

## Preface

### Source Protection Committee Commitment

The CTC Source Protection Committee (SPC) is a multi-stakeholder committee selected to represent municipal, economic, and public interests. The SPC has legislated responsibilities to protect drinking water sources across the CTC Source Protection Region.

The SPC has developed a Source Protection Plan that is currently being implemented by responsible parties, including municipalities, in order to eliminate, reduce, or manage threats to drinking water sources, both now and in the future.

### About This Document

This Assessment Report identifies the location and nature of threats to sources of municipal drinking water supplies. These threats include activities that are impacting or could adversely impact drinking water quality or quantity from groundwater and/or surface water sources.

Note: The Ministry of Environment, Conservation and Parks has undergone several name changes throughout the years. It was called the Ministry of Environment (MOE) in the early 2000's. In June 2014, the name was changed to the Ministry of the Environment and Climate Change (MOECC). In June 2018, the name was changed yet again, to the Ministry of the Environment, Conservation and Parks (MECP), as it is currently known.

In June 2014, the Ministry of Natural Resources (MNR) changed its name to the Ministry of Natural Resources and Forestry (MNRF). In 2021, the Ministry of Natural Resources and Forestry changed its name to Ministry of Northern Development, Mines, Natural Resources and Forestry. In 2022, the Ministry of Northern Development, Mines, Natural Resources and Forestry was split into three separate ministries: Ministry of Natural Resources, Ministry of Northern Development and Ministry of Mines.

The recent and past names of both Ministries are used within this document.

## Version Control

Version Number	Approval Date	Effective Date	Description of Amendment
1.0	July 22, 2015	December 31, 2015	N/A
	n/a	n/a	<p>Section 51: Review and update for consistency between chapters, as well as with the Toronto and Region and Central Lake Ontario Assessment Reports.</p> <p>Section 51: Update wording for Tables of Drinking Water Threats to direct readers to <a href="http://swpip.ca/">http://swpip.ca/</a>.</p> <p>Date amendment posted: June 5, 2018</p>
2.0	March 11, 2019	March 25, 2019	Section 34: Addition of Wellhead Protection Areas, Vulnerability Assessment and Threats Enumeration for Inglewood Drinking Water System.
3.0	December 3, 2019	December 5, 2019	Section 34: Addition of Wellhead Protection Areas, Vulnerability Assessment and Threats Enumeration for Alton Well 4A, Caledon Village – Alton Drinking Water System.
4.0	n/a	n/a	<p>Section 51: Amendments to correct clerical, grammatical or typographical errors; to make changes referencing a name, title, location, or address that has changed; to incorporate Phase I Director Technical Rule 2017 amendments; and to account for the discontinuation of the use of Inglewood Well 2 in the Inglewood Drinking Water System.</p> <p>Date amendment posted: May 20, 2022.</p>
5.0	February 29, 2024	March 6, 2024	Section 34: Addition of Wellhead Protection Areas, Vulnerability Assessment and Threats Enumeration for Caledon Village – Alton Drinking Water System.

Version Number	Approval Date	Effective Date	Description of Amendment
6.0	TBD	TBD	Section 34: Addition of Wellhead Protection Areas, Vulnerability Assessment and Threats Enumeration for Town of Erin Drinking Water System.

## **Acknowledgements**

The preparation of this Assessment Report has been a collaborative exercise with support from staff with the Region of Halton, the Town of Orangeville, the Region of Peel, the Town of Halton Hills, the Townships of Amaranth and East Garafraxa, and Credit Valley Conservation. Work in this report has been directed through the Credit Valley Source Protection Authority and the CTC Source Protection Committee. Funding to complete the majority of technical studies on which this Assessment Report is based has been provided by the Province of Ontario. Technical studies completed since the Assessment Report was approved in July 2015 have primarily been funded by the municipalities responsible for the treatment, distribution, and provision of drinking water. The Province of Ontario also funds conservation authority staff and Source Protection Committee members for their work on the Drinking Water Source Protection Program. Technical experts, including consultants working for municipalities and conservation authorities have prepared background technical reports, peer reviewed documents, and provided advice and direction in completing this Assessment Report. Members of the CTC Source Protection Committee and Working Groups have reviewed the technical studies and the text of this Assessment Report.

## Executive Summary

### Why should you read this document?

The *Approved Amended Assessment Report: Credit Valley Source Protection Area* (Assessment Report) has been prepared under the direction of the CTC Source Protection Committee (SPC), one of 19 such committees across Ontario ([Figure ES- 1](#)). It is a requirement of the *Clean Water Act, 2006 (CWA)* and Ontario Regulation (O. Reg.) 287/07 as amended by O. Reg. 59/10 and has been developed in accordance with the regulations, the *Technical Rules: Assessment Report* (MOE, 2009) and the *Terms of Reference: CVSPA*, as approved by the Minister of the Environment. Amendments to the Credit Valley Assessment Report resulting in versions 2.0, 3.0 and 4.0 were made using the 2017 Director's Technical Rules and Tables of Drinking Water Threats. Further amendments resulting in **versions 5.0 and 6.0** were made using the 2021 Director's Technical Rules. Sections of the Assessment Report that were not updated as part of those amendments refer to the 2009 **and/or 2017** edition of the Director's Technical Rules and Tables of Drinking Water Threats.

This Assessment Report identifies the location and nature of threats to sources of municipal drinking water supplies. These threats include activities that are adversely impacting or could adversely impact drinking water quality or quantity from groundwater and/or surface water sources.

This Assessment Report identifies the location and nature of potential threats to sources of municipal drinking water. These threats include activities that are adversely impacting, or could impact, drinking water quality or quantity from groundwater and/or surface water sources.

Source protection committees determine threats to drinking water sources by delineating vulnerable areas and applying vulnerability scores to these areas, where they exist, within each source protection area, as discussed in the legislation. These areas are:

- Intake protection zones (IPZs);
- Highly vulnerable aquifers (HVAs);
- Significant groundwater recharge areas (SGRAs);
- Wellhead protection areas for water quality (WHPAs);
- Issue contributing areas (ICAs); and
- Wellhead protection areas for water quantity (WHPA-Q1/Q2).

Detailed information about how these vulnerable areas were delineated and scored can be found in **Chapters 3, 4** (regarding vulnerability), and **5** (regarding Intake Protection Zone-3). This Assessment Report identifies and describes per the *Technical Rules (2009)* each of these types of vulnerable areas within the Credit Valley Source Protection Area

(CVSPA). Descriptions, scoring, and documentation on the analyses performed to arrive at these delineations are all contained in the body of this Assessment Report or in the referenced technical appendices.

Work has been undertaken to delineate water quantity vulnerable areas around wells in Amaranth, Mono, Orangeville, Acton, and Georgetown as part of Tier 3 Water Budget study ([Figure ES- 2](#)). This work also resulted in changes to the areas delineated as wellhead protection areas, and issue contributing areas around these wells. Refinements to the mapping of significant groundwater recharge areas were also completed through this work.

In the CVSPA, there are two municipal drinking water system intakes which are sourced from Lake Ontario. These intakes supply drinking water to over 1,250,000 people within the CVSPA and beyond, including residents in York Region who receive some of their municipal water from these water treatment plants. The **IPZ-1** and **IPZ-2 map** ([Figure ES- 3](#)) indicates areas near these drinking water intakes where a contaminant spill could reach the intake before a plant operator is able to respond.

The IPZ-1 is based on drawing a one-kilometre radius around each intake. The IPZ-2 is based on the estimation of the distance a contaminant might move in a two-hour time of travel to the intake and is made up of two parts – the in-lake portion, and the landward extent. The delineation of the in-lake portion is based on hydrodynamic modelling, while the delineation of the landward extent is based on the extent of storm sewer drained areas, and on the *two-year storm* velocities in contributory watercourses. The upland component considers various setbacks, and transport pathways, such as tile drainage, with the residual time of travel onto the land as a limiting factor. Details on this work can be found in **Chapter 4** of this Assessment Report.

The IPZ-3 map ([Figure ES- 4](#)) shows the IPZ-3 delineations, which are associated with a number of spill scenarios that were modelled as part of the Lake Ontario Collaborative to determine if certain land-based source 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. Once a contaminant is modelled to reach an intake, an IPZ-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. A dashed line was 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 wastewater treatment plant (WWTP) is represented by a spill collector dashed line only. [Figure ES- 4](#) presents an integrated intake map of all IPZ zones for the CVSPA. More details about this work can be found in **Chapter 5** of this Assessment Report. Note that the IPZ-3 outside of the CVSPA jurisdiction has not been clipped to the IPZ-2 boundaries as required by the Technical Rules. The clipping has been completed only where the source is located within CVSPA.

Details on this IPZ-3 work can be found in **Chapter 5** of this Assessment Report, along with detailed maps for each of the Lake Ontario systems. These maps show the shortest path that a modelled spill which has been identified as a significant drinking water threat could take to reach the intakes within the CVSPA, or that could be affected by activities within the CVSPA.

Figure No.	Description
Figure 5.53	Burlington WTP Intake
Figure 5.54	Burloak WTP Intake
Figure 5.55	Oakville Intake
Figure 5.56	Lorne Park Intake
Figure 5.57	Arthur P. Kennedy (formerly Lakeview) Intake
Figure 5.58	R.L. Clark Intake
Figure 5.59	R.C Harris Intake

The SGRA map ([Figure ES- 5](#)) indicates areas where a high percentage of water from rain or snow seeps down into the ground and flows to an aquifer that is used for drinking water (including both municipal and other users). These areas are delineated according to the methodology provided in **Chapter 4** using the recharge results from the water budget process described in **Chapter 3** of this Assessment Report. Under the *Clean Water Act, 2006* the CTC SPC may choose to develop policies to protect SGRAs within CVSPA.

The HVA map ([Figure ES- 6](#)) indicates areas where one or more aquifer have been determined to be highly vulnerable to surface contaminants moving from elsewhere into the aquifer, e.g., contaminants on the surface move downwards into the groundwater. HVAs are more extensive than SGRAs because they are not dependent on the 230 mm/yr recharge threshold. Extra caution should be taken when constructing wells in vulnerable aquifers. Water well construction standards are set out in O.Reg. 903 under the *Ontario Water Resources Act, 1990*. Under the *Clean Water Act, 2006*, the CTC SPC may choose to develop policies to protect HVAs within CVSPA.

The WHPA map ([Figure ES- 7](#)) indicates areas around municipal groundwater systems where certain activities are more likely to negatively impact the quality of a drinking water source. The WHPA map shows the vulnerability scores within the WHPA around municipal groundwater systems. [Figure ES- 7](#) illustrate the vulnerability of areas where certain activities are more likely to negatively impact a drinking water source. **Chapter 4** of this

Assessment Report provides detailed maps for each of the municipal groundwater systems within the CVSPA.

Figure No.	Description
Figure 4.7	Orangeville WHPAs
Figure 4.10	Mono WHPAs
Figure 4.13	Amaranth WHPAs
Figure 4.18	Erin WHPAs
Figure 4.19	Hillsburgh WHPAs
Figure 4.20	Bel-Erin WHPAs
Figure 4.28	Acton WHPAs
Figure 4.29	Georgetown WHPAs
Figure 4.35	Alton and Caledon Village WHPAs
Figure 4.36	Inglewood WHPAs
Figure 4.37	Cheltenham WHPAs

Where there is evidence of contamination levels increasing within the water reaching a municipal well, Issue Contributing Areas (ICA) are delineated ([Figure ES- 7](#)). These areas are where activities could release the contaminant of concern and thereby contribute to the rising contaminant levels. **Chapter 5** of this Assessment Report provides the maps for these areas as listed below:

Figure No.	Description
Figure 5.13	Orangeville ICAs for sodium and chloride issues
Figure 5.38	Georgetown ICA for chloride issue
Figure 5.39	Acton ICA for nitrate issue

Where Tier 3 Water Budget studies are undertaken, water quantity vulnerable areas are delineated around wells or groups of wells where they interact with one another, called WHPA-Q1 and Q2 ([Figure ES- 2](#)). **Chapter 3** of this Assessment Report describes how



these areas are delineated and **Figure 3.28** and **Figure 3.37** show these WHPA-Q1 and Q2 in Orangeville, Mono, Amaranth, Acton, and Georgetown.

The Source Protection Plan (SPP) identifies actions required to reduce, manage, or eliminate current threats to municipal drinking water sources, as well as to prevent future potential threats. The SPP also set out requirements for regular monitoring and reporting on the implementation of the SPP. Public consultation was an important part of developing the SPP, which started in early 2011. The SPP was submitted to the Minister of the Environment for approval in October 2012, and again in December 2014 as an amended plan. The Source Protection Plan was approved by the Minister of the Environment and Climate Change on July 28, 2015, and became effective on December 31, 2015.

## What does all this Mean?

This Assessment Report describes the physical features and water resources within the Credit Valley Source Protection Area (CVSPA). Using approved provincial methodologies, it delineates vulnerable areas and assesses specific activities on the landscape within these vulnerable areas as potential drinking water threats. It should be noted that municipal drinking water supplies for the CVSPA's jurisdiction come from both groundwater and surface water sources.

The analysis of the Watershed Characterization component in **Chapter 2** of this Assessment Report shows that groundwater quality across the CVSPA is generally high. In the deeper groundwater formations there are naturally elevated iron, manganese, and hardness levels. Surface water quality in the streams discharging into Lake Ontario shows some elevated chlorides and phosphorus levels as compared against ecosystem and aquatic life standards (Canadian Water Quality Guidelines). These contaminants are thought to be associated with the impact of urbanization within the CVSPA. The surface water in these streams is not used as a drinking water supply. Water quality in Lake Ontario in the vicinity of intakes is generally very good. Occasionally higher levels of some contaminants are found after significant rainfall. The currents in the near shore area of the western end of Lake Ontario are complex. Contaminants released from a spill can be transported in both easterly and westerly directions along the shore, as well as moving from the surface to lower depths.

The water budget analysis in **Chapter 3** of this Assessment Report assesses potential water quantity stress in both surface water (not including Lake Ontario) and groundwater. Groundwater sources in CVSPA are used for drinking water supplies for both municipal and private wells, and to support ecosystem functions. The surface water in streams in the study area is important for supporting the ecosystem and is also used for irrigation and other non-drinking water purposes.

Fletcher's Creek Subwatershed was found to have moderate surface water stress levels, while the Orangeville, Black Creek, and Silver Creek Subwatersheds were inferred to have

moderate groundwater stress levels. Orangeville, Black Creek, and Silver Creek Subwatersheds are each utilized as municipal groundwater sources, and as such, detailed Tier 3 Water Budget assessments are required for each. The Tier 3 Water Budget study has been completed for wells serving Orangeville, and parts of Mono and Amaranth, and more recently for those servicing Acton and Georgetown. Since the *Technical Rules* exclude consideration of Great Lakes in water budget “stress” assessments, Lake Ontario was not included in the water budget studies.

**Chapter 4** assesses and scores vulnerability in all vulnerable areas in CVSPA (IPZs, HVAs, SGRAs, and WHPAs). The IPZs for the study area (IPZ-1s and IPZ-2s) were all ranked as having low vulnerability. The results of the CVSPA HVA and SGRA vulnerability analyses reflect the presence of many shallow aquifers that are naturally vulnerable. WHPA delineation and scoring has been completed for every municipal groundwater system within the CVSPA, identifying areas where certain types of activities may pose drinking water threats.

In **Chapter 5**, vulnerability is considered together with provincial hazard scores outlined in the Tables of Drinking Water Threats for the various activities and their associated chemicals and pathogens to determine a risk score. Using both the natural vulnerability and hazard scores, potential drinking water threats are ranked as significant, moderate, or low in the vulnerable areas (IPZ-1s and IPZ-2s, HVAs, SGRAs, and WHPAs). In certain vulnerable areas (Issue Contributing Areas (ICA), and Well Head Protection Areas for quantity (WHPA-Q1/Q2) determined to have a significant risk level for water quantity threats) all the relevant existing and future activities are deemed to be significant drinking water threats. In Well Head Protection Areas for Quantity (WHPA-Q1/Q2) which have been determined to have a moderate risk level only the relevant future activities are deemed to be significant drinking water threats.

In the case of the IPZ-3s for intakes in Lake Ontario, the determination of whether a threat activity is significant was determined through event based spill scenario modelling to assess the impact of a particular spill scenario on individual intakes.

Existing significant threats must be identified and located in the Assessment Report and addressed in the Source Protection Plan. This Assessment Report update includes limited information from threats verification. In the absence of field verification, the Source Protection Committee took a conservative approach in identifying threats, assuming that a threat activity could exist based on current land use and other available information. However, Source Protection Plan policies will only apply to activities which actually exist or are planned. If the activity does not exist or ceases to exist on a property where it could pose a drinking water threat, any policies directed at the activity would not apply. Likewise, if an activity has not been identified in this enumeration but has been found to occur on the property (through field checks) - any policy directed at that activity would apply.

If the activity is categorized as a moderate or low-level threat, the province requires only the identification of all of the circumstances that could pose a threat to drinking water by reference to the Provincial Tables of Circumstances.

It should be noted that these moderate and low threats may not actually exist within the vulnerable areas discussed.

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

- Disinfection failure at each Lake Ontario waste water treatment plants (WWTP) to evaluate the potential effects to nearby water treatment plants (WTP);
- Release of *E. coli* from an industrial processing facility into the Credit River;
- Combined sewer overflow (CSO) release in the City of Toronto to evaluate the potential effects to the Toronto WTPs (this does not impact any CVSPA intake);
- Sanitary trunk sewer (STS) break within certain Toronto tributaries (this does not impact any CVSPA intake);
- Spill of gasoline or refined products from large pipelines located under major tributaries to Lake Ontario (e.g., Credit River, Humber River, etc.);
- Release of gasoline or refined products containing benzene from a bulk petroleum fuel storage facility in the Keele/Finch area of Toronto (this does not impact any CVSPA intake) and in the Mississauga/Oakville area; and
- Discharge of tritium from nuclear generating plants at Pickering or Darlington (this does not impact any CVSPA intake).

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

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 was delineated for activities in the tributary using the required setbacks from the contaminant point of release to a point representing the maximum landward extent of the IPZ-2. 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 spill collector line

represents the shortest path to the intake within the area where concentrations were modelled to exceed the threshold for the contaminant. Once a contaminant is modelled to reach an intake at a level that is identified as a significant drinking water threat, 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.

With respect to surface water, three significant drinking water quality threat locations have been identified in CVSPA. With respect to groundwater, 9,588 significant drinking water quality threats have been identified in this Assessment Report.

Drinking water issues relating to sodium (Na) and chloride (Cl) were identified in WHPAs of municipal wells servicing the Towns of Orangeville, and issues related to chloride were identified for municipal supply wells for the Town of Georgetown. Issues relating to Nitrates (NO<sub>3</sub>) were found in municipal wells servicing the Town of Acton. These are areas in the middle and upper zones where sizeable populations receive municipal water supplies sourced from the ground. The Tier 3 work has also identified 392 significant drinking water quantity threats at Orangeville, Mono, Amaranth, and Acton.

**You may request more information by writing to:**

[ctcswp@cvc.ca](mailto:ctcswp@cvc.ca)

**or by regular mail to:**

Chair, CTC Source Protection Committee  
c/o Credit Valley Conservation  
1255 Old Derry Road, Mississauga, ON L5N 6R4

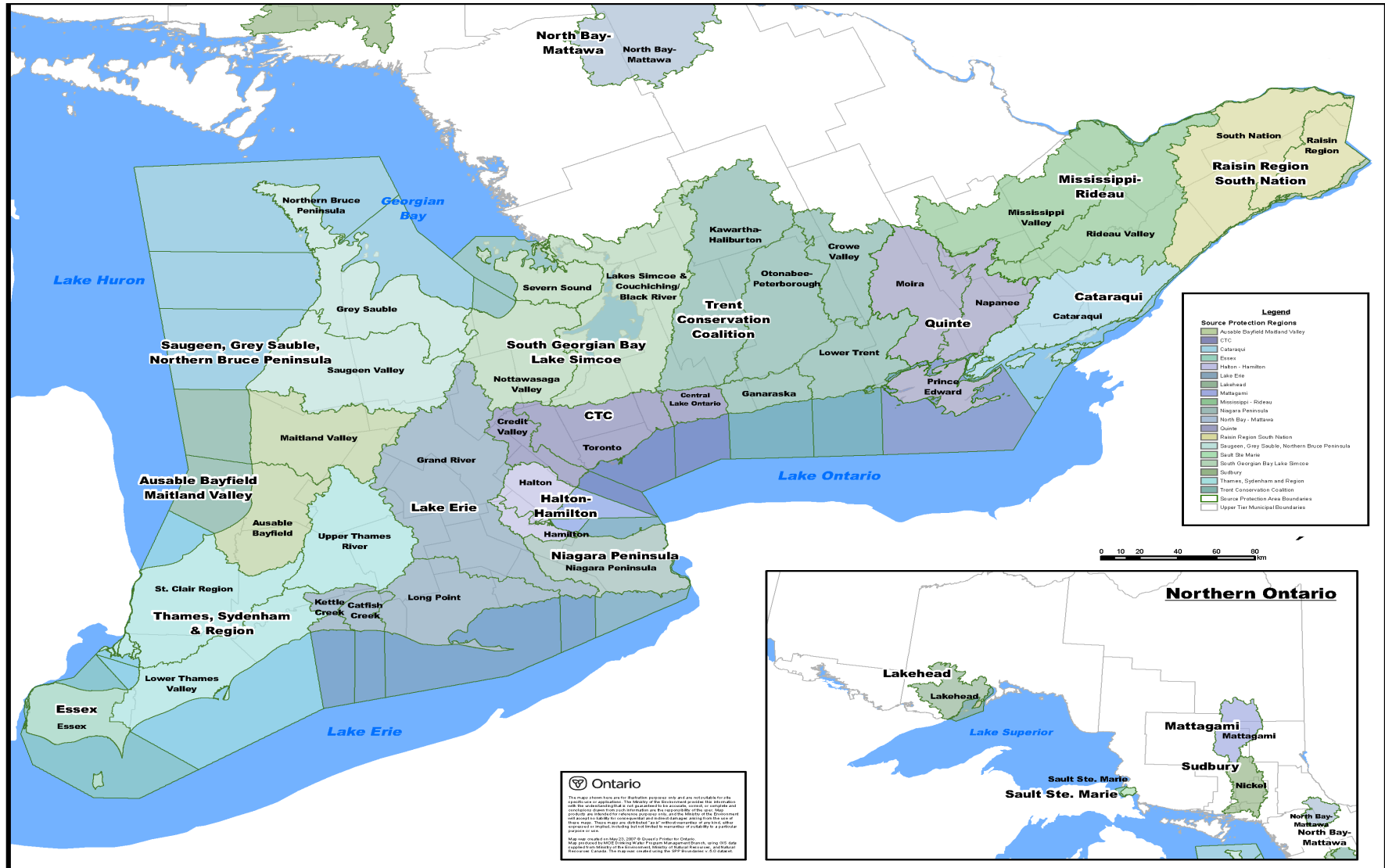
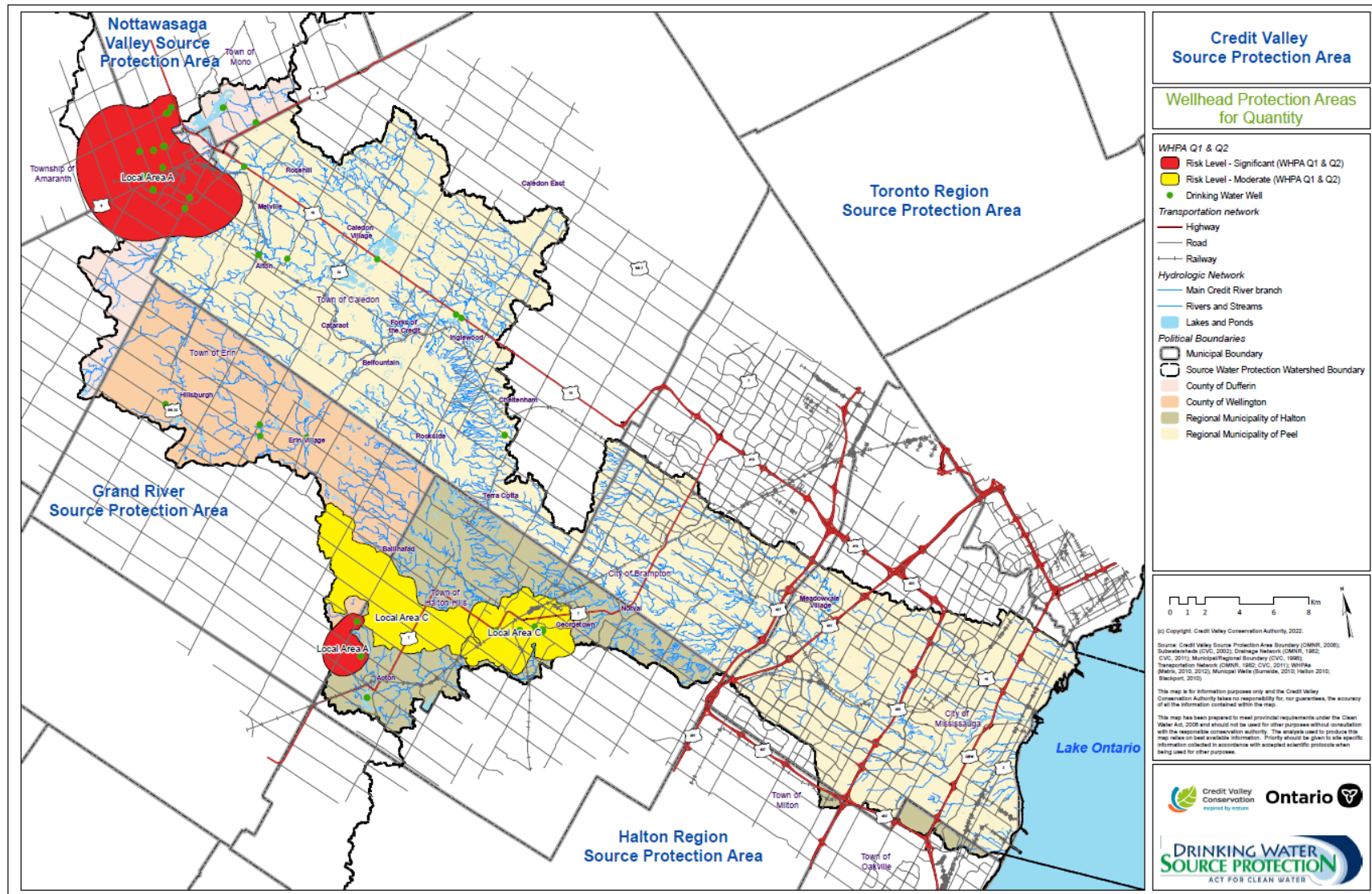
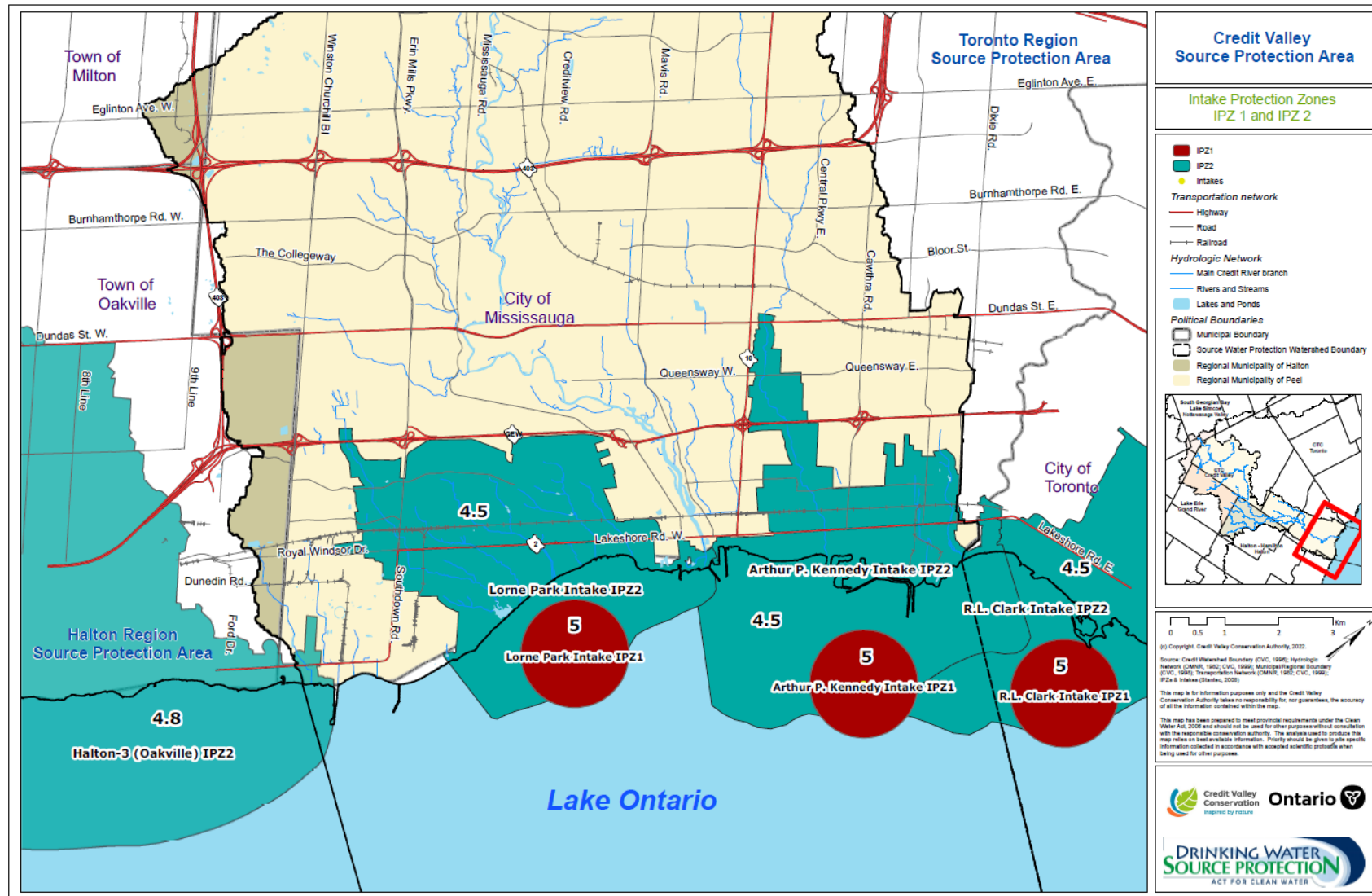


Figure ES- 1: Source Protection Regions and Source Protection Areas in Ontario



**Figure ES- 2: WHPA-Q1/Q2 Tier 3 Water Budget in CVSPA**



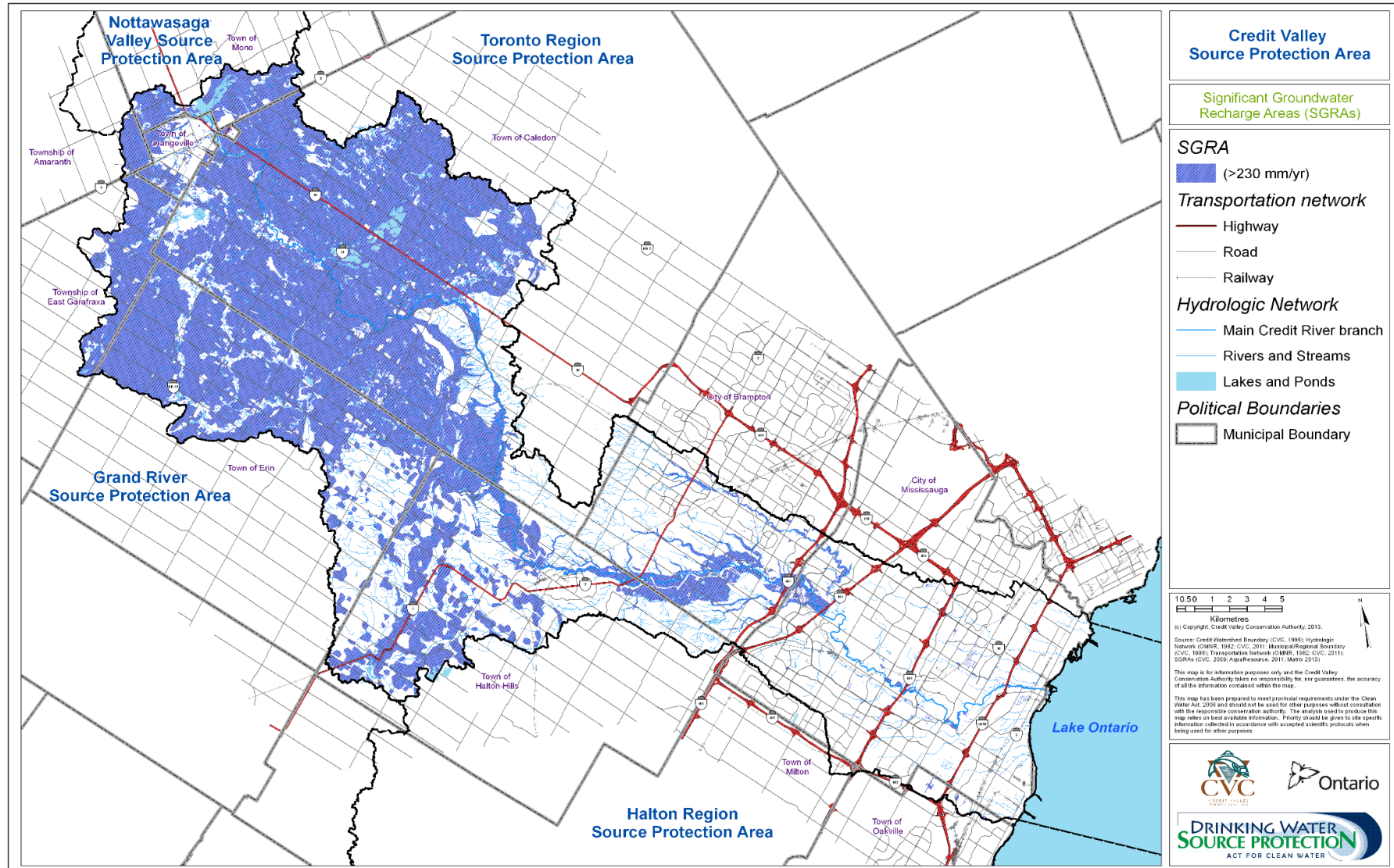


**Figure ES- 3: Intake Protection Zones Delineation 1 and 2 with Vulnerability Scoring for Peel Region Water Treatment Plants**

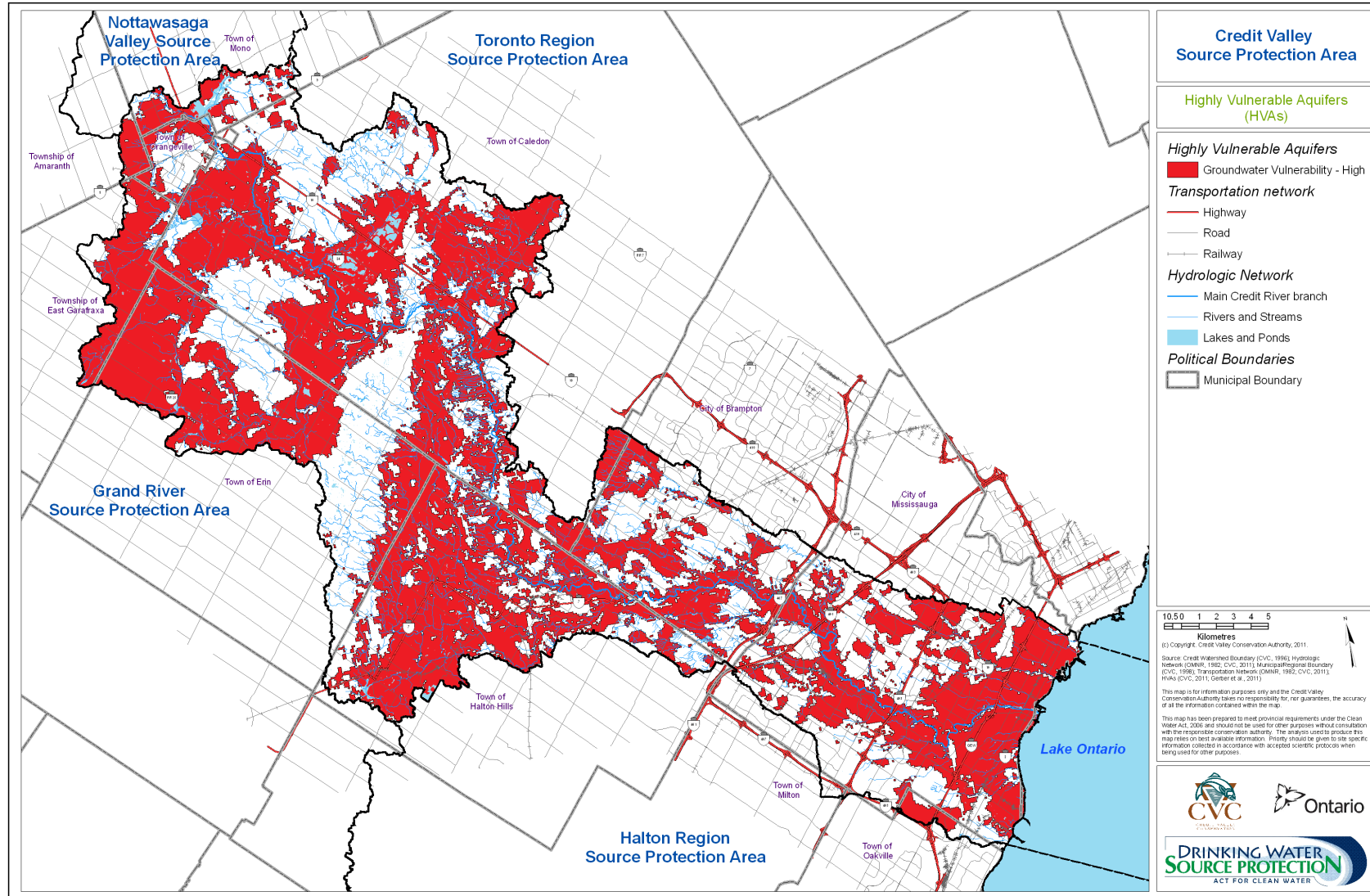


**Figure ES- 4: Location of Intake Protection Zones and Municipal Surface Water Intakes**



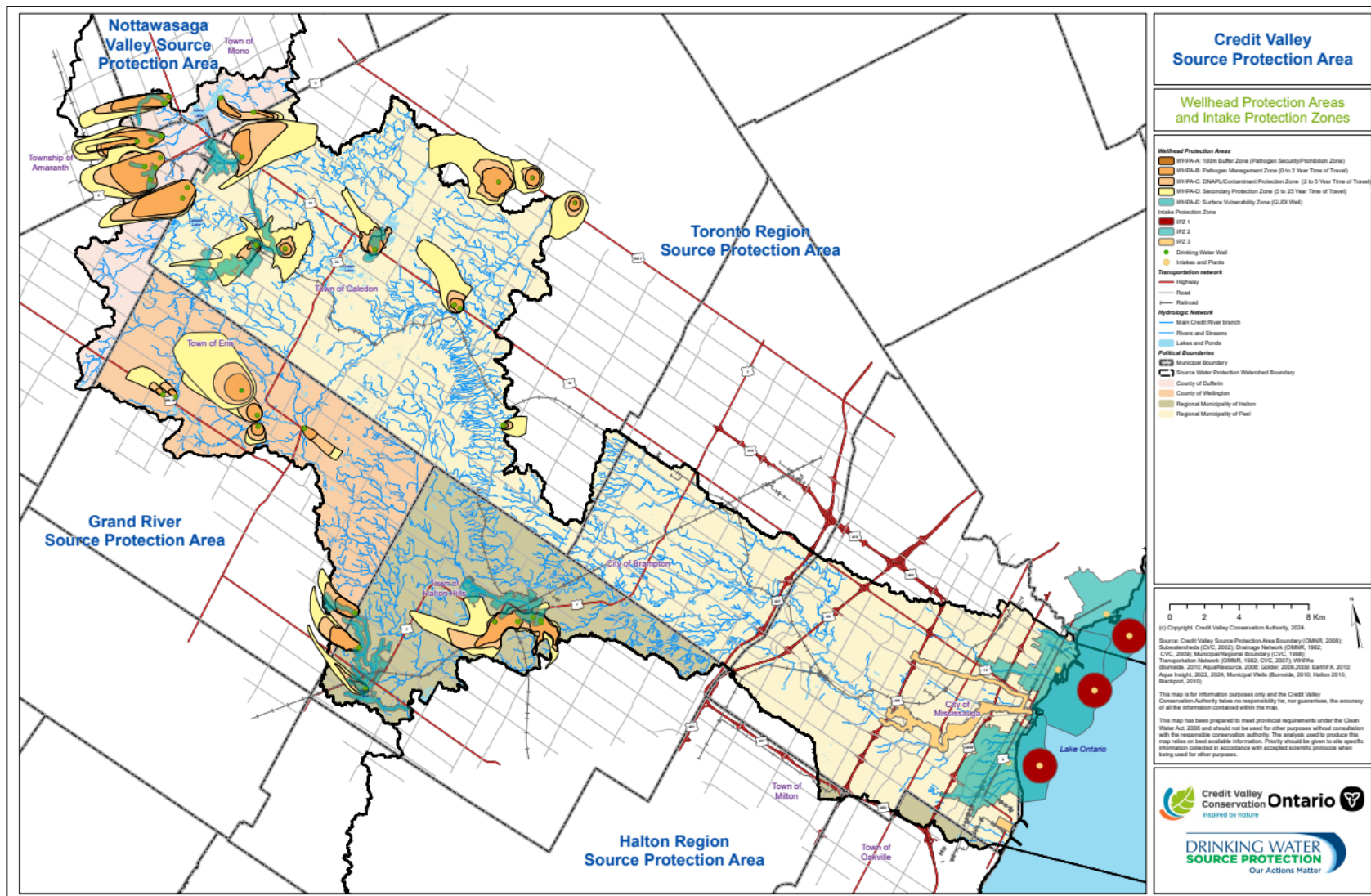


**Figure ES- 5: Significant Groundwater Recharge Areas (SGRAs)**



**Figure ES- 6: Highly Vulnerable Aquifers (HVAs) with Vulnerability Scoring**





**Figure ES- 7: Wellhead Protection Areas, Intake Protection Zones, and Issue Contributing Area**

## Glossary

Below are some terms, both scientific and non-scientific, related to Drinking Water Source Protection. Note that some of these terms are derived from draft documents, and as such may be subject to change. They are provided here for information purposes, not as official legal definitions.

**Abandoned Well:** A well that is deserted because it is dry, contains non-potable water, was discontinued before completion, is not being properly maintained, was constructed poorly, or for which it has been determined that natural gas may pose a hazard.

**Abiotic:** Not relating to living things.

**Activity:** One or a series of related processes, natural or anthropogenic that occurs within a geographical area and may be related to a particular land use.

**Aggregate Risks:** Multiple risks in a municipal water supply protection area that are considered together relative to the overall risk to drinking water sources.

**Agro-ecosystem:** Any agricultural system, which incorporates a natural community of plants and animals within a particular physical environment, on land where domestic animals are raised or crops grown.

**Ambient water:** Natural concentration of water quality constituents prior to mixing of either point or non-point source load of contaminants.

**Aquifer:** An underground layer of water-bearing sediments (e.g., sand, gravel) or permeable rock from which groundwater can be usefully extracted via a water well.

**Aquifer Vulnerability Index (AVI):** A numerical indicator of an aquifer's intrinsic or inherent vulnerability susceptibility to contamination expressed as a function of the thickness and permeability of overlying layers.

**Aquitard:** The layer of geological material that prevents or inhibits the transmission of water in a confined aquifer.

**Artesian:** Groundwater under sufficient pressure to rise above the top of the aquifer containing it.

**Baseflow:** The sustained component of flow in a watercourse (i.e., stream, river) which continues even through dry weather periods. It is normally regarded as the sum of groundwater flow and delayed throughflow.

**Bedrock:** The solid rock underlying unconsolidated surface material.

**Bedrock Geology:** The study of the solid rock underlying unconsolidated surface material. Also refers to description of bedrock types.

**Benthic Invertebrates:** Small aquatic organisms that live in stream sediments and are a good indicator of water quality and stream health.

**Biochemical Oxygen Demand (BOD):** A measurement used to assess the rate at which water is deoxygenated. High BOD generally corresponds to water containing high amounts of organic pollution.

**Bog:** A wetland ecosystem characterized by high acidity, low nutrient levels, and accumulation of peat and mosses, chiefly *Sphagnum*. The water table is at or near the surface in spring, and slightly below during the remainder of the year. The bog surface is often raised, if flat or level with the surrounding wetlands, it is virtually isolated from mineral soil waters. Peat is usually formed in situ under closed drainage and oxygen saturation is very low.

**Campylobacter Bacteria:** Bacteria commonly found in the intestines of humans and animals. Some types of *Campylobacter* can cause serious illness in humans.

**Catchment:** The groundwater and surface water drainage area from which a woodland, wetland, or watercourse derives its water.

**Chemical:** A substance used in conjunction with, or associated with, a land use activity or a particular entity, and with the potential to adversely affect water quality.

**Climate:** The average weather conditions of a place or region throughout the seasons.

**Cold water:** Water with a temperature of approximately 14 °C. This thermal habitat is typically considered ideal for brook and brown trout.

**Conceptual Water Budget:** A written description of the overall flow system dynamics for each watershed in the Source Protection Area taking into consideration surface water and groundwater features, land cover (e.g., proportion of urban vs. rural uses), human-made structures (e.g., dams, channel diversions, water crossings), and water takings.

**Cone of Influence:** For one or more wells that draw water from an aquifer, this is the area within the depression created in the water table or potentiometric surface when the wells are pumped at a rate equivalent to their allocated plus planned quantities of water.

**Confined Aquifers:** An aquifer that is bounded above and perhaps below by layers of geological material that do not transmit water readily.

**Contaminant:** Chemicals and pathogens.

**Contaminant of Concern:** A chemical or pathogen that is or may become a drinking water threat.

**Contamination:** The mixing of harmful elements, compounds or microorganisms with surface or groundwater. Contamination can occur naturally (e.g., an aquifer flowing through mineral deposits that contain heavy metals) or through human activity (e.g., sewer water flowing into a river). Nutrients, such as nitrogen and phosphorus, can also cause water contamination when they are present in excessive amounts.

**Decommissioned Wells:** To permanently fill in and seal a well to eliminate the well as a source of water, or as a potential physical hazard and to prevent movement of water within well.

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

**Designated System:** A drinking water system that is included in a Terms of Reference for developing source protection plans, pursuant to resolution passed by a municipal council under subsection 8(3) of the *Clean Water Act, 2006* or added by the Minister.

**Developed / Developable:** Reference to the useable portion of a parcel of land that meets the regulatory zoning provisions, particularly those pertaining to defining the area of occupation for buildings, structures, facilities, and infrastructure.

**Discharge Area:** An area where water leaves the saturated zone across the water table surface.

**Dissemination Areas (Da):** the smallest standard geographic area for which all census data are disseminated (Census Canada).

**Drainage System:** A drain constructed by any means, including the improving of a natural watercourse, and includes works necessary to regulate the water table or water level within or on any lands or to regulate the level of the waters of a drain, reservoir, lake or pond, and includes a dam, embankment, wall, protective works or any combination thereof. Physically, a municipal drain is simply a drainage system. Under the Drainage Act, municipalities are legislated to maintain, and repair drains and to respond to petitions for new drainage systems. Municipal drains are generally watercourses as defined under the Conservation Authorities Act and are therefore regulated by Conservation Authorities.

**Drained:** A condition in which the level or volume of groundwater or surface water has been reduced or eliminated from an area by artificial means.

**Drinking Water Concern:** A purported drinking water issue that has not been substantiated by monitoring, or other verification methods. Drinking water concerns will be identified through consultations with the public, stakeholder groups, and technical experts (e.g., water treatment plant operators).

**Drinking Water Threat:** An existing activity, possible future activity or existing condition that results from a past activity 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.

**Drinking Water Issue:** A substantiated condition relating to the quality of quantity of water that interferes or is anticipated to soon interfere with the use of a drinking water source by a municipal residential system or designated system.

**Downgradient:** A downward hydrologic slope that causes groundwater to move toward lower elevations.

**Ecological:** Relating to the totality or pattern relations between organisms and their environment.

**Ecosystem:** A natural community of plants and animals within a particular physical environment, which is linked by a flow of materials throughout the non-living (abiotic) as well as the living (biotic) section of the system.

**Empirical:** Information gained by means of observation, experience, or experiment.

**Enhancement:** To add to, or to make greater; for example, to add additional water to a wetland, in order to make greater its environmental functionality.

**Erosion:** The wearing away of the land by the action of water, wind, or glacial ice.

***Escherichia coli (E. coli)* and *Campylobacter*:** A type of coliform bacteria found in human and animal feces. Their presence in surface and groundwater indicates fecal contamination. Some types of *E. coli* can cause serious illness for humans.

**Event:** Occurrence of an incident (isolated or frequent) with the potential to promote the introduction of a threat into the environment. An event can be intentional, as in the case of licensed discharge or accidental, as in the case of a spill.

**Existing Drinking Water Source:** The aquifer or surface water body from which municipal residential systems or other designated systems currently obtain their drinking water. This includes the aquifer or surface water body from which back-up wells or intakes for municipal residential systems or other designated systems obtain their drinking water when their current source is unavailable, or an emergency occurs.

**Exposure:** The extent to which a contaminant or pathogen reaches a water resource. Exposure, like a drinking water threat, can be quantified based on the intensity, frequency, duration, and scale. The degree of exposure will differ from that of a drinking water threat dependent on the nature of the pathway or barrier between the source (threat) and the target (receptor) and is largely dependent on the vulnerability of the resource.

**Extirpated:** A species that still exists somewhere in the world but is no longer found in the study area.

**Fen:** Nutrient-rich, peat-forming wetland that receives water from surface water or groundwater flow. They are usually less acidic than bogs.

**Flood Pulse:** The peak flow during a flooding event.

**Floodplain:** The flat, low-lying area along a stream channel that is subjected to recurrent flooding. It is formed when the stream overflows its channel during times of high flow. When the water recedes, alluvial deposits generally are deposited along the plain bordering the stream.

**Flow Regime:** The pattern of how water levels change in a stream.

**Flow Stability:** Determined by measuring the ratio of surface discharge to groundwater discharge on an annual basis.

**Fluvial:** Process associated with rivers and the deposits and landforms they create.

**Forest Cover:** The percentage of the watershed that is forested.

**Forest Interior:** The portion of a woodlot which remains when a 100-metre buffer is removed from the perimeter of the forest (e.g., 100 metres in from the outside edge).

**Function:** An ecological role for human benefit.

**Future Municipal Water Supply Areas:** An area corresponding to a wellhead protection area or a surface water intake protection zone, or an aquifer or groundwater area identified for future municipal water supply infrastructure (either a well or a surface water intake pipe).

**Geology:** The science of the composition, structure, and history of the Earth. It thus includes the study of the material of which the Earth is made, the forces which act upon these materials and the resulting structures.

**Geomorphology:** The scientific study of the origin of land, including riverine and ocean features on the Earth's surface.

**Glaciation:** The covering of an area or the action on that area, by an ice sheet or by glaciers.

**Granular:** Having a texture composed of small particles.

**Great Lakes:** The five interconnected freshwater lakes located along the border of Canada and the United States: Lake Ontario, Lake Superior, Lake Huron, Lake Erie, and Lake Michigan.

**Great Lakes Connecting Channels:** The rivers that connect the Great Lakes (e.g., St. Clair River, St. Lawrence River).

**Groundwater:** Subsurface water that occurs beneath the water table in soils and geological formations that are fully saturated.

**Groundwater Discharge:** An area in which there are upward components of hydraulic head in the aquifer. Groundwater is flowing toward the surface in a discharge area and may escape as a spring, seep, or baseflow; or by evaporation and transpiration.

**Groundwater Recharge Area:** The area where an aquifer is replenished from (a) natural processes, such as the infiltration of rainfall and snowmelt and the seepage of surface water from lakes, streams, and wetlands, (b) from human interventions, such as the use of storm water management systems, and (c) whose recharge rate exceeds a specified threshold.



**Groundwater Table:** The surface in an unconfined aquifer or confining bed at which the pore water pressure is atmospheric. It can be measured by installing shallow wells extending a few metres into the zone of saturation and then measuring the water level in those wells.

**Groundwater Under the Direct Influence (GUDI):** Raw groundwater supply obtained from a water well and where there is an interaction between the surface water and groundwater supply that may impact the water quality at the well.

**Habitat:** The environment of an organism; the place where it is usually found.

**Hazard:** A contaminant and/or pathogen threat.

**Hazard Rating:** The numeric value which represents the relative potential for a contaminant of concern to impact drinking water sources at concentrations significant enough to cause human illness.

**Headwaters:** Area of a watershed where a major river system originates.

**High Water Mark:** 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. Under the director's technical rules, this term is consistent with the definition of 'ordinary high water mark' as defined by Fisheries and Ocean Canada as described in DFOs Fish Habitat Fact Sheet #T-6.

**Highly Vulnerable Aquifer (HVA):** An aquifer that can be easily changed or affected by contamination from both human activities and natural processes as a result of (a) its intrinsic susceptibility, as a function of the thickness and permeability of overlaying layers, or (b) by preferential pathways to the aquifer.

**Hydraulic Gradient:** A measure of the change in groundwater head over a given distance. Maximum flow will normally be in the direction of the maximum fall in head per unit of vertical distance.

**Hydric Soil:** A soil that is saturated, flooded, or ponded long enough during the growing season to develop anaerobic conditions that favour the growth and regeneration of hydrophytic vegetation.

**Hydrogeology:** Hydrogeology is the study of the movement and interactions of groundwater in geological materials.

**Hydrologic Cycle:** The continuous movement of water on, above, and below the surface of the earth.

**Hydrologic Function:** The functions of the hydrological cycle that include the occurrence, circulation, distribution, and chemical and physical properties of water on the surface of the land, in the soil and underlying rocks, and in the atmosphere, and water's interaction with the environment including its relation to living things.

**Hydrology:** The study of the Earth's water, particularly of water on and under the ground before it reaches the ocean or before it evaporates into the air.

**Hydro-period:** The seasonal pattern of the water level of a wetland that is a hydrologic signature of each wetland type. It defines the rise and fall of a wetland surface and subsurface water.

**Imminent Threat to Health:** A contaminant of concern that can affect human health in a short period of time.

**Index of Biotic Integrity (IBI):** Indicator of overall stream health.

**Infiltration:** The downward entry of water through the soil surface into the soil.

**Inland Rivers:** A creek, stream, brook, and any similar watercourse inland from the Great Lakes that is not a connecting channel between two Great Lakes

**Intermittent Stream:** A watercourse that does not flow permanently year-round.

**Intrinsic Vulnerability:** The potential for the movement of a contaminant(s) through the subsurface based on the properties of natural geological materials.

**Impact:** Often considered the consequence or effect, the impact should be measurable and based on an agreed set of indicators. In the case of drinking water source protection, the parameters may be an acceptable list of standards which identify maximum raw water levels of contaminants and pathogens of concern. In the case of water quantity, the levels may relate to a minimum annual flow, piezometric head or lake level.

**Knowledge Gaps:** Lack of referenced materials or expertise to assess certain characteristics of the specific watershed that can be adequately described without tabular or spatial data.

**Landform:** Defines the physical shape of the landscape and the materials based on how the geologic material was deposited by glaciers.

**Land Use:** The management and modification of the natural environment for associated activities, substances and events related to the particular land use designation.

**Local Discharge:** Discharge to a watercourse that originates nearby. The water moves through the upper layers of the groundwater system.

**Low flow:** The flows that exist in a stream channel in dry conditions.

**Marsh:** Wetlands frequently or continually inundated with water, characterized by emergent soft-stemmed vegetation adapted to saturated soil conditions (e.g., cattails).

**Meltwater Channel:** The path of drainage and leftover sedimentary deposits usually from the ice margin of an alpine or continental glacier.

**Model:** An assembly of concepts in the form of mathematical equations or statistical terms that portrays the behaviour of an object, process, or natural phenomenon.

**Model Calibration:** The process for generating information over the life cycle of the project that helps to determine whether a model and its analytical results are of a quality sufficient to serve as the basis of a decision.

**Model Evaluation:** A comparison of model results with numerical data independently derived from experiments or observations of the environment.

**Model Validation:** A test of a model with known input and output information that is used to adjust or estimate factors for which data are not available.

**Model Verification:** The examination (normally performed by the model developers) of the numerical technique in the computer code to ascertain that it truly represents the conceptual model and that there are no inherent numerical problems with obtaining a solution.

**Monitoring:** Periodic evaluation of a site to determine success in achieving goals.

**Moraine:** Marginal glacial deposits (lateral, medial, terminal, ground) of unsorted and stratified material.

**Municipal Residential System:** All municipal drinking-water systems that serve or are planned to serve a major residential development (i.e., six or more private residencies).

**Natural Heritage:** The legacy of natural objects and attributes encompassing the countryside and natural environment, including plants and animals.

**Naturally Occurring Processes:** Processes that occur in nature and that are not the result of human activity. For example, erosion along a stream that provides a source of drinking water or the leaching of naturally occurring metals found in bedrock into groundwater.

**Non-Aqueous Phase Liquid (NAPL):** An organic liquid that is insoluble in water (hydrophobic), such as oil, gasoline, and other petroleum products.

**Nonconsumptive Water Use:** Water use that does not diminish the source or impair future water use.

**Non-Point Source:** A source of pollutants from a wide geographic area, such as manure runoff, stream bank erosion, and storm water runoff, which threatens the quality of surface and groundwater sources of drinking water.

**Nutrient:** Something that nourishes and promotes growth. It is possible to have too many nutrients in an ecosystem, which can result in an unhealthy imbalance or overgrowth of certain species.

**Ontario Drinking Water Standards (ODWS):** Water quality standards through which the Provincial Government of Ontario regulates drinking water quality. Standards contain maximum allowable concentrations (MAC) for major inorganic and organic parameters in water.

**Organic Matter:** Of, relating to, or derived from living organisms.

**Overburden:** Unconsolidated geologic material above the bedrock.

**Parcel Level:** A parcel is a conveyable property, in accordance with the provisions of the Land Titles Act. The parcel is the smallest geographic scale at which risk assessment and risk management are conducted.

**Pathogen:** A disease-causing organism.

**Percolation:** The downward movement of water in the ground through porous soil and cracked or loosely packed rock.

**Permeability:** The ability of a material to transmit a fluid, a measure of how quickly fluid will flow through the rock or sediment.

**Phosphorus:** A non-toxic pollutant that is an essential nutrient. In excessive amounts it leads to eutrophication of a water system. Phosphorus accumulates along the entire length of a river from a variety of point and non-point sources.

**Physiography:** The study or description of landforms.

**Planned Drinking Water Source:** The drinking water source (i.e., aquifer or surface water body) from which planned municipal residential systems or other planned designated systems are projected to obtain their drinking water from in the future and for which specific wellhead protection areas and surface water intake protection zones have been identified.

**Point Source:** A source of pollutants from a municipal treatment plant or an industrial facility, often by way of a pipe.

**Precipitation:** The deposits of water in either liquid or solid form which reach the Earth from the atmosphere. It includes rain, sleet, snow, and hail.

**Preferential Pathways:** Any structure of land alteration or condition resulting from a naturally occurring process or human activity which would increase the probability of a contaminant reaching a drinking water source.

**Raw Water:** Water that is in a drinking-water system or in plumbing that has not been treated in accordance with, (a) the prescribed standards and requirements that apply to the system, or (b) such additional treatment requirements that are imposed by the license or approval for the system.

**Raw Water Supply:** Water outside a drinking-water system that is a source of water for the system.

**Recharge Area:** An area where water enters a saturated zone at the water table surface.

**Regional Discharge:** Water that has traveled deep beneath the ground through the saturated zone and resurfaces at the water table.

**Regulated Areas:** Those areas for which conservation authorities delineate and restrict land uses by making regulations under subsection 28(1) of the *Conservation Authority Act*. This subsection applies to watercourses, streams, lakes, valleys, flood plains, and wetlands in Ontario. Provincially approved standards and methodologies for delineating Regulated Areas are outlined in draft guidance documents prepared by Conservation Ontario in cooperation with the Ontario Ministry of the Natural Resources (MNR).

**Reserve Amounts:** Minimum flows in streams that are required for the maintenance of the ecology of the ecosystem.

**Return Period:** The frequency in which a flow event in a stream is likely to repeat itself.

**Receptor:** The exposed target in danger of incurring a potential impact. An example would be any aquifer or surface water body used for drinking water consumption.

**Response Factor:** Typical factors affecting the response include dilution, rate of discharge, absorption, and degradation of the contaminant or pathogen in question. Because of the nature of the water resource, certain contaminants and pathogens may not have an impact (see definition), great enough to warrant concern or responsive action. The level of impact may not effectively degrade the water resource and therefore would not require a mitigative action.

**Riparian Areas:** Vegetated areas close to or within a water body that directly or indirectly contribute to fish habitat by providing a variety of functions such as shade, cover, and food production areas.

**Risk:** The likelihood of a drinking water threat (a) rendering an existing or planned drinking water source impaired, unusable, or unsustainable, or (b) compromising the effectiveness of a drinking water treatment process, resulting in the potential for adverse human health effects.

**Riverine:** Relating to or resembling a river.

**Runoff:** Water that moves over land rather than being absorbed into the ground. Runoff is greatest after heavy rains or snowmelts, and can pick up and transport contaminants from landfills, farms, sewers, industry, and other sources.

**Saturated Soil:** Soil that is full of moisture.

**Sediment:** Material deposited by water, wind, or glaciers.

**Sedimentary Bedrock:** Rock formed of mechanical, chemical, or organic sediment such as rock formed from sediment transported from elsewhere, by chemical precipitation from solution or from inorganic remains of living organisms.

**Semi-Quantitative:** Describes an approach or methodology that uses measurable or ranked data, derived from both quantitative and qualitative assessments, to produce numerical values to articulate results.

**Sensitivity Analysis:** Sensitivity analysis evaluates the effect of changes in input values or assumptions on a model's results.

**Severity:** The degree to which an impact is measured compared to an idealized value of some indicator of concern. In the case of water quality, the severity may relate to degree of measurable exceedance of some contaminant or pathogen. In the case of water quantity, deviation from some measurable indicator (e.g., minimum annual flow, piezometric head or lake level) must also be established.

**Significant Hydrologic Features:** (a) A permanent or intermittent stream, (b) wetlands, (c) kettle lakes and their surface catchment areas, (d) seepage areas and springs, and (e) aquifers and recharge areas that have been identified as significant by the Ministry of Natural Resources, using evaluation procedures established by that Ministry, as amended from time to time.

**Sinkhole:** Any depression in the surface of the ground, with or without collapse of the surrounding soil or rock, which provides a means through which surface water can enter the ground and therefore come in contact with groundwater. Sinkholes often allow this contact to occur quite rapidly and do little to filter any contaminants the surface water may contain.

**Site-level:** The most refined scale at which technical assessment of hydrological and hydrogeological conditions can be conducted. These assessments may contribute to water budgets, vulnerability assessments, and issues evaluation.

**Slope:** Ground that forms a natural or artificial incline.

**Source Protection (Drinking Water Source Protection):** Protecting surface water sources such as lakes, rivers and streams, and groundwater sources from contamination or overuse, particularly through the planning process under the *Clean Water Act, 2006*. It is the first step in the multi-barrier approach to protecting drinking water.

**Source Protection Planning:** The creation of local, watershed-based plans for the protection of the quality and quantity of drinking water sources, now and in the future.

**Spillway:** The valley that results when glacial meltwater cuts into the landscape. Spillways are often composed of sand and gravel.

**Stratigraphy:** Geology that deals with the origin, composition, distribution, and succession of layers of the Earth.

**Stream:** A body of running water flowing on the surface of the Earth.

**Subwatershed:** An area that is drained by an individual tributary into the main watercourse of a watershed.

**Surface Water:** Water occurring in lakes, rivers, and streams that may be used as a source of drinking water. As water moves in a cycle (hydrologic cycle), groundwater and

surface water interact; this may cause contaminants to move between groundwater and surface water systems.

**Surface to Aquifer Advection Time (SAAT):** The average time required by a water particle to travel from a point at the surface to the aquifer of concern. The SAAT is approximated by using the vertical component of the advective velocity integrated over the vertical distance and the average porosity.

**Surface to Well Advection Time (SWAT):** The average time required by a water particle to travel from a point at the ground surface to the well, including both vertical and horizontal movement.

**Surface Water Intake Protection Zone (IPZ):** The contiguous area of land and water immediately surrounding a surface water intake, which includes:

- 1) The distance from the intake,
- 2) The minimum travel time of the water associated with the intake of a municipal residential system or other designated system, based on the minimum response time for the water treatment plant operator to respond to adverse conditions or an emergency, and
- 3) The remaining watershed area upstream of the minimum travel time area (also referred to as the Total Water Contributing Area) is applicable to inland water courses and inland lakes only.

**Surficial Geology:** Deals with the study and description of the forms on the outer layer of the Earth.

**Swamp:** Any wetland dominated by woody plants such as trees and shrubs. This is generally considered as 25% or more cover of trees or tall shrubs. Standing to gently flowing waters occurs seasonally or persist for long periods on the surface. Many swamps are characteristically flooded in spring, with dry relict pools apparent later in the season.

**Targets:** In the context of technical guidance documents, these are detailed goals that are often expressed as numeric goals (e.g., to reduce contaminant X in this aquifer by 10 per cent by 2009).

**Terrestrial:** Living on or growing on land.

**Thermal Regime:** The characteristic behaviour and pattern of temperature.

**Till:** A term applied to a mixture of unstratified grain sizes ranging from clay to boulders deposited directly by glacial activity.

**Time of Travel (TOT):** An estimate of the time required for a particle of water to move in the saturated zone from a specific point in an aquifer into the well intake.

**Tolerance of a Water Supply System:** A measure of the ability to sustain required pumping levels even during exposure events.

**Topography:** A detailed description or representation of the features, both natural and artificial, or an area. Also, the physical and natural features of an area, and their structural relationships.

**Transport Pathway:** A man-made or natural feature on the landscape that may promote quicker travel of contaminants to the water bearing rock material, than would otherwise occur in the surrounding landscape. Where transport pathways occur the vulnerability score may be increased.

**Uncertainty Analysis:** Uncertainty analysis investigates the effects of lack of knowledge and other potential sources of error in the model.

**Uncertainty Score:** Uncertainty addresses known gaps in data/information about, or deficiencies in methods of assessment for, threats and/or vulnerability. It reflects the degree of confidence in the semi-quantitative data used to calculate risk.

**Unconfined Aquifer:** An aquifer whose upper boundary is the water table.

**Unsaturated Zone Advection Time (UZAT):** Estimated time for water to flow vertically from ground surface through to the water table.

**Valley:** A long, narrow depression on the Earth surface, usually with a fairly regular downward slope. A river or stream usually flows through it.

**Valuation of the Supply:** An evaluation of the importance of a particular municipal well or intake to the whole municipal drinking water supply. For example, where there are multiple supplies, value may be smaller, versus a single supply where value may be greater.

**Water Treatment Plant (WTP):** A facility that provides municipal drinking water.

**Waste Water Treatment Plant (WWTP):** A facility that treats sanitary sewage.

**Water Well Information System (WWIS):** A Government of Ontario database of water wells installed across Ontario.

**Water Balance:** Use of a water budget to mitigate changes to the hydrological cycle following urbanization, typically by increasing infiltration and evaporation and decreasing runoff.

**Water Budget:** The movement of water within the hydrologic cycle can be described through a water budget or water balance. It is a tool that when used properly allows the user to determine the source and quantity of water flowing through a system. From a groundwater perspective the key components of a water budget are: infiltration, contribution to baseflow, deeper groundwater flow outside the study area and groundwater taking.

**Water Control Structure:** An engineered structure designed to hold back water and mimic a natural water regime that promotes wetland restoration, without affecting adjacent agricultural practices.



**Watercourse:** An identifiable depression in the ground in which a flow of water regularly or continuously occurs (*Conservation Authorities Act*, Section 28(1), Regulations by the Minister of Natural Resources, May 2006).

**Water Cycle:** The continuous movement of water from the oceans to the atmosphere (by evaporation), from the atmosphere to the land by condensation and precipitation, and from the land back to the sea (via stream flow).

**Watershed:** A watershed is the area of land where all of the water that is under it or drains off of it goes into the same place. Its boundaries are defined by ridges of high land.

**Water Quality Indicator:** An entity that provides information on the condition and quality of water through its life cycle patterns. Water quality can also be determined through non-living sources, like chemical sampling.

**Water Table:** The surface below which the soil is saturated with water.

**Water Wells:** A hole in the Earth surface used to obtain water from an aquifer. For a bored well, an earth auger is used to bore a hole to carry earth to the surface. The casing is usually steel, concrete or plastic pipe. Modern dug wells are dug by power equipment and typically are lined with concrete tile. Dug and bored wells have a large diameter and expose a large area to the aquifer. These wells are able to obtain water from less-permeable materials such as very fine sand, silt, or clay. Drilled wells are constructed by either percussion or rotary-drilling machines. Drilled wells that penetrate unconsolidated material require installation of casing and a screen to prevent inflow of sediment and collapse. A flowing, or Artesian, well is completed in a confined aquifer that has a water level higher than the ground surface at the location of the well. This causes water to flow out of the well.

**Weathering:** The disintegration of the Earth crust by exposure to the atmosphere, most importantly, rain.

**Well Capture Zone:** The area in the aquifer that will contribute water to a well in a certain time period; often measured in days and years. Area at the ground surface is also included if the time period chosen is longer than the travel time for water in the aquifer and the groundwater recharge area is incorporated.

**Wellhead Protection Area (WHPA):** The surface and underground area surrounding a water well or well field that supplies a municipal residential system or other designated system through which contaminants are reasonably likely to move so as to eventually reach the water well or wells.

**Wetland:** Land that is seasonally or permanently covered by shallow water, as well as land where the water table is close to or at the surface. In either case, the presence of abundant water has caused the formation of hydric soils and has favoured the dominance of either hydrophytic plants or water tolerant plants. The four major types of wetlands are swamps, marshes, bogs, and fens.