

CHAPTER 8: CITY OF BARRIE

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8 CITY OF BARRIE

8.1 INTRODUCTION

This chapter contains information on two drinking water systems for the City of Barrie, in the South Georgian Bay-Lake Simcoe Source Protection Region. Various consultants have completed the work presented, all of which was reviewed by South Georgian Bay-Lake Simcoe Source Water Protection staff, City of Barrie staff, and members of the Source Protection Committee. In this chapter, each of the groundwater systems and the surface water system is discussed separately for easier readability.

Each municipal system section begins with an introduction of the characteristics of the drinking water system. This includes an overview of the location, number of people served, and source of the water supply. The sections following the system introductions are comprised of a Vulnerability Assessment and Issues and Threats evaluation of the system. The Vulnerability assessment includes the delineation of the Vulnerable Area(s) (Wellhead Protection Area or Intake Protection Zone), and the assignment of a Vulnerability Score for the delineated area. An Uncertainty Rating is also provided for the Vulnerable Area delineation and the Vulnerability Assessment as per Technical Rules 13-15 (Part I.4 – Uncertainty Analysis – Water Quality (MOE, 2008a)) to express the level of confidence in the results based on the information that was available for the study.

The Issues evaluation is intended to identify chemical parameters or pathogens in the raw drinking water that will limit the ability of the water to serve as a drinking water source either now or in the future. Any Issues identified for the systems will be listed in this section, along with a map illustrating the Issues Contributing Area if an Issue is known. The Threats evaluation identifies potential Significant Drinking Water Threats within the delineated Vulnerable Areas. This process includes creating lists for Drinking Water Threats for Activities and Conditions, generating maps showing areas that are or would be Significant, Moderate, or Low Drinking Water Threats, and a final enumeration of Significant Drinking Water Threats.

For more information, readers are encouraged to read Chapter 5: Methods Overview as well as, the responsible consultant reports and memos (found in Appendix MO and B) for a more in depth description of the methods used, as well as the Glossary for any unfamiliar terms.

8.2 DRINKING WATER SYSTEMS

The City of Barrie operates groundwater and surface water based supplies for the entire City. As shown in Table 8-1 and Figure 8-1, the groundwater and surface water supply are within the South Georgian Bay-Lake Simcoe (SGBLS) Source Protection Region (SPR). Table 8-1 also indicates the Source Protection Region and corresponding lead Source Protection Authority (SPA) for the municipal water supplies.

Table 8-1: Municipal Surface and Groundwater Supplies in the City of Barrie.

Local Municipality	Community Water Supply	Source Protection Region & Source Protection Authority (SPA)
City of Barrie	Barrie Well Supply	SGBLS SPR &
	Barrie Water Treatment Plant	Lakes Simcoe and Couchiching / Black River SPA

While still in the SGBLS Source Protection Region, four wells of the Barrie Well Supply are within the Nottawasaga watershed in addition to a number of Wellhead Protection Areas (WHPA) from other Barrie wells. Information on the system that is presented in this report will also be available in the Nottawasaga Valley Assessment Report (Chapter 9).

8.3 BARRIE WELL SUPPLY

The Barrie Well WHPA delineation, supply Vulnerability and Threats Assessment was completed by Golder Associates Limited (Golder, 2004, 2010f) under contract of the City of Barrie.

The City of Barrie is located on Kempenfelt Bay of Lake Simcoe. The City currently obtains potable water from groundwater and surface water sources and has a total of fourteen municipal wells that service approximately 78,500 residents. The Barrie Groundwater Supply operates under Permit To Take Water # 2353-7SLPRF, which expires June 17, 2019. The City's Water Treatment Plant (WTP) is a newly constructed intake in Kempenfelt Bay on the southwest side of Lake Simcoe that services approximately 61,500 residents. The treatment plant was brought online in the summer of 2011 and now serves the southern portion of the city; as a result demand on the city's groundwater wells has decreased.

The majority of the municipal wells are located within the central and lakeshore area of Barrie, and consists of Wells, 3A, 4, 5, 7, 11, 12, 14, 15, 17, 18 and 19. Three wells, Wells 9, 13 and 16, are located in the north part of the City. With the exceptions of Wells 9/13, 11/14, and 17/18 all wells are constructed at separate locations (Figure 8a-1). At the time this report has been published Well 19 has not yet been put online. It should be noted that an additional well (Well 10), previously located in the south part of the City was decommissioned in 2013. The City of Barrie has completed all of the necessary steps (as prescribed by Section 14 of Ontario Regulation 287/07) to ensure that the Clean Water Act no longer applies to this decommissioned well; as a result Well 10 has been removed from the Assessment Report.

The aquifers underlying the City of Barrie are part of a regionally extensive and complex aquifer system, within which four major sand and gravel aquifer units have been identified. Locally, these are referred to as the upper (Aquifer A1), intermediate (Aquifer A2) and lower (Aquifer A3 and A4) aquifers.

Aquifer A1 is largely unconfined under all of the central and most other parts of the City and is therefore susceptible to contamination from surface activities. The portions of the upper aquifer identified in the Oro-Medonte and upland areas immediately west of the City correspond to the regional Aquifer A1, which is mapped as ice contact stratified drift. In some places, this aquifer may be confined by the silt till materials also mapped in the uplands. This aquifer is described as coarse textured lacustrine deposits, which are part of a regionally extensive plain extending west to Angus.

Aquifer A2 is regionally extensive, but does pinch out in some areas, for example to the south in the Town of Innisfil, and to the northwest. It is thickest and most extensive towards the west and under the Oro Moraine. The aquifer is complex within the central core area of Barrie, where it consists of inter-layered sand and silt/clay materials. The aquifer is overlain by 5 to 20 or more metres of confining materials in most areas, reported to consist of clayey and silty sediments. The lower elevation of the aquifer in the vicinity of Kempenfelt Bay corresponds with the deeper channelized aquifer (see below) and suggests that it may represent infilled former river channels in this area.

The lower aquifers, A3 and A4, are extensive sand and gravel aquifers, which form the source of the majority of Barrie's groundwater supply, as well as that of the surrounding communities of Midhurst, Shanty Bay, and Stroud. These aquifers are in direct contact with one another under the central Barrie area, as well as further to the west. It is noted that Aquifer A2 is in contact with the lower aquifer in the vicinity of Well 6 (not presently part of the system). Additionally, based on the base elevation of the Kempenfelt Bay and the known elevation of the upper surface of Aquifer A3, it is interpreted that the aquifer is in contact with Kempenfelt Bay in areas to the east.

Wells 3A, 5, and 12 are all constructed in the deeper Aquifer A4. Wells 7, 9, 11, 13, 14, 15, 17, and 18 are located approximately in the centre of the combined A3/A4 aquifer, whereas the remaining wells (Wells 4, and 16) are located in the upper part of Aquifer 3.

8.3.1 Groundwater Vulnerability Assessment

The Wellhead Protection Area (WHPA) is the primary Vulnerable Area delineated to ensure the protection of the municipal water supply wells. The Groundwater Vulnerability has been assessed to provide an indication, within the WHPA, which current (or future) Threats at the surface present the greatest risk to contaminate the water supply. The Vulnerability Analysis considers the WHPA and the Groundwater Vulnerability, as well as the potential for the vulnerability to be increased by man-made (anthropogenic) structures, through Transport Pathways, by developing a "Vulnerability Score" within the WHPA. Conversion of Vulnerability categories (High, Medium, and Low) to Vulnerability Scores (10, 8, 6, 4, and 2) results in a new map for each WHPA that expresses the relative degree to which a Threat could affect the drinking water supply. A higher value Vulnerability Score will always be assigned to the immediate vicinity of the well and to any areas that are shown to be vulnerable.

The Groundwater Vulnerability for the City of Barrie water supply has been delineated following the process recommended in the Technical Rules. The areas that contribute groundwater to the wells were delineated as WHPAs. The Groundwater Vulnerability Assessment was carried out as follows:

- Confirm the WHPA for delineation for Well 19 and evaluation of the WHPA delineation for all of the Barrie wells based on the inclusion of Well 19;
- Assess Groundwater Vulnerability (AVI Method);
- Assign Vulnerability Score prior to modifiers (Transport Pathways);
- Consider modifications to Vulnerability Score based on Transport Pathways;
- Assign the final Vulnerability Score; and,
- Determine the level of uncertainty in the Vulnerability Assessment.

Detailed methods describing the Vulnerability Analysis completed by Golder (2010f) are provided in Appendix B. Note that the methods used to assign vulnerability scores in the Golder report differ slightly than those within this Assessment Report. The Golder report

includes a modification to vulnerability based on water quality. While Directors approval to use this alternate approach was requested under Technical Rule 15.1, approval was only given to increase vulnerability from low to medium, and not to increase vulnerability to high. As permission to only partially increase the vulnerability score was approved, it was recommended not to increase vulnerability due to water quality. An explanation from MOE detailing the reason why the alternate method could not be used is provided in Appendix B.

8.3.1.1 Wellhead Protection Area (WHPA) Delineation

The South Simcoe Groundwater Study (SSGS) included the delineation of the WHPAs for all of the municipal wells in the City of Barrie. A three-dimensional (FEFLOW) groundwater flow model was constructed to enhance the knowledge of the regional groundwater system and to delineate the capture zones for the Barrie wells. A detailed description of the groundwater flow modeling undertaken for these wells can be found in the SSGS report (Golder, 2004).

Two additional wells, Well 18 and 19, were developed by the City of Barrie subsequent to the issuance of the SSGS report. The WHPA for Well 18 was delineated as part of an earlier system permit application (Golder, 2008). The most recent update to the FEFLOW model included the addition of municipal Well 19 (Golder, 2008). As part of the 2008 work, time-of-travel capture zones were delineated for Well 19; however, the remaining Barrie municipal well capture zones were not revisited. Therefore the WHPAs previously delineated for the other City of Barrie wells have been re-assessed (See Golder 2010f).

The WHPAs for the City of Barrie wells are complex and cover much of the city core seamlessly. There are a number of instances where similar time-of-travel zones from different wells border one another, while in other instances different time-of travel zones are side by side. These model output WHPAs (WHPA B and C) have been modified to produce final WHPAs which represent combined capture areas as shown on Figure 8a-1.

The WHPAs in the core area of the City have been combined into two main areas: the Lakeshore Wells (Wells 11, 12, 14, and 15) and wells west of the Lakeshore Wells (Wells 3A, 4, 5, 7, 17, 18, and 19). The combined WHPAs, in place of the individual core area WHPAs, have been implemented based on the rationale found in the Golder (2010f) report.

8.3.1.2 Groundwater Vulnerability

The Groundwater Vulnerability within the WHPAs of the fourteen municipal wells in Barrie is shown in Figure 8a-2.

The regional scale intrinsic susceptibility index (ISI) Vulnerability was completed for the City of Barrie in the SSGS. As the municipal aquifers in the City of Barrie are located

below the first aquifer defined in this method, the resulting ISI Vulnerability does not accurately reflect the Vulnerability of the municipal supply aquifer, which in most cases is overlain by low permeability materials.

To account for the added protection that the confining units may provide and the fact that the Vulnerability of the aquifer was lower than calculated, the Vulnerability was calculated to the municipal aquifer for each well. The Vulnerability of the municipal aquifers was calculated using the Aquifer Vulnerability Index (AVI) method rather than the ISI approach. As many of the wells in the area do not reach the depth of the municipal aquifer, it was not possible to use the geologic logs of the individual well records to calculate the Vulnerability. Therefore the layers from the calibrated numerical model developed as part of the SSGS were utilized to calculate the Vulnerability to the municipal aquifer.

The Groundwater Vulnerability has been determined from an analysis of AVI approaches as documented in Golder, 2010f. Due to the depth of the municipal aquifer and presence of confining units, all of the City of Barrie WHPAs are calculated to have a Low Intrinsic Vulnerability.

8.3.1.3 Transport Pathway Increase

The Technical Rules allow for increasing the aquifer vulnerability based on Transport Pathways that are anthropogenic in origin (i.e. man-made structures). The presence of the Transport Pathways should be accounted for in the Vulnerability assessment and include:

- Private water wells, unused water wells and abandoned water wells;
- Construction of underground services;
- Subsurface excavations; and,
- Pits and quarries.

There were no adjustments made to the Vulnerability Scoring for the Barrie systems, with the exception of private wells.

Constructed Transport Pathways to an aquifer, for example water wells, can have a locally significant impact on the Vulnerability of an aquifer. To assess this impact, a transport pathway private well inventory was undertaken for Barrie within the area of the WHPAs in 2007. Details on the methodology can be found within the report Golder (2008). The inventories were aimed at identifying and locating wells within the WHPAs and included a categorization of those wells which pose the highest risk to the aquifer. The wells were classified based on: (1) the physical condition of the well (i.e., Class A, B, or C), based on height of the casing above grade and likely condition of the well cap; and (2) increasing risk (Category 1, 2, and 3) based on the aquifer they were completed in. Wells with a risk rating of 3C were included as transport pathways as they are considered to have the highest risk as this comprises the wells completed to the municipal aquifer which have below standard well casing height. The high risk rating

does not imply that these wells necessarily represent a Transport Pathway that is or could cause impact to the municipal aquifer. It implies that, based on the physical condition and depth of the well, there is an increased risk associated with these locations. These are the only wells (3C) that have been used to modify the Vulnerability Scoring, based on the rationale provided in Golder, 2010f.

8.3.1.4 WHPA-E

None of the wells in this study have been identified as GUDI (Groundwater Under the Influence), therefore delineation of a WHPA-E was not required. Since a WHPA-E was not required for any of the wells, the delineation of a WHPA-F was also not required.

8.3.1.5 Vulnerability Score

The WHPA zones for the Barrie Water Supply, (Figure 8a-1), the Groundwater Vulnerability, (Figure 8a-2), and increases due to Transport Pathways were used to assign a Vulnerability Score using the matrix from Table 5.3 (Chapter 5: Methods Overview, Section 5.2.4). Figure 8a-3 illustrates the Vulnerability Scores for the Barrie Water Supply. Figure 8a-3 will be used to assess Drinking Water Threats in Section 8.3.3.

8.3.1.6 Uncertainty Rating

The Technical Rules require that an Uncertainty Rating, characterized as High or Low, be assigned for completed Vulnerability and WHPA assessments. Uncertainty assessment for WHPA delineation was undertaken by both Golder 2010f and independent peer review. In situations where different uncertainty estimates are provided (i.e. Low and High), the most conservative (High uncertainty) has been applied. Uncertainty of the Vulnerability Assessment was only undertaken by Golder 2010f.

The independent peer review of WHPA delineation was undertaken by Dillon Consulting using a standard scoring matrix (Table 1, Appendix MO). The Uncertainty Rating assigned for the Barrie WHPAs is High. The full results of the WHPA delineation Peer Review process for Barrie is available in Appendix B and discussed in Chapter 5 (Methods Overview). Based on the rationale provided for the Vulnerability Assessment (see below), Golder 2010f, characterized uncertainty of the WHPA delineation as Low. As this differs from that provided by the peer review, the most conservative, 'High' Uncertainty ranking will currently apply.

The uncertainty associated with the Vulnerability Assessment was evaluated using a qualitative process outlined in Golder, 2010f. The Uncertainty Assessment methodology considers the type, quantity and quality of available data, the methods used to determine the Vulnerability Assessment components, and the nature of the groundwater flow system.

Considering all of the available data, the Uncertainty of the Vulnerability for the Barrie Water Supply is considered Low close to the municipal wells and increases at the outer reaches of the 25 year capture area. Overall the Vulnerability Uncertainty is characterized as Low.

8.3.2 Drinking Water Issues

The intent of the Issues Evaluation is to identify parameters (e.g. chemicals or pathogens) in the raw drinking water that will limit the ability of the water to serve as a drinking water source either now or in the future. To be considered a Drinking Water Issue, a parameter needs to be at a concentration that may result in the deterioration of the quality of the water for use as a source of drinking water or if there is a trend of increasing concentrations of the parameter and a continuation of that trend that would result in the deterioration of the quality of the water as a source of drinking water (Technical Rule 114.(1)(a-b)). However, a parameter may not be considered an Issue in cases where it is naturally occurring or effective treatment is in place.

The City of Barrie Drinking Water Issues Evaluation was based on previously completed groundwater studies (Golder, 2004), annual drinking water quality reports, water quality digital data provided by the City, as well as input from municipal authorities to confirm the Issues list.

Water quality data from municipal supply wells and sentinel wells for the municipal supply wells was assessed to identify parameters (including pathogens) for which there were indications of elevated concentrations. These parameters were further reviewed to determine if: (i) current or projected concentrations exceed the ODWQS, (ii) if the parameter was considered to be anthropogenic or natural in origin, and (iii) if the parameter should be made a Drinking Water Issue. The projected concentrations were based on linear regression analysis for the available dataset. Where projected trends at 50 years indicated concentrations which were close to but not exceeding the ODWQS, the most recent data was evaluated to determine if there was indication of an increase in the trend or stabilization in the concentrations. If recent data indicated concentrations above the projected trend line, the parameter was included as a Drinking Water Issue.

Based on the review of the data, Drinking Water Issues were identified for the City of Barrie.

Well 3A – Chloride

Well 3A has been identified to have a Drinking Water Issue due to an increasing trend of chloride concentrations. The most recent reported concentration of chloride from this well was 73 mg/L. The projected 50 year concentration trend indicates that chloride at Well 3A (245 mg/L) would approach the ODWQS limit. However, recent data suggests a possible steepening in the chloride trend and therefore it has been included as a Drinking Water Issue. Chloride is listed in the ODWQS as an aesthetic objective, however, its origins are considered to be anthropogenic in this area. The chloride Issue

for Well 3A likely results from non-point source inputs such as road salt. As delineation of an ICA is difficult it is considered that the entire WHPA should be part of the ICA (Figure 8a-4).

Well 11, 12 and 14 – Chloride and Sodium

Wells 11, 12 and 14 have been identified to have a Drinking Water Issue due to elevated chloride concentrations. Recent reported chloride concentrations are 110 mg/L at Well 11, 85 mg/L at Well 14, and 197 mg/L at Well 12. The trend in chloride concentrations at these wells indicates that chloride concentrations would approach or exceed the ODWQS limit of 250 mg/L within a 50 year period. Recent data at Well 14 suggest a possible stabilizing trend; however, chloride is still considered a Drinking Water Issue considering its shared capture with and proximity to Well 11.

In addition to chloride, Well 11 and Well 12 also exhibit increasing concentration trends of sodium, which are projected to exceed the ODWQS limit of 200 mg/L in 50 years. As with chloride, sodium is an aesthetic objective within the ODWQS, but the increasing concentrations are considered to be associated with anthropogenic impacts. It is noted that the concentrations of chloride and sodium exhibit a scattered pattern at Well 12, which may result in varying interpretation of trends, however, an overall upward trend is observed at this well. Chloride and sodium are considered to result from non-point source inputs, and therefore the entire WHPAs for these wells are considered part of the ICA. Given the proposed combined capture zones for the Lakeshore wells, the combined Well 11, 12, 14, and 15 WHPA would be delineated as the ICA (Figure 8a-4).

Within the Issue Contributing Area, the Technical Rules requires that all Threats related to a particular issue are modified to be a Significant Drinking Water Threat, regardless of the Vulnerability. Therefore if a property is located with the Issue Contributing Area and has been identified as having a prescribed Threat related to Chloride or Sodium (according to the MOE Tables) then the property is flagged as a Significant Drinking Water Threat. The following lists the Threats related to chloride and sodium as defined by the MOE database of Threats and associated chemical parameters.

- Application of Road Salt;
- Handling and Storage of Road Salt;
- Storage of Snow;
- Sewage System or Sewage Works – Discharge of Untreated Stormwater From Stormwater Retention Pond;
- Sewage System or Sewage Works – Industrial Effluent Discharges;
- Sewage System or Sewage Works – Septic Systems; and,
- Sewage System or Sewage Works – Septic System Holding Tank.

The results of the Drinking Water Issues related threats are provided in Section 8.3.3.5. As discussed in Section 8.3.3.5, the Threats related to septic systems and application of

road salt have been assigned as one threat for each threat type within each Issue Contributing Area (one for the combined Lakeshore wells WHPA and the other for the combined WHPA of wells upgradient of this) instead of assigning individual threats at each parcel where a septic system or application of road salt was identified.

Lakeshore Wells VOC Detections

Low concentrations of volatile organic compounds (VOC) have been detected on more than one occasion at Wells 11, 12, 14, and 15, located in the Lakeshore area. The presence and trends of the VOC at these wells were reviewed to determine if a Drinking Water Issue designation is warranted. Based on the evaluation of the existing data it was determined that there was insufficient evidence to support the inclusion of the VOCs as a Drinking Water Issue. This evaluation is based upon the approach noted above, as follows:

- Whereas the municipal production wells have exhibited detectable concentrations of VOC including perchloroethylene (PCE), trichloroethylene (TCE) and cis-1,2-dichloroethylene (DCE), the reported concentrations are consistently below the maximum allowable concentrations outlined in the ODWQS;
- In the case of Wells 12 and 15, the reported concentrations are only detected sporadically and are near the laboratory reporting limit;
- Current data indicate that the overall trend of the concentrations of these compounds is stable at the current pumping rates and therefore trending does not indicate exceedance of the ODWQS in 50 years. It is noted that the relationship between the observed concentrations and pumping rate requires further investigation. Should further evaluation provide additional information to support identification of VOC as a Drinking Water Issue, this should be included in future updates to the Assessment Report;
- There have been no reported concentrations which have exceeded the ODWS in any monitoring wells completed within the municipal aquifer (A3/A4); and,
- The presence of VOC is assessed within the Water Operations Branch Operational Plan.

Barrie established a monitoring program in 2003 that includes regular sampling from a series of production wells and sentinel monitoring wells. The monitoring program is managed by the Environmental Operations Branch. VOC analysis, which includes TCE, is carried out monthly at the production wells and annually at the monitoring wells with the exception of some select monitoring well locations which are sampled quarterly or on a semi-annual basis.

When a Drinking Water Issue is identified, the Technical Rules require the following to be prepared:

- A List of prescribed drinking water threats activities that may lead to the Issue is to be prepared (See section 8.3.3.1). No additional local circumstances were identified by the SPC that may be lead to the Drinking Water Issue.
- Conditions that may contribute to the Issue were investigated. No conditions related to sodium of chloride were identified (Section 8.3.3.2).
- A list of the threat activities, land uses and circumstances that could contribute to the Drinking Water Issue has been prepared and a Map has been prepared to illustrate the Issues Contributing Area where these activities are or would a Significant, drinking water threat (Section 8.3.3.4).
- All current activities, land uses and circumstances that could contribute to the Drinking Water Issue within the Issues Contributing Area have been identified and included in the table of enumerated significant threats (Section 8.3.3.5.2)

8.3.3 Drinking Water Threats Evaluation

An assessment of Drinking Water Threats for the Barrie Water Supply was completed in accordance with the detailed methodology presented in Golder, 2010f (Appendix B). A Drinking Water Threat is defined as “an Activity or Condition that adversely affects, or has the potential to adversely affect, the quality and quantity of any water that is or may be used as a source of drinking water, and includes any activity or condition that is prescribed by the regulations as a drinking water threat.” An Activity is 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, whereas a Condition refers to the presence of a contaminant in the soil, sediment, or groundwater resulting from past activities. Therefore, it is not only presently existing Threats that must be regulated, but future ones as well.

The Drinking Water Threats Assessment for the Barrie Water Supply includes preparation of:

- A list of Drinking Water Threats for Activities,
- A list of Drinking Water Threats for Conditions,
- Maps showing areas that are or would be Significant, Moderate, or Low Drinking Water Threats for Activities,
- Maps showing areas that are or would be Significant, Moderate, or Low Drinking Water Threats for Conditions, and
- An enumeration of Drinking Water Threats.

8.3.3.1 List of Drinking Water Threats – Activities

The list of Prescribed Drinking Water Threats considered in the assessment for Barrie Drinking Water Supply is provided in Chapter 5, section 5.5.1.

The key data sources used to identify Threats on properties included:

- MOE Look Up Tables (LUT) Database (2009);
- Municipal Property Assessment Corporation (MPAC) (2007) assessment information;
- South Simcoe Groundwater Study (SSGS) Contaminant Source Inventories;
- Hazardous Waste Information Network (HWIN) (2009);
- MOE Records Database (2009);
- MOE Biosolids Database (2004- 2008);
- City of Barrie mapping and datasets including snow storage, storm water management ponds, and sewer exemption list (2009); and,
- Golder Field Windshield Surveys (2008/2009).

Section 8.3.3.5 describes how these datasets were used to identify and enumerate potential Significant Threat Activities for the Barrie drinking water system.

No additional local Drinking Water Threats were identified for consideration. No local circumstances for prescribed Threats were identified.

8.3.3.2 List of Drinking Water Threats – Conditions

The initial compilation of Conditions was based on the MOE Records Database and the MOE Brownfields Database (2009) and supplemented by information provided by the City. The MOE Records database (2009) included a compilation of files from the MOE District office for properties within approximately 500 m of a municipal well. The database included a number of records relating to Certificates of Approval, Records of Site Condition, miscellaneous reports, waste generator registration information, permits, applications, and correspondence. The files in this list of potential Conditions were reviewed in greater detail to determine if there was sufficient evidence to confirm a Condition based on the Technical Rules criteria. The scoring of Condition Threats implemented by Golder uses the precautionary approach of assuming a Hazard Score of 10 since the Condition review methodology did not include detailed evaluation of all potential evidence/documentation that the contamination has not and will not move off-site. This type of information is typically not readily available for contaminated sites. The Conditions assessment was supplemented with information provided by Barrie for properties known to meet the Conditions criteria.

Six Conditions were identified for the Barrie Well Supply, based on the criteria outlined in the Technical Rules.

The Conditions identified are not linked with the Drinking Water Issues (chloride and sodium) for the Barrie wells. The majority of the Conditions identified are on lands owned by the City of Barrie, as this information was most readily available for assessment of Conditions. The six Conditions are related to:

- TCE (2);
- Petrohydrocarbons (1);
- BTEX (benzene, toluene, ethylbenzene and xylenes) and PHCs (petroleum hydrocarbons) (2); and,
- Vinyl Chloride (1).

Of the six Conditions, all six are considered Significant Drinking Water Threats. Additional information is provided in Golder, 2010f (Appendix B).

8.3.3.3 Identifying Areas of Significant/Moderate/Low Threats – Activities

The areas where Activities are or would be Drinking Water Threats are illustrated on a series of maps based on the Vulnerability Scores and Vulnerable Area delineations. The maps include references to a series of tables prepared by MOE to correlate activities that are or would be Drinking Water Threats with the Vulnerability Scores. The tables can be found at: <http://www.ene.gov.on.ca/en/water/cleanwater/provincialTables.php>.

8.3.3.3.1 Pathogen Parameters

The Key Table on Figure 8a-5 can be used in conjunction with the Vulnerability Scores to identify the areas where Activities associated with pathogen Threats are or would be Significant, Moderate, or Low Drinking Water Threats for the City of Barrie Water Supply Areas within the WHPA-A and WHPA-B with a Vulnerability Score of less than six are not illustrated as they do not contain Circumstances (high enough Hazard Score) for an Activity Threat to be considered Significant, Moderate, or Low.

8.3.3.3.2 Chemical Parameters

The Key Table on Figure 8a-6 can be used in conjunction with the Vulnerability Scores to identify the areas where activities associated with chemical threats are or would be Significant, Moderate, or Low Drinking Water Threats for the City of Barrie Water Supply, Areas within the WHPA that have a Vulnerability Score of less than six are not illustrated as they do not contain Circumstances (high enough Hazard Score) for an Activity Threat to be considered Significant, Moderate, or Low. The Key Table on Figure 8a-6 illustrates where activities associated with chemical threats are or would be Low Drinking Water Threats for the City of Barrie Water Supply.

8.3.3.3.3 DNAPL Chemical Parameters

Figure 8a-7 illustrates the area of the 5-year time-of-travel zone (WHPA-C) where activities associated with DNAPL parameters are considered to be Significant Drinking Water Threats for the City of Barrie Water Supply. The Key Table on Figure 8a-7 can be

used to can be used to identify the circumstances in which these Activities would be Significant, or Moderate, or Low Drinking Water Threats.

8.3.3.3.4 Sodium and Chloride Drinking Water Issue

Sodium and Chloride were identified as a Drinking Water Issues. As per the Technical Rules, land use activities that can release parameters that are identified as a Drinking Water Issue within the identified Issues Contributing Area are to be considered as Significant Drinking Water Threats. Appendix B provides a list of the land uses that can potentially release Sodium and Chloride to the environment within the identified Issues Contributing Area (Figure 8a-4).

Figure 8a-4 illustrates the Issues Contributing Area where activities and circumstances listed in Appendix B are considered to be a Significant Drinking Water Threat for the Barrie Well Supply.

8.3.3.4 Identifying Areas of Significant/Moderate/Low Threats – Conditions

Further to Section 8.3.3.2, six Conditions were identified within the WHPA for the City of Barrie Water Supply (Golder, 2010f).

A Condition or potential Condition that has not been identified would potentially be a Significant, Moderate, or Low Threat to Drinking Water based on the combination of Hazard Rating and Vulnerability Rating as described in Section 5.5.5 (Chapter 5: Methods Overview) and Technical Memorandum A5 (Appendix MO). The Hazard Rating is dependent on whether there is evidence the Condition is causing off-site contamination, and whether the Condition is located on the same property as the supply well.

A Condition would be a threat to municipal drinking water in the following situations:

- **Significant:** where the Vulnerability Score is ≥ 8 and there is evidence that the Condition is causing off-site contamination, and/or that the Condition is located on the same property as the supply well.
- **Moderate:** (1) where the Vulnerability Score ≥ 6 and < 8 , and there is evidence that the Condition is causing off-site contamination, and/or that the Condition is located on the same property as the supply well; or (2) Where the Vulnerability Score is 10, and there is no evidence of off-site contamination.
- **Low:** Where the Vulnerability Score ≥ 8 and < 10 and there is no evidence of off-site contamination.

Figure 8a-3 illustrates the Vulnerability Score map for Barrie well supply that can be used to determine where a Condition is or would be a Significant, Moderate, or Low Threat to Drinking Water.

8.3.3.5 Enumerating Drinking Water Threats

8.3.3.5.1 Enumerating Significant Drinking Water Threats – Methods

Identification and enumeration of Significant Drinking Water Threats related to Issues and Conditions have been described in Section 8.3.2 and 8.3.3.2, respectively. This section describes the identification and enumeration of Significant Drinking Water Threat Activities. Identification of Activities requires determining where they are located in terms of vulnerable areas and their associated Risk Score based on the type of Activity. Detailed methodology can be found in Golder, 2010f. Additional refinement of the Significant Drinking Water Threats enumeration was completed using the methodology outlined in Chapter 5 (Section 5.5.6.4) of this Assessment Report.

A number of data sources were utilized as part of the Activity Threat Assessment. The data sources used to obtain Threat information for the GIS based algorithm developed for the project are described in Golder 2010f and summarized in Section 8.3.3.1. In most cases, the detailed information required to document the MOE Circumstances was not readily available. The approach was designed to represent typical Activities occurring at different property types. The approach is considered conservative and, in many cases, likely results in a higher Threat ranking than may otherwise actually be present in many cases. The assumed Circumstances and MOE Hazard Scores are described in Golder, 2010f, and were based on MPAC property codes (and MOE LUT Activities). It is noted that the assessment has not involved field verification or site visits to validate information.

The Threat ranking algorithm was designed to perform the Threat rankings in an automated manner for properties within the WHPAs. The Threat ranking algorithm process begins with a yes/no question for each Prescribed Threat (e.g., Application of Agricultural Source Material (ASM) to Land, Application of Road Salt) to assess if the Activity is occurring on the property. If the answer was no, then no Threat was identified, and the algorithm did not calculate a Risk Score for that Threat. If the answer was yes, the algorithm proceeded to the Hazard Score related to the assumed Circumstance using the MOE LUT database.

The input data lead the algorithm to relevant reference IDs in the MOE Drinking Water Threats Tables that reflect the Circumstances identified on the property. A lookup table is used to link the selected Circumstance to an MOE Hazard Score which, when multiplied by the Vulnerability Score, provides the resultant Risk Score for the Threat in question. When multiple chemical parameter Circumstances are present for a given Threat, Risk Scores are calculated for each parameter and the highest score is tabulated for the Threat. It is noted that the Vulnerability Score used to rank a property is based on the maximum Vulnerability Score intersected by the parcel for the WHPA being evaluated. Finally, if the calculated Risk Score for a Threat is greater than or equal to 80, the Threat is ranked as Significant.

Two unique 'polygon' Threats were assigned to each WHPA with a Vulnerability Score of 10 in accordance with the common methodology developed by SGBLS (SGBLS,

2010). For the Threat 'sewage system or sewage works – sanitary sewers and related pipes', one Threat was assigned to each WHPA to account for the potential Threat that could exist related to the sanitary network. One Threat was assigned to represent the entire network since detailed information regarding distribution and conveyance capacities was not readily available within some study areas. The second polygon Threat assigned was related to domestic fuel storage (i.e. Fuel Storage) which may be on a property as a primary source of heating fuel. One fuel storage Threat was assigned to each WHPA where there was a high probability that natural gas was not available in the area. Generally in urban areas, where natural gas availability was probable, the polygon Fuel Threat was not assigned as in the City of Barrie WHPAs.

Some Threats such as the Application of Agricultural Source Material to Land have Circumstances based on datasets that are on a scale larger than individual properties. These Circumstances included percent Managed Lands, Livestock Density, and Impervious Surfaces. Therefore, additional calculations were required to determine these Circumstances for each WHPA and IPZ. The percent Managed Lands and Livestock Density calculations were completed for this project using a methodology developed in consultation with the South Georgian Bay-Lake Simcoe Source Protection Region and was based on the MOE Technical Bulletin for Managed Land and Livestock Density Calculations (MOE, September 2009). The percent Managed Land and the Livestock Density of an area is used as an estimation to represent the quantity of nutrients present as a result of nutrient generation, storage and land application within a WHPA. Managed Lands, Livestock Density, and Impervious Surfaces are discussed in more detail below.

8.3.3.5.1.1 Managed Lands

Managed Land is land to which nutrients (Agriculture Source Material (ASM), commercial fertilizer, Non-Agricultural Source Material (NASM)) are applied. It includes crop land, fallow land, pasture land, golf courses, sports fields, and residential lawns. Managed Lands are broken into two subsets: agricultural managed lands and non-agricultural managed lands. Agricultural managed lands include areas of crop land, fallow, and pasture land that may receive nutrients. Non-agricultural managed lands include golf courses, sports fields, and residential lawns and other built up grassed areas that may receive nutrients (primarily commercial fertilizers).

Technical Rule 16(9) (August 2009) requires the Assessment Report to include maps showing the location of Managed Lands and the percentage of Managed Lands within a Vulnerable Area, including WHPA-A, -B, -C, -D, and -E. This mapping is not required where the Vulnerability Scores for the area are less than the Vulnerability Score necessary for the Activity to be considered a threat in the Table of Drinking Water Threats.

Managed Lands were identified and the Managed Lands proportions were determined for the Barrie WHPA as outlined in Golder, 2010f.

The results from this analysis were used in the enumeration of Significant Drinking Water Threats (Section 8.3.3.5). Figure 8a-8 illustrates the location and proportion of Managed Lands within the delineated WHPA zones for the Barrie Water Supply where Vulnerability Scores were 6 or greater for WHPA-A to WHPA-D. The Managed Land within the majority of Barrie is within the lowest threshold of 0 to 40%. Managed Lands within the WHPAs of Wells 16, and 9 and 13 are calculated to be within the moderate category of 40 to 80%. Within the Well 16 WHPA-A, greater than 80% managed land is calculated. This is due to WHPA-A encompassing the parcel of the neighboring golf course, thus increasing the managed land area. This is a function of the methodology of including the entire parcel area into the calculation rather than including only the area within the WHPA.

8.3.3.5.1.2 Livestock Density

Livestock Density is calculated to provide a measure of the potential for generating, storing, and land applying ASM as a source of nutrients within a defined area. The livestock density is expressed as Nutrient Units per Acre. It is determined by dividing the Nutrient Units generated in each area by the number of acres of agricultural managed land in the area where agricultural source material is applied.

Technical Rule 16(10) (August 2009) requires the Assessment Report to include maps showing the Livestock Density within WHPA-A, -B, -C, -D, and -E. This mapping is not required where the Vulnerability Scores for the area are less than the Vulnerability Score necessary for the Activity to be considered a Threat in the Table of Drinking Water Threats.

The Livestock Density was determined for the Barrie WHPA as outlined in Golder, 2010f. The results from this analysis were used in the enumeration of Significant Drinking Water Threats (Section 8.3.3.5). Figure 8a-9 illustrates the distribution of Livestock Density within the delineated WHPA zones for the Barrie Water Supply where Vulnerability Scores were greater than 6 for WHPA-A to WHPA-D. The Livestock Density figure reflects the distribution of Agricultural Managed Lands. As expected, the livestock density calculations result in <0.5 NU/acres within all of Barrie WHPAs where densities were calculated (i.e. greater than a Vulnerability of 6) with the exception of the Barrie 9/13 WHPA-B which has a livestock density of 0.5 to 1.0 NU/acre.

8.3.3.5.1.3 Impervious Surfaces

Technical Rule 16(11) (August 2009) requires the Assessment Report to include maps showing the percentage of surface area where road salt could be applied to Impervious Surfaces within WHPA-A, -B, -C, -D, and -E. This mapping is not required where the Vulnerability Scores for the area are less than the Vulnerability Score necessary for the Activity to be considered a Threat in the Table of Drinking Water Threats.

The proportion of Impervious Surfaces within the Barrie WHPA was determined in accordance with the methodology in Golder, 2010f. The results from this analysis were

used in the enumeration of Significant Drinking Water Threats (Section 8.3.3.5). Figure 8a-10 illustrates the distribution of Impervious Surfaces within the delineated WHPA zones for the Barrie Water Supply where Vulnerability Scores were greater than 6 for WHPA-A to WHPA-D. It is noted that an impervious area of 8 to 80% has been assigned within all lands contained within the City limits as the WHPAs generally cover an urban or urban/rural mix of land use types.

8.3.3.5.2 Enumerating Significant Drinking Water Threats – Results

A total of three hundred and twenty (320) activities that are considered to be Significant Drinking Water Threats were identified in association with 293 land parcels in the WHPAs for the City of Barrie groundwater supply. This represents approximately 1% of the parcels assessed within the Barrie WHPAs. The total number of Significant Threats is higher than the total number of parcels with Significant Threats, as there are parcels which have multiple Threats identified. Table 8-2, Table 8-3, and Table 8-4 document the enumeration of existing activities that are considered to be Significant Drinking Water Threats within the WHPAs for the Barrie groundwater supply. The total number of Condition Threats identified in the WHPAs is six of which six are ranked as Significant.

A total of eighty-seven (87) Significant Activity Threats related to Drinking Water Issues were identified in these WHPAs. There were no Conditions identified that are related to the identified Drinking Water Issues. Of the Threat activities related to the Drinking Water Issues, two (2) were related to application of road salt (one threat for each Issue Contributing Area), seventy-nine (79) to storm water ponds, two (2) to septic tanks (one threat for each Issue Contributing Area), one (1) to storage of snow, and three (3) to storage of road salt. The Threats related to septic systems and application of road salt are based on assigning one threat for each threat type within each of the Issue Contributing Areas (Figure 8a-4). There are potentially 536 septic system and 745 application of road salt threats identified which could be categorized as a Significant Threat. Individually, however, these sources are not expected to significantly contribute to the Drinking Water Issue. It was therefore determined that these threats should be identified as one combined threat for each Issue Contributing Area. The application of road salt threat within the Issue Contributing area represents road salt application on the transportation networks within the City as well as on individual parking lot parcels.

Table 8-2: Number of Significant Drinking Water Threats in the WHPA for City of Barrie wells 3A, 4, 5, 7, 11, 12, 14, 15, 17, 18, and 19.

Enumeration of Significant Threats (Wellhead Protection Areas)			
Threat		Significant Threat Counts	
		#	#
		threats	parcels
1	The establishment, operation or maintenance of a waste disposal site within the meaning of Part V or the Environmental Protection Act.	1	1
2	The establishment, operation or maintenance of a system that collects, stores, transmits, treats or disposes of sewage.	102	102
3	The application of agricultural source material to land.	0	0
4	The storage of agricultural source material.	0	0
5	The management of agricultural source material.	0	0
6	The application of non-agricultural source material to land.	0	0
7	The handling and storage of non-agricultural source material.	0	0
8	The application of commercial fertilizer to land.	0	0
9	The handling and storage of commercial fertilizer.	1	1
10	The application of pesticide to land.	1	1
11	The handling and storage of pesticide.	1	1
12	The application of road salt.	2	2
13	The handling and storage of road salt.	3	3
14	The storage of snow.	1	1
15	The handling and storage of fuel.	3	3
16	The handling and storage of a dense non-aqueous phase liquid.	162	162
17	The handling and storage of an organic solvent.	2	2
18	The management of runoff that contains chemicals used in the de-icing of aircraft.	0	0
21	The use of land as livestock grazing or pasturing land, an outdoor confinement area, or a farm-animal yard.	0	0
TOTAL NUMBER OF SIGNIFICANT THREATS:		279*	
TOTAL PARCELS WITH SIGNIFICANT THREATS:		254	
Note: The number of parcels identified will typically be fewer than the number of significant threats as multiple threats can be observed per parcel.			
*18 verified existing Threats and 261 potential Threats that require further verification			

Table 8-3: Number of Significant Drinking Water Threats in the WHPA for City of Barrie wells 9 and 13.

Enumeration of Significant Threats (Wellhead Protection Areas)			
Threat		Significant Threat Counts	
		#	#
		threats	parcels
1	The establishment, operation or maintenance of a waste disposal site within the meaning of Part V or the Environmental Protection Act.	0	0
2	The establishment, operation or maintenance of a system that collects, stores, transmits, treats or disposes of sewage.	1	1
3	The application of agricultural source material to land.	0	0
4	The storage of agricultural source material.	0	0
5	The management of agricultural source material.	0	0
6	The application of non-agricultural source material to land.	0	0
7	The handling and storage of non-agricultural source material.	0	0
8	The application of commercial fertilizer to land.	0	0
9	The handling and storage of commercial fertilizer.	0	0
10	The application of pesticide to land.	0	0
11	The handling and storage of pesticide.	0	0
12	The application of road salt.	0	0
13	The handling and storage of road salt.	0	0
14	The storage of snow.	0	0
15	The handling and storage of fuel.	1	1
16	The handling and storage of a dense non-aqueous phase liquid.	5	5
17	The handling and storage of an organic solvent.	0	0
18	The management of runoff that contains chemicals used in the de-icing of aircraft.	0	0
21	The use of land as livestock grazing or pasturing land, an outdoor confinement area, or a farm-animal yard.	0	0
TOTAL NUMBER OF SIGNIFICANT THREATS:		7*	
TOTAL PARCELS WITH SIGNIFICANT THREATS:		6	
Note: The number of parcels identified will typically be less than the number of significant threats as multiple threats can be observed per parcel.			
*2 verified existing Threats and 5 potential Threats that require further verification			

Table 8-4: Number of Significant Drinking Water Threats in the WHPA for City of Barrie well 16.

Enumeration of Significant Threats (Wellhead Protection Areas)			
Threat		Significant Threat Counts	
		#	#
		threats	parcels
1	The establishment, operation or maintenance of a waste disposal site within the meaning of Part V or the Environmental Protection Act.	0	0
2	The establishment, operation or maintenance of a system that collects, stores, transmits, treats or disposes of sewage.	1	1
3	The application of agricultural source material to land.	0	0
4	The storage of agricultural source material.	0	0
5	The management of agricultural source material.	0	0
6	The application of non-agricultural source material to land.	0	0
7	The handling and storage of non-agricultural source material.	0	0
8	The application of commercial fertilizer to land.	32	32
9	The handling and storage of commercial fertilizer.	0	0
10	The application of pesticide to land.	1	1
11	The handling and storage of pesticide.	0	0
12	The application of road salt.	0	0
13	The handling and storage of road salt.	0	0
14	The storage of snow.	0	0
15	The handling and storage of fuel.	0	0
16	The handling and storage of a dense non-aqueous phase liquid.	0	0
17	The handling and storage of an organic solvent.	0	0
18	The management of runoff that contains chemicals used in the de-icing of aircraft.	0	0
21	The use of land as livestock grazing or pasturing land, an outdoor confinement area, or a farm-animal yard.	0	0
TOTAL NUMBER OF SIGNIFICANT THREATS:		34*	
TOTAL PARCELS WITH SIGNIFICANT THREATS:		33	
Note: The number of parcels identified will typically be less than the number of significant threats as multiple threats can be observed per parcel.			
*2 verified existing Threats and 32 potential Threats that require further verification			

8.4 CITY OF BARRIE WATER TREATMENT PLANT

The City of Barrie Water Treatment Plant (WTP) is a newly constructed intake in Kempenfelt Bay on the southwest side of Lake Simcoe. Construction of the raw water intake was completed in 2007, while the treatment plant, pumping station, 20 ML reservoir, and administration building were completed in 2011. The treatment plant was brought online in August 2011 and is intended to supply the southern portion of the city as it grows. The Phase I design capacity is 60 ML/day, however the plant has the ability to treat as much as 240 ML/day and the capacity will be increased as the city requires more water.

The raw water intake is located approximately 10 km southwest of the mouth of Kempenfelt Bay. The intake is located approximately 400 m from the south shore, in approximately 27 m water depth (referenced to the last 100-year average lake level of 218.95 m). The 805 m intake pipe is made of high-density polyethylene (HDPE) pipe, has an outer diameter of 1606 mm and an intake structure located approximately 4.0 m above the lakebed at the end of the pipe. The City of Barrie WTP will treat Lake Simcoe water using membranes and a granular activated carbon system to treat the water before it is chlorinated.

Based on the interview questionnaire completed by the representative of the City of Barrie WTP on March 18, 2009, the WTP can be shut down within 30 minutes to two hours upon notification. It was estimated that the notification time (by MOE) in the event of a spill is in the order of hours.

IPZ delineation and Vulnerability presented in this section is based on Baird (2010b) while the Issues and Threats Assessment is based on Genivar (2010a) report.

8.4.1 Methods and Uncertainties

8.4.1.1 Surface Water Vulnerability

The following section describes the methods used to assess the Vulnerability of the City of Barrie Water Treatment Plant. Intake Protection Zones for the City of Barrie WTP were delineated by Baird and Associates (Baird, 2010b). The City of Barrie intake is classified as Type D surface water intake (Rule 55; MOE, 2008a). For Type D intakes, three zones are to be delineated: the IPZ-1 is based on a fixed radius around the intake; the IPZ-2 acts as a secondary protection zone around the IPZ-1; and the IPZ-3 is considered an additional protection zone. For the purposes of delineating the IPZ-3, the Lake Simcoe intakes are also identified as a special case (Rule 68) and those rules applicable to Type A and B intakes also apply in this regard.

8.4.1.2 Delineating IPZ-1 and IPZ-2

IPZ-1 was delineated according to the Technical Rules and as outlined in Chapter 5. The IPZ-1 was based on the 1km radius and the 120m setback from the shoreline and was prepared using GIS.

The IPZ-2 is defined based on the area that may contribute water to the intake where the time-of-travel to the intake is equal to or less than the time that is sufficient to allow the operator of the system to respond to an adverse condition in the quality of the surface water (Rule 65; MOE, 2008a). The two hour minimum response time was used for the Barrie WTP based on the interview questionnaire completed by the City of Barrie WTP representative.

The IPZ-2 is comprised of four areas:

1. In-lake IPZ-2: the area within each surface water body and an extension up tributaries flowing into the IPZ-2;
2. Up-tributary: IPZ-2 is extended up tributary to the 2-hour time-of-travel limit;
3. Inland setback: Greater of either the 120 m setback inland along the abutted land or the regulation limit;
4. Transport Pathways: an extension to include areas that contribute water to the IPZ-2 through a Transport Pathway.

8.4.1.2.1 In-lake IPZ-2 delineation

The approach used in this study was to define the in-water IPZ-2 based on the currents predicted by the MIKE3 hydrodynamic model as described in Baird (2010b). The Lake Simcoe model is based on the original model developed for the Assimilative Capacity Studies as described in Baird (2006). This previous work demonstrated that MIKE3 model could successfully simulate both wind driven currents and thermocline development in Lake Simcoe.

For delineating IPZ-2, currents were developed for 10 year return period wind events, for eight wind directions, run at 45° intervals (Appendix R – Table 2.2, Baird 2010d). For each wind condition, the model was run with a constant wind applied to the surface of the lake, until the currents in the lake were fully developed. Reverse particle tracking was used to track the paths that the currents would have transported neutrally buoyant particles to the intake over a 2 hour period. Although the intakes are located near the lakebed, particles were introduced at the surface and near the lakebed. The particles released at both depths were considered in delineating the IPZ-2, as this is a more conservative approach. The impact of the water withdrawn by the intake on the local currents was also investigated, with the model indicating that the intake only significantly influences the currents within a 2 m to 5 m radius of the intake.

Currents inshore of the breaker or surf zone are complex and are not well defined by existing numerical models. Comparison of the intake depth with the depth at the estimated lakeward limit of the surf zone suggests that the intakes at Lagoon City and South Ramara are located inside the surf zone, where wave-induced currents and the associated mass transport and mixing are more likely to affect the IPZ-2 delineation. However, it is recognized that there is potential for currents in the surf zone to transport a contaminant in an offshore direction from the shoreline. The significance of this

increases for intakes located in high wave energy environments and for intakes located within the surf zone. A preliminary assessment of the location of the surf zone was undertaken by Baird (2010b). The assumption is that mixing processes inside the surf zone could transport a contaminant to the offshore limit of the surf zone. Estimated depth at offshore limit of surf zones is presented in Appendix B – Table 5.1, Baird 2010b.

8.4.1.2.2 Up Tributary

The upstream limit of the IPZ-2 was calculated as (2 hours minus the travel time from the intake to tributary mouth) multiplied by the tributary velocity. Tributary velocity was based on velocity at bank full stage as per the MOE (2006a) recommendation and it was assumed that bank full flow is equivalent to the 2 year return period event.

There are two tributaries located within the IPZ-2 for the City of Barrie WTP intake. A velocity of 2.23 m/s was assumed for Lover's Creek and a velocity of 0.21 was assumed for Hewitt's Creek (Appendix B – Baird, 2010b). Tributary velocities provided by the LSRCA were used where available. Alternatively, the velocity was estimated from bank full discharge divided by the approximate area of the cross-section at the mouth of the tributary.

8.4.1.2.3 Inland Setback

Where the IPZ-2 abuts land, it includes the greater of either (1) a setback of not more than 120 m inland along the abutted land measured from the high water mark of the surface water body; or (2) the area of land within the Conservation Authority Regulation Limit along the abutted land (Rule 65; MOE, 2008a). The Regulation Limit for Lake Simcoe was provided by LSRCA, and is the April 24, 2009 Board of Directors approved version.

The shorelines of Lake Simcoe were used in lieu of the high water mark (HWM). The shoreline was developed by digitizing the lake boundary from the 2002 colour 20 cm orthorectified aerial photography.

It must be noted however that the definition of HWM used in this assessment differs to that provided by the MOE. MOE, 2009b, defines the HWM for water bodies where a long term water level record exists, as the 80th percentile for the month within which the highest water level occurs, or where a long term record of water levels does not exist, the level at which flood plains are flooded and leave a mark where natural vegetation changes from predominantly aquatic vegetation to terrestrial vegetation. The HWM is defined by LSRCA in terms of fish habitat, as the average annual high water which is 219.15 meters above sea level (masl). A review of the shoreline used to define the HWM for the IPZ delineation and the HWM provided by LSRCA (219.15 masl) was completed in the Baird (2010d) report. The review found the two shorelines to be comparable. More information on the difference between these two approaches is documented in Baird (2010) report located in Appendix B.

8.4.1.2.4 Transport Pathways

The IPZ-2s were modified to include potential Transport Pathways based on Rules 72 to 74 of the Technical Rules. A complete description of the methodology, analysis and Transport Pathway delineation is provided in Baird 2010b.

Data were acquired by LSRCA from field surveys, in-house development, and from participating municipalities. Datasets included (but were not limited to) Storm sewersheds; Storm water pond locations; Sewershed outfall locations, diameters, flows and velocities; Ditch locations and cross-sections; Rural drainage networks; Impervious areas; Subsurface tile drains; Watercourse engineered and modeled cross-sections; Soils and land use data; and Ortho-imagery.

The sewersheds discharging into the IPZ-2 were identified from LSRCA and municipal storm water network datasets. Residence time and the velocity were then used to estimate a maximum within-sewershed travel distance. A summary of travel distance calculations for Barrie can be found in Baird 2010b. In all sewersheds, the travel distance was greater than the assumed longest flow path in the sewershed, so the entire sewershed was included in the revised IPZ-2. The revised sewershed excludes a very small segment that spans a railroad. The sewershed was split at the railroad, and a part excluded due to drainage (based on topography).

8.4.1.3 *Delineating IPZ-3*

The MIKE3 model was used to delineate the area within the surface water body through which contaminants released during an extreme event could be transported to the intake. An extreme event is defined in MOE (2008a) as: a period of heavy precipitation or winds up to a 100 year storm event; a freshet; or a surface water body exceeding its high water mark.

Three events were initially selected for modeling: a 100 year return period wind event with average flows in tributaries; a 10 year return period wind event with 2 year return period non-freshet flows; and a 2 year return period freshet with average winds.

Preliminary test runs with the MIKE3 model showed that the effects of the tributary flows on currents within the lake were very localized (limited to close proximity to the mouth of the tributary). Desktop calculations showed that for the tributaries in the Lake Simcoe watershed, a contaminant could be transported from the headwaters to Lake Simcoe during a freshet or extreme non-freshet flow event. Evaluating the spatial distribution of potential transport within the lake therefore became the focus of the modeling investigations. The details of these investigations can be found in Baird, 2010b.

The modeling demonstrates that a contaminant could reach an intake from anywhere in Lake Simcoe, during extreme events. The size and irregular shape of the lake, with two large bays (Cook's Bay and Kempenfelt Bay) means that movement of the contaminant across the lake, behind islands, and in and out of bays is highly dependent on the directionality of the wind. To complicate matters further, there are eight intakes in Lake Simcoe, and there is substantial overlapping of the IPZ-3s. Based on discussions with

LSRCA and MOE, it was agreed that the modeling supports the original direction in MOE (2006a), to extend the IPZ-3 to the watershed limits. Additional site specific contaminant modeling will be undertaken in the next phase. It will consider specific threats to determine whether or not a contaminant could reach the intake that is of sufficient concentration to compromise the drinking water at the intake (MOE, 2008a; Rule 130).

The IPZ-3 sub-areas, used to define areas with varying Vulnerability Scores, were delineated based on the sub-watershed boundaries. The Lake Simcoe water body was also delineated as one sub-area. Although Lake Simcoe generally flows into Lake Couchiching through Atherley Narrows, data showed that reverse flow does occur, with water flowing from Lake Couchiching into Lake Simcoe. The Lake Couchiching water body and watershed were therefore included as IPZ-3 sub-areas. The IPZ-3 was extended up tributaries from the lake, to the watershed limit. A setback of 120 m was applied on Lake Couchiching (as there is no Regulation Limit) and the Regulation limit used to define the setback within the Lake Simcoe watershed.

8.4.1.4 IPZ Vulnerability Scores

The Vulnerability Score ranks the relative Vulnerability of the intake to contaminants. Vulnerability Score is based on the Area Vulnerability Factor and the Source Vulnerability Factor using the formula below:

$$B \times C$$

where,

B = the Area Vulnerability Factor of the area of the IPZ

C = the Source Vulnerability Factor of the surface water of the IPZ

The range of possible Vulnerability Scores can be found in Table 5-4, Section 5.3.2 of Chapter 5: Methods Overview.

8.4.1.4.1 Area Vulnerability Factor

Each of the Intake Protection Zones is assigned an Area Vulnerability Factor (B) with the IPZs closest to the intake having the highest factor.

For IPZ-1s, the Area Vulnerability Factor is assigned a value of 10 due to its close proximity to the intake (Rule 88; MOE, 2008a).

For the IPZ-2, a 'base' Area Vulnerability Factor of 8 (the median factor for an IPZ-2) was initially assigned, and then altered by four modifier scores based factors such as land cover, hydrology, slope and the characteristics of the subwatershed that the IPZ-2 is located in (the four potential modifiers can be found in Baird, 2010b).

The IPZ-2 base Area Vulnerability Factor, modifiers and final Area Vulnerability Factor for the City of Barrie WTP intake are listed in Table 8-5. An Area Vulnerability Factor of 8 was recommended for the Barrie WTP IPZ-2.

Table 8-5: Derivation of IPZ-2 Area Vulnerability Factor (B) for the City of Barrie WTP Intake.

Intake	Sub-watershed Closest to Intake	Base Area Vuln. Factor	IPZ-2 Land % Modifier ¹	Drainage Density Modifier ¹	SCS Curve Number Modifier	Land Use Modifier	Relief/Length Ratio Modifier	IPZ-2 Final Area Vuln. Factor (B)
Barrie	Hewitt's Creek	8	0	0	0	0	0	8

¹ The IPZ-2 Land Modifier and Drainage Density Modifier both reflect the ratio of water to land. The sum of these two modifiers cannot change the Area Vulnerability Factor by more than +/- 1.

The Area Vulnerability Factors for the IPZ-3 sub-areas were determined, using the same methodology as IPZ-2, with some minor additions. IPZ-3 sub-areas were defined as the sub-watersheds within the Lake Simcoe watershed and Lake Couchiching subwatershed. The Lake Simcoe and Lake Couchiching water bodies were also defined as IPZ-3 sub-areas. As stated previously, the Area Vulnerability Factors that are assigned to the IPZ-3 sub-areas cannot be greater than the Area Vulnerability Factor assigned to the IPZ-2 (Rule 91; MOE, 2008a). Methodology can be found in Baird, 2010b.

The IPZ-3 sub-area base Area Vulnerability Factors, modifiers and final Area Vulnerability Factors for the City of Barrie WTP are listed in Table 8-6.

Table 8-6: Derivation of IPZ-3 Area Vulnerability Factors for the City of Barrie WTP Intake.

IPZ-3 Sub-zones	Base Area Vuln. Factor	Distance Modifier ¹	Drainage Density Modifier ²	SCS Curve Number Modifier ³	Land Use Modifier ⁴	Relief-Length Modifier ⁵	Final Area Vuln. Factor (B) ⁶
Lake Simcoe waterbody (incl. islands)	7	0	-	-	-	-	7
Lake Couchiching waterbody (incl. islands)	7	0	-	-	-	-	7
Hewitts Creek subwatershed	7	0	0	0	0	0	7
Lovers Creek subwatershed	7	0	0	0	0	0	7
Barrie Creeks subwatershed	7	-1	0	0	1	1	7
Oro South Creeks subwatershed	7	-2	0	0	0	0	5
Hawkestone Creek subwatershed	7	-2	0	-1	0	1	5
Innisfil Creeks subwatershed	7	-2	0	0	0	0	5
Georgina Creeks subwatershed	7	-2	-1	1	0	0	5
Black River subwatershed	7	-3	0	0	-1	0	3
Oro North Creeks subwatershed	7	-3	0	0	1	1	6
Maskinonge subwatershed	7	-3	0	1	0	0	5
East Holland subwatershed	7	-3	1	0	1	0	6
West Holland subwatershed	7	-3	1	0	0	0	5
Lake Couchiching subwatershed	7	-3	-1	0	0	0	3
Ramara Creeks subwatershed	7	-3	0	0	0	0	4
Pefferlaw Brook + Uxbridge Brook subwatershed	7	-3	0	0	-1	0	3
Beaver River subwatershed	7	-3	0	-1	0	0	3
Upper + Lower Talbot River subwatershed	7	-4	0	-1	0	-1	1
Whites Creek subwatershed	7	-4	0	0	0	0	3

¹ If waterbody area or nearest subwatershed, Modifier = 0. If further subwatershed, Modifier: Within: <-1 S.D. of mean = -1, >-1 S.D. and mean = -2, mean and <+1 S.D. = -3, >+1 S.D. = -4.

² Drainage density = (Total Length of Streams)/(Subwatershed Area). Modifier: Within +/-1 S.D. of mean = 0: >+1 S.D. of mean = +1: <-1 S.D. of mean = -1

³ Adjusted SCS Curve Number. Modifier: Within +/-1 S.D. of mean = 0: >+1 S.D. of mean = +1: <-1 S.D. of mean = -1. Lake Couchiching CN is average of all other subwatersheds since no data was available.

⁴ Land use: Natural/Forested = -1: Agricultural = 0: Urban/Developed = +1, coarsely interpreted from 1999 LandSat Imagery

⁵ Relief-Length Ratio = (Relief)/(Subwatershed Length). Modifier: Within +/-1 S.D. of mean = 0: >+1 S.D. of mean = +1: <-1 S.D. of mean = -1

⁶ Final Area Vulnerability Factor plus/minus all modifiers

8.4.1.4.2 Source Vulnerability Factor

A Source Vulnerability Factor is assigned to each surface water intake (Rule 94; MOE, 2008a). Source Vulnerability for intakes within the SGBLS Source Protection Region

was based on that developed by the Michigan Department of Environmental Quality (MDEQ). The first three rows in Table 8-7 were taken directly from MDEQ (2004), while the fourth row lists the corresponding Vulnerability Factor assigned for the City of Barrie WTP.

Table 8-7: Intake Vulnerability Criteria based on Intake Distance from Shore and Depth (adapted from MDEQ, 2004).

Category ¹	Nearshore-Shallow Water	Nearshore-Deep Water	Offshore-Shallow Water	Offshore-Deep Water
Parameters ¹	<300 m offshore <6 m depth	<300 m offshore >6 m depth	>300 m offshore <6 m depth	>300 m offshore >6 m depth
Vulnerability ¹ (MDEQ)	High	High to Moderate	High to Moderate	Moderate
Recommended Source Vulnerability Factor based on Intake Offset and Depth	1.0	0.9	0.9	0.8

¹Category, parameters and vulnerability based on MDEQ (2004).

None of the water treatment plant operators interviewed by LSRCA for this study reported a plant shut down due to water quality issues, similarly the issues evaluation (below) did not identify any issues for this intake. As no Water Quality Issues were identified the Source vulnerability Score was based on the water depth and distance offshore only. The City of Barrie WTP intake is located 400 m from shore in a water depth 27 m. A Source Vulnerability Factor (C) of 0.8 was therefore assigned, based on the values presented in Table 8-7 (MDEQ, 2004).

8.4.1.5 Uncertainty Assessment

This section summarizes some of the uncertainty identified by Baird (2010b) when delineating IPZs and the assigning Vulnerability Scores; the entire discussion of uncertainties is presented in Baird 2010d, Appendix R. This assessment was used by Baird (2010b) to assign Uncertainty Ratings of either “High” or “Low” for each area and source Vulnerability Score.

8.4.1.5.1 Data Quality and Gaps:

Data gaps and data quality issues identified during the study included: bathymetry and shoreline delineation data sets that may be out of date or too low resolution; wind data from a single location (Lagoon City Buoy) being applied to the entire lake; tributary flow

data being limited to the major tributaries; lower level of confidence in the calibration for the Lake Couchiching model, due to the limited measured current data used in the model calibration; and limited raw water quality data is available. Complete list of data quality and gaps listed in Baird 2010b, Appendix B.

8.4.1.5.2 Model Capabilities and Application

A model is a tool that is used to improve our understanding of the physical processes. It is important to understand the model limitations, as well as the limitations of the application, that is how the model was set up, the data was used as input to the model, the model runs undertaken, and the interpretation of the results. The limitations of the model used in this study include: (A complete list and description of model uncertainties is provided by Baird (2010b), Appendix B.

- The MIKE3 model does not consider waves and wave induced currents;
- Separate models for Lake Simcoe and Lake Couchiching means that flow through Atherley Narrows may not be accurately modeled since the Narrows are considered as an open boundary;
- Wind direction (45° intervals) and speed (10 year return periods) data that enables consistency between projects was used, but this does not capture actual shifts in wind speed and direction;
- Complex river networks and flow patterns at the north end of Lake Couchiching with limited gauge data and tributary cross-sections in this area;
- Flow velocities were estimated using either measured cross-section data from the mouth of the tributary or approximated cross-sections developed from the bathymetry field sheets for the lake. However, modeling indicated that the effect of tributary flow was localized, and did not significantly impact the in-lake IPZs
- Model application does not consider temperature induced density currents or lake stratification. Where the temperature of a tributary flowing into a lake differs from the lake temperature, there is potential for reduced travel times to the intake, as a result of density driven currents.

8.4.1.5.3 Quality Assurance/Quality Control

In completing this project, Baird followed their established *Project Quality Control Program (QCP)*, which includes: Preparation of the Project Control Plan (PCP); Identification of the Project Manager (PM), Project Team (PT), Quality Control Reviewers (QCRs) and Quality Assurance Manager (QAM); Schedule and Budget; Description of tasks, project phases and/or deliverables to be reviewed; Identification of checklists to be utilized during reviews; Discussion of Quality Assurance procedures to be used during the project life cycle.

8.4.1.5.4 Extent and Level of Model Calibration/Validation

The MIKE3 model was calibrated with measured current data from two locations on Lake Simcoe, and one location in Lake Couchiching. It is important to note that the ADCP data sets are of limited duration and spatial coverage. They did not include the extreme events that were modeled for the matrix runs. The level of calibration was based on the available data and in general, the models captured the trends in the surface currents. Based on the calibration undertaken, the model seemed to capture the general trends in current speed and direction.

8.4.1.5.5 Area and Source Vulnerability Factors

The factors considered in assigning the Area Vulnerability values include: the percentage of the area of the IPZ-2 or IPZ-3, as the case may be that is composed of land; the land cover, soil type, permeability of the land and the slope of any setbacks; the hydrological and hydrogeological conditions in the area that contributes water to the area through Transport Pathways; and in respect of an IPZ-3, the proximity of the area of the IPZ-3 to the intake. The only subwatershed characteristic that is relatively uncertain is the SCS Curve, with the uncertainty arising from the fact that the SCS Curve No. is based on many parameters including rainfall, land cover, soil permeability and slope. The parameters considered in assigning the Source Vulnerability Factors were the distance of the intake from shore and the depth of water that it is located in, and the history of water quality concerns. Genivar (2010a) did not report any water quality Issues in their Issues Evaluation report, however limited data were available for the analysis.

8.4.2 Results - City of Barrie Water Treatment Plant

8.4.2.1 Intake Protection Zones (IPZ)

The IPZ-1 and IPZ-2 for the City of Barrie WTP are shown in Figure 8b-1. IPZ-1 consists of a 1 km radius centered on the intake, extending 120 m inland. The IPZ-2 includes Transport Pathways, such as drains and ditches that extend the IPZ-2 in various locations within the Barrie community. The IPZ-3 for the City of Barrie WTP, as with all intakes in Lake Simcoe, has been defined as the entire Lake Simcoe and Lake Couchiching sub-watershed (Figure 8b-2). The Lake Couchiching water body and watershed were included as IPZ-3 sub-areas because current flow measurements show that reverse flow (i.e. from Lake Couchiching to Lake Simcoe), does occur.

8.4.2.2 Intake Protection Zone (IPZ) Vulnerability Scores

The Vulnerability Factors and Scores for the IPZ-1, IPZ-2 and IPZ-3 sub-areas are summarized below in Table 8-8 and Figure 8b-1 and Figure 8b-2.

Table 8-8: Summary of Vulnerability Factors and Scores for the City of Barrie WTP Intake.

IPZ and IPZ-3 sub-zones	Area Vulnerability Factor (B)	Source Vulnerability Factor (C)	Vulnerability Score (V)
IPZ-1	10	0.8	8
IPZ-2	8	0.8	6.4
IPZ-3 Sub-areas			
Lake Simcoe waterbody (incl. islands)	7	0.8	5.6
Lake Couchiching waterbody (incl. islands)	7	0.8	5.6
Hewitts Creek subwatershed	7	0.8	5.6
Lovers Creek subwatershed	7	0.8	5.6
Barrie Creeks subwatershed	7	0.8	5.6
Oro South Creeks subwatershed	5	0.8	4.0
Hawkestone Creek subwatershed	5	0.8	4.0
Innisfil Creeks subwatershed	5	0.8	4.0
Georgina Creeks subwatershed	5	0.8	4.0
Black River subwatershed	3	0.8	2.4
Oro North Creeks subwatershed	6	0.8	4.8
Maskinonge subwatershed	5	0.8	4.0
East Holland subwatershed	6	0.8	4.8
West Holland subwatershed	5	0.8	4.0
Lake Couchiching subwatershed	3	0.8	2.4
Ramara Creeks subwatershed	4	0.8	3.2
Pefferlaw Brook + Uxbridge Brook subwatershed	3	0.8	2.4
Beaver River subwatershed	3	0.8	2.4
Upper + Lower Talbot River subwatershed	1	0.8	0.8
Whites Creek subwatershed	3	0.8	2.4

8.4.2.3 Uncertainty for IPZ Delineation and Vulnerability

Based on the factors discussed above, Baird (2010b) recommended an IPZ delineation Uncertainty Rating for the IPZ-1 as low and IPZ-2 and IPZ-3 as High. The Uncertainty Rating for the IPZ-1, -2 and -3 Vulnerability Scores are all High (Table 8-9).

While the location of the intake was relatively well defined and no Drinking Water Issues were reported (see Section 8.4.3) based on the data analyzed, limited data were available for the Issues Analysis and the operator raised some concerns (Baird, 2010b). A High Uncertainty was therefore assigned to the Vulnerability Score for the IPZ-1.

The IPZ-2 delineation is based on current velocities in the vicinity of the intake. Based on the data, model, model application, and model calibration limitations presented in this section, a High rating of Uncertainty is recommended. The High levels of Uncertainty are not a reflection of the quality of work, but recognition of the limitations presented. With respect to extension of the IPZ-2 up tributaries, the velocities in small tributaries, in many cases, were assumed, due to lack of data. Similarly, no fieldwork was undertaken to define the characteristics of Transport Pathways and there are significant data gaps. A High level of Uncertainty was therefore assigned to the IPZ-2 delineation. Vulnerability Scores for the IPZ-2 were assigned based on the Area and Source Vulnerability Factors. The Uncertainty Rating for the data used to define the Source Vulnerability Factor (offset from shore, depth, and history of water quality concerns) is High as discussed for the IPZ-1. The level of Uncertainty for the Area Vulnerability for the IPZ-2 is also High due to the degree of uncertainty in the methodology used to develop the Area Vulnerability Factor. This in part stems from the fact that the Rules (MOE, 2009a) do not provide specific guidance.

Table 8-9: Summary of Uncertainty Ratings for the City of Barrie WTP Intake IPZs and Vulnerability Scores.

IPZ	Uncertainty for IPZ Delineation	Uncertainty for Vulnerability Scores
IPZ-1	Low	High
IPZ-2	High	High
IPZ-3	High	High

Contaminant specific modeling to determine if an activity represents a Significant Drinking Water Threat [Rule 130; MOE, 2008a] has not been completed as part of this project. This modeling is required to determine if the release of a chemical or pathogen would be transported through the surface water IPZ to the intake and result in deterioration of the water for use as a drinking water source. Concentration, specific gravity, decay rate, and the size of the spill must all be considered. Contaminant specific modeling should be undertaken in the future to improve the level of certainty in

the IPZ-3 delineation. A High level of Uncertainty has therefore been assigned to the IPZ-3 delineation.

A High level of Uncertainty has also been assigned to the Vulnerability Scoring for the IPZ-3 subareas, for the reasons discussed with respect to the IPZ-1 and IPZ-2.

8.4.3 Drinking Water Issues Evaluation

The intent of the Issues Evaluation is to identify parameters (e.g. chemicals or pathogens) in the raw drinking water that will limit the ability of the water to serve as a drinking water source either now or in the future. To be considered a Drinking Water Issue, a parameter needs to be at a concentration that may result in the deterioration of the quality of the water for use as a source of drinking water or if there is a trend of increasing concentrations of the parameter and a continuation of that trend that would result in the deterioration of the quality of the water as a source of drinking water (Technical Rule 114.(1)(a-b)). However, a parameter may not be considered an Issue in cases where it is naturally occurring or effective treatment is in place.

Available data describing raw water quality for the new surface water intake for the Barrie Surface Water Treatment Plant has been reviewed to identify Drinking Water Issues that are considered likely to result in a deterioration of the quality of water for use as a source of drinking water. Details of the Drinking Water Issues Evaluation for the Barrie Surface Water Treatment Plant are provided in Technical Memorandum Q1 – Drinking Water Issues Evaluation – Barrie (Appendix B).

No Drinking Water Issues were identified for the raw water quality supply to the Barrie Surface Water Treatment Plant.

The occasional presence of *E. coli* and coliform bacteria in the surface water are not considered to be a Drinking Water Issue as these parameters will be treated effectively and in accordance with Safe Drinking Water Act regulations. Sodium concentrations in Lake Simcoe have been shown to be slightly increasing but are not projected to exceed the ODWQS of 200 mg/L within 50 years.

Water quality monitoring will be conducted as the treatment plant is tested and put into operation. The water quality data should be reviewed regularly to identify any changes in the water quality and trends that would result in a deterioration of the water for use as a drinking water source.

8.4.4 Drinking Water Threats Evaluation

An assessment of Drinking Water Threats for the City of Barrie Water Supply was completed in accordance with the detailed methodology presented in Technical Memo – A5 (Appendix MO). A Drinking Water Threat is defined as “an Activity or Condition that adversely affects or has the potential to adversely affect, the quality and quantity of any water that is or may be used as a source of drinking water, and includes any activity or condition that is prescribed by the regulations as a drinking water threat.” An Activity is

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, whereas a Condition refers to the presence of a contaminant in the soil, sediment, or groundwater resulting from past activities. Therefore, it is not only presently existing Threats that must be regulated, but future ones as well.

The Drinking Water Threats Assessment for the Barrie Water builds on the information from the Vulnerability Analysis and Issues Evaluation and includes preparation of:

- A List of Drinking Water Threats for Activities,
- A List of Drinking Water Threats for Conditions,
- Maps showing areas that are or would be Significant, Moderate, or Low Drinking Water Threats for Activities,
- Maps showing areas that are or would be Significant, Moderate, or Low Drinking Water Threats for Conditions, and
- An enumeration of Drinking Water Threats.

8.4.4.1 List of Drinking Water Threats – Activities

The list of Prescribed Drinking Water Threats considered in the assessment for the Barrie WTP Drinking Water Supply is provided in Chapter 5, Section 5.5.1.

No additional Drinking Water Threats were identified for consideration. No local circumstances for prescribed Threats were identified.

8.4.4.2 List of Drinking Water Threats – Conditions

The following information sources were consulted to identify existing Conditions that could affect the Barrie Surface Water Treatment Plant:

- Files provided by the Ministry of the Environment local offices pertaining to licenses and records of spills in the area of the delineated IPZs.
- Records available from the Ministry of the Environment website containing registry of Brownfield Sites.
- Records from available technical studies and previous contaminant source inventories that identified situations that may qualify as conditions.
- Interviews of City of Barrie staff to identify potential Conditions within the identified IPZs for the drinking water supply.

No confirmed Conditions have been identified within the IPZs for the Barrie WTP. No potential Conditions have been identified for consideration at this time.

8.4.4.3 Identifying Areas of Significant/Moderate/Low Threats – Activities

The areas where Activities are or would be Drinking Water Threats are illustrated on a series of maps based on the Vulnerability Scores and Vulnerable Area delineations. The maps include references to a series of tables prepared by MOE to correlate activities that are or would be Drinking Water Threats with the Vulnerability Scores. The tables can be found at: <http://www.ene.gov.on.ca/en/water/cleanwater/provincialTables.php>.

8.4.4.3.1 Pathogen Parameters

The Key Table on Figure 8b-3 can be used in conjunction with the Vulnerability Scores to identify the areas where Activities associated with pathogen threats are or would be Significant, Moderate, or Low Drinking Water Threats for the Barrie Water Treatment Plant. Activities that are or would be Significant Drinking Water Threats for pathogens can be observed within the areas where the Vulnerability Score is greater than 8.

Within the IPZ-3, Activities can be a Threat where the Vulnerability Score is greater than 4 (Figure 8b-4).

8.4.4.3.2 Chemical Parameters

The Key Table on Figure 8b-5 can be used in conjunction with the Vulnerability Scores to identify the areas where activities associated with chemical threats are or would be Significant, Moderate, or Low Drinking Water Threats for the water supply to the Barrie Water Treatment Plant. Activities that are or would be Significant Drinking Water Threats for chemicals can be observed within areas where the Vulnerability Score is greater than 8.

Within the IPZ-3, Activities can be a Threat where the Vulnerability Score is greater than 4 (Figure 8b-6).

8.4.4.4 Identifying Areas of Significant/Moderate/Low Threats – Conditions

Further to Section 8.4.4.2, no Conditions have been confirmed within the WHPA for the Barrie WTP.

A Condition or potential Condition that has not been identified would potentially be a Significant, Moderate, or Low Threat to Drinking Water based on the combination of Hazard Rating and Vulnerability Rating as described in Section 5.5.5 (Chapter 5: Methods Overview) and Technical Memorandum A5 (Appendix MO). The Hazard Rating is dependent on whether there is evidence the Condition is causing off-site contamination, and whether the Condition is located on the same property as the supply well.

A Condition would be a threat to municipal drinking water in the following situations:

- **Significant:** where the Vulnerability Score is ≥ 8 and there is evidence that the Condition is causing off-site contamination, and/or that the Condition is located on the same property as the supply well.
- **Moderate:** (1) where the Vulnerability Score ≥ 6 and < 8 , and there is evidence that the Condition is causing off-site contamination, and/or that the Condition is located on the same property as the supply well; or (2) Where the Vulnerability Score is 10, and there is no evidence of off-site contamination.
- **Low:** Where the Vulnerability Score ≥ 8 and < 10 and there is no evidence of off-site contamination.

Figure 8b-1 and Figure 8b-2 illustrates the Vulnerability Score map for City of Barrie WTP that can be used to determine where a Condition is or would be a Significant, Moderate, or Low Threat to Drinking Water.

8.4.4.5 Enumerating Drinking Water Threats

The number of Significant Drinking Water Threats for the Barrie Water Treatment Plant has been determined using the methodology outlined in Technical Memorandum A5 (Appendix MO). There are no Significant Threats associated with Conditions or Drinking Water Issues.

No landuse activities that are significant Drinking Water Threats were identified for the IPZ of the Barrie Water Treatment Plant.

8.4.4.6 Managed Lands

Technical Rule 16(9) (August 2009) requires the Assessment Report to include maps showing the location of Managed Lands and the percentage of Managed Lands within a Vulnerable Area, including IPZ-1, -2 and -3. This mapping is not required where the Vulnerability Scores for the area are less than the Vulnerability Score necessary for the Activity to be considered a threat in the Table of Drinking Water Threats.

Managed Lands were identified and the managed lands proportions were determined for the Barrie IPZ-1 and IPZ-2 as outlined in Technical Memorandum A5 (Appendix MO). The results from this analysis were used in the enumeration of Significant Drinking Water Threats (Section 8.4.4.5). The Managed Lands are used in the identification of Threat activities associated with the application of Agricultural Source Material, Non-Agricultural Source Material, and commercial fertilizer.

Figure 8b-7 illustrates the location and proportion of Managed Lands within the delineated IPZ-1 and IPZ-2 for the Barrie WTP. The Managed Lands proportions for the IPZ-3 associated with the surface water intakes in Lake Simcoe are presented in Figure 8b-8.

8.4.4.7 Livestock Density

Technical Rule 16(10) (August 2009) requires the Assessment Report to include maps showing the livestock density within including IPZ-1, -2 and -3. This mapping is not required where the Vulnerability Scores for the area are less than the Vulnerability Score necessary for the Activity to be considered a Threat in the Table of Drinking Water Threats.

The Livestock Density was determined for the Barrie IPZ-1 and IPZ-2 as outlined in Technical Memorandum A5 (Appendix A). The results from this analysis were used in the enumeration of Significant Drinking Water Threats (Section 8.4.4.5). Nutrient units per farm are used in the identification of threat activities associated with the storage of Agricultural Source Material, and the grazing and/or confinement of livestock.

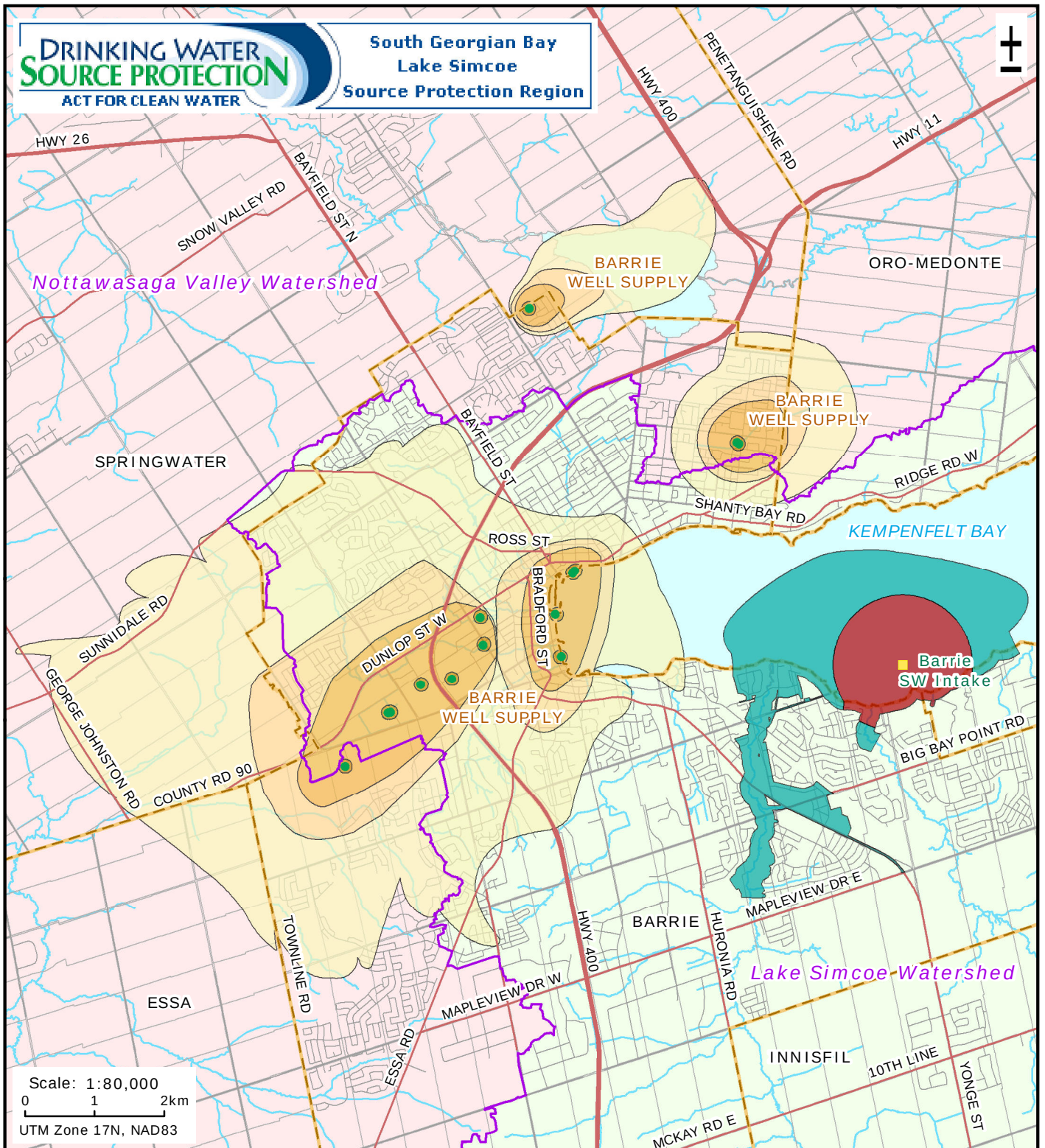
Figure 8b-9 illustrates the distribution of livestock density within the delineated IPZ-1 and IPZ-2 for the Barrie WTP. The Livestock Density for the IPZ-3 associated with the surface water intakes in Lake Simcoe are presented Figure 8b-10.

8.4.4.8 Impervious Surfaces

Technical Rule 16(11) (August 2009) requires the Assessment Report to include maps showing the percentage of surface area where road salt could be applied to Impervious Surfaces within including IPZ-1, -2 and -3. This mapping is not required where the Vulnerability Scores for the area are less than the Vulnerability Score necessary for the Activity to be considered a Threat in the Table of Drinking Water Threats.

The proportion of impervious surfaces within the delineated IPZ-1 and IPZ-2 for the Barrie Surface Water Treatment Plant Supply was determined in accordance with the methodology in Technical Memorandum A5 (Appendix MO). The results from this analysis were used in the enumeration of Significant Drinking Water Threats (Section 8.4.4.5). The Impervious Surfaces are used in the identification of threat activities associated with the application of winter de-icing agents (salt).

Figure 8b-11 illustrates the distribution of impervious surfaces within the delineated IPZ-1 and IPZ-2 for the Barrie WTP. The proportion of Impervious Surfaces for the IPZ-3 associated with the surface water intakes in Lake Simcoe are presented in Figure 8b-12.



- Municipal Surface Water Intakes
- IPZ-1 (1000m on water or 120m inland)
- IPZ-2 (2 hr time of travel)
- Municipal Supply Well in City of Barrie
- WHPA-A (100m)
- WHPA-B (2-years time of travel)
- WHPA-C (5-years time of travel)
- WHPA-D (25-years time of travel)

**Drinking Water System
Vulnerable Areas in City of Barrie**



**Golder
Associates**

Barrie, Ontario

Created by: LSRCA
Date: 2014-04-10

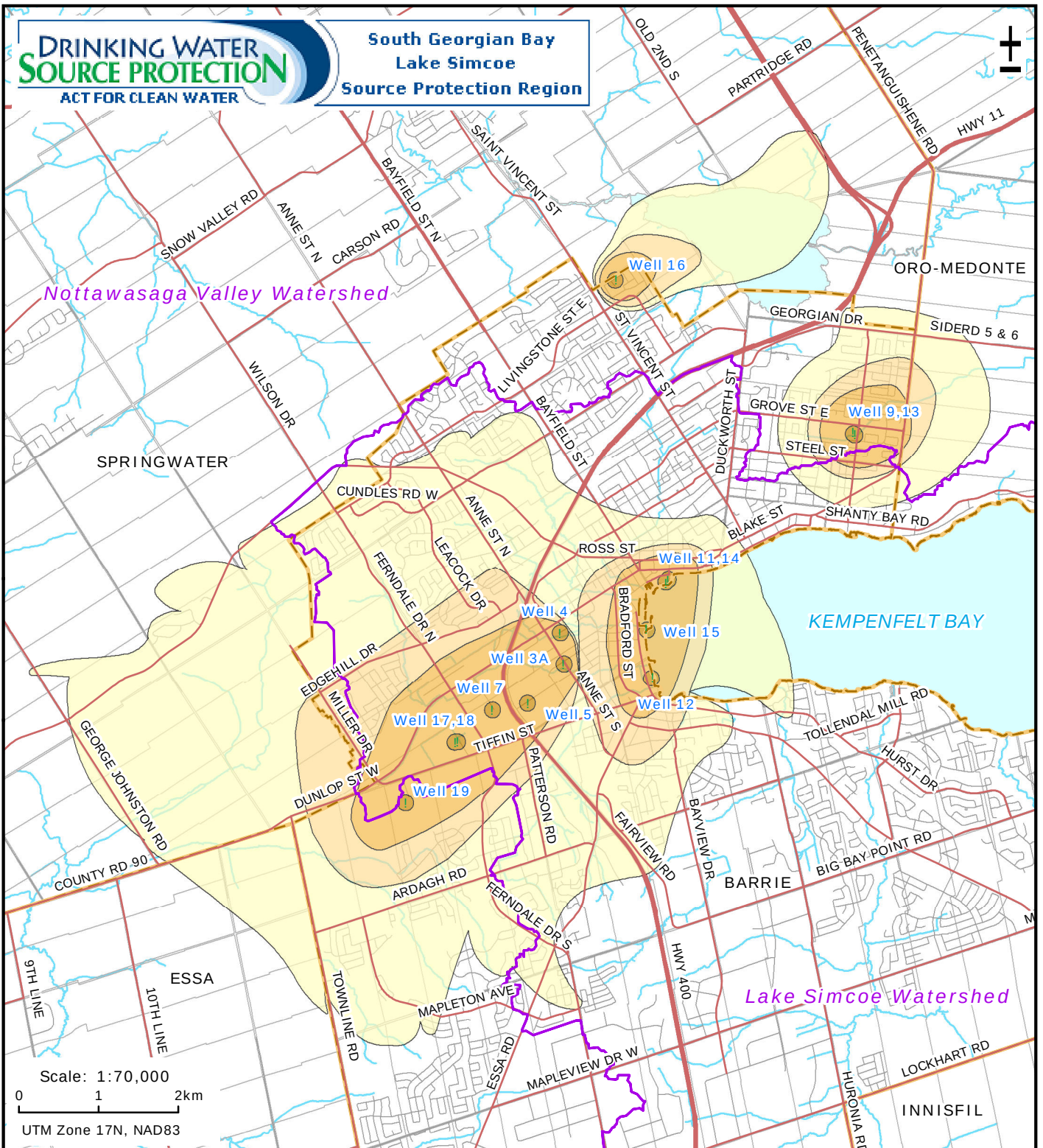


This map was produced by the Lake Simcoe Region Conservation Authority, lead agency of the South Georgian Bay Lake Simcoe Region Source Protection Region. Base data have been compiled from various sources, under data sharing agreements. While every effort has been made to accurately depict the base data, errors may exist.



Ontario

Figure 9-1



- Municipal Supply Well
- WHPA-A (100m)
- WHPA-B (2-years time of travel)
- WHPA-C (5-years time of travel)
- WHPA-D (25-years time of travel)
- SWP Watershed Area
- Municipality Boundary

**City of Barrie
Wellhead Protection Areas**

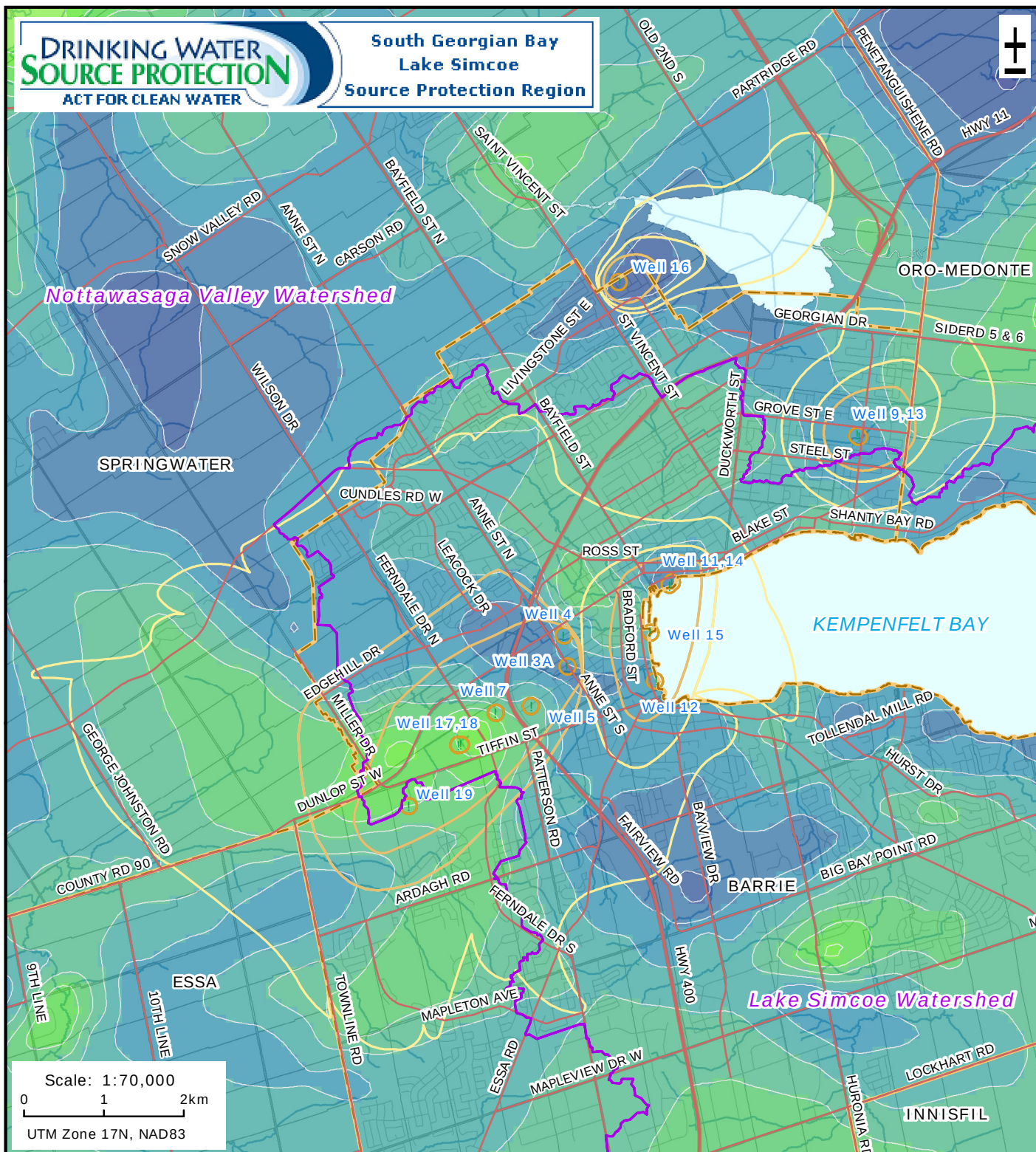
Created by: LSRCA
Date: 2014-04-10



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Figure 9a-1



Scale: 1:70,000
0 1 2km
UTM Zone 17N, NAD83

Calculated AVI	171 - 175	!	Municipal Supply Well
< 140	176 - 180		WHPA-A (100m)
141 - 145	181 - 185		WHPA-B (2-yr TOT)
146 - 150	186 - 190		WHPA-C (5-yr TOT)
151 - 155	191 - 195		WHPA-D (25-yr TOT)
156 - 160	196 - 200		SWP Watershed Area
161 - 165	> 200		Municipality Boundary
166 - 170			

**Model Calculated AVI
To Top Of Aquifer A3 with
Combined Capture Zones**

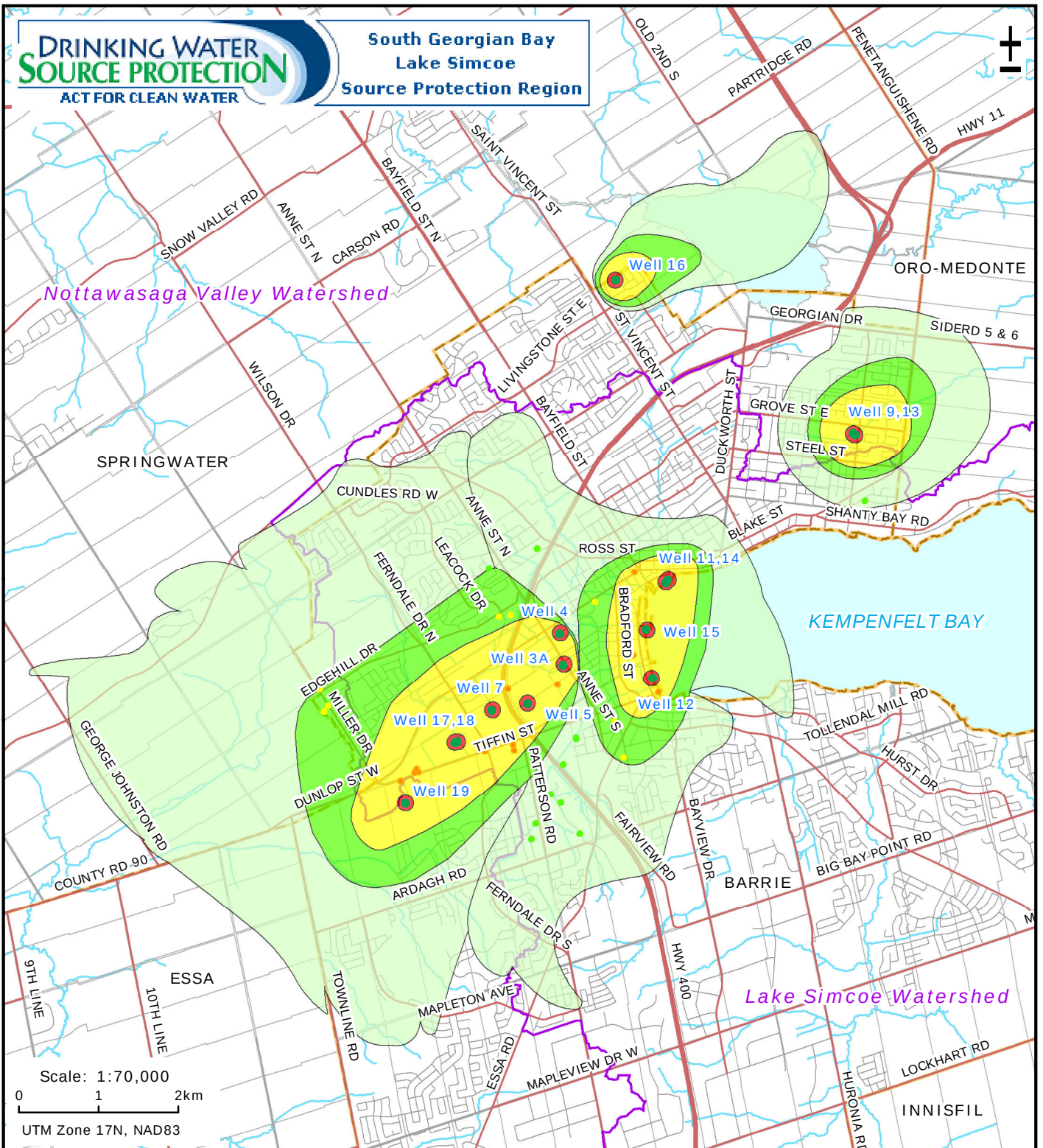
Created by: LSRCA
Date: 2014-04-10



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Figure 9a-2



Scale: 1:70,000
0 1 2km
UTM Zone 17N, NAD83

- ! Municipal Supply Well
- Vulnerability Score = 10
- Vulnerability Score = 8
- Vulnerability Score = 6
- Vulnerability Score = 4
- Vulnerability Score = 2
- SWP Watershed Area
- Municipality Boundary

**City of Barrie
Wellhead Protection Areas
Final Vulnerability Scoring**

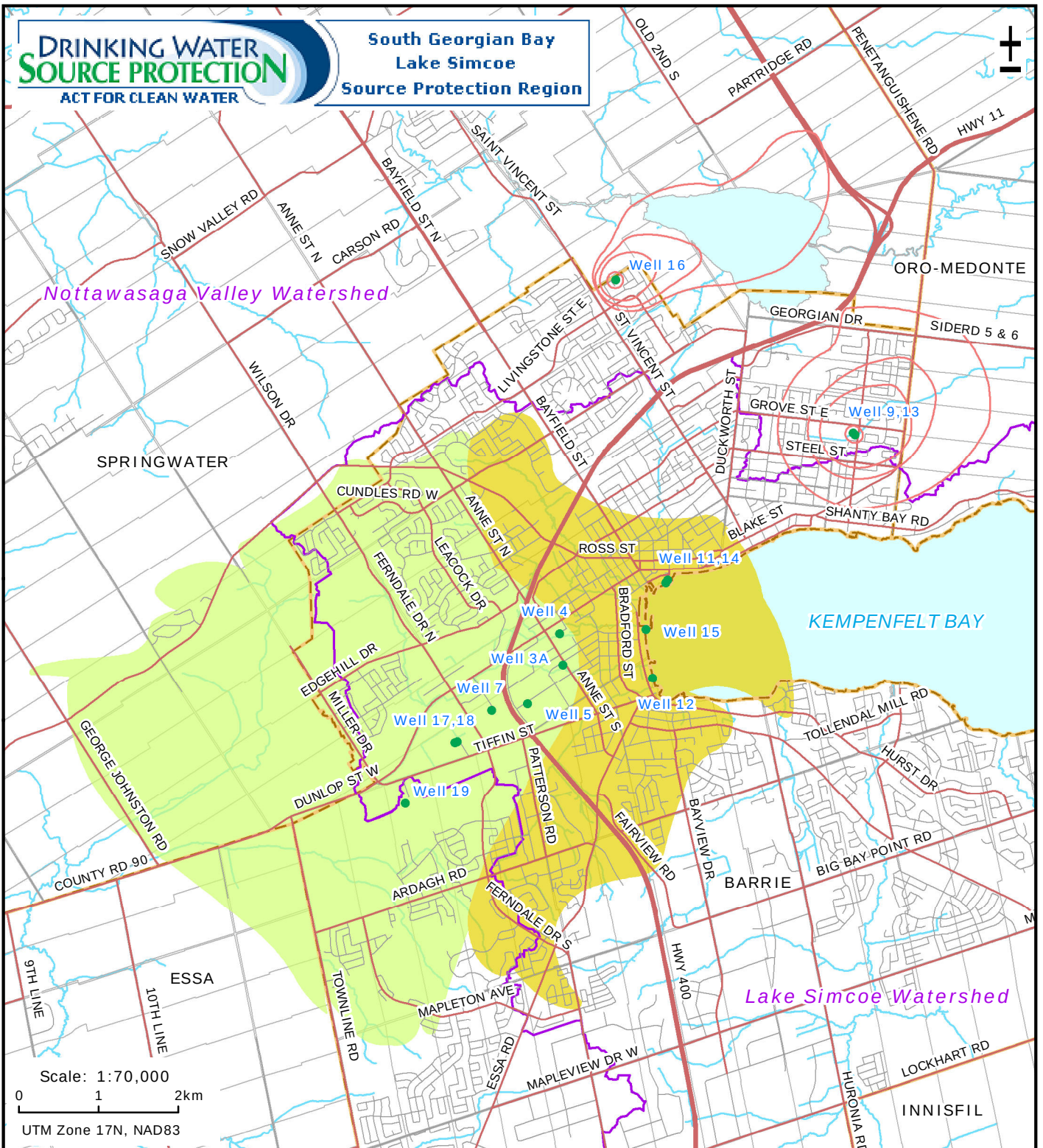
Created by: LSRCA
Date: 2014-04-10



This map was produced by the Lake Simcoe Region Conservation Authority, lead agency of the South Georgian Bay Lake Simcoe Region Source Protection Region. Base data have been compiled from various sources, under data sharing agreements. While every effort has been made to accurately depict the base data, errors may exist.



Figure 9a-3



- ! Municipal Supply Well
- Issue Contributing Area
 - Chloride and Sodium
 - Chloride
- SWP Watershed Area
- Municipality Boundary
- Adjacent Well Field WHPA

**City of Barrie
Drinking Water Issues
Contributing Areas**

Created by: LSRCA
Date: 2014-04-10



This map was produced by the Lake Simcoe Region Conservation Authority, lead agency of the South Georgian Bay Lake Simcoe Region Source Protection Region. Base data have been compiled from various sources, under data sharing agreements. While every effort has been made to accurately depict the base data, errors may exist.

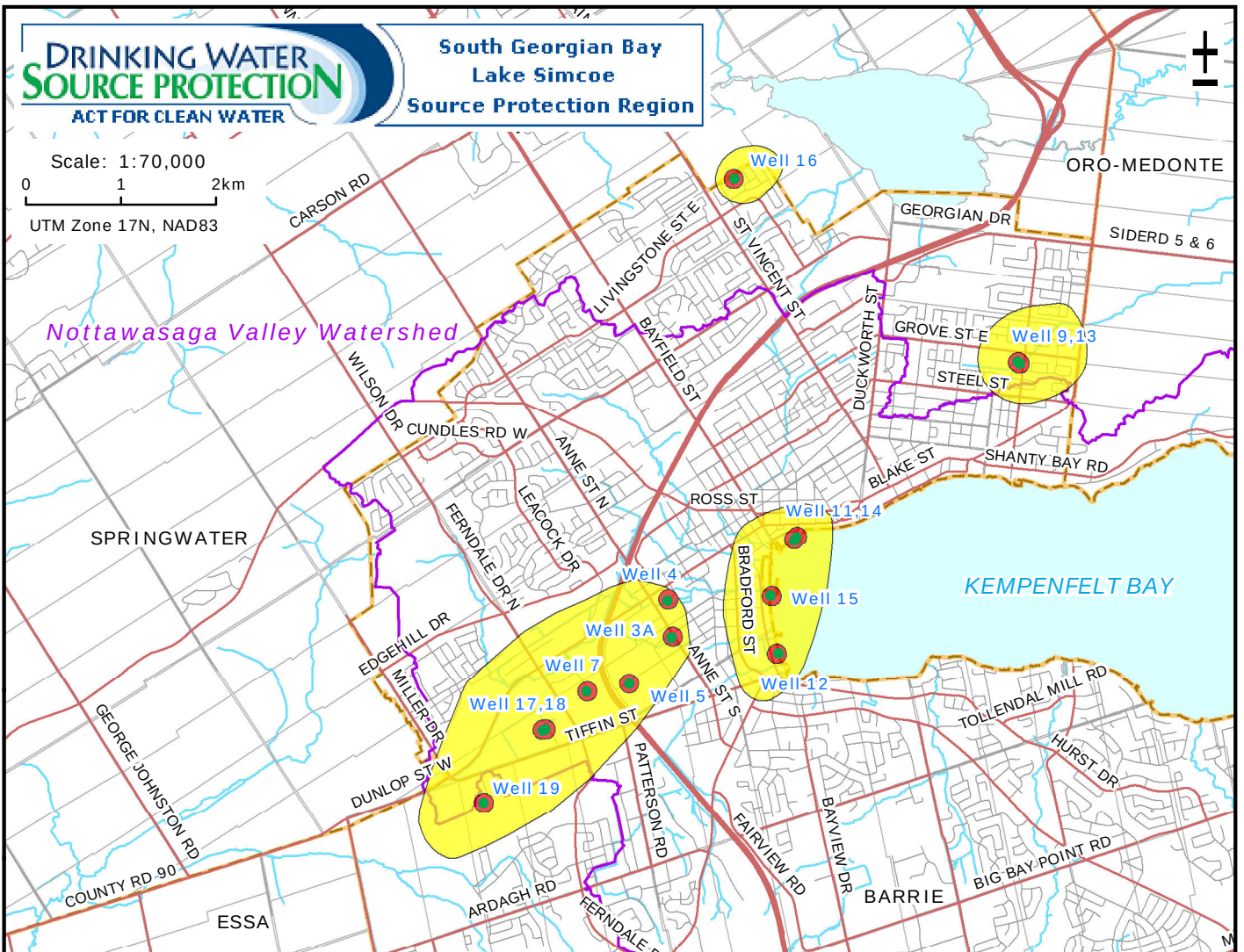


Figure 9a-4

DRINKING WATER SOURCE PROTECTION ACT FOR CLEAN WATER

South Georgian Bay Lake Simcoe Source Protection Region

Scale: 1:70,000
0 1 2km
UTM Zone 17N, NAD83



Pathogens

Vulnerability Score ¹	Number of circumstances in Table of Drinking Water Threats ²		
	Significant	Moderate	Low
10	16 (PW10S ³)	4 (PW10M)	0
8	0	16 (PW8M)	4 (PW8L)
6	0	0	16 (PW6L)

1 Areas with vulnerability scores less than 6 can not have significant, moderate or low threats. Pathogens are not a threat in WHPA C, C1 or D: 2 The number of circumstances was determined from information distributed along with the Tables of Circumstances as prepared by the MOE from the Table of Drinking Water Threats (November 2009). 3 Refers to the MOE Table of Circumstances that corresponds to this vulnerability score and parameter (See: <http://www.ene.gov.on.ca/en/water/cleanwater/provincialTables.php>).

- Municipal Supply Well
- Vulnerability Score = 10
- Vulnerability Score = 8
- Vulnerability Score = 6
- SWP Watershed Area
- Municipality Boundary

Areas That are or would be Significant,
Moderate or Low Drinking Water Threats
Activities Pathogen

Golder Associates
Barrie, Ontario

Created by: LSRCA
Date: 2014-04-10



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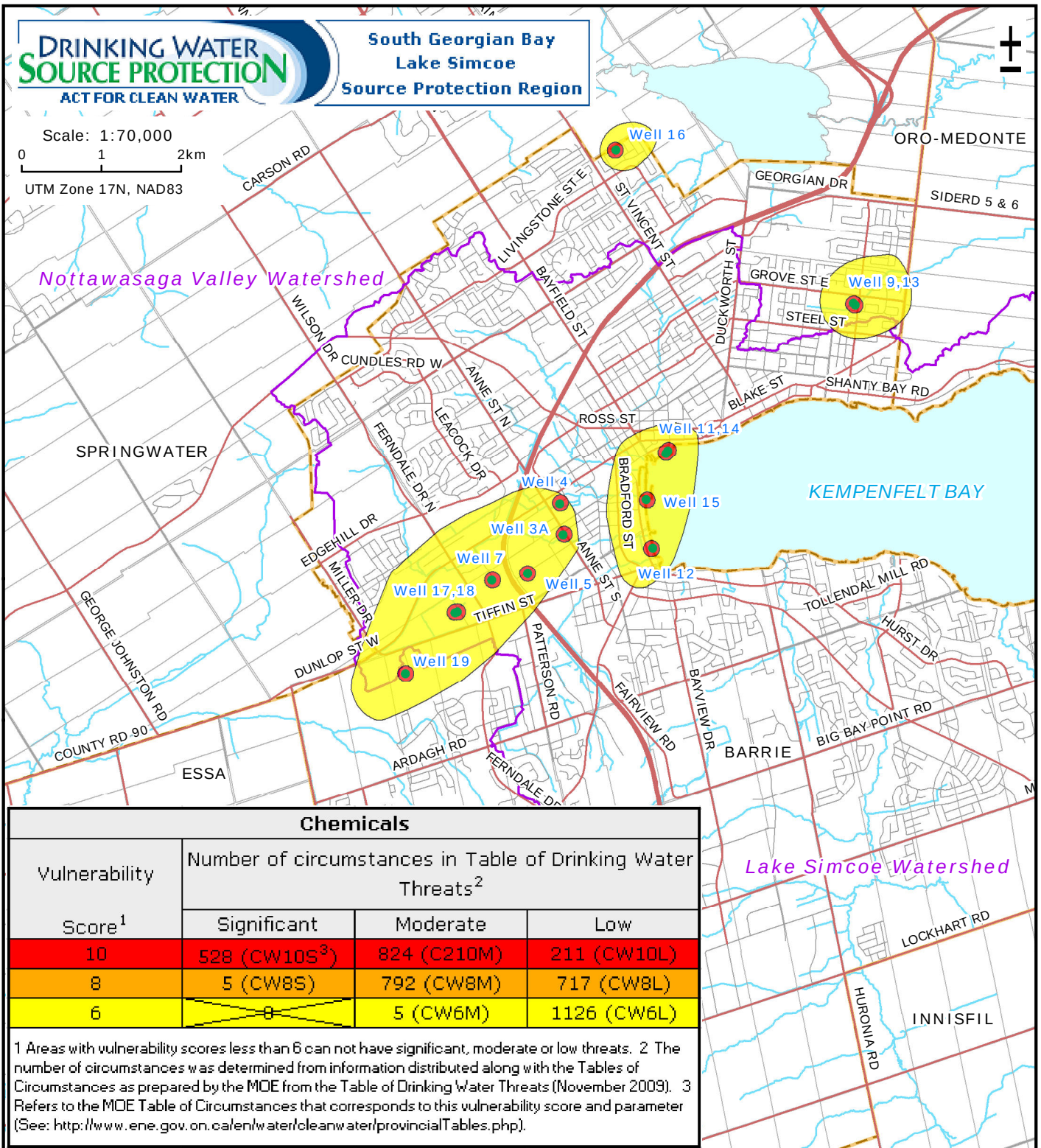


Figure 9a-5

DRINKING WATER SOURCE PROTECTION ACT FOR CLEAN WATER

South Georgian Bay Lake Simcoe Source Protection Region

Scale: 1:70,000
0 1 2km
UTM Zone 17N, NAD83



- ! Municipal Supply Well
- Red box Vulnerability Score = 10
- Orange box Vulnerability Score = 8
- Yellow box Vulnerability Score = 6
- Purple outline SWP Watershed Area
- Orange outline Municipality Boundary

Areas That are or would be Significant,
Moderate or Low Drinking Water Threats
Activities Chemical

Created by: LSRCA
Date: 2014-04-10

Golder Associates
Barrie, Ontario



This map was produced by the Lake Simcoe Region Conservation Authority, lead agency of the South Georgian Bay Lake Simcoe Region Source Protection Region. Base data have been compiled from various sources, under data sharing agreements. While every effort has been made to accurately depict the base data, errors may exist.

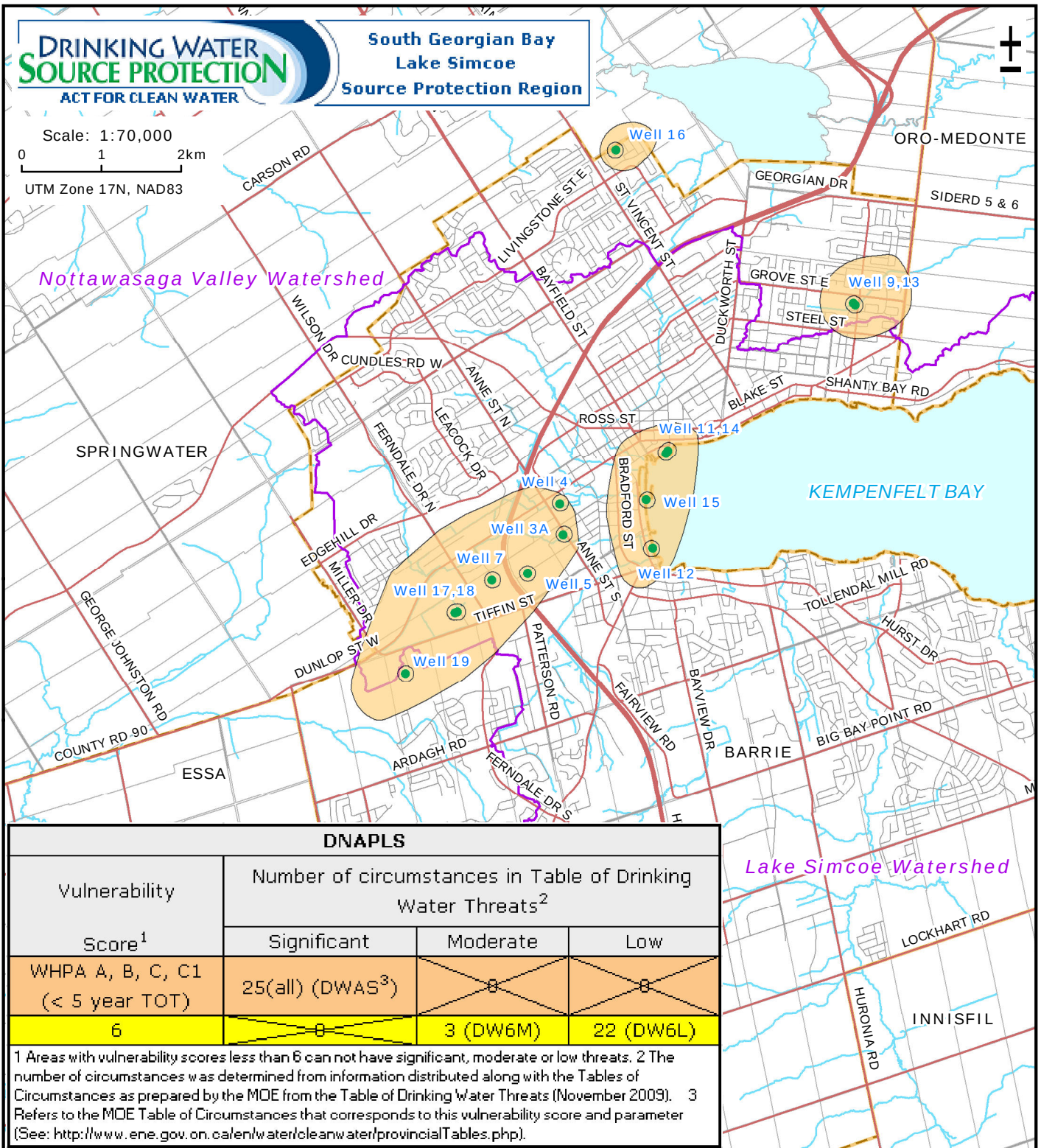


Figure 9a-6

DRINKING WATER SOURCE PROTECTION ACT FOR CLEAN WATER

South Georgian Bay Lake Simcoe Source Protection Region

Scale: 1:70,000
0 1 2km
UTM Zone 17N, NAD83



- Municipal Supply Well
- WHPAA, B, C or C1
- WHPA D with V.Score ≥ 6
- SWP Watershed Area
- Municipality Boundary

Areas That are or would be Significant,
Moderate or Low Drinking Water Threats
Activities DNAPLS

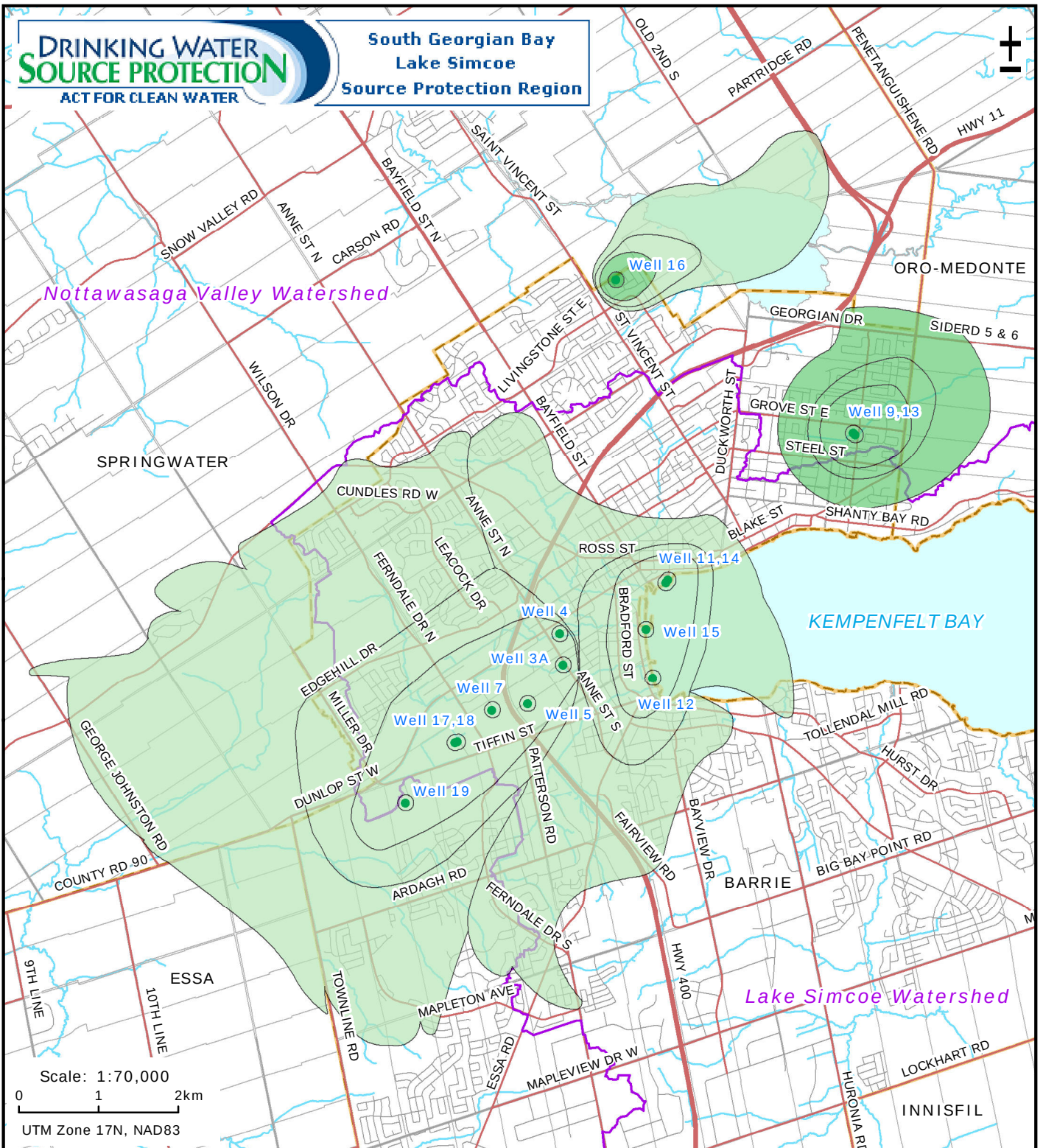
Created by: LSRCA
Date: 2014-04-10



This map was produced by the Lake Simcoe Region Conservation Authority, lead agency of the South Georgian Bay Lake Simcoe Region Source Protection Region. Base data have been compiled from various sources, under data sharing agreements. While every effort has been made to accurately depict the base data, errors may exist.



Figure 9a-7



- ! Municipal Supply Well
- Percent Managed Lands
 - Managed Land < 40%
 - Managed Land 40 - 80%
 - Managed Land > 80%
- SWP Watershed Area
- Municipality Boundary

**City of Barrie
Wellhead Protection Areas
Managed Land**

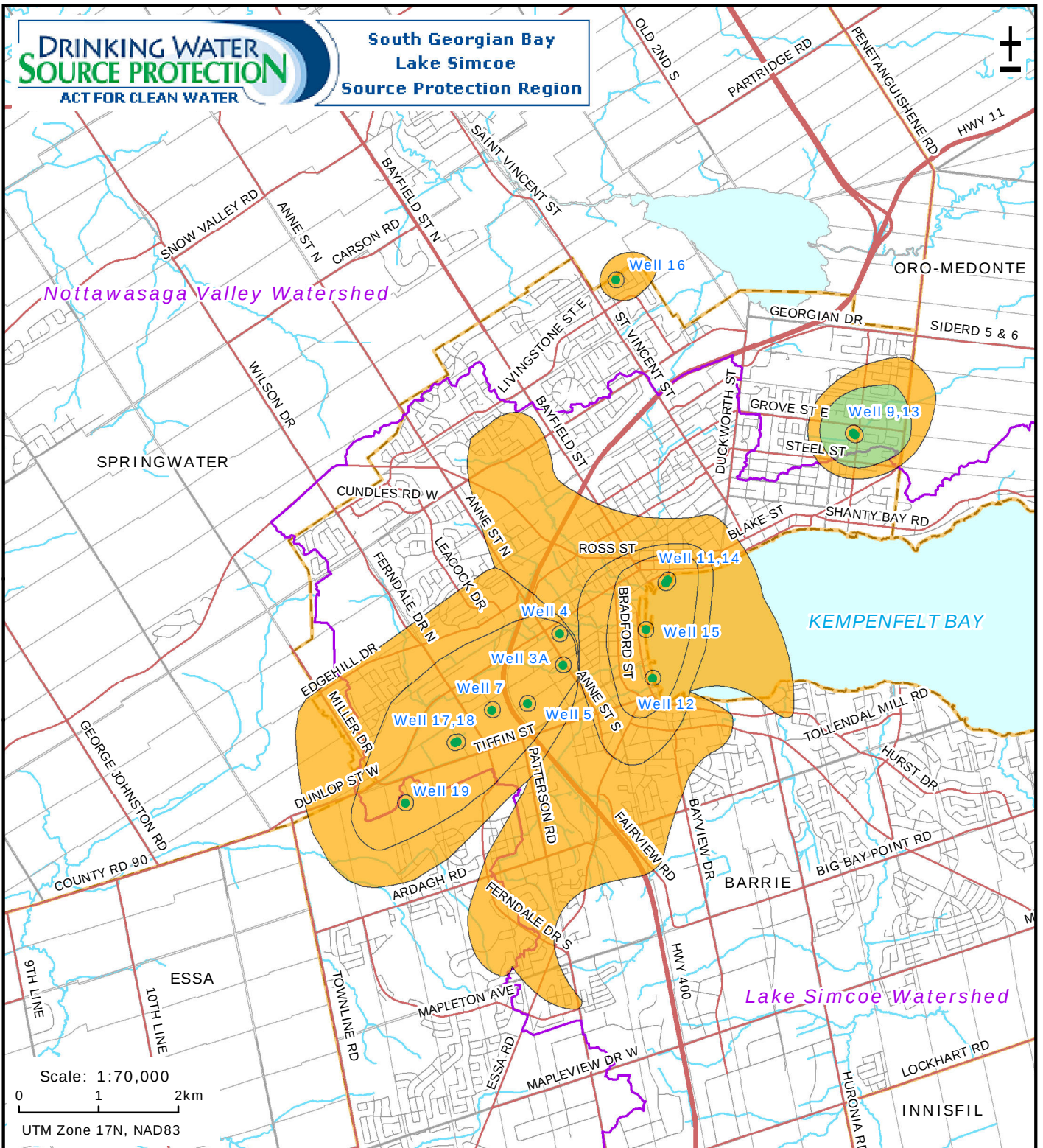
Created by: LSRCA
Date: 2014-04-10



This map was produced by the Lake Simcoe Region Conservation Authority, lead agency of the South Georgian Bay Lake Simcoe Region Source Protection Region. Base data have been compiled from various sources, under data sharing agreements. While every effort has been made to accurately depict the base data, errors may exist.



Figure 9a-8



- Municipal Supply Well
- Livestock Density**
- Livestock Density <0.5 NU/Acre
- Livestock Density 0.5-1.0 NU/Acre
- SWP Watershed Area
- Municipality Boundary

**City of Barrie
Wellhead Protection Areas
Livestock Density**

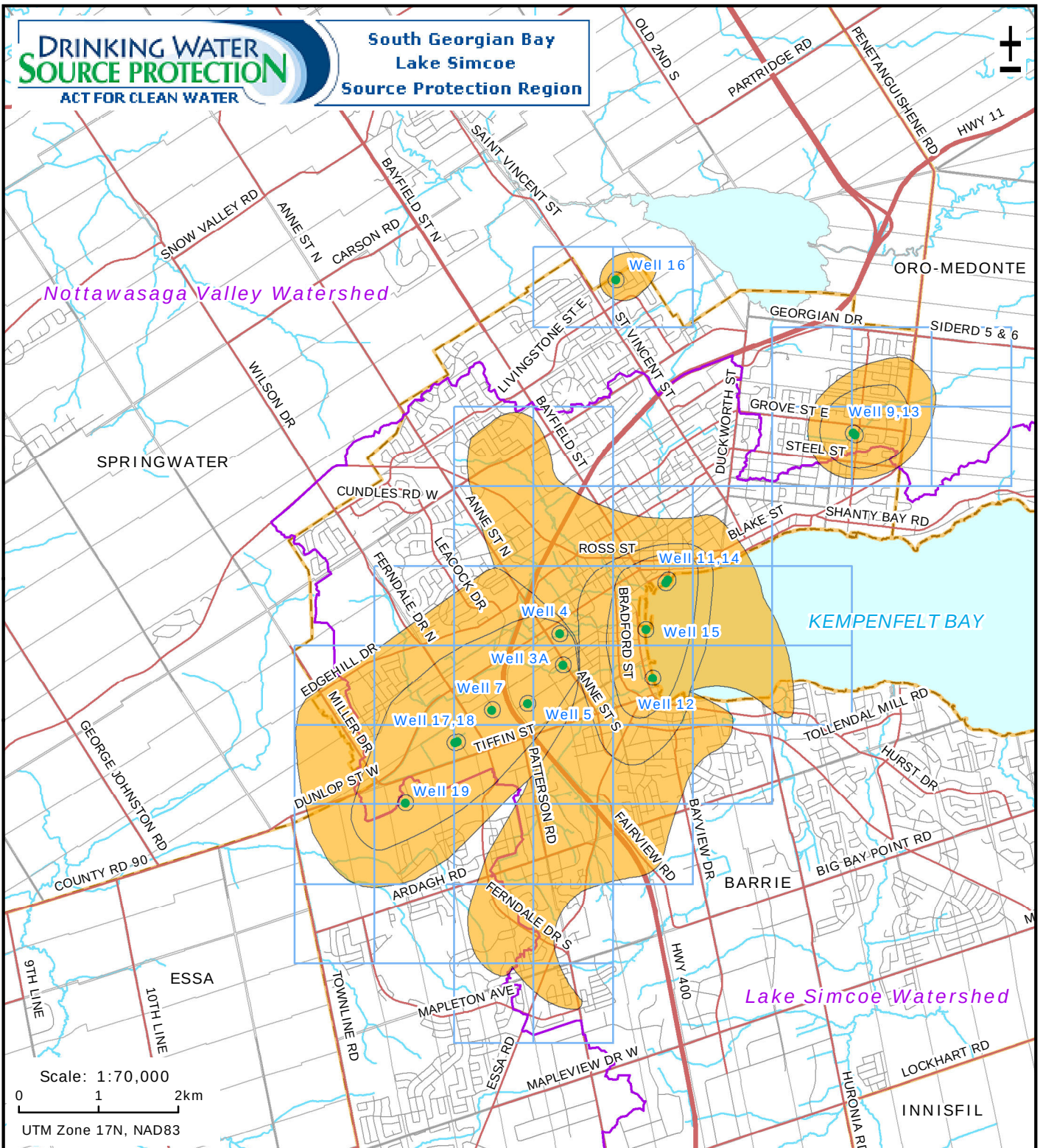
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Date: 2014-04-10



This map was produced by the Lake Simcoe Region Conservation Authority, lead agency of the South Georgian Bay Lake Simcoe Region Source Protection Region. Base data have been compiled from various sources, under data sharing agreements. While every effort has been made to accurately depict the base data, errors may exist.



Figure 9a-9



- ! Municipal Supply Well
- Percent Impervious Area
- <= 1%
- >1% and <8%
- >8% and <80%
- >= 80%
- SWP Watershed Area
- Municipality Boundary
- 1km2 Grid

**City of Barrie
Wellhead Protection Areas
Impervious Area**

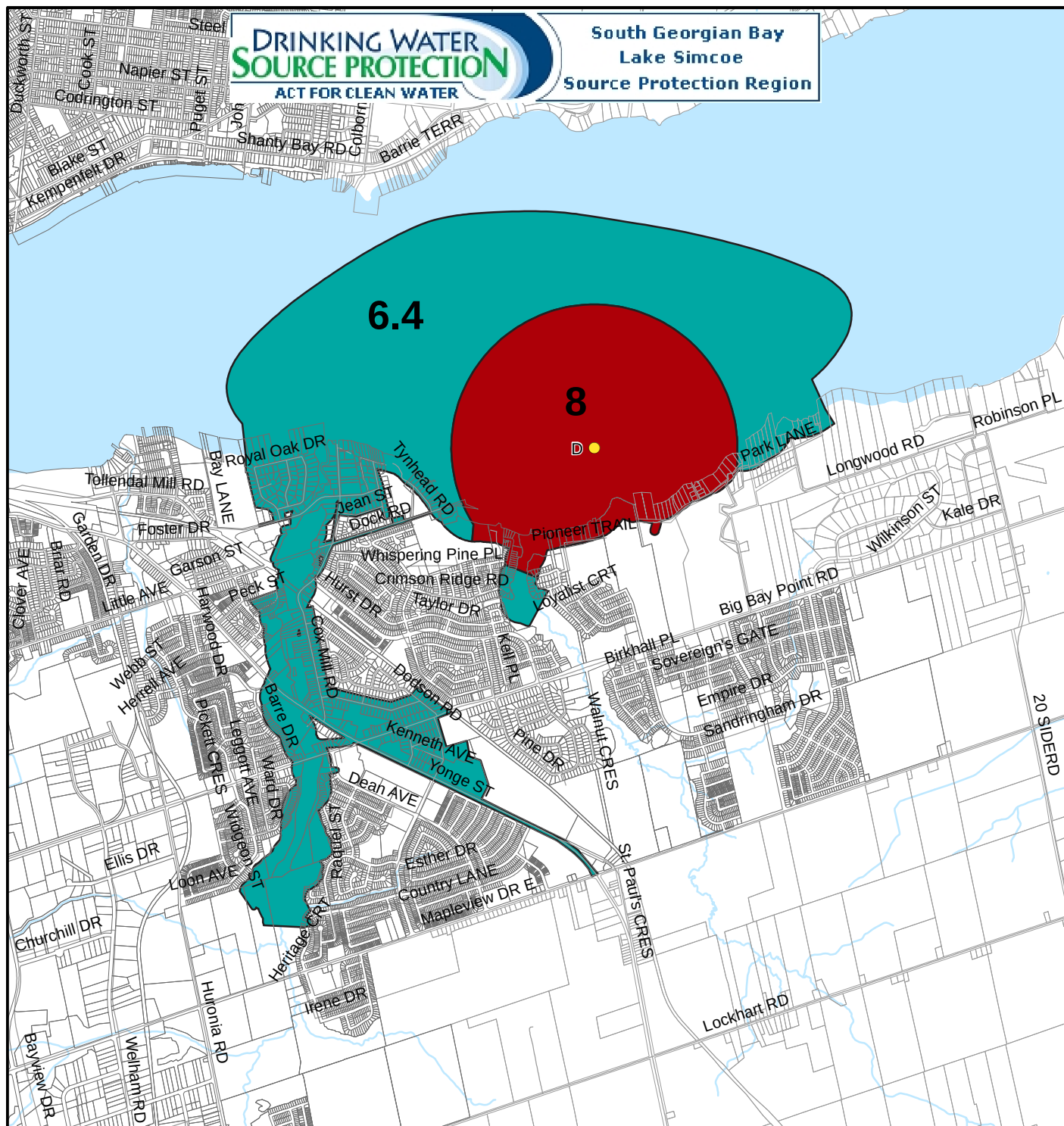
Created by: LSRCA
Date: 2014-04-10



This map was produced by the Lake Simcoe Region Conservation Authority, lead agency of the South Georgian Bay Lake Simcoe Region Source Protection Region. Base data have been compiled from various sources, under data sharing agreements. While every effort has been made to accurately depict the base data, errors may exist.



Figure 9a-10



Legend

- IPZ 1 AND VULNERABILITY SCORE
- IPZ 2 AND VULNERABILITY SCORE
- SURFACE WATER INTAKE (TYPE D)



480 240 0 480 Metres

INTAKE PROTECTION ZONES AND VULNERABILITY SCORES - BARRIE

ASSESSMENT OF DRINKING WATER THREATS
SELECTED MUNICIPAL GROUNDWATER SUPPLIES
South Georgian Bay Lake Simcoe
Source Protection Region

DATE: JUNE 2010

SCALE: 1:40000

PROJECT: 0-071948.08

FILE. NO.: 0-07194808F18-1

This map was produced for the South Georgian Bay Lake Simcoe Source Protection Region for the purposes of completing the South Georgian Bay Lake Simcoe Assessment Report. Base data have been compiled from various sources, under data sharing agreements. While every effort has been made to accurately depict the base data, errors may exist.



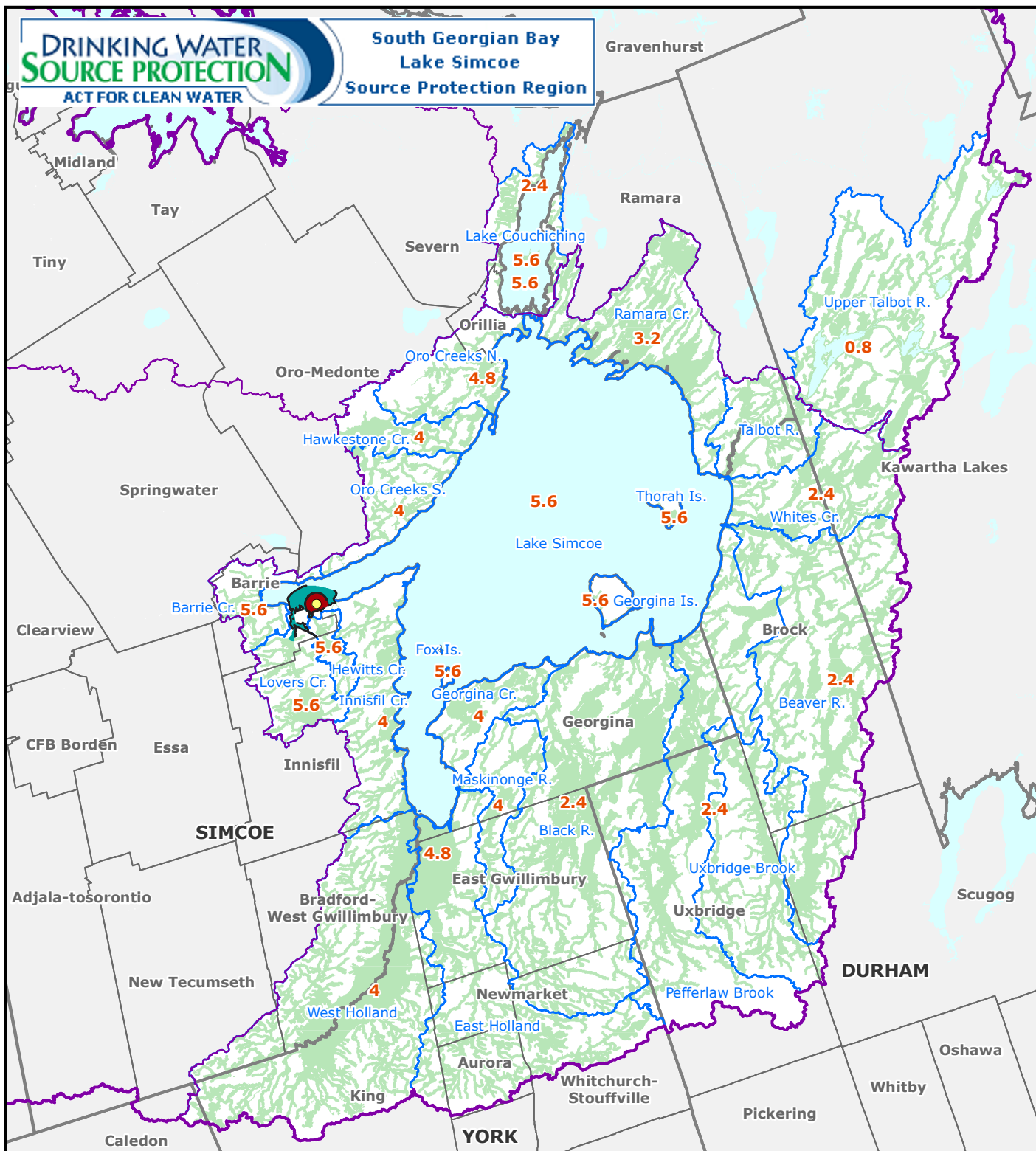
GENIVAR



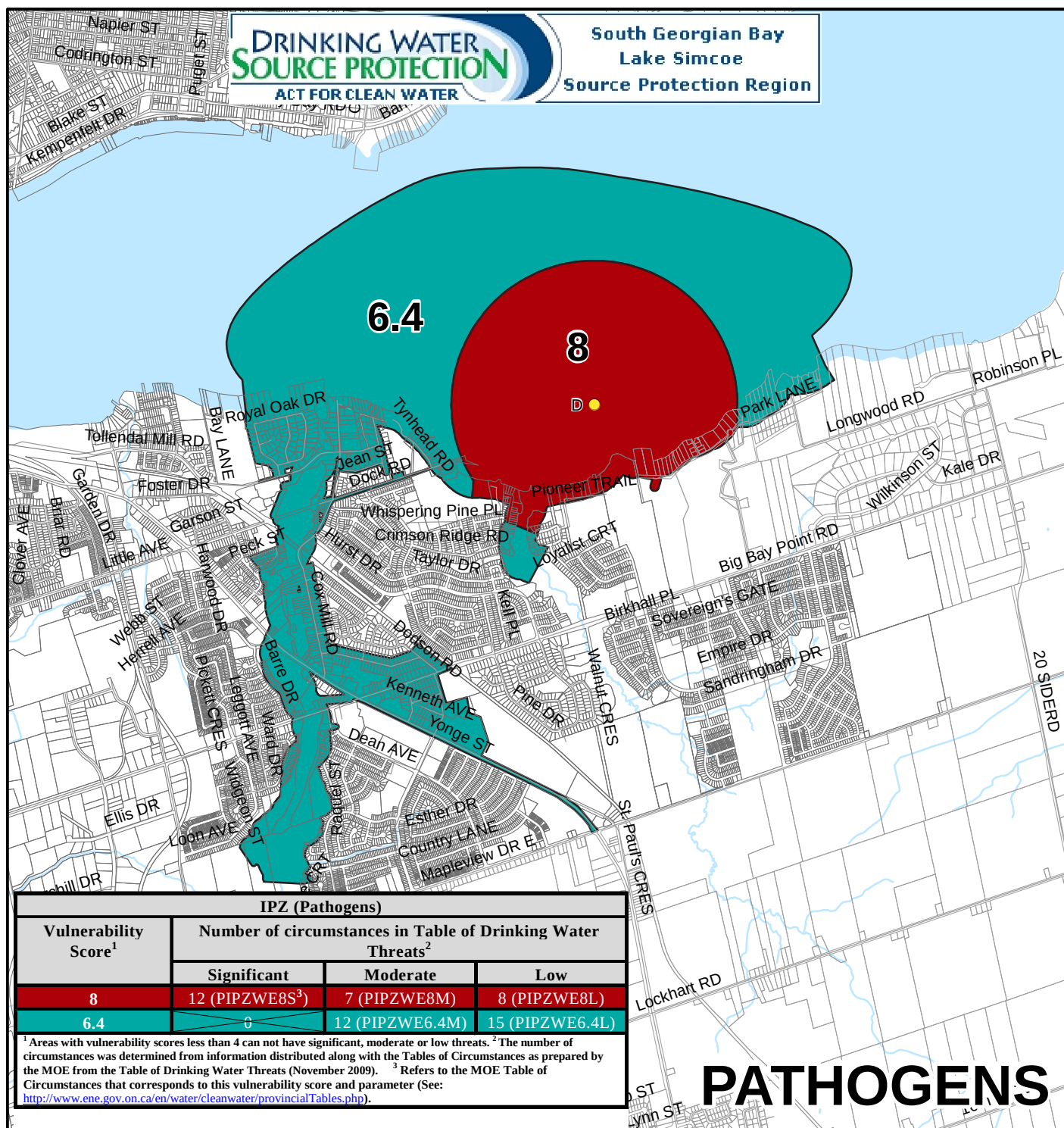
Ontario

FIGURE

8b-1



This map was produced by the Lake Simcoe Region Conservation Authority, lead agency of the South Georgian Bay Lake Simcoe Region Source Protection Region. Base data have been compiled from various sources, under data sharing agreements. While every effort has been made to accurately depict the base data, errors may exist.	Intake Protection Zone 3 and Vulnerability Scores Barrie WTP, City of Barrie Created by: LSRCA Date: 2010-10-20 GENIVAR Scale: 1:500,000 0 2 4 6 8 10km UTM Zone 17N, NAD83 Ontario Figure 8b-2
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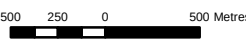


Legend

IPZ 1 AND VULNERABILITY SCORE 8

IPZ 2 AND VULNERABILITY SCORE 6.4

SURFACE WATER INTAKE (TYPE D)

This figure is to be used to identify the areas where a landuse activity is or would be a drinking water threat based on the Technical Rules. The key table is intended to correlate the vulnerability score with circumstances that are significant, moderate, or low threats in the Table of Drinking Water Threats. The table shows the number of circumstances and references the table designation in the Provincial Tables of Circumstances for each threat category.

AREAS WHERE PATHOGENS ARE OR WOULD BE SIGNIFICANT, MODERATE, OR LOW THREATS - BARRIE

DATE: JUNE 2010

PROJECT: 0-071948.08

SCALE: 1:40000

FILE. NO.: 0-07194808F18-2



GENIVAR

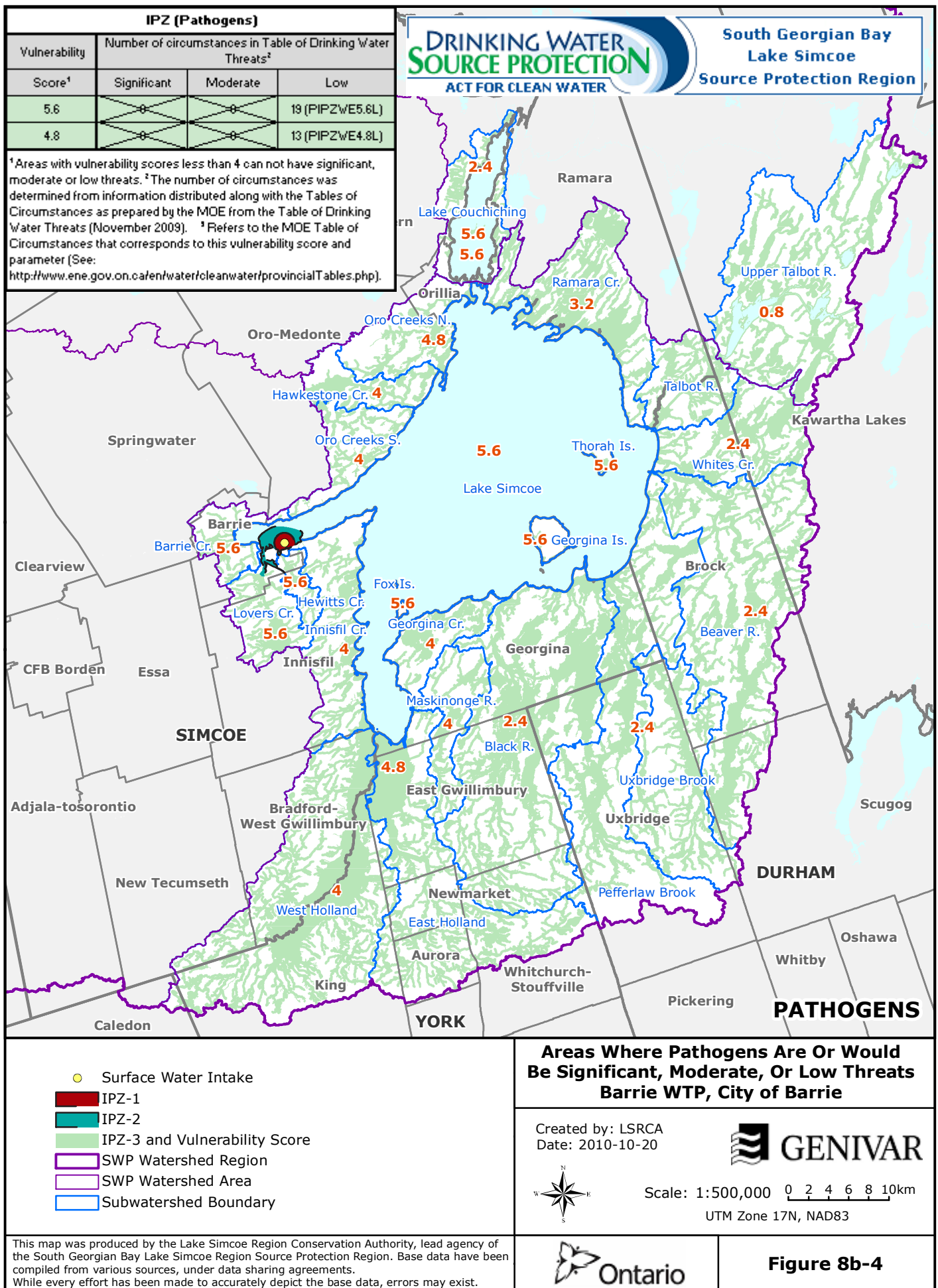


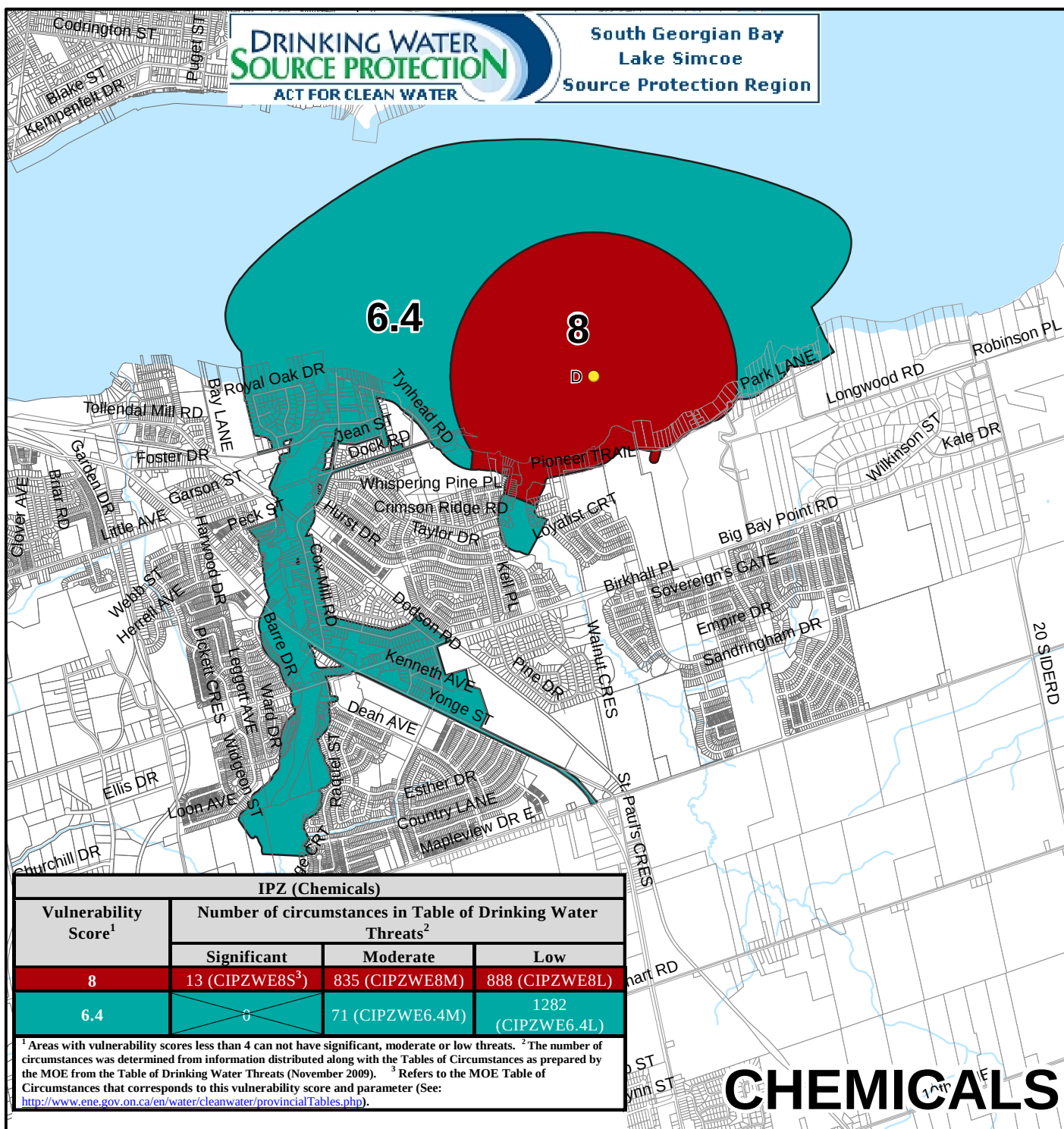
Ontario

FIGURE

8b-3

This map was produced for the South Georgian Bay Lake Simcoe Source Protection Region for the purposes of completing the South Georgian Bay Lake Simcoe Assessment Report. Base data have been compiled from various sources, under data sharing agreements. While every effort has been made to accurately depict the base data, errors may exist.





Legend

-  IPZ 1 AND VULNERABILITY SCORE
 IPZ 2 AND VULNERABILITY SCORE
 SURFACE WATER INTAKE (TYPE D)



This figure is to be used to identify the areas where a landuse activity is or would be a drinking water threat based on the Technical Rules. The key table is intended to correlate the vulnerability score with circumstances that are significant, moderate, or low threats in the Table of Drinking Water Threats. The table shows the number of circumstances and references the table designation in the Provincial Tables of Circumstances for each threat category.

This map was produced for the South Georgian Bay Lake Simcoe Source Protection Region for the purposes of completing the South Georgian Bay Lake Simcoe Assessment Report. Base data have been compiled from various sources, under data sharing agreements. While every effort has been made to accurately depict the base data, errors may exist.

AREAS WHERE CHEMICALS ARE OR WOULD BE SIGNIFICANT, MODERATE, OR LOW THREATS - BARRIE

DATE: JUNE 2010

SCALE: 1:40000

PROJECT: 0-071948.08

FILE. NO.:0-07194808F18-3



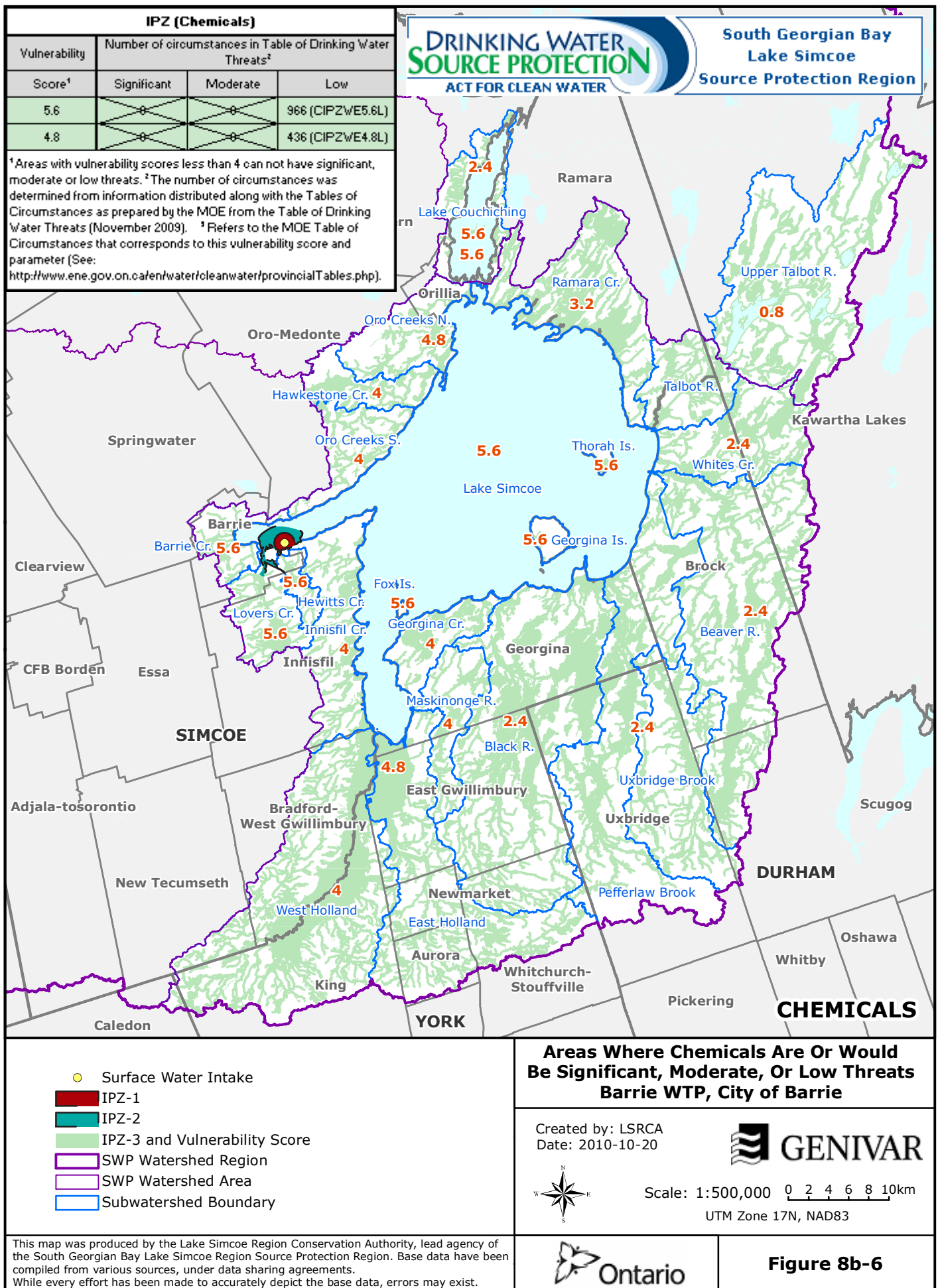
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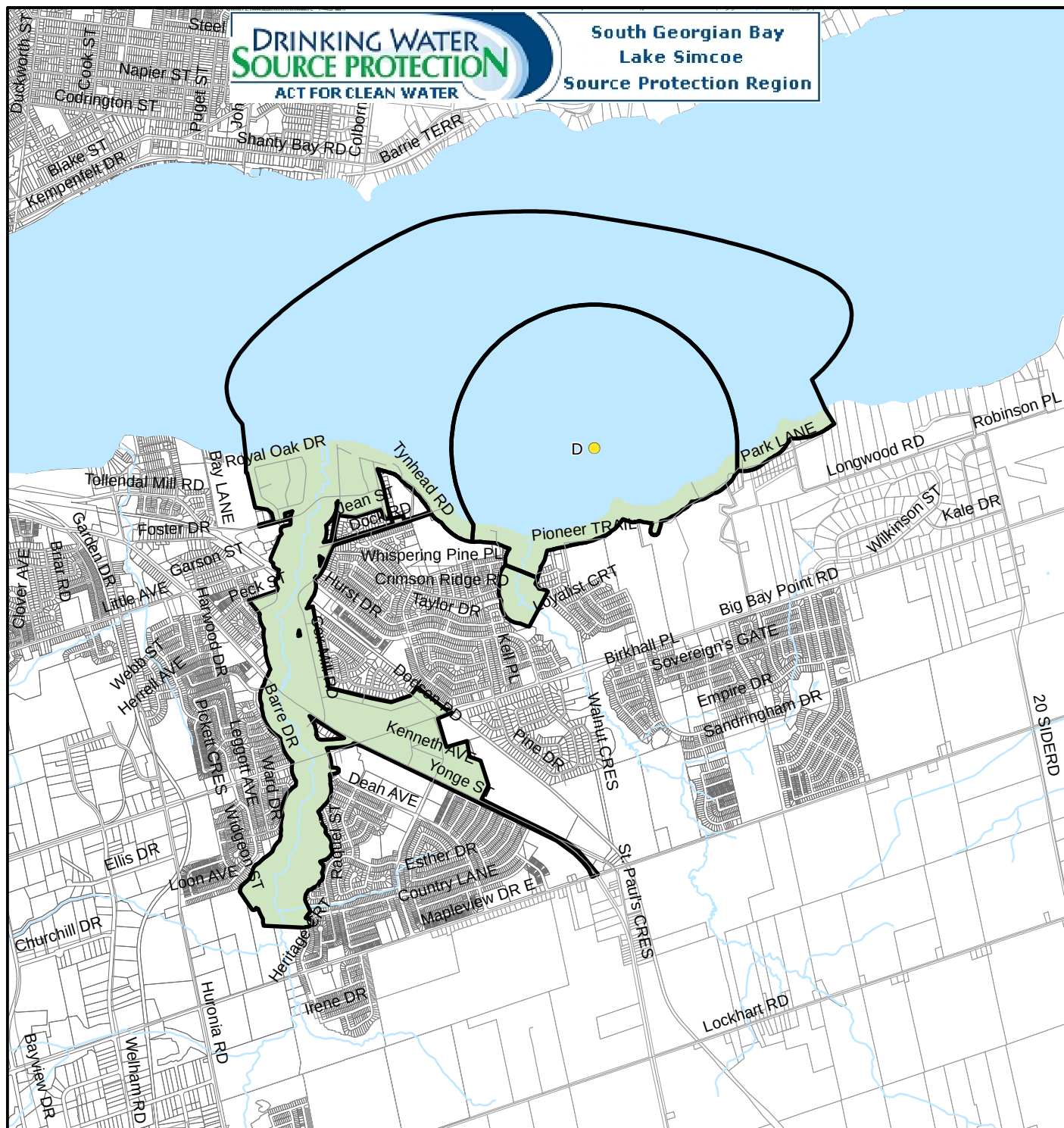


Ontario

FIGURE

8b-5





The Managed Land proportion proportion is illustrated for the parts of IPZ 1 and 2 where the vulnerability score is greater than 4.1.

This map was produced for the South Georgian Bay Lake Simcoe Source Protection Region for the purposes of completing the South Georgian Bay Lake Simcoe Assessment Report. Base data have been compiled from various sources, under data sharing agreements. While every effort has been made to accurately depict the base data, errors may exist.

DATE: JUNE 2010

SCALE: 1:40000

PROJECT: 0-071948.08

FILE. NO.: 0-07194808F18-4



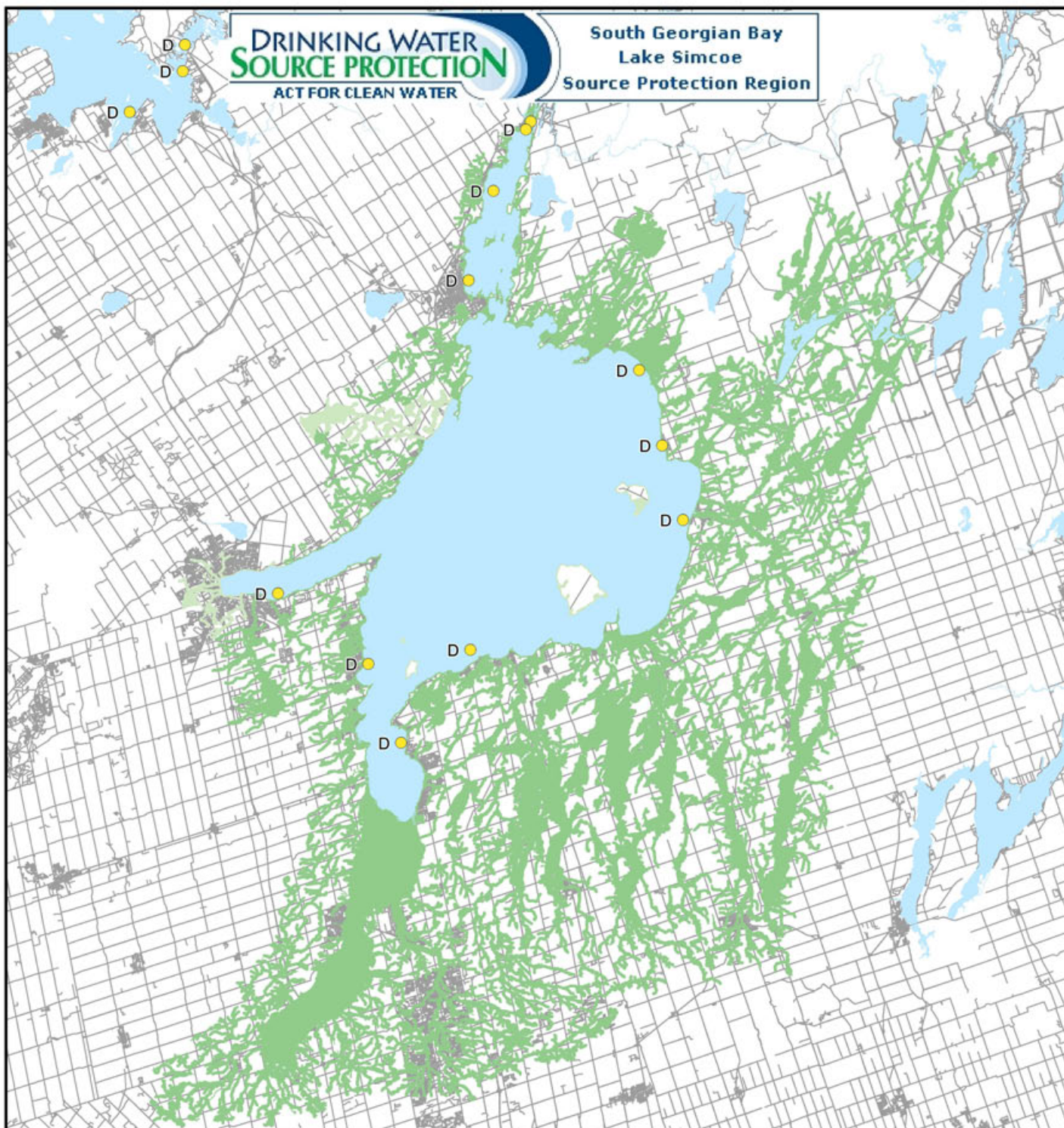
GENIVAR



Ontario

FIGURE

8b-7



Legend

- MANAGED LANDS (<40%)
- MANAGED LANDS (40-80%)
- MANAGED LANDS (>80%)
- SURFACE WATER INTAKE (TYPE D)



5,300 2,650 0 5,300 Metres

MANAGED LANDS - INTAKE PROTECTION ZONE 3

ASSESSMENT OF DRINKING WATER THREATS
SELECTED MUNICIPAL GROUNDWATER SUPPLIES
South Georgian Bay Lake Simcoe
Source Protection Region

The Managed Land proportion is illustrated for the parts of IPZ 3 where the vulnerability score is greater than 4.1.

DATE: JUNE 2010

SCALE: 1:505000

PROJECT: 0-071948.00

FILE. NO.: 0-07194800F3.3-4

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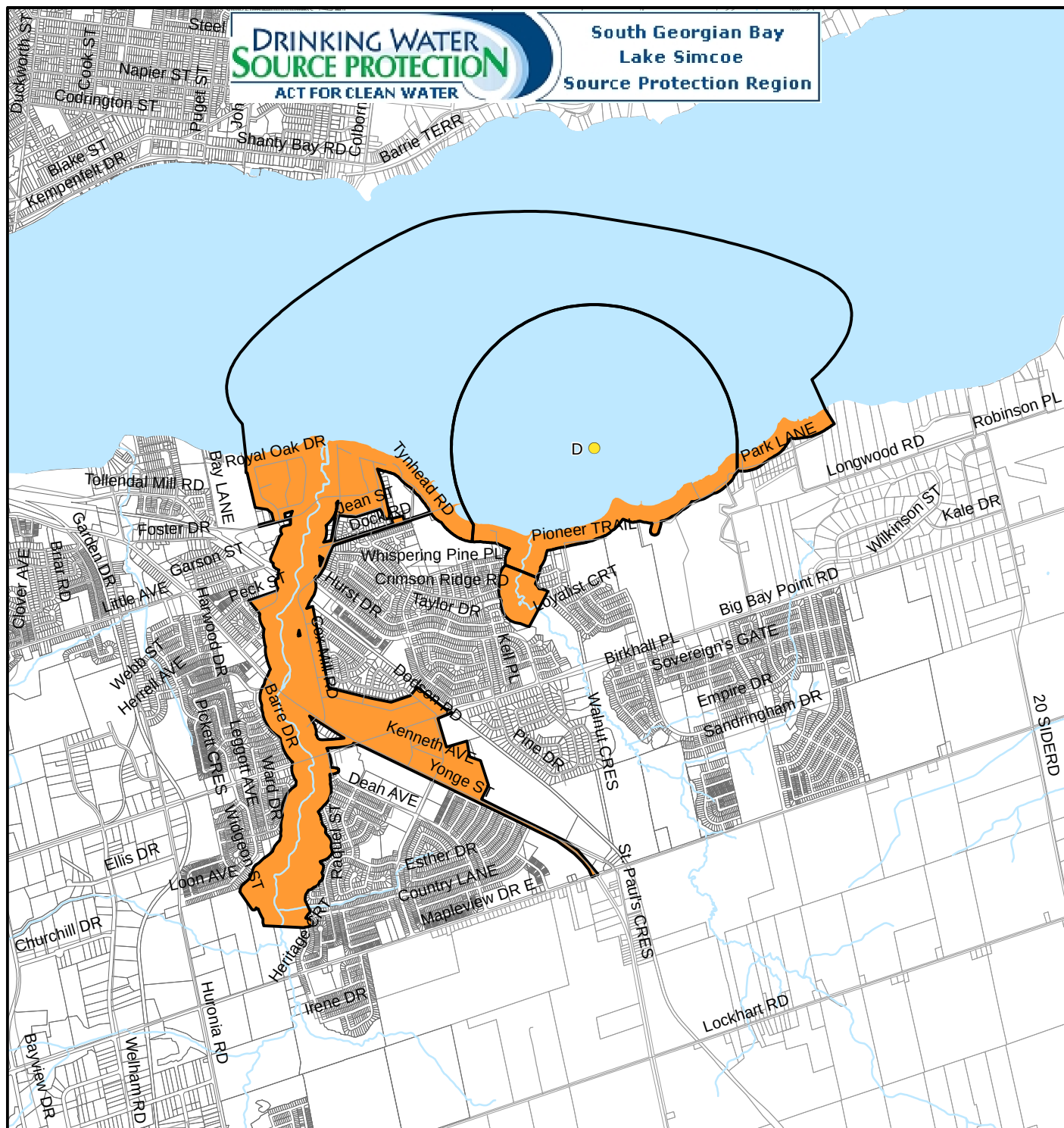
GENIVAR



Ontario

FIGURE

8b-8



The Livestock Density proportion is illustrated for the parts of IPZ 1 and 2 where the vulnerability score is greater than 4.1.

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DATE: JUNE 2010

SCALE: 1:40000

PROJECT: 0-071948.08

FILE. NO.:0-071948.08F18-5



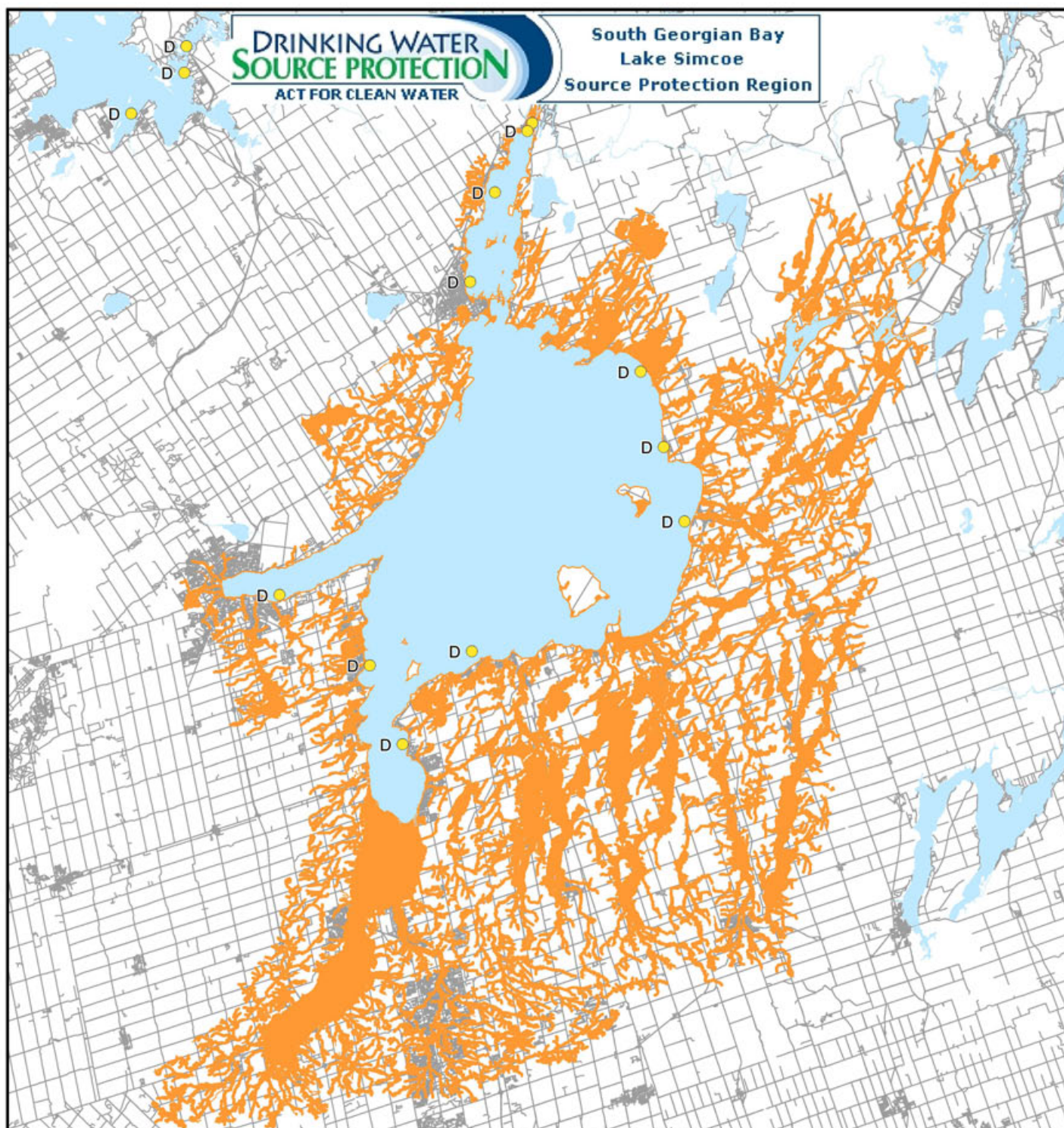
GENIVAR



Ontario

FIGURE

8b-9



Legend

- LIVESTOCK DENSITY (<0.5 NUTRIENT UNITS/ACRE)
- LIVESTOCK DENSITY (0.5-1.0 NUTRIENT UNITS/ACRE)
- LIVESTOCK DENSITY (>1.0 NUTRIENT UNITS/ACRE)
- SURFACE WATER INTAKE (TYPE D)



5,300 2,650 0 5,300 Metres

LIVESTOCK DENSITY - INTAKE PROTECTION ZONE 3

ASSESSMENT OF DRINKING WATER THREATS
SELECTED MUNICIPAL GROUNDWATER SUPPLIES
South Georgian Bay Lake Simcoe
Source Protection Region

The Livestock Density proportion is illustrated for the parts of IPZ 3 where the vulnerability score is greater than 4.1.

DATE: JUNE 2010

SCALE: 1:505000

PROJECT: 0-071948.00

FILE. NO.: 0-07194800F3.3-5

This map was produced for the South Georgian Bay Lake Simcoe Source Protection Region for the purposes of completing the South Georgian Bay Lake Simcoe Assessment Report. Base data have been compiled from various sources, under data sharing agreements. While every effort has been made to accurately depict the base data, errors may exist.



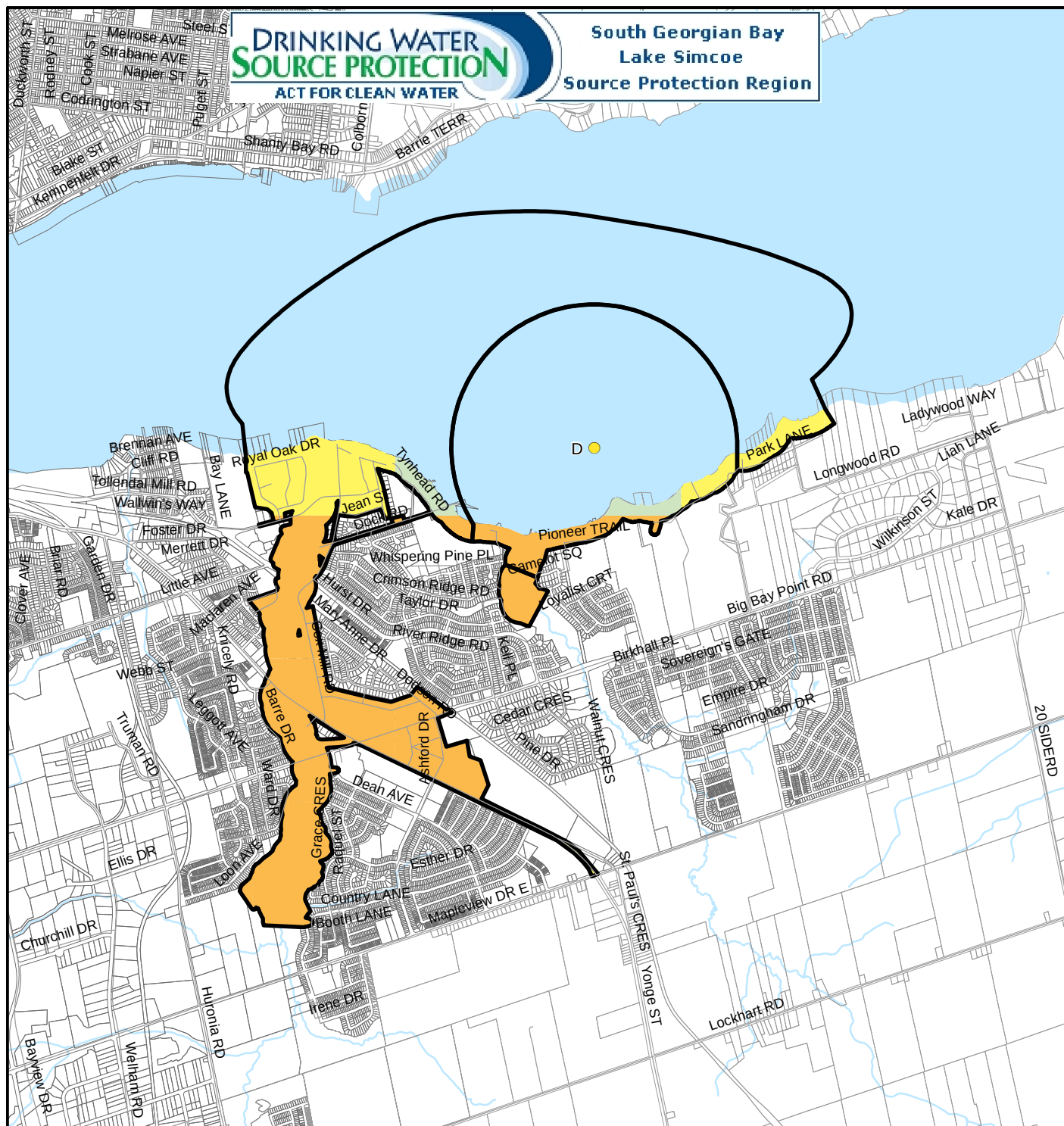
GENIVAR



Ontario

FIGURE

8b-10



Legend

IMPERVIOUS SURFACE

- <1%
- >1% and <8%
- >8% and <80%

Surface Water Intake (Type D)



500 250 0 500 Metres

IMPERVIOUS SURFACES - BARRIE

The Impervious Surfaces proportion is illustrated for the parts of IPZ 1 and 2 where the vulnerability score is greater than 4.1.

This map was produced for the South Georgian Bay Lake Simcoe Source Protection Region for the purposes of completing the South Georgian Bay Lake Simcoe Assessment Report. Base data have been compiled from various sources, under data sharing agreements. While every effort has been made to accurately depict the base data, errors may exist.

DATE: JUNE 2010

SCALE: 1:40000

PROJECT: 0-071948.08

FILE. NO.: 0-07194808F18-6



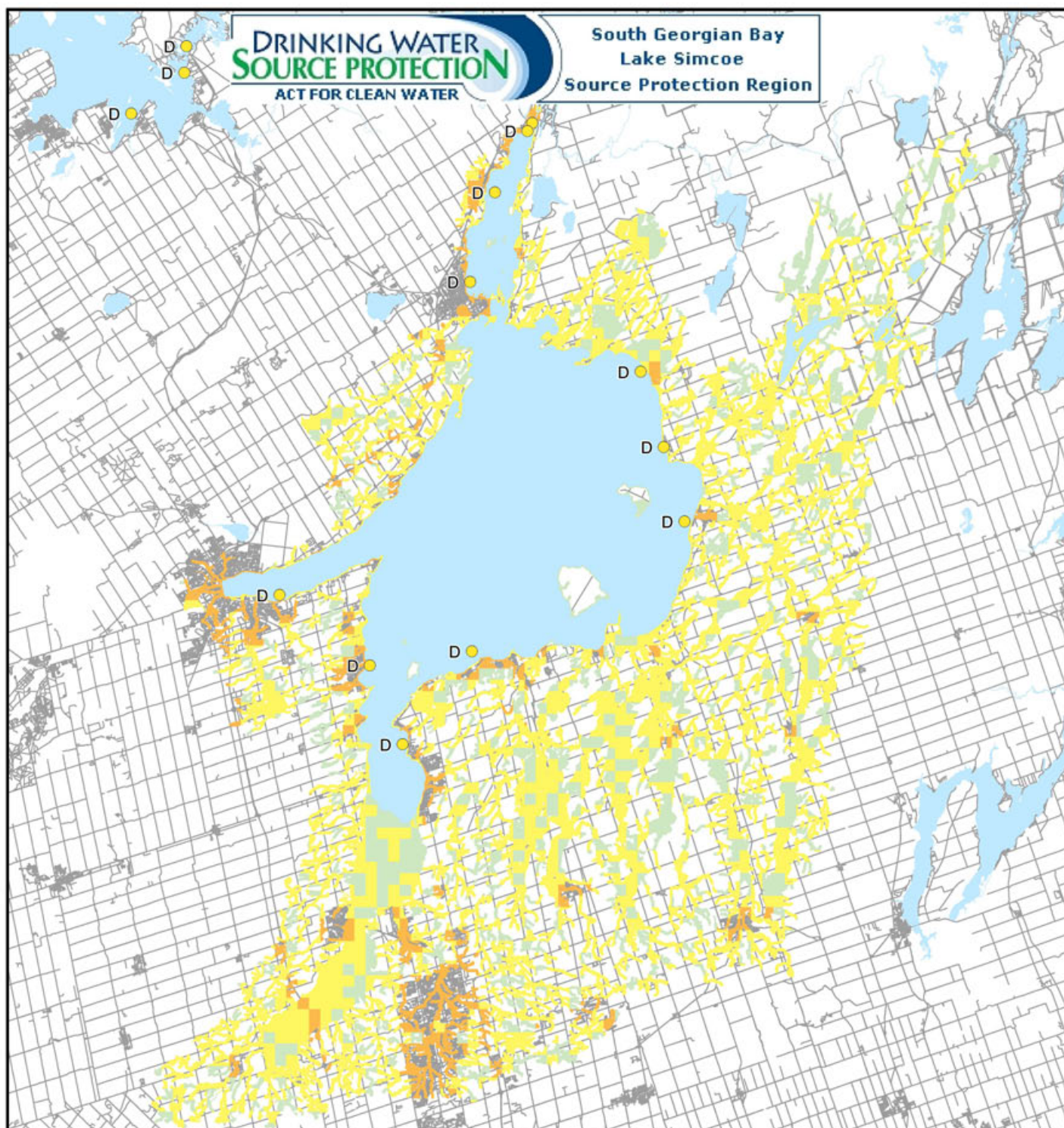
GENIVAR



Ontario

FIGURE

8b-11



Legend

IMPERVIOUS SURFACE

- <1%
- >1% and <8%
- >8% and <80%
- SURFACE WATER INTAKE (TYPE D)



5,400 2,700 0 5,400 Metres

IMPERVIOUS SURFACES - INTAKE PROTECTION ZONE 3

ASSESSMENT OF DRINKING WATER THREATS
SELECTED MUNICIPAL GROUNDWATER SUPPLIES
South Georgian Bay Lake Simcoe
Source Protection Region

The Impervious Surfaces proportion is illustrated for the parts of IPZ 3 where the vulnerability score is greater than 4.1.

DATE: JUNE 2010

SCALE: 1:505000

PROJECT: 0-071948.00

FILE. NO.: 0-07194803F3.3-6

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GENIVAR



Ontario

FIGURE

8b-12