## FIGURES

## TABLES

# 5.0 DRINKING WATER THREATS ASSESSMENT

## 5.1 OVERVIEW

### 5.1.1 Threats to Drinking Water Quantity

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

**Watershed**: 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.

There are no municipal groundwater and inland surface water systems, located within the CLOSPA study area. Lake Ontario is the source of all the municipal supplies within the CLOSPA jurisdiction. Note that the *Technical Rules* exempt Great Lakes sources from the water quantity threat assessment. Conceptual and Tier 1 Water Budgets were completed for the CLOSPA study area, as per *Technical Rules (19–24)*. Groundwater and surface water stress was found in some watersheds, but because none of this *stress* is related to municipal drinking water supplies, no additional work was conducted under the *Clean Water Act, 2006* (*CWA)*. A Tier 3 water budget study conducted by York Region for groundwater systems outside of CLOSPA's jurisdiction resulted in a very small area in the northwest portion where significant drinking water threats exist and water quantity policies will apply. This is, however, expected to have minimal impact on activities in CLOSPA. 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 makes an activity a low, moderate, or significant drinking water threat. The Provincial Tables of Circumstances that apply in the CLOSPA 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 CLOSPA as per *Rules* (*114)* and (*115)* (issues) and *Rule (126)* (conditions).**

| Threat Type | Vulnerability Area | Vulnerability Score | Threat Classification and Provincial Tables of Circumstances | | |
|---|---|---|---|---|---|
| | | | Significant | Moderate | Low |
| Chemicals* | IPZ | 4.0 | N/A | N/A | N/A |
| | | 4.5 | N/A | N/A | 43[CIPZWE4.5L] |
| | | 5.0 | N/A | N/A | 74[CIPZWE5L] |
| | HVA | 6.0 | N/A | 17[CSGRAHVA6M] | 18[CSGRAHVA6L] |
| DNAPL's | HVA | 6.0 | N/A | 10[DW6M] | 11[DW6L] |
| Pathogens | IPZ | 4.0 | N/A | N/A | N/A |
| | | 4.5 | N/A | N/A | 72[PIPZWE4.5L] |
| | | 5.0 | N/A | N/A | 69[PIPZ5L] |

***Note:*** *Only MOECC Tables of Circumstances that apply within the CLOSPA are included*
*N/A: does not apply*
** In some Tables of Circumstances, both chemicals and DNAPLs are listed*

**Table 5.1: Provincial Tables of Circumstances**

## 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 quantity and quality perspective. Threats are classified as low, moderate, or significant, according to criteria provided by the Province that consider the natural vulnerability of the area as well as hazard scores assigned to the chemicals and pathogens associated with the various land-use activities.

*Part X* (Quantity Threats) of the *Technical Rules* outlines a process that endorses using the best science available and making continuous improvements. This process evaluates the ability of a water supply system to support a municipality's current and planned drinking water needs. Under the *Technical Rules,* 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 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). Nineteen 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 MOECC using input from multiple stakeholder groups and committees:

1. The establishment, operation, or maintenance of a waste disposal site within the meaning of Part V of the *Environmental Protection Act (EPA)*;
2. The establishment, operation, or maintenance of a system that collects, stores, transmits, treats or disposes of sewage;
3. The application of agricultural source material to land;
4. The storage of agricultural source material;
5. The management of agricultural source material;
6. The application of non-agricultural source material (NASM) to land;
7. The handling and storage of non-agricultural source material NASM;
8. The application of commercial fertilizer to land;
9. The handling and storage of commercial fertilizer;
10. The application of pesticide to land;
11. The handling and storage of pesticide;
12. The application of road salt;
13. The handling and storage of road salt;
14. The storage of snow;
15. The handling and storage of fuel;
16. The handling and storage of a *dense non-aqueous phase liquid* (DNAPL);
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*) and

**Dense Non-Aqueous Phase Liquids (DNAPLs):** A group of chemicals that are insoluble and denser than water.

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

21. The use of land as livestock grazing or pasturing land, an outdoor confinement area, or a farm-animal yard; and
22. The establishment and operation of a liquid hydrocarbon pipeline (per inclusion under 2017 Phase 1 Director's Technical Rules)*.

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

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

- 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 E3**.

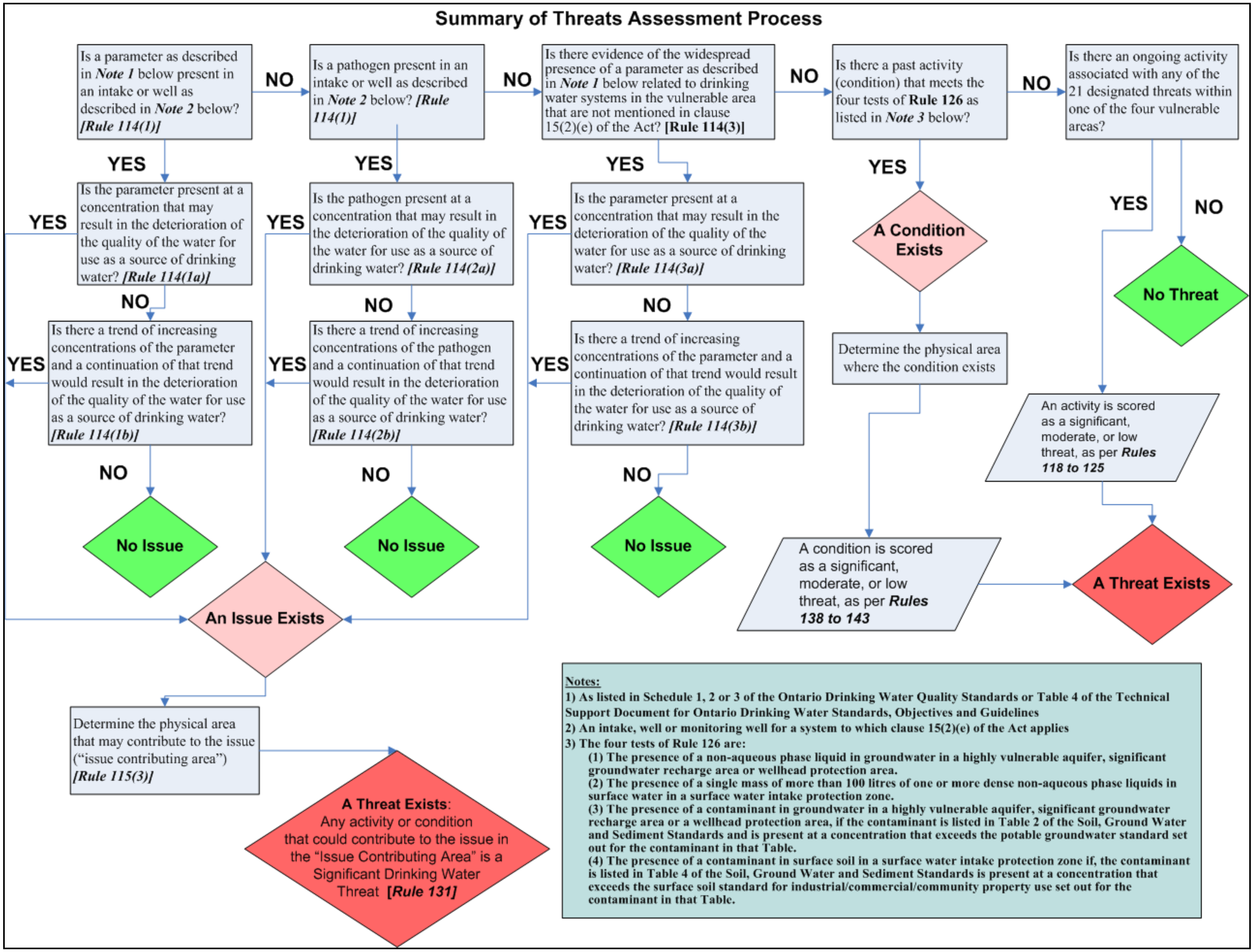



**Figure 5.1: Summary of Threats Assessment Process**

For each vulnerable area, the SPC list and describe 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 CLOSPA:

- 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 Darlington Nuclear Generation Station.

The Director accepted the 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 J.**

### 5.2.2 Threats from Conditions

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

- The presence of a *non-aqueous phase liquid (NAPL)* in groundwater in a highly vulnerable aquifer (HVA), significant groundwater recharge area (SGRA), or wellhead protection area (WHPA).
- The presence, in surface water of a single mass of more than 100 litres, of one or more dense non-aqueous phase liquids (DNAPLs) in a surface water intake protection zone (IPZ).
- The presence of a contaminant in groundwater in an HVA 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.

### 5.2.3 Threats from Issues

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

Municipal operators of water systems have been surveyed to identify issues affecting their intakes and wellheads. The survey involved referencing reports and communicating with intake/pump operators. Where adequate documentation exists, drinking water issues are defined and described in compliance with *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 "Drinking Water Source 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 tests in *Rule (114)* and the cause is fully or partly anthropogenic. If the issue does not meet the tests 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, IPZ (1 to 2), or WHPA (zone A to F)), should be addressed. The issue contributing area should be mapped as a polygon within the vulnerable area;
- List of activities, conditions from past activities, and natural conditions that are associated with the parameter or pathogen; and
- Circumstances under which the parameter or pathogen is considered.

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

### 5.2.4 Assessing Threats from Activities

Once lists of threats have been compiled, the next step is to determine circumstances under which the threats may be low, moderate, or significant for each vulnerable area. The MOECC Provincial Tables of Circumstances show the threats 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 2, or HVA). Vulnerability scores are assigned in a process described in **Chapter 4.** The hazard ratings of various threats can be found in the MOECC Table of Drinking Water Threats which is part of the *Technical Rules.* Both scores are then used to determine a risk score.

Eleven water quantity threats have been identified in CLOSPA (Earthfx Inc., 2013). Water quality threats are discussed in **Section 5.4** and **Section 5.7.** If the drinking water threat is identified as significant, the SPC is required to identify where these activities are located and count the instances. If the drinking water threat is moderate or low, the Province simply requires all the circumstances that could pose a drinking water threat be identified. It should be noted that these moderate or low threat circumstances are not counted or located in the assessment and may not actually exist in the vulnerable areas discussed. These are listed in Section 1.1 (1)—Appendix E.1, of Ontario, Reg. 287/07 *(CWA, 2006).*

For each vulnerable area, 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.* 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).*

**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. 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:

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

Where:

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

**Risk Score**

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

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

### 5.2.5 Managed Lands

Managed lands are lands to which nutrients are or may be applied to the landscape. They include both agricultural and non-agricultural land uses. The agricultural land uses are commonly found on the fringes of urban areas and vacant Greenfield lands. Non-agricultural uses include golf facilities, athletic fields, and 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, IPZ-1 and IPZ-2s). The nutrients can originate from chemical sources (e.g., non-agricultural source materials (NASMs) or from animal manure (e.g., agricultural source materials (ASMs)).

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

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 (HVAs high), or 4.4 or higher for surface water (IPZ-1 and IPZ-2s), 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); and
- Photo interpretation.

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

Managed land calculations rely heavily on the accuracy of the CLOCA Ecological Land Classification (ELC) and Land Cover Dataset (last major update based on 2008 air photos) and the Municipal Property Assessment Corporation's (MPAC) parcel data. ELC and Land Cover Dataset information is accurate to a 1:4000 scale, and is susceptible to interpretation errors by the analyst. As a conservative estimate of risk, it was assumed that all managed lands receive some type of nutrient application. To evaluate the threat of over-application of nutrients in a vulnerable area (or in subsets of this area), the thresholds are defined as follows:

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

### 5.2.6 Livestock Density

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

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

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

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, 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.

### 5.2.7 Impervious Surfaces

Impervious surfaces are defined by the *CWA* as the surface area of all highways and other impervious land surfaces used for vehicular traffic and parking, and all pedestrian paths. As per subsection 16 (11) in Part II of the *CWA 2006*, 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 CLOSPA jurisdiction (IPZs and HVAs).

The impervious surfaces analyses for the CLOSPA study area were completed for HVAs, IPZ-1s and IPZ-2s where they extend onto the land (see Oshawa). No impervious surface analyses were required for the Tier 3 water budget area that was added as an update to this Assessment Report as the area extends into an undeveloped area in the northwest corner of CLOSPA's jurisdiction. The analyses include all on-land areas where the vulnerability exceeds a score of 6 in HVAs, and 4.4 in IPZ-1 and IPZ-2s. The impervious surfaces evaluation followed the steps outlined below.

The data sources required to complete the impervious area calculations included the CLOSPA HVA, SGRA and IPZ-1 and IPZ-2s delineations with their associated vulnerability scoring (**Chapter 4** and **Appendices E, F** and **G** of this Assessment Report) and mapping of the road network throughout Durham Region (Durham Region, 2010). The information from these data sources was overlain so that the vulnerability mapping and road networks were presented on a single figure. Durham Region (2010) included the primary and secondary roadway network across Durham Region. CLOSPA is located completely within the boundaries of Durham Region. Notably absent from the dataset were parking lots, driveways or pedestrian pathways, which could receive road salt application and thus, were NOT included in this assessment.

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

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

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

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

Based on the above information, each roadway was assigned a threat level of significant, moderate, low, or not applicable with respect to the application of road salt.

### 5.2.8 Uncertainty Assessment

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

Uncertainty analysis includes the effects of the lack of knowledge and other potential sources of error. For the threats assessment, a number of databases were used, each of which has elements of uncertainty associated with the location or nature of the activity. The accuracy of the databases used depends on the source, the age of the information, and the scale at which the spatial information was recorded. Without any site specific assessment, the potential exists for errors.

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, however, was done as a desktop exercise, for which the level of confidence 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 uncertainties related to assessing 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 urban areas there is a moderate level of 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.

## 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 is documented in **Appendix E** of this Assessment Report. As described in **Chapter 3**, the vulnerable area for water quantity in the CLOSPA 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:

- 3 permitted, non-municipal wells; and
- 8 non-permitted wells.

## 5.4 GROUNDWATER QUALITY THREATS IN HIGHLY VULNERABLE AQUIFERS (HVAS)

In HVAs, no significant threats can be identified using the methodology associated with the scoring system for vulnerability and hazards as documented in the *Technical Rules;* only moderate or low threat scores are possible. The location and number of potential moderate and low threat activities do not need to be identified; only reference to 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 in HVAs

No conditions or issues have been identified in the HVAs within the CLOSPA. However, CLOSPA staff will continue to monitor background groundwater quality through the Provincial Groundwater Monitoring Network (PGMN).

### 5.4.2 Threats from Activities in HVAs

According to the Provincial Tables of Circumstances within the HVAs in the study area where the vulnerability score is 6 (high). There are 1,148 circumstances on the chemical list that could pose a low-level threat (see **Table 5.2**). There are no significant threats identified in the HVAs.

It should be noted that these moderate or low threats 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 Tables 10 (DW6M DNAPLS) and 17 (CSGRAHVA6M Chemical) reflects the full listing of circumstances that represent moderate threats in HVAs, while **Tables** 11 (DW6L DNAPLS), and 18 (CSGRAHVA6L Chemical) provides the listing of circumstances that represent low threats in (see **Table 5.1**). **Table 5.2** provides the number of threat circumstances for HVAs. The HVAs are shown on **Figure 5.2.**

| Vulnerable Area: HVA (Score 6) | Number of Possible Circumstances with Threat Classification | | | Total |
|---|---|---|---|---|
| | Significant | Moderate | Low | |
| Pathogens | 0 | 0 | 0 | 0 |
| Chemicals | 0 | 5 | 1126 | 1131 |
| DNAPL | 0 | 3 | 22 | 25 |
| Total Threats | 0 | 8 | 1148 | 1156 |

**Table 5.2: Number of Circumstances that could pose a threat in HVAs**

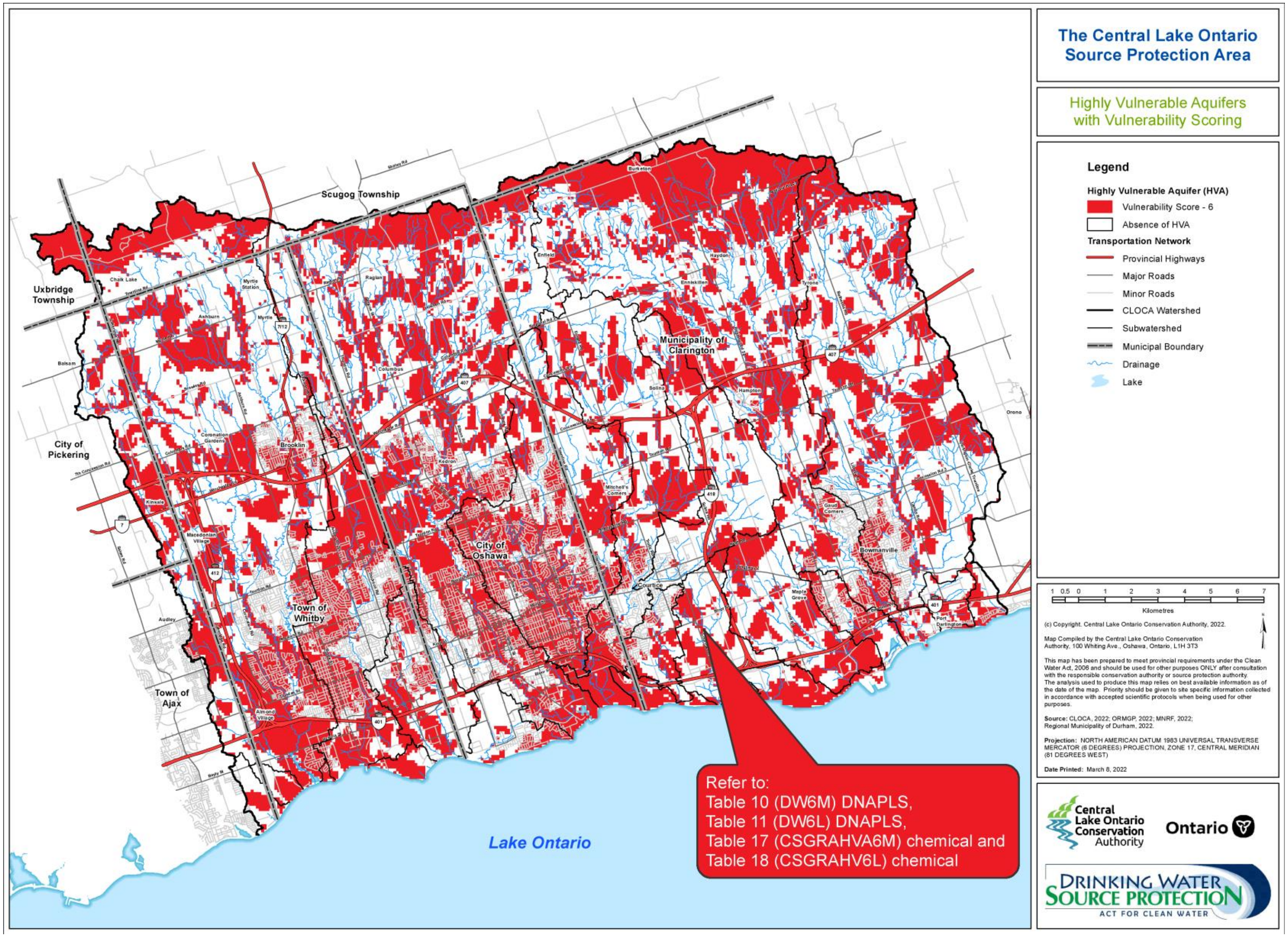



**Figure 5.2: Highly Vulnerable Aquifers with Vulnerability Scoring (HVAs - Provincial Tables of Circumstances)**

The information that appears in the Provincial Tables of Circumstances.

### 5.4.3 Threats from Managed Lands in HVAs

**Figure 5.3** and **Figure 5.4** show significant clusters of agricultural activities throughout the rural northern part of the CLOSPA. As expected, areas with a higher potential for nutrient application exist in the rural northern part of the central areas in Oshawa and Clarington. Note that the non-HVA areas are left unshaded on these maps because the methodology does not apply outside of the vulnerable areas.

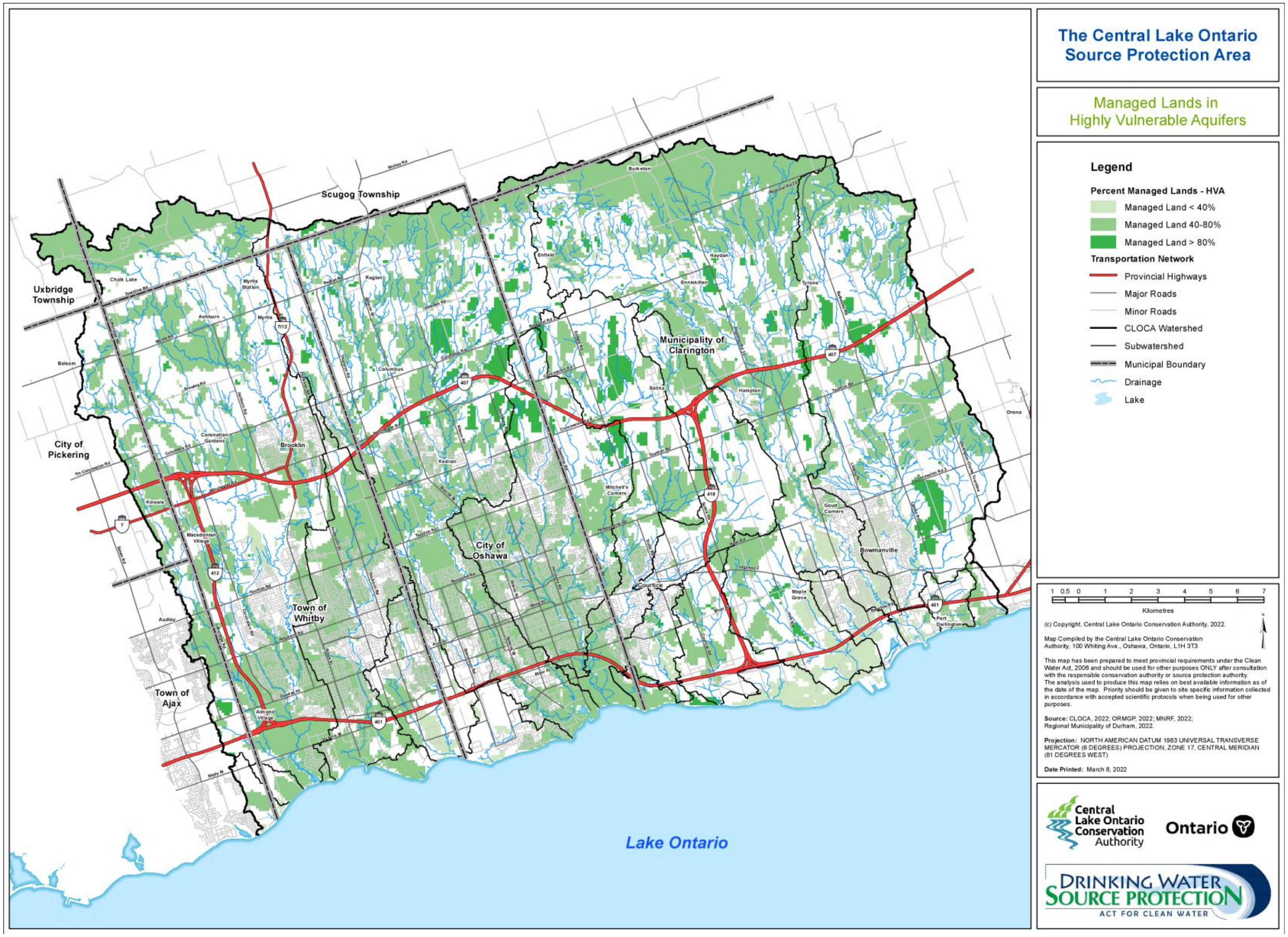
The HVAs mapping shows clusters of managed land activities along the Whitby/Oshawa border where there is a potential for the application of nutrients (see **Figure 5.3**). This is likely associated with the Oshawa airport, golf courses, cemeteries, schools, parks, and employment lands. There are as well, some urban fringe agricultural activities on vacant Greenfield lands within the urban areas. A few other very small isolated areas of moderate potential for nutrient application scattered throughout the study area were identified. For the most part, these are municipal parks and community complexes, and in one instance, land that had been cleared prior to residential development. It is not surprising that the managed land areas with low or moderate nutrient application are generally located in the urban regions of the study area.

**Table 5.3** provides the overall threat score (low) for activities associated with managed lands in CLOSPA. It also shows the percentage of the HVAs with the corresponding risk score. Approximately 85% of the HVAs in the CLOSPA have a moderate risk score due to nutrient application. Only 7% of the HVAs have a high risk score for nutrient application.

| Managed Lands (%) in HVAs | Risk Score | % of Total HVAs | Threat Score |
|---|---|---|---|
| < 40 | Low | 8.6 | Low |
| 40–80 | Moderate | 84.4 | |
| > 80 | High | 7.0 | |

**Table 5.3: Managed Lands in Highly Vulnerable Aquifers**

The Provincial Tables of Circumstances specify that in HVAs with a vulnerability score of 6 only low threat scores are possible for managed land activities (see **Table 5.1**).




## Figure 5.3: Managed Lands in Highly Vulnerable Aquifers (HVAs)

No analysis is required where the Vulnerability Score is <6. White space means absence of HVAs.

### 5.4.4 Threats from Estimated Livestock Density in HVAs

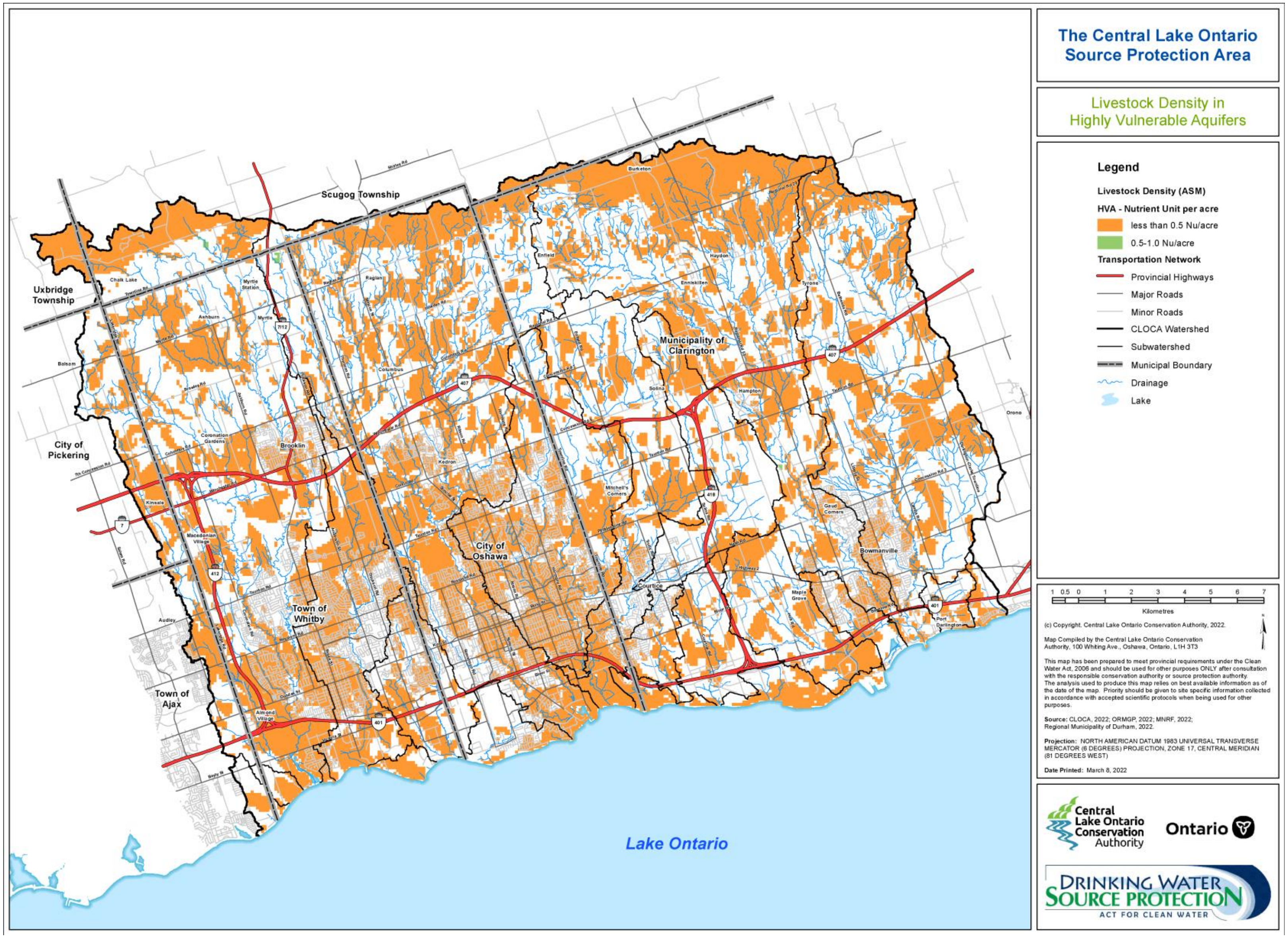
**Figure 5.5** and **Figure 5.6** show what percentage of the HVA areas have significant, moderate, or low threat levels, associated with the application of nutrients that exceed crop requirements. Only those areas of HVAs where livestock facilities were found are included. Note that the non-HVA are left unshaded on these maps because the methodology does not apply outside of the vulnerable areas.

In most CLOSPA HVAs, it is very unlikely that the application of nutrients would exceed crop requirements. There are three areas where the potential for over application of nutrients associated with livestock is elevated to a moderate level: the central area of the Municipality of Clarington, the northeast portion of the Town of Whitby, and in the Township of Scugog. **Table 5.4** shows the percentage of the HVAs in these areas that have a low, moderate, or high risk score, associated with the application of nutrients that exceed crop requirements from livestock activities. In CLOSPA approximately 99% of the HVAs have a low risk score, and less than 1% has moderate risk score for the vulnerable areas. No amount of nutrient applied will result in a significant threat.

| Estimated Livestock Density in HVAs | Risk Score | % of Total HVAs | Threat Score |
|---|---|---|---|
| < 0.5 NUs/acre | Low | 99.9 | Low |
| 0.5–1.0 NU/acre | Moderate | 0.1 | |
| > 1.0 NU/acre | High | 0 | |

**Table 5.4: Estimated Livestock Density in Highly Vulnerable Aquifers**

In HVAs with a vulnerability score of 6 only low threat scores are possible for nutrients application from livestock density that are listed on the Provincial Tables of Circumstances, (see **Table 5.1**).




## Figure 5.4: Livestock Density in Highly Vulnerable Aquifers (HVAs)

The provincial methodology requires calculating over the delineated vulnerable areas (HVA, IPZ-1s and 2s) and utilizing provincial ranges. The reader should note that there are limitations when reading the maps (see Appendix H for more details on the Managed Lands methodology). No analysis is required where the Vulnerability Score is <6. White space means absence of HVAs.

### 5.4.5 Threats for Impervious Surfaces in HVAs

Urban areas made up of residential subdivisions, commercial developments and roads, and other infrastructure and institutions that service these areas are, by their very nature, likely to have highly impervious surfaces, far more than the rural and agricultural areas of the watershed (see **Figure 5.5**). 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** summarizes the percentages of impervious surfaces within the HVAs. About 91% of the HVAs within the CLOSPA watershed have a low threat score. The remaining 9% of the HVAs have less than 1% impervious surfaces where the threat due to impervious surfaces is extremely limited.

| Impervious Surfaces (%) in HVAs | % of Total HVAs | Threat Score |
|---|---|---|
| Not more than 1 | 9.1 | No threat |
| More than 1, not more than 8 | 60.8 | Low |
| More than 8, not more than 80 | 30.1 | |
| 80 or more | 0 | |

**Table 5.5: Impervious Surfaces in Highly Vulnerable Aquifers**

In HVAs with a vulnerability score of 6 only low threat scores are possible for road salt applications that are listed on the Provincial Tables of Circumstances, (see **Table 5.1**).

The percentages in the table above reflect the amount of land that is urbanized in the HVAs that exist along the lakeshore. As expected, HVAs with less than 1% impervious surfaces are found within rural areas with one major exception: the HVAs close to the Lake Ontario waterfront, where the boundaries of the City of Oshawa and the Municipality of Clarington meet. This is because the provincially significant Second Mash Coastal Wetland, McLaughlin Bay, and Darlington Provincial Park are all located in this area. The road network is very limited here, as are those land uses that would have impervious surfaces. Impervious values are greater in urban areas, rural settlement areas (hamlets), areas of aggregate extraction, and even within clusters of rural residential areas.

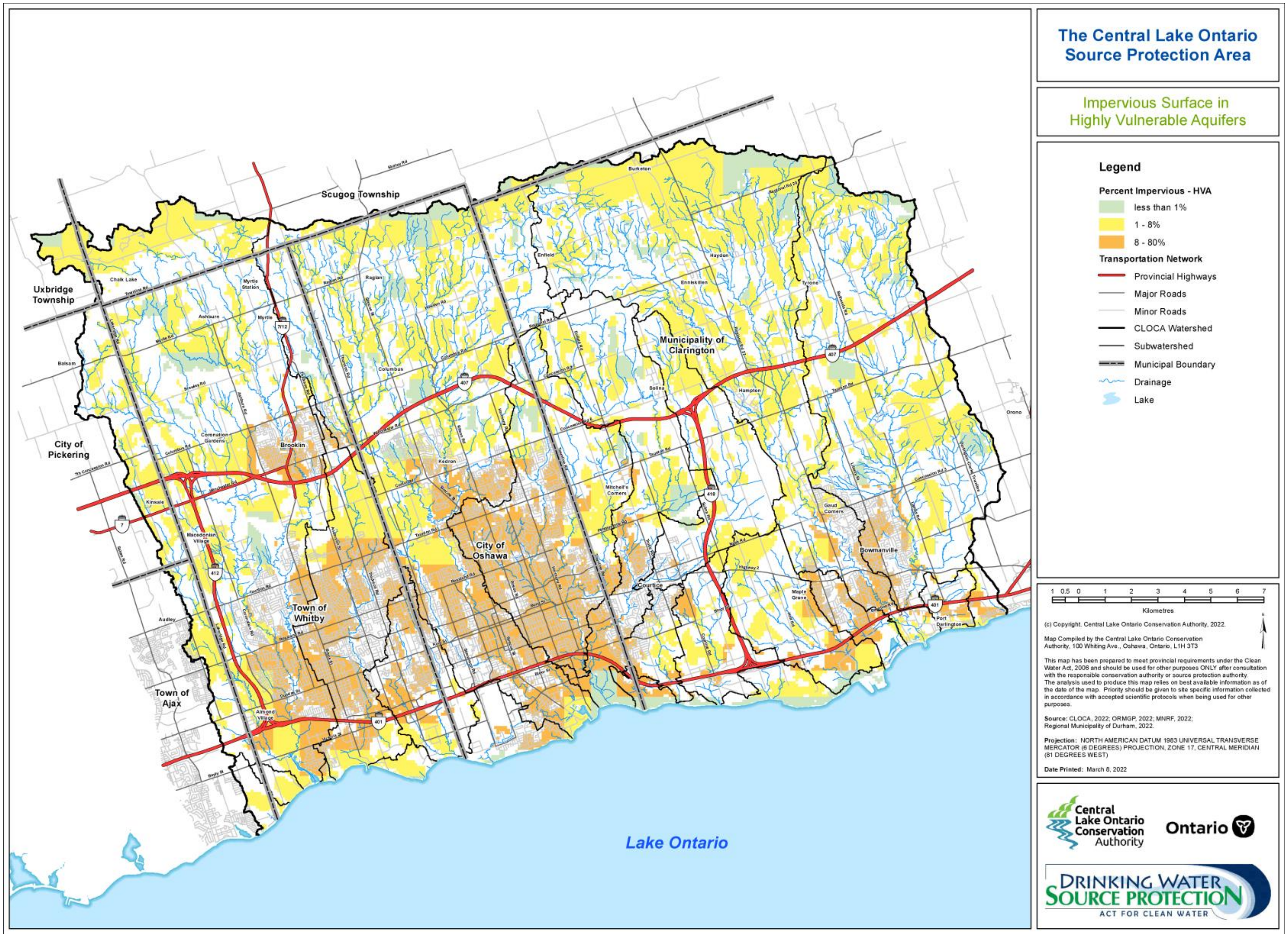



**Figure 5.5: Impervious Surface in Highly Vulnerable Aquifers (HVAs)**
No analysis is required where the vulnerability Score is <6. Where space means absence of HVA

## 5.5 GROUNDWATER QUALITY THREATS IN WELL HEAD PROTECTION AREAS (WHPAS)

There are no Well Head Protection Areas (WHPAs) in the CLOSPA study area.

## 5.6 SURFACE WATER QUANTITY THREATS

There are no inland municipal surface water intakes in CLOSPA. The only surface water intakes in CLOSPA 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 the CLOSPA.

## 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-1s and IPZ-2s), including those in Lake Ontario. 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 that 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 have been identified in the IPZ-1s and IPZ-2s within the CLOSPA. However, staff from the Regional Municipality of Durham will continue to monitor the municipal raw water quality in accordance with the *Safe Drinking Water Act (2002)* to ensure that no issues occur in the future.

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

In an IPZ-1 with a vulnerability score of 5.0 (Ajax, Whitby, Oshawa, Bowmanville, and Newcastle water treatment plants (WTP)) a number of activities, where they exist, could pose a low risk to drinking water within the intake protection zones, according to the Provincial Tables of Circumstances. None of the potential activities with their associated circumstances, therefore, pose a significant level of threat to the IPZ-1s, which are the most vulnerable areas around the intakes. Where the IPZ-1 delineation extends onto the shore (as with Oshawa approximately 150 metres onto the shore), some circumstances (according to the provincial tables) may be considered potential low-level threats.

According to the Provincial Tables of Circumstances, tables 74(CIPZWE5L Chemical) and 69(PIPZ5L Pathogen) provide the listing of circumstances that represent low threats in IPZ-1s (vulnerability 5.0), while Tables 43(CIPZWE4.5L Chemical) and 72(PIPZWE4.5L Pathogen) reflect the full listing of circumstances that represent low threats in IPZ-2s (vulnerability score 4.5), (see **Table 5.1**). These low threat circumstances are not counted or located in the assessment and may not actually exist in the vulnerable areas discussed (see **Table 5.6** and **Table 5.7**).

For IPZ areas with vulnerability score less than 4.2, no activities listed pose a threat according to the Provincial Tables of Circumstances.

There are a number of circumstances where an activity could pose a low risk to the intakes where they exist, according to the Provincial Tables of Circumstances. **Figure 5.9** and **Table 5.6** show the count of potential activities that pose threats in vulnerable IPZ-1s, including 13 activities associated with pathogens and 558 activities associated with chemicals.

| Vulnerable Area: IPZ1 (score 5.0: Ajax, Whitby, Oshawa, Bowmanville and Newcastle) | Number of Possible Circumstances with Threat Classification | | | Total |
|---|---|---|---|---|
| | Significant | Moderate | Low | |
| Pathogens | 0 | 0 | 13 | 13 |
| Chemical (*) | 0 | 0 | 558 | 558 |
| Total Threats | 0 | 0 | 571 | 571 |

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

**Table 5.6: Number of Circumstances that could pose a threat in IPZ-1s with a vulnerability score of 5.0**

In an IPZ-2 with a low vulnerability score of 4.5 (Ajax and Oshawa WTPs) a number of activities, where they exist, could pose a low risk to the drinking water within the intake protection zones, according to the Provincial Tables of Circumstances. **Figure 5.10** and **Table 5.7** show the count of circumstances that pose threats in vulnerable IPZ-2s, including 239 circumstances associated with chemicals and 13 activities associated with pathogens.

| Vulnerable Area: IPZ-2 (score 4.5: Ajax/Oshawa) | Number of Possible Circumstances with Threat Classification | | | Total |
|---|---|---|---|---|
| | Significant | Moderate | Low | |
| Pathogens | 0 | 0 | 13 | 13 |
| Chemical (*) | 0 | 0 | 239 | 239 |
| Total Threats | 0 | 0 | 252 | 252 |

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

**Table 5.7: Number of Circumstances that could pose a threat in IPZ-2s with a vulnerability score of 4.5**

In an IPZ-2 with a low vulnerability score of 4.0 (Whitby, Bowmanville, and Newcastle WTPs) no activities listed could pose any level of risk to the intakes, according to Provincial Tables of Circumstances.

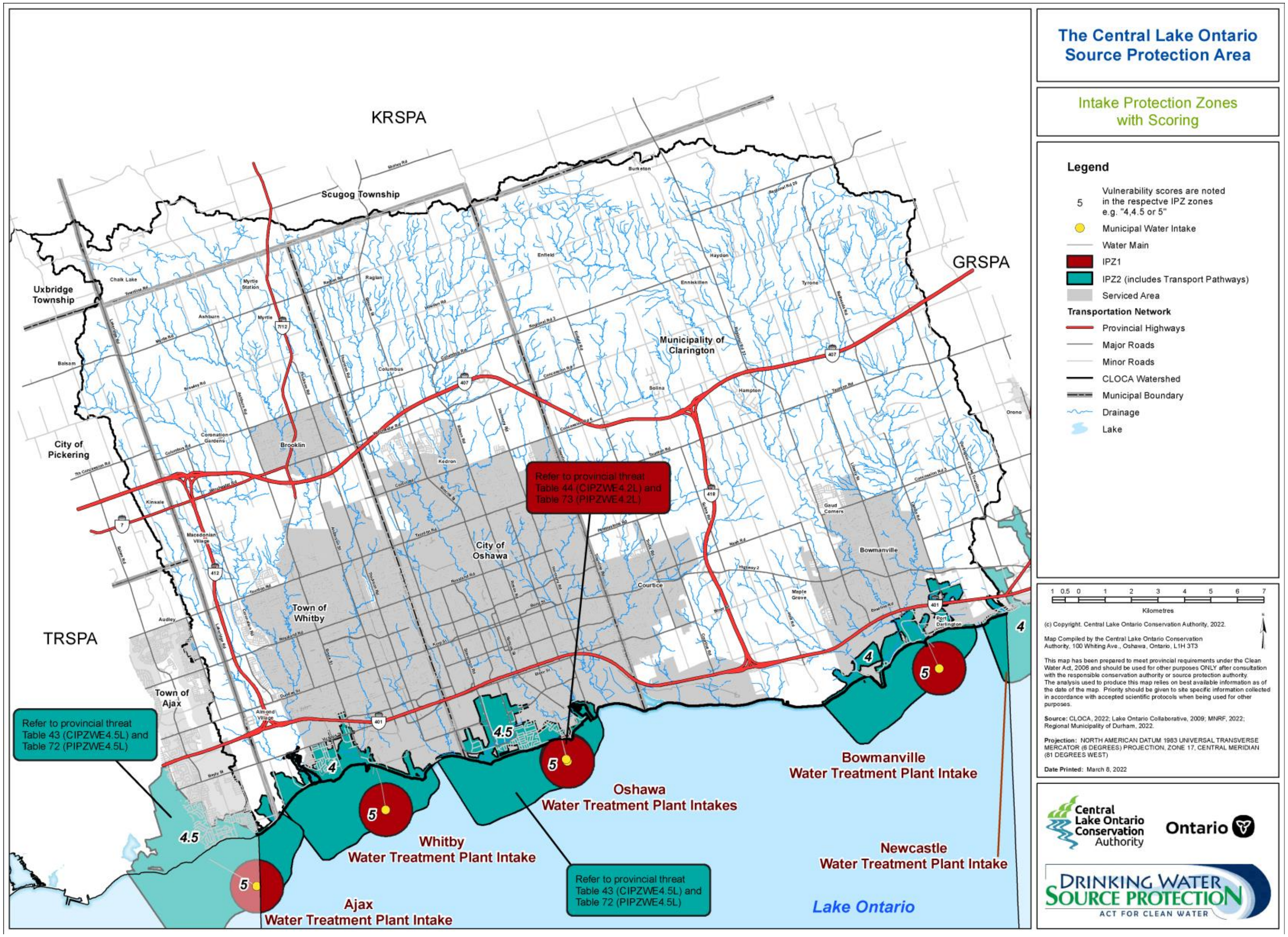



**Figure 5.6: Intake Protection Zones with Scoring (IPZ-1 and 2s - Provincial Tables of Circumstances)**

No analysis is required where the Vulnerability score is < 4.4. White space means absence of IPZ-1 and 2s

### 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 the 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. The vulnerability score for the IPZ-2s in proximity to the water intake at Whitby, Bowmanville and Newcastle plants falls below 4.4, so no managed land analyses is required in these areas.

At the Oshawa WTPs both IPZ-1s and IPZ-2s are assessed as both extend onto the land. The Ajax WTP is located in the TRSPA, but the IPZ-2 extends into CLOSPA. Within the portion of the Ajax IPZ-2 that extends into CLOSPA, the managed land analysis is calculated and shown in **Figure 5.10**.

Much like the HVAs analyses, all the IPZ-1s and IPZ-2s in CLOSPA have a low threat score associated with the application of nutrients due to managed land activities. There are a mix of land uses along the Lake Ontario waterfront in CLOSPA, ranging from urban residential, employment areas, quarries, nuclear plant, marinas and ports, parks, agriculture, and coastal wetlands. Specifically, pockets of rural lands and environmentally significant areas separate the urban land uses between the traditional built-up communities of Ajax, Whitby, Oshawa, and Courtice. The amount of managed lands, however, whether agricultural or non-agricultural, is not enough to elevate the risk score associated with nutrients to even moderate (see **Figure 5.10**).

The managed land results for both IPZ-1s for Oshawa have a moderate risk score for nutrient application (see **Table** 5.8).

| Managed Lands (%) in IPZ-1: Oshawa (Vulnerability 5.0) | Risk Score | % of Total IPZ-1s Managed Lands: Oshawa West | % of Total IPZ-1s Managed Lands: Oshawa East | Threat Score |
|---|---|---|---|---|
| < 40 | Low | 0 | 0 | Low |
| 40–80 | Moderate | 100 | 100 | |
| > 80 | High | 0 | 0 | |

**Table 5.8: Managed Lands in Intake Protection Zone-1s**

The Provincial Tables of Circumstances specify that in an IPZ-1 with a low vulnerability score of 5.0 (Ajax and Oshawa WTPs) only low threat scores are possible for managed land activities as listed (see **Table 5.1**).

The managed lands results for the Ajax WTP identify a moderate risk score resulting from the potential application of nutrients. The managed lands results for both IPZ-2s for Oshawa have a low-risk score for nutrient application (see **Table 5.9**). The reader should note that only small portions of the land in the urbanized IPZ-2s in the study area are covered by managed lands. The balance is built-up area as one would expect.

| Managed Lands (%) in IPZ-2 (Vulnerability 4.5) | % of Total IPZ-2 Managed Lands: Ajax | % of Total IPZ-2 Managed Lands: Oshawa West | % of Total IPZ-2 Managed Lands: Oshawa East | Risk Score | Threat Score |
|---|---|---|---|---|---|
| < 40 | 0 | 100 | 100 | Low | Low |
| 40–80 | 100 | 0 | 0 | Moderate | |
| > 80 | 0 | 0 | 0 | High | |

**Table 5.9: Managed Lands in Intake Protection Zone-2s**

The Provincial Tables of Circumstances specify that in an IPZ-2 with a low vulnerability score of 4.5 (Ajax and Oshawa WTPs), only low threat scores are possible for managed land activities as listed (see **Table 5.1**).

In conclusion, no amount of nutrients applied will result in a significant or moderate drinking water threat.

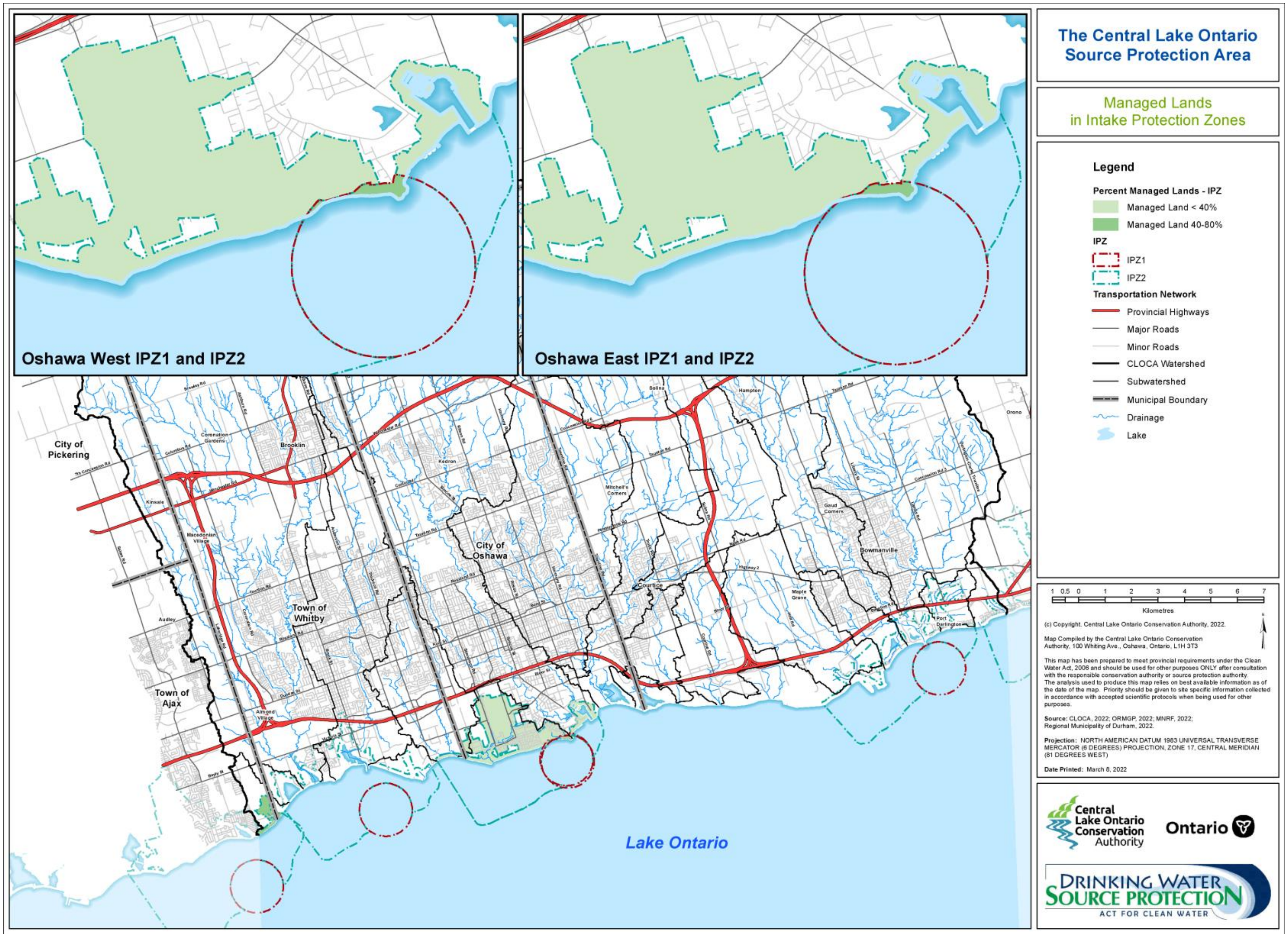



**Figure 5.7: Managed Lands in Intake Protection Zones (IPZ-1s and 2s)**

No analysis is required where the Vulnerability Score is <4.4. White space means absence of IPZ-1s and 2s

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

Due to the urbanized nature of the fields, there is no livestock activity in these vulnerable areas within the study area nor is there any likelihood of these activities occurring in these areas in the future.

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

IPZs within CLOSPA were mapped according to *Technical Rule 16 (11).* The *Technical Rules* require that areas in an IPZ-1 and IPZ-2 with impervious surfaces be mapped where the vulnerability score is 4.4 or higher (Ajax and Oshawa WTPs).

The following table summarizes the percentages of impervious surfaces within the IPZ-1s. About 100% of the IPZ-1 Oshawa West and East areas (1% to 80%) within the CLOSPA watershed experience low threats score. These levels rise based on land use, (see **Table 5.10**).

| Impervious Surfaces (%) in IPZ-1s (Vulnerability 5.0) | % of Total IPZ-1s Oshawa West | % of Total IPZ-1s Oshawa East | Threat Score |
|---|---|---|---|
| Not more than 1 | 0 | 0 | No threat |
| More than 1, not more than 8 | 54.5 | 58.1 | Low |
| More than 8, not more than 80 | 45.5 | 41.9 | |
| 80 or more | 0 | 0 | |

**Table 5.10: Impervious Surfaces in Intake Protection Zones -1s**

The percentages in the table above reflect the amount of land that is urbanized in the IPZ-1s that exist along CLOSPA's Lake Ontario waterfront.

In an IPZ-1 with a low vulnerability score of 5 (Oshawa WTPs), only low threat scores are possible for road salt applications that are listed on the Provincial Tables of Circumstances (see **Table 5.1**).

**Table 5.11** summarizes the percentages of impervious surfaces within the IPZ-2. About 92% of the IPZ-2 in Ajax within the CLOSPA watershed experience low threat score (1 to 8%). About 92% of the IPZ-2s in Oshawa West and East areas within the CLOSPA watershed experience low threats score (1 to 80%). The remaining 8% of the IPZ-2 areas have less than 1% impervious surfaces where the threat due to road salt application on impervious surfaces is extremely limited. These levels rise based on land use.

| Impervious Surfaces (%) in IPZ-2 (Vulnerability 4.5) | % of Total IPZ-2 Ajax | % of Total IPZ-2 Oshawa West | % of Total IPZ-2 Oshawa East | Threat Score |
|---|---|---|---|---|
| Not more than 1 | 7.9 | 8.1 | 8.0 | No threat |
| More than 1, not more than 8 | 92.1 | 36.6 | 36.7 | Low |
| More than 8, not more than 80 | 0 | 55.3 | 55.3 | |
| 80 or more | 0 | 0 | 0 | |

**Table 5.11: Impervious Surfaces in Intake Protection Zones -2s**

In an IPZ-2 with a low vulnerability score of 4.5 (Oshawa WTPs), only low threat scores are possible for road salt applications that are listed on the Provincial Tables of Circumstances, (see **Table 5.1**).

In the Ajax IPZ-2, impervious surfaces in the 1 to 8% range are associated with the urbanized nature of the area. Industrial parks along the lakeshore are not assessed because of data gaps (only roads are included in the road network dataset).

Generally, in Oshawa IPZ-2 areas with less than 8% imperviousness are associated with lakefront parks, conservation areas, and provincially significant coastal wetlands. For example, the provincially significant Second Mash Coastal Wetland, McLaughlin Bay and Darlington Provincial Park, and Lakeview Park make up a large area that falls below the 8% impervious surfaces mark. In these areas, the road network tends to be quite limited and there is somewhat limited development.

There are no areas with more than 80% impervious surfaces located within the Oshawa IPZ-1s and IPZ-2s even with the existence of the General Motors plant in the Oshawa IPZs. This is because pedestrian walkways, parking lots and driveways where road salt may be applied are not included in the road network dataset and have thus been noted as a gap to be addressed during a future update of this Assessment Report (see **Figure 5.11**).

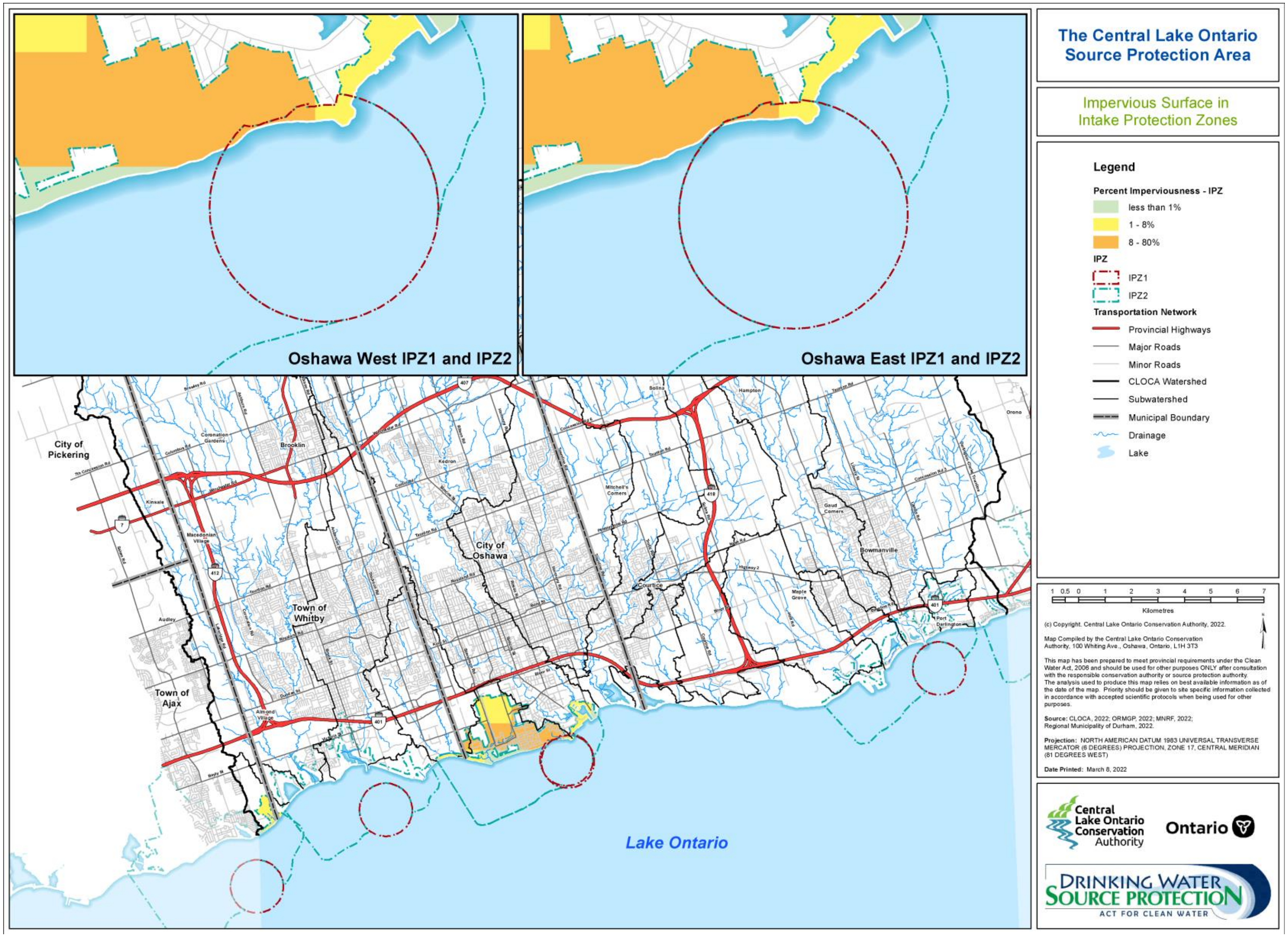



**Figure 5.8: Impervious Surface in Intake Protection Zones (IPZ-1s and 2s)**

No analysis is required where the vulnerability Score is <4.4. Where space means absence of IPZ-1s and 2s

### 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 I**.

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

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

The *Technical Rules* require an IPZ-3 to be delineated if modelling demonstrates that contaminants may be transported to an intake and result in deterioration of the raw water quality as 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-3 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 exceed the threshold, the land use activity was identified as a significant threat and an IPZ-3 was delineated to identify the contaminant travel path to the intake.

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

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

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

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

- Disinfection failure at each Lake Ontario WWTP to evaluate the potential effects to nearby WTPs;
- Release of *E coli* from an industrial processing facility into the Credit River (this does not impact any CLOSPA intake);
- Combined Sewer Overflow (CSO) release in the City of Toronto to evaluate the potential effects to the Toronto WTPs, (this does not impact any CLOSPA intake);
- Sanitary Trunk Sewer (STS) break within some Toronto area tributaries (this does not impact any CLOSPA intake);
- 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 facility in the Keele/Finch area of Toronto (this does not impact any CLOSPA intake), and in the Mississauga - Oakville area (this does not impact any CLOSPA intake);
- Discharge of tritium from nuclear-generating plants at Pickering or Darlington.

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 are 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 I**. 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.

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 5.12** below and described in the text following the table. **Table 5.12** presents all of the scenarios that were modelled for the CTC Source Protection Region.

| Spill Scenario Details | | | Contaminant of Concern |
|---|---|---|---|
| Type | Location | Volume and Duration of Spill | |
| Disinfection Failure at WWTP | Mid-Halton WWTP<br>SW-Halton WWTP<br>SE-Halton WWTP<br>Clarkson WWTP<br>G.E. Booth WWTP<br>Humber WWTP<br>Ashbridges Bay WWTP<br>Highland Creek WWTP<br>Duffins Creek WWTP<br>Wellington WWTP<br>Corbett Creek WWTP<br>Harmony Creek WWTP<br>Courtice WWTP<br>Port Darlington WWTP | Disinfection failure at the plant, leading to a release of *E. coli* at a level of 5,000,000/100mL for a two day period between April and August. | *E. coli* |
| Sanitary Trunk Sewer (STS) Breaks | Sanitary trunk sewer breaks from pipes located within 120 meters or the regulated limit of the main tributaries along the Toronto Waterfront (Etobicoke Creek, Humber River, Don River, and Highland Creek) up to and including the location of the first lateral sewer connection up river from the mouth. | Actual density of *E.coli* (1,000,000 CFU/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 about 50% of their design flow at an *E. coli* density of 5,000,000 CFU/100mL; all simulated for a 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<br>Joshua Creek<br>Credit River<br>Etobicoke Creek<br>Humber River<br>Don River<br>Highland Creek<br>Rouge River<br>Petticoat Creek<br>Duffins Creek | 2,700 $m^3$, 6 hour duration | Benzene |

| Spill Scenario Details | | | Contaminant of Concern |
|---|---|---|---|
| Type | Location | Volume and Duration of Spill | |
| | Carruthers Creek | | |
| | Lynde Creek | | |
| | Oshawa Creek | | |
| | Bowmanville Creek | | |
| | Wilmot Creek | | |
| | Graham Creek | | |
| | 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<br>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 (i.e. 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 (i.e. the estimated total amount of tritium activity released was $2.3x10^{15}$ Bq) | Tritium |

**Table 5.12: Lake Ontario Model Spill Scenarios**

### 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 CLOSPA WTPs. The modelled parameter of concern for these scenarios was *E. coli* and the recreational standard for *E. coli* used to assess for deterioration of the quality of water is 100 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 CLOSPA 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 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. The trunk sewer flow was estimated at 50% of the design flow of each WWTP.

The Highland Creek sewer break was modelled based on measurements taken during an actual event (August 2005). Water quality was sampled downstream of the actual break, where mixing with Highland Creek itself had already diluted the sewage effluent. In the other three cases the breaks in the other streams (Etobicoke Creek, Humber River, Don River) were modelled by adding sewer flows to the tributary flows at the river mouths to account for dilution that would occur before the sewage reached Lake Ontario. The simulation 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/100 ml. In 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 of decay of *E.coli* was applied. Decay of the population of bacterial pathogens (*E. coli* in this case), breaks down at a constant rate over time. A first order of 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**

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

**Lagoon Spill**

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

**Petroleum Pipeline Breaks**

Modelling scenarios were undertaken to determine if gasoline containing benzene spilled from an oil pipeline rupture as it crosses the Credit River, Humber River, Don River, Highland Creek, Rouge River or

Duffins Creek would reach any of the CLOSPA 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.

**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 of the quality of raw water for the intakes located in Lake Ontario. The modelled parameter of concern was tritium and the threshold used was the ODWS for tritium (7000 Bq/L). The model also simulated a threshold of 20 Bq/L. The Minister of the Environment and Climate Change's Advisory Committee on Testing and Standards has recommended an annual average of 20 Bq/L as a revised ODWS.

The scenario was based on a 1992 spill event when heavy water leaked into the cooling water stream. This resulted in the release of 2,900 kg of tritiated water at a concentration of $7.9 \times 10^{11}$ 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 I**.

The Lake Ontario modelling identified eight locations of significant drinking water quality threats for Lake Ontario intakes within the CLOSPA. 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 (SPA).

In addition, CLOSPA has identified significant drinking water threats located outside of the CLOSPA. These activities, although not enumerated in this Assessment Report, affect water treatment plants located in CLOSPA, and must be addressed through source protection plan policies developed in adjacent source protection areas. CLOSPA staff will bring 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 5.13** outlines the results where the model scenarios predict that an activity will be a significant drinking water threat, including:

- Threats located within the CLOSPA that are a significant threat to intakes located within the CLOSPA (eight unique threats to three intakes); and
- Threats located outside of the CLOSPA that are a significant threat to intakes located within the CLOSPA (eleven unique threats to three intakes).

**Table 5.13** shows all of the modelled spill scenarios that result in significant drinking water threats to the CLOSPA intakes, as well as spill scenarios located in CLOSPA that result in significant drinking water threats in adjacent source protection areas. Further details are provided in **Appendix I**.

| SPR/SPA | WTP Affected | Spill Model Scenario | Spill Location | Parameter of Concern | Water Quality Threshold | Concentration at the Intake | Significant Threat |
|---|---|---|---|---|---|---|---|
| CTC/TRSPA | Ajax | Lynde Creek pipeline break | IPZ-3 CLOSPA | Benzene | 0.005 mg/L | * | Yes |
| | | Oshawa Creek pipeline break | IPZ-3 CLOSPA | Benzene | | 0.14 mg/L | Yes |
| | | Corbett Creek WWTP bypass | IPZ-3 CLOSPA | *E.coli* | 100 cfu/100mL | 479/100mL | Yes |
| | | Harmony Creek WWTP bypass | IPZ-3 CLOSPA | *E.coli* | | 210/100mL | Yes |
| | | Courtice Creek WWTP bypass | IPZ-3 CLOSPA | *E.coli* | | 353/100mL | Yes |
| CTC/CLOSPA | Whitby | Rouge River pipeline break | IPZ-3 TRSPA | Benzene | 0.005 mg/L | 0.006 mg/L | Yes |
| | | Highland Creek pipeline break | IPZ-3 TRSPA | Benzene | | 0.008 mg/L | Yes |
| | | Duffins Creek pipeline break | IPZ-3 TRSPA | Benzene | | 0.011 mg/L | Yes |
| | | Petticoat Creek pipeline break | IPZ-3 TRSPA | Benzene | | * | Yes |
| | | Oshawa Creek pipeline break | IPZ-3 CLOSPA | Benzene | | 0.32 mg/L | Yes |
| | | Lynde Creek pipeline break | IPZ-3 CLOSPA | Benzene | | * | Yes |
| | | Carruthers Creek pipeline break * | IPZ-3 TRSPA | Benzene | | * | Yes |
| | | Pickering Nuclear Waste release | IPZ-3 TRSPA | Tritium | 7000 Bq/L | 12,000 Bq/L | Yes |
| | | Duffins Creek WWTP bypass | IPZ-3 TRSPA | *E.coli* | 100 cfu/100 mL | 6,480/100 mL | Yes |
| | | Ashbridges WWTP bypass | IPZ-3 TRSPA | *E.coli* | | 422/100 mL | Yes |
| | | Highland Creek WWTP bypass | IPZ-3 TRSPA | *E.coli* | | 1,064/100 mL | Yes |
| | | Corbett Creek WWTP bypass | IPZ-3 CLOSPA | *E.coli* | | 4342/100mL | Yes |
| | | Harmony Creek WWTP bypass | IPZ-3 CLOSPA | *E.coli* | | 791/100mL | Yes |
| | | Courtice Creek WWTP bypass | IPZ-3 CLOSPA | *E.coli* | | 1813/100mL | Yes |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| CTC/CLOSPA | Oshawa | Oshawa Creek pipeline break | IPZ-3 CLOSPA | Benzene | 0.005 mg/L | 1.4 mg/L | Yes |
| | | Pickering nuclear wastewater release | ipz-3 TRSPA | Tritium | 7000 Bq/L | 20,000 Bq/L | Yes |
| | | Darlington nuclear wastewater release | IPZ-3 CLOSPA | Tritium | 7000 Bq/L | 8,200 Bq/L | Yes |
| | | Corbett Creek WWTP bypass | IPZ-3 CLOSPA | *E.coli* | 100 cfu/100 mL | 5550/100mL | Yes |
| | | Harmony Creek WWTP bypass | IPZ-3 CLOSPA | *E.coli* | | 4931/100mL | Yes |
| | | Courtice Creek WWTP bypass | IPZ-3 CLOSPA | *E.coli* | | 4946/100mL | Yes |
| | Bowmanville | Bowmanville Creek pipeline break | IPZ-3 CLOSPA | Benzene | 0.005 mg/L | 1.0 mg/L | Yes |
| | | Wilmot Creek pipeline break | IPZ-3 GRSPA | Benzene | | 3.3 mg/L | Yes |
| | | Graham Creek pipeline break | IPZ-3 GRSPA | Benzene | | 3.0 mg/L | Yes |
| | | Darlington nuclear wastewater release | IPZ-3 CLOSPA | Tritium | 7000 Bq/L | 8,700 Bq/L | Yes |
| | | Port Darlington WWTP | IPZ-3 CLOSPA | *E.coli* | 100 cfu/100 m | 700/100mL | Yes |
| TCC/Ganaraska | Newcastle | Bowmanville Creek pipeline break | IPZ-3 CLOSPA | Benzene | 0.005 mg/L | 1.0 mg/L | Yes |
| | | Port Darlington WWTP | IPZ-3 CLOSPA | *E.coli* | 100 cfu/100 m | 146/100mL | Yes |

**Table 5.13: Modelling Results of Significant Drinking Water Threats to Lake Ontario Intakes**

* 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 a potential threat, with a “connector” line that highlights the shortest path to the affected intake. Note that the paths shown are not representative of any particular date or current direction. Each scenario is shown in a different colour to best represent the variety and extent of the potential threats. See **Figure 5.9** through **Figure 5.13** for the spills scenarios where there are threat activities located within CLOSPA or municipal intakes located in CLOSPA are affected by threat activities located within other source protection areas.

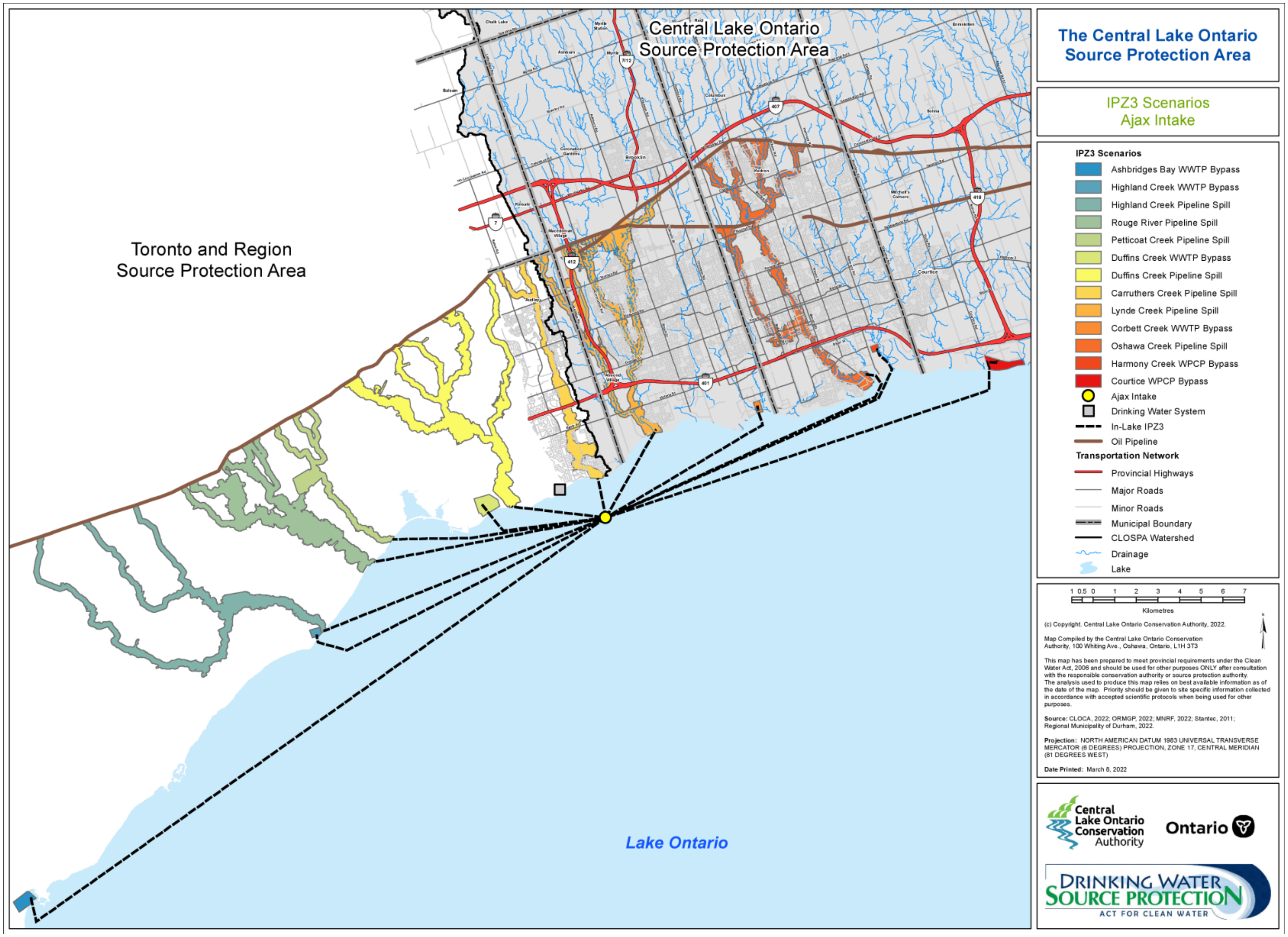



**Figure 5.9: Spills Scenario, Ajax Intake**

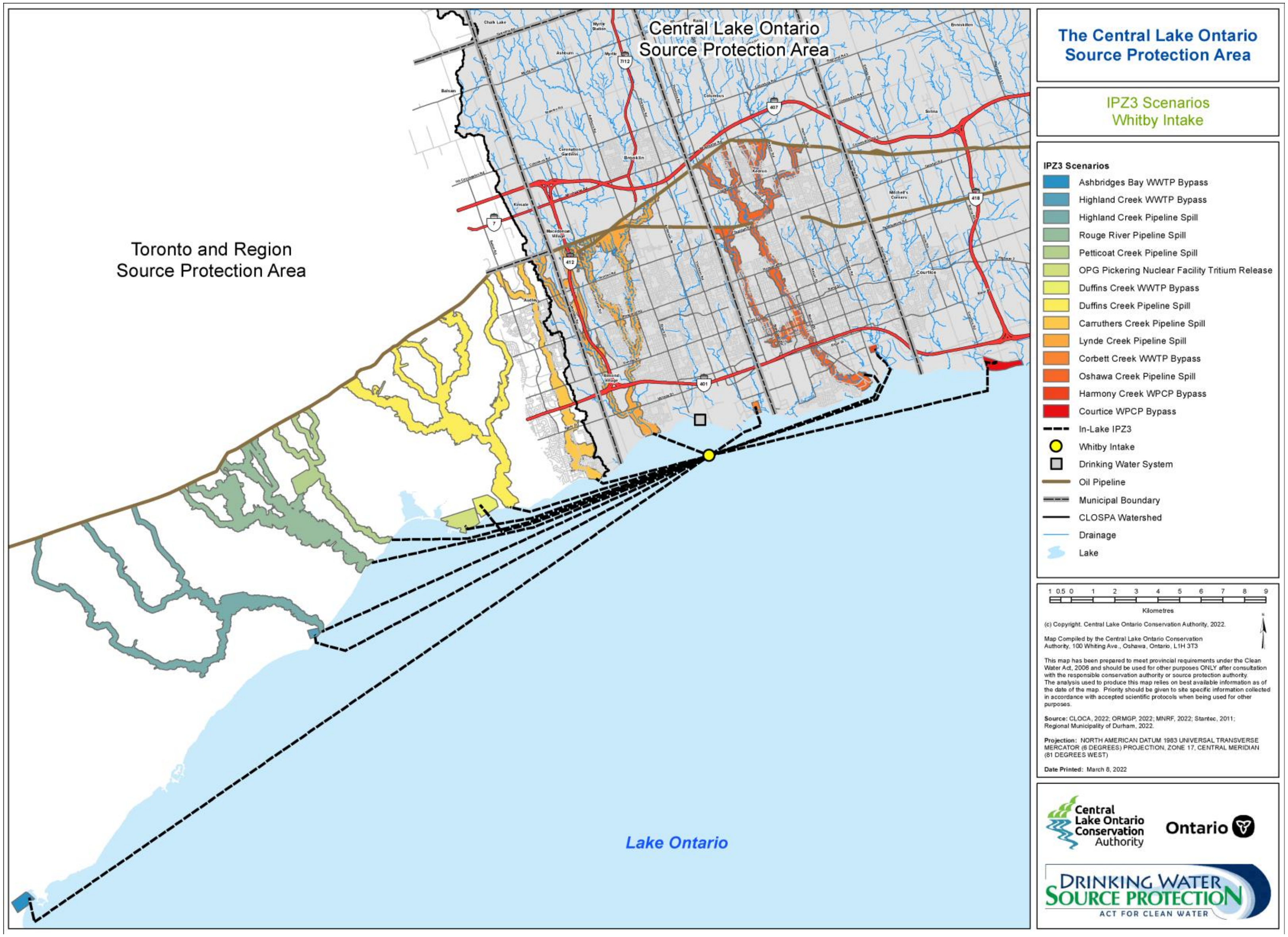



**Figure 5.10: Spills Scenario, Whitby Intake**

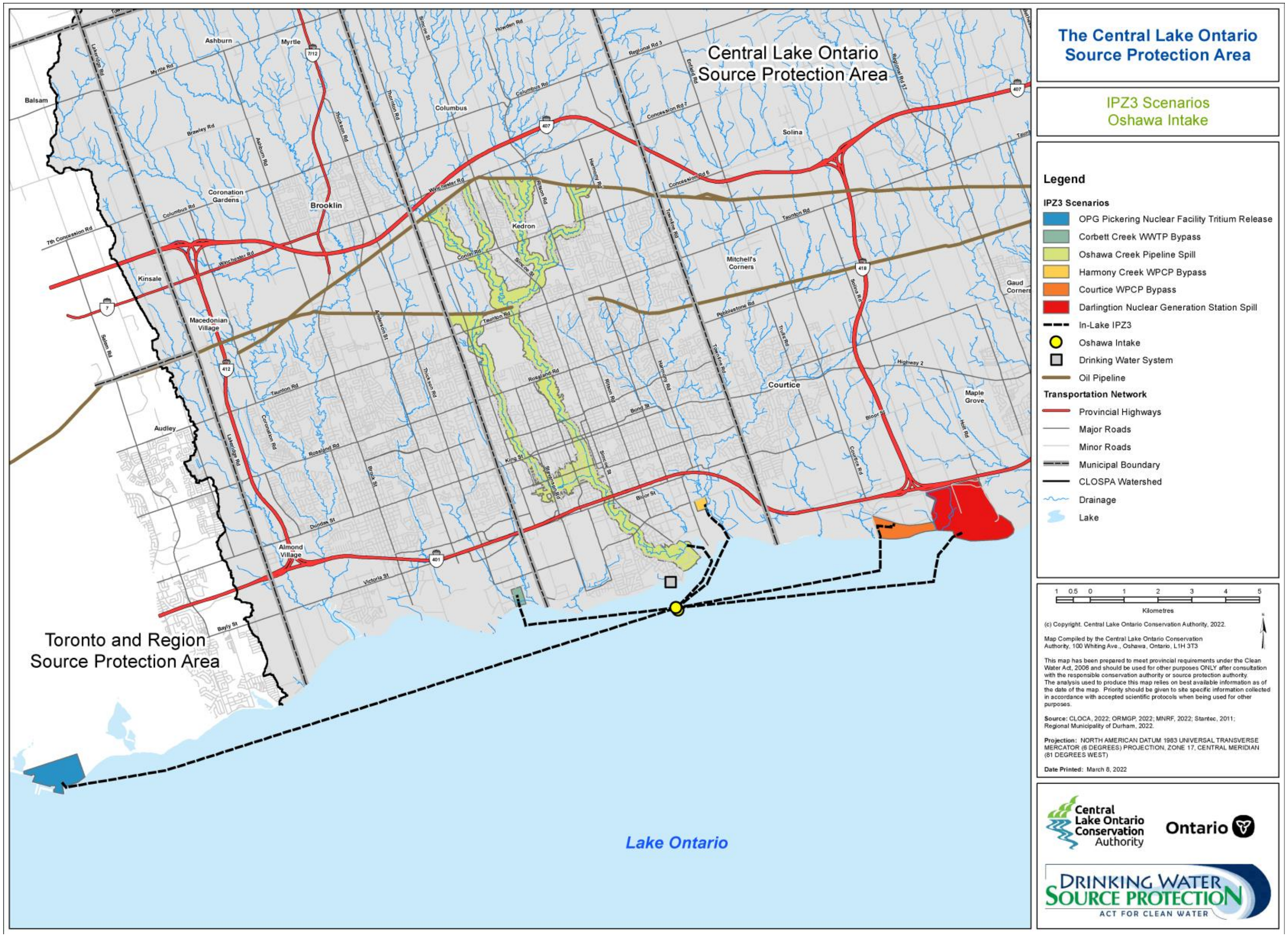



**Figure 5.11: Spills Scenario, Oshawa Intake**

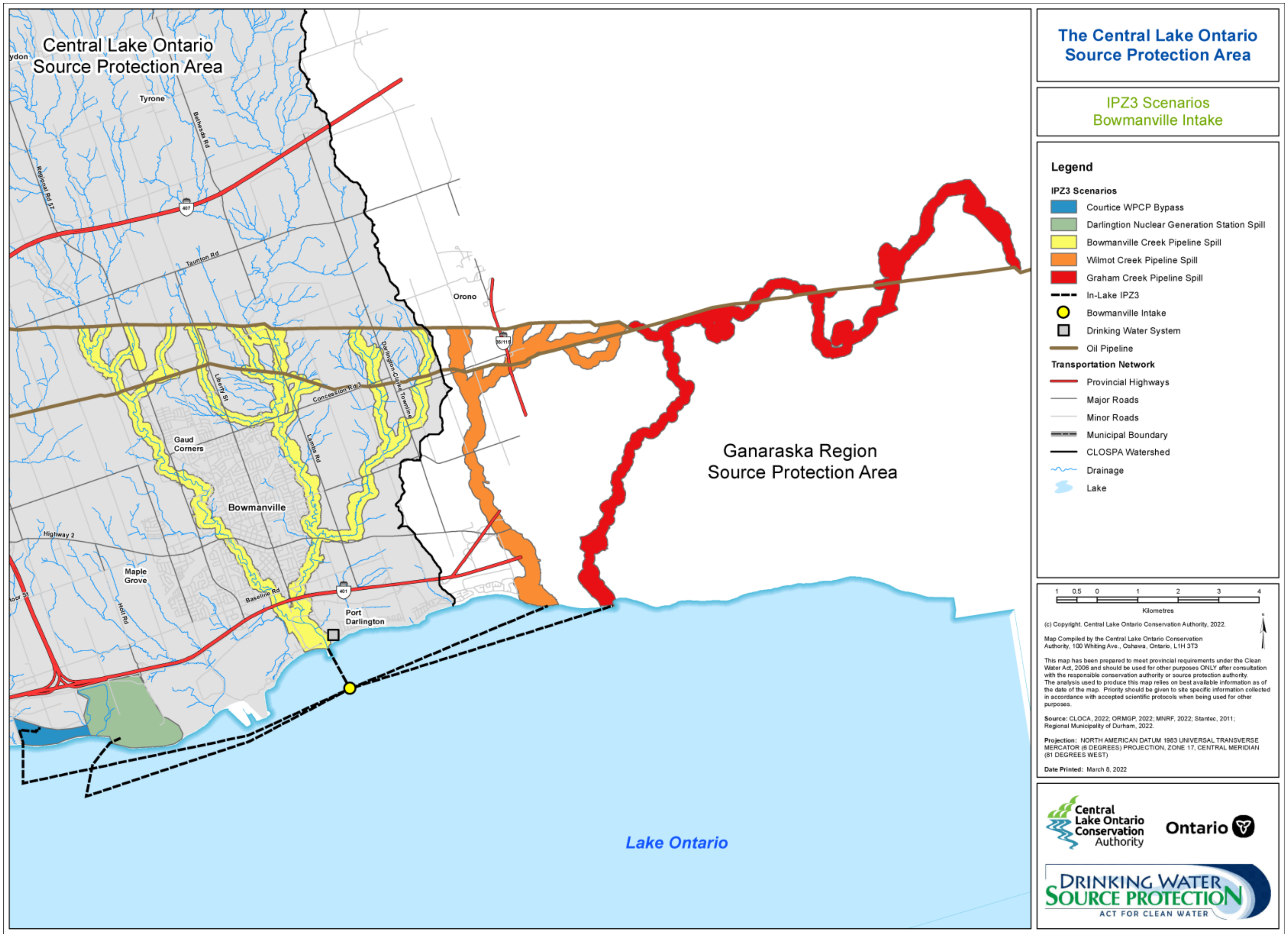



**Figure 5.12: Spills Scenario, Bowmanville Intake**

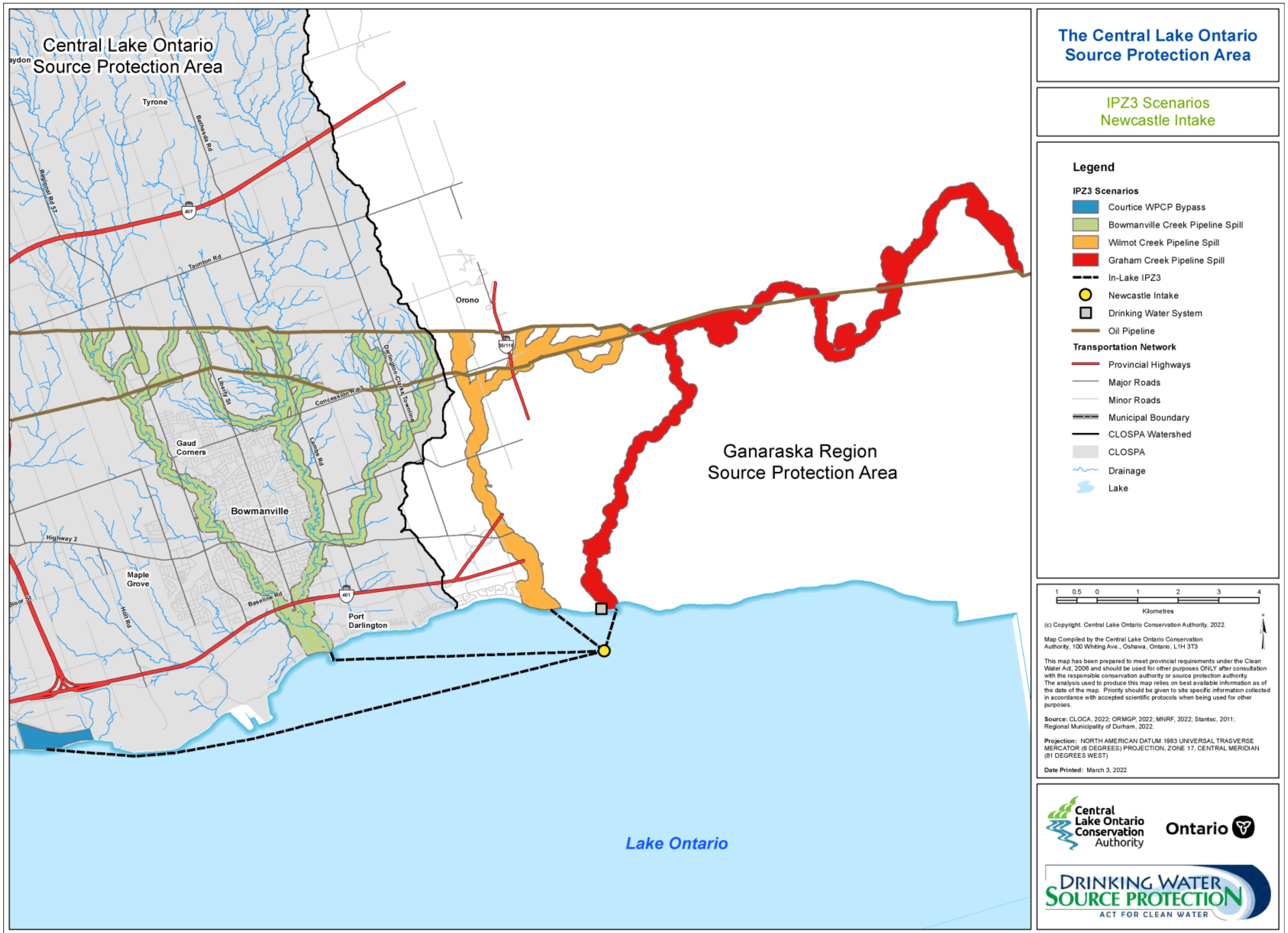



**Figure 5.13: Spills Scenario, Newcastle Intake**

**Significant Threats Enumeration**

**Table 5.14** provides the number of significant drinking threats located in CLOSPA, extracted from the information found in **Table 5.13**. Note that **Table 5.13** includes multiple references to a single significant drinking water threat location. There are eight significant threat locations in CLOSPA (note that a threat may affect more than one intake and that some of the affected intakes are outside the CLOSPA).

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, CLOSPA has identified significant drinking water threats from activities located outside the CLOSPA. These activities affect water treatment plants located in CLOSPA 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 5.13,** but are not enumerated as part of the CLOSPA threat inventory, since they are located outside of the CLOSPA. CLOSPA 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.

| **Number of Significant Threat Locations in CLOSPA** | | |
|---|---|---|
| **Threat Locations** | **Parameter of Concern** | **WTP Affected** |
| Lynde Creek pipeline break | Benzene | Ajax (in TRSPA) Whitby |
| Oshawa Creek pipeline break | Benzene | Ajax (in TRSPA) Whitby, Oshawa |
| Bowmanville Creek pipeline break | Benzene | Bowmanville, Newcastle (in Ganaraska SPA) |
| Corbett Creek WWTP bypass | *E. coli* | Ajax (in TRSPA) Whitby, Oshawa |
| Harmony Creek WWTP bypass | *E. coli* | Ajax (in TRSPA) Whitby, Oshawa |
| Courtice WWTP bypass | *E. coli* | Ajax (in TRSPA) Whitby, Oshawa, |
| Port Darlington WWTP bypass | *E. coli* | Bowmanville, Newcastle (in Ganaraska SPA) |
| Darlington nuclear waste water release | Tritium | Oshawa, Bowmanville |
| **Total Number of Significant Threat Locations** | | **8** |

**Table 5.14: Significant Threats for the CLOSPA WTPs**

*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 shall be delineated where modelling demonstrates that a contaminant released during an event may be transported to the intake resulting in an unacceptable deterioration in the quality of water rendering it unsuitable as a source of drinking water. The modelled results outlined in **Table 5.13** show where spill events would lead to the concentration of contaminants at the respective intakes in CLOSPA 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 the 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 a spill at a WWTP is represented by a spill collector dashed line only. The following maps (**Figures 5.14, 5.15, 5.16** ) show the (IPZ-1, IPZ-2 and IPZ-3) for each of the municipal intakes located within CLOSPA.

The spill scenarios modelled are illustrated in **Figure 5.18** through **Figure 5.20**. It should be noted that the Intake Protection Zones **Figure 5.18** through **Figure 5.20**, additionally present the IPZ-3s delineated for intakes in neighbouring SPAs (TRSPA, GRSPA) where they affect the CLOSPA intakes. These may overlap with existing IPZ-1s and 2s of these SPAs and where this occurs, the IPZ-3s should be truncated at the boundary of the IPZ-1s or 2s in the mapping provided by those SPAs (i.e., there should be no overlap). The delineation of the STS break IPZ-3s and associated EBAs were revised in 2015. A technical addendum is presented in **Appendix I 1.4.3**.

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

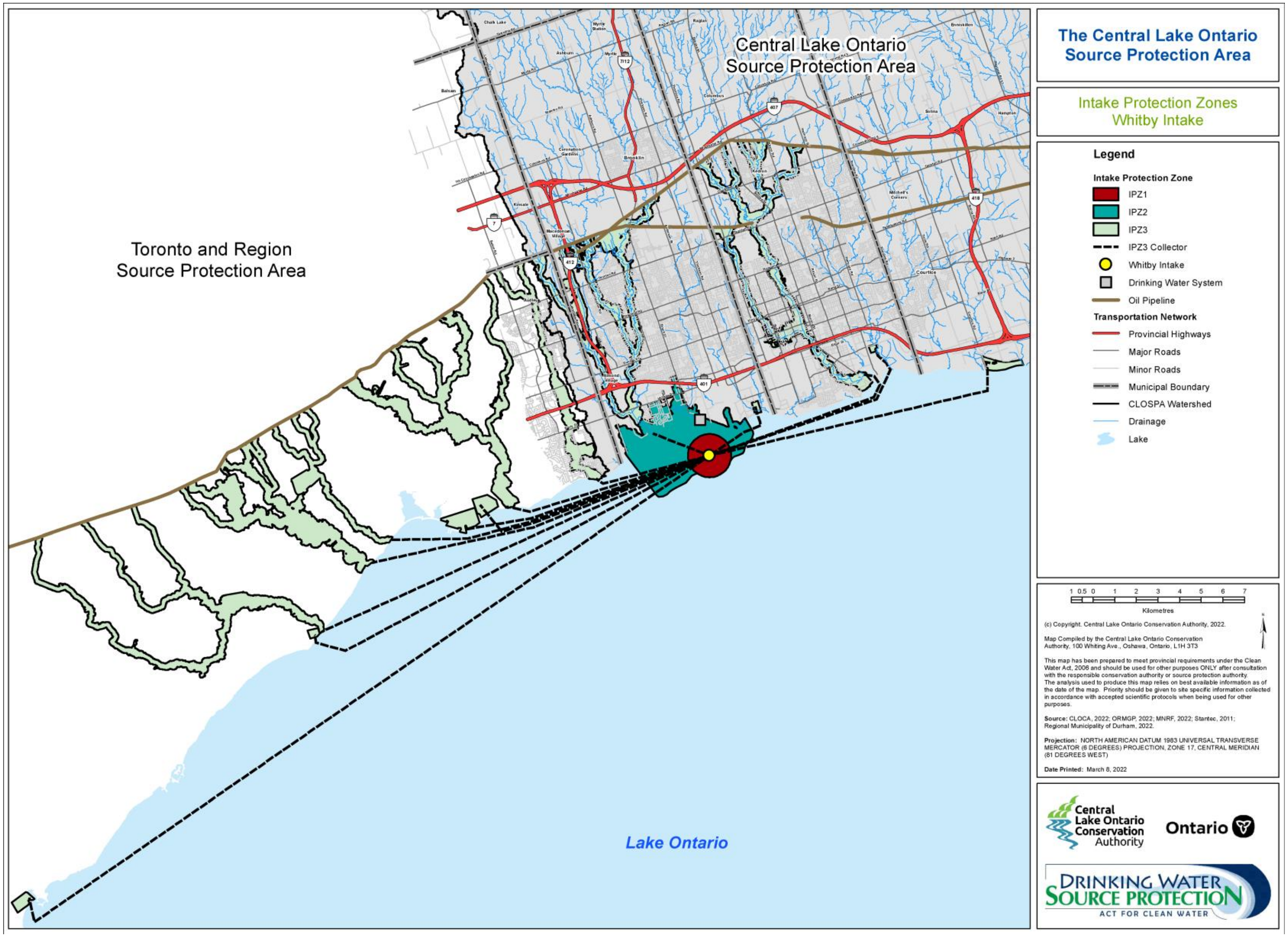



**Figure 5.14: Intake Protection Zones Whitby Intake**

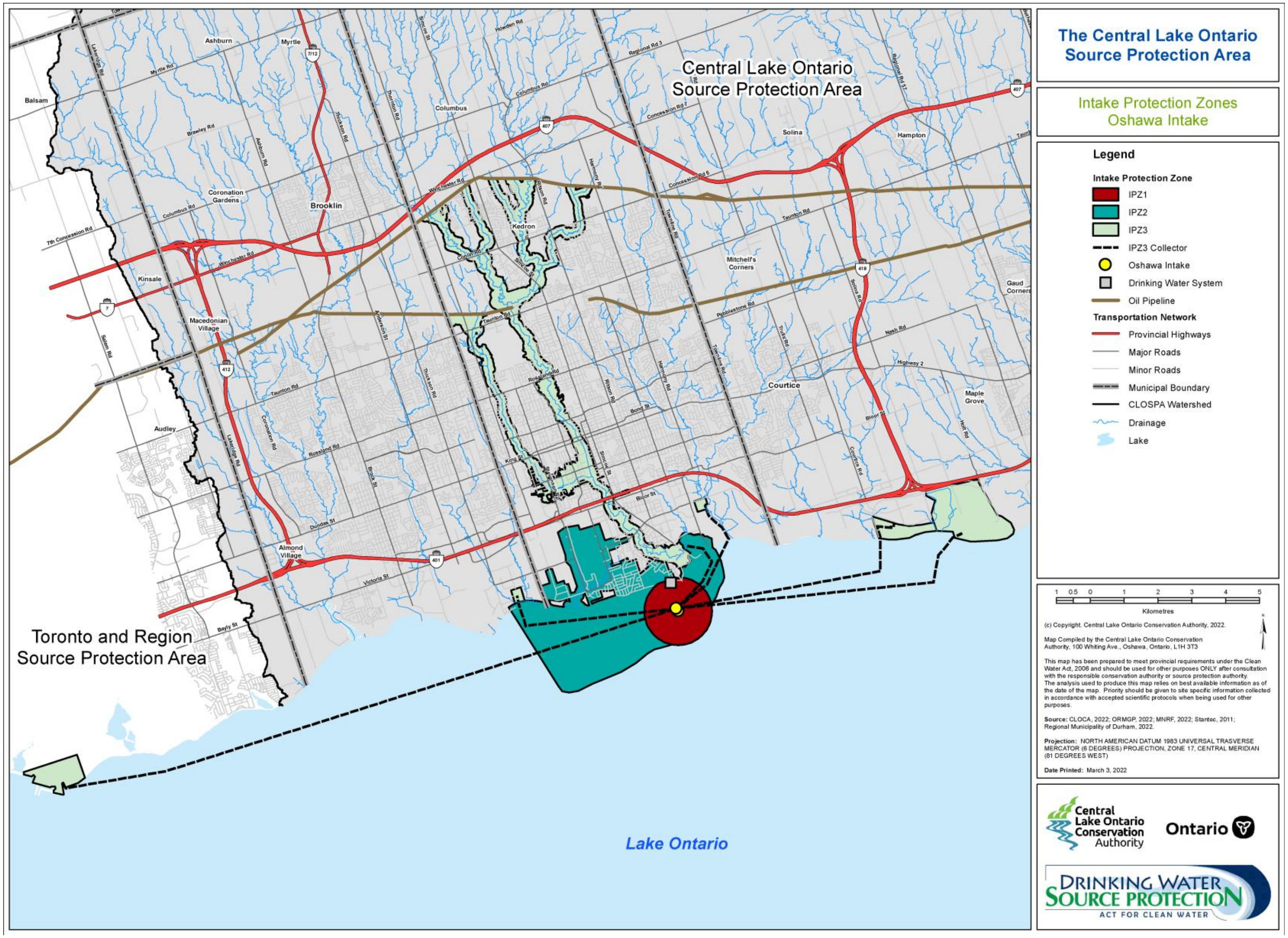



**Figure 5.15: Intake Protection Zone Oshawa Intake**

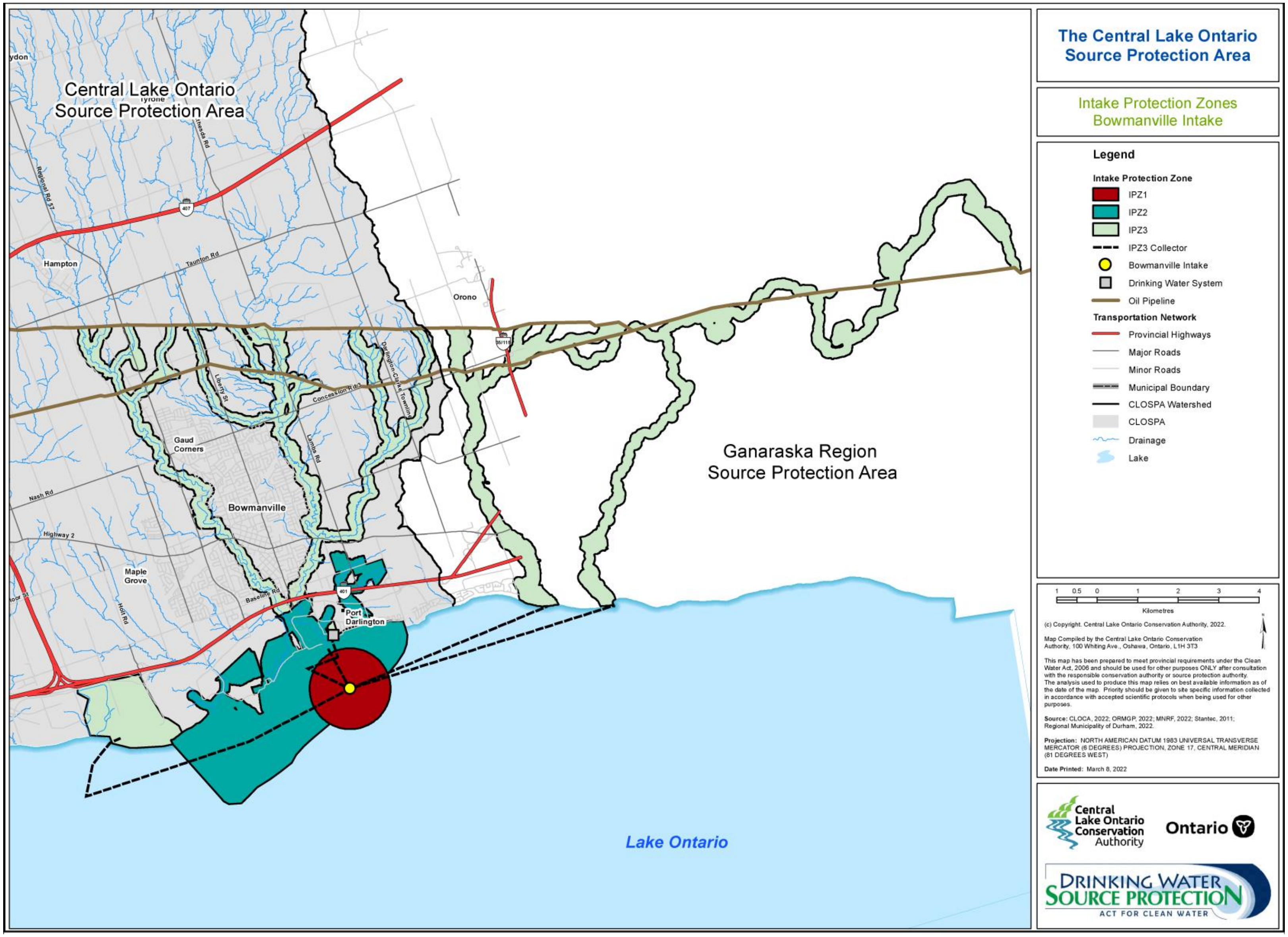



**Figure 4.16: Intake Protection Zone Bowmanville Intake**

### 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 5.15**.

| 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 |

**Table 5.15: Uncertainty Associated with IPZ-3 Delineation**

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. The dashed line is labelled a "spill collector" to show the connection between the threat and the intake. As per the *CWA 2006, Rule (75),* the delineated IPZ-3 cannot contain any part of the IPZ-1 or 2. 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 CLOSPA staff using HEC-RAS software to determine if it would be reasonable to include other creeks not modelled in the oil pipeline break scenario in delineating an IPZ-3. Watercourses that were not included in the original pipeline rupture scenarios were reviewed to determine if similar contaminant transport characteristics were apparent. Where the oil pipeline crossed these additional watercourses, and they were located between other modelled tributaries and a particular intake, it was assumed that these watercourses may be delineated as an IPZ-3 for that intake. This greatly reduced the amount of hydrodynamic modelling required.

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

The model assumed that each contaminant did not undergo any transformation during the time period for the model run. This assumption is reasonable in the case of tritium, but will likely overestimate the concentrations of benzene over time which may evaporate or be chemically changed. *E. coli* are living organisms naturally found in the intestines of humans and warm-blooded animals and will die sometime after they have been released into the environment. The rate that *E. coli* will die is dependent on time, environmental conditions such as temperature, whether they are shielded by being attached to suspended particles or exposed to disinfecting chemicals. In general terms, *E. coli* survives for about 4-12 weeks in water at a temperature of 15-18°C. Normally 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 CLOSPA is generally very good based on the information provided by municipal plant operators. The water quality in Lake Ontario may be affected by changes in climate. As the population of the Lake Ontario basin continues to grow, there will likely be more water taken for drinking water along with more 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 to the watershed (such as population growth, and land-use or intensification change), the teams should be able to identify all vulnerable areas. Potential climate change impacts will likely be further addressed in future versions of the CLOSPA Assessment Report. As required by the Province, some general points about the potential effects follow.

### 5.8.1 Water Resources Management

Water resources management is complex, balancing the demands of many different users with rapidly increasing urbanization and economic growth, and in-stream flow needs. Most communities in the province rely on surface water, although 90% of rural inhabitants rely solely on groundwater for their potable water supply (MOE, 2001; MOE, 2006b; Chiotti and Lavender, 2008). Although total annual runoff is projected to decrease as a result of future climate change, flows are expected to increase during the winter and decrease significantly during the summer, when demand is highest (Mortsch *et al.,* 2000; Cunderlink and Simonovic, 2005; 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 CLOSPA watersheds.

Despite the general abundance of freshwater supplies, seasonal water shortages have been documented (de Loë *et al*., 2001; Ivey, 2001*;* 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 5.16** identifies projected changes in regional hydrology that have implications for water quality and quantity**.** Of particular concern are areas already under stress from non-climatic factors. Communities accessing water from the Great Lakes via shallow water intakes or pipelines designed for relatively high historical water levels may experience problems in the future, resulting from more frequent low water levels. In conjunction with increased algal growth, low water levels will likely cause problems for water supply, odour, and taste (Chiotti and Lavender, 2008).

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

Note: From de Loë and Berg, 2006; Adaptation to Climate Change, 2007

**Table 5.16: Expected Changes to Water Resources in the 21st Century Great Lakes Basin**

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

The ability to access water in the Great Lakes through deepwater intakes reduces the water supply's vulnerability to drought, as do the interconnected water treatment and distribution systems, which allow sharing between plants during shortages (Chiotti and Lavender, 2008). With the potential for more summer drought periods, contamination of Lake Ontario intakes may increase. Reduced sediment transport from watersheds due to lower flows increases clarity in nearshore 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).

In areas reliant on groundwater, deeper sources are more protected from climate variability, and are used as shallow sources are compromised (Environment Canada, 2004; Chiotti and Lavender, 2008).

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's monthly still water levels could drop below historical record low elevations under future climate change/climate variation conditions by three to four-tenths of a metre.

When assessing the impacts of extreme low Lake Ontario water levels on municipal water intakes in the lake, the depth of water over the intakes will affect the hydraulic intake pumping capacity and the quality of raw intake water as determined by seasonal variations in water depth and surface water quality (see **Table 2.6** for Summary of Water Treatment Plants information on the intake depth and intake distance from the shoreline). The nominal depths of water over municipal intakes in the Durham Region are 7.6 metres at the Oshawa West intake to 16 metres at the Whitby intake.

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

### 5.8.2 Flooding

Most flood emergencies reported in this area between 1992 and 2003 happened 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 CLOSPA 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 CLOSPA, are exempt from this water quantity threat assessment. There are no municipal groundwater drinking water supplies located in CLOSPA. A Tier 3 analysis conducted in York Region where stressed watersheds with municipal groundwater supplies exist (for quantity), however, shows impacted areas that extend into a small part of CLOSPA's jurisdiction where source protection plan policies will apply. There are eleven significant drinking water quantity threats (in the York Region WHPA Q1/Q2 area where it extends into CLOSPA) related to municipal drinking water supplies that are located outside of CLOSPA.

**Threats to Groundwater Quality**

There are no Well Head Protection Areas (WHPAs) related to quality in the CLOSPA study area. In HVAs, 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.

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.

No groundwater-based threats from activities, conditions or issues were identified in CLOSPA.

**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.**

**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 (this does not impact any CLOSPA intake);
- Combined sewer overflow release in the City of Toronto to evaluate the potential effects to the Toronto WTPs, (this does not impact any CLOSPA intake);
- Sanitary trunk sewer break within some Toronto tributaries (this does not impact any CLOSPA intake);
- Spill of gasoline/refined product from large pipelines located under major tributaries to Lake Ontario (e.g., Credit River, Humber River, etc.);

- Release of gasoline from a bulk petroleum fuel storage facility in the Keele/Finch area of Toronto (this does not impact any CLOSPA intake), and in the Mississauga - Oakville area (this does not impact any CLOSPA intake);
- Discharge of tritium from nuclear-generating plants at Pickering or Darlington.

*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. During implementation, the responsible authority will assess the effectiveness of any existing risk management measures in protecting the source of municipal 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 the 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 eight locations of significant drinking water quality threats for Lake Ontario intakes within the CLOSPA. 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, CLOSPA has identified significant drinking water threats located outside of the CLOSPA. These activities, although not enumerated in this Assessment Report, affect water treatment plants located in CLOSPA, and must be addressed through source protection plan policies developed in adjacent source protection areas. CLOSPA 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.

CLOCA staff, as part of their other conservation authority programs, are actively engaging consultants to minimize the effects of urbanization and climate change on the hydrology and hydrogeology. 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. 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.