Chapter 8: The Township of Adjala-Tosorontio

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8.1 Introduction

This chapter contains information on seven drinking water systems for the Township of Adjala-Tosorontio. Various consultants have completed the work presented, all of which was reviewed by South Georgian Bay-Lake Simcoe Source Water Protection staff and members of the Technical Work Group. In this chapter, each of the groundwater systems and surface water systems 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 (MECP~~OE~~, 2021~~08a~~)) 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 A) 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 Township of Adjala-Tosorontio operates ~~groundwater based~~groundwater-based water supplies in seven (7) communities and does not have a surface water intake. As shown in Figure 8-1 all of the groundwater supplies are within the South Georgian Bay-Lake Simcoe (SGBLS)

Source Protection Region (SPR). The list below also indicates the Source Protection Region and corresponding lead Source Protection Authority (SPA) for the municipal water supplies.

Municipal Groundwater Supplies in the Township of Adjala-Tosorontio within the Nottawasaga Valley SPA included in this report:

- Colgan
- Everett
- Hockley
- Lisle
- Loretto Heights
- Rosemont
- Weca

In addition to the groundwater systems within Adjala-Tosorontio, a number of vulnerable areas from surrounding municipalities extend into the Township (Table 8-1~~Table 8-1~~). WHPAs from the Alliston and Hillcrest Subdivision Well supplies extend west from the Town of New Tecumseth into the Township of Adjala-Tosorontio. Information on these systems can be found in this report, Chapter 14.

Also, WHPAs from the Lisle, Rosemont, Hockley, and Colgan water supplies extend out of the Township into other municipalities (Table 8-1~~Table 8-1~~).

Table 8-1: WHPA that cross into and out of the Township of Adjala-Tosorontio in the SGBLS SPR.

Local Municipality that WHPA extends into	Municipality where wellhead is located	Name of Water Supply	Source Protection Region (SPR) and Source Protection Authority (SPA)	Location where entire Assessment can be obtained
Township of Adjala-Tosorontio	Town of New Tecumseth	Alliston	SGBLS SPR and Nottawasaga Valley SPA	This report (Chapter 14)
Township of Adjala-Tosorontio	Town of New Tecumseth	Hillcrest Subdivision	SGBLS SPR and	This report (Chapter 14)

Local Municipality that WHPA extends into	Municipality where wellhead is located	Name of Water Supply	Source Protection Region (SPR) and Source Protection Authority (SPA)	Location where entire Assessment can be obtained
			Nottawasaga Valley SPA	
Mulmur	Township of Adjala-Tosorontio	Lisle	SGBLS SPR and Nottawasaga Valley SPA	This Chapter
Mono	Township of Adjala-Tosorontio	Rosemont	SGBLS SPR and Nottawasaga Valley SPA	This Chapter
Mono	Township of Adjala-Tosorontio	Hockley	SGBLS SPR and Nottawasaga Valley SPA	This Chapter
New Tecumseth	Township of Adjala-Tosorontio	Colgan	SGBLS SPR and Nottawasaga Valley SPA	This Chapter

The Township of Adjala-Tosorontio is located in Simcoe County, with the northern boundary situated approximately 25 km south of Georgian Bay and the eastern boundary 30 km west of Lake Simcoe. The study area is comprised of the Township lands and an additional 5 km buffer zone that covers a total area of approximately 89,716 ha. The ground surface elevation in the Township of Adjala-Tosorontio ranges from a high of over 400 m above sea level (masl) in the southwest near Mono Mills to lows in the region of 200 masl in the north east, near Alliston.

The Township is a part of the Nottawasaga Valley Watershed and drainage is generally north eastward into this system. The low areas of the Township are generally found in the vicinity of the major drainage channels which are the Nottawasaga River and Sheldon and Bailey Creeks.

The northern portion of the Township is dominantly sand plains with some spillways, till moraine and till plains. Lisle and Everett are located within the sand plains. Rosemont is situated in elevated till plains lined with drumlins. Loretto is located in clay plains known as the Schomberg Clay and consists of deep deposits of stratified clay and silt.

The southern portion of the Township of Adjala-Tosorontio is located within the Oak Ridges Moraine. The surface identified as kame moraine is hilly with a knob and basin relief typical of end moraine (Chapman and Putnam, 1984). Sediments are for the most part composed of sandy or gravelly materials with good drainage.

The surficial geology of the Township consists of sediment deposited during the final Wisconsinian Stage of glaciation. These deposits include glacial till, ice-contact stratified deposits and glacio-fluvial deposits. Older alluvium deposits are found along the main rivers and tributaries.

The Colgan, Loretto, and Rosemont well fields are located near silty to clayey till deposits known as the Kettleby Till (Ontario Division of Mines Map P-835, 1973). The Lisle and Everett wells are located near glacio-fluvial deposits consisting of sand and gravel. Ice-contact stratified deposits are located in the most southern portion of the Township, in the vicinity of the Hamlet of Hockley.

Bedrock in the area consists of blue-grey shale and inter-bedded limestone of the Georgian Bay Formation. The Georgian Bay Formation is considered to be a part of the Blue Mountain-Georgian Bay hydrogeologic unit and is regarded as a low yielding aquifer (Singer *et al*., 2003). Most wells in Adjala-Tosorontio are completed in overburden sediments with the exception of the Rosemont area. The Rosemont municipal wells utilize the shale bedrock of the Queenston Formation as a water supply aquifer.

8.3 Colgan Well Supply

The Colgan Water Supply System provides water to an estimated population of 2400 corresponding to~~-~~ 841 (Colgan 1), 878 (Colgan 2), plus 29 (Colgan commercial), and 454 (Colgan institutional) plus the equivalent population is 232 in the existing Hamlet.

~~of 192 persons (Burnside, 2006) serving 71 homes and one school.~~ There are currently three ~~sources considered~~municipal wells as ~~to be a~~ part of the Colgan water supply system~~: for Colgan,~~ CW1, C~~P~~W2, and C~~P~~W3.

~~The following discussion provides an outline of the~~ Historically ~~history and current status of these wells~~, the ~~. The~~ oldest well in the system ~~is~~ was PW2 which was drilled in 1986. ~~6 as the water supply source for the community.~~ Due to water quality problems at PW2, a new well, PW3, was drilled, however similar water quality problems were encountered (Burnside, 2005b). The Source Protection Committee recognizes that the Township of Adjala-Tosorontio has since decommissioned Colgan wells PW2, PW3 and observation well TW3-97 (Appendix A, Pg 264) as of July 29, 2011 with approval was granted from the MECP.

. ~~In order to accommodate increased water demand TW3-97 was drilled in 1997. Shortly after being drilled TW3-97 encountered silt production and methane problems, despite efforts to reduce pumping rates the turbidity problem was not resolved and the well was subsequently taken off line.~~

As part of an effort to find a new ~~groundwater based~~groundwater-based source, CW1 was completed in 20054 and brought online in 2009, replacing ~~. CW1 was constructed to replace~~ PW2 and PW3. ~~CW1 was brought online in 2009. Three~~ Two other municipal production wells, CW2 and CW3, ~~s~~are present at the CW1 site and have similar construction and geology.

The existing groundwater supply wells (CW1, CW2, and CW3, drilled in 2005) were constructed as 152-mm diameter, 36.6 m deep wells, with screened intervals between 30.5 m and 36.6 m and completed within a sand and gravel aquifer.

In 2016, Colgan completed a Schedule B Environmental Assessment Amendment (Greenland 2016) to their Master Servicing Plan Study Report under the Municipal Class Environmental Assessment (Class EA) process. To service the complete buildout of the Colgan 1 development, and a portion of the Colgan 2 development, an ADD of 6.2 L/s and MDD of 12.4 L/s were estimated.

~~CW1 (TW1/04) has a 150 mm diameter casing that extends from 0.6 m above grade to 30.5 m below grade (bg) and a 140 mm diameter well screen installed from 29.9 to 36.6 m bg. The well is constructed in a grey sand aquifer at a depth from 26.0 to 36.6 m bg. The driller's log indicates clay from 11.3 to 13.1 m bg and from 24.4 to 26.0 m bg (Burnside, 2005a).~~

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~~The well field at the CW1 site is the planned water supply system for Colgan that will be developed over time. The additional wells at this site are slated to act as standby wells for CW1 with the intent that they will be brought online as part of a consolidated permit for the Colgan CW1 well field. Due to ongoing problems with the operation of the new CW1 well field PW2 and PW3 continue to be utilized as the sources for water supply in Colgan. PW2 and PW3 are located near the Village of Colgan. PW2 and PW3 were constructed in 1986 and 1987, respectively. PW2 is a 127 mm diameter PVC cased well constructed to a depth of 49.4 m. PW3 is a 152 mm diameter steel cased well with a depth of 49.2 m. Since both wells are located in a deep confined aquifer and are in close proximity to each other, the wells were modeled together as one combined well (Golder & WHI, 2004).~~

~~The Source Protection Committee recognizes that the Township of Adjala-Tosorontio has since decommissioned Colgan wells PW2, PW3 and observation well TW3-97 (Appendix A, Pg 264). As of July 29, 2011 approval was granted from the MECPOE to remove the wells from the Terms of Reference, the Assessment Report and subsequently the Source Protection Plan (Appendix A pg 260. This leaves Colgan with three wells (CW1, CW2 and CW3) on future PTTW.~~

The Information presented for the Colgan section of this Chapter is based on Burnside, 2010d report and WSP Golder (2022). ~~-~~

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 Colgan water supply has been delineated following the process recommended in the Technical Rules. The areas that contribute groundwater to the wells were delineated as WHPA. The Groundwater Vulnerability within the WHPA was assessed and consideration was included to consider the effects of man-made structures that may increase the Vulnerability. The WHPA and the Vulnerability were considered together as per the

Technical Rules to determine a Vulnerability Score for the Colgan Water Supply. Details of the methods for the Vulnerability Analysis are provided in ~~Burnside, 2010d~~WSP Golder (2022).

8.3.1.1 Wellhead Protection Area (WHPA) Delineation

The WHPA modelling for the Colgan municipal drinking water system has been completed through three phases:

1) The original ~~Wellhead Protection Areas~~ WHPAs for the Colgan wells (PW2 and PW3, since ~~were~~decommissioned) were completed as part of the South Simcoe Municipal Groundwater Study (SSMGS) completed by Golder Associates (Golder) in ~~2004.~~2004.
2) WHPAs for the new Colgan wells (CW1, CW2, and CW3) were completed by S.S Papadopulos as part of a Threats Assessment that was completed by Burnside in 2007.
3) The WHPA update to reflect the increased taking and WHPA-E delineation of CW1, CW2, and CW3 by Golder (2022).

~~As part of~~The ~~-~~original ~~the South Simcoe Municipal Groundwater Study (~~SSMGS~~), numerical groundwater flow models were developed by Golder Associates and Waterloo Hydrogeologic Inc (WHI now Schlumberger Water Services) for the areas of Colgan, Lisle, Everett and Loretto. These areas were part of a larger model developed for the Borden-Angus and Tottenham municipal systems which were also part of the SSMGS~~ model was used for the ~~. The~~ Colgan, Loretto, and Weca areas ~~were modeled~~ through the use of the ~~using the~~ Tottenham three-dimensional numerical model. The Tottenham model consisted of six overburden and one bedrock layer in the region of the Loretto and Weca wells. Overall model boundaries were established using static water levels from the ~~MOE~~ MECP Water Well Information System (WWIS). Boundary conditions were applied at rivers and creeks in the vicinity of the municipal wells.

For the Colgan, Loretto, and Weca wells, the model was calibrated to represent steady state conditions utilizing 86 static water levels from wells located throughout the model domain~~. Additional details on the model assumptions and considerations are provided in the model summary report in~~ (Burnside, 2010d).

The groundwater flow model for the new Colgan wells (CW1, CW2, and CW3) was developed by S.S. Papadopulos and Associates (2007) using the USGS three-dimensional groundwater simulator MODFLOW-2000. The model domain extended 9 km in the east-west direction and 10 km in the north-south direction, centred at the well location. The model domain was divided vertically into three layers representing the three layers of overburden sediments. The model

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boundaries were aligned with the groundwater path lines that were inferred from the interpolated water level contours and the locations of streams.

There was very sparse data to serve as calibration targets in this area and hence the model was calibrated in a trial and study method where aquifer parameters were modified until the best fit to observed water levels was obtained. Full details of the modeling completed including assumptions and results are included Burnside, 2010d.

The latest modelling exercise, completed by Golder (2022), was undertaken using a newly developed (3D) MODFLOW groundwater model which is a 3D groundwater flow code developed by the United States Geological Survey and is recognized as an industry standard for general purpose groundwater flow modelling. The current model area is irregularly shaped and spans an area of approximately 17.8 km^2.

The MODPATH module in MODFLOW was used to generate 3D pathlines which indicate the source and travel pathway of recharge supplying the well. For this analysis the 2-year, 5-year and 25-year time of travel capture zones were examined as these periods correspond to the WHPA-B, -C and -D WHPA designations under the Technical Rules. Capture zones were modelled using the average daily demand of 6.2 L/s corresponding to the anticipated demand over the wellfield. (It is noted that each of the individual wells can produce 6.4 L/s, but that ADD rate is the total for the system). The ADD is considered the most realistic portrayal of long-term water use, compared to the proposed MDD of 12.4 L/s, which according to the anticipated water use would only occur for relatively short periods. The WHPA extends radially to the south and east to a maximum upgradient distance of about 980 m, and marginally to the northeast. The width of the capture zone is about 815m. The overall vulnerability and WHPA uncertainty is characterized as Low.

The area associated with each WHPA zone is outlined below in km^2. It is noted that the zones are not exclusive. For example, the WHPA-C in GIS incorporates the WHPA A, WHPA B and WHPA C area and not just the WHPA C without A and B.

WHPA A	0.04 km^2
WHPA B	0.09 km^2
WHPA C	0.23 km^2
WHPA D	6.67 km^2

~~There was very sparse data to serve as calibration targets in this area and hence the model was calibrated in a trial and study method where aquifer parameters were modified until the best~~

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~~fit to observed water levels was obtained. Full details of the modeling completed including assumptions and results are included Burnside, 2010d.~~

~~The WHPA for Colgan PW2 and PW3 is linear in shape and extends in a southward direction. The length of the WHPA extends approximately 1,700 m from the wells with a maximum width of 365 m. The total area of the WHPA is approximately 50 ha.~~

~~The WHPA generated for CW1 (TW1-04), CW2, and CW3 is roughly circular in shape with a slight elongation in a westerly to south-westerly direction. The capture zones resemble fans rather than long thin features. The width of the capture zone reflects the fact that the source of the water for the well is captured recharge rather than interception of flow from a distant up-gradient boundary. This is characteristic of pumping from an unconfined aquifer. The zone extends approximately 750 m from the well and is approximately 1,100 m across; the total area covered by the protection zones is approximately 102 ha.~~

The WHPAs for the Colgan Wells are shown in Figure 8a-1.

8.3.1.2 WHPA-E ~~/ WHPA-F~~

The analysis conducted in 2010 (Burnside, 2010) found that the Colgan wells were not considered to be classified as GUDI, and as such no WHPA-E was defined. The pumping test assessment conducted in 2011 (Burnside, 2011), at a rate of 15.2 L/s for a period of 15 days, reported a measurable response at several surface water features in the vicinity of the pumping wells. Subsequent testing in 2017 (Golder, 2018), at a pumping rate of 10.5 L/s for a period of 55-days, noted a decline in the groundwater level in the offline pond located east of the supply wells, and no measurable effect was noted on the water levels at the various stream monitoring locations. The results of the groundwater modelling evaluation, predict a loss of baseflow to Beeton Creek, and surface water discharge (i.e., leakage) from the creek to the aquifer at a rate of approximately 0.5 L/s under the MDD conditions. Based on the results of the various pumping test programs, and the groundwater modelling predictions, it is assumed that at the proposed taking rates the pumping wells (CW1, CW2, CW3) would be operating under GUDI conditions.

As a result, the WHPA-E was delineated for the Colgan municipal wells.

Due to the relatively small size of the drainage basin, and the expectation that flow within the indicated surface water bodies would predominantly be associated with rainfall events, it was conservatively assumed that the full extent of the features would be within a 2-hour travel time of the WHPA-E location.

The vulnerability score of the WHPA-E is 6.3. Further, the area associated with the WHPA-E corresponds to 2.44 km^2.

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~~None of the wells in this study have been identified as Groundwater Under the Direct Influence of surface water (GUDI), 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.~~

8.3.1.3 Groundwater Vulnerability

The aquifer vulnerability was calculated using the Aquifer Vulnerability Index (AVI) method as outlined in the Draft Assessment Report Guidance Module 3 – Appendix 3 (December 2006). This was completed in a GIS environment and was conducted outside of the environment of the groundwater flow model. The AVI assessment was based on both the model information (i.e., layers, conductivity), the geological information available from the MECP Water Well Database, and the assessment presented in Burnside (2010) and updated by Golder (2022) for the new WHPA delineation. ~~The primary datasets used in this support role were the Ministry of Northern Development and Mines surficial Geology of Southern Ontario and the Ministry of Natural Resource and Forestry (MNRF) Ontario Base Data. Calculations for aquifer vulnerability are based upon the geologic material present and the thickness of the material overlying aquifer.~~

Various interpolation methods were evaluated to determine the best method for creating the AVI surface. It was determined that the interpolation produced by the Australian National University's Digital Elevation Model algorithm (ANUDEM) performed the best. Following the interpolation, post processing was performed on the results to produce a vector polygon dataset, and areas less than 5 ha in size were merged with larger areas. The final AVI surface used for this study is a combination AVI surface - using bedrock wells, supplemental points, and overburden wells greater than 500 m from a bedrock well. This combination AVI surface was created to reflect aquifer vulnerability for the municipal wells. More details on the AVI approach and their limitations are available in Burnside, 2010d.

The Groundwater Vulnerability is shown in ~~Figure 8a-2~~ and illustrates the ~~-~~area within WHPA-B, WHPA-C, and WHPA-D generally classified as having a "Medium" intrinsic vulnerability, except for a "Low" vulnerability area over the western portion of the WHPA-C and WHPA-D as the production aquifer is confined throughout the area. This result is consistent with the aquifer vulnerability classification presented in Burnside (2010).

~~The Vulnerability of the Colgan WHPAs is dominated by zones of Medium and Low Vulnerability as the production aquifer is confined throughout the area. For CW1, It is noted that WHPA-A through C are comprised solely of Medium and Low Vulnerability areas. There is one area of High Vulnerability located at the southern edge of WHPA-D. Based on geology it is assumed that the High Vulnerability of this area is due to highly permeable (sand and gravel) layers being encountered in the overburden at this location. The Vulnerability within the PW2 and PW3 WHPAs is mapped as Low Vulnerability.~~

8.3.1.4 Transport Pathway Increase

The Technical Rules allow for an increase in Vulnerability Rating of an aquifer due to the presence of Transport Pathways that may increase the Vulnerability of the aquifer by providing a conduit for contaminants to bypass the natural protection of the aquifer. The Vulnerability Rating can be increased from Medium to High, Low to Medium, or from Low to High in accordance with the potential for artificial Transport Pathways to increase the observed Vulnerability.

Transport pathways are developed where man-made (anthropogenic) features in the aquifer provide a path along which contaminants can migrate to the regional aquifer. The following features were considered as Transport Pathways for all systems listed in **Error! Reference source not found.**~~Table 8-1~~ within the context of the ~~Burnside, 2010d study~~Golder (2022) study. ~~:~~

Due to the depth of the supply aquifer, it is unlikely that underground services or subsurface excavations would reach the aquifer. Further, there are no pits or quarries in the area. Thus, the only transport pathway of potential concern would involve private domestic wells.

~~**Septic Systems**~~

~~Septic systems are considered Transport Pathways as they can provide a conduit for contaminants to travel through the ground to the water table. Septic systems are generally built in the upper few metres of the ground and consist of a tank and drainage tiles for which the sewage discharge infiltrates back into the ground. Septic systems are associated with all rural houses in the various WHPAs.~~

~~Since septic systems only penetrate the upper few metres of the ground, they will only provide Transport Pathways when they penetrate the water table of an unconfined aquifer system. The only wells that utilize an unconfined aquifer are located in Rosemont (see Section 8.8 for the Rosemont system).~~

~~**Surface Water Features**~~

~~Several surface water ponds were identified in the various WHPAs. Ponds present a threat when they are interconnected to the underlying aquifer. Since information regarding the nature of the ponds is not available it is not possible to predict the risk of each individual pond. Based on the hydrogeology of the areas, most of the aquifers utilized by the municipal wells are protected by an aquitard, thus most ponds will be located above the aquitard and have little to no connectivity with the regional aquifer.~~

Domestic Water Wells

Domestic water wells are the most common man-made preferential pathway in rural areas. Improperly constructed wells can potentially introduce a cumulative impact to drinking water sources, particularly when the casing deteriorates. Similarly, if the well is no longer in use, improper abandonment also provides a preferential pathway for a contaminant to impact a drinking water source. ~~A well no longer in use is unlikely to be maintained on a regular basis.~~

Golder (2022) reviewed the private well records in the MECP water well record database within the WHPAs, and the results were compared to the analysis presented in Burnside (2010). A total of twelve private water supply water well records are listed in the MECP water well database. The results were further refined to reflect the wells that are screened in a comparable aquifer as the municipal production wells.

~~A review of water well records from the MECPOE water well database and a field survey were conducted to identify wells within the WHPAs. The wells were then ranked based on their risk to the supply aquifer. This process is described in detail in Burnside, 2010d. The survey resulted in the identification of 184 water wells within the WHPAs and classified 61 of the wells as high risk~~

~~Water wells are the main Transport Pathway of concern because they present a risk to the municipal supply as they may create a conduit for contaminants to enter the aquifer.~~ To account for the potential risk for contaminants to enter the aquifer by high risk wells, the vulnerability around each well for a 30 m radius was increased by one category. A 30 m radius has been chosen based on the recommended setback distance from contamination sources in the Ontario Regulation 903 as amended.

~~Within the Burnside, 2010d study, an upgrade of Vulnerability based on Transport Pathways was only performed for areas that fell within the WHPAs delineated as part of the study.~~ The locations of transport pathways and increased vulnerability are reflected in the maps of Vulnerability Scores (See Section 8.3.1.5).

8.3.1.5 Vulnerability Score

The WHPA zones for the Colgan Water Supply, as shown in Figure 8a-1, the Groundwater Vulnerability, as shown in Figure 8a-2, as well as any increases due to Transport Pathways, were used to assign a Vulnerability Score by using the matrix from Table 5.3 (Chapter 5: Methods Overview, Section 5.2.4). Figure 8a-3 illustrates the Vulnerability Scores for the Colgan Water Supply. Figure 8a-3 will be used to assess Drinking Water Threats in Section 8.3.3. The Transport Pathways are illustrated as circles with 30 m radius in the WHPAs.

Further, the area with a vulnerability score of 10 is limited to the WHPA-A. As a result, it is noted that the only area where significant threats could be realized are within WHPA-A, other than DNAPLs, which extend into WHPA-C. The vulnerability score for the WHPA-E was determined to be 6.3 and have no significant drinking water threats associated to it due to the score.

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8.3.1.6 Uncertainty Rating

The Technical Rules require that an Uncertainty Rating of either High or Low be assigned with each Vulnerable Area as outlined in Technical Rules 13-15 (Part I.4 – Uncertainty Analysis – Water Quality (MECP~~OE~~, 2021 ~~2008a~~)). ~~A component of the Uncertainty Rating is to be provided for the WHPA delineation by the technical peer review consultant~~. ~~A second component of the Uncertainty Rating is to be provided in association with the Vulnerability Assessment.~~

As noted above, the vulnerability assessment for the Colgan water supply network is based on the AVI method using a combination of the information provided by the numerical model and a review of geological data available in the MECP water well record database. The WHPA delineation was also based on the numerical flow model, and therefore the uncertainty associated with both items are similar as they are both linked with the ability of the numerical flow model to satisfactorily represent actual conditions. The model updates are based on high-quality drill logs and aquifer testing. The subsequent model calibration demonstrates that the model can achieve a reasonable representation of hydrogeologic conditions, particularly in the area of the Site. Considering these factors, the level of uncertainty is considered low in the area

and increases to the outer reaches of the WHPA-D area. However, the final WHPA-B, -C, and -D incorporate a conservative "uncertainty envelope" which, in effect, reduces overall uncertainty in the capture zone results. As such, the overall vulnerability and WHPA uncertainty is characterized as Low.

~~The Uncertainty Rating associated with the WHPA A-D delineation was assessed using a qualitative process outlined in Burnside 2010d. As mentioned above, a technical peer review consultant was also used to assess the uncertainty of the WHPA delineation. As a more conservative assessment, the results from the peer review are presented for this section.~~

~~The uncertainty delineation of the Colgan WHPAs was determined by peer reviewers from Dillon Consulting using a standard scoring matrix (Table 1, Appendix MO). The Uncertainty Rating assigned for the Colgan WHPAs is High. The full results of the WHPA delineation Peer Review process for Colgan is available in Appendix A and discussed in Chapter 5 (Methods Overview).~~

~~The Uncertainty Assessment methodology used by Burnside, 2010d, 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. Using information from the Vulnerability mapping and the Transport Pathway update it is concluded that while the uncertainty for the Transport Pathway mapping is High, the overall Vulnerability Assessment uncertainty can be considered to be Low.~~

8.3.2 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.

As part of the Issues Evaluation, ~~Burnside 2010d~~Golder (2022) assessed whether any contaminants are impacting or have the potential to impact or interfere with Colgan's drinking water source by a review of available water quality data.

~~Water quality data collected by Burnside in 2005 was reviewed. The water quality data indicates that the well water is within the Ontario Drinking Water Quality Standards (ODWQS)~~

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~~for all measured parameters, with the exception of hardness and iron. Both parameters exceeded the ODWQS Aesthetic Objectives.~~ The MECP~~OE~~ Drinking Water Systems O. Reg. 170/03, Annual Reports for 2006, 2009, 2014, and 2019 ~~and 2008 were also reviewed~~were reviewed to identify any water quality concerns. No exceedances were identified. However, routine monitoring as part of on-going groundwater supply activities has indicated that the isolated presence of total coliforms in the raw water supply from well CW2. Total coliforms were also noted at well CW3 in 2021, however this well was inactive and the sample was collected strictly for monitoring purposes (Golder, 2022). The concentrations of the remaining tested parameters were found to be within their applicable ODWS guideline values. It is understood that treatment measures are currently in place to address the potential for the presence of coliforms. Based on this information, no issues were identified for the Colgan wellfield.

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No Drinking Water Issues were identified for the Colgan Water Supply.

8.3.3 Drinking Water Threats Evaluation

An assessment of Drinking Water Threats for the Colgan water supply was completed by Golder (2022) in accordance with the Director Technical Rules (MECP, 2022)~~detailed methodology presented in Burnside 2010d~~. 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 Colgan water supply builds on the information from the Vulnerability Analysis and Issues Evaluation and includes the 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
- 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 the Colgan 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.

8.3.3.2 List of Drinking Water Threats – Conditions

The following information sources were consulted to identify existing Conditions that could affect the Colgan Well Supply:

- Ecolog Environmental Risk Information Services Ltd Search
    - Federal Government Source databases
    - Provincial Government Source Databases
    - Private Source Databases
- Municipal Planning Documents
- Aerial Photo Interpretation

More details ~~and~~ on these sources can be found in ~~Burnside~~ Golder (2022)~~2010d~~.

No confirmed Conditions have been identified for the Colgan Water Supply. No potential Conditions have been identified for consideration at this time.

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 MECP~~OE~~ to correlate activities that are or would be Drinking Water Threats with the Vulnerability Scores. The tables can be found at the Source Water Protection Information Portal. ~~Government of Ontario's Drinking Water Threats and Circumstances.~~

8.3.3.3.1 Pathogen Parameters

~~The Key Table on~~ Figure 8a-4~~Figure 8a-4 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 Colgan Well Supply.~~ Activities that are or would be Significant Drinking Water Threats for pathogens can be observed within the areas where the Vulnerability Score is 10 (Figure 8a-4~~Figure 8a-4~~). Pathogens can also only be a Significant, Moderate, or Low Threat within WHPA-A,-B and -E.

8.3.3.3.2 Chemical Parameters

~~The Key Table on~~ Figure 8a-5~~Figure 8a-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 Colgan Well Supply.~~ Activities that are or would be Significant Drinking Water Threats for chemicals can be observed within areas where the Vulnerability Score is equal to or greater than 8 (Figure 8a-5~~Figure 8a-5~~).

8.3.3.3.3 DNAPL Chemical Parameters

Figure 8a-6~~Figure 8a-6~~ illustrates the area of the 5-year time-of-travel zone (WHPA-C) and areas with a Vulnerability Score of 6, where Activities associated with DNAPL parameters are considered to be a Significant Drinking Water Threat for the Colgan Well Supply. ~~The Key Table on~~ Figure 8a-6~~Figure 8a-6 can be used to can be used to identify the circumstances in which these Activities would be Significant or Moderate Drinking Water Threats.~~

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

Further to Section 8.3.3.2, no Conditions have been confirmed within the WHPA for the Colgan Well Supply.

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~~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 Colgan 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. The 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 ~~Burnside, 2010d~~Golder (2022).

In order to classify activities in the study area, the various databases and sources outlined in Section 8.3.3.2 were reviewed and information on site activities was compiled. The circumstances under which activities are considered threats and the classification of those threats are contained in the Part XII of the Technical Rules (December 2021)~~Table of Drinking Water Threats~~ ~~, provided by the MECPOE (MECPOE, 2008b).~~

~~An automated process was developed to search the Table and provide an indication of the Hazard and Risk Score for each identified Activity. The automated process generates a project database that houses information on the threat and also includes the various component scores that are included in the final determination of risk category. The risk category in the automated process is calculated using processes described by the MECPOE in their document~~

~~Threats EBR Lookups (MECPOE, 2009d) and is identical to that used by the Tables of Drinking Water Threats. As a quality control mechanism the calculated risk categories were verified by manual searches of the MECPOE Tables of Drinking Water Threats to ensure that the automated calculations were correct for threats categorized as Significant. In order to ensure consistency in the approach for assumptions regarding various activities and the methodology for the evaluations of threats a consensus was arrived at among all consultants conducting work within the SGBLS Region (SGBLS, 2010).~~

Once a Hazard Rating is assigned to an identified parcel ~~based on the MECPOE tables~~, a Risk Score can be assigned. The Risk Score is calculated by multiplying the Vulnerability Score as defined by the Vulnerability component of the study (Section 8.3.1.5) with the Hazard Rating which provides a score out of 100. The Risk Score is classified as Significant when the score is greater than 80.

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', where present, 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.

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. The percent Managed Lands and Livestock Density calculations were completed for this project using a methodology developed in consultation with the SGBLS Source Protection Region and was based on the MECP~~OE~~ Technical Bulletin for Managed Land and Livestock Density Calculations (MECP~~OE~~, ~~September~~ November 2009). 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, and/or Non-Agricultural Source Material (NASM)) are applied. 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~~ MECP, 2021~~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, ~~and~~ ~~–~~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, .i.e. 6. ~~Managed Lands were identified and the Managed Lands proportions were determined for the Township of Adjala-Tosorontio WHPAs as outlined in Burnside, 2010d. The results from this analysis were used in the enumeration of Significant Drinking Water Threats (Sections 8.3.3.5.1 and 8.3.3.5.2).~~ The percent managed lands are mapped per the following classes: less than 40%; 40 to 80%; and greater than 80%. It was found that the total percent managed land within WHPA-A, -B, and -C is less than 40%, and between 40 and 80% in the WHPA-D.

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Figure 8a-7 illustrates the distribution of Managed Lands within the delineated WHPA zones for the Colgan Supply.

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~~ MECP, 2021~~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, e.g. vulnerability score <6.

One livestock operation, a horse farm, was identified which overlaps with a relatively small portion the WHPA-C area, and was estimated to have a livestock density of between 0.5 and 1.0 Nu/acre. No livestock operations were identified within the limits of WHPA-A or WHPA-B. Therefore, the mapped livestock density in each of the overall WHPA-A, -B, and -C areas was defined to be less than 0.5 NU/acre.

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~~in the Table of Drinking Water Threats~~. ~~The Livestock Density was determined for the Township of Adjala-Tosorontio WHPAs as outlined in Burnside, 2010d. The results from this analysis were used in the enumeration of Significant Drinking Water Threats (Section 8.3.3.5.2).~~ Figure 8a-8~~Figure 8a-8~~ illustrates the distribution of Livestock Density within the delineated WHPA zones for the Colgan Supply.

8.3.3.5.1.3 Impervious Surfaces

Impervious Surfaces are defined in the Technical Rules as areas that receive road salt application and include roads and parking lots. ~~The areas were determined using road mapping from the National Road Network (Natural Resources Canada) and satellite air photography to identify large parking lots and paved areas. Using a 1 km x 1 km grid centred over each vulnerable area, the percentage of impermeable surfaces within each square kilometre was calculated. For further details on the methods used to assess impervious surfaces for the Township of Adjala-Tosorontio WHPAs see Burnside, 2010d.~~

Technical Rule 16(11) (~~August~~ MECP, 2021~~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~~-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. Impervious features and their associated areas within the WHPAs were manually quantified using GIS measurement tool and using Google satellite imagery. It was found that the percent impervious land within all the designated WHPA areas (WHPA-A, -B, -C and -D) was between 1 % and <8% (Golder, 2022).

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Figure 8a-9 illustrates the distribution of Impervious Surface within the delineated WHPA zones for the Colgan Supply.

8.3.3.5.2 Enumerating Significant Drinking Water Threats – Results

~~The number of Significant Drinking Water Threats associated with the Colgan well supply has been determined using the methodology outlined in the Burnside, 2010d report.~~

As discussed above there are no Significant Threats associated with Conditions or Drinking Water Issues. In addition, no land use activities that would result in potential Significant Drinking Water Threats were identified for the Colgan water supply.

8.4 Hockley Well Supply

The Hockley Water Supply System serves the hamlet of Hockley located in the west half of Lot 13, Concession 1. The water system provides water for approximately 14 homes and consists of one production well drilled in 1979. During drilling, the well encountered gravel from surface to 1.8 m, silty clay to 7.6 m bg, followed by gravel to 29 m bg, and sand to 32.6 m bg. The well was completed with a diameter of 100 mm and is screened in the gravel and sand overburden from 27.4 m to a depth of 32.6 m below grade (Burnside, 2000d).

Information presented for the Hockley section of this Chapter is based on the Burnside, 2010d report.

8.4.1 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 Hockley water supply has been delineated following the process recommended in the Technical Rules. The areas that contribute groundwater to the wells were delineated as WHPA. The Groundwater Vulnerability within the WHPA was assessed and a consideration of the effects of man-made structures that may increase the Vulnerability was undertaken. The WHPA and the Vulnerability were considered together as per the Technical Rules to determine a Vulnerability Score for the Hockley Water Supply. Details of the methods for the Vulnerability Analysis are provided in Burnside, 2010d.

8.4.1.1 Wellhead Protection Area (WHPA) Delineation

Wellhead Protection Areas for the Hockley wells were completed as part of the South Simcoe Municipal Groundwater Study (SSMGS) completed by Golder Associates (Golder) in 2004.

An analytical model was developed for the Hockley system using United States Environment Protection Agency's (USEPA's) WHPA code. The model simulated steady state, two-dimensional flow for a homogeneous, semi-confined aquifer. No stream or barrier boundaries were specified in the flow domain. Leakage from an adjacent aquifer was simulated to occur through a relatively thick, low hydraulic conductivity layer. Several model simulations were conducted to evaluate the impact of parameter variations on the predicted outcome. These simulations were combined to provide the final model predictions. As a method of verification of the predicted outcome, a water balance calculation was also used to determine if the predicted capture zones were adequately sized to produce the volume of water being pumped at the wells. Further information on the modeling assumptions, considerations, and limitations is included in Burnside, 2010d.

The Hockley WHPA extends in a south-west direction from the well (Figure 8b-1). The relatively low pumping rate of the well has resulted in capture zones that are long and linear. The WHPA-B is not shown in Figure 8b-1 since it is within the WHPA-A. The WHPA-D ends approximately 813 m from the well. The total area covered by the WHPA is 6.4 ha.

8.4.1.2 WHPA-E / WHPA-F

None of the wells in this study have been identified as Groundwater Under the Direct Influence of surface water (GUDI), 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.

8.4.1.3 Groundwater Vulnerability

The Groundwater Vulnerability Assessment was consistent for all Township systems. Please refer to Section 8.3.1.3 for details on assessment methods.

The Groundwater Vulnerability is shown in Figure 8b-2. The Vulnerability of the Hockley WHPA is marked by having an area of High Vulnerability in WHPA-A and WHPA-B or in the closest proximity to the well. The outlying WHPA-C and D are noted to be mainly of Low and Medium Vulnerability. The geology at the site of the wells suggests that the High Vulnerability is due to the encountering of high permeability sand and gravel layers within the overburden.

8.4.1.4 Transport Pathway Increase

The Technical Rules allow for an increase in Vulnerability Rating of an aquifer due to the presence of Transport Pathways that may increase the Vulnerability of the aquifer by providing a conduit for contaminants to bypass the natural protection of the aquifer. The Vulnerability Rating can be increased from Medium to High, Low to Medium, or from Low to High in accordance with the potential for artificial Transport Pathways to increase the observed Vulnerability.

Transport pathways are developed where man-made (anthropogenic) features in the aquifer provide a path along which contaminants can migrate to the regional aquifer. Features that were considered as Transport Pathways within the context of the Burnside, 2010d study are listed in Section 8.3.1.4. The locations of transport pathways and increased vulnerability are reflected in the maps of Vulnerability Scores (See Section 8.4.1.5).

8.4.1.5 Vulnerability Score

The WHPA zones for the Hockley Water Supply, as shown in Figure 8b-1, the Groundwater Vulnerability, as shown in Figure 8b-2, and any increases due to Transport Pathways were used to assign a Vulnerability Score by using the matrix from Table 5.3 (Chapter 5: Methods Overview, Section 5.2.4). Figure 8b-3 illustrates the Vulnerability Scores for the Hockley Water Supply. Figure 8b-3 will be used to assess Drinking Water Threats in Section 8.4.3. The Transport Pathways are illustrated as circles with 30 m radius in the WHPAs.

8.4.1.6 Uncertainty Rating

The Technical Rules require that an Uncertainty Rating of either High or Low be assigned with each Vulnerable Area as outlined in Technical Rules 13-15 (Part I.4 – Uncertainty Analysis – Water Quality (MOE, 2008a)). A component of the Uncertainty Rating is to be provided for the WHPA delineation by the technical peer review consultant. A second component of the Uncertainty Rating is to be provided in association with the Vulnerability Assessment.

The Uncertainty Rating associated with the WHPA A-D delineation was assessed using a qualitative process outlined in Burnside 2010d. As mentioned above, a technical peer review consultant was also used to assess the uncertainty of the WHPA delineation. As a more conservative assessment, the results from the peer review are presented for this section.

The uncertainty delineation of the Hockley WHPA was determined by peer reviewers from Dillon Consulting using a standard scoring matrix (Table 1, Appendix MO). The Uncertainty Rating assigned for the Hockley WHPA is High. The full results of the WHPA delineation Peer

Review process for Hockley is available in Appendix A and discussed in Chapter 5 (Methods Overview).

The Uncertainty Assessment methodology used by Burnside, 2010d, 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. Using information from the Vulnerability mapping and the Transport Pathway update it is concluded that while the uncertainty for the Transport Pathway mapping is High, the overall Vulnerability Assessment uncertainty can be considered to be Low.

8.4.2 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.

As part of the Issues Evaluation, Burnside 2010d assessed whether any contaminants are impacting or have the potential to impact or interfere with Colgan's drinking water source by a review of available water quality data.

Historical water quality data for 2000 to 2002 was reviewed. The results indicate that water quality had exceedances in turbidity, hardness, and iron. Bacteriological analysis of 52 samples between 2000 and 2002 showed only sporadic detections of total coliforms with no *E. coli* detections.

The MOE Drinking Water Systems O. Reg. 170/03, Annual Reports for the Hockley Well Supply System 2006 and 2008 were reviewed to identify any water quality concerns. No exceedances were identified.

In the 2006 Annual Report, an arsenic concentration of 0.023 mg/L was recorded. This is close to the ODWQS of 0.025 mg/L. Historical data (2000-2002) does not show any indication of high arsenic concentrations with an average concentration of <0.006 mg/L. Sampling in 2008 resulted in an arsenic concentration of 0.003 mg/L. It is likely that the high concentration found in 2005 was an anomaly and does not reflect a water quality Issue.

No Drinking Water Issues were identified for the Hockley Water Supply.

8.4.3 Drinking Water Threats Evaluation

An assessment of Drinking Water Threats for the Hockley water supply was completed in accordance with the detailed methodology presented in Burnside 2010d. 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 Hockley water supply builds on the information from the Vulnerability Analysis and Issues Evaluation and includes the 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
- an enumeration of Drinking Water Threats

8.4.3.1 List of Drinking Water Threats – Activities

The list of Prescribed Drinking Water Threats considered in the assessment for the Hockley 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.

8.4.3.2 List of Drinking Water Threats – Conditions

The following information sources were consulted to identify existing Conditions that could affect the Hockley Well Supply:

- Ecolog Environmental Risk Information Services Ltd Search
    - Federal Government Source databases
    - Provincial Government Source Databases
    - Private Source Databases
- Municipal Planning Documents
- Aerial Photo Interpretation

More details and on these sources can be found in Burnside 2010d.

No confirmed Conditions have been identified for the Hockley Water Supply. No potential Conditions have been identified for consideration at this time.

8.4.3.3 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 the Government of Ontario's Drinking Water Threats and Circumstances.

8.4.3.3.1 Pathogen Parameters

The Key Table on Figure 8b-4 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 Hockley Well Supply. Activities that are or would be Significant Drinking Water Threats for pathogens can be observed within the areas where the Vulnerability Score is 10. Pathogens can also only be a Significant, Moderate, or Low Threat within WHPA-A,-B and -E.

8.4.3.3.2 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 Hockley Well Supply. Activities that are or would be Significant Drinking Water Threats for chemicals can be observed within areas where the Vulnerability Score is equal to or greater than 8.

8.4.3.3.3 DNAPL Chemical Parameters

Figure 8b-6 illustrates the area of the 5-year time-of-travel zone (WHPA-C) and areas with a Vulnerability Score of 6, where activities associated with DNAPL parameters are considered to be a Significant Drinking Water Threat for the Hockley Well Supply. The Key Table on Figure 8b-6 can be used to can be used to identify the circumstances in which these Activities would be Significant or Moderate Drinking Water Threats.

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

Further to Section 8.4.3.2, no Conditions have been confirmed within the WHPA for the Hockley Well Supply.

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

8.4.3.5 Enumerating Drinking Water Threats

8.4.3.5.1 Enumerating Significant Drinking Water Threats – Methods

Identification and enumeration of Significant Drinking Water Threats related to Issues and Conditions have been described in Section 8.4.2 and 8.4.3.2, 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 Burnside, 2010d. 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.

In order to classify activities in the study area the various databases and sources outlined in Section 8.4.3.2 were reviewed and information on site activities was compiled. The circumstances under which Activities are considered threats and the classification of those threats are contained in the Table of Drinking Water Threats provided by the MOE (MOE 2008b).

An automated process was developed to search the Table and provide an indication of the Hazard and Risk Score for each identified Activity. The automated process generates a project database that houses information on the threat and also includes the various component scores that are included in the final determination of risk category. The risk category in the automated process is calculated using processes described by the MOE in their document Threats EBR Lookups (MOE, 2009d) and is identical to that used by the Tables of Drinking Water Threats. As a quality control mechanism the calculated risk categories were verified by manual searches of the MOE Tables of Drinking Water Threats to ensure that the automated calculations were correct for threats categorized as Significant. In order to ensure consistency in the approach for assumptions regarding various activities and the methodology for the evaluations of threats a consensus was arrived at among all consultants conducting work within the SGBLS Region (SGBLS, 2010).

Once a Hazard Rating is assigned to an identified parcel based on the MOE tables, then a Risk Score can be assigned. The Risk Score is calculated by multiplying the Vulnerability Score as defined by the Vulnerability component of the study (Section 8.4.1.5) with the Hazard Rating which provides a score out of 100. The Risk Score is classified as Significant when the score is greater than 80.

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', where present, 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.

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. The percent Managed Lands and Livestock Density calculations were completed for this project using a methodology developed in consultation with the SGBLS Source Protection Region and was based on the MOE Technical Bulletin for Managed Land and Livestock Density Calculations (MOE, September 2009). Managed Lands, Livestock Density, and Impervious Surfaces are discussed in more detail below.

8.4.3.5.1.1 Managed Lands

Managed Land is land to which nutrients (Agriculture Source Material (ASM), commercial fertilizer, and/or Non-Agricultural Source Material (NASM)) are applied. Managed Lands is 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 Township of Adjala-Tosorontio

WHPAs as outlined in Burnside, 2010d.The results from this analysis were used in the enumeration of Significant Drinking Water Threats (Section 8.3.3.5.1 and 8.4.3.5.2).

Figure 8b-7 illustrates the distribution of Managed Lands within the delineated WHPA zones for the Hockley Supply.

8.4.3.5.1.2 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 Township of Adjala-Tosorontio WHPAs as outlined in Burnside, 2010d. The results from this analysis were used in the enumeration of Significant Drinking Water Threats (Section 8.4.3.5.2). Figure 8b-8 illustrates the distribution of Livestock Density within the delineated WHPA zones for the Hockley Supply.

8.4.3.5.1.3 Impervious Surfaces

Impervious Surfaces are defined in the Technical Rules as areas that receive road salt application and include roads and parking lots. The areas were determined using road mapping from the National Road Network (Natural Resources Canada) and satellite air photography to identify large parking lots and paved areas. Using a 1 km x 1 km grid centred over each vulnerable area, the percentage of impermeable surfaces within each square kilometre was calculated. For further details on the methods used to assess impervious surfaces for the Township of Adjala-Tosorontio WHPAs see Burnside, 2010d.

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.

Figure 8b-9 illustrates the distribution of Impervious Surfaces within the delineated WHPA zones for the Hockley Supply.

8.4.3.5.2 Enumerating Significant Drinking Water Threats – Results

As discussed above there are no Significant Threats associated with Conditions or Drinking Water Issues.

Table 8-2~~Table 8-2~~ documents the enumeration of existing and potential activities that are considered to be Significant Drinking Water Threats within the WHPAs for the Hockley Water Supply.

A total of five (5) activities that are considered to be potential Significant Drinking Water Threats have been identified in association with five (5) land parcels. The identified activities were all related to residential land uses. Four (4) parcels were identified as having potential significant threat activities relating to residential land use via the use of private individual sewage disposal systems. One (1) Significant threat within each area where the Vulnerability Score is 10 has also been included to represent the potential for subsurface storage of fuel for home heating purposes.

Table 8-2: Number of Significant Drinking Water Threats for the Hockley Well Supply, Enumeration of Significant Threats (Wellhead Protected Area)

Threat Number	Threat	Significant Threat Counts Number of Threats	Significant Threat Counts Number of 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	4	4
3	The application of agricultural source material to land	0	0
4	The storage of agricultural source material to land	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 to land	0	0
10	The application of pesticide to land	0	0
11	The handling and storage of pesticide	0	0

Threat Number	Threat	Significant Threat Counts Number of Threats	Significant Threat Counts Number of Parcels
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 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, and outdoor confinement area, or a farm-animal yard	0	0
22	The establishment and operation of a liquid hydrocarbon pipeline. O. Reg. 385/08, s. 3; O. Reg. 206/18, s. 1.	0	0
-	Total Number	5*	5

Notes for the table above:

1. The number of parcels identified will typically be less than the number of significant threats as multiple threats can be observed per parcel
2. *4 verified existing Threats and 1 potential Threat that require further investigation

8.5 Everett Well Supply

The Everett Water Supply System has two functional wells, Well 1 and Well 2, and one standby well, Well 3. The system serves approximately 641 homes.

The Grohal Pumphouse at this location consists of the primary well, Well 1 (PW1-88) and Well 3 (PW3/78) as the standby well. Well 1 (PW1-88) was drilled in 1988 to a depth of 63.5 m bg. The well is 254 mm in diameter and is screened in the lower sand aquifer from 56.8 m to 62.9 m bg. Well 3 (PW3/78) was drilled in 1978. The well is 200 mm in diameter and is screened from 54.3 to 58.8 m bg in the lower sand and gravel aquifer.

Well 2 – The Ball Park Well (PW1/90) was originally drilled in 1987 as a monitoring well and was converted to a municipal pumping well in 1990. Well 2 (PW1-90) was drilled to a depth of 66.8 m bg. The well is 250 mm in diameter and was screened from 54.2 m to 59.7 m bg across the lower coarse sand confined aquifer (Burnside, 2000d).

Information presented for the Everett section of this Chapter is based on Burnside, 2010d report.

8.5.1 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 Everett water supply has been delineated following the process recommended in the Technical Rules. The areas that contribute groundwater to the wells were delineated as WHPA. The Groundwater Vulnerability within the WHPA was assessed and a consideration of the effects of man-made structures that may increase the Vulnerability was undertaken. The WHPA and the Vulnerability were considered together as per the

Technical Rules to determine a Vulnerability Score for the Everett Water Supply. Details of the methods for the Vulnerability Analysis are provided in Burnside, 2010d.

8.5.1.1 Wellhead Protection Area (WHPA) Delineation

Wellhead Protection Areas for the Everett wells were completed as part of the South Simcoe Municipal Groundwater Study (SSMGS) completed by Golder Associates (Golder) in 2004.

As part of the South Simcoe Municipal Groundwater Study (SSMGS), numerical groundwater flow models were developed by Golder Associates and Waterloo Hydrogeologic Inc (WHI now Schlumberger Water Services) for the areas of Colgan, Lisle, Everett, and Loretto. These areas were part of a larger model developed for the Borden-Angus and Tottenham municipal systems which were also part of the SSMGS. The Everett and Lisle areas were modeled using the Angus-Borden three dimensional numerical model. The Angus-Borden model used an initial model grid of 230 m by 230 m cells to define the model domain. These cells were refined to approximately 15 m in the vicinity of the municipal wells. The model consisted of eight overburden layers and one bedrock layer.

For the Everett and Lisle areas the model was calibrated to represent steady state conditions in the aquifer using static water levels data from approximately 150 wells scattered throughout the model domain. The NRMS error for the calibration is reported as being 7.0% which is considered to be within the acceptable limits of less than 10% for numerical models. Further details on the model assumptions and considerations are included in the model summary report in Burnside, 2010d.

The WHPA of the Everett wells extend in a westerly direction towards the Niagara Escarpment (Figure 8c-1). The zones tend to stay deep, traveling horizontally in the municipal aquifer thus creating their round shape (Golder & WHI, 2004). The WHPA for Well 1 and Well 3 merges with the WHPA of Well 2 within WHPA-C1 and extends as a single WHPA-D continuing in a south westerly direction. The zones extend approximately 3.2 km from Well 1 / Well 3 and are approximately 1.4 km across; the total area covered by the combined protection zones is approximately 320 ha.

8.5.1.2 WHPA-E / WHPA-F

None of the wells in this study have been identified as Groundwater Under the Direct Influence of surface water (GUDI), 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.

8.5.1.3 Groundwater Vulnerability

The Groundwater Vulnerability Assessment was consistent for all Township systems. Please refer to Section 8.3.1.3 for details on assessment methods.

The Groundwater Vulnerability is shown in Figure 8c-2. Within the Everett WHPA the Vulnerability shows two significant areas of High Vulnerability that are aligned in a north to south direction. The first swath begins just south of Well 1 and 3, curls north and then southwest towards Well 2. The WHPA-A at Well 1 and Well 3 is located in a zone of Medium Vulnerability. A second area of High Vulnerability is located in the western portion of the WHPA and within the WHPA-D zone for both sources. Due to the nature of the aquifer in this area it is assumed that High Vulnerability is indicative of high permeability sediments within the overburden.

8.5.1.4 Transport Pathway Increase

The Technical Rules allow for an increase in Vulnerability Rating of an aquifer due to the presence of Transport Pathways that may increase the Vulnerability of the aquifer by providing a conduit for contaminants to bypass the natural protection of the aquifer. The Vulnerability Rating can be increased from Medium to High, Low to Medium, or from Low to High in accordance with the potential for artificial Transport Pathways to increase the observed Vulnerability.

Transport pathways are developed where man-made (anthropogenic) features in the aquifer provide a path along which contaminants can migrate to the regional aquifer. Features that were considered as Transport Pathways within the context of the Burnside, 2010d study are listed in Section 8.3.1.4. The locations of transport pathways and increased vulnerability are reflected in the maps of Vulnerability Scores (See Section 8.5.1.5).

8.5.1.5 Vulnerability Score

The WHPA zones for the Everett Water Supply, as shown in Figure 8c-1, the Groundwater Vulnerability, as shown in Figure 8c-2, and any increases due to Transport Pathways were used to assign a Vulnerability Score by using the matrix from Table 5.3 (Chapter 5: Methods Overview, Section 5.2.4). Figure 8c-3 illustrates the Vulnerability Scores for the Everett Water Supply. Figure 8c-3 will be used to assess Drinking Water Threats in Section 8.5.3. The Transport Pathways are illustrated as circles with 30 m radius in the WHPAs.

8.5.1.6 Uncertainty Rating

The Technical Rules require that an Uncertainty Rating of either High or Low be assigned with each Vulnerable Area as outlined in Technical Rules 13-15 (Part I.4 – Uncertainty Analysis – Water Quality (MOE, 2008a)). A component of the Uncertainty Rating is to be provided for the WHPA delineation by the technical peer review consultant. A second component of the Uncertainty Rating is to be provided in association with the Vulnerability Assessment.

The Uncertainty Rating associated with the WHPA A-D delineation was assessed using a qualitative process outlined in Burnside 2010d. As mentioned above, a technical peer review consultant was also used to assess the uncertainty of the WHPA delineation. As a more conservative assessment, the results from the peer review are presented for this section.

The uncertainty delineation of the Everett WHPAs was determined by peer reviewers from Dillon Consulting using a standard scoring matrix (Table 1, Appendix MO). The Uncertainty Rating assigned for the Everett WHPAs is High. The full results of the WHPA delineation Peer Review process for Everett is available in Appendix A and discussed in Chapter 5 (Methods Overview).

The Uncertainty Assessment methodology used by Burnside, 2010d, 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. Using information from the Vulnerability mapping and the Transport Pathway update it is concluded that while the uncertainty for the Transport Pathway mapping is High, the overall Vulnerability Assessment uncertainty can be considered to be Low.

8.5.2 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.

As part of the Issues Evaluation, Burnside 2010d assessed whether any contaminants are impacting or have the potential to impact or interfere with Everett's drinking water source by a review of available water quality data.

In 1986 a sampling program completed in Everett found that shallow wells located in the upper unconfined aquifer had high concentrations of nitrates (Trow, 1987). A plume of nitrate was identified in the shallow unconfined aquifer however the deeper municipal supply aquifer was deemed to be protected from conditions in the upper aquifer by an aquitard (Trow, 1987). No indications of connectivity between the two aquifers have been identified. This is confirmed by water quality data from (1995-2008) showing nitrate concentrations of less than 0.1 mg/L in the municipal wells.

Historical water quality data collected between 1995 to 2000 show that the treated water from both the Grohal and Ball Park systems exceeded the ODWQS standards for turbidity, aluminum, colour, hardness, iron, and pH.

The MOE Drinking Water Systems O. Reg. 170/03, Annual Reports 2006 and 2008 were reviewed to identify any water quality concerns. No exceedances were identified.

No Drinking Water Issues were identified for the Everett Water Supply.

8.5.3 Drinking Water Threats Evaluation

An assessment of Drinking Water Threats for the Everett water supply was completed in accordance with the detailed methodology presented in Burnside 2010d. 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 Everett water supply builds on the information from the Vulnerability Analysis and Issues Evaluation and includes the 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

- an enumeration of Drinking Water Threats

8.5.3.1 List of Drinking Water Threats – Activities

The list of Prescribed Drinking Water Threats considered in the assessment for the Everett 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.

8.5.3.2 List of Drinking Water Threats – Conditions

The following information sources were consulted to identify existing Conditions that could affect the Everett Well Supply:

- Ecolog Environmental Risk Information Services Ltd Search
    - Federal Government Source databases
    - Provincial Government Source Databases
    - Private Source Databases
- Municipal Planning Documents
- Aerial Photo Interpretation

More details and on these sources can be found in Burnside 2010d.

No confirmed Conditions have been identified for the Everett Water Supply. No potential Conditions have been identified for consideration at this time.

8.5.3.3 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 the Government of Ontario's Drinking Water Threats and Circumstances.

8.5.3.3.1 Pathogen Parameters

The Key Table on Figure 8c-4 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 Everett Well Supply. Activities that are or would be Significant Drinking Water Threats for pathogens can be observed within the areas where the Vulnerability Score is 10. Pathogens can also only be a Significant, Moderate, or Low Threat within WHPA-A,-B and -E.

8.5.3.3.2 Chemical Parameters

The Key Table on Figure 8c-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 Everett Well Supply. Activities that are or would be Significant Drinking Water Threats for chemicals can be observed within areas where the Vulnerability Score is equal to or greater than 8.

8.5.3.3.3 DNAPL Chemical Parameters

Figure 8c-6 illustrates the area of the 5-year time-of-travel zone (WHPA-C) and areas with a Vulnerability Score of 6, where activities associated with DNAPL parameters are considered to be a Significant Drinking Water Threat for the Everett Well Supply. The Key Table on Figure 8c-6 can be used to can be used to identify the circumstances in which these Activities would be Significant or Moderate Drinking Water Threats.

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

Further to Section 8.5.3.2, no Conditions have been confirmed within the WHPA for the Everett Well Supply.

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

8.5.3.5 Enumerating Drinking Water Threats

8.5.3.5.1 Enumerating Significant Drinking Water Threats – Methods

Identification and enumeration of Significant Drinking Water Threats related to Issues and Conditions have been described in Section 8.5.2 and 8.5.3.2, respectively. This section describes the identification and enumeration of Significant Drinking Water Threat Activities. The 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 Burnside, 2010d. 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.

In order to classify Activities in the study area the various databases and sources outlined in Section 8.5.3.2 were reviewed and information on site activities was compiled. The circumstances under which Activities are considered threats and the classification of those threats are contained in the Table of Drinking Water Threats provided by the MOE (MOE 2008b).

An automated process was developed to search the Table and provide an indication of the Hazard and Risk Score for each identified Activity. The automated process generates a project database that houses information on the threat and also includes the various component

scores that are included in the final determination of risk category. The risk category in the automated process is calculated using processes described by the MOE in their document Threats EBR Lookups (MOE, 2009d) and is identical to that used by the Tables of Drinking Water Threats. As a quality control mechanism the calculated risk categories were verified by manual searches of the MOE Tables of Drinking Water Threats to ensure that the automated calculations were correct for threats categorized as Significant. In order to ensure consistency in the approach for assumptions regarding various activities and the methodology for the evaluations of threats a consensus was arrived at among all consultants conducting work within the SGBLS Region (SGBLS, 2010).

Once a Hazard Rating is assigned to an identified parcel based on the MOE tables, a Risk Score can be assigned. The Risk Score is calculated by multiplying the Vulnerability Score as defined by the Vulnerability component of the study (Section 8.5.1.5) with the Hazard Rating which provides a score out of 100. The Risk Score is classified as Significant when the score is greater than 80.

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', where present, 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.

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. The percent Managed Lands and Livestock Density calculations were completed for this project using a methodology developed in consultation with the SGBLS Source Protection Region and was based on the MOE Technical Bulletin for Managed Land and Livestock Density Calculations (MOE, September 2009). Managed Lands, Livestock Density, and Impervious Surfaces are discussed in more detail below.

8.5.3.5.1.1 Managed Lands

Managed Land is land to which nutrients (Agriculture Source Material (ASM), commercial fertilizer, and/or Non-Agricultural Source Material (NASM)) are applied. Managed Lands is 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 Township of Adjala-Tosorontio WHPAs as outlined in Burnside, 2010d. The results from this analysis were used in the enumeration of Significant Drinking Water Threats (Section 8.3.3.5.1 and 8.5.3.5.2).

Figure 8c-7 illustrates the distribution of Managed Lands within the delineated WHPA zones for the Everett Supply.

8.5.3.5.1.2 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 Township of Adjala-Tosorontio WHPAs as outlined in Burnside, 2010d. The results from this analysis were used in the enumeration of Significant Drinking Water Threats (Section 8.5.3.5.2). Figure 8c-8 illustrates the distribution of Livestock Density within the delineated WHPA zones for the Everett Supply.

8.5.3.5.1.3 Impervious Surfaces

Impervious surfaces are defined in the Technical Rules as areas that receive road salt application and include roads and parking lots. The areas were determined using road mapping from the National Road Network (Natural Resources Canada) and satellite air photography to identify large parking lots and paved areas. Using a 1 km x 1 km grid centred over each vulnerable area, the percentage of impermeable surfaces within each square kilometre was calculated. For further details on the methods used to assess impervious surfaces for the Township of Adjala-Tosorontio WHPAs see Burnside, 2010d.

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.

Figure 8c-9 illustrates the distribution of Impervious Surface within the delineated WHPA zones for the Everett Supply.

8.5.3.5.2 Enumerating Significant Drinking Water Threats – Results

As discussed above there are no Significant Threats associated with Conditions or Drinking Water Issues.

Table 8-3~~Table 8-3~~ documents the enumeration of existing and potential Activities that are considered to be Significant Drinking Water Threats within the WHPAs for the Everett Water Supply.

A total of 114 Activities that are considered to be potential Significant Drinking Water Threats have been identified in association with 103 land parcels. The identified Activities include residential, commercial, and agricultural land uses. Ninety-two (92) parcels were identified as having significant threat Activities relating to residential land use via the use of private individual sewage disposal systems. Two (2) parcels were identified as potentially having application of agricultural source material (ASM) to land. Three (3) properties were identified as each having potential significant threat Activities related to application of commercial fertilizer and pesticides to land as well as handling and storage of commercial fertilizer and pesticides. One Significant threat within each area where the Vulnerability Score is 10 has also been included to represent the potential for subsurface storage of fuel for home heating purposes. There are 92 residential parcels within this area. Six (6) parcels within the WHPA were identified as having potential for handling and storage of dense non-aqueous phase liquids (DNAPLs).

Table 8-3: Number of Significant Drinking Water Threats for the Everett Well Supply, Enumeration of Significant Threats (Wellhead Protected Area)

Threat Number	Threat	Significant Threat Counts Number of Threats	Significant Threat Counts Number of 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	92	92
3	The application of agricultural source material to land	2	2
4	The storage of agricultural source material to land	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	3	3
9	The handling and storage of commercial fertilizer to land	3	3
10	The application of pesticide to land	3	3
11	The handling and storage of pesticide	3	3

Threat Number	Threat	Significant Threat Counts Number of Threats	Significant Threat Counts Number of Parcels
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	2	2
16	The handling and storage of dense non-aqueous phase liquid	6	6
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, and outdoor confinement area, or a farm-animal yard	0	0
22	The establishment and operation of a liquid hydrocarbon pipeline. O. Reg. 385/08, s. 3; O. Reg. 206/18, s. 1.	0	0
-	Total Number	114*	103

Notes for the table above:

1. The number of parcels identified will typically be less than the number of significant threats as multiple threats can be observed per parcel
2. *85 verified existing Threats and 29 potential Threat that require further investigation

8.6 Lisle Well Supply

Two municipal wells make up the Lisle Water Supply System which services 78 homes. Well 1 (PW1) drilled in 1977, is 150 mm in diameter and is completed to a depth of 59.7 m bg. The well encountered 4.6 m of surficial sand underlain by 11 m of a confining clay unit followed by sand deposits ranging in texture from fine sand to sand and gravel with a 0.6 m thick layer of clay encountered at 20 m bg. The well is screened from 56.1 m to 59.7 m bg in a sand and gravel aquifer encountered immediately above the bedrock surface. Well 2 (PW2), drilled in 1986, is also 150 mm in diameter and screened in the same overburden aquifer from 54.0 to 57.6 m bg (Burnside, 2000d).

Information presented for the Lisle section of this Chapter is based on Burnside, 2010d report.

8.6.1 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 Lisle water supply has been delineated following the process recommended in the Technical Rules. The areas that contribute groundwater to the wells were delineated as WHPA. The Groundwater Vulnerability within the WHPA was assessed and consideration was included to consider the effects of man-made structures that may increase the Vulnerability. The WHPA and the Vulnerability were considered together as per the Technical Rules to determine a Vulnerability Score for the Lisle Water Supply. Details of the methods for the Vulnerability Analysis are provided in Burnside, 2010d.

8.6.1.1 Wellhead Protection Area (WHPA) Delineation

Wellhead Protection Areas for the Lisle wells were completed as part of the South Simcoe Municipal Groundwater Study (SSMGS) completed by Golder Associates (Golder) in 2004.

As part of the South Simcoe Municipal Groundwater Study (SSMGS), numerical groundwater flow models were developed by Golder Associates and Waterloo Hydrogeologic Inc (WHI now Schlumberger Water Services) for the areas of Colgan, Lisle, Everett, and Loretto. These areas were part of a larger model developed for the Borden-Angus and Tottenham municipal systems which were also part of the SSMGS. Refer to Section 8.5.1.1 for details on the modeling for the Lisle system.

The Lisle WHPA extends in a southwest direction from the wells. The zones are broad as a result of the Lisle wells being screened in a shallow overburden aquifer which thins as you move west causing reduced transmissivity. The capture zone is approximately 1,115 m across at its widest point and 4,700 m long (Figure 8d-1). The total area of the WHPA is approximately 430 ha.

8.6.1.2 WHPA-E / WHPA-F

None of the wells in this study have been identified as Groundwater Under the Direct Influence of surface water (GUDI), 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.

8.6.1.3 Groundwater Vulnerability

The Groundwater Vulnerability Assessment was consistent for all Township systems. Please refer to Section 8.3.1.3 for details on assessment methods.

The Groundwater Vulnerability is shown in Figure 8d-2. An evaluation of the Vulnerability mapping for this location shows that the Vulnerability within the WHPA is mainly comprised by areas of Medium Vulnerability. There are small areas of Low Vulnerability that are located along the northern portion of the WHPA. Two rounded areas of High Vulnerability are located within the WHPA. The first and smaller area is located at the extreme western tip of the WHPA-D. The second and slightly larger area is located at the eastern end of the WHPA within WHPA-A and B. As at other locations in the township it is assumed that the areas of High Vulnerability represent zones of high permeability in the overburden.

8.6.1.4 Transport Pathway Increase

The Technical Rules allow for an increase in the Vulnerability Rating of an aquifer due to the presence of Transport Pathways that may increase the Vulnerability of the aquifer by providing a conduit for contaminants to bypass the natural protection of the aquifer. The Vulnerability Rating can be increased from Medium to High, Low to Medium, or from Low to High in accordance with the potential for artificial Transport Pathways to increase the observed Vulnerability.

Transport pathways are developed where man-made (anthropogenic) features in the aquifer provide a path along which contaminants can migrate to the regional aquifer. Features that were considered as Transport Pathways within the context of the Burnside, 2010d study are listed in Section 8.3.1.4. The locations of transport pathways and increased vulnerability are reflected in the maps of Vulnerability Scores (See Section 8.6.1.5).

8.6.1.5 Vulnerability Score

The WHPA zones for the Lisle Water Supply, as shown in Figure 8d-1, the Groundwater Vulnerability, as shown in Figure 8d-2, and any increases due to Transport Pathways were used to assign a Vulnerability Score by using the matrix from Table 5.3 (Chapter 5: Methods Overview, Section 5.2.4). Figure 8d-3 illustrates the Vulnerability Scores for the Lisle Water Supply. Figure 8d-3 will be used to assess Drinking Water Threats in Section 8.6.3. The Transport Pathways are illustrated as circles with 30 m radius in the WHPAs.

8.6.1.6 Uncertainty Rating

The Technical Rules require that an Uncertainty Rating of either High or Low be assigned with each Vulnerable Area as outlined in Technical Rules 13-15 (Part I.4 – Uncertainty Analysis – Water Quality (MOE, 2008a)). A component of the Uncertainty Rating is to be provided for the WHPA delineation by the technical peer review consultant. A second component of the Uncertainty Rating is to be provided in association with the Vulnerability Assessment.

The Uncertainty Rating associated with the WHPA A-D delineation was assessed using a qualitative process outlined in Burnside 2010d. As mentioned above, a technical peer review consultant was also used to assess the uncertainty of the WHPA delineation. As a more conservative assessment, the results from the peer review are presented for this section.

The uncertainty delineation of the Lisle WHPA was determined by peer reviewers from Dillon Consulting using a standard scoring matrix (Table 1, Appendix MO). The Uncertainty Rating assigned for the Lisle WHPAs is High. The full results of the WHPA delineation Peer Review process for Lisle is available in Appendix A and discussed in Chapter 5 (Methods Overview).

The Uncertainty Assessment methodology used by Burnside, 2010d, 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. Using information from the Vulnerability mapping and the Transport Pathway update it is concluded that while the uncertainty for the Transport Pathway mapping is High, the overall Vulnerability Assessment uncertainty can be considered to be Low.

8.6.2 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.

As part of the Issues Evaluation, Burnside 2010d assessed whether any contaminants are impacting or have the potential to impact or interfere with Lisle's drinking water source by a review of available water quality data.

Historical water quality results for the period of 1995 to 2000 were reviewed. The results indicated that the water quality generally exceeds the ODWQS aesthetic and operational guidelines for hardness and iron. Historical microbiological results collected from the period of 1998 to 2000 (95 samples) were reviewed. Only two occurrences of Total coliforms were identified. *E. coli* has not been detected in any of the samples submitted.

The MOE Drinking Water Systems O. Reg. 170/03, Annual Reports for the Lisle Well Supply System 2006 and 2008 were reviewed to identify any water quality concerns. No exceedances were identified.

No Drinking Water Issues were identified for the Lisle Water Supply.

8.6.3 Drinking Water Threats Evaluation

An assessment of Drinking Water Threats for the Lisle water supply was completed in accordance with the detailed methodology presented in Burnside 2010d. 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 Lisle water supply builds on the information from the Vulnerability Analysis and Issues Evaluation and includes the 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
- an enumeration of Drinking Water Threats

8.6.3.1 List of Drinking Water Threats – Activities

The list of Prescribed Drinking Water Threats considered in the assessment for the Lisle 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.

8.6.3.2 List of Drinking Water Threats – Conditions

The following information sources were consulted to identify existing Conditions that could affect the Lisle Well Supply:

- Ecolog Environmental Risk Information Services Ltd Search
    - Federal Government Source databases
    - Provincial Government Source Databases
    - Private Source Databases
- Municipal Planning Documents
- Aerial Photo Interpretation

More details and on these sources can be found in Burnside 2010d.

No confirmed Conditions have been identified for the Lisle Water Supply. No potential Conditions have been identified for consideration at this time.

8.6.3.3 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 the Government of Ontario's Drinking Water Threats and Circumstances.

8.6.3.3.1 Pathogen Parameters

The Key Table on Figure 8d-4 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 Lisle Well Supply. Activities that are or would be Significant Drinking Water Threats for pathogens can be observed within the areas where the Vulnerability Score is 10. Pathogens can also only be a Significant, Moderate, or Low Threat within WHPA-A,-B and -E.

8.6.3.3.2 Chemical Parameters

The Key Table on Figure 8d-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 Lisle Well Supply. Activities that are or would be Significant Drinking Water Threats for chemicals can be observed within areas where the Vulnerability Score is equal to or greater than 8.

8.6.3.3.3 DNAPL Chemical Parameters

Figure 8d-6 illustrates the area of the 5-year time-of-travel zone (WHPA-C) and areas with a Vulnerability Score of 6, where Activities associated with DNAPL parameters are considered to be a Significant Drinking Water Threat for the Lisle Well Supply. The Key Table on Figure 8d-6 can be used to can be used to identify the circumstances in which these Activities would be Significant or Moderate Drinking Water Threats.

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

Further to Section 8.6.3.2, no Conditions have been confirmed within the WHPA for the Lisle Well Supply.

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

8.6.3.5 Enumerating Drinking Water Threats

8.6.3.5.1 Enumerating Significant Drinking Water Threats – Methods

Identification and enumeration of Significant Drinking Water Threats related to Issues and Conditions have been described in Section 8.6.2 and 8.6.3.2, 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 Burnside, 2010d. 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.

In order to classify activities in the study area the various databases and sources outlined in Section 8.6.3.2 were reviewed and information on site activities was compiled. The circumstances under which Activities are considered threats and the classification of those threats are contained in the Table of Drinking Water Threats provided by the MOE (MOE 2008b).

An automated process was developed to search the Table and provide an indication of the Hazard and Risk Score for each identified Activity. The automated process generates a project database that houses information on the threat and also includes the various component scores that are included in the final determination of risk category. The risk category in the automated process is calculated using processes described by the MOE in their document Threats EBR Lookups (MOE, 2009d) and is identical to that used by the Tables of Drinking Water Threats. As a quality control mechanism the calculated risk categories were verified by manual searches of the MOE Tables of Drinking Water Threats to ensure that the automated calculations were correct for threats categorized as Significant. In order to ensure consistency in the approach for assumptions regarding various activities and the methodology for the evaluations of threats a consensus was arrived at among all consultants conducting work within the SGBLS Region (SGBLS, 2010).

Once a Hazard Rating is assigned to an identified parcel based on the MOE tables, a Risk Score can be assigned. The Risk Score is calculated by multiplying the Vulnerability Score as defined by the Vulnerability component of the study (Section 8.6.1.5) with the Hazard Rating which provides a score out of 100. The Risk Score is classified as Significant when the score is greater than 80.

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', where present, 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.

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. The percent Managed Lands and Livestock Density calculations were completed for this project using a methodology developed in consultation with the SGBLS Source Protection Region and was based on the MOE Technical Bulletin for Managed Land and Livestock Density Calculations (MOE, September 2009). Managed Lands, Livestock Density, and Impervious Surfaces are discussed in more detail below.

8.6.3.5.1.1 Managed Lands

Managed Land is land to which nutrients (Agriculture Source Material (ASM), commercial fertilizer, and/or Non-Agricultural Source Material (NASM)) are applied. Managed Lands is 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 Township of Adjala-Tosorontio WHPAs as outlined in Burnside, 2010d. The results from this analysis were used in the enumeration of Significant Drinking Water Threats (Section 8.3.3.5.1 and 8.6.3.5.2).

Figure 8d-7 illustrates the distribution of Managed Lands within the delineated WHPA zones for the Lisle Supply.

8.6.3.5.1.2 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 Township of Adjala-Tosorontio WHPA as outlined in Burnside, 2010d. The results from this analysis were used in the enumeration of Significant Drinking Water Threats (Section 8.6.3.5.2).

Figure 8d-8 illustrates the distribution of Livestock Density within the delineated WHPA zones for the Lisle Supply.

8.6.3.5.1.3 Impervious Surfaces

Impervious Surfaces are defined in the Technical Rules as areas that receive road salt application and include roads and parking lots. The areas were determined using road mapping from the National Road Network (Natural Resources Canada) and satellite air photography to identify large parking lots and paved areas. Using a 1 km x 1 km grid centred over each vulnerable area, the percentage of impermeable surfaces within each square kilometre was calculated. For further details on the methods used to assess impervious surfaces for the Township of Adjala-Tosorontio WHPAs see Burnside, 2010d.

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.

Figure 8d-9 illustrates the distribution of Impervious Surface within the delineated WHPA zones for the Lisle Supply.

8.6.3.5.2 Enumerating Significant Drinking Water Threats – Results

As discussed above there are no Significant Threats associated with Conditions or Drinking Water Issues.

Table 8-4~~Table 8-4~~ documents the enumeration of existing and potential activities that are considered to be Significant Drinking Water Threats within the WHPAs for the Lisle Water Supply.

A total of twenty-one (21) Activities that are considered to be potential Significant Drinking Water Threats have been identified in association with eighteen (18) land parcels. The identified Activities include mostly residential land uses. Fourteen (14) parcels were identified as having potential significant threat Activities relating to residential land use via the use of private individual sewage disposal systems. Other identified activities relate to application of pesticides to land (1), application of agricultural source material to land (1), storage of agricultural source material (1), the use of land as livestock grazing or pasturing land, an outdoor confinement area, or a farm-animal yard (1), and handling and storage of DNAPLs (2). One Significant threat within each area where the Vulnerability Score is 10 has also been included to represent the potential for subsurface storage of fuel for home heating purposes. There are 14 residential parcels within this area.

Table 8-4: Number of Significant Drinking Water Threats for the Lisle Well Supply, Enumeration of Significant Threats (Wellhead Protected Area)

Threat Number	Threat	Significant Threat Counts Number of Threats	Significant Threat Counts Number of 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	14	14
3	The application of agricultural source material to land	1	1
4	The storage of agricultural source material to land	1	1
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 to land	0	0
10	The application of pesticide to land	1	1
11	The handling and storage of pesticide	0	0

Threat Number	Threat	Significant Threat Counts Number of Threats	Significant Threat Counts Number of Parcels
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 dense non-aqueous phase liquid	2	2
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, and outdoor confinement area, or a farm-animal yard	1	1
22	The establishment and operation of a liquid hydrocarbon pipeline. O. Reg. 385/08, s. 3; O. Reg. 206/18, s. 1.	0	0
-	Total Number	21*	18

Notes for the table above:

1. The number of parcels identified will typically be less than the number of significant threats as multiple threats can be observed per parcel
2. *12 verified existing Threats and 9 potential Threat that require further investigation

8.7 Loretto Heights and Weca Well Supplies

The Loretto Heights Water Supply System services the hamlet of Loretto and is located just south and west of the intersection of Highway 50 and County Road 1. The Loretto Heights Water Supply System consists of one supply well which services approximately 26 homes. Well 1 (PW1) was drilled in 1971 and is 178 mm in diameter. The well is 29.26 m in depth and screened from 23.8 m to 25.9 m bg across a gravel and sand aquifer confined by a layer of overlying silt till (Burnside, 2000d).

The Weca Water Supply System is also located in the hamlet of Loretto and serves approximately 87 homes. The Weca Water Supply System consists of two wells that are screened in the same confined aquifer as Loretto Well 1. WECA Well 1 is 178 mm in diameter and 25.9 m in depth. The well is screened from 23.8 m to 25.9 m bg. WECA Well 2 is 150 mm in diameter and 35.4 m in depth. This well is screened from 32.3 m to 35.4 m bg across a coarse gravelly sand aquifer (Burnside, 2000d).

Information presented for the Loretto Heights and Weca section of this Chapter is based on Burnside, 2010d report.

8.7.1 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 Loretto Heights and Weca water supplies has been delineated following the process recommended in the Technical Rules. The areas that contribute groundwater to the wells were delineated as WHPA. The Groundwater Vulnerability within the WHPA was assessed and a consideration of the effects of man-made structures that may increase the Vulnerability was undertaken. The WHPA and the Vulnerability were considered together as per the Technical Rules to determine a Vulnerability Score for the

Loretto Heights and Weca water supplies. Details of the methods for the Vulnerability Analysis are provided in Burnside, 2010d.

8.7.1.1 Wellhead Protection Area (WHPA) Delineation

Wellhead Protection Areas for the Loretto Heights and Weca water supplies were completed as part of the South Simcoe Municipal Groundwater Study (SSMGS) completed by Golder Associates (Golder) in 2004. As part of the Burnside 2010d study, the 2004 Golder model was reconstructed in order to develop revised capture zones for the Loretto Heights and WECA wells.

As part of the South Simcoe Municipal Groundwater Study (SSMGS), numerical groundwater flow models were developed by Golder Associates and Waterloo Hydrogeologic Inc (WHI now Schlumberger Water Services) for the areas of Colgan, Lisle, Everett, and Loretto. These areas were part of a larger model developed for the Borden-Angus and Tottenham municipal systems which were also part of the SSMGS. The Colgan, Loretto, and Weca areas were modeled using the Tottenham three-dimensional numerical model. Refer to Section 8.3.1.1 for details on this model.

Subsequent to the completion of the modelling for Loretto Heights and Weca it was determined that no WHPA delineation had been undertaken for Weca 1. As part of the current round of evaluations it was determined that the existing model would be reconstructed in an effort to develop WHPAs for Weca 1 and at the same time confirm those for WECA 2 and the Loretto Heights Well 1. Golder Associates, the developers of the previous model, were retained by the LSRCA to undertake the model reconstruction.

The reconstructed model was built from the assumptions of the previous model and consisted of six overburden layers and one bedrock layer as in the previous model. The model was divided into 50 m by 50 m grids over the model domain with a transition to 5 m by 5 m grids in the vicinity of the supply wells. The reconstructed model was calibrated to groundwater levels obtained from the MOE WWIS data that had been updated since the completion of the previous model in 2004. The reconstructed model was calibrated to steady state condition using a total of 1,085 data points (Golder, 2010). For this calibration the NRMS error was 6.7% which is within the acceptable range for groundwater models. Details of the model reconstruction are included in Burnside, 2010d.

The Loretto Heights and Weca 1 and Weca 2 capture zones were determined using forecast pumping rates. The forecast pumping rates were the 2008 actual maximum pumping rates for each of the supply wells as reported by the Township of Adjala-Tosorontio (Golder, 2010).

The Loretto Heights and Weca WHPA areas extend southwest from the wells towards the community of Archill, along the topographic high between the Nottawasaga River and Bailey Creek drainage areas. The WHPAs for the individual wells become merged within WHPA-C and extend as a single WHPA-D continuing in a south westerly direction. The combined WHPA is approximately 2,464 m long and 1,717 m wide and covers a total area of 290 ha (Figure 8e-1).

8.7.1.2 WHPA-E / WHPA-F

None of the wells in this study have been identified as Groundwater Under the Direct Influence of surface water (GUDI), 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.

8.7.1.3 Groundwater Vulnerability

The Groundwater Vulnerability Assessment was consistent for all Township systems. Please refer to Section 8.3.1.3 for details on assessment methods.

The Groundwater Vulnerability is shown in Figure 8e-2. The Vulnerability at the Loretto and Weca WHPA is dominated by areas of Low Vulnerability. Areas of Medium Vulnerability occur in the southern end of WHPA-D and in the middle of the WHPA-C. There is generally an absence of significant areas of High Vulnerability within the WHPA. This is interpreted to indicate that the overburden in this area does not include significant layers of high permeability sand and gravel. A small patch of High Vulnerability is located on the south east side of the WHPA within WHPA-D.

8.7.1.4 Transport Pathway Increase

The Technical Rules allows for an increase in Vulnerability Rating of an aquifer due to the presence of Transport Pathways that may increase the Vulnerability of the aquifer by providing a conduit for contaminants to bypass the natural protection of the aquifer. The Vulnerability Rating can be increased from Medium to High, Low to Medium, or from Low to High in accordance with the potential for artificial Transport Pathways to increase the observed Vulnerability.

Transport pathways are developed where man-made (anthropogenic) features in the aquifer provide a path along which contaminants can migrate to the regional aquifer. Features that were considered as Transport Pathways within the context of the Burnside, 2010d study are listed in Section 8.3.1.4. The locations of transport pathways and increased vulnerability are reflected in the maps of Vulnerability Scores (See Section 8.7.1.5).

8.7.1.5 Vulnerability Score

The WHPA zones for the Loretto Heights and Weca Water Supplies, as shown in Figure 8e-1, the Groundwater Vulnerability, as shown in Figure 8e-2, and any increases due to Transport Pathways were used to assign a Vulnerability Score by using the matrix from Table 5.3 (Chapter 5: Methods Overview, Section 5.2.4). Figure 8e-3 illustrates the Vulnerability Scores for the Loretto Heights Weca Water Supplies. Figure 8e-3 will be used to assess Drinking Water Threats in Section 8.7.3. The Transport Pathways are illustrated as circles with 30 m radius in the WHPAs.

8.7.1.6 Uncertainty Rating

The Technical Rules require that an Uncertainty Rating of either High or Low be assigned with each Vulnerable Area as outlined in Technical Rules 13-15 (Part I.4 – Uncertainty Analysis – Water Quality (MOE, 2008a)). A component of the Uncertainty Rating is to be provided for the WHPA delineation by the technical peer review consultant. A second component of the Uncertainty Rating is to be provided in association with the Vulnerability Assessment.

The Uncertainty Rating associated with the WHPA A-D delineation was assessed using a qualitative process outlined in Burnside 2010d. As mentioned above, a technical peer review consultant was also used to assess the uncertainty of the WHPA delineation. As a more conservative assessment, the results from the peer review are presented for this section.

The uncertainty delineation of the Loretto Heights and Weca WHPA was determined by peer reviewers from Dillon Consulting using a standard scoring matrix (Table 1, Appendix MO). The Uncertainty Rating assigned for the Loretto Heights and Weca WHPAs is High. The full results of the WHPA delineation Peer Review process, for Loretto Heights and Weca is available in Appendix A and discussed in Chapter 5 (Methods Overview).

The Uncertainty Assessment methodology used by Burnside, 2010d, 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. Using information from the Vulnerability mapping and the Transport Pathway update it is concluded that while the uncertainty for the Transport Pathway mapping is High the overall Vulnerability Assessment uncertainty can be considered to be Low.

8.7.2 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.

As part of the Issues Evaluation, Burnside 2010d assessed whether any contaminants are impacting or have the potential to impact or interfere with Loretto Heights' and Weca's drinking water source by a review of available water quality data.

Water quality results of treated water from the Loretto Water Supply System for the period of 1995 to 2000 were reviewed. The results showed exceedances of the ODWQS for turbidity, colour, hardness, iron, and manganese.

Historical microbiological water quality data collected from PW1 for 1998 to 2000 was reviewed. The raw water had two consecutive samples (September 2000) which tested positive for total coliforms with a plate count of 1 CFU/100 mL but tested negative for *E. coli*. All tests after these samples did not show the presence of total coliforms (Burnside, 2000d). Since there have been no other concerns with total coliforms or *E. coli* bacteria documented at the Loretto well, *E. coli* and Total Coliforms are not considered to be an issue.

The MOE Drinking Water Systems O. Reg. 170/03, Annual Reports for the Loretto Heights Well Supply System for 2006 and 2008 were reviewed to identify any water quality concerns. No exceedances were identified.

No Drinking Water Issues were identified for the Loretto Heights Water Supply.

Historical water quality results for the period of 1995 to 2000 indicate that PW1 and PW2 regularly exceed the ODSWQS for hardness, iron, and manganese. Historical microbiological water quality data for 1998 to 2000 was reviewed. No concerns with total coliforms or *E. coli* bacteria have been documented.

The MOE Drinking Water Systems O.Reg. 170/03, Annual Report 2006 for Weca Well Supply System was reviewed to identify any water quality concerns. No exceedances were identified

No Drinking Water Issues were identified for the Weca Water Supply.

8.7.3 Drinking Water Threats Evaluation

An assessment of Drinking Water Threats for the Loretto Heights and Weca water supplies was completed in accordance with the detailed methodology presented in Burnside 2010d. 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 Loretto Heights and Weca water supplies builds on the information from the Vulnerability Analysis and Issues Evaluation and includes the 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
- an enumeration of Drinking Water Threats

8.7.3.1 List of Drinking Water Threats – Activities

The list of Prescribed Drinking Water Threats considered in the assessment for the Loretto Heights and Weca drinking water supplies 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.

8.7.3.2 List of Drinking Water Threats – Conditions

The following information sources were consulted to identify existing Conditions that could affect the Loretto Heights and Weca Well Supply:

- Ecolog Environmental Risk Information Services Ltd Search

  - Federal Government Source databases
  - Provincial Government Source Databases
  - Private Sources Databases
- Municipal Planning Documents
- Aerial Photo Interpretation

More details and on these sources can be found in Burnside 2010d.

No confirmed Conditions have been identified for the Loretto Heights and Weca water supplies. No potential Conditions have been identified for consideration at this time.

8.7.3.3 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 the Government of Ontario's Drinking Water Threats and Circumstances.

8.7.3.3.1 Pathogen Parameters

The Key Table on Figure 8e-4 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 Loretto Heights and Weca Well Supplies. Activities that are or would be Significant Drinking Water Threats for pathogens can be observed within the areas where the Vulnerability Score is 10. Pathogens can also only be a Significant, Moderate, or Low Threat within WHPA-A,-B and -E.

8.7.3.3.2 Chemical Parameters

The Key Table on Figure 8e-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 Loretto Heights and Weca Well Supplies. Activities that are or would be Significant Drinking Water Threats for chemicals can be observed within areas where the Vulnerability Score is equal to or greater than 8.

8.7.3.3.3 DNAPL Chemical Parameters

Figure 8e-6 illustrates the area of the 5-year time-of-travel zone (WHPA-C) and areas with a Vulnerability Score of 6, where activities associated with DNAPL parameters are considered to be a Significant Drinking Water Threat for the Loretto Heights and Weca Well Supplies. The Key Table on Figure 8e-6 can be used to can be used to identify the circumstances in which these Activities would be Significant or Moderate Drinking Water Threats.

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

Further to Section 8.7.3.2, no Condition has been confirmed within the WHPA for the Loretto Heights and Weca Well Supplies.

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 8e-3 illustrates the Vulnerability Score map for Loretto Heights and Weca Well Supplies that can be used to determine where a Condition is or would be a Significant, Moderate, or Low Threat to Drinking Water.

8.7.3.5 Enumerating Drinking Water Threats

8.7.3.5.1 Enumerating Significant Drinking Water Threats – Methods

Identification and enumeration of Significant Drinking Water Threats related to Issues and Conditions have been described in Section 8.7.2 and 8.7.3.2, 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 Burnside, 2010d. 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.

In order to classify activities in the study area the various databases and sources outlined in Section 8.7.3.2 were reviewed and information on site activities was compiled. The circumstances under which activities are considered threats and the classification of those threats are contained in the Table of Drinking Water Threats provided by the MOE (MOE 2008b).

An automated process was developed to search the Table and provide an indication of the Hazard and Risk Score for each identified Activity. The automated process generates a project database that houses information on the threat and also includes the various component scores that are included in the final determination of risk category. The risk category in the automated process is calculated using processes described by the MOE in their document Threats EBR Lookups (MOE, 2009d) and is identical to that used by the Tables of Drinking Water Threats. As a quality control mechanism, the calculated risk categories were verified by manual searches of the MOE Tables of Drinking Water Threats to ensure that the automated calculations were correct for threats categorized as Significant. In order to ensure consistency in the approach for assumptions regarding various Activities and the methodology for the evaluations of threats a consensus was arrived at among all consultants conducting work within the SGBLS Region (SGBLS, 2010).

Once a Hazard Rating is assigned to an identified parcel based on the MOE tables, a Risk Score can be assigned. The Risk Score is calculated by multiplying the Vulnerability Score as defined by the Vulnerability component of the study (Section 8.7.1.5) with the Hazard Rating which provides a score out of 100. The Risk Score is classified as Significant when the score is greater than 80.

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', where present, 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.

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. The percent Managed Lands and Livestock Density calculations were completed for this project using a methodology developed in consultation with the SGBLS Source Protection Region and was based on the MOE Technical Bulletin for Managed Land and Livestock Density Calculations (MOE, September 2009). Managed Lands, Livestock Density, and Impervious Surfaces are discussed in more detail below.

8.7.3.5.1.1 Managed Lands

Managed Land is land to which nutrients (Agriculture Source Material (ASM), commercial fertilizer, and/or Non-Agricultural Source Material (NASM)) are applied. Managed Lands is 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 Township of Adjala-Tosorontio

WHPAs as outlined in Burnside, 2010d. The results from this analysis were used in the enumeration of Significant Drinking Water Threats (Section 8.3.3.5.1 and 8.7.3.5.2).

Figure 8e-7 illustrates the distribution of Managed Lands within the delineated WHPA zones for the Loretto Heights and Weca Well Supplies.

8.7.3.5.1.2 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 Township of Adjala-Tosorontio WHPAs as outlined in Burnside, 2010d. The results from this analysis were used in the enumeration of Significant Drinking Water Threats (Section 8.7.3.5.2).

Figure 8e-8 illustrates the distribution of Livestock Density within the delineated WHPA zones for the Loretto Heights and Weca Well Supplies.

8.7.3.5.1.3 Impervious Surfaces

Impervious surfaces are defined in the Technical Rules as areas that receive road salt application and include roads and parking lots. The areas were determined using road mapping from the National Road Network (Natural Resources Canada) and satellite air photography to identify large parking lots and paved areas. Using a 1 km x 1 km grid centred over each vulnerability area, the percentage of impermeable surfaces within each square kilometre was calculated. For further details on the methods used to assess impervious surfaces for the Township of Adjala-Tosorontio WHPAs see Burnside, 2010d.

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.

Figure 8e-9 illustrates the distribution of Impervious Surface within the delineated WHPA zones for the Loretto Heights and Weca Well Supplies.

8.7.3.5.2 Enumerating Significant Drinking Water Threats – Results

As discussed above there are no Significant Threats associated with Conditions or Drinking Water Issues.

Table 8-5~~Table 8-5~~ documents the enumeration of existing and potential activities that are considered to be Significant Drinking Water Threats within the WHPA for the Loretto Heights and Weca Water Supply. A total of forty-one (41) activities that are considered to be potential Significant Drinking Water Threats have been identified in association with forty (40) land parcels. Thirty-six (36) parcels were identified as having potential significant threat activities relating to residential land use via the use of private individual sewage disposal systems. One Significant threat and parcel has also been included where the Vulnerability Score is 10 to represent the potential for subsurface storage of fuel for home heating purposes. There are 17 residential parcels within this area. Other potential Significant Threats identified include the application of commercial fertilizer to land (1), the application of pesticide to land (2), and the handling and storage of DNAPLs (1).

Table 8-5: Number of Significant Drinking Water Threats for the Loretto and Weca Well Supplies, Enumeration of Significant Threats (Wellhead Protected Area)

Threat Number	Threat	Significant Threat Counts Number of Threats	Significant Threat Counts Number of 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	36	36
3	The application of agricultural source material to land	0	0
4	The storage of agricultural source material to land	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	1	1
9	The handling and storage of commercial fertilizer to land	0	0
10	The application of pesticide to land	2	2
11	The handling and storage of pesticide	0	0

Threat Number	Threat	Significant Threat Counts Number of Threats	Significant Threat Counts Number of Parcels
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 dense non-aqueous phase liquid	1	1
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, and outdoor confinement area, or a farm-animal yard	0	0
22	The establishment and operation of a liquid hydrocarbon pipeline. O. Reg. 385/08, s. 3; O. Reg. 206/18, s. 1.	0	0
-	Total Number	41*	40

Notes for the table above:

1. The number of parcels identified will typically be less than the number of significant threats as multiple threats can be observed per parcel
2. *35 verified existing Threats and 6 potential Threats that require further investigation

8.8 Rosemont Well Supply

The Rosemont Water Supply System currently consists of two wells, PW1A and PW3A and services a population of approximately 280 people (2003).

PW1A was drilled as a 200 mm hole to 30.5 m, and is cased from 0.67 m above grade to 6.4 m below grade with a 200 mm stainless steel casing. From 4.3 m to 30.5 m below grade a 150 mm slotted steel casing is telescoped into the well and installed against the bedrock aquifer that the well obtains its water from (Burnside, 2007d). PW1A was drilled 4 m from PW1 which is located in the Jamieson Street pumphouse.

PW1 was completed in 1970 and is a 150 mm diameter well drilled to a depth of 30.5 m. The well was completed in the grey shale bedrock as open hole. Currently PW1 is a standby well that is included in the PTTW for this site.

PW3A was completed in 2005 and is a 150 mm diameter well drilled to a depth of 22.9 m. The well is screened with steel well screen from 15.2 m to 19.8 m bg across a sequence of sand and gravel with some clay and a slotted steel casing is installed from 19.8 m to 22.9 m bg in the shale bedrock (Burnside, 2007d).

Information presented for the Rosemont section of this Chapter is based on Burnside, 2010d report.

8.8.1 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 Rosemont 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 within the WHPAs was

assessed and consideration of the effects of man-made structures that may increase the Vulnerability was undertaken. The WHPAs and the Vulnerability were considered together as per the Technical Rules to determine a Vulnerability Score for the Rosemont Water Supply. Details of the methods for the Vulnerability Analysis are provided in Burnside, 2010d.

8.8.1.1 Wellhead Protection Area (WHPA) Delineation

The WHPAs for the Rosemont wells were developed as part of the Burnside, 2010d study, which was also completed by S.S. Papadopulos & Associates in 2007. The modeling reports for Rosemont are included Burnside, 2010d.

The Rosemont groundwater flow model, developed by S.S. Papadopulos and Associates (2007), used the USGS three-dimensional groundwater simulator MODFLOW-2000. The model domain extended 6 km in the east-west direction and 4 km in the north-south direction, centred at the well location and extending to the natural surface water divides. Based on the known hydrostratigraphy, the model domain was divided vertically into two layers. The first model layer represents the overburden, and the second layer represents the upper weathered bedrock. A model grid with variable spacing was used to provide a relatively fine resolution around the water supply wells. The grid spacing around the wells was 25 m and the spacing increased to 100 m away from the wells. The model grid contains a total of 6,932 active cells in 57 rows and 93 columns.

The groundwater model was calibrated to steady state conditions with calibration targets consisting of 37 wells selected from the MOE water well database that are located throughout the model domain. An additional seven wells that had updated water level measurements based on fieldwork completed by Burnside were also included as calibration targets. The Burnside wells were assigned a greater weighting in the calibration process. The correlation between observed and calculated heads was 0.99 and the overall RMS error of the calibration was 3.2 %, which is acceptable for groundwater models. Full details of the modelling exercise are included in Burnside, 2010d.

In completing the various TOT capture zones for Rosemont PW1A and PW3A, the pumping rates used were taken from the current permitted capacity of the wells. For Rosemont, simultaneous operation of the wells was assumed to be 1.5 L/sec and 0.6 L/s (S.S. Papadopulos & Assoc., 2007b). PW1 in Rosemont is included in the PTTW but is currently used only as a stand by for PW1A.

The Rosemont WHPAs extend in a southwest direction from the supply wells (Figure 8f-1). The capture zones are fan shaped up to 2 years of pumping and then start to develop a long thin shape that follows the mean direction of groundwater flow. The width of the capture zone is

indicative of the unconfined nature of the aquifer. The WHPA for PW1A extends 600 m from the supply well and covers an area of approximately 17 ha. The WHPA for PW3A extends 450 m from the supply well and covers an area of approximately 7.7 ha.

8.8.1.2 WHPA-E / WHPA-F

None of the wells in this study have been identified as Groundwater Under the Direct Influence of surface water (GUDI), 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.

8.8.1.3 Groundwater Vulnerability

The Groundwater Vulnerability Assessment was consistent for all Township systems. Please refer to Section 8.3.1.3 for details on assessment methods.

The Groundwater Vulnerability is shown in Figure 8f-2. In the Rosemont area, the Vulnerability of the WHPA is dominated by a large area of High Vulnerability in the WHPA for PW1 and PW1A. This High Vulnerability area traverses the entire WHPA and covers the southern portion of the WHPA-A. The entire WHPA for PW3A is located within areas of Medium Vulnerability. It is interpreted that the large area of High Vulnerability in Rosemont is generated by the thin layer of overburden (shallow depth of the bedrock) at this location.

8.8.1.4 Transport Pathway Increase

The Technical Rules allow for an increase in the Vulnerability Rating of an aquifer due to the presence of Transport Pathways that may increase the Vulnerability of the aquifer by providing a conduit for contaminants to bypass the natural protection of the aquifer. The Vulnerability Rating can be increased from Medium to High, Low to Medium, or from Low to High in accordance with the potential for artificial Transport Pathways to increase the observed Vulnerability.

Transport pathways are developed where man-made (anthropogenic) features in the aquifer provide a path along which contaminants can migrate to the regional aquifer. Features that were considered as Transport Pathways within the context of the Burnside, 2010d study are listed in Section 8.3.1.4.

As mentioned in Section 8.3.1.4, septic systems are considered Transport Pathways as they can provide a conduit for contaminants to travel through the ground to the water table. Septic systems are generally built in the upper few metres of the ground and consist of a tank and drainage tiles for which the sewage discharge infiltrates back into the ground. Since septic systems only penetrate the upper few metres of the ground, they will only provide Transport

Pathways when they penetrate the water table of an unconfined aquifer system. Rosemont is the only system whose wells utilize an unconfined aquifer. The locations of transport pathways and increased vulnerability are reflected in the maps of Vulnerability Scores (See Section 8.8.1.5).

8.8.1.5 Vulnerability Score

The WHPA zones for the Rosemont Water Supply, as shown in Figure 8f-1, the Groundwater Vulnerability, as shown in Figure 8f-2, and any increases due to Transport Pathways were used to assign a Vulnerability Score by using the matrix from Table 5.3 (Chapter 5: Methods Overview, Section 5.2.4). Figure 8f-3 illustrates the Vulnerability Scores for the Rosemont Water Supply. Figure 8f-3 will be used to assess Drinking Water Threats in Section 8.8.3. The Transport Pathways are illustrated as circles with 30 m radius in the WHPAs.

8.8.1.6 Uncertainty Rating

The Technical Rules require that an Uncertainty Rating of either High or Low be assigned with each Vulnerable Area as outlined in Technical Rules 13-15 (Part I.4 – Uncertainty Analysis – Water Quality (MOE, 2008a)). A component of the Uncertainty Rating is to be provided for the WHPA delineation by the technical peer review consultant. A second component of the Uncertainty Rating is to be provided in association with the Vulnerability Assessment.

The Uncertainty Rating associated with the WHPA A-D delineation was assessed using a qualitative process outlined in Burnside 2010d. As mentioned above, a technical peer review consultant was also used to assess the uncertainty of the WHPA delineation. As a more conservative assessment, the results from the peer review are presented for this section.

The uncertainty delineation of the Rosemont WHPAs was determined by peer reviewers from Dillon Consulting using a standard scoring matrix (Table 1, Appendix MO). The Uncertainty Rating assigned for the Rosemont WHPAs is High. The full results of the WHPA delineation Peer Review process for Rosemont is available in Appendix A and discussed in Chapter 5 (Methods Overview).

The Uncertainty Assessment methodology used by Burnside, 2010d, 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. Using information from the Vulnerability mapping and the Transport Pathway update it is concluded that while the uncertainty for the Transport Pathway mapping is High, the overall Vulnerability Assessment uncertainty can be considered to be Low.

8.8.2 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.

As part of the Issues Evaluation, Burnside 2010d assessed whether any contaminants are impacting or have the potential to impact or interfere with Rosemont's drinking water source by a review of available water quality data.

A review of available water quality data was completed to identify water quality issues in the supply aquifer. This includes data for the current wells PW1A, PW3A, and the previous supply wells PW1 and PW2.

A review of microbiological water quality data from PW1 and PW2 (1998 - 2000) indicates that there are no concerns with total coliforms or *E. coli* bacteria. Microbiological testing of PW1A and PW3A in 2006 and 2007 also resulted in no detectable quantities of Total or Fecal Coliforms or *E. coli* (Burnside, 2007).

Water quality results for PW1A, PW3A (2006-2008) and for PW1 and PW2 (1995 - 2005) show exceedances in sodium, chloride, hardness, iron, manganese, and total dissolved solids.

The groundwater in the study area is indicative of the bedrock chemistry. The waters are naturally hard and high in iron and manganese. Water quality results show that most supply wells exceed the ODWQS for hardness and iron. High iron and manganese can affect the turbidity, total dissolved solids (TDS), and colour of the water. In some cases the water may also be high in other parameters related to the bedrock such as chloride and sodium.

Hardness is listed in the ODWQS as operational guidelines (OG), which means that it can affect the treatment and distribution of the water. Iron, colour, TDS, chloride, manganese, and sodium are listed as aesthetic objectives (AO), which means that these parameters may impair the taste, smell, or colour of the water or interfere with good water quality control practices. These parameters do not pose any health threats and the communities have adjusted its water use patterns to match the suitability of the water it receives from their wells.

Although sodium is listed under the aesthetic objectives in the ODWQS (200 mg/L), in the interest of persons that require a low sodium diet the local Medical Officer of Health must be informed when sodium levels exceed 20 mg/L. High sodium is characteristic of the water in the study area and exceeds 20 mg/L in all of the supply wells.

Sodium and chloride were identified as parameters of concern for Rosemont.

Elevated sodium and chloride concentrations were identified in the Rosemont Wells. As discussed above elevated sodium and chloride concentrations are typical of groundwater associated with the Georgian Bay Formation (Singer *et al*., 2003). Sodium and chloride concentrations for the Rosemont wells have been plotted to identify any increasing trends. The plot indicates that levels of chloride and sodium at Rosemont exceed the aesthetic objectives for the ODWQS however there are no discernable increasing trends.

No Drinking Water Issues were identified for the Rosemont Water Supply.

8.8.3 Drinking Water Threats Evaluation

An assessment of Drinking Water Threats for the Rosemont water supply was completed in accordance with the detailed methodology presented in Burnside 2010d. 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 Rosemont water supply builds on the information from the Vulnerability Analysis and Issues Evaluation and includes the 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

- an enumeration of Drinking Water Threats

8.8.3.1 List of Drinking Water Threats – Activities

The list of Prescribed Drinking Water Threats considered in the assessment for the Rosemont 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.

8.8.3.2 List of Drinking Water Threats – Conditions

The following information sources were consulted to identify existing Conditions that could affect the Rosemont Well Supply:

- Ecolog Environmental Risk Information Services Ltd Search
    - Federal Government Source databases
    - Provincial Government Source Databases
    - Private Source Databases
- Municipal Planning Documents
- Aerial Photo Interpretation

More details and on these sources can be found in Burnside 2010d.

No confirmed Conditions have been identified for the Rosemont Water Supply. No potential Conditions have been identified for consideration at this time.

8.8.3.3 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 the Government of Ontario's Drinking Water Threats and Circumstances.

8.8.3.3.1 Pathogen Parameters

The Key Table on Figure 8f-4 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 Rosemont Well Supply. Activities that are or would be Significant Drinking Water Threats for pathogens can be observed within the areas where the Vulnerability Score is 10. Pathogens can also only be a Significant, Moderate, or Low Threat within WHPA-A,-B and -E.

8.8.3.3.2 Chemical Parameters

The Key Table on Figure 8f-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 Rosemont Well Supply. Activities that are or would be Significant Drinking Water Threats for chemicals can be observed within areas where the Vulnerability Score is equal to or greater than 8.

8.8.3.3.3 DNAPL Chemical Parameters

Figure 8f-6 illustrates the area of the 5-year time-of-travel zone (WHPA-C) and areas with a Vulnerability Score of 6, where Activities associated with DNAPL parameters are considered to be a Significant Drinking Water Threat for the Rosemont Well Supply. The Key Table on Figure 8f-6 can be used to can be used to identify the circumstances in which these Activities would be Significant or Moderate Drinking Water Threats.

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

Further to Section 8.8.3.2, one Condition and one potential Condition has been confirmed within the WHPA for the Rosemont Well Supply.

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

8.8.3.5 Enumerating Drinking Water Threats

8.8.3.5.1 Enumerating Significant Drinking Water Threats – Methods

Identification and enumeration of Significant Drinking Water Threats related to Issues and Conditions have been described in Section 8.8.2 and 8.8.3.2, 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 Burnside, 2010d. 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.

In order to classify activities in the study area the various databases and sources outlined in Section 8.8.3.2 were reviewed and information on site Activities was compiled. The circumstances under which Activities are considered threats and the classification of those threats are contained in the Table of Drinking Water Threats provided by the MOE (MOE 2008b).

An automated process was developed to search the Table and provide an indication of the Hazard and Risk Score for each identified Activity. The automated process generates a project database that houses information on the threat and also includes the various component scores that are included in the final determination of risk category. The risk category in the automated process is calculated using processes described by the MOE in their document Threats EBR Lookups (MOE, 2009d) and is identical to that used by the Tables of Drinking Water

Threats. As a quality control mechanism the calculated risk categories were verified by manual searches of the MOE Tables of Drinking Water Threats to ensure that the automated calculations were correct for threats categorized as Significant. In order to ensure consistency in the approach for assumptions regarding various activities and the methodology for the evaluations of threats a consensus was arrived at among all consultants conducting work within the SGBLS Region (SGBLS, 2010).

Once a Hazard Rating is assigned to an identified parcel based on the MOE tables, then a Risk Score can be assigned. The Risk Score is calculated by multiplying the Vulnerability Score as defined by the Vulnerability component of the study (Section 8.8.1.5) with the Hazard Rating which provides a score out of 100. The Risk Score is classified as Significant when the score is greater than 80.

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', where present, 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.

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. The percent Managed Lands and Livestock Density calculations were completed for this project using a methodology developed in consultation with the SGBLS Source Protection Region and was based on the MOE Technical Bulletin for Managed Land and Livestock Density Calculations (MOE, September 2009). Managed Lands, Livestock Density, and Impervious Surfaces are discussed in more detail below.

8.8.3.5.1.1 Managed Lands

Managed Land is land to which nutrients (Agriculture Source Material (ASM), commercial fertilizer, and/or Non-Agricultural Source Material (NASM)) are applied. Managed Lands is 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 Township of Adjala-Tosorontio WHPAs as outlined in Burnside, 2010d. The results from this analysis were used in the enumeration of Significant Drinking Water Threats (Section 8.8.3.5.1 and 8.8.3.5.2).

Figure 8f-7 illustrates the distribution of Managed Lands within the delineated WHPA zones for the Rosemont Supply.

8.8.3.5.1.2 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 Township of Adjala-Tosorontio WHPAs as outlined in Burnside, 2010d. The results from this analysis were used in the enumeration of Significant Drinking Water Threats (Section 8.8.3.5.2).

Figure 8f-8 illustrates the distribution of Livestock Density within the delineated WHPA zones for the Rosemont Supply.

8.8.3.5.1.3 Impervious Surfaces

Impervious surfaces are defined in the Technical Rules as areas that receive road salt application and include roads and parking lots. The areas were determined using road mapping

from the National Road Network (Natural Resources Canada) and satellite air photography to identify large parking lots and paved areas. Using a 1 km x 1 km grid centred over each vulnerability area, the percentage of impermeable surfaces within each square kilometre was calculated. For further details on the methods used to assess impervious surfaces for the Township of Adjala-Tosorontio WHPAs see Burnside, 2010d.

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.

Figure 8f-9 illustrates the distribution of Impervious Surface within the delineated WHPA zones for the Rosemont Supply.

8.8.3.5.2 Enumerating Significant Drinking Water Threats – Results

As discussed above there are no Significant Threats associated with Conditions or Drinking Water Issues.

Table 8-6~~Table 8-6~~ documents the enumeration of existing and potential activities that are considered to be Significant Drinking Water Threats within the WHPAs for the Rosemont Water Supply.

A total of twenty-seven (27) Activities that are considered to be potential Significant Drinking Water Threats have been identified in association with twelve (12) land parcels. The identified activities include residential and agricultural land uses. Six (6) parcels were identified as having potential significant threat activities relating to residential land use via the use of private individual sewage disposal systems. One (1) Significant threat and parcel has been included where the Vulnerability Score is 10 to represent the potential for subsurface storage of fuel for home heating purposes. There are 8 residential parcels within this area. Other identified activities include application of commercial fertilizer to land (9), application of agricultural source material to land (4), application of pesticides to land (3), handling and storage of pesticides (2), and handling and storage of commercial fertilizers (2).

Table 8-6: Number of Significant Drinking Water Threats for the Rosemont Well Supply, Enumeration of Significant Threats (Wellhead Protected Area)

Threat Number	Threat	Significant Threat Counts Number of Threats	Significant Threat Counts Number of 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	6	6
3	The application of agricultural source material to land	4	4
4	The storage of agricultural source material to land	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	9	9
9	The handling and storage of commercial fertilizer to land	2	2
10	The application of pesticide to land	3	3
11	The handling and storage of pesticide	2	2

Threat Number	Threat	Significant Threat Counts Number of Threats	Significant Threat Counts Number of Parcels
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 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, and outdoor confinement area, or a farm-animal yard	0	0
22	The establishment and operation of a liquid hydrocarbon pipeline. O. Reg. 385/08, s. 3; O. Reg. 206/18, s. 1.	0	0
-	Total Number	27*	12

Notes for the table above:

1. The number of parcels identified will typically be less than the number of significant threats as multiple threats can be observed per parcel
2. *10 verified existing Threats and 17 potential Threats that require further investigation

Figure 8-1: Vulnerable Areas in the Township of Adjala-Tosorontio.

Figure 8a-1: Wellhead Protection Areas - Colgan.

Figure 8a-2: Groundwater Vulnerability - Colgan.

Figure 8a-3: Vulnerability Scores - Colgan.

Figure 8a-4: Areas of Significant, Moderate or Low Threats - Pathogens.

Figure 8a-5: Areas of Significant, Moderate or Low Threats - Chemicals.

Figure 8a-6: Areas of Significant, Moderate or Low Threats - DNAPLs.

Figure 8a-7: Managed Lands - Colgan.

Figure 8a-8: Livestock Density - Colgan.

Figure 8a-9: Impervious Surfaces - Colgan.

Figure 8b-1: Wellhead Protection Areas - Hockley.

Figure 8b-2: Groundwater Vulnerability - Hockley.

Figure 8b-3: Vulnerability Scores - Hockley.

Figure 8b-4: Areas of Significant, Moderate or Low Threats - Pathogens.

Figure 8b-5: Areas of Significant, Moderate or Low Threats - Chemicals.

Figure 8b-6: Areas of Significant, Moderate or Low Threats - DNAPLs.

Figure 8b-7: Managed Lands - Hockley.

Figure 8b-8: Livestock Density - Hockley.

Figure 8b-9: Impervious Surfaces - Hockley.

Figure 8c-1: Wellhead Protection Areas - Everett.

Figure 8c-2: Groundwater Vulnerability - Everett.

Figure 8c-3: Vulnerability Scores - Everett.

Figure 8c-4: Areas of Significant, Moderate or Low Threats - Pathogens.

Figure 8c-5: Areas of Significant, Moderate or Low Threats - Chemicals.

Figure 8c-6: Areas of Significant, Moderate or Low Threats - DNAPLs.

Figure 8c-7: Managed Lands - Everett.

Figure 8c-8: Livestock Density - Everett.

Figure 8c-9: Impervious Surfaces - Everett.

Figure 8d-1: Wellhead Protection Areas - Lisle.

Figure 8d-2: Groundwater Vulnerability - Lisle.

Figure 8d-3: Vulnerability Scores - Lisle.

Figure 8d-4: Areas of Significant, Moderate or Low Threats - Pathogens.

Figure 8d-5: Areas of Significant, Moderate or Low Threats - Chemicals.

Figure 8d-6: Areas of Significant, Moderate or Low Threats - DNAPLs.

Figure 8d-7: Managed Lands - Lisle.

Figure 8d-8: Livestock Density - Lisle.

Figure 8d-9: Impervious Surfaces - Lisle.

Figure 8e-1: Wellhead Protection Areas - Loretto Heights and Weca.

Figure 8e-2: Groundwater Vulnerability - Loretto Heights and Weca.

Figure 8e-3: Vulnerability Scores - Loretto Heights and Weca.

Figure 8e-4: Areas of Significant, Moderate or Low Threats - Pathogens.

Figure 8e-5: Areas of Significant, Moderate or Low Threats - Chemicals.

Figure 8e-6: Areas of Significant, Moderate or Low Threats - DNAPLs.

Figure 8e-7: Managed Lands - Loretto Heights and Weca.

Figure 8e-8: Livestock Density - Loretto Heights and Weca.

Figure 8e-9: Impervious Surfaces - Loretto Heights and Weca.

Figure 8f-1: Wellhead Protection Areas - Rosemont.

Figure 8f-2: Groundwater Vulnerability - Rosemont.

Figure 8f-3: Vulnerability Scores - Rosemont.

Figure 8f-4: Areas of Significant, Moderate or Low Threats - Pathogens.

Figure 8f-5: Areas of Significant, Moderate or Low Threats - Chemicals.

Figure 8f-6: Areas of Significant, Moderate or Low Threats - DNAPLs.

Figure 8f-7: Managed Lands - Rosemont.

Figure 8f-8: Livestock Density - Rosemont.

Figure 8f-9: Impervious Surfaces - Rosemont.