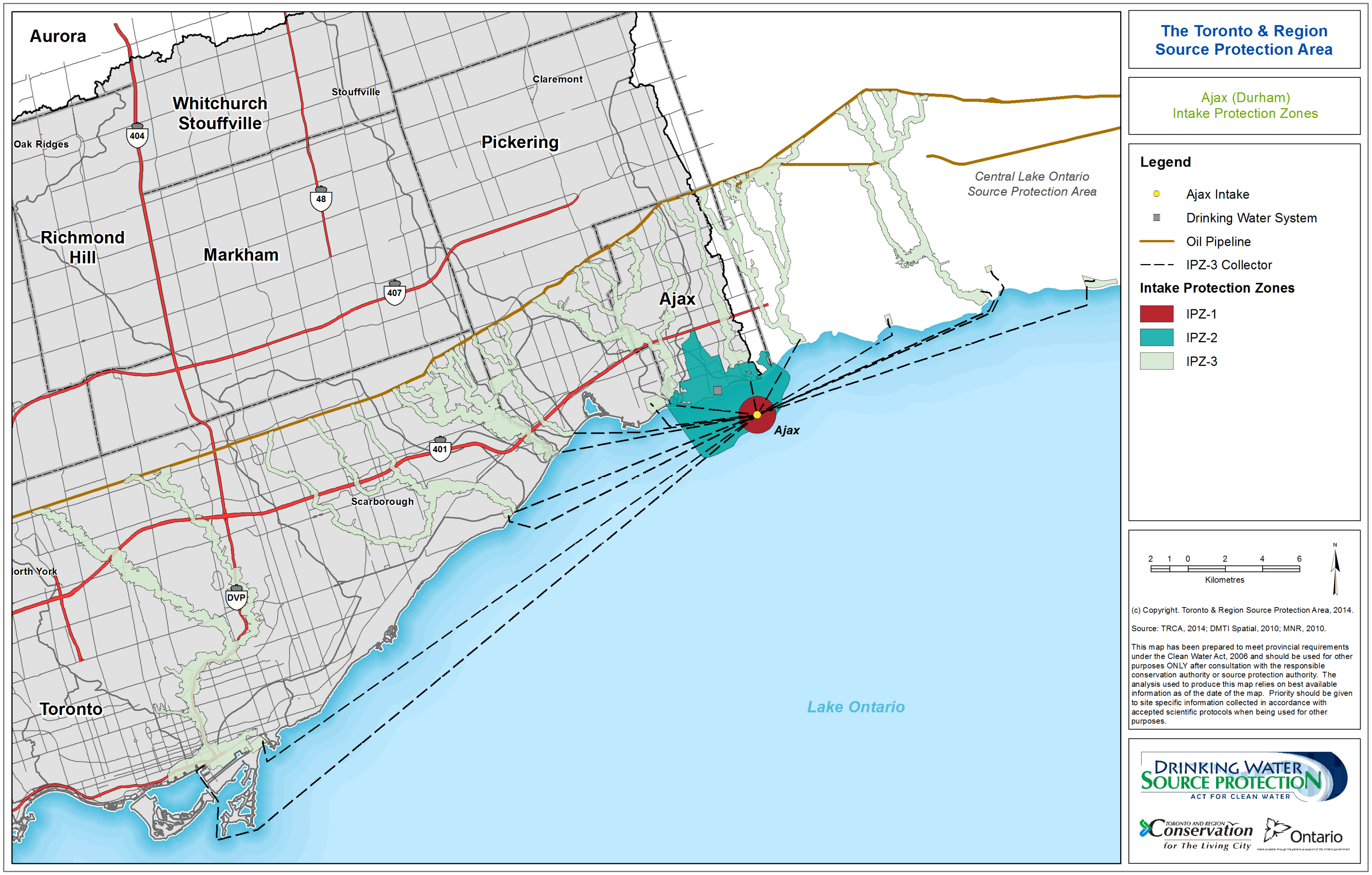


Figure 5.44: Ajax (Durham) Intake Protection Zones

Uncertainty Assessment

IPZ-3 delineation was undertaken in accordance with the Director's Rule (68) of the CWA, 2006. The delineation contains 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 5.21**.

Table 5.21: 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 established benchmarks 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 TRCA staff using HEC-RAS software to determine if it would be reasonable to include other creeks not modeled 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 waste water 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 is underway on the model calibration and validation process, but could not be completed within the time frame for completing 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. This will 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 TRSPA is generally very good based on the information provided by municipal plant operators. The water quality in Lake Ontario maybe 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 discharge 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* 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 within the TRCA, staff has considered the outputs of climate change models, such as the Hadley model developed in the United Kingdom and the Canadian General Circulation Model (CGCM) in conjunction with population growth and land-use changes. However, the work completed to date has used regional scale output (i.e., one cell covers the entire jurisdiction), and only two scenarios were considered. Further modelling is needed with statistical downscaling to examine more closely the potential effects of climate change. Therefore, climate change impacts will likely be further addressed in future versions of the TRSPA Assessment Report. As required by the Province, some general points about the potential effects follow.

Within the TRSPA there are a variety of initiatives underway regarding the assessment and adaptation to Climate Change. These include:

- Enhancements to the Regional Monitoring Program to measure seasonal variations and trends in local climate;
- Staff participation on provincial committees developing the science behind climate change modelling;
- Sustainable Communities Evaluation Program (STEP) which tests innovative water management practices that could be employed to mitigate the effects of climate change; and
- With York University and the Ministry of the Environment and Climate Change, developing training materials on climate change science and integration with source protection.

5.8.1 Water Resources Management

Water resources management is complex, balancing the demands of many different users, 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 TRSPA 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 5.22** 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).

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

Table 5.22: Expected Changes to Water Resources in the 21st Century Great Lakes Basin

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 base flow 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

Note: 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). Within the TRSPA, the regional municipalities of Peel, York, and Durham, as well as the City of Toronto, rely exclusively or significantly on Lake Ontario for their water supplies. 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 (Kreutzwiser *et al*., 2003). 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). 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.

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

5.8.2 Flooding

Most flood emergencies reported in this area between 1992 and 2003 happened between 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.

5.9 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, 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 (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 potential 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 TRSPA 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, including Lake Ontario, which supplies most of the drinking water within the TRSPA, are exempt from this water quantity threat assessment. A Tier 3 Water Budget project, led by York Region was completed (discussed in **Chapter 3** of this Assessment Report) and includes the area around all the York and Durham wells located within the TRSPA. The assessment of groundwater quantity threats within the TRSPA did not identify any existing significant water quantity threats. Future (new) activities however are considered significant drinking water threats within this vulnerable area.

Threats to Groundwater Quality

Significant threats to groundwater quality for drinking water must be identified and counted in this Assessment Report. A total of 456 such significant drinking water quality threats were identified within the TRSPA. The number of threats was calculated using a variety of sources of data identifying activities that might be taking place, checked in some cases by windshield surveys.

In HVAs and SGRAs, no significant threats can be identified using the methodology associated with the scoring 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. 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.

It should be noted that these threats may or may not exist within the study area because site-level verification has not yet been completed. The enumeration of these threats also does not consider any contaminant management/mitigation strategies.

The *Technical Rules* require potential moderate and low level threats to be referenced, identifying the number of circumstances associated with particular activities, as detailed in the applicable provincial threats table. This Chapter contains table listings and a count of potential activities that would pose a moderate or low threat to a drinking water source protection area if they are present.

The existence of conditions that may pose a threat to municipal drinking water supplies were investigated by consultants on behalf of the regions of Peel, York, and Durham. Although no conditions were confirmed, it is possible that sites may be identified through ongoing risk management activities.

Threats to Surface Water Quality

A number of spill scenarios were modelled as part of the Lake Ontario Collaborative 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 to the Toronto WTPs (this did not impact any TRSPA intakes);
- Sanitary trunk sewer break within some Toronto tributaries;
- 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 facilities in the Keele/ Finch area of Toronto and in the Mississauga - Oakville area; and
- Discharge of tritium from nuclear plants at Pickering or Darlington (this did not impact any TRSPA intake).

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 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 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 Lake Ontario modelling identified 19 locations of significant drinking water quality threats for Lake Ontario intakes within the TRSPA. 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, TRSPA has identified significant drinking water threats located outside of the TRSPA. These activities, although not enumerated in this Assessment Report, affect water treatment plants located in TRSPA, and must be addressed through source protection plan policies developed in adjacent source protection areas. TRSPA 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.

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.

TRCA staff are actively engaging consultants to minimize the effects of urbanization and climate change on the hydrology and hydrogeology across the TRSPA. 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. This level of uncertainty is expected in a desktop study with limited to no field verification undertaken to support the results. It is anticipated that additional information collected over time (mail surveys, field verification) will allow for the uncertainty related to the threats inventory to be reduced. 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. Based on the uncertainty involved in the threats inventory and the hazard ratings for this study, the uncertainty for all of the threats is classified as high. In particular, the Lake Ontario threats have been identified through the Lake Ontario Collaborative modelling work. The models used are the best available, but involve significant over-simplification of the complex Lake Ontario hydrology. 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.

Table listings and a count of potential activities that may pose a moderate or low threat to a drinking water source protection area are presented in tables throughout the chapter. These threats may not exist within the study area. 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.