Drinking Water Threats Assessment

Figures

Tables

E1 MOECC TECHNICAL BULLETINS

This section focuses on bulletins used to drinking water threats assessment of the Assessment Report (**Chapter 5**) in the four vulnerable areas:

- Wellhead Protection Areas (WHPA);
- Highly Vulnerable Aquifers (HVA);
- Significant Groundwater Recharge Areas (SGRA); and
- Intake Protection Zones (IPZs).

E1.1 Objectives

The objective of the drinking water threats assessment is to complete water quantity and quality risk assessments to identify any activity, condition and issue that could stress or contaminate the municipal drinking water supplies may be associated with Wellhead Protection Areas (WHPAs), intakes (IPZs), or the broader landscape (HVAs, SGRAs).

E1.2 Technical Rules

The following *Technical Rules (2009, 2013)* describe the requirements for drinking water threats assessment:

- Part IX Local Area Risk Level *(Rule 97 to 109);*
- Part X Drinking Water Threats: Water Quantity *(Rule 110 to 113)*; and
- Part XI Drinking Water Threats: Water Quality *(Rule 114 to 138).*

E1.3 Technical Bulletins

To provide additional clarification and direction, the MOECC released the following technical memos regarding water threats assessment:

- Proposed Methodology for Calculating Percentage of Managed Lands and livestock for Land Application of Agricultural Source of Material, Non-Agricultural Source of Material and Commercial Fertilizers (November 2009);
- Provincial Tables of Circumstances: Understanding the Provincial Tables (March 2010);
- Threats Assessment and Issues Evaluation (March 2010);
- Part IX Local Area Risk Level (April 2010);
- Delineation of Intake Protection Zone 3 Using the Event Based Approach EBA (July 2009);
- Clean Water Act, 2006. Addressing Transportation Threats (September 2010);
- Earth (Geothermal) Energy Systems (November 2009); and
- Burial of Animals on Farms as a Drinking Water Threats (Deadstock Disposal) (December 2009).

These eight technical bulletins are below.

DRINKING WATER SOURCE PROTECTION
ACT FOR CLEAN WATER

Technical Bulletin: Proposed Methodology for Calculating Percentage of Managed Lands and Livestock Density for Land Application of Agricultural Source of Material, Non-Agricultural Source of Material and Commercial Fertilizers

Date: December 2009

Ontario Ministry of the Environment

Support for this guidance provided by

- Lake Erie Source Protection Region (LESPR)
- Ontario Ministry of Agriculture, Food and Rural Affairs (OMAFRA)
- Conservation Ontario

INTRODUCTION

The *Clean Water Act, 2006* sets the legal framework that ensures communities are able to protect their municipal drinking water supplies by developing collaborative, locally driven, science-based protection plans. Communities will identify potential risks to local drinking water sources and take action to reduce or eliminate these risks. Regulation 287/07 and technical rules (updated November 2009) govern the content of the assessment report. The regulation includes a list of prescribed activities that must be considered when identifying and categorizing activities that pose a risk to drinking water. The technical rules include Tables of Drinking Water Threats that set out the circumstances under which the activities in the regulation pose a significant, moderate, or low drinking water threat. Included in these tables are threats that require consideration of the percent managed lands and livestock density within vulnerable areas. The technical rules include a requirement for maps of percent managed land and livestock density to support the analysis of these circumstances. This is explained in more detail below.

In determining the percentage of *managed land,s* source protection committees must determine the areas where there may be application of agricultural source material (ASM), commercial fertilizer, or non-agricultural source material (NASM). These areas are expressed as percentages of the total area being evaluated. In determining the livestock density in an area, expressed in terms of nutrient units/acre (NU/Acre), committees have to determine nutrient units (NU) generated as a percentage of the total agricultural managed lands in the area.

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The combination of the percentage of managed land and the livestock density of an area is then used as a surrogate for representing the quantity of nutrients present as a result of nutrient generation, storage, and land application within an area. This surrogate is then used to determine the potential impact of a single property on water quality.

This methodology has been developed by the Grand River Conservation Authority (GRCA) in the Lake Erie Source Protection Region (LESPR) with the support from MOE, Conservation Ontario and OMAFRA, to map the *percentage of managed lands* and calculate *livestock density* areas for use in determining the "quantity" of land applied nutrients in an area.

This technical bulletin describes a tested, consistent methodology that can be applied by any Source Protection Committee (SPC) in the province, to evaluate the circumstances in which land application of Agricultural Source Material (ASM), Non-agricultural Source Material (NASM), and Commercial Fertilizers could be considered as chemical threats in their source protection area. The approach outlined uses the combination of managed land intensity and livestock density (expressed in terms of NU/acre) to arrive at a surrogate measure of the extent of use of these chemical threats of nitrogen and phosphorus in an area of interest.

The working group also reviewed and set directions on how nutrients can be considered when determining the applicable chemical threat circumstances related to the use of land as livestock grazing or pasturing land, an outdoor confinement area or a farm-animal yard. Note that pathogen threats associated with these same activities are identified and categorized using a separate, independent approach.

Although the proposed methodology is intended to assist all SPC's in calculating the percentage of managed lands and livestock densities required for the development of the Assessment Reports, the Source Protection Programs Branch of Ministry of the Environment recognizes that a SPC may choose to apply an alternative method that may be more appropriate for the local conditions or data availability for its area. The SPC should document any method used to undertake the task.

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1. MANAGED LAND AND AGRICULTURAL MANAGED LAND

1.1 Background

Managed land is land to which nutrients (ASM, fertilizer, NASM) are applied. It includes, but is not limited to, cropland, fallow land, improved pasture, golf courses, sports fields, and lawns.

Managed lands can be broken into 2 subsets: agricultural managed land and non-agricultural managed land. *Agricultural managed land* includes areas of cropland, fallow, and improved pasture that may receive nutrients. *Non-agricultural managed lands* includes golf courses (turf), sports fields, lawns (turf) and other built-up grassed areas that may receive nutrients (primarily commercial fertilizer).

The November 2009 technical rules include the development of a map that shows:

16 (9) One or more maps of the percentage of managed lands within,

(a) a significant groundwater recharge area;

(b) a highly vulnerable aquifer;

(c) each of the following areas within a vulnerable area:

(i) *WHPA-A.*

(ii) *WHPA-B.*

(iii) *WHPA-C.*

(iv) *WHPA-C1, if any.*

(v) *WHPA-D.*

(vi) *WHPA-E.*

(vii) *IPZ-1.*

(viii) *IPZ-2.*

(ix) *IPZ-3, if any.*

If two or more areas in an area referred to in clause (a) to (c) have different vulnerability scores, the percentage of managed land may be determined for each of those areas. Mapping the percentage of managed lands is not required for any area in an area mentioned in clause (a) to (c) where the vulnerability scores for that area are less than those necessary for the following activities to be considered a significant, moderate or low drinking water threat in the Table of Drinking Water Threats: the application of agricultural source material to land,

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the application of non-agricultural source material to land and the application of commercial fertilizer to land. Each map prepared in accordance with this subrule shall be labelled the "managed land map".

(10) One or more maps of livestock density for each area referred to in subrule (9). Livestock density shall be determined by dividing the NUs generated in each area by the number of acres of agricultural managed land in that area where agricultural source material is applied. If two or more areas in an area referred to in subrule (9) (a) to (c) have different vulnerability scores, the livestock density may be determined for each of those areas. Mapping livestock density is not required for any area in an area mentioned in clause (9) (a) to (c) where the vulnerability scores for that area are less than those necessary for the following activities to be considered a significant, moderate or low drinking water threat in the Table of Drinking Water Threats: the application of agricultural source material to land, the application of non-agricultural source material to land and the application of commercial fertilizer to land. Each map prepared in accordance with this subrule shall be labelled the "livestock density map".

Both *managed lands* and *agricultural managed lands* are to be identified within each of the vulnerable areas where the vulnerability score for that area is high enough for activities to be considered a significant, moderate or low drinking water or for subsets of these vulnerable areas. Based on the tables, any area with a score of 6 or higher for groundwater or 4.4 or higher for surface water (including IPZs and WHPA E) can have threats identified. The percentage of managed lands and livestock density are only required for these areas as it is only in these areas where the vulnerability is high enough for a threat to be present.

For example, the *managed land* percentage must be identified within HVAs. This can be done by determining the percentage over the combined HVA area, or within several HVAs combined, or for individual HVA polygons. . Also, the subset of a WHPA-D considered in order to identify the managed lands can be either the sum of all parts of the WHPA D scoring 6, or each individual WHPA-D subset scoring 6, depending on the amount and sizes of WHPA-D subsets that score 6. Professional judgment should be applied for this decision.

The percentage of managed land area within a vulnerable area or subset of the vulnerable area should be the sum of agricultural managed land and non-agricultural managed land, divided by the total land area within the vulnerable area (or subset of the area) multiplied by 100.

Where only a portion of a *managed land* parcel falls within a vulnerable area, only the portion of the parcel within the vulnerable area should be factored into the calculations for the total *managed land* in the vulnerable area.

1.2 Considerations for Percentage of Managed Lands Calculation

(a) Delineating Areas of Agricultural Managed Lands

Agricultural managed land includes farmed areas (cropland, fallow land and improved pasture). Methods to delineate these areas may vary for each SPA and may include GIS, photo interpretation work, field inspection where the vulnerable area to be inspected is small, or a combination of these methods.

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In cases where there are both the time and resources available, or where uncertainty is high as a result of discrepancies in the data collected, a roadside survey/field checking is recommended as confirmation/support of the air photo interpretation or GIS to reduce the uncertainty and make adjustments on the identification of agricultural managed lands. Also, the air-photo interpretation would be best undertaken by an individual with knowledge of general agricultural systems, and it is recommended someone with similar background and skills undertake the roadside survey as confirmation/support of the air photo interpretation, since the data collected during the field checking would also be used to confirm the estimates of the livestock density in the area.

(b) Delineating Areas of Non-Agricultural Managed Lands

Areas of non-agricultural managed lands are grassed areas that may receive commercial fertilizers such as residential lawns, sports fields and golf courses.

Golf Courses

Methods to determine golf course area vary with local availability of data and may include direct measurement using air photo interpretation or GIS where the area is small, subwatershed and stormwater /master plan estimates where they have been done, municipal zoning requirements and golf course irrigation Permits to Take Water (PTTW). Municipal Property Assessment Corporation (MPAC) property layer often categorizes information on golf courses using code 490. As with agricultural managed lands, in cases where there are both the time and resources available, or where uncertainty is high as a result of discrepancies of direct measurement, a roadside survey/field checking is recommended as confirmation/support of the air photo interpretation or GIS to reduce the uncertainty and make adjustments on the identification of golf courses.

Alternatively, the National Golf Course Owners Association of Canada has a list of its members on their website (see www.ngcoa.ca) which can help locate golf courses that are in the region. The Municipal Property Assessment Corporation (MPAC) property layer often categorizes information on golf courses using code 490. Using the MPAC layer would give the location and area of golf courses that may be in the vulnerable areas. Aerial photos help to identify the actual golf course areas that would be considered managed lands, omitting the forested areas, wetlands and large rivers and lakes.

For example, within the Grand River Watershed of the Lake Erie Source Protection Region, GRCA staff examined aerial photos overlaid with UTM coordinates of golf course irrigation PTTWs. Local knowledge helped fill in the gaps to include the rest of the courses that may be on municipal supply and not need a PTTW. Figure 1 shows the golf course locations in the Lake Erie Source Protection Region watersheds.

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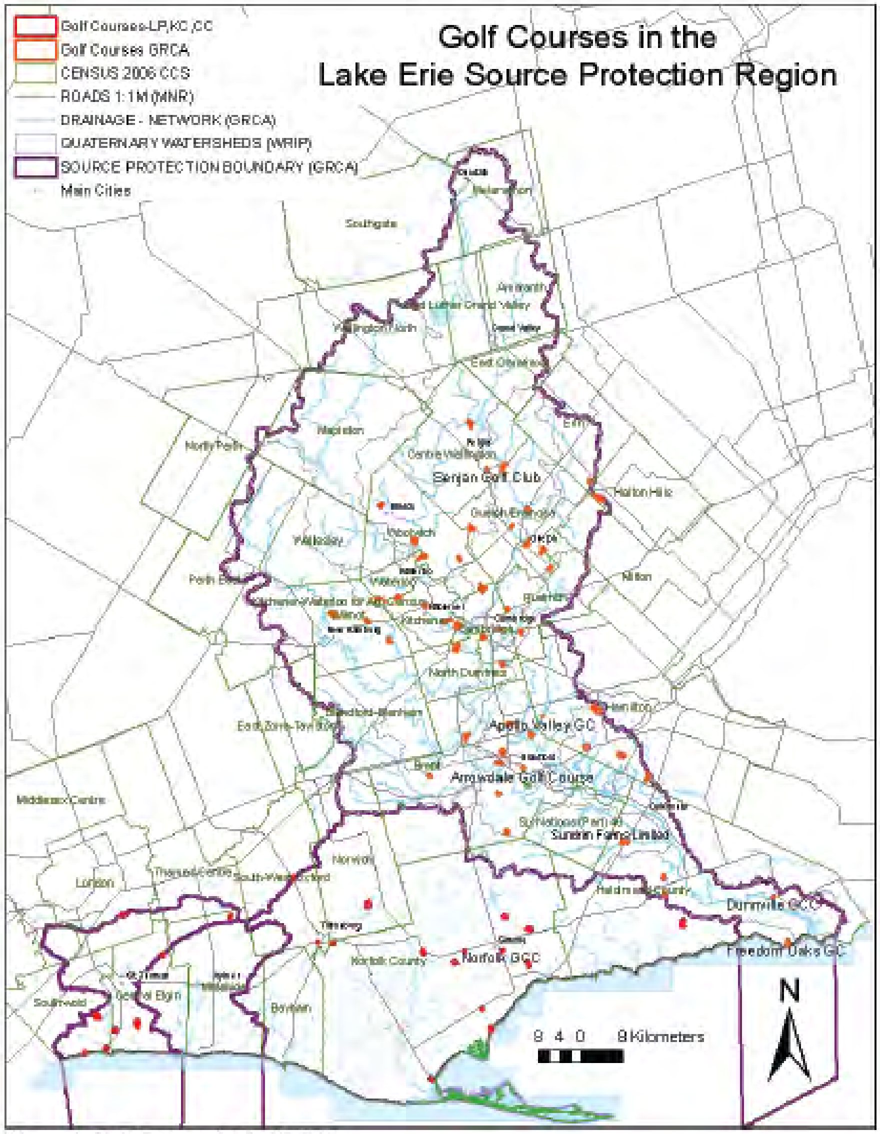

Figure 1: Golf Courses in the LESPR

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Residential/Commercial/Institutional Lawn and Sports Fields

Determination of total managed land includes an estimate of residential, commercial and institutional land area that could receive application of fertilizer (i.e. the lawn/turf area). Recognizing that property size varies across the province, the appropriate method to estimate lawn area will vary by SPA depending on local knowledge and availability of information. Direct measurement and photo interpretation can be used where the area is small. In cases where there are both the time and resources available, or where uncertainty is high as a result of discrepancies in the data collected, a roadside survey/field checking is recommended as confirmation/support of the air photo interpretation to reduce the uncertainty and make adjustments on the identification of pervious urban areas.

Subwatershed plans, storm water management plans/master plans, and other hydrologic studies frequently include estimates of percent impervious surface, which can be used indirectly to estimate the percent grassed area (assuming that pervious surfaces are grassed). Some municipalities will record this information in their official plans (OP's).

Some municipal zoning by-laws specify lot coverage maximums from which grassed areas can be indirectly derived. Some examples:

- In Toronto, for example, the maximum structure size is 35% (municipal zoning lot coverage max) + 10% driveway leaving a grass area of 55%. Similarly in Mississauga, the maximum structure size is 25% + 10% driveway leaving a grass area of 65%.

- In Kitchener, the impervious cover analysis was done for a subwatershed study showing a range between 45% to 65% imperviousness in residential areas, including roads. This would leave between 35% to 55% grassed areas, depending on the age of the subdivision and type of housing (low density or multi-residential).

These estimates try to integrate areas where lot coverage is higher (i.e. townhouses and office complexes with parking lots) with areas where lot coverage is lower (i.e. neighbourhoods containing parks and larger parcels).

(c) Table of Drinking Water Threats: Thresholds for Percentage of Managed Lands

As a conservative estimate of risk, it is assumed that all managed lands receive some type of nutrient application. The thresholds defined in order to evaluate the risk of over-application of nutrients in a vulnerable area or subsets of this area are:

- If managed lands in total account for less than 40% of the vulnerable area or subsets of this area, the area is considered to have a low potential for nutrient application to be causing contamination of drinking water sources,
- If managed lands in total account from 40% to 80% of the vulnerable area or subsets of this area, the area is considered to have a moderate potential for nutrient application to be causing contamination of drinking water sources, and

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- If managed lands in total account for over 80% of the vulnerable area or subsets of this area, the area is considered to have a high potential for nutrient application to be causing contamination of drinking water sources.

2. LIVESTOCK DENSITY (NU/Acre)

2.1 Calculation of Livestock Density

Livestock density is used as a surrogate 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 in NU/Acre.

The NUs (NUs) is expressed as:

- The number of animals housed, or pastured, at one time on a Farm Unit, that generate enough manure to fertilize the same area of crop landbase under the most limiting of either nitrogen or phosphorus as determined by OMAFRA's Nutrient Management (NMAN) software

  Or, in the case where no animals are housed:

- The weight or volume of manure or other biosolids used annually on a Farm Unit, that fertilizes the same area of crop landbase under the most limiting of either nitrogen or phosphorus as determined by OMAFRA's Nutrient Management (NMAN) software

The Nutrient Management Protocol defines the Farm Unit as:

1. For agricultural operations that generate a prescribed nutrient:
   - Can be no smaller than a single deed, or
   - Can be no smaller than the landbase of a generating facility under a single continuous roof, or
   - Must include all land receiving nutrients generated on the deeded property, as required by the Nutrient Management Strategy and/or Plan; whether or not the land itself is on the same deed; and
   - Must include nutrient generating facilities on other deeds owned by the same person/corporation if the nutrients generated on these other deeds are utilized on the landbase of the first deed; and
   - If nutrients are generated in different locations on your overall operation and those nutrients are not spread on the same landbase, then these different locations can be two or more separate farm units.
2. For agricultural operations that do not generate, but use nutrients
   - The farm unit can be no smaller than a single field

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The calculation of livestock density in a specified area requires the following three steps:

1) Estimate the number of each category of animals present within the specified area,

2) Convert the number of each category of poultry and livestock present into NUs, which are suggested in Section 2.1 of this Technical Bulletin, to enable all livestock to be compared on an equivalent unit of measure in terms of the nutrients produced by each type.

3) Sum the total NU of all categories of poultry and livestock within the specified area and then divide this NU value by the area of agricultural managed land within the same specified area. The applicable area used for the calculation of livestock density (NU/acre) is different for each of the following activities. Rule 1 of the technical rules includes a definition of livestock density, which is calculated over one of two areas described in (a) and (b):

a) In respect of land used for the application of nutrients, the number of NU per acre of agricultural managed land in the vulnerable area or subset of the vulnerable area, and detailed in Section 2.1 of this Technical Bulletin;

For the purposes of estimating the NUs required for the estimation of livestock density in a farm unit, where a portion of a farm unit falls within a vulnerable area, the NUs generated on the entire parcel of land should be factored into the calculations rather than the NUs generated within the portion of land that falls within a vulnerable area.

The rate for livestock density (NU/Acre) shall be calculated by dividing the total NUs generated on the farm unit by the total agricultural managed land within this farm unit. By calculating the rate for livestock density for the entire farm unit, this rate is already prorated to the portion of the farm that is in the vulnerable area.

For example, a farm unit has 200 acres of crop area, and □ of the crop area is located within the vulnerable area. The barn can be located either inside or outside the vulnerable area, and the farm unit has 100 cows, generating about 100 NU. The NU generated on this farm unit very likely will be used on its own crops. Therefore, the NU/acre is 100NU/200 acres = 0.5 NU/acre. Then, for this example, the area of "agricultural managed land" to be accounted within the vulnerable area is 100 acres, and the livestock density is 0.5 NU/acre.

b) In respect of land that is part of a farm unit and that is used for livestock grazing or pasturing, the number of NUs per acre that is used for those purposes, and detailed in Section 2.4 of this Technical Bulletin.

The land use data required for estimation of the above NU/Acre can be obtained from the same sources as the data required for the identification of managed land. The areas considered to calculate the NUs for each of the agricultural activities are described in Sections 2.2 to 2.4 below.

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2.2 Estimating the Number of Animals and Nutrient Units for Use in Livestock Density Calculations

The *Nutrient Management Act* developed a method of comparing livestock nutrient generation by converting the number of individual livestock into NU. This technical bulletin provides two methods to obtain the number of NU in a vulnerable area or subset of the vulnerable area. The first method is using a barn size calculation to estimate NU. The second method is converting actual animal numbers using the NU conversion table in the *Nutrient Management Protocol* of the *Nutrient Management Act*.

(a) ***Estimating Nutrient Units based on the Square Footage of the Barn***

To estimate NUs based on square footage requires a three step approach. The first step is identifying the type of livestock operation on a farm unit. This may be accomplished two ways. Firstly, the Municipal Property Assessment Corporation (MPAC) farm classification system can be used to identify the farm use on a property (i.e. Dairy, Swine, Beef, etc.). The air photography and/or road side surveys, as described in Appendix A, can be used to address inconsistencies between MPAC data and local knowledge.

The MPAC data identifying the land use may in some cases be missing, an air photo interpretation helps to confirm the identification of barns and therefore to refine the estimates of the number of animals. For small areas a roadside survey as confirmation/support of the air photo interpretation is recommended to confirm the location of the barns and number of barns, as well to reduce the uncertainty on the identification of the number and type of animals that a farm unit may hold.

Once the type of livestock operation is known, the second step is to estimate the area of the livestock building. The square footage of each identified livestock building can be estimated using air photography and a GIS area measurement tool.

Once the livestock type and the barn dimensions are known, Table 1 below, or Tables 4 through 6, which can be found in Appendix B, may be used to estimate the number of NU on the farm unit. If there is no available detailed data about the property then Table 1 should be used. If more detail about the operation is known then Tables 4 through 6 in Appendix B should be used.

Table 1 below contains barn area per NU conversions based on the MPAC farm classification system. Tables 4 through 6 also provide barn area per NU conversion, but more detailed and specific to livestock sub-type (i.e. milking age cows, heifers, calf) and livestock sub-sub-type (i.e. freestall, tie stall and bedded pack) if such data is available.

For example, if a road side survey determines that a dairy farm houses Jersey cows, then Table 4 should be used to refine the calculation for that farm.

However, local knowledge or direct contact with property owners will always take precedence over any information gathered through this method.

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Table 1: *NU Conversion Factors based on barn size for different MPAC farm classifications.*

MPAC Classification	Sq.ft./NU	Sq.m./NU
Dairy	**120**	**11**
Swine	**70**	**7**
Beef	**100**	**9**
Chickens	**267**	**25**
Turkeys	**260**	**24**
Horse	**275**	**26**
Goat	**200**	**19**
Sheep	**150**	**14**
Fur	**2400**	**223**
Mixed	**140**	**13**

(b) ***Estimating Nutrient Units based on documented animal numbers***

The number of animals can be obtained by using the MPAC data and contacting the landowners within the vulnerable areas directly. The MPAC farm classification system can be used to identify the farm use on a property (i.e. Dairy, Swine, Beef, etc.). Information of number of livestock per farm units may also be available for some areas by contacting the Ontario Cattlemen's Association.

For conversion of the number of individual livestock into NUs, see http://www.omafra.gov.on.ca/english/livestock/index.html for each livestock type under Manure and Nutrient Management by commodity. The values that can be used to convert estimated poultry and livestock numbers into NUs are also provided in Table 2 below.

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Table 2: *Nutrient Unit Conversion Factors for Poultry, Cattle and Swine and Other Types of Livestock*

Livestock Category	Agricultural Census Category(s)	Description of Operation from OMAFRA (or surrogate for AgCensus Category)	Nutrient Unit Conversion Factor	Divide # of Animals by NU Conversion Factor
Poultry	laynen	Laying Hens (number of layer spaces in barn - after pullet stage, until end of laying period)	150 birds/NU	150
	pulets	Layer Pullets (number of pullet spaces in barn - day old to laying)	500 pullets/NU	500
	broiler	Chicken Broilers (8-week cycle)	351 birds/NU	250
		Chicken Broilers (9-week cycle)	300 birds/NU	
		Chicken Broilers (10-week cycle)	250 birds/NU	
		Chicken Broilers (12-week cycle)	199 birds/NU	
		Chicken Broiler Breeders (layers and roosters transferred in from growing barn)	100 birds/NU	
		Broiler Breeders (growing - pullets and cockerels transferred out to layer barn)	300 pullets/NU	
	turkey	Turkeys - Broilers/Hens/Toms/Pullets (total square feet of floor growing area)	58 birds/NU	58
	chick	Average of all chickens	300 chickens/NU	300
	tothplt	Average of all Other Poultry	245 birds/NU	245.33
Cattle	tbfcows	Beef Cows Includes calves to weaning	1 animal/NU	1
	tsteers	Beef Backgrounders 261-408 kilograms (575-900 pounds)	3 animals/NU	3
	bfheif	Beef Feeders 261-567 kilograms (575-1,250 pounds)	3 animals/NU	3
	fdheif	Beef Feeders 261-567 kilograms (575-1,250 pounds)	3 animals/NU	3
	milkcow bulls	Dairy Cows (Large Frame, i.e. Holstein) 545-636 kilograms (1,200-1,400 pounds)	0.7 animals/NU	0.7
	milkheif	Dairy Heifers (Large Frame, i.e. Holstein) 182-545 kilograms (400-1,200 pounds)	2 animals/NU	2
	calfu1	Dairy Calves (Large Frame, i.e. Holstein) 45-182 kilograms (100-400 pounds)	6 animals/NU	6
	cow	Average all Cows	0.85 animals/NU	0.85
Swine	tsows	Lactating-Age Sows - Includes weaners to 6.8 kilograms (15 pounds)	3.33 animals/NU	3.33
	grwpig	Finishing Pigs Number of spaces in barn for animals between 27.3-104.5 kilograms (60-230 pounds)	6 animals/NU	6
	boars	SEW Sows Lactating-Age Sows - Includes weaners to 6.8 kilograms (15 pounds)	3.33 animals/NU	3.33
	nurpig	SEW Weaners 6.8-27.3 kilogram (15-60 pounds)	20 animals/NU	20
		Average of All Swine	0.858 animals/NU	8.165

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Livestock Category	Agricultural Census Category(s)	Description of Operation from OMAFRA (or surrogate for AgCensus Category)	Nutrient Unit Conversion Factor	Divide # of Animals by NU Conversion Factor
Sheep	ewes rams	Sheep - Meat Breeding Ewes - includes lambs to 32 kilograms (70 pounds) (most sheep in GRCA are for meat)	8 animals/NU	8
	lambs	Feeder Lambs 32-57 kilograms (70-125 pounds)	20 animals/NU	20
Other Livestock	horses	Horses Medium Frame includes foals to weaning from 227-680 kilograms (500-1,500 pounds)	1 animal/NU	1
	goats	Goats – Dairy milking-age does (includes kids, replacements and bucks)	8 animals/NU	8
	wildboar	Wild Boar - Breeding Age Sows includes boars, replacements, and weaned piglets to 27 kilograms (60 pounds)	5 animals/NU	5
	fox	Fox Breeding Females includes replacements, market animals and males	25 animals/NU	25
	mink	Mink Breeding Females includes replacements, market animals and males	90 animals/NU	90
	bison	Bison Adults includes unweaned calves and replacements	1.3 animals/NU	1.3
	lamas	Llama Adults or Alpaca Adults includes unweaned young and replacements	5 animals/NU 8 animals/NU	6.5
	elk	Elk Adults (24 months and older)	2 animals/NU	2
	deer	Deer (average of red, white tail and fallow) (24 months and older)	10.33 animals/NU	10.33
	rabbits	Breeding Does (includes replacements, market animals and males)	40 animals/NU	40

2.3 Livestock Density for Land Application of Nutrients (NU/Acre)

(a) Area Used to Calculate Livestock Density for Land Application of Nutrients

For the purposes of determining the circumstances related to the application of nutrients, the livestock density (NU/acre) is calculated using the areas of '*managed agricultural land*' within each of the vulnerable areas or subset of the vulnerable areas as the denominator, as described in Section 1.1(a) of this bulletin. In other words, the total NUs of all livestock generated in the vulnerable area or subset of the vulnerable area divided by the acreage of *Agricultural Managed Lands within this area equals the livestock density in NU/acre*.

As detailed in Section 2.1, for the purposes of estimating the NUs and therefore the rate of livestock Density (NU/) within the vulnerable area or subset of the area, where a portion of a farm unit falls within a vulnerable area, the NUs generated on the entire parcel of land should be factored into the calculations rather than the NUs generated within the portion of land that falls

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within a vulnerable area, as this is then prorated by making it a NU/acre rate of application, which will apply to the portion of land in the vulnerable area.

(b) Table of Drinking Water Threats: Livestock Density Thresholds for Land Application of Nutrients

The conservative assumption used as the basis for this calculation is that a higher NU density results in a greater concentration of nutrients (the chemical threat) present in an area for storage, and land application and therefore an increased potential for nutrient contamination of source waters within the vulnerable area. For land application of ASM, a high livestock density in an area suggests an increased potential that over-application of ASM may occur as adequate land-base to properly dispose of all the ASM may not exist. In areas with low livestock density adequate land-base is more likely to exist to properly dispose of the ASM. Commercial fertilizers will likely be used to compensate for any under supply of ASM-based nutrients. The amounts applied, however, are regulated by the fact that this is a purchased crop input. The rational is that growers will want to closely match commercial fertilizer applications to crop requirements to minimize their cost of crop production.

The thresholds defined in order to evaluate the risk of over-application of ASM are:

- If livestock density in the vulnerable area is less than 0.5 NU/acre, the area is considered to have a low potential for nutrient application exceeding crop requirements,
- If livestock density in the vulnerable areas is over 0.5 and less than 1.0 NU/acre, the area is considered to have a moderate potential for nutrient application exceeding crop requirements, and
- If livestock density in the vulnerable areas is over 1.0 NU/acre, the area is considered to have a high potential for nutrient application exceeding crop requirements.

2.4 Livestock Density for Use of Land as Livestock Grazing or Pasturing Land, an Outdoor Confinement Area or a Farm-Animal Yard (NU/Acre)

(a) The Use of Land as Livestock Grazing or Pasturing Land

For the use of land as livestock grazing or pasturing land within the vulnerable areas, the NUs shall be calculated only for animal species that have the potential to be pastured in the same manner as above, but the area used for the calculation of livestock density shall be considered at the farm level. The nutrients generated at an annual rate for the circumstances under Table 1 of the technical rules shall be determined by the number of NU for the farm divided by the size of the livestock grazing land or pasturing land.

As detailed in Section 2.1, for the purposes of estimating the NUs and then the NU/Acre within the vulnerable area or subset of the area, where a portion of a farm unit falls within a vulnerable area, then the entire livestock grazing land or pasturing land should be factored into the calculations over the full area, to create a NU/acre that applies to the portion of land within the vulnerable area.

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(b) The Use of Land as Livestock Outdoor Confinement Area or a Farm-Animal Yard

For the use of land as livestock outdoor confinement area (OCA) or a farm-animal yard within the vulnerable areas, the NUs shall also be calculated only for animal species that have the potential to dwell in an outdoor confinement area at the farm level. The nutrients generated at an annual rate for the circumstances under Table 1 of the Technical Rules shall be determined by the number of NU for the farm divided by the size of the livestock OCA or a farm-animal yard in hectares.

Furthermore, where a portion of the grazing and pasture, OCAs and farm-yards of a farm unit falls within a vulnerable area, then the entire parcel of land for these purposes should be factored into the calculations over the full area, to create a NU/acre that applies to the portion of land within the vulnerable area.

3. CLARIFICATIONS OF THREATS RELATED TO APPLICATION OF NUTRIENTS

Table 1 of the Tables of Drinking Water Threats requires that you consider the maps for both percentage of managed lands and livestock density when evaluating the circumstances with regard to each of the thresholds for land application of nutrients. Table 3 illustrates the chemical hazard scorings for various combinations of percentage of managed lands and livestock densities. These are the consolidated hazard scores, incorporating the quantity, toxicity and fate scores. The highlighted combinations of percentage of managed land and NU/Acre give a hazard rating for land application of nutrients that, when combined with the area vulnerability scores of 9 or 10, would result in significant risk to source waters.

Table 3: ***Chemical Hazard Scorings for Various Combinations of Percentage of Managed Lands and Livestock Densities***

Groundwater Chemical Hazard Scores

Percentage Managed Land to Total Land	**Nutrient Units per Acre of Cropland**		
	< 0.5 NU/acre	0.5 to 1.0 NU/acre	> 1.0 NU/acre
> 80%	8 **Significant in areas of Vuln=10**	8.4 **Significant in areas of Vuln=10**	8.4 **Significant in areas of Vuln=10**
40 to 80%	6.8	7.6	8.4 **Significant in areas of Vuln=10**
< 40%	6	6.8	8 **Significant in areas of Vuln=10**

Technical Bulletin: Managed Lands and Livestock Density

Surface water Chemical Hazard Scores

Percentage Managed Land of Total Area	Nutrient Units per Acre of Cropland		
	< 0.5 NU/acre	0.5 to 1.0 NU/acre	> 1.0 NU/acre
> 80%	8.8 **Significant in areas of Vuln=10**	9.2 **Significant in areas of Vuln=10 or 9**	9.2 **Significant in areas of Vuln=10 or 9**
40 to 80%	7.6	8.4 **Significant in areas of Vuln=10**	9.2 **Significant in areas of Vuln=10 or 9**
< 40%	6.8	7.6	8.8 **Significant in areas of Vuln=10**

4. CLASSIFICATION OF THREATS RELATED TO THE USE OF LAND FOR LIVESTOCK GRAZING OR PASTURING OR OUTDOOR CONFINEMENT AREA OR A FARM-ANIMAL YARD

In general, the use of land as livestock grazing or pasturing land will be a **significant chemical threat in Vulnerable Areas scoring 9 or 10** if:

- **Vulnerable Areas scoring 9** if the livestock density is sufficient to generate nutrients at an annual rate that is more than 1.0 NU/Acre; or
- **Vulnerable Areas scoring 10** if the livestock density is sufficient to generate nutrients at an annual rate that is at least 0.5 NU/Acre for surface water or more than 1.0 NU/Acre for groundwater; and
- the land use may result in the presence of Nitrogen or Phosphorus in surface water or Nitrogen in groundwater.

Note: the tables include Phosphorus in groundwater, but do not identify any threats associated with it.

The use of land as livestock outdoor confinement area or a farm-animal yard will be a **significant chemical threat in**:

- **Vulnerable Areas scoring 10** if the number of animals confined in the area at any time is sufficient to generate nutrients at a rate of more than 300 NUs per hectares of the area annually for groundwater and at a rate of more than 120 NUs per hectares of the area annually for surface water; or
- **Vulnerable Areas scoring 9** if the number of animals confined in the area at any time is sufficient to generate nutrients at a rate of more than 120 NUs per hectares of the area annually for surface water; and
- the land use may result in the presence of Nitrogen or Phosphorus in surface water or Nitrogen in groundwater.

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5. CLASSIFICATION OF THREATS RELATED TO ASM STORAGE

ASM storage includes: 1) storage at or above grade in or on a permanent nutrient storage facility, 2) storage at or above grade on a temporary field nutrient storage site, 3) storage below grade in or on a permanent nutrient storage facility, and 4) storage where a portion, but not all, of the ASM is stored above grade in or on a permanent nutrient storage facility. A barn is considered a threat when it is used to store ASM.

It is assumed that a high amount of NUs on a farm unit suggests the possibility of point source release of a large quantity of ASM. It is also assumed that if the farm unit has a high value of NUs, the livestock density (NU/acre) for land application would be high.

Therefore, the technical rules state that the use of land to store ASM would be a **significant chemical threat in Vulnerable Areas scoring 9 or 10** if the weight or volume of manure stored annually on a Farm Unit is sufficient to annually land apply nutrients at a rate that is more than 1.0 NU/Acre of the farm unit. The nutrients stored and applied at an annual rate for the circumstances under the Table of Drinking Water Threats of the technical rules for ASM storage is determined by the NU stored **on farm** divided by **the size of farm unit**.

Furthermore, circumstance 3 for ASM storage is that a **spill** of the material **or runoff** from the area where the material is stored (i.e. a point source release) may result in the presence of Nitrogen or Phosphorus in groundwater or surface water.

The tables of drinking water threats assume that generation of ASM is linked to the application of ASM in the farm unit and therefore circumstances are linked to application rates. If this is not the case, the SPC's can consider requesting the addition of other circumstances for ASM storage. For example:

- Storage of ASM where the NUs generated on the farm unit are more than 200 NU;
- Storage of ASM where the NUs generated on the farm unit are less than 200 NU but more than 100 NU;
- Storage of ASM where the NUs generated on the farm unit are less than or equal to 100 NU;

Technical Bulletin: Managed Lands and Livestock Density

APPENDIX A: EXAMPLE OF CALCULATIONS

This working example has been undertaken by GRCA and OMAFRA in order to illustrate the process of calculating the % of managed land and livestock density for land application of nutrients. A WHPA within the Lake Erie Source Protection Region (LESPR) was selected for this exercise. The vulnerable areas have been delineated according to the technical rules. An illustration of the WHPAs A, B and C is presented in Figure 3 in the example below.

(a) Determining amount of "managed land" and "agricultural managed land"

Section 3 of this bulletin states that the *managed land* and *% managed land* areas must be calculated for each of the wellhead protection areas WHPAs A,B and C, and for each of the intake protection zones IPZ1 and IPZ2. The suggested method is to use a GIS/aerial photo-based approach to calculate the amount of agricultural managed land and tillable land within the vulnerable areas.

For this example, a simplified approach was taken for illustrative purposes, and the managed land and % of managed lands were calculated for a combined area of WHPA A, B and C as:

- WHPA A+B = the 2 year TOT boundary
- WHPA A+B+C = the 5 year TOT boundary

For this wellfield example, the percentage of managed land was calculated using ArcGIS as:

Total defined Vulnerable Area = 5865 acres

This total can be broken down as follows:

- WHPA-A = 76 acres
- WHPA-B = 3262 acres
- WHPA-C = 2527 acres
- Total = 5865 acres

For this example, managed lands within the WHPA were calculated using GIS as:

Managed Lands = Vulnerable Area (WHPA A, B and C) – (build up areas) – (areas of pits and quarries) – (areas of Woodlands) – (Large Rivers and Lakes) – (wetlands)

For illustrative purposes, the example considered that large open spaces (such as golf courses in the picture) are considered "pervious" and may or may not receive nutrients. The example in Figure 2 below (north part of the picture) shows impervious in purple and pervious in green. Therefore, the total managed lands for this example were estimated using GIS as:

- WHPA A + B = 3120 acres
- WHPA A + B + C = 5114 acres

Technical Bulletin: Managed Lands and Livestock Density

Fig 2: Impervious versus Pervious Areas for the WHPAs A, B and C areas

Therefore, the percentage of managed land to total land is calculated as managed land/WHPA:

- WHPA A + B = 93 %
- WHPA A + B + C = 87 %

For this example, the description of managed land included only golf courses and playing fields but not pervious areas within urban areas. The built up area in this case represents about 15% of the area of WHPA A+B and the pervious built up area can be assumed as about 7 to 10 %. However, in some situations the pervious portion of the urban area could represent a significant percentage of the total WHPAs that would affect the scoring for the thresholds for moderate or high risk of contamination. Therefore, for these cases the suggested approach suggested in Section 3.1(b) of this bulletin is recommended for calculation of pervious built up areas of *managed lands*.

Technical Bulletin: Managed Lands and Livestock Density

Agricultural Managed Land (for livestock density calculation) was calculated using GIS as following:

Agricultural Managed Land = (WHPA) – (Built up areas) – (areas of pits and quarries) – (large rivers and lakes) – (wetlands) – (areas of Woodlands)

Resulting in:

- WHPA A + B = 2616 acres
- WHPA B + C = 4534 acres

(b) Determining Nutrient Units (for use in livestock density calculations)

For this example, the NUs within WHPAs A, B and C (i.e. to the 5 year TOT boundary) were calculated using photo interpretation work and MPAC data to identify all buildings that could potentially house farm animals (barns) and estimating the number of animals per barn based on the air-photo-interpreted square footage of the barn.

For illustration, figure 3 shows the locations of Wellheads (red dots represent the WHPA-A), WHPAs B and C, and possible barns within the WHPAs (small black building outlines) using photo interpretation work. Some buildings in the WHPAs were screened out during the photo interpretation since they were obviously not used for livestock housing. Still, in order to briefly verify which building outlined in the photo interpretation work were barns, a quick roadside survey was undertaken to confirm the location of the barns as well as whether the barns would be eventually used to house livestock, and to adjust the findings on number of barns and the type of animals that they may hold.

The air photo interpretation findings in general will take precedence over the MPAC code. For this example, for this area, one farmstead site was identified by MPAC as being "poultry". From the air photos, however, a lot of large grain bins and connecting elevators were observed present around the buildings. This is not a typical building for poultry barns. It was estimated from the air photos and further confirmed by the roadside survey that the building was actually a grain handling facility.

The square footage of each identified livestock building was estimated using the GIS area measurement tool and the NU's within each WHPA were then added up using method described in Section 2.1 (a) and Table 2 of this bulletin. Then, the NUs were divided by the area of agricultural managed farm land.

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DRINKING WATER SOURCE PROTECTION
ACT FOR CLEAN WATER

Technical Bulletin: Provincial Tables of Circumstances:

Understanding the provincial tables

Date: March 2010

The Clean Water Act (the Act), along with regulations and rules governing the content of the assessment report (AR), requires that source protection committees (SPCs) identify areas and circumstances where activities are or would be significant, moderate or low drinking water threats. To meet the minimum requirements of the Act, the Technical Rules: Assessment Report (the Rules) allow SPCs to reference the Tables of Drinking Water Threats that make up part of the Rules. Although this reference meets the minimum requirement of the Act, it is anticipated that assessment reports will need to provide the public with maps and tables that allow the public to easily determine if an activity is or would be a significant, moderate, or low drinking water threat in a specific area. Therefore, to provide provincial consistency and limit the local work needed to create tables that can be referenced in assessment reports, the province has developed the Provincial Tables of Circumstances posted with this bulletin. The purpose of this Technical Bulletin is to provide these tables along with an explanation of the information contained in these tables.

How the Provincial Tables of Circumstances can be used in the assessment report is described in the companion Technical Bulletin titled "Threats Assessment and Issues Evaluation" available at the following location: http://www.ene.gov.on.ca/en/water/cleanwater/cwa-technical-rules.php.

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PIBS 7584e

Rationale for the Provincial Tables of Circumstances

As part of the AR, SPCs are having vulnerability scoring maps developed for four types of vulnerable areas:

- Highly vulnerable aquifers (HVAs) – groundwater
- Significant Groundwater Recharge Areas (SGRAs) - groundwater
- Wellhead Protection Areas (WHPAs) - groundwater
- Intake Protection Zones (IPZs) – surface water

Within these zones, vulnerability scores range from two to ten (2-10). Theranges in scores for each type of area that can result in the identification of a threat are:

- HVAs – 6
- SGRAs – 4, 6
- WHPAs – 4, 6, 8, 10
- IPZs - 4.2, 4.5, 4.8, 4.9, 5, 5.4, 5.6, 6, 6.3, 6.4, 7, 7.2, 8, 8.1, 9, 10

Based on the possible combinations of areas and scores, 76 different Provincial Tables of Circumstances have been created to represent the different combinations for which there are provincially prescribed threats and circumstances within the Tables of Drinking Water Threats. Not all combinations of vulnerable area and score have threats and circumstances associated with them.

The 76 tables are listed in the companion technical bulletin "Technical Bulletin: Threats Assessment and Issues Evaluation". There are a number of components of each table that require an explanation.

1. The tables are broken up into 5 types of tables, chemical tables for groundwater, Dense Non-Aqueous Phase Liquid (DNAPL) tables for groundwater, pathogen tables for groundwater, chemical and DNAPL tables for surface water, and pathogen tables for surface water.
2. Each of the 5 types of tables have been broken out into activities that are significant, moderate, or low drinking water threats for the vulnerability scores available for that type of vulnerable area. For example, chemical based activities in a WHPA with a score of 10, where the activity is a significant drinking water threat.

3. Two names have been given to each table. The first is a provincial table number from 1 to 76. The second, in brackets after the provincial table number, is a table name that used the following identifiers:
    - C – Chemical
    - P – Pathogen
    - D – DNAPL
    - W – WHPA
    - IPZ – IPZ
    - IPZWE – IPZ and WHPA-E
    - (number) - vulnerability score
    - S – Significant Drinking Water Threats
    - M – Moderate Drinking Water Threats
    - L - Drinking Water Threats
    - A – All vulnerability scores
4. For the chemical and DNAPL tables, an explanation of the table set up is provided on page 4.
5. For pathogens, an explanation of the table set up is provided on page 5.

Technical Bulletin: Provincial Tables of Circumstances

Reference Number from the November 2009 Tables of Drinking Water Threats

Circumstance from the November 2009 Tables of Drinking Water Threats

Prescribed Threat

Blank field means that the circumstance is the same as the last one listed. This generally means that there are a group of chemicals that apply to the same circumstance. This can help the reader see where an activity can have multiple chemicals of concern associated with it, which in most cases means it could be counted as one activity when enumerating significant threats.

Threat Subcategory (from database), which provides a way to group circumstances under the prescribed threat. This is only provided where the subcategory and prescribed threat wording is sufficiently different.

Chemical of concern: in many cases there are a number of chemicals associated with the same activity and circumstances.

PROVINCIAL TABLE 1 (CW10S): Chemicals in a WHPA with a vulnerability score of 10 where threats are significant

The application of road salt.

Ref #	Circumstances	Chemical
94	1.The road salt is applied in an area where the percentage of total impervious surface area, as set out on a total impervious surface area map, is 80 percent or more.	Chloride
95		Sodium

The establishment, operation or maintenance of a waste disposal site within the meaning of Part V of the Environmental Protection Act. **Threat Subcategory: Application Of Untreated Septage To Land**

Ref #	Circumstances	Chemical
100	1.The application of hauled sewage to land. 2.The application area is more than 10 hectares.	Nitrogen

The handling and storage of fuel. **Threat Subcategory: Handling Of Fuel**

Ref #	Circumstances	Chemical
177	1.The above grade handling of liquid fuel in relation to its storage at a facility as defined in section 1 of O. Reg. 213/01 (Fuel Oil) made under the Technical Standards and Safety Act, 2000 or a facility as defined in section 1 of O. Reg. 217/01 (Liquid Fuels) made under the Technical Standards and Safety Act, 2000, but not including a bulk plant. 2.The quantity of liquid fuel stored is more than 2,500 litres.	BTEX
178		Petroleum Hydrocarbons F1 (nC6-nC10)
182	1.The below grade handling of liquid fuel in relation to its storage at a bulk plant as defined in section 1 of O. Reg. 217/01 (Liquid Fuels) made under the Technical Standards and Safety Act, 2000, or a facility that manufactures or refines fuel. 2.The quantity of liquid fuel stored is more than 2,500 litres.	BTEX
183		Petroleum Hydrocarbons F1 (nC6-nC10)

A blank cell indicates the text is the same as previous cells

Technical Bulletin: Provincial Tables of Circumstances

Reference number from November 2009 Tables of Drinking Water Threats

Prescribed Threat

Threat Subcategory (from database), which provides a way to group circumstances under the prescribed threat.

Circumstance: the circumstances from the tables of drinking water threats.

PROVINCIAL TABLE 12 (PW10S): Pathogens in WHPA A, B with a vulnerability of 10 where threats are significant

Ref #	Prescribed Threat	ThreatSubcategory	Circumstances
1944	The application of agricultural source material to land.	Application Of Agricultural Source Material (ASM) To Land	1. Agricultural source material is applied to land in any quantity. 2. The application may result in the presence of one or more pathogens in groundwater or surface water.
1945	The use of land as livestock grazing or pasturing land, an outdoor confinement area or a farm-animal yard. O. Reg. 385/08, s. 3.	Management Or Handling Of Agricultural Source Material - Agricultural Source Material (ASM) Generation	1. The use of land as livestock grazing or pasturing land for one or more animals. 2. The land use may result in the presence of one or more pathogens in groundwater or surface water.
1946	The use of land as livestock grazing or pasturing land, an outdoor confinement area or a farm-animal yard. O. Reg. 385/08, s. 3.	Management Or Handling Of Agricultural Source Material - Agricultural Source Material (ASM) Generation	1. The use of land as an outdoor confinement area or a farm-animal yard for one or more animals. 2. The land use may result in the presence of one or more pathogens in groundwater or surface water.
1956	The establishment, operation or maintenance of a system that collects, stores, transmits, treats or disposes of sewage.	Sewage System Or Sewage Works - Septic System	1. The system is an earth pit privy, privy vault, cesspool, or a leaching bed system and its associated treatment unit and is a sewage system as defined in section 1 of O. Reg. 350/06 (Building Code) made under the Building Code Act, 1992 or a sewage works as defined in section 1 of the Ontario Water Resources Act. 2. A discharge from the system may result in the presence of one or more pathogens in groundwater or surface water.
1957	The establishment, operation or maintenance of a system that collects, stores, transmits, treats or disposes of sewage.	Sewage System Or Sewage Works - Septic System Holding Tank	1. The system requires or uses a holding tank for the retention of hauled sewage at the site where it is produced before its collection by a hauled sewage system. 2. A spill from the tank may result in the presence of one or more pathogens in groundwater or surface water.
1958	The establishment, operation or maintenance of a system that collects, stores, transmits, treats or disposes of sewage.	Sewage System Or Sewage Works - Sanitary Sewers and related pipes	1. The system is a wastewater collection facility that collects or transmits sewage containing human waste, but does not include any part of the facility that is a sewage storage tank or works used to carry out a designed bypass. 2. The discharge from the system may result in the presence of one or more pathogens in groundwater or surface water.

DRINKING WATER SOURCE PROTECTION
ACT FOR CLEAN WATER

Technical Bulletin: Threats Assessment and Issues Evaluation

Date: March 2010

Background

The Clean Water Act (the Act) requires that source protection committees (SPC) list activities that are or would be drinking water threats in four types of vulnerable areas. Through Ontario Regulation (O. Reg.) 287/07 (General) and the Director's Assessment Report: Technical Rules (the Rules), the province has set out which activities, at a minimum, are considered drinking water threats under specific circumstances. Specifically, section 1.1 of O. Reg. 287/07 lists activities that are prescribed as drinking water threats and the Tables of Drinking Water Threats (the Tables) in the Rules specify under what circumstances these activities are categorised as significant, moderate or low drinking water threats. Categorising drinking water threats is achieved using the ***Threats Based Approach*** (previously called the Semi-Quantitative Risk Assessment), the ***Issues Based Approach,*** the ***Events Based Approach***, or a combination of these three approaches. Appendix 1 provides a summary of relevant sections of the Act, O. Reg. 287/07 and Rules.

Guidance on the Assessment Report

An integral part of the assessment report and a prerequisite for the threats assessment and issues evaluation is the identification and delineation of vulnerable areas in each source protection area as per section 15(2)(d) and (e) of the Act. Specifically:

- Highly Vulnerable Aquifers (HVAs)

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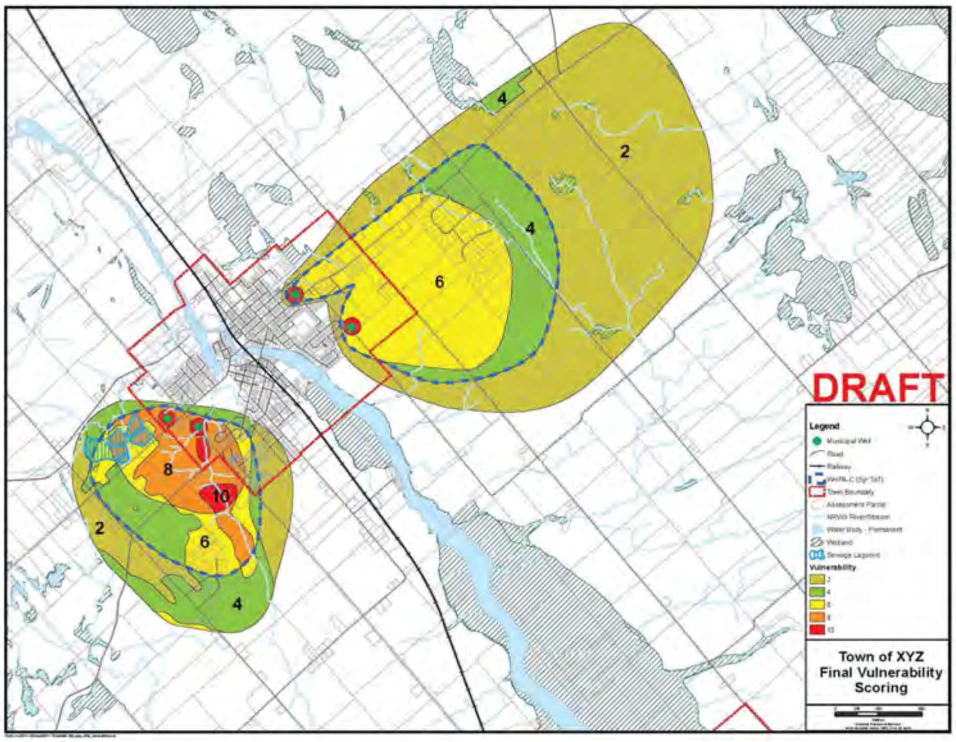
PIBS 7557e

Technical Bulletin: Threats Assessment and Issues Evaluation

- Significant Groundwater Recharge Areas (SGRAs)
- Wellhead Protection Areas (WHPAs)
- Intake Protection Zones (IPZs)

Vulnerability scores are assigned to all the vulnerable areas identified in a source protection area. Part VII and VIII of the Rules (rules 79 to 96) list the requirements for assigning vulnerability scores. The vulnerable areas and scoring for each area can be shown in one or more maps such as these:

Vulnerable Areas – Groundwater mapping example



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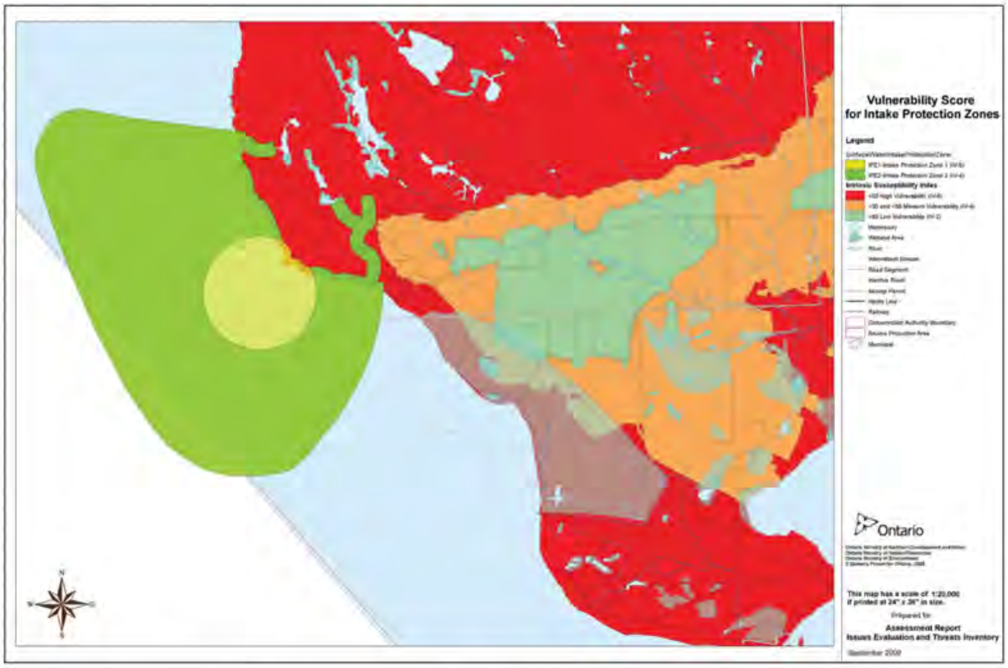
Vulnerable Areas – Surface Water mapping example (also includes groundwater vulnerability)



There are four specific requirements set out in O. Reg. 287/07 and the Rules for the completion of the Threats Assessment and Issues Evaluation component of the assessment report for each vulnerable area in a source protection area:

A) Identification of the activities or conditions that are or would be drinking water threats for each type of vulnerable area. These threats are different depending on whether the source of water is groundwater or surface water.

B) A list of the circumstances under which each activity listed above makes or would make the activity a significant, moderate, or low drinking water threat. For conditions, include the information that confirms there is a condition and the hazard rating for the condition.

C) Show the areas (for example, area scoring 10) within each vulnerable areas and the relevant circumstances where an activity or condition is or would be a significant, moderate or low drinking water threat.

D) Determine the number of locations (for example, parcels of land) at which a person is engaging in an activity that is a significant drinking water threat or where there is a condition that is a significant drinking water threat.

Detailed Requirements

A) Listing Drinking Water Threats

To satisfy **A)** there are three approaches that you may use to list the activities and conditions that are or would be a threat, meaning this is about existing and future activities to ensure appropriate policies can be written for future activities. Therefore, an inventory of activities is not required in this step. Please note this step does not require you to list the circumstances, only the threats.

1. **Listing prescribed drinking water threats (Activities):** O. Reg. 287/07 prescribes a list of activities that are or would be drinking water threats in all vulnerable areas under certain circumstances. As per Rule 118, you can collectively reference the activities listed in O. Reg. 287/07 and do not have to actually list the threats in the assessment report.

2. **Adding local threats (Activities):** The SPC can add a new activity based on local knowledge. As per Rule 119, the threat can not be added unless that the hazard rating of the activity is >4 and the Director under the Act has provided approval.

   Requests to add local threats can be made through the SPC's provincial liaison officer.

3. **Listing Drinking Water Threats (Conditions):** List conditions that the SPC is aware exist within each vulnerable area as per Rule 126 and provide the documentation on the condition.

Background for Requirements for B) and C)

Understanding the Tables of Drinking Water Threats

The Tables provide the list of circumstances where provincially prescribed activities are drinking water threats. These tables can be used to identify circumstances where activities are significant, moderate, or low drinking water threats (described in more detail in Section B of this bulletin) and to identify areas where activities are significant, moderate, or low drinking water threats (see Section C). To determine these circumstances and areas, it is important to understand how the Tables were set up.

The Tables make a link between the hazard rating of an activity under a specific circumstance and for a specific source water source water, and the vulnerability scores needed to make the activity/circumstance a significant, moderate, or low drinking water threat. By multiplying the hazard rating and the vulnerability score, the risk is assigned as per the following risk score ranges:

Risk Score Range	Drinking Water Threat Classification
80-100	Significant
60-<80	Moderate
>40 and <60	Low

The hazard ratings are not provided in the Tables, but are available within the lookup table database that generated the Tables. The lookup table database has been provided to the lead conservation authority in each source protection area and is available upon request. The database takes the hazard rating for each activity (with a specific set of circumstances) and back calculates the vulnerability scores necessary for the activity to fall in the risk score ranges above. Therefore, if the hazard rating is 8.5 for an activity in a surface water environment, then theoretically that activity would be a significant drinking water threat in a vulnerable area that has a vulnerability score of 9.5 or higher (9.5 multiplied by 8.5 equals 80.75 which is within the significant risk score range). However, the Tables will show a vulnerability score of 10 for surface water under the column labelled significant (column 4 in the figure below). This is because the multiplication of area vulnerability factors and source vulnerability factors do not allow a vulnerability score of 9.5. So the Table includes a vulnerability score of 10 rather than the theoretical vulnerability score range of 9.5 to 10. Further information on the Tables is provided on the following page.

Technical Bulletin: Threats Assessment and Issues Evaluation

Excerpt: Tables of Drinking Water Threats - Chemicals

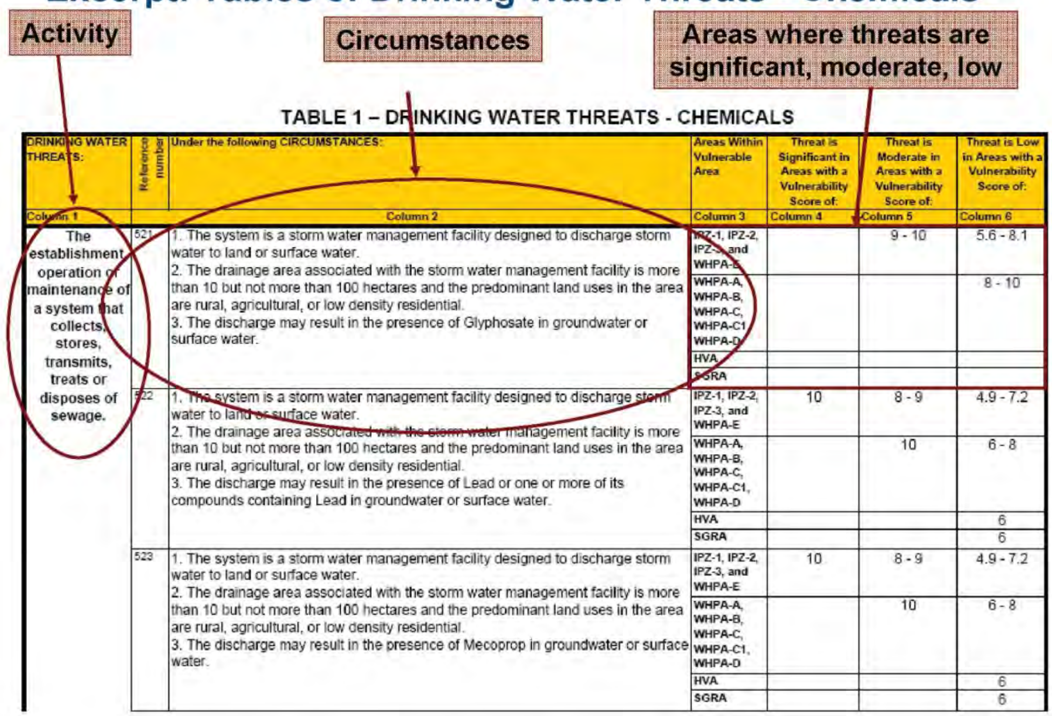


TABLE 1 – DRINKING WATER THREATS - CHEMICALS

DRINKING WATER THREATS:	Reference number	Under the following CIRCUMSTANCES:	Areas Within Vulnerable Area	Threat is Significant in Areas with a Vulnerability Score of:	Threat is Moderate in Areas with a Vulnerability Score of:	Threat is Low in Areas with a Vulnerability Score of:
Column 1		Column 2	Column 3	Column 4	Column 5	Column 6
The establishment operation or maintenance of a system that collects, stores, transmits, treats or disposes of sewage.	521	1. The system is a storm water management facility designed to discharge storm water to land or surface water. 2. The drainage area associated with the storm water management facility is more than 10 but not more than 100 hectares and the predominant land uses in the area are rural, agricultural, or low density residential. 3. The discharge may result in the presence of Glyphosate in groundwater or surface water.	IPZ-1, IPZ-2, IPZ-3, and WHPA-E		9 - 10	5.6 - 8.1
			WHPA-A, WHPA-B, WHPA-C, WHPA-C1 WHPA-D			8 - 10
			HVA			
			SGRA			
	522	1. The system is a storm water management facility designed to discharge storm water to land or surface water. 2. The drainage area associated with the storm water management facility is more than 10 but not more than 100 hectares and the predominant land uses in the area are rural, agricultural, or low density residential. 3. The discharge may result in the presence of Lead or one or more of its compounds containing Lead in groundwater or surface water.	IPZ-1, IPZ-2, IPZ-3, and WHPA-E	10	8 - 9	4.9 - 7.2
			WHPA-A, WHPA-B, WHPA-C, WHPA-C1, WHPA-D		10	6 - 8
			HVA			6
			SGRA			6
	523	1. The system is a storm water management facility designed to discharge storm water to land or surface water. 2. The drainage area associated with the storm water management facility is more than 10 but not more than 100 hectares and the predominant land uses in the area are rural, agricultural, or low density residential. 3. The discharge may result in the presence of Mecoprop in groundwater or surface water.	IPZ-1, IPZ-2, IPZ-3, and WHPA-E	10	8 - 9	4.9 - 7.2
			WHPA-A, WHPA-B, WHPA-C, WHPA-C1, WHPA-D		10	6 - 8
			HVA			6
			SGRA			6

As shown in the above excerpt, the Tables are comprised of four main fields as follows:

Location in Table	Field
Column 1	Drinking Water Threat, based on the 21 prescribed drinking water threats
Column 2	Set of Circumstances specific to a Drinking Water Threat, including presence of contaminant parameters, volumes, and release into the environment
Column 3	Areas within Vulnerable Areas, grouped whether threat relates to surface water (IPZ and WHPA-E), groundwater (WHPA A-D, HVA, or SGRA)
Columns 4 - 6	Vulnerability scores that make up the significant, moderate and low threat matrix – the vulnerability scores listed identify whether the activity under the set of circumstances in that line of the table is a significant, moderate or low drinking water threat

In summary, to determine whether an activity is a significant drinking water threat, you need to know:

1. if the activity is identified as a prescribed drinking water threat or a local threat
2. the set of circumstances related to the contaminant's presence and/or release into the environment
3. what vulnerable area it is located in; and
4. the vulnerability score for the area where the activity is located.

Once the above information is known, you can determine if the activity is a significant, moderate or low drinking water threat.

B) Listing circumstances for activities

Meeting the requirements for listing circumstances is required for both the provincially prescribed drinking water threats and any local threats as outlined below:

1. **For activities within the Tables**: Rule 118.1 allows you to reference the Tables. However, SPCs may want to use lists more specific to the vulnerable area and vulnerability score. SPCs may also want to develop other lists for consultation purposes. ***Appendix 2 elaborates on the various approaches that can be used to develop these lists.*** One approach is that the province has generated tables of activities and circumstances for all combinations of vulnerable area and vulnerability score. These Provincial Tables of Circumstances can be referenced and would not need to be produced in full in the assessment report.

2. **For local activities or prescribed activities with new circumstances:** Where activities or circumstances have been added locally, a list of the new activities and set of circumstances under which these activities are significant, moderate, or low drinking water threats are necessary. The set of circumstances includes the vulnerability score that makes the activity significant, moderate, or low.

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C) Identifying areas where threats are significant, moderate or low

To satisfy **C)** there should be a map showing the areas where the activities, under the circumstances listed, and conditions are significant, moderate or low drinking water threats. There are three approaches as follows:

1. **Through the Threats Approach based on vulnerability:** To show areas where activities or conditions are significant, moderate or low using this approach you can use the vulnerability score maps and legends that link the activities and circumstances and conditions that are or would be threats in each area. For example, if you have a list of activities that are significant drinking water threats in a groundwater based vulnerable area with a vulnerability score of 8, then a map of all groundwater based vulnerable areas with the vulnerability score of 8 could have a legend referencing a table that lists all activities and circumstances that are significant in these areas. ***See Appendix 2 for further detail on how to develop these lists.*** One approach is that you will be able to use the lists of activities and circumstances for all combinations of vulnerable area and vulnerability score the province has generated.

   For this same example, conditions with a hazard rating of 10 would also have to be included on the legend indicating that these conditions would also be significant in an area with a vulnerability score of 8.

Please note the following:

a. No inventory of existing threats is needed for this step. The requirement is to identify any areas where an activity or condition is or would be a significant, moderate, or low drinking water threat, so the presence or absence of an activity is not relevant. Source protection plans are to have policies for existing significant drinking water threats as well as policies to prevent future significant drinking water threats.

b. For most chemicals, only vulnerability scores >4 need to be shown on maps as a risk score of >40 is needed for an activity or condition to be a significant, moderate, or low drinking water threat.

c. DNAPL and pathogen threats need special considerations. DNAPLs are a significant drinking water threat anywhere in WHPA A, B, C, or C1, and pathogen threats can not be a threat outside WHPA B using the threats approach.

d. Therefore, for each vulnerable area, you could produce three maps to show the areas where activities are significant, moderate or low drinking water threats. ***See Appendix 3 for a more detailed description of the three example maps below.***

1. A map for chemicals that shows all subareas of the vulnerable areas with their respective vulnerability scores. As indicated above, a legend could link the areas with the same vulnerability score to a table that lists the activities that are significant, moderate or low drinking water threats with that specific vulnerability score.

2. A map for pathogens that shows vulnerability scores in WHPA-A, WHPA-B, WHPA-E and all subareas of an IPZ where the vulnerability score is greater than 4.

3. A map for DNAPLs that shows WHPA-A, B, and C/C1 as areas where DNAPLs are significant and the areas with vulnerability scores greater than 4 in WHPA-D, WHPA-E, and all subareas of IPZs.

2. **Through the Issues Approach:** The identification of drinking water threats related to issues is an iterative approach.

- First, you identify an issue, the intake, well, or monitoring well where the issue is defined, and the parameter or pathogen of concern (see below for what to consider)

- Second, you identify the issue contributing area (ICA) for any issue meeting the tests in Rule 114. This is the "area within a vulnerable area" where an activity or condition can contribute to an issue. The issue contributing area can only be shown within any one of the four vulnerable areas (WHPA, IPZ, HVA, or SGRA).

- If you don't have enough information to delineate the issue contributing area, you include a plan in the Assessment Report to delineate this area (Rule 116).

- Third, you identify activities or conditions that could contribute to the issue (i.e., they have the chemical or pathogen associated with it that could contribute to the issue.).
- If an analysis of these steps suggests the ICA does not capture threats then a second analysis (iteration) is required to define the appropriate ICA.
- Once the issues and ICA's are defined, the SPC can define the areas where threats are significant, moderate or low drinking water threats. For this, the issue contributing area becomes the area where activities and conditions that could contribute to this issue are:
    - significant drinking water threats for systems to which section 15(2) of the CWA (Clean Water Act) applies (systems in the Terms of Reference); and
    - moderate drinking water threats if the issues are related to any other drinking water system.

Therefore, to show the areas where activities are either significant or moderate drinking water threats as a result of an identified issue, one approach is to provide a:

- map(s) of the vulnerable area and the issue contributing area; and
- reference to all activities or conditions that are either significant or moderate drinking water threats, depending on the type of drinking water system, in the area.

SPCs can create these lists using one of the database tools available for exporting activities related to chemicals or pathogens (the lookup tables data base or the Upper Thames River Conservation Authority Threat Analysis Tool (web based tool). Relevant local threats or conditions should be added to these lists.

Considerations when identifying Issues

SPCs are enabled through the CWA to identify issues related to the drinking water systems in their source protection area. Where an issue meets the following tests, as set out in Rule 114, the SPC is required to identify the issue contributing area and follow the steps in the previous section. The tests in Rule 114 are:

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a. Issues can only be identified at an intake, well, or monitoring well.

b. For drinking water systems included in the Terms of Reference (types I, II, and III systems), issues can be identified for parameters in Schedules 1, 2 or 3 of the Ontario Drinking Water Quality Standard (ODWQS) or in Table 4 of the Technical Support Document.

c. For any other drinking water systems as defined under the Safe Drinking Water Act (SDWA), only chemical drinking water issues may be included (Schedules 2 and 3 of the ODWQS or Table 4 of the Technical Support Document).

d. The definition of a drinking water system under the SDWA means any system that takes water for drinking water purposes. This includes any private well or intake.

It is not mandatory that every elevated parameter in the raw water be considered an issue. The SPC should consult with the operators of the system, and the municipality if they are not the operator, to determine if the raw water quality presents a problem for them. Sometimes a water treatment plant easily deals with the elevated concentration of a parameter and treatment would have to continue even if human activities are managed, as natural conditions also cause the parameter to be elevated. In other cases, the water treatment plant adequately deals with the problem, but the costs associated with treatment of the parameter are prohibitive and/or managing human activities could reduce or eliminate the problem and reduce treatment costs. In some cases, an issue is identified, but most activities contributing to this problem are already identified as significant drinking water threats, so the SPC does not see a need to also identify it as an issue. All of these factors should be considered when assessing if something should be identified as an issue.

3. **Event Based Approach:**

> ***Note: This approach is limited to Type A and B intakes and Types C and D intakes in Lake Nipissing, Lake Simcoe, Lake St. Clair or the Ottawa River.***

The event based approach was designed to address threats to drinking water in systems drawing water from larger water bodies where the vulnerability scores are generally low. The approach allows for the use of modeling or other methods (referred to as modeling in this bulletin) to identify existing or future activities or existing conditions as significant drinking water threats if the modeling results indicate that there would be a drinking water issue at an intake if chemicals or pathogens were released from the location under an extreme event. It is a two part process, one part allows you to identify threats that could cause an issue and the second part allows you to develop an IPZ-3. This approach is an iterative process, where you identify an activity or condition of concern, undertake the modeling, and then draw an IPZ-3 to include that location if the modeling shows an issue could occur. You can undertake additional modeling on other activities and/or conditions and expand the area as more information is made available.

The modeling of an activity or condition using this approach can be completed in any of the subareas of an IPZ for drinking water systems to which Rule 68 applies, i.e., within an IPZ-1, IPZ-2, or IPZ-3. Different rules are used to understand how this works. First, using rule 68, modeling that is undertaken for an activity located beyond IPZ-1 and IPZ-2 can be used to determine the extent of IPZ-3. Rules 74 and 75 ensure that IPZ-1 and IPZ-2, which have been delineated separately, are not part of IPZ-3. Therefore, after the modeling has been completed, you now have an IPZ-1, IPZ-2, and IPZ-3 for that specific intake. Under Rule 130, any activity anywhere in an IPZ, i.e. IPZ-1, IPZ-2, and IPZ-3, is a significant drinking water threat if modeling shows that a contaminant released from that activity under an extreme event could cause an issue at that intake. This modeling can be done for an existing or proposed activity. For conditions, Rule 140.1 applies in the same way. If the SPC has not delineated an IPZ-3, modeling can still be undertaken as per rule 130 / 140.1 for activities / conditions in IPZ-1 or IPZ-2.

In essence, modeling can be used in two different ways. First modeling can be used to delineate an IPZ-3 (if undertaken beyond IPZ-2). Second modeling can be used to identify activities / conditions as significant drinking water threats (this applies anywhere in an IPZ).

Once you identify the locations where an activity or condition that could cause an issue "is or would be engaged in", the location of the activity or condition is the area where the activity is a significant drinking water threat. This means the building or property (parcel) where the modelled activity is located and which could cause an issue.

One approach to meet the requirements for the assessment report, is to develop a map of the IPZ (IPZ-1, IPZ-2 and IPZ-3 where delineated), identify the properties (parcels) or areas where there are significant drinking water threats determined

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through this method, and identify through a table, map, or text what circumstances make that activity or condition a significant drinking water threat.

Delineation of IPZ-3 is only required where modeling or other methods have shown contaminants can reach an intake. You can complete the assessment report without this IPZ-3 and submit an updated assessment report once modeling has been completed.

D) Enumeration of Significant Drinking Water Threats

To satisfy **D)** the assessment report should include the number of existing significant drinking water threats. The following points are considerations when enumerating significant drinking water threats:

- O. Reg 287/07 Section 13(1) (6) refers to "is or would be" significant drinking water threats. In this context:
  - "is" – means the locations where an activity is currently undertaken or a condition exists.
  - "would be" – means the locations where the infrastructure is there to undertake an activity at any time.
  - Vacant lots and areas of future development with associated zoning are not counted as locations where an activity is or would be engaged in.
- The level of effort to confirm the count of significant drinking water threats should be dependent on your knowledge of the source protection area and vulnerable areas, along with the level of comfort of the SPC, stakeholders, and public.
- For activities where there is high certainty that they are a significant drinking water threat (e.g., gas stations, where the quantity of fuel and chemicals are relatively standard), no site visit needs to be completed to enumerate this threat.
- Where there is little information, high uncertainty, or a high level of discomfort around an activity or condition, there may be a need for a site visit.
- In some areas, SPCs and CAs will have to make decisions on how many site visits can be completed based on the time and resources available.

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- SPC's may choose to identify areas where they expect there are significant drinking water threats and list the number of potential locations. For example, for an area potentially serviced by sanitary sewers where, without site visits, you can not confidently confirm the exact number of locations on septic systems. In this case, you may want to draw a line around the area and indicate that there are potentially X number of significant drinking water threats (where X is the number of lots).

APPENDIX 1

The following text is provided in support of the content of this technical bulletin. Readers are referred to the current version of the various acts, regulations and technical rules for complete details.

What do you need when identifying threats in vulnerable areas?

The Clean Water Act, 2006, regulations and technical rules specify the components that need to be contained in the assessment report with respect to identifying drinking water threats in vulnerable areas. The specifics are as follows:

Clean Water Act, 2006:

- Section 15(2(g)): list, for each vulnerable area identified under clauses (d) and (e),
  - (i) activities that are or would be drinking water threats, and
  - (ii) conditions that result from past activities and that are drinking water threats.
- Section 15(2(h)): identify within each vulnerable area identified under clauses (d) and (e),
  - (i) the areas where an activity listed under clause (g) is or would be a significant drinking water threat, and
  - (ii) the areas where a condition listed under clause (g) is a significant drinking water threat

General Regulation 287/07

- Section 13(1(2)): For each vulnerable area identified under clause 15 (2) (d) or (e) of the Act, an identification of the following areas within the vulnerable area:
  - i. Areas where an activity listed under subclause 15 (2) (g) (i) of the Act is or would be a moderate drinking water threat.
  - ii. Areas where an activity listed under subclause 15 (2) (g) (i) of the Act is or would be a low drinking water threat.

iii. Areas where a condition listed under subclause 15 (2) (g) (ii) of the Act is a moderate drinking water threat.

iv. Areas where a condition listed under subclause 15 (2) (g) (ii) of the Act is a low drinking water threat.

- Section 13(1(3)): For each area identified under subclause 15 (2) (h) (i) of the Act, the circumstances in which the activity listed under clause 15 (2) (g) of the Act is or would be a significant drinking water threat.
- Section 13(1(4)): For each area identified under subparagraph 2 i, the circumstances in which the activity listed under subclause 15 (2) (g) (i) of the Act is or would be a moderate drinking water threat.
- Section 13(1(5)): For each area identified under subparagraph 2 ii, the circumstances in which the activity listed under subclause 15 (2) (g) (i) of the Act is or would be a low drinking water threat.
- Section 13(1(6)): For each vulnerable area identified under clause 15 (2) (d) or (e) of the Act,

  i. the number of locations at which a person is engaging in an activity listed under subclause 15 (2) (g) (i) of the Act that is or would be a significant drinking water threat, and

  ii. the number of locations at which a condition listed under subclause 15 (2) (g) (ii) of the Act is a significant drinking water threat.

Technical Rules

- Part XI.2 – Listing drinking water threats – Activities
- Rules 118 and 118.1 allow for the Regulation 287/07 (General) and the Tables of Drinking Water Threats to be referenced when listing activities and circumstances
- Rules 119 to 125 allows for a process to list activities and circumstances
- Part XI.3 – Listing drinking water threats – Conditions
- Rule 126 lists the information needed when listing conditions that result from past activities

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- Part XI.4 – Identifying areas for significant, moderate and low drinking water threats – Activities
- Rules 127 to 131.1 indicate what makes an activity a significant drinking water threat
- Rules 132 to 134.2 indicate what makes an activity a moderate drinking water threat
- Rules 135 to 137 indicate what makes an activity a low drinking water threat
- Part XI.5 – Identifying areas for significant, moderate and low drinking water threats – Conditions

APPENDIX 2

There are three different approaches to extract the activities and circumstances from the database used to build the Tables of Drinking Water Threats:

Approach 1 – Using the UTRCA (Upper Thames Region Conservation Authority) Threats Analysis Tool: This web based tool allows the extraction of lists into an Excel spreadsheet of activities and circumstances given specified information is provided (e.g. vulnerability score, type of vulnerable area, and whether the threat is a chemical, pathogen or DNAPL). The website can be found at: http://maps.thamesriver.on.ca/SWPThreats/threats/threatsList.aspx

Approach 2 – Querying the MS Access look up tables used to generate the Tables of Drinking Water Threats by using the query functions built into the database.

Approach 3 – Using the Provincial Reference Tables developed by MOE. In response to several inquiries, the Ministry has prepared a series of "provincial reference tables" to assist SPCs in meeting their obligations as set out in the regulations and technical rules regarding the documentation of various lists of potential circumstances that address the terminology "is or would be a significant, moderate or low drinking water threat". These tables are posted with the technical bulletins at
http://www.ene.gov.on.ca/en/water/cleanwater/cwa-technical-rules.php.

This approach simply references a specific table name associated with a chemical or pathogen, the vulnerability area and score and contains all of the potential circumstances that meet this set of criteria. Rather than having each SPC "screen" the Tables of Drinking Water Threats for the various circumstances that identify which activity and circumstance meets the above criteria and generate their own list, a "provincial set" of tables has been prepared.

The tables have been generated using the following criteria:

- Chemical, Pathogen or DNAPL
- WHPA, IPZ, HVA or SGRA
- Vulnerability score
- Significant, moderate of low drinking water threat

SPC's will now be able to provide their mapping product of the vulnerability area combined with a reference to a specific provincial reference table (or tables) instead of putting the table(s) itself in the assessment report. These tables will be posted on the Clean Water Act web site and a list of the table numbers and names is provided at the end of this Appendix.

Example: If a SPC is linking a map that illustrates pathogens in an IPZ with a vulnerability score of 10, and they need to indicate what activities are low drinking water threats in that area, they can reference the areas with a vulnerability score of 10 in the map to Table PIPZ10L which provides the list of activities that are low drinking water threats in that area. The province will also include simplified table names.

Similarly, if they have a map that illustrates chemicals in a HVA that has a vulnerability score of 6, and they need to indicate what activities are low drinking water threats in that area, they can now reference Table CSGRAHVA6L to indicate what activities are moderate threats in this area.

Provincial Tables Of Circumstances

Provincial Table Number	Table Name	Table Title
1	CW10S	Chemicals in a WHPA with a vulnerability score of 10 where threats are significant
2	CW8S	Chemicals in a WHPA with a vulnerability score of 8 where threats are significant
3	CW10M	Chemicals in a WHPA with a vulnerability score of 10 where threats are moderate
4	CW8M	Chemicals in a WHPA with a vulnerability score of 8 where threats are moderate
5	CW6M	Chemicals in a WHPA with a vulnerability score of 6 where threats are moderate
6	CW10L	Chemicals in a WHPA with a vulnerability score of 10 where threats are low
7	CW8L	Chemicals in a WHPA with a vulnerability score of 8 where threats are low
8	CW6L	Chemicals in a WHPA with a vulnerability score of 6 where threats are low

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Provincial Table Number	Table Name	Table Title
9	DWAS	DNAPLS in WHPA A, B, C, C1, with any vulnerability where threats are significant
10	DW6M	DNAPLS in WHPA D with a vulnerability of 6 where threats are moderate
11	DW6L	DNAPLS in WHPA D with a vulnerability of 6 where threats are low
12	PW10S	Pathogens in WHPA A, B with a vulnerability of 10 where threats are significant
13	PW10M	Pathogens in WHPA A, B with a vulnerability of 10 where threats are moderate
14	PW8M	Pathogens in WHPA A, B with a vulnerability of 8 where threats are moderate
15	PW8L	Pathogens in WHPA A, B with a vulnerability of 8 where threats are low
16	PW6L	Pathogens in WHPA A, B with a vulnerability of 6 where threats are low
17	CSGRAHVA 6M	Chemicals in an SGRA or HVA with a vulnerability score of 6 where threats are moderate
18	CSGRAHVA 6L	Chemicals in an SGRA or HVA with a vulnerability score of 6 where threats are low
19	CIPZ10S	Chemicals in an IPZ with a vulnerability of 10 where threats are significant
20	CIPZWE9S	Chemicals in an IPZ or WHPA E where the vulnerability score is 9 where threats are significant
21	CIPZWE8.1S	Chemicals in an IPZ or WHPA E where the vulnerability score is 8.1 where threats are significant
22	CIPZWE8S	Chemicals in an IPZ or WHPA E where the vulnerability score is 8 where threats are significant
23	CIPZ10M	Chemicals in an IPZ with a vulnerability of 10 where threats are moderate
24	CIPZWE9M	Chemicals in an IPZ or WHPA E where the vulnerability score is 9 where threats are

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Provincial Table Number	Table Name	Table Title
		moderate
25	CIPZWE8.1 M	Chemicals in an IPZ or WHPA E where the vulnerability score is 8.1 where threats are moderate
26	CIPZWE8M	Chemicals in an IPZ or WHPA E where the vulnerability score is 8 where threats are moderate
27	CIPZWE7.2 M	Chemicals in an IPZ or WHPA E where the vulnerability score is 7.2 where threats are moderate
28	CIPZWE7M	Chemicals in an IPZ or WHPA E where the vulnerability score is 7 where threats are moderate
29	CIPZWE6.4 M	Chemicals in an IPZ or WHPA E where the vulnerability score is 6.4 where threats are moderate
30	CIPZWE6.3 M	Chemicals in an IPZ or WHPA E where the vulnerability score is 6.3 where threats are moderate
31	CIPZWE10L	Chemicals in an IPZ with a vulnerability of 10 where threats are low
32	CIPZWE9L	Chemicals in an IPZ or WHPA E where the vulnerability score is 9 where threats are low
33	CIPZWE8.1L	Chemicals in an IPZ or WHPA E where the vulnerability score is 8.1 where threats are low
34	CIPZWE8L	Chemicals in an IPZ or WHPA E where the vulnerability score is 8 where threats are low
35	CIPZWE7.2L	Chemicals in an IPZ or WHPA E where the vulnerability score is 7.2 where threats are low
36	CIPZWE7L	Chemicals in an IPZ or WHPA E where the vulnerability score is 7 where threats are low

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Provincial Table Number	Table Name	Table Title
37	CIPZWE6.4L	Chemicals in an IPZ or WHPA E where the vulnerability score is 6.4 where threats are low
38	CIPZWE6.3L	Chemicals in an IPZ or WHPA E where the vulnerability score is 6.3 where threats are low
39	CIPZWE5.6L	Chemicals in an IPZ or WHPA E where the vulnerability score is 5.6 where threats are low
40	CIPZWE5.4L	Chemicals in an IPZ or WHPA E where the vulnerability score is 5.4 where threats are low
41	CIPZWE4.9L	Chemicals in an IPZ or WHPA E where the vulnerability score is 4.9 where threats are low
42	CIPZWE4.8L	Chemicals in an IPZ or WHPA E where the vulnerability score is 4.8 where threats are low
43	CIPZWE4.5L	Chemicals in an IPZ or WHPA E where the vulnerability score is 4.5 where threats are low
44	CIPZWE4.2L	Chemicals in an IPZ or WHPA E where the vulnerability score is 4.2 where threats are low
45	PIPZ10S	Pathogens in an IPZ with a vulnerability of 10 where threats are significant
46	PIPZWE9S	Pathogens in an IPZ or WHPA E with a vulnerability of 9 where threats are significant
47	PIPZWE8.1S	Pathogens in an IPZ or WHPA E with a vulnerability of 8.1 where threats are significant
48	PIPZWE8S	Pathogens in an IPZ or WHPA E with a vulnerability of 8 where threats are significant
49	PIPZWE10M	Pathogens in an IPZ with a vulnerability of 10 where threats are moderate

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Provincial Table Number	Table Name	Table Title
50	PIPZWE9M	Pathogens in an IPZ or WHPA E with a vulnerability of 9 where threats are moderate
51	PIPZWE8.1M	Pathogens in an IPZ or WHPA E with a vulnerability of 8.1 where threats are moderate
52	PIPZWE8M	Pathogens in an IPZ or WHPA E with a vulnerability of 8 where threats are moderate
53	PIPZWE7.2M	Pathogens in an IPZ or WHPA E with a vulnerability of 7.2 where threats are moderate
54	PIPZWE7M	Pathogens in an IPZ or WHPA E with a vulnerability of 7 where threats are moderate
55	PIPZWE6.4M	Pathogens in an IPZ or WHPA E with a vulnerability of 6.4 where threats are moderate
56	PIPZWE6.3M	Pathogens in an IPZ or WHPA E with a vulnerability of 6.3 where threats are moderate
57	PIPZ6M	Pathogens in an IPZ with a vulnerability of 6 where threats are moderate
58	PIPZ10L	Pathogens in an IPZ with a vulnerability of 10 where threats are low
59	PIPZWE9L	Pathogens in an IPZ or WHPA E with a vulnerability of 9 where threats are low
60	PIPZWE8.1L	Pathogens in an IPZ or WHPA E with a vulnerability of 8.1 where threats are low
61	PIPZWE8L	Pathogens in an IPZ or WHPA E with a vulnerability of 8 where threats are low
62	PIPZWE7.2L	Pathogens in an IPZ or WHPA E with a vulnerability of 7.2 where threats are low
63	PIPZWE7L	Pathogens in an IPZ or WHPA E with a vulnerability of 7 where threats are low
64	PIPZWE6.4L	Pathogens in an IPZ or WHPA E with a vulnerability of 6.4 where threats are low

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Provincial Table Number	Table Name	Table Title
65	PIPZWE6.3L	Pathogens in an IPZ or WHPA E with a vulnerability of 6.3 where threats are low
66	PIPZ6L	Pathogens in an IPZ with a vulnerability of 6 where threats are low
67	PIPZWE5.6L	Pathogens in an IPZ or WHPA E with a vulnerability of 5.6 where threats are low
68	PIPZWE5.4L	Pathogens in an IPZ or WHPA E with a vulnerability of 5.4 where threats are low
69	PIPZ5L	Pathogens in an IPZ with a vulnerability of 5 where threats are low
70	PIPZWE4.9L	Pathogens in an IPZ or WHPA E with a vulnerability of 4.9 where threats are low
71	PIPZWE4.8L	Pathogens in an IPZ or WHPA E with a vulnerability of 4.8 where threats are low
72	PIPZWE4.5L	Pathogens in an IPZ or WHPA E with a vulnerability of 4.5 where threats are low
73	PIPZWE4.2L	Pathogens in an IPZ or WHPA E with a vulnerability of 4.2 where threats are low
74	CIPZWE5L	Chemicals in an IPZ or WHPA E where the vulnerability score is 5 where threats are low
75	CIPZWE6M	Chemicals in an IPZ or WHPA E where the vulnerability score is 6 where threats are moderate
76	CIPZWE6L	Chemicals in an IPZ or WHPA E where the vulnerability score is 6 where threats are low

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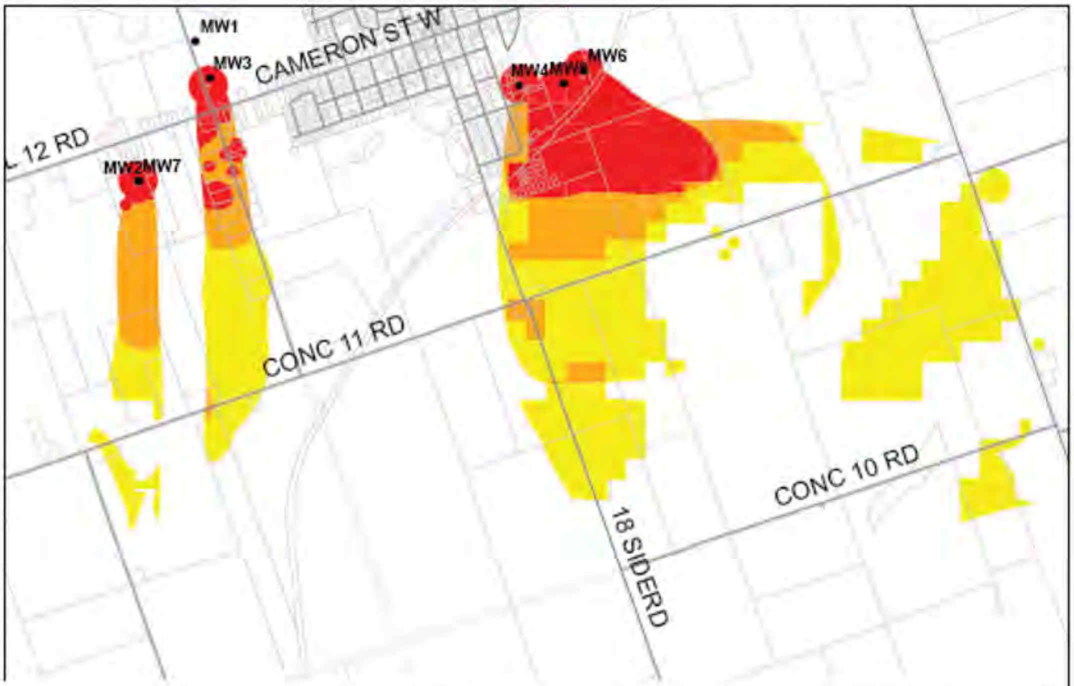
APPENDIX 3

Appendix 3 provides a series of examples illustrating a possible approach to mapping areas where an activity or condition is a significant, moderate, or low drinking water threat in as assessment report.

3.1 CHEMICAL THREAT EXAMPLE

The following example illustrates a possible approach for mapping of chemical threats in a WHPA:



Vulnerability Score	Chemicals		
	Provincial Table Number (Table Name)		
	Significant	Moderate	Low
10 (red)	1 (CW10S)	3 (CW10M)	6 (CW10L)
8 (orange)	2 (CW8S)	4 (CW8M)	7 (CW8L)
6 (yellow)	-	5 (CW6M)	8 (CW6L)

The figure and table above illustrates the vulnerability score for each vulnerable area and the areas and Provincial Table of Circumstances with the chemical related activities that are or would be significant, moderate or low drinking water threats. The map would also need references to lists of conditions or new threats/circumstances that apply to these areas.

Extract of Provincial Table 1 (CW10S): Circumstances where the threat associated with a Chemical is or would be a Significant Drinking Water Threat in a WHPA with a vulnerability score of 10.

PROVINCIAL TABLE 1 (CW10S): Chemicals in a WHPA with a vulnerability score of 10 where threats are significant

The application of agricultural source material to land.

Ref #	Circumstances	Chemical
5	1.The agricultural source material is applied to land located in a vulnerable area, where the managed land map shows a managed land percentage for the applicable area that is less than 40% and the livestock density map shows a livestock density for the applicable area that is sufficient to annually apply agricultural source material at a rate that is more than 1.0 nutrient units per acre.	Nitrogen
11	1.The agricultural source material is applied to land located in a vulnerable area, where the managed land map shows a managed land percentage for the applicable area that is at least 40%, but not more than 80% and the livestock density map shows a livestock density for the applicable area that is sufficient to annually apply agricultural source material at a rate that is more than 1.0 nutrient units per acre.	Nitrogen
13	1.The agricultural source material is applied to land located in a vulnerable area, where the managed land map shows a managed land percentage for the applicable area that is more than 80% and the livestock density map shows a livestock density for the applicable area that is sufficient to annually apply agricultural source material at a rate that is than 0.5 nutrient units per acre.	Nitrogen
15	1.The agricultural source material is applied to land located in a vulnerable area, where the managed land map shows a managed land percentage for the applicable area that is more than 80% and the livestock density map shows a livestock density for the applicable area that is sufficient to annually apply agricultural source material at a rate that is at least 0.5 nutrient units per acre but not more than 1.0 nutrient unit per acre.	Nitrogen
17	1.The agricultural source material is applied to land located in a vulnerable area, where the managed land map shows a managed land percentage for the applicable area that is more than 80% and the livestock density map shows a livestock density for the applicable area that is sufficient to annually apply agricultural source material at a rate that is more than 1.0 nutrient units per acre.	Nitrogen

The application of commercial fertilizer to land.

Ref #	Circumstances	Chemical
23	1.The commercial fertilizer is applied to land located in a vulnerable area, where the managed land map shows a managed land percentage for the applicable area that is less than 40% and the livestock density map shows a livestock density for the applicable area that is sufficient to annually apply agricultural source material at a rate that is more than 1.0 nutrient units per acre.	Nitrogen
29	1.The commercial fertilizer is applied to land located in a vulnerable area, where the managed land map shows a managed land percentage for the applicable area that is at least 40%, but not more than 80% and the livestock density map shows a livestock density for the applicable area that is sufficient to annually apply agricultural source material at a rate that is more than 1.0 nutrient units per acre.	Nitrogen
31	1.The commercial fertilizer is applied to land located in a vulnerable area, where the managed land map shows a managed land percentage for the applicable area that is more than 80% and the livestock density map shows a livestock density for the applicable area that is sufficient to annually apply agricultural source material at a rate that is less than 0.5 nutrient units per acre.	Nitrogen
33	1.The commercial fertilizer is applied to land located in a vulnerable area, where the managed land map shows a managed land percentage for the applicable area that is more than 80% and the livestock density map shows a livestock density for the applicable area that is sufficient to annually apply agricultural source material at a rate that is at least 0.5 nutrient units per acre but not more than 1.0 nutrient unit per acre.	Nitrogen
35	1.The commercial fertilizer is applied to land located in a vulnerable area, where the managed land map shows a managed land percentage for the applicable area that is more than 80% and the livestock density map shows a livestock density for the applicable area that is sufficient to annually apply agricultural source material at a rate that is more than 1.0 nutrient units per acre.	Nitrogen

The application of non-agricultural source material to land.

Ref #	Circumstances	Chemical
41	1.The non-agricultural source material is applied to land located in a vulnerable area, where the managed land map shows a managed land percentage for the applicable area that is less than 40% and the livestock density map shows a livestock density for the applicable area that is sufficient to annually apply agricultural source material at a rate that is more than 1.0 nutrient units per acre.	Nitrogen
47	1.The non-agricultural source material is applied to land located in a vulnerable area, where the managed land map shows a managed land percentage for the applicable area that is at least 40%, but not more than 80% and the livestock density map shows a livestock density for the applicable area that is sufficient to annually apply agricultural source material at a rate that is more than 1.0 nutrient units per acre.	Nitrogen
49	1.The non-agricultural source material is applied to land located in a vulnerable area, where the managed land map shows a managed land percentage for the applicable area that is more than 80% and the livestock density map shows a livestock density for the applicable area that is sufficient to annually apply agricultural source material at a rate that is less than 0.5 nutrient units per acre.	Nitrogen
51	1.The non-agricultural source material is applied to land located in a vulnerable area, where the managed land map shows a managed land percentage for the applicable area that is more than 80% and the livestock density map shows a livestock density for the applicable area that is sufficient to annually apply agricultural source material at a rate that is at least 0.5 nutrient units per acre but not more than 1.0 nutrient unit per acre.	Nitrogen
53	1.The non-agricultural source material is applied to land located in a vulnerable area, where the managed land map shows a managed land percentage for the applicable area that is more than 80% and the livestock density map shows a livestock density for the applicable area that is sufficient to annually apply agricultural source material at a rate that is more than 1.0 nutrient units per acre	Nitrogen

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3.2 PATHOGEN THREAT EXAMPLE

The following example illustrates a possible approach for mapping pathogen threats in vulnerable areas:

Pathogens			
Vulnerability Score	Provincial Table Number (Table Name)		
	Significant	Moderate	Low
10 (red)	12 (PW10S)	13 (PW10M)	-
8 (orange)	-	14 (PW8M)	15 (PW8L)
6 (yellow)*	-	-	16 (PW6L)

*could be excluded from legend of this example since no area with vulnerability of 6

The figure above illustrates the vulnerability score for each vulnerable area and the areas and the Provincial Table of Circumstances for pathogen related activities that are or would be significant, moderate or low drinking water threats. The map would also need references to lists of conditions or new threats/circumstances that apply to these areas.

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Extract of Provincial Table 12 (PW10S): Circumstances where the threat associated with a pathogen is or would be a significant drinking water threat in a WHPA with a vulnerability score of 10.

PROVINCIAL TABLE 12 (PW10S): Pathogens in WHPA A, B with a vulnerability of 10 where threats are significant

Ref #	Prescribed Threat	ThreatSubcategory	Circumstances
1944	The application of agricultural source material to land.	Application Of Agricultural Source Material (ASM) To Land	1. Agricultural source material is applied to land in any quantity. 2. The application may result in the presence of one or more pathogens in groundwater or surface water.
1945	The use of land as livestock grazing or pasturing land, an outdoor confinement area or a farm-animal yard. O. Reg. 385/08, s. 3.	Management Or Handling Of Agricultural Source Material - Agricultural Source Material (ASM) Generation	1. The use of land as livestock grazing or pasturing land for one or more animals. 2. The land use may result in the presence of one or more pathogens in groundwater or surface water.
1946	The use of land as livestock grazing or pasturing land, an outdoor confinement area or a farm-animal yard. O. Reg. 385/08, s. 3.	Management Or Handling Of Agricultural Source Material - Agricultural Source Material (ASM) Generation	1. The use of land as an outdoor confinement area or a farm-animal yard for one or more animals. 2. The land use may result in the presence of one or more pathogens in groundwater or surface water.
1956	The establishment, operation or maintenance of a system that collects, stores, transmits, treats or disposes of sewage.	Sewage System Or Sewage Works - Septic System	1. The system is an earth pit privy, privy vault, cesspool, or a leaching bed system and its associated treatment unit and is a sewage system as defined in section 1 of O. Reg. 350/06 (Building Code) made under the Building Code Act, 1992 or a sewage works as defined in section 1 of the Ontario Water Resources Act. 2. A discharge from the system may result in the presence of one or more pathogens in groundwater or surface water.
1957	The establishment, operation or maintenance of a system that collects, stores, transmits, treats or disposes of sewage.	Sewage System Or Sewage Works - Septic System Holding Tank	1. The system requires or uses a holding tank for the retention of hauled sewage at the site where it is produced before its collection by a hauled sewage system. 2. A spill from the tank may result in the presence of one or more pathogens in groundwater or surface water.
1958	The establishment, operation or maintenance of a system that collects, stores, transmits, treats or disposes of sewage.	Sewage System Or Sewage Works - Sanitary Sewers and related pipes	1. The system is a wastewater collection facility that collects or transmits sewage containing human waste, but does not include any part of the facility that is a sewage storage tank or works used to carry out a designed bypass. 2. The discharge from the system may result in the presence of one or more pathogens in groundwater or surface water.
1959	The establishment, operation or maintenance of a system that collects, stores, transmits, treats or disposes of sewage.	Sewage System Or Sewage Works - Sewage Treatment Plant Effluent Discharges (Includes Lagoons)	1. The system is a wastewater treatment facility that discharges to surface water through a means other than a designed bypass. 2. A discharge may result in the presence of one or more pathogens in groundwater or surface water.
1960	The establishment, operation or maintenance of a system that collects, stores, transmits, treats or disposes of sewage.	Sewage System Or Sewage Works - Storage Of Sewage (E.G. Treatment Plant Tanks)	1. The system is a sewage treatment tank or sewage storage tank in either a wastewater collection facility or wastewater treatment facility, and any part of the tank is at or above grade. 2. A spill from the tank may result in the presence of one or more pathogens in groundwater or surface water.
1961	The establishment, operation or maintenance of a system that collects, stores, transmits, treats or disposes of sewage.	Sewage System Or Sewage Works - Storage Of Sewage (E.G. Treatment Plant Tanks)	1. The system is a sewage treatment tank or sewage storage tank in a wastewater collection facility or a wastewater treatment facility and the tank is below grade. 2. A spill from the tank may result in the presence of one or more pathogens in groundwater or surface water.
1962	The storage of agricultural source material.	Storage Of Agricultural Source Material (ASM)	1. Any portion of the agricultural source material is stored at or above grade in or on a permanent nutrient storage facility. 2. A spill of the material or runoff from an area where the material is stored may result in the presence of one or more pathogens in groundwater or surface water.
1963	The storage of agricultural source material.	Storage Of Agricultural Source Material (ASM)	1. The agricultural source material is stored entirely below grade in or on a permanent nutrient storage facility. 2. A spill of the material or runoff from an area where the material is stored may result in the presence of one or more pathogens in groundwater or surface water.
1964	The storage of agricultural source material.	Storage Of Agricultural Source Material (ASM)	1. The agricultural source material is stored at a temporary field nutrient storage site. 2. A spill of the material or runoff from an area where the material is stored may result in the presence of one or more pathogens in groundwater or surface water.

3.3 DNAPL THREAT EXAMPLE

The following example illustrates a possible approach for mapping DNAPL threats in vulnerable areas.

DNAPLs			
Vulnerability Score	Provincial Table Number (Table Name)		
	Significant	Moderate	Low
WHPA A, B, C, C1 (<5 year TOT) (beige)	9 (DWAS)	-	-
6 (within WHPA D) yellow	-	10 (DW6M)	11 (DW6L)

The figure above illustrates the vulnerability score for each vulnerable area and the areas and Provincial Table of Circumstances with activities where DNAPLs are or would be significant, moderate or low drinking water threats. Note that the vulnerability score is irrelevant within the 5 year TOT and so does not need to be included. The map should also reference lists of conditions or new threats/circumstances that apply to these areas.

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Extract of Provincial List DWAS: Circumstances where a threat associated with a DNAPL is or would be a significant drinking water threat in a WHPA A, B, C, and C1 with any vulnerability score.

PROVINCIAL TABLE 9 (DWAS): DNAPLS in WHPA A, B, C, C1, with any vulnerability where threats are significant

The handling and storage of a dense non-aqueous phase liquid. **Threat Subcategory: Handling Of A Dense Non Aqueous Phase Liquid (DNAPL)**

Ref #	Circumstances	Chemical
102	1. The below grade handling of a DNAPL in relation to its storage.	Dioxane-1,4
103		one or more Polycyclic Aromatic Hydrocarbons (PAHs)
104		Tetrachloroethylene (PCE)
105		Trichloroethylene or another DNAPL that could degrade to Trichloroethylene
106		Vinyl chloride or another DNAPL that could degrade to vinyl chloride
107	1. The above grade handling of a DNAPL in relation to its storage.	Dioxane-1,4
108		one or more Polycyclic Aromatic Hydrocarbons (PAHs)
109		Tetrachloroethylene (PCE)
110		Trichloroethylene or another DNAPL that could degrade to Trichloroethylene
111		Vinyl chloride or another DNAPL that could degrade to vinyl chloride

The handling and storage of a dense non-aqueous phase liquid. **Threat Subcategory: Storage Of A Dense Non Aqueous Phase Liquid (DNAPL)**

Ref #	Circumstances	Chemical
1098	1. The storage of a DNAPL at or above grade.	Dioxane-1,4
1099		one or more Polycyclic Aromatic Hydrocarbons (PAHs)
1100		Tetrachloroethylene (PCE)
1101		Trichloroethylene or another DNAPL that could degrade to Trichloroethylene
1102		Vinyl chloride or another DNAPL that could degrade to vinyl chloride
1103	1. The storage of a DNAPL below grade.	Dioxane-1,4
1104		one or more Polycyclic Aromatic Hydrocarbons (PAHs)
1105		Tetrachloroethylene (PCE)
1106		Trichloroethylene or another DNAPL that could degrade to Trichloroethylene
1107		Vinyl chloride or another DNAPL that could degrade to vinyl chloride
1108	1. The storage of a DNAPL if a portion, but not all, of the storage is below grade.	Dioxane-1,4
1109		one or more Polycyclic Aromatic Hydrocarbons (PAHs)
1110		Tetrachloroethylene (PCE)
1111		Trichloroethylene or another DNAPL that could degrade to Trichloroethylene
1112		Vinyl chloride or another DNAPL that could degrade to vinyl chloride

DRINKING WATER SOURCE PROTECTION
ACT FOR CLEAN WATER

Technical Bulletin: Part IX Local Area Risk Level

Date: April 2010

Ontario Ministry of the Environment
Ontario Ministry of Natural Resources

Clarification of the technical terms and alternate method for the assessment and assignment of a risk level to a local area.

The *Clean Water Act, 2006* (the Act), which came into effect in July 2007, sets the legal framework that ensures communities are able to protect their municipal drinking water supplies by developing collaborative, locally driven, science-based protection plans. Communities will identify potential risks to local water sources and take action to reduce or eliminate these risks.

In October 2006, the Ministry of the Environment (MOE) issued the document called "Assessment Report: Draft Guidance Modules" to guide the tasks being undertaken for the source protection technical studies in advance of the technical rules and regulations under the *Clean Water Act, 2006*.

The development of the assessment report is set out in the Act, regulation 287/07, and the "Technical Rules: Assessment Report" (the technical rules), dated November 2009. With the technical rules coming into effect, some of the methods set out in the Draft Guidance Modules are no longer valid. This Technical Bulletin provides updated guidance in certain areas.

The province has three (3) Tier 3 Water Quantity Risk Assessment (WQnRA) projects underway to implement the approach set out in the Technical Rules. In undertaking these first projects, the province has identified a number of situations where the methods in the technical rules are not sufficient to meet the intent of the Act.

Based on these projects, the Part IX – Local Area Risk Level of the Technical Rules has been reviewed as a result of the ongoing Tier 3 WQnRA projects. As consequence, where necessary, an alternative approach may be required to assign a local area risk level. The following approach is a **tested** and **consistent** alternative approach that can be applied by any source

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protection committee (SPC) in the province to evaluate the circumstances in which water quantity threats could be considered as significant or moderate threats in their source protection area.

The focus of this Technical Bulletin is to provide clarity on the following:

- The assessment of the circumstances in which significant and moderate local area risk levels are assigned, by providing tables that link the type of system, temporal and landscape scenarios and the circumstances for each scenario;

- The application and evaluation of "tolerance" and "other uses", as part of the assessment of circumstances. This method would clearly align with the method used to evaluate the risk of water quality threats through an assessment of circumstances:

  By undertaking the risk assessment following the tables provided in this technical bulletin, the tables would clearly guide the application of tolerance only to existing municipal systems and only when average demand can be met but peak demands cannot.

  Also, the tables would clearly guide the consideration of "other uses" only for planned municipal systems or existing municipal systems with committed demand for average conditions. Other uses would not be considered for existing systems or drought scenarios.

- The introduction of thresholds when considering "other uses" for the reduction of groundwater discharge-surface water flows (because of increased groundwater pumping) for cold water fisheries in headwaters of rivers and streams;

- The introduction of professional judgement (unacceptable impacts or measurable but potentially unacceptable impacts to regulated water levels and/or flows or permits, aquatic habitat of river systems and provincially significant wetlands) to assist in assigning risk levels to local areas;

- The clarification of terms used in the evaluation of Risk Level under Part IX of the Technical Rules, such as allocated and committed demands

The result is an assigned level of risk to the local area thereby eliminating the term "*exposure*", which becomes irrelevant following the proposed alternative approach and tables of circumstances.

Alternative Approach for Assigning a Risk Level to a Local Area

This Technical bulletin has been organised into the following Sections:

1. Alternative Approach for Part IX – Local Area Risk Level
   Task 1: Evaluation of Risk
   Task 2: Tolerance Level, Existing Drinking Water Systems

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Task 3: Assignment of Risk Level

2. Clarifications in Regard to Allocated Quantity of Water

3. Rule 15.1 – Alternative Approach

These sections describe the steps required to undertake Part IX – Local Area Risk Level of the Technical Rules required for water quantity risk assessment of the Assessment Report in assigning a risk level to a local area, by following an alternative approach which reflects the above clarifications.

1. Alternative Approach for Part IX – Local Area Risk Level

Task 1: Evaluation of Risk Level

(1) A risk level must be assigned to every local area required to be delineated in accordance with Part III of the Technical Rules. The risk level must be assigned by:

- evaluating the scenarios developed in the water budget models for the Tier 3 of the WQnRA, and described in Tables 4A and 4B which are provided below in this Technical Bulletin

- for each scenario, evaluating the circumstances in Tables 4C and 4D which are provided below in this Technical Bulletin.

Tables 4A and 4B describe respectively the Surface Water and the Groundwater Risk Scenarios. For each assessment Scenario, the Tables provide the time period for the assessment, as well as requirements for land cover, municipal allocated pumping rate, non-municipal pumping rates and model simulation approach.

Tables 4C and 4D provide the Circumstances to be taken into account for each Scenario to assign significant or moderate Risk, for each type of drinking water system.

(2) For the purposes of assessing the circumstances described in Tasks 2 and 3 below:

(A) the time period to be assessed is the time period described in Column 2 of Tables 4A and 4B; and

(B) the data used shall meet the requirements listed in Columns 3 and 4 of Tables 4A and 4B where one or more parameters in respect of the data are listed, and in all other cases the data shall be reflective of conditions that existed during the time period.

(3) For the purposes of Task 3 below, the other uses of water in the area are,

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(A) with respect to surface water,

(a) waste water assimilation,

(b) surface water takings downstream of the intake or intakes,

(c) electric power generation,

(d) navigation,

(e) recreation,

(f) aquatic habitat, and

(g) provincially significant wetlands; and

(B) with respect to groundwater,

(h) down gradient groundwater takings by other persons in the area,

(i) aquatic habitat, and

(j) provincially significant wetlands.

Task 2: Tolerance Level, Existing Drinking Water Systems

If the local area relates to an existing municipal drinking water system, a tolerance level must be assigned in accordance with the approach described below:

An existing type I, II or III system shall be assigned one of the following tolerance levels:

(1) High, if the system obtains water from a surface water intake relating to a local area assessed in accordance with the circumstances described in Task 3.1 (1)(b) of this Technical Bulletin and at all times during that assessment, the system would have been capable of meeting the peak demands of users of the system.

(2) High, if the system obtains water from a well relating to a local area assessed in accordance with the circumstances described in Task 3.1 (2)(b) of this Technical Bulletin and at all times during that assessment, the system would have been capable of meeting the peak demands of users of the system.

(3) Low, if a tolerance level is not assigned in accordance with either of (1) or (2) above.

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Task 3: Assignment of Risk Level.

The models used in Part III of the Technical Rules to prepare the water budget for the local area shall be used to assess the scenarios described in Task 3.

Task 3.1: Assignment of Significant Risk Level

A local area has a risk level of significant if one or more of the following circumstances exist:

(1) Scenarios A and B in Tables 4A and 4C - One or More Surface Water Intakes.

(a) If at any time during scenario A or B the quantity of water that could have been taken from surface water bodies in the local area would not have been sufficient to meet the allocated quantity of water taken by those municipal surface water intakes.

(b) If at any time during scenario A or B the quantity of water that could have been taken from surface water bodies in the local area would have been sufficient to meet the allocated quantity of water taken by those municipal surface water intakes and the tolerance is Low.

(2) Scenarios C and D in Tables 4B and 4D - One or More Groundwater Wells

(a) If at any time during scenario C or D the quantity of water that could have been taken from groundwater in the local area would not have been sufficient to meet the allocated quantity of water taken by those municipal groundwater wells.

(b) If at any time during scenario C or D the quantity of water that could have been taken from groundwater in the local area would have been sufficient to meet the allocated quantity of water taken by those municipal groundwater wells and the tolerance is Low.

(3) Scenarios E1, E2, E3 and F1, F2, F3 in Tables 4A and 4C - One or More Surface Water Intakes.

(a) If a planned system or an existing system with a committed demand greater than 0 L/s, at any time during scenarios E1,2,3 or F1,2,3 the quantity of water that can be taken from surface water bodies in the local area would not be sufficient to meet the allocated quantity of water for those municipal surface water intakes.

(b) If a planned system or an existing system with a committed demand greater than 0 L/s, at any time during scenario E1,2,3 the quantity of water that can be taken from surface water bodies in the local area would be sufficient to meet the allocated quantity of water for those municipal surface water intakes and one or more of the following circumstance exists:

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(i) the reduction in existing surface water levels and/or flows results, in response to the allocated pumping rates, in unacceptable impacts to existing regulated water levels and/or flows or permits.

(ii) the reduction in existing surface water levels and/or flows results, in response to the allocated pumping rates, in unacceptable impacts to aquatic habitat and provincially significant wetlands.

(4) Scenarios G1, G2, G3 and H1, H2, H3 in Tables 4B and 4D - One or More Groundwater Wells

(a) If a planned system or an existing system with a committed demand greater than 0 L/s, at any time during scenarios G1,2,3 or H1,2,3 the quantity of water that can be taken from groundwater in the local area would not be sufficient to meet the allocated quantity of water for those municipal groundwater wells.

(b) If a planned system or an existing system with a committed demand greater than 0 L/s, at any time during scenarios G1,2,3 the quantity of water that can be taken from groundwater in the local area would be sufficient to meet the allocated quantity of water for those municipal groundwater wells and one or more of the following circumstance exists:

(i) the reduction in existing groundwater levels and/or flows results, in response to the allocated pumping rates, in unacceptable impacts to existing regulated water levels and/or flows or permits.

(ii) the reduction in existing groundwater discharge, in response to the allocated pumping rates, into a coldwater watercourse by a threshold calculated as greater than 20 percent as compared to the existing estimated monthly streamflow Qp80 (the flow that is exceeded 80 percent of the time) or the average monthly baseflow of the watercourse or another threshold that has already been defined as a condition in an exiting permit.

(iii) the reduction in existing groundwater levels and/or flows results, in response to the allocated pumping rates, in unacceptable impacts to provincially significant wetlands.

Task 3.2: Assignment of Moderate Risk Level

A local area has a risk level of moderate if one or more of the following circumstances exist:

(1) Scenarios E1, E2, E3 in Tables 4A and 4C - One or More Surface Water Intakes .

(a) If a planned system or an existing system with a committed demand greater than 0 L/s, at any time during scenarios E1,2,3 the quantity of water that can be taken from surface water bodies in the local area would be sufficient to meet the

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allocated quantity of water for those municipal surface water intakes and one or more of the following circumstance exists:

(i) the reduction in existing surface water levels and/or flows results, in response to the allocated pumping rates, in measurable and potentially unacceptable impacts to existing regulated water levels and/or flows or permits.

(ii) the reduction in existing surface water levels and/or flows results, in response to the allocated pumping rates, in a measurable and potentially unacceptable impact to aquatic habitat and provincially significant wetlands.

(2) Scenarios G1, G2, G3 in Tables 4B and 4D - One or More Groundwater Wells

(a) If a planned system or an existing system with a committed demand greater than 0 L/s, at any time during scenarios G1,2,3 the quantity of water that can be taken from groundwater in the local area would be sufficient to meet the allocated quantity of water for those municipal groundwater wells and one or more of the following circumstance exists:

(i) the reduction in existing groundwater levels and/or flows results, in response to the allocated pumping rates, in measurable and potentially unacceptable impacts to existing regulated water levels and/or flows or permits.

(ii) the reduction in existing groundwater discharge, in response to the allocated pumping rates, into a coldwater watercourse by a threshold calculated between a minimum of 10 percent but not greater than 20 percent as compared to the existing estimated monthly streamflow Qp80 (the flow that is exceeded 80 percent of the time) or the average monthly baseflow of the watercourse or another threshold that has already been defined as a condition in an exiting permit.

(iii) the reduction in existing groundwater levels and/or flows results, in response to the allocated pumping rates, in measurable but acceptable impacts to provincially significant wetlands.

Task 3.3: Uncertainty and Sensitivity Analysis

An analysis of the uncertainty, characterized as high or low, must be made in respect of the risk level for the local area.

(1) The following factors shall be considered in an analysis of uncertainty for Task 3.2:

(a) The distribution, variability, quality and relevance of the available input data;

(b) The ability of the methods and models used to accurately reflect the hydrologic system;

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(c) The quality assurance and quality control procedures applied; and

(d) The extent and level of calibration and validation achieved for any groundwater and surface models used or calculations and general assessments completed.

(2) Despite Task 3.2, a local area has a risk level of significant if,

(a) uncertainty determined in accordance with (1) is high; and

(b) a sensitivity analysis of the data used to prepare the water budget for the local area suggests that the risk level for the local area could be significant.

Task 3.4: Assignment of Low Risk Level

Where a local area was not assigned a risk level of significant or moderate in accordance with Tasks 3.1, 3.2 and 3.3, the local area has a risk level of low.

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Table 4A – Surface Water Risk Scenarios

Scenario	Time Period	Surface Water Model Scenarios				
		Land Cover	Allocated Pumping Rate (municipal)	Pumping Rate (non-municipal)	Model Simulation	
A	The period for which climate and stream flow data are available for the local area	Existing	Existing	Existing	Continuous (Daily); Monthly pumping	
B	2/10 year drought period	Existing	Existing	Existing	Continuous (Daily); Monthly pumping	
E(1)	The period for which climate and stream flow data are available for the local area	Land cover reflective of the planned or existing plus committed (Official Plan)	Existing plus committed plus planned	Future	New Impervious Areas and Increase in Total Demand	Continuous (Daily); Monthly pumping
E(2)		Existing	Existing plus committed plus planned	Existing	Increase in Municipal Demand	
E(3)		Land cover reflective of the planned or existing plus committed (Official Plan)	Existing	Future	New Impervious Areas and Increase in Non-Municipal Demand	
F(1)	2/10 year drought period	Land cover reflective of the planned or existing plus committed (Official Plan)	Existing plus committed plus planned	Future	New Impervious Areas and Increase in Total Demand	Continuous (Daily); Monthly pumping
F(2)	2/10 year drought period	Existing	Existing plus committed plus planned	Existing	Increase in Municipal Demand	
F(3)	2/10 year drought period	Land cover reflective of the planned or existing plus committed (Official Plan)	Existing	Future	New Impervious Areas and Increase in Non-Municipal Demand	

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Table 4B – Groundwater Risk Scenarios

<table>
<tr><th rowspan="2">Scenario</th><th rowspan="2">Time Period</th><th colspan="5">Groundwater Model Scenarios</th></tr>
<tr><th>Land Cover</th><th>Allocated Pumping Rate (municipal)</th><th>Pumping Rate (non-municipal)</th><th colspan="2">Model Simulation</th></tr>
<tr><td>C</td><td>The period for which climate and stream flow data are available for the local area</td><td>Existing</td><td>Existing</td><td>Existing</td><td colspan="2">Steady-state, Average Annual Recharge</td></tr>
<tr><td>D</td><td>10 year drought period</td><td>Existing</td><td>Existing</td><td>Existing</td><td colspan="2">Transient; Monthly pumping and recharge rates</td></tr>
<tr><td>G(1)</td><td rowspan="3">The period for which climate and stream flow data are available for the local area</td><td>Land cover reflective of the planned or existing plus committed (Official Plan)</td><td>Existing plus committed plus planned</td><td>Future</td><td>GW Recharge Reduction and Increase in Total Demand</td><td rowspan="3">Steady-State; Average Annual Recharge</td></tr>
<tr><td>G(2)</td><td>Existing</td><td>Existing plus committed plus planned</td><td>Existing</td><td>Increase in Municipal Demand</td></tr>
<tr><td>G(3)</td><td>Land cover reflective of the planned or existing plus committed (Official Plan)</td><td>Existing</td><td>Future</td><td>GW Recharge Reduction and Increase in Non-Municipal Demand</td></tr>
<tr><td>H(1)</td><td>10 year drought period</td><td>Land cover reflective of the planned or existing plus committed (Official Plan)</td><td>Existing plus committed plus planned</td><td>Future</td><td>GW Recharge Reduction and Increase in Total Demand</td><td rowspan="3">Transient; Monthly pumping and recharge</td></tr>
<tr><td>H(2)</td><td>10 year drought period</td><td>Existing</td><td>Existing plus committed plus planned</td><td>Existing</td><td>Increase in Municipal Demand</td></tr>
<tr><td>H(3)</td><td>10 year drought period</td><td>Land cover reflective of the planned or existing plus committed (Official Plan)</td><td>Existing</td><td>Future</td><td>GW Recharge Reduction and Increase in Non-Municipal Demand</td></tr>
</table>

DRINKING WATER SOURCE PROTECTION
ACT FOR CLEAN WATER

Technical Bulletin: Delineation of Intake Protection Zone 3

Using the Event Based Approach (EBA)

Date: July 2009

1- Introduction

The Clean Water Act requires the Source Protection Committee to prepare an Assessment Report for each source protection area they represent, in accordance with the regulations, the Director's Technical Rules and the approved terms of reference for that source protection area.

As part of the Assessment Report, committees must identify four types of vulnerable areas within each Source Protection Area. These include wellhead protection areas (WHPAs), intake protection zones (IPZs), highly vulnerable aquifers (HVAs), and significant groundwater recharge areas (SGRAs). Once these areas are delineated, the rules require that vulnerability scores be assigned within these areas.

This technical bulletin provides guidance to Source Protection Committees on the process of identifying and delineating Intake Protection Zone 3 (IPZ-3) using the Event Based Approach (EBA) under the Technical Rules for the Assessment Report – Part VI.5 rules 68 and 69. The event based approach can be used for Type A and B intakes located at Great Lakes and Connecting Channels, and for Type C and D intakes located on Lake Nipissing, Lake Simcoe, Lake St. Clair and the Ottawa River. Requirements for assigning vulnerability scores to the IPZs are set out in Part VIII of the Technical Rules and are not addressed in this bulletin.

The Technical Rules allow the Source Protection Committees to use a number of methods to identify and delineate the IPZ-3 as set out below. This Technical Bulletin

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PIBS 7579e

references that Director's Technical Rules published by the Ministry of the Environment on December 12, 2008.

Part VI.5 of the Technical Rules states,

68. An area known as IPZ-3 shall be delineated for each type A and type B surface water intake and each type C and type D surface water intake located in Lake Nippissing, Lake Simcoe, Lake St. Clair or the Ottawa River, associated with a drinking water system described in rule 58 and shall be composed of the following areas: Subject to rule 69, the area within each surface water body through which, modeling demonstrates, contaminants released during an extreme event may be transported to the intake;

(1) *where the area delineated in accordance with subrule (1) abuts land,*

(a) *a setback of not more than 120 metres inland along the abutted land measured from the high water mark of the surface water body that encompasses the area where overland flow drains into the surface water body; and*

(b) *the area of the Regulation Limit along the abutted land.*

69. *The area delineated in accordance with subrule 6868 shall not exceed the area within each surface water body that may contribute water to the intake during or as a result of an extreme event.*

The first step in the EBA is to delineate an IPZ-3 that includes areas beyond IPZ-1 and IPZ-2, based on extreme event conditions and an understanding of contaminant transport to the intake. The EBA then allows activities to be identified as a significant drinking water threat if it can be shown through modeling that a release of a specific contaminant from an activity would result in an issue at the intake. The identification of such an activity is governed under rule 130 of the Technical Rules, as follows:

130. *An activity listed as a drinking water threat in accordance with rule 118 or 119 is a significant drinking water threat in an IPZ-3 delineated in accordance with rule 68 at the location where the activity is carried on if modeling demonstrates that a release of a chemical parameter or pathogen from the activity would be transported through the surface water intake protection zone to the intake and result in the deterioration of the water for use as a source of drinking water for the intake.*

2- IPZ-3 Delineation Options

Figure 1 shows a flowchart with three options to delineate IPZ-3 using the EBA. The SPC may decide which option is appropriate for the drinking water system in question based on the data and information available on the water bodies and any activity(ies) they might be concerned about. The three options are discussed in more detail in sections 2.1 to 2.3.

Two relevant criteria in delineating IPZ-3 (EBA) for all three options are the flood event discharge and time of travel.

The flood event discharge can be estimated by considering an extreme wind storm event or 100 year flood event or snowmelt event during spring times (freshet) or any combination that in the opinion of the SPC represents the 100 year combined probability of an extreme event. The Technical Rules also allow less frequent storm events to be considered.

Time of travel (ToT) is a key issue in determining the IPZ-3 boundary. Based on the understanding of the flood event hydrograph (flood wave duration) and the stream-river system responses to flood events, a time of travel can be estimated with one of the following alternatives:

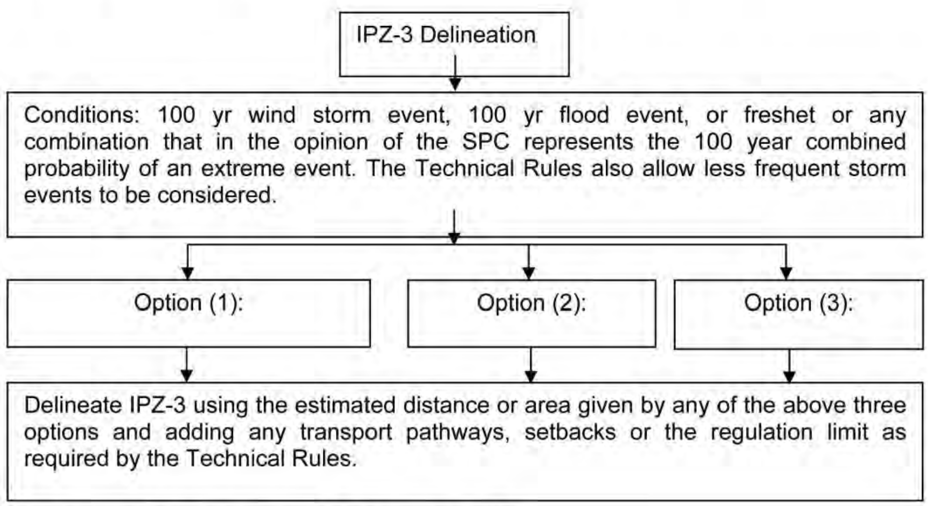

Fig. 1: Flowchart on options used for delineating IPZ-3.

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Alternative 1: Unit Hydrograph

This method can be applied if the unit hydrographs are known at particular gauging stations. In figure 2, assume there are two gauging stations GS1 and GS2 where the unit flood hydrograph is measured or calculated at those stations. The time difference between the flood peaks, **T**, may represent the time of travel for the distance between the two gauging stations. The time of travel (ToT) from an activity that is being modeled to the intake can be interpolated or extrapolated depending on its distance to either of the gauging stations. For example, assume an activity is located at a certain distance between GS1 and GS2; the time of travel for that activity can be obtained by interpolating the time of travel between the two stations and the distance between the activity and the two stations.

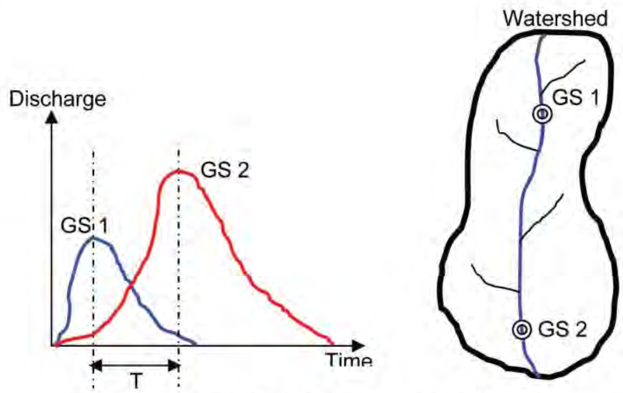

Fig.2: Illustration of unit hydrographs related to time of travel (ToT).

The same concept can be applied if an activity is located outside the distance between GS1 and GS2 but in this case the ToT is obtained by extrapolation. The unit hydrograph method assumes that the flow is uniform and under steady state conditions along the entire stream/river reach, which is not always the case. The estimated time of travel depends on the accuracy of the data and an understanding of the input, output and storage volumes of water within that stream / river system.

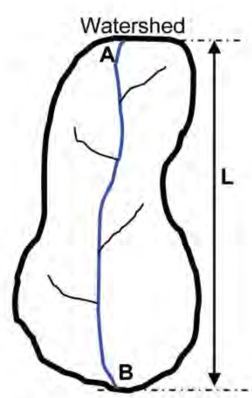

Fig.3: Illustration of a watershed with the longest hydraulic path.

Alternative 2: Time of Concentration

If the unit hydrographs mentioned in method (1) are not available, the time of concentration equation based the Soil Conservation Service (SCS) lag formula can be used, equation 1. The time of concentration, t_c, is defined as the amount of time for the entire watershed to contribute to the outflow or the amount of time for the water to reach

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the outlet from the furthest point from the outlet. The **t_c** formula is a function of the watershed length, **L**, the watershed slope, **Sw**, and the curve number, **CN**. The length **L** can be estimated from the data set related to the watershed and it is the longest hydraulic path in the watershed. The slop, **Sw**, is the average slope of the watershed which equals to elevation difference between point **A** and point **B** over the watershed length, **L**, see figure 3.

$$t_c = 0.00526L^{0.8}\left(\frac{1000}{CN} - 9\right)^{0.7} S_w^{-0.5} \quad \text{Eq.1}$$

Where **t_c** is the time of concentration (min), which is equivalent to the time of travel, **L** is the watershed length (ft), **Sw** is the average watershed slope (ft/ft) and **CN** is the curve number (-).

The curve number, **CN**, is the parameter that represents the potential maximum retention of rainfall. The Curve Number depends on the soil type (Group A, B, C, or D), land use and moisture conditions. Examples of suggested Curve Numbers for use with SCS hydrology is given in Table 1. However, users can calculate an appropriate value for **CN** based on the watershed characterisation. For additional information, see Urban Hydrology for Small Watersheds, Technical Release 55, United States Department of Agriculture, June 1986 and McCuen, 1998.

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Table 1: Curve Numbers for different types of Hydrologic Soil Group (McCuen, 1998).

Land Use Description	Average % impervious[b]	Hydrologic Soil Group A	B	C	D
Fully developed urban areas[a] (vegetation established)					
Lawns, open spaces, parks, golf courses, cemeteries, etc.					
Good condition; grass cover on 75% or more of the area		39	61	74	80
Fair condition; grass cover on 50% to 75% of the area		49	69	79	84
Poor condition; grass cover on 50% or less of the area		68	79	86	89
Paved parking lots, roofs, driveways, etc.		98	98	98	98
Streets and roads					
Paved with curbs and storm sewers		98	98	98	98
Gravel		76	85	89	91
Dirt		72	82	87	89
Paved with open ditches		83	89	92	93
Commercial and business areas	85	89	92	94	95
Industrial districts	72	81	88	91	93
Row houses, town houses, and residential with lots sizes 1/8 acre or less	65	77	85	90	92
Residential: average lot size					
1/4 acre	38	61	75	83	87
1/3 acre	30	57	72	81	86
1/2 acre	25	54	70	80	85
1 acre	20	51	68	79	84
2 acre	12	46	65	77	82
Developing urban areas[c] (no vegetation established)					
Newly graded area		77	86	91	94
Western desert urban areas					
Natural desert landscaping (pervious area only)[f]		63	77	85	88
Artificial desert landscaping		96	96	96	96

Land Use Description	Treatment or Practice[d]	Hydrologic Condition	Curve Numbers for Hydrologic Soil Group A	B	C	D
Cultivated agricultural land						
Fallow	Straight row or bare soil		77	86	91	94
	Conservation tillage	Poor	76	85	90	93
	Conservation tillage	Good	74	83	88	90
Row crops	Straight row	Poor	72	81	88	91
	Straight row	Good	67	78	85	89
	Conservation tillage	Poor	71	80	87	90
	Conservation tillage	Good	64	75	82	85
	Contoured	Poor	70	79	84	88
	Contoured	Good	65	75	82	86
	Contoured and conservation tillage	Poor	69	78	83	87
		Good	64	74	81	85

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The time of concentration formula is an empirical formula that is based on a number of assumptions and therefore, will, in most cases, produce a smaller IPZ-3 than if more advanced modelling was available. However, this method is a good starting method to estimate the time of travel within the watershed in the absence of an advanced numerical model. The formula is intended for use on watersheds where overland flow dominates and was developed for non-urban watersheds of 4000 acres or less. This does not mean it can not be used to determine a time of travel in a more urban watershed, but does mean that the numbers may be lower than expected in these types of watershed. Time of travel calculated using this formula is based on the following assumptions: average slope of the watershed, one type of land use and soil and an approximated watershed length.

If neither the alternative (1) nor the alternative (2) can be used, the time of travel (ToT) for a watershed can be the same time of travel of another watershed if both watersheds have similar characterisations.

2.1 Option 1: Contaminant Transport Approach:

If the SPC is concerned about specific activities that are being carried out upstream of the surface water intake, this approach can be used to determine the transport of contaminant(s) to the intake. If the contaminant reaches the intake, the IPZ-3 boundary can be delineated including the area of that activity. With this approach, the SPC would need to determine a concentration threshold to decide whether a contaminant released at the location of the activity in question has reached the intake or not. If not, i.e. the SPC decides the concentration of the contaminant is too low for it to be considered reaching the intake, then the location of that activity may not be included in the delineation of an IPZ-3. An understanding of contaminant transport from a number of activities can then be used to determine the extent of the IPZ-3.

As a second step, if the contaminant reaches the intake and results in the deterioration of the water quality (as per Rule 130), then this activity would be identified as a significant drinking water threat. The IPZ-3 delineation will include the contributing area of the activity(ies) that cause(s) an issue at the surface water intake.

Methods that can be used to delineate IPZ-3:

a- Numerical models (1D, 2D or 3D)

b- Analytical approach (explained below in section 3.4). This approach does not need a time of travel to be determined.

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Required inputs to apply option (1): flood discharge, estimated time of travel, and mass of the contaminant, either continuous or instant. The estimated TOT may be used as the simulation time if a numerical model is used.

2.2 Option 2: Boundary Approach:

This option can be used if in the opinion of the SPC there are no activities of concern upstream of the intake. This approach determines the boundary of IPZ-3 within the water body without analysing specific activity(ies). This approach requires that a time of travel (ToT) is determined as mentioned above. The assumption would be that whatever is released within the chosen ToT would reach the intake (under specific storm event conditions).

Methods that can be used to delineate IPZ-3:

a- Particle Tracking

b- Numerical Model (1D)

c- Manning equation

Required inputs to apply the option (2): flood discharge and estimated time of travel, which may be used as the simulation time if a numerical model is used.

2.3 Option 3: Combined Approach:

This approach is a combination of option (1) and (2). As a first step, option (2) is used to delineate the IPZ-3. As a second step, if the SPC is concerned about specific activities that are located inside or outside the IPZ-3, option (1) would then be used to determine whether the IPZ-3 needs to be expanded or reduced, by determining whether the contaminant from a specific activity reaches the intake or not. As in option 1, the SPC would need to determine a concentration threshold to decide whether a contaminant has reached the intake or not. If yes, modify the delineated IPZ-3 to include (or exclude) the contributing area of that activity. As a third step, the SPC can then determine whether the activity causes an issue or not (as per Rule 130).

Methods that can be used to delineate IPZ-3 in option (3) are a combination of methods mentioned in option (1) and option (2).

3- Supporting Methods

There are several physical processes controlling the transport of contaminants in river systems: mixing; molecular diffusion; turbulent diffusion; dispersion; advection;

dilution (decay function); and sorption. The mixing process is affected by the spatial variation of velocity on the macroscopic scale according to the Fick's law 1855.

If an activity discharges into a stream, the initial mixing of a contaminant is determined by the momentum and buoyancy forces of the discharge. As the contaminant is diluted, those forces disappear and the transport of the contaminant is dominated by ambient water velocity variation in the stream. Then, the contaminant plume is spread along the stream by dispersion and advection. Typical flow velocities of rivers range from 0.1 m/s to 1.5 m/s corresponding to channel slopes of 0.02% to 1% (Chin, 2006).

Numerical models are one of the tools that can be used to delineate the IPZ-3. Simple analytical approaches or particle tracking are other options to estimate the concentration of contaminants in the water bodies. Particle tracking is one of the more recently developed tools that provide information on the distance from an intake that particles can be transported through by knowing the flow velocities and concentration of the particles. This document presents an overview of the numerical models but focuses more on an analytical approach that can help users to calculate the distance contaminants are transported in a water system.

3.1 Numerical Codes

Several numerical codes are now available to simulate water quality in rivers and streams. Most codes typically provide numerical solutions to the advection-dispersion equation or some other forms of the law of mass conservation. The numerical solutions are produced at discrete locations and times for complex boundary conditions, and spatially and temporally disturbed contaminant transport. The numerical codes used in practical engineering are mostly 1D and 2D. 3D numerical codes are sometimes used but generally more costly. Numerical codes are commonly used to facilitate the analysis of fate and transport process of contaminants in river systems and include QUAL2E, HSPS, WASP6, SED2D, MIKE family, DELFT family, TELEMAC system, and HEC-6. It is up to the user to select the appropriate numerical model to simulate the contaminant transport based on the capabilities and limitations of each model and the local condition.

3.2 Particle Tracking Method

Particle tracking is a technique that is linked to hydrodynamic numerical models. The particle tracking method describes the effects of molecular and turbulent diffusion on the dispersion of constituents with time and can determine path lines in spatially variable parameter domains. When calculations are computed in reverse time, it is called Reverse Particle Tracking (RPT) and when computed in forward time it is call Forward Particle Tracking (FRT). The particle tracking method identifies an area from points of withdrawal that are likely to contribute flow to the intake within a specific time period. To use the particle tracking method, the location of an intake should be determined in

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both x and y directions if two-dimensional approach is used and in x, y and z directions if a three-dimensional approach is used. The number of hypothetical particles for tracking analyses should be specified as well as the time of travel (ToT) to determine the distance of the traveling particles. The diffusion rate of particles is controlled by flow velocities and longitudinal and transverse diffusions. This method determines the distance traveled in the water body, and as a second step the transport pathways, setbacks or regulation limit need to be added to delineate the IPZ-3.

3.3 Manning Equation

The Manning Equation is the most commonly used equation to analyze open channel flows. It is a semi-empirical equation for simulating water flows in channels and culverts where the water is open to the atmosphere, i.e. not flowing under pressure. The distance from the intake can be determined as follows:

$$D = V.T \qquad , V = \frac{1}{n} R^{2/3} S^{1/2} \text{ (Part a)} \quad \text{or} \quad V = \frac{Q}{A} \text{ (Part b)} \quad \text{Eq. 2}$$

Where **D** is the distance from an intake in the water body (m), **T** is the estimated time of travel as explained (s), **n** is the Manning coefficient (friction coefficient), which varies from 0.001 to 0.03 based on type of stream bed material and flow, **R** is the hydraulic radius (m) which in most cases is equivalent to the water depth of river, and **S** is the energy slope which is equivalent to the stream slope.

If the inflow discharge of a flood event is known, then the flow velocity can be determined through equation 2, part b. If the water depth at the flood event is known but not the discharge, then equation 1, part a can be used to calculate the flow velocity. Then the distance, **D**, from the surface water intake can be determined. This approach determines the distance traveled in the water body, and as a second step the transport pathways, setbacks or regulation limit need to be added to delineate the IPZ-3.

3.4 Analytical Approach

The analytical approach provides a mechanism that can be used if the contaminant mass and type entering a water body are known. The analytical approach can be used for point source discharges such as industrial or municipal discharges, stormwater discharges, or spills, and considers the physical properties of the contaminants only. Spills in rivers or streams can be a result of major collisions on transportation routes or failures at large storage sites. Spills can be thought of as large masses of contaminants that are released in a very short period of time.

Non-point sources of contaminants, such as runoff from rural or agricultural areas and urban runoff are not considered in this approach. The main goal is to determine the

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concentration of a contaminant at the surface water intake according to option (1). There are two concepts that can be used to calculate the concentration of a contaminant: 1) without dispersion and 2) with dispersion.

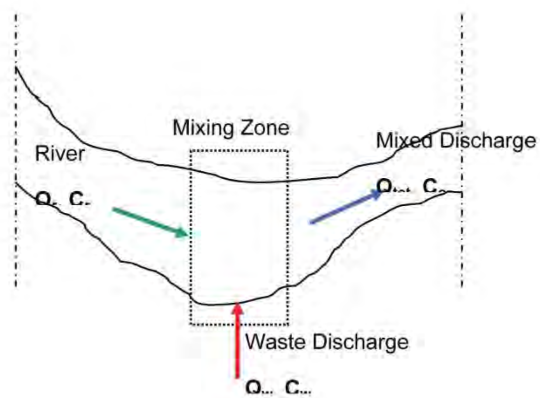
3.4.1 No dispersion

If full mixing, decay and no dispersion are considered, equation 4 calculates the concentration at a certain distance. To do that, first determine the mean concentration of a contaminant after mixing; see figure 4, with the water body of the stream through equation 3:

$$Q_r C_r + Q_w C_w = Q_{tot} C_o \Rightarrow C_o = \frac{Q_r C_r + Q_w C_w}{Q_r + Q_w} \quad \text{Eq.3}$$

Fig.4:

Initial mixing of waste discharge with stream discharge.



For simplicity, it can be assumed that the discharge of a contaminant is well mixed across the cross section.

$$C(x,t) = C_o e^{-\lambda \frac{XA}{Q}} \quad \text{Eq.4}$$

Where **C** is the concentration of the contaminant at the surface water intake (kg/m^3), **X** is the distance between the point discharge from an activity projected on the stream flow and the surface water intake along the stream line (m), λ is the decay (s^{-1}), **A** is the wet cross sectional area of the stream (m^2) and **Q** is the discharge that has been determined to represent the extreme event (m^3/s).

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The coefficient, ✤, can be expressed in terms of the *half-life*, **T_{50}**, which is the time required for 50% of the initial mass to decay as follows, equation 5:

$$T_{50} = \frac{\ln 2}{\lambda} \quad \text{Eq.5}$$

The half-life time depends on the type of chemical or contaminant released. An example of the half-life time of several organic compounds in soils has been compiled by Howard *et al.*, 1991, see Table 2. Users will need to determine the correct value for the contaminant(s) in question.

Table 2: First order decay rates of selected organic compounds in Soil.

Compound	Half-Life, T_{50} (days)	First-Order Decay Rate, λ (day^{-1})
Acetone	2–14	0.050–0.35
Benzene	10–730	0.00095–0.069
Bis(2-ethylhexyl)phthalate	10–389	0.00178–0.069
Carbon tetrachloride	7–365	0.0019–0.099
Chloroethane	14–56	0.0124–0.0495
Chloroform	56–1800	0.000385–0.0124
1,1-Dichloroethane	64–154	0.00450–0.0108
1,2-Dichloroethane	100–365	0.00190–0.00693
Ethylbenzene	6–228	0.00304–0.116
Methyl *tert*-butyl ether	56–365	0.00190–0.0124
Methylene chloride	14–56	0.0124–0.0495
Naphthalene	1–258	0.00269–0.693
Phenol	0.5–7	0.099–1.39
Toluene	7–28	0.0248–0.099
1,1,1-Trichloroethane	140–546	0.00127–0.00495
Trichloroethene	321–1650	0.000420–0.00216
Vinyl chloride	56–2880	0.000241–0.0124
Xylenes	14–365	0.00190–0.0495

Source: Howard et al. (1991).

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3.4.2 With dispersion

If full mixing, decay, longitudinal dispersion, mass of contaminant released are considered, the following can be applied:

The governing equation for longitudinal dispersion that is well mixed over the cross sections of rivers and streams is given in equation 6. This equation considers dispersion and first order decay and assumes that a mass of contaminant, **M**, is instantaneously mixed over the cross section of the stream at time **t=0**.

$$C(x,t) = \frac{Me^{-\lambda t}}{A\sqrt{4\pi K_L t}} \exp\left[-\frac{(x - Vt)^2}{4K_L t}\right] \quad \text{Eq.6}$$

Where **C** is the concentration of contaminant (kg/m^3) at a point, **M** is the mass of contaminant released from the facility (kg), **V** is the average flow velocity (m/s), K_L is the longitudinal dispersion (m^2/s), ⚜ is the coefficient that includes dilution (decay); dissolved oxygen concentration; water temperature etc. (s^{-1}), and **A** is the cross-sectional area of the stream (m^2). If the contaminant is assumed to be conservative, then the decay coefficient is equal to zero. The exponential term in equation 6 is equal to 1 if the flow is uniform and steady. This term appears only when the water body is stagnant, i.e., **V=0**.

In equation 6: the flow velocity can be calculated from the determined flow discharge that represents the extreme event discharge, **Q**, and average cross-sectional area of the stream, **A**. The time, **t**, can be calculated by knowing the average flow velocity, **V**, in the stream and the distance between the surface water intake and the projected location of the activity on the stream. The mass of contaminant should be specified based on available data of the activity.

One of the first approaches to estimate the dispersion coefficient in river systems, K_L, is mentioned in Elder 1959 which states that $K_L = 5.93u.\bar{d}$ where $\bar{d}$ is the mean depth of stream (m) and u_* is the shear velocity of flow (m/s). However, several new approaches have been developed to estimate the K_L, and a summary of them is given in Table 3. To apply the equations shown in Table 3, the stream width must be larger than the mean water depth (**w** >> **d**) where longitudinal dispersion is dominated by transverse variations in the mean velocity and the dispersion caused by vertical variations in mean velocity is relatively small. Typical values of K_L are 0.05m^2/s to 0.3m^2/s for small streams (Genereux, 1991) and as high as 1000m^2/s for larger rivers (Wanner et al., 1989).

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Table 3: Estimates of the Longitudinal Dispersion Coefficient in Rivers, Chin 2006.

Formula	Reference
$\frac{K_L}{du_*}=0.011\left(\frac{w}{d}\right)^2\left(\frac{V}{u_*}\right)^2$	Fischer et al. (1979)
$\frac{K_L}{du_*}=0.18\left(\frac{w}{d}\right)^2\left(\frac{V}{u_*}\right)^{0.5}$	Liu (1977)
$\frac{K_L}{du_*}=0.6\left(\frac{w}{d}\right)^2$	Koussis and Rodríguez-Mirasol (1998)
$\frac{K_L}{du_*}=2.0\left(\frac{w}{d}\right)^{1.5}$	Iwasa and Aya (1991)
$\frac{K_L}{du_*}=5.915\left(\frac{w}{d}\right)^{0.620}\left(\frac{V}{u_*}\right)^{1.428}$	Seo and Cheong (1998)
$\frac{K_L}{du_*}=0.01875\left[0.145+\frac{1}{3520}\frac{V}{u_*}\left(\frac{w}{d}\right)^{1.38}\right]^{-1}\left(\frac{w}{d}\right)^{5/3}\left(\frac{V}{u_*}\right)^2$	Deng et al. (2001)

The shear flow velocity, **u***, in Table 3 can be determined from equation 7,

$$u_* = \sqrt{\tau_o/\rho}\,;\ \tau_o = \rho g R S;\ R = A/P \quad \text{Eq.7}$$

Where ✤✤ is the mean shear stress on the wetted perimeter (N/m^2), ✤ is the water density (kg/m^3), **g** is the gravity (m/s^2), **R** is the hydraulic radius (m), **P** is the wetted perimeter (m), **A** is the cross section (m^2) and **S** is the energy slope (-). To apply this equation the average water depth in the stream should be known. For simplicity, the energy slope can be assumed to be equal to the stream slope. The wetted perimeter, **P**, is the sum of all wet lengths along the cross section, see figure 5:

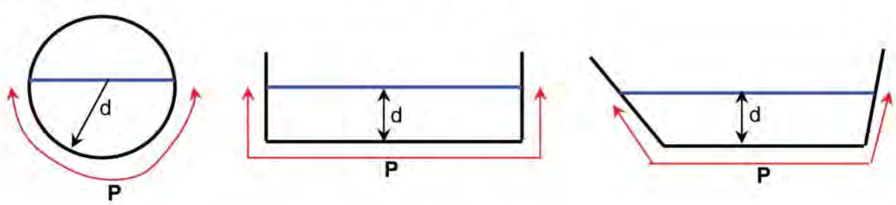


Fig. 5: Illustration of wetted perimeter over different cross sections of streams.

If the cross section of a river or stream changes significantly along the distance, the above approach can be used with some adjustment for each cross-section change as follows: Assume there is a longitudinal section of a river as shown in figure 6, the section consists of four reaches and each reach has a different width and small changes in water depth. Each reach has two cross sections 1 and 2 that represent the beginning and end of each reach.

The goal is to calculate the contaminant concentration at section 2 of reach 4, i.e. $C_{2\text{-}4}$. Continuity is valid which means that the amount of flow through each reach is the same, i.e. no losses in the total volume of water passing. To calculate the contaminant concentration $C_{2\text{-}4}$, follow the steps below.

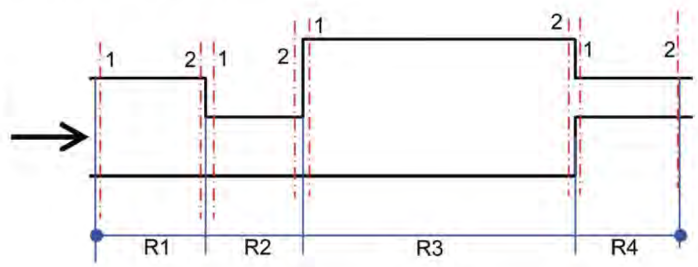
1- Calculate $V_{1\text{-}1}$, $A_{1\text{-}1}$, $C_{1\text{-}1}$, M is known;

2- Calculate $C_{1\text{-}2}$;

3- Use $C_{1\text{-}2} = C_{2\text{-}1}$, then calculate $M_{2\text{-}2}$ and $C_{2\text{-}2}$;

4- Use $C_{2\text{-}2} = C_{3\text{-}1}$; then calculate $C_{3\text{-}2}$ and etc.

Fig. 6: Illustration of varied longitudinal section of river.



River or stream calculations can be done either manually by assuming one or two reaches for the entire stream length or by using a spreadsheet calculation (as shown below) or any other tool that users find appropriate.

Technical Bulletin: Delineation of Intake Protection Zone 3
Using the Event Based Approach (EBA)

4- Examples

This section provides two examples that illustrate the method and analytical solution shown above.

Example 1:

Let us assume a wastewater treatment plant discharges its effluent into a small stream with a water depth of 0.8m and a width of 6.0m and a flow velocity of 0.2m/s, figure 7. The wastewater treatment plant discharges 0.04m^3/s of chemical A with a concentration of 18mg/l into the stream. The concentration of chemical A in the stream upstream of the wastewater treatment plant is 0.22mg/l. Assume no dispersion and full instantaneous mixing with a dilution coefficient of 1.2d^{-1}. What is the concentration of chemical A 3km downstream of the wastewater treatment plant? At what distance downstream from the wastewater treatment plant will the concentration of chemical A in the stream be 0.22mg/l?

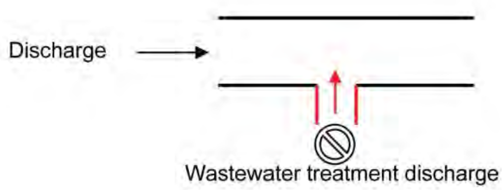


Fig. 7: Illustration of example 1.

Solution:

Q stream = 0.8*6.0*0.2 = 0.96m^3/s

Velocity after the WWT= (0.96+0.04)/(0.8*6) = 0.21m/s

C downstream of the WWT, Eq. 3 = (0.96*0.22 + 0.04*18)/ (0.96+0.04) = 0.9312mg/l

C at 3000 m, Eq.5 = 0.9312 *$e^{(-[1.2*3000/(3600*24*0.21)]}$ = 0.7636mg/l

X at C=0.22 mg/l, Eq.5 => 0.22=0.9312* $e^{(-[1.2*t/(3600*24)]}$ → t = 149874.3s, V=0.21m/s

Then X= 21,706m from the discharge position.

Technical Bulletin: Delineation of Intake Protection Zone 3
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Example 2:

Let us assume an intake as shown in figure 8. In this figure, the distance of the boundaries of IPZ-1, 2, and 3 from the intake is $\mathbf{D_1}$, $\mathbf{D_2}$, and $\mathbf{D_3}$, respectively and the flow direction is from left to right.

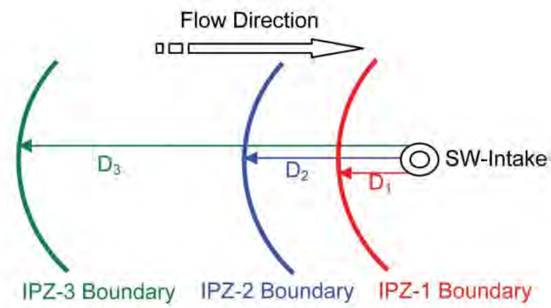

Fig. 8: Illustration of intake protection zone distances, example 2.

Assume a spill of a specific contaminant of 10,000kg occurred at a point upstream from the intake. The river has a width **w** = 75m and an average water depth **d** = 1.5m, a discharge of **Q** = $90m^3/s$ and an energy slope of 0.0004. Assume the first order decay rate of this contaminant is $5.E\text{-}5s^{-1}$. Calculate the concentration of the contaminant at a distance 40km from the spill location with decay and without decay.

Solution:

A spreadsheet is used to calculate the maximum concentration at a distance of 40km from the intake. Figure 9 shows the distance **X** that represents $\mathbf{D_3}$ for the delineation of **IPZ-3**. Based on the type of contaminant of concern, the parameters shown in figure 9 may change. The spreadsheet can now be used to calculate the maximum concentration that reaches the intake. The user will need to determine the concentration at the intake that could be used as a threshold to decide whether the contaminant has reached the intake or not.

Technical Bulletin: Delineation of Intake Protection Zone 3
Using the Event Based Approach (EBA)

GIVEN										
Mass M(kg)	10000									
River width w (m)	75									
River depth d (m)	1.5									
Discharge Q (m^3/s)	90									
Energy Slope S (-)	0.0004									
Decay coefficient l (s^{-1})	5.00E-05									
REQUIRED	**X1**	**X2**	**X3**	**X4**	**X5**	**X6**	**X7**	**X8**	**X9**	**X10**
Distance X(m)	100	1000	5000	10000	15000	20000	25000	30000	35000	40000
CALCULATED										
Hydraulic Piermeter P (m)	78									
Hydraulic Radius (m)	1.44230769									
Shear velocity u_* (m/s)	0.07523042									
Velocity V(m/s)	0.8									
Long. Dispersion K_L (m^2/s)	169.268434									
Max. Con. w/o decay (kg/ m^3)	0.17242874	0.0545268	0.024385107	0.01724	0.01408	0.01219	0.01091	0.00996	0.00922	0.00862
Max. Con. with decay (kg/ m^3)	0.17135442	0.0512231	0.017840525	0.00923	0.00551	0.00349	0.00229	0.00153	0.00103	0.00071

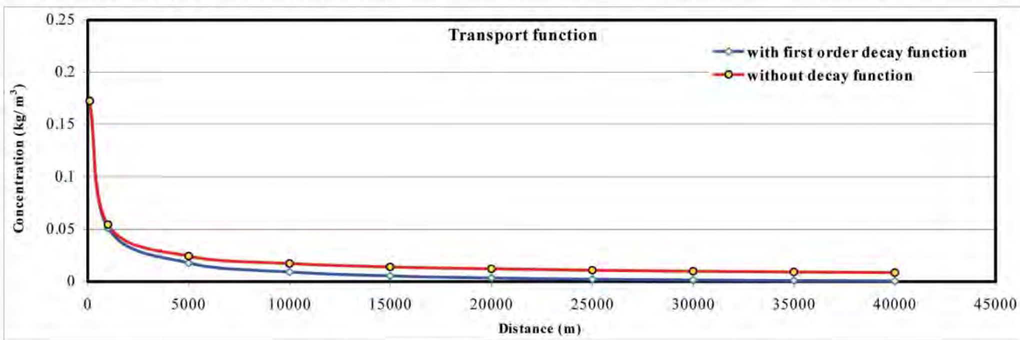

Fig. 9: Illustration to calculate the maximum concentration as a function of distance.

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DRINKING WATER SOURCE PROTECTION
ACT FOR CLEAN WATER

Technical Bulletin: Addressing Transportation Threats

Date: April 2009

Background

- The Clean Water Act requires that source protection committees list activities that are or would be drinking water threats. Through regulations and technical rules, the province has set out which activities must be considered drinking water threats under specific circumstances. Specifically, Section 1.1 of Ontario Regulation 287/07 (General) lists activities that are prescribed as drinking water threats and the Table of Drinking Water Threats in the Technical Rules specify under what circumstances these activities are considered threats.
- The regulations and technical rules provide a mechanism through which source protection committees can add drinking water threats or add additional circumstances to activities the province has already listed as a threat.
- The list of activities that are prescribed as drinking water threats was established using input from multiple stakeholder groups and committees. The method of determining when an activity is a threat, and more specifically a significant, moderate, or low drinking water threat, is based on a semi-quantitative risk assessment that considers both the nature of the activity itself (the hazard rating) and the vulnerability of the area in which the activity is located. This is used to determine a risk score. The methodology was widely consulted on in advance of the posting of the regulations and technical rules around the assessment report.
- During the consultation on the regulations and technical rules for the assessment report, questions were raised around the inclusion of transportation corridors as drinking water threats. Corridors were not included in the list of prescribed activities in the current regulations and technical rules as the inclusion of corridors did not fit within the semi-quantitative risk assessment process, and therefore, had not been consulted on. In addition, the current rules around the addition of threats and circumstances do not provide a method for the inclusion of transportation corridors.

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- Although transportation corridors have not been included as a prescribed threat and cannot be added, there are a number of ways that specific activities taking place within a transportation corridor could be identified as a threat at the discretion of the Director under the Clean Water Act.

Including Transportation Threats in the Assessment Report

- Not being listed as a prescribed threat does not preclude the source protection committees (SPCs) from determining that, on a local level, transportation of *specific* substances along certain routes does pose a threat to local source waters and SPCs have the flexibility to include them in the assessment report.

- Transportation threats can be considered by adding a new drinking water threat as per Rule 119 of the Technical Rules. An SPC can include a threat that is not prescribed in O. Reg. 287/07 if:

  (1) the activity has been identified by the SPC as an activity that may be a drinking water threat;
  (2) in the opinion of the Director,
  (a) the chemical hazard rating of the activity is greater than 4, or
  (b) the pathogen hazard rating of the activity is greater than 4; and
  (3) the risk score for an area within the vulnerable area in respect of the activity calculated in accordance with rule 122 is greater than 40.

- Rules 120 and 121 set out how the hazard rating is determined:

  120. The chemical hazard rating of an activity that is not prescribed to be a drinking water threat under O. Reg. 287/07 (General) shall be a rating that in the opinion of the Director reflects the hazard presented by the chemical parameter associated with the activity, if any, considering the following factors:

  (1) Toxicity of the parameter.
  (2) Environmental fate of the parameter.
  (3) Quantity of the parameter.
  (4) Method of release of the parameter to the natural environment.
  (5) Type of vulnerable area in which the activity is or would be located.

  121. The pathogen hazard rating of an activity that is not prescribed to be a drinking water threat under O. Reg. 287/07 (General) shall be a rating that in the opinion of the Director reflects the hazard presented by pathogens associated with the activity, if any, considering the following factors:

Technical Bulletin: Addressing Transportation Threats

(1) The frequency of the presence of pathogens that may be associated with the activity.
(2) Method of release of the pathogen to the natural environment.
(3) Type of vulnerable area in which the activity is or would be located.

- Before adding a transportation threat to the assessment report, Director approval of the hazard rating and the risk score must be obtained.

- Once a new threat is added, then the SPC must follow the same process around identifying where the threat is significant, moderate or low and how many significant drinking water threats are in each vulnerable area.

Source Protection Plans and Transportation Threats

NOTE: *Because no source protection plan regulation is in place, the following policy options cannot yet be confirmed and are subject to change. They are provided merely for the purpose of considering the implications of adding transportation threats to the assessment report.*

- When making the decision regarding whether to add transportation-related threats to the assessment reports, there are a number of things SPCs should consider relating to the source protection plan.

- If a transportation threat is identified as a significant threat in the assessment report, the *Clean Water Act, 2006* requires the source protection plan to contain a policy that satisfies the objectives of ensuring this threat ceases to be and never becomes significant (policies that result in "managed threats" may satisfy these objectives). There are several options for addressing significant transportation threats in source protection plans.

  1. Reducing the likelihood that a spill will occur.

     - There are various policy approaches which an SPC could use when formulating a policy to reduce the likelihood that a spill will occur in a vulnerable area:

       - Policies relating to education and outreach could be developed, including those that require the installation of signs making transporters aware that they are travelling through a vulnerable drinking water source protection area, and thus motivating them to voluntarily undertake appropriate precautions.

       - Policies could be developed that reduce the speed of the vehicles or restrict the route used to transport certain substances on some roads (where municipalities have the jurisdiction to make such policies). However, it should be noted

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that SPCs do not have the authority to make policies to change transportation routes on provincial or federal transportation corridors, nor do they have the power to change where existing corridors are located.

2. Reducing the impact of a spill, should it occur.

   - There are also several policy approaches which an SPC could use when developing a policy to address the impact of spills:

     - Policies relating to structural and operational risk management measures, including the construction of berms or setbacks, which could reduce the speed at which spilled contaminants would reach the drinking water source.

     - Plan policies could direct that municipal emergency response plans be reviewed to ensure that the response plans consider drinking water systems and their associated vulnerable areas and have effective measures to address a spill of the substances identified as a transportation threat in the assessment report when it is being transported through vulnerable areas.

   - It should be noted that any policy in a plan to address a significant drinking water threat may have to provide supporting rationale or otherwise demonstrate the extent to which it effectively manages or reduces the risk of the threat so that it ceases to be or become significant.

Addressing Transportation Threats Outside of the *Clean Water Act, 2006*

- The Rules around the inclusion of additional drinking water threats are enabling and do not require that SPCs add any threats. SPCs, at their own discretion, may request that the Director approve the hazard rating and inclusion of local threats that are not already prescribed in regulation under the Clean Water Act.

- An SPC may decide not to include transportation threats in the Assessment Report and instead choose to advise municipalities of their concerns with respect to transportation threats and may also choose to work with municipalities to ensure effective management of these threats.

- In the event that SPCs do not add transportation threats to a source protection plan, municipalities have the power to implement most actions listed in the previous section through official plans and by-laws, education and outreach, and emergency planning.

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- It should be noted that an SPC cannot include policies for addressing transportation threats in a source protection plan if the assessment report does not list any related transportation activities as threats.

Important Considerations

- SPCs should consider the nature of transportation threats in their Source Protection Areas. It may only be necessary to include one transportation threat in the assessment report (e.g., one about which much information is known) if plan policies to address this threat (which are often broad reaching) could also address all incidences of transportation threats in the area. For example, reduction in speeds or rerouting truck traffic could apply to all transportation.
- The assessment report may identify that transportation threats are a moderate or low threat and then the SPC could exercise their discretionary authority under the Act to establish policies in the plan. However, policy options for addressing these moderate or low transportation threats may be limited and public bodies need only "have regard to" (i.e., consider, as opposed to "conform with") moderate and low threat policies.
- The Emergency Management and Civil Protection Act requires municipalities to complete a HIRAI (hazard identification and risk assessment) and to identify critical infrastructure. It also requires municipalities to have emergency response plans but does not specify that drinking water systems and associated vulnerable areas be included.
- If additional systems are elevated into the source protection planning process, these systems and their associated vulnerable areas may not have been identified in municipal emergency response plans. SPCs should consider this when thinking about recommendations for emergency response plans.

Summary

- Transportation corridors are not included in the list of prescribed threats.
- SPCs could seek approval of the Director to have site-specific transportation threats related to the transport of specific substances included as a local drinking water threat in the assessment report through the process set out in the rules to include additional threats.
- Including transportation threats as significant threats in the assessment report has important ramifications for the source protection plan – all significant threats must cease to be or never become significant.

Technical Bulletin: Addressing Transportation Threats

- Policy options for addressing significant transportation threats could address the likelihood of a spill or the impact of a spill once it occurs.
- SPCs may decide to make municipalities aware of transportation threats outside of the *Clean Water Act, 2006* and help them address these threats through existing tools. This may simplify the analysis and achieve similar outcomes, potentially in a timelier manner.

Future Steps

- The province is proposing to consult on the inclusion of transportation corridors as threats as the first round of assessment reports is being developed with an eye to proposing options for the inclusion of corridors for future rounds of planning.

Example:
Adding the threat of "transportation of fuel" to address transportation of fuel through an IPZ.

Step A. Determine threat and circumstances to be added.

Threat: Transportation of fuel.

Circumstances:

1. The fuel is transported in a quantity that is more than 10,000 litres (Large trucks transporting fuels typically have capacities ranging from 28,400 litres to 37,500 litres).
2. A spill of the fuel may result in the presence of BTEX in groundwater or surface water.

Step B. Determine the hazard rating according to rule 120

The hazard rating would be calculated by considering the factors listed below:

(NOTE: the values given are hypothetical and should not be used as a basis for further calculations without confirmation)

1. Toxicity of the parameter	BTEX: 8
2. Environmental fate of the parameter	BTEX: 6 (direct)
3. Quantity of the parameter	BTEX: 15,000 L (scoring 10)
4. Method of Release (RIM score):	BTEX: 6 (low)
5. Type of Vulnerable Area	IPZ

For this hypothetical example, the **Hazard Rating would be 7.8**.

Technical Bulletin: Addressing Transportation Threats

Step C. Determine where the activity would be a significant, moderate or low drinking water threat, according to rules 129, 134 and 137.

With a hypothetical hazard rating of 7.8, handling of fuel according to the circumstance described above would be a moderate drinking water threat in areas within the IPZ with vulnerability scores from 8 to 10. It would be a low drinking water threat in areas within the IPZ with vulnerability scores of 6 and 7.

DRINKING WATER SOURCE PROTECTION
ACT FOR CLEAN WATER

Technical Bulletin: Earth (Geothermal) Energy Systems

Date: November 2009

This fact sheet is for earth energy systems, also known as geothermal heating systems, as they relate to drinking water source protection. It explains the types of activities that are associated with the construction and operation of systems which utilize water, either directly or indirectly, for heating or cooling. It also identifies how such activities are or could potentially be addressed under the Clean Water Act requirements.

Installing earth energy systems requires making holes in the ground. If these holes are wells, which would apply if there were any tests for or on groundwater in the boring or installation, they must meet the requirements of Regulation 903 to minimize the risk of contaminating groundwater. Improperly constructed, maintained and abandoned wells can create pathways for contamination to move from the surface down into the groundwater or from one water-bearing horizon to another. Most of these systems will not be on record, so this creates an unknown in terms of pathways and vertical vulnerability. The Canadian Standards Association has published C448.2-01 and C448.2-02 for the Design and Installation of Earth Energy Systems, which recommends using high density polyethylene plastic pipe and pressure testing the system at key points to determine if there are any leaks at key points during the installation. Furthermore, the CSA standard also requires that boreholes be filled with grout for the entire length of the hole which would minimize the potential for contamination or leakage. However, the CSA Standard is only applied when there is an application for a building permit and there is a poor understanding of

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PIBS 7575e

the need for the permit.

What is an earth energy system and how does it work?

O.Reg. 177/98 under the Environmental Protection Act defines a ground source heat pump as a heating and cooling system for buildings that use a liquid to exchange heat with the ground or ground water.

Geothermal (or earth) energy comes from the soil and rock of the earth. Ground temperature is relatively constant all year long. Groundwater flowing slowly through soil pores and bedrock fractures also has similar constant temperatures. In winter, the ground is warmer than the air, and in summer, it is cooler. An earth energy system (heat pump) harnesses this underground temperature to heat and cool buildings.

There are two basic types of earth energy heat pump systems - open and closed loop. Stated simply, open loop systems extract water from the environment to use for heating and cooling and then discharge the water back to the environment either directly or indirectly. Closed loop systems circulate a heat transfer fluid (HTF) through pipes installed in the environment (typically in the ground) to utilize the thermal gradient between the HTF and the environment for heating or cooling. HTFs typically used include ethanol or propylene glycol.

How are earth energy systems considered for Drinking Water Source Protection?

Earth energy systems have the potential to affect both the quantity and quality of source water for drinking purposes. The taking of water from surface water or groundwater regimes for open loop systems could have an affect on the water budget for a given area. The presence of the HTF has the potential to impact the quality of source waters if it is released into the environment and could, therefore, be considered a threat to the quality of the source water. The presence of wells for the purpose of earth energy systems may also serve as a conduit or transport pathway for the potential transfer of contaminants from the surface down to aquifers or for water between aquifers within the ground.

Earth Energy Systems and Water Quantity Risks

Where these systems extract water from the environment, this withdrawal should be considered under the water budget and water quantity risk assessment, where applicable. It is estimated that single residential systems typically use 25 to 40 litres per minute for heating and cooling, with maximums of 25000 to 40000 litres per day. Larger commercial or industrial systems would use even greater amounts of water.

While permits to take water for residential earth energy water taking systems are not required if they are for normal household use (such as heating), the withdrawal should be considered in the overall water budget, particularly at a Tier 3 stage.

It should be further noted that the operation of open loop systems could have a notable effect on the groundwater flow regime through the induction of piezometric changes due to the withdrawal and recharge of the water used.

Earth Energy Systems and Water Quality Risks

The withdrawal and recharge of water for use in earth energy systems can result in a thermal gradient in the groundwater regime, but this is typically limited to a local effect. Depending on the degree to which the temperature of the water changes, the configuration of the system and the nature of the hydrogeochemical environment, it could also induce minor changes in groundwater chemistry but not likely induce threats to water quality.

The presence of HTFs in the subsurface in earth energy systems can pose a threat to water quality, particularly if they should leak in the subsurface piping. While this activity is not a prescribed threat under the current legislation, preliminary analysis suggests that:

- residential systems with low volumes of HTFs, would be considered a low drinking water threat in areas with a vulnerability of greater than 7, and
- larger commercial or industrial systems with higher volumes of HTFs would be a:
    - significant drinking water threat in areas with a vulnerability score of 10,

- moderate threat in areas with vulnerability scores between 7.5 and <10, and
- low threat in areas with vulnerability scores between 5 and <7.5.

Earth Energy Systems as Transport Pathways

The presence of boreholes or wells associated with these systems could be considered a transport pathway in the Assessment Report, where its construction provides a conduit from the surface down to an aquifer or allows for enhanced flow between aquifers. In this circumstance, the groundwater vulnerability may be adjusted higher to account for the transport pathway. Under the current legislation, where a transport pathway is confirmed as a factor in contributing to a significant drinking water threat, addressing the pathway could be part of the risk management plan for addressing such a threat. This could include, but not be limited to:

- requiring or confirming that the construction complies with CSA requirements
- testing the well or boring, where possible, to determine if it provides a conduit for flow
- monitoring the system to determine if there is enhanced flow or if there is any loss of HTF from the system
- providing an emergency contingency plan in the event that there is a leak to minimize the impact on source waters
- restricting the installation or application of earth energy systems
- decommissioning faulty or high risk earth energy systems

Earth Energy Systems with Source Water Issues

Where there is an existing deterioration of water quantity or quality for a municipal residential drinking water system, this can be considered an issue under the Clean Water Act. Where such an impact on source water is associated with an earth energy system, the system could be considered a significant threat and require risk management measures, as mentioned above, to mitigate the risk to the drinking water supply.

Summary

Considerations of Earth Energy Systems in drinking water source protection can be done as part of the assessment of transport pathways. Where such pathways are associated with significant threats to drinking water sources, they could be addressed in a risk management plan for that threat.

The activity of Earth Energy Systems is not a prescribed threat under the current regulations. However, if it were to be added, preliminary analysis suggests that it would only be a significant threat for ethanol and propylene glycol heat transfer fluids in a relatively large volume commercial/industrial system in a vulnerable area with a score of 10. Within a vulnerable area of any lesser score with such a system or any residential system, this activity would not be a significant threat under the current assessment.

Additional Information

For more information on these types of systems, please refer to the Technical Bulletin on Constructing Earth Energy Systems in Ontario released in September 2009. http://www.ene.gov.on.ca/publications/7219e.pdf

DRINKING WATER SOURCE PROTECTION
ACT FOR CLEAN WATER

Technical Bulletin: Burial of Animals on Farms as a Drinking Water Threat (Deadstock Disposal)

Date: December 2009

The *Clean Water Act, 2006* provides source protection committees (SPCs) with the authority to protect their municipal drinking water supplies by developing collaborative, locally driven, science-based protection plans. SPCs identify potential risks to local water sources and take action to set out policies in source protection plans that reduce or eliminate these risks. Regulations and technical rules governing the content of the assessment report became law in late 2008 and were amended in November 2009.

Regulation 287/07, under the Clean Water Act, includes a list of prescribed activities that must be considered when identifying activities that pose a risk to sources of drinking water. The technical rules include Tables of Drinking Water Threats that set out the circumstances under which the activities in the regulation pose a significant, moderate, or low drinking water threat.

Until recently the burial of dead animals was governed under Part V of the Environmental Protection Act (EPA) with respect to the disposal of on farm animals and the Deadstock Disposal Act, 1968 (DDA) for the use of deadstock. The November 2008 technical rules under the Clean Water Act included the burial of farm animals as a circumstance in which the "Establishment or Maintenance of a Waste Disposal Site within the meaning of Part V of the Environmental Protection Act" was considered a threat to drinking water. In March 2009, amendments were made to regulations under the EPA, the DDA

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was repealed, and a new regulation was made under the Nutrient Management Act, 2002 (NMA) such that the burial of farm animals on farms is now regulated through Ontario Regulation 106/09, Disposal of Dead Farm Animals. Changes were also made to the Food Safety and Quality Act, 2002 (FSQA) to govern off farm animal use and disposal. The Clean Water Act (CWA) and its regulations stipulate that an activity can only be identified as a drinking water threat if it is listed in O. Regulation 287/07 or added locally with the approval of the director. With the change in the regulatory framework, the deadstock burial no longer falls under any of the 21 activities listed in the regulation and therefore, circumstances in the Technical Rules: Tables of Drinking Water Threats had to be removed. These tables only list circumstances related to activities in the O. Regulation 287/07. Without amending Regulation 287/07, the only option for identifying deadstock burial as a threat is to add this activity locally through Director's approval.

Background information on the new framework regulating deadstock can be found at the following link
http://www.omafra.gov.on.ca/english/nm/regs/deadstock/summary.htm

INCLUDING DEADSTOCK DISPOSAL THREATS IN ASSESSMENT REPORTS

Although burial of farm animals is no longer in the Tables of Drinking Water Threats, the Clean Water Act, regulations and technical rules provide a mechanism by which SPCs can add drinking water threats or add additional circumstances to activities the province has already listed as a prescribed drinking water threat. Therefore, an SPC can request that "burial of farm animals on a farm under the O. Regulation 106/09 of the Nutrient Management Act" be added as a drinking water threat by making a request to the Director under the Clean Water Act. The activity can only be considered a local threat, according to the technical rules, if:

(1) *the activity has been identified by the SPC as an activity that may be a drinking water threat;*

(2) *in the opinion of the Director,*

   (a) *the chemical hazard rating of the activity is greater than 4, or*
   (b) *the pathogen hazard rating of the activity is greater than 4; and*

(3) the risk score for an area within the vulnerable area in respect of the activity calculated in accordance with rule 122 is greater than 40.

Rules 120 and 121 set out how the hazard rating is determined by the province:

120. The chemical hazard rating of an activity that is not prescribed to be a drinking water threat under O. Reg. 287/07 (General) shall be a rating that in the opinion of the Director reflects the hazard presented by the chemical parameter associated with the activity, if any, considering the following factors:

(1) Toxicity of the parameter.

(2) Environmental fate of the parameter.

(3) Quantity of the parameter.

(4) Method of release of the parameter to the natural environment.

(5) Type of vulnerable area in which the activity is or would be located.

121. The pathogen hazard rating of an activity that is not prescribed to be a drinking water threat under O. Reg. 287/07 (General) shall be a rating that in the opinion of the Director reflects the hazard presented by pathogens associated with the activity, if any, considering the following factors:

(1) The frequency of the presence of pathogens that may be associated with the activity.

(2) Method of release of the pathogen to the natural environment.

(3) Type of vulnerable area in which the activity is or would be located.

Before adding a deadstock disposal threat to the assessment report, Director's approval of the hazard rating and the risk score must be obtained. A request can be made by the SPC through the provincial liaison officer to the SPC.

Once a new threat is added, the SPC must follow the same process in the technical rules to identify where the threat is significant, moderate or low and how many significant drinking water threats exist within each vulnerable area.

Background on the new framework regulating deadstock is provided below.

NUTRIENT MANAGEMENT ACT, 2002

The NMA came into force in 2002 and enhances the protection of Ontario's water resources by minimizing the effects of livestock manure and other nutrients that are stored on farm properties or land applied. The preparation of nutrient management plans, non-agricultural source material (NASM) plans, and nutrient management strategies is a key requirement of the NMA. The NMA provides clear requirements for environmental protection for Ontario's agricultural industry, municipalities and other generators and receivers of materials that contain nutrients.

Application of the NMA for Deadstock Disposal

The regulation under the NMA sets out requirements for the disposal of dead farm animals on the farm. This regulation applies to all farm operations, regardless of the requirement to have a nutrient management strategy or plan under O. Regulation 267/03. The DDA and its regulations were repealed and replaced by the Disposal of Dead Farm Animals regulation under the NMA and the Disposal of Deadstock Regulation under the FSQA. The new regulations came into force on March 27, 2009. They provide more disposal options for livestock producers and meat plant operators, with measures that will protect the environment.

The new framework builds on the past requirements in the DADA and continues to focus on minimizing potential food safety and animal health risks while also minimizing environmental impacts and disease threats. The regulation under the NMA addresses on-farm disposal. The regulation under the FSQA addresses disposal when the animal dies at places other than the farm. Both regulations provide greater flexibility for industry in the disposal of deadstock.

The regulations set out requirements for the disposal of not only cattle, goats, sheep, horses and swine as per the DADA, but also deer, elk, alpacas, llamas, bison, yaks, donkeys, ponies, rabbits, poultry and fowl, ratites, and fur bearing animals.

The operator of the farm is responsible for disposing of the animal within 48 hours of its death, which was the requirement within the DADA. The two exceptions to this rule are:

- If a delay occurs in order to perform a post mortem on the animal, or

- If the animal is put into temporary storage conditions as specified in the regulation.

Additional disposal options for greater flexibility to manage deadstock include:

- Burial
- Incineration
- Composting
- Disposal vessels
- Collection by a licensed collector
- Anaerobic digestion
- Delivery to a waste disposal site approved under the EPA
- Delivery to a disposal facility as defined under the FSQA
- Delivery to a licensed veterinarian for post mortem and disposal.

E2 REDUCING INCONSISTENCIES IN THREAT SUBCATEGORY ENUMERATION: AGREED APPROACHES FOR ENSURING CONSISTENT STANDARDS

E2.1 Threat Subcategory Enumeration

DRINKING WATER SOURCE PROTECTION
ACT FOR CLEAN WATER

South Georgian Bay Lake Simcoe Source Protection Region

Reducing Inconsistencies in Threat Subcategory Enumeration:

Agreed approaches for ensuring consistent standards

Outcomes and decision summary

May 19th, 2010

Compiled and led by the SGBLS Region

Background

Reviews of draft technical reports completed for drinking water systems in the South Georgian Bay Lake Simcoe (SGBLS) Region revealed a number of inconsistencies in the manner that consultants enumerated significant threats. These inconsistencies would have led to difference in the way that a land use activities in one vulnerable area is classified (i.e., potential significant threat or not) compared to another if not resolved. Recognizing the importance of reducing these inconsistencies, and under the direction of SWP committee, an exercise was undertaken to ensure consistency in threats enumeration across the Region. As decisions made in the SGBLS region also affect how adjacent Regions undertake the enumeration process, participation in the process was extended to the TCC and CTC Regions

The process to establish consistent standards involved: 1) Identifying which threat subcategories the inconsistencies were occurring within; 2) Identifying why the inconsistencies were occurring; (3) Resolving the differences through a series of workshops and meeting, ranking evaluation and seeking further clarification from the Province. Due to the alternate approaches to identifying significant threats (i.e., threat specific database versus identifying land uses from the MOE Look-Up Tables (LUT)) it will never be possible to have complete consistency in identification of potential significant threats, moreover the approach taken was to ensure standardization in application of the LUT approach and the associated circumstance assumptions.

This document summarizes the decisions related to those threat subcategories identified as having larger inconsistencies.

Identifying threat subcategories with inconsistencies

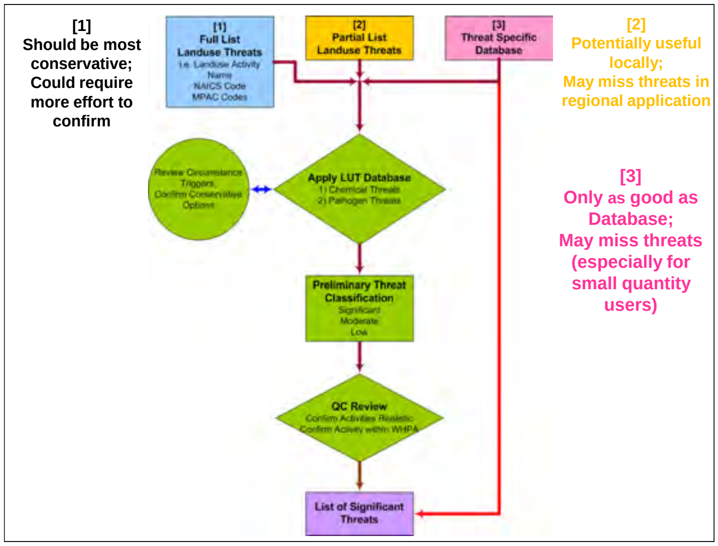
A review of draft technical reports and in discussion with various consultants the threat subcategories were classified according to the degree of inconsistence. The exercise of ensuring standard approaches focused on those threat subcategories identified as having minor and potentially larger differences. Other sources for inconsistencies arising from calculation of Managed lands and stock density have previously been resolved.

Status	Threat category / subcategory
Largely consistent	The establishment, operation or maintenance of a waste disposal site within the meaning of Part V of the Environmental Protection Act.*
	The application of agricultural source material to land.
	The storage of agricultural source material.
	The management of agricultural source material.
	The application of road salt.
	The handling and storage of road salt.
	The storage of snow.
	The use of land as livestock grazing or pasturing land, an outdoor confinement area or a farm-animal yard. O. Reg. 385/08, s. 3.
Minor difference	The application of non-agricultural source material to land.
	The handling and storage of non-agricultural source material.
	The application of commercial fertilizer to land.
	The handling and storage of commercial fertilizer.
	The application of pesticide to land.
	The handling and storage of pesticide.
Potential larger differences	The handling and storage of a dense non-aqueous phase liquid.
	The handling and storage of fuel.
	The handling and storage of an organic solvent.
	The establishment, operation or maintenance of a system that collects, stores, transmits, treats or disposes of sewage.
	Waste Disposal Site - Storage of wastes described in clauses (p), (q), (r), (s), (t) or (u) of the definition of hazardous waste

Approach

Significant threat enumeration in the region was undertaken using one of 3 approaches, these being;

1. Assigning threats by associating land use activity to threat subcategories in LUT. Full and partial list
    - Advantage: Casts wide net
    - Disadvantage: more uncertainty & false positives
2. Using specific databases (e.g., TSSA fuel) to identify threats
    - Advantage: more certainty that a threat exists and what circumstances
    - Disadvantage: chances that significant threats missed if not in database
3. Combination of the two



Based on this summary of approaches, three areas were identified as requiring standardization, these being

1) Defendable database: Ensure threat specific databases have sufficient information (i.e., do not miss potential significant threat): default to full list approach if needed
2) Consistent Lists: Ensure consistency when assigning land use activities to threat subcategories (full or partial list approach)
3) Similar circumstances: If unknown, no local knowledge

To ensure consistent standard are applied any studies in the Region need to either defend the use of threat specific database (e.g., is it reliable and up-to-date and will therefore adequately identify potential significant threats), or use the agreed upon full or partial land use activity lists and circumstances.

Identifying a consistent list of land use activities

The full list of land use activities in the MOE LUT was identified as overly conservative and would identify many land use activities as a potential significant threat, when in reality there is a very low likelihood, they would be a significant threat. To reduce the number of 'false positives' an exercise was undertaken to rationalize the LUT land use activity lists for some of the threat subcategories. The process used professional expertise of each consulting firm to rank the likelihood of the activity being a significant threat. In general, those activities ranked as "must be included" or "uncertain" were included—the uncertain category was included to be more conservative. Those activities that were consistently identified as "remove from list" were not included in the final list of activities. Final list of land use activities is appended to the end of this document. Also, in some instances it was noted that additional land use activities were missing and needed to be added.

Consistent Circumstances

In situations where circumstances for a land use activity was not known, it was agreed in general that the most conservative circumstances would be applied until further information becomes available – i.e., those circumstances that make the activity a significant threat were applied.

The following sections outline the outcomes and decisions for each subcategory.

Application of Pesticides

1) Threat specific databases:

- Not relevant to application

2) LUT land use-threat subcategories: 12 Land use Activities

LUT Land use activity (or equivalent Parcel information)	**Action**
	Include **all agricultural managed lands** - crop and **pasture** including listed below
Forest Nurseries and Gathering of Forest Products	Include nursery
Fruit and Tree Nut Farming	Include
Golf Courses and Country Clubs	Include
Greenhouse, Nursery and Floriculture Production	Include
Oilseed and Grain Farming	Include
Other Crop Farming	Include
Power Line Corridor	Data gap
Residential Lawns	**Do not Include – Pesticide ban**
Support Activities for Crop Production	Include
Transportation Corridors	Data gap
Vegetable and Melon Farming	Include
Zoos and Botanical Gardens	Include

3) Circumstance assumptions:

Threat Sub Category	Vulnerability to be Significant	Minimum Circumstances	Proposed assumptions
Application of pesticides	WHPA with VS=10	Total application area >1 ha	Agreed land use activities >1ha Assume all pesticides in tables

Notes:

- No threats specific database available, therefore need to use identified land use activities
- Use land use activities identified in above table. Sports fields and cemeteries should not be included as they are largely covered under the cosmetic pesticide Ban
- As no one has attempted to identify power line and transport corridors as a threat, they will be treated as a data gap in the current round of the Assessment Report.
- Unless local knowledge available assume following circumstance: Application of pesticide >1ha to be significant threat.

Handling and Storage of Pesticides

1) Threat specific databases:

- Threats specific database alone is not sufficient to identify all potential significant threats

2) LUT land use threat subcategories: 13 Land use Activities

LUT Land use activity (or equivalent Parcel information)	Action
	Include **All agricultural managed lands** - crop and **pasture** including listed below
Building Material and Supplies Dealers	Include
Forest Nurseries and Gathering of Forest Products	Include
Fruit and Tree Nut Farming	Include
Golf Courses and Country Clubs	Include
Greenhouse, Nursery and Floriculture Production	Include
Lawn and Garden Equipment and Supplies Stores	Include
Oilseed and Grain Farming	Include
Other Crop Farming	Include
Pesticide, Fertilizer and Other Agricultural Chemical Manufacturing	Include
Residential Homes	Do not Include – Pesticide ban
Support Activities for Crop Production	Include
Vegetable and Melon Farming	Include
Zoos and Botanical Gardens	Include

3) Circumstance assumptions:

Threat Sub Category	Vulnerability to be Significant	Minimum Circumstances	Proposed assumptions
Storage of a Pesticide	WHPA with VS=10	Activity: Manufacture, retail sale or use Quantity: 250-2500kg; >2500kg Toxicity: Type of pesticide (Mecoprop & MCPA are highest for 250-2500kg)	Assume all listed pesticides are stored >250 kg or L Use revised list of land use activities

Notes:

- Need to use identified land use activities (table above) or equivalent
- Unless local knowledge available assume following circumstance: quantity of Mecoprop & MCPA (2 common herbicides) are present in quantity >250kg or L

Handling and Storage of DNAPL

1) Threat specific databases:

- Threats specific database alone are not sufficient to identify all potential significant threats

2) LUT land use threat subcategories:

- Use revised list of land uses (see appendix)

Main LUT land use activity categories

3) Circumstance assumptions:

Threat Sub Category	Vulnerability to be Significant	Minimum Circumstances	Proposed assumptions
Handling and Storage of DNAPL	WHPA A-C1 WHPA-D VS=6)	Activity: 139 listed Quantity: any Grade: above and below	Use revised list of land use activities Any quantity

Notes:

- Threats specific database alone are not sufficient to identify all potential significant threats
- The revised list of land use activities needs to be used. Modification of list based on ranked evaluation by all consultants – see appendix

Handling and Storage of Fuel

1) Threat specific databases:

- Use available databases if defendable e.g. TSSA fuel storage locations, Ecolog (e.g. Private fuel storage 1989-1996);

2) LUT land use-threat subcategories:

- If not using databases then use revised list of land uses (see appendix)

3) Circumstance assumptions:

Threat Sub Category	Vulnerability to be Significant	Minimum Circumstances	Proposed assumptions
Handling and Storage of fuel	WHPA with VS=10	Use any combination of quality or storage location that would make threat significant (in the absence of local knowledge)	For Residential – assume 250-2500L below grade fuel storage for all residences where gas line data does not suggest gas servicing Use revised list of land use activities

Notes:

- Existing databases should be sufficient to identify significant threats. Reports will need to provide description/support that this is the case (i.e. what data is provided, how frequently updated, requirements for information to be in database)
- Land use categories: Use revised list
- Circumstances: use any combination of quality or storage location that would make threat significant (in the absence of local knowledge)
- Domestic Fuel storage:
  - Recognized that difficult to identify all potential significant threats for domestic fuel storage due to lack of available information.
  - Each WHPA with vulnerability score of 10 will be assigned a single significant threat for handling and storage of fuel under the assumption that there may be residential properties

present that have below grade storage of fuel >250L. This assumption would not be made in areas where there is a high probability that natural gas would be used as primary source of heating fuel. If not possible to determine if natural gas is available, then assume it is not, and apply single threat for WHPA VS=10.

Handling and Storage of an Organic Solvent

1) Threat specific databases:

- Use threat specific databases if they can be defended

2) LUT land use threat subcategories:

- If not using databases then use revised list of land uses (see appendix)

3) Circumstance assumptions:

Threat Sub Category	Vulnerability to be Significant	Minimum Circumstances	Proposed assumptions
Handling and Storage of organic solvent	WHPA with VS=10	Release: at, above, below grade Quantity: >25L	Use revised list of land use activities Assume >25L Below grade until actual chemicals confirmed

Notes:

- Threats specific database alone are likely not sufficient to identify all potential significant threats. If do use, then need to provide adequate supporting information;
- Land use categories: Use revised list in appendix
- Circumstances: Unless database or local knowledge available assume >25L stored below grade.

Waste Disposal Site - Storage of wastes described in clauses (p), (q), (r), (s), (t) or (u) of the definition of hazardous waste

1) Threat specific databases:

- Must use databases to identify potential significant threats (Waste generators and Waste Receivers)

2) LUT land use threat subcategories:

- Do not use LUT land use activities. Most do not have C of A for waste disposal and therefore should not be included.

3) Circumstance assumptions:

Threat Sub Category	Vulnerability to be Significant	Minimum Circumstances	Proposed assumptions
Waste Disposal Site - Storage of wastes described in clauses (p), (q), (r), (s), (t) or (u) of the definition of hazardous waste	WHPA with VS=10	Release: at, above, below grade Any quantity	Assume all activities in database significant threat unless local knowledge available

Notes: Following notes were drafted after clarification from the Province

The Province has now provided legal advice to clarify the intent of identifying significant threats under the threat subcategory: "Waste Disposal Site - Storage of wastes described in clauses (p), (q), (r), (s), (t) or (u) of the definition of hazardous waste". They will be sending an official email or technical bulletin out in relation to this matter soon, but in the meantime, here is a summary of the interpretation and direction for identifying associated threats.

1) Legally, a "Waste Disposal Site includes any waste disposal site with a C of A and waste generators". This defines what activities need to be considered under Column 1 of the Tables.
2) As these facilities may also receive small amounts of hazardous waste that they may not be approved to accept, it is necessary to determine if they are a significant threat for the chemicals circumstances under the clauses of (p), (q), (r), (s), (t) or (u) of the definition hazardous waste (Column 2 of the Tables).
3) Given that the activity would require a C of A to be considered within this threat subcategory it is not appropriate to enumerate these threats using the LUT land use activity approach. Activities that are significant threats can be identified using the "waste receivers" and "waste generators" databases.
4) Given that it is not feasible to determine if the land use activity is generating or receiving the waste in accordance with clauses (p), (q), (r), (s), (t) or (u) of the definition of hazardous waste, we must assume that all activities within the two databases are a significant threat for this threat subcategory.

Application of Commercial Fertilizer

1) **Threat specific databases:** None (based on Nutrient Unit calculation)
2) **LUT land use threat subcategories:**
    - 10 Land use Activities (agreed managed lands)
3) **Circumstance assumptions:**

Threat Sub Category	Vulnerability to be Significant	Minimum Circumstances	Proposed assumptions
Application of commercial fertilizer	WHPA with VS=10	% managed lands NU per Acre	As per Managed Lands Bulletin: Ensure 50% of residential area is managed lands

Notes:

- Ensure residential areas are identified as a significant threat if managed lands in vulnerable area exceed 80%. Assign agreed 50% area for managed lands.

Handling and Storage of Commercial Fertilizer

1) **Threat specific databases:**
    - No threat specific database available

2) LUT land use threat subcategories:

- Use revised list of land use activities in table below

Fertilizer Storage LandUseActivityName	Stantec	Burnside	Golder	Genivar	AECOM	TRCA	comment
Fertilizer Manufacturing	1	1	1	1	1	1	Include
Forest Nurseries and Gathering of Forest Products	1	1	1	1	1	1	Include
Fruit and Tree Nut Farming	1	1	1	1	1	1	Include
Golf Courses and Country Clubs	1	1	1	1	1	1	Include
Greenhouse, Nursery and Floriculture Production	1	1	1	1	1	1	Include
Oilseed and Grain Farming	1	1	1	1	1	1	Include
Other Crop Farming	1	1	1	1	1	1	Include
Residential Lawns	3	3	3	3	3	3	Exclude
Support Activities for Crop Production	1	1	1	1	1	1	Include
Timber Tract Operations	1	1	1	1	1	1	Include
Vegetable and Melon Farming	1	1	1	1	1	1	Include
Zoos and Botanical Gardens	1	1	1	1	1	1	Include
home building supply stores	1						Recommended additional land use
Hardware Stores		1	1				Recommended additional land use
Lawn and Garden Equipment and Supplies Stores		1	1				Recommended additional land use
Grocery Stores		1					Use professional judgement as to whether a particular store should be considered
Department Stores		1					
Pesticide, Fertilizer and Other Agricultural Chemical Manufacturing			1				Recommended additional land use
Building Material and Supplies Dealers			1				Recommended additional land use

3) Circumstance assumptions:

Threat Sub Category	Vulnerability to be Significant	Minimum Circumstances	Proposed assumptions
Handling and Storage of commercial fertilizer	WHPA with VS=10	Activity: Nitrogen >2500kg	Land use activities: >2500kg N stored

Notes:

- Threats specific database alone are not sufficient to identify all potential significant threats
- Use revised land use activities in table above
- Only include agriculture as a potential threat if structure/building where fertilizer may be stored is within the WHPA.
- Agreed to use 2500kg N circumstance assumption if no local information available

Application of NASM

1) Threat specific databases:

- Biosolids database should be used to identify potential significant threats

2) LUT land use threat subcategories:

- Only include activities identified in the biosolids database

LUT Land use activity (or equivalent Parcel information)	Action
Fruit and Tree Nut Farming	Include if identified in Biosolids database (quantities based on managed land %)
Golf Courses and Country Clubs	
Greenhouse, Nursery and Floriculture Production	
Oilseed and Grain Farming	
Other Crop Farming	
Septage Waste Application	
Vegetable and Melon Farming	

3) Circumstance assumptions:

Threat Sub Category	Vulnerability to be Significant	Minimum Circumstances	Proposed assumptions
Application of NASM (37)	WHPA with VS=10	Chemical: % managed land area nu/acre	Identified in biosolids database
	WHPA with VS=10	Pathogen: meat plant or sewage works	Identified in biosolids database

Notes:

- application of ASM only assigned if property identified in biosolids database

Handling and Storage of NASM

1) Threat specific databases:

- Biosolids database not likely to include sufficient information

2) LUT land use threat subcategories:

- Use land use activities identified in table below

NASM storage LandUseActivityName	Stantec	Burnside	Golder	Genivar	AECOM	[illegible]	Min Score	#1	#2	#3	Summary	Proposed action
Sewage Treatment Facilities	1	1	2	1	0	1	1	4	1	0	Majority include or not present	Include
Animal Food Manufacturing	0	0	1	1	0	1	1	3	0	0	Majority include or not present	Include
Beverage Manufacturing (excluding 312130 Wineries)	0	0	1	1	0	1	1	3	0	0	Majority include or not present	Include
Converted Paper Product Manufacturing	0	0	1	1	0	1	1	3	0	0	Majority include or not present	Include
Dairy Product Manufacturing	0		1	1	0	1	1	3	0	0	Majority include or not present	Include
Meat Product Manufacturing	0	0	1	1	0	1	1	3	0	0	Majority include or not present	Include
Other Farm Product Wholesaler-Distributors	0	2	1	1	0	1	1	3	1	0	Majority include or not present	Include
Other Food Manufacturing	0	0	1	1	2	1	1	3	1	0	Majority include or not present	Include
Pulp, Paper and Paperboard Mills	0	0	1	1	0	1	1	3	0	0	Majority include or not present	Include
Seafood Product Preparation and Packaging	0	0	1	1	0	1	1	3	0	0	Majority include or not present	Include
Sugar and Confectionary Product Manufacturing	0	0	1	1	0	1	1	3	0	0	Majority include or not present	Include
Tobacco Product Manufacturing	0	0	1	1	0	1	1	3	0	0	Majority include or not present	Include
Bakeries and Tortilla Manufacturing	0	0	1	1	0	3	1	2	0	1	Mixed	Include
Food Wholesaler-Distributor	0	0	1	1	0	3	1	2	0	1	Mixed	Include
Fruit and Vegetable Preserving and Specialty Food Manufacturing	0	0	1	1	0	3	1	2	0	1	Mixed	Include
Grain and Oilseed Milling	0	3	1	1	0	2	1	2	1	1	Mixed	Include
Grocery Stores	3	3	2	1	0	3	1	1	1	3	Majority exclude or unsure	Exclude
Municipal composting Facilities												Include

3) Circumstance assumptions:

Threat Sub Category	Vulnerability to be Significant	Minimum Circumstances	Proposed assumptions
Handling and Storage of NASM	WHPA with VS=10	Chemical: At or above grade Temporary: 0.5 to 5 T Permanent: >5 T Nitrogen	Assume Below grade storage & > 0.5 tonnes
	WHPA with VS=10	Pathogen: Meat plants	Any quantity

Notes:

- Threats specific database alone are not sufficient to identify all potential significant threats
- Assume that the facilities for these types of activities would be permanent, and therefore need greater than 5 tonne capacity to be significant. When considering if land use should be included evaluate whether it is likely to have >5 tonne permanent storage.

The establishment, operation or maintenance of a system that collects, stores, transmits, treats or disposes of sewage.

Databases: Use appropriate databases for each sub category e.g. Municipal Sanitary Serviced Areas, Sewage Treatment Plants, Stormwater Outfalls, Stormwater Catchment areas, Sanitary Service pipes

Assumptions: Use assumptions identified in the following table

Threat Sub Category	Vulnerability to be Significant	Minimum Circumstances	Proposed assumptions
Sewage System Or Sewage Works - Discharge Of Untreated Stormwater From A Stormwater Retention Pond	WHPA with VS=10	>10 acres (industrial lands) >100 acres (rural, residential)	Calculated from stormwater catchment layer or assume worst case
Sewage System Or Sewage Works - Sanitary Sewers and related pipes	WHPA with VS=10	Sanitary sewer with a conveyance of 10000 or more m3/d	**Assume one threat for each WHPA VS 10 where sanitary connections exist**
Sewage System Or Sewage Works - Septic System	WHPA with VS=10	Septic system holding tank that is subject to the Building Code.	Non-serviced properties
Sewage System Or Sewage Works - Septic System Holding Tank	WHPA with VS=10	Septic system holding tank that is subject to the Building Code.	Non-serviced properties
Sewage System Or Sewage Works - Sewage Treatment Plant Effluent Discharges (Includes Lagoons)	WHPA with VS=10	Sewage Treatment Plants that discharge treated effluent ≥17,500 m3/d on an annual average	Use discharge rates if available, if not assume highest discharge rate

Threat Sub Category	Vulnerability to be Significant	Minimum Circumstances	Proposed assumptions
Sewage System Or Sewage Works - Storage Of Sewage (E.G. Treatment Plant Tanks)	**WHPA with VS=8**	Sewage Treatment Plants that discharge treated effluent ≥2,500 m3/d and STP holding tank that is installed completely below grade, except for the access points	Use discharge rates if available, if not assume highest discharge rate and below ground

Notes:

- Agreed that in areas with municipal sewer connection one threat per WHPA VS=10 would be applied for the threat subcategory "Sewage System or Sewage Works - Sanitary Sewers and related pipes".

Final threat enumeration

- In general, each threat subcategory counted once per property, unless:
    - Consider how it may be managed in future: e.g.
        - Multiple tenants per parcel (e.g., strip mall)
- An activity identified as a significant threat under both chemical and pathogen tables counted as a single threat unless
    - Considered how they would be managed differently in future
- Threats in parcel, but outside of WHPA, can be removed unless could be applied in WHPA e.g., point source threats can be removed; application threats not
- Vacant lots and areas of future development with associated zoning are not counted as locations where an activity is or would be engaged in.

Revised list of land use activities to be considered for each threat subcategory.

Fuel storage
Aerospace Product and Parts Manufacturing
Agricultural, Construction and Mining Machinery Manufacturing
Alumina and Aluminum Production and Processing
Animal Aquaculture
Animal Food Manufacturing
Architectural and Structural Metals Manufacturing
Audio and Video Equipment Manufacturing
Automobile Dealers
Automotive Equipment Rental and Leasing
Automotive Parts, Accessories and Tire Stores
Bakeries and Tortilla Manufacturing
Basic Chemical Manufacturing
Beverage Manufacturing
Boiler, Tank and Shipping Container Manufacturing
Building Equipment Contractors

Fuel storage
Building Finishing Contractors
Building Material and Supplies Dealers
Cattle Ranching and Farming
Cement and Concrete Product Manufacturing
Charter Bus Industry
Chemical (except Agricultural) and Allied Product Wholesaler-Distributors
Clay Product and Refractory Manufacturing
Clothing Accessories and Other Clothing Manufacturing
Clothing Knitting Mills
Coating, Engraving, Heat Treating and Allied Activities
Commercial and Industrial Machinery and Equipment (except Automotive and Electronic) Repair and Maintenance
Commercial and Industrial Machinery and Equipment Rental and Leasing
Commercial and Service Industry Machinery Manufacturing
Communications Equipment Manufacturing
Community Colleges and C.E.G.E.P.s
Computer and Peripheral Equipment Manufacturing
Construction, Forestry, Mining, and Industrial Machinery, Equipment and Supplies Wholesaler-Distributors
Converted Paper Product Manufacturing
Cut and Sew Clothing Manufacturing
Cutlery and Hand Tool Manufacturing
Dairy Product Manufacturing
Deep Sea, Coastal and Great Lakes Water Transportation
Defence Services
Dry Cleaning and Laundry Services
Educational Support Services
Electric Lighting Equipment Manufacturing
Electric Power Generation, Transmission and Distribution
Electrical Equipment Manufacturing
Electronic and Precision Equipment Repair and Maintenance
Elementary and Secondary Schools
Engine, Turbine and Power Transmission Equipment Manufacturing
Fabric Mills
Farm, Lawn and Garden Machinery and Equipment Wholesaler-Distributors
Fibre, Yarn and Thread Mills
Fishing
Forest Nurseries and Gathering of Forest Products
Forging and Stamping
Foundation, Structure, and Building Exterior Contractors
Foundries
Fruit and Tree Nut Farming
Fruit and Vegetable Preserving and Specialty Food Manufacturing
Gasoline Stations
General Freight Trucking
General Medical and Surgical Hospitals
Glass Product Manufacturing from Purchased Glass
Grain and Oilseed Milling

Fuel storage
Greenhouse, Nursery and Floriculture Production
Hardware Manufacturing
Hardware Stores
Highway, Street and Bridge Construction
Hog and Pig Farming
Household and Institutional Furniture and Kitchen Cabinet Manufacturing
Household Appliance Manufacturing
Industrial Gas Manufacturing
Industrial Machinery Manufacturing
Inland Water Transportation
Interurban and Rural Bus Transportation
Iron and Steel Mills and Ferro-Alloy Manufacturing
Junk / Scrap / Salvage Yards
Land Subdivision
Lawn and Garden Equipment and Supplies Stores
Lime and Gypsum Product Manufacturing
Logging
Lumber, Millwork, Hardware and Other Building Supplies Wholesaler-Distributors
Machine Shops, Turned Product, and Screw, Nut and Bolt Manufacturing
Manufacturing and Reproducing Magnetic and Optical Media
Marinas
Meat Product Manufacturing
Medical and Diagnostic Laboratories
Medical Equipment and Supplies Manufacturing
Metalworking Machinery Manufacturing
Motor Vehicle Body and Trailer Manufacturing
Motor Vehicle Manufacturing
Motor Vehicle Parts Manufacturing
Motor Vehicle Wholesaler-Distributors
Municipal Fire-Fighting Services
Natural Gas Distribution
Navigational, Measuring, Medical and Control Instruments Manufacturing
Non-Ferrous Metal (except Aluminum) Production and Processing
Non-Metallic Mineral Mining and Quarrying
Non-residential Building Construction
Non-Scheduled Air Transportation
Office Furniture (including Fixtures) Manufacturing
Oil and Gas Extraction
Oilseed and Grain Farming
Other Ambulatory Health Care Services
Other Animal Production
Other Chemical Product Manufacturing
Other Crop Farming
Other Electrical Equipment and Component Manufacturing
Other Fabricated Metal Product Manufacturing
Other Food Manufacturing
Other Furniture-Related Product Manufacturing
Other General-Purpose Machinery Manufacturing

Fuel storage
Other Heavy and Civil Engineering Construction
Other Miscellaneous Manufacturing
Other Motor Vehicle Dealers
Other Non-Metallic Mineral Product Manufacturing
Other Personal Services (812921 - Photo Finishing Laboratories (except One-Hour)), (812922 - One-Hour Photo Finishing)
Other Pipeline Transportation
Other Recyclable Material Wholesaler-Distributors
Other Schools and Instruction
Other Specialty Trade Contractors
Other Support Activities for Air Transportation
Other Support Activities for Transportation
Other Textile Product Mills
Other Transit and Ground Passenger Transportation
Other Transportation Equipment Manufacturing
Other Wood Product Manufacturing
Paint, Coating and Adhesive Manufacturing
Personal and Household Goods Repair and Maintenance
Pesticide, Fertilizer and Other Agricultural Chemical Manufacturing
Petrochemical Manufacturing
Petroleum and Coal Product Manufacturing
Petroleum Product Wholesaler-Distributors
Pharmaceutical and Medicine Manufacturing
Pipeline Transportation of Crude Oil
Pipeline Transportation of Natural Gas
Plastic Product Manufacturing
Poultry and Egg Production
Printing and Related Support Activities
Provincial Fire-Fighting Services
Psychiatric and Substance Abuse Hospitals
Pulp, Paper and Paperboard Mills
Rail Transportation
Railroad Rolling Stock Manufacturing
Recyclable Metal Wholesaler-Distributors (e.g., Junk/Scrap/Salvage Yards)
Remediation and Other Waste Management Services
Research and Development in the Physical, Engineering and Life Sciences
Residential Building Construction
Residential Fuel / Hydrocarbon Storage
Resin, Synthetic Rubber, and Artificial and Synthetic Fibres and Filaments Manufacturing
Rubber Product Manufacturing
RV (Recreational Vehicle) Parks and Recreational Camps
Sawmills and Wood Preservation
Scenic and Sightseeing Transportation, Land
Scenic and Sightseeing Transportation, Other
Scenic and Sightseeing Transportation, Water
Scheduled Air Transportation
School and Employee Bus Transportation
Scientific Research and Development Services

Fuel storage
Seafood Product Preparation and Packaging
Semiconductor and Other Electronic Component Manufacturing
Sheep and Goat Farming
Ship and Boat Building
Soap, Cleaning Compound and Toilet Preparation Manufacturing
Specialized Freight Trucking
Specialty (except Psychiatric and Substance Abuse) Hospitals
Spring and Wire Product Manufacturing
Steel Product Manufacturing from Purchased Steel
Sugar and Confectionary Product Manufacturing
Support Activities for Air Transportation
Support Activities for Crop Production
Support Activities for Forestry
Support Activities for Mining and Oil and Gas Extraction
Support Activities for Rail Transportation
Support Activities for Road Transportation
Support Activities for Water Transportation
Taxi and Limousine Service
Technical and Trade Schools
Textile and Fabric Finishing and Fabric Coating
Textile Furnishings Mills
Timber Tract Operations
Tobacco Manufacturing
Universities
Urban Transit Systems
Used Motor Vehicle Parts and Accessories Wholesaler-Distributors
Utility System Construction
Vegetable and Melon Farming
Veneer, Plywood and Engineered Wood Product Manufacturing
Ventilation, Heating, Air-Conditioning, and Commercial Refrigeration Equipment Manufacturing
Warehousing and Storage
Waste Collection
Waste Treatment and Disposal
Water, Sewage and Other Systems

DNAPLS
Aerospace Product and Parts Manufacturing
Agricultural, Construction and Mining Machinery Manufacturing
Alumina and Aluminum Production and Processing
Animal Food Manufacturing
Architectural and Structural Metals Manufacturing
Audio and Video Equipment Manufacturing
Automobile Dealers
Automotive Parts, Accessories and Tire Stores
Automotive Repair and Maintenance
Bakeries and Tortilla Manufacturing

DNAPLS
Basic Chemical Manufacturing
Beverage Manufacturing
Boiler, Tank and Shipping Container Manufacturing
Building Material and Supplies Dealers
Cement and Concrete Product Manufacturing
Charter Bus Industry
Coating, Engraving, Heat Treating and Allied Activities
Commercial and Industrial Machinery and Equipment (except Automotive and Electronic) Repair and Maintenance
Commercial and Service Industry Machinery Manufacturing
Communications Equipment Manufacturing
Community Colleges and C.E.G.E.P.s
Computer and Peripheral Equipment Manufacturing
Converted Paper Product Manufacturing
Cutlery and Hand Tool Manufacturing
Dairy Product Manufacturing
Dry Cleaning and Laundry Services
Electric Lighting Equipment Manufacturing
Electric Power Generation, Transmission and Distribution
Electrical Equipment Manufacturing
Electronic and Precision Equipment Repair and Maintenance
Engine, Turbine and Power Transmission Equipment Manufacturing
Forging and Stamping
Foundries
Fruit and Vegetable Preserving and Specialty Food Manufacturing
Gasoline Stations
General Freight Trucking
General Medical and Surgical Hospitals
Grain and Oilseed Milling
Hardware Manufacturing
Household and Institutional Furniture and Kitchen Cabinet Manufacturing
Household Appliance Manufacturing
Industrial Machinery Manufacturing
Interurban and Rural Bus Transportation
Iron and Steel Mills and Ferro-Alloy Manufacturing
Lawn and Garden Equipment and Supplies Stores
Machine Shops, Turned Product, and Screw, Nut and Bolt Manufacturing
Manufacturing and Reproducing Magnetic and Optical Media
Marinas
Meat Product Manufacturing
Medical and Diagnostic Laboratories
Medical Equipment and Supplies Manufacturing
Metalworking Machinery Manufacturing
Motor Vehicle Body and Trailer Manufacturing
Motor Vehicle Manufacturing
Motor Vehicle Parts Manufacturing
Natural Gas Distribution
Navigational, Measuring, Medical and Control Instruments Manufacturing

DNAPLS
Non-Ferrous Metal (except Aluminum) Production and Processing
Non-Scheduled Air Transportation
Office Furniture (including Fixtures) Manufacturing
One-Hour Photo Finishing
Other Chemical Product Manufacturing
Other Electrical Equipment and Component Manufacturing
Other Fabricated Metal Product Manufacturing
Other Food Manufacturing
Other Furniture-Related Product Manufacturing
Other General-Purpose Machinery Manufacturing
Other Heavy and Civil Engineering Construction
Other Miscellaneous Manufacturing
Other Motor Vehicle Dealers
Other Personal Services (812921 - Photo Finishing Laboratories (except One-Hour)), (812922 - One-Hour Photo Finishing)
Other Professional, Scientific and Technical Services
Other Schools and Instruction
Other Support Activities for Air Transportation
Other Transit and Ground Passenger Transportation
Other Transportation Equipment Manufacturing
Other Wood Product Manufacturing
Paint, Coating and Adhesive Manufacturing
Personal and Household Goods Repair and Maintenance
Pesticide, Fertilizer and Other Agricultural Chemical Manufacturing
Petroleum and Coal Product Manufacturing
Pharmaceutical and Medicine Manufacturing
Photo Finishing Laboratories (except One-Hour)
Photographic Services
Plastic Product Manufacturing
Printing and Duplicating
Pulp, Paper and Paperboard Mills
Rail Transportation
Railroad Rolling Stock Manufacturing
Recyclable Metal Wholesaler-Distributors (e.g., Junk/Scrap/Salvage Yards)
Research and Development in the Physical, Engineering and Life Sciences
Resin, Synthetic Rubber, and Artificial and Synthetic Fibres and Filaments Manufacturing
Rubber Product Manufacturing
Sawmills and Wood Preservation
Scheduled Air Transportation
Scientific Research and Development Services
Seafood Product Preparation and Packaging
Semiconductor and Other Electronic Component Manufacturing
Ship and Boat Building
Soap, Cleaning Compound and Toilet Preparation Manufacturing
Specialized Freight Trucking
Spring and Wire Product Manufacturing
Steel Product Manufacturing from Purchased Steel
Sugar and Confectionary Product Manufacturing

DNAPLS
Support Activities for Air Transportation
Support Activities for Rail Transportation
Technical and Trade Schools
Tobacco Manufacturing
Universities
Urban Transit Systems
Utility System Construction
Veneer, Plywood and Engineered Wood Product Manufacturing
Ventilation, Heating, Air-Conditioning, and Commercial Refrigeration Equipment Manufacturing
Waste Collection

Solvents
Dry Cleaning and Laundry Services
Audio and Video Equipment Manufacturing
Basic Chemical Manufacturing
Communications Equipment Manufacturing
Computer and Peripheral Equipment Manufacturing
Electrical Equipment Manufacturing
Other Chemical Product Manufacturing
Other Electrical Equipment and Component Manufacturing
Pharmaceutical and Medicine Manufacturing
Resin, Synthetic Rubber, and Artificial and Synthetic Fibres and Filaments Manufacturing
Rubber Product Manufacturing
Electric Lighting Equipment Manufacturing
Fruit and Vegetable Preserving and Specialty Food Manufacturing
Household Appliance Manufacturing
Industrial Injection / Waste Disposal Wells
Leather and Hide Tanning and Finishing
Manufacturing and Reproducing Magnetic and Optical Media
Meat Product Manufacturing
Navigational, Measuring, Medical and Control Instruments Manufacturing
Other Leather and Allied Product Manufacturing
Pesticide, Fertilizer and Other Agricultural Chemical Manufacturing
Petroleum and Coal Product Manufacturing
Pulp, Paper and Paperboard Mills
Semiconductor and Other Electronic Component Manufacturing
Soap, Cleaning Compound and Toilet Preparation Manufacturing
Converted Paper Product Manufacturing
Bakeries and Tortilla Manufacturing
Beverage Manufacturing
Seafood Product Preparation and Packaging
Sugar and Confectionary Product Manufacturing
Tobacco Manufacturing
Funeral Services
Machine Shops, Turned Product, and Screw, Nut and Bolt Manufacturing
Other Personal Services (812921 - Photo Finishing Laboratories (except One-Hour)), (812922 - One-Hour Photo Finishing)
General Medical and Surgical Hospitals

Solvents
Other Fabricated Metal Product Manufacturing
Other Food Manufacturing
Paint, Coating and Adhesive Manufacturing
Plastic Product Manufacturing
Printing and Related Support Activities
Fabric Mills
General Freight Trucking
Interurban and Rural Bus Transportation
Medical and Diagnostic Laboratories
Other Professional, Scientific and Technical Services (541940 - Veterinary Services)
Other Textile Product Mills
Other Wood Product Manufacturing (321991 - Manufactured (Mobile) Home Manufacturing)
Sawmills and Wood Preservation
Scientific Research and Development Services
Specialized Freight Trucking
Textile and Fabric Finishing and Fabric Coating
Textile Furnishings Mills
Urban Transit Systems
Veneer, Plywood and Engineered Wood Product Manufacturing
Coating, Engraving, Heat Treating and Allied Activities
Dairy Product Manufacturing
Grain and Oilseed Milling
Other Support Activities for Transportation
Other Transit and Ground Passenger Transportation
Scenic and Sightseeing Transportation, Land
Scenic and Sightseeing Transportation, Other
Support Activities for Road Transportation
Cut and Sew Clothing Manufacturing (315292 - Fur and Leather Clothing Manufacturing)
Fibre, Yarn and Thread Mills
Charter Bus Industry
School and Employee Bus Transportation
Taxi and Limousine Service
Rail Transportation

E2.2 Ecolog Eris: Individual Source for each Database

EcoLog Environmental Risk Information Services Ltd. (EcoLog ERIS) is a national database service, which provides specific environmental and real estate information for locations across Canada. A review of all available provincial, federal, and private environmental databases was requested for the area comprising the WHPA for each of the wells included in the current study. The search included the following databases:

Federal Government Source Databases

- National PCB Inventory 1988-June 2004
- National Pollutant Release Inventory 1994-2004
- Environmental Issues Inventory System 1992-2001

- Federal Convictions 1988-January 2002
- Contaminated Sites on Federal Land June 2000-2005
- Environmental Effects Monitoring 1992-2004
- Fisheries & Oceans Fuel Tanks 1964-September 2003
- Indian & Northern Affairs Fuel Tanks 1950-August 2003
- National Analysis of Trends in Emergencies System (NATES) 1974-1994
- National Defence & Canadian Forces Fuel Tanks Up to May 2001
- National Defence & Canadian Forces Spills March 1999-February 2005
- National Defence & Canadian Forces Waste Disposal Sites 2001,2003
- National Environmental Emergencies System (NEES) 1974-2003
- Parks Canada Fuel Storage Tanks 1920-January 2005
- Transport Canada Fuel Storage Tanks 1970-May 2003

Provincial Government Source Databases

- Certificates of Approval 1985-September 2002
- Ontario Regulation 347 Waste Generators Summary 1986-2004
- Ontario Regulation 347 Waste Receivers Summary 1986-2004
- Private Fuel Storage Tanks 1989-1996
- Ontario Inventory of PCB Storage Sites 1987-April 2003
- Compliance and Convictions 1989-2002
- Waste Disposal Sites – MOE CA Inventory 1970-September 2002
- Waste Disposal Sites – MOE 1991 Historical Approval Inventory Up to October 1990
- Occurrence Reporting Information System 1988-2002
- Pesticide Register 1988-August 2003
- Wastewater Discharger Registration Database 1990-1998
- Coal Gasification Plants 1987, 1988
- Non-Compliance Reports 1992(water only), 1994-2003
- Ministry Orders 1995-1996
- Aggregate Inventory Up to May 2005
- Abandoned Aggregate Inventory Up to September 2002

- Abandoned Mines Inventory System 1800-2005
- Record of Site Condition 1997-September 2001
- Ontario Oil and Gas Wells (1999-Oct 2004; 1800-May 2004 available for 14 select counties)
- Drill Holes 1886-2005
- Mineral Occurrences 1846-October 2004
- Environmental Registry 1994-July 2003

Private Sources Databases

- Retail Fuel Storage Tanks 1989-June 2005
- Canadian Pulp and Paper 1999, 2002, 2004, 2005
- Andersen's Waste Disposal Sites 1930-2004
- Scott's Manufacturing Directory 1992-2005
- Chemical Register 1992,1999-June 2005
- Canadian Mine Locations 1998-2005
- Oil and Gas Wells October 2001-2005
- Automobile Wrecking & Supplies 2001-June 2005
- Anderson’s Storage Tanks 1915-1953
- ERIS Historical Searches, March 1999-2000

E3 ASSESSMENT OF THREATS TO GROUNDWATER, DUFFERIN COUNTY, WELLINGTON COUNTY, AND PEEL REGION

E3.1 Methodology for Calculating Managed Land Percentage

Percent managed lands were calculated via the methodology recommended by the MOECC Technical Bulletin and detailed in **Appendix E1**. Input data included aerial photography and satellite imagery along with GIS and MPAC data.

Step 1: Determining Parts of Parcels that were within the WHPA

Within each WHPA the MPAC property layer was overlaid over the WHPAs and all the properties that fell entirely or partially within the WHPA were selected for assessment. Using GIS capabilities, the area of each parcel that only fell within the WHPA was determined.

Step 2: Removal of Natural Areas (not subject to land management)

The GIS layers for wooded areas, wetlands, and drainage (polygons determining spatial extent, not just linear location) were used to determine the extent of these land uses and were removed from the combined the areas created in the GIS process in Step 1.

Step 3: Determining Agricultural and Non-Agricultural Managed Lands

Agricultural managed lands (AML) were identified within the WHPAs through air photo interpretation and the field windshield surveys. AML includes cropland, improved pasture, and fallow. The land area of these agricultural lands was summed then calculated as a percentage of the WHPA.

Non-agricultural managed lands include golf courses (turf), sports fields, lawns (turf), and other built-up grassed areas that may receive nutrients (primarily commercial fertilizer). Non-agricultural managed lands (NAML) were also identified through air photo interpretation, field windshield surveys and MPAC data.

All residential lands were assumed to be 50% managed lands per parcel. The area of residential parcels was multiplied by 0.5 to determine the amount of NAML in each parcel. Parks or other open green space that were interpreted as turf or grass were all assumed to have commercial fertilizers applied and thus defined as non-agricultural managed lands.

The sum of all the NAML areas within the parcels intersecting the WHPA was divided by the total area of the parcels intersecting the WHPA to get the percentage of NAML.

Step 4: Total Managed Lands

The area of NAML and the area of AML from Step 3 were summed then divided by the total area of the WHPA to get the percentage of managed lands.

Table E3-1: Managed Lands – Town of Orangeville WHPAs

Well Field	WHPA	Managed Lands (ha)	% Managed Lands	% Agricultural Managed Lands	% Non - Agricultural Managed Lands
Well 2A, 5/5A, 7 & 9A/9B	WHPA-A	1.7	13.6%	0.0%	13.6%
	WHPA-B	277.8	55.9%	48.0%	7.9%
	WHPA-C	99.6	54.5%	53.5%	1.0%
	WHPA-D	N/A	N/A	N/A	N/A
	WHPA-E	17.5	20.3%	11.8%	8.5%
Well 6 & 11	WHPA-A	0.9	14.5%	0.0%	14.5%
	WHPA-B	139.7	29.1%	9.1%	20.0%
	WHPA-C	117.2	59.5%	55.5%	4.0%
	WHPA-D	N/A	N/A	N/A	N/A
Well 8B/8C & 12	WHPA-A	3.9	36.0%	31.8%	4.2%
	WHPA-B	240.7	66.3%	64.7%	1.6%
	WHPA-C	55.3	88.8%	87.0%	1.8%
	WHPA-D	N/A	N/A	N/A	N/A
	WHPA-E	6.1	26.4%	21.3%	5.1%
Well 10	WHPA-A	0.5	14.6%	5.3%	9.3%
	WHPA-B	108.5	62.8%	59.6%	3.2%
	WHPA-C	247.0	70.7%	69.4%	1.3%
	WHPA-D	400.9	71.7%	70.6%	1.1%
	WHPA-E	76.2	30.6%	25.8%	4.8%

N/A – denotes area not evaluated since vulnerability score is less than 6

Table E3-2: Managed Lands – Town of Mono WHPAs

Well Field	WHPA	Managed Lands (ha)	% Managed Lands	% Agricultural Managed Lands	% Non - Agricultural Managed Lands
Cardinal Woods	WHPA-A	1.5	17.9%	0.0%	17.9%
	WHPA-B	115.8	55.9%	51.3%	4.5%
	WHPA-C	65.0	69.6%	58.8%	10.8%
	WHPA-D	N/A	N/A	N/A	N/A
	WHPA-E	35.6	44.9%	42.5%	2.4%
Coles Wells	WHPA-A	0.0	0.0%	0.0%	0.0%
	WHPA-B	18.6	61.8%	58.6%	3.3%
	WHPA-C	9.4	74.7%	74.7%	0.0%
	WHPA-D	N/A	N/A	N/A	N/A
Island Lake	WHPA-A	0.9	28.0%	27.3%	0.7%
	WHPA-B	36.2	61.0%	39.5%	21.5%
	WHPA-C	45.4	57.2%	51.3%	5.8%
	WHPA-D	9.1	76.5%	76.5%	0.0%

Table E3-3: Managed Lands – Pullen Well

WHPA	Managed Lands (ha)	% Managed Lands	% Agricultural Managed Lands	% Non - Agricultural Managed Lands
WHPA-A	0.0	0.0%	0.0%	0.0%
WHPA-B	79.5	97.8%	97.8%	0.0%
WHPA-C	N/A	N/A	N/A	N/A
WHPA-D	N/A	N/A	N/A	N/A

N/A - denotes area not evaluated since vulnerability score less than 6

Table E3-4: Managed Lands – Region of Peel WHPAs

Well Field	WHPA	Managed Lands (ha)	% Managed Lands	% Agricultural Managed Lands	% Non - Agricultural Managed Lands
Alton Wells 3 & 4A	WHPA A	3.6	7.2%	0.0%	12.6%
	WHPA B	19.9	12.1%	0.0%	18.3%
	WHPA C	75.6	54.7%	0.9%	14.2%
	WHPA D	N/A	N/A	N/A	N/A
	WHPA E	435.2	33.1%	18.7%	13.3%
Caledon Village Well 3	WHPA A	0.0	0.0%	0.0%	0.0%
	WHPA B	0.0	0.0%	0.0%	0.0%
	WHPA C	0.0	0.0%	0.0%	0.0%
	WHPA D	N/A	N/A	N/A	N/A
	WHPA E	0.0	0.0%	0.0%	0.0%
Caledon Village Well 4	WHPA A	0.0	0.6%	0.0%	0.6%
	WHPA B	0.5	3.1%	0.0%	3.1%
	WHPA C	13.2	56.0%	0.0%	56.0%
	WHPA D	N/A	N/A	N/A	N/A
	WHPA E	36.9	19.7%	18.0%	1.7%
Cheltenham Wells 1 & 2	WHPA A	2.5	79.6%	32.2%	47.5%
	WHPA B	4.8	89.1%	76.1%	12.9%
	WHPA C	14.5	91.2%	91.1%	0.1%
	WHPA D	N/A	N/A	N/A	N/A
Inglewood Well 3	WHPA A	0.1	7.0%	7.0%	0.0%
	WHPA B	0.6	11.7%	5.4%	6.4%
	WHPA C	5.5	46.2%	41.3%	4.8%
	WHPA D	N/A	N/A	N/A	N/A
Inglewood Well 4	WHPA A	0	0%	0%	0%
	WHPA B	0	0%	0%	0%
	WHPA C	56	4%	4%	0%
	WHPA D	N/A	N/A	N/A	

N/A - denotes area not evaluated since vulnerability score less than 6

Orangeville

Based on the criteria thresholds and the results, there are no significant managed lands threats in Orangeville, except in the following WHPAs:

- Wells 8B/8C, & 12—WHPA-C

Mono

Based on the criteria thresholds and the results, there are no significant managed lands threats.

Amaranth

Based on the criteria thresholds and the results, there are no significant managed lands threats.

Caledon (Peel)

Based on the criteria thresholds and the results, there are no significant managed lands threats, except in the following WHPAs:

- Cheltenham: Wells 1 & 2—WHPA-A, WHPA-B, and WHPA-C

Percentage managed lands in Orangeville, Mono, Amaranth and Caledon (Peel) are shown in the following figures.

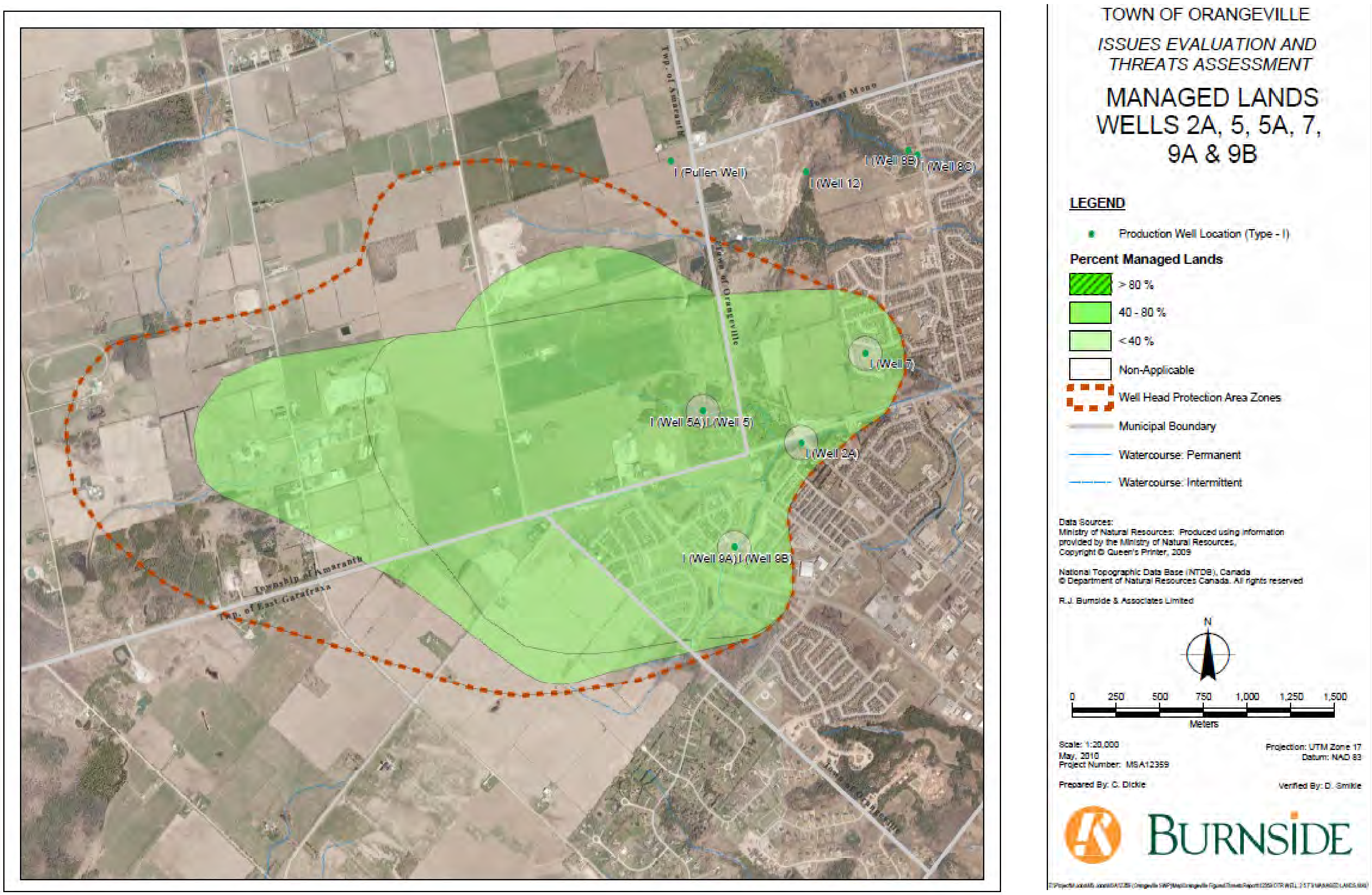


Figure E3-1: Percent Managed Land – Orangeville Wells 2A, 5, 5A, 7, 9A & 9

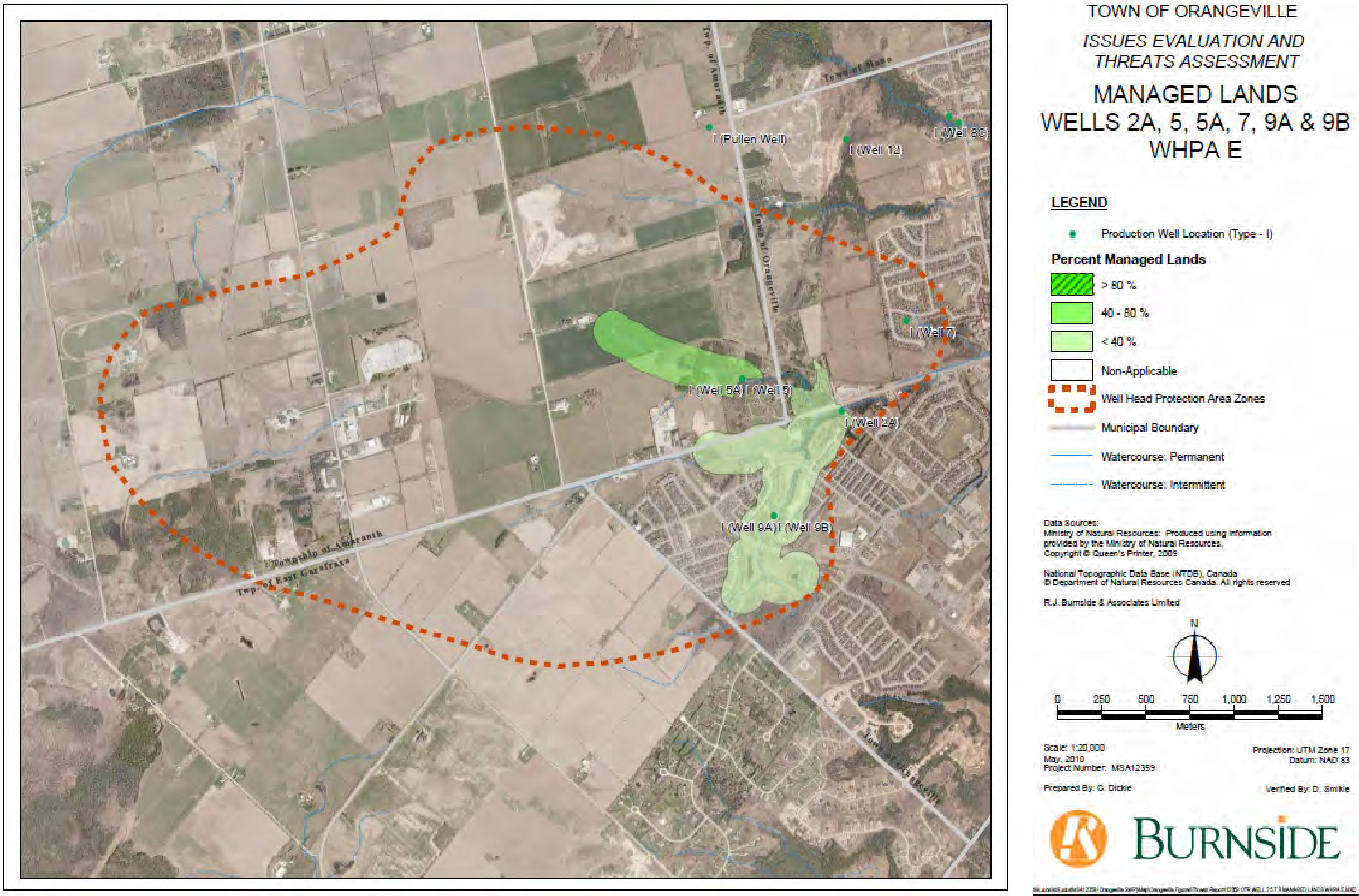


Figure E3-2: Percent Managed Land – WHPA E, Orangeville Wells 5, 5A,9A & 9B

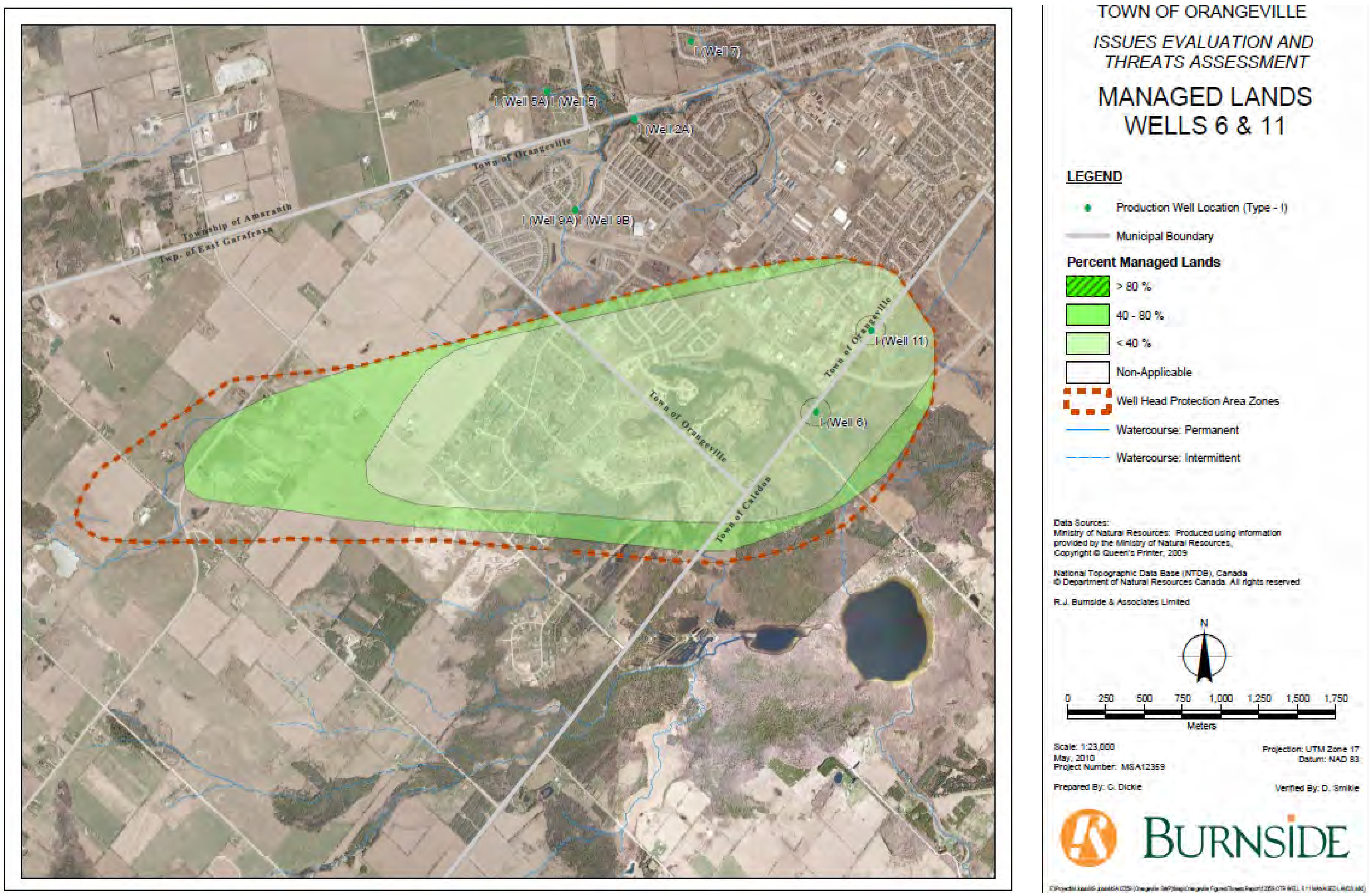


Figure E3-3: Percent Managed Land - Orangeville Wells 6 and 11

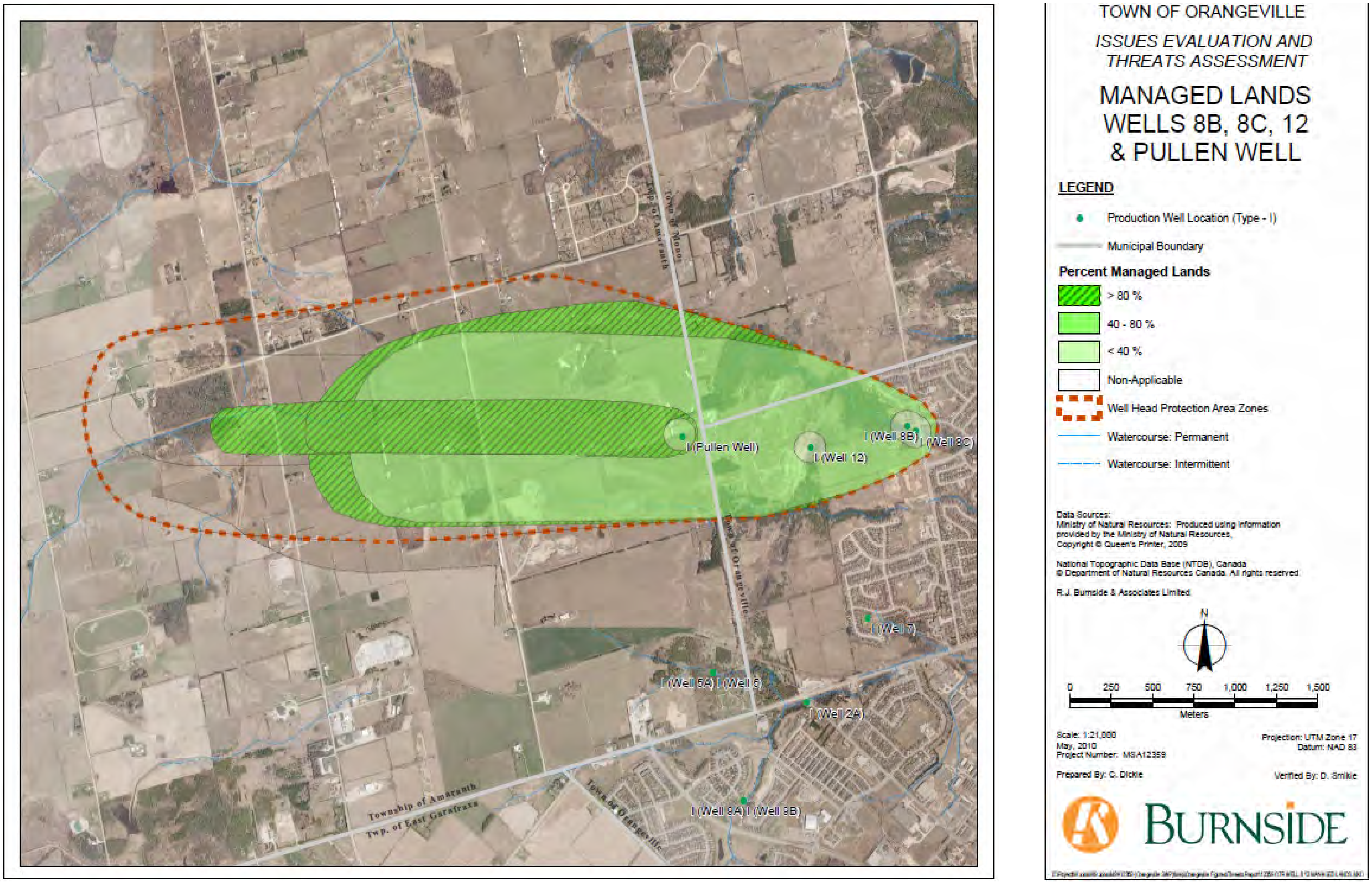


Figure E3-4: Percent Managed Land – Orangeville Wells 8B, 8C, 12 and Pullen Well

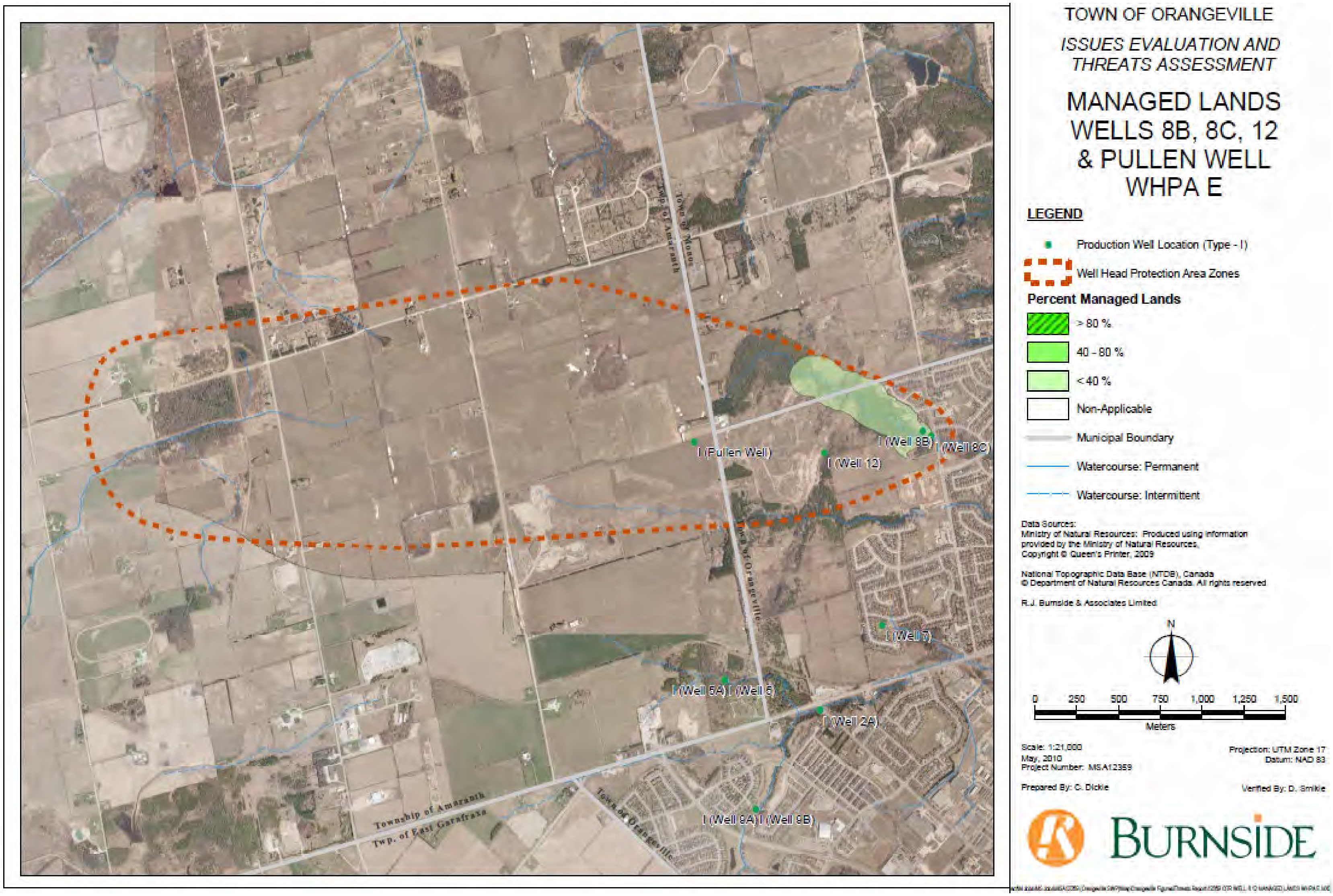


Figure E3-5: Percent Managed Land – WHPA E, Orangeville Wells 8B

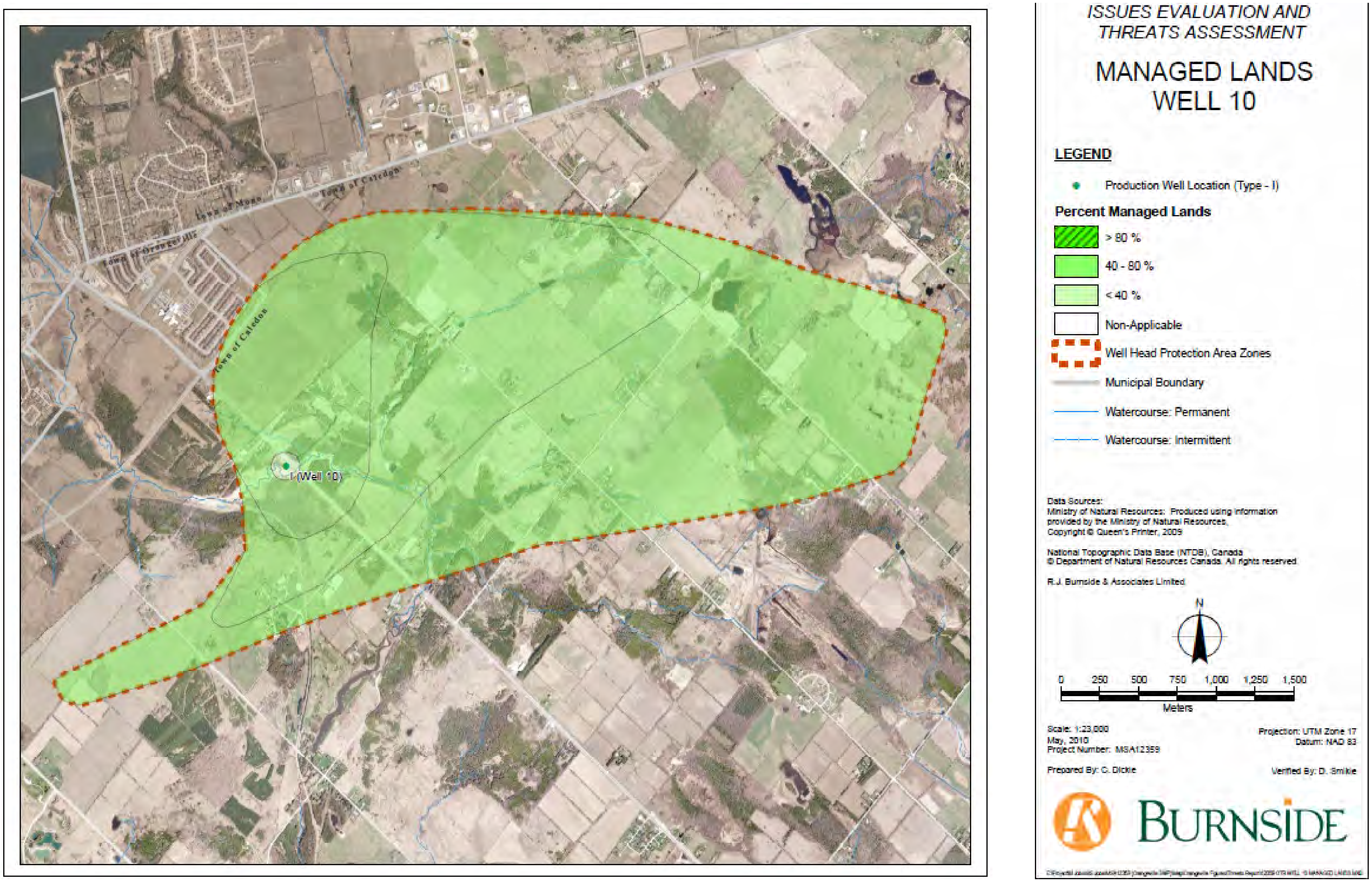


Figure E3-6: Percent Managed Land – Orangeville Well 10

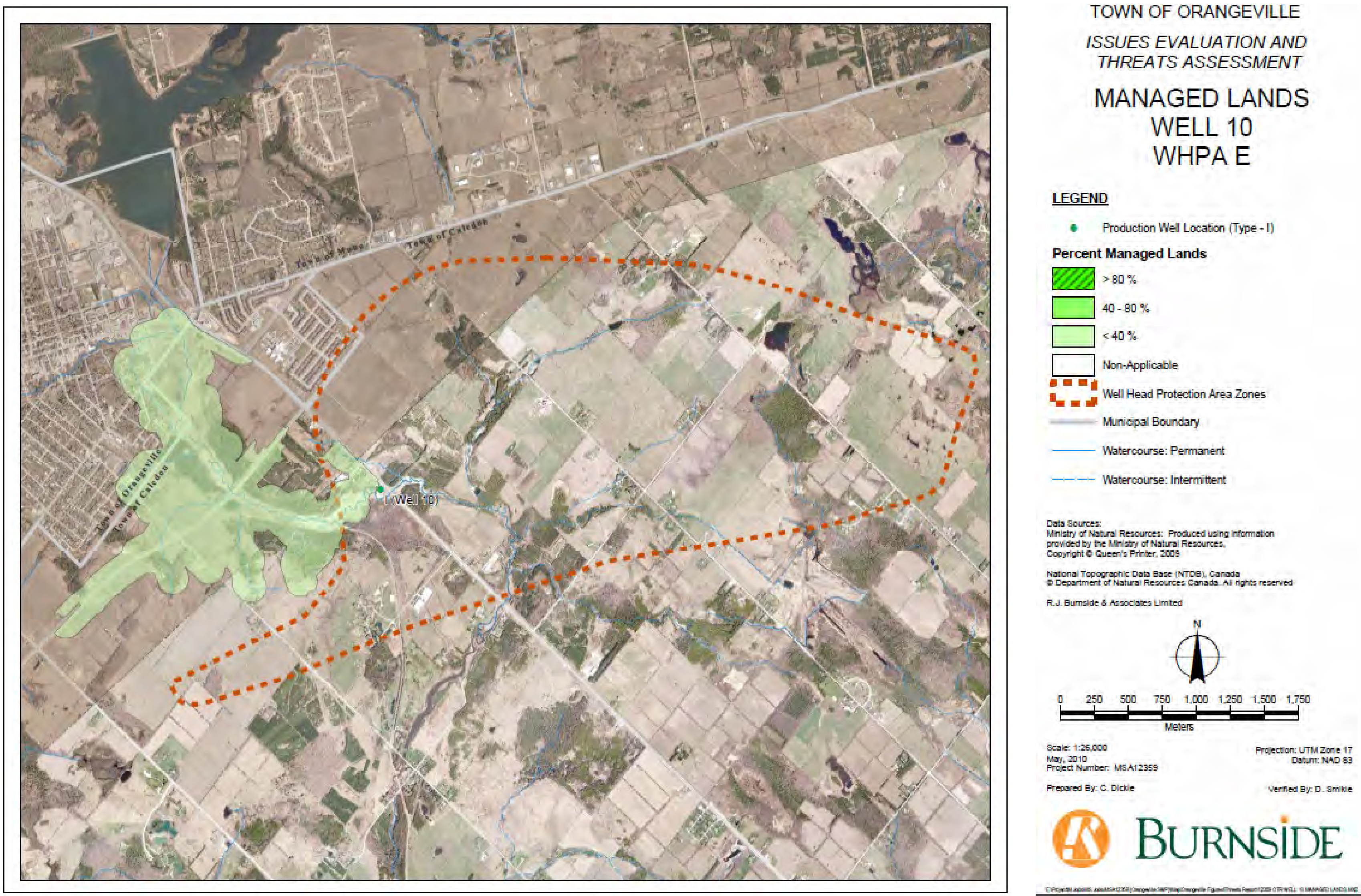


Figure E3-7: Percent Managed Land – WHPA E, Orangeville Well 10

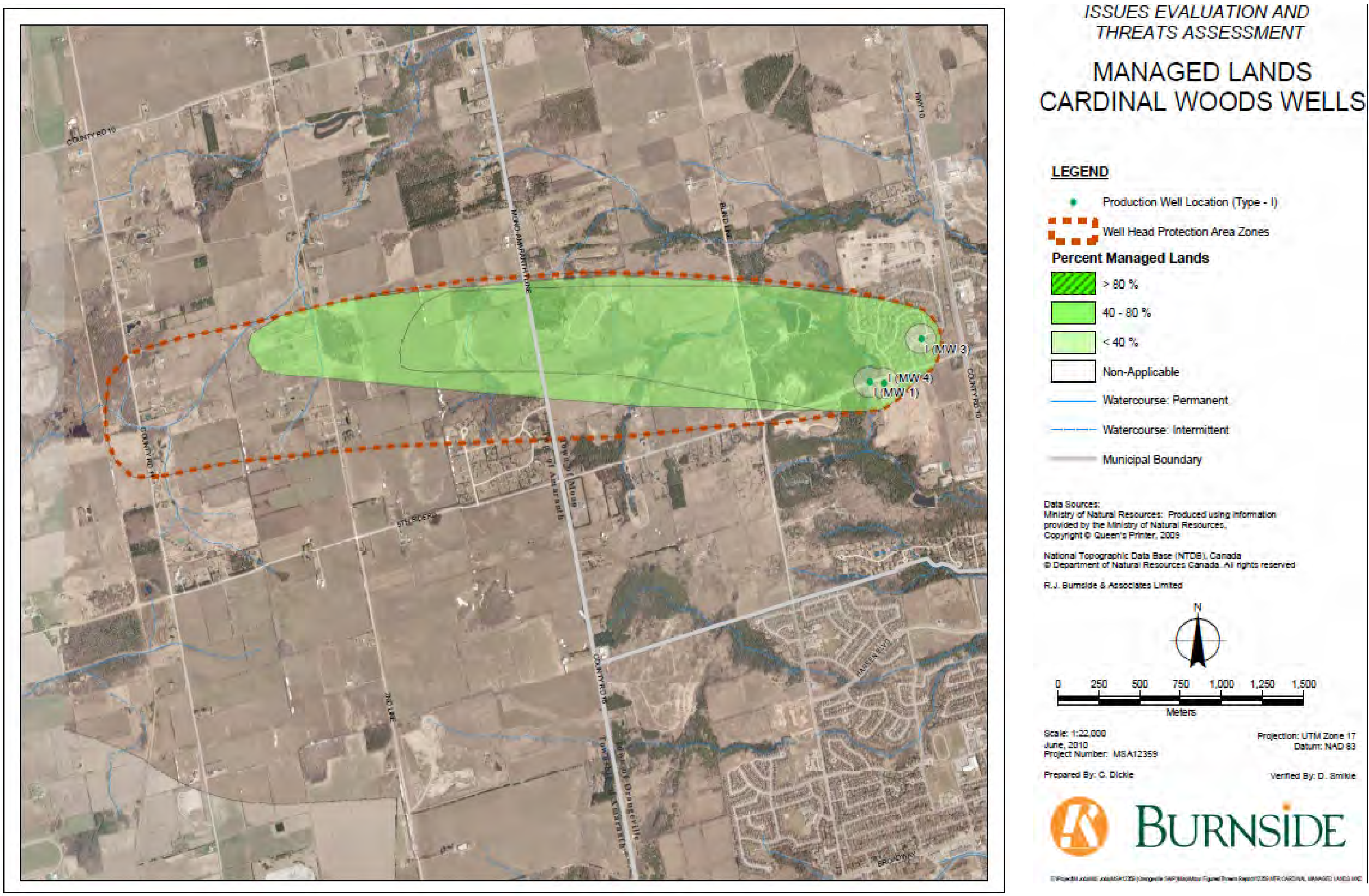


Figure E3-8: Percent Managed Land – Cardinal Woods, Mono

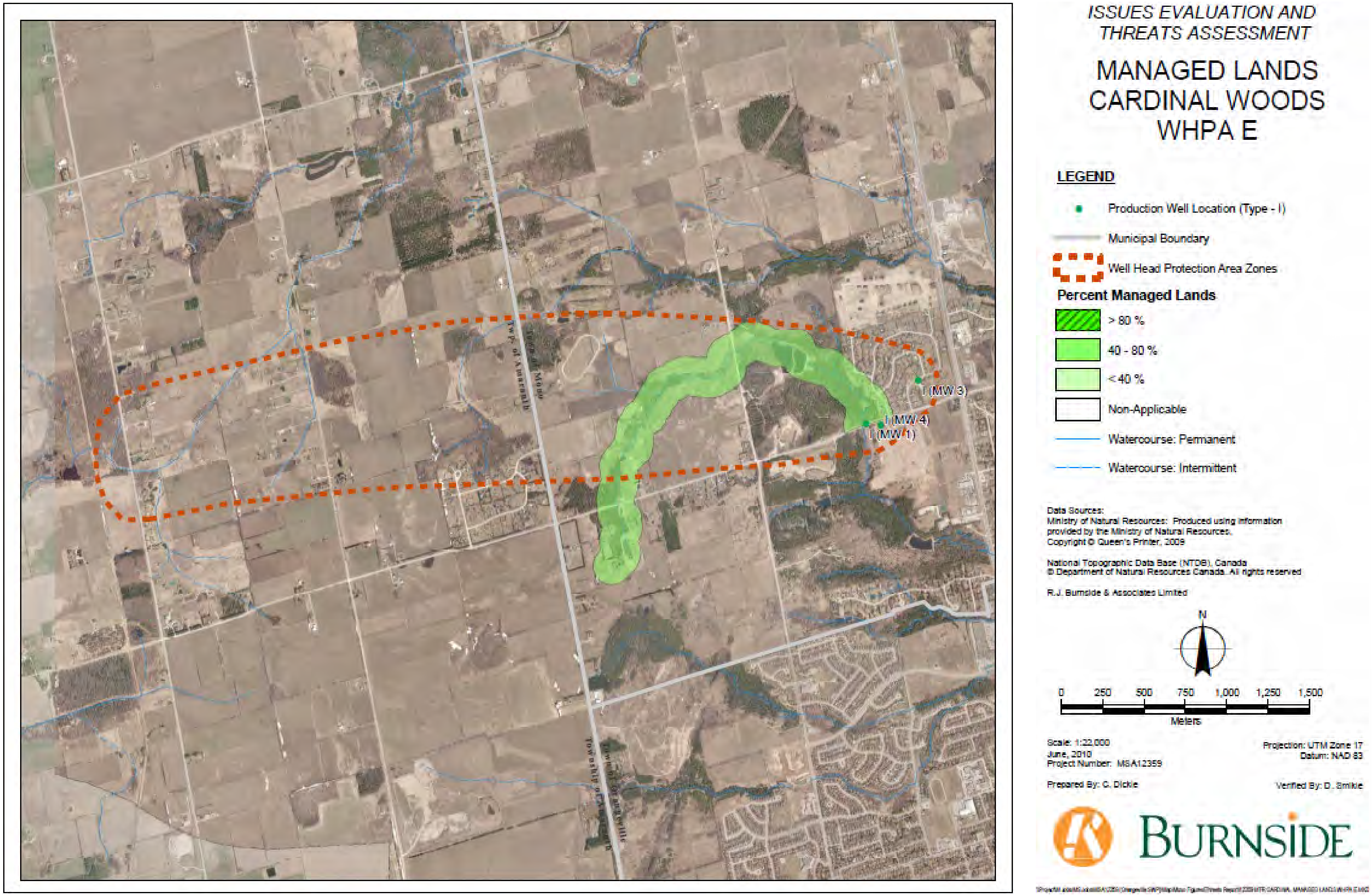


Figure E3-9: Percent Managed Land – WHPA-E, – Cardinal Woods, Mono

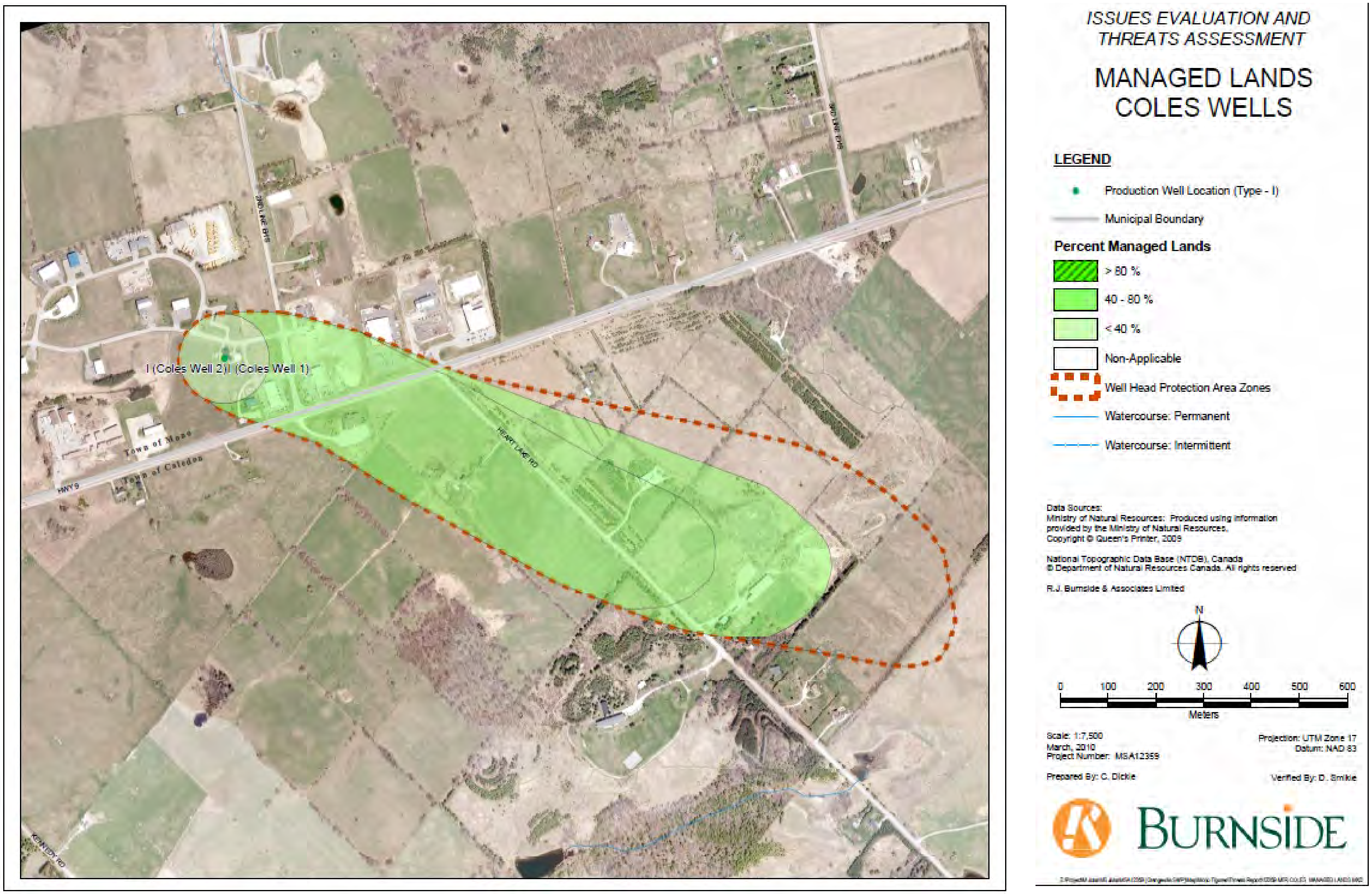


Figure E3-10: Percent Managed Land – Coles, Mono

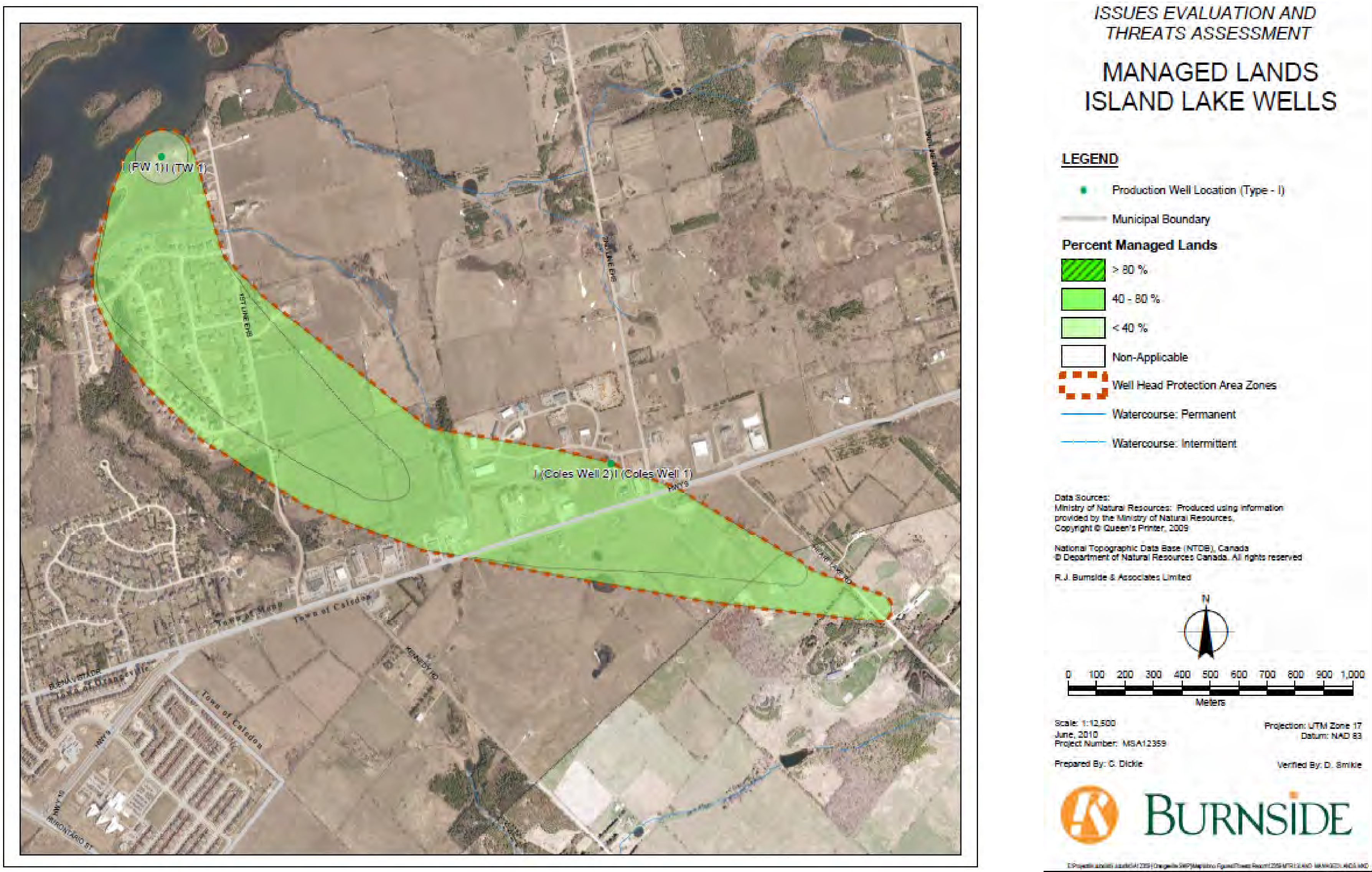


Figure E3-11: Percent Managed Land – Island Lake, Mono

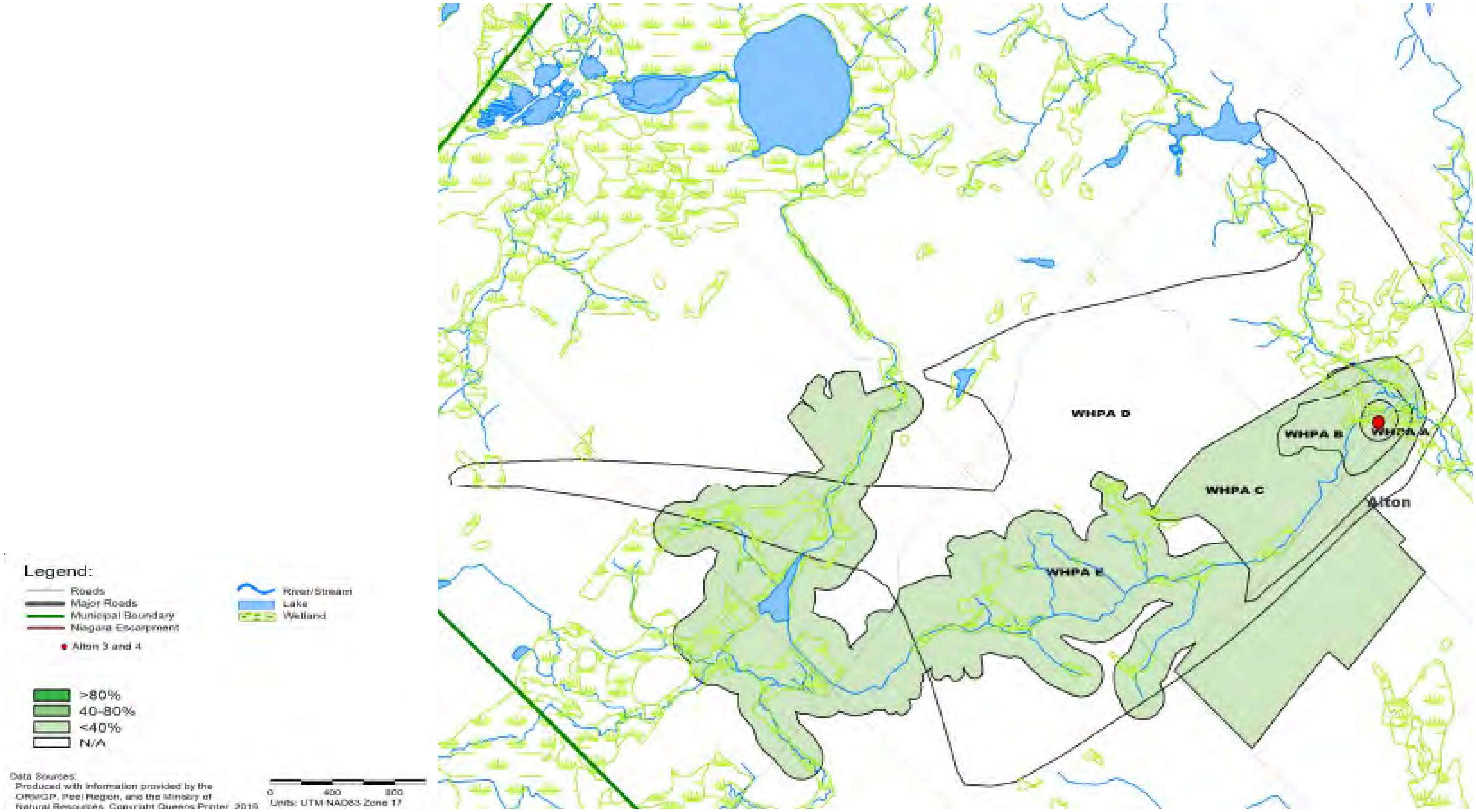


Figure E3-12: Percent Managed Land – Alton Wellfield, Caledon (EarthFx and GeoKamp Ltd., 2019)

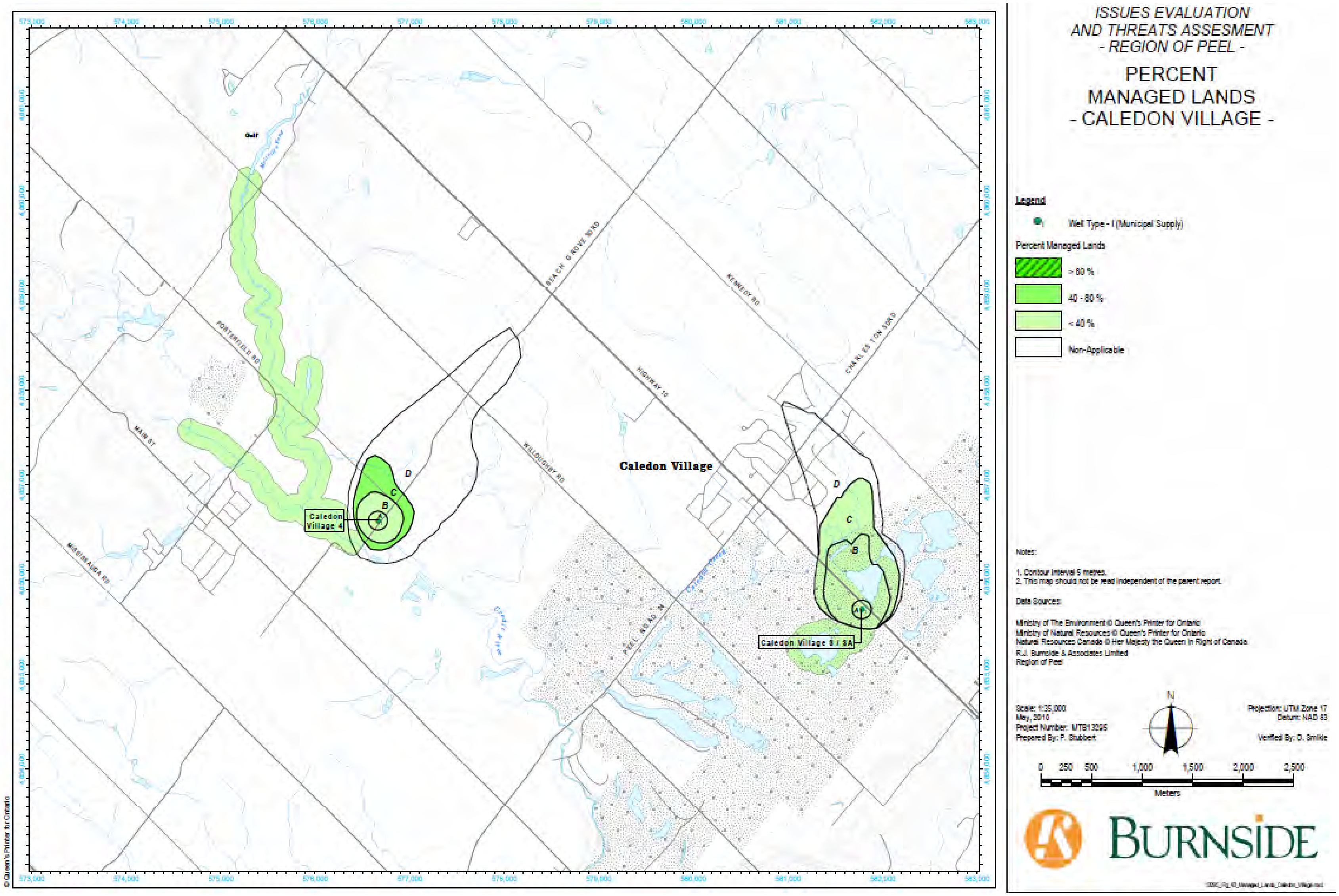


Figure E3-12: Percent Managed Land – Caledon Village Wellfield, Caledon

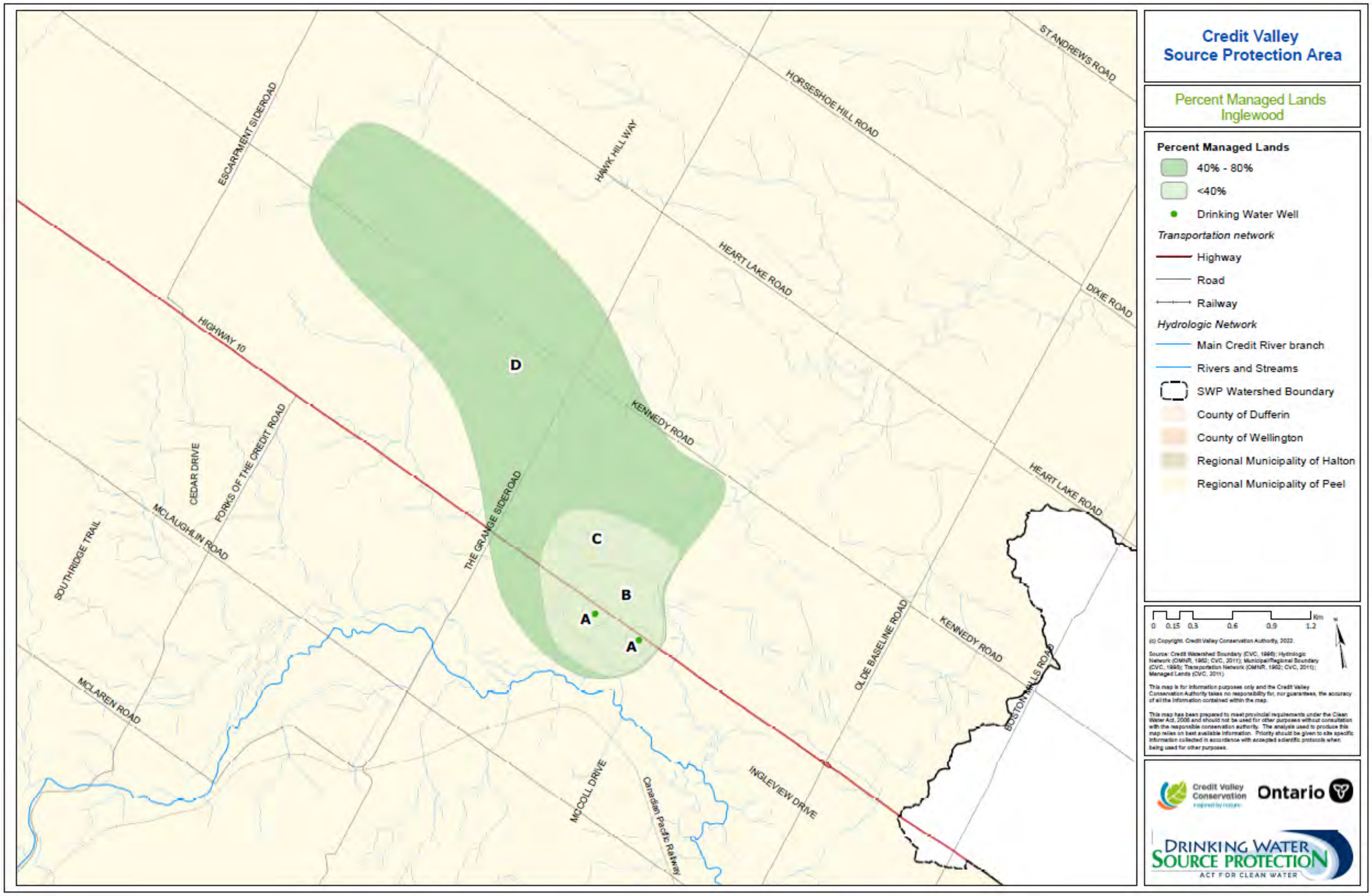


Figure E3-13: Percent Managed Land – Inglewood, Caledon

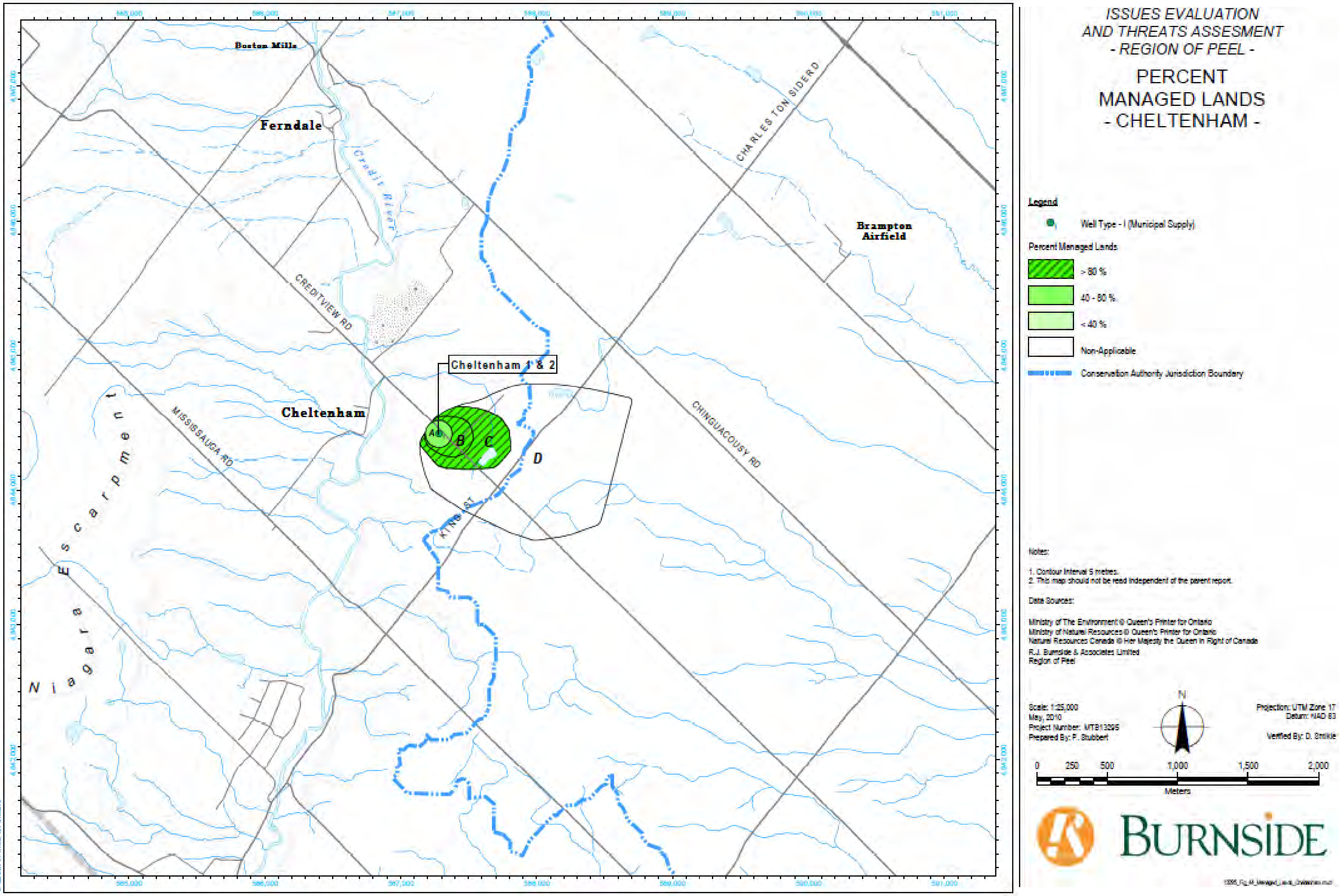


Figure E3-14: Percent Managed Land – Cheltenham, Caledon

E3.2 Methodology for Calculating Livestock Density

Livestock density is calculated via the methodology recommended by the MOECC Technical Bulletin and detailed in **Appendix E1**. Input data included aerial photography and satellite imagery along with GIS and MPAC data.

The livestock density is expressed as nutrient units per acre (NU/Acre) and is calculated based on the number of animals housed or pastured on a farm unit that generates enough manure to fertilize an area of land.

Step 1: Identifying Livestock Farming and Locating Barns

The type of farming taking place on each agricultural parcel was determined using a combination of information from MPAC, field surveys and air photo interpretation.

A review of air photography was completed to determine whether barns were present on a parcel that fell either partially or entirely within each WHPA. The parcels that were used were the same ones identified in Step 1 of the managed lands methodology above.

Step 2: Estimating Size of Livestock Barns and Nutrient Units

Once a livestock housing barn was selected, the type of livestock that was assumed to be housed in the barn was estimated with help from the MPAC farm code description, air photo interpretation, and field survey notes. The area of the barn structure was estimated using GIS and this area was used for further analysis. The area of the barn was multiplied by the conversion factor for that livestock type, relating the area of the barn (in square metres) per nutrient unit (NU), as supplied by OMAFRA in the MOECC Technical Bulletin (MOE, 2009). The calculated nutrient units are assumed to be applied uniformly over the agricultural managed lands within the farm unit. A definition of a farm unit is provided in the *Nutrient Management Act, 2002*.

Step 3: Estimating Total Nutrient Units for the Portion in the WHPA

Once all the livestock barns were identified and the NU's calculated, the total NU applied to the area within the WHPA is needed. Using area weighting, the livestock density (in NU/acre) of each farm parcel was applied to only the area within the WHPA and summed with all the other NU calculations on farm parcels in the WHPA.

Step 4: Calculating Livestock Density in WHPA

The total NU generated by all the barns was divided by the total AML in the WHPA, as calculated in Step 4 of the managed lands methodology, regardless of the type of farm (livestock or non-livestock). The livestock density in the WHPA is thus the sum of all NU applied within the WHPA divided by the total AML area (in acres).

The results of the calculations for livestock density are provided in **Table C-8** for the Region of Peel WHPAs.

E3.3 Calculating Livestock Density for Use of Land as Livestock Grazing or Pasturing Land, an Outdoor Confinement Area or Farm-Animal Yard

For the use of land for livestock grazing or pasturing land within the vulnerable areas, the nutrient units for the farm were calculated based on the identified animal species and size of barn on the farm. The total nutrient units were then divided by the size of the livestock grazing land or pasturing land to get nutrient units per acre. For use of an outdoor confinement area or farm-animal yard the total nutrient units was divided by the size of the livestock outdoor confinement area or farm-animal yard in hectares. When a portion of the grazing and pasture, outdoor confinement area or farm animal yard fell within the vulnerable area, the entire parcel of land was factored into the calculations to create a NU/acre that applies to the portion of land within the vulnerable area.

E3.4 Calculating Livestock Density Related to Agricultural Source Material Storage

Agricultural source material storage was assumed to exist at all farms with livestock and farm outbuildings. The nutrients stored and applied at an annual rate for the circumstances under the Table of Drinking Water Threats of the *Technical Rules* for ASM storage were determined by the NU stored on the farm divided by the size of the farm unit. The NU stored of the farm was calculated based on the livestock type and size of barn used for the livestock and provided MOECC conversion factors.

Table E3-5: Livestock Density Analysis – Town of Orangeville WHPAs

		Livestock Density	
Well Field	**WHPA**	**(NU/acre)**	**(NU/ha)**
Well 2A, 5/5A, 7 & 9A/9B	WHPA-A	0.0	0.0
	WHPA-B	0.2	0.6
	WHPA-C	0.1	0.3
	WHPA-D	N/A	N/A
	WHPA-E	0.2	0.4
Well 6 & 11	WHPA-A	0.0	0.0
	WHPA-B	0.1	0.1
	WHPA-C	0.7	1.8
	WHPA-D	N/A	N/A
Well 8B/8C & 12	WHPA-A	0.0	0.0
	WHPA-B	0.6	1.6
	WHPA-C	0.3	0.7
	WHPA-D	N/A	N/A
	WHPA-E	0.0	0.0
Well 10	WHPA-A	0.0	0.0
	WHPA-B	0.0	0.1
	WHPA-C	0.0	0.1
	WHPA-D	0.1	0.3
	WHPA-E	0.0	0.0

N/A – denotes area not evaluated since vulnerability score is less than 6

Table E3-6: Livestock Density Analysis – Town of Mono WHPAs

Well Field	WHPA	Livestock Density (NU/acre)	Livestock Density (NU/ha)
Cardinal Woods	WHPA-A	0.0	0.0
	WHPA-B	0.1	0.2
	WHPA-C	0.1	0.3
	WHPA-D	N/A	N/A
	WHPA-E	0.2	0.6
Coles Wells	WHPA-A	0.0	0.0
	WHPA-B	0.1	0.4
	WHPA-C	0.1	0.3
	WHPA-D	N/A	N/A
Island Lake	WHPA-A	0.0	0.0
	WHPA-B	0.0	0.0
	WHPA-C	0.0	0.0
	WHPA-D	0.0	0.0

N/A – denotes area not evaluated since vulnerability score is less than 6

Table E3-7: Livestock Density – Pullen Well (Township of Amaranth)

WHPA	Livestock Density (NU/acre)	Livestock Density (NU/ha)
WHPA-A	0.0	0.0
WHPA-B	0.1	0.2
WHPA-C	N/A	N/A
WHPA-D	N/A	N/A

N/A - area not evaluated since vulnerability score less than 6

Table E3-8: Livestock Density Analysis – Town of Caledon WHPAs

		Livestock Density	
Well Field	**WHPA**	**(NU/acre)**	**(NU/ha)**
Alton Wells 3 & 4A	WHPA A	0.0	0.0
	WHPA B	0.0	0.0
	WHPA C	0.0	0.0
	WHPA D	N/A	N/A
	WHPA E	0.35	0.14
Caledon Village Well 3	WHPA A	0.0	0.0
	WHPA B	0.0	0.0
	WHPA C	0.0	0.0
	WHPA D	N/A	N/A
	WHPA E	0.0	0.0
Caledon Village Well 4	WHPA A	0.0	0.0
	WHPA B	0.0	0.0
	WHPA C	0.0	0.0
	WHPA D	N/A	N/A
	WHPA E	0.1	0.2
Cheltenham Wells 1 & 2	WHPA A	0.6	1.4
	WHPA B	0.6	1.6
	WHPA C	0.5	1.2
	WHPA D	N/A	N/A
Inglewood Wells 3 & 4	WHPA A	0.0	0.0
	WHPA B	0.0	0.0
	WHPA C	0.0	0.0
	WHPA D	N/A	N/A

N/A - denotes area not evaluated since vulnerability score less than 6

Orangeville

Based on the criteria thresholds and the results, the potential for nutrient application to exceed crop requirements is inferred to be low, except around the following wells, which showed a moderate potential:

- Wells 6 & 11—WHPA-C; and
- Wells 8B/8C & 12—WHPA-B.

Mono

Based on the criteria thresholds and the results, the potential for nutrient application to exceed crop requirements is inferred to be low in all of Mono's WHPAs.

Amaranth

Based on the criteria thresholds and the results, the potential for nutrient application to exceed crop requirements is inferred to be low around the Pullen Well.

Caledon (Peel)

Based on the criteria thresholds and the results, the potential for nutrient application to exceed crop requirements is inferred to be low in the majority of Peel Region's WHPAs, with the exception of the following:

Moderate Potential

Cheltenham: Wells 1& 2—WHPA-A, WHPA-B, and WHPA-C

Livestock density in Orangeville, Mono, Amaranth and Caledon (Peel) is shown in the following figures.

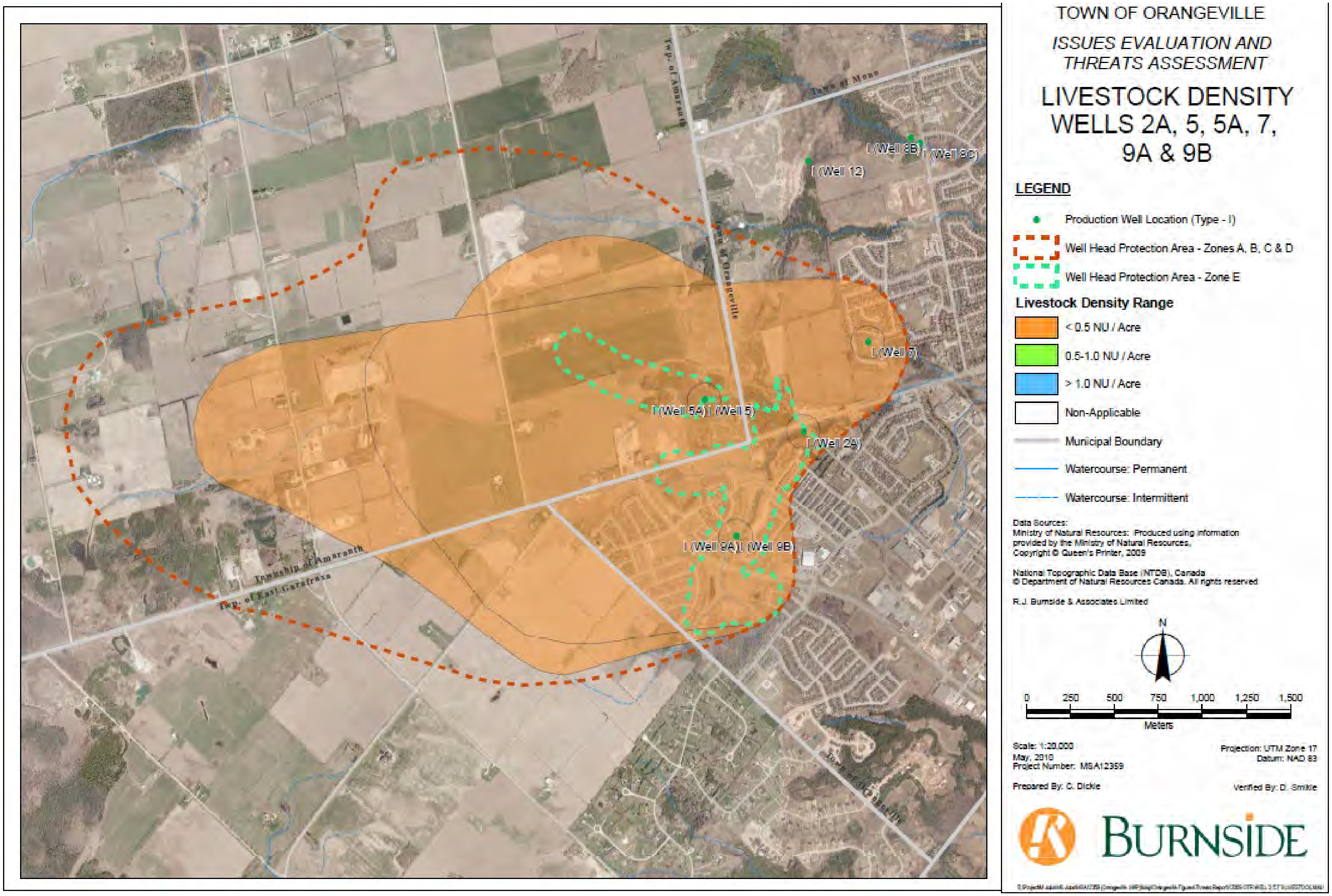


Figure E3-15: Livestock Density – Orangeville Wells 2A, 5, 5A,7, 9A & 9B

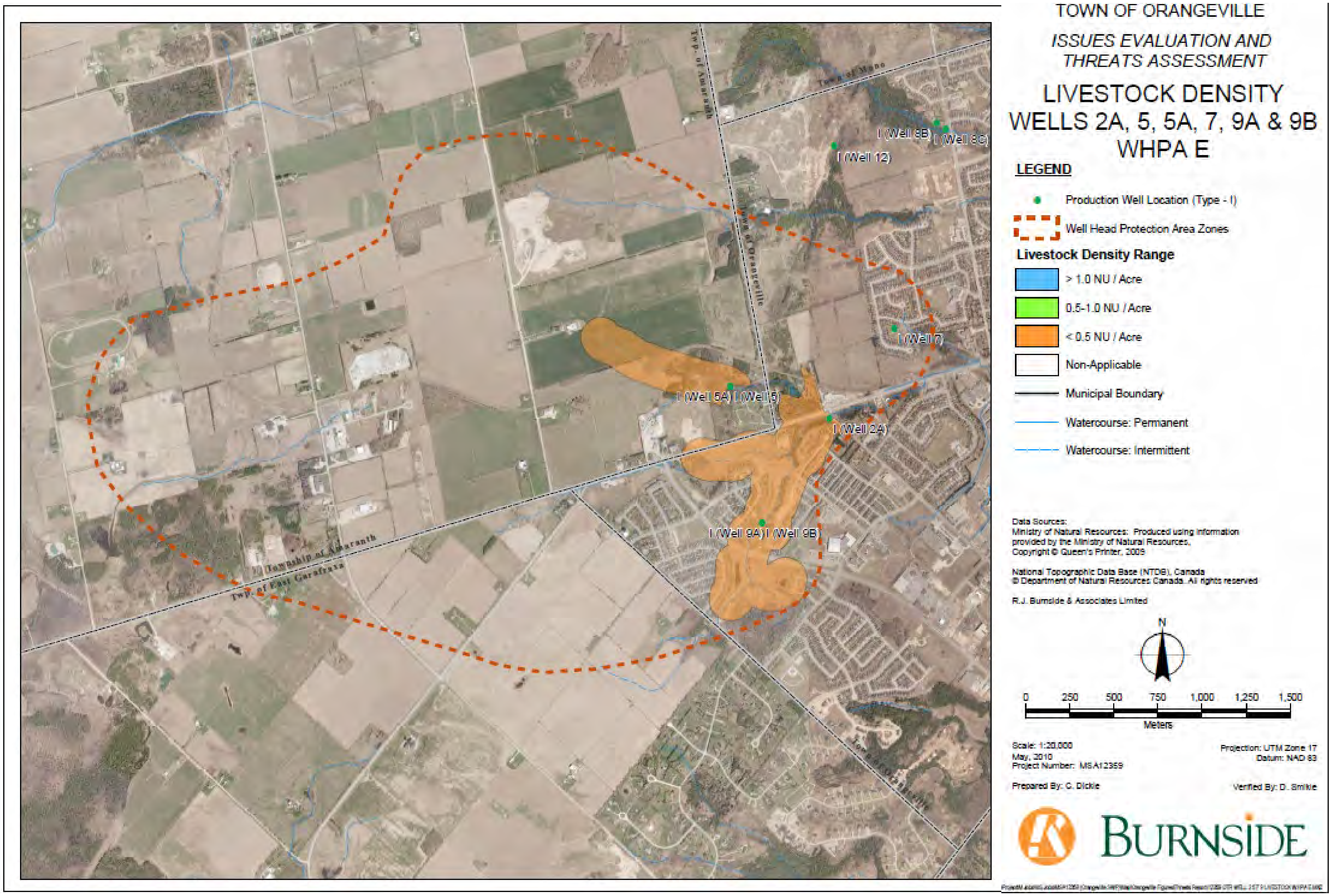


Figure E3-16: Livestock Density – WHPA-E, Orangeville Wells 5, 5A, 9A & 9B

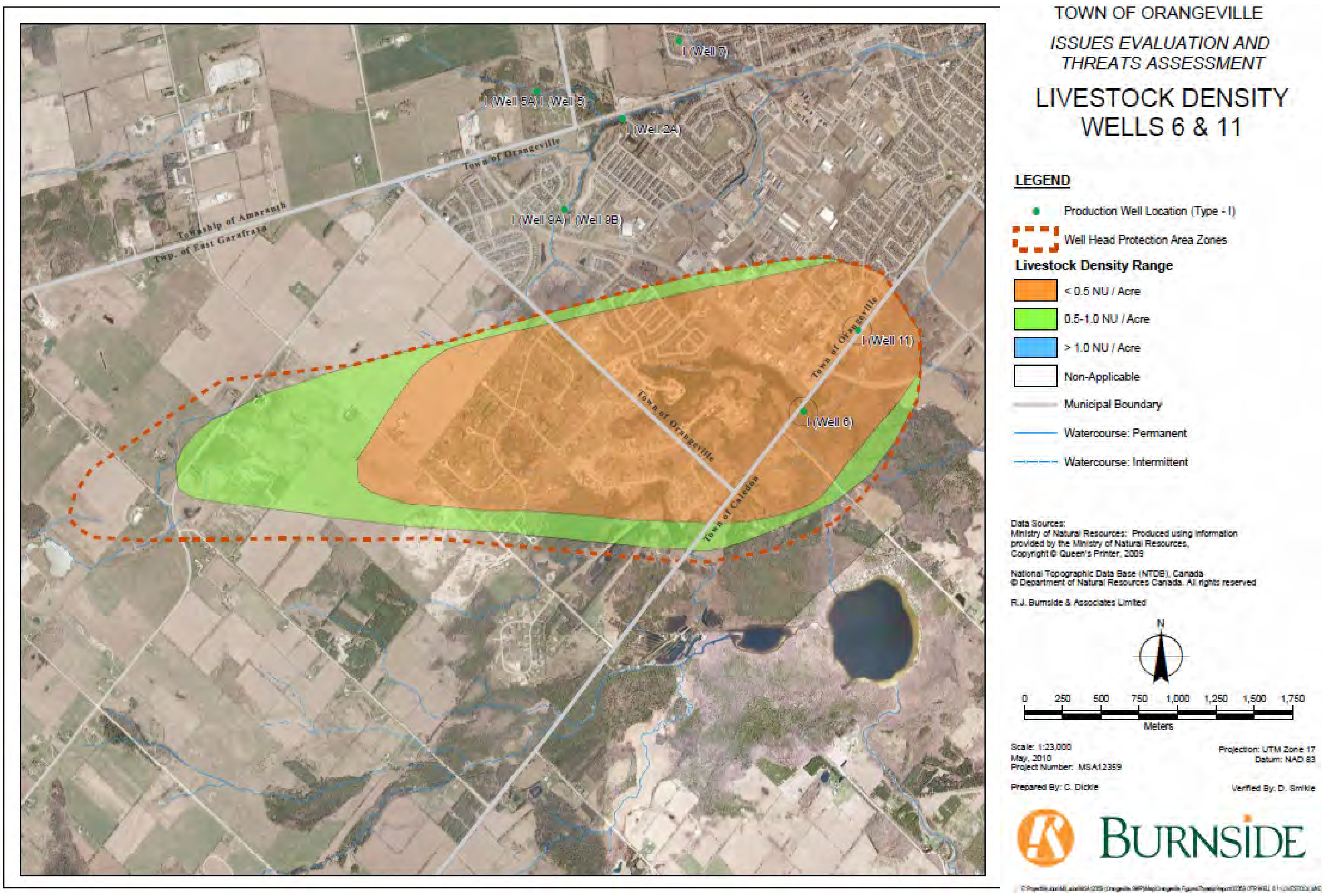


Figure E3-17: Livestock Density – Orangeville Wells 6 & 11

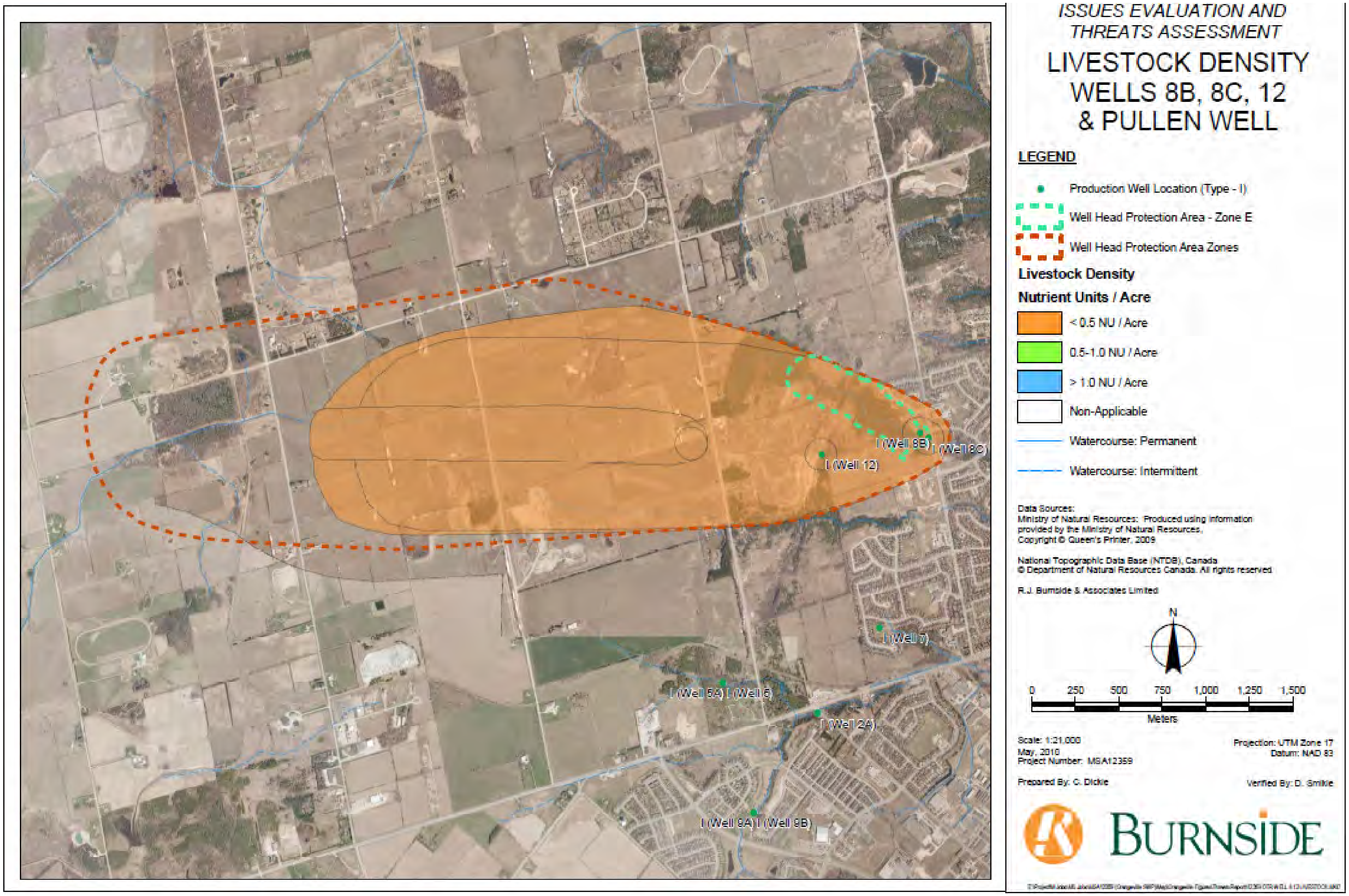


Figure E3-18: Livestock Density – Orangeville Wells 8B,8C & Pullen (Amaranth)

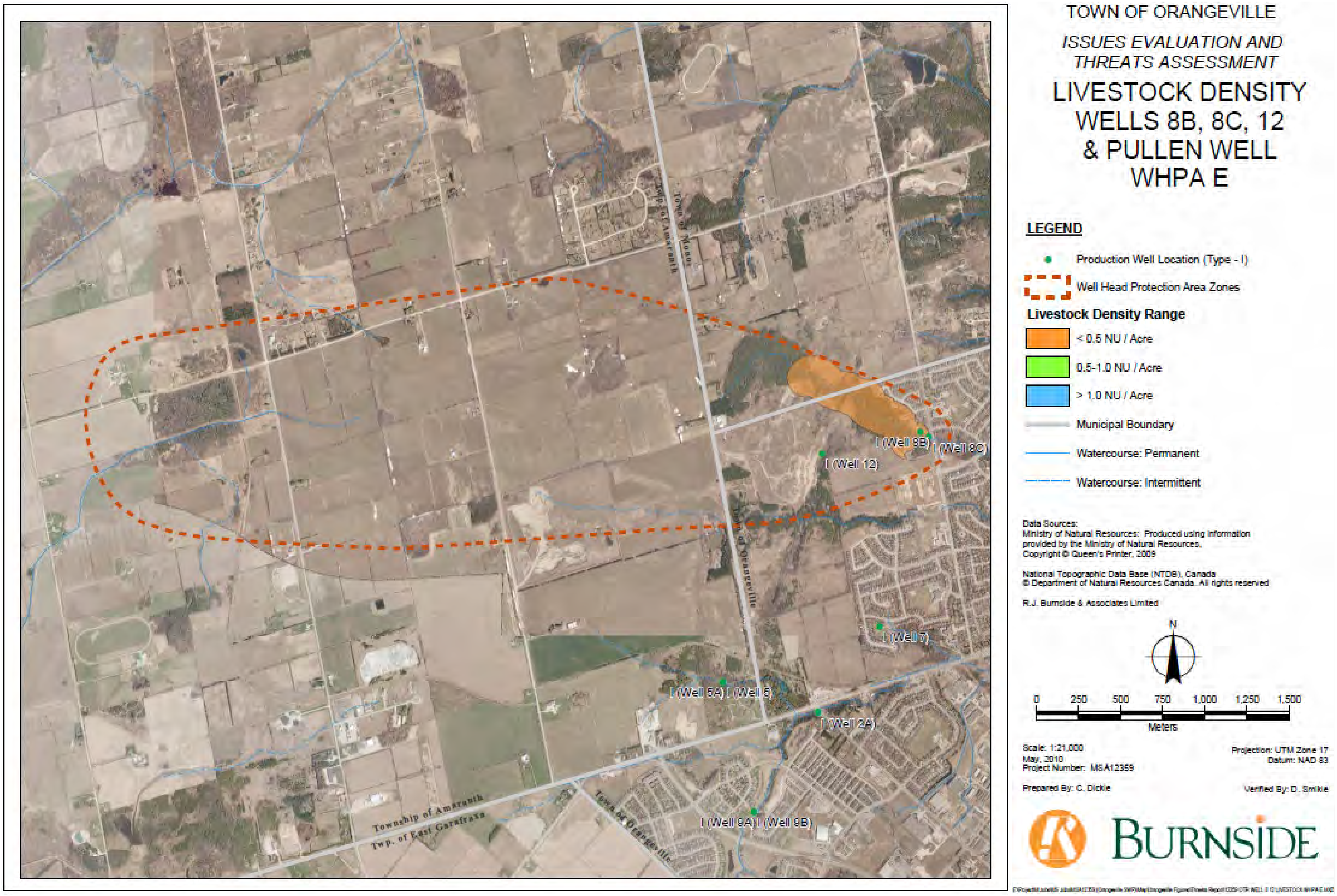


Figure E3-19: Livestock Density – WHPA E- Orangeville Wells 8B, 8C

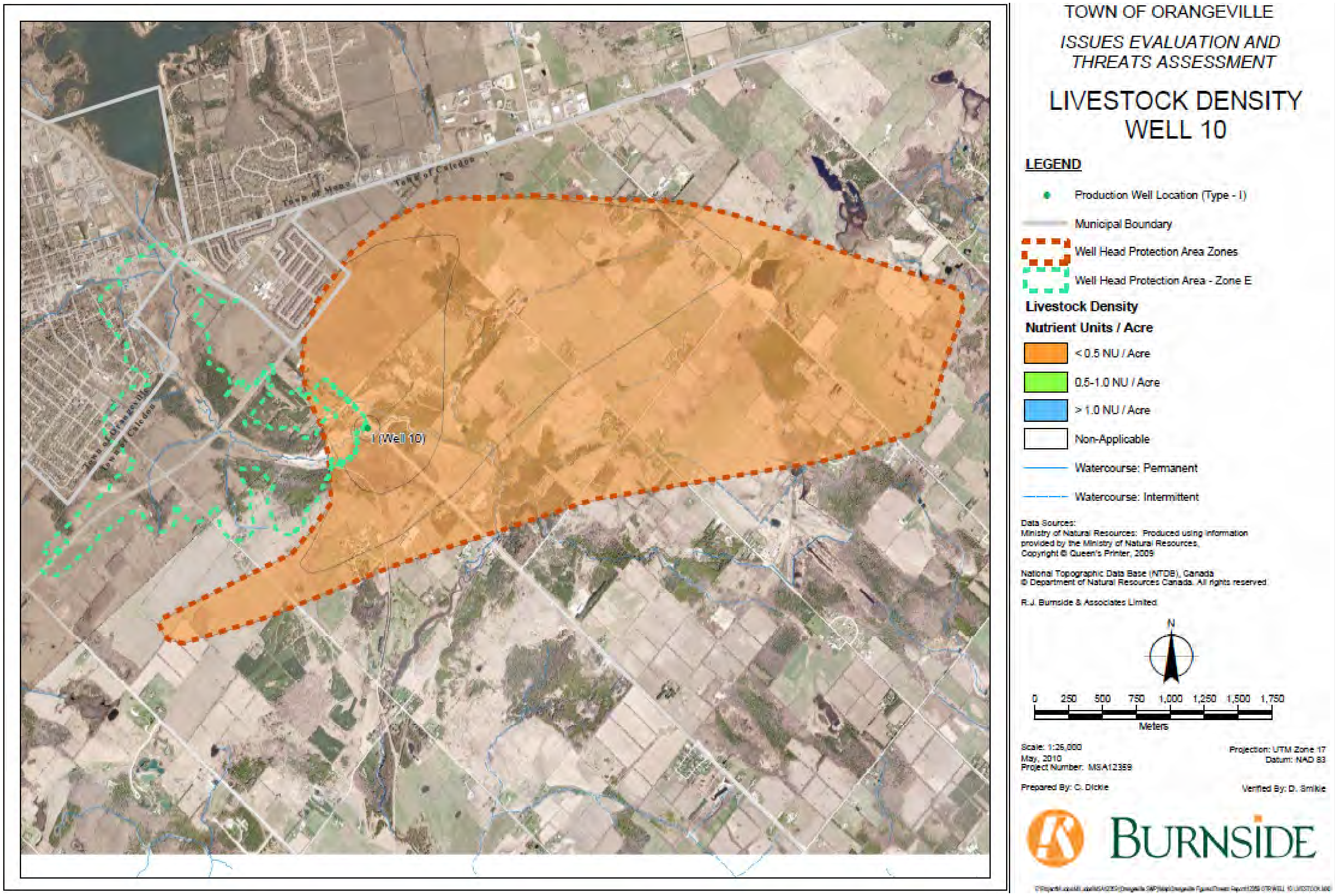


Figure E3-20: Livestock Density – Orangeville Well 10

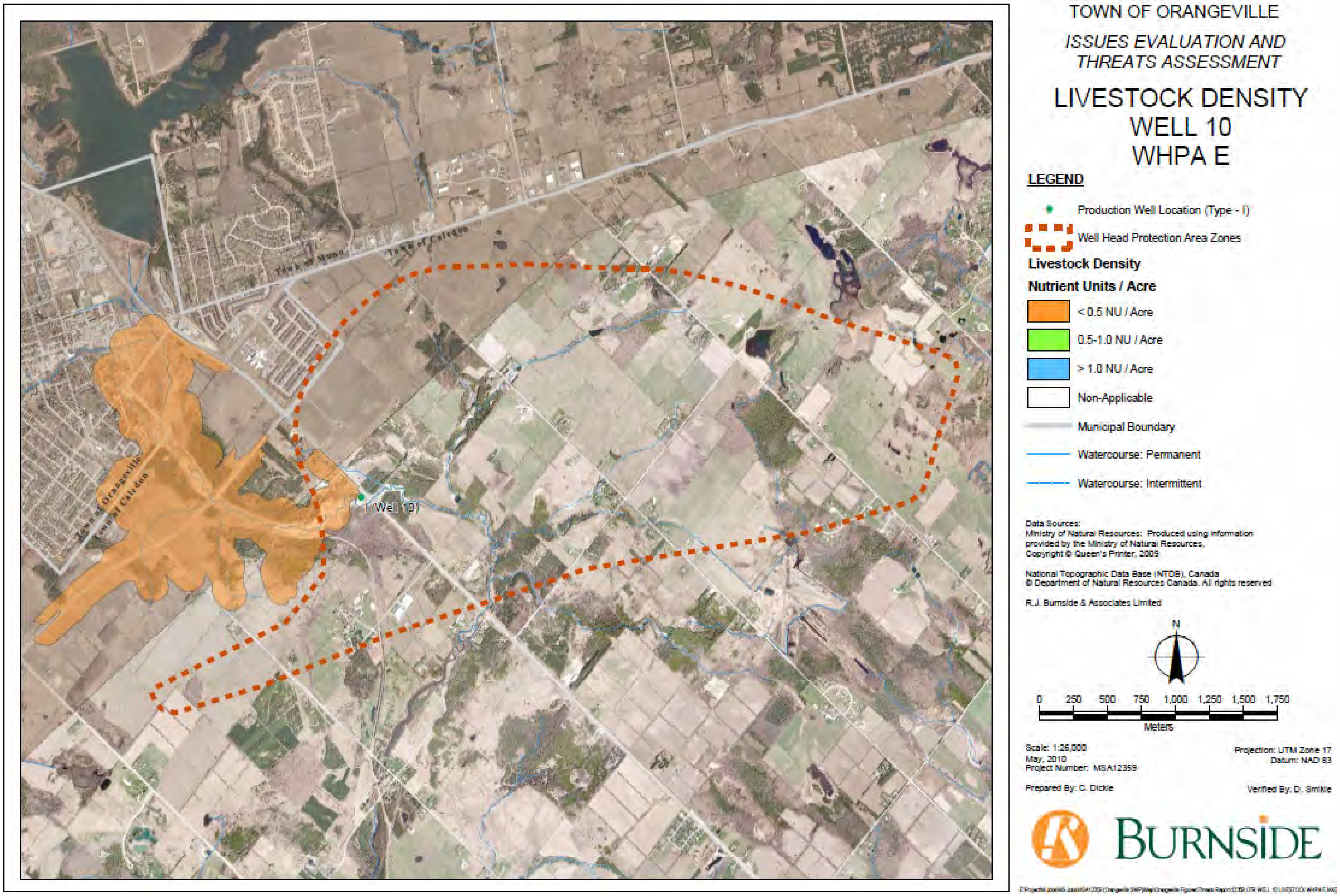


Figure E3-21: Livestock Density – WHPA-E, Orangeville Well 10

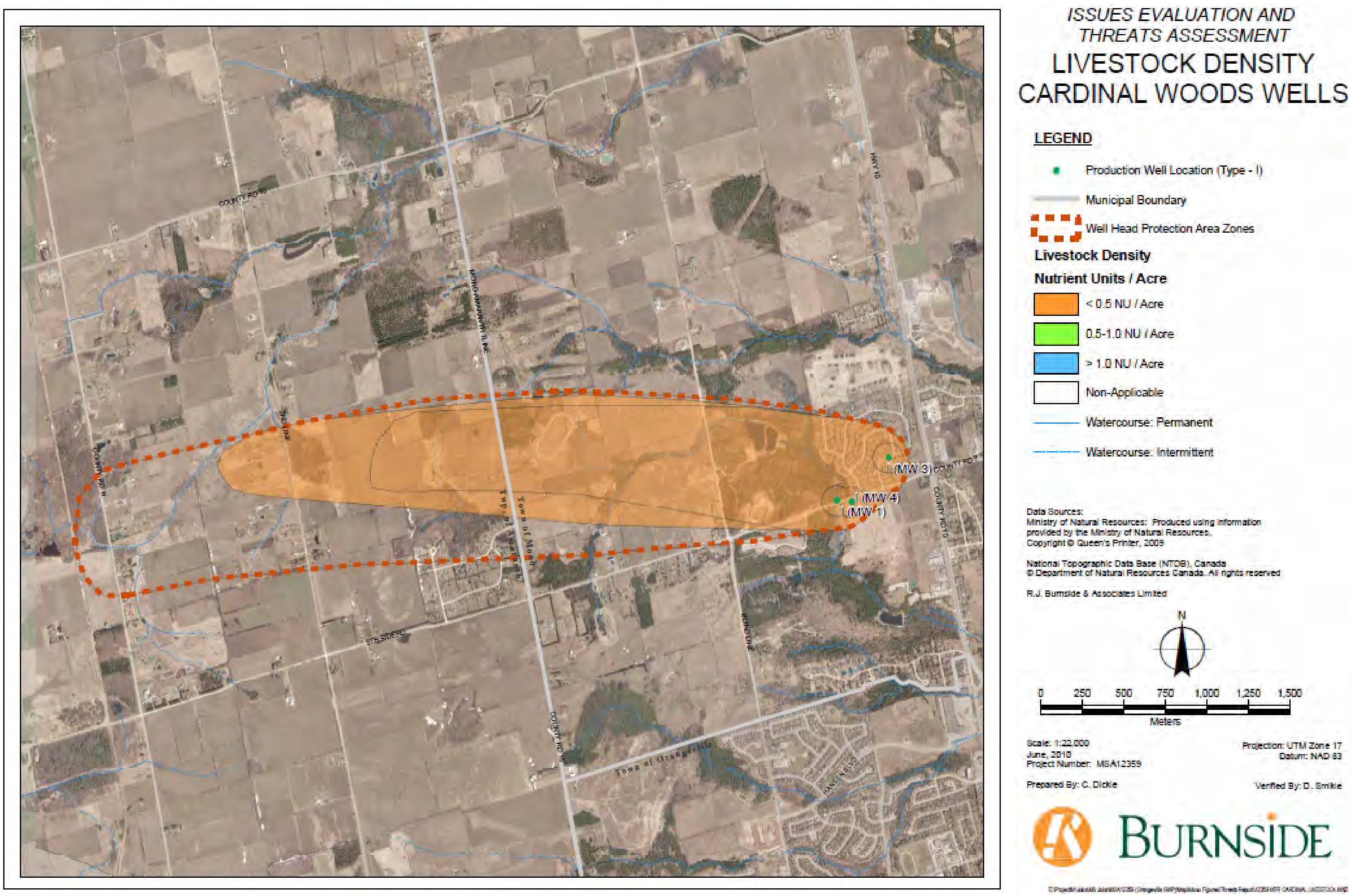


Figure E3-22: Livestock Density – Cardinal Woods, Mono

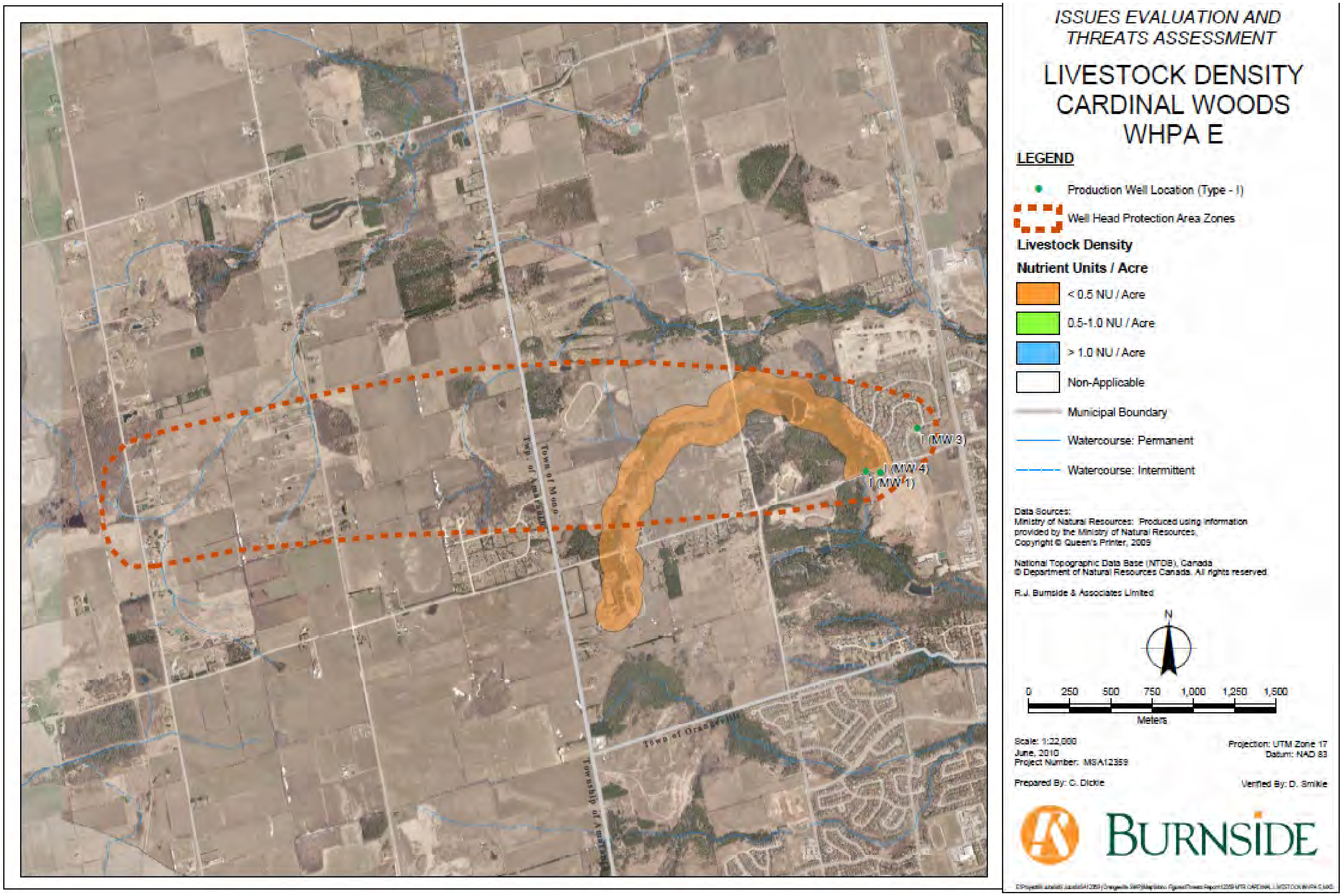


Figure E3-23: Livestock Density – WHPA-E, Cardinal Woods, Mono

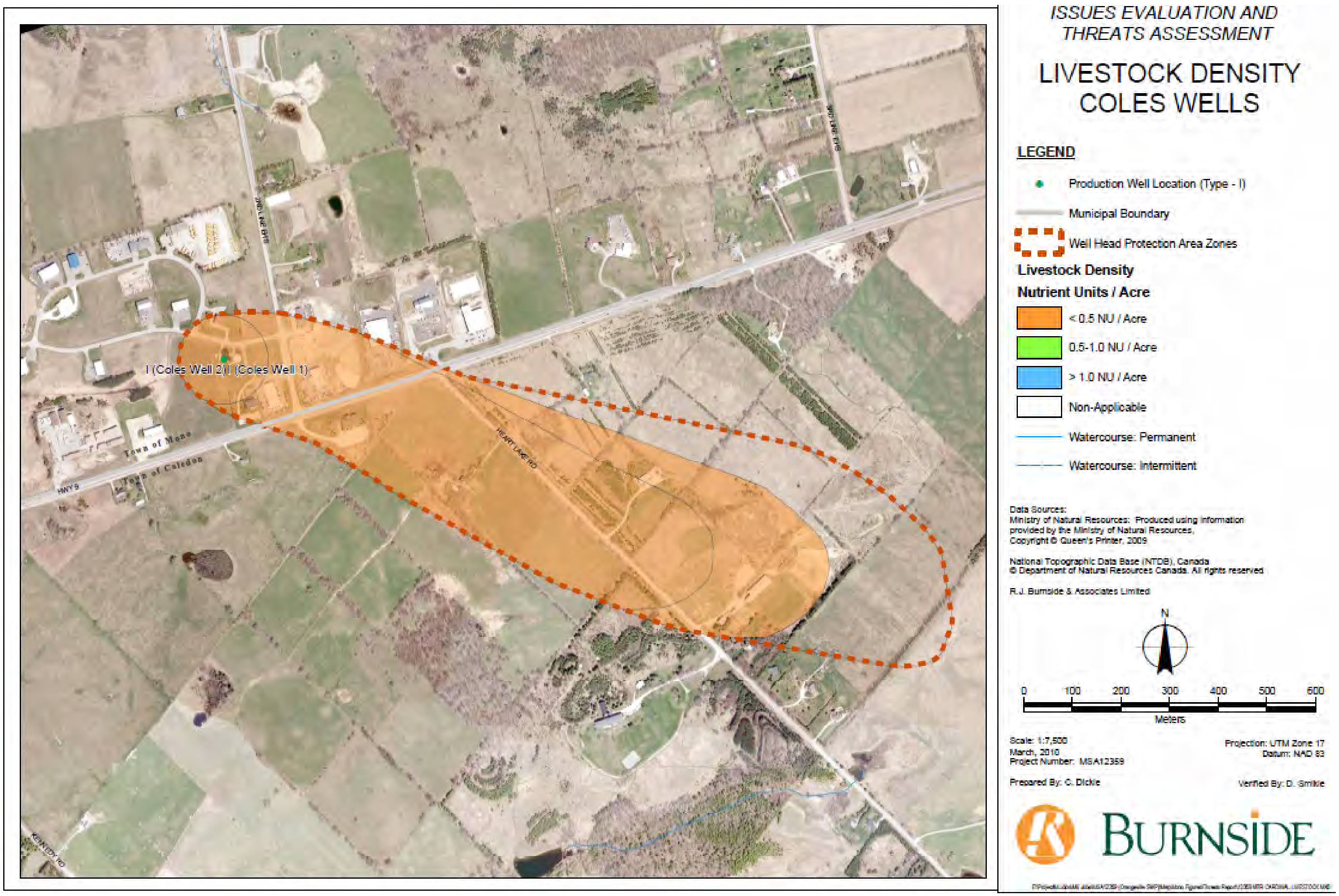


Figure E3-24: Livestock Density – Coles, Mono

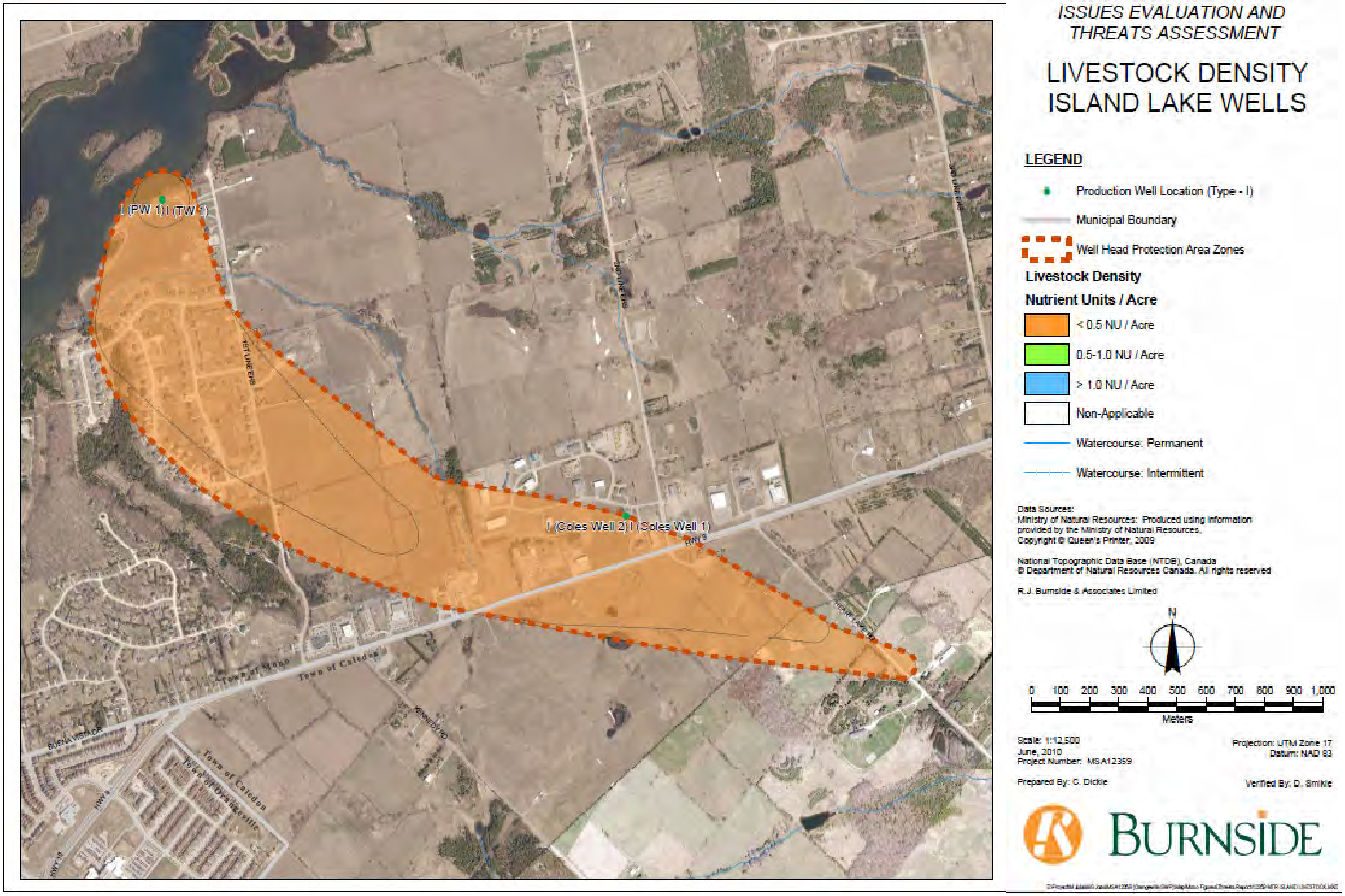


Figure E3-25: Livestock Density – Island Lake, Mono

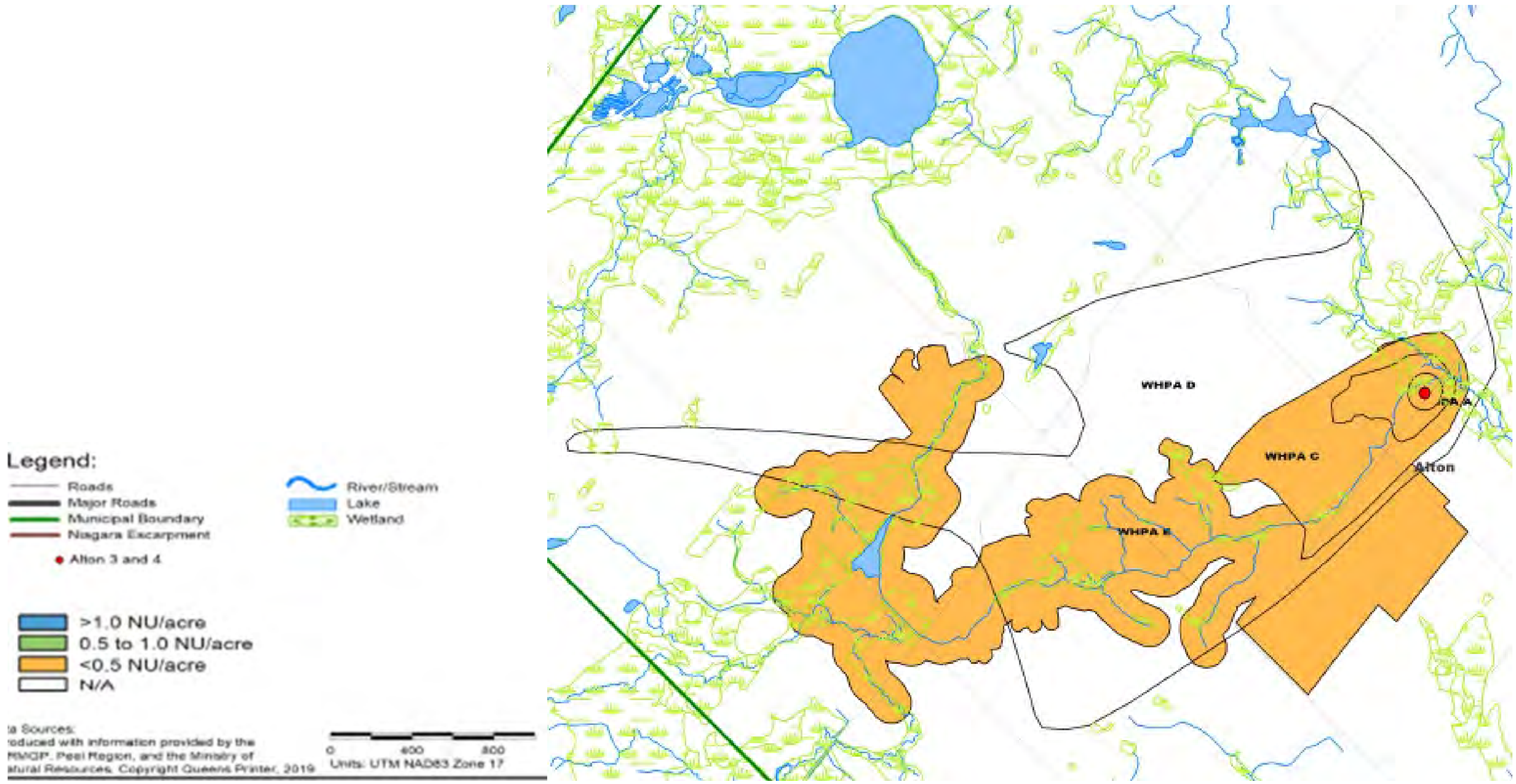


Figure E3-26: Livestock Density – Alton (EarthFx and GeoKamp Ltd., 2019)

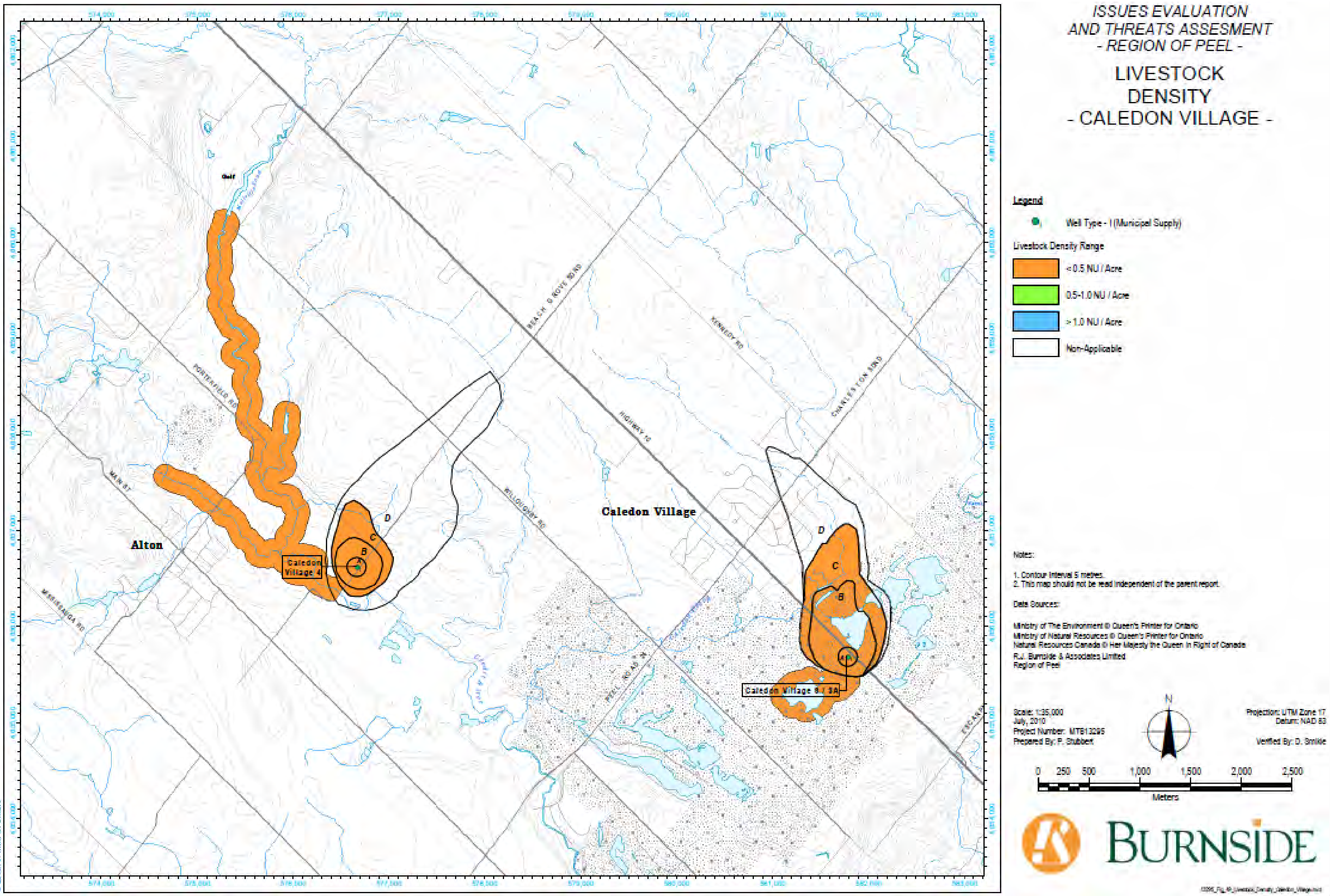


Figure E3-27: Livestock Density - Caledon Village

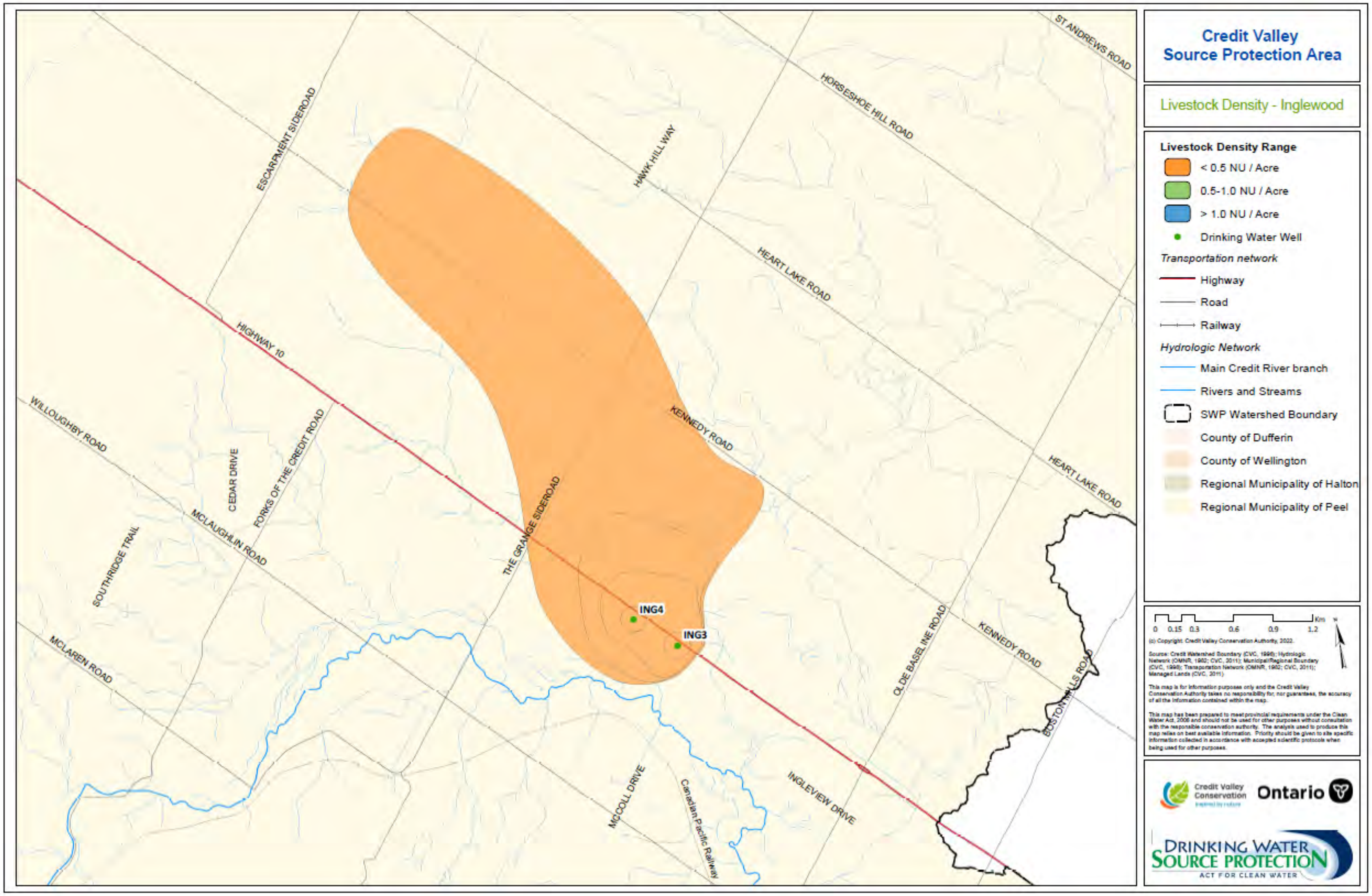


Figure E3-28: Livestock Density – Inglewood

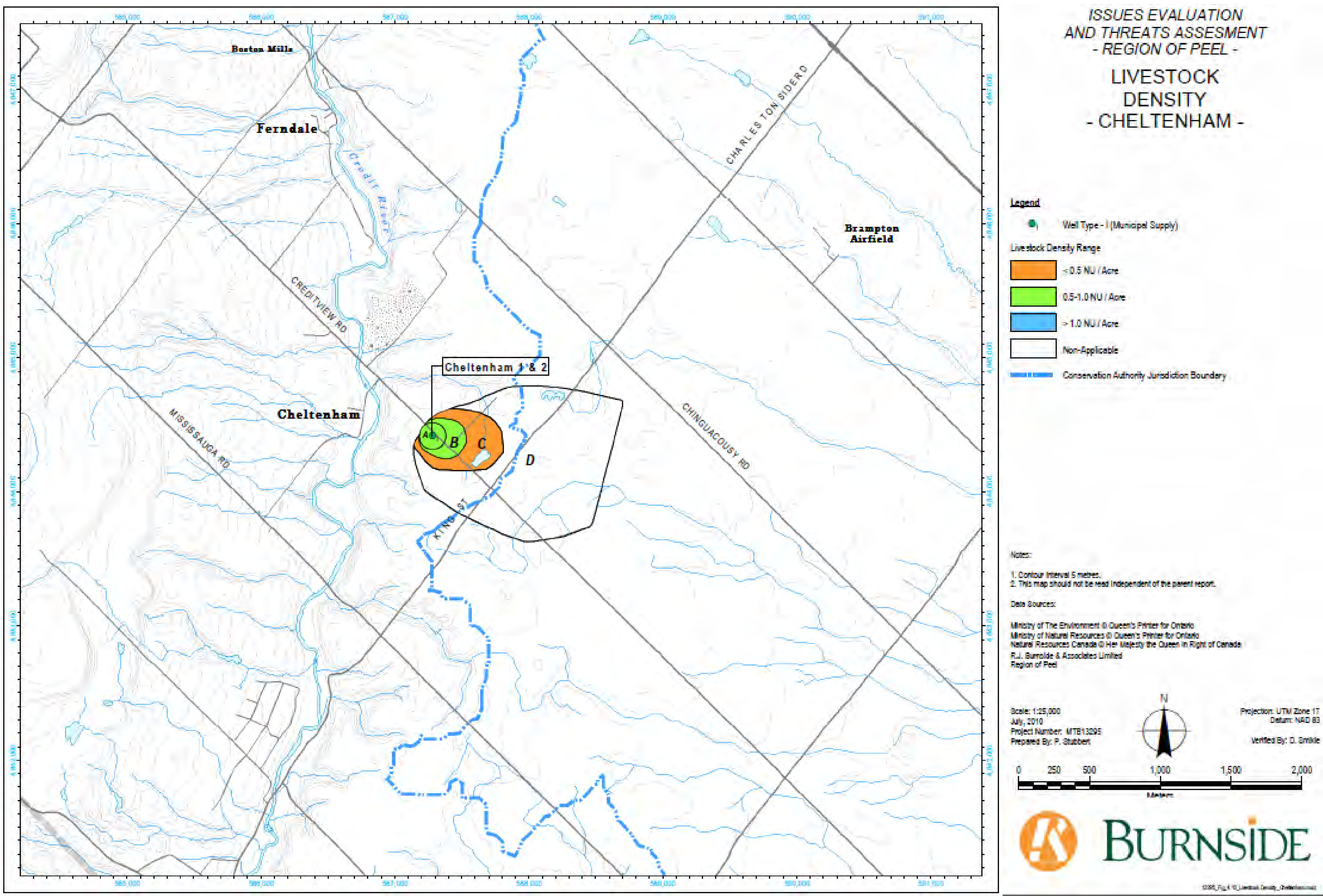


Figure E3-29: Livestock Density – Cheltenham

E3.5 Methodology for Calculating Percent Impervious Surfaces

The methodology for the calculation of impervious surfaces generally follows that for the wider landscape (**Chapter 5**).

The surfaces considered in the analyses for impervious surfaces include the road networks, and areas occupied by gravel roads and large parking lots. Data were sourced from the National Road Network (Natural Resources Canada), and satellite aerial photography was used to identify roads (including gravel roads) and large parking lots.

Orangeville

None of the roads rate as a significant threat when evaluated against the provisions of the *Technical Rules* for impervious surface assessment.

Based on the analyses and threshold criteria, the following inferences have been made:

- Wells 2A, 5/5A, 7, & 9A/9B—Most of the combined WHPA contains impervious surfaces in the order of 1–8%. The majority of the WHPA-E for Wells 2A and 9A/B contains impervious surfaces in the order of 8–80%;
- Wells 6 & 11—Most of the combined WHPA contains impervious surfaces in the order of 1–8%;
- Well 10—Most of the WHPA contains impervious surfaces in the order of 1–8%; and
- Wells 8B/8C & 12—The majority of the combined WHPA contains impervious surfaces in the order of 1–8%.

It is inferred that the majority of the vulnerable areas surrounding the municipal wellheads fall within the percentage range of < 1% to a maximum of 8%, which would infer a low potential for threat due to the road network.

Mono

Based on the analyses, it is inferred that the majority of the vulnerable areas fall within the percentage range of 1% to 8%, which would infer a low potential for threat due to road networks. None of the roads rate as a significant threat when evaluated against the threshold criteria for impervious surface assessment.

Amaranth, Caledon (Peel)

Based on the analyses and the threshold criteria, it is inferred that the majority of the vulnerable areas surrounding the Pullen's wellhead fall within the range of < 1% to a maximum of 8%, which would infer a low potential for threat due to the road network. None of the roads rate as a significant threat when evaluated against the provisions of the *Technical Rules* for impervious surface assessment. Percent impervious surfaces in Orangeville, Mono, Amaranth and Caledon are shown below.

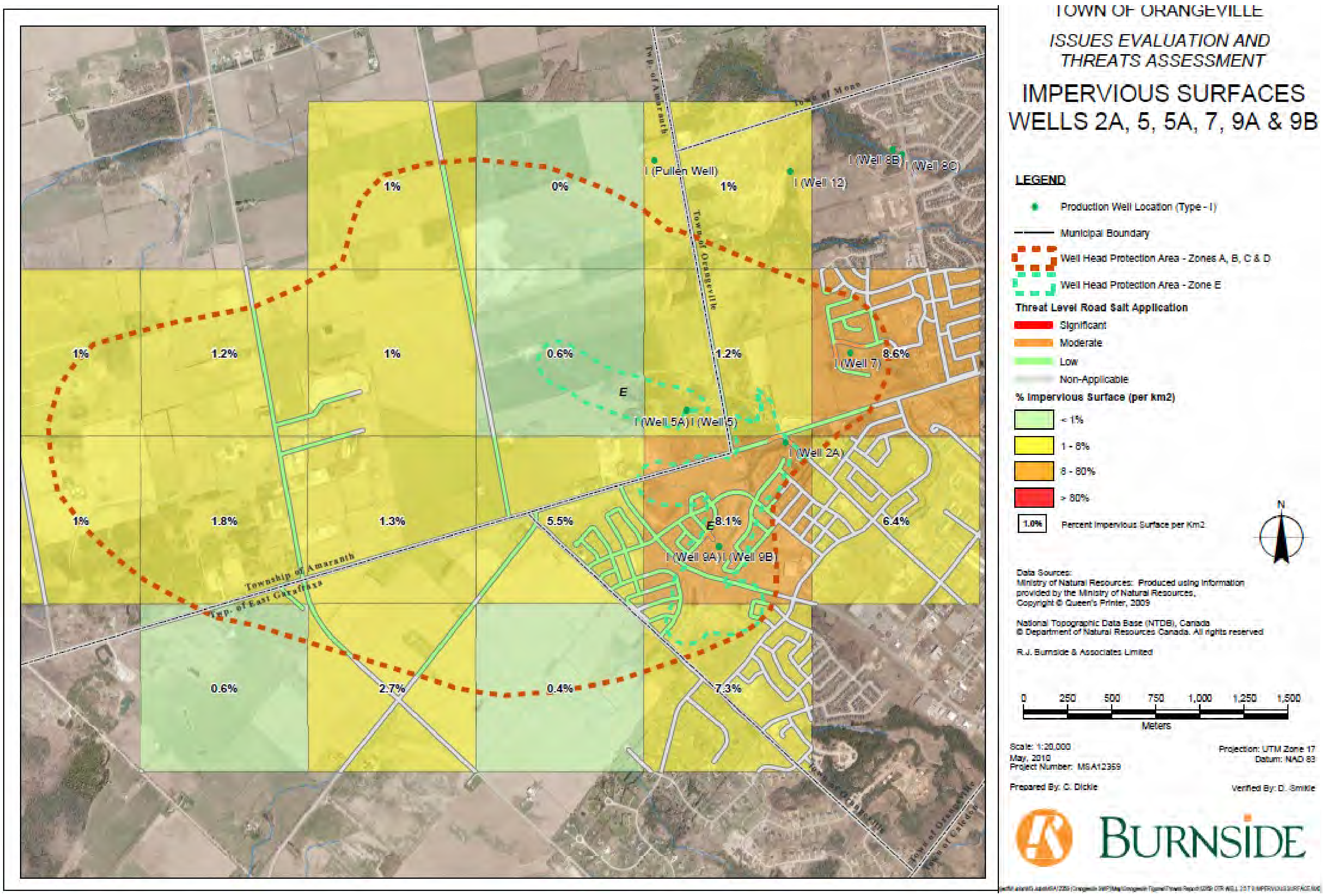


Figure E3-30: Impervious Surfaces – Orangeville Wells 2A, 5, 5A, 7,9A & 9B

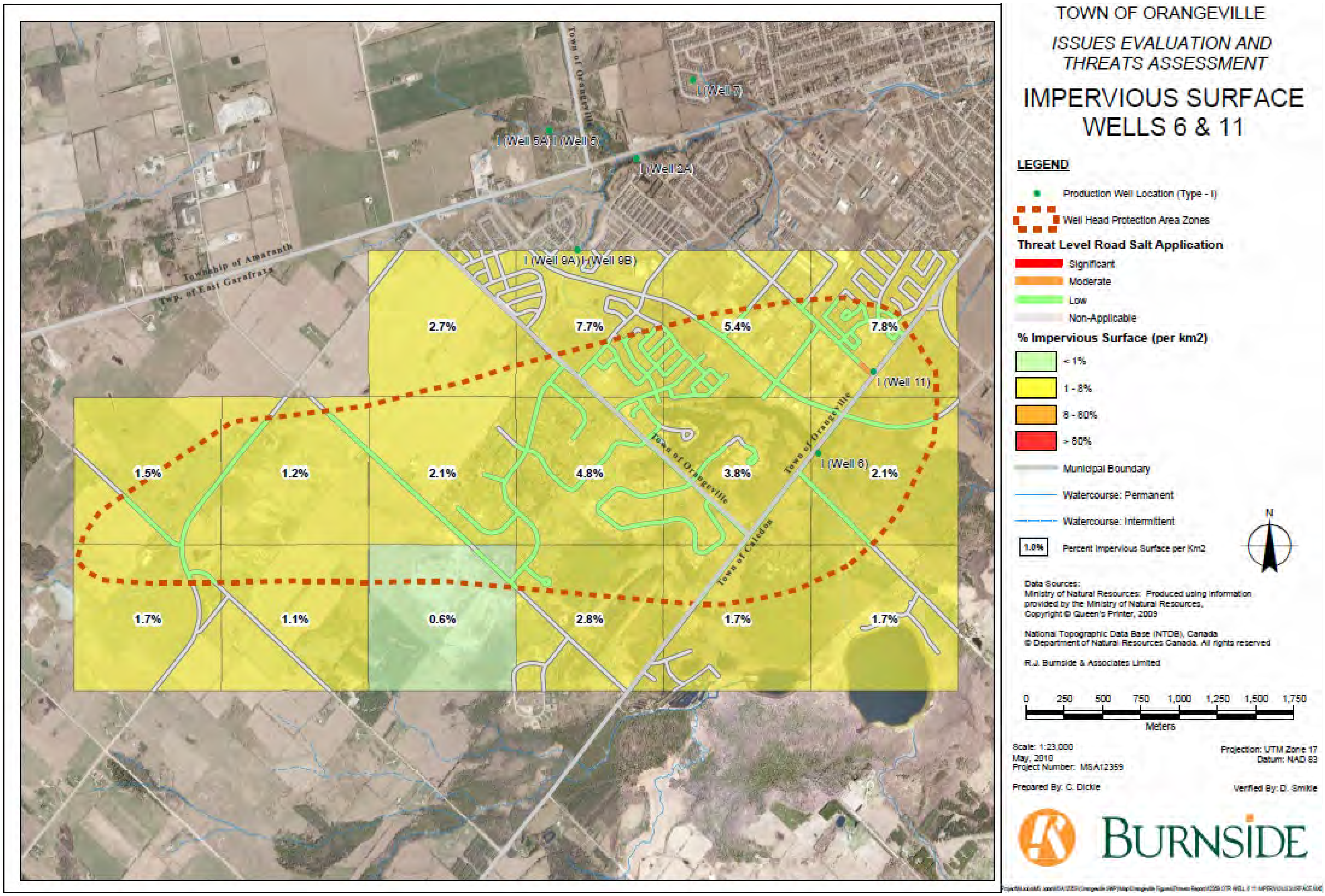


Figure E3-31: Impervious Surfaces – Orangeville Wells 6 & 11

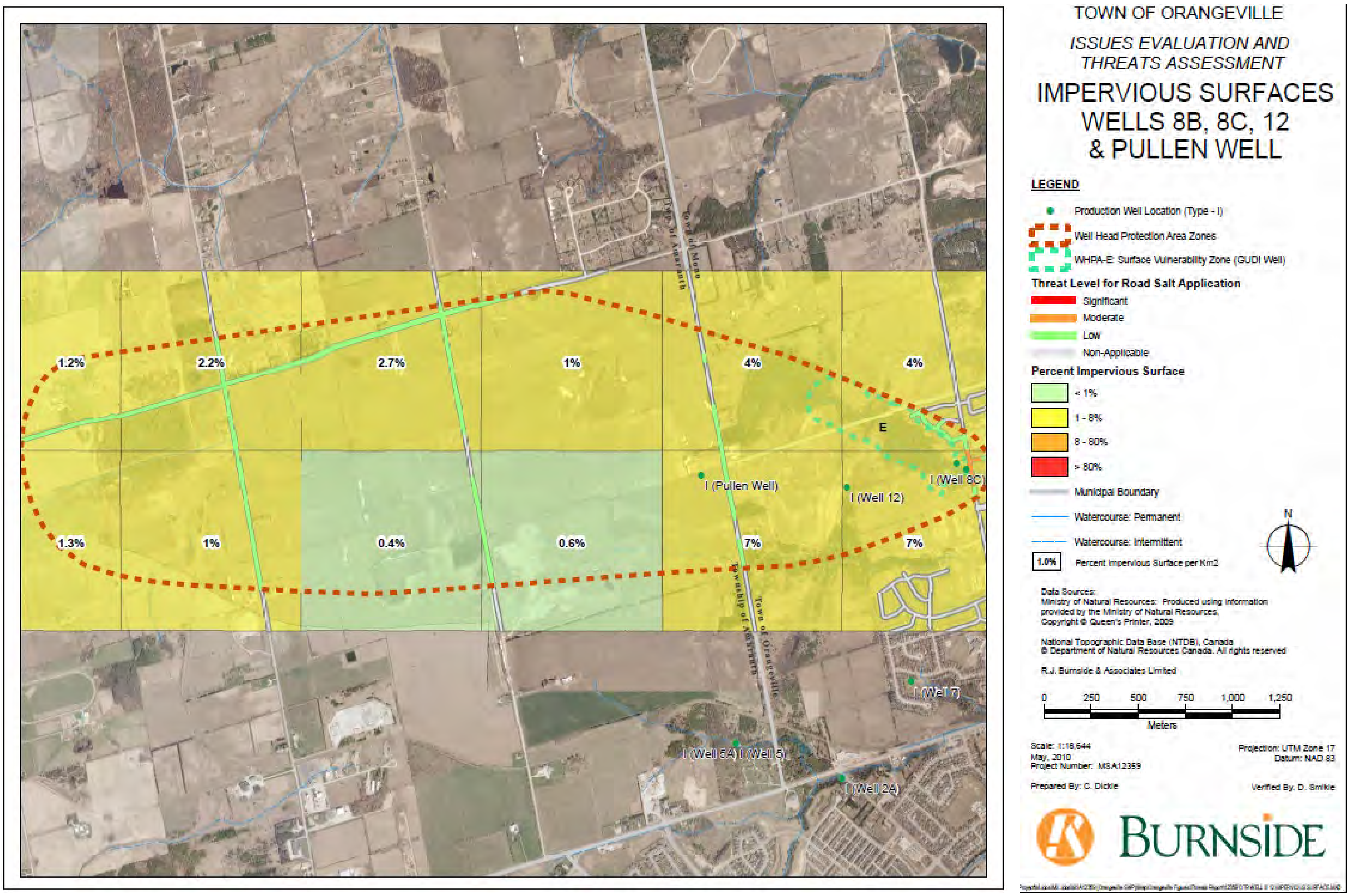


Figure E3-32: Impervious Surfaces – Orangeville Wells 8B, 8C, 12 & Pullen (Amaranth)

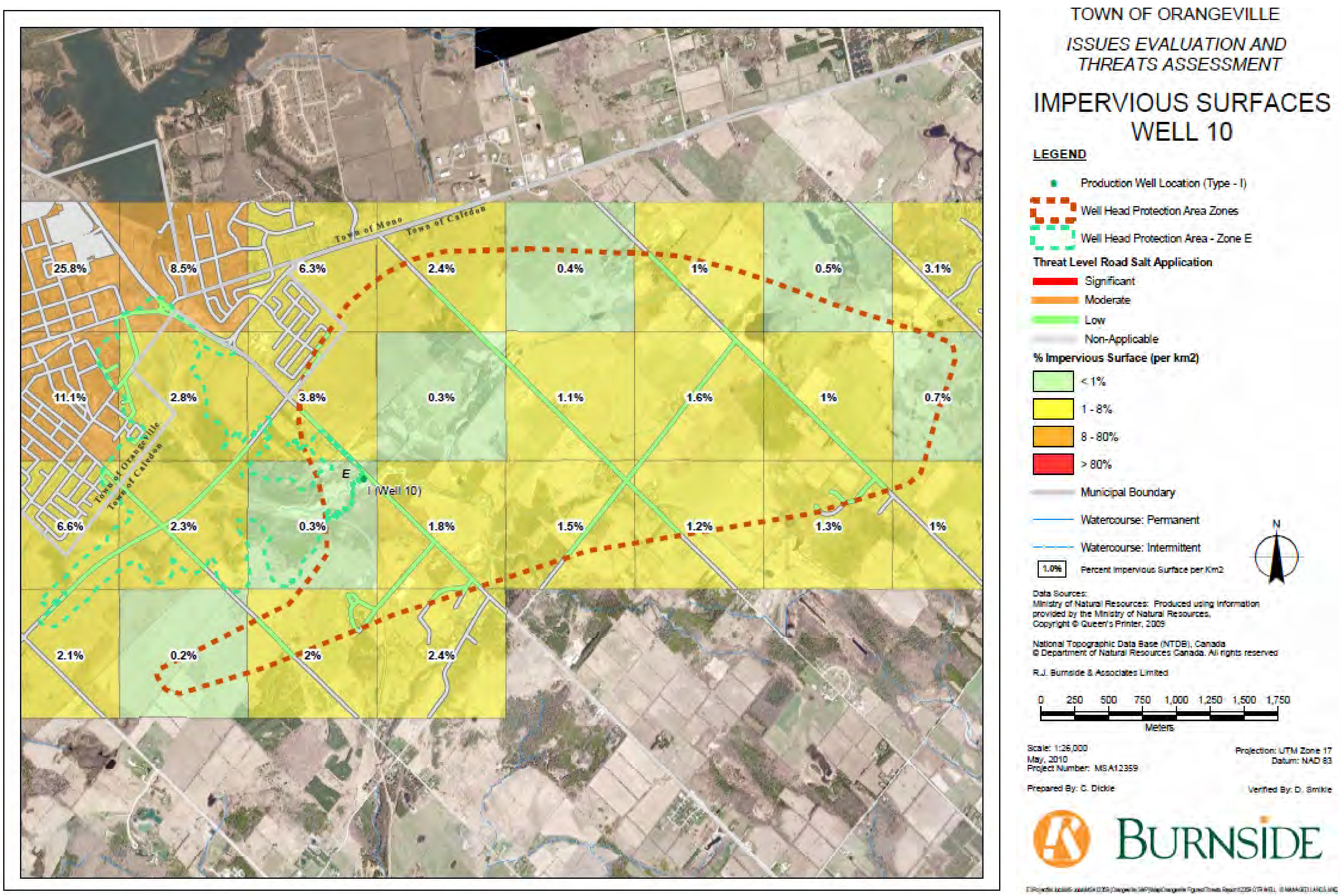


Figure E3-33: Impervious Surfaces – Orangeville Wells 2A,5, 5A,7,9A & 9B

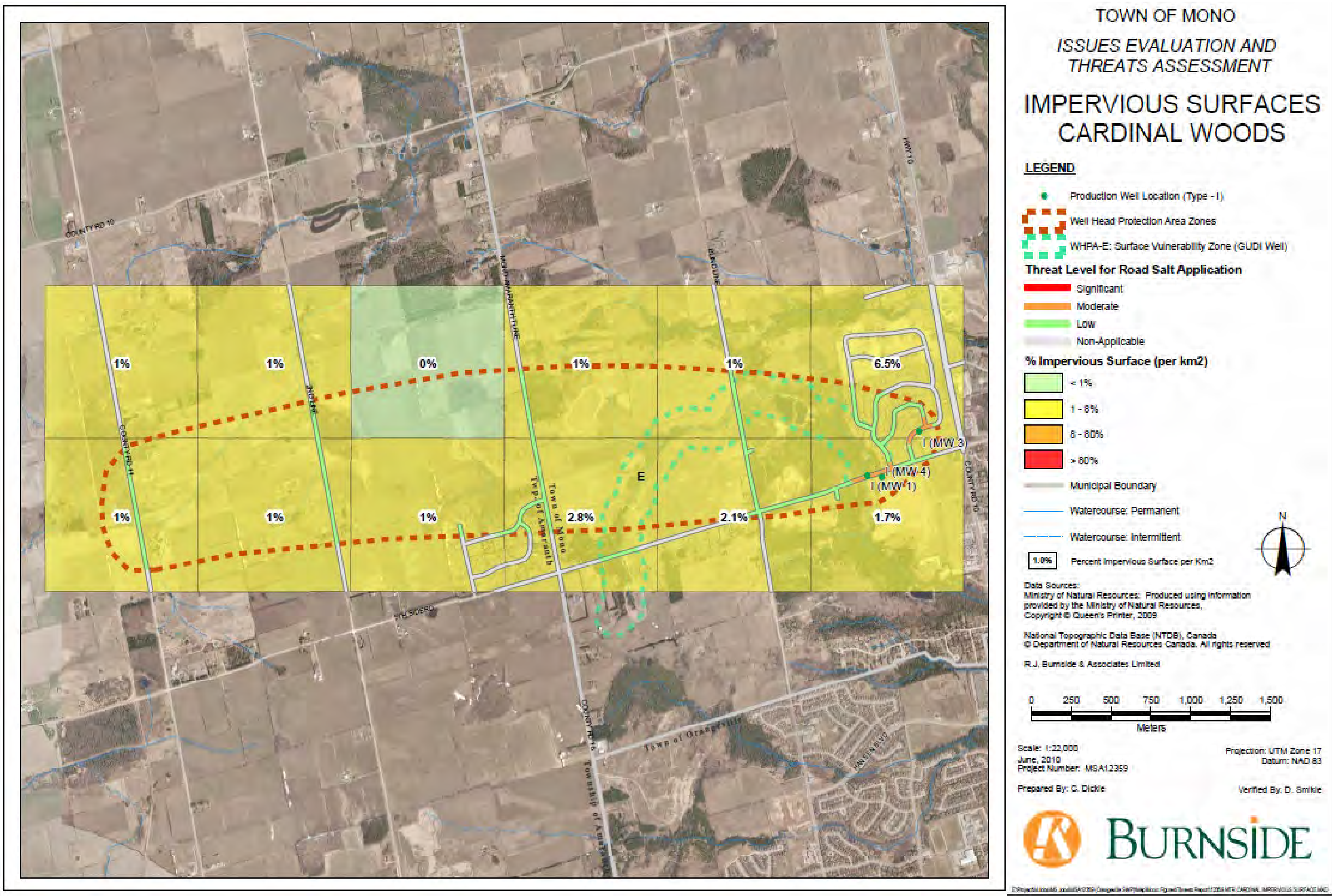


Figure E3-34: Impervious Surfaces – Cardinal Woods

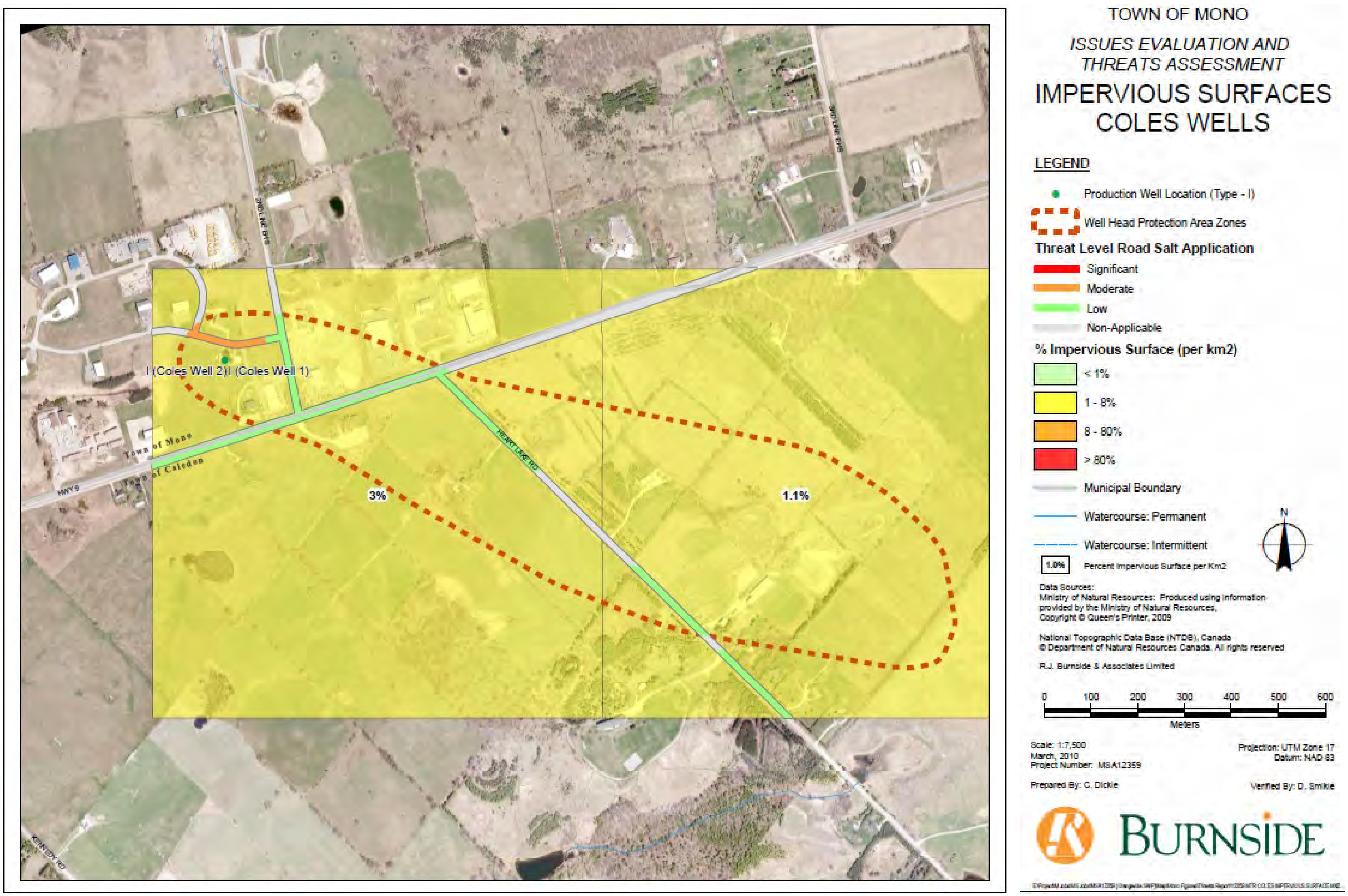


Figure E3-35: Impervious Surfaces – Coles

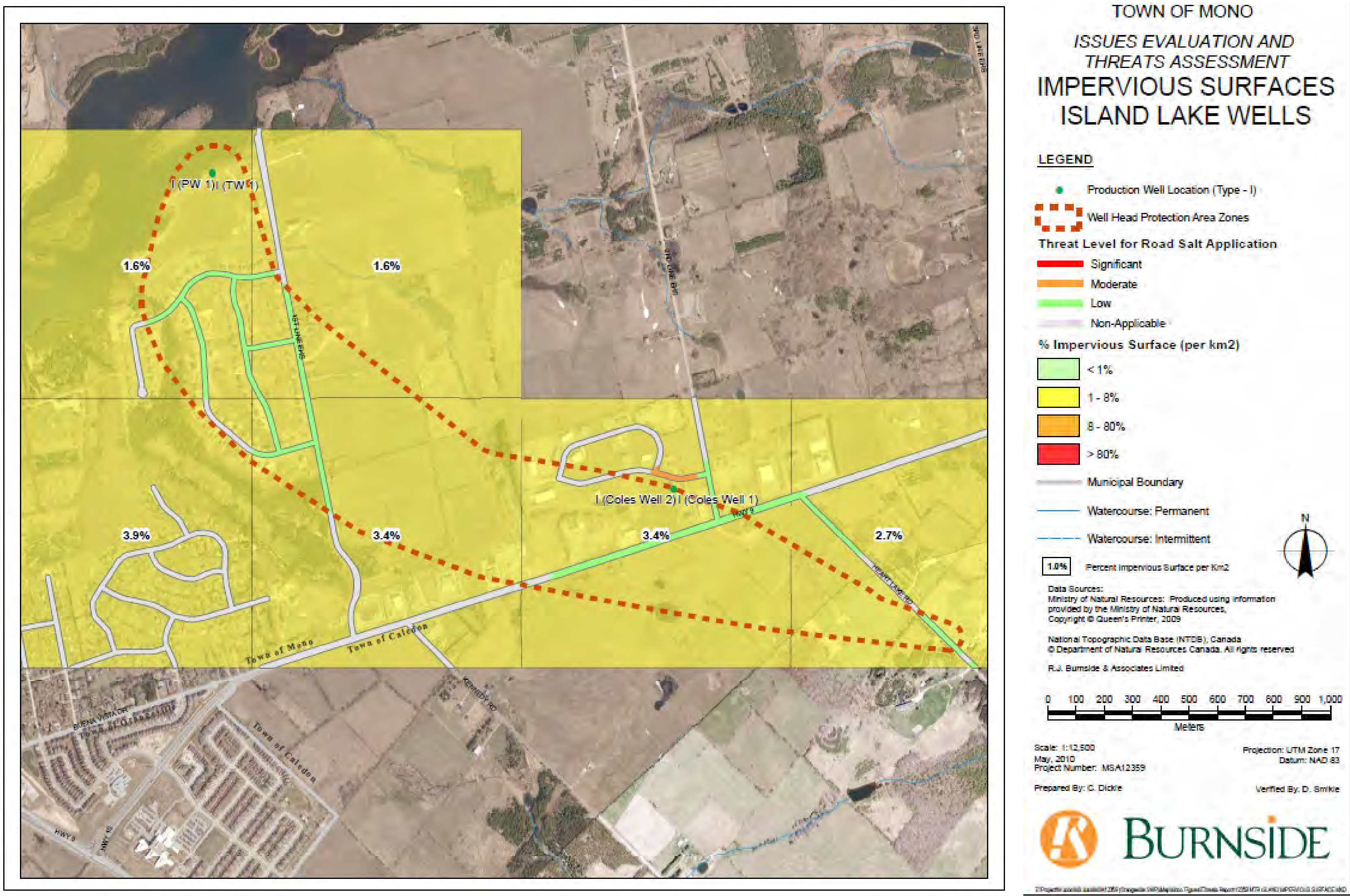


Figure E3-36: Impervious Surfaces – Island Lake

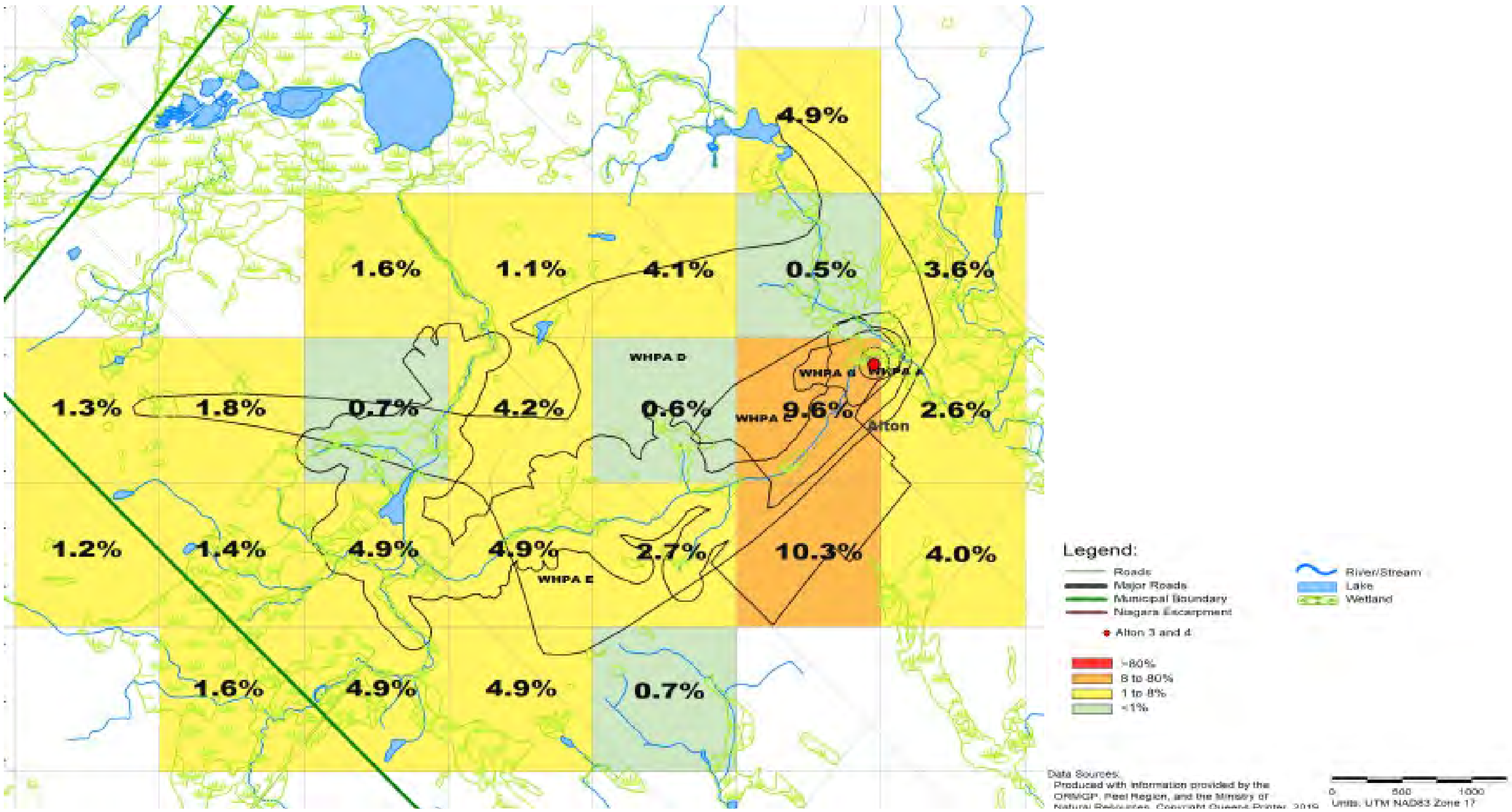


Figure E3-37: Impervious Surfaces – Alton Wellfield (EarthFx and GeoKamp Ltd., 2019)

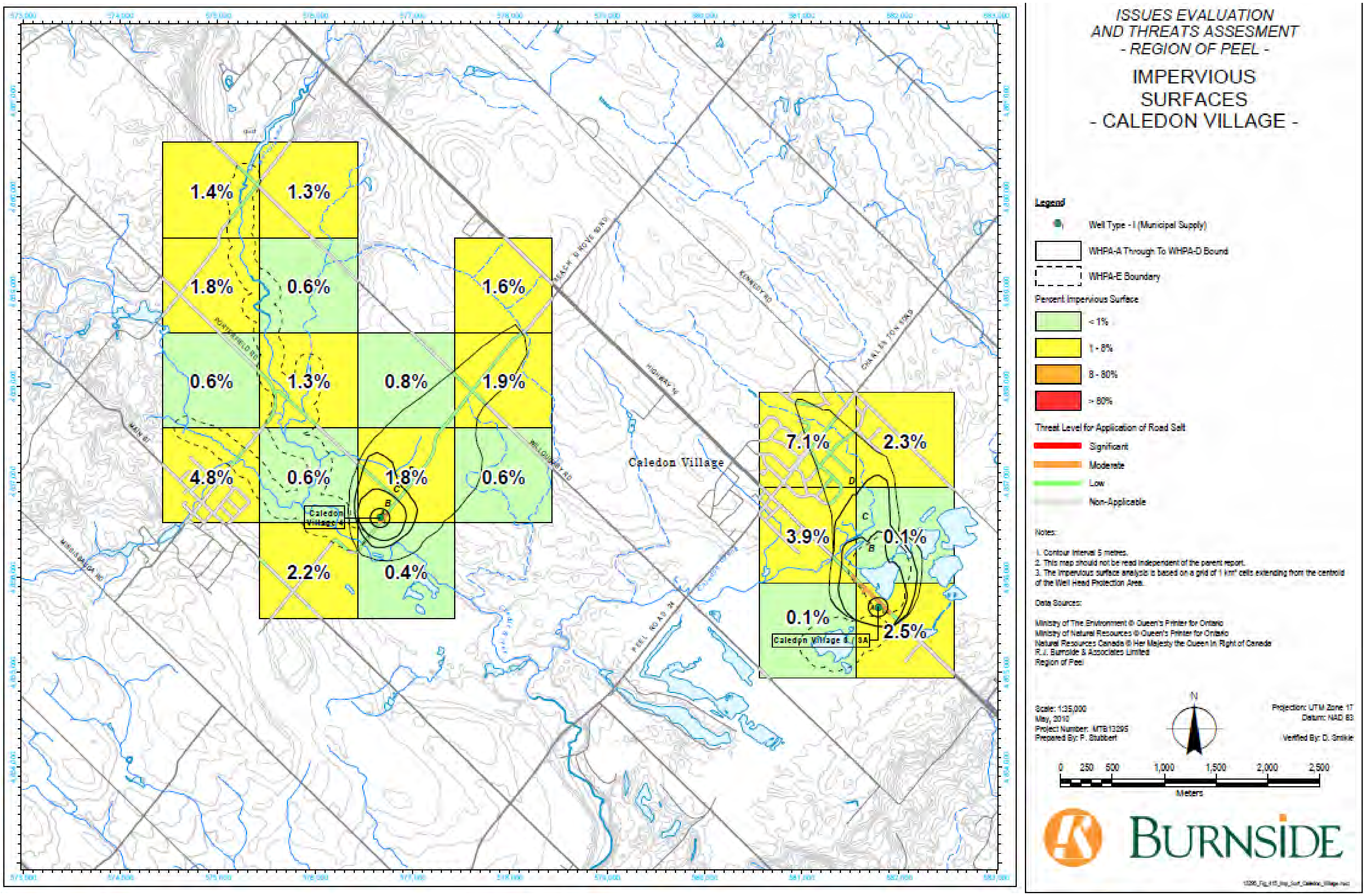


Figure E3-38: Impervious Surfaces – Caledon Village

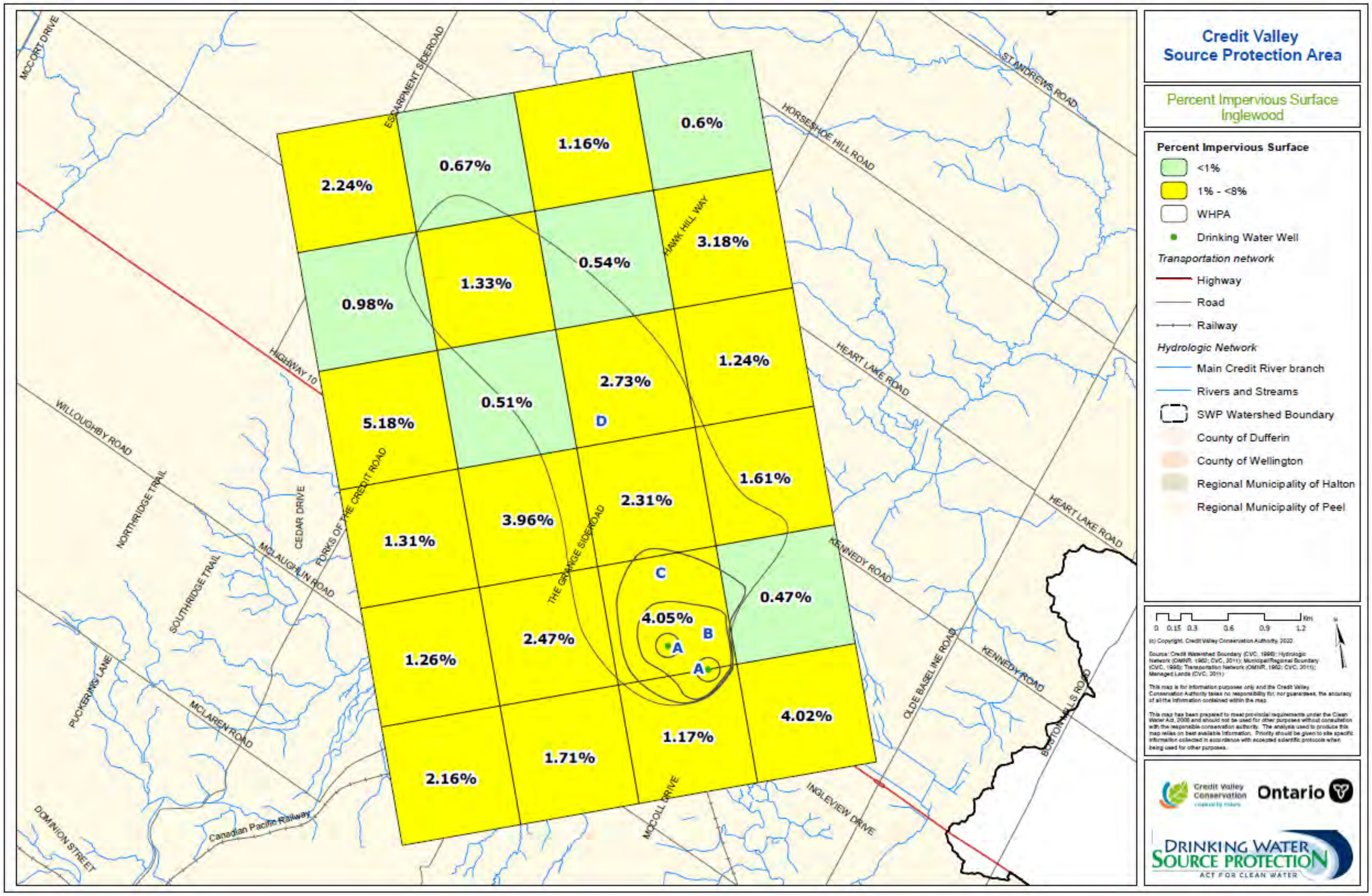


Figure E3-39: Impervious Surfaces – Inglewood

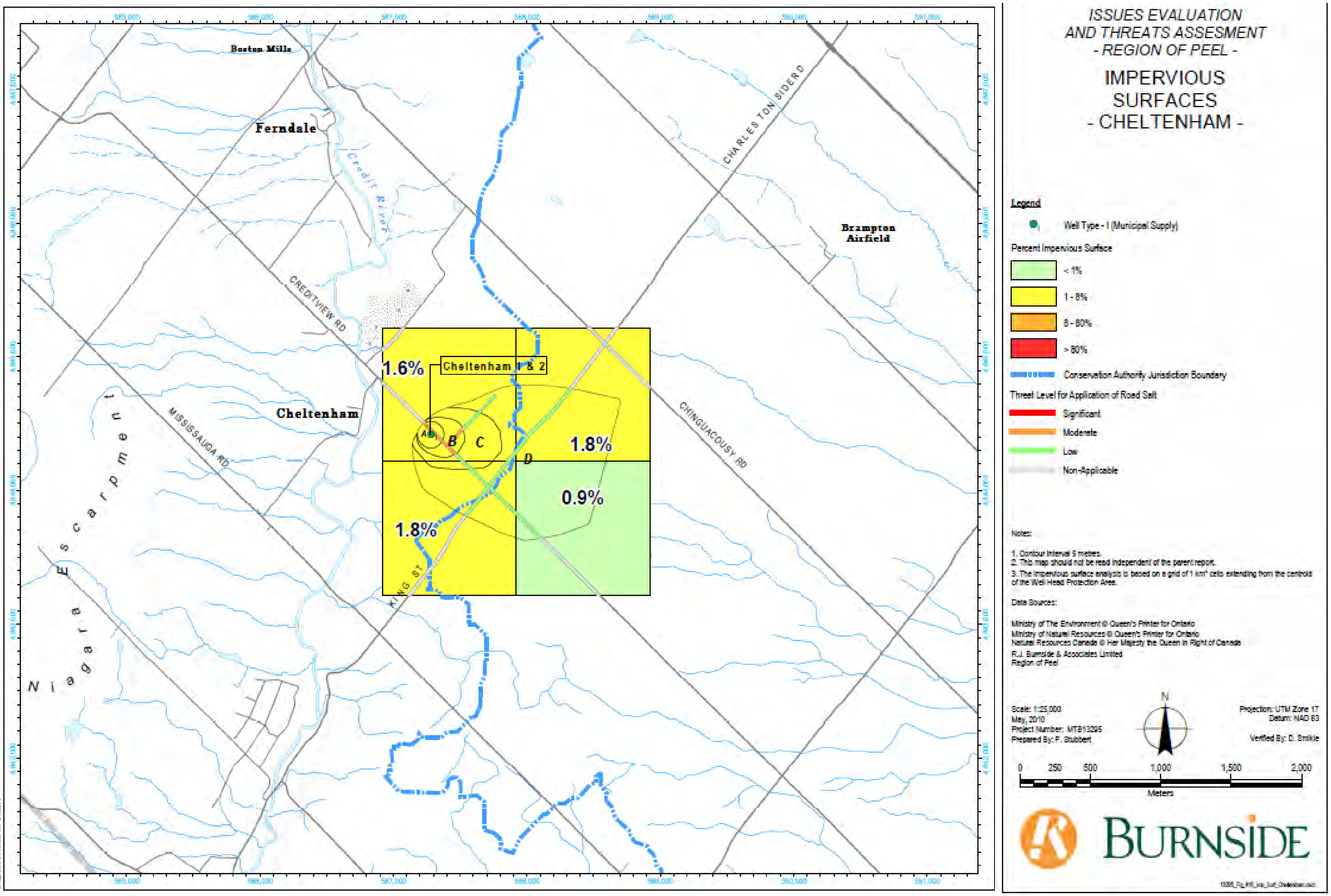


Figure E3-40: Impervious Surfaces – Cheltenham

E3.6 Methodology for Calculating Managed Land Percentage

Percent managed lands were calculated via the methodology recommended by the MOECC Technical Bulletin and are detailed in **Chapter 5**. Input data included aerial photography and satellite imagery along with GIS and MPAC data. The methodology consisted of the following key components:

- Delineation of Agricultural Managed Lands – This was completed based on MPAC codes to identify properties with agricultural land use. Areas were calculated for parcels with appropriate agricultural MPAC codes removing areas of forests, wetlands, rivers, and lakes from the calculation.
- Delineation of Non-Agricultural Managed Lands – This was completed by identifying areas of large lawn/turf areas where fertilizer/nutrients may be applied. This was completed through MPAC property code review for golf courses and residential areas. Areas were calculated for parcels with appropriate MPAC codes removing areas of forests, wetlands, rivers, and lakes from the calculation. An assumed value of 50% of residential parcel areas was used for the area calculations.
- Calculation of Percent Managed Lands – The agricultural managed land area, non-agricultural managed land area, total managed land area and percent managed land were calculated for each WHPA zone. These percentages are based on the total managed land area divided by the total land area (WHPA area and parcels that touch the WHPA).

Per the MOECC Technical Bulletin, where a portion of managed land parcel crosses a protection area boundary, the entire parcel was factored into the calculations of managed land rather than only the portion of land that falls within the WHPA. Where a property lies on the border between two WHPAs (i.e., WHPA-A and B), the parcel area was included in both WHPA zone calculations.

Table E3-9: Managed Lands – Town of Erin

Well Field	WHPA	Managed Lands (ha)	% Managed Lands	% Agricultural Managed Lands	% Non - Agricultural Managed Lands
Erin, well E7	WHPA A	73.59	61.04%	28.65%	32.39%
	WHPA B	266.60	65.31%	45.01%	20.30%
	WHPA C	537.63	73.19%	59.74%	13.45%
	WHPA D	1776.22	69.85%	63.78%	6.07%
Erin, well E8	WHPA A	65.60	75.19%	33.15%	42.05%
	WHPA B	109.50	67.13%	34.02%	33.11%
	WHPA C	196.81	63.71%	40.51%	23.20%
	WHPA D	203.23	59.79%	58.17%	1.62%
Hillsburgh, well H2	WHPA A	161.15	99.48%	97.31%	2.17%
	WHPA B	356.20	99.65%	99.12%	0.53%
	WHPA C	533.13	95.16%	95.16%	0.0%
	WHPA D*	928.73	79.63	78.89	0.74

Well Field	WHPA	Managed Lands (ha)	% Managed Lands	% Agricultural Managed Lands	% Non - Agricultural Managed Lands
Hillsburgh, well H3	WHPA A	0.0	43.0%	0.0%	43.0%
	WHPA B	45.19	100.0%	53.31%	46.69%
	WHPA C	243.52	89.98%	84.01%	5.79%
	WHPA D*	N/A	N/A	N/A	N/A
Bel Erin well BE1/BE2	WHPA A	2.5	25.55%	25.55%	0.0%
	WHPA B	97.13	89.1%	76.1%	12.9%
	WHPA C	14.5	91.2%	91.1%	0.1%
	WHPA D	N/A	N/A	N/A	N/A

N/A – denotes area not evaluated since vulnerability score is less than 6

* WHPA-D of Hillsburgh wells H2 and H3 merge. The data is reflective of this joint area

Based on the criteria thresholds, and the results, there are no significant managed lands threats in vulnerable areas surrounding Erin and Hillsburgh municipal wells, or around the Bel-Erin wells.

Percent managed lands around Erin, Hillsburgh and the Bel-Erin wells are shown below.

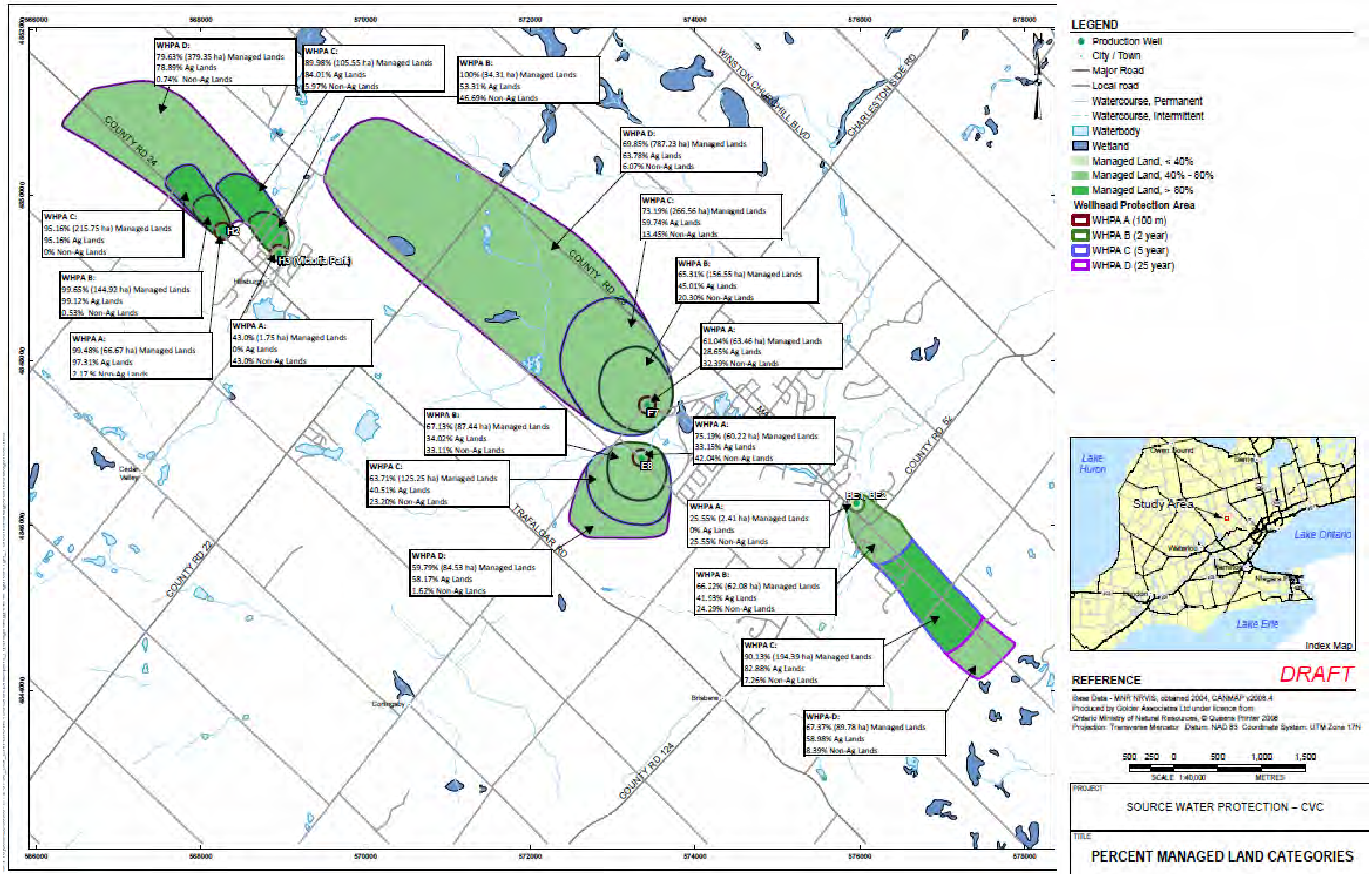


Figure E3-41: Percent Managed Land – Erin

E3.7 Methodology for Calculating Livestock Density

Livestock density was calculated via the methodology recommended by the MOECC Technical Bulletin and detailed in **Chapter 5**. Input data included aerial photography and satellite imagery along with GIS and MPAC data.

The methodology consisted of the following key steps:

- Identify agricultural properties within a WHPA based on MPAC property codes where the vulnerability was six or greater;
- Determine from Explore Wellington website, aerial photography and local knowledge, if barns exist on a property for the identified agricultural properties;
- Determine farm (animal type) from MPAC code when available. If farm type was not readily identifiable, a mixed animal type and associated NU was assumed (Table 1 – MOECC Technical Bulletin September 2009);
- Barn Size/Nutrient Unit Relationship Table in the MOECC Technical Bulletin was used to determine the maximum number of Nutrient Units for the property assuming livestock housing is at capacity;
- Sum the number of nutrient units within the WHPA; and
- Calculate the livestock density by dividing total nutrient units by the agricultural managed land in each WHPA.

Table E3-10: Livestock Density – Town of Erin

Well Field	WHPA	Livestock Density (NU/acre)
Erin, well E7	WHPA A	0.00
	WHPA B	0.08
	WHPA C	0.00
	WHPA D	0.09
Erin, well E8	WHPA A	0.00
	WHPA B	0.15
	WHPA C	0.32
	WHPA D	0.00
Hillsburgh, well H2	WHPA A	0.00
	WHPA B	0.15
	WHPA C	0.00
	WHPA D	0.02
Hillsburgh, well H3	WHPA A	0.00
	WHPA B	0.00
	WHPA C	0.00
	WHPA D	0.00
Bel-Erin well BE1/BE2	WHPA A	0.00
	WHPA B	0.44
	WHPA C	0.67
	WHPA D	N/A

N/A – denotes area not evaluated since vulnerability score is less than 6

Based on the criteria thresholds and the results, the potential for nutrient application to exceed crop requirements is inferred to be low in all vulnerable areas, except for the WHPA-C of the Bel-Erin wells, where a moderate potential has been inferred.

Livestock density around Erin, Hillsburgh, and the Bel-Erin wells is shown below.

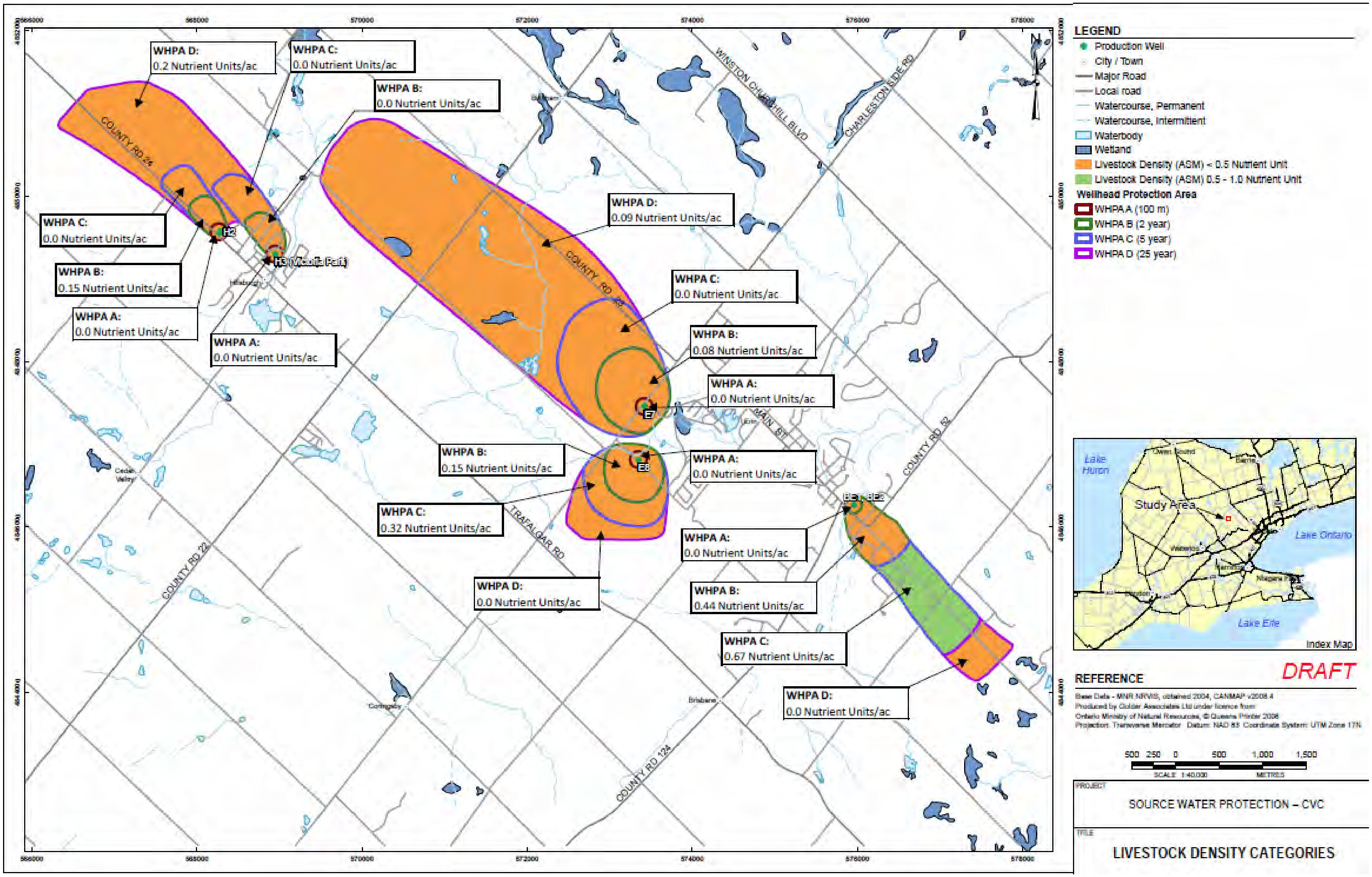


Figure E3-42: Livestock Density – Erin

E3.8 Methodology for Calculating Percent Impervious Surface

The surfaces considered in the analyses for impervious surfaces include the road networks, and areas occupied by gravel roads and large parking lots. Data were sourced from the National Road Network (Natural Resources Canada), and satellite aerial photography was used to identify roads (including gravel roads) and large parking lots.

To calculate the area of roadways an existing database layer (CANMAP v2008.4) was used to capture areas of impervious surface. A 4.5 m wide buffer was applied to the roadways to account for the paved surface. The area of impervious surface was then calculated per the *Technical Rules*.

Based on the data presented, it is inferred that the majority of the WHPAs fall within the range of 1% to 8%, which would infer a low potential for threat due to road salting, with the exception of the following, where a high potential has been inferred:

- Bel-Erin Wells, WHPA-A and WHPA-B; and
- Hillsburgh Well H-3, WHPA-A and WHPA-B.

Maps showing the percent impervious surface in Erin, Hillsburgh, and Bel-Erin are presented below.

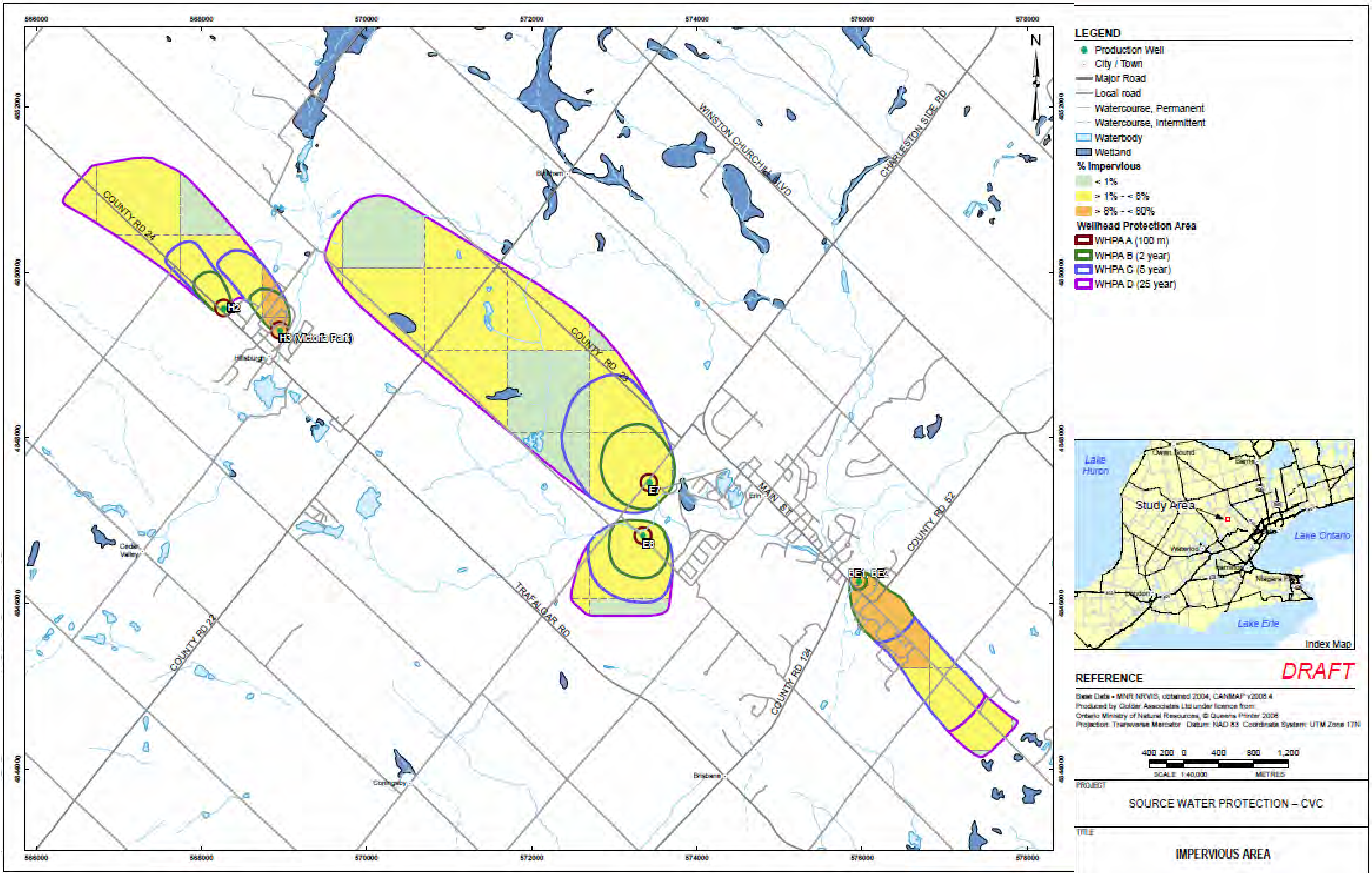


Figure E3-43: Impervious Surfaces – Erin

E4 ASSESSMENT OF THREATS TO GROUNDWATER, HALTON REGION

E4.1 Methodology for Calculating Managed Land Percentage

Percent managed land was calculated via the methodology recommended by the MOECC Technical Bulletin and detailed in **Chapter 5**. Input data included aerial photography and satellite imagery along with GIS and MPAC data. Each selected parcel was assigned a Managed Land Ratio (MLR), which is an estimate of the percentage of pervious land within a parcel i.e., land area within a parcel to which fertilizer, ASM or NASM could be applied. The two options used for assigning an MLR in this report were:

1) The MLR is indirectly estimated based on the MPAC code describing the primary land use, such as residential types, commercial and industrial types, golf courses, etc. A parcel with a typical property code is assigned a generic MLR. The Managed Land Bulletin provides an example where a parcel coded for a single family detached home in Toronto was given a MLR of 0.55 based on the maximum structure size and impervious areas (i.e., driveways) as defined in the municipal zoning by-laws. The MLRs for applicable MPAC property codes used in this report were obtained from the *Catfish Creek Proposed Assessment Report*; and

2) Where the *Catfish Creek Proposed Assessment Report* did not include an MLR for an MPAC property code applicable to this report, an orthophoto (2006) was used to estimate the percentage of pervious area for a parcel. A list of all MPAC parcel codes and related MLRs used in this report is included in **Appendix D**. It should be noted that if a parcel only partially fell within a WHPA, the entire parcel area was selected and used to calculate the MLR.

Clipping operations were then performed on the parcels to remove a) non-managed lands that included wooded areas, wetlands and water bodies and b) the portion of parcels that were outside of the HVA. The non-managed lands clipping features (i.e., wooded areas, wetlands, and water bodies) were obtained from 1:10,000 scale Canvec topographic data available from www.geogratis.ca. As this data is at a larger scale, the 2006 orthophoto was used to modify and refine several polygons to more accurately reflect the land cover. After clipping, the area remaining for an individual parcel was the total area to which the land could have commercial fertilizer, ASM or NASM applied. This area was then multiplied by the MLR for that parcel to obtain a final parcel area of managed land.

The clipped MPAC parcel shapefile was further clipped by each WHPA. The managed land area falling within each WHPA clipped area was summed to give a total managed land area. The total managed land area was divided by the total area of each WHPA, and multiplied by 100, to give the percent managed land per WHPA area.

Table E4-1: Managed Lands – Town of Halton Hills

Wellhead	WHPA	Managed Area (ha)	% Managed Land	% Agricultural Managed Land	% Non-Agricultural Managed Land
Acton					
Fourth Line	WHPA A	1.3	43.0	26.3	16.7
	WHPA B	60.9	58.6	57.0	1.6
	WHPA C	23.4	30.9	26.9	4.0
	WHPA D	29.9	39.5	36.2	3.3
	WHPA E	31.0	32.5	29.3	3.2
Davidson	WHPA A	2.1	68.1	63.8	4.3
	WHPA B	92.8	65.2	58.7	6.5
	WHPA C	55.1	68.6	66.3	2.3
	WHPA D	60.7	44.8	43.4	1.4
	WHPA E	51.2	56.1	53.4	2.7
Prospect Park	WHPA A	0.9	25.9	0.0	25.9
	WHPA B	9.8	31.0	15.1	15.9
	WHPA C	34.5	63.4	61.0	2.5
	WHPA D	97.7	64.6	61.9	2.7
	WHPA E	258.4	39.0	26.2	12.8
Georgetown					
Lindsay Court 9	WHPA A	0.9	27.4	17.6	9.8
Princess Anne 5/6	WHPA A	0.7	21.6	0.0	21.6
Cedarvale 1a	WHPA A	0.9	29.7	0.0	29.7
Cedarvale 3a/4a	WHPA A	1.6	30.7	0.0	30.7
Lindsay Court 9, Princess Anne 5/6, Cedarvale 1a/4a	WHPA B	155.2	36.7	17.5	19.2
	WHPA C	137.1	48.8	32.8	16.0
	WHPA D	262.9	37.4	27.3	10.1
Cedarvale 1a	WHPA E	146.5	31.8	8.0	23.9
Cedarvale 4a	WHPA E	159.2	32.2	6.9	25.3

Based on the criteria thresholds and the results, there are significant managed land threats in Acton, and in Georgetown.

Percent managed lands in Acton and Georgetown are shown below.

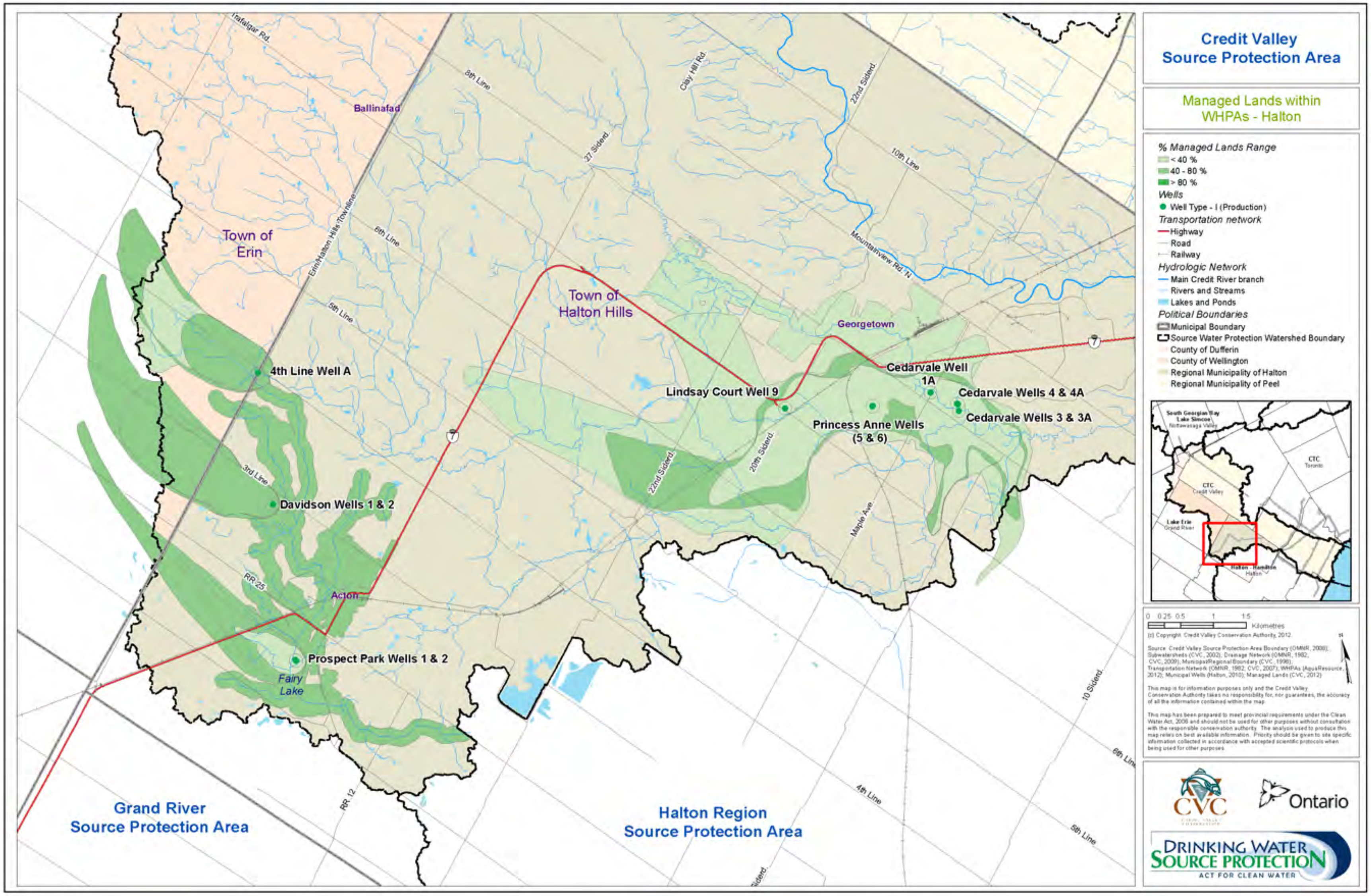


Figure E4-1: Managed Land within WHPAs– Halton Hills

E4.2 Methodology for Calculating Livestock Density

Livestock density was calculated via the methodology recommended by the MOECC Technical Bulletin and detailed in **Chapter 5**. Input data included aerial photography and satellite imagery along with GIS and MPAC data.

The first step in estimating livestock density involved determining where livestock farming took place within WHPAs. This was accomplished primarily by selection of the land parcels coded as 200-series (areas of agricultural managed lands are coded as 200-series numbers and include cropland and pasture land that may have ASM applied), in conjunction with the 2006 orthophoto provided by the CVC. Where livestock or equipment related to livestock farming was visible in the orthophoto, the MPAC parcel was coded by "farm type." Most farms in the study area produce crops or are currently not in production. Four parcels had visible cattle, and three parcels had racetracks and/or equestrian equipment visible.

The next step was to determine the barn sizes on each parcel where livestock farming took place. This was done using ArcMap's area measurement tool to measure barn area based on visual inspection of the orthophoto. The ML Bulletin provides nutrient unit (NU) conversion factors based on square footage of a barn and type of livestock. Dividing the measured barn area by the conversion factor gave total NUs on each parcel used for livestock. The total NUs were then divided by the agricultural managed area of each parcel for NU/acre. As an example, calculation, a parcel used for cattle farming has a 300 m^2 barn. Cattle farming has a NU conversion factor of 10 NU/m^2, so there could be up to 30 NUs on this farm (30 head of cattle = 300/10). The farm parcel is 600 acres, giving 0.05 NU/acre (30/600).

To determine NU/acre over each WHPA, the area of each livestock parcel that fell within a WHPA was determined by clipping the land parcel shapefile. From the previous example, 200 of the total 600 acres of cattle farm fell within WHPA-B. The farm has 0.05 NU/acre, which was multiplied by 200 acres to get 10 NUs that fall within the WHPA-B only. NUs were determined for each land parcel area falling with a WHPA and were then summed to give total NUs in each WHPA. The total NUs were divided by the total area of each WHPA, to give a final ratio of NU/acre for each WHPA.

Table E4-2: Livestock Density – Town of Halton Hills

Wellhead	WHPA	Livestock Density Area (ha)	Nutrient units / Acre
Acton			
Fourth Line	WHPA A	3.1	0.1
	WHPA B	103.9	0.1
	WHPA C	75.6	0.1
	WHPA D	75.8	0.1
	WHPA E	95.3	0.1
Davidson	WHPA A	3.1	0.3
	WHPA B	142.3	0.1
	WHPA C	80.3	0.2
	WHPA D	135.4	0.3

Wellhead	WHPA	Livestock Density Area (ha)	Nutrient units / Acre
	WHPA E	91.3	0.2
Prospect Park	WHPA A	3.4	0.0
	WHPA B	31.5	0.0
	WHPA C	54.4	0.0
	WHPA D	151.2	0.4
	WHPA E	661.8	0.1
Georgetown			
Lindsay Court 9	WHPA A	3.1	0.4
Princess Anne 5/6	WHPA A	3.4	0.0
Cedarvale 1a	WHPA A	3.1	0.0
Cedarvale 3a/4a	WHPA A	5.3	0.0
Lindsay Court 9, Princess Anne 5/6, Cedarvale 1a/4a	WHPA B	423.5	0.1
	WHPA C	280.9	0.3
	WHPA D	703.1	0.1
Cedarvale 1a	WHPA E	460.0	0.0
Cedarvale 4a	WHPA E	495.1	0.0

Based on the criteria thresholds and the results, the potential for nutrient application to exceed crop requirements is inferred to be low in all WHPAs.

Livestock density in Acton and Georgetown is shown below.

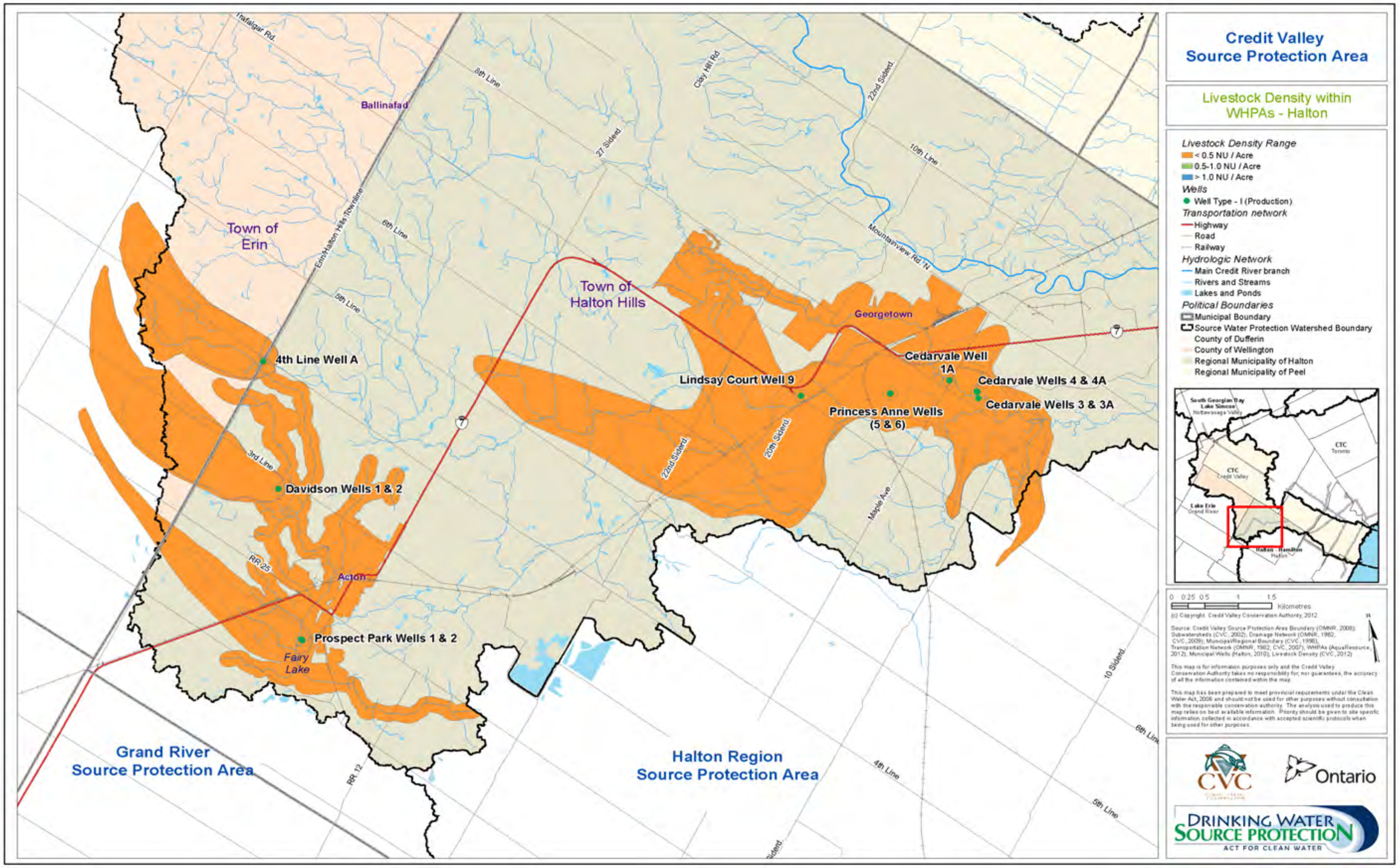


Figure E4-2: Livestock Density within WHPAs – Halton Hills

E4.3 Methodology for Calculating Percent Impervious Surfaces

The surfaces considered in the analyses for impervious surfaces include the road networks, and areas occupied by gravel roads and large parking lots. The methodology for the calculation of impervious surfaces is as follows:

- Road segment shapefiles from Canvec tiles 40P09 and 30M12 (1:10,000 scale) were approximated by using a seven-metre road width (a standard road lane width is 3.65 metres) to represent the impervious road surfaces. Other forms of impervious surfaces such as parking lots, pedestrian paths, and other surfaces that may receive salt application for melting of snow and/or ice were not considered in the analysis.
- The road buffer was then "unioned" with the 1 km square grid in ArcGIS and areas calculated for each resulting polygon of buffered road. To obtain percent impervious surface per square kilometre, the buffered road area was divided by the total area of the square kilometre grid and multiplied by 100.

Based on the analyses, it is inferred that the majority of the area fall within the impervious surface percentage range of 1% to 8%, which would infer a low potential for threat due to road salting. However, in the more developed areas, closer to the municipal wellheads of Acton and Georgetown, the percentage generally ranges from 8 – 80%, inferring a moderate potential for threat due to road salting.

Maps showing percent impervious surfaces in Acton and Georgetown are presented below.

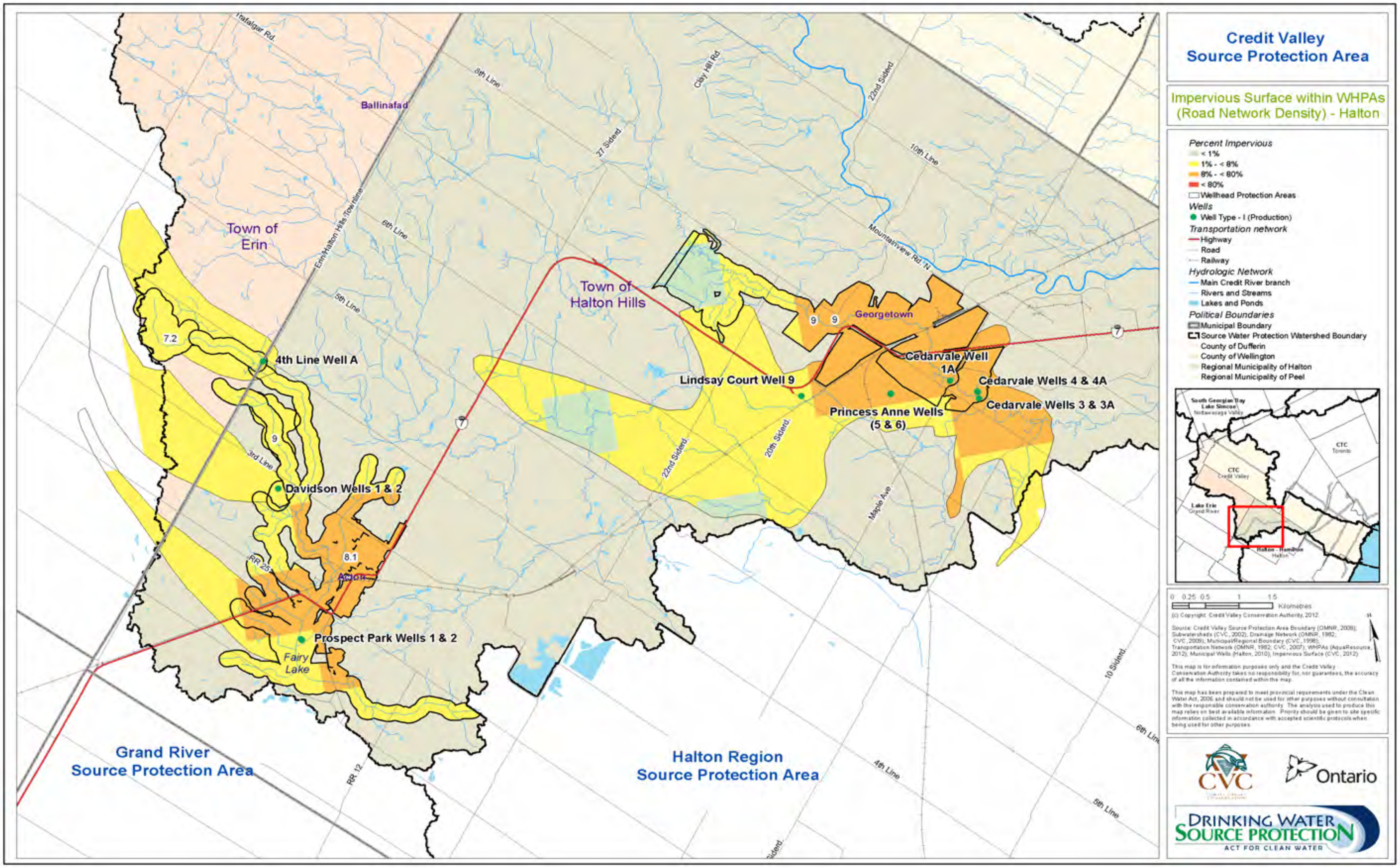


Figure E4-3: Impervious Surfaces within WHPAs (Road Network Density) – Halton Hills

E5 ASSESSMENT OF THREATS TO LAKE ONTARIO

This appendix has been prepared based on input from the Lake Ontario Collaborative, municipal staff, and consultants. The findings in this appendix have been peer reviewed. In particular, we want to thank Rodney Bouchard, Project Manager from the Region of Peel, Bill Snodgrass from the City of Toronto, and Dr. Ray Dewey, modelling consultant.

E5.1 Rationale for Using the Event-Based Approach

In a large lake system such as Lake Ontario, water quality and the sources and processes that influence water quality are not the same for the near shore area (coastal zone) as compared to that found further offshore (main lake area). In Lake Ontario the coastal zone can be considered as the area from the shoreline out to the 30 m depth contour (**Figure E5-1** and **Figure E5-2**). In the coastal zone, water quality is influenced by land based discharges (such as rivers, streams, wastewater treatment plants, and groundwater) which mixes at the boundary of the zone with the off-shore main lake waters. The rate at which this mixing of the coastal and main lake water occurs is subject to hydrodynamic forces such as prevailing wind speed and direction, water and air temperatures and the bathymetry. The source of water for Lake Ontario based municipal drinking water intakes, is in this coastal zone.

The quality of water in the main lake area is established largely by water flowing from the upstream Great Lakes (Erie, Huron, Michigan, and Superior) through the Niagara River into Lake Ontario and direct rainfall and atmospheric fallout to the lake's surface together with biochemical processes that occur within Lake Ontario. **Figure E5-1** and **Figure E5-2** illustrate the importance of protecting the water quality in the coastal zone where most of the source of drinking water is drawn from. The intake pipes are located along the near-shore (0.5 – 5 km). In the western basin of Lake Ontario, expanding urbanization has a dominant influence on the near-shore zone water quality. At current rates the population growth will be 20% in five years in the area shown in **Figure E5-2**.

This appendix provides a technical summary of the how the events based analyses were done and the findings which are the basis for the information found in **Chapter 5** of the Assessment Report. In carrying out this work, events were modelled based on large releases of contaminants associated with existing activities on land that might result in deterioration of water quality to the point that it is unsuitable for use as a source of drinking water. A number of spill scenarios were modelled as part of the Lake Ontario Collaborative (LOC) project to determine if certain land-based activities could pose a potential drinking water threat to these intakes. Any scenario that identifies conditions under which a contaminant could exceed a threshold in the raw water is identified as a significant drinking water threat. The events that were modelled were: disinfection failures at each municipal waste water treatment plant; accidental large scale release of tritiated water from nuclear power plants; product of waste spills from industrial facilities; and spills from a petroleum pipeline as it crosses major tributaries. The list of events was developed in consultation with municipal staff responsible for water and waste water, conservation authority staff and some industrial representatives

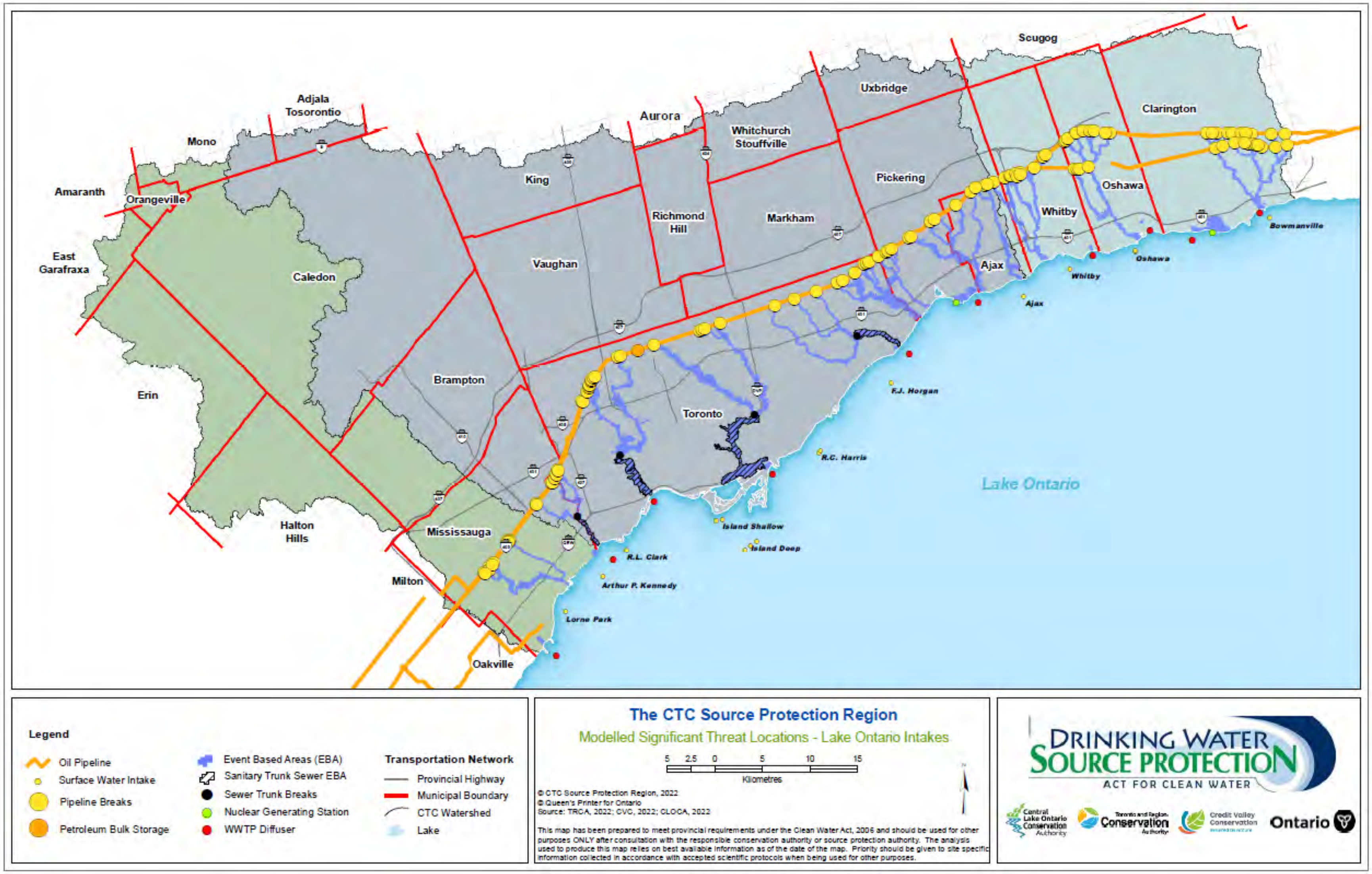


Figure E5-1: Significant Threat Location Lake Ontario Intakes – Oakville to Port Darlington

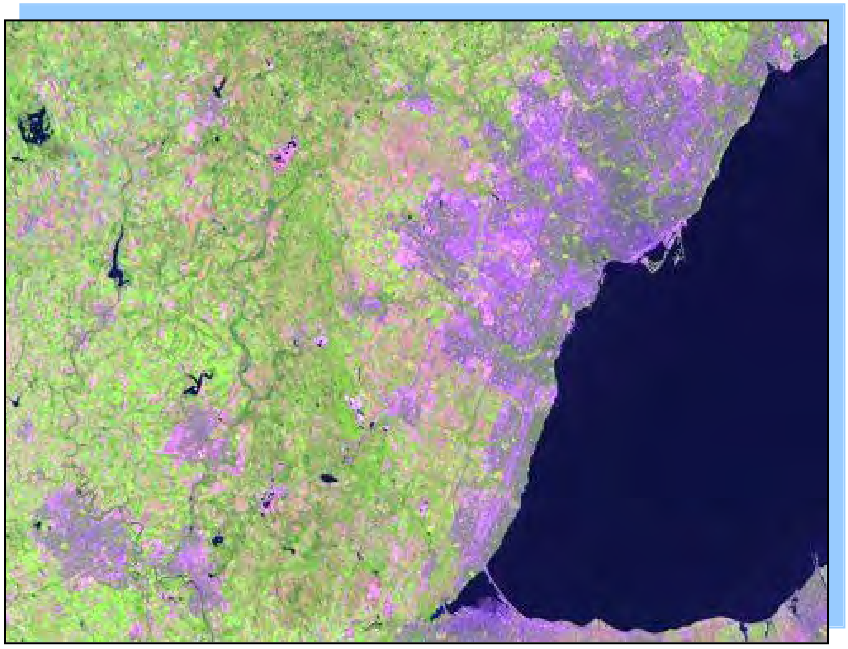


Figure E5-1: Urban (purple) and rural (green) areas adjoining Lake Ontario

This work does not represent the complete identification or analysis of all activities that might pose threats to municipal drinking water intakes in Lake Ontario. Nor does it consider the impact of ongoing or projected future discharge of wastewater or runoff from land. Rather it represents a first step in a systematic consideration of how a major spill or event from an activity which could reach Lake Ontario might impact on specific drinking water intakes. The development of a calibrated and validated three-dimensional model with which to do the events based scenario modelling also provides a tool that can be used in future to expand this type of analysis to update the respective assessment reports.

- **Section E7.2** summarizes study methods used, including MOECC published rules for IPZ-3 analyses under *Technical Rules (68 and 130),* and the approach used for the LOC (modelling methodology, the evidence-based approach);
- **Section E7.3** documents the modelling results for each intake, which provides the basis for determining what spills are significant under *Technical Rules (68 and 130);*
- **Section E7.4** describes the methodology for extrapolating the modelling results spatially as zones of contamination within Lake Ontario, especially within the near shore zone;
- **Section E7.5** presents study conclusions and summary comments on event based areas (EBA) uncertainty and next steps; and
- **Section E7.6** provides the references.

E5.2 Methods

The LOC used the event based modelling for the identification of significant threats to Lake Ontario drinking water intakes in the study area (see below for further description of the approach and applicable guidance). Under this approach, the Source Protection Committee (SPC) decides, based on local knowledge, what activities it wants evaluated through modelling.

The LOC used an impact assessment method to determine if an activity poses a significant drinking water threat by determining "whether a spill has the potential to reach surface water intake(s) at a sufficient concentration to cause deterioration in water quality (the impact)".

E5.2.1 Ontario Ministry of Environment and Climate Change (MOECC) Guidance

Context and Application for Event-based Approach

In November 2008 (and amended November 2009), the MOECC released the *Clean Water Act, 2006 Assessment Report Technical Rules* which superseded the MOECC source protection Guidance Modules. Prior to the amendments in November 2009, the vulnerability scoring methodology for Intake Protection Zones (IPZs) for Great Lakes intakes identified in the Guidance Modules and embedded in the earlier version of the *Technical Rules* did not allow the identification of significant drinking water threats for Great Lake intakes. In the amended *Technical Rules,* there is recognition that there may be circumstances where such significant threats exist and so additional rules were added to allow for the identification of such threats. *Technical Rule 130* allows the use of event-based approach for the identification of significant threats to Great Lakes water treatment plant (WTP) intakes.

The MOECC and concerned stakeholders conducted several meetings and workshops (December 2008 and June 2009) to support the development of the EBA approach, and to develop an understanding of how to undertake such an approach. This section summarizes the results of these meetings and workshops.

Figure E5-3 provides an overview of the process that can be used for assessing sources of municipal drinking water. The event-based approach applies to all Lake Ontario (Type A and B) intakes. Under this approach, the SPC decides, based on local knowledge, what activities it wants evaluated through modelling. This is an iterative process that allows identification of significant drinking water threats:

- Delineation of IPZ-3 based on current knowledge of activities and the transport of contaminants to the intake;
- Can use modelling (e.g., contaminant transport modelling / spill release scenarios) to determine whether release of contaminant would result in the deterioration of the water for use as a source of drinking water for the intake; and
- Modelling is interpreted broadly and includes "other analysis".

The IPZ-3 delineation is only required where this modelling has been completed and shows that contaminants released from activities identified by the SPC can reach the intakes at levels above the threshold established by the SPC.

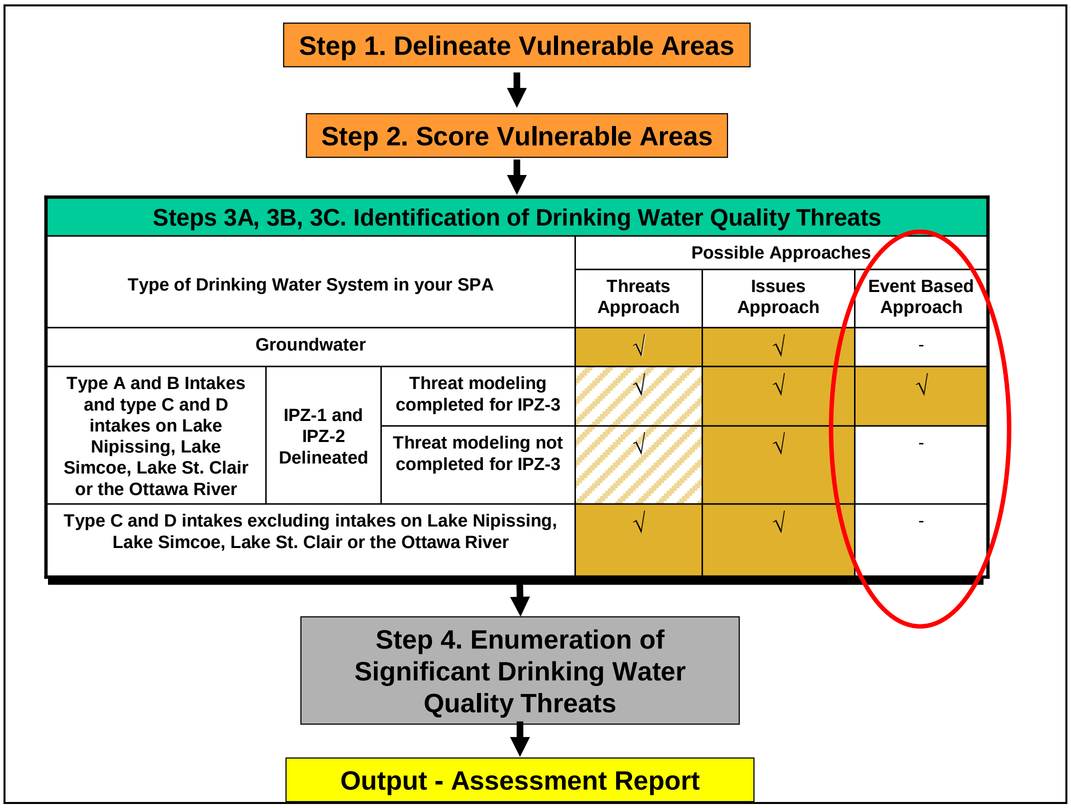


Figure E5-2: Approaches Used to Determine Significant Drinking Water Threats (Keller, 2009)

The following are the relevant sub-sections of the *Technical Rules (2009)*:

- IPZ-3 includes the areas within each surface water body through which, modelling of a failure of an “activity” demonstrates, that contaminants released during an extreme event, may be transported to the intake. *(Part VI.5 Rule 68(1));*
- IPZ-3 includes a setback of maximum 120 m setback and Regulation Limit *(Part VI.5 Rule 68(2)); and*
- Re Intake Protection Zones 3 – Definition of term, an “extreme event” means:
    - (a) A period of heavy precipitation or wind up to a 100-year storm event;
    - (b) A freshet; and
    - (c) A surface water body exceeding its high water mark (*Part I.1 Rule 1(1) - Definitions).*

Additional Information

Additional information was forwarded to participants from the September 2010 workshop and is to be taken as “published” guidance *(Letter from Heather Malcolmson, dated Nov 15, 2010 – Relevant portions are extracted* (Jacoub, 2011) and provided in the **Section E7.7**.

The formative basis relevant to the Lake Ontario analysis, developed at the September 2010 workshop includes the following:

1) A variety of methodologies were discussed, ranging from the Impact Assessment method used for the LOC through to delineation of an offshore portion of an IPZ-3, using Reverse Particle Tracking (RPT) under 10 different wind scenarios extending to the tributaries – for example Lake St. Clair;
2) The Impact Assessment method of the LOC focuses on the idea behind event-based approach for IPZ-3 delineation: "the potential for discharges that could reach surface water intake(s) at a sufficient concentration to cause an effect". It addresses the question: "during such an event, will water reach the intake from spill location; and gives an estimation of how big IPZ-3 could be as a function of each specific contaminant;
3) Based on hydrodynamics and dispersion simulations of the 1992 tritium spill from Pickering, these numerical studies suggested a 30 m water depth in Lake Ontario (a potential definition of the coastal zone of Lake Ontario) could be used (as a minimum) for delineating the offshore portion of IPZ-3. These studies would be expanded to examine the upland areas and certain activities;
4) The *Technical Rules (2009)* which govern the Event Approach, *Rules (68 and 130)*, are read together, to understand the entire picture of identifying certain activities that may release contaminants during extreme events that may reach the intake and cause deterioration to the water quality of raw water. That is, delineating of an IPZ-3 results from arrival of a contaminant of sufficient concentration to cause a concern;
5) The intent of *Rules (68 and 130)* can be confusing, especially for those professionals who are used to delineating a vulnerable area first and then evaluating a hazard score within the delineated area;
6) The main intent of *Rule (68)* is to look for a specific activity or activities that the SPC is aware of and is concerned about the release of contaminants that may cause deterioration to the water quality at the intake. The intent was not to determine the type of contaminant and then catch the activities that contribute to that contaminant. If this was the aim, a chemical parameter such as nitrogen or pathogen would be too complex to be modelled because this may result in including the entire watershed of Lake Ontario, for example, as an IPZ-3 (see **Section E7.7** for further clarification);
7) Based on understanding *Rule (130)*, an activity is classified as a significant drinking water threat if a release of contaminant during an extreme event causes deterioration to the water quality. It is up to the SPC to use whatever standard to identify where and how the word "deterioration" applies;
8) The word "deterioration" raises some concerns whether the deterioration to the raw water or the treated water. Some supported that WTP capabilities should not be a criterion in determining whether the raw water is deteriorated or not when contaminants get into the intake during extreme events at a certain concentration. Others suggested that the deterioration is meant to be impairing the water for use as a source of drinking water for the intake, which may include the treated water as well - but this meaning is embedded. However, it should be noted that the Ontario Drinking Water Standards (ODWS) refers to the treated water and not to the raw water;
9) *Rule (130)* has been amended to give the flexibility to the SPC to identify current or future activities that may be examined under *Rules (68 and 130)* using modelling approach, for all

intake protection zones: i.e., IPZ-1, IPZ-2, and IPZ-3. IPZ-3 is generated to capture an activity identified as a significant drinking water threat (SDWT) since the SDWTs must be within a vulnerable area while IPZ-1 and IPZ-2 are delineated first and then the activities are evaluated. The future activities here refer to activities that have been planned / approved to take place and their sites are known but they have not yet commenced operation (see **Section E7.7** for further clarification);

10) Evaluating contaminant – specific, locations of a spill-like discharge could result in delineating different IPZ-3s for the same surface water intake based on the type of contaminant transported to the intake. The intent of *Rule (68)* is to have one single IPZ-3 for a surface water intake (similar to IPZ-1 and IPZ-2). If more than one activity is examined and more than one contributing area is obtained as a result of modelling exercise, an IPZ-3 that merges all contributing areas should be made. If there are two intakes close to each other and their IPZ-3 overlaps, a suggested approach was to merge them together to get one IPZ-3 (see **Section E7.7** for further clarification);

11) The size of IPZ-3 was discussed. The main intent of Ministry guidance is not to have an excessively large IPZ-3 that may impact individuals unnecessarily, but the IPZ-3 should capture the activity(ies) itself. In addition, some discussants suggested that delineating the area between the activity and the intake would capture any other activities that may contribute the same type of contaminant that was the concern of capturing the main activity; and

12) IPZ-3 could be also determined through the issue approach, i.e., the other possibility for delineating an IPZ-3 for Great Lake intakes. If there is an issue at the intake, currently occurring, the activities that contribute contaminant to the issue should be identified, and their areas will be identified as Issue Contributing Areas; these areas must fall in a vulnerable area, which in this case will be an IPZ-3.

Introduction to Spill Scenario Modelling

LOC Approach

The event based approach has been used to identify whether existing facilities, such as bulk petroleum storage facilities, wastewater treatment plants, and industrial chemical facilities, are significant threats to nearby drinking water intakes. If spill scenario modelling results indicate that a spill/release from an existing facility has the potential to impact a drinking water plant (basically reach an intake) at a level that a drinking water plant needs to shut down, then that facility is automatically identified as a significant drinking water threat to that drinking water plant. There is no consideration of time of travel within the event based approach.

Event based scenario modelling can simulate events up to and including worst-case weather events (i.e., 100-year storm, wind, or precipitation) to drive the hydrodynamic model. Instead, we used normal weather conditions using actual measured data for the time during which the event was modelled. The weather conditions and dates used are identified for each scenario below.

Source of Spills

In 2009, the LOC initiated the event based approach for the purpose of identifying significant drinking water threats to the LOC municipal partners' Lake Ontario sourced drinking water plants. A list of proposed spill scenario simulations for existing facilities was developed in concurrence with municipal partners, Source Protection Committees, and MOECC. The following criteria were used to develop the list of preliminary spill scenarios for various industrial, commercial, and municipal facilities:

- Identify the location and possible materials released under normal operation and spill scenarios;
- Using calibrated and validated lake models, predict under what conditions contaminants could reach drinking water intakes;
- Predict the concentration of key parameters and assess risks using threshold concentrations for each contaminant established by the CTC SPC per MOECC *Technical Rules;* and
- Evaluate historical raw water analyses at drinking water plants to assess whether there are observed elevations of parameters that may be linked to storm events or past spill or weather conditions and to establish threshold levels for some contaminants.

Based on the above criteria and discussions with municipal and SPC partners, the following represent the generalized locations of the spills considered by the LOC:

- A disinfection system failure at each Lake Ontario waste water treatment plant (WWTP) in the study area (data for the remainder of the Durham WWTP will be provided by the LOC during the consultation period and will be included in the finalized assessment reports submitted for approval by July 27, 2011);
- Sanitary trunk sewer break caused by stream erosion in river valleys between the Rouge River and Etobicoke Creek;
- A combined sewer overflow (CSO) release in the City of Toronto;
- Release of contaminants (a spill of *E. coli*) from the lagoon of a rural industry (an industrial animal food processing facility) located adjacent to a tributary of the Credit River;
- A release of gasoline from bulk petroleum fuel storage facilities;
- A spill of gasoline/refined product from large pipelines co-located with transmission corridor across the northern part of the GTA where the pipeline crosses under the watercourses and which would discharge to the major tributaries flowing south to the north shore of Lake Ontario; and
- A discharge of tritium from the nuclear power generating stations located in the Region of Durham.

Another spill scenario evaluated by the LOC (Dewey, 2011), and not discussed in this Appendix is:

- A petroleum/chemical spill from a shipping vessel / tanker travelling across the ‘Skyway Bridge” over the Burlington ship canal.

E5.2.2 Lake and Stream Modelling Methodology

Evaluation of spill scenarios requires a water quality model for the lake and in some instances, a water quality model for watercourses, which transport a spill from an upland source to Lake Ontario.

Lake Modelling Methodology

The water quality model for the lake used the MIKE-3 computer code (Dewey, 2011) and is based on two components:

(i) Hydrodynamic component – which forecasts current speed and direction; and

(ii) Water quality component – which computes constituent concentrations (bacterial densities, radiological activity) based on mass balance theory.

A whole lake model is required to predict the water currents in the nearshore area of interest, (the coastal zone of Lake Ontario). The whole lake model used in this study is based on the DHI (formerly Danish Hydraulic Institute DHI) Water and Environment MIKE-3 model. MIKE-3 uses the full three-dimensional representation of water motion, including thermodynamics. It accurately simulates the seasonal thermal conditions and summer stratification that affects the circulation pattern in Lake Ontario, which is required for accurate predictions of water currents. The MIKE-3 model is based on a mathematical formulation known as the finite difference (FD) method. The lake is represented by a grid of squares with vertical layers. The whole lake is divided up into squares with edges 2,430 m long. Equal length vertical layers are used to represent the water depth.

The calibration process involves selecting the appropriate grid sizing, vertical distribution, wind source and other driving forces, and then adjusting the model parameters (fine tuning) to make the model predictions agree with observed data. Normally current data collected with instruments deployed in the lake are used to calibrate the hydrodynamic module. Temperature data collected at water intakes are also valuable in this process.

The major forcing function used to drive the currents in the model is wind stress. Wind speed and direction time series from Pearson Airport and other sources were used to provide the surface wind stress. The following sources of wind data have been evaluated and used in this study. Single station data such as airports are used to provide a uniform wind over the whole lake. There has been limited success with combining data from several airports, by some form of bilinear interpolation, to produce a two-dimensional (2-D) wind field. NOAA can provide a 5-kilometre grid of their North American Mesoscale Atmospheric model at 1-hour intervals. The NOAA model is a weather prediction tool, which uses observed data at stations throughout North America and is considered the most accurate 2-D wind field available for model use, but it has been available only during the 2000 decade.

Model Calibration / Validation

The ability of the model to forecast lake physics (currents, thermal character) was evaluated based on extensive calibration effort. This involved comparing model calculations with observations for near-shore current meters located off sites between Darlington and Halton, ambient temperature profiles in the main lake, and temperature data from drinking water plant intakes.

For calibration, the model was driven by NOAA wind field for 2006 and Pearson Airport wind for both 2006 and 2007. Acoustic Doppler Current Profiler (ADCP) data were available at Pickering for 2006 and 2007, and Darlington ADCP had data only for 2006.

To further evaluate the ability of the model to forecast nearshore currents within the coastal zone, the data on the tritium spills of 1992 and 1995 was used together with intake monitoring data which included Oshawa to Hamilton. Since the NOAA wind field data are not available for the early 1990's, single station data were evaluated and the data from the best station (Trenton for forecasting transport to the West) was selected.

For *E. coli,* model forecasts of *E. coli* levels in the Toronto Inner harbour were compared with observations from two field seasons (2007 – a relatively dry year, and 2008 – a relatively wet year) and used to establish the *E. coli* decay rate in the water column of the near-shore zone.

Other Comments about Modelling

For spills to watercourses, a conservative assumption was generally applied that the spill occurred at the location of the discharges to the lake, except for a spill from the 'industrial' lagoon in which a HEC – RAS simulation was used to estimate how the spill was diluted and transported down the Credit River.

A sequential peer review effort is underway; including inter-comparisons between Lake Ontario based modelling groups who used different computer codes, critique of approach and methodology by LOC staff, and a critique of hydrodynamic model calibration by two external reviewers. LOC staff provided the final interpretation of the models' calculations and implications, with input from the modelling consultant.

Lake Model Simulation Period

Both event approaches and continuous simulation approaches were used to evaluate the effects of spills. The main modelling approach used was continuous simulation.

The simulation period starts with thermal stratification of Lake Ontario, which begins after the spring thaw. Water near the shoreline warms up first and the zone of warmer water slowly spreads out as the heating from the sun increases. Water temperatures start out at 4°C and warm from there.

The maximum density of water occurs at 4°C and this density difference between water at 4°C and warmer water is the major factor in the formation of the thermal stratification. Water at 4°C will sink below warmer water (and colder water or ice). Wind mixing of the upper water column is only sufficient to keep the top 20 to 35 metres well mixed during the summer period, causing water below this depth to remain at 4°C. There will be a structured thermal distribution in the water column.

Typically, the water column would be 20°C from the surface to say 20 m, over the next 10 m or so the temperature decreases non-linearly to 4°C and from 35 m downward the water is a constant 4°C. The spatial distribution of the layers is not even, typically a dome forms in the lake with the warm layer thinnest in the center of the lake and thickest at the shoreline.

When the lake is stratified, wind stress affects the lake differently than when the lake is isothermal as in the spring and fall. Upwelling and downwelling events occur during stratification, which cause cold deep lake water to flow toward the north shore displacing warmer water with clean fresh cold water; downwelling has the opposite effect. These events are not predicted by two-dimensional models, which is why three-dimensional models are used.

In order to cause warming and cooling of the water in the lake, a thermodynamic balance is required. The heat balance is controlled by latent heat loss by thermal radiation to outer space and evaporation and heat gain by solar radiation (long wave and short wave) and conduction from surface air. The physical parameters required for these calculations are: relative humidity, cloud cover, and air temperature. Hourly time series data for these parameters measured at Pearson Airport and other sources were used in this study.

To accommodate the effects of across lake transport while providing the spatial resolution needed within the near shore zone, three or four different sizes of linked meshes are used as illustrated in **Figure E5-4** and **Figure E5-5**. All in-lake spill scenario modelling was conducted using the MIKE-3 and is reported in Dewey (2011).

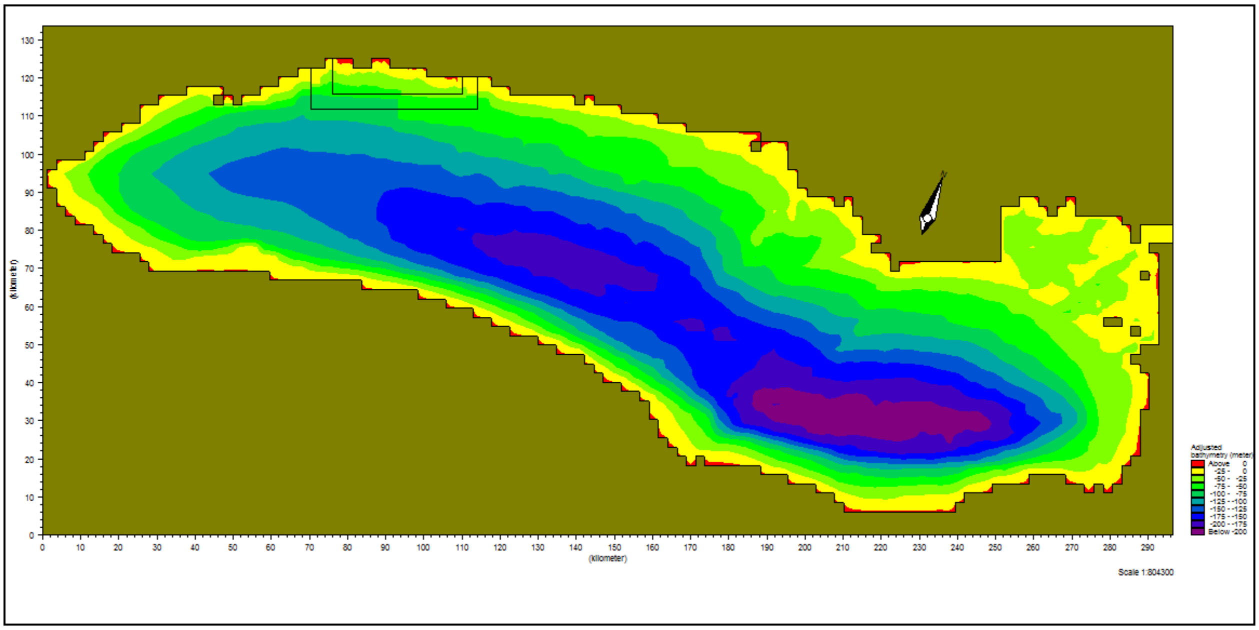


Figure E5-3: 2430 m whole lake grid with nested grids

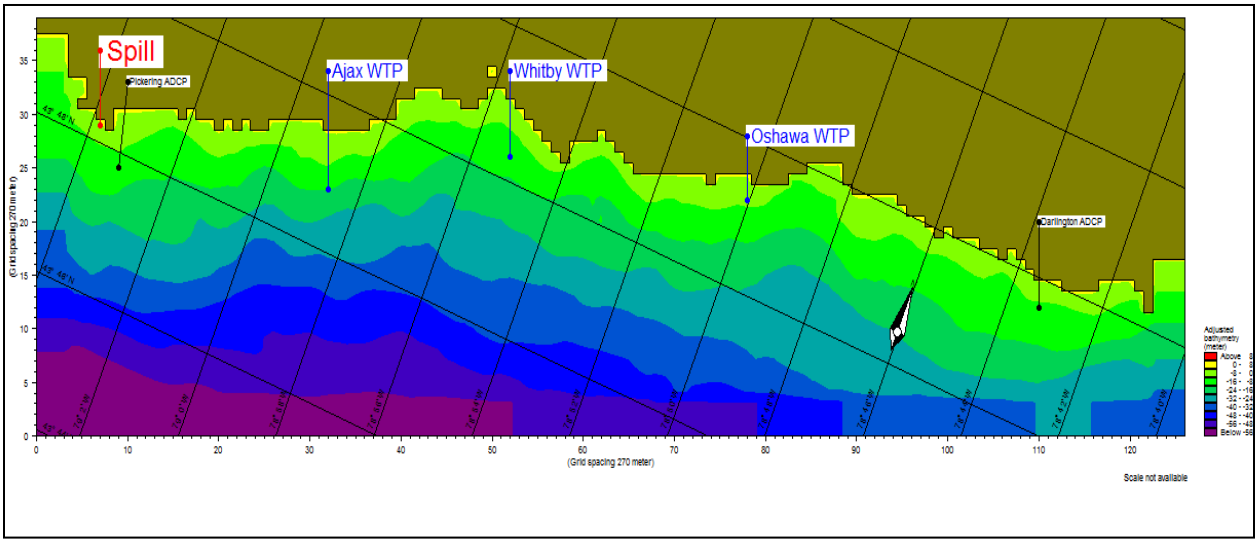


Figure E5-4: 270 m nested grid with ADCP locations

Lake Current Directions

The current rose calculated by the model is displayed for two locations, to assist the reader in understanding the similarities and differences along the Lake Ontario coastline.

Figure E5-6 shows the current distribution offshore of Etobicoke and **Figure E5-7** shows the currents offshore of Pickering. The Etobicoke currents are generally equally distributed to east and west currents with higher speed events flowing westward - possibly due to the larger fetch from the east. The equal distribution would indicate that there is not a stable eddy in the western basin. The Pickering currents are biased to easterly flows in the majority and with stronger speeds over the period. This current distribution with the major easterly flow would indicate a clockwise eddy in the central basin.

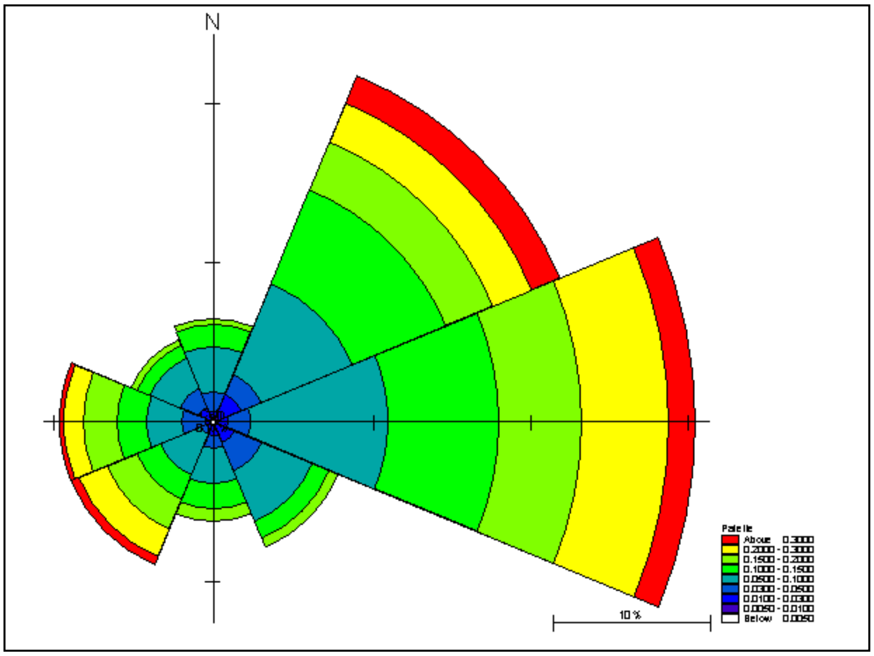


Figure E5-5: Calculated Current Compass Rose in Etobicoke section of Coastal Zone

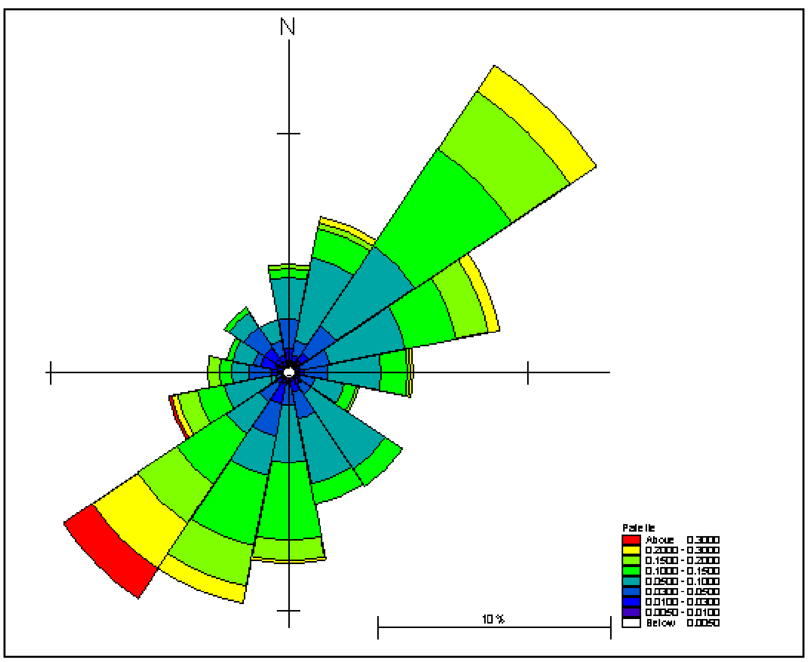


Figure E5-6: Calculated Current Compass Rose in Pickering section of Coastal Zone

River / Stream Modelling Methodology

River and stream flow modelling was undertaken to estimate 2-year and 100-year return event (storm flows) to calculate travel-time for contaminants released in major tributaries to reach Lake Ontario. This was completed to support spill simulations for evaluation of drinking water threats from industrial pipelines and facilities located along these tributaries.

Conservative tracer-based travel-time estimation was proposed for 24 selected tributary and petroleum product pipeline intersection sites. The travel-time was estimated using U.S. Army Corps of Engineer's HEC-RAS 4.1 model. HEC-RAS model is a hydraulic model, which is widely used for floodplain delineation by conservation authorities. Recently the developers of the model introduced a water-quality module to this model. The new module allows travel-time estimation of conservative tracer and other pollutants between two points of interest. The HEC-RAS modelling was undertaken by the staff of the conservation authorities for the selected tributaries within their specific jurisdiction. The travel-time estimates were received from the participating agencies and the results are presented in **Table E5-1** and **Table E5-2**.

The travel-times are a function of the distance between the river and oil-pipe intersection and mouth of the river at Lake Ontario, size of the river, drainage area, and velocity of flow. The travel time for 2-year flows ranged from 0.41-9.75 hrs. and for 100-year flow, ranged from 0.34-7.99 hrs. The results indicate that the travel-times are short enough that if there is a breach in the oil pipeline close to a river, the miscible constituents of oil will reach Lake Ontario quickly. Therefore, the dominant impact of a spill from a pipeline to the intakes in Lake Ontario is the quantity that leaks into a watercourse and the duration of a spill.

E5.2.3 Description of Scenarios Used in the Evidence Based Approach Modelling

An evidence-based approach has been used by LOC to undertake these spill scenarios. When possible, past events, such as a pipeline spill near a waterbody, have been used to inform the spill scenarios being undertaken. Further, actual facility data (e.g., bulk petroleum facility tank volume and contents) has been incorporated into each scenario.

It should be noted that identification of significant threats did not consider any regulated risk management requirements. Current risk management measures and the adequacy of existing regulatory requirements will be considered in the development of the Source Protection Plan. Source Protection Plans are required to reduce or eliminate threats to drinking water.

The following describes the details of the parameters used for each scenario.

Wastewater Treatment Plant (WWTP) Disinfection Failure Scenario

The setting of a wastewater treatment plant is illustrated in **Figure E5-8** together with the regulatory and best practices framework in place. For purposes of spill evaluation, the spill was modelled as a release from the outfall located at the specific offshore distance for each WWTP site.

WWTP scenarios are based on a 4-month process breakdown in treatment plant that results in secondary treatment by-pass for that duration of time in summer months. This scenario is loosely based on an event that occurred at one of Peel's WWTPs several years ago which was the result of a large discharge of orange juice into the sanitary sewer that effectively shut down the biological treatment process at G.E. Booth (formerly Lakeview) WWTP for several months. For each WWTP, actual flow data for the WWTP obtained from each municipality was used for the simulation. For source protection plan development, the scenarios can be re-evaluated using a shorter process breakdown period such as 1 week or 60 days.

Table E5-1: Travel Time for 2 Year Recurrence Flow Conditions

Tributary	Travel Time (hr)	Distance (km)	Average Flow Velocity (m/s)	Average Discharge (m^3/s)
Twenty Creek	5	20	1.10	28.60
Joshua Creek	0.68	3	1.17	23
16 Mile Creek	1.13	5	0.70	159.90
Sheldon Creek	0.68	4	1.17	18.70
Shoreacres Creek	0.43	3	1.84	28.60
Credit River	2.25	13	1.60	120
Etobicoke Creek	0.73	7	2.76	137.20
Humber River	2.93	15	1.43	175
Don River	0.41	2	1.45	160.30
Rouge River	2.33	12	1.38	53.42
Petticoat Creek	2.01	11	1.53	11.99
Duffins Creek	3.99	14	0.99	69.50
Carruthers Creek	8.22	13	0.44	13.20
Lynde (Heber Creek)	9.24	22	0.67	16.88
Lynde Creek	9.75	25	0.70	24.05
Oshawa Creek	2.80	17	1.66	34.89
Harmony Creek	3.25	14	1.20	23.44
Farewell Creek	4.40	17	1.07	17.20
Black Creek	2.47	14	1.58	26.89
Wilmot Creek	1.64	8	1.27	11.90
Graham Creek	4.77	12	1.11	7.30
Ganaraska	1.44	7	1.61	64.30
Cobourg Creek West	3.60	10	1.29	13.30
Cobourg	4.13	10	1.11	13.30

Table E5-2: Travel Time for 100 Year Recurrence Flow Conditions

Tributary	Travel Time (hr)	Distance (km)	Average Flow Velocity (m/s)	Average Discharge (m^3/s)
Twenty Creek	2.10	20	2.70	175.20
Joshua Creek	0.72	3	1.11	58
16 Mile Creek	0.87	5	0.92	311.10
Sheldon Creek	0.55	4	1.45	68.35
Shoreacres Creek	0.42	3	120	175.20
Credit River	1.50	13	2.40	557
Etobicoke Creek	0.56	7	3.59	467
Humber River	1.78	15	2.36	573
Don River	0.34	2	1.75	492.50
Rouge River	1.72	12	1.86	202.67
Petticoat Creek	1.57	11	1.96	45.16
Duffins Creek	3.47	14	1.14	244.80
Carruthers Creek	4.21	13	0.85	54.65
Lynde (Heber Creek)	7.60	22	0.81	86.54
Lynde Creek	7.99	25	0.85	114.69
Oshawa Creek	2.16	17	2.15	163.77
Harmony Creek	5.28	14	0.74	78
Farewell Creek	6.25	17	0.76	17.20
Black Creek	1.76	14	2.22	77.89
Wilmot Creek	1.23	8	2	49.10
Graham Creek	2.59	12	1.68	34
Ganaraska	0.96	7	2.90	425
Cobourg Creek West	2.87	10	2.11	59
Cobourg	3.27	10	1.87	59

Figure E5-7: Illustration of WWTP site located on shore of Lake Ontario.

Future modelling evaluations during the source protection plan development phase could consider the likelihood of the spill characteristics and running other scenarios. The source protection plan development will consider the effectiveness and adequacy of risk management measures that are in place.

In terms of microbial risk from pathogens in LOC intakes, this report has focused on *E. coli* as the main indicator of risk, as there are accepted numerical water quality limits for drinking water. In addition, a limited study has been undertaken to develop an understanding on the levels of pathogens such as *Cryptosporidium* and *Giardia* at intakes in Peel Region and the nearby Toronto intake. A scoping level evaluation using Quantitative Mircobial Risk Assessment (QMRA) techniques was undertaken by Peel Region. The QMRA study, conducted as an exploratory project, suggests that it is possible to obtain preliminary assessment of risks and the health burden to population considering both levels in raw and treated water. However, the study authors point out the need for additional professional effort and sampling to refine the coarse estimates and to relate the observed intake levels to specific sources of contamination and to effectiveness of water treatment. The results are being compiled into a comprehensive LOC study report to be made available in the summer of 2011.

Stream Erosion Causing a Sanitary Trunk Sewer (STS) Break

Figure E5-8 illustrates STS infrastructure which is vulnerable to stream meandering, bank erosion, or bed incision. A break of the Highland STS occurred on August 19, 2005.

Figure E5-8: Picture and Location of STS erosion in Highland Creek watershed caused by Aug 19th, 2005 storm extreme weather event

The simultaneous spill from four STS locations (in Etobicoke Creek, Humber River, Highland Creek and Rouge River) was simulated as a sewer pipeline break occurring due to an intense rainstorm; the simulation used a 24-hour break, and estimated *E. coli* and TSS concentrations. The sanitary trunk sewer (STS) spill was based on the result of the intense rainstorm of August 19, 2005 event increasing flow in Highland Creek changing the course of the creek and eroding the bank supporting the sewer, which broke, releasing raw sewage. The rainstorm occurred mainly between 3 p.m. and 6 p.m. in the Highland Creek watershed on August 19, 2005. The break was located on Monday morning August 22, 2005, after flood flows had decreased sufficiently to identify the break point. The break was isolated in the early evening by redirecting flow from the broken point back into the STS. Thus, it is estimated that the break occurred for about 3 days, before interception was complete.

In order to model potential impacts on Lake Ontario drinking water plants, two scenarios were evaluated. The first simulated a simultaneous break in each of the STS systems (Etobicoke Creek, Humber River, Highland Creek, and Rouge River), based on a 24-hour spill occurring on August 19, 2005 (i.e., estimated river flows and lake currents of that period).

The second scenario simulated a series of simultaneous 24-hour breaks in each of the above STS systems occurring at 5-to-6-day intervals between May and August, 2005. The purpose of this scenario was to capture different river flow and lake current conditions. This was a simulation technique used in lieu of seventeen separate computer runs. Because of the decay rates used for the attenuation of *E. Coli* in the model and dilution from onshore and offshore currents, these simulations did not result in a cumulative assessment of the *E. coli* concentrations (i.e., there was no build-up of *E. coli* from the multiple discharges over the summer simulation period).

For both scenarios, it was assumed that the following design flows and discharge points applied:

- York-Durham STS (1.8 m^3/s; discharge to the Rouge River);
- Highland STS (0.6 m^3/s ; discharge to Highland Creek);
- West Don STS (2.2 m^3/s; discharge to Don River);
- Humber STS (1.77 m^3/s; discharge to Humber River); and
- N – E Lakeview STS (1.4 m^3/s; discharge to Etobicoke Creek).

The spill rates from each trunk sewer were estimated at approximately 50% of the design flow in each system, at an *E. coli* density of 5,000,000 CFU/100 ml. (Refer to Dewey, 2011 for details).

Combined Sewer Overflow (CSO) Spill

In older parts of Toronto, some combined sewers discharge to rivers or directly to Lake Ontario during heavy rain events, when the WWTPs cannot handle the volume of incoming wastewater. The picture below (**Figure E5-10**) of the Humber River plume from the May 2000 storm (which caused the tragedy in Walkerton) shows how material is transported out into the nearshore area.

The CSO spill was simulated as a set of overflow events which occurred in 2008 due to the high rainfall. The watershed simulations were generated using the city's watershed modelling tools (HSPF for the Don River System; INFOWORKS for the CSO Service area where it discharges either into the Lower Don River or into the Inner Harbour) (MMM, 2011). These models have been calibrated to water quality measurements in the Lower Don River. The MIKE-3 model was calibrated to the Inner Harbour data for the years 2007 and 2008 (Dewey, 2011).

The effects of CSO spills associated with the 2008 rainfall pattern were simulated from the discharge points (Lower Don River, Inner harbour), flowing through the Inner and Outer Harbour, and transported by lake currents out to the different intakes for the period of April to August 2008.

Figure E5-9: Discharge from Humber River into Lake Ontario Following a Major Storm in May, 2000

The combined sewer system overflow emulates spill-like events that occur in older downtown areas such as Toronto (and other similar urban areas) based on calibrated models which forecast the volume and timing of overflows at the Toronto waterfront. The main areas within the Lake Ontario watershed, which have combined sewer systems from which spill events could occur, are largely contained within the downtown areas of Toronto and Hamilton. Other municipalities have been built largely with separated sewer systems.

The *E. coli* model was calibrated (Dewey, 2011) by using the forecast time series for the Don River and combined sewer overflows to the Toronto Inner Harbour to define *E. coli* loadings to the Inner Harbour and comparing calculations and observations for 2007 (a 'dry' year) and 2008 (a 'wet' year). This model was used to forecast the *E. coli* levels at nearby drinking water plant intakes (R.L. Clarke, Island, R.C. Harris, and F.J. Horgan) for the summer period of 2008.

Spill from Wastewater Lagoons at Industrial Food Processing Facility

Figure E5-11 shows an industrial animal food processing complex and the water management/lagoon system. Wastewater from the animal food process undergoes tertiary treatment for removal of phosphorus, nitrates, and pathogens (e.g., *E. coli*). The wastewater is stored in lagoons and flows into two equalization basins with a total storage volume of 105,600 m^3. The spill scenario was based on a breach in the lagoons with 50% of the stored partially treated (before tertiary treatment) wastewater reaching Levi Creek (tributary of the Credit River) within 24-hours. The spilled wastewater was assumed to contain *E. coli* at a level 5,000,000 CFU/100mL. The spill scenario was modelled with the release occurring at different times over the simulation period to assess the effects during most of the possible in-lake current regimes. The time of travel and subsequent dilutions of the plume down the creek eventually reaching Lake Ontario was simulated using the HEC- RAS model as the spill travelled down the river.

Figure E5-10: Industrial Animal Food Processing Lagoon

Pipeline Rupture Spill Scenario

The picture (**Figure E5-12**) below shows a pipeline crossing a water course.

Figure E5-11: Location of Pipeline Crossing below Representative Water Course in GTA Area
Note: (orange posts on right – hand bank mark crossing location of one pipeline; another pipeline crosses upstream (near-field) below gravel bar located in middle of water course). The watercourse at this specific location is eroding downward, causing loss of cover above the pipeline.

The pipeline break was modelled as a six-hour event with event dates occurring about 1.5 days apart. This method provides a typical lake response and does not rely upon selected directional events. There are a series of pipelines that transport various petroleum products between Montreal and Toronto, Clarkson (Mississauga), Oakville, Nanticoke, and Sarnia. In the CTC watersheds, pipelines are generally co-located with electrical transmission corridors. Products flow from both east to west, and west to east. There are four companies in the CTC with pipeline systems located within the transmission right-of-ways. The pipeline that has been used for spill scenarios is the mainline that runs from Toronto to Montreal carrying refined products. Spill scenarios were simulated for release of product as the pipeline that crosses underneath each of the major tributaries that discharge to Lake Ontario.

The basis for selecting the magnitude of the spill for this scenario was the pipeline spill that occurred near Kalamazoo, Michigan in summer of 2010. Available information indicates that approximately 19,500 barrels of oil (equivalent to approximately 3,028,329 litres) was released into a creek, which ultimately made its way into Lake Morrow and then to the Kalamazoo River – a main tributary discharging into Lake Michigan. The pipeline company information is that the rupture was found near Marshall, Michigan in a 30-inch line carrying 30,000,000 litres/day of synthetic, heavy, and medium crude oil from Griffith, Indiana to Sarnia, Ontario. The spill occurred from a ruptured seam approximately five feet in length on this pipeline which was put into service in the late 1960s.

The estimates for quantity of petroleum product, which could spill, were based on the following information. Initial information obtained for pipelines in Ontario indicates that a 30-inch diameter petroleum products pipeline is used for shipping various finished products such as gasoline and extends east-west along the entire GTA and Lake Ontario north shore area. Additional specific information is available from various web sites. Section 2.2.1 of the report at the following webpage (http://www.neb-one.gc.ca/clf-nsi/rnrgynfmtn/nrgyrprt/trnsprttn/ trnsprttnssssmnt2009/trnsprttnssssmnt2009-eng.pdf), provides the following information on the pipeline which transports refined petroleum products west from Montreal to Toronto and operates bi-directionally between Toronto and Oakville, Ontario. This pipeline also transports refined products from a refinery at Nanticoke, Ontario east to Toronto. Figure 2.10 shows that in the first quarter of 2009, the pipeline throughput averaged 34,900 m^3/d (220 Mb/d) of petroleum products. The pipeline is generally operating at capacity.

Based on information from the report found at http://publications.gc.ca/collections/collection_2009/bst-tsb/TU3-8-02-2E.pdf indicates that the pipeline is 273.1 millimetre in diameter (approx. 10-inch). The capacity of pipeline is difficult to calculate because it has multiple delivery locations and different capacities on each segment of the pipeline. For example, from Montreal to Farran's Point the capacity is 21,000 m^3/d (132 Mb/d); from Farran's Point to Belleville the capacity is 11,500 m^3/d (72 Mb/d); and, from Belleville to Toronto the capacity is 10,000 m^3/d (63 Mb/d).

For purposes of the LOC event simulations, our scenarios use the lowest rate identified above of 10,000 m^3/d. Regular gasoline, 87 Octane, has between 0.5 and 1% benzene, added to increase the octane number. Assuming a 1% concentration, then 0.00125 m^3/s of pure benzene could be spilled during a pipe rupture. The pipeline flow was assumed to mix with the river flow and discharge at the mouth of the river. Benzene is miscible in water, and it is assumed that the benzene in the gasoline will fully mix in the river water.

The temperature in the tributaries was set constant at 20°C, as was the temperature of the gasoline in the pipeline. Different lake temperatures were used by the model, starting from 4 °C isothermal at start up and through to developing the summer stratification. The pipeline break was modelled as a six-hour event. The event dates were randomly chosen - usually about 36 hours apart. This method provides a typical lake response and does not rely upon selected directional events.

Future modelling evaluations during the source protection plan development phase could consider:

(i) Effects of management measures which would reduce the length of a spill, due to spill detection systems and isolation technologies; and

(ii) Effects of spills caused by different means other than pipeline rupture due to failure of the pipeline, e.g., pressure failure, a low loss rate caused by a weep or corrosion pit, or riverbed erosion.

Bulk Petroleum Storage and Handling Spill Scenarios

Two types of spill scenarios were simulated for petroleum product storage facilities located near the lakefront in Oakville, as well an inland facility in North York. An example of a bulk petroleum storage facility is illustrated in **Figure E5-13**.

Figure E5-12: Example of Petroleum Fuel Storage near a Water Body

The first series of scenarios simulated a spill from a large gasoline storage tank. The size of the tanks was based on the Oakville facility. A recent site plan (2010) for this Oakville site was obtained and it indicated that the largest gasoline storage tank was 26 million litres. The site plan also indicates that transport pathways, both natural and man-made, connect the facility to Lake Ontario. For the North York location, travel through the storm sewer network and into the tributaries was estimated using the same approach as was used in the pipeline rupture scenarios described above.

These scenarios were based on the complete loss of product from the largest gasoline storage tank at the facility with benzene present in the product. The release of the 26 million litres of gasoline was assumed to occur over a 1-hour period. Regular gasoline, 87 Octane, has between 0.5 and 1% benzene, added to increase the octane number. Assuming a 1% concentration; 260,000 litres of pure benzene would be released during the spill. It was assumed that the benzene in the gasoline was fully mixed in the river water. The scenarios considered both easterly and westerly wind and current events that approach the 2-year return period.

To sample a range of lake currents over a range of wind events, both easterly and westerly, the modeling was based on a series of spills, occurring about 5 to 6 days apart. It is recognized that benzene disappears from water over time (e.g., physiochemical processes). This decay rate for benzene is included in the model to ensure that there is no accumulation of benzene concentrations over the modelling period. The simulation period was from May 15, 2006 (with isothermal conditions of 4° C) to August 10, 2006. The spill from the Oakville facility was modelled as a discharge from Bronte Creek to Lake Ontario, while the spill from the North York site was modelled as if the product discharged from the mouth of either the Don or Humber rivers, because the storage spills are located on the watershed divide between the Humber and Don rivers.

A second series of scenarios was simulated to represent small volume and duration spills from a ship loading gasoline at the pier of the Oakville Storage facility. Again, benzene was assumed to be present at 1% in the gasoline. Three scenarios, with the following volumes of gasoline spillage, were simulated:

1. 20,000 L released in 15 minutes (200 L of Benzene);
2. 50,000 L released in 15 minutes (500 L of Benzene); and
3. 100,000 L released in 15 minutes (1000 L of Benzene).

Pickering and Darlington Tritium Spill Scenario

The tritium spill release scenario is based on an actual tritium release event that occurred from in the summer of 1992 from the Pickering Nuclear Plant (**Figure E5-14**). The spill started on August 2 at 4:00 am, continuing for six hours at a release rate of 0.000119 m^3/s of tritium-contaminated water resulting in a total release volume of approximately 2900 kg. The estimated tritium concentration in the discharge was 7.9 $x10^{11}$ Bq/kg = Bq/L. Tritium levels were measured at the water intakes and shoreline locations along the north shore of Lake Ontario for several weeks after the event. These observations were reported in Report NA44-REP-03483.2-0021-R00, 1994, OHN.

Initially the tritium plume moved eastward, impacting the Ajax intake. Then the winds shifted, and the plume reversed course, travelling west. Tritium was then detectable at all of the drinking water intakes as far as Hamilton.

Figure E5-13: Illustration of Site for Tritium Spill

The actual tritium data measured at the intakes during the 1992 event were used to calibrate the MIKE-3 model which has been used for all the spill scenario modelling events described in this appendix. For the tritium spill scenario, the actual event was recreated in the model and the model results were within acceptable limits for calibration purposes. The model was also run to simulate easterly current conditions to evaluate what effects the tritium spill would have on municipal intakes east of the spill locations.

Spills from the Pickering facility were considered as the primary scenario because the cooling water discharge is located near the shore, and the spill of tritiated heavy water was into the cooling water stream.

To assess the potential impact of the other nearby nuclear generating station, the scenario was modelled using the same size spill as occurred in 1992 but the spill was modelled entering Lake Ontario through the cooling water discharge diffuser, which is located approximately 800 m offshore at this facility. It should be noted that at this location this cooling system design is different reducing the likelihood that spill of this magnitude would occur.

E5.3 Modelling Results for CTC Area Intakes

E5.3.1 Overview of Spills Scenario Modelling

The results from the event based modelling are presented as follows:

- Wastewater Treatment Plant disinfection failure **(Section E7.3.2);**
- Sanitary trunk sewer break caused by stream erosion **(Section E7.3.3);**
- CSO spill **(Section E7.3.4);**
- Industrial animal food processing facility lagoon spill **(Section E7.3.5);**
- Pipeline rupture **(Section E7.3.6);**
- Bulk petroleum storage facility spill of gasoline **(Section E7.3.7); and**
- Tritium spill from nuclear generating station **(Section E7.3.8).**

Spills from the different sources were either modelled as a specific event, or as a series of events. Both a design event approach and a continuous simulation approach are accepted standard approaches in limnological-based, water quality modelling.

For most spill sources, a series of events were modelled, because this method provides a typical lake response, rather than relying on specific directional events. A typical lake response could involve anyone of a spectrum of current directions and speeds that could occur at the specific time that a spill occurs.

The results are presented below in several forms, including:

- Graphical (the calculated concentration over time, for representative intakes);
- Tabular (peak concentration/ density/ activity) at each plant's intake;
- Duration of exceedance of threshold (reported for pipeline spill and disinfection failure); and
- Spatial mapping of extent of contamination for specific isopleths.

A comprehensive summary of all modelling results for all intakes are presented in Dewey (2011).

E5.3.2 Wastewater Treatment Plant Disinfection Failure Scenario

Figure E5-15 shows the predicted *E. coli* densities at the listed drinking water intakes during the disinfection failure event at the G.E. Booth WWTP modelled over the four-month duration (May through August). The maximum density predicted is nearly 21,000 CFU/100mL at the R. L. Clark intake, but the model results show that densities vary greatly over time and are specific to each intake, reflecting the complexity of the hydrodynamic regime.

Table E5-3, Table E5-4, and **Table E5-5** show the resulting peak levels and mean densities of *E.* coli predicted at individual drinking water intakes from disinfection failures at the specific WWTP. The mean values represent the arithmetic average over the simulation period. The peak concentrations are used in the **Chapter 5** of the Assessment Report for purposes of determining whether a particular source represents a significant threat to each respective intake. The mean values are relevant to the manager of a water treatment plant in making operational decisions if they had to respond to address this type of failure scenario. **Table E5-6** shows the percentage of the time that the *E. coli* densities are above the threshold level during the four-month duration of this scenario.

The results for these WWTP by-pass scenarios indicate that *E. coli* would be present at the intake at levels that exceed the normal range of *E. coli* typically found in raw water in Lake Ontario at these intakes under normal conditions. Note that these *E. coli* levels would persist for the entire duration of the by-pass event. For example, at the Arthur P. Kennedy (formerly Lakeview) drinking water plant in Peel, the levels of *E. coli* in raw water typically range from 0 to an occasional high of 100 colony forming units (CFU). However, the results of the WWTP by-pass scenario for Peel's GE Booth WWTP indicate that the *E. coli* levels at the G.E. Booth WWTP would average 1,600 CFU/100 ml for the duration of the by-pass event. It should be noted that the model results may over predict actual results in the event of the scenario as it does not reflect all the natural processes that could reduce *E. coli* levels in the surface waters.

The data in the tables below show that drinking water intakes may be impacted by disinfection failures from WWTPs that are located at some distance away. The map showing the areas with maximum predicted *E. coli* densities above 1,000 CFU/100 ml based on the WWTP disinfection failures at the Duffins, Highland Creek, Ashbridges Bay, Humber, and G.E. Booth WWTPs is provided in **Figure E5-15** also helps to show that contaminants released in this area travel east and west within the coastal zone at relatively high concentrations before they are mixed with the water in the main lake. This illustrates the importance of protecting water quality in the near shore as this is the source of drinking water for several million residents of Ontario.

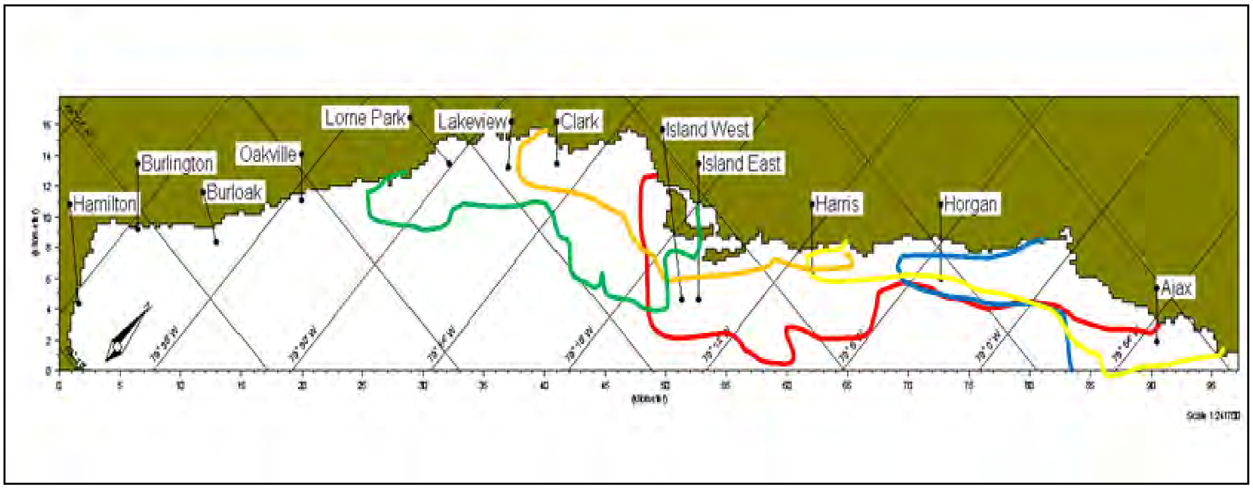


Figure E5-14: *E. coli* Time Series for Clark, Lakeview (renamed Arthur P. Kennedy), Lorne Park and Oakville Intakes

Note: [RED = ABTP, Blue = Duffins Creek, Yellow = Highland Creek, Orange = Humber, Green = Lakeview (renamed G.E. Booth)].

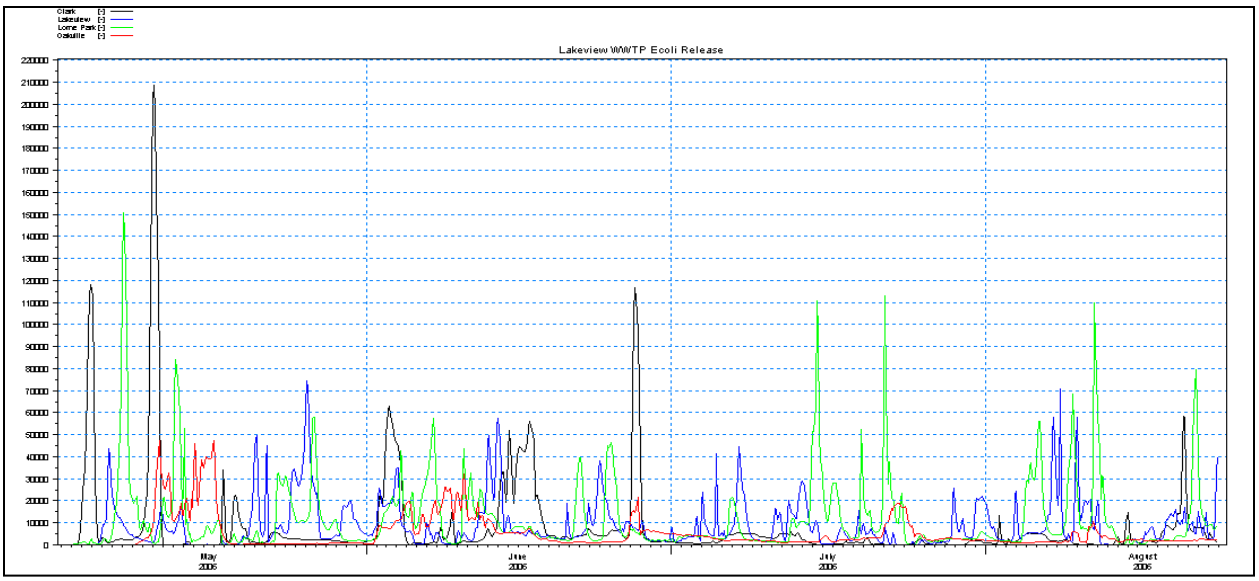


Figure E5-15: Composite Contaminant Map for *E. coli* from Disinfection Failures at GTA area WWTP's

Table E5-3: WWTP Disinfection Failure Scenarios (Duffins Creek Westward)

WWTP	Duffins Creek		Highland		ABTP		Humber		G.E. Booth		Mid-Halton		Oakville SE		Oakville SW		Clarkson	
Intake Units are (CFU/100mL)	Peak (CFU/ 100mL)	Mean (CFU/ 100mL)	Peak (CFU/ 100mL)	Mean (CFU/ 100mL)	Peak (CFU/ 100mL)	Mean (CFU/ 100mL)	Peak (CFU/ 100mL)	Mean (CFU/ 100mL)	Peak (CFU/ 100mL)	Mean (CFU/ 100mL)	Peak (CFU/ 100mL)	Mean (CFU/ 100mL)	Peak (CFU/ 100mL)	Mean (CFU/ 100mL)	Peak (CFU/ 100mL)	Mean (CFU/ 100mL)	Peak (CFU/ 100mL)	Mean (CFU/ 100mL)
Whitby	6480	460	1064	58	422	16	23	0.3										
Ajax	7320	700	1225	94	423	14	32	0.5										
Horgan	2470	173	10471	810	1373	52	100	3	45	1.2								
Harris	450	21	1308	66	4911	200	216	15	110	6								
Island West Deep	14	0.12	3	0.03	68	1	28	1.1	41	0.3								
Clark	23	0.43	32	0.6	2671	80	11688	334	55600	5500	32	1	52	2	35	1.3	1400	42
Arthur P. Kennedy			37	0.8	780	40	2906	100	83800	1600	62	2	58	3	46	2	1426	59
Lorne Park			13	0.3	756	16	734	33	38000	2400	248	11	539	26	216	14	5600	529
Oakville			2	0.05	108	2	78	2	3070	70	5756	766	1456	105	12168	1820	9950	593
Burloak					56	1.5	66	1.4	1000	22	1367	33	265	9	637	60	889	50
Burlington					11	0.1	6	0.1	20	0.5	6153	425	103	1.7	1050	40	623	9
Hamilton										0.1	369	14	5	0.07	58	1.6	25	0.5

Table E5-4: WWTP Disinfection Failure Scenarios (Courtice WWTP Eastward)

WWTP/Intake	Cobourg East		Cobourg West		Port Hope		Corbett Creek		Harmony Creek		Courtice	
	Peak (#/100mL)	Mean (#/100mL)	Peak (#/100mL)	Mean (#/100mL)	Peak (#/100mL)	Mean (#/100mL)	Peak (#/100mL)	Mean (#/100mL)	Peak (#/100mL)	Mean (#/100mL)	Peak (#/100mL)	Mean (#/100mL)
Cobourg	17810	1580	6522	595	647	72						
Port Hope	805	40	721	36	3550	335						
Ajax							479	21	210	13	353	30
Whitby							4342	73	791	50	1813	109
Oshawa							5550	789	4931	428	4946	406
Bowmanville *											4946	406
Newcastle *											1813	109

* NOTE: Bowmanville & Newcastle are estimates based on similar distance from Courtice to Oshawa (Bowmanville) and Courtice to Whitby (Newcastle)

Table E5-5: WWTP Disinfection Failure Scenarios (Skyward and Woodward WWTP)

Intake	Skyway WWTP		Woodward WWTP	
	Peak (CFU/100mL)	Mean (CFU/100mL)	Peak (CFU/100mL)	Mean (CFU/100mL)
Oakville	38	0.8	29	1.3
Burloak	6	0.2	2	0.1
Burlington	1380	55	882	64
Hamilton	2300	135	`464	186
Grimsby	32	0.7	4	0.2

Table E5-6: Percent of Time *E. coli* above Threshold of 100 CFU/100ml

Intake/Source	Cobourg East	Cobourg West	Port Hope	Courtice	Harmony	Corbett	Duffins	Highland	ABTP	Humber	G.E. Booth	Mid-Halton	Oakville SE	Oakville SW	Clarkson	Skyway	Woodward
Cobourg	72	59	24														
Port Hope	15.7	15.6	58														
Bowmanville*				29													
Newcastle *				17													
Oshawa				29	58	42											
Whitby				17	4.4	27	47	13	5								
Ajax				13.2	2.6	3.5	58	27	5								
Horgan							22	33	15	.09							
Harris							8	16	31	3	0.3						
Island Shallow																	
Island Deep																	
Clark									15	22	76						
Arthur P. Kennedy									13	9	52				13		
Lorne Park									4	7	38	2.3			17		
Oakville									0.2		10	63	7	4	51		
Burloak											6	9	22	74	32		
Burlington												27	.8	24	15	15	20
Hamilton												4	.1	9	2	29	66

E5.3.3 Sanitary Trunk Sewer (STS) Break Due to Stream Erosion

The calculated time series for *E. coli* to the drinking water plant intakes are provided in **Figure E5-17**, and the corresponding peak *E. coli* densities at each intake are tabulated in **Table E5-7**.

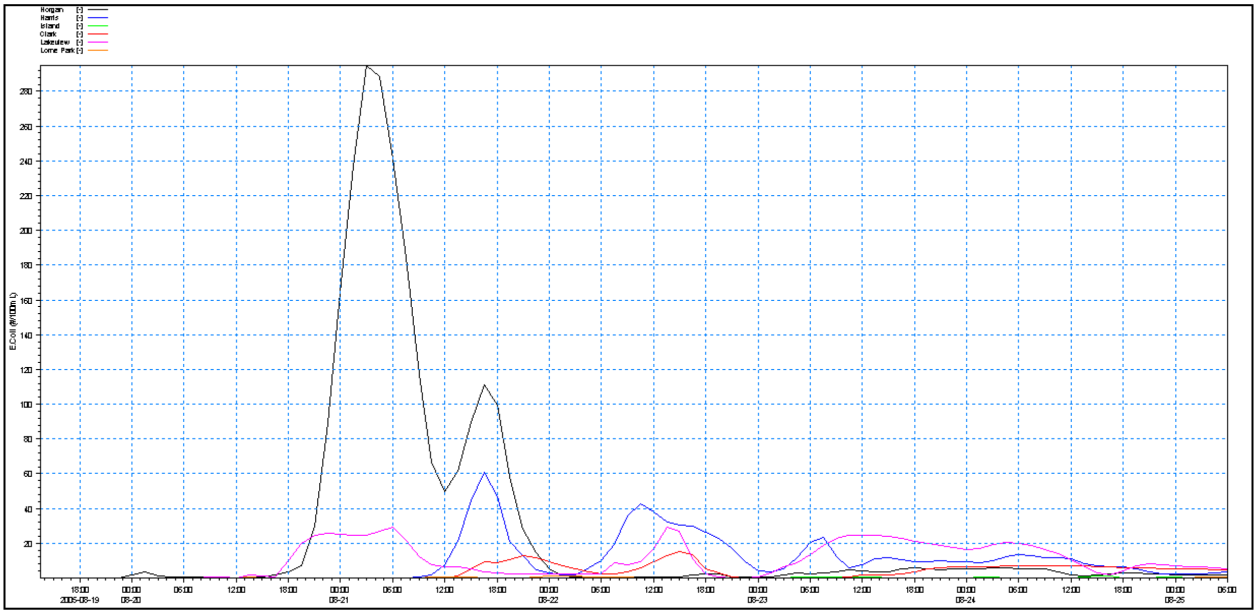


Figure E5-16*: E. coli* time series for STS Breaks

Table E5-7: Peak *E. coli* Densities in the STS Break Scenarios

Intake	Peak *E. coli* Densities (CFU/100ml) for STS Breaks under August 19, 2005 Conditions (Scenario 1)	Peak *E. coli* (#/100ml) for STS Breaks under various Summer, 2005 Meteorological conditions (Scenario 2)
Ajax	2	2
Horgan	290	300
Harris	60	180
Island Shallow	19	30
Clark	15	1000 (Etobicoke) 340 (Humber)
Arthur P. Kennedy	29	110 (Humber) 180 (Etobicoke)
Lorne Park	1	360
Oakville	<1	160

The results of the two STS break scenarios are provided in the above table. As discussed in **Section E6.2.4**, the first scenario is based on meteorological and limnological conditions that occurred during the August 19, 2005 period. The modelled *E. coli* levels are only above the threshold of 100 CFU *E. coli* /100 ml at the Horgan WTP from the spill caused by erosion of the Highland STS.

The results of the second scenario indicate that different river flow and lake current conditions could cause *E. coli* levels to above the threshold of 100 *E. coli*/ 100 ml for several of the WTPs, rather than just the Horgan intake. It is concluded that STS breaks in the TRSPA, as modelled, represent a significant threat to the following intakes:

- Horgan WTP, caused by discharge from Highland Creek;
- Harris WTP, caused by discharge from Don River;
- Clark and Arthur P. Kennedy (located in CVSPA) WTPs, caused by discharge from Etobicoke Creek and Humber River; and
- Lorne Park (located in CVSPA) and Oakville (located in Halton SPA) WTPs, caused by a discharge from Etobicoke Creek.

E5.3.4 CSO Spill

The risk to local intakes from *E. coli* levels from a spill associated with CSO's is provided in **Figure E5-18** and **Figure E5-19** for the four Toronto intakes. The calculated *E. coli* levels at the F. J. Horgan and R.C. Harris intakes range from 20 – 60 CFU/100 ml, while the results for the for R. L. Clark and Deep Island intakes are lower. All the results are below the threshold value of 100 CFU/100ml used to identify significant threats.

When these predicted results are compared with results from *E. coli* monitoring, the modelled results are higher. This is likely due to the conservative assumptions in the model.

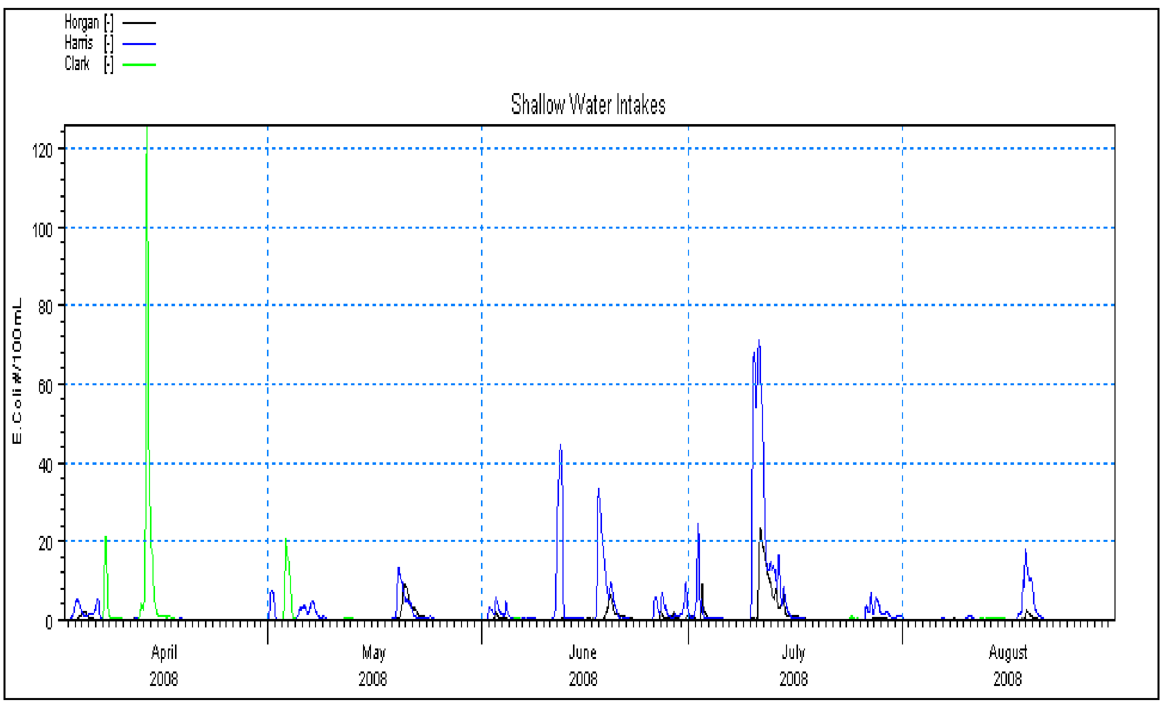


Figure E5-17: *E. coli* Levels for Horgan, Harris, and Clark from CSO Spill

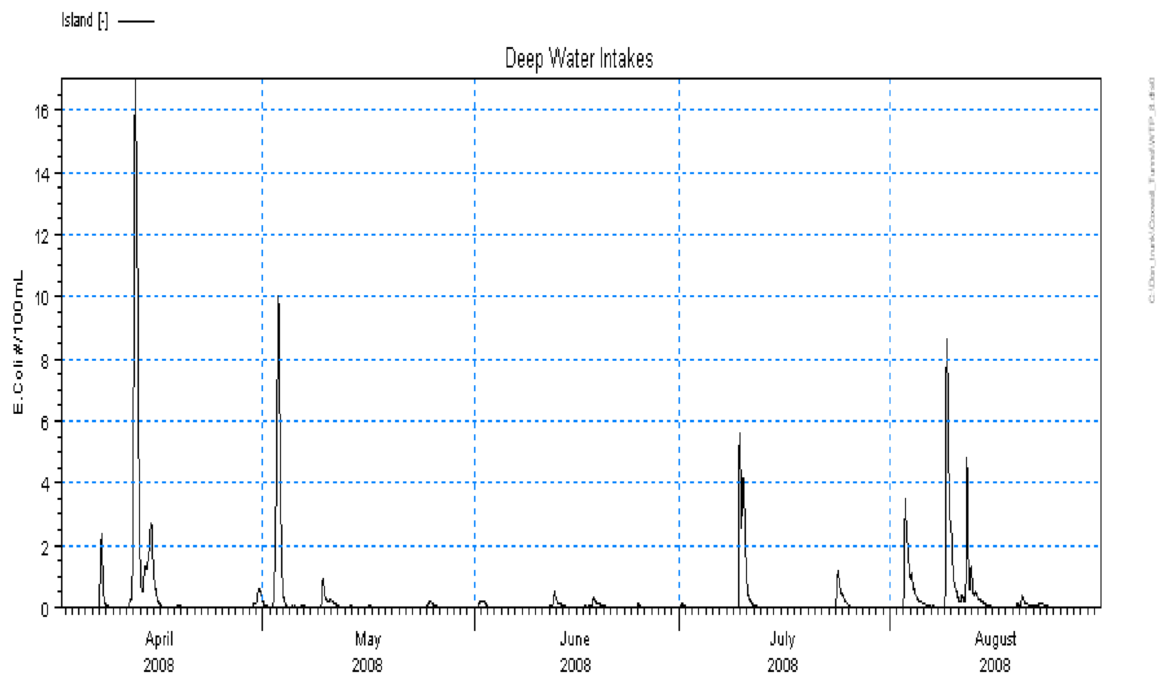


Figure E5-18: *E. coli* Levels Predicted for Toronto Island Intakes from CSO Spill

E5.3.5 Industrial Animal Food Processing Lagoon Spill

Figure E5-20 provides the calculated time series of *E. coli* at intakes near the mouth of the Credit River (Clarke, Arthur P. Kennedy, and Lorne Park). The resultant *E. coli* density at the mouth of the Credit River was estimated at 25 CFU/100ml. As the maximum densities are less than 100 *E. coli* CFU/100 ml at the intakes, a spill from the industrial animal food processing lagoon has not been identified as a significant threat to these intakes.

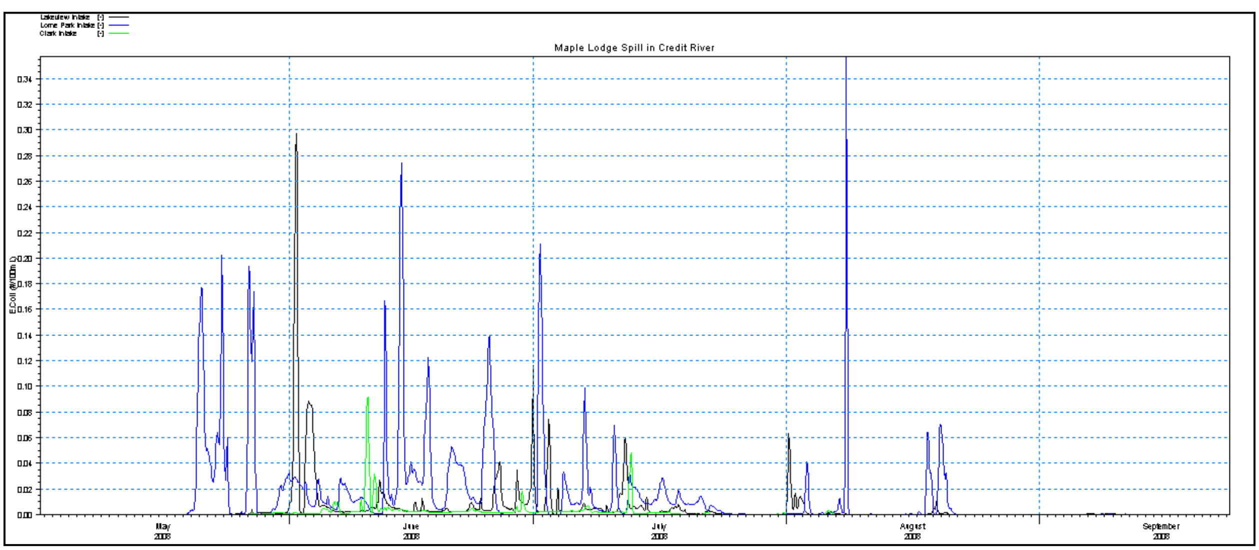


Figure E5-19: Predicted *E. coli* Densities from Industrial Animal Food Processing Lagoon Scenario (*note that Lakeview Intake has been renamed Arthur P. Kennedy)

E5.3.6 Benzene Spill from Pipeline Rupture

The effects of a pipeline break in crossing the Credit River are significant for the Arthur P. Kennedy, Lorne Park and Clark intakes. **Figure E5-21**Figure E5-20 shows a representative time series of benzene concentration at the Arthur P. Kennedy drinking water plant intake. **Table E5-8** lists the peak levels of benzene predicted at each intake from the spill locations modelled affecting the CTC Source Protection Region. The fraction of the simulation period that the concentrations exceed 0.05 mg/L is tabulated on **Table E5-21**; it indicates that typically the drinking water plant would need to deal with the episode for a few days.

The results of each pipeline spill scenario indicate that each spill would reach nearby drinking water plant intakes at concentrations that exceed the ODWS for benzene of 0.005mg/l. Preliminary tests using less conservative scenarios were run for Joshua Creek and Etobicoke Creek, and confirmed pipeline spills at these locations as significant threats to the Arthur P. Kennedy and Lorne Park intakes. The composite contaminant map for benzene spill from GTA intakes is provided in **Figure E5-22**, using 0.05 mg/l as the mapped contour, as relevant to the Coastal Zone of Lake Ontario. The corresponding maps, using the drinking water limit of 0.005 mg/l is located at the end of this Appendix.

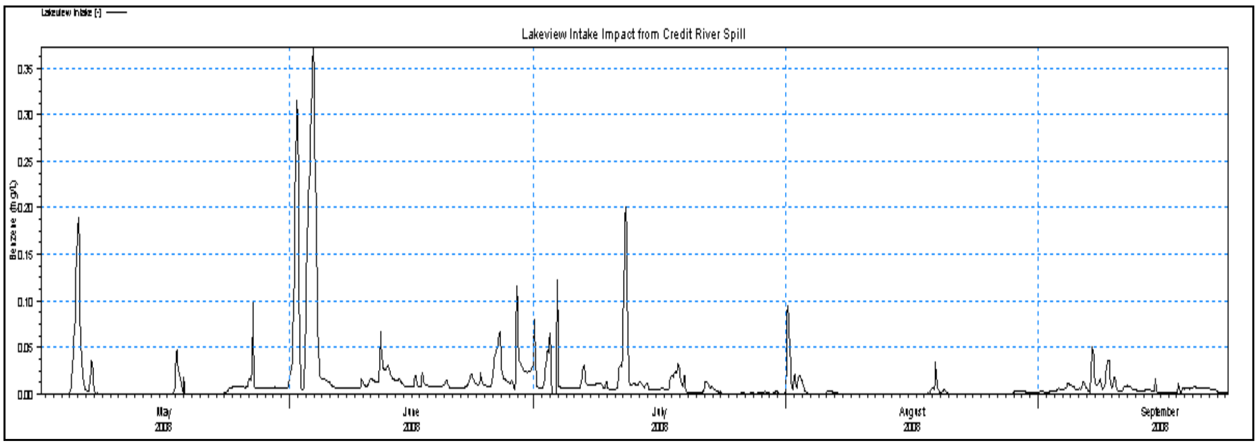


Figure E5-20: Arthur P. Kennedy time series from Credit River (*note that Lakeview Intake is renamed Arthur P. Kennedy)

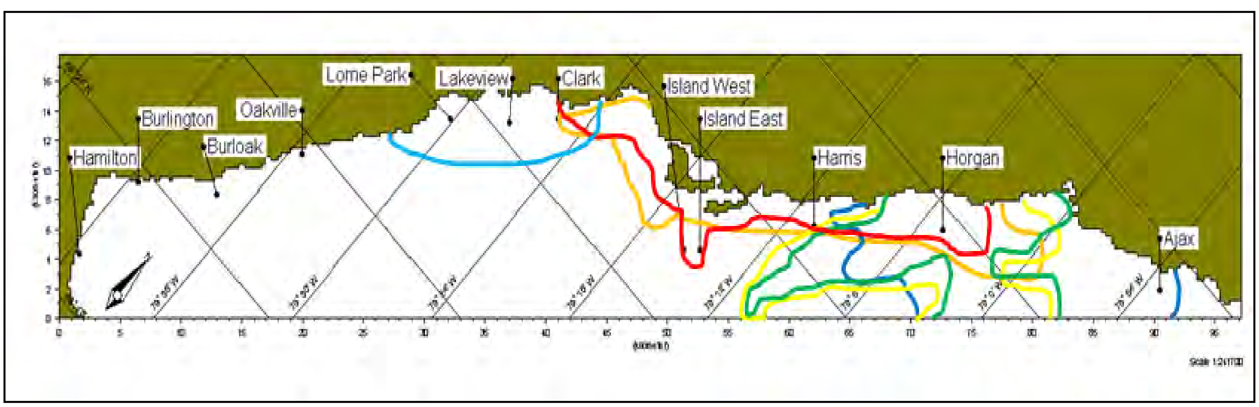


Figure E5-21: Composite Contaminant Map for Benzene from Pipeline Spill at GTA Watercourse Crossings (*note that Lakeview Intake is renamed Arthur P. Kennedy)

Note: Red = Humber, Neon Blue = Credit, Orange = Don, Blue = Duffins, Green = Rouge, Yellow = Highland Creek

Table E5-8: Peak Levels Benzene from Pipeline Break at municipal drinking water intakes (mg/L)

Intake \ Discharge	Cobourg Creek	Ganaraska River	Wilmot Creek	Graham Creek	Bowmanville Creek	Oshawa Creek	Duffins Creek	Rouge River	Highland Creek	Don River	Humber River	Etobicoke Creek*	Credit River	Joshua Creek*	16 Mile Creek
Cobourg	3.00	1.0													
Port Hope	1.17	3.0													
Newcastle			3.0	3.0	1.0										
Bowmanville			3.3	3.0	1.0										
Oshawa						1.40									
Whitby						0.32	0.011	0.006	0.008						
Ajax						0.14	0.061	0.011	0.010	0.010					
Horgan							0.075	0.270	0.290	0.250					
Harris							0.047	0.045	0.088	0.310	0.101				
Island Shallow										1.000	0.400				
Island Deep										0.010	0.010				
Clark										0.035	0.790	0.010	0.15	0.0002	
Arthur P. Kennedy										0.023	0.300	0.0057	0.37	0.007	
Lorne Park												0.006	2.40	0.065	0.012
Oakville												0.0045		0.150	0.120
Burloak												0.0008		0.04	0.014
Burlington														0.008	0.035
Hamilton														0.0001	0.007

* Preliminary tests run in 2013

Table E5-9: Typical Duration of Benzene above the Threshold at Municipal Drinking Water Intakes (hr)

Intake \ Discharge	Cobourg Creek	Ganaraska River	Wilmot Creek	Graham Creek	Bowmanville Creek	Duffins Creek	Rouge River	Highland Creek	Don River	Humber River	Credit River
Cobourg	48	36									
Port Hope	37	60									
Newcastle			30	24	36						
Bowmanville			24	24	36						
Ajax						36-72	36-72	36-72			
Horgan											
Harris						36-72	36-72	36-72	36-72	36-72	
Island Shallow											
Island Deep									36-72	36-72	
Clark									36-72	36-72	36-72

E5.3.7 Bulk Petroleum Storage and Handling Spill Scenarios

Results from spills from bulk petroleum storage facilities located on the Lake Ontario shoreline (Oakville), as well in North York (which could discharge to the Don or Humber rivers through storm sewers) are documented in this section.

Spills from Storage Tanks at the Oakville Site

The peak concentrations of benzene at each of the water treatment plant intakes from storage tank spills at the Oakville facility are listed in **Table E5-10**Table E5-10**.** The concentrations at the Oakville and Burlington WTP intakes are higher than at the Burloak WTP intake despite Burloak being closest to the Bronte Creek discharge point because the former intakes are close to shore, while Burloak is much further offshore in about 16 to 18 metres of water.

Table E5-10: Peak Benzene Concentrations from Petroleum Storage and Handling at Bulk Facilities

Intake	Oakville Bulk Tank Spill Peak Benzene Concentration(mg/L)	North York Bulk Tank Spill via Humber River Peak Benzene Concentration (mg/L)	North York Bulk Tank Spill via Don River Peak Benzene Concentration (mg/L)
Ajax			0.0004
Horgan		0.001	0.0380
Harris	0.0005	0.006	0.0590
Island Deep	0.0020	0.015	0.0090
Clark	0.0140	0.550	0.0004
Arthur P. Kennedy	0.5000	0.317	0.0030
Lorne Park	1.2500	0.078	
Oakville	9.0000	0.003	
Burloak	0.6700		
Burlington	11.0000		
Hamilton	0.8400		

Figure E5-23 graphically shows the benzene levels at the impacted intakes. The benzene plume from each of the spill scenarios is calculated to persist for several days. For example, at the Burlington intake, there are events in June which have levels above 0.4 mg/L benzene for three days. Other intakes have levels above 0.5 mg/L for up to two days.

The results of the westerly gasoline-benzene spill event indicate that the benzene plume persists for several days at each intake. Burlington, two big events in June, has levels above 0.4 mg/L for three days. Other intakes have levels above 0.5 mg/L for up to two days.

The results of the easterly gasoline-benzene spill event indicate that the contaminant reaches the Lorne Park intake first, in less than 24 hours with a peak concentration of 1.25mg/L with levels declining to 0.005 mg/L after several days. The Arthur P. Kennedy intake is not impacted until 11 days later with a level of 0.5 mg/L which increases up to 0.001 mg/L over a week's time. The spill is predicted to reach the R. L. Clark intake two weeks after the spill event with levels eventually reaching 0.14 mg/L. The plume lingers in the vicinity of both the Arthur P. Kennedy and R. L. Clark intakes for several weeks at the 0.001 to 0.0005 mg/L.

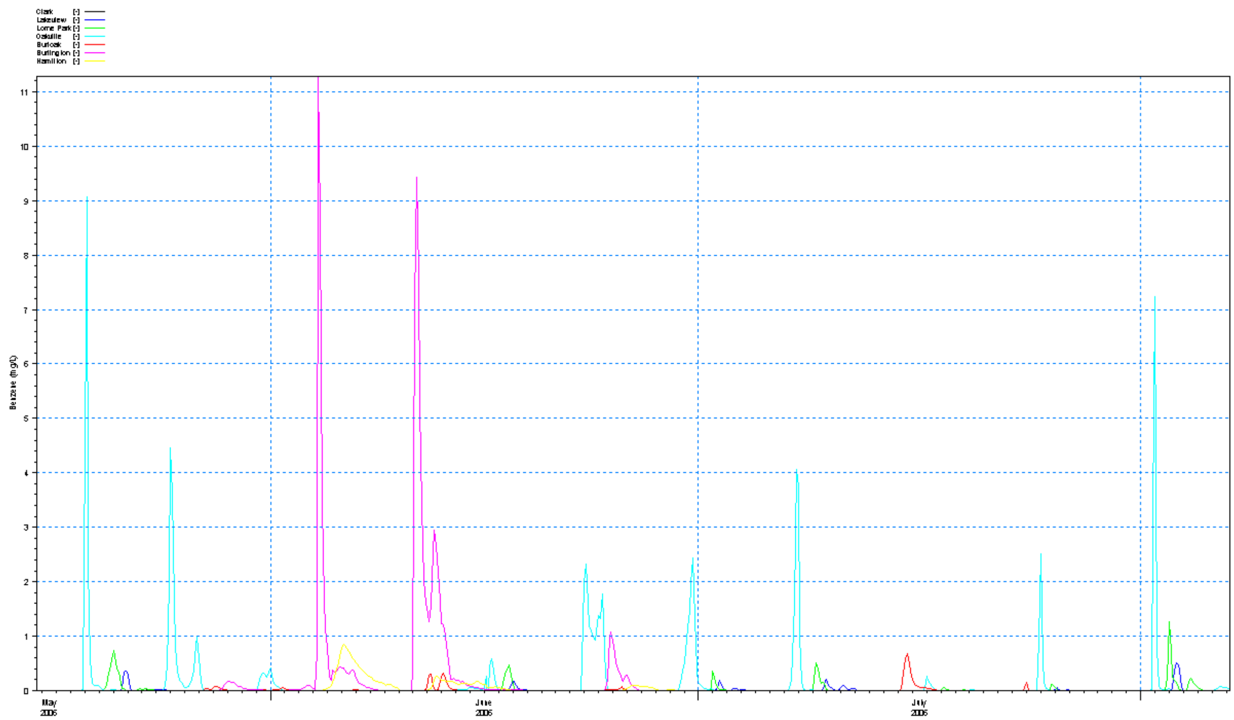


Figure E5-22: Benzene Concentrations (mg/L) at Intakes from Simulated Gasoline Storage Spills (*note that Lakeview Intake is renamed Arthur P. Kennedy)

The spatial extent of the plume using a 0.05 mg/L isopleth, is shown in **Figure E5-24**. The elevated concentrations are focused on the shoreline between Arthur P. Kennedy WTP to the east and Burlington WTP to the west.

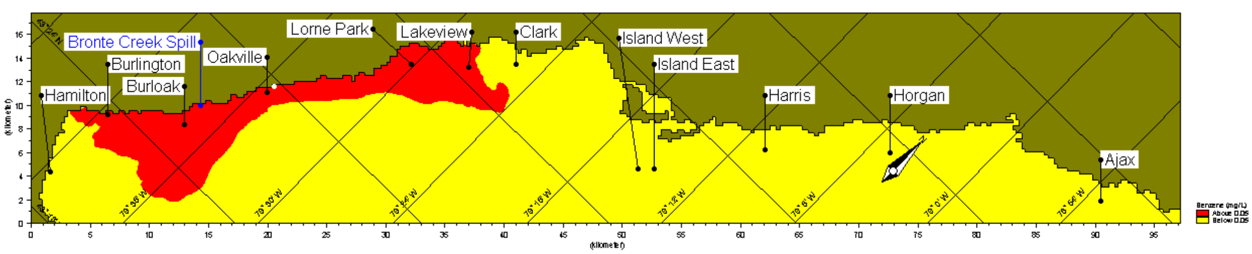


Figure E5-23: Oakville Storage Facility Spill - 0.05 mg/L Benzene Isopleth (*note that Lakeview Intake is renamed Arthur P. Kennedy)

Spills from Unloading of Gasoline at Oakville Storage Facility

The peak levels of benzene at each water treatment plant intake from each of the three ship unloading spill scenarios are tabulated in **Table E5-11**. The results indicate that the increase in peak concentrations is approximately linear as a function of increase in spill volume. The Burlington intake is estimated to have the highest benzene concentrations. The time that benzene concentrations are predicted to be above 0.005 mg/L is about 2-hours for the 200-litre spill, 10-hours for the 500-litre spill and 13 hours for the 1000-litre spill.

Table E5-11: Peak Benzene Concentrations at Intakes from Ship Spills of Gasoline at Oakville Storage Facility

Intake	Spill Volume		
	200 L in 15 minutes	500 L in 15 minutes	1000 L in 15 minutes
	Benzene (mg/L)	Benzene (mg/L)	Benzene (mg/L)
Arthur P. Kennedy	0.0003	0.0008	0.0017
Lorne Park	0.0013	0.0034	0.0068
Oakville	0.0080	0.0200	0.0440
Burloak	0.0020	0.0060	0.0130
Burlington	0.0200	0.0050	0.1030
Hamilton	0.0020	0.0050	0.0108

Figure E5-25 shows the 0.05 mg/L isopleth for the 100,000-litre gasoline (1000 litre benzene) spill for the simulation period of May 15 to June 6, 2006 (see Dewey, 2011).

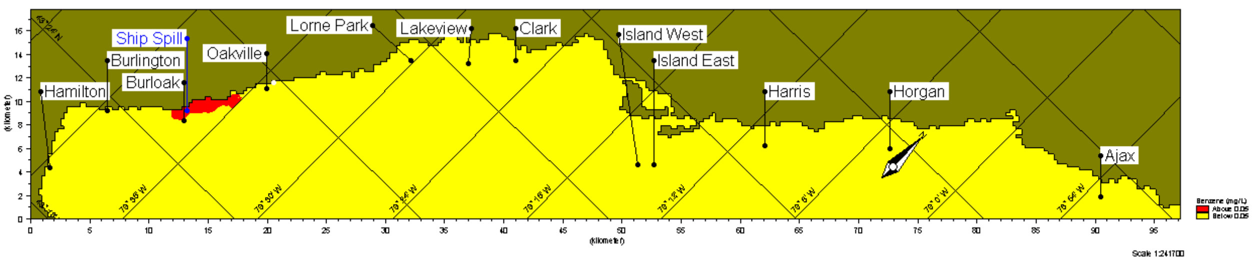


Figure E5-24: Scenario of 1000 L Spill with a Benzene Isopleth of 0.05 mg/L (*note that Lakeview Intake is renamed Arthur P. Kennedy)

Spill from Storage Tanks at the North York Site

The North York site is located close to the watershed divide between the Humber and Don rivers. Depending on the location of the tank, the spill could either flow into the Humber River or the Don River. The results of the model simulations (**Table E5-12**) show the maximum concentrations for a spill to either river. There is a significant risk to all four City of Toronto intakes, because concentrations exceed the threshold of 0.005 mg/l at F.J. Horgan, R.C. Harris, Toronto Island (shallow) and R.L. Clark.

Table E5-12: Benzene Concentrations at Intakes Due to Petroleum Spill from North York Facility

Intakes	Benzene Concentration from Spill Reaching the Humber River (mg/L)	Benzene Concentration from Spill Reaching the Don River (mg/L)
Ajax	<0.001	<0.001
Horgan	0.001	0.038
Harris	0.006	0.059
Island Deep	0.015	0.009
Clark	0.550	0.004
Arthur P. Kennedy	0.317	0.004
Lorne Park	0.078	< 0.005

Note: see Dewey, 2011, for calculated concentrations at other nearby intakes

E5.3.8 Nuclear generating Station Tritium Spill Scenario

The tritium levels over time at several intakes from the Pickering spill scenario are shown on **Figure E5-26**. The results between the observed and modelled results show good correlation.

The peak tritium levels in Becquerels per litre predicted by the model are tabulated in **Table E5-42** for drinking water intakes within the GTA environs. The modelled results indicate that the Pickering spill could affect two intakes within the CTC (Whitby, Oshawa) at levels above 7,000 Bq/L, the current Ontario Drinking Water Standard which has been selected as the threshold to identify a significant threat.

The time series of tritium at each intake due to spill from the Darlington outfall is shown in **Figure E5-27.** The data in **Table E5-33** shows that a release from Darlington could exceed the threshold of 7,000 Bq/L for Oshawa and Bowmanville intakes.

Table E5-13: Peak Tritium Activity (Bq /L)

Intake	Pickering Spill (Bq/L)	Darlington Spill (Bq/L)
Hamilton	90	47
Burlington	60	46
Burloak	140	73
Oakville	97	74
Lorne Park	122	131
Arthur P. Kennedy	138	217
R.L. Clark	144	238
Island deep		500 (shallow layer)
R.C. Harris	198	728
F.J. Horgan	354	946
Ajax	2000	3500
Whitby	12,000	4600
Oshawa	20,000	8200
Bowmanville	1160	8700
Newcastle	920	4800
Port Hope	810	2500
Cobourg	810	830

(Note: Pickering data from the 270 m grid file; Darlington calculations from 2430 m grid file.)

Since the two nuclear generating stations have been identified as significant threat activities which are located within the CTC SPR, source protection plan policies must be developed. This will include consideration of the effectiveness and adequacy of existing risk management and spill response protocols.

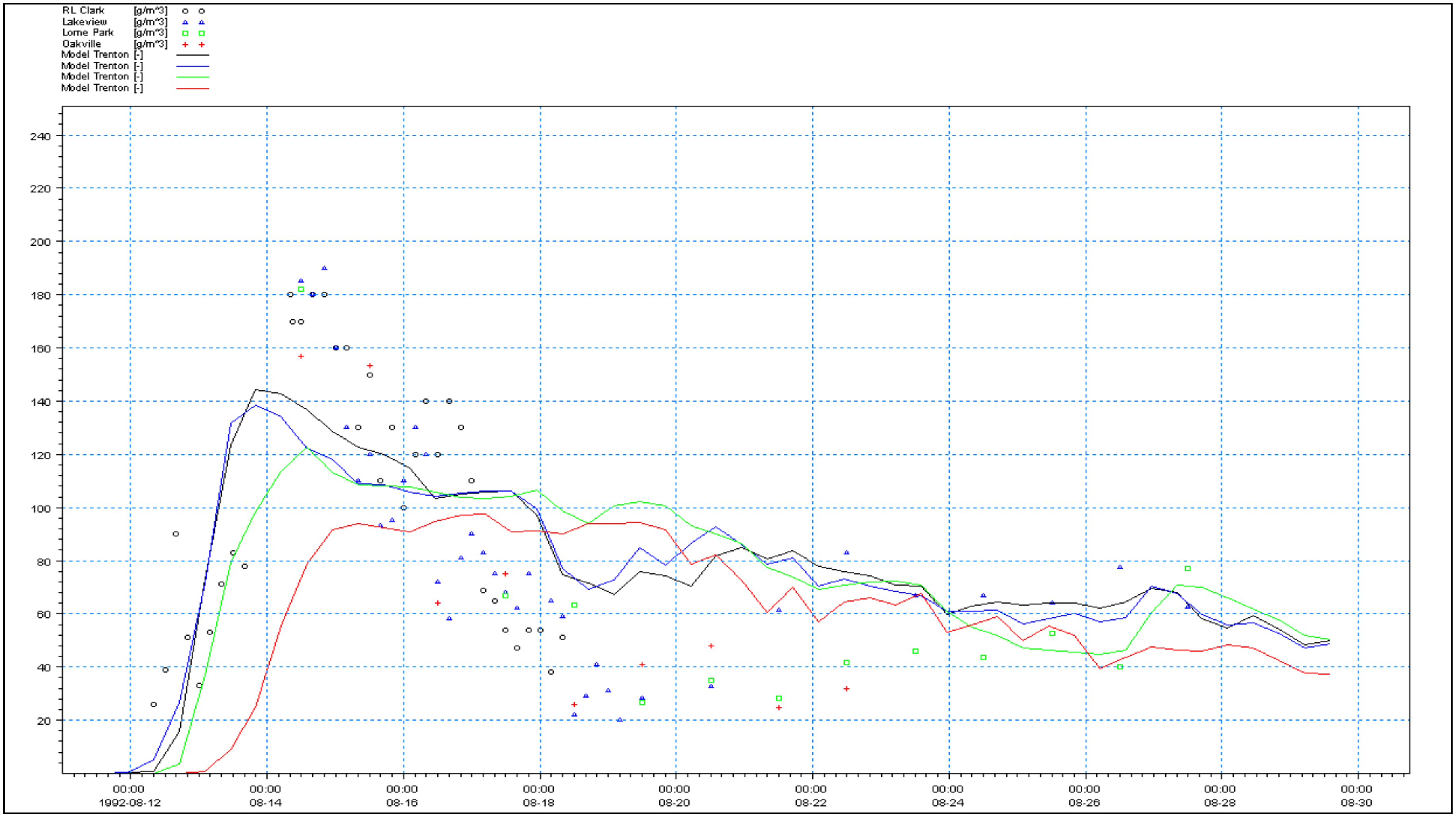


Figure E5-25: Model Calibration: Comparison of Model Calculations with observations using Trenton Winds for Clark to Oakville intakes (*note that Lakeview Intake is renamed Arthur P. Kennedy)

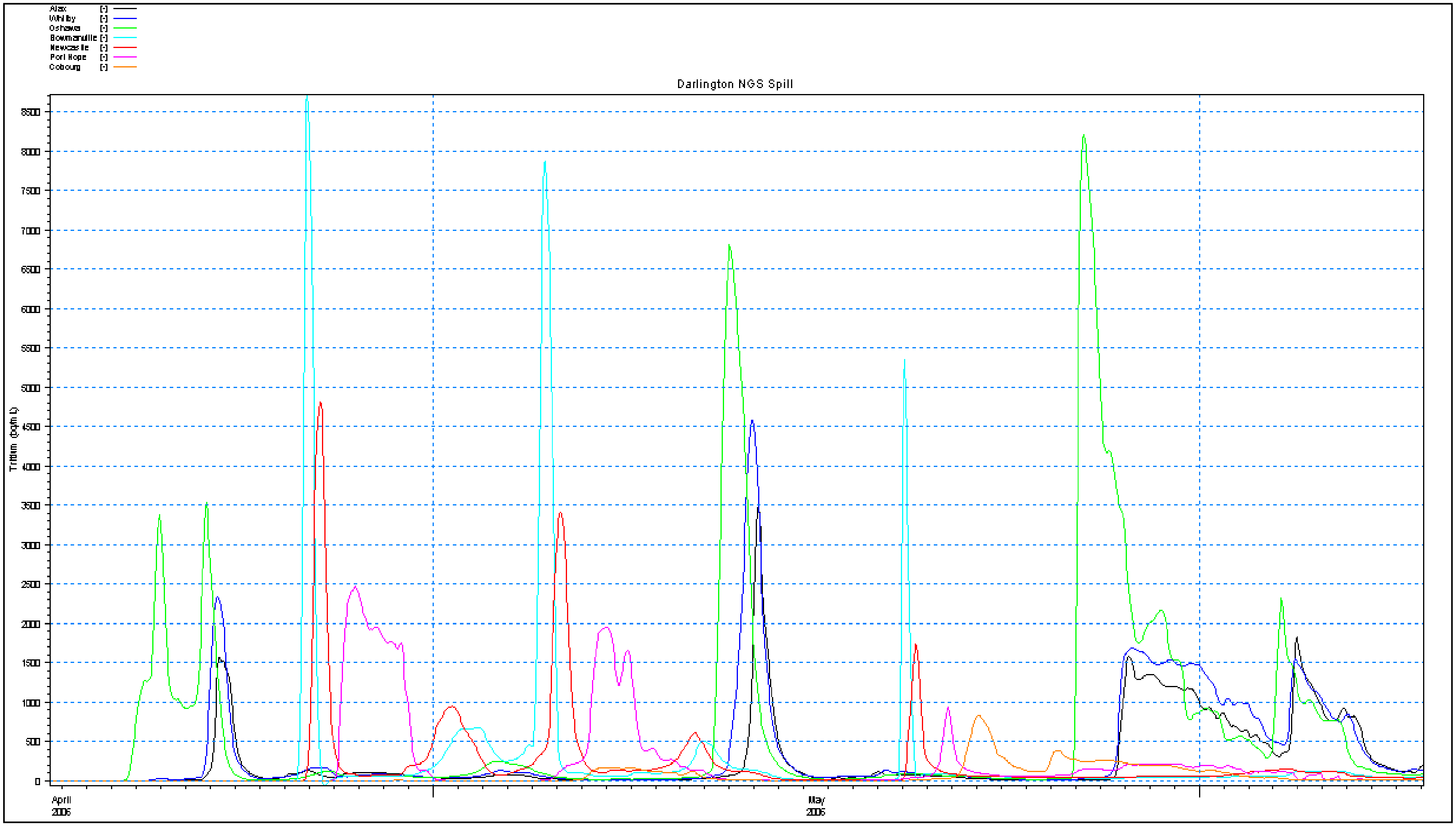


Figure E5-26: Tritium time series at Intakes (Ajax to Cobourg) for release from Darlington outfall

Background Tritium Levels in the Great Lakes

Internet based sources suggest the background level of tritium is approximately 2 Bq/L in Lake Ontario (Fairlie, 2007). In 2006, Toronto's drinking water concentration for tritium averaged of 3.3 Bq/L, with a maximum value of 12 Bq/L. This is a marked decrease since the mid-1960s peak in tritium concentrations in the environment (Fairlie, 2007). Another report **Table E5-14** estimates that levels of tritium in Lake Ontario are 7.1 Bq/L and increasing annually. Tritium has a half time of approximately 12 years so after spills of the type modelled in these scenarios it would take 2-3 decades for the spill effects to be significantly dissipated through radionuclide decay processes.

Table E5-14: Average tritium concentrations in the Great Lakes in 1997/98

Great Lakes	Average Tritium Concentration (Bq/L)
Superior	2.0
Michigan	3.0
Huron	7.0
Erie	5.5
Ontario	7.1

Source King et al. (1998, 1999)

The contaminant map showing the predicted tritium contours of 150 Bq/L from the Pickering spill scenario is provided on **Figure E5-28**. This illustrates the extent of contamination in the coastal zone that could occur.

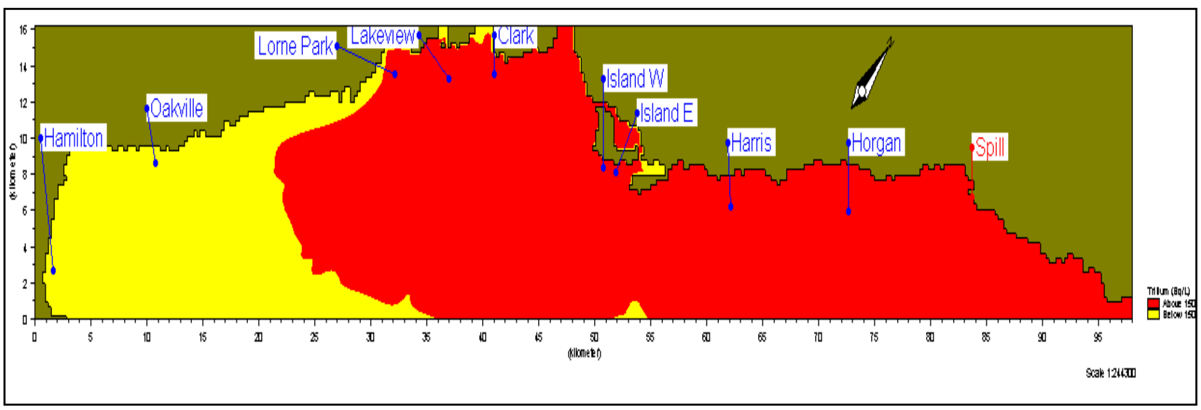


Figure E5-27: Extent of Contamination for Tritium, using a 150 Bq/L contour (*note that Lakeview Intake is renamed Arthur P. Kennedy)

E5.4 Spatial Representation of Results

The methodology used to develop the spatial mapping for IPZ-3 delineation by the Lake Ontario Collaborative is summarized in this section. The actual maps are either provided in **Chapter 5** of the main body of the Assessment Report, or in this Appendix.

E5.4.1 Mapping Zone of Contamination Within Lake Ontario

Peak concentrations have been used to determine whether a spill from a specific source represents a significant threat to an intake. Two alternatives were considered (Dewey, 2011) to map the spatial in-lake limits of spills from a specific source:

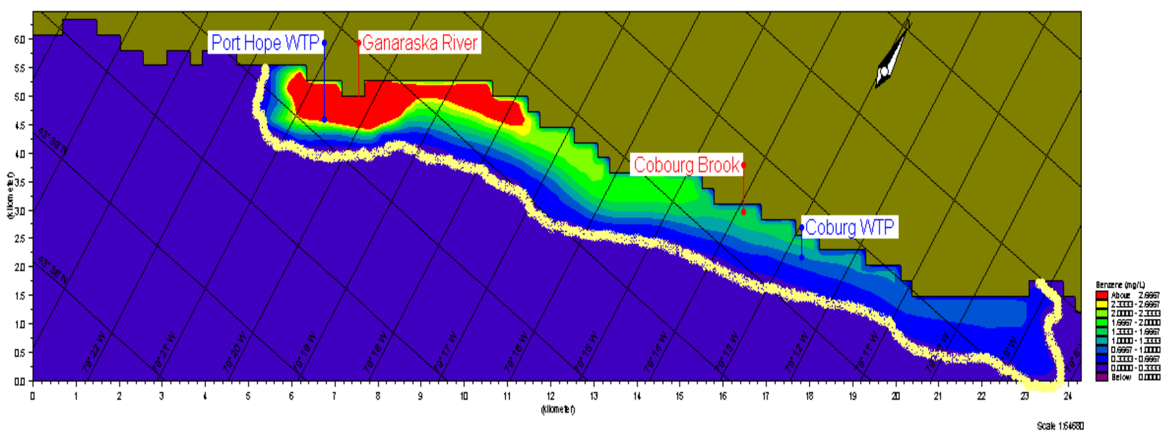
- A specific event; or
- A series of events.

Method 1 – Based on Spatial Extent of a Specific Event

The first method considered was to map the in-lake extent of the maximum concentration in the time series from one event. The term, "elevated concentrations" was defined as concentrations / activity/ density above the selected threshold, is the indicator of impact used in this approach.

The peak concentrations within each grid cell in the geographical area around the intake and between the intake and the spill source was extracted from the model simulations and then concentration contours were calculated. Concentrations calculated for a five-day period around the event was used.

This method was evaluated mainly for the WWTP Disinfection Failure scenario and for the Pipeline Failure scenario. For benzene spills to intakes such as Cobourg and Newcastle, the method predicted impacts which extended both east and west of the intakes **Figure E5-29**.



Note that the boundary shows the 0.11 to .33mg/L contours

Figure E5-28: Boundary for Benzene Spill for Ganaraska River – Easterly Plume

Evaluation of other intakes and substances indicated that the selected event (largest peak concentration) resulted in a small area around the discharge point, and often was located only in one direction from the discharge. This is illustrated in **Figure E5-30** (time series for Arthur P. Kennedy intake) and **Figure E5-31** (Spatial Extent). This method, therefore, may underestimate the area to which a spill might extend.

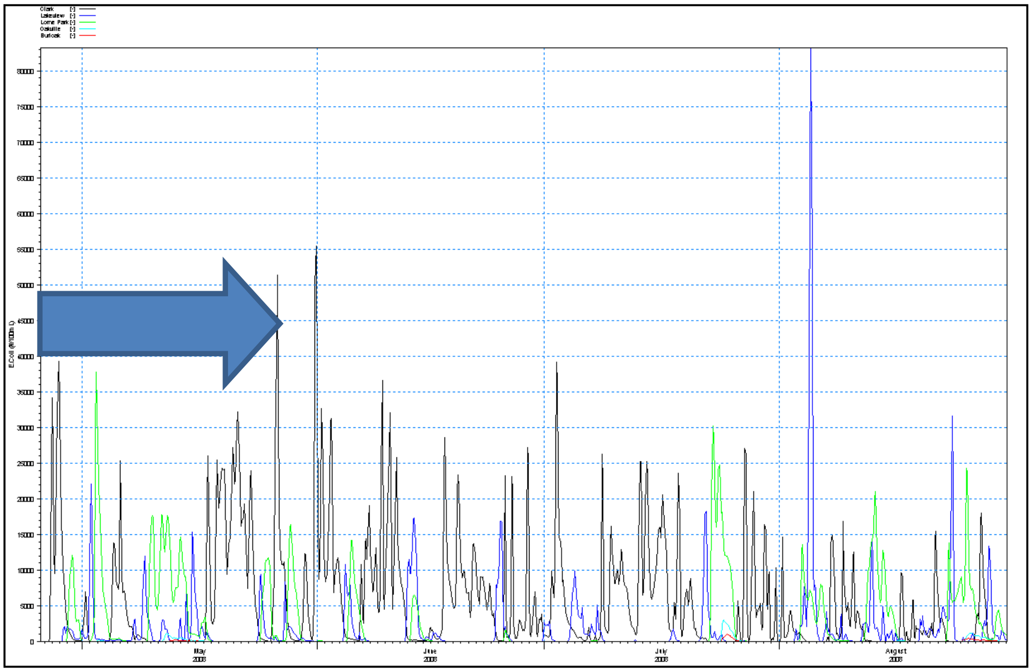


Figure E5-29: Arthur P. Kennedy Time Series (*note that Lakeview Intake is renamed Arthur P. Kennedy)

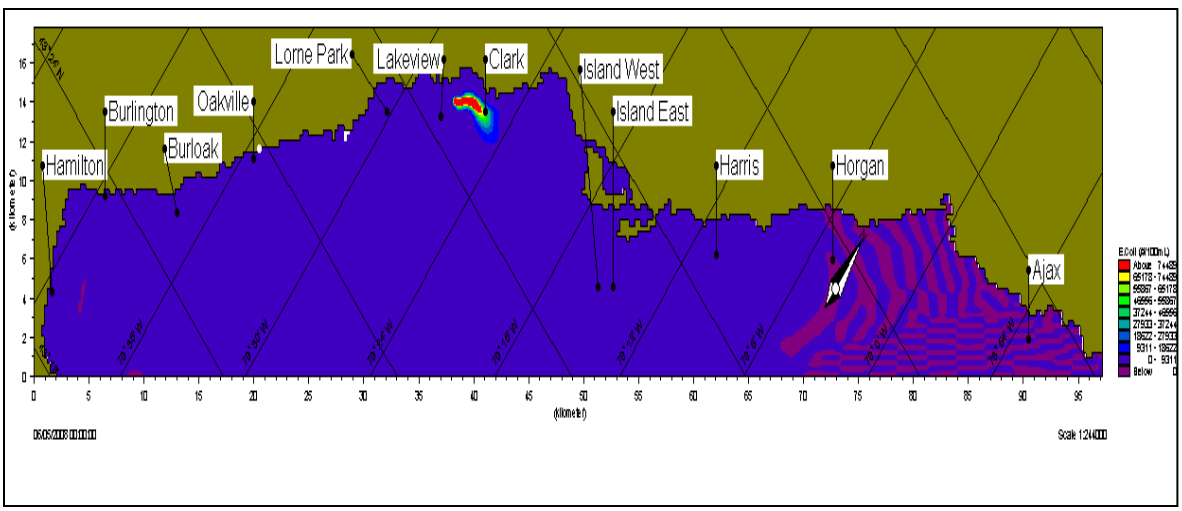


Figure E5-30: Spatial Extent of Impact from Spill occurring Aug 5 (*note that Lakeview Intake is renamed Arthur P. Kennedy)

Method 2 – Spatial Extent of Zone of Contamination based on Multiple Peaks at the WTP

A second method was developed to address the potential underestimation of the spill impact extent. The second method involves selecting a time period of several weeks and calculating the peak concentrations around the intake for this period. The period was selected to include a mix of days with east-trending and west-trending currents, around the discharge point into Lake Ontario. The results were contoured to produce concentration isopleths, as shown on **Figure E5-32**Figure E5-31.

The criteria of ensuring that both east and west currents are part of the modelled period may result in a different time period being used for different discharge points and intake locations. The rationale for choosing different computational periods is that variable local circulation patterns can occur within the same area of the lake.

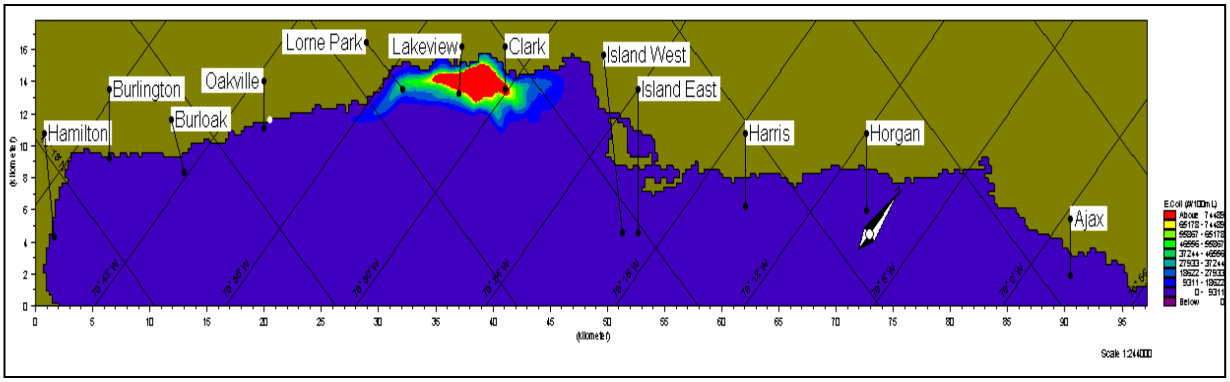


Figure E5-31: Spatial Extent of Impact from Spills starting April 4 for a Four–week period (*note that Lakeview Intake is renamed Arthur P. Kennedy)

The resultant location of the contour corresponding to the selected threshold value was used to define the in-lake extent for the IPZ-3 boundary. For land-based spill points, the IPZ-3 boundary extends upstream along the river channel to the spill point.

Summary of Threat Mapping for Zones of Contamination

A summary map of all 'significant threat sources' is provided, summarizing the in-lake and land-based sources of discharge. For example, the pipeline rupture threat location is at the stream crossing, while the disinfection failure discharge location is the WWTP outfall.

Example maps of zones of contamination using different numerical criteria for representative intakes are provided on **Figure E5-33** to **Figure E5-37**. The isopleths for the benzene and *E. coli* 'significant threat' thresholds extend further into the lake than those using ten times the threshold value. These are summarized as separate maps shown as for specific thresholds and specific contaminants, as follows:

- *E. coli* zone of contamination for 1000 *E. coli CFU*/100 mL and a 100 *E. coli CFU*/100 mL threshold due to WWTP disinfection failure;
- Benzene zone of contamination for a 0.005 mg/l threshold and a 0.05 mg/l concentration due to pipeline rupture; and
- Tritium zone of contamination for a 20, 350, and 7,000 Bq/L due to a spill from a nuclear power generating station.

These maps provide a summary of the extent of impacts from specific scenarios. They indicate that the zones of contamination generally include the complete coastal zone from Cobourg to Hamilton and that the intensity of zones is centered in the CTC area (Peel to Durham), with a lower intensity to the east between Bowmanville and Cobourg.

Additional modelling to identify significant threat activities may be undertaken in the source protection plan policy development phase. This modelling may also further refine the zone delineations and facilitate a better understanding of the key hydrodynamic factors which affect the movement of a spill to the intakes.

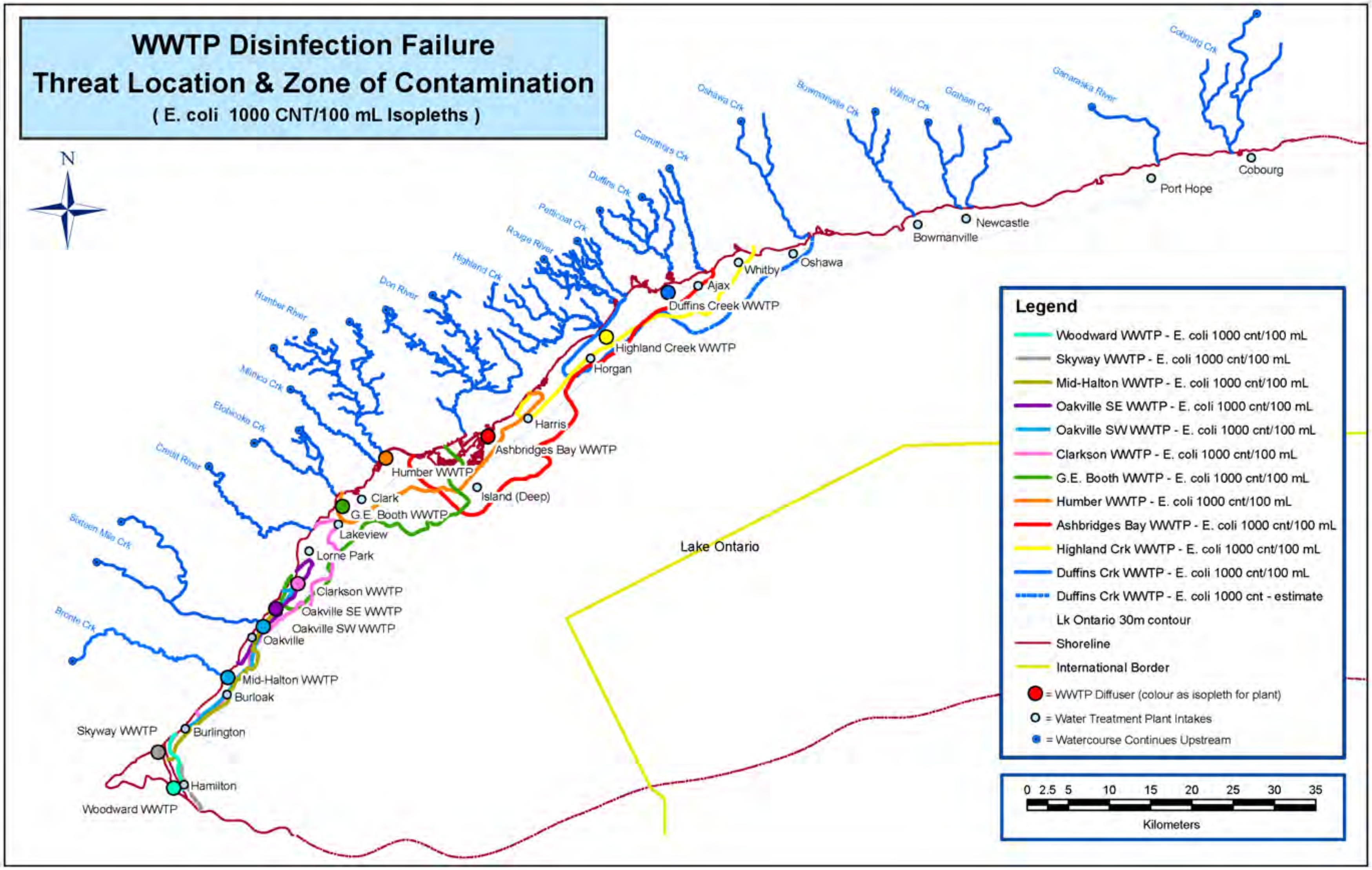


Figure E5-32: WWTP Disinfection Failure Threat Location and Zone of Contamination *(E. coli* 1000 CFU/100 ml Isopleth*)* *note that Lakeview Intake is renamed Arthur P. Kennedy

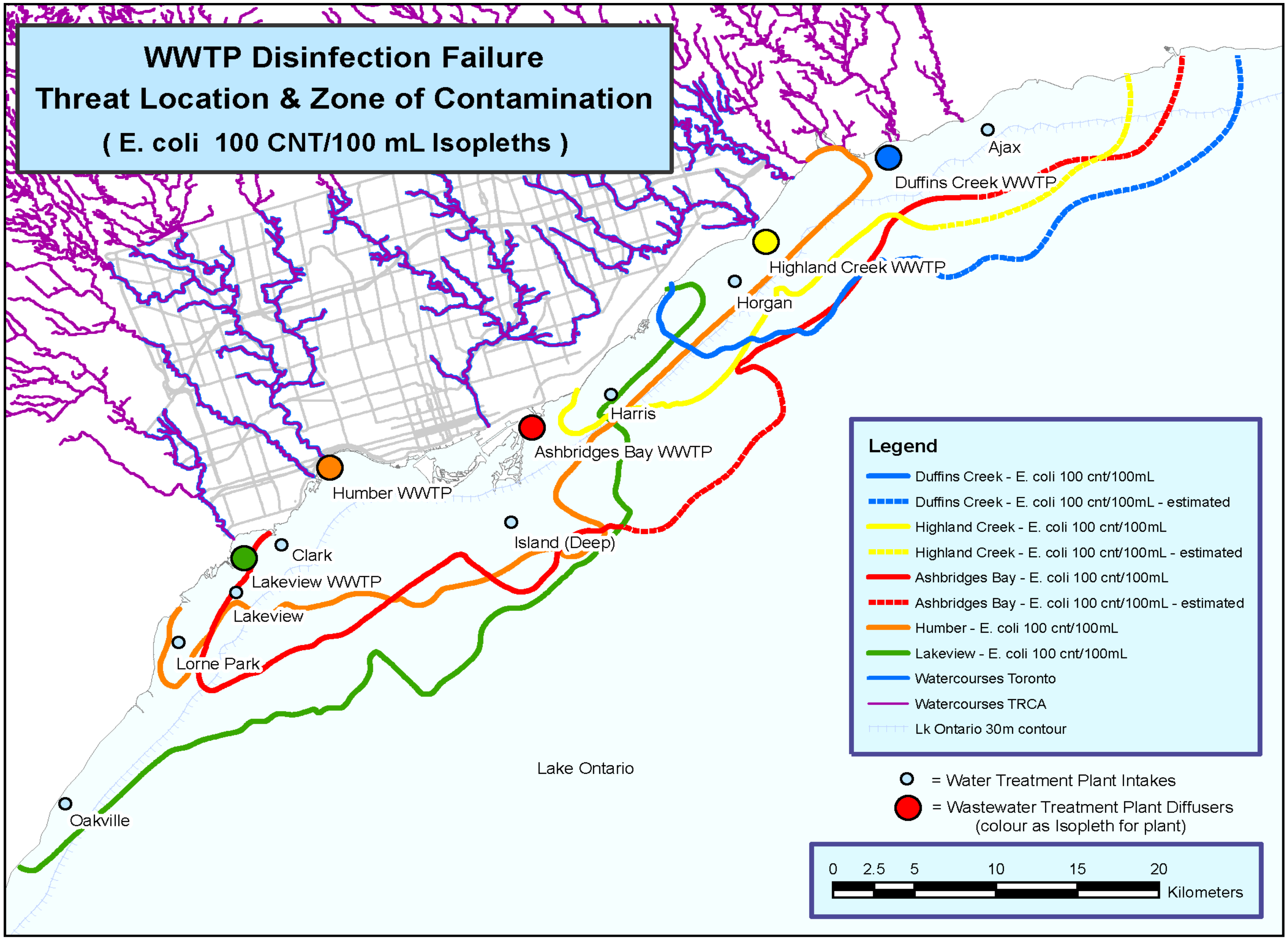


Figure E5-33: WWTP Disinfection Failure Threat Location and Zone of Contamination (E. coli 100 CFU/100 ml Isopleth) *note that Lakeview Intake is renamed Arthur P. Kennedy and Lakeview WWTP is now called G.E. Booth

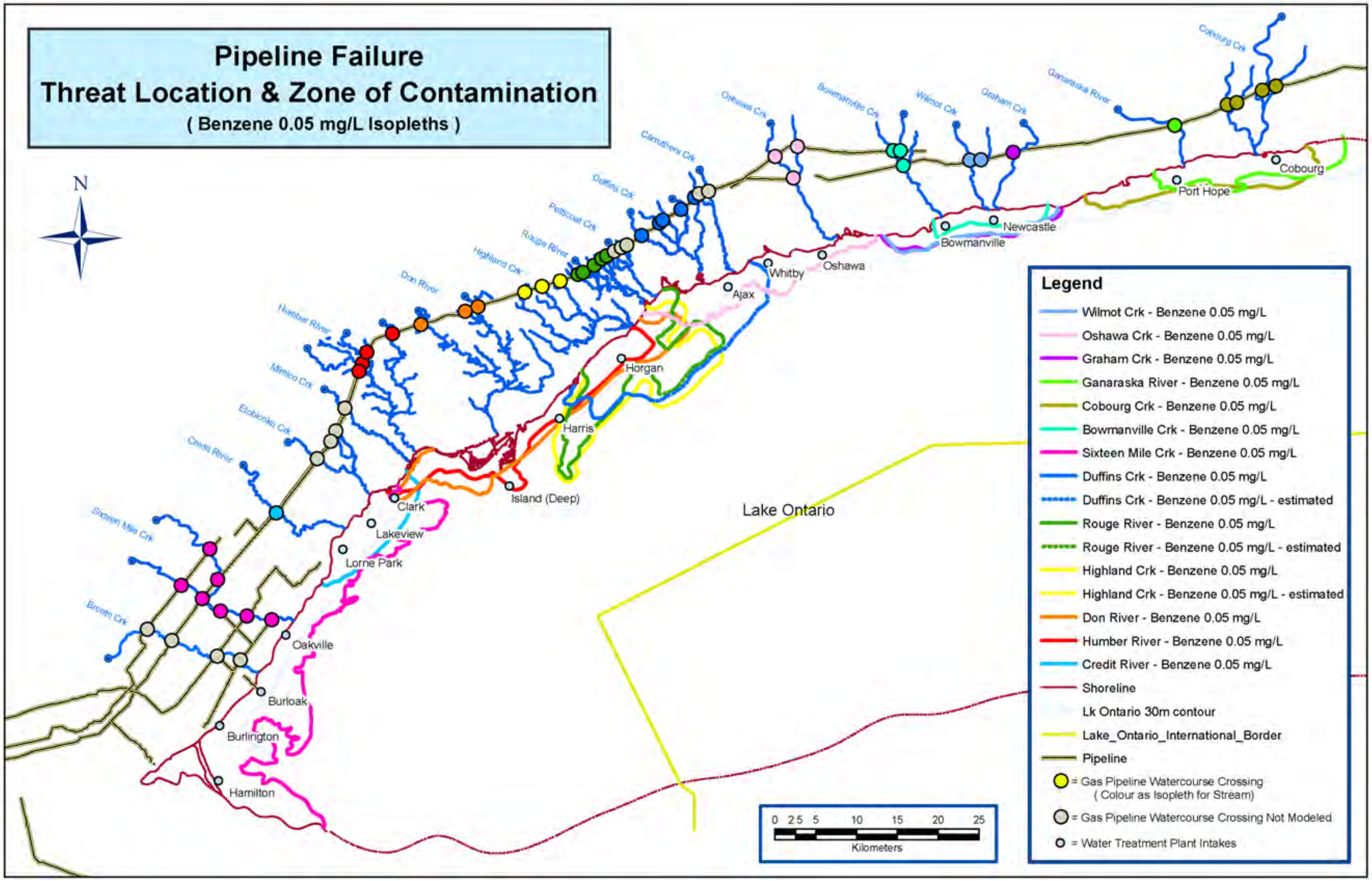


Figure E5-34: Pipeline Failure Threat Location and Zone of Contamination (Benzene 0.05 mg/L Isopleth*)* *note that Lakeview Intake is renamed Arthur P. Kennedy

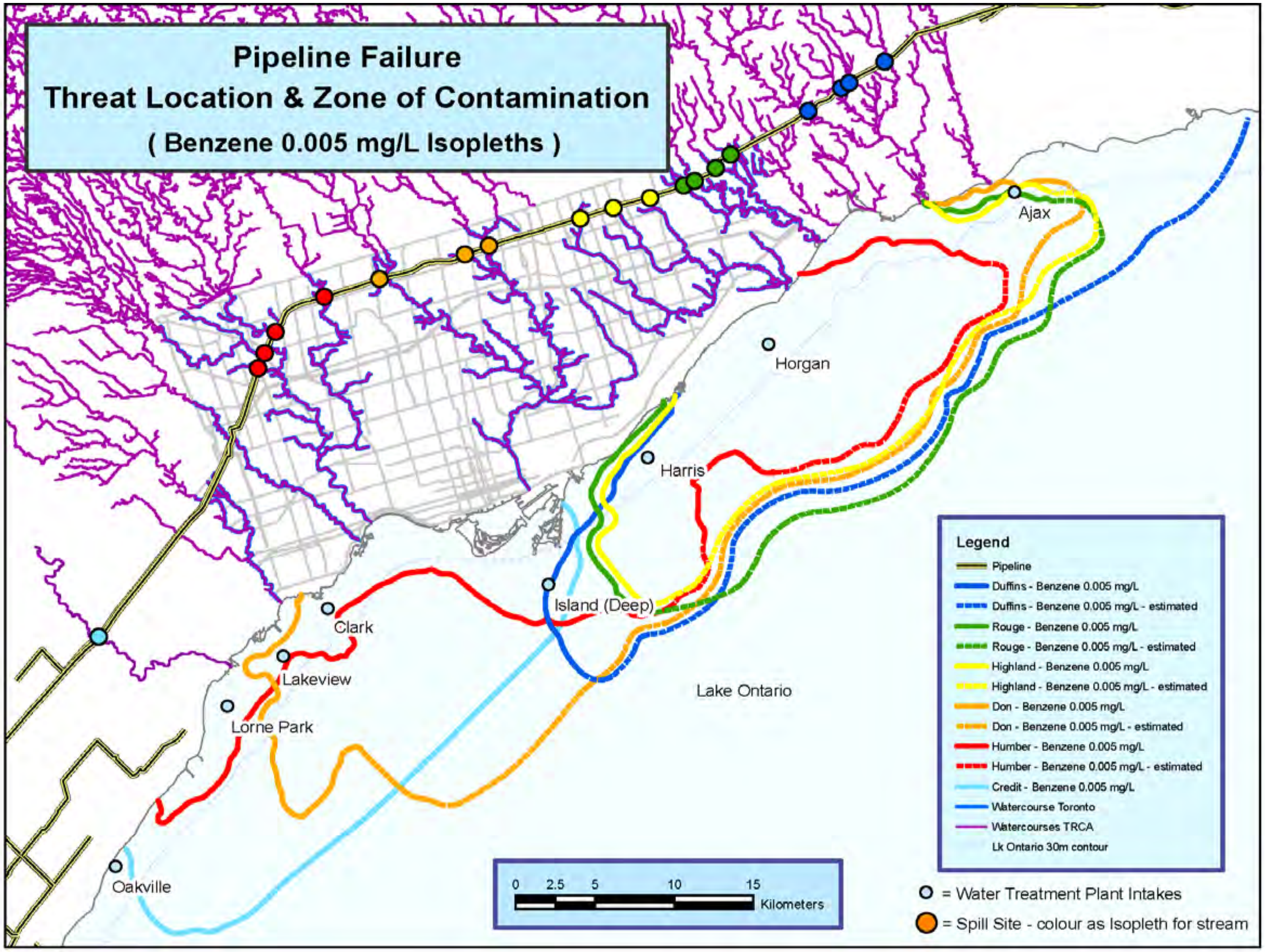


Figure E5-35: Pipeline Failure Threat Location and Zone of Contamination (Benzene 0.005 mg/L Isopleths) *note that Lakeview Intake is renamed Arthur P. Kennedy

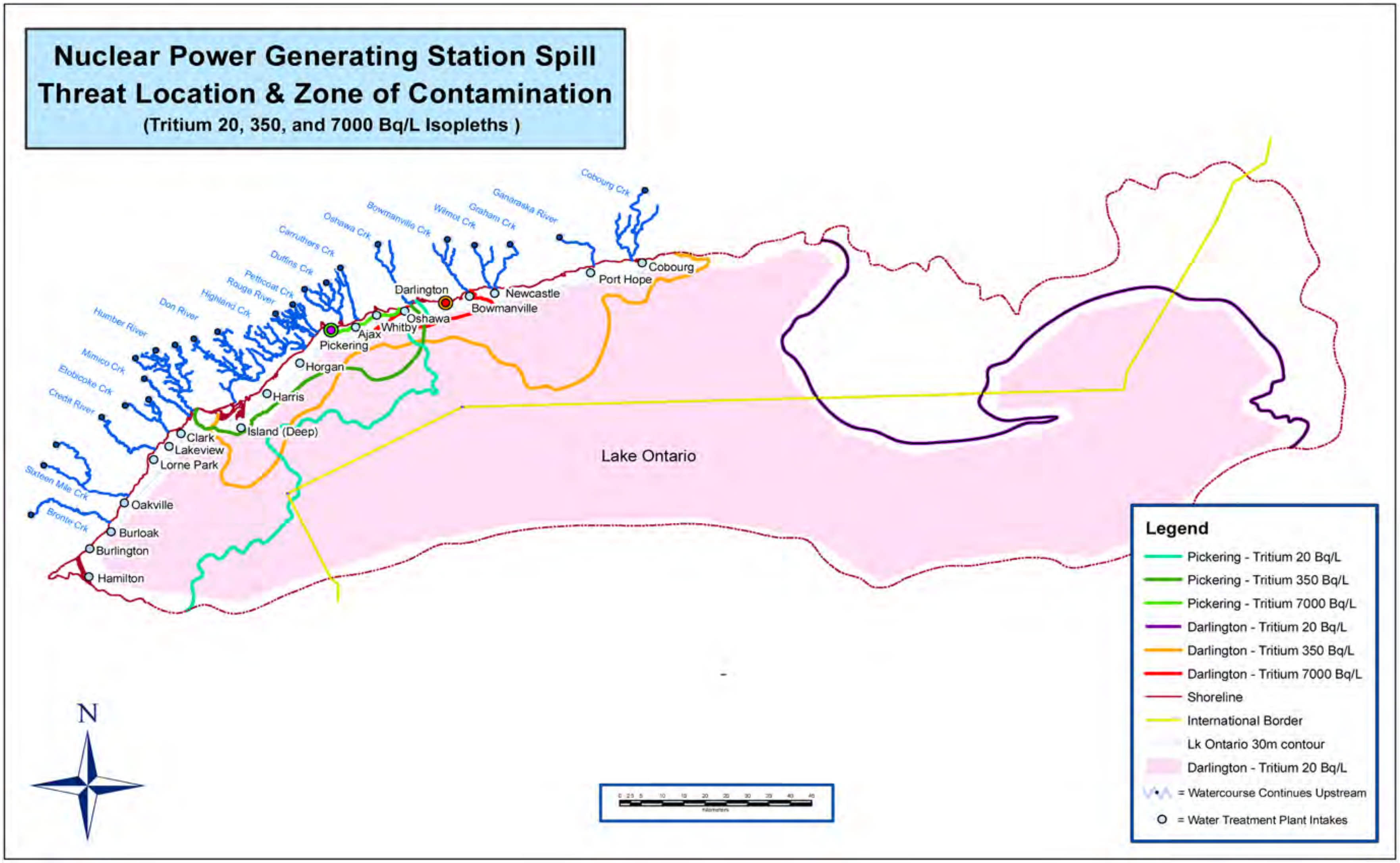


Figure E5-36: Nuclear Power Generating Station Spill Threat Location and Zone of Contamination (Tritium 20, 350 and 7000 Bq/L Isopleths) *note that Lakeview Intake is renamed Arthur P. Kennedy

E5.4.2 Linking each WWTP Intake to Source of Contamination to address Technical Rules

A decision was made by the CTC Technical Working Group that dotted lines would be used within the lake to link intakes to sources contamination where they enter the lake. For purposes of mapping flow of the contaminant from the spill point within a watershed, the *Technical Rules (68 and 130)* specified width along a river channel is used as the physical limit.

Where pipeline spills into specific riverine sources were not modelled, but a significant threat was demonstrated between riverine sources on either side of the 'non-modelled river source' this source is concluded to be a significant threat and is also mapped.

E5.4.3 Addendum to Spill Scenario Modelling for Lake Ontario Intakes Report: Sanitary Trunk Sewer Impacts

Purpose: Updated evaluation of the impacts of rupture/break in Sanitary Trunk Sewer (STS) on the water quality at some specific intakes located in CTC region by:

i) Considering STS breaks at the location below which no additional major lateral is flowing into the STSs;
ii) Applying instream *E. coli* decay to estimate *E. coli* concentration at the mouth of the river(s)/creek(s) where the spill would reach;
iii) Comparing the concentrations resulted from step (ii) with the concentrations at the mouth used in the LOC model; and
iv) Determining the *E. coli* concentrations at the intakes and estimating the size of the event based area where the LOC model results together with the estimate of *E. coli* in steps (ii and iii) would still be valid.

Background: In the previous version of this Assessment Report the IPZ-3 was represented only by a dotted line connecting the location of the modelled spill to the drinking water intake (now referred to as the 'spill collector'). Similar to the IPZ-1s and IPZ-2s, the *Technical Rules*, however, require the creation of a spatial file where policies will be applied including setbacks. Once a contaminant is modelled to reach an intake at a level at or above the threshold to be a significant threat, the event based area (EBA) portion for the IPZ-3 was delineated using the required setbacks, from the point of its release in the tributary to a point representing the maximum landward extent of the IPZ-2. In 2015, the MOECC reviewed the *Spill Scenario Modelling for Lake Ontario Intakes* report and requested revisions to "Section 6.5: Sanitary Trunk Sewer Impacts" of the EBA mapping by considering:

i) Limiting the upstream boundary of the EBA to coincide with the location where first major lateral joins the STS. This is where the STS pipe diameter is at its largest and stays constant to the waste water treatment plant. Thus, a break anywhere from this point to the waste water plant can be assumed to discharge a similar volume of sewage; and

ii) Whether there could be instream *E. coli* decay which would reduce the level of contaminants entering Lake Ontario. The modelling of this scenario already includes consideration of the in-lake decay of *E. coli*.

Approach and Outcomes:

The following describes the analysis and subsequent revisions to EBA mapping that was used to address MOECC's suggestions:

i) **Location of the STSs break**: The sanitary sewer network of the study area was revisited, and locations were identified where the STSs cross Etobicoke Creek, Humber River, Don River, and Highland Creek. There were multiple locations where STSs crossed the rivers/creeks; however, the locations of the largest STSs below all major laterals discharging into the STSs were selected for EBAs. **Figure E5-38** shows the new locations of the EBAs for the study area.

ii) **Instream *E. coli* decay**: Instream *E. coli* decay was estimated using the first order decay equation (the same approach that was used in the lake modeling).

$$C_t = C_o * e^{(-kt)},$$

where C_t = the bacteria density at elapsed time t, in colonies per 100 milliliters;
C_o = the initial bacteria density in colonies per 100 milliliters;
k = the decay constant in $hours^{-1}$; and
t = the elapsed time in hours.

Table E5-15 shows the values of C_o, k, and t used in this equation to estimate bacteria concentration at the mouths of the rivers/creeks. The values of these parameters were extracted from the assessment report, the ones used for lake modeling and/or for travel time estimation. Overall, there is 1-6% reduction in the *E. coli* concentration due to decay within the longitudinal section selected for each spill at the relevant creek/river. **Table E5-15** presents the new *E. coli* concentrations at the mouth of the rivers/creeks.

iii) ***E. coli* concentration at the water treatment plants:** The lake model was not rerun using the new *E. coli* values at the mouths of the rivers/creeks to estimate *E. coli* concentrations at the intakes of the water treatment plants; however, proportional decay in the *E. coli* levels was assumed. For example, if the percent decay at the mouth of the river was 4%, it was assumed that *E. coli* concentration at the water intakes would drop by 4%. This assumption was made in the absence of a better modelling tool to determine the size of the EBA in a reasonable manner. **Table E5-16** shows the *E. coli* concentrations that were presented in the *Spill Scenario Modelling for Lake Ontario Intakes* report (December 2011 version). **Table E5-17** shows the new values of *E. coli* at the intakes considering decay. The highlighted cells in **Table E5-17** and **Table E5-18** indicate that the modelled spill at the relevant creek/river of the STS has exceeded the benchmark values selected by the CTC SPC (100 CFU/100ml) at the intakes. Therefore, the STSs at these locations and within the relevant EBAs remain significant drinking water threats.

Conclusion

Based upon the presented methodology, **Figure E5-38** presents the new EBAs for the study area.

Table E5-15: *E. coli* concentrations at the mouth of rivers/creeks using first order decay equation

	Ecoli Concentration (Co, #/100mL)	Decay Coeff (1/s) (k)	Travel elapsed (s)	Length of Travel (km)	Ecoli at the mouth	% decay
Etobicoke Cr	50000000	0.000011	1268.12	3.5	49307378.25	1%
Humber River	50000000	0.000011	4545.45	6.5	47561471.23	5%
Don River	50000000	0.000011	5862.07	8.5	46877613.94	6%
Highland Park Cr	10000000	0.000011	3600.00	4.5	9611738.318	4%

Table E5-16: *E. coli* concentrations at the water treatment plant intake as presented in the Spill Scenario Modelling for Lake Ontario Intakes Report (December 2011 version) *note that Lakeview Intake is renamed Arthur P. Kennedy

Intake	Mega Event from Table 13 E. coli (#/100mL)	Highland Sole Source E. coli (#/100mL)	Don Sole Source E. coli (#/100mL)	Humber Sole Source E. coli (#/100mL)	Etobicoke Sole Source E. coli (#/100mL)	Total Sole Source E. coli (#/100mL)
Ajax	2	0.39	0.03	0.007	0.006	0.42
Horgan	299	288	13	13	13	327
Harris	175	91	127	2.9	1.4	222
Island Shallow	28	13	5	15	25	58
Clark	1252	3.2	15	343	1013	1374
Lakeview	182	2.5	4	109	183	298
Lorne Park	363	1.9	0.25	39	367	408
Oakville	162	0.27	0.03	1.4	144	145
Burloak	17			1	21	22
Burlington	6			0.22	5.8	6

Table E5-17: *E. coli* concentrations at the water treatment plant intake using new at the mouth *E. coli* concentrations (*note that Lakeview Intake is renamed Arthur P. Kennedy)

Intake	Mega Event from Table 13 E. coli (#/100mL)	Highland Sole Source E. coli (#/100mL)	Don Sole Source E. coli (#/100mL)	Humber Sole Source E. coli (#/100mL)	Etobicoke Sole Source E. coli (#/100mL)	Total Sole Source E. coli (#/100mL)
Ajax	2	0.4	0.0	0.0	0.0	0.4
Horgan	299	276.8	12.2	12.4	12.8	307.4
Harris	175	87.5	119.1	2.8	1.4	208.7
Island Shallow	28	12.5	4.7	14.3	24.7	54.5
Clark	1252	3.1	14.1	326.3	999.0	1291.6
Lakeview	182	2.4	3.8	103.7	180.5	280.1
Lorne Park	363	1.8	0.2	37.1	361.9	383.5
Oakville	162	0.3	0.0	1.3	142.0	136.3
Burloak	17			1.0	20.7	20.7
Burlington	6			0.2	5.7	5.6

Setbacks:

The Director's Rule (68) guides the delineation of IPZ-3s, which requires that setbacks from tributaries where the modelled contaminant could travel to reach Lake Ontario be determined based on the greater of the area of land measured from the high water mark (not exceed 120 metres) or the Conservation Authority regulation limit.

In the case of the Don River, in delineating the pipeline EBA, it was determined that with the alignment and configuration of the valleys, there would be spillage over land. This was considered in the delineation of the EBAs for the STSs to be consistent. The Sanitary Trunk Sewers are located in the valley and the regulated limit files were used to delineate the valley extents. The EBA in the lower Don follows the existing Regulation Limit, which corresponds to the Lower Don Special Policy boundary which was based on flood modelling.

These setbacks have been incorporated into the delineation of the EBAs for the revised STS break scenarios using this new approach. The EBAs capture all the modelled locations of the STSs.

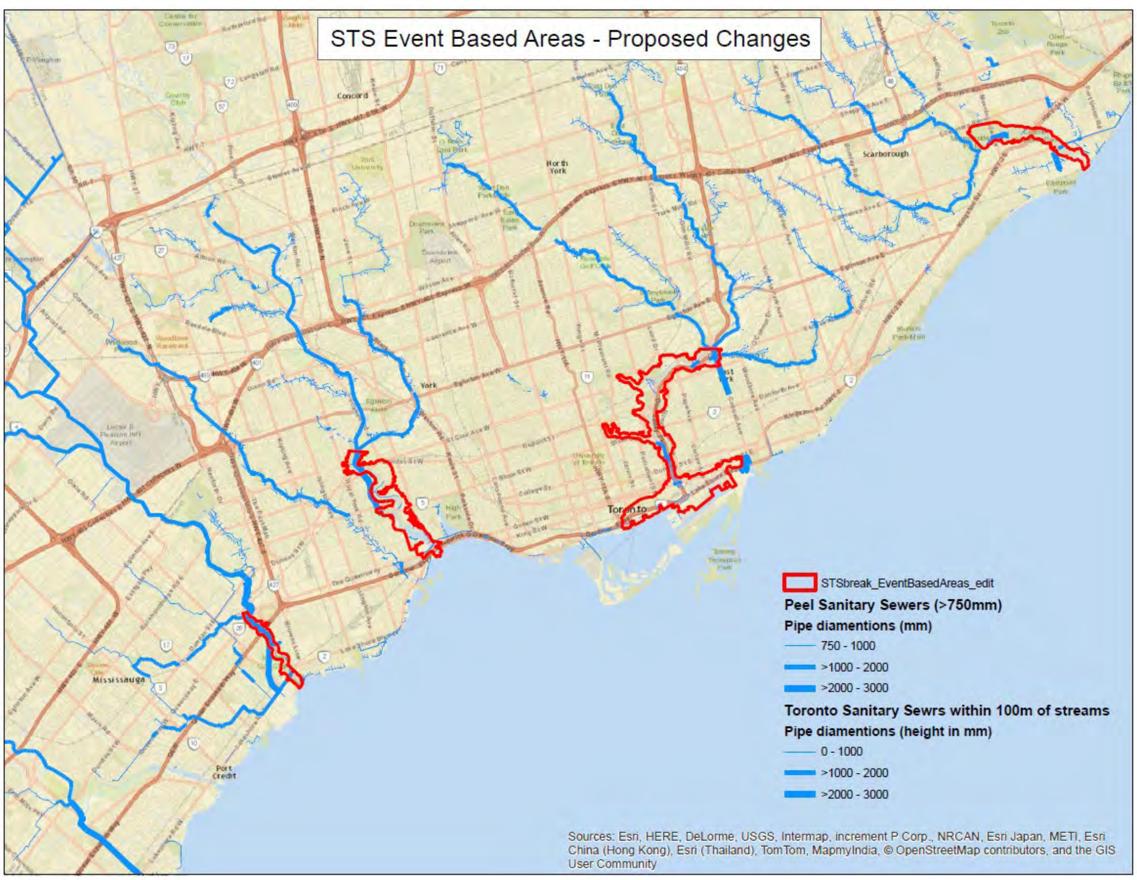


Figure E5-37: Revised STS EBAs for CTC study area (2015)

E5.4.4 Conclusions

The results of preliminary spill scenario modeling simulations as described in this report indicate the following:

- Wastewater treatment system disinfection failure scenarios impact Durham Region, Toronto, Peel Region, Halton Region, Hamilton and Niagara Region municipal drinking water intakes at levels above the selected 100 *E. coli* CFU/100ml threshold;
- Spill of sewage from sewer trunk sanitary break scenarios impact nearby municipal drinking water intakes above the selected 100 *E. coli* CFU/100ml threshold;
- Spill of gasoline containing benzene from a bulk gasoline storage facility in Oakville indicated impacts to Peel and Halton municipal drinking water intakes above the selected 0.005 mg/l benzene threshold;
- Spill of gasoline containing benzene from a bulk gasoline storage facility in North York indicated impacts to some Toronto municipal drinking water intakes above the selected 0.005 mg/l benzene threshold;
- Spill of gasoline containing benzene from a petroleum products pipeline that intersects Lake Ontario tributaries along the north shore of Lake Ontario indicated impacts to Cobourg, Port Hope, Durham Region, Toronto, Peel Region, Halton Region and Hamilton municipal drinking water intakes above the selected 0.005 mg/l benzene threshold; and
- Release of tritium from nuclear generating stations on north shore of Lake Ontario indicated impacts to three Durham Region municipal drinking water intakes above the selected 7,000 Becquerels/l threshold.

It should be noted that these preliminary results are based on specific scenarios with selected parameters such as volumes of material release, chemical/pathogen concentrations, wind and lake current velocity and direction. Changing the spill circumstance could significantly affect these results.

E5.5 Summary

Combinations of sources of spills and potential contaminants of concern were screened by the Lake Ontario Collaborative. Both contaminant-based issues (benzene, *E. coli*) and WTP operational issues were considered.

Contaminant spill scenario modelling was carried out to identify significant drinking water threats as per the *Clean Water Act, 2006*. Operational issues were considered through both operational experience and scenario modelling and have been used to support analysis of the contaminant spill scenario modelling.

Contaminant mapping has been developed to identify IPZ-3s for substances whose release causes a significant drinking water threat at an intake. *Technical Rule (68)* is used with *Rule (130)* to identify activities that may release contaminants that may reach the intake and cause deterioration to the water quality of raw water.

Spill scenarios were developed, using an evidence-based approach based on actual events. The activities of concern were located, and scenarios were developed to evaluate the impact on nearby municipal drinking water intakes. The spills were modelled for specific time periods and over a multiple number of times within a season to capture a variety of conditions.

Chemical concentrations, radiological activity, and *E. coli* density levels at each intake were used in the initial screening to determine potential intakes impacted by the spill (release) from each specific source. Results from the simulations were graphed as a time trend of concentrations for a season at each intake and tabulated as peak concentrations calculated for each intake.

E5.5.1 Uncertainty Analysis

For the LOC IPZ-3 delineation, a calibrated model was used. **Table E5-18** summarizes the level of uncertainty in the analysis.

Table E5-18: Uncertainty Assessment

Spill Source	Lake Hydrodynamic Model		Source Term (as Lake Input)	
	Uncertainty Level	Comment	Uncertainty Level	Comment
Tritium	low	Model Calibrated to specific event	low	Measured discharge
E. coli @WWTP	low	Model calibrated to both hydrodynamics and decay	low	Evidence – based Discharge
E. coli from STS break	high	Model calibrated to general hydrodynamics	low	Evidence – based Discharge
E. coli from CSO spill	low	Based on calibrated Inner Harbour model for both hydrodynamics and *E. coli* decay	low	Based on calibrated rainfall-runoff model
Rural industrial spill of *E. coli*	high	Model calibrated to general hydrodynamics	low	Evidence – based Discharge, transformed by river modelling
Benzene spill from Storage Farm	high	Model calibrated to general hydrodynamics	low	Evidence – based Discharge
Pipeline break of Benzene	high	Model calibrated to general hydrodynamics	high	Evidence – based Discharge without river modelling

E5.6 References

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King K.G., *et al*. (1998). Tritium in the Great Lakes in 1997. AECL Report RC-1981.

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E5.7 Addendum to Appendix E2

Ministry of the Environment	Ministère de l'Environnement
Source Protection Programs Branch 14th Floor 40 St. Clair Ave. West Toronto ON M4V 1M2	Direction des programmes de protection des sources 14e étage 40, avenue St. Clair Ouest Toronto (Ontario) M4V 1M2

15 November 2010.

From: Heather Malcolmson, Manager, Source Protection Planning,

Source Protections Programs Branch, Ministry of the Environment.

RE: Clarifications on items raised during the GL Technical Workshop held on Sept 16th, 2010.

Thank you for attending our workshop on Sept 16th, 2010. At the workshop, we identified a number of items where additional guidance was needed. We trust that you will consider this guidance. If you have questions or concerns, please contact George Jacoub or Clara Tucker, Source Protection Programs Branch, MOE.

E5.7.1 Intent of Rule (68) and Rule (130) of the Technical Rules (2009)

Rule(68) prescribes the approach that should be used for delineating IPZ-3 for Type A, Type B and certain Types of C and D intakes (as stated per *Rule (68)*). The approach, known as Event Based Approach (EBA), was added to the *Technical Rules (2009)* in response to public comments related to the vulnerability of systems in large water bodies. Through this approach, the source protection committee (SPC) can identify threats based on site specific evaluations instead of the semi-quantitative risk assessment approach, and then include them in a vulnerable area.

Basically, *Rule (68)* prescribes that, if the modelling exercise or other method shows that a contaminant (i.e. chemical parameter or pathogen) released from an activity would be transported through the water system and would reach the intake causing a deterioration to the water quality at the intake, an IPZ-3 shall be delineated capturing the area of this activity. If the contaminant transported through the water system does not reach the intake, there is no obligation to delineate an IPZ-3. The concentration used to determine if the contaminant has reached the intake is not defined and is at the discretion of the SPC in consultation with the plant operator. The delineation of IPZ-3 using EBA is an iterative approach following *Rules (68 and 130).*

The intent of *Rules (68 and 130)* was that the location and type of activity of concern would be identified, and based on an understanding of that type of activity estimates would be made of the type of contaminant that may be released from that activity and the volume or mass for this contaminant(s) of concern. Then based on the outcome of the EBA application, the SPC would determine whether or not an IPZ-3 should be delineated for the intake, and then identify the location as a location, where an activity, under the modelled circumstance, would be a significant drinking water threat.

Once an IPZ-3 is delineated using the approach described above, the SPC can evaluate any other existing, proposed or future activity, using the same EBA to determine if a release of contaminates from that activity would reach the intake and result in the deterioration of the water for use as a source of drinking water, as prescribed in *Rule (130).* Based on this evaluation the IPZ-3 may be extended if other modelling or methods show a larger area IPZ-3 is warranted.

It should be noted that the area delineated as an IPZ-3 in *Rule (68)* can only be delineated beyond the IPZ-1 and IPZ-2. *Rule (130)* applies to the full IPZ, which is the sum of the IPZ-1, IPZ-2, and IPZ-3. The Technical Bulletin released by MOE (EBA, MOE 2009) describes different numerical approaches for delineating this EBA IPZ-3. This evaluation can also be done through in-stream water quality transport models or hydraulic models with water quality sub-routing (e.g. HEC-RAS). These models should be capable of simulating the point-source release/spill, the transport and the fate of a known quantity of a contaminant through a water system to the intake and estimate the concentration of the contaminant that would reach the intake.

Moreover, the intent of *Rules (68 and 130)* was not to run a modelling exercise to back-track the sources of a specific contaminant that has been identified at one intake. The assessment required for this approach, known as an Issue Approach, is prescribed in *Rules (114, 115, 131, 134.1, and 141).*

E5.7.2 Different Contributing Areas in IPZ-3

Rule (58) requires that, an area of IPZ-1, IPZ-2 and IPZ-3 should be delineated for each surface water intake associated with a Type I system or a Type II system or a Type III system, meaning that one IPZ-3 is allowed to be delineated for a surface water intake.

For surface water intakes where *Rule (68)* applies, the activity(ies) that may release a certain contaminant or several contaminants to the intake may be located in more than one contributing area to the intake. Then for these cases, if the test of applying *Rule (68)* is met, the individual contributing areas should be merged into one IPZ-3.

For example, if the activities identified for the modelling exercise are one refinery that could release a significant quantity fuel and one Sewage Treatment Plant that could release Pathogens, and both contaminants would reach the intake, the contributing areas for these two activities should be merged into one IPZ-3.

E6 PRIORITIZING AND RANKING OF THREATS WITHIN ISSUE CONTRIBUTING AREAS IN THE CVSPA

The work to assess the threats to drinking water within an Issues Contributing Area (ICA) was completed to meet the requirements of the *Technical Rules: Assessment Report*, *Clean Water Act, 2006* (*Technical Rules*) (MOE, November 2009). *Technical Rule 131* provides direction to enumerate activities that contribute to a drinking water issue within an ICA as a significant threat.

This work was undertaken within the Wellhead Protection Areas (WHPA) that were delineated for the municipalities of Orangeville, Acton and Georgetown in 2010. The WHPAs for Acton and Georgetown were subsequently amended in 2012, and updated issues analyses undertaken in 2013 resulted in significant changes in the issues assignment and in the delineation of the ICAs. As such, the prioritization and ranking exercise pertaining to the previous ICA for Acton and Georgetown, as reported in the *Approved Assessment Report* (January 2012) has been removed pending future analyses in the amended ICA.

The first step in the process was to obtain existing data and information from previous studies. The data included existing reports and documentation and the databases and GIS shapefiles produced in the previous studies. The previous reports were reviewed with specific attention to the methods and approaches used to delineate significant drinking water threats, particularly within the identified ICAs.

The geodatabases were reviewed and updated as required by Genivar to interface with the MOECC Threats Look-Up Table (LUT) database Version 7.1.2 that is the electronic equivalent of the Table of Drinking Water Threats (MOE, 2009). Genivar added a field for each parcel record that could be correlated with the “LanduseActivityName” field in the LUT database. The values were assigned to this field based on information in the Municipal Property Assessment Code (MPAC) database and previous databases prepared for the threat assessment.

Representatives of the Town of Orangeville provided technical support and review to provide confidence that the updated work would provide additional value to the municipalities while meeting the requirements of the *Technical Rules*. R.J. Burnside were also asked to review the threat counts within the Town of Orangeville and these findings were reviewed to ensure that a single consistent result was provided to the town and the Source Protection Committee.

The next step was to prepare a list of the drinking water threats that are associated with the chemical parameters that have been identified as a drinking water issue as required by *Technical Rule 115(4)*. These tables were prepared by searching and filtering the LUT database for activities and circumstances that are associated with the chemical parameter identified as a drinking water issue. The activities and circumstances are associated with the list of prescribed drinking water threats as outlined in **Chapter 5.1.1** of the Assessment Report.

The final step in the process was to identify and count existing land use activities within the ICA that can contribute to the drinking water issue. This process was completed using the Geographic Information System (GIS) and MSAccess to query the threats LUT database. The updated land use database described above is linked to the threats LUT Database on the common field of “LanduseActivityName”. This process generates a georeferenced table containing the information describing the threat circumstances from the Table of Drinking Water Threats that are associated with the identified land uses. A list is then created for each property of the circumstances that are considered to be drinking water threats, and in particular significant drinking water threats.

This information is available within the GIS environment and can be output in a variety of mapping or tabular formats as requested by the authorized user.

The list of significant threats for each ICA was presented in a tabular format as suggested by the MOECC. Entries in this table identify the number of occurrences of the 19 prescribed threat activities and the number of affected parcels. Note that the total number of threats will normally be greater than the number of affected parcels as several prescribed threat activities can be associated with a single land use. For this study, the number of activities was subdivided by land use to provide perspective in prioritizing the significant drinking water threats for action.

The updated lists of activities that are significant drinking water threats and the counts of significant drinking water threats in the ICA were subsequently reviewed with the municipal representatives and prioritized to assist the Source Protection Committee in understanding relative priorities for considering policy options.

E6.1 Orangeville (Sodium and Chloride Issue)

Sodium and chloride as drinking water issues are identified at nine (9) of the twelve (12) municipal water supply wells in Orangeville. The source of the sodium and chloride in the groundwater is attributed to use of winter de-icing agents within the capture zones of the municipal wells. This source of sodium and chloride appears to be reasonable based on the correlation of the trends and the timing of development and of a lack of increasing trends in the vicinity of wells where there is minimal residential development in the delineated capture zones.

Identification of Threat Activities – Na/Cl

As per the *Technical Rules*, land use activities that can release parameters that are identified as a drinking water issue are to be considered as significant drinking water threats. These activities typically relate to the handling, storage or application of road salt and use of private sewage disposal systems.

Enumeration of Threat Activities – Na/Cl

The number of potential significant threat activities in the ICAs for each of the wellfields in Orangeville has been determined separately. A total number of significant threat activities has been prepared for the combined ICA in Orangeville.

The count of activities that are potentially significant threats and the number of parcels affected, are provided in the assessment report. This analysis was undertaken by querying the Table of Drinking Water Threats for land use activities that can release sodium or chloride and are provided in the Assessment Report.

The potential for sodium and chloride to be released due to application of road salt on municipal roads has been assigned as one activity and one parcel. The values shown in the Assessment Report are corrected to consider only one activity and one parcel associated with road salt application by the municipalities within the ICAs for the Town of Orangeville wells.

One (1) parcel has been identified as having potential for handling and storage of road salt in association with the municipal winter maintenance operations. All parcels within the ICA have potential to store some salt and have been included in the enumeration, subdivided by land use category.

One (1) parcel is identified as having a history or potential for being used for snow storage in conjunction with municipal operations.

The land use activity links in the Table of Drinking Water Threats do not identify all of the potential properties where road salt may be applied. Commercial, institutional, industrial and residential land uses may also apply road salt. Land use data and orthophotographs were used to identify 76 commercial, institutional, and multi-residential parcels with private parking lots in the combined ICAs. There are a total of 2,188 residential parcels within the combined ICA that also have potential for application of road salt.

The effluent discharge from the Water Pollution Control Plant is located within the ICA for Well 10. The discharge of treated sewage effluent is considered to be a significant threat and is considered as one (1) activity and one (1) parcel.

There are 353 parcels within the combined ICAs that are serviced by private on-site sewage disposal systems. This includes rural estate lot subdivisions within the ICA for Wells 6 and 11. The potential loading of sodium and chloride from a private on-site sewage disposal system is considered to be greater for systems that are equipped with water softeners. Data is not currently available to describe how many private systems use water softeners.

In addition to these activities that are associated with existing land use, there remains potential that natural concentrations of sodium and chloride in the groundwater may contribute in part to the observed concentrations in the municipal wells. The observed increasing trends may be a result of drawing water from bedrock formations that have a higher natural salt content. Additional studies will be required to confirm.

Prioritization of Threats

The activities listed in **Section 5.1.1** (Assessment Report) are recommended to be considered in decisions regarding future land use within the ICA.

The Source Protection Plan will contain policies that will apply to minimize the potential for release of sodium and chloride from the existing activities within the ICA. The relative priority for implementation of these policies should be:

- Management of winter road salt storage and application on municipal roads.
- Management of winter road salt storage and application on private lands that include parking lots and public access.
- Management of salt content in effluent from municipal water pollution control plant.
- Management of winter road salt storage and application on residential parcels.
- Management of potential salt loadings in private sewage disposal systems, including use of water softeners.

The following sections present a review of the reasoning behind establishing this order of priority. The priority is based on the relative quantity of salt that is potentially used by each group.

Road Salt Application – Municipal

The Town of Orangeville is responsible for winter road maintenance through the majority of the ICAs. The Province of Ontario, Town of Caledon, Dufferin County, Township of Amaranth and Township of East Garafraxa also have some responsibility for application of salt to public roads within the ICAs. All public roads within the ICA were considered in this estimate.

The amount of salt applied for winter road maintenance can vary from jurisdiction to jurisdiction and will vary with road type, number and frequencies of winter precipitation, temperature, and policies. As such, providing an accurate estimate of the quantity of salt applied in any area is a substantial challenge. Highways and arterial roads will typically receive more salt than local roads or rural roads. For rural roads the salt application is typically much lower and is limited to the use of salt to keep sand from freezing (typically 3 to 5%). **Table E6-1** illustrates the range of rates based on information provided by representatives of the individual municipalities.

The Town of Orangeville provided estimates of the total road salt application to roads within the ICAs for wells 2, 5, 6, 7, 9, and 11 in the 2010-2011 season. This information consisted of the total quantity of salt purchased and the number of lane kilometres to which the salt was applied for both collector/arterial roads and for local roads. Similar information for higher maintenance and average maintenance roads were also provided by Dufferin County. The salt application rate estimates varied from 9.08 tonnes/lane-km to 17.9 tonnes/lane-km. Not all of the roads within the ICA were included in this estimate. Based on the information provided, an average annual salt application rate per lane kilometre was calculated as a weighted average at 13.25 tonnes/ lane-km. This value is roughly in the middle of the historical range observed in **Table E6-1** and is a reasonable value for an estimate that will balance the loading on rural roads that may receive less salt with the loading on highways and intersections that receive more intense salt application.

The weighted average annual salt application rate was then used by Genivar to estimate the total mass of salt applied on road segments within the ICAs. The per lane application rates were adjusted by Genivar to reflect the length of 2-lane and 4-lane roads within the ICAs. **Table E6-2** provides an estimate of the potential amount of salt that can be applied on the roads within the delineated ICAs for Orangeville. Experience has shown that the quantity of salt applied can vary greatly in response to seasonal conditions. Information provided by the Town of Orangeville indicated that the 2010-2011 seasons may have seen 35-40% more salt applied on the roads in 2009/10, but less than that applied in 2007/8 or 2008/9. Variations from year to year can be more than double. An average rate has been considered based on the information provided for 2010/11. The range of values produced by this assumption is similar to rates observed in other studies and is considered to be a reasonable estimate based on available data.

Table E6-1 Historical Salt Use – Orangeville and Adjacent Municipalities

Agency	Year	Road Lengths			Salt Use			Application Rate		
		Highway/ Collector/ Arterial	Local	Total	Highway/ Collector/ Arterial	Local	Total	Highway/ Collector/ Arterial	Local	Total
		(lane-km)			Tonnes			Tonnes/(lane-km)		
Town of Orangeville	2010/2011	98.8	150.5	249.3	1,370.0	1,370.0	2,740.0	13.9	9.1	11.0
	2009/2010	98.8	150.5	249.3	974.0	974.0	1,948.0	9.9	6.5	7.8
	2008/2009	98.8	148.2	247.0	1,977.0	1,977.0	3,954.0	20.0	13.3	16.0
	2007/2008	**98.8**	**147.2**	246.0	**2,224.0**	**2,224.0**	4,448.0	22.5	15.1	18.1
Dufferin County	2010/2011	na	na	648.0	na	na	9,690.0	na	na	15.0
	2009/2010	na	na	648.0	na	na	7,010.0	na	na	10.8
	2008/2009	na	na	648.0	na	na	9,138.1	na	na	14.1
Township of East Garafraxa	2010/2011	na	na	300.0	na	na	100.0	na	na	0.3
Township of Amaranth	2010/2011	na	na	433.0	na	na	250.0	na	na	0.6
Town of Caledon	2010/2011	62.0	1,418.0	1,480.0	930.0	10,170.0	11,100.0	15.0	7.2	7.5
Province of Ontario (Highway 10)	2010/2011	na	na	na	na	na	na	14.0	na	14.0

Notes:
na - not available/not applicable

Table E6-2: Estimated Salt Loading from Public Road Maintenance

WHPA Area	Road Type	Road Length in ICA	Annual Salt Application Rate				Potential Annual Salt Loading				
			Range			Representative	Range			Representative	
		(km)	(kg/km)				(kg)				
Issues Contributing Area – Orangeville Wells 2, 5, 7 & 9											
WHPA-A	2-Lane	0.7	18,180	to	35,800	26,500	12,726	to	25,060	18,550	18,550
	4-Lane	0.0	36,360	to	71,600	54,000	0	to	0	0	
WHPA-B	2-Lane	14.1	18,180	to	35,800	26,500	256,338	to	504,780	373,650	487,050
	4-Lane	2.1	36,360	to	71,600	54,000	76,356	to	150,360	113,400	
WHPA-C	2-Lane	2.4	18,180	to	35,800	26,500	43,632	to	85,920	63,600	85,200
	4-Lane	0.4	36,360	to	71,600	54,000	14,544	to	28,640	21,600	
WHPA-D	2-Lane	3.4	18,180	to	35,800	26,500	61,812	to	121,720	90,100	106,300
	4-Lane	0.3	36,360	to	71,600	54,000	10,908	to	21,480	16,200	
WHPA-E	2-Lane	0.7	18,180	to	35,800	26,500	12,726	to	25,060	18,550	40,150
	4-Lane	0.4	36,360	to	71,600	54,000	14,544	to	28,640	21,600	
Total		24.5					489,042	to	963,020	737,250	737,250
Issues Contributing Area – Orangeville Wells 6, 11											
WHPA-A	2-Lane	0.4	18,180	to	35,800	26,500	7,272	to	14,320	10,600	10,600
	4-Lane	0.0	36,360	to	71,600	54,000	0	to	0	0	
WHPA-B	2-Lane	21.4	18,180	to	35,800	26,500	389,052	to	766,120	567,100	567,100
	4-Lane	0.0	36,360	to	71,600	54,000	0	to	0	0	
WHPA-C	2-Lane	3.3	18,180	to	35,800	26,500	59,994	to	118,140	87,450	87,450
	4-Lane	0.0	36,360	to	71,600	54,000	0	to	0	0	
WHPA-D	2-Lane	2.1	18,180	to	35,800	26,500	38,178	to	75,180	55,650	55,650
	4-Lane	0.0	36,360	to	71,600	54,000	0	to	0	0	
WHPA-E	2-Lane	0.0	18,180	to	35,800	26,500	0	to	0	0	0
	4-Lane	0.0	36,360	to	71,600	54,000	0	to	0	0	
Total		27.2					494,496	to	973,760	720,800	720,800
Issues Contributing Area – Orangeville Well 10											
WHPA-A	2-Lane	0.2	18,180	to	35,800	26,500	3,636	to	7,160	5,300	5,300
	4-Lane	0.0	36,360	to	71,600	54,000	0	to	0	0	
WHPA-B	2-Lane	1.4	18,180	to	35,800	26,500	25,452	to	50,120	37,100	47,900
	4-Lane	0.2	36,360	to	71,600	54,000	7,272	to	14,320	10,800	
WHPA-C	2-Lane	3.3	18,180	to	35,800	26,500	59,994	to	118,140	87,450	87,450
	4-Lane	0.0	36,360	to	71,600	54,000	0	to	0	0	
WHPA-D	2-Lane	7.7	18,180	to	35,800	26,500	139,986	to	275,660	204,050	204,050
	4-Lane	0.0	36,360	to	71,600	54,000	0	to	0	0	
WHPA-E	2-Lane	5.5	18,180	to	35,800	26,500	99,990	to	196,900	145,750	221,350
	4-Lane	1.4	36,360	to	71,600	54,000	50,904	to	100,240	75,600	
Total		19.7					336,330	to	682,390	566,050	566,050
Total Combined Issues Contributing Areas - Orangeville											
WHPA-A	2-Lane	1.3	18,180	to	35,800	26,500	23,634	to	46,540	34,450	34,450
	4-Lane	0.0	36,360	to	71,600	54,000	0	to	0	0	
WHPA-B	2-Lane	36.9	18,180	to	35,800	26,500	670,842	to	1,321,020	977,850	1,102,050
	4-Lane	2.3	36,360	to	71,600	54,000	83,628	to	164,680	124,200	
WHPA-C	2-Lane	9.0	18,180	to	35,800	26,500	163,620	to	322,200	238,500	260,100
	4-Lane	0.4	36,360	to	71,600	54,000	14,544	to	28,640	21,600	
WHPA-D	2-Lane	13.2	18,180	to	35,800	26,500	239,976	to	472,560	349,800	366,000
	4-Lane	0.3	36,360	to	71,600	54,000	10,908	to	21,480	16,200	
WHPA-E	2-Lane	6.2	18,180	to	35,800	26,500	112,716	to	221,960	164,300	261,500
	4-Lane	1.8	36,360	to	71,600	54,000	65,448	to	128,880	97,200	
Total ICA	2-Lane	66.6	18,180	to	35,800	26,500	1,210,788	to	2,384,280	1,764,900	2,024,100
	4-Lane	4.8	18,180	to	35,800	54,000	87,264	to	171,840	259,200	
Total		**71.4**					**1,319,868**	**to**	**2,599,080**	**2,024,100**	**2,024,100**

Road Salt Application - Private

There is currently no regulation to govern the application of salt by owners of commercial, industrial, institutional or multi-residential buildings. Concerns for public safety and pressures to minimize insurance claims typically result in relatively frequent and high application rates of de-icing agents.

The relative quantity of salt applied in the ICA has been estimated based on the area of impervious surfaces and an assumed application rate. The Town of Orangeville provided information on the potential range of application rates used in municipal and private parking lots. The annual salt application rates were considered to range from 1.2 kg/m^2 to 7.9 kg/m^2. For the purposes of this study and average annual application rate of 4 kg/m^2 per event is considered to reasonably reflect this range. **Table E6-3** provides an estimate of the potential amount of salt that would be applied in the ICAs on private commercial, industrial, institutional or multi-residential parcels.

Road Salt Application – Residential

There is currently no regulation to govern the application of salt by owners of private residents. The use of salt is a personal preference and is not carried out by all residents. The use of salt is typically governed by concerns for personal safety and convenience under icy conditions.

The relative quantity of salt applied in the ICA has been estimated based on the number of parcels and an assumption that each parcel could apply up to 10 kg of salt during a season. This is typically the amount from one bag. This value should be reasonably representative as there are likely individuals who apply no salt and others who apply more either for personal safety or because of larger surface areas to cover. There are also likely some residents in rural subdivisions with longer driveways and potential for application of salt in greater quantities. **Table E6-4** documents the calculation of the potential salt loading from private residents.

Table E6-3: Estimated Salt Loading from Winter Maintenance on Private Parcels - Orangeville

Land Use	Land Use	Number of Parcels	Annual Salt Application Rate (kg)	Potential Annual Salt Loading (kg)	
Issues Contributing Area – Orangeville Wells 2, 5, 7 & 9					
WHPA-A	Suburban Residential	64	10	640	670
	Rural Residential	3	10	30	
WHPA-B	Suburban Residential	884	10	8,840	9,050
	Rural Residential	21	10	210	
WHPA-C	Suburban Residential	0	10	0	70
	Rural Residential	7	10	70	
WHPA-D	Suburban Residential	1	10	10	70
	Rural Residential	6	10	60	
WHPA-E	Suburban Residential	0	10	0	0
	Rural Residential	0	10	0	
	Total	**986**		**9,860**	**9,860**
Issues Contributing Area – Orangeville Wells 6, 11					
WHPA-A	Suburban Residential	0	10	0	0
	Rural Residential	0	10	0	
WHPA-B	Suburban Residential	721	10	7,210	9,130
	Rural Residential	192	10	1,920	
WHPA-C	Suburban Residential	78	10	780	840
	Rural Residential	6	10	60	
WHPA-D	Suburban Residential	0	10	0	20
	Rural Residential	2	10	20	
WHPA-E	Suburban Residential	0	10	0	0
	Rural Residential	0	10	0	
	Total	**999**		**9,990**	**9,990**
Issues Contributing Area – Orangeville Well 10					
WHPA-A	Suburban Residential	0	10	0	10
	Rural Residential	1	10	10	
WHPA-B	Suburban Residential	24	10	240	290
	Rural Residential	5	10	50	
WHPA-C	Suburban Residential	2	10	20	190
	Rural Residential	17	10	170	
WHPA-D	Suburban Residential	5	10	50	470
	Rural Residential	42	10	420	
WHPA-E	Suburban Residential	103	10	1,030	1,070
	Rural Residential	4	10	40	
	Total	**203**		**2,030**	**2,030**
Total Combined Issues Contributing Areas – Orangeville					
WHPA-A	Suburban Residential	64	10	640	680
	Rural Residential	4	10	40	
WHPA-B	Suburban Residential	1,629	10	16,290	18,470
	Rural Residential	218	10	2,180	
WHPA-C	Suburban Residential	80	10	800	1,100
	Rural Residential	30	10	300	
WHPA-D	Suburban Residential	6	10	60	560
	Rural Residential	50	10	500	
WHPA-E	Suburban Residential	103	10	1,030	1,070
	Rural Residential	4	10	40	
	Total	**2,188**		**21,880**	**21,880**
Total for Combined ICA		**2,188**		**21,880**	

Table E6-4: Estimated Road Salting from Winter Maintenance on Private Roads – Orangeville

Part A. Commercial/Industrial/Institutional/Multi-Unit Residential

WHPA Area	Land Use	Estimated Paved Surface Area	Salt Application Rate	Number of Events	Annual Salt Application Rate				Potential Annual Salt Loading				
					Range			Representative	Range			Representative	
		(m^2)	(kg/m^2)		(kg/m^2)				(kg)				
Issues Contributing Area – Orangeville Wells 2, 5, 7 & 9													
WHPA-A	Commercial	8,700	0.012	40	1.2	to	7.9	4	10,440	to	68,730	34,800	34,800
	Industrial	0	0.012	10	1.2	to	7.9	4	0	to	0	0	
	Institutional	0	0.012	10	1.2	to	7.9	4	0	to	0	0	
	Multi Unit Residential	0	0.012	10	1.2	to	7.9	4	0	to	0	0	
WHPA-B	Commercial	38,300	0.012	40	1.2	to	7.9	4	45,960	to	302,570	153,200	355,600
	Industrial	28,900	0.012	10	1.2	to	7.9	4	34,680	to	228,310	115,600	
	Institutional	21,700	0.012	10	1.2	to	7.9	4	26,040	to	171,430	86,800	
	Multi Unit Residential	0	0.012	10	1.2	to	7.9	4	0	to	0	0	
WHPA-C	Commercial	0	0.012	40	1.2	to	7.9	4	0	to	0	0	128,000
	Industrial	32,000	0.012	10	1.2	to	7.9	4	38,400	to	252,800	128,000	
	Institutional	0	0.012	10	1.2	to	7.9	4	0	to	0	0	
	Multi Unit Residential	0	0.012	10	1.2	to	7.9	4	0	to	0	0	
WHPA-D	Commercial	0	0.012	40	1.2	to	7.9	4	0	to	0	0	0
	Industrial	0	0.012	10	1.2	to	7.9	4	0	to	0	0	
	Institutional	0	0.012	10	1.2	to	7.9	4	0	to	0	0	
	Multi Unit Residential	0	0.012	10	1.2	to	7.9	4	0	to	0	0	
WHPA-E	Commercial	0	0.012	40	1.2	to	7.9	4	0	to	0	0	0
	Industrial	0	0.012	10	1.2	to	7.9	4	0	to	0	0	
	Institutional	0	0.012	10	1.2	to	7.9	4	0	to	0	0	
	Multi Unit Residential	0	0.012	10	1.2	to	7.9	4	0	to	0	0	
	Total	**128,600**										**618,400**	**618,400**
Issues Contributing Area – Orangeville Wells 6, 11													
WHPA-A	Commercial	0	0.012	40	1.2	to	7.9	4	0	to	0	0	11,200
	Industrial	0	0.012	10	1.2	to	7.9	4	0	to	0	0	
	Institutional	2,800	0.012	10	1.2	to	7.9	4	3,360	to	22,120	11,200	
	Multi Unit Residential	0	0.012	10	1.2	to	7.9	4	0	to	0	0	
WHPA-B	Commercial	76,800	0.012	40	1.2	to	7.9	4	92,160	to	606,720	307,200	937,200
	Industrial	150,300	0.012	10	1.2	to	7.9	4	180,360	to	1,187,370	601,200	
	Institutional	4,000	0.012	10	1.2	to	7.9	4	4,800	to	31,600	16,000	
	Multi Unit Residential	3,200	0.012	10	1.2	to	7.9	4	3,840	to	25,280	12,800	
WHPA-C	Commercial	11,200	0.012	40	1.2	to	7.9	4	13,440	to	88,480	44,800	56,800
	Industrial	3,000	0.012	10	1.2	to	7.9	4	3,600	to	23,700	12,000	
	Institutional	0	0.012	10	1.2	to	7.9	4	0	to	0	0	
	Multi Unit Residential	0	0.012	10	1.2	to	7.9	4	0	to	0	0	
WHPA-D	Commercial	0	0.012	40	1.2	to	7.9	4	0	to	0	0	0
	Industrial	0	0.012	10	1.2	to	7.9	4	0	to	0	0	
	Institutional	0	0.012	10	1.2	to	7.9	4	0	to	0	0	
	Multi Unit Residential	0	0.012	10	1.2	to	7.9	4	0	to	0	0	
WHPA-E	Commercial	0	0.012	40	1.2	to	7.9	4	0	to	0	0	0
	Industrial	0	0.012	10	1.2	to	7.9	4	0	to	0	0	
	Institutional	0	0.012	10	1.2	to	7.9	4	0	to	0	0	
	Multi Unit Residential	0	0.012	10	1.2	to	7.9	4	0	to	0	0	
	Total	**261,300**										**1,006,200**	**1,006,200**
Issues Contributing Area – Orangeville Well 10													
WHPA-A	Commercial	0	0.012	40	1.2	to	7.9	4	0	to	0	0	0
	Industrial	0	0.012	10	1.2	to	7.9	4	0	to	0	0	
	Institutional	0	0.012	10	1.2	to	7.9	4	0	to	0	0	
	Multi Unit Residential	0	0.012	10	1.2	to	7.9	4	0	to	0	0	
WHPA-B	Commercial	0	0.012	40	1.2	to	7.9	4	0	to	0	0	25,504
	Industrial	0	0.012	10	1.2	to	7.9	4	0	to	0	0	
	Institutional	6,376	0.012	10	1.2	to	7.9	4	7,651	to	50,370	25,504	
	Multi Unit Residential	0	0.012	10	1.2	to	7.9	4	0	to	0	0	
WHPA-C	Commercial	0	0.012	40	1.2	to	7.9	4	0	to	0	0	0
	Industrial	0	0.012	10	1.2	to	7.9	4	0	to	0	0	
	Institutional	0	0.012	10	1.2	to	7.9	4	0	to	0	0	
	Multi Unit Residential	0	0.012	10	1.2	to	7.9	4	0	to	0	0	
WHPA-D	Commercial	0	0.012	40	1.2	to	7.9	4	0	to	0	0	0
	Industrial	0	0.012	10	1.2	to	7.9	4	0	to	0	0	
	Institutional	0	0.012	10	1.2	to	7.9	4	0	to	0	0	
	Multi Unit Residential	0	0.012	10	1.2	to	7.9	4	0	to	0	0	
WHPA-E	Commercial	26,900	0.012	40	1.2	to	7.9	4	32,280	to	212,510	107,600	235,200
	Industrial	22,300	0.012	10	1.2	to	7.9	4	26,760	to	176,170	89,200	
	Institutional		0.012	10	1.2	to	7.9	4	0	to	0	0	
	Multi Unit Residential	9,600	0.012	10	1.2	to	7.9	4	11,520	to	75,840	38,400	
	Total	**86,176**										**260,704**	**260,704**
Total Combined Issues Contributing Areas – Orangeville													
WHPA-A	Commercial	8,700	0.012	40	1.2	to	7.9	4	10,440	to	68,730	34,800	46,000
	Industrial	0	0.012	10	1.2	to	7.9	4	0	to	0	0	
	Institutional	2,800	0.012	10	1.2	to	7.9	4	3,360	to	22,120	11,200	
	Multi Unit Residential	0	0.012	10	1.2	to	7.9	4	0	to	0	0	
WHPA-B	Commercial	115,100	0.012	40	1.2	to	7.9	4	138,120	to	909,290	460,400	1,318,304
	Industrial	179,200	0.012	10	1.2	to	7.9	4	215,040	to	1,415,680	716,800	
	Institutional	32,076	0.012	10	1.2	to	7.9	4	38,491	to	253,400	128,304	
	Multi Unit Residential	3,200	0.012	10	1.2	to	7.9	4	3,840	to	25,280	12,800	
WHPA-C	Commercial	11,200	0.012	40	1.2	to	7.9	4	13,440	to	88,480	44,800	184,800
	Industrial	35,000	0.012	10	1.2	to	7.9	4	42,000	to	276,500	140,000	
	Institutional	0	0.012	10	1.2	to	7.9	4	0	to	0	0	
	Multi Unit Residential	0	0.012	10	1.2	to	7.9	4	0	to	0	0	
WHPA-D	Commercial	0	0.012	40	1.2	to	7.9	4	0	to	0	0	0
	Industrial	0	0.012	10	1.2	to	7.9	4	0	to	0	0	
	Institutional	0	0.012	10	1.2	to	7.9	4	0	to	0	0	
	Multi Unit Residential	0	0.012	10	1.2	to	7.9	4	0	to	0	0	
WHPA-E	Commercial	26,900	0.012	40	1.2	to	7.9	4	32,280	to	212,510	107,600	235,200
	Industrial	22,300	0.012	10	1.2	to	7.9	4	26,760	to	176,170	89,200	
	Institutional	0	0.012	10	1.2	to	7.9	4	0	to	0	0	
	Multi Unit Residential	9,600	0.012	10	1.2	to	7.9	4	11,520	to	75,840	38,400	
	Total	**448,076**										**1,361,504**	**1,384,304**
Total for Combined ICA		**446,076**										**1,784,304**	**1,784,304**

Municipal Sewage Treatment

The treated sewage effluent from the Town of Orangeville sewage treatment plant is discharged into the Credit River system within the ICA for Well 10. The treated effluent provides a significant portion of the annual baseflow to the Credit River.

The Town of Orangeville provided data describing the annual volume of treated effluent discharged and chloride concentrations in the treated effluent from the Water Pollution Control Plant. These values were used to estimate an equivalent annual mass load of salt that can be compared with the amount generated by other activities.

The estimated mass of chloride and the equivalent mass of salt released annually within the treated sewage effluent is provided in **Table E6-5**. This mass is only released within the WHPA-E portion of the ICA for Well 10. WHPA-E has been defined for this well as it is classified as Groundwater Under the Influence of Surface Water (GUDI) with effective filtration.

Qualitative analysis was carried out to further assess the potential threat that the release of sodium and chloride in the treated effluent presents to the water quality at Well 10. Information on sodium and chloride concentrations in the Credit River were provided by Credit Valley Conservation. This information documents the presence of elevated sodium and chloride concentrations in the Credit River upstream of Well 10. This information also shows that the concentrations are higher downstream of the confluence of Mill Creek and the point of effluent discharge from the Water Pollution Control Plant. The information from Credit Valley Conservation also shows that concentrations in the Credit River decrease downstream of Orangeville, but increase again through the built-up areas close to Lake Ontario. The trend analysis data for water from Well 10 shows that the sodium and chloride concentrations have increased from 2002 through 2008.

An assessment was completed by Burnside in 2002 to evaluate the potential for surface water from the Credit River to reach the intake at Well 10 and to determine the appropriate classification as either GUDI, GUDI with effective filtration, or groundwater. Based on the Burnside report and other observations the well was classified as “GUDI with effective filtration” and an appropriate filtration and treatment system was installed. This treatment system has also addressed other aesthetic issues in the water by reducing iron and manganese concentrations.

Although the well was ultimately classified as GUDI with effective filtration much of the information presented in the Burnside (2002) report supports an assessment as “groundwater”. Some of these observations include:

- Static groundwater elevations indicate that groundwater flow is directed upwards to discharge as baseflow to the Credit River when Well 10 is not pumping. Under pumping conditions there is potential that flow can be reversed.
- A pumping test was completed for 120 hours in 2002 (Burnside, 2002). This test did not conclusively demonstrate direct hydraulic connection with the river.
- Water quality tests during the 120 hour pumping test showed that sodium and chloride concentrations in Well 10 were substantially lower than the values in the Credit River.
- Samples collected to evaluate oxygen and hydrogen isotope concentrations in the Credit River and in Well 10 showed differences in water quality with a conclusion that the groundwater was not directly connected to surface water.

The available information indicates that although there is potential for water from winter road maintenance and effluent discharge from the Water Pollution Control Plant to increase the sodium and chloride concentrations in the Credit River, there is not sufficient information available to define a clear and direct path of hydraulic connection from the surface water to the well intake. This lack of clear connection raises questions as to whether the concentrations of sodium and chloride in surface water in the Credit River are directly or solely responsible for the observed increasing trend in groundwater at Well 10.

Private Sewage Systems

Private sewage systems have the potential to release sodium and chloride to the natural environment as drainage is directed through the tile beds. The sources of sodium and chloride in the sewage effluent include sewage waste, wastes from food preparation and clean-up, laundry, and water softener systems.

The potential loading of salt from private sewage systems within the ICAs have been estimated based on the number of private sewage systems, a range of chloride concentrations and an average daily water use. **Table E6-6** documents the calculation of potential chloride loadings based on a daily water use of 1,000 L for a range of effluent quality for chloride. For non-residential systems the daily water use volume has been assumed to be 2,500 L. The typical range of effluent chloride concentrations is from 30 to 100 mg/L. The average value used to estimate a potential total loading of chloride is biased slightly toward the high end of the observed range at 75 mg/L to be conservative. The chloride loading has been used to estimate a loading of salt (as sodium chloride) that can be compared to the quantities used in winter road maintenance.

Table E6-5: Estimated Salt Loading from Sewage Systems - Orangeville

Land Use	Land Use	Number of Parcels	Average Daily Water	Chloride Concentration in Effluent				System Chloride Load								Equivalent Salt Load				
								Daily (kg)				Annual				Annual				
				Range			Average	Range			Average	Range			Average	Range			Average	
			(L/day)	(mg/L)				(kg)				(kg)				(kg)				
A. Municipal Sewage System - Orangeville (Issues Contributing Area for Well 10)																				
WHPA-E	Total	1	9,111,319	380	to	450	416	3,462	to	4,100	3,790	1,263,740	to	1,496,534	1,383,463	2,083,299	to	2,467,066	2,280,884	
B. Private Sewage Systems																				
Issues Contributing Area – Wellfields 2, 5, 7 & 9																				
WHPA-A	Non-Residential	0	2,500	30	to	100	75	0.0	to	0.0	0.0	0	to	0	0	0	to	0	0	135
	Residential	3	1,000	30	to	100	75	0.1	to	0.3	0.2	33	to	110	82	54	to	181	135	
WHPA-B	Non-Residential	6	2,500	30	to	100	75	0.5	to	1.5	1.1	164	to	548	410.6	271	to	903	677	1,715
	Residential	23	1,000	30	to	100	75	0.7	to	2.3	1.7	252	to	840	630	415	to	1,384	1,038	
WHPA-C	Non-Residential	5	2,500	30	to	100	75	0.4	to	1.3	0.9	137	to	456	342.2	226	to	752	564	835
	Residential	6	1,000	30	to	100	75	0.2	to	0.6	0.5	66	to	219	164	108	to	361	271	
WHPA-D	Non-Residential	0	2,500	30	to	100	75	0.0	to	0.0	0.0	0	to	0	0.0	0	to	0	0	677
	Residential	15	1,000	30	to	100	75	0.5	to	1.5	1.1	164	to	548	411	271	to	903	677	
WHPA-E	Non-Residential	0	2,500	30	to	100	75	0.0	to	0.0	0.0	0	to	0	0.0	0	to	0	0	0
	Residential	0	1,000	30	to	100	75	0.0	to	0.0	0.0	0	to	0	0	0	to	0	0	
Total	Total	68	1,284	30	to	100	75	2.2	to	7.6	5.6	816	to	2,719	2,039	1,346	to	4,483	3,362	3,362
Issues Contributing Area – Wellfields 6 & 11																				
WHPA-A	Non-Residential	0	2,500	30	to	100	75	0.0	to	0.0	0.0	0	to	0	0	0	to	0	0	0
	Residential	0	1,000	30	to	100	75	0.0	to	0.0	0.0	0	to	0	0	0	to	0	0	
WHPA-B	Non-Residential	0	2,500	30	to	100	75	0.0	to	0.0	0.0	0	to	0	0.0	0	to	0	0	8,710
	Residential	193	1,000	30	to	100	75	5.8	to	19.3	14.5	2,113	to	7,045	5,283	3,484	to	11,613	8,710	
WHPA-C	Non-Residential	0	2,500	30	to	100	75	0.0	to	0.0	0.0	0	to	0	0.0	0	to	0	0	316
	Residential	7	1,000	30	to	100	75	0.2	to	0.7	0.5	77	to	256	192	126	to	421	316	
WHPA-D	Non-Residential	0	2,500	30	to	100	75	0.0	to	0.0	0.0	0	to	0	0.0	0	to	0	0	226
	Residential	5	1,000	30	to	100	75	0.2	to	0.5	0.4	55	to	183	137	90	to	301	226	
WHPA-E	Non-Residential	0	2,500	30	to	100	75	0.0	to	0.0	0.0	0	to	0	0.0	0	to	0	0	0
	Residential	0	1,000	30	to	100	75	0.0	to	0.0	0.0	0	to	0	0	0	to	0	0	
Total	Total	206	1,000	30	to	100	75	6.2	to	20.6	15.4	2,245	to	7,483	5,612	3,701	to	12,335	9,251	9,251
Issues Contributing Area – Well 10																				
WHPA-A	Non-Residential	0	2,500	30	to	100	75	0.0	to	0.0	0.0	0	to	0	0	0	to	0	0	45
	Residential	1	1,000	30	to	100	75	0.0	to	0.1	0.1	11	to	37	27	18	to	60	45	
WHPA-B	Non-Residential	1	2,500	30	to	100	75	0.1	to	0.3	0.2	27	to	91	68.4	45	to	150	113	384
	Residential	6	1,000	30	to	100	75	0.2	to	0.6	0.5	66	to	219	164	108	to	361	271	
WHPA-C	Non-Residential	3	2,500	30	to	100	75	0.2	to	0.8	0.6	82	to	274	205.3	135	to	451	338	1,061
	Residential	16	1,000	30	to	100	75	0.5	to	1.6	1.2	175	to	584	438	289	to	963	722	
WHPA-D	Non-Residential	0	2,500	30	to	100	75	0.0	to	0.0	0.0	0	to	0	0.0	0	to	0	0	2,121
	Residential	47	1,000	30	to	100	75	1.4	to	4.7	3.5	515	to	1,716	1,287	848	to	2,828	2,121	
WHPA-E	Non-Residential	0	2,500	30	to	100	75	0.0	to	0.0	0.0	0	to	0	0.0	0	to	0	0	181
	Residential	4	1,000	30	to	100	75	0.1	to	0.4	0.3	44	to	146	110	72	to	241	181	
Total	Total	78	1,077	30	to	100	75	2.5	to	8.4	6.3	920	to	3,068	2,300	1,518	to	5,064	3,791	3,791
Total Combined Issues Contributing Areas – Orangeville																				
WHPA-A	Non-Residential	0	2,500	30	to	100	75	0.0	to	0.0	0.0	0	to	0	0	0	to	0	0	181
	Residential	4	1,000	30	to	100	75	0.1	to	0.4	0.3	44	to	146	110	72	to	241	181	
WHPA-B	Non-Residential	7	2,500	30	to	100	75	0.5	to	1.8	1.3	192	to	639	479.1	316	to	1,053	790	10,808
	Residential	222	1,000	30	to	100	75	6.7	to	22.2	16.7	2,431	to	8,103	6,077	4,007	to	13,358	10,018	
WHPA-C	Non-Residential	8	2,500	30	to	100	75	0.6	to	2.0	1.5	219	to	730	547.5	361	to	1,203	903	2,211
	Residential	29	1,000	30	to	100	75	0.9	to	2.9	2.2	318	to	1,059	794	523	to	1,745	1,309	
WHPA-D	Non-Residential	0	2,500	30	to	100	75	0.0	to	0.0	0.0	0	to	0	0.0	0	to	0	0	3,024
	Residential	67	1,000	30	to	100	75	2.0	to	6.7	5.0	734	to	2,446	1,834	1,209	to	4,031	3,024	
WHPA-E	Non-Residential	0	2,500	30	to	100	75	0.0	to	0.0	0.0	0	to	0	0.0	0	to	0	0	181
	Residential	4	1,000	30	to	100	75	0.1	to	0.4	0.3	44	to	146	110	72	to	241	181	
Total	Total	341	1,086	30	to	100	75	10.9	to	36.4	27.3	3,980	to	13,268	9,951	6,562	to	21,872	16,404	16,404
Total for Combined ICA		341						10.9	to	36.4	27.3	3,980	to	13,268	9,951	6,562	to	21,872	16,404	16,404

Notes:

1) Range of chloride concentrations in sewage effluent obtained from "Table 4-14, Page 181, Small and Decentralized Wastewater Management Systems" Crites and Tchobanoglous, 1998.
2) Daily water/sewage use for household of 1000 L considered based on various MOE guidance.
3) Water softeners assumed to be used in 100% of households. Softener water usage is assumed to be 6% of total water use. Range of salt concentrations and average chloride concentrations for effluent with softeners from Ontario Rural

Table E6-6: Estimated Salt Loading from Sewage Systems - Orangeville

Land Use	Land Use	Number of Parcels	Average Daily Water Use	Chloride Concentration in Effluent				System Chloride Load								Equivalent Salt Load				
								Daily (kg)				Annual				Annual				
				Range			Average	Range			Average	Range			Average	Range			Average	
			(L/day)	(mg/L)				(kg)				(kg)				(kg)				
C. Private Sewage Systems - With Water Softeners																				
Issues Contributing Area – Wellfields 2, 5, 7 & 9																				
WHPA-A	Non-Residential	0	150	40	to	6,000	1500	0.0	to	0.0	0.0	0	to	0	0	0	to	0	#REF!	#REF!
	Residential	3	60	40	to	6,000	1500	0.0	to	1.1	0.3	3	to	394	99	4	to	650	162	
WHPA-B	Non-Residential	6	150	40	to	6,000	1500	0.0	to	5.4	1.4	13	to	1,971	493	22	to	3,249	812	2,058
	Residential	23	60	40	to	6,000	1500	0.1	to	8.3	2.1	20	to	3,022	756	33	to	4,982	1,246	
WHPA-C	Non-Residential	5	150	40	to	6,000	1500	0.0	to	4.5	1.1	11	to	1,643	411	18	to	2,708	677	1,002
	Residential	6	60	40	to	6,000	1500	0.0	to	2.2	0.5	5	to	788	197	9	to	1,300	325	
WHPA-D	Non-Residential	0	150	40	to	6,000	1500	0.0	to	0.0	0.0	0	to	0	0	0	to	0	0	812
	Residential	15	60	40	to	6,000	1500	0.0	to	5.4	1.4	13	to	1,971	493	22	to	3,249	812	
WHPA-E	Non-Residential	0	150	40	to	6,000	1500	0.0	to	0.0	0.0	0	to	0	0	0	to	0	0	0
	Residential	0	60	40	to	6,000	1500	0.0	to	0.0	0.0	0	to	0	0	0	to	0	0	
Total		68	77	40	to	8,000	1600	0.2	to	26.8	6.7	86	to	9,788	98	4	to	868	4,037	#REF!
Issues Contributing Area – Wellfields 6 & 11																				
WHPA-A	Non-Residential	0	150	40	to	6,000	1500	0.0	to	0.0	0.0	0	to	0	0	0	to	0	0	0
	Residential	0	60	40	to	6,000	1500	0.0	to	0.0	0.0	0	to	0	0	0	to	0	0	
WHPA-B	Non-Residential	0	150	40	to	6,000	1500	0.0	to	0.0	0.0	0	to	0	0	0	to	0	0	10,452
	Residential	193	60	40	to	6,000	1500	0.5	to	69.5	17.4	169	to	25,360	6,340	279	to	41,807	10,452	
WHPA-C	Non-Residential	0	150	40	to	6,000	1500	0.0	to	0.0	0.0	0	to	0	0	0	to	0	0	379
	Residential	7	60	40	to	6,000	1500	0.0	to	2.5	0.6	6	to	920	230	10	to	1,506	379	
WHPA-D	Non-Residential	0	150	40	to	6,000	1500	0.0	to	0.0	0.0	0	to	0	0	0	to	0	0	271
	Residential	5	60	40	to	6,000	1500	0.0	to	1.8	0.5	4	to	657	164	7	to	1,083	271	
WHPA-E	Non-Residential	0	150	40	to	6,000	1500	0.0	to	0.0	0.0	0	to	0	0	0	to	0	0	0
	Residential	0	60	40	to	6,000	1500	0.0	to	0.0	0.0	0	to	0	0	0	to	0	0	
Total		206	60	40	to	8,000	1600	0.6	to	73.8	18.6	180	to	28,937	0	0	to	0	11,102	11,102
Issues Contributing Area – Well 10																				
WHPA-A	Non-Residential	0	150	40	to	6,000	1500	0.0	to	0.0	0.0	0	to	0	0	0	to	0	0	55
	Residential	1	60	40	to	6,000	1500	0.0	to	0.4	0.1	1	to	131	33	1	to	217	55	
WHPA-B	Non-Residential	1	150	40	to	6,000	1500	0.0	to	0.9	0.2	2	to	329	82	4	to	542	135	460
	Residential	6	60	40	to	6,000	1500	0.0	to	2.2	0.5	5	to	788	197	9	to	1,300	325	
WHPA-C	Non-Residential	3	150	40	to	6,000	1500	0.0	to	2.7	0.7	7	to	986	246	11	to	1,625	406	1,272
	Residential	16	60	40	to	6,000	1500	0.0	to	5.8	1.4	14	to	2,102	526	23	to	3,466	866	
WHPA-D	Non-Residential	0	150	40	to	6,000	1500	0.0	to	0.0	0.0	0	to	0	0	0	to	0	0	2,545
	Residential	47	60	40	to	6,000	1500	0.1	to	16.9	4.2	41	to	6,176	1,544	68	to	10,181	2,545	
WHPA-E	Non-Residential	0	150	40	to	6,000	1500	0.0	to	0.0	0.0	0	to	0	0	0	to	0	0	217
	Residential	4	60	40	to	6,000	1500	0.0	to	1.4	0.4	4	to	526	131	6	to	866	217	
Total		78	66	40	to	8,000	1600	0.2	to	30.2	7.8	74	to	11,038	33	1	to	217	4,649	4,649
Total Combined Issues Contributing Areas – Orangeville																				
WHPA-A	Non-Residential	0	150	40	to	6,000	1500	0.0	to	0.0	0.0	0	to	0	0	0	to	0	0	217
	Residential	4	60	40	to	6,000	1500	0.0	to	1.4	0.4	4	to	526	131	6	to	866	217	
WHPA-B	Non-Residential	7	150	40	to	6,000	1500	0.0	to	6.3	1.6	15	to	2,300	575	25	to	3,791	948	12,970
	Residential	222	60	40	to	6,000	1500	0.5	to	79.9	20.0	194	to	29,171	7,293	321	to	48,089	12,022	
WHPA-C	Non-Residential	8	150	40	to	6,000	1500	0.0	to	7.2	1.8	18	to	2,628	657	29	to	4,332	1,083	2,653
	Residential	29	60	40	to	6,000	1500	0.1	to	10.4	2.6	25	to	3,811	953	42	to	6,282	1,570	
WHPA-D	Non-Residential	0	150	40	to	6,000	1500	0.0	to	0.0	0.0	0	to	0	0	0	to	0	0	3,628
	Residential	67	60	40	to	6,000	1500	0.2	to	24.1	6.0	59	to	8,804	2,201	97	to	14,513	3,628	
WHPA-E	Non-Residential	0	150	40	to	6,000	1500	0.0	to	0.0	0.0	0	to	0	0	0	to	0	0	217
	Residential	4	60	40	to	6,000	1500	0.0	to	1.4	0.4	4	to	526	131	6	to	866	217	
Total		341	64	40	to	8,000	1600	0.8	to	130.8	32.7	318	to	47,764	181	6	to	888	18,886	18,886
Total for Combined ICA		341	64					0.9	to	130.9	32.7	318	to	47,764	131	5	to	866	19,685	19,685

Notes:

1) Range of chloride concentrations in sewage effluent obtained from "Table 4-14, Page 181, Small and Decentralized Wastewater Management Systems" Crites and Tchobanoglous, 1998.
2) Daily water/sewage use for household of 1000 L considered based on various MOE guidance.
3) Water softeners assumed to be used in 100% of households. Softener water usage is assumed to be 6% of total water use. Range of salt concentrations and average chloride concentrations for effluent with softeners from Ontario

Private water softeners have potential to release sodium and chloride to the environment both during regular use and as part of system maintenance. Information provided in a study by the Ontario Rural Wastewater Centre at the University of Guelph indicates that maintenance of softener systems is typically 6% of the total water usage. The study also showed that the chloride concentrations in the effluent could vary between 40 and 6,000 mg/L. An average concentration for the effluent during maintenance is provided in this study as 1,500 mg/L. The additional contributions of salt due to softener systems was estimated in Table 2-7C by assuming: 1) that 100% of the private water supplies used softeners; 2) that 6% of the assumed flow was associated with system maintenance; and 3) that the average concentration with this maintenance flow is 1,500 mg/L.

Despite these potential mass loadings, private sewage systems are typically designed such that the daily volume of treated effluent is distributed through the tile beds and mixed with underlying groundwater such that the concentrations of chloride at the property boundaries remain similar to background.

Summary

Table E6-7 provides a summary of the estimated salt loadings from various contributing sources within the ICAs for the Orangeville Wells. The potential for sodium and chloride to be released from the Water Pollution Control Plant is seen to account for approximately 70% of the total salt released in the ICA for Well 10 and approximately 37% of the total for the combined ICAs. The sodium and chloride released from the Water Pollution Control Plant is discharged to the Credit River within the WHPA-E defined for Well 10.

In the ICAs for wellfields 2, 5, 7, 9, and 6 and 11, approximately 98% of the salt potential salt loading is estimated to come from winter road maintenance. A similar proportion is observed for Well 10 if the contribution from treated municipal sewage effluent is not considered (Figure 2-3C). For wellfields 2, 5, 7, and 9 and 6 and 11, the majority of the salt mass is released within WHPA-B and WHPA-C. For Well 10, the majority of the salt mass is released within WHPA-E and WHPA-D. The proportion of salt that comes from public and private sources in the wellfields is variable. This is reasonable as each will contain a different proportion of private parking lots. For the combined ICAs, the public roads are considered to be responsible for 33% of the applied salt while only 29% may come from the private application on parking lots.

The application of road salt by private residents and the release of sodium and chloride from private sewage, including the potential contribution from water softeners is seen to be insignificant (combined less than 1%) relative to the quantities estimated from winter road maintenance and municipal sewage treatment. These activities related to private residences were included in the count of significant threat activities based on the requirements of the *Technical Rules*. This analysis shows that the release of salt through activities at private residences is not likely contributing significantly to the observed concentration trends for sodium and chloride.

E6.2 Georgetown (Chloride Issue)

Estimates of the salt mass loading for the revised WHPA of Cedarvale Wells 1A, 4, and 4A are provided in **Table E6-1** and **Table E6-8**, respectively. The majority of the estimated mass of salt (approximately 80%) is applied within WHPA-B and E.

The relative proportion of salt mass loading by activity within the WHPA for Cedarvale Wells 1A, 4, and 4A is shown in **Table E6-2**. Approximately 98% of the potential salt loading is estimated to come from winter road maintenance. An estimated 85% of the salt may come from private non-residential maintenance on commercial, industrial, institutional or multi-residential parcels. Approximately 14% of the potential salt loading is considered to come from the municipal public road maintenance programs.

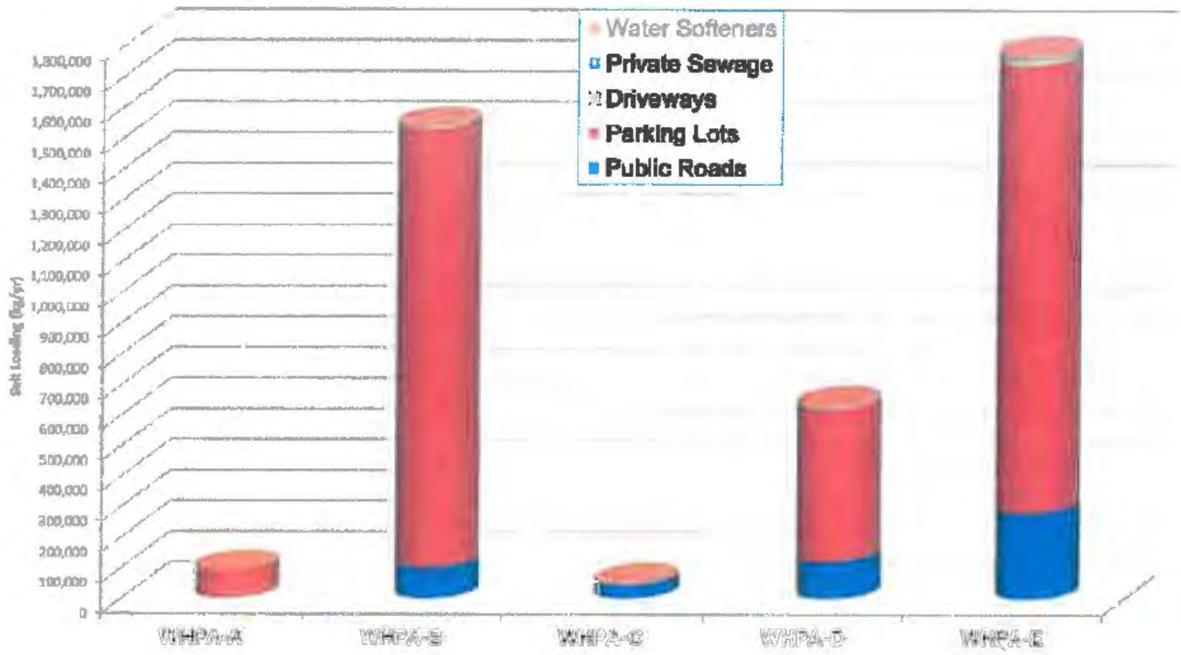

Figure E6-1: Distribution of Salt mass Loading in WHPA A to E, Cedarvale Wells 1A, 4, 4 A, Georgetown

The application of road salt by private residence and the releases of sodium and chloride sewage, including the potential contribution from water softeners is seen to be insignificant (combined approximately 1%) relative to the quantities estimated from winter maintenance.

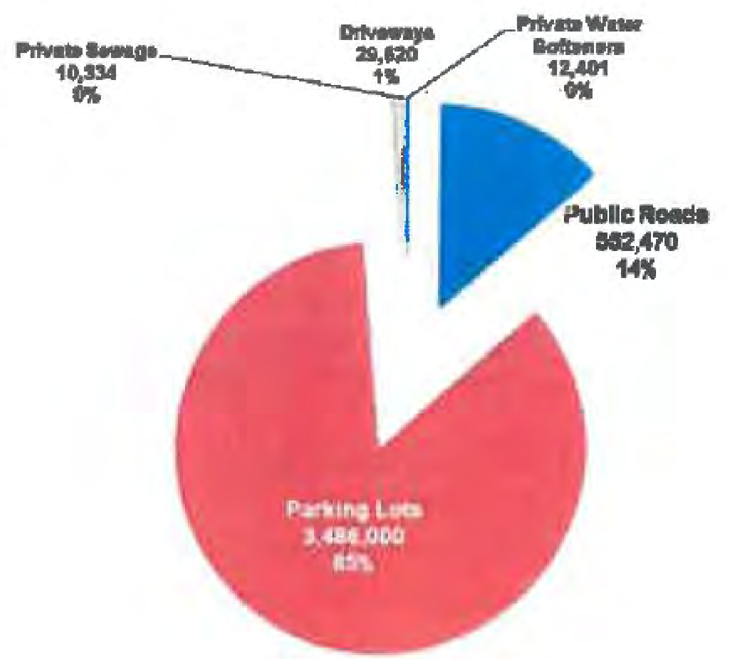

Figure E6-2: Proportion of Salt Mass Loading by Activity in WHPA A to E, Cedarvale Wells 1A, 4, 4 A, Georgetown

Table E6-7: Summary of Salt Loading Estimates – Orangeville

Issues Contributing Area	WHPA Area	Estimated Salt Loading												
		Winter Maintenance						Municipal Sewage		Private Sewage		Water Softeners		Total
		Public Roads		Private - Non-Residential		Private - Residential								
		Average (kg)	% of Total	Estimate (kg)	% of Total	Estimate (kg)	% of Total	Estimate (kg)	% of Total	Estimate (kg)	% of Total	Estimate (kg)	% of Total	(kg)
Wellfields 2, 5, 7 & 9	WHPA-A	18,550	34%	34,800	64%	670	1.2%	0	0.0%	135	0.2%	162	0.3%	54,318
	WHPA-B	487,050	57%	355,600	42%	9,050	1.1%	0	0.0%	1,715	0.2%	2,058	0.2%	855,473
	WHPA-C	85,200	40%	128,000	60%	70	0.0%	0	0.0%	835	0.4%	1,002	0.5%	215,107
	WHPA-D	106,300	99%	0	0%	70	0.1%	0	0.0%	677	0.6%	812	0.8%	107,859
	WHPA-E	40,150	100%	0	0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	40,150
	Total ICA	**737,250**	**58%**	**518,400**	**41%**	**9,860**	**0.8%**	**0**	**0.0%**	**3,362**	**0.3%**	**4,034**	**0.3%**	**1,272,907**
Wellfields 6 & 11	WHPA-A	10,600	49%	11,200	51%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	21,800
	WHPA-B	567,100	37%	937,200	61%	9,130	0.6%	0	0.0%	8,710	0.6%	10,452	0.7%	1,532,591
	WHPA-C	87,450	60%	56,800	39%	840	0.6%	0	0.0%	316	0.2%	379	0.3%	145,785
	WHPA-D	55,650	99%	0	0%	20	0.0%	0	0.0%	226	0.4%	271	0.5%	56,166
	WHPA-E	0	0%	0	0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0
	Total ICA	**720,800**	**41%**	**1,005,200**	**57%**	**9,990**	**0.6%**	**0**	**0.0%**	**9,251**	**0.5%**	**11,102**	**0.6%**	**1,756,343**
Well 10	WHPA-A	5,300	98%	0	0%	10	0.2%	0	0.0%	45	0.8%	54	1.0%	5,409
	WHPA-B	47,900	64%	25,504	34%	290	0.4%	0	0.0%	384	0.5%	460	0.6%	74,538
	WHPA-C	87,450	97%	0	0%	190	0.2%	0	0.0%	1,061	1.2%	1,273	1.4%	89,973
	WHPA-D	204,050	98%	0	0%	470	0.2%	0	0.0%	2,121	1.0%	2,545	1.2%	209,186
	WHPA-E	221,350	8%	235,200	9%	1,070	0.0%	2,280,664	83.3%	181	0.0%	217	0.0%	2,738,682
	Total ICA	**566,050**	**18%**	**260,704**	**8%**	**2,030**	**0.1%**	**2,280,664**	**73.2%**	**3,791**	**0.1%**	**4,549**	**0.1%**	**3,117,788**
Combined Areas	WHPA-A	34,450	42%	46,000	56%	680	0.8%	0	0.0%	181	0.2%	217	0.3%	81,527
	WHPA-B	1,102,050	45%	1,318,304	54%	18,470	0.8%	0	0.0%	10,808	0.4%	12,970	0.5%	2,462,602
	WHPA-C	260,100	58%	184,800	41%	1,100	0.2%	0	0.0%	2,211	0.5%	2,654	0.6%	450,865
	WHPA-D	366,000	98%	0	0%	560	0.2%	0	0.0%	3,024	0.8%	3,628	1.0%	373,212
	WHPA-E	261,500	9%	235,200	8%	1,070	0.0%	2,280,664	82.1%	181	0.0%	217	0.0%	2,778,832
	Total ICA	**2,024,100**	33%	**1,784,304**	**29%**	**21,880**	**0.4%**	**2,280,664**	**37.1%**	**16,404**	**0.3%**	**19,685**	**0.3%**	**6,147,038**

Table E6-8: Summary of Salt Loading Estimates – Georgetown

Issues Contributing Area	WHPA Area	Estimated Salt Loading										
		Winter Maintenance						Private Sewage		Water Softeners		Total
		Public Roads		Private - Non-Residential		Private - Residential						
		Average (kg)	% of Total	Estimate (kg)	% of Total	Estimate (kg)	% of Total	Estimate (kg)	% of Total	Estimate (kg)	% of Total	(kg)
Cedarvale Wells 1A, 4, 4A, Georgetown	WHPA-A	2,020	2%	90,000	98%	120	0.1%	0	0.0%	0	0.0%	92,140
	WHPA-B	101,000	7%	1,433,200	93%	5,700	0.4%	45	0.0%	54	0.0%	1,539,999
	WHPA-C	45,450	88%	4,400	8%	1,650	3.2%	156	0.3%	190	0.4%	51,847
	WHPA-D	122,210	19%	498,400	79%	3,890	0.6%	3,858	0.6%	4,630	0.7%	632,989
	WHPA-E	281,790	16%	1,460,000	82%	18,260	1.0%	6,273	0.4%	7,527	0.4%	1,773,850
	Total ICA	**552,470**	**14%**	**3,486,000**	**85%**	**29,620**	**0.7%**	**10,334**	**0.3%**	**12,401**	**0.3%**	**4,090,826**

E7 THE CTC SOURCE PROTECTION COMMITTEE REQUEST FOR ADDITION OF LOCAL THREATS AND MOE RESPONSE

CTC SOURCE
PROTECTION
REGION

DRINKING WATER SOURCE PROTECTION
ACT FOR CLEAN WATER

May 16, 2011

Ian Smith
Director, Source Protection Programs Branch
Ministry of the Environment
8th Floor, 2 St Clair Avenue West
Toronto ON M4V1L5

Dear Mr. Smith:

Request to Add Local Threats

Pipeline Transporting Petroleum Products Containing Benzene
Nuclear Generating Stations' Storage and Handling of Tritiated Deuterium

Under the *Clean Water Act, 2006*, Technical Rule 130 (November 16, 2009), a Source Protection Committee (SPC) can identify an activity, in addition to the activities in the prescribed list of threats, that may be a drinking water threat. Under Technical Rule 68, modeling can be used to delineate an IPZ-3 area for Type A intakes where a contaminant can be transported to a surface water intake. Through the Lake Ontario Collaborative a number of scenarios have been modeled to determine if contaminants that could be released under certain spill scenarios would reach one or more drinking water intakes at levels where the contaminant would pose a threat to the source of drinking water.

In the CTC, two activities have been identified that could pose threats to the source of drinking water and are not on the list of prescribed drinking water threats set out in paragraphs 1 through 18 and paragraph 21 of subsection 1.1(1) of O. Reg. 287/07 (General). Therefore, we are seeking approval to add these as unique "local threats".

At the April 19, 2011 meeting of the CTC Source Protection Committee, two activities were identified for inclusion as local threats to drinking water. Staff was directed by RES.# 247/11 to submit this request to the Ministry of the Environment (the "Director") to add the following two activities as local threats:

5 Shoreham Drive, Downsview ON M3N 1S4 tel. (416) 661-6600 fax (416) 661-6898 www.ctcswp.ca

- Pipeline transporting petroleum product (containing benzene) which crosses a tributary flowing into Lake Ontario.

  MODELED CIRCUMSTANCE: The scenario is based on the parameters from an actual spill from a similar pipeline transporting similar products in Kalamazoo, Michigan in the summer of 2010. Using modeling of the individual streams, the concentration of benzene reaching the lake was calculated and the Lake Ontario version of the MIKE-3 model was used to estimate the concentrations of benzene that could reach each intake. The model considers how the contaminant can move from the surface to the depth where the intake is located. A pipeline rupture at most streams in the CTC, where the existing pipeline crosses the stream, has the potential to release benzene at concentrations that would result in levels above the Ontario Drinking Water Standard (ODWA) at the nearby intake.

- Handling and storage of tritiated deuterium at the Pickering or Darlington Nuclear Generating stations.

  MODELED CIRCUMSTANCE: The scenario is based on the parameters from the actual tritium spill in 1992 from the Pickering Nuclear Generating Station. The modeled spill scenario resulted in tritium levels exceeding the ODWS at the Whitby and Oshawa intakes. Note a number of other intakes, including all of those in the CTC and some beyond the CTC had predicted tritium concentrations above the proposed revised tritium standard of 20 Bq/litre recommended by the Minister's Advisory Committee on Testing and Standards.

Technical staff from your branch have attended briefings on the work and have been provided draft reports. We are still awaiting the final report from the consultants but intend to include a description of the relevant spill scenario modeling work and findings in the updates to each of the assessment reports in the CTC currently in progress.

Accordingly, I request that these activities be included as local Drinking Water Threats for the CTC Source Protection Region.

5 Shoreham Drive, Downsview ON M3N 1S4 tel. (416) 661-6600 fax (416) 661-6898 www.ctcswp.ca

Page 3 of 3

Your consideration of this matter is appreciated. Please do not hesitate to contact me if you require any further explanation or information – telephone 416-844-3875 (cell) or mailto:bthorpe@trca.on.ca.

Yours truly,

Beverley Thorpe

Beverley Thorpe
CTC Source Protection Region Project Manager

cc. Susan Self, Chair CTC SPC
Brian Denney, Chief Administrative Officer, TRSPA
Rae Horst, Chief Administrative Officer, CVSPA
Russ Powell, Chief Administrative Officer, CLOSPA
Deb Martin-Downs, CTC Executive Lead
Heather Malcolmson, Manager, Source Protection Planning Branch
John Westlake, CTC MOE Liaison Officer
Jennifer Stephens, Project Manager, Trent Conservation Coalition
Brian Wright, Project Manager Niagara Peninsula Source Protection Area
Diane Bloomfield, Project Manager Halton-Hamilton Source Protection Region
Keith Taylor, Project Manager Quinte Source Protection Region

5 Shoreham Drive, Downsview ON M3N 1S4 tel. (416) 661-6600 fax (416) 661-6898 www.ctcswp.ca

Ministry of the Environment
Source Protection Programs Branch
14th Floor
40 St. Clair Ave. West
Toronto ON M4V 1M2

Ministère de l'Environnement
Direction des programmes de protection des sources
14° étage
40, avenue St. Clair Ouest
Toronto (Ontario) M4V 1M2

Ontario

ENV1174IT-2011-56

July 5, 2011

Ms. Beverley Thorpe
CTC Source Protection Region Project Manager
CTC Source Protection Committee
5 Shoreham Drive
Downsview, ON M3N 1S4

Dear Ms. Thorpe:

Thank you for your letter of May 16, 2011 and your subsequent request for clarification via email of June 14, 2011. Please disregard my earlier letter of June 10th and consider this letter the official correspondence related to your requests.

In your letter of May 16, 2011 you requested a Director's opinion regarding the addition of the following activities as local drinking water threats, in vulnerable areas for specific drinking water systems, under Rule 119 of the technical rules:

1. Pipeline transporting petroleum product (containing benzene) which crosses a tributary flowing into Lake Ontario;
2. The storage and treatment of tritiated deuterium at the Pickering or Darlington Nuclear Generating stations

In accordance with my authority under Rules 119, 120, or 121, I am of the opinion that the hazard rating is greater than 4 for both activities. The information on the activities, circumstances under which the activities would be drinking water threats and the assigned hazard rating for each threat related to your proposed request is provided below.

As per your letter, we understand you will be evaluating these activities using the event based modelling approach allowed under technical rule 130. Under that approach, the hazard rating is not relevant to the evaluation of the threat. The hazard rating is required to confirm that the activities are threats that can be considered using the event based approach.

1

Activity	Circumstance	Hazard Rating	
The conveyance of oil by way of a pipeline	1. The conveyance of oil by way of a pipeline that would be designated as transmitting or distributing "liquid hydrocarbons", including "crude oil", "condensate", or "liquid petroleum products", and not including "natural gas liquids" or "liquefied petroleum gas", within the meaning of the Ontario Regulation 210/01 under the Technical Standards and Safety Act, or is subject to the National Energy Board Act. 2. The rupture of a pipeline in an area where the pipeline crosses a body of open water and may result in the presence of BTEX in surface water.	**IPZ 9.4**	
		IPZ	**WHPA**
The storage and treatment of tritiated deuterium	1. The storage and treatment of tritiated deuterium at the Pickering or Darlington Nuclear Generating stations 2. The above grade handling of tritiated deuterium in tanks at facilities that are not required to report to the NPRI. 3. A spill of the tritiated deuterium may result in the presence of tritiated deuterium in surface water.	6.8	7
The storage and treatment of tritiated deuterium	1. The storage and treatment of tritiated deuterium at the Pickering or Darlington Nuclear Generating stations. 2. The above grade handling of tritiated deuterium in tanks at facilities that are required to report to the NPRI. 3. A spill of the tritiated deuterium may result in the presence of tritium in surface water.	7.2	7.4

The activities are both approved as local threats within the CTC Source Protection Region. Your rationale for the inclusion of these local threats along with a copy of this letter must be included in your assessment report.

I hope this has addressed your concerns, however, should you wish to discuss this matter further please feel free to contact me at (416) 212-6459.

Sincerely,

Paul Heeney, Director (A)
Source Protection Programs Branch
Ministry of the Environment

c: Keith Willson, Manager, Source Protection Approvals
Paul Heeney, Manager, Source Protection Implementation
Heather Malcolmson, Manager, Source Protection Planning
Katie Fairman, Supervisor, Source Protection Implementation
John Westlake, Liaison Officer, CTC Source Protection Region
Clara Tucker, Watershed Management Specialist, Source Protection Planning

2

Table 1: Conveyance of Petroleum Hydrocarbons Using Pipelines which are exposed above ground and cross a surface water body

Activity	Vulnerability Score to produce a Significant DWT	Vulnerability Score to produce a Moderate DWT	Vulnerability Score to produce a Low DWT
	IPZ-1,2,3, WHPA-E	IPZ-1,2,3,WHPA-E	IPZ-1,2,3, WHPA-E
1. The conveyance of oil by way of a pipeline that would be designated as transmitting or distributing "liquid hydrocarbons", including "crude oil", "condensate", or "liquid petroleum products", and not including "natural gas liquids" or "liquefied petroleum gas", within the meaning of the Ontario Regulation 210/01 under the *Technical Standards and Safety* Act, or is subject to the National Energy Board Act. 2. The rupture of a pipeline in an area where the pipeline crosses a body of open water and may result in the presence of BTEX in surface water.	10	7 – 9	4.8 – 6.4

3

Table 2: Storage and treatment of tritiated deuterium at the Pickering or Darlington Nuclear Generating stations

Activity	Vulnerability Score to produce a Significant DWT	Vulnerability Score to produce a Moderate DWT	Vulnerability Score to produce a Low DWT
	IPZ-1,2,3; WHPA-E	IPZ-1,2,3; WHPA-E	IPZ-1,2,3; WHPA-E
1. The storage and treatment of tritiated deuterium at the Pickering or Darlington Nuclear Generating stations 2. The above grade handling of tritiated deuterium in tanks at facilities that are not required to report to the NPRI. 3. A spill of the tritiated deuterium may result in the presence of tritiated deuterium in surface water.	n/a	9-10	6-8.1
1. The storage and treatment of tritiated deuterium at the Pickering or Darlington Nuclear Generating stations. 2. The above grade handling of tritiated deuterium in tanks at facilities that are required to report to the NPRI. 3. A spill of the tritiated deuterium may result in the presence of tritium in surface water.	n/a	8.1-10	5.6-8