WATER QUALITY
RISK ASSESSMENT

March 2015

Essex Region Source Protection Area

Updated Assessment Report

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https://www.ontario.ca/environment-and-energy/provincial-tables-circumstances

4.0 Water Quality Risk Assessment

4.1. Groundwater

The Essex Region Source Protection Area (ERSPA) has no groundwater sources for the municipal residential drinking water systems in the region. Nevertheless an evaluation of *highly vulnerable aquifers* (Technical Rules, 5, 37, 38 and 43) and *significant groundwater recharge areas* (Technical Rules 5 and 44 to 46) is required under the Clean Water Act, 2006.

4.1.1. Intrinsic Groundwater Vulnerability

An analysis of groundwater vulnerability considers the susceptibility an aquifer has to contaminants which can reach it from the surface. This assessment is based on the geology and hydrogeology of the sediments overlying the aquifer. The resulting vulnerability depends on such factors as the geologic structure, the hydraulic conductivity of the sediments, the vertical hydraulic gradient and the hydraulic link between surface water and the aquifer.

Map 4.1 shows areas of *intrinsic groundwater vulnerability*. The high and moderate vulnerable areas correspond with the presence of sandy soils in the southern portion of the region, whereas low vulnerability areas are associated with the vast clay soils that make up most of the area.

4.1.1.1. Methodology

There are many different approaches in estimating groundwater vulnerability that have been approved under the Clean Water Act, 2006. The method undertaken by the ERSPA follows Technical Rule 37(1), the *intrinsic susceptibility index (ISI),* and Technical Rule 38(1).

The Ministry of the Environment (MOE) developed the ISI method, which Dillon Consulting and Golder Associates employed in the preparation of the Essex Region/Chatham-Kent Region Groundwater Study in 2004. The ISI is determined from information on soil and rock conditions recorded in Water Well Records on the basis of the thickness of a geologic formation and the general conductivity of the geologic unit. This process is repeated through the entire depth of successive geologic units until the target aquifer is reached (Dillon and Golder, 2004). An ISI map is produced using a computer algorithm, such as kriging or natural neighbours, to interpolate index values between water well locations. These areas are then divided into areas of high, moderate and low vulnerability (Technical Rule 38(1)) based on the following criteria, where ISI < 30 the vulnerability is high, 30 ≤ ISI ≤ 80 the vulnerability is moderate, and ISI > 80 the vulnerability is low (**Map 4.1**).

4.1.1.2. Limitations and Uncertainty

There is uncertainty associated with the underlying Water Well Record information, including location accuracy, reliability of the geologic log and measurement of water level, which represent a considerable limitation in the assessment. Furthermore, there is natural variability in the hydraulic conductivity which is not captured in the analysis. As a result, the uncertainty of the groundwater vulnerability analysis is considered to be high.

It should also be noted, that transport pathways, such as abandoned wells, were not considered in the analysis, due to lack of information on locations of abandoned wells. As a result, the vulnerability associated with the Intrinsic Susceptibility Index, may not be the only indication of groundwater vulnerability.

4.1.2. Highly Vulnerable Aquifers (HVAs)

Areas where the *Intrinsic Susceptibility Index (ISI)* mapping shows high vulnerability are considered to be *Highly Vulnerable Areas* (Technical Rule 43). For the Essex Region Source Protection Area (ERSPA) these HVAs are shown in red on **Map 4.2**. According to Ontario Regulation 287/07, HVAs are defined as aquifers on which external sources have or are likely to have a significant adverse impact, and include the land above the aquifer. A number of factors such as how close the aquifers are to the ground surface, what type of soil or rock are covering the aquifers and, the characteristics of the soil or rock surrounding them, determine the vulnerability of the aquifer to contamination.

4.1.2.1. Vulnerability Scoring in Highly Vulnerable Aquifers

As per Rule 79 (*Technical Rules Part VII: Assessment Report, 2008*) a highly vulnerable aquifer (HVA) which does not overlap with a wellhead protection area (WHPA) is assigned a vulnerability score of 6.

4.1.2.2. Drinking Water Threats in Highly Vulnerable Aquifers

Based on the maximum vulnerability score of 6 that any HVA can be assigned, activities and conditions that are or would be drinking water threats in HVAs cannot be significant drinking water threats through the threats approach ('scoring approach'). Some of the activities or conditions are prescribed as moderate or low drinking water threats based on the Ministry of the Environment's Tables of Drinking Water Threats.

The Tables of Drinking Water Threats can be accessed using the following link:

http://www.essexregionsourcewater.org/downloads/download_tables_of_drinking_water_threats.pdf

Table 4.1 summarizes the number of prescribed drinking water threats and the number of corresponding prescribed circumstances for HVAs. Pathogens cannot be considered a threat in highly vulnerable aquifers (HVAs) through the threats approach ('scoring approach').

Table 4.1: Summary of Number of Potential Drinking Water Threats (Chemical type) in Highly Vulnerable Aquifers (HVAs) in the Essex Region SPA

Vulnerable Areas	Number of Drinking Water Threats (Chemical type)		
	Significant	Moderate	Low
HVAs[1]	0	5	1126

[1] Highly vulnerable aquifer with high intrinsic vulnerability (V= 6.0).

Note: Note: Details on types of prescribed threats and circumstances are discussed in Section 4.1.4 (and listed in Table 4.7 and Appendix V).

Table 4.2 summarizes the list of threats that are or would be moderate and low drinking water threats if they were to exist in the subject area. The moderate and low threats listed in this table do not necessarily exist in the subject areas but would be deemed as moderate or low threats, if they were to exist. Activities listed in the tables may be identified as moderate or low drinking water threats depending upon various circumstances such as the quantity and type of chemicals used. As per the Directors Rules, only significant drinking water threats that exist in the vulnerable areas are required to be listed in the Assessment Report, therefore, no efforts were needed to conduct an inventory of drinking water threats in the HVAs of the Essex Region SPA.

Table 4.2: Summary of Potential Drinking Water Threats in Highly Vulnerable Aquifers (HVAs) in the Essex Region SPA

No.	Prescribed Drinking Water Threat	SIG	MOD	LOW
1	The establishment, operation or maintenance of a system that collects, stores, transmits, treats or disposes of sewage		√	√
2	The establishment, operation or maintenance of a waste disposal site within the meaning of Part V of the Environmental Protection Act		√	√
3	Application of agricultural source material to land			√
4	Storage of agricultural source material			√
5	Management of agricultural source material to land			
6	Application of non-agricultural source material to land			√
7	Handling and storage of non-agricultural source material			√
8	Application of commercial fertilizer			√
9	Handling and storage of commercial fertilizer			√
10	Application of pesticide			√
11	Handling and storage of pesticide			√
12	Application of road salt			√
13	Handling and storage of road salt			√
14	Storage of snow			√
15	Handling and storage of fuel			√
16	Handling and storage of non-aqueous dense phase liquids		√	√
17	Handling and storage of organic solvent			√
18	Management of runoff that contains chemicals used in the de-icing of aircraft			√
19	Use of land as livestock grazing or pasturing land, an outdoor confinement area or a farm-animal yard			√

4.1.2.3. Percentage of Managed Lands and Livestock Density in Vulnerable Areas

Introduction

The Technical Rules include Tables of Drinking Water Threats that indicate the circumstances under which the activities in the regulation pose a significant, moderate or low drinking water threat (MOE Technical Bulletin, 2009). Included in these tables there are a number of threats that require an assessment of the *percentage of managed lands* and *livestock density* within the various vulnerable areas. Note that these assessments are required for all highly vulnerable aquifers, significant groundwater recharge areas and intake protection zones.

The determination of the *percentage of managed lands* includes areas where there may be application of agricultural source material (ASM), commercial fertilizer or non-agricultural source material (NASM).

Livestock density in an area is to be measured in terms of nutrient units/acre (NU/acre). The combination of percent managed lands and livestock density is used as an estimate of the quantity of nutrients present due to nutrient generation, storage and land application within an area (MOE Technical Bulletin, 2009).

Mapping the percentage of managed lands and/or the livestock density is not required where the vulnerability scores for the areas in question are less than the scores necessary to be considered a significant, moderate or low drinking water threat. Both managed lands and livestock density are to be identified for areas with a score ≥ 6 for groundwater or ≥ 4.4 for surface water (MOE Technical Bulletin, 2009). With respect to groundwater, these areas can be identified by determining the percentage over the combined HVA or SGRA area, within several HVAs or SGRAs combined or for individual HVA or SGRA polygons. The first approach was taken in this Assessment Report, identification of areas by determining percentage over the combined area. Where only a portion of a managed land parcel falls within a vulnerable area only the portion of the parcel within the vulnerable area is factored into the calculations (MOE Technical Bulletin, 2009).

Percentage of Managed Lands

Managed lands are categorized into two groups: *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 land includes golf courses (turf), sports fields, lawns (turf) and other built-up grassed areas that may receive nutrients, primarily commercial fertilizer (MOE Technical Bulletin, 2009).

The MOE has determined a conservative estimate of risk and assumed that all managed lands receive some type of nutrient application. Categories were defined to evaluate the risk of over-application of nutrients in vulnerable areas (MOE Technical Bulletin, 2009):

- Total managed lands < 40% of vulnerable area – area considered to have low potential for nutrient application to cause contamination of drinking water sources.
- Total managed lands between 40% and 80% of vulnerable area – area considered to have moderate potential for nutrient application to cause contamination of drinking water sources; and
- Total managed lands > 80% of vulnerable area – area considered to have high potential for nutrient application to cause contamination of drinking water sources.

Municipal Property Assessment Corporation (MPAC) data was used in delineating both agricultural and non-agricultural managed lands. MPAC property codes describe various types of land use (http://m.mpac.ca/property_owners/how/propertyCodeInventory.asp). The 200 series of property codes, with the exception of the codes associated with managed forest property, indicate an agricultural property and are used in classifying agricultural managed lands. Once these areas were filtered out a visual inspection of the 2008 air photo was conducted and it was estimated that 1% to 5% of individual agricultural parcels were made up of physical structures. In following the MOE guidance of using a conservative estimate of risk, the whole area was deemed to be agricultural managed land.

The following property code descriptions were used to delineate non-agricultural managed lands: Municipal parks and common land in the 100 series of property codes; all properties designated as residential in the 300 series of property codes, with the exception of vacant land; small office

buildings, lodges, resorts, golf courses, driving ranges, schools, day cares, seniors homes, educational institutions, cemeteries, places of worship, sports clubs, libraries, and clubs in the 400, 600 and 700 series of property codes. Once the final areas were selected a random sampling of the 2008 air photo for the differing parcels was conducted and it was determined that the average grass area was 65% of the parcel.

Map 4.3 shows the percent managed land category for the HVAs.

Livestock Density

Livestock density is an alternate measure of the potential for the generation, storage and application of ASM as a source of nutrients to an area. The unit of measurement is NU/acre, where NU is 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 land under the most limiting of either nitrogen or phosphorus as determined by OMAFRAs Nutrient Management (NMAN) software (MOE Technical Bulletin, 2009). Alternatively, where no animals are housed the NU is the weight or volume of manure or other biosolids used annually on a farm unit as per the above definition.

The calculation of livestock density involves three steps (MOE Technical Bulletin, 2009):

1) Estimate the number of each category of animals present within the specified area;
2) Convert the number of each category present into NUs in order to compare all livestock on an equivalent unit of measure in terms of nutrients produced;
3) Sum the total NU of all categories and divide the resulting NU value by the area of agricultural managed land within the same area.

Step one above is carried out by selecting all parcels from the MPAC database which have a farm operation code which indicates livestock. These parcels are then located on the 2008 air photo to confirm the location and number of barns on the parcel (MOE Technical Bulletin, 2009). In addition, air photo interpretation was used to assess if there were any other structures housing livestock and estimates of livestock were refined based on these observations. The area of the barn is then measured from the air photo and **Table 4.3** is used for step two to determine the number of "nutrient units".

Table 4.3: Nutrient Unit Conversion Factors based on Barn size for different MPAC farm classifications

MPAC Classification	Square Meters/NU
Mixed Farming	13
Beef	9
Dairy	11
Poultry	25
Swine	7
Sheep	14
Horse	26
Goat	19
Fur	223

Source: MOE Technical Bulletin, 2009 – p. 11.

Step three requires taking the total number of "nutrient units" calculated from the livestock parcels and dividing by the total area of agricultural managed land (MOE Technical Bulletin, 2009).

The MOE defined categories to evaluate the risk of over-application of ASM are:

- Livestock density < 0.5 NU/acre – area considered to have low potential for nutrient application exceeding crop requirements;
- Livestock density between 0.5 and 1.0 NU/acre – area considered to have moderate potential for nutrient application exceeding crop requirements; and
- Livestock density > 1.0 NU/acre – area considered to have high potential for nutrient application exceeding crop requirements.

Map 4.4 shows that the livestock density in HVAs falls in the *lowest category* (< 0.5 NU/acre). The categories for SGRAs and IPZs are discussed in Section 4.1.3 and Section 4.2 (under each Water Treatment Plant discussion) respectively.

For the assessment of chemical threats related to the application of nutrients, the specified area refers to the vulnerable area being evaluated (only if a threat can exist there), while the agricultural managed land refers to all agricultural managed land, including cropland and pasture.

In the assessment of chemical threats related to the use of land for livestock grazing, pasturing or outdoor confinement area or animal yard, the specified area refers to the whole of the farm being examined, while the agricultural managed land refers to only agricultural managed land being assessed, i.e. grazing land, pasture land, outdoor confinement area or animal yard.

Risk Assessment using Managed Lands and Livestock Density

Percentage of managed land and livestock density of an area are used together as a surrogate for representing the quantity of nutrients present as a result of nutrient generation, storage and application within an area.

Table 1 of the "Tables of Drinking Water Threats" as provided by MOE, requires the consideration of both managed lands and livestock density when evaluating the circumstances with regard to each of the thresholds for land application of nutrients (MOE Technical Bulletin, 2009). **Table 4.4** shows the chemical hazard scorings for various combinations of percentage of managed lands and livestock densities. These are the consolidated hazard scores, which include the quantity, toxicity and fate scores.

Table 4.4: Chemical Hazard Scores for Various Combinations of Percentage Managed Lands and Livestock Densities.

Percent Managed Land Category	Livestock Density Category		
	<0.5 NU/acre	0.5 to 1.0 NU/acre	>1.0 NU/acre
Groundwater			
> 80%	8.0	8.4	8.4
40% to 80%	6.8	7.6	8.4
< 40%	6.0	6.8	8.0
Surface Water			
> 80%	8.8	9.2	9.2
40% to 80%	7.6	8.4	9.2
< 40%	6.8	7.6	8.8
Significant in area of Vulnerability score = 10		Significant in area of Vulnerability score = 10 or 9	

Source: MOE Technical Bulletin, 2009 (p.15)

The percentage of agricultural managed land in the HVAs is > 80% and the livestock density category is < 0.5 NU/acre; therefore from Table 4.4 the hazard score for HVAs will be 8.0. This number is multiplied by the vulnerability score for HVAs of 6, to arrive at a risk score of 48 (*low risk*). The categories for SGRAs and IPZs are discussed in Section 4.1.3 and Section 4.2 (under each Water Treatment Plant discussion) respectively.

Chemical Threats Related to the Use of Land for Livestock Grazing, Pasturing or Outdoor Confinement Area or Farm-Animal Yard

The use of land as livestock grazing or pasture land will be a significant chemical threat in:

- Vulnerable areas scoring 9 if the livestock density is greater than 1.0 NU/acre (N/A for ERSPA); or
- Vulnerable areas scoring 10 if the livestock density is at least 0.5 NU/acre in an IPZ or greater than 1.0 NU/acre for groundwater (N/A for ERSPA); and
- If the land use may result in the presence of Nitrogen or Phosphorus in surface water or Nitrogen in groundwater.

In general, the use of land as livestock grazing or pasture land can only attain a high risk score of 50 in a highly vulnerable aquifer, which places it in the range of a *low risk* (MOE Technical Bulletin, 2009). The categories for SGRAs and IPZs are discussed in Section 4.1.3 and Section 4.2 (under each Water Treatment Plant discussion) respectively.

The use of land as a 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 generates nutrients of more than 300 NU/hectare of the area annually for groundwater and a rate of more than 120 NU/hectare of the area annually for surface water (N/A for ERSPA); or
- Vulnerable areas scoring 9 if the number of animals confined in the area at any time generates nutrients of more than 120 NU/hectare of the area annually for surface water (N/A for ERSPA); and
- The land use may result in presence of Nitrogen or Phosphorus in surface water or Nitrogen in groundwater.

Chemical Threats Related to Agricultural Source Material Storage

Based on the technical rules and associated tables of drinking water threats, 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 parcel is sufficient to annually apply nutrients at a rate greater than 1.0 NU/acre of the farm parcel. This is determined by the NU stored on a farm parcel divided by the size of the parcel. Another circumstance for ASM storage is that a spill of the material or runoff from the area where the material is stored (a point source release) may result in the presence of Nitrogen or Phosphorus in groundwater or surface water.

Table 4.95a shows the percent managed lands and livestock density for all vulnerable areas.

4.1.2.4. Percentage of Impervious Surface Areas in Vulnerable Areas

For each vulnerable area (such as Highly Vulnerable Aquifers, Intake Protection Zones, etc.), a map of the percentage of impervious surface area where road salt can be applied per square kilometre is required (Technical Rule 16(11)).

Mapping of the percent impervious surface area was performed by dividing the vulnerable area in question into 1km x 1km grid squares, with the node of the grid positioned at the centroid of the zone (MOE Technical Bulletin, 2009). Using GIS, a percentage impervious area was calculated for each grid square. Only those areas where salt is likely to be applied were identified as impervious, i.e. parking lots, roadways and sidewalks.

The mapping of percentage of impervious surface area is not required where the vulnerability score is less than the vulnerability score necessary for the application of road salt to be considered a significant, moderate or low threat in the Table of Drinking Water Threats (Technical Rule 16(11)).

There are four possible outcomes for the percentage of impervious surface area based on the MOE guidelines: < 1% impervious; 1% to < 8% impervious; 8% to < 80% impervious and ≥ 80% impervious.

For the Highly Vulnerable Aquifers (HVAs) in the Essex Region, the impervious surface area categories are shown in **Map 4.5**. The results are also summarized in **Table 4.95b**, located at the end of Section 4. Based on the vulnerability score of 6 for the HVAs, the application of road salt is considered to be a low threat in the HVAs.

Threats Identified through Calculation and Mapping of Impervious Surfaces, Managed Lands and Livestock Density

The maps indicating impervious surfaces, managed lands and livestock density were updated based on MOE comments received from the Draft Assessment Report. The above mapping was not completed for the IPZ-3 regions associated with Type D intakes in Lake St. Clair, Type B intakes in the Detroit River, or Type A intakes in Lake Erie. The identification of the threats related to the mapped areas, with the exception of the aforesaid IPZ-3 regions, is completed.

Due to the vulnerability scoring of IPZs and for HVAs and SGRAs, the analysis did not result in the identification of any significant threats in these vulnerable areas.

For activities related to the use of land as livestock grazing or pasturing land, an outdoor confinement area or a farm-animal yard, no chemical or pathogen threats were identified in IPZs with vulnerability scores greater than or equal to 4.5 (chemical) and 4.2 (pathogen) due to current land use. Scores lower than these do not result in these activities being identified as threats in IPZs.

4.1.3. Significant Groundwater Recharge Areas (SGRAs)

Significant Groundwater Recharge Areas (SGRAs) are defined as per Regulation 287/07 as areas within which it is desirable to regulate or monitor drinking water threats that may affect the recharge of an aquifer. Groundwater recharge occurs where rain or snowmelt percolates into the ground and flows to an aquifer. The greatest recharge usually occurs in areas which have loose or permeable soil such as sand or gravel that allows the water to seep easily into the aquifer.

Based on the amounts of recharge occurring in the watersheds, some parts of the region are identified as SGRAs. The Clean Water Act requires that SGRAs be delineated in order to assess them as vulnerable areas. Rules 44 and 45, under PartV.2 of the Technical Rules, describe the methodology for delineating the SGRAs.

4.1.3.1. Methodology

The methodology for recharge estimation is described in detail in the Tier 1 Water Budget, which can be found in **Appendix IV** in this Assessment Report. A summary of the methodology is presented in **Section 3.4.3** of this report. The recharge distribution map is presented in **Map 3.11.**

The Technical Rules 44 - 46 of the Director's Technical Rules provide guidance on how to delineate the SGRAs. They are

44. Subject to rule 45, an area is a significant groundwater recharge area if,

(1) the area annually recharges water to the underlying aquifer at a rate that is greater than the rate of recharge across the whole of the related groundwater recharge area by a factor of 1.15 or more; or

(2) the area annually recharges a volume of water to the underlying aquifer that is 55% or more of the volume determined by subtracting the annual evapotranspiration for the whole of the related groundwater recharge area from the annual precipitation for the whole of the related groundwater recharge area.

45. Despite rule 44, an area shall not be delineated as a significant groundwater recharge area unless the area has a hydrological connection to a surface water body or aquifer that is a source of drinking water for a drinking water system.

46. The areas described in rule 44 shall be delineated using the models developed for the purposes of Part III of these rules and with consideration of the topography, surficial geology, and how land cover affects groundwater and surface water.

Recharge rates were calculated using slope, soil type and land cover as inputs and then multiplying these factors by the runoff potential, which is defined as precipitation less evapotranspiration. The recharge estimation is described in Section 3.4.3.2., and further detailed in the Tier 1 Water Budget (**Appendix IV**).

As a first step, the maps delineating potential SGRAs were prepared based on both Technical Rules 44 (1) and 44 (2). Based on Rule 44 (1), the areas with recharge rates of 1.15 times the average recharge of the entire study area were delineated. Thus the areas that have a recharge rate equal to or greater than 69 mm/year (i.e., 1.15 x average recharge of 60 mm/year) were delineated as per this method. The areal extent of SGRAs indicated through this method is 306 km^2, shown in **Map 4.6**. Similarly, as per Rule 44 (2), areas with 55% or more of the net runoff potential (obtained by subtracting annual evapotranspiration from the annual precipitation) were used for analysis. This resulted in a null set, which means that none of the pixels fall in a SGRA classification under this Rule. This null set was due to the large differences between the estimates of net runoff potential and the recharge estimates. Therefore the SGRA obtained by Rule 44 (1) (shown in **Map 4.6**) was used for further analysis.

The total SGRA surface area of about 306 km^2, obtained by following Rule 44 (1), contains numerous smaller areas of land depicted as potential SGRAs. Considering that the input maps (such as soils, land use, and slope) are not accurate to the scale of the maps being used for generating the SGRA maps, it was determined that the smaller isolated areas of potential SGRAs should be filtered out.

A map with SGRA clusters less than 100 ha in size was filtered out, and in order to establish the linkage between recharge areas with water wells, a GIS based overlay analysis was performed which identified the recharge areas that have water wells as an additional filter, as shown in **Map 4.7**. The resulting areas are categorized as the SGRAs in the Essex Region SPA, which are spread over an area of 195 km^2, as shown in **Map 4.8**.

The SGRAs shown in **Map 4.8** are categorized as high, medium and low vulnerability. These categories were delineated by overlaying the SGRA map over the map of Intrinsic Susceptibility which depicts high, moderate and low vulnerability, as discussed in Section 4.1.1.1. The areas that were categorized as highly vulnerable aquifers are correspondingly highly vulnerable SGRAs, and

the medium and low vulnerability areas determined the medium and low SGRAs. As can be seen from **Map 4.8**, most of the SGRAs are located in the southern part of the Essex Region, in the Harrow area, parts of Leamington and Kingsville, and limited parts of the Turkey Creek and Pelee Island subwatersheds. Most of the areas identified as SGRAs in the Essex Region are situated in areas with sandy soil.

4.1.3.2. Limitations and Uncertainty

At this juncture, it is important to recognize the limitations of the map generated above. The SGRA results were calculated based on soils, land use and slope maps, which in turn are generated from regional maps. Also, given the scope of the work, the approach adopted here is somewhat simplified. The scales of the maps used for this study are very coarse and the use of such information for inferences at a local scale is likely inaccurate. In particular, inferences based on subwatersheds which used data translated from the Canard River subwatershed should be used cautiously due to the coarse level of the inputs. Therefore, these results should be viewed in the regional perspective rather than very local scales. The delineation of the HVAs and SGRAs is considered to have high uncertainty and the boundaries should not be treated as rigid lines. It should also be noted that the analysis did not consider the influence of transport pathways, such as abandoned wells, due to the lack of information on the locations of abandoned wells.

4.1.3.3. Vulnerability Scoring in Significant Groundwater Recharge Areas

As per Rule 81 (1) (2) (3) (*Technical Rules Part VII.2: Assessment Report, 2008*), SGRAs with high, medium and low intrinsic vulnerability were given vulnerability scores of 6, 4 and 2 respectively.

4.1.3.4. Drinking Water Threats in Significant Groundwater Recharge Areas

As described in the above section, the maximum vulnerability score that any area within SGRAs can receive is 6 and therefore no activities or conditions resulting from past activities can be assessed as significant drinking water threats in the SGRAs with high, medium or low intrinsic vulnerability. As a result only the SGRAs with *high intrinsic vulnerability* can have moderate and low level drinking water threats. **Table 4.5** summarizes the possible potential drinking water threats (Chemical Type) that are or would be moderate or low drinking water threats, if they were to exist, in SGRAs with *high intrinsic vulnerability*.

The moderate and low threats listed in this table do not necessarily exist in the subject areas but would be deemed as moderate or low threats, if they were to exist. Activities listed in the tables may be identified as moderate or low drinking water threats depending upon various circumstances such as the quantity and type of chemicals used. Details on the types of potential prescribed drinking water threats and corresponding prescribed circumstances for SGRAs are discussed in **Section 4.1.4** and listed in **Table 4.7** and **Appendix V**.

Pathogens cannot be considered a threat in SGRAs or highly vulnerable aquifers (HVAs) through the threats approach ('scoring approach').

Table 4.5: Summary of the Number of Potential Drinking Water Threats (Chemical type) in Significant Recharge Areas (SGRAs) in the Essex Region SPA

Vulnerable Areas	Number of Drinking Water Threats (Chemical type)		
	Significant	Moderate	Low
SGRA-H	0	5	1126
SGRA-M	0	0	0
SGRA-L	0	0	0

SGRA - H = Significant Groundwater Recharge Areas with ***high intrinsic vulnerability*** (V= 6.0)
SGRA - M = Significant Groundwater Recharge Areas with ***medium intrinsic vulnerability*** (V= 4.0)
SGRA - L = Significant Groundwater Recharge Areas with ***low intrinsic vulnerability*** (V= 2.0)

Note: Details on types of prescribed threats and circumstances are discussed in Section 4.1.4 (and listed in Table 4.7 and Appendix V).

4.1.3.5. Percentage of Managed Lands and Livestock Density in SGRAs

Refer to section 4.1.2.3 (Percentage of Managed Lands and Livestock Density in Vulnerable Areas) for a review of the requirements, definitions and methodology of percentage of managed lands and livestock density within vulnerable areas.

Percentage of Managed Lands

The MOE has determined a conservative estimate of risk and assumed that all managed lands receive some type of nutrient application. Categories were defined to evaluate the risk of over-application of nutrients in vulnerable areas (MOE Technical Bulletin, 2009):

- Low potential risk – *managed lands < 40% of vulnerable area*;
- Moderate potential risk – *managed lands between 40% to 80% of vulnerable area*; and
- High potential risk – *managed lands > 80% of vulnerable area*.

Map 4.9 shows the percent managed land category for SGRAs.

Livestock Density

The MOE defined categories to evaluate the risk of over-application of ASM are:

- Low potential of exceeding crop requirements – *livestock density < 0.5 NU/acre*
- Moderate potential of exceeding crop requirements – *livestock density between 0.5 and 1.0 NU/acre*

- High potential of exceeding crop requirements – *livestock density > 1.0 NU/acre*

Map 4.10 shows the livestock density category for SGRAs. Referring to Table 4.4, in Section 4.1.2.3, the combined effects of livestock density < 0.5 NU/acre and percentage of agricultural managed land > 80% result in a hazard score for SGRAs of 8.0. Considering the vulnerability scores of SGRAs, which are 6, 4 and 2 for high, medium and low vulnerable SGRAs, respectively, the risk scores are 48 (low risk) for highly vulnerable SGRAs, 32 (no risk) for SGRAs with medium vulnerability and 16 (no risk) for SGRAs with low vulnerable. **Table 4.95a** shows the percent managed lands and livestock density for all vulnerable areas.

4.1.3.6. Percentage of Impervious Surface Areas in SGRAs

Please refer to section 4.1.2.4 (Percentage of Impervious Surface Area in Vulnerable Areas) for a review of the requirements, definitions and methodology of percentage of impervious surface areas in vulnerable areas. There are four possible outcomes for the percentage of impervious surface area based on the MOE guidelines: < 1% impervious; 1% to < 8% impervious; 8% to < 80% impervious and ≥ 80% impervious.

The percent impervious categories are shown in **Map 4.11**, and the results are summarized in **Table 4.95b** located at the end of Section 4. With a vulnerability score of 6 for highly vulnerable SGRAs, the threat of road salt application is considered to be low (Table 1 – Drinking Water Threats – Chemicals, Ref. No. 90/91).

Table 4.6: Summary of Potential Drinking Water Threats in Significant Groundwater Recharge Areas (SGRAs) in the Essex Region SPA

No.	Prescribed Drinking Water Threat	SIG	MOD	LOW
1	The establishment, operation or maintenance of a system that collects, stores, transmits, treats or disposes of sewage		√	√
2	The establishment, operation or maintenance of a waste disposal site within the meaning of Part V of the Environmental Protection Act		√	√
3	Application of agricultural source material to land			√
4	Storage of agricultural source material			√
5	Management of agricultural source material to land			
6	Application of non-agricultural source material to land			√
7	Handling and storage of non-agricultural source material			√
8	Application of commercial fertilizer			√
9	Handling and storage of commercial fertilizer			√
10	Application of pesticide			√
11	Handling and storage of pesticide			√
12	Application of road salt			√
13	Handling and storage of road salt			√
14	Storage of snow			√
15	Handling and storage of fuel			√
16	Handling and storage of non-aqueous dense phase liquids		√	√
17	Handling and storage of organic solvent			√
18	Management of runoff that contains chemicals used in the de-icing of aircraft			√
19	Use of land as livestock grazing or pasturing land, an outdoor confinement area or a farm-animal yard			√

NOTE: Types of potential DW threats are based on vulnerability scores and the MOE's Tables of Drinking Water Threats, and do not necessarily exist in the subject HVAs or SGRAs, but would be deemed as significant, moderate or low threats if they were to exist

4.1.4. Prescribed Circumstances and Drinking Water Threats - HVAs and SGRAs

As per O.Reg 286/07, the Assessment Report shall include the list of *prescribed circumstances* for significant, moderate and low drinking water threats in each vulnerable area in the source protection region. In the case of HVAs and SGRAs, only moderate and low drinking water threats could be possible through the threats approach ('scoring approach'). Since both the HVAs and the SGRAs with high intrinsic vulnerability have a vulnerability score of 6.0, the number and types of moderate and low drinking water threats and prescribed circumstances would be the same for both of these vulnerable areas.

Based on the vulnerability score of 6, and the MOE's Tables of Drinking Water Threats, the lists of potential moderate or low drinking water quality threats were generated for the HVAs and SGRAs. The Tables of Drinking Water Threats can be accessed using the following link:

http://www.essexregionsourcewater.org/downloads/download_tables_of_drinking_water_threats.pdf

Table 4.7 lists the potential drinking water threats that are or would be moderate drinking water threats, if they were to exist, with corresponding prescribed circumstances for the HVAs and the SGRAs. Detailed information on the prescribed circumstances for *low* drinking water threats for these vulnerable areas is presented in **Appendix V.**

Table 4.7: List of circumstances under which a prescribed drinking water threat is moderate in HVA and SGRA, with vulnerability score 6, in the Essex Region SPA.

Prescribed Drinking Water Threat (3)	Threat Subcategory	Chemical of Concern	Chemical Quantity Circumstance (8)
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)	Vinyl chloride or another DNAPL that could degrade to vinyl chloride	1. Sewage treatment plant that discharge treated effluent at or above the rate of 50,000 m^3/d on an annual average. 2.STP holding tank that is installed completely below grade, except for the access points
	Sewage System Or Sewage Works - Storage Of Sewage (e.g. Treatment Plant Tanks)	Vinyl chloride or another DNAPL that could degrade to vinyl chloride	1. Sewage treatment plant that discharge treated effluent at or above the rate of 50,000 m^3/d on an annual average. 2. STP holding tank that is installed partially below grade.
The establishment, operation or maintenance of a waste disposal site within the meaning of Part V of the Environmental Protection Act.	Waste Disposal Site-Municipal waste Landfilling	Vinyl chloride or another DNAPL that could degrade to vinyl chloride	Landfill area > 10 ha.
	Waste Disposal Site-Solid non-hazardous industrial or commercial waste Landfilling	Vinyl chloride or another DNAPL that could degrade to vinyl chloride	Landfill area > 10 ha.
	Waste Disposal Site-Industrial liquid waste injection into a well	Vinyl chloride or another DNAPL that could degrade to vinyl chloride	Throughput rate of > 38,000,000 m^3 per year.
The handling and storage of a dense non-aqueous phase liquid (DNAPL)	Handling Of A Dense Non Aqueous Phase Liquid (DNAPL)	Vinyl chloride or another DNAPL that could degrade to vinyl chloride	Any quantity. The below grade handling of a DNAPL in relation to its storage
	Storage Of A Dense Non Aqueous Phase Liquid (DNAPL)	Vinyl chloride or another DNAPL that could degrade to vinyl chloride	Any quantity. The storage of a DNAPL completely below grade
	Storage Of A Dense Non Aqueous Phase Liquid (DNAPL)	Vinyl chloride or another DNAPL that could degrade to vinyl chloride	Any quantity. The storage of a DNAPL partially below grade

4.1.5. Drinking Water Issues and Conditions in HVAs and SGRAs

A drinking water *issue* is defined as the presence of a parameter, listed in Schedules 1, 2, or 3 of O. Reg 170/03, or Table 4 of the Technical Support Document for the Ontario Drinking Water Quality Standards (ODWQS) Objectives and Guidelines, at a concentration, that may result in the deterioration of the quality of water for use as a source of drinking water. The process of issue evaluation is explained in more detail in the Proposed Issues Evaluation Methodology Report (June 2009) that was adopted by the Essex Region Source Protection Committee (**Appendix VI**). At present **no *issues* have been identified** in the HVAs or SGRAs of the Essex Region SPA due to lack of chemical and microbiological water quality data for private wells and aquifers in the Region. More work will be undertaken on identifying and assessing issues in the HVAs and SGRAs and the Assessment Report will be amended, if necessary in the future.

The Clean Water Act (2006) defines *conditions* as contamination that already exists and is associated with past activities. As per Rule 126, the list of conditions that are drinking water threats shall include each of the following conditions that exist in a vulnerable area (e.g. IPZs, WHPAs, HVAs and SGRAs) and that result from a past activity:

- Presence of a Non-Aqueous Phase Liquid (NAPL) in groundwater in a HVA, SGRA or WHPA;
- A single mass of 100 litres of one or more Dense Non- Aqueous Phase Liquid (DNAPL) in surface water in an IPZ;
- Presence of a contaminant listed in Table 2 of the Soil, Groundwater and Sediment Standards in groundwater in a HVA, SGRA or WHPA and the concentration of contaminant exceeds the potable groundwater standard set out for the contaminant in the table;
- A contaminant listed in Table 4 of the Soil, Groundwater and Sediment Standards in surface water in an IPZ and the concentration of contaminant exceeds the surface soil standard for the industrial/ commercial/ community property use set out for contaminant in the table;
- Or a contaminant listed in Table 1 of the Soil, Groundwater and Sediment Standards and the concentration of contaminant exceeds the sediment standard in the table.

Should a condition be identified as described above; the condition is to be considered a drinking water threat. As with all drinking water threats, the risk score of a condition is determined as the product of the vulnerability score and hazard score. Further details on hazard scoring of conditions are described in Section 4.2.1.4.2. Currently, based on limited information available on groundwater contamination and sediment contamination, **no *conditions* have been identified** in the HVAs or SGRAs of the Essex Region Source Protection Area. More work will be undertaken on identifying and assessing conditions in the SGRAs with high vulnerability and the Assessment Report will be amended if necessary.

4.1.6. Parameters of Groundwater Quality Concern in the Essex Region SPA

It appears from the microbiological data obtained from the MOH on private wells in the Region that presence of *E. coli* and total coliform is spatially widespread and not limited to HVAs or SGRAs. Details on actual levels of bacteria as well as the frequency of their presence in well waters is lacking to date. These details are necessary to make any sound conclusion about the quality of aquifers in the region in terms of microbial contamination. ERCA is attempting to acquire such information through the Windsor Essex Health Unit and other sources.

4.1.7. Data Gaps

Following are the major data gaps identified in terms of groundwater quality and contaminated sediment in the Essex Region SPA.

- Chemical and microbiological data (e.g. *E. coli* and Pathogens etc) for private wells and aquifers in the Region;
- Information updates on Arsenic contamination in the groundwater of the Town of Amherstburg;
- Information on any contamination issues related to sediment or surface soil in the Essex Region SPA.

4.2. Surface Water Vulnerability

Through the *Clean Water Act*, *2006* (CWA), Source Protection Authorities are required to develop plans to protect the quality of their municipal drinking water, and reduce risks by addressing threats such as land use activities and spills. Land use activities include, but are not limited to: sewage treatment effluent discharges; industrial effluent discharges; land application of pesticides or fertilizers; and road salt application; etc. These and many other land use activities have the potential to adversely impact the raw water quality, especially when such activities exist in the vicinity of the raw water intake. Spills of toxic chemicals into the water or on the land near a drinking water intake may also adversely impact raw water quality at the intake.

In order to develop plans to protect source water at the drinking water system intakes, it is essential to first delineate areas around the intakes which are potentially vulnerable to pollution activities and can impact raw water quality at the intakes. These areas for surface water intakes are called intake protection zones (IPZs). Further steps involved in the process includes vulnerability scoring of IPZs, identification and inventory of potential and existing drinking water threats in the vulnerable areas, identification of drinking water issues and conditions. The following sections provide a brief overview on the background and methodology associated with the intake classification, the IPZs delineation, vulnerability scoring, drinking water quality threats, issues and conditions. More details can be found in the Reports provided by Stantec Consulting Ltd and Baird & Associates in **Appendices VII, VIII, IX, X and XIV**.

4.2.1. Delineation of Intake Protection Zones (IPZs)

4.2.1.1. Classification of Intake Types

As per *Rule 55 (Part VI.I) (Technical Rules: Assessment Report),* a surface water intake associated with a type I, II or III system should be classified as a type A, type B, type C or type D intake (**Table 4.8**). Type 1 system refers to an existing and planned municipal drinking water system, while type II and type III refers to the other drinking water systems which may be brought in by municipal resolution and the Minister of the Environment or Federal government respectively. There are seven (7) municipal drinking water systems in the Essex Region Source Protection Area (ERSPA); all of them draw source water from surface water bodies such as lakes and rivers.

Table 4.8: Different Intake Types and Associated Source Water Bodies

Intake Type	Source Water Body
Type A	Great Lakes (e.g. Lake Erie, Lake Ontario)
Type B	Great Lakes Connecting Channels (e.g. Detroit River)
Type D	Inland Lakes (e.g. Lake St. Clair, Lake Simcoe or other than Type A, B and C)
Type C	Inland Rivers & Streams (e.g. Grand River)

The intake classification for the seven municipal drinking water systems in the ERSPA is summarized in **Table 4.9**. In addition to these WTPs, the Wheatley WTP intake is also included in the surface water vulnerability assessment of this report because the IPZ-1, IPZ-2 and IPZ-3 of this WTP include some portion of the Muddy Creek watershed which is a part of the Essex region watershed, however the intake is located in the Thames-Sydenham and Region Source Protection Region (TSRSPR). The **Wheatley WTP** is classified as a Type A intake because it draws source water from Lake Erie.

Table 4.9: Classification of the Intakes for the Seven Drinking Water Systems in the Essex Region Source Protection Area

Drinking Water System	Source Water Body	Intake Type
Stoney Point WTP	Lake St Clair	Type D
Lakeshore (Belle River) WTP	Lake St Clair	Type D
A. H. Weeks (Windsor) WTP	The Detroit River	Type B
Amherstburg WTP	The Detroit River	Type B
Harrow-Colchester South WTP	Lake Erie	Type A
Union WTP	Lake Erie	Type A
Pelee Island West Shore WTP	Lake Erie	Type A

4.2.1.2. Intake Protection Zones

As per Rule 58 *(Part VI.2) (Technical Rules: Assessment Report),* an intake protection zone for a drinking water intake associated with a type I system or a type II system or a type III system, is the area created by combining IPZ-1, IPZ-2, and IPZ-3. These zones are delineated differently for river based-intakes (e.g. Type C intakes) than lake-based intakes (e.g. Type A, Type B and Type D intakes).

Table 4.10 summarizes details on the criteria provided by the MOE, for intake protection zones for different types of drinking water intakes. As described in the Table, IPZ-1s, considered the most vulnerable zones, include set distances around the centre point of the intakes both in- water and upland components. The IPZ-2 area extends from the IPZ-1 and it is the second highest priority zone. It may also include in-water and upland components. The IPZ-1 and IPZ-2 consist of two components, in-water and upland. IPZ-3 extends from IPZ-2.

4.2.1.2.1. In-Water Delineation Methodology

IPZ-1 in-water delineation: In general, the in-water component of the IPZ-1 has set areas prescribed by the MOE in the Technical Rules, and is dependent upon the type of intake. For example, for type A (Great Lakes) and type D (others) intakes the in-water component of IPZ-1 is a circular area that has a radius of 1000 m from the centre point of the intake. For type B intakes, it is a semi-circle with a radius of 1000 m extending upstream from the centre point of the intake with a setback of 100 m extending downstream. The results of the delineation of in-water components of each WTP's IPZ-1s in the ERSPA are provided in respective WTP sections. Complete details on these technical studies can be found in the Reports prepared by Stantec Consulting Ltd., and Baird & Associates (**Appendix VII**).

Table 4.10: Intake Protection Delineation for Type I, II and III Systems to which O. Regulation 170/03 or 252/05 *Safe Drinking Water* Act, 2002 applies.

Intake Type	IPZ-1	IPZ-2[1]	IPZ-3[1]
Type A (Great Lakes)	Radius of 1 km around each intake. If that boundary extends onto land, the area includes Regulation Limit[2] and a setback up to 120 meters from the high water mark where overland flow drains into the surface water body.	Extends outward from IPZ-1. In water, IPZ -2 reflects the response time for the water treatment plant operator to respond an emergency. This would be a minimum of a two-hour travel time. If that boundary abuts land, the area includes the following setbacks along the abutted land: Regulation Limit[2] and a setback up to 120 meters from the high water mark where overland flow drains into the surface water body.	IPZ-3 extends outward from IPZ-2 to include all rivers and tributaries where modeling demonstrates that contaminant spills may reach the intake. If that boundary abuts land, the area includes the following setbacks along the abutted land: Regulation Limit[2] and a setback up to 120 meters from the high water mark where overland flow drains into the surface water body.
Type B (Connecting Channels)	1 km semi-circle radius of water and land upstream of the intake and extending 100 m downstream of the intake. This boundary may be modified to reflect local hydrodynamic conditions. If that boundary extends onto land, the area includes Regulation Limit[2] and a setback up to 120 meters from the high water mark where overland flow drains into the surface water body.		
Type C (Inland Rivers)	A semi-circle area that has a radius of 200 meters extending upstream from the centre point of the intake and a rectangle with a length of 400 meters from the centre point of the intake and a width of 10 meters downstream of the intake. This boundary may be modified to reflect local hydrodynamic conditions. If that boundary extends onto land, the area includes Regulation Limit[2] and a setback up to 120 meters from the high water mark where overland flow drains into the surface water body		
Type D	Radius of 1 km around each intake. If that boundary extends onto land, the area includes Regulation Limit[2] and a setback up to 120 meters from the high water mark where overland flow drains into the surface water body.		

[1]All IPZ-2 and IPZ-3s may be extended to include transport pathways such as storm sewersheds, drainage swales or field tile drains that provide a preferential pathway for contaminants to reach the intake.

[2]'Regulation Limit' means the area of land delineated on a map or series of maps filed at the head office of a conservation authority in accordance with a regulation made under subclause 28(1) (c) of the Conservation Authorities Act and subsection 4(4) of O.Reg. 97/04 made under that Act.

IPZ-2 in-water delineation: The in-water component of the IPZ-2 was delineated using numerical or hydrodynamic modeling and a 2-hour time-of-travel (TOT). A 2-hour TOT was adopted by the Essex Region Source Protection Committee based on the Draft Guidance Module 4 (MOE, 2006a), Technical Rules and communication with WTP operators.

This in-water IPZ delineation work was conducted by Baird & Associates under contract to Stantec Consulting Ltd. (**Appendix VII**). Baird & Associates proprietary three-dimensional hydrodynamic model, MISED was used for in-water IPZ-2 delineation work. The boundary conditions for the MISED model were defined using the Lake Huron Operational Forecast System (LHOFS) and the Lake Erie Operational Forecast System (LEOFS), the applications of the Princeton Ocean Model (POM) by the National Oceanic and Atmospheric Administration (NOAA). The model was calibrated and validated with Acoustic Doppler Current Profiler (ADCP) data collected in the western basin of Lake Erie in 2007 by the MOE. ADCP data were also collected in 2008 in the Chenal Ecarte, and near the north and south shores of the Detroit River. Lakebed depths (bathymetry), water levels, recorded and modeled wind data, measured currents, and tributary flows were used in the calibration of the model. The model was run for a range of conditions using combined 10-year return period events and a full range of wind directions was also considered. Reverse particle tracking was used to delineate the in-water IPZ-2s for the intakes in the ERSPA. The most conservative result of the reverse particle tracking was used to delineate extent of the IPZ-2s. The results of the delineation of in-water components of each WTP's IPZ-2s in the ERSPA are provided in respective WTP sections. The complete details on the Baird & Associates Study on hydrodynamic modeling for the in-water IPZ-2 delineation can be found in **Appendix VII**.

4.2.1.2.2. Upland Delineation Methodology

IPZ-1 Upland Delineation: As described in **Table 4.10**, the upland component of the IPZ-1 includes a setback alongshore of the abutted land of the in-water IPZ-1. This setback extends up to 120 m or the area of the Regulation Limit, whichever is greater, measured from the high watermark. The results of the delineation of upland components of each

WTP's IPZ-1s in the ERSPA are provided in respective WTP sections. This work was conducted by Stantec Consulting Ltd. (in **Appendix VII**).

IPZ-2 Upland Delineation:

The upland IPZ-2 includes the following two major components:

1. Tributaries and streams including municipal drains etc.,
2. A 120 m set back or the area of the Regulation Limit measured from the high water mark, whichever is greater along the abutted land, and
3. Storm sewersheds; and transport pathways (such as tile drain networks and other drainage systems).

Each of the above components is delineated differently using different methods as described in the following sections.

Tributary analysis methodology: Rivers, streams and municipal drains were considered as tributary pathways for the up-tributary IPZ-2 delineation purpose. The extent of this zone was based on the instantaneous velocity of the water at the discharge point; and the residual time of travel (TOT) at the watercourse discharge point. In the absence of actual velocity information for most tributaries or streams, theoretical velocities were estimated using watercourse cross-section profiles and the digital elevation model (DEM) information. The residual TOTs, in combination with the 2-year full bank flow velocity for each watercourse, were used to estimate the distance the IPZ-2 extends up-tributary. If the calculated up-tributary distance is greater than the actual length of the watercourse, the IPZ-2 was truncated at the outer limit of the full length of tributary with a 120 meter radius cap. The details of various mathematical equations and assumptions used in the velocity estimation are described in Stantec Consulting Ltd.'s Report (**Appendix VII**). Similar methodology was followed for the closed municipal drains, except that different hydraulic equations were used for estimating instantaneous velocities and the TOTs. The results of the delineation of upland components of each WTP's IPZ-2s in the ERSPA are provided in respective WTP sections.

Transport Pathways in IPZ-2s: Technical Rule 72 stipulates that the IPZ-2s must be extended to include storm sewersheds (land serviced by storm sewers) to account for at least the residual 2-hr TOT of flow in the storm sewer systems. For this study, Stantec Consulting Ltd. had collected information available on storm sewershed networks and storm sewershed outfalls. In areas where information on storm sewer catchments was available, the locations of the outfalls were used to determine which storm sewer catchments were to be included in the upland pathway delineation. In areas where only storm sewer networks were available, outfall locations and the DEM were used to estimate the upland extent of the IPZ-2. In the absence of any such information, the upland extent was delineated using aerial photography and watershed boundaries. The results of the delineation of storm sewer-sheds for each WTP's IPZ-2s in the ERSPA are provided in respective WTP sections of the Assessment Report.

Based on Technical Rules 72 and 73, transport pathways that may be included in the delineation of upland IPZ-2 are tile drainage and other drainage systems. In the preliminary stages of delineation work, Stantec Consulting Ltd. had included the tile drainage systems on agricultural lands. The current information on the extent of agricultural lands with tile drainage in the Essex Region was found to be outdated and inaccurate, resulting in many 'gaps' on the IPZ-2 maps. Local knowledge and experience suggests that most cultivated lands are typically tile drained in the Essex Region. On cultivated lands that are not currently tile drained, they typically have surface drainage systems such as furrows etc. Based on the above and other considerations, it was decided to consider all lands as having transport pathways and that they be included in the IPZ-2 delineations. The extent of the lands that may be included in the IPZ-2s was based on the 2-hour TOT. Only portions of transport pathways that may contribute water to the intake within the 2-hour TOT were included. It was assumed the flow velocity in a pathway is the same as the flow velocity of the watercourse (drain or tributary) it empties into. The delineation method is described in more detail in the Stantec Consulting Ltd. Technical Memo dated January 18, 2010 (in **Appendix VII**). The results of the delineation of transport pathways for each WTP's IPZ-2s in the ERSPA are provided in respective WTP sections.

4.2.1.2.3. IPZ-3 Delineation

In general, an IPZ-3 is to be delineated if modeling demonstrates that contaminants released during an extreme event may be transported to an intake. The Technical Rules define an extreme event as a period of heavy precipitation or up to a 100 year storm (wind), or a freshet. General approaches to the modeling were provided in the MOE's Technical Bulletin: Delineation of Intake Protection Zone 3 Using Event Based Approach (EBA) dated July 2009. Additional guidance was provided in a memorandum issued November 15, 2010 from the MOE. It explains that 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, contaminants of concern, and potential spill volume, the Events Based Approach would be used to determine whether or not an IPZ-3 should be delineated. Future activities may be considered where it is known that an activity will be taking place or is expected to take place in the future.

Baird & Associates completed the in-water hydrodynamic modeling for the WTPs along Lake St. Clair, the Detroit River and Lake Erie.

Lake St. Clair WTPs

The modeling completed for the WTPs located along Lake St. Clair followed the general approach outlined in the MOE Technical Bulletin (July 2009) and incorporated both reverse particle tracking and contaminant transport modeling. The model completed 10 runs of differing 100-year return periods determined using a joint probability analysis. The duration of the selected events (wind, flow in St. Clair River, flow in tributaries) used in the joint probability analysis was three days, as it reasonably accounted for the lead up and lag of a storm. Pike Creek and Ruscom River were the two locations selected for the simulated tanker truck spill contaminant modeling. Two contaminants were used at each location: gasoline (with 2% benzene) and sodium chloride, of volumes 34,000 L and 6.000 L respectively. For each tributary, a road crossing near the mouth and a road crossing near the headwaters was identified for a spill release.

These tanker truck spill locations were also considered representative of potential fixed fuel locations in the area and, in the threats analysis, they were also considered representative of the activity of the transportation of fuels. Refer to Section 4.2.1.4.4 'Event Based Approach' for further details.

If it was found that the contaminant reached the intake at a concentration above the benchmark (Ontario Drinking Water Quality Standard), an IPZ-3 would be required to be delineated if the spill location is outside IPZ-1 and IPZ-2. Baird and Associates recommended that, where modeling shows that spills close to the headwaters would result in exceedances at the intake, the delineation be extended to the headwaters. This is because a spill which occurs a little further upstream (i.e. at the headwaters of the same watercourse) would also result in an exceedance at the intake.

Further, Baird and Associates recommended extending the delineation to the watershed limits of the modeled watercourses, thereby including all tributaries of these watercourses. Baird and Associates also recommended that all tributaries between the modeled watercourses and the applicable WTP intake, as well as in the vicinity of the intake, be included in the delineation. This is based on several important considerations. Firstly these tributaries have a shorter flow path than the modeled watercourses. Also, the flow characteristics of these tributaries are very similar to those of the modeled watercourses. If modeling shows that spills close to the headwaters of modeled watercourses result in exceedances at the intake, then spills occurring along these tributaries would also result in similar, likely greater, exceedances at the intake.

As specified in the Technical Rules, the Floodplain Regulation Limit was also used in delineating the extent of the IPZ-3 along subject waterways where this limit exceeded the 120 meter setback. Further if the modeling showed that the contaminant reached an intake located in the Detroit River, the IPZ-3 was delineated for that intake as well, based on the above spill scenarios. The hydrodynamic modeling report from Baird & Associates, as well as the Stantec Consulting Ltd. Report (April 2011) addressing IPZ-3 delineation for WTPs along Lake St. Clair is in **Appendix VII**.

Detroit River WTPs

The modeling completed for the WTPs located along Detroit River followed the general approach outlined in the MOE Technical Bulletin (July 2009), and incorporated both reverse particle tracking and contaminant transport modeling. A joint probability analysis was preformed to define the combinations of wind, lake level (or flow in connecting channels) and tributary flow with a given return period, to produce 100 year return period events. Two events were selected for modeling, with one event incorporating the reverse flow in Detroit River observed December 15, 1987. The 1987 flow reversal was selected to evaluate the potential for spills occurring downstream of both A.H. Weeks and Amherstburg WTPs to reach the intakes during a flow reversal in the Detroit River.

There were six spill locations modeled with the above listed events; two of which were tanker truck spills along Turkey Creek and Canard River. The tanker truck spills, and the fixed fuel storage spill scenarios, were used for delineation and were also considered representative of potential fixed fuel storage locations. In the threats analysis, the tanker trucks were also considered representative of the activity of the transportation of fuels. Refer to Section 4.2.1.4.4 ‘Event Based Approach’ for further details.

The scenarios varied in location, Detroit River flow direction, spill volume and contaminant (gasoline, diesel, bunker fuel). If it was found that the contaminant reached the intake at a concentration above the benchmark (Ontario Drinking Water Quality Standards), an IPZ-3 would be required to be delineated if the spill location is outside the IPZ-1 and IPZ-2. Baird and Associates recommended that, where modeling shows that spills close to the headwaters would result in exceedances at the intake, the delineation be extended to the headwaters. This is because a spill occurring a little further upstream, i.e. at the headwaters of the same watercourse, would also result in an exceedance at the intake.

Further, Baird and Associates recommended extending the delineation to the watershed limits of the modeled watercourses, thereby including all tributaries of these watercourses. Baird and Associates also recommended that all tributaries between the modeled watercourses and the applicable WTP intake be included in the delineation. This is based on several important considerations. Firstly these tributaries have a shorter flow path than

the modeled watercourses. Also, the flow characteristics of these tributaries are very similar to those of the modeled watercourses. If modeling shows that spills close to the headwaters of modeled watercourses result in exceedances at the intake, then spills occurring along these tributaries would also result in similar, likely greater, exceedances at the intake.

As specified in the Technical Rules, the Floodplain Regulation Limit was also used in delineating the extent of the IPZ-3 along subject waterways, where this Limit exceeds the 120 metre setback. The hydrodynamic modeling report from Baird & Associates, as well as the Stantec Consulting Ltd. report (April 2011) addressing IPZ-3 delineation for WTPs along the Detroit River is in **Appendix VII**.

Lake Erie WTPs

The modeling completed for the WTPs located along Lake Erie followed the general approach outlined in the MOE Technical Bulletin (July 2009) and incorporated both reverse particle tracking and contaminant transport modeling. The joint probability analysis previously undertaken by Baird was used to define the 100 year return period event. Five actual wind events and two year return period flow from the Detroit River and the modeled tributaries were used to model the impacts of spills on Lake Erie intakes. Big Creek, Richmond Drain/Cedar Creek, Sturgeon Creek, Pelee/Hillman Creek and Pelee Island were the locations selected for the simulated tanker truck spill contaminant modeling of a 34,000L gasoline (with 2% benzene) spill. For each tributary, a road crossing near the headwaters was identified for a spill release. On Pelee Island one spill location was used for the West and North pump outlets. These tanker truck spill locations were also considered representative of potential fixed fuel locations in the area and, in the threats analysis, they were also considered representative of the activity of the transportation of fuels. Refer to Section 4.2.1.4.4 ‘Event Based Approach’ for further details.

If it was found that the contaminant reached the intake at a concentration above the benchmark (Ontario Drinking Water Quality Standard), an IPZ-3 would be required to be delineated if the spill location is outside IPZ-1 and IPZ-2. For this analysis, Baird and Associates used a conservative maximum equilibrium concentration of 10 mg/L for

Benzene concentrations at the mouth of the tributaries; however the equilibrium concentration may be as high as 58 mg/L. Given that all spill scenarios resulted in exceedances of the Ontario Drinking Water Quality Standard at this conservative concentration, it is reasonable to assume that higher equilibrium concentrations would also result in exceedances. Baird and Associates recommended that, where modeling shows that spills close to the headwaters would result in exceedances at the intake, the delineation could be extended to the headwaters. This is because the time of travel to the spill location is relatively small and dilution unlikely to occur which would still result in an exceedance at the intake.

Further, Baird and Associates recommended extending the delineation to the watershed limits of the modeled watercourses, thereby including all tributaries of these watercourses. Baird and Associates also recommended that all tributaries between the modeled watercourses and the applicable WTP intake, as well as in the vicinity of the intake, be included in the delineation. This is based on several important considerations. Firstly these tributaries have a shorter flow path than the modeled watercourses. Also, the flow characteristics of these tributaries are very similar to those of the modeled watercourses. If modeling shows that spills close to the headwaters of modeled watercourses result in exceedances at the intake, then spills occurring along these tributaries would also result in similar, likely greater, exceedances at the intake.

As specified in the Technical Rules, the Floodplain Regulation Limit was also used in delineating the extent of the IPZ-3 along subject waterways where this limit exceeded the 120 meter setback. Further if the modeling showed that the contaminant reached any intake located in Lake Erie, that tributary was included in the IPZ-3 delineated for that intake as well. The Baird & Associates report (August 2013) addressing IPZ-3 delineation for WTPs along Lake Erie is in **Appendix XIV**

4.2.1.2.4. Event Based Area

The Event Based Area (EBA) is an area where modeling has demonstrated that a spill from a specific activity can or could cause deterioration to the raw water quality at the drinking water system. If the modeling test is met, the activity is deemed a significant drinking water

threat and becomes subject to Source Protection Plan policies. For each intake in the Essex Region, the EBA is the combination of IPZ-1, IPZ-2 and IPZ-3 for modeled activities (i.e. fuel spill with 2% benzene, and specific volume criteria for each EBA dependant on modeling results) to which associated significant drinking water threat policies apply. Some areas of very high uncertainty may be included in the IPZ-3, which are acceptable under Rule 68 (Part VI.5) (*Technical Rules: Assessment Report CWA, 2006*), but are excluded from the EBA (Rule 130 (Part VI.5) (*Technical Rules: Assessment Report CWA, 2006*). Future studies may improve the certainty of these areas, which could be added to the EBA in an updated Assessment Report. In the case of the Essex Region Source Protection Area, the in water portions of the IPZs for all intakes are included in the EBAs because a large fuel spill in the shipping channels (e.g. from a tanker or ferry) would reach the drinking water intakes at concentrations that could cause deterioration of raw water quality. Time of travel of the in-water portions of IPZs is shorter than the time of travel from the modeled spill locations in the watersheds to the drinking water intakes which would result in higher concentrations of benzene at the intakes. Therefore, it is very reasonable to assume that if such spills occur in the in-water portions, they would be considered as significant threats. Exclusions for each WTP in the ERSPA are discussed in respective WTP sections. EBA maps which show the extent of the EBA as well as the spill locations used for modeling fuel spills are also included in each WTP section.

4.2.1.3. Vulnerability Scoring for Intake Protection Zones (IPZs)

The vulnerability score (V) is a numerical expression of the susceptibility of the intake to contamination. Vulnerability scores are assigned for each type of intake for IPZ-1 and IPZ-2 and for type C and type D intakes for IPZ-3. In the ERSPA there are only types A, B and D intakes. The vulnerability scores are based on the attributes of the intakes (e.g. length and depth), type of source water body, and the physical characteristics of the environment it is situated in. The vulnerability score (V) is a unitless factor and is calculated by multiplying area vulnerability factor (B) by the source vulnerability factor (C) as expressed below:

$$V = B \times C$$

The area vulnerability factor (B) is unique for each IPZ and relates to features and processes in the local environment that may impact the intake. The area vulnerability factor was prescribed by the Technical Rules for all IPZ-1s, which receive a score of 10, regardless of the type of intake. Typical factors that may dictate the area vulnerability factor for IPZ-2s include percentage of the area of the IPZ-2 that is composed of land, land cover, soil type, permeability and slope and hydrological conditions in the area that contribute water to the area via transport pathways. The area vulnerability factor for IPZ-3s must be based upon the above listed factors as well as proximity to the intake. To quantify these factors Stantec Consulting Ltd. generated matrices using ranges of characteristics for each of the sub factors (percentage of land, land characteristics and transport pathways, and also for IPZ-3s, intake proximity). All sub factors were assumed to be of equal importance and thus weighted equally. In general, a higher percentage of land, higher runoff potential, greater number of transport pathways and a close proximity to the intake will result in higher area vulnerability factor score. Complete details on the matrices can be found in Stantec Consulting Ltd's vulnerability delineation and scoring reports in **Appendix VII**. The results of the area vulnerability factor analysis are provided in respective WTP sections in this report.

For the IPZ-2s, each sub factor was assigned a low, medium or high factor of 7, 8 or 9 respectively. For IPZ-3s, each sub factor was assigned a low, medium or high factor of 1, 5 or 9 respectively. The percentage of land sub factor was divided into the categories of low (<33% land), medium (33% to 66% land), and high (>66% land). This sub factor was based on the assumption that a higher percentage of area that is land may indicate a higher potential for runoff. The land cover was assigned a low, medium or high factor for 'mainly vegetated' lands, 'mixed vegetated and developed', or 'mainly developed' lands respectively. Land characteristics were comprised of land cover, soil type, permeability, and percent slope. Soil type was assigned low, medium or high factors depending on whether soils were sandy, silty clay, or clay. Permeability was assigned low, medium or high factors for values of >66%, 33% to 66%, and <33% respectively. Percent slope was assigned low, medium or high factors based on values being <2%, 2% to 5%, or >5% respectively. Storm catchment areas were assigned low, medium or high factors based on the area being <33%, 33% to 66%, or >66% respectively. In addition to these sub factors,

the proximity to the intake was also considered for scoring IPZ-3s and areas within them, by assigning low, medium and high factor to the times of travel of >12 hours, 6 to 12 hours, and <6 hours respectively.

The source vulnerability factor (C) relates to the type of water body, intake characteristics (length, depth) and number of recorded drinking water issues. The MOE Guidelines for the Design of Water Treatment Works (MOE, 1992) prescribes the minimum submergence of raw water intake at three meters, but the guidelines state a preference for submergence of at least 10 m. There are no prescribed guidelines or suggestions for the distance from the shoreline in the MOE design guidelines (MOE, 1992). The State of Michigan, as part of their Source Water Protection Program, categorizes surface water intakes in four ways according to distance offshore and depth to intake. A corresponding intake vulnerability is also listed. The above listed references were considered when assigning the source vulnerability factor. Note that the State of Michigan classifications were only considered when scoring type A intakes. In general, if an intake was less than 3 m deep, less than 300 m from shore and had several recorded drinking water issues, it would be assigned the highest source vulnerability factor. Conversely, if the intake was greater than 6 m deep, greater than 500 m from shore and had minimal recorded drinking water issues, it would be assigned the lowest source vulnerability factor. These results of the source vulnerability factor analysis are provided for each WTP in their respective sections in this report.

Table 4.11 summarizes the ranges of vulnerability scoring for intakes in all types of surface water sources, with each source type and zone having a different range of possible scores.

Table 4.11: Ranges of Vulnerability Scores for Intake Protection Zones of Different Types of Intakes

Intake Type	Area Vulnerability Factor (B)			Source Vulnerability Factor (C)	Vulnerability Score (V=BXC)		
	IPZ-1	IPZ-2	IPZ-3		IPZ-1	IPZ-2	IPZ-3
Type A (Lake Erie)	10	7 to 9	n/a	0.5 to 0.7	5 to 7	3.5 to 6.3	n/a
Type B (The Detroit River)	10	7 to 9	n/a	0.7 to 0.9	7 to 9	4.9 to 8.1	n/a
Type D (Lake St Clair)	10	7 to 9	1 to 9	0.8 to 1.0	8 to 10	5.6 to 9.0	0.8 to 9.0
Type C (Not Applicable in the Essex Region SPA)	10	7 to 9	1 to 9	0.9 to 1.0	9 to 10	6.3 to 9.0	0.9 to 9.0

The IPZ-3 related to type A intake or type B intake is not assigned a vulnerability score, while areas within an IPZ-3 related to type C intake and type D intakes are. According to Technical Rule 91, the area vulnerability factor for the IPZ-3, or an area within it, cannot be greater than the area vulnerability factor for IPZ-2.

4.2.1.4. Drinking Water Threats

A drinking water threat is defined, according to the MOE, as a chemical or pathogen that poses a potential risk to the drinking water source. The MOE has prescribed 21 types of activities that are considered as drinking water threats as listed below:

1. The establishment, operation or maintenance of a system that collects, stores, transmits, treats or disposes of sewage
2. The establishment, operation or maintenance of a waste disposal site within the meaning of Part V of the Environmental Protection Act
3. The application of agricultural source material (ASM) to land
4. The storage of agricultural source material (ASM)
5. The management of agricultural source material (ASM)
6. The application of non-agricultural source material (NASM) to land
7. The handling and storage of non-agricultural source material (NASM)
8. The application of commercial fertilizer
9. The handling and storage of commercial fertilizer
10. The application of pesticide
11. The handling and storage of commercial pesticide

12. The application of road salt
13. The handling and storage of road salt
14. The storage of snow
15. The handling and storage of fuel
16. The handling and storage of non-aqueous dense phase liquids (DNAPL)
17. The handling and storage of organic solvent
18. The management of runoff that contains chemicals used in the de-icing of aircraft
19. The use of land as livestock grazing or pasturing land, an outdoor confinement area or a farm-animal yard
20. An activity that takes water from an aquifer or a surface water body without returning the water taken to the same aquifer or surface water
21. An activity that reduces the recharge of an aquifer.

Out of the above mentioned 21 activities, the first 19 are the drinking water quality threats while the last two are the drinking water quantity threats. In addition to the above mentioned threats, the Essex Region Source Protection Committee has the authority to include additional threats specific to the ESPR Areas where they deem appropriate as long as the threat meets the criteria outlined in *the Technical Rules (Part XI.2, Rule 125)*.

Drinking water quality threats that are prescribed by the MOE may be deemed as significant, moderate, or low threats in the vulnerable areas through the following three approaches:

1. *Threats Approach (the Tables of DW Threats and Conditions)*
2. *Issues Approach, and*
3. *Event Based Modeling Approach.*

4.2.1.4.1. Threats Approach

The Tables of Drinking Water Threats: The threats approach is based on the quantitative risk score estimation for an activity that is or would be a drinking water threat in a specific vulnerable area. The risk score is calculated by multiplying the vulnerability score (V) with the hazard rating which provides a score out of 100. The risk score is classified as significant when the score is greater than 80, moderate when the score is less than 80 and greater than 60, and low when the risk score is less 60 and greater than 40 as summarized below.

Risk Score	Threat Level
80-100	Significant
60-79	Moderate
40-59	Low
Risks with scores lower than 40 do not have to be dealt with under *the Clean Water Act.*	

Each vulnerable area for the drinking water systems is assigned a numerical value of a vulnerability score based on various factors that are described in previous sections of this report. A hazard rating is a science based, numerical value, which represents the relative potential for a contaminant to impact drinking water sources at concentrations significant enough to cause human illness. Hazard ratings are calculated differently for chemicals than pathogenic organisms. The chemical hazard ratings for all threats were computed by the following equation:

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

Where T = Toxicity, F = Environmental Fate, Q = Quantity and RIM = Release to Environment.

The hazard rating for pathogen threats was determined based on the land use activity and the likelihood of it impacting the water source using a RIM rating. These methods were the basis for the Tables of Drinking Water Threats that was provided by the MOE in November 2009. The Tables of Drinking Water Threats can be accessed using the following link:

http://www.essexregionsourcewater.org/downloads/download_tables_of_drinking_water_threats.pdf

The Table of Drinking Water Threats consists of two look-up tables, one for the chemicals and the other for pathogens. The Table takes into account all of the factors of the hazard rating and the vulnerability scores of the vulnerable area in which the activity is or would be located. Each type of activity is assigned one or more circumstances which need to be

evaluated in order to determine if that activity is a low, moderate or high drinking water threat in a particular vulnerable zone. The Tables of Circumstances can be accessed using the following link:

https://www.ontario.ca/environment-and-energy/provincial-tables-circumstances

Based on the vulnerability scores assigned to each vulnerable area (IPZ-1, IPZ-2, or IPZ-3 for Type C or D intakes) and the MOE's Table of Drinking Water Threats, the lists of potential drinking water quality threats (significant, moderate and low) were generated. These lists are provided for each WTP in the ERSPA in their respective sections in this report, with details of the study provided in **Appendix VIII**. The list of circumstances for each threat is provided in **Appendix IX**.

4.2.1.4.2. Conditions

Conditions are areas, resultant of past activities, where there is an existing contamination, for example contaminated soil at an old industrial site that is no longer in use, that may be considered as a drinking water threat. Section 4.1.4 (HVAs/SGRAs) describes in detail how to identify some conditions resulting from past activities. In general, available soil and sediment sampling data is compared to Tables 4 and 1 of the Soil, Ground Water and Sediment Standards, respectively. Any soil or sediment parameter found to be present at a concentration that exceeds the standard set out for that parameter was listed as a condition resulting from a past land use activity. Should a condition be identified as described above; the condition is to be considered a drinking water threat.

As with all drinking water threats, the risk score of a condition is determined as the product of the vulnerability score and hazard score. As per Technical Rules, the hazard score of a condition is:

i. **10**, if there is evidence that the situation is causing off-site contamination
ii. **10**, if the condition is on a property where a well, intake or monitoring well (existing and planned drinking water systems that are major residential, included in the Terms of reference by resolution or upon order of the Director, or serve reserves) is located
iii. **6**, if (i) and (ii) do not apply.

Conditions are then classified as significant, moderate or low drinking water threat based on the final risk score calculated by multiplying the hazard rating with the vulnerability score of the vulnerable area in which the condition is located. Note that the Assessment Report may be amended in the future to include any new information obtained on conditions. The preliminary conditions analysis can be found in the Stantec Consulting Ltd. report dated December 2010 (in **Appendix X**), and the results are summarized in each of the sections pertaining to respective WTPs.

4.2.1.4.3. Issues Approach

As per *The Clean Water Act* (2006) Technical Rule 114, a drinking water *issue* is defined as the presence of a parameter, listed in Schedules 1, 2, or 3 of *O. Reg 170/03*, or Table 4 of the Technical Support Document for the Ontario Drinking Water Quality Standards (ODWQS) Objectives and Guidelines, at a concentration, that may result in the deterioration of the quality of water for use as a source of drinking water. The issues evaluation methodology that was adopted by the Essex Region Source Protection Committee is described in the Issues Evaluation section 4.2.1.5 of this report, and is provided as **Appendix VI**.

The Clean Water Act (2006) Technical Rule 115 requires that once an issue is identified at the intake, well or monitoring well, and is determined to be wholly or partially a result of anthropogenic causes, the *issue contributing area* (ICA) needs to be identified and mapped in *the Assessment Report*. The ICA is that area within a vulnerable area where activities and conditions may contribute to the identified issue. A third intake protection zone (IPZ-3) for surface water intakes must be delineated (outside of the IPZ-1 and IPZ-2) to include the activity and area known to contribute to the drinking water quality issue. The Technical Rules implicitly state that any activity or condition that can contribute to issues (identified as per Rules 114 and 115) is a ***significant drinking water threat*** in intake protection zones and wellhead protection areas for drinking water systems identified in the Source Protection Area Terms of Reference (the work plan to guide the source protection planning process). Risks associated with the significant drinking water threats must be mitigated through the source protection plan.

The issues that were identified at each intake in the ERSPA through the issues evaluation methodology are described in the respective WTP section. Currently it has not yet been determined if the identified issues resulted from anthropogenic or natural sources or both. In the case of microcystin-LR, there is insufficient data to delineate an ICA. Therefore the identified issues are described as per Technical Rule 115.1, by identifying the parameter, and describing the nature as well as possible causes of the issue. This is often referred to as an issue identified under the Act to differentiate it from an issue identified under the rules (specifically rule 114). Issues identified as per rule 115.1 do not require the delineation of an ICA and cannot have significant threats identified which contribute to the issue. They may however be addressed through specify action policies and be the subject of monitoring and reporting. If more information becomes available to the Source Protection Committee, it may be possible to identify the issue under rule 114, at which time an ICA would be delineated and significant drinking water threats associated with the issue. This information may be included in a future Assessment Report.

4.2.1.4.4. Event Based Approach

The events based approach is addressed in Technical Rules 68, 69 and 130 and further direction was provided from the MOE's Technical Bulletin: Delineation of Intake Protection Zone 3 Using the Events Based Approach (EBA) dated July 2009. In general, an IPZ-3 is to be delineated if modeling demonstrates that contaminants released during an extreme event may be transported to an intake. In addition, that activity is or would be a significant threat if the modeling demonstrates the contaminant reaches the intake at a concentration that deteriorates the water as a drinking water source.

Additional guidance was provided in a memorandum issued November 15, 2010 from the MOE. It explains that 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, contaminants of concern and potential spill volume, the Events Based Approach would be used to determine whether or not an IPZ-3 should be delineated. Future activities may be considered where it is known that an activity will be taking place or is expected to take place in the future.

The combined modeling approach, which incorporates the boundary approach and contaminant approach, was undertaken by Baird & Associates for the delineation of IPZ-3s for the WTPs along Lake St. Clair, the Detroit River and Lake Erie. Details are in the Stantec Consulting Ltd. Reports (of April 2011), addressing IPZ-3 delineation and events based threats analysis for Stoney Point, Lakeshore (Belle River), A. H. Weeks (Windsor) and Amherstburg WTPs, in **Appendix VII**. The Baird & Associates report (August 2013) addressing IPZ-3 delineation for WTPs along Lake Erie is in **Appendix XIV.** The modeled scenarios included spills from fixed fuel storage tanks and fuel tanker truck activities at various locations. If modeling indicated that the contaminant considered reached the intake and exceeded a certain benchmark, then the activity would be considered a significant threat.

4.2.1.4.5. Local Threats

Fixed fuel storage tanks are considered 'prescribed' drinking water quality threats, as they are included under the activity of 'handling and storage of fuel' in the MOE Drinking Water Threats Tables. However the transportation of fuel (such as by tanker trucks) is not an activity listed in these Threats Tables. A request was made to the Director in June 2011 to add the transportation of fuel as an 'other' or 'local' drinking water quality threat. This request was made because there are many high intensity transportation corridors (e.g. highways, roads, railways, navigation channels) in the vulnerable areas of the Essex Region Source Protection Area. The Director approved the transportation of fuel and other chemicals of concern (i.e. organic solvents, DNAPLs, pesticides/herbicides and fertilizers) as local drinking water threats in August 2011) (**Appendix XIII).** At this time only spill events of transportation of fuels containing 2% benzene have been modeled in the Essex Region SPA and deemed to be significant drinking water threats in all Event Based Areas (EBAs) in the ERSPA. Because none of the IPZs in ERSPA have a vulnerability score of 10, only moderate or low local threats can be identified using the vulnerability score, for more details see Director's Letter dated August 2011 (**Appendix XIII)**. Tables that show the classification of the transportation of various substances as significant, moderate or low drinking water threats based on the vulnerability score of each IPZ are included for each WTP in the ERSPA in the respective WTP sections. In order to determine which

circumstance of which local threat activity is or would be a low or moderate threat using the vulnerability score, the tables need to be read in conjunction with the Director's letter.

4.2.1.5. Issues Evaluation

The Clean Water Act (2006) requires drinking water quality issues at the intakes of drinking water systems included in the Assessment Report to be identified. The activities or conditions that contribute to identified issues (known to be wholly or partially a result of anthropogenic causes) are deemed significant threats in IPZs and WHPAs, for drinking water systems identified in the Source Protection Area Terms of Reference. This section of the Assessment Report gives an overview about what parameters in the raw water may be considered as issues, and the methodology used to identify issues at the seven drinking water systems in the ERSPA. The results of the issues evaluation for each WTP are presented in the respective WTP sections.

What is a Drinking Water Quality Issue? A drinking water *issue* is defined as the presence of a parameter, listed in Schedules 1, 2, or 3 of O. Reg 170/03, or Table 4 of the Technical Support Document for the Ontario Drinking Water Quality Standards (ODWQS) Objectives and Guidelines, at a concentration, that may result in the deterioration of the quality of water for use as a source of drinking water. Pathogens are also considered an issue if they are present at certain concentrations that may result in the deterioration of the quality of water for use as a source of drinking water. A brief description of each group of parameters is provided in the following paragraphs. In addition to these parameters, the Source Protection Committee (SPC) may identify other parameters for the issues evaluation; however, no additional parameters have been identified by the ERSPA SPC to date.

Schedule 1 Parameters: These include two indicator microorganisms namely *E. coli* and total coliform. These microorganisms are present in fecal matter (e.g. sewage effluents) and their presence indicates the presence of harmful pathogens, such as Giardia and Cryptosporidium.

Schedule 2 Parameters: Schedule 2 parameters include chemical parameters (e.g. metals, inorganics, pesticides and neurotoxins) such as lead, nitrate, atrazine and microcystin-LR. These parameters are potentially toxic and may adversely affect human health at or above certain concentrations in drinking water. Some of these parameters occur naturally in the environment, while others are results of human activities.

Schedule 3 Parameters: These parameters include radio-active materials such as uranium-235. These parameters are potentially toxic and may adversely affect human health at or above certain concentrations in drinking water.

The ODWQS recommends human health based treated drinking water standards called Maximum Acceptable Concentrations (MACs) or Interim MACs for the Schedule 1, 2 and 3 parameters.

Schedule 4 Parameters: These consist mostly of parameters that may impair the taste, odour or colour of the water. These parameters may adversely impact the treatment, disinfection and the distribution of the treated water. The ODWQS identifies either aesthetic objectives (AOs) or operational guidelines (OGs) for the parameters.

Pathogens: These are disease causing microorganisms including protozoa, bacteria and viruses. Pathogens can cause severe or fatal waterborne illness in humans. Some of the pathogens are resistant to commonly used disinfectants at water treatment plants. Currently these are not monitored at the WTPs due to lack of reliable laboratory detection methods. Also there are no established Canadian Water Quality Guidelines for these pathogens. For the same reasons, pathogens are not considered in the issues evaluation for the intakes of the ERSPA.

Methodology: Assessment of the potential issues related to the raw water quality at the seven WTPs in the ERSPA was conducted following a three step method. This methodology was developed by the Thames-Sydenham and Region Source Protection Region (TSRSPR) and adopted by the Essex Region Source Protection Committee in June 2009 (**Appendix VI**). Issues evaluation work for the intakes of the ERSPA was conducted by Stantec Consulting Ltd. except for the assessment of microcystin-LR at Lake Erie intakes which was conducted by the Essex Region Source Protection staff in collaboration

with the Thames-Sydenham and Region Source Protection Region staff and their respective Source Protection Committees.

The methodology included three main stages:

1. Screening,

2. Issue identification, and

3. Issue description

The screening steps involved flagging of parameters based on certain concerns or previous water quality data review and reports. For this purpose, operating authority concerns, the Essex Region Watershed Characterization Report (August 2006), Annual Drinking Water Systems (DWS) Reports, Drinking Water Surveillance Program (DWSP) data, and Drinking Water Information Systems (DWIS) were reviewed. The flagged parameters were then further evaluated against respective MACs, AOs and OGs.

The standard for recreational waters of 100 CFU/100mL was used as the benchmark for the Schedule 1 parameter *E. coli* and the standard for recreational waters of 1000 CFU/100mL was used as the benchmark for the Schedule 1 parameter total coliform. The Schedule 2 and 3 data were compared to 10%, 25%, and 50% of the ODWQS Maximum Allowable Concentration (MAC). Since the ODWQS relates to treated potable water, it was decided that comparing fractions of the MAC may adequately review the quality of raw water as a source for the WTP. The 50% MAC was adopted to be the upper limit as exceeding this limit in the treated potable water triggers a regulatory requirement of O.Reg 170 for the operations staff to increase sampling and rectify any problems that may compromise the quality of the treated water. The Table 4 AO and OG parameters were analyzed similar to that of Schedule 2 and 3. The preliminary results of the issue evaluation process were discussed and reviewed with the plant manager/operator of the WTP. The identified issues are summarized for each WTP in their respective sections. The actual details on the results of screening, issue identification, and issue description steps can be found in the January 2010 and December 2010 Stantec Consulting Ltd. Issue Evaluation Technical Memoranda in **Appendix X** and in the 'Technical Memorandum on Issue Evaluation for microcystin-LR at Lake Erie drinking water intakes in the Essex Region (**Appendix XV**).

Implication of Issues

The Clean Water Act (2006) Technical Rule 115 requires that once an issue is identified and the issue is known to be partially or wholly due to anthropogenic sources, the *issue contributing area* and *activities* need to be identified in *the Assessment Report*. The *issue contributing area* is that area within a vulnerable area where activities and conditions may contribute to the identified issue. A third intake protection zone (IPZ-3) for surface water intakes may be delineated (outside of the IPZ-1 and IPZ-2) to include the activity and area known to contribute to the drinking water quality issue. Technical Rule 131 implicitly states that any activity or condition that can contribute to issues is a ***significant drinking water threat*** in intake protection zones and wellhead protection areas (for drinking water systems identified in the Source Protection Area Terms of Reference). Further, issues in HVAs or SGRAs or those linked to a system not identified in the Terms of Reference may lead to the identification of moderate drinking water threats (not significant threats). Systems not identified in the Terms of Reference may be those included in the source protection planning process through municipal council resolution or by the Minister (MOE).

Risks associated with the significant drinking water threats must be mitigated through the source protection plan. In the Essex Region Source Protection Area, the sources of the identified issues are not determined and therefore issues contributing area and activities are not identified at this time. Refer to Section 4.2.1.4.3 (Issues Approach)

4.2.2. Stoney Point Water Treatment Plant

This section summarizes the results of technical studies conducted by Stantec Consulting Ltd. and Baird & Associates for the Stoney Point Water Treatment Plant (WTP) in the Essex Region Source Protection Area. The complete details of these technical studies can be found in **Appendices VII, VIII, IX** and **X**. Please refer to Section 4.2.1 of this Assessment Report for the details on concepts, methodology and requirements related to intake classification, intake protection zone delineation, vulnerability scoring, drinking water threats assessment and issues evaluation.

4.2.2.1. Intake Classification

The Stoney Point WTP is located on St. Clair Road in the Town of Lakeshore. It withdraws its source water from Lake St. Clair. The treatment processes at the plant include chemical coagulation/flocculation, sedimentation, filtration and chlorination. The plant also includes taste and odour control, zebra mussel control and fluoridation systems. Other details such as intake pipe location, crib depth etc, are summarized in **Table 4.12**. The Service Area for this plant includes approximately 208 km of water distribution pipes of various sizes and serves around 3,500 people (see Map 1.1).

Table 4.12: Overview of the Stoney Point Water Treatment Plant

Drinking Water System: Stoney Point Water Treatment Plant	
Operating Authority	The Corporation of the Town of Lakeshore
Location	6011 St. Clair Road, Lakeshore
System Classification	Type I System (Municipal Residential)
Rated (design) Capacity	4,546 m^3/day
UTM Coordinates	371829 E 4687035 N
Intake Depth	1.94 m (lake bottom); 1.04 m (crib top)
Distance of Intake from Shore	1219 m

Lake St. Clair is considered as an inland lake for the purpose of classification of intake types, and as per Rule 55 (Part VI.1) (*Technical Rules: Assessment Report CWA, 2006*) the intake of the Stoney Point WTP was classified as a Type D intake. The intake protection zones (IPZs) for the Stoney Point WTP were delineated as per the guidelines described in **Table 4.10** (Section 4.2.1.2).

4.2.2.2. Intake Protection Zone -1 (IPZ-1)

As described in Section 4.2.1.2 (**Table 4.10**) the in-water portion of the IPZ-1 for a Type D intake is an area of 1 km radius drawn from the centre point of the intake and if the circle extends onto land, the IPZ-1 includes land up to 120 meters from the high water mark of the water body, or the Regulation Limit, whichever is greater. Since the intake crib is 1219 meters away from the shore, the IPZ-1 for the Stoney Point WTP did not abut shore (land), and is shown as a full circle in Lake St. Clair (**Map 4.12a)**.

4.2.2.3. Intake Protection Zone -2 (IPZ-2)

The IPZ-2 is a secondary protective zone around the IPZ-1 and is delineated based on both the minimum response time required for the plant operator to respond to adverse conditions or a spill, and the travel time in the lake and/or tributary. A 2-hour response time was adopted by the Essex Region Source Protection Area based on the Draft Guidance Module 4 (MOE, 2006a), the Technical Rules, and interviews with the plant operators and authorities in the Region. There are two components to the IPZ-2, namely the in-water IPZ-2 and upland IPZ-2, the extent of which are determined based on the 2-hour time of travel considering the estimated flow velocities.

The in-water component of the IPZ-2 for the Stoney Point WTP was delineated by Baird & Associates, using hydrodynamic modeling and reverse particle tracking method. Refer to Section 4.2.1 of this Assessment Report and **Appendix VII** for further information relating to the hydrodynamic modeling. The resulting in-water zone extends off the shore of Lake St. Clair and includes a zone about 4.2 km east, 6 km west and 3.5 km north of the intake as illustrated in **Map 4.12a**.

The upland IPZ-2 includes the following three major components:

1. Tributaries and streams including municipal drains etc.,
2. A 120 m set back or the area of the Regulation Limit, whichever is greater along the abutted land, and
3. Storm sewersheds; and transport pathways (such as tile drain networks and other drainage systems).

The extents of these components are delineated differently, based on the 2-hour time of travel, using different methods as described in Section 4.2.1. The resulting boundary of the IPZ-2 of the Stoney Point WTP with various components is illustrated in **Map 4.12a.** Refer to the Technical Memorandum prepared by Stantec Consulting Ltd. (**Appendix VII**) for further information on variety of data sources and approaches used to determine the up-land extent of the IPZ-2.

4.2.2.4. Intake Protection Zone-3 (IPZ-3)

As per Rule 68 (Part VI.5) (*Technical Rules: Assessment Report CWA, 2006*) IPZ-3 may be delineated for *Type D* intakes if modeling indicates that a contaminant released during an extreme event (100 year storm) may be transported to the intake and be shown to result in deterioration of the water source. The Essex Region SPC has accepted that an exceedance of the ODWQS indicates deterioration. Appropriate guidelines for delineation of IPZ-3 are described in **Table 4.10** (Section 4.2.1.2). Baird & Associates conducted the modeling to determine if an IPZ-3 would be required for the Stoney Point WTP and the details of this study are in **Appendix VII**.

The methodology is described in Section 4.2.1.2.3. The modeling incorporated both reverse particle tracking (boundary approach) and contaminant transport modeling to determine the boundaries of the in-water IPZ-3. The model completed 10 runs of differing 100-year return periods determined using a joint probability analysis. The duration of the selected events (wind, flow in St. Clair River, flow in tributaries) used in the joint probability analysis was three days, as it reasonably accounted for the lead up and lag of a storm. Ruscom River was selected for the simulated tanker truck spill contaminant modeling. Two contaminants were used (gasoline with 2% benzene and sodium chloride) with two spill locations in each tributary; close to the headwaters and at the mouths. The locations

for Ruscom River are shown in **Figure 3.1** of the Stantec Consulting Ltd. Report (April 2011), addressing IPZ-3 delineation and threats analysis for Stoney Point, Lakeshore (Belle River) and A. H. Weeks (Windsor) WTPs, in **Appendix VII** and in **Map 4.12c**.

Based on the model results, a fuel spill (with 2% benzene, and a volume of 34,000 L) approximately 30,000 m upstream from the mouth of the Ruscom River would result in an exceedance of the ODWQS benchmark for benzene at the Stoney Point WTP. Sodium chloride did not show exceedances at the intake.

Baird & Associates recommended that the IPZ-3 delineation be extended, as described in Section 4.2.1.2.3 (IPZ-3 delineation methodology). They recommended that the delineation be extended to the watershed limits of the modeled watercourse, thereby including the headwaters of these watercourses and their tributaries. Baird & Associates also recommended that the delineation be extended to the tributaries between the watercourses modeled and the WTP intake, as well as the vicinity of the intake. Based on these recommendations, the IPZ-3 for the Stoney Point intake was extended to include the Ruscom River and its tributaries. Also, all tributaries located between the Ruscom River and the Stoney Point intake, were included up to the watershed boundary. Further, tributaries within a short distance to the east of the intake, such as Little Creek were included, up to the Essex Region watershed boundary.

An off-bank setback of 120 m was applied to all watercourses; however this setback was truncated at subwatersheds as overland flow would be traveling away from the watercourse. As specified in the Technical Rules, the Floodplain Regulation Limit was also used in delineating the extent of the IPZ-3 along subject waterways, where this Limit exceeds the 120 m setback. The hydrodynamic modeling report from Baird & Associates, as well as the Stantec Consulting Ltd. report (April 2011) addressing IPZ-3 delineation for Stoney Point WTP is in **Appendix VII**. Refer to **Map 4.12b** for the IPZ-3 delineation.

4.2.2.5. Event Based Area

The Event Based Area for Stoney Point WTP is the combination of all on land portions and in water portions of IPZ-1, IPZ-2 and IPZ-3 (see **section 4.2.1.2.4**). Refer to **Map 4.12c** for the Event Based Area to which the significant drinking water threat policies for

the handling and storage of fuel and transportation of fuel along shipping and ferries corridors apply.

4.2.2.6. Vulnerability Scoring of IPZs

The vulnerability score (V) is a numerical expression of the susceptibility of the intake to contamination. Details on the methodology of vulnerability scoring, and the data sources used in assigning vulnerability scores for the IPZs can be found in Section 4.2.1.3 and the reports prepared by Stantec Consulting Ltd. dated January 2010, and April 2011 (**Appendix VII**).

The area factor vulnerability (B) is assigned a value of 10 for the IPZ-1 of the Stoney Point WTP, which is a set value for IPZ-1s of all types of intakes. The IPZ-2 is assigned a B score of 7 based on a variety of characteristics. The IPZ-3 was divided into three proximity zones (a, b, and c) and assigned B scores of 7, 6, and 5 respectively. The IPZs are assigned a C score of 0.9, based on characteristics of the Stoney Point WTP intake. Based on these scores, the overall vulnerability scores for the IPZ-1, IPZ-2 and IPZ-3a,b,c of the Stoney Point WTP were calculated as 9.0, 6.3, 6.3, 5.4, and 4.5 respectively (**Table 4.13, Map 4.13a and Map 4.13b**).

Table 4.13: Vulnerability Scores Assigned to IPZ-1, IPZ-2 and IPZ-3 of Stoney Point WTP

Intake Type	Area Vulnerability Factor (B)					Source Vulnerability Factor (C)	Vulnerability Score (V=BxC)				
	IPZ-1	IPZ-2	IPZ-3				IPZ-1	IPZ-2	IPZ-3		
			a	b	c				A	b	c
Type D	10	7	7	6	5	0.9	9	6.3	6.3	5.4	4.5

These vulnerability scores were then used in combination with the MOE's Table of Drinking Water Threats to determine the number and types of potential drinking water threats in the respective intake protection zone that are discussed in the following section.

4.2.2.7. Drinking Water Threats

A drinking water threat is defined, according to the MOE, as a chemical or pathogen that poses a potential risk to the drinking water source. Please refer to Section 4.2.1.4 for the

list of 21 types of activities that are considered as drinking water threats prescribed by the MOE. These activities may be deemed as significant, moderate, or low drinking water threats in the vulnerable areas through four different approaches as described in Section 4.2.1.4. The following section describes the results of the threats assessment obtained through the "threats approach" and the "event based approach."

4.2.2.7.1. Threats Based Approach

The threats approach is based on the quantitative risk score estimation for an activity that is or would be a drinking water threat in a vulnerable area. Refer to Section 4.2.1.4 for further details on methodology of the Threats approach. Based on the vulnerability scores that were assigned to IPZ-1, IPZ-2 and IPZ-3, and the MOE's Tables of Drinking Water Threats, the lists of potential drinking water quality threats (significant, moderate and low) were generated for the Stoney Point WTP. The threats approach study including lists of potential threats based on zone and vulnerability score is provided in **Appendix VIII**.

Table 4.14 summarizes the number of possible drinking water quality threats (chemical and pathogen) that would be deemed as significant, moderate or low if they were to exist in the IPZ-1, IPZ-2 or IPZ-3 of the Stoney Point WTP. These threats were further classified into chemical and pathogen types and are illustrated in **Map 4.14**.

Table 4.14: Number of Potential Drinking Water Quality Threats for the Stoney Point WTP

Intake Protection Zone	V Score	Number of Potential DW Threats			
		Significant	Moderate	Low	Total
IPZ-1	9.0	252	956	647	**1855**
IPZ-2	6.3	0	52	1272	**1324**
IPZ-3	6.3	0	52	1272	**1324**
	5.4	0	0	852	**852**
	4.5	0	0	252	**252**

NOTE: Number of potential DW threats are based on vulnerability scores and the MOE's Tables of Drinking Water Threats, and do not necessarily exist in the subject IPZs, but would be deemed as significant, moderate or low threats if they were to exist

The types of activities that may be classified as significant, moderate or low drinking water threats in the IPZ-1, IPZ-2 and IPZ-3 of the Stoney Point WTP are listed in **Table 4.15** and **Tables 4.16a, b, and c**. Activities listed in the tables may be identified as significant, moderate or low drinking water threats depending upon various circumstances such as the quantity and type of chemicals used. The circumstances under which the listed activities would be deemed significant, moderate or low drinking water threats are listed in **Appendix IX (A)**. The MOE's Tables of Drinking Water Threats can be accessed using the following link:

http://www.essexregionsourcewater.org/downloads/download_tables_of_drinking_water_threats.pdf

The Tables of Circumstances can be accessed using the following link: https://www.ontario.ca/environment-and-energy/provincial-tables-circumstances

Table 4.15: Summary of Prescribed Potential Drinking Water Threats Based on V Score of 9.0 for IPZ-1 of the Stoney Point WTP

No.	Prescribed Drinking Water Threat	SIG	MOD	LOW
1	The establishment, operation or maintenance of a system that collects, stores, transmits, treats or disposes of sewage	√	√	√
2	The establishment, operation or maintenance of a waste disposal site within the meaning of Part V of the Environmental Protection Act	√	√	√
3	Application of agricultural source material to land	√	√	
4	Storage of agricultural source material	√	√	√
5	Management of agricultural source material		√	
6	Application of non-agricultural source material to land	√	√	
7	Handling and storage of non-agricultural source material	√	√	√
8	Application of commercial fertilizer	√	√	
9	Handling and storage of commercial fertilizer		√	√
10	Application of pesticide	√	√	
11	Handling and storage of pesticide	√	√	√
12	Application of road salt	√	√	
13	Handling and storage of road salt	√	√	√
14	Storage of snow	√	√	√
15	Handling and storage of fuel		√	√
16	Handling and storage of non-aqueous dense phase liquids		√	
17	Handling and storage of organic solvent		√	√
18	Management of runoff that contains chemicals used in the de-icing of aircraft	√	√	√
19	Use of land as livestock grazing or pasturing land, an outdoor confinement area or a farm-animal yard	√	√	

NOTE: Types of potential DW threats are based on vulnerability scores and the MOE's Tables of Drinking Water Threats, and do not necessarily exist in the subject IPZs, but would be deemed as significant, moderate or low threats if they were to exist

Table 4.16a: Summary of Prescribed Potential Drinking Water Threats Based on V Score of 6.3 for IPZ-2 and IPZ-3a of the Stoney Point WTP

No.	Prescribed Drinking Water Threat	SIG	MOD	LOW
1	The establishment, operation or maintenance of a system that collects, stores, transmits, treats or disposes of sewage		√	√
2	The establishment, operation or maintenance of a waste disposal site within the meaning of Part V of the Environmental Protection Act		√	√
3	Application of agricultural source material to land		√	√
4	Storage of agricultural source material		√	√
5	Management of agricultural source material			√
6	Application of non-agricultural source material to land		√	√
7	Handling and storage of non-agricultural source material		√	√
8	Application of commercial fertilizer			√
9	Handling and storage of commercial fertilizer			√
10	Application of pesticide		√	√
11	Handling and storage of pesticide			√
12	Application of road salt			√
13	Handling and storage of road salt			√
14	Storage of snow			√
15	Handling and storage of fuel			√
16	Handling and storage of non-aqueous dense phase liquids			√
17	Handling and storage of organic solvent			√
18	Management of runoff that contains chemicals used in the de-icing of aircraft			√
19	Use of land as livestock grazing or pasturing land, an outdoor confinement area or a farm-animal yard		√	√

NOTE: Type of potential DW threats are based on vulnerability scores and the MOE's Tables of Drinking Water Threats, and do not necessarily exist in the subject IPZs, but would be deemed as significant, moderate or low threats if they were to exist

Table 4.16b: Summary of Prescribed Potential Drinking Water Threats Based on V Score of 5.4 for IPZ-3b of the Stoney Point WTP

No.	Prescribed Drinking Water Threat	SIG	MOD	LOW
1	The establishment, operation or maintenance of a system that collects, stores, transmits, treats or disposes of sewage		√	√
2	The establishment, operation or maintenance of a waste disposal site within the meaning of Part V of the Environmental Protection Act		√	√
3	Application of agricultural source material to land		√	√
4	Storage of agricultural source material		√	√
5	Management of agricultural source material			√
6	Application of non-agricultural source material to land		√	√
7	Handling and storage of non-agricultural source material		√	√
8	Application of commercial fertilizer			√
9	Handling and storage of commercial fertilizer			√
10	Application of pesticide			√
11	Handling and storage of pesticide			√
12	Application of road salt			√
13	Handling and storage of road salt			√
14	Storage of snow			√
15	Handling and storage of fuel			√
16	Handling and storage of non-aqueous dense phase liquids			√
17	Handling and storage of organic solvent			√
18	Management of runoff that contains chemicals used in the de-icing of aircraft			√
19	Use of land as livestock grazing or pasturing land, an outdoor confinement area or a farm-animal yard		√	√

NOTE: Type of potential DW threats are based on vulnerability scores and the MOE's Tables of Drinking Water Threats, and do not necessarily exist in the subject IPZs, but would be deemed as significant, moderate or low threats if they were to exist

Table 4.16c: Summary of Prescribed Potential Drinking Water Threats Based on V Score of 4.5 for IPZ-3c of the Stoney Point WTP

No.	Prescribed Drinking Water Threat	SIG	MOD	LOW
1	The establishment, operation or maintenance of a system that collects, stores, transmits, treats or disposes of sewage			√
2	The establishment, operation or maintenance of a waste disposal site within the meaning of Part V of the Environmental Protection Act			√
3	Application of agricultural source material to land			√
4	Storage of agricultural source material			√
5	Management of agricultural source material			
6	Application of non-agricultural source material to land			√
7	Handling and storage of non-agricultural source material			√
8	Application of commercial fertilizer			√
9	Handling and storage of commercial fertilizer			√
10	Application of pesticide			√
11	Handling and storage of pesticide			√
12	Application of road salt			√
13	Handling and storage of road salt			√
14	Storage of snow			√
15	Handling and storage of fuel			√
16	Handling and storage of non-aqueous dense phase liquids			√
17	Handling and storage of organic solvent			√
18	Management of runoff that contains chemicals used in the de-icing of aircraft			√
19	Use of land as livestock grazing or pasturing land, an outdoor confinement area or a farm-animal yard			√

NOTE: Type of potential DW threats are based on vulnerability scores and the MOE's Tables of Drinking Water Threats, and do not necessarily exist in the subject IPZs, but would be deemed as significant, moderate or low threats if they were to exist

4.2.2.7.2. Event Based Threats Approach

As per Technical Rule 68 in conjunction with Rule 130, an activity is or would be a significant drinking water threat in a surface water intake protection zone at the location where an activity is or would be engaged in, if modeling demonstrates that a release of a chemical parameter or pathogen from the activity or proposed activity would be transported through the surface water intake protection zone to the intake and result in a deterioration of the water for use as a source of drinking water. The Essex Region SPC has accepted the Ontario Drinking Water Quality Standard (ODWQS) to identify deterioration of raw water quality at the intake.

The modeling that was completed to delineate the IPZ-3 for the Stoney Point WTP is described in Section 4.2.2.4, while the general methodology on the events based approach is described in Section 4.2.1.4.4. Further details are described in the hydrodynamic modeling report from Baird & Associates, as well as the Stantec Consulting Ltd. report (April 2011) addressing IPZ-3 delineation and significant threat identification for this WTP in **Appendix VII.**

The Essex Region SPC has expressed concern with the potential for fuel spills along transportation corridors, as well as the possible presence of fixed fuel tanks, in close proximity to watercourses and drains within the IPZ-2s and IPZ-3s. Consequently, the contaminant modeling undertaken by Baird & Associates involved spills of volume 34,000 L of 2% benzene gasoline at two locations along Ruscom River. The two spill locations were approximately 6,500 m and 30,000 m upstream of the mouth of the river. These locations are shown in **Figure 3.1** of the Stantec Consulting Ltd. Report (April 2011), addressing IPZ-3 delineation and threats analysis for Stoney Point, Lakeshore (Belle River) and A. H. Weeks (Windsor) WTPs, in **Appendix VII** and in **Map 4.12c**. Simulated fuel tanker truck spills were used to represent potential fixed fuel storage locations near watercourses and drains within the local area. This modeling simulation identified that for the storm events modeled at 30,000 m upstream of the mouth of the river, exceedances of 4.6 times the ODWQS for benzene (0.005 mg/L) occurred at the Stoney Point WTP intake. The model determines concentrations in a vertical column of six layers. The concentration in the layer to which the depth of the intake is the closest is considered.

From the results of the modeling and level of exceedance, it is reasonable to assume that a substantially reduced spill volume would also result in an exceedance at the intake. The volume of spill and concentration at the intake are not necessarily proportional but it is reasonable to deduce that a reduction of approximately 50% or more in spill volume would also result in a significant threat. Based upon the modeling completed to date and interpretation of the results it is logical to assume that a spill volume of approximately 15,000 L from existing or planned above ground fixed fuel storage sites as well as transportation of fuel along shipping and ferries corridors be considered as significant threats.

Consequently, existing and future fixed fuel storage sites and transportation of fuel along shipping and ferries corridors of approximately 15,000 L in the IPZ-1, IPZ-2 and IPZ-3, near watercourses and drains in the Ruscom River watersheds as well as watersheds closer to the intake, would be considered to be significant threats as they would inherently deteriorate the quality of source water in the event of a spill. **Table 4.16d** provides a summary of the potential significant threats criteria based on the modeling work as described above for the Stoney Point WTP.

Table 4.16d: Potential Significant Threats Criteria for the Stoney Point WTP for 2% Benzene in Fuel

WTP	IPZ-1, 2, and 3 Storage Volume
Stoney Point	15,000 L

4.2.2.7.3. Local Threats

The transportation of fuel, organic solvents, DNAPLs, pesticides/herbicides and fertilizers was approved by the Director as a local threat in August 2011 (see **Section 4.2.1.4.5** and **Appendix XIII**). The threat level for all identified local threats in IPZs must be assessed using the vulnerability score, for more details see Director's Letter dated August 2011 (**Appendix XIII)**. Table **4.17** shows the classification of these local threats as moderate or low drinking water threats based on the vulnerability score of each IPZ for the Stoney Point WTP. Note that the transportation of fuel (2% benzene) was determined to be a significant threat in the EBA of Stoney Point WTP using the events based approach. No other substances have been modeled at this time.

Table 4.17: Threat level for Local Threats (transportation of various substances) for Stoney Point WTP

IPZ	Vulnerability Score	Significant	Moderate	Low
1	**9**		√	√
2	**6.3**			√
3a	**6.3**			√
3b	**5.4**			√
3c	**4.5**			

4.2.2.7.4. Existing Significant Drinking Water Threats

It is evident from **Table 4.15** that (based on a vulnerability score of 9) it is theoretically possible to have 14 types (out of 19 prescribed DW Quality Threats) of prescribed drinking water threats in the IPZ-1 of the Stoney Point WTP. However, in reality, since the entire IPZ-1 is on the waters of the lake, no significant drinking water threat currently is known to exist within IPZ-1, based on the threats approach. Using the threats approach and vulnerability scores of 6.3, 5.4 or 4.5, it is not possible to have any significant threats in the IPZ-2 or IPZ-3 of the Stoney Point WTP.

For the events based approach, a desktop GIS exercise was performed to identify existing sites with greater than 15,000 L of above ground fuel storage in the EBA for the Stoney

Point WTP using established criteria (fuel with 2% benzene, at volumes of 15,000 L, see **Table 4.16d**). Information from fuel providers in Essex County, Google Street View, and 2013 aerial photography overlaid with the EBA delineation using ESRI ArcGIS 10.2.2 for Desktop, were all used to determine the locations of fuel storage and approximate size of fuel storage tanks. For the Stoney Point WTP this resulted in 32 unconfirmed fuel threats. **Table 4.18** summarizes the existing significant drinking water threats for the EBA of the Stoney Point WTP. Also, **Map 4.12c** shows the area where these existing significant threats are located.

Table 4.18: Number of *Existing Unconfirmed Significant Drinking Water Threats* in the EBA of the Stoney Point WTP

Specific Land Use Activity	Number of Threats	Uncertainty
Above ground fuel storage – parcel based*	**32**	High

***Identified through events based modeling**

4.2.2.8. Drinking Water Issues

As further described in Section 4.2.1.5, a drinking water *issue* is defined as the presence of a parameter, listed in Schedules 1, 2, or 3 of O. Reg 170/03, or Table 4 of the Technical Support Document for the Ontario Drinking Water Quality Standards (ODWQS) Objectives and Guidelines, at a concentration, that may result in the deterioration of the quality of water for use as a source of drinking water. The process of issue evaluation is explained in more detail in the Proposed Issues Evaluation Methodology Report (June 2009) that was adopted by the Essex Region Source Protection Committee (**Appendix VI**).

Initial screening of the raw water quality data for the Stoney Point WTP flagged *E. coli*, total coliform (Schedule 1 Parameter), aluminum, colour, hardness, iron, organic nitrogen and turbidity (Table 4 Parameters).

Further assessment of the raw water data for these flagged parameters identified only aluminum, turbidity and organic nitrogen as drinking water quality issues for the Stoney Point WTP. These identified issues are summarized for the Stoney Point WTP intake in **Table 4.19**. Further details on methodology, variety of data sets used and results of issues

evaluation, can be found in the Technical Memoranda on Issue Evaluation for the Essex Region WTPs, dated January 2010 and December 2010 by Stantec Consulting Ltd (**Appendix X**). Sources contributing to the identified issues are yet to be determined.

Table 4.19: Summary of Issues Identified at the Intake of the Stoney Point WTP

Identified Issues*	Data Source & Duration of Data	Result of Issue Evaluation	Natural or Anthropogenic Source
Aluminum	DWSP (1987-2006)	Approximately 53% of the raw water samples collected over a 10 year period exceeded the 100% OG benchmark for aluminum (0.1 mg/L). A linear increasing trend was also observed in the same dataset.	Possibly from both anthropogenic and natural sources.
Turbidity	DWSP (1987-2006)	Over 87% of the raw water samples collected over a 10 year period exceeded the 100% AO benchmark for turbidity (5 NTU). A linear increasing trend was also observed in the same dataset.	Possibly from both anthropogenic and natural sources.
Organic Nitrogen	DWSP (1987-2006)	Almost 100% of the raw water samples collected over a 10 year period exceeded the 100% OG benchmark (0.15 mg/L). A linear increasing trend was also observed in the same dataset.	Possibly from both anthropogenic and natural sources.

*Identified according to Technical Rule 115.1

Further studies may assist in identifying the sources of the identified issues. These investigations could include extensive sampling and analysis of the parameters of concern (i.e. turbidity, aluminum and organic nitrogen). Studies of the correlation between wind and run-off events and turbidity levels at the intake may also assist in determining the sources of issues. Currently, this information is a gap. Refer to Section 4.3.3 for further information on data gaps related to issues evaluation. If information becomes available to the SPC that indicates the sources of issues to be wholly or partially anthropogenic, then issue contributing areas, and the activities contributing to the issues would be determined in a future assessment report.

4.2.2.9. Conditions

Conditions are areas, result of past activities, where there is existing contamination, for example contaminated soil at an old industrial site that is no longer in use, that may be considered as a drinking water threat. Based on a preliminary investigation by Stantec Consulting (report from December 2010, in **Appendix X**) conducted on available surface water, groundwater, sediment and soil pollution data in the Region, some conditions have been identified in the sediments in the IPZ-2 of the Stoney Point Water Treatment Plant. However there was a lack of data to establish off-site contamination due to the conditions. Also, there were no sampling sites for soil. Based on a hazard score of 6, the conditions resulted in no drinking water threats. The threats due to conditions in the Essex Region SPA may be further assessed as new information is gathered during future updates of the Assessment Report.

4.2.2.10. Percentage of Managed Lands and Livestock Density in IPZs

Please refer to Section 4.1.2.3 (Percentage of Managed Lands and Livestock Density in Vulnerable Areas) for a review of the requirements, definitions and methodology of the percentage of managed lands and livestock density within vulnerable areas.

Maps 4.15 and **4.16** estimate the percent managed land category and the livestock density category in the IPZ-1 and IPZ-2 of the Stoney Point WTP. The Guidelines provided by the MOE are shown in **Table 4.20**. As the IPZ-1 is in water, these calculations are not applicable. For the IPZ-2, the percentage of managed land was > 80% and the livestock density was < 0.5 NU/acre. The hazard score 8.8 multiplied by the vulnerability score of 6.3 resulted in a risk score of 55 which indicates that the managed lands and livestock densities are low threats in the Stoney Point IPZ-2.

Table 4.20: Surface Water Chemical Hazard Scores for Various Combinations of Percentage Managed Lands and Livestock Density

Managed Land Category	Livestock Density Category		
	<0.5 NU/acre	0.5 to 1.0 NU/acre	>1.0 NU/acre
>80%	8.8	9.2	9.2
40% to 80%	7.6	8.4	9.2
<40%	6.8	7.6	8.8

Source: MOE Technical Bulletin, 2009 (p.15)

4.2.2.11. Percentage of Impervious Surface Area in IPZs

Please refer to Section 4.1.2.4 (*Percentage of Impervious Surface Area in Vulnerable Areas: Groundwater Vulnerability Section of the AR*) for a review of the requirements, definitions and methodology of the percentage of impervious surface areas within vulnerable areas. There are four possible categories for the percentage impervious surface area based on the MOE guidelines: <1% impervious; 1% to <8% impervious; 8% to <80% impervious and ≥ 80% impervious.

There are no impervious areas in the IPZ-1, as it is located entirely with-in the water. **Map 4.17** depicts the categories of percent impervious areas in the IPZ-2, and the results are also summarized in **Table 4.95b**, located at the end of Section 4. Based on the vulnerability score, the application of road salt is considered to be a low threat in the IPZ-2.

4.2.3. Lakeshore (Belle River) Water Treatment Plant

This section summarizes the results of technical studies conducted by Stantec Consulting Ltd and Baird & Associates for the Lakeshore (Belle River) Water Treatment Plant (WTP) in the Essex Region Source Protection Area. The complete details of these technical studies can be found in **Appendix VII, VIII, IX** and **X**. Please refer to Section 4.2.1 of this Assessment Report for the details on concepts, methodology and requirements related to intake classification, intake protection zone delineation, vulnerability scoring, drinking water threats assessment and issues evaluation.

4.2.3.1. Intake Classification

The Belle River WTP was decommissioned in January 2009 when the Lakeshore (Belle River) WTP was put into service. The new Lakeshore (Belle River) WTP intake was put into service in May 2009 and is at a farther distance from the shore than the old intake.

The Lakeshore (Belle River) WTP is located on Lakeview Drive in the Town of Lakeshore. It withdraws its source water from Lake St. Clair. The treatment processes at the plant include screening, pre-chlorination, coagulation, flocculation, sedimentation and post chlorination. The plant also processes treated water through the granular activated carbon filtration system. Other details such as intake pipe location, crib depth etc, are summarized in **Table 4.21**. The Service Area for this plant includes approximately 225 km of water distribution pipes of various sizes and serves around 22,000 people (see **Map 1.1**).

Table 4.21: Overview of the Lakeshore (Belle River) Water Treatment Plant

Drinking Water System: Lakeshore (Belle River) Water Treatment Plant	
Operating Authority	The Corporation of the Town of Lakeshore
Location	492 Lakeview Drive, Belle River
System Classification	Type I System (Municipal Residential)
Rated (design) Capacity	36, 360 m^3/day
UTM Coordinates	359316 E 4685259 N
Intake Depth (from water level)	3.1 m (lake bottom); 2.3 m (crib top)
Distance of Intake from Shore	1050 m

Lake St. Clair is considered as an inland lake for the purpose of classification of intake types, and as per Rule 55 (Part VI.I) (*Technical Rules: Assessment Report CWA, 2006*) the intake of the Lakeshore (Belle River) WTP was classified as a Type D intake. The intake protection zones (IPZs) for the Lakeshore (Belle River) WTP were delineated as per the guidelines described in **Table 4.10** (Section 4.2.1.2).

4.2.3.2. Intake Protection Zone -1 (IPZ-1)

As described in Section 4.2.1.2 (**Table 4.10**) the in-water portion of the IPZ-1 for a Type D intake is an area of 1 km radius drawn from the centre point of the intake and if the circle extends onto land, the IPZ-1 includes land up to 120 meters from the high water mark of the water body, or the Regulation Limit, whichever is greater. The major portion of the IPZ-1 for the Lakeshore (Belle River) WTP is within the lake, while a small portion of the Belle River Marina is also included in the IPZ-1 (**Map 4.18a**).

4.2.3.3. Intake Protection Zone -2 (IPZ-2)

The IPZ-2 is a secondary protective zone around the IPZ-1 and is delineated based on the minimum response time required for the plant operator to respond to adverse conditions or a spill and the travel time in the lake and/or tributary. A 2-hour response time was adopted by the ERSPA based on the Draft Guidance Module 4 (MOE, 2006a), Technical Rules and interviews with the plant operators and authorities in the Region. There are two components to the IPZ-2, namely the in-water IPZ-2 and upland IPZ-2, the extent of which are determined based on the 2-hour time of travel considering the estimated flow velocities.

The in-water component of the IPZ-2 for the Lakeshore (Belle River) WTP was delineated by Baird & Associates using hydrodynamic modeling and reverse particle tracking method. Refer to Section 4.2.1 of this Assessment Report and **Appendix VII** for further information relating to the hydrodynamic modeling. The resulting in-water zone extends off the southern shore of Lake St. Clair and includes a zone about 3 km east, 5 km west and 4 km north of the intake as illustrated in **Map 4.18a**.

The upland IPZ-2 includes the following three major components:

1. Tributaries and streams including municipal drains etc.,
2. A 120 m set back or the area of the Regulation Limit, whichever is greater along the abutted land, and
3. Storm sewersheds; and transport pathways (such as tile drain networks and other drainage systems).

The extents of these components are delineated differently, based on the 2-hour time of travel, using different methods as described in Section 4.2.1. The resulting boundary of the IPZ-2 of the Lakeshore (Belle River) WTP with various components is illustrated in **Map 4.18a.** Refer to the Technical Memorandum prepared by Stantec Consulting Ltd. (**Appendix VII**) for further information on variety of data sources and approaches used to determine the up-land extent of the IPZ-2.

4.2.3.4. Intake Protection Zone-3 (IPZ-3)

As per Rule 68 (Part VI.5) (*Technical Rules: Assessment Report CWA, 2006*) IPZ-3 may be delineated for *Type D* intakes if modeling indicates that a contaminant released during an extreme event (100 year storm) may be transported to the intake and be shown to result in deterioration of the water source. The Essex Region SPC has accepted that an exceedance of the ODWQS indicates deterioration. Appropriate guidelines for delineation of IPZ-3 are described in **Table 4.10** (Section 4.2.1.2). Baird & Associates conducted the modeling to determine if an IPZ-3 would be required for the Lakeshore (Belle River) WTP.

The methodology is described in Section 4.2.1.2.3. The modeling incorporated both reverse particle tracking (boundary approach) and contaminant transport modeling to determine the boundaries of the in-water IPZ-3. The model completed 10 runs of differing 100-year return periods determined using a joint probability analysis. The duration of the selected events (wind, flow in St. Clair River, flow in tributaries) used in the joint probability analysis was three days, as it reasonably accounted for the lead up and lag of a storm. Ruscom River and Pike Creek were selected for the simulated tanker truck spill contaminant modeling. Two contaminants were used (gasoline with 2% benzene and sodium chloride) with two spill locations in each tributary, near the headwaters and the mouths. These locations are shown in **Figure 3.1** of the Stantec Consulting Ltd. Report

(April 2011), addressing IPZ-3 delineation and threats analysis for Stoney Point, Lakeshore (Belle River) and A. H. Weeks (Windsor) WTPs, in **Appendix VII** and in **Map 4.18c**.

Based on model results, a fuel spill from a tanker truck approximately 30,000 m upstream of the mouth of Ruscom River would result in an exceedance of the ODWQS benchmark for benzene at the Lakeshore (Belle River) WTP. The modeling also indicated that a fuel spill approximately 17,000 m upstream of the mouth of Pike Creek would result in an exceedance of the ODWQS benchmark at the intake.

Baird & Associates recommended that the IPZ-3 delineation be extended, as described in Section 4.2.1.2.3 (IPZ-3 delineation methodology). They recommended that the delineation be extended to the watershed limits of the modeled watercourse, thereby including the headwaters of these watercourses and their tributaries. Baird & Associates also recommended that the delineation be extended to the tributaries between the watercourses modeled and the WTP intake (i.e. closer to the intake). Based on these recommendations, the IPZ-3 for the Lakeshore (Belle River) intake was extended to include the headwaters of Ruscom River and Pike Creek, and tributaries of both. Also, all tributaries located between these two watercourses and the intake, were included. This includes Belle River, Puce River, Duck Creek, and other smaller tributaries.

An off-bank setback of 120 m was applied to all watercourses; however this setback was truncated at subwatersheds as overland flow would be traveling away from the watercourse. As specified in the Technical Rules, the Floodplain Regulation Limit was also used in delineating the extent of the IPZ-3 along subject waterways, where this Limit exceeds the 120 m setback. The hydrodynamic modeling report from Baird & Associates, as well as the Stantec Consulting Ltd. report (April 2011) addressing IPZ-3 delineation for Lakeshore (Belle River) WTP is in **Appendix VII**. Refer to **Map 4.18b** for the IPZ-3 delineation.

4.2.3.5. Event Based Area

The Event Based Area for Lakeshore (Belle River) WTP is the combination of all on land portions and in water portions of IPZ-1, IPZ-2 and IPZ-3 (see **section 4.2.1.2.4**). Refer to **Map 4.18c** for the Event Based Area to which the significant drinking water threat policies

for the handling and storage of fuel and transportation of fuel along shipping and ferries corridors apply.

4.2.3.6. Vulnerability Scoring of IPZs

The vulnerability score (V) is a numerical expression of the susceptibility of the intake to contamination. Details on the methodology of vulnerability scoring, and the data sources used in assigning vulnerability scores for the IPZs can be found in Section 4.2.1.3 and the reports prepared by Stantec Consulting Ltd. dated January 2010, and April 2011 (**Appendix VII**).

The area vulnerability factor (B) is assigned a value of 10 for the IPZ-1 of the Lakeshore (Belle River) WTP, which is a set value for IPZ-1s of all types of intakes. The IPZ-2 is assigned a B score of 7. The IPZ-3 was divided into three proximity zones (a, b, c) and assigned B scores of 7, 6, and 5 respectively. The source vulnerability factor (C) for Lakeshore (Belle River) WTP was determined to be 0.9 based on the characteristics of the intake. Based on these scores, the overall vulnerability scores for the IPZ-1, IPZ-2 and IPZ-3a, b, and c for the Lakeshore (Belle River) WTP were calculated as 9.0, 6.3, 6.3, 5.4 and 4.5 respectively (**Table 4.22**). The vulnerability scores are also shown in **Maps 4.19a** and **4.19b**.

Table 4.22: Vulnerability Scores Assigned to IPZ-1, IPZ-2 and IPZ-3 of Lakeshore (Belle River) WTP

Intake Type	Area Vulnerability Factor (B)					Source Vulnerability Factor (C)	Vulnerability Score (V=BxC)				
	IPZ-1	IPZ-2	IPZ-3				IPZ-1	IPZ-2	IPZ-3		
			a	b	c				a	b	c
Type D	10	7	7	6	5	0.9	9	6.3	6.3	5.4	4.5

These V scores were finally used in combination with the MOE's Table of Drinking Water Threats to determine the number and types of potential drinking water threats in the respective intake protection zones that are discussed in the following section.

4.2.3.7. Drinking Water Threats

A drinking water threat is defined, according to the MOE, as a chemical or pathogen that poses a potential risk to the drinking water source. Please refer to Section 4.2.1.4 for the list of 21 types of activities that are considered as drinking water threats prescribed by the MOE. These activities may be deemed as significant, moderate, or low drinking water threats in the vulnerable areas through four different approaches as described in Section 4.2.1.4. The following section describes the results of threats assessment obtained through the "threats approach" and the "events based approach."

4.2.3.7.1. Threats Based Approach

The threats approach is based on the quantitative risk score estimation for an activity that is or would be a drinking water threat in a specific vulnerable area. Refer to Section 4.2.1.4 for further details on methodology of the Threats approach. Based on the vulnerability scores that were assigned to IPZ-1, IPZ-2 and IPZ-3, and the MOE's Tables of Drinking Water Threats, the lists of potential drinking water quality threats (significant, moderate and low) were generated for the Lakeshore (Belle River) WTP. The threats approach study including lists of potential treats based on zone and vulnerability score is provided in **Appendix VIII**.

Table 4.23 summarizes the number of possible drinking water quality threats (chemical and pathogen) that would be deemed as significant, moderate or low if they were to exist in the IPZ-1, IPZ-2 and IPZ-3 of the Lakeshore (Belle River) WTP. These threats were further classified into chemical and pathogen types and are illustrated in **Map 4.20**.

Table 4.23: Number of Potential Drinking Water Quality Threats for the Lakeshore (Belle River) WTP

Intake Protection Zone	V Score	Number of Potential DW Threats			
		Significant	Moderate	Low	Total
IPZ-1	9.0	252	956	647	**1855**
IPZ-2	6.3	0	52	1272	**1324**
IPZ-3	6.3	0	52	1272	**1324**
	5.4	0	0	852	**852**
	4.5	0	0	252	**252**

NOTE: Number of potential DW threats are based on vulnerability scores and the MOE's Tables of Drinking Water Threats, and do not necessarily exist in the subject IPZs, but would be deemed as significant, moderate or low threats if they were to exist

The types of activities that may be classified as significant, moderate or low drinking water threats in the IPZ-1, IPZ-2 and IPZ-3 of the Lakeshore (Belle River) WTP are listed in **Table 4.24** and **Tables 4.25a, b and c**. Activities listed in the tables may be identified as moderate or low drinking water threats depending upon various circumstances such as the quantity and type of chemicals used. The circumstances under which the listed activities would be deemed significant, moderate or low drinking water threats for both IPZ-1 and IPZ-2 are listed in **Appendix IX (B)**. The MOE Tables of Drinking Water Threats can be accessed using the following link:

http://www.essexregionsourcewater.org/downloads/download_tables_of_drinking_water_threats.pdf

The Tables of Circumstances can be accessed using the following link:

https://www.ontario.ca/environment-and-energy/provincial-tables-circumstances

Table 4.24: Summary of Prescribed Potential Drinking Water Threats Based on V Score of 9.0 for IPZ-1 of the Lakeshore (Belle River) WTP

No.	Prescribed Drinking Water Threat	SIG	MOD	LOW
1	The establishment, operation or maintenance of a system that collects, stores, transmits, treats or disposes of sewage	√	√	√
2	The establishment, operation or maintenance of a waste disposal site within the meaning of Part V of the Environmental Protection Act	√	√	√
3	Application of agricultural source material to land	√	√	
4	Storage of agricultural source material	√	√	√
5	Management of agricultural source material		√	
6	Application of non-agricultural source material to land	√	√	
7	Handling and storage of non-agricultural source material	√	√	√
8	Application of commercial fertilizer	√	√	
9	Handling and storage of commercial fertilizer		√	√
10	Application of pesticide	√	√	
11	Handling and storage of pesticide	√	√	√
12	Application of road salt	√	√	
13	Handling and storage of road salt	√	√	√
14	Storage of snow	√	√	√
15	Handling and storage of fuel		√	√
16	Handling and storage of non-aqueous dense phase liquids		√	
17	Handling and storage of organic solvent		√	√
18	Management of runoff that contains chemicals used in the de-icing of aircraft	√	√	√
19	Use of land as livestock grazing or pasturing land, an outdoor confinement area or a farm-animal yard	√	√	

NOTE: Types of potential DW threats are based on vulnerability scores and the MOE's Tables of Drinking Water Threats, and do not necessarily exist in the subject IPZs, but would be deemed as significant, moderate or low threats if they were to exist

Table 4.25a: Summary of Prescribed Potential Drinking Water Threats Based on V Score of 6.3 for IPZ-2 and IPZ-3a of the Lakeshore (Belle River) WTP

No.	Prescribed Drinking Water Threat	SIG	MOD	LOW
1	The establishment, operation or maintenance of a system that collects, stores, transmits, treats or disposes of sewage		√	√
2	The establishment, operation or maintenance of a waste disposal site within the meaning of Part V of the Environmental Protection Act		√	√
3	Application of agricultural source material to land		√	√
4	Storage of agricultural source material		√	√
5	Management of agricultural source material			√
6	Application of non-agricultural source material to land		√	√
7	Handling and storage of non-agricultural source material		√	√
8	Application of commercial fertilizer			√
9	Handling and storage of commercial fertilizer			√
10	Application of pesticide		√	√
11	Handling and storage of pesticide			√
12	Application of road salt			√
13	Handling and storage of road salt			√
14	Storage of snow			√
15	Handling and storage of fuel			√
16	Handling and storage of non-aqueous dense phase liquids			√
17	Handling and storage of organic solvent			√
18	Management of runoff that contains chemicals used in the de-icing of aircraft			√
19	Use of land as livestock grazing or pasturing land, an outdoor confinement area or a farm-animal yard		√	√

NOTE: Type of potential DW threats are based on vulnerability scores and the MOE's Tables of Drinking Water Threats, and do not necessarily exist in the subject IPZs, but would be deemed as significant, moderate or low threats if they were to exist

Table 4.25b: Summary of Prescribed Potential Drinking Water Threats Based on V Score of 5.4 for IPZ-3b of the Lakeshore (Belle River) WTP

No.	Prescribed Drinking Water Threat	SIG	MOD	LOW
1	The establishment, operation or maintenance of a system that collects, stores, transmits, treats or disposes of sewage		√	√
2	The establishment, operation or maintenance of a waste disposal site within the meaning of Part V of the Environmental Protection Act		√	√
3	Application of agricultural source material to land		√	√
4	Storage of agricultural source material		√	√
5	Management of agricultural source material			√
6	Application of non-agricultural source material to land		√	√
7	Handling and storage of non-agricultural source material		√	√
8	Application of commercial fertilizer			√
9	Handling and storage of commercial fertilizer			√
10	Application of pesticide			√
11	Handling and storage of pesticide			√
12	Application of road salt			√
13	Handling and storage of road salt			√
14	Storage of snow			√
15	Handling and storage of fuel			√
16	Handling and storage of non-aqueous dense phase liquids			√
17	Handling and storage of organic solvent			√
18	Management of runoff that contains chemicals used in the de-icing of aircraft			√
19	Use of land as livestock grazing or pasturing land, an outdoor confinement area or a farm-animal yard		√	√

NOTE: Type of potential DW threats are based on vulnerability scores and the MOE's Tables of Drinking Water Threats, and do not necessarily exist in the subject IPZs, but would be deemed as significant, moderate or low threats if they were to exist

Table 4.25c: Summary of Prescribed Potential Drinking Water Threats Based on V Score of 4.5 for IPZ-3c of the Lakeshore (Belle River) WTP

No.	Prescribed Drinking Water Threat	SIG	MOD	LOW
1	The establishment, operation or maintenance of a system that collects, stores, transmits, treats or disposes of sewage			√
2	The establishment, operation or maintenance of a waste disposal site within the meaning of Part V of the Environmental Protection Act			√
3	Application of agricultural source material to land			√
4	Storage of agricultural source material			√
5	Management of agricultural source material			
6	Application of non-agricultural source material to land			√
7	Handling and storage of non-agricultural source material			√
8	Application of commercial fertilizer			√
9	Handling and storage of commercial fertilizer			√
10	Application of pesticide			√
11	Handling and storage of pesticide			√
12	Application of road salt			√
13	Handling and storage of road salt			√
14	Storage of snow			√
15	Handling and storage of fuel			√
16	Handling and storage of non-aqueous dense phase liquids			√
17	Handling and storage of organic solvent			√
18	Management of runoff that contains chemicals used in the de-icing of aircraft			√
19	Use of land as livestock grazing or pasturing land, an outdoor confinement area or a farm-animal yard			√

NOTE: Type of potential DW threats are based on vulnerability scores and the MOE's Tables of Drinking Water Threats, and do not necessarily exist in the subject IPZs, but would be deemed as significant, moderate or low threats if they were to exist

4.2.3.7.2. Event Based Threats Approach

As per Technical Rule 68 in conjunction with Rule 130, an activity is or would be a significant drinking water threat in a surface water intake protection zone at the location where an activity is or would be engaged in, if modeling demonstrates that a release of a chemical parameter or pathogen from the activity or proposed activity would be transported through the surface water intake protection zone to the intake and result in a deterioration of the water for use as a source of drinking water. The Essex Region SPC has accepted the Ontario Drinking Water Quality Standard (ODWQS) to identify deterioration of raw water quality at the intake.

The modeling that was completed to delineate the IPZ-3 for the Lakeshore (Belle River) WTP is described in Section 4.2.3.4, while the general methodology on the events based approach is described in Section 4.2.1.4.4. Further details are described in the hydrodynamic modeling report from Baird & Associates, as well as the Stantec Consulting Ltd. report (April 2011) addressing IPZ-3 delineation and significant threat identification for this WTP in **Appendix VII.**

The Essex Region SPC has expressed concern with the potential for fuel spills along transportation corridors, as well as the possible presence of fixed fuel tanks, in close proximity to watercourses and drains within the IPZ-2s and IPZ-3s. Consequently, the contaminant modeling undertaken by Baird & Associates involved two locations simulating a tanker truck spill of 34,000 L of 2% benzene gasoline on both Ruscom River and Pike Creek, which is also considered representative of potential fixed fuel storage locations. These locations are shown in **Figure 3.1** of the Stantec Consulting Ltd. Report (April 2011), addressing IPZ-3 delineation and threats analysis for Stoney Point, Lakeshore (Belle River) and A. H. Weeks (Windsor) WTPs, in **Appendix VII** and in **Map 4.18c**. Simulated fuel tanker truck spills were used to represent potential fixed fuel storage locations near watercourses and drains within the local area. The modeling simulations identified that a spill location approximately 30,000 m upstream of the mouth of Ruscom River and a fuel spill location approximately 17,000 m upstream of the mouth of Pike Creek resulted in an exceedance of the ODWQS for benzene (by 12.6 times and 4.4 times respectively) at the Lakeshore (Belle River) WTP intake. The model determines

concentrations in a vertical column of six layers. The concentration in the layer to which the depth of the intake is the closest is considered.

From the results of the modeling and level of exceedance, it is reasonable to assume that a substantially reduced spill volume would also result in an exceedance at the intake. The volume of spill and concentration at the intake are not necessarily proportional but it is reasonable to deduce that a reduction of approximately 50% or more in spill volume would also result in a significant threat. Based upon the modeling completed to date and interpretation of the results it is logical to assume that a spill volume of approximately 15,000 L from existing or planned above ground fixed fuel storage sites as well as transportation of fuel along shipping and ferries corridors be considered as significant threats.

Consequently, existing and future fixed fuel storage sites and transportation of fuel along shipping and ferries corridors of approximately 15,000 L in the IPZ-1, IPZ-2 and IPZ-3, near watercourses and drains in the Pike Creek and Ruscom River watersheds as well as watersheds closer to the intake, would be considered to be significant threats as they would inherently deteriorate the quality of source water in the event of a spill. **Table 4.25d** provides a summary of the potential significant threats criteria based on the modeling work as described above for the Lakeshore (Belle River) WTP.

Table 4.25d: Potential Significant Threats Criteria for the Lakeshore (Belle River) WTP for 2% Benzene in Fuel

WTP	IPZ-1, 2, and 3 Storage Volume
Lakeshore (Belle River)	15,000 L

4.2.3.7.3. Local Threats

The transportation of fuel, organic solvents, DNAPLs, pesticides/herbicides and fertilizers was approved by the Director as a local threat in August 2011 (see **Section 4.2.1.4.5** and **Appendix XIII**). The threat level for all identified local threats in IPZs must be assessed using the vulnerability score, for more details see Director's Letter dated August 2011 (**Appendix XIII)**. Table **4.25e** shows the classification of these local threats as moderate or low drinking water threats based on the vulnerability score of each IPZ for the Belle River (Lakeshore) WTP. Note that the transportation of fuel (2% benzene) was determined to be a significant threat in the EBA of Belle River (Lakeshore) WTP using the events based approach. No other substances have been modeled at this time.

Table 4.25e: Threat level for Local Threats (transportation of various substances) for Lakeshore (Belle River) WTP

IPZ	Vulnerability Score	Significant	Moderate	Low
1	**9**		√	√
2	**6.3**			√
3a	**6.3**			√
3b	**5.4**			√
3c	**4.5**			

4.2.3.7.4. Existing Significant Drinking Water Threats

It is evident from **Table 4.24** that (based on a vulnerability score of 9) it is theoretically possible to have 14 types (out of 19 prescribed DW Quality Threats) prescribed drinking water threats in the IPZ-1 of the Lakeshore (Belle River) WTP. However, in reality, since the IPZ-1 is almost entirely on the water of Lake St. Clair, no significant drinking water threat currently is known to exist within IPZ-1, based on the threats approach. Using the threats approach and vulnerability scores of 6.3, 5.4 and 4.5 it is not possible to have any significant threats in the IPZ-2 or IPZ-3.

For the events based approach, a desktop GIS exercise was performed to identify existing sites with greater than 15,000 L of above ground fuel storage in the EBA for the Lakeshore (Belle River) WTP using established criteria (fuel with 2% benzene, at volumes of 15,000 L, see **Table 4.25d**). Information from fuel providers in Essex County, Google Street View, and 2013 aerial photography overlaid with the EBA delineation using ESRI ArcGIS 10.2.2 for Desktop, were all used to determine the locations of fuel storage and approximate size of fuel storage tanks. For the Lakeshore (Belle River) WTP this resulted in 61 unconfirmed fuel threats. **Table 4.25f** summarizes the existing significant drinking water threats for the EBA of the Lakeshore (Belle River) WTP. Also, **Map 4.18c** shows the area where these existing significant threats are located.

Table 4.25f: Number of *Existing Unconfirmed Significant Drinking Water Threats* in the EBA of the Lakeshore (Belle River) WTP

Specific Land Use Activity	Number of Threats	Uncertainty
Above ground fuel storage *	**61**	High

***Identified through events based modeling**

4.2.3.8. Drinking Water Issues

As further described in Section 4.2.1.5, a drinking water *issue* is defined as the presence of a parameter, listed in Schedules 1, 2, or 3 of O. Reg 170/03, or Table 4 of the Technical Support Document for the Ontario Drinking Water Quality Standards (ODWQS) Objectives and Guidelines, at a concentration, that may result in the deterioration of the quality of water for use as a source of drinking water. The process of issue evaluation is explained in more detail in the Proposed Issues Evaluation Methodology Report (June 2009) that was adopted by the Essex Region Source Protection Committee (**Appendix VI**).

Initial screening of the raw water quality data for the old Belle River WTP intake flagged *E. coli*, total coliform (Schedule 1 Parameter), aluminum, colour, hardness, iron, organic nitrogen and turbidity (Table 4 Parameters). Further assessment of the raw water data for these flagged parameters identified only aluminum, turbidity, organic nitrogen and iron as drinking water quality issues for the old Belle River WTP intake. However, as described earlier, the old Belle River WTP was decommissioned in January 2009 when the Lakeshore

(Belle River) WTP was put into service. The new Lakeshore (Belle River) WTP intake was put into service in May 2009 and is further offshore than the old intake. The new intake's raw water quality data was also reviewed to identify issues, as per an updated issues report by Stantec Consulting, December 2010, added to **Appendix X**. Aluminum, organic nitrogen and turbidity were identified as issues. Although iron was identified as an issue at the old intake, iron levels are reduced at the new Lakeshore (Belle River) WTP intake and are not identified as an issue.

These identified issues are summarized for the Lakeshore (Belle River) WTP intake in **Table 4.26**. Information on the old Belle River intake (not in service) is also provided. Further details on methodology, variety of data sets used and results of issues evaluation, can be found in the January 2010 and December 2010 Stantec Consulting Ltd Technical Memoranda on Issue Evaluation for the Essex Region Water Treatment Plants (**Appendix X**). Sources contributing to these issues are yet to be determined.

Table 4.26: Summary of Issues Identified at the Intake of the Lakeshore (Belle River) WTP

Identified Issues*	Data Source & Duration of Data	Result of Issue Evaluation	Natural or Anthropogenic Source
Aluminum	DWSP (Lakeshore intake: 2009-2010; Belle River intake: 1987-2006)	At the Lakeshore intake, three of four raw water samples collected (75%) exceeded the 100% OG benchmark for aluminum (0.1 mg/L). At the old Belle River intake (now not in service), approximately 85% of the raw water samples collected over a 10 year period exceeded the 100% OG benchmark for aluminum (0.1 mg/L). A linear increasing trend was also observed in the same dataset.	Possibly from both anthropogenic and natural sources.
Turbidity	DWSP (Lakeshore intake: 2009-2010; Belle River intake: 1987-2006)	At the Lakeshore intake, three of four raw water samples collected (75%) exceeded the 100% AO benchmark for turbidity (5 NTU). At the old Belle River intake (now not in service), over 98% of the raw water samples collected over a 10 year period exceeded the 100% AO benchmark for turbidity (5 NTU). A linear increasing trend was also observed in the same dataset.	Possibly from both anthropogenic and natural sources.
Organic Nitrogen	DWSP (Lakeshore intake: 2009-2010; Belle River intake: 1987-2006)	At the Lakeshore intake, three of four raw water samples collected (75%) exceeded the 100% OG benchmark of 0.15 mg/L. At the old Belle River intake (now not in service), 100% of the raw water samples collected over a 10 year period exceeded the 100% OG benchmark (0.15 mg/L). A linear increasing trend was also observed in the same dataset.	Possibly from both anthropogenic and natural sources.

*Identified according to Technical Rule 115.1

Further studies may assist in identifying the sources of the identified issues. These investigations could include extensive sampling and analysis of the parameters of concern (i.e. turbidity, aluminum and organic nitrogen). Studies of the correlation between wind and run-off events and turbidity levels at the intake may also assist in determining the sources of issues. Currently, this information is a gap. Refer to Section 4.3.3 for further information on data gaps related to issues evaluation. If information becomes available to the SPC that indicates the sources of issues to be wholly or partially anthropogenic, then issue contributing areas, and the activities contributing to the issues would be determined in a future assessment report.

4.2.3.9. Conditions

Conditions are areas, result of past activities, where there is an existing contamination, for example contaminated soil at an old industrial site that is no longer in use, that may be considered as a drinking water threat. Based on a preliminary investigation by Stantec Consulting (report from December 2010, in **Appendix X**) conducted on available surface water, groundwater, sediment and soil pollution data in the Region, some conditions have been identified in the sediments in the IPZ-1 and IPZ-2 of the Lakeshore (Belle River) Water Treatment Plant. However there was a lack of data to establish off-site contamination due to the conditions. Also, there were no sampling sites for soil. Based on a hazard score of 6, the conditions resulted in low drinking water threats in the IPZ-1, and no drinking water threats in IPZ-2. The threats due to conditions in the Essex Region SPA may be further assessed as new information is gathered during future updates of the Assessment Report.

4.2.3.10. Percentage of Managed Lands and Livestock Density in IPZs

Please refer to Section 4.1.2.3 (Percentage of Managed Lands and Livestock Density in Vulnerable Areas) for a review of the requirements, definitions and methodology of the percentage of managed lands and livestock density within vulnerable areas.

Maps 4.21 and **4.22** show the percent managed land and the livestock density category in the IPZ of the Lakeshore (Belle River) WTP. The MOE Guidelines are shown in **Table 4.20**. In the IPZ-1, the percentage of managed land was found to be <40% and the

livestock density was < 0.5 NU/acre. The accompanying Chemical Hazard Score of 6.8 was multiplied by the Vulnerability Score of 9.0 resulting in a moderate risk score of 61 (there are currently no agricultural activities in this zone). In the IPZ-2, the percentage of managed land was 40 – 80% and the livestock density was < 0.5 NU/acre. The Chemical Hazard Score of 7.6 was multiplied by the Vulnerability Score of 6.3 resulting in a low risk score of 48.

4.2.3.11. Percentage of Impervious Surfaces in IPZs

Please refer to Section 4.1.2.4 (Percentage of Impervious Surface Area in Vulnerable Areas: Groundwater Vulnerability Section of the AR) for a review of the requirements, definitions and methodology of the percentage of impervious surface areas within vulnerable areas. There are four possible categories for the percentage impervious surface area based on the MOE guidelines: < 1% impervious; 1% to <8% impervious; 8% to <80% impervious and ≥ 80% impervious.

Map 4.23 shows the categories of percent impervious surface areas in the IPZ-1 and IPZ-2 of the Lakeshore (Belle River) WTP. The results are also summarized in **Table 4.95b** located at the end of Section 4. Based on the respective vulnerability scores and the percent impervious surface area, the road salt application land use is considered as a moderate and a low threat in the IPZ-1 and IPZ-2 of the Lakeshore (Belle River) WTP, respectively.

4.2.4. A. H. Weeks (Windsor) Water Treatment Plant

This section summarizes the results of technical studies conducted by Stantec Consulting Ltd and Baird & Associates for the A. H. Weeks (Windsor) Water Treatment Plant (WTP) in the Essex Region Source Protection Area. The complete details of these technical studies can be found in **Appendix VII, VIII, IX** and **X**. Please refer to Section 4.2.1 of this Assessment Report for the details on concepts, methodology and requirements related to intake classification, intake protection zone delineation, vulnerability scoring, drinking water threats assessment and issues evaluation.

4.2.4.1. Intake Classification

The A. H. Weeks (Windsor) WTP is located at 3665 Wyandotte Street East in the City of Windsor. It withdraws its source water from the Detroit River. The Plant has two raw water intakes namely, the East intake and the West intake. The treatment processes at the plant include screening, pre-chlorination, coagulation, flocculation, sedimentation and post chlorination. The plant also includes processes like pH adjustment with CO_2, primary disinfection using ozone, dual media filtration and fluoridation system. Other details such as intake pipe diameter, crib depth etc, are summarized in **Table 4.27**. The plant serves approximately 267,000 people in the City of Windsor and several neighboring municipalities (see **Map 1.1**).

Table 4.27: Overview of the A. H. Weeks (Windsor) Water Treatment Plant

Drinking Water System: A. H. Weeks (Windsor) Water Treatment Plant	
Operating Authority	Windsor Utilities Commission
Location	3665 Wyandotte Street E, Windsor
System Classification	Type I System (Municipal Residential)
Rated (design) Capacity	349,000 m^3/day
UTM Coordinates	335566 E 4688155 N
Intake Depth	East intake: 7.0 m (crib top) West intake: 7.4 m (crib top)
Distance of Intake from Shore	East intake: 95 m West intake: 70 m
Classification of Intakes	Type B

For the purpose of this study the intakes of the A. H. Weeks (Windsor) WTP are classified as Type B intakes (Great Lakes Connecting Channels) and intake protection zones for these intakes were delineated as per the guidelines described in **Table 4.10** (Section 4.2.1.2).

4.2.4.2. Intake Protection Zone -1 (IPZ-1)

As described in Section 4.2.1.2 (**Table 4.10**) the in-water portion of the IPZ-1 for Type B intakes is a semicircle area of 1 km radius extending upstream drawn from the centre point of the intake and with a setback distance of 100 m extending downstream of the intake. The east and west intake IPZ-1s for the A.H. Weeks (Windsor) WTP were delineated using a semicircle that has a radius of 1km extending upstream with the 100 m downstream extent as shown in **Maps 4.24a** and **4.25a,** respectively. As per the MOE's Technical Rules, the IPZ-1s were extended 120 m upland where the zones abutted land. Details are found in the Reports by Stantec Consulting Ltd dated January 2011 and Baird & Associates (**Appendix VII**).

4.2.4.3. Intake Protection Zone -2 (IPZ-2)

The IPZ-2 is a secondary protective zone around the IPZ-1 and is delineated based on the minimum response time required for the plant operator to respond to adverse conditions or a spill and the travel time in the lake and/or tributary. A 2-hour response time was adopted by the ERSPA based on the Draft Guidance Module 4 (MOE, 2006a), Technical Rules as well as interviews with the plant operators and authorities in the Region. There are two components to the IPZ-2, namely the in-water IPZ-2 and upland IPZ-2, the extent of which are determined based on the 2-hour time of travel considering the estimated flow velocities.

The in-water component of the IPZ-2s for the intakes of the A.H. Weeks (Windsor) WTP were delineated using hydrodynamic modeling and a reverse particle tracking method. Refer to Section 4.2.1 of this Assessment Report and **Appendix VII** for further information relating to the hydrodynamic modeling. The resulting in-water zones for the East and West intakes are illustrated in **Maps 4.24a** and **4.25a,** respectively. There is little difference between the IPZ-2s, due to the close proximity of the intakes. The modeled in-water IPZ-2s included areas within the United States. These areas, as well as the portions of the IPZs which extend into the United States are considered when determining the vulnerability

score; however the delineation is visually truncated at the international boundary for the purpose of the Assessment Report, as required by MOE (see Section 4.2.1). The modeled IPZ-2s include areas downstream of the intakes due to the phenomenon of reverse flow in the Detroit River. The limit of the in-water IPZ-2 downstream of the intakes is based on the modeling of the extent of the 2 hour time of travel for reverse flow, as further detailed in the Report by Baird & Associates dated November 2010, which is part of **Appendix VII.**

The upland component of the IPZ-2 includes the following three major components:

1. Tributaries and streams including municipal drains etc.,
2. A 120 m set back or the area of the Regulation Limit, whichever is greater along the abutted land, and
3. Storm sewersheds; and Transport pathways (such as tile drain networks and other drainage systems).

The extents of these components are delineated differently, based on the 2-hour time of travel, using different methods as described in Section 4.2.1 of this Assessment Report. The resulting boundary of the IPZ-2s of the East and West intake are illustrated in **Maps 4.24a and 4.25a,** respectively. Refer to the Technical Memorandum prepared by Stantec Consulting Ltd dated January 2011 (**Appendix VII**) for further information on variety of data sources and approaches used to determine the up-land extent of the IPZ-2.

4.2.4.4. Intake Protection Zone-3 (IPZ-3)

As per Rule 68 an IPZ-3 may be delineated if modeling demonstrates that a release of a chemical parameter or pathogen from an activity or a proposed activity during an extreme event would be transported to the intake and result in the deterioration of the water for use as a source of drinking water. The Essex Region SPC has accepted the ODWQS to identify deterioration of raw water quality at the intake.

Appropriate guidelines for delineation of IPZ-3 are described in **Table 4.10** and Section 4.2.1.2.3. Baird & Associates conducted hydrodynamic modeling to determine whether an IPZ-3 would be required for the A.H. Weeks (Windsor) WTP. The methodology is described in Section 4.2.1.2.3. The modeling incorporated both reverse particle tracking (boundary approach) and contaminant transport modeling to determine the boundaries of

the in-water IPZ-3. The model completed 10 runs of differing 100-year return periods determined using a joint probability analysis. The duration of the selected events (wind, flow in St. Clair River, flow in tributaries) used in the joint probability analysis was three days, as it reasonably accounted for the lead up and lag of a storm. The modeling work was completed in two phases.

The first phase involved simulating a fuel tanker truck spill (gasoline with 2% benzene and sodium chloride) approximately 17,000 m upstream of the mouth of Pike Creek. These locations are shown in **Figure 3.1** of the Stantec Consulting Ltd. report (April 2011), addressing IPZ-3 delineation and threats analysis for Stoney Point, Lakeshore (Belle River) and A. H. Weeks (Windsor) WTPs, in **Appendix VII** and in **Maps 4.24c** and **4.25c** for the East and West intakes, respectively. Based on model results, the fuel tanker spill would result in an exceedance of the ODWQS benchmark for benzene at the A.H. Weeks (Windsor) WTP.

Baird & Associates recommended that the IPZ-3 delineation be extended, as described in Section 4.2.1.2.3 (IPZ-3 delineation methodology). They recommended that the delineation be extended to the watershed limits of the modeled watercourse, thereby including the headwaters of these watercourses and their tributaries. Baird & Associates also recommended that the delineation be extended to the tributaries between the watercourses modeled and the WTP intake (i.e. closer to the intake). Based on these recommendations, the IPZ-3s for the A. H. Weeks (Windsor) intakes were extended to include the headwaters of Pike Creek, and its tributaries. Also, all tributaries located between this watercourse and the intake, were included. This includes Little River and other smaller tributaries.

The second phase of work involved simulating a fuel spill from an industrial site located downstream of the intakes within the IPZ-2. The modeling simulation resulted in an exceedance of the ODWQS benchmark at the A.H. Weeks (Windsor) WTP intakes and the contaminant travel pathway was entirely within the IPZ-2 area. The IPZ-3 delineation work was based upon a combination of both phases of work yet Technical Rule 75 restricts the area of an IPZ-3 such that it may not include areas that lie within IPZ-1 or IPZ-2. Therefore

the final IPZ-3 delineation is technically composed of the results of the first phase of modeling.

An off-bank setback of 120 m was applied to all watercourses; however this setback was truncated at subwatersheds as overland flow would be traveling away from the watercourse. As specified in the Technical Rules, the Floodplain Regulation Limit was also used in delineating the extent of the IPZ-3 along subject waterways, where this Limit exceeds the 120 m setback. The hydrodynamic modeling report from Baird & Associates, as well as the Stantec Consulting Ltd. report (April 2011) addressing IPZ-3 delineation for the A.H. Weeks (Windsor) WTP is in **Appendix VII**. Refer to **Map 4.24b** for the IPZ-3 (east intake) delineation, and **Map 4.25b** for the IPZ-3 (west intake) delineation.

4.2.4.5. Event Based Area

The Event Based Area for A.H. Weeks (Windsor) WTP is the combination of all on land portions and in water portions of IPZ-1, IPZ-2 and IPZ-3 (see **section 4.2.1.2.4**). Refer to **Map 4.24c and Map 4.25c** for the Event Based Area to which the significant drinking water threat policies for the handling and storage of fuel and transportation of fuel along shipping and ferries corridors apply.

4.2.4.6. Vulnerability Scoring of IPZs

The vulnerability score (V) is a numerical expression of the susceptibility of the intake to contamination. Details on the methodology of vulnerability scoring, variety of data sources used in assigning vulnerability scores for the IPZs can be found in Section 4.2.1.3 and the Technical Memorandum prepared by Stantec Consulting Ltd (**Appendix VII**).

The area vulnerability factor (B) is assigned a value of 10 for the IPZ-1 of the A.H. Weeks (Windsor) WTP, which is a set value for IPZ-1s of all types of intakes.

The area vulnerability factor (B) for IPZ-2 is calculated based on a variety of characteristics considered through an area vulnerability decision matrix provided in the above mentioned technical memorandum, and described in detail in Section 4.2.1.3 of this assessment report. The east intake IPZ-2 has 58% land cover, while the west intake has 57% land cover. Both are comprised of mainly developed lands, clayey soil, lower permeability (less than 33%), little slope (less than 2%), and storm catchment area of more than 66%. Considering these

characteristics through the decision matrix, the B scores of the IPZ-2s of both the east and west intakes are calculated to be 9.

A source vulnerability factor (C) of 0.9 was assigned to both the intakes of the A.H. Weeks (Windsor) WTP based on intake characteristics. Based on the area and source vulnerability factors, the overall vulnerability scores for the IPZ-1s and IPZ-2s of the A.H. Weeks (Windsor) WTP were calculated as 9.0 and 8.1 respectively, as shown in **Table 4.28**. The vulnerability scores are also shown in **Map 4.26** for the east intake, and **Map 4.27** for the west intake.

Table 4.28: Vulnerability Scores Assigned to IPZ-1s and IPZ-2s of A. H. Weeks (Windsor) WTP

Intake Type	Area Vulnerability Factor (B)		Source Vulnerability Modifying Factor (C)	Vulnerability Score (V=BxC)	
	IPZ-1	IPZ-2		IPZ-1	IPZ-2
East Intake					
Type B	10	9	0.9	9.0	8.1
West Intake					
Type B	10	9	0.9	9.0	8.1

These Vulnerability scores were finally used in combination with the MOE Table of Drinking Water Threats to determine the number and types of potential drinking water threats in the respective intake protection zones that are further discussed in the following section.

As per the MOE's Technical Rules, vulnerability scores are not applicable to IPZ-3s of type B intakes (intakes on connecting channels). Therefore the A. H. Weeks (Windsor) IPZ-3s are not assigned vulnerability scores.

4.2.4.7. Drinking Water Threats

A drinking water threat is defined, according to the MOE, as a chemical or pathogen that poses a potential risk to the drinking water source. Please refer to Section 4.2.1.4 for the

list of 21 types of activities that are considered as drinking water threats prescribed by the MOE. These activities may be deemed as significant, moderate, or low drinking water threats in the vulnerable areas through four different approaches as described in Section 4.2.1.4. The following section describes the results of threats assessment obtained through the "threats approach" and "events based approach."

4.2.4.7.1. Threats Based Approach

The threats approach is based on the quantitative risk score estimated for an activity that is or would be a drinking water threat in a specific vulnerable area. Refer to Section 4.2.1.4 for further details on methodology of the Threats approach. Based on the vulnerability scores of 9.0 and 8.1 that were assigned to IPZ-1s and IPZ-2s, respectively, and the MOE Tables of Drinking Water Threats, the lists of potential drinking water quality threats (significant, moderate and low) were generated for the A.H. Weeks (Windsor) WTP. The threats approach study including lists of potential threats based on zone and vulnerability score is provided in **Appendix VIII**. As per the MOE's Technical Rules, vulnerability scores are not applicable to the IPZ-3s for Type B (connecting channel) intakes. Therefore threats analysis in IPZ-3s of the A. H. Weeks (Windsor) WTP through the 'threats approach' is not applicable.

Table 4.29 summarizes the number of possible drinking water quality threats (chemical and pathogen) that would be deemed as significant, moderate or low if they were to exist in the IPZ-1s and IPZ-2s of the A.H. Weeks WTP. The numbers of potential drinking water threats are the same for both intakes' IPZ-1s and IPZ-2s due to the same vulnerability scores assigned to the east and west intakes. These threats were further classified into chemical and pathogen types and are illustrated in **Map 4.28** (east intake) and **Map 4.29** (west intake).

Table 4.29: Number of Potential Drinking Water Quality Threats for the A. H. Weeks (Windsor) WTP

Intake Protection Zone	V Score	Number of Potential DW Threats		
		Significant	Moderate	Low
IPZ-1 (for East Intake and West Intake)	9.0	252	956	647
		Total 1855		
IPZ-2 (for East Intake and West Intake)	8.1	26	826	897
		Total 1749		

NOTE: Number of potential DW threats are based on vulnerability scores and the MOE's Tables of Drinking Water Threats, and do not necessarily exist in the subject IPZs, but would be deemed as significant, moderate or low threats if they were to exist

The types of activities that may be classified as significant, moderate or low drinking water threats in the IPZ-1s and IPZ-2s of the A. H. Weeks (Windsor) WTP are listed in **Table 4.30 and Table 4.31**, respectively. Activities listed in the tables may be identified as significant, moderate or low drinking water threats depending upon various circumstances such as the quantity and type of chemicals used. The circumstances under which the listed activities would be deemed significant, moderate or low drinking water threats for both IPZ-1s and IPZ-2s are listed in **Appendix IX (C)**. The MOE Tables of Drinking Water Threats can be accessed using the following link:

http://www.essexregionsourcewater.org/downloads/download_tables_of_drinking_water_threats.pdf

The Tables of Circumstances can be accessed using the following link:

https://www.ontario.ca/environment-and-energy/provincial-tables-circumstances

Table 4.30: List of Prescribed Potential Drinking Water Threats Based on V Score of 9.0 for IPZ-1 of the A. H. Weeks (Windsor) WTP (for both East Intake and West Intake)

No.	Prescribed Drinking Water Threat	SIG	MOD	LOW
1	The establishment, operation or maintenance of a system that collects, stores, transmits, treats or disposes of sewage	√	√	√
2	The establishment, operation or maintenance of a waste disposal site within the meaning of Part V of the Environmental Protection Act	√	√	√
3	Application of agricultural source material to land	√	√	
4	Storage of agricultural source material	√	√	√
5	Management of agricultural source material		√	
6	Application of non-agricultural source material to land	√	√	
7	Handling and storage of non-agricultural source material	√	√	√
8	Application of commercial fertilizer	√	√	
9	Handling and storage of commercial fertilizer		√	√
10	Application of pesticide	√	√	
11	Handling and storage of pesticide	√	√	√
12	Application of road salt	√	√	
13	Handling and storage of road salt	√	√	√
14	Storage of snow	√	√	√
15	Handling and storage of fuel		√	√
16	Handling and storage of non-aqueous dense phase liquids		√	
17	Handling and storage of organic solvent		√	√
18	Management of runoff that contains chemicals used in the de-icing of aircraft	√	√	√
19	Use of land as livestock grazing or pasturing land, an outdoor confinement area or a farm-animal yard	√	√	

NOTE: Types of potential DW threats are based on vulnerability scores and the MOE's Tables of Drinking Water Threats, and do not necessarily exist in the subject IPZs, but would be deemed as significant, moderate or low threats if they were to exist

Table 4.31: List of Prescribed Potential Drinking Water Threats Based on V Score of 8.1 for IPZ-2 of the A. H. Weeks (Windsor) Windsor WTP (for both East Intake and West Intake)

No.	Prescribed Drinking Water Threat	SIG	MOD	LOW
1	The establishment, operation or maintenance of a system that collects, stores, transmits, treats or disposes of sewage	√	√	√
2	The establishment, operation or maintenance of a waste disposal site within the meaning of Part V of the Environmental Protection Act	√	√	√
3	Application of agricultural source material to land	√	√	√
4	Storage of agricultural source material	√	√	√
5	Management of agricultural source material			√
6	Application of non-agricultural source material to land	√	√	√
7	Handling and storage of non-agricultural source material	√	√	√
8	Application of commercial fertilizer		√	√
9	Handling and storage of commercial fertilizer		√	√
10	Application of pesticide	√	√	√
11	Handling and storage of pesticide		√	√
12	Application of road salt		√	√
13	Handling and storage of road salt		√	√
14	Storage of snow		√	√
15	Handling and storage of fuel		√	√
16	Handling and storage of non-aqueous dense phase liquids		√	√
17	Handling and storage of organic solvent		√	√
18	Management of runoff that contains chemicals used in the de-icing of aircraft		√	√
19	Use of land as livestock grazing or pasturing land, an outdoor confinement area or a farm-animal yard	√	√	

NOTE: Types of potential DW threats are based on vulnerability scores and the MOE's Tables of Drinking Water Threats, and do not necessarily exist in the subject IPZs, but would be deemed as significant, moderate or low threats if they were to exist

4.2.4.7.2. Event Based Threats Approach

As per Technical Rule 68 in conjunction with Rule 130, an activity is or would be a significant drinking water threat in a surface water intake protection zone at the location where an activity is or would be engaged in, if modeling demonstrates that a release of a chemical parameter or pathogen from the activity or proposed activity would be transported through the surface water intake protection zone to the intake and result in a deterioration of the water for use as a source of drinking water. The Essex Region SPC has accepted the Ontario Drinking Water Quality Standard (ODWQS) to identify deterioration of raw water quality at the intake.

The modeling that was completed to delineate the IPZ-3 for the A. H. Weeks (Windsor) WTP is described in Section 4.2.4.4, while the general methodology on the events based approach is described in Section 4.2.1.4.4. Further details are described in the hydrodynamic modeling report from Baird & Associates, as well as the Stantec Consulting Ltd. report (April 2011) addressing IPZ-3 delineation and significant threat identification for this WTP in **Appendix VII.**

The Essex Region SPC has expressed concern with the potential for fuel spills along transportation corridors, as well as the possible presence of fixed fuel tanks, in close proximity to watercourses and drains within the IPZ-2s and IPZ-3s. Consequently, the modeling that was completed to delineate IPZ-3 for the A.H. Weeks WTP (refer to Section 4.2.4.4) consisted of two phases of modeling. The first phase involved modeling hypothetical fuel tanker truck spills (of volume 34,000 L) in Pike Creek, and the second involved a bulk fuel industrial site (volume 6,800,000 L) located within the downstream IPZ-2s. Both phases of modeling identified exceedances of the ODWQS benchmark (0.005 mg/L) for benzene at the intakes and as a result significant threats were identified. The model determines concentrations in a vertical column of six layers. The concentration in the layer to which the depth of the intake is the closest is considered. The spills modeling and events based threats analysis is described in detail below.

Tanker truck fuel spill modeling results and conclusions: In the first phase of modeling, tanker truck spills (of volume 34,000 L and 2% benzene content fuel) were simulated to occur near watercourse and drains (with two different storm events) and to demonstrate the

susceptibility of contamination at the intake from spills occurring at significant distances upstream. These locations are shown in **Figure 3.1** of the Stantec Consulting Ltd. Report (April 2011), addressing IPZ-3 delineation and threats analysis for Stoney Point, Lakeshore (Belle River) and A. H. Weeks (Windsor) WTPs, in **Appendix VII** and in **Maps 4.24c** and **4.25c** for the East and West intakes, respectively. The modeling results indicated that hypothetical fuel spills near the headwaters of Pike Creek (17,000 m from the mouth) had benzene concentrations at the intake 2.6 times the ODWQS benchmark for benzene for one of the storm events modeled.

From the results of the first phase of modeling and level of exceedance, it is reasonable to assume that a substantially reduced spill volume would also result in an exceedance at the intake. The volume of spill and concentration at the intake are not necessarily proportional but it is reasonable to deduce that a reduction of approximately 50% or more in spill volume would also result in a significant threat. Based upon the modeling completed to date and interpretation of the results it is logical to assume that a spill volume of approximately 15,000 L from existing or planned above ground fixed fuel storage sites as well as transportation of fuel along shipping and ferries corridors be considered as significant threats.

Consequently, existing and future fixed fuel storage sites and transportation of fuel along shipping and ferries corridors of approximately 15,000 L in the IPZ-1, IPZ-2 and IPZ-3, near watercourses and drains in the Pike Creek watershed as well as watersheds closer to the intake, would be considered to be significant threats as they would inherently deteriorate the quality of source water in the event of a spill. **Table 4.32** provides a summary of the potential significant threats criteria for the A.H. Weeks WTP.

Existing fuel storage sites spill modeling results and conclusions: In the second phase of modeling, the simulated spill (of 6,800,000 L volume, and 2% benzene in the fuel) at the bulk fuel industrial site assisted in demonstrating the susceptibility of the intake to contamination from potential bulk fuel spills, and in identifying an existing significant threat. This location is 'Scenario 5' shown in **Figure 3.1** of the Stantec Consulting Ltd. Report (April 2011), addressing IPZ-3 delineation and threats analysis for A. H. Weeks (Windsor) and Amherstburg WTPs, in **Appendix VII** (also shown in **Maps 4.24c** and

4.25c for the East and West intakes, respectively). This location is downstream of the A. H. Weeks (Windsor) intake, in the IPZ-2. The model was used to predict concentrations at the intake for a scenario of fixed variables (volume, % benzene, release rate, etc). It resulted in an exceedance of the ODWQS benchmark at the A.H. Weeks WTP intake and therefore constitutes an ***existing significant drinking water threat***. The spills modeling results were then used to define what would constitute a significant threat, as discussed further below. The duration of the storm event was approximately 11 hours compared to that of the 2 hour travel time which was used to delineate the IPZ-2. From that comparison it was reasonable to assume that the 6,800,000 L fuel spill that was simulated for this scenario, which is located within the downstream IPZ-2, would likely exceed the benchmark anywhere within the 2 hour time of travel of the downstream IPZ-2s, especially given that the exceedance was approximately thirty (30) times that of the ODWQS benchmark of 0.005 mg/L for benzene. An additional bulk fuel industrial storage is located close to the Scenario 5 site (approximately 300 m to the east), and is of similar size. This additional fuel storage and the Scenario 5 site have the same transport pathway. Therefore a spill from this additional fuel storage site would reach the intake in the same manner as shown by the Scenario 5 spill modeling, and result in similar levels of benzene exceedance at the intake. This additional fuel storage site is also identified as an ***existing significant drinking water threat***.

From the results of the second phase of modeling and the high level of exceedance, it is reasonable to assume that a substantially reduced spill volume would also result in an exceedance at the intake. The volume of spill and concentration at the intake are not necessarily proportional but it is reasonable to deduce that a reduction of approximately 50% or more in spill volume would also result in a significant threat. Based upon the modeling completed to date and interpretation of the results it is logical to assume that a spill volume of approximately 3,000,000 L from existing or planned above ground fixed fuel storage sites (within the downstream portions of both IPZ-1s and IPZ-2s) be considered as significant threats. **Table 4.32** provides a summary of the potential significant threats criteria based on the modeling work as described above for the A.H. Weeks WTP.

Table 4.32: Potential Significant Threats Criteria for the A.H. Weeks (Windsor) WTP for 2% Benzene in Fuel

WTP	IPZ-1, 2, and 3 Upstream Storage Volume (L)	IPZ-1 and 2 Downstream Storage Volume (L)
A.H. Weeks (Windsor)	15,000	3,000,000

4.2.4.7.3. Local Threats

The transportation of fuel, organic solvents, DNAPLs, pesticides/herbicides and fertilizers was approved by the Director as a local threat in August 2011 (see **Section 4.2.1.4.5** and **Appendix XIII**). The threat level for all identified local threats in IPZs must be assessed using the vulnerability score, for more details see Director's Letter dated August 2011 (**Appendix XIII)**. Table **4.33** shows the classification of these local threats as moderate or low drinking water threats based on the vulnerability score of each IPZ for the A.H. Weeks (Windsor) WTP. Note that the transportation of fuel (2% benzene) was determined to be a significant threat in the EBA of A.H. Weeks (Windsor) WTP using the events based approach. No other substances have been modeled at this time.

Table 4.33: Threat level for Local Threats (transportation of various substances) for A. H. Weeks (Windsor) WTP

IPZ	Vulnerability Score	Significant	Moderate	Low
1	**9**		√	√
2	**8.1**		√	√
3	**N/A**			

4.2.4.7.4. Existing Significant Drinking Water Threats

An inventory of land use activities, within the IPZs with vulnerability scores greater than 8.0, for the WTPs in the Essex Region SPA, was undertaken by Stantec Consulting Ltd. A desktop analysis was conducted based on parcel information from the Region and Municipal Property Assessment Corporation (MPAC) data, property owner contact and

business specific surveys. The detail on the methodology that was applied during the inventory work is described in detail in the Technical Memorandum submitted by Stantec Consulting Ltd dated February 2011 (**Appendix XI**).

An analysis of each activity, namely, the ability to discharge to surface water, the requirement to report to the NPRI, and the chemicals that may be present in the discharge was conducted and properties of the threats were investigated. Based on the desktop investigation eight municipal significant threats were identified. The eight significant threats consisted of pathogen threats from combined sewers and a wastewater treatment plant. These analyses also identified 4 *unconfirmed existing significant threats* for the IPZ-1 and IPZ-2 (for both intakes) for the A.H. Weeks (Windsor) WTP. These *unconfirmed threats* are storm water discharge from two combined sewers and two storm sewers. If it is determined that there is the presence of particular contaminants (for example arsenic, mercury etc.) in the discharge, these threats would be considered significant threats. This work has not been undertaken.

For the events based approach, a desktop GIS exercise was performed to identify existing sites with greater than 15,000 L of above ground fuel storage in the EBA for the A.H. Weeks (Windsor) WTP using established criteria (fuel with 2% benzene, at volumes of 15,000 L, see **Table 4.25d**). Information from fuel providers in Essex County, Google Street View, and 2013 aerial photography overlaid with the EBA delineation using ESRI ArcGIS 10.2.2 for Desktop, were all used to determine the locations of fuel storage and approximate size of fuel storage tanks. For the A.H. Weeks (Windsor) WTP this resulted in 26 unconfirmed fuel threats and 2 confirmed fuel threats from the previous study. **Tables 4.34a-c** summarizes the existing significant drinking water threats for the IPZs of the A. H. Weeks (Windsor) WTP. Also, **Maps 4.30 and 4.31** shows the existing significant threats in the IPZs.

Therefore there are eight confirmed existing significant threats and four unconfirmed significant threats for the A.H. Weeks (Windsor) WTP. **Tables 4.34a** to **4.34c** summarize the existing significant drinking water threats for the IPZ-1s and IPZ-2s, and EBAs , for both intakes of the A. H. Weeks (Windsor) WTP . Also, **Map 4.30** and **Map 4.31** show the existing significant threats in the east and west intakes IPZs respectively.

Table 4.34a: Number of *Confirmed/Unconfirmed Existing Significant Drinking Water Threats* in the IPZ-1s of the East and West Intakes of the A. H. Weeks (Windsor) WTP

Significant DW Threats	Number of Threats	Uncertainty
Combined sewer - confirmed	**3**	Low
Combined sewer - unconfirmed	**2**	High

Table 4.34b: Number of *Confirmed/Unconfirmed Existing Significant Drinking Water Threats* in the IPZ-2s of the East and West Intakes of the A. H. Weeks (Windsor) WTP

Specific Land Use Activity	Number of Threats	Uncertainty
Combined sewer – confirmed	**4**	Low
Wastewater Treatment Plant - confirmed	**1**	Low
Storm sewer - unconfirmed	**2**	High

Table 4.34c: Number of *Existing Confirmed/Unconfirmed Significant Drinking Water Threats* in the EBA of the East and West Intakes of the A.H. Weeks (Windsor) WTP

Specific Land Use Activity	Number of Threats	Uncertainty
Above ground fuel storage – unconfirmed*	**26**	High
Above ground fuel storage – confirmed	**2**	High

***Identified through events based modeling**

4.2.4.8. Drinking Water Issues

As further described in Section 4.2.1.5, a drinking water *issue* is defined as the presence of a parameter, listed in Schedules 1, 2, or 3 of O. Reg 170/03, or Table 4 of the Technical Support Document for the Ontario Drinking Water Quality Standards (ODWQS) Objectives and Guidelines, at a concentration, that may result in the deterioration of the quality of water for use as a source of drinking water. The process of issue evaluation is explained in more detail in the Proposed Issues Evaluation Methodology Report (June 2009) that was adopted by the Essex Region Source Protection Committee (**Appendix VI**).

Initial screening of the raw water quality data for the Windsor WTP flagged *E. coli*, total coliform (Schedule 1 Parameter), aluminum, colour, hardness, iron, organic nitrogen and turbidity (Table 4 Parameters). Further assessment of the raw water data for these flagged parameters identified only aluminum, turbidity and organic nitrogen as drinking water quality issues for the A. H. Weeks (Windsor) WTP. These identified issues are summarized for the Windsor WTP intake in **Table 4.35**. Sources contributing to these issues are yet to be determined.

Table 4.35: Summary of Issues Identified at the Intake of the A. H. Weeks (Windsor) WTP

Identified Issues*	Data Source & Duration of Data	Result of Issue Evaluation	Natural or Anthropogenic Source
Aluminum	DWSP (1987-2006)	Approximately 59% of the raw water samples collected over a 10 year period exceeded the 100% OG benchmark for aluminum. A linear increasing trend was also observed in the same dataset.	Possibly from both anthropogenic and natural sources.
Turbidity	DWSP (1987-2006)	Over 75% of the raw water samples collected over a 10 year period exceeded the 100% AO benchmark for turbidity (5 NTU).	Possibly from both anthropogenic and natural sources.
Organic Nitrogen	DWSP (1987-2006)	Over 97% of the raw water samples collected over a 10 year period exceeded the 100% OG benchmark. A linear increasing trend was also observed.	Possibly from both anthropogenic and natural sources.

*Identified according to Technical Rule 115.1

Further details on methodology, variety of data sets used and results of issues evaluation, can be found in the Technical Memorandum on Issue Evaluation for the Essex Region WTPs, prepared by Stantec Consulting Ltd (**Appendix X**).

Further studies may assist in identifying the sources of the identified issues. These investigations could include extensive sampling and analysis of the parameters of concern (i.e. turbidity, aluminum and organic nitrogen). Studies of the correlation between wind and run-off events and turbidity levels at the intake may also assist in determining the sources of issues. Currently, this information is a gap. Refer to Section 4.3.3 for further information on data gaps related to issues evaluation. If information becomes available to the SPC that indicates the sources of issues to be wholly or partially anthropogenic, then issue contributing areas, and the activities contributing to the issues would be determined in a future assessment report.

4.2.4.9. Conditions

Conditions are areas, result of past activities, where there is an existing contamination, for example contaminated soil at an old industrial site that is no longer in use, that may be considered as a drinking water threat. Based on a preliminary investigation by Stantec Consulting (report from December 2010, in **Appendix X**) conducted on available surface water, groundwater, sediment and soil pollution data in the Region, some conditions have been identified in the soil and sediments in the IPZ-1 and IPZ-2 of the A. H. Weeks (Windsor) Water Treatment Plant. However there was a lack of data to establish off-site contamination due to the conditions. Based on a hazard score of 6, the conditions resulted in low drinking water threats. The threats due to conditions in the Essex Region SPA may be further assessed as new information is gathered during future updates of the Assessment Report.

4.2.4.10. Percentage of Managed Lands and Livestock Density in IPZs

Please refer to Section 4.1.2.3 (Percentage of Managed Lands and Livestock Density in Vulnerable Areas: Groundwater Vulnerability Section of the AR) for a review of the requirements, definitions and methodology of the percentage of managed lands and livestock density within vulnerable areas.

Maps 4.32 and **4.33** show the percent managed land in the IPZs of the A. H. Weeks East and West intake, respectively, while livestock density categories for the IPZs of the A. H. Weeks East and West intake are presented in Maps 4.34 and 4.35, respectively. Based on the percentage of managed land and livestock density in the A. H. Weeks IPZs, the hazard scores were estimated as per the Guidelines provided by the MOE (**Table 4.18**). These results are summarized in **Table 4.36**.

Table 4.36: Summary of the results of the percent managed land and livestock densities in the IPZs of the A. H. Weeks (Windsor) WTP

Intake Protection Zone	Managed Land Category	Livestock Density Category	Hazard Score	Vulnerability score	Risk Score
East Intake					
IPZ-1	40% - 80%	< 0.5 NU/acre	7.6	9.0	68 (mod)
IPZ-2	< 40%	< 0.5 NU/acre	6.8	8.1	55 (low)
West Intake					
IPZ-1	40% - 80%	< 0.5 NU/acre	7.6	9.0	68 (mod)
IPZ-2	< 40%	< 0.5 NU/acre	6.8	8.1	55 (low)

The risk scores calculated based on the hazard scores and the vulnerability scores of the respective IPZs indicated that the managed lands and livestock densities would be moderate and low threats in the IPZ-1s and IPZ-2s, respectively, for the A. H. Weeks (Windsor) WTP. There are currently no agricultural activities in the IPZ-1s of both intakes.

4.2.4.11. Percentage of Impervious Surfaces in IPZs

Please refer to Section 4.1.2.4 (Percentage of Impervious Surface Area in Vulnerable Areas: Groundwater Vulnerability Section of the AR) for a review of the requirements, definitions and methodology of the percentage of impervious surface areas within vulnerable areas. There are four possible categories for the percentage impervious surface area based on the MOE guidelines: < 1% impervious; 1% to <8% impervious; 8% to <80% impervious and ≥ 80% impervious.

Maps 4.36 and **4.37** show the percent impervious surface areas in the IPZs of the East and West intake, respectively, for the A. H. Weeks (Windsor) WTP. The results are also summarized in **Table 4.95b** located at the end of Section 4. Based on the vulnerability scores and the percent impervious surface areas, the road salt application land use is considered as a moderate threat in the IPZ-1s and in most of the area of the IPZ-2s of the A. H. Weeks (Windsor) WTP intakes. Some very small areas near the easterly limit of the IPZ-2s would result in a low threat for road salt application.

4.2.5. Amherstburg Water Treatment Plant

This section summarizes the results of technical studies conducted by Stantec Consulting Ltd and Baird & Associates for the Amherstburg Water Treatment Plant (WTP) in the Essex Region Source Protection Area. The complete details of these technical studies can be found in **Appendix VII, VIII, IX** and **X**. Please refer to Section 4.2.1 of this Assessment Report for the details on concepts, methodology and requirements related to intake classification, intake protection zone delineation, vulnerability scoring, drinking water threats assessment and issues evaluation.

4.2.5.1. Intake Classification

The Amherstburg Water Treatment Plant (WTP) is located on Front Road North in the Town of Amherstburg. It withdraws its source water from the Detroit River which is a connecting channel between Lake St. Clair and Lake Erie. The treatment processes at the plant include coagulation, flocculation, clarification, filtration and chlorination. Chlorine is added at the mouth of the intake structure for zebra mussel control. Other details such as intake pipe location, crib depth etc, are summarized in **Table 4.37**. The Service Area for this plant includes approximately 326 km of water distribution pipes of various sizes and serves around 21,000 people (see **Map 1.1**).

Table 4.37: Overview of the Amherstburg Water Treatment Plant

Drinking Water System: Amherstburg Water Treatment Plant	
Operating Authority	Corporation of the Town of Amherstburg
Location	415 Front Road N, Amherstburg
System Classification	Type I System (Municipal Residential)
Rated (design) Capacity	18,184 m^3/day
UTM Coordinates	325154 E 4665894 N
Intake Depth	6.8 m (river bed); 4.6 m (crib top)
Distance of Intake from Shore	61 m (from river bank)

For the purpose of this study the intake of the Amherstburg WTP is classified as a Type B intake (Great Lakes Connecting Channels) and an intake protection zone for this intake was delineated as per the guidelines described in **Table 4.10** (Section 4.2.1.2).

4.2.5.2. Intake Protection Zone -1 (IPZ-1)

As described in Section 4.2.1.2 (**Table 4.10**) the in-water portion of the IPZ-1 for a Type B intake is a semicircle area of 1 km radius extending upstream drawn from the centre point of the intake and with a setback distance of 100 m extending downstream of the intake. The in-water IPZ-1 for the Amherstburg WTP was delineated using a semicircle that has a radius of 1km extending upstream with the 100 m downstream extent as shown in **Map 4.38a**. As per the MOE's Technical Rules, the IPZ-1s were extended 120 m upland where the zones abutted land. Further details in this regard are found in the Reports by Stantec Consulting Ltd. and Baird & Associates (**Appendix VII**).

4.2.5.3. Intake Protection Zone -2 (IPZ-2)

The IPZ-2 is a secondary protective zone around the IPZ-1 and is delineated based on the minimum response time required for the plant operator to respond to adverse conditions or a spill and the travel time in the lake and/or tributary. A 2-hour response time was adopted by the ERSPA based on the Draft Guidance Module 4 (MOE, 2006a), Technical Rules and on interviews with the plant operators and authorities in the Region. There are two components to the IPZ-2, namely the in-water IPZ-2 and upland IPZ-2, the extent of which are determined based on the 2-hour time of travel considering the estimated flow velocities.

The in-water component of the IPZ-2 for the Amherstburg WTP was delineated by Baird & Associates, using hydrodynamic modeling and reverse particle tracking method. Refer to Section 4.2.1 of this Assessment Report and **Appendix VII** for further information relating to the hydrodynamic modeling. The resulting in-water zone for the Amherstburg intake is illustrated in **Map 4.38a**. The IPZ-2 includes areas downstream of the intake, due to the modeling of the reverse flow phenomenon in the Detroit River. The modeled in-water IPZ-2s included areas within the United States. These areas, as well as the portions of the IPZs which extend into the United States are considered when determining the vulnerability score; however the delineation is visually truncated at the international

boundary for the purpose of the Assessment Report, as required by MOE (see Section 4.2.1). The limits of the in-water IPZ-2 are based on the modeling of the extent of the 2 hour time of travel as further detailed in the Report by Baird & Associates dated November 2010 which is part of **Appendix VII**.

The upland IPZ-2 includes the following three major components:

1. Tributaries and streams including municipal drains, etc.,
2. A 120 m set back or the area of the Regulation Limit, whichever is greater along the abutted land, and
3. Storm sewersheds; and Transport pathways (such as tile drain networks and other drainage systems).

The extents of these components are delineated differently, based on the 2-hour time of travel, using different methods as described in Section 4.2.1. The resulting boundary of the IPZ-2 of the Amherstburg WTP with various components is illustrated in **Map 4.38a.** Refer to the Technical Memorandum prepared by Stantec Consulting Ltd. (**Appendix VII**) for further information on variety of data sources and approaches used to determine the up-land extent of the IPZ-2.

4.2.5.4. Intake Protection Zone-3 (IPZ-3)

As per Rule 68 an IPZ-3 may be delineated if modeling demonstrates that a release of a chemical parameter or pathogen from an activity or a proposed activity during an extreme event would be transported to the intake and result in the deterioration of the water for use as a source of drinking water. The Essex Region SPC has accepted the ODWQS to identify deterioration of raw water quality at the intake.

Appropriate guidelines for delineation of IPZ-3 are described in **Table 4.10** and Section 4.2.1.2.3). Baird & Associates conducted hydrodynamic modeling to determine whether an IPZ-3 would be required for the Amherstburg WTP. The modeling incorporated both reverse particle tracking (boundary approach) and contaminant transport modeling to determine the boundaries of the in-water IPZ-3.

The delineation was based upon six locations; two simulated fuel tanker truck spills along Canard River and Turkey Creek; and simulated spills from four existing fuel storage locations. These are summarized in **Table 4.38** below, and shown in **Figure 3.1** of the

Stantec Consulting Ltd. Report (April 2011), addressing IPZ-3 delineation and threats analysis for A. H. Weeks (Windsor) and Amherstburg WTPs, in **Appendix VII** and in **Map 4.38c**.

Table 4.38: Overview of Spill Scenarios Considered

Spill Scenario	General Spill Location	Flow Direction*	Volume (L)
1	Canard River	Normal	34,000
2	West Windsor	Normal	25,000,000
2a	West Windsor	Normal	7,500,000
3	Amherstburg	Normal	35,000,000
3a	Amherstburg	Reverse	35,000,000
4	Central Windsor	Normal	6,800,000
5	Central Windsor	Reverse	6,800,000
6	Turkey Creek	Normal	34,000

*Detroit River

The simulated fuel tanker truck spill (gasoline with 2% benzene) in the upper reaches of Canard River and Turkey Creek result in an exceedance of the ODWQS for benzene at the Amherstburg WTP. Baird & Associates recommended that the IPZ-3 delineation be extended, as described in Section 4.2.1.2.3 (IPZ-3 delineation methodology). They recommended that the delineation be extended to the watershed limits of the modeled watercourse, thereby including the headwaters of these watercourses and their tributaries. Baird & Associates also recommended that the delineation be extended to the tributaries between the watercourses modeled and the WTP intake. Based on these recommendations, the IPZ-3 for the Amherstburg intake was extended to include the headwaters of Turkey Creek and Canard River, and their tributaries. Also, all tributaries located between these watercourses and the intake, were included.

The modeling of existing above ground fuel storage tanks at several locations along the Detroit River in Windsor also indicated exceedances of the ODWQS for benzene at the Amherstburg WTP intake. As a result the IPZ-3 also extends further upstream along the Detroit River to the limit of the Little River watershed based on the results from spill Scenario 4 in central Windsor (in the future, modeling of spills on Little River would assist in determining if the IPZ-3 should be further extended past the limit of the Little River

watershed). The delineation includes the storm sewer transport pathway that was assumed to convey the spill from the industrial site near Drouillard Road (in Windsor) to the Detroit River.

The IPZ-3 limits include a 120 m setback or the area of the Regulation Limit, whichever is greater for each watercourse and drain. Note that one fuel storage tank location is within the IPZ-2 of the Amherstburg WTP and the modeled contaminant transport pathway occurred within the IPZ-2 as well. Therefore this scenario was not included in the delineation of IPZ-3 as Technical Rule 75 restricts the area of IPZ-3 such that it may not include areas that lie within IPZ-1 or IPZ-2.

The hydrodynamic modeling report from Baird & Associates, as well as the Stantec Consulting Ltd. report (April 2011) addressing IPZ-3 delineation for the Amherstburg WTP is in **Appendix VII**. Refer to **Map 4.38b** for the IPZ-3 delineation.

4.2.5.5. Event Based Area

The Event Based Area for Amherstburg WTP is the combination of all on land portions and in water portions of IPZ-1, IPZ-2 and IPZ-3 (see section 4.2.1.2.4). Refer to **Map 4.38c** for the Event Based Area to which the significant drinking water threat policies for the handling and storage of fuel and transportation of fuel along shipping and ferries corridors apply.

4.2.5.6. Vulnerability Scoring of IPZs

The vulnerability score (V) is a numerical expression of the susceptibility of the intake to contamination. Details on the methodology of vulnerability scoring, and the data sources used in assigning vulnerability scores for the IPZs can be found in Section 4.2.1.3 and the Technical Memorandum prepared by Stantec Consulting Ltd. (**Appendix VII**).

The area vulnerability factor (B) is assigned a value of 10 for the IPZ-1 of the Amherstburg WTP, which is a set value for IPZ-1s of all types of intakes. The area vulnerability factor (B) for IPZ-2 is calculated based on a variety of characteristics considered through an area vulnerability decision matrix provided in the above mentioned technical memorandum, and described in detail in Section 4.2.1.3 of this assessment report. The IPZ-2 has 42% land cover. It is comprised of mixed vegetated and developed lands, clayey soil, has low

permeability, little slope, and a large storm catchment area. Considering these characteristics through the decision matrix, the B score of the IPZ-2 is calculated to be 8. A source vulnerability factor (C) of 0.9 was assigned to the Amherstburg WTP intake based on intake characteristics.

Based on the area and source vulnerability factors, the overall vulnerability scores are shown in **Table 4.39**. The vulnerability scores are also shown in **Map 4.39**.

Table 4.39: Vulnerability Scores Assigned to IPZ-1 and IPZ-2 of Amherstburg WTP

Intake Type	Area Vulnerability Factor (B)		Source Vulnerability Factor (C)	Vulnerability Score (V=BxC)	
	IPZ-1	IPZ-2		IPZ-1	IPZ-2
Type B	10	8	0.9	9	7.2

As per the MOE's Technical Rules, vulnerability scores are not applicable to IPZ-3 of type B intakes (intakes on connecting channels). Therefore the Amherstburg IPZ-3 is not assigned a vulnerability score.

These vulnerability scores were used in combination with the MOE's Table of Drinking Water Threats to determine the number and types of potential drinking water threats in the respective intake protection zone that are discussed in the following section.

4.2.5.7. Drinking Water Threats

A drinking water threat is defined, according to the MOE, as a chemical or pathogen that poses a potential risk to the drinking water source. Please refer to Section 4.2.1.4 for the list of 21 types of activities that are considered as drinking water threats prescribed by the MOE. These activities may be deemed as significant, moderate, or low drinking water threats in the vulnerable areas through four different approaches as described in Section 4.2.1.4. The following section describes the results of threats assessment obtained through the "threats approach" and events based approach.

4.2.5.7.1. Threats Based Approach

The threats approach is based on the quantitative risk score estimation for an activity that is or would be a drinking water threat in a specific vulnerable area. Refer to Section 4.2.1.4 for further details on methodology of the Threats approach. Based on the vulnerability scores of 9.0 and 7.2 that were assigned to IPZ-1 and IPZ-2, respectively, and the MOE Tables of Drinking Water Threats, the lists of potential drinking water quality threats (significant, moderate and low) were generated for the Amherstburg WTP. The threats approach study including lists of potential treats based on zone and vulnerability score is provided in **Appendix VIII**. As per the MOE's Technical Rules, vulnerability scores are not applicable to the IPZ-3 for Type B (connecting channel) intakes. Therefore threats analysis in IPZ-3 of the Amherstburg WTP through the 'threats approach' is not applicable.

Table 4.40 summarizes the number of possible drinking water quality threats (chemical and pathogen) that would be deemed as significant, moderate or low drinking water threat if they were to exist in the IPZ-1 and IPZ-2 of the Amherstburg WTP. These threats were further classified into chemical and pathogen types and are illustrated in **Map 4.40**.

Table 4.40: Number of Potential Drinking Water Quality Threats for the Amherstburg WTP

Intake Protection Zone	V Score	Number of Potential DW Threats			
		Significant	Moderate	Low	Total
IPZ-1	9.0	252	956	647	**1855**
IPZ-2	7.2	0	437	1177	**1614**

NOTE: Number of potential DW threats are based on vulnerability scores and the MOE's Tables of Drinking Water Threats, and do not necessarily exist in the subject IPZs, but would be deemed as significant, moderate or low threats if they were to exist)

The types of activities that may be classified as significant, moderate or low drinking water threats in the IPZ-1 and IPZ-2 of the Amherstburg WTP are listed in **Table 4.41** and **Table 4.42** respectively. Activities listed in the tables may be identified as significant, moderate or low drinking water threats depending upon various circumstances such as the quantity and type of chemicals used. The circumstances under which the listed activities would be deemed significant, moderate or low drinking water threats for both IPZ-1 and IPZ-2 are

listed in **Appendix IX (D)**. The Tables of Drinking Water Threats can be accessed using the following link:

http://www.essexregionsourcewater.org/downloads/download_tables_of_drinking_water_threats.pdf

The Tables of Circumstances can be accessed using the following link:

https://www.ontario.ca/environment-and-energy/provincial-tables-circumstances

Table 4.41: Summary of Prescribed Potential Drinking Water Threats Based on V Score of 9.0 for IPZ-1 of the Amherstburg WTP

No.	Prescribed Drinking Water Threat	SIG	MOD	LOW
1	The establishment, operation or maintenance of a system that collects, stores, transmits, treats or disposes of sewage	√	√	√
2	The establishment, operation or maintenance of a waste disposal site within the meaning of Part V of the Environmental Protection Act	√	√	√
3	Application of agricultural source material to land	√	√	
4	Storage of agricultural source material	√	√	√
5	Management of agricultural source material		√	
6	Application of non-agricultural source material to land	√	√	
7	Handling and storage of non-agricultural source material	√	√	√
8	Application of commercial fertilizer	√	√	
9	Handling and storage of commercial fertilizer		√	√
10	Application of pesticide	√	√	
11	Handling and storage of pesticide	√	√	√
12	Application of road salt	√	√	
13	Handling and storage of road salt	√	√	√
14	Storage of snow	√	√	√
15	Handling and storage of fuel		√	√
16	Handling and storage of non-aqueous dense phase liquids		√	
17	Handling and storage of organic solvent		√	√
18	Management of runoff that contains chemicals used in the de-icing of aircraft	√	√	√
19	Use of land as livestock grazing or pasturing land, an outdoor confinement area or a farm-animal yard	√	√	

NOTE: Types of potential DW threats are based on vulnerability scores and the MOE's Tables of Drinking Water Threats, and do not necessarily exist in the subject IPZs, but would be deemed as significant, moderate or low threats if they were to exist

Table 4.42: Summary of Prescribed Potential Drinking Water Threats Based on V Score of 7.2 for IPZ-2 of the Amherstburg WTP

No.	Prescribed Drinking Water Threat	SIG	MOD	LOW
1	The establishment, operation or maintenance of a system that collects, stores, transmits, treats or disposes of sewage		√	√
2	The establishment, operation or maintenance of a waste disposal site within the meaning of Part V of the Environmental Protection Act		√	√
3	Application of agricultural source material to land		√	√
4	Storage of agricultural source material		√	√
5	Management of agricultural source material			√
6	Application of non-agricultural source material to land		√	√
7	Handling and storage of non-agricultural source material		√	√
8	Application of commercial fertilizer		√	√
9	Handling and storage of commercial fertilizer		√	√
10	Application of pesticide		√	√
11	Handling and storage of pesticide		√	√
12	Application of road salt		√	√
13	Handling and storage of road salt		√	√
14	Storage of snow		√	√
15	Handling and storage of fuel		√	√
16	Handling and storage of non-aqueous dense phase liquids		√	√
17	Handling and storage of organic solvent		√	√
18	Management of runoff that contains chemicals used in the de-icing of aircraft		√	√
19	Use of land as livestock grazing or pasturing land, an outdoor confinement area or a farm-animal yard		√	√

NOTE: Type of potential DW threats are based on vulnerability scores and the MOE's Tables of Drinking Water Threats, and do not necessarily exist in the subject IPZs, but would be deemed as significant, moderate or low threats if they were to exist

4.2.5.7.2. Event Based Threats Approach

As per Technical Rule 68 in conjunction with Rule 130, an activity is or would be a significant drinking water threat in a surface water intake protection zone at the location where an activity is or would be engaged in, if modeling demonstrates that a release of a chemical parameter or pathogen from the activity or proposed activity would be transported through the surface water intake protection zone to the intake and result in a deterioration of the water for use as a source of drinking water. The Essex Region SPC has accepted the Ontario Drinking Water Quality Standard (ODWQS) to identify deterioration of raw water quality at the intake.

The modeling that was completed to delineate IPZ-3 for the Amherstburg WTP is described in Section 4.2.5.4, while the general methodology on the events based approach is described in Section 4.2.1.4.4. Further details are described in the hydrodynamic modeling report from Baird & Associates, as well as the Stantec Consulting Ltd. report (April 2011) addressing IPZ-3 delineation and significant threat identification for this WTP in **Appendix VII.**

The Essex Region SPC has expressed concern with the potential for fuel spills along transportation corridors, as well as the possible presence of fixed fuel tanks, in close proximity to watercourses and drains within the IPZ-2s and IPZ-3s. Consequently, the modeling that was completed to delineate IPZ-3 for the Amherstburg WTP (refer to Section 4.2.5.4) consisted of hypothetical fuel tanker truck spills, and spills from existing above ground fuel storage tank locations. The modeling predicted exceedances of the ODWQS for benzene (0.005 mg/L) at the intakes for all spill scenarios except the simulated spill from an industrial property located downstream of the intake, under normal flow conditions. The modeling did indicate an exceedance for this spill scenario under reverse flow conditions, however. The model determines concentrations in a vertical column of six layers. The concentration in the layer to which the depth of the intake is the closest is considered. The spills modeling and events based threats analysis is described in detail below.

Tanker truck fuel spill modeling results and conclusions: The two simulations (scenarios no. 1 and 6) of tanker truck spills of fuel (with 2% benzene and spill volume of 34,000 L)

near watercourses and drains, assisted in demonstrating the susceptibility of the intake to contamination from spills occurring at significant distances upstream. These locations are summarized in **Table 4.38** (in Section 4.2.5.4) and shown in **Figure 3.1** of the Stantec Consulting Ltd. report (April 2011), addressing IPZ-3 delineation and threats analysis for A. H. Weeks (Windsor) and Amherstburg WTPs, in **Appendix VII** and in **Map 4.38c**. The modeling results indicated that hypothetical fuel spills near the headwaters of the Canard River (40,300 meters from the mouth) and Turkey Creek (17,300 meters from the mouth) yield concentrations at the intake approximately 3.5 times the ODWQS benchmark for benzene for each scenario.

From the results of the modeling for scenarios 1 and 6, and levels of exceedance, it is reasonable to assume that a substantially reduced spill volume would also result in an exceedance at the intake. The volume of spill and concentration at the intake are not necessarily proportional but it is reasonable to deduce that a reduction of approximately 50% or more in spill volume would also result in a significant threat. Based upon the modeling completed to date and interpretation of the results it is logical to assume that a spill volume of approximately 15,000 L from existing or planned above ground fixed fuel storage sites as well as transportation of fuel along shipping and ferries corridors be considered as significant threats, in the areas described below.

Existing and future fixed fuel storage sites and transportation of fuel along shipping and ferries corridors of approximately 15,000 L in the IPZ-1, IPZ-2 and IPZ-3 areas upstream of the intake, and near watercourses and drains up to and including the Turkey Creek watersheds, would be considered to be significant threats as they would inherently deteriorate the quality of source water in the event of a spill. **Table 4.43a** provides a summary of the potential significant threats criteria.

Existing fuel storage sites spill modeling results and conclusions: The scenarios that were simulations of existing above ground fixed fuel storage sites (scenarios 2, 2a, 4, 5, 3, 3a) assisted in demonstrating the susceptibility of the intake to contamination from potential bulk fuel spills, and in identifying existing significant threats. These locations are summarized in **Table 4.38** (in Section 4.2.5.4) and shown in **Figure 3.1** of the Stantec Consulting Ltd. Report (April 2011), addressing IPZ-3 delineation and threats analysis for

A. H. Weeks (Windsor) and Amherstburg WTPs, in **Appendix VII** and **Map 4.38c**. The modeling was used to predict results for a scenario of fixed variables (volume, % benzene concentration, release rate, etc.). The spills modeling results were then used to define what would constitute a significant threat, as described further below.

There were two scenarios, no. 2 and no. 2a, that simulated fuel spills at two locations upstream of the Amherstburg IPZ-2 in west Windsor with spill volumes of 25,000,000 and 7,500.000 L respectively. These existing sites are in close proximity to each other. The spill scenarios resulted in exceedances of the ODWQS benchmark by approximately 14 and 6 times the objective respectively. Consequently, the existing fixed fuel locations associated with these scenarios are identified as two ***existing significant threats***, as included in the count of existing significant threats shown in **Table 4.43c**. There were two scenarios (no. 4 – normal Detroit river flow direction, and no. 5- reverse Detroit river flow direction) at the same site that is also located upstream of the Amherstburg WTP, where a fuel spill of 6,800,000 L was simulated. The model results indicated exceedances at the intake by up to approximately 3.5 times the benchmark for benzene. Consequently, the existing fixed fuel location associated with these two scenarios (no. 4 and no. 5, at the same site) are also identified as one ***existing significant threat***, as included in the count of existing significant threats shown in **Table 4.43c**. An additional bulk fuel industrial storage site is located close to the Scenario 5 site (approximately 300 metres away), and is of similar size. This additional fuel storage and the Scenario 5 site have the same transport pathway. Therefore a spill from this additional fuel storage site would reach the intake in the same manner as shown by the Scenario 5 spill modeling, and would result in similar levels of benzene exceedance at the intake. This additional fuel storage site is also identified as an ***existing significant drinking water threat***. This is also included in the count of existing significant threats shown in **Table 4.43c**.

The scenarios (nos. 2, 2a, 4, and 5) linked to these existing fixed fuel storage sites may be utilized to establish criteria as to what would constitute a significant threat in the IPZ-3 for the Amherstburg WTP, upstream of Turkey Creek (refer to the discussion of Scenarios 1 and 6 for the portion of the IPZ-3 downstream of Turkey Creek). The location associated with Scenarios 4 and 5 is further upstream in the Detroit River than the sites associated

with Scenarios 2 and 2a, and therefore the potential significant threats may be representative of the location furthest upstream. A limited number of model runs were simulated. However, from the results of these scenarios it is reasonable to assume that substantially reduced spill volumes (less than the 6,800,000 L associated with scenarios 4 and 5) would result in an exceedance at the intake.

From the results of the modeling for scenarios 4, and 5, and level of exceedances, it is reasonable to assume that a substantially reduced spill volume would also result in an exceedance at the intake. The volume of spill and concentration at the intake are not necessarily proportional but it is reasonable to deduce that a reduction of approximately 50% or more in spill volume would also result in a significant threat. Based upon the modeling completed to date and interpretation of the results it is logical to assume that a spill volume of approximately 3,000,000 L from existing or planned above ground fixed fuel storage sites as well as transportation of fuel along shipping and ferries corridors be considered as significant threats, in the areas described below.

Existing and future fixed fuel storage sites and transportation of fuel along shipping and ferries corridors of approximately 3,000,000 L in the IPZ-3, upstream of Turkey Creek to the limit in the IPZ-3 in the upper Detroit River, would be considered to be significant threats as they would inherently deteriorate the quality of source water in the event of a spill to the Detroit River upstream of Turkey Creek. Work has not been completed to identify additional existing sites that meet these criteria, and this is considered an important gap which should be addressed in the future. **Table 4.43a** provides a summary of the potential significant threats criteria.

In addition to the fixed existing fuel storage sites scenarios 2, 2a, 4 and 5, there were two scenarios modeled that involved one above ground fixed fuel storage site located in the IPZ-2 downstream of the Amherstburg WTP intake. They were modeled using normal flow (scenario no. 3) and reverse flow (scenario no. 3a) conditions in the Detroit River to examine resultant benzene concentrations at the Amherstburg WTP intake, from a large spill volume of 35,000, 000 L. Both scenarios 3 and 3a resulted in an exceedance of the ODWQS benchmark at the surface, but only the reverse flow scenario 3a also resulted in

an exceedance of the ODWQS for benzene near the bottom. Consequently, this existing fixed fuel location in the IPZ-2 and IPZ-1 downstream and associated with reverse flow (scenario 3a) is identified as an ***existing significant threat,*** as included in the count of existing significant threats shown in **Table 4.43c**. This existing fixed fuel storage site may be utilized to establish criteria as to what could constitute a significant threat within the IPZ-2 and downstream of the Amherstburg WTP. The duration of exposure at the intake for both scenarios 3 and 3a was approximately 2-3 hours compared to the 2 hour time of travel used to delineate the IPZ-2. From that comparison it is reasonable to assume that a fuel spill of the same size (35,000,000 L) from other locations within the IPZ-2 would also result in an exceedance of the benchmark. A limited number of model runs were simulated. In addition, Baird & Associates have advised that the reverse flow event that was used to model Scenario 3a may not necessarily be representative of a strong flow reversal at Amherstburg. This event was used in the modeling because measured current data were collected during the reversal. Therefore conditions with a stronger flow reversal at Amherstburg could be expected to result in higher concentrations of benzene at the intake. From the results of the modeling for scenario 3a, and the level of exceedances, it is reasonable to assume that a substantially reduced spill volume would also result in an exceedance at the intake. The volume of spill and concentration at the intake are not necessarily proportional but it is reasonable to deduce that a reduction of approximately 50% or more in spill volume would also result in a significant threat, where above ground fixed fuel storage facilities may discharge by means of a spill to the Detroit River downstream of the Amherstburg WTP. Therefore based upon the modeling completed to date and interpretation of the results, it is reasonable to suggest that a fuel spill volume of approximately 15,000,000 L containing 2% benzene from existing or planned above ground fixed fuel storage sites that may discharge by means of a spill to the Detroit River downstream of the Amherstburg WTP would be considered to be significant threats, as they could inherently deteriorate the quality of source water in the event of a spill. **Table 4.43a** provides a summary of the potential significant threats criteria. Work has not been completed to identify additional existing sites that meet these criteria, and this is considered an important gap which should be addressed in the future.

Table 4.43a: Potential Significant Threats Criteria for the Amherstburg WTP for 2% Benzene in Fuel

WTP	IPZ-1, 2, and 3 Upstream of Intake		IPZ-1, and 2 Downstream of Intake
	*From the intake to vicinity of Turkey Creek and Turkey Creek watershed; Storage Volume	*From the vicinity of Turkey Creek to Upper Detroit River; Storage Volume	Storage Volume
Amherstburg	15,000 L	3,000,000 L	15,000,000 L

***Transition point from 15,000 L to 3,000,000 L is approximately 1.3 km upstream of the mouth of Turkey Creek (Refer to Report SPC 11/11 in Appendix VII)**

4.2.5.7.3. Local Threats

The transportation of fuel, organic solvents, DNAPLs, pesticides/herbicides and fertilizers was approved by the Director as a local threat in August 2011 (see **Section 4.2.1.4.5** and **Appendix XIII**). The threat level for all identified local threats in IPZs must be assessed using the vulnerability score, for more details see Director's Letter dated August 2011 (**Appendix XIII)**. Table **4.43b** shows the classification of these local threats as moderate or low drinking water threats based on the vulnerability score of each IPZ for the Amherstburg WTP. Note that the transportation of fuel (2% benzene) was determined to be a significant threat in the EBA of Amherstburg WTP using the events based approach. No other substances have been modeled at this time.

Table 4.43b: Threat level for Local Threats (transportation of various substances) for Amherstburg WTP

IPZ	Vulnerability Score	Significant	Moderate	Low
1	**9**		√	√
2	**7.2**			√
3	**N/A**			

4.2.5.7.4. Existing Significant Drinking Water Threats

An inventory of land use activities, within the IPZs with vulnerability scores greater than 8.0, for the WTPs in the Essex Region SPA, was undertaken by Stantec Consulting Ltd. A desktop analysis was conducted based on parcel information from the Region and Municipal Property Assessment Corporation (MPAC) data, property owner contact and business specific surveys. The detail on the methodology that was applied during the inventory work is described in detail in the Technical Memorandum submitted by Stantec Consulting Ltd dated February 2011 (**Appendix XI**). Based on this desktop investigation there were no significant threats identified.

For the events based approach, a desktop GIS exercise was performed to identify existing sites with above ground fuel storage in the EBA for the Amherstburg WTP using established criteria (see **Table 4.43a**). Information from fuel providers in Essex County, Google Street View, and 2013 aerial photography overlaid with the EBA delineation using ESRI ArcGIS 10.2.2 for Desktop, were all used to determine the locations of fuel storage and approximate size of fuel storage tanks. For the Amherstburg WTP this resulted in **54** unconfirmed fuel threats. **Table 4.43c** summarizes the existing significant drinking water threats for the EBA of the Amherstburg WTP. Also, **Map 4.38c** shows the number of existing significant threats in the EBA.

Table 4.43c: Number of *Existing Unconfirmed Significant Drinking Water Threats* in the EBA of the Amherstburg WTP

Specific Land Use Activity	Number of Threats	Uncertainty
Above ground fuel storage *	**54**	High

***Identified through events based modeling**

4.2.5.8. Drinking Water Issues

As further described in Section 4.2.1.5, a drinking water *issue* is defined as the presence of a parameter, listed in Schedules 1, 2, or 3 of O. Reg 170/03, or Table 4 of the Technical Support Document for the Ontario Drinking Water Quality Standards (ODWQS) Objectives and Guidelines, at a concentration, that may result in the deterioration of the quality of water for use as a source of drinking water. The process of issue evaluation is explained in more detail in the Proposed Issues Evaluation Methodology Report (June 2009) that was adopted by the Essex Region Source Protection Committee (**Appendix VI**).

Initial screening of the raw water quality data for the Amherstburg WTP flagged *E. coli*, total coliform (Schedule 1 Parameter), aluminum, colour, hardness, iron, organic nitrogen and turbidity (Table 4 Parameters). Further assessment of the raw water data for these flagged parameters identified only aluminum, turbidity, *E. coli* and organic nitrogen as drinking water quality issues for the Amherstburg WTP. A review of additional recent data confirmed that *E. coli* levels have reduced. According to a Stantec Consulting February 2011 report, the *E. coli* levels at this intake drastically reduced in recent years (2008 to 2010), compared to levels before that (2002 to 2007). It was strongly recommended to remove *E. coli* from the list of issues identified at this intake. Further, according to an ERCA staff report to the Source Protection Committee in February 2011, the 2010 *E. coli* results at this intake and its surrounding area are not high enough to result in the identification of *E. coli* as an issue at the Amherstburg intake. Therefore *E. coli* is removed from the list of issues for this intake.

The identified issues are summarized for the Amherstburg WTP intake in **Table 4.44**. Further details on methodology, variety of data sets used and results of issues evaluation, can be found in the Technical Memorandum on Issue Evaluation for the Essex Region WTPs (January 2010), and the report Escherichia coli Analysis for the Amherstburg Water Treatment Plant (February 2011) prepared by Stantec Consulting Ltd. These reports as well as the ERCA staff report on *E. coli* levels (February 2011) are provided in **Appendix X**. Sources contributing to these issues are yet to be determined.

Table 4.44: Summary of Issues Identified at the Intake of the Amherstburg WTP

Identified Issues*	Data Source & Duration of Data	Result of Issue Evaluation	Natural or Anthropogenic Source
Aluminum	DWSP (1987-2006)	Approximately 84% of the raw water samples collected over a 10 year period exceeded the 100% OG benchmark for aluminum (0.1 mg/L). A linear increasing trend was also observed in the same dataset.	Possibly from both anthropogenic and natural sources.
Turbidity	DWSP (1987-2006)	Over 92% of the raw water samples collected over a 10 year period exceeded the 100% AO benchmark for turbidity (5 NTU). A linear increasing trend was also observed in the same dataset.	Possibly from both anthropogenic and natural sources.
Organic Nitrogen	DWSP (1987-2006)	Over 98% of the raw water samples collected over a 10 year period exceeded the 100% OG benchmark. A linear increasing trend was also observed in the same dataset.	Possibly from both anthropogenic and natural sources.

*Identified according to Technical Rule 115.1

Further studies may assist in identifying the sources of the identified issues. These investigations could include extensive sampling and analysis of the parameters of concern (i.e. turbidity, aluminum and organic nitrogen). Studies of the correlation between wind and run-off events and turbidity levels at the intake may also assist in determining the sources of issues. Currently, this information is a gap. Refer to Section 4.3.3 for further information on data gaps related to issues evaluation. If information becomes available to the SPC that indicates the sources of issues to be wholly or partially anthropogenic, then issue contributing areas, and the activities contributing to the issues would be determined in a future assessment report.

4.2.5.9. Conditions

Conditions are areas, result of past activities, where there is an existing contamination, for example contaminated soil at an old industrial site that is no longer in use, that may be considered as a drinking water threat. Based on a preliminary investigation by Stantec

Consulting (report from December 2010, in **Appendix X**) conducted on available surface water, groundwater, sediment and soil pollution data in the Region, some conditions have been identified in the sediments in the IPZ-2 of the Amherstburg Water Treatment Plant. However there was a lack of data to establish off-site contamination due to the conditions. Also there was no soil data. Based on a hazard score of 6, the conditions resulted in low drinking water threats. The threats due to conditions in the Essex Region SPA may be further assessed as the new information is gathered during future updates of the Assessment Report.

4.2.5.10. Percentage of Managed Lands and Livestock Density in IPZs

Please refer to Section 4.1.2.3 (Percentage of Managed Lands and Livestock Density in Vulnerable Areas) for a review of the requirements, definitions and methodology of the percentage of managed lands and livestock density within vulnerable areas.

Maps 4.42 and **4.43** show the percent managed land category and the livestock density category in the IPZs of the Amherstburg WTP, respectively. The Guidelines provided by the MOE are shown in **Table 4.18.** For IPZ-1, the percentage of managed land was found to be <40% and the livestock density was < 0.5 NU/acre. The accompanying Chemical Hazard Score of 6.8 was multiplied by the Vulnerability Score of 9.0 resulting in a moderate risk score of 61. There are currently no agricultural activities in the IPZ-1. For the IPZ-2, the percentage of managed land was < 40% and the livestock density was < 0.5 NU/acre. The Chemical Hazard Score of 6.8 was multiplied by the Vulnerability Score of 7.2 resulting in a low risk score of 49. These risk scores indicate that the managed lands and livestock densities are moderate and low threat in the IPZ-1 and IPZ-2, respectively, for the Amherstburg WTP.

4.2.5.11. Percentage of Impervious Surfaces in IPZs

Please refer to Section 4.1.2.4 (Percentage of Impervious Surface Area in Vulnerable Areas: Groundwater Vulnerability Section of the AR) for a review of the requirements, definitions and methodology of the percentage of impervious surface areas within vulnerable areas. There are four possible categories for the percentage impervious surface

area based on the MOE guidelines: < 1% impervious; 1% to <8% impervious; 8% to <80% impervious and ≥ 80% impervious.

Map 4.44 shows the percent impervious surface area categories in the IPZ-1 and IPZ-2 of the Amherstburg WTP. The results are also summarized in **Table 4.95b**, located at the end of Section4. Based on the vulnerability scores and the percent impervious surface areas, the road salt application land use is considered as a moderate and a low threat in the IPZ-1 and IPZ-2 of the Amherstburg WTP, respectively.

4.2.6. Harrow-Colchester South Water Treatment Plant

This section summarizes the results of technical studies conducted by Stantec Consulting Ltd and Baird & Associates for the Harrow-Colchester South Water Treatment Plant (WTP) in the Essex Region Source Protection Area. The complete details of these technical studies can be found in **Appendix VII, VIII, IX** and **X**. Please refer to Section 4.2.1 of this Assessment Report for the details on concepts, methodology and requirements related to intake classification, intake protection zone delineation, vulnerability scoring, drinking water threats assessment and issues evaluation.

4.2.6.1. Intake Classification

The Harrow-Colchester South Water Treatment Plant (WTP) is located in the Community of Colchester in the Town of Essex. It withdraws its source water from Lake Erie. The treatment processes at the plant include coagulation, flocculation, clarification, filtration and chlorination. The plant also includes taste and odour control and zebra mussel control systems. Other details such as intake pipe diameter, crib depth etc, are summarized in **Table 4.45**. The plant serves around 9,000 people in the southern part of the municipality that encompasses the former Town of Harrow and Township of Colchester South (see **Map 1.1**).

Table 4.45: Overview of the Harrow-Colchester South Water Treatment Plant

Drinking Water System: Harrow-Colchester South Water Treatment Plant	
Operating Authority	The Town of Essex
Mailing Address	405 Clitherow Street, Harrow, ON
System Classification	Type I System (Municipal Residential)
Rated (design) Capacity	10,227 m^3/day
UTM Coordinates	340200 E 4649310 N
Intake Depth	3.8 m (lake bottom); 0.61 m (crib top)
Distance of Intake from Shore	381 m

As per Rule 55 (Part VI.I) (*Technical Rules: Assessment Report CWA, 2006*), the intake of the Harrow-Colchester South WTP was classified as Type A intake. The intake protection

zones (IPZs) for the Harrow-Colchester South WTP were delineated as per the guidelines described in **Table 4.10** (Section 4.2.1.2).

4.2.6.2. Intake Protection Zone -1 (IPZ-1)

As described in Section 4.2.1.2 (**Table 4.10**) the in-water portion of the IPZ-1 for a Type A intake is an area of 1 km radius drawn from the centre point of each intake and if the circle extends onto land, the IPZ-1 includes land up to 120 meters from the high water mark of the water body, or the Regulation Limit, whichever is greater. The major portion of the IPZ-1 for the Harrow-Colchester South WTP is the lake water surface (**Map 4.45)**.

4.2.6.3. Intake Protection Zone -2 (IPZ-2)

The IPZ-2 is a secondary protective zone around the IPZ-1 and is delineated based on the minimum response time required for the plant operator to respond to adverse conditions or a spill and the travel time in the lake and/or tributary. A 2-hour response time was adopted by the Essex Region Source Protection Area based on the Draft Guidance Module 4 (MOE, 2006a) as well as based on interviews with the plant operators and authorities in the Region. There are two components to the IPZ-2, namely the in-water IPZ-2 and upland IPZ-2, the extent of which are determined based on the 2-hour time of travel considering the estimated flow velocities.

The in-water component of the IPZ-2 for the Harrow-Colchester South WTP was delineated by Baird Associates, using hydrodynamic modeling and reverse particle tracking method. Refer to Section 4.2.1 of this Assessment Report and **Appendix VII** for further information relating to the hydrodynamic modeling. The resulting in-water zone extends about 3.9 km east of the intake, 7 km west of the intake and 3.7 km offshore at its furthest extent as illustrated in **Map 4.45**.

The upland IPZ-2 includes the following three major components:

1. Tributaries and streams including municipal drains etc.,
2. A 120 m set back or the area of the Regulation Limit, whichever is greater along the abutted land, and
3. Storm sewersheds; and transport pathways (such as tile drain networks and other drainage systems).

The extents of these components are delineated differently, based on the 2-hour time of travel, using different methods as described in Section 4.2.1. The resulting boundary of the IPZ-2 of the Harrow-Colchester South WTP with various components is illustrated in **Map 4.45.** Refer to the Technical Memorandum prepared by Stantec Consulting Ltd (**Appendix VII**) for further information on the variety of data sources and approaches used to determine the up-land extent of the IPZ-2.

4.2.6.4. Intake Protection Zone-3 (IPZ-3)

As per Rule 68 (Part VI.5) (*Technical Rules: Assessment Report CWA, 2006*) IPZ-3s may be delineated for the *Type A* intakes which extend outward from IPZ-2 to include all rivers and tributaries that may contribute water to the intake under extreme storm event conditions up to a 100 year storm event. Appropriate guidelines for delineation of IPZ-3 are described in **Table 4.10** (Section 4.2.1.2). Baird & Associates conducted the modeling to determine if an IPZ-3 would be required for the Harrow-Colchester South WTP and the details of this study are in **Appendix XIV**.

The methodology is described in Section 4.2.1.2.3. The modeling incorporated both reverse particle tracking (boundary approach) and contaminant transport modeling to determine the boundaries of the in-water IPZ-3. The joint probability analysis previously undertaken by Baird was used to define the 100 year return period event. Five actual wind events and two year return period flow from the Detroit River and the modeled tributaries were used to model the impacts of spills on Lake Erie intakes. Big Creek and Richmond Drain/Cedar Creek were selected for the simulated tanker truck spill contaminant modeling. For each tributary, a road crossing near the headwaters was identified for a spill release. These spill locations are shown in **Figure 2.1** of the Baird and Associates report (August 2013) in **Appendix XIV** and in **Map 4.45c**.

Based on model results, a fuel spill (with 2% benzene, and a volume of 34,000 L) from a tanker truck approximately 13,500 m upstream of the mouth of Big Creek would result in an exceedance of the ODWQS benchmark for benzene at the Harrow-Colchester South WTP. The modeling also indicated that a fuel spill approximately 21,100 m upstream of the mouth of Richmond Drain/Cedar Creek would result in an exceedance of the ODWQS benchmark at the intake.

Baird & Associates recommended that the IPZ-3 delineation be extended, as described in Section 4.2.1.2.3 (IPZ-3 delineation methodology). They recommended that the delineation be extended to the watershed limits of the modeled watercourse, thereby including the headwaters of these watercourses and their tributaries because the time of travel to the spill location from the headwaters is small and dilution unlikely to occur which would still result in an exceedance at the intake. Baird & Associates also recommended that the delineation be extended to the tributaries between the watercourses modeled and the WTP intake, as well as in the vicinity of the intake (i.e. closer to the intake) because these tributaries have a shorter flow path than the modeled watercourses. The area west of the outlet of Big Creek is included in the IPZ-3 because the time of travel to the mouth of Big Creek is shorter than that of the spill location. Based on these recommendations, the IPZ-3 for the Harrow-Colchester South intake was extended to include the headwaters of Big Creek and Richmond Drain/Cedar Creek, and tributaries of both as well as Fox/Dolson's Creek and Colchester Area Drainage.

An off-bank setback of 120 m was applied to all watercourses; however this setback was truncated at subwatersheds as overland flow would be traveling away from the watercourse. As specified in the Technical Rules, the Floodplain Regulation Limit was also used in delineating the extent of the IPZ-3 along subject waterways, where this Limit exceeds the 120 metre setback. The modeling report from Baird & Associates report (August 2013) addressing IPZ-3 delineation for Harrow-Colchester South WTP is in **Appendix XIV**. Refer to **Map 4.45b** for the IPZ-3 delineation**.**

4.2.6.5. Event Based Area

The Event Based Area for Harrow-Colchester South WTP is the combination of all on land portions and in water portions of IPZ-1, IPZ-2 and IPZ-3 (see **section 4.2.1.2.4**). Refer to **Map 4.45c** for the Event Based Area to which the significant drinking water threat policies for the handling and storage of fuel and transportation of fuel along shipping and ferries corridors apply

4.2.6.6. Vulnerability Scoring of IPZs

The vulnerability score (V) is a numerical expression of the susceptibility of the intake to contamination. Vulnerability scores are assigned for each intake protection zone based on the attributes of the intakes (e.g. length and depth), type of source water body, and the physical characteristics of the environment it is situated in. The vulnerability score (V) is calculated by multiplying area vulnerability factor (B) factor by the source vulnerability factor (C) as expressed below:

$$V = B \times C$$

B is the area vulnerability factor relating to each IPZ and relates to features and processes in the local environment that may impact the intake. C is the source vulnerability factor relating to type of water body. The factors that drive the B score include: soil types; slope of the upland area; runoff generation potential; transportation routes; storm sewers; and wastewater discharges. The physical characteristics of the intake (e.g. offshore distance and crib depth), and the quality of raw water and other water quality concerns dictated the C score of the IPZs. Further details on the methodology of vulnerability scoring, and the data sources used in assigning vulnerability scores for the IPZs can be found in Section 4.2.1.3 and the Technical Memorandum prepared by Stantec Consulting Ltd (**Appendix VII**).

The vulnerability zone factor (B) is assigned a value of 10 for the IPZ-1 of the Harrow-Colchester South WTP, which is a set value for IPZ-1s of all types of intakes. The IPZ-2 is assigned a B score of 8. A C score of 0.6 is assigned, based on variety of characteristics of the Harrow-Colchester South WTP intake. Based on these scores, the overall vulnerability score for the IPZ-1 and IPZ-2 of the Harrow-Colchester South WTP was calculated as 6.0 and 4.8 respectively (**Table 4.46** and **Map 4.46**).

Table 4.46: Vulnerability Scores Assigned to IPZ-1s and IPZ-2s of the Harrow-Colchester South WTP

Intake Type	Area Vulnerability Factor (B)		Source Vulnerability Factor (C)	Vulnerability Score (V=BXC)	
	IPZ-1	IPZ-2		IPZ-1	IPZ-2
Type A	10	8	0.6	6	4.8

Finally, these V scores were used in combination with the MOE's Table of Drinking Water Threats to determine the number and types of potential drinking water threats in the respective intake protection zone that are discussed in the following section. As per the MOE's Technical Rules, vulnerability scores are not applicable to IPZ-3s of type A intakes (intakes on Great Lakes). Therefore the Harrow-Colchester South IPZ-3s are not assigned vulnerability scores.

4.2.6.7. Drinking Water Threats

A drinking water threat is defined, according to the MOE, as a chemical or pathogen that poses a potential risk to the drinking water source. Please refer to Section 4.2.1.4 for the list of 21 types of activities that are considered as drinking water threats prescribed by the MOE. These activities may be deemed as significant, moderate, or low drinking water threats in the vulnerable areas through four different approaches as described in Section 4.2.1.4. The following section describes the results of threats assessment obtained through the "threats approach" and the "events based approach."

4.2.6.7.1. Threats Based Approach

The threats approach is based on the quantitative risk score estimation for an activity that is or would be a drinking water threat in a specific vulnerable area. Refer to Section 4.2.1.4 for further details on methodology of the Threats approach. Based on the vulnerability scores of 6.0 and 4.8 that were assigned to IPZ-1 and IPZ-2, respectively, and the MOE's Tables of Drinking Water Threats, the lists of potential drinking water quality threats (significant, moderate and low) were generated for the Harrow-Colchester South WTP. The threats approach study including lists of potential threats based on zone and vulnerability score is provided in **Appendix VIII**.

Table 4.47 summarizes the number of possible drinking water quality threats (chemical and pathogen) that would be deemed as significant, moderate or low drinking water threat if they were to exist in the IPZ-1 and IPZ-2 of the Harrow-Colchester South WTP. These threats were further classified into chemical and pathogen types and are illustrated in **Map 4.47**.

Table 4.47: Number of Potential Drinking Water Quality Threats for the Harrow-Colchester South WTP

Intake Protection Zone	V Score	Number of Potential DW Threats			
		Significant	Moderate	Low	Total
IPZ-1	6.0	0	25	1213	**1238**
IPZ-2	4.8	0	0	447	**447**

NOTE: Number of potential DW threats are based on vulnerability scores and the MOE's Tables of Drinking Water Threats, and do not necessarily exist in the subject IPZs, but would be deemed as significant, moderate or low threats if they were to exist)

The types of activities that may be classified as significant, moderate or low drinking water threats in the IPZ-1 and IPZ-2 of the Harrow-Colchester South WTP are listed in **Table 4.48** and **Table 4.49,** respectively. Activities listed in the tables may be identified as moderate or low drinking water threats depending upon various circumstances such as the quantity and type of chemicals used. The circumstances under which the listed activities would be deemed significant, moderate or low drinking water threats for both IPZ-1 and IPZ-2 are listed in **Appendix IX (E)**. The MOE Tables of Drinking Water Threats can be accessed using the following link:

http://www.essexregionsourcewater.org/downloads/download_tables_of_drinking_water_threats.pdf

The Tables of Circumstances can be accessed using the following link:

https://www.ontario.ca/environment-and-energy/provincial-tables-circumstances

Table 4.48: Summary of Prescribed Potential Drinking Water Threats Based on V Score of 6.0 for IPZ-1 of the Harrow-Colchester South WTP

No.	Prescribed Drinking Water Threat	SIG	MOD	LOW
1	The establishment, operation or maintenance of a system that collects, stores, transmits, treats or disposes of sewage		√	√
2	The establishment, operation or maintenance of a waste disposal site within the meaning of Part V of the Environmental Protection Act		√	√
3	Application of agricultural source material to land		√	√
4	Storage of agricultural source material		√	√
5	Management of agricultural source material			√
6	Application of non-agricultural source material to land		√	√
7	Handling and storage of non-agricultural source material		√	√
8	Application of commercial fertilizer			√
9	Handling and storage of commercial fertilizer			√
10	Application of pesticide			√
11	Handling and storage of pesticide			√
12	Application of road salt			√
13	Handling and storage of road salt			√
14	Storage of snow			√
15	Handling and storage of fuel			√
16	Handling and storage of non-aqueous dense phase liquids			√
17	Handling and storage of organic solvent			√
18	Management of runoff that contains chemicals used in the de-icing of aircraft			√
19	Use of land as livestock grazing or pasturing land, an outdoor confinement area or a farm-animal yard		√	√

NOTE: Types of potential DW threats are based on vulnerability scores and the MOE's Tables of Drinking Water Threats, and do not necessarily exist in the subject IPZs, but would be deemed as significant, moderate or low threats if they were to exist

Table 4.49: Summary of Prescribed Potential Drinking Water Threats Based on V Score of 4.8 for IPZ-2 of the Harrow-Colchester South WTP

No.	Prescribed Drinking Water Threat	SIG	MOD	LOW
1	The establishment, operation or maintenance of a system that collects, stores, transmits, treats or disposes of sewage			√
2	The establishment, operation or maintenance of a waste disposal site within the meaning of Part V of the Environmental Protection Act			√
3	Application of agricultural source material to land			√
4	Storage of agricultural source material			√
5	Management of agricultural source material			
6	Application of non-agricultural source material to land			√
7	Handling and storage of non-agricultural source material			√
8	Application of commercial fertilizer			√
9	Handling and storage of commercial fertilizer			√
10	Application of pesticide			√
11	Handling and storage of pesticide			√
12	Application of road salt			√
13	Handling and storage of road salt			√
14	Storage of snow			√
15	Handling and storage of fuel			√
16	Handling and storage of non-aqueous dense phase liquids			√
17	Handling and storage of organic solvent			√
18	Management of runoff that contains chemicals used in the de-icing of aircraft			√
19	Use of land as livestock grazing or pasturing land, an outdoor confinement area or a farm-animal yard			√

NOTE: Type of potential DW threats are based on vulnerability scores and the MOE's Tables of Drinking Water Threats, and do not necessarily exist in the subject IPZs, but would be deemed as significant, moderate or low threats if they were to exist

4.2.6.7.2. Event Based Threats Approach

As per Technical Rule 68 in conjunction with Rule 130, an activity is or would be a significant drinking water threat in a surface water intake protection zone at the location where an activity is or would be engaged in, if modeling demonstrates that a release of a chemical parameter or pathogen from the activity or proposed activity would be transported through the surface water intake protection zone to the intake and result in a deterioration of the water for use as a source of drinking water. The Essex Region SPC has accepted the Ontario Drinking Water Quality Standard (ODWQS) to identify deterioration of raw water quality at the intake.

The modeling that was completed to delineate the IPZ-3 for the Harrow-Colchester South WTP is described in Section 4.2.6.4, while the general methodology on the events based approach is described in Section 4.2.1.4.4. Further details are described in the modeling report from Baird & Associates (August 2013) addressing IPZ-3 delineation for this WTP is in **Appendix XIV.**

The Essex Region SPC has expressed concern with the potential for fuel spills along transportation corridors, as well as the possible presence of fixed fuel tanks, in close proximity to watercourses and drains within the IPZ-2s and IPZ-3s. Consequently, spill locations of 34,000 L of 2% benzene gasoline were selected for contaminant modeling undertaken by Baird & Associates on Big Creek and Richmond Drain/Cedar Creek as described in section 4.2.6.4. The selection of the location and volume of gasoline is a simulated tanker truck spill that is also considered representative of potential fixed fuel storage locations. Simulated fuel tanker truck spills were used to represent potential fixed fuel storage locations near watercourses and drains within the local area. The modeling simulations identified that a spill location approximately 13,500 m upstream of the mouth of Big Creek and a fuel spill location approximately 21,100 m upstream of the mouth of Richmond Drain/Cedar Creek resulted in an exceedance of the ODWQS for benzene (by 2.5 times and 2.7 times respectively) at the Harrow-Colchester South WTP intake.

From the results of the modeling and level of exceedance, it is reasonable to assume that a substantially reduced spill volume would also result in an exceedance at the intake. The volume of spill and concentration at the intake are not necessarily proportional but it is

reasonable to deduce that a reduction of approximately 50% or more in spill volume would also result in a significant threat. Based upon the modeling completed to date and interpretation of the results it is logical to assume that a spill volume of approximately 15,000 L from existing or planned above ground fixed fuel storage sites as well as transportation of fuel along shipping and ferries corridors be considered as significant threats.

Consequently, existing and future fixed fuel storage sites and transportation of fuel along shipping and ferries corridors of 15,000 L or greater in the Event Based Area for Harrow-Colchester South WTP (**Map 4.45c**), would be considered to be significant threats as they would inherently deteriorate the quality of source water in the event of a spill. **Table 4.50** provides a summary of the potential significant threats criteria based on the modeling work as described above for the Harrow-Colchester South WTP.

Table 4.50: Potential Significant Threats Criteria for the Harrow-Colchester South WTP for 2% Benzene in Fuel

WTP	EBA Storage Volume (L)
Harrow-Colchester South	15,000 L

4.2.6.7.3. Local Threats

The transportation of fuel, organic solvents, DNAPLs, pesticides/herbicides and fertilizers was approved by the Director as a local threat in August 2011 (see **Section 4.2.1.4.5** and **Appendix XIII**). The threat level for all identified local threats in IPZs must be assessed using the vulnerability score, for more details see Director's Letter dated August 2011 (**Appendix XIII)**. Table **4.51** shows the classification of these local threats as moderate or low drinking water threats based on the vulnerability score of each IPZ for the Harrow-Colchester WTP. Note that the transportation of fuel (2% benzene) was determined to be a significant threat in the EBA of Harrow-Colchester WTP using the events based approach. No other substances have been modeled at this time.

Table 4.51: Threat level for Local Threats (transportation of various substances) for Harrow-Colchester WTP

IPZ	Vulnerability Score	Significant	Moderate	Low
1	**6**			√
2	**4.8**			
3	**N/A**			

4.2.6.7.4. Existing Significant Drinking Water Threats:

Using the threats based approach, it is not possible to have any significant threats based on the vulnerability scores in IPZ-1 (6.0), IPZ-2 (4.8) or IPZ-3 (no vulnerability score) of the Harrow-Colchester South WTP (see **Table 4.47).**

For the events based approach, a desktop GIS exercise was performed to identify existing sites with greater than 15,000 L of above ground fuel storage in the EBA for the Harrow-Colchester South WTP using established criteria (fuel with 2% benzene, at volumes of 15,000 L, see **Table 4.50**). Information from fuel providers in Essex County, Google Street View, and 2013 aerial photography overlaid with the EBA delineation using ESRI ArcGIS 10.2.2 for Desktop, were all used to determine the locations of fuel storage and approximate size of fuel storage tanks. For the Harrow-Colchester South WTP this resulted in 21 unconfirmed fuel threats. **Table 4.52** summarizes the existing significant drinking water threats for the EBA of the Harrow-Colchester South WTP. Also, **Map 4.45c** shows the number of existing significant threats in the EBA.

Table 4.52: Number of *Existing Unconfirmed Significant Drinking Water Threats* in the EBA of the Harrow-Colchester South WTP

Specific Land Use Activity	Number of Threats	Uncertainty
Above ground fuel storage *	**21**	High

***Identified through events based modeling**

4.2.6.8. Drinking Water Issues

As further described in Section 4.2.1.5, a drinking water *issue* is defined as the presence of a parameter, listed in Schedules 1, 2, or 3 of O. Reg 170/03, or Table 4 of the Technical Support Document for the Ontario Drinking Water Quality Standards (ODWQS) Objectives and Guidelines, at a concentration, that may result in the deterioration of the quality of water for use as a source of drinking water. The process of issue evaluation is explained in more detail in the Proposed Issues Evaluation Methodology Report (**Appendix VI)**.

Initial screening of the raw water quality data for the Harrow-Colchester South WTP flagged *E. coli*, total coliform (Schedule 1 Parameter), aluminum, colour, hardness, iron, organic nitrogen and turbidity (Table 4 Parameters). Further assessment of the raw water data for these flagged parameters identified only aluminum, turbidity and organic nitrogen as drinking water quality issues for the Harrow-Colchester South WTP. These identified issues are summarized for the Harrow-Colchester South WTP intake in **Table 4.53**. Further details on methodology, variety of data sets used and results of issues evaluation can be found in the Technical Memorandum on Issue Evaluation for the Essex Region WTPs (**Appendix X**). Sources contributing to these issues are yet to be determined.

In 2013, at the request of municipalities and the recommendation of the Source Protection Committee, and in response to the growing concerns related to re-emergence of blue-green algae and microcystins in the Great Lakes, ERCA received funding from the MOE through the Source Protection Program to complete additional technical studies to determine whether microcystin-LR should be considered a drinking water issue for Lake Erie intakes. Microcystin-LR is a neurotoxin produced by blue-green algae (cyanobacteria). Cyanobacteria blooms occur annually in Lake Erie and are increasing in size and severity and affect the operations of drinking water treatment plants. Further details on methodology, data sets evaluated and results of issues evaluation can be found in the Technical Memorandum on Issue Evaluation for Microcystin-LR at Lake Erie Drinking Water intakes in the Essex Region (**Appendix XV)**. Using the issue evaluation methodology and available data, the Essex Region SPC determined that microcystin-LR is a drinking water issue under the Clean Water Act pursuant to rule 115.1 at all Lake Erie

intakes, including Harrow-Colchester South WTP, because total microcystins levels in the raw water at the Lake Erie drinking water intakes has, on occasion, been above 50% of the maximum allowable concentration (MAC) for drinking water (1.5 µg/L). Data from Harrow-Colchester, Union and Wheatley WTP were considered together in this decision. Phosphorus modelling was completed to determine the contribution from Lake Erie tributaries, however the results were inconclusive and the sources contributing to this issue are yet to be determined.

Table 4.53: Summary of Issues Identified at the Intake of the Harrow-Colchester South WTP

Identified Issues*	Data Source & Duration of Data	Result of Issue Evaluation	Natural or Anthropogenic Source
Aluminum	DWSP (1987-2006)	Approximately 60% of the raw water samples collected over a 10 year period exceeded the 100% OG benchmark for aluminum (0.1 mg/L). A linear increasing trend was also observed in the same dataset.	Possibly from both anthropogenic and natural sources.
Turbidity	DWSP (1987-2006)	Over 53% of the raw water samples collected over a 10 year period exceeded the 100% AO benchmark for turbidity (5 NTU). A linear increasing trend was also observed in the same dataset.	Possibly from both anthropogenic and natural sources.
Organic Nitrogen	DWSP (1987-2006)	Over 98% of the raw water samples collected over a 10 year period exceeded the 100% OG benchmark. A linear increasing trend was also observed in the same dataset.	Possibly from both anthropogenic and natural sources.
Microcystin-LR	DWSP (2011-2013)	Total microcystins concentrations exceeded the maximum allowable concentration for drinking water (1.5 ug/L) in the raw water at Lake Erie drinking water intakes on a few occasions consistent with those expected to occur during algal blooms. Limited data did not allow for the evaluation of trends.	Predominantly from anthropogenic sources.

*Identified according to Technical Rule 115.1

Further studies may assist in identifying the sources of the identified issues. These investigations could include extensive sampling and analysis of the parameters of concern (i.e. turbidity, aluminum, organic nitrogen and microcystins). Studies of the correlation between wind and run-off events and turbidity levels at the intake as well as those which continue to examine the contribution of phosphorus from Lake Erie intakes may assist in determining the sources of issues. Currently, this information is a gap. Refer to Section 4.3.3 for further information on data gaps related to issues evaluation. If information becomes available to the SPC that indicates the sources of issues to be wholly or partially anthropogenic, then issue contributing areas, and the activities contributing to the issues would be determined in a future assessment report.

4.2.6.9. Conditions

Conditions are areas, result of past activities, where there is an existing contamination, for example contaminated soil at an old industrial site that is no longer in use, that may be considered as a drinking water threat. Based on a preliminary investigation by Stantec Consulting (report from December 2010, in **Appendix X**) conducted on available surface water, groundwater, sediment and soil pollution data in the Region, some conditions have been identified in the sediment (based on one sample only), in the IPZ-2 of the Harrow Colchester South Water Treatment Plant. However there was a lack of data to establish off-site contamination due to the conditions. Also there was no soil data. Based on a hazard score of 6, the conditions resulted in no drinking water threats. The threats due to conditions in the Essex Region SPA may be further assessed as the new information is gathered during future updates of the Assessment Report.

4.2.6.10. Percentage of Managed Lands and Livestock Density in IPZs

Please refer to Section 4.1.2.3 (Percentage of Managed Lands and Livestock Density in Vulnerable Areas) for a review of the requirements, definitions and methodology of the percentage of managed lands and livestock density within vulnerable areas.

Maps 4.48 and **4.49** show the percent managed land category and the livestock density category, respectively, in the IPZs of the Harrow-Colchester South WTP. The Guidelines provided by the MOE are shown in **Table 4.20.** For IPZ-1, the percentage of managed land

was found to be 40 – 80% and the livestock density was < 0.5 NU/acre. The accompanying Chemical Hazard Score of 7.6 was multiplied by the Vulnerability Score of 6.0 resulting in a low risk score of 46. For the IPZ-2, the percentage of managed land was > 80% and the livestock density was < 0.5 NU/acre. The Chemical Hazard Score of 8.8 was multiplied by the Vulnerability Score of 4.8 resulting in a low risk score of 42. These scores indicate that the managed lands and livestock densities are low threats in the IPZ-1 and IPZ-2 of the Harrow-Colchester South WTP.

4.2.6.11. Percentage of Impervious Surfaces in IPZs

Please refer to Section 4.1.2.4 (Percentage of Impervious Surface Area in Vulnerable Areas: Groundwater Vulnerability Section of the AR) for a review of the requirements, definitions and methodology of the percentage of impervious surface areas within vulnerable areas. There are four possible categories for the percentage impervious surface area based on the MOE guidelines: < 1% impervious; 1% to <8% impervious; 8% to <80% impervious and ≥ 80% impervious.

Map 4.50 shows the impervious surface areas in the IPZ-1 and IPZ-2 of the Harrow-Colchester South WTP. The results are also summarized in **Table 4.95b**, located at the end of Section 4. Based on the respective vulnerability scores and the percent impervious surface area, the road salt application land use is considered as a low threat in the IPZ-1 and no threat in the IPZ-2 of the Harrow-Colchester South WTP.

4.2.7. Union Water Treatment Plant

This section summarizes the results of technical studies conducted by Stantec Consulting Ltd and Baird & Associates for the Union Water Treatment Plant (WTP) in the Essex Region Source Protection Area. The complete details of these technical studies can be found in **Appendix VII, VIII, IX** and **X**. Please refer to Section 4.2.1 of this Assessment Report for the details on concepts, methodology and requirements related to intake classification, intake protection zone delineation, vulnerability scoring, drinking water threats assessment and issues evaluation.

4.2.7.1. Intake Classification

The Union Water Treatment Plant (WTP) is located on Union Avenue in the Community of Ruthven in the Town of Kingsville. It withdraws its source water from Lake Erie. The treatment processes at the plant include coagulation, flocculation, clarification, filtration, and primary & secondary disinfection. The plant also uses sodium hypochlorite at the mouth of intakes to control zebra mussel. Other details such as intake pipe diameter, crib depth etc, are summarized in **Table 4.54**. The plant serves around 57,000 people in the Town of Kingsville, Municipality of Leamington, a part of the Town of Essex, and a part of the Town of Lakeshore (see **Map 1.1**).

Table 4.54: Overview of the Union Water Treatment Plant

Drinking Water System: Union Water Treatment Plant	
Operating Authority	The Town of Essex, Town of Kingsville and Municipality of Leamington. Plant operated by Ontario Clean Water Agency
Location	1615 Union Avenue, Ruthven, ON
System Classification	Type I System (Municipal Residential)
Rated (design) Capacity	124,588 m^3/day
UTM Coordinates	361450.82 E 4654734.97 N
Intake Depth	Primary Intake: 7.5 m (lake bottom); 5.1 m (crib top) Emergency Intake: 4.9 m(lake bottom); 2.4 m (crib top)
Distance of Intake from Shore	Primary Intake: 1,054 m Emergency Intake: 441 m

The Union WTP has two intakes namely Primary (south) intake and Emergency (north) intake; and both of these intakes are classified as Type A intakes, as per Rule 55 (Part VI.I) (*Technical Rules: Assessment Report CWA, 2006*). The IPZs for both intakes of the Union WTP were delineated as per the guidelines described in **Table 4.10** (Section 4.2.1.2).

4.2.7.2. Intake Protection Zone -1 (IPZ-1)

As described in Section 4.2.1.2 (**Table 4.10**) the in-water portion of the IPZ-1 for a Type A intake is an area of 1 km radius drawn from the centre point of the intake and if the circle extends onto land, the IPZ-1 includes land up to 120 meters from the high water mark of the water body, or the Regulation Limit. The IPZ-1s for the Primary intake and Emergency intake of the Union WTP are shown in **Map 4.51** and **Map 4.52**, respectively. The IPZ-1 for Primary intake is entirely in the waters of the lake, while some portion of the IPZ-1 for Emergency intake covers the land.

4.2.7.3. Intake Protection Zone -2 (IPZ-2)

The IPZ-2 is a secondary protective zone around the IPZ-1 and is delineated based on the minimum response time required for the plant operator to respond to adverse conditions or a spill and the travel time in the lake and/or tributary. A 2-hour response time is adopted by the Essex Region Source Protection Area based on the Draft Guidance Module 4 (MOE, 2006a) as well as based on interviews with the plant operators and authorities in the Region. There are two components to the IPZ-2, namely the in-water IPZ-2 and upland IPZ-2, the extent of which are determined based on the 2-hour time of travel considering the estimated flow velocities.

The in-water component of IPZ-2s for the Union WTP was delineated by Baird Associates, using hydrodynamic modeling and reverse particle tracking method. Refer to Section 4.2.1 of this Assessment Report and **Appendix VII** for further information relating to the hydrodynamic modeling. The in-water component of the IPZ-2 for the Primary intake extends about 2 km east of the intake, 4 km west of the intake and 6.5 km offshore at its furthest extent as illustrated in **Map 4.51**. The in-water component of the IPZ-2 for the Emergency intake extends about 1.3 km east of the intake, 4 km west of the intake and 4 km offshore at its furthest extent as illustrated in **Map 4.52**.

The upland IPZ-2 includes the following three major components:

1. Tributaries and streams including municipal drains etc.,
2. A 120 m set back or the area of the Regulation Limit, whichever is greater along the abutted land, and
3. Storm sewersheds; and Transport pathways (such as tile drain networks and other drainage systems).

The extents of these components are delineated differently, based on the 2-hour time of travel, using different methods as described in Section 4.2.1. The resulting boundaries of the IPZ-2s of the Union WTP with various components are illustrated in **Map 4.51** (Primary intake) and **Map 4.52** (Emergency intake). Refer to the Technical Memorandum (**Appendix VII**) for further information on variety of data sources and approaches used to determine the up-land extent of the IPZ-2.

4.2.7.4. Intake Protection Zone-3 (IPZ-3)

As per Rule 68 (Part VI.5) (*Technical Rules: Assessment Report CWA, 2006*) IPZ-3s may be delineated for the *Type A* intakes which extend outward from IPZ-2 to include all rivers and tributaries that may contribute water to the intake under extreme storm event conditions up to a 100 year storm event. Appropriate guidelines for delineation of IPZ-3 are described in **Table 4.7** (Section 4.2.1.2). Baird & Associates conducted the modeling to determine if an IPZ-3 would be required for the Union WTP and the details of this study are in **Appendix XIV**.

The methodology is described in Section 4.2.1.2.3. The modeling incorporated both reverse particle tracking (boundary approach) and contaminant transport modeling to determine the boundaries of the in-water IPZ-3. The joint probability analysis previously undertaken by Baird was used to define the 100 year return period event. Five actual wind events and two year return period flow from the Detroit River and the modeled tributaries were used to model the impacts of spills on Lake Erie intakes. Richmond Drain/Cedar Creek and Sturgeon Creek were selected for the simulated tanker truck spill contaminant modeling. For each tributary, a road crossing near the headwaters was identified for a spill release. These spill locations are shown in **Figure 2.1** of the Baird and Associates report (August 2013) in **Appendix XIV** and in **Maps 4.51c** and **4.52c**.

Based on model results, a fuel spill (with 2% benzene, and a volume of 34,000 L) from a tanker truck approximately 21,100 m upstream of the mouth of Richmond Drain/Cedar Creek would result in an exceedance of the ODWQS benchmark for benzene at the Union WTP. The modeling also indicated that a fuel spill approximately 12,500 m upstream of the mouth of Sturgeon Creek would result in an exceedance of the ODWQS benchmark at the intakes.

Baird & Associates recommended that the IPZ-3 delineation be extended, as described in Section 4.2.1.2.3 (IPZ-3 delineation methodology). They recommended that the delineation be extended to the watershed limits of the modeled watercourse, thereby including the headwaters of these watercourses and their tributaries because the time of travel to the spill location from the headwaters is small and dilution unlikely to occur which would still result in an exceedance at the intake. Baird & Associates also recommended that the delineation be extended to the tributaries between the watercourses modeled and the WTP intakes, as well as in the vicinity of the intakes (i.e. closer to the intakes) because these tributaries have a shorter flow path than the modeled watercourses. Although the area just north of Point Pelee does not drain into Sturgeon Creek, Baird and Associates recommended including it in the IPZ-3 because it is pumped to an outlet near the mouth of Sturgeon Creek. The time of travel from this area to the mouth of Sturgeon Creek is shorter than that from the modeled spill location and it is therefore reasonable that a fuel spill would result in an exceedance at the Union WTP intakes. It was also recommended to include the tributaries and in water area along the west shore of Point Pelee. Additionally, Point Pelee has been added to the IPZ-3 because the in water portion of both sides is included either in the Union IPZ-3 or Wheatley IPZ-3 and spills on land may also reach the intakes. Although these areas were not modeled, it was felt that it would be reasonable to include these areas in the IPZ-3. Based on these recommendations, the IPZ-3 for the Union intakes was extended to include the headwaters of Richmond Drain/Cedar Creek and Sturgeon Creek, and tributaries of both as well as Wigle Creek, Mill Creek, Point Pelee and Leamington Area Drainage.

An off-bank setback of 120 m was applied to all watercourses; however this setback was truncated at subwatersheds as overland flow would be traveling away from the

watercourse. As specified in the Technical Rules, the Floodplain Regulation Limit was also used in delineating the extent of the IPZ-3 along subject waterways, where this Limit exceeds the 120 m setback. The modeling report from Baird & Associates report (August 2013) addressing IPZ-3 delineation for Union WTP is in **Appendix XIV**. Refer to **Map 4.51b** and **Map 4.52b** for the IPZ-3 delineations for the primary and emergency intakes of the Union WTP**.**

4.2.7.5. Event Based Area

The Event Based Area for Union WTP is the combination of most on land portions and in water portions of IPZ-1, IPZ-2 and IPZ-3 (see **section 4.2.1.2.4**). Point Pelee, the tributaries on the west shore of Point Pelee and the in water portion in Lake Erie west of Point Pelee have been excluded from the EBA because there is high uncertainty that fuel storage or transportation in these areas would result in a significant drinking water threat. Refer to **Maps 4.51c and 4.52c (Primary and Emergency intakes, respectively)** for the Event Based Area to which the significant drinking water threat policies for the handling and storage of fuel and transportation of fuel along shipping and ferries corridors apply.

4.2.7.6. Vulnerability Scoring of IPZs

The vulnerability score (V) is a numerical expression of the susceptibility of the intake to contamination. Vulnerability scores are assigned for each intake protection zone based on the attributes of the intakes (e.g. length and depth), type of source water body, and the physical characteristics of the environment it is situated in. The vulnerability score (V) is calculated by multiplying area vulnerability factor (B) factor by the source vulnerability factor (C) as expressed below:

$$V = B \times C$$

B is the area vulnerability factor relating to each IPZ and relates to features and processes in the local environment that may impact the intake. C is the source vulnerability factor relating to type of water body. The factors that drive the B score include: soil types; slope of the upland area; runoff generation potential; transportation routes; storm sewers; and wastewater discharges. The physical characteristics of the intake (e.g. offshore distance and crib depth), and the quality of raw water and other water quality concerns dictated the C score of the IPZs. Further details on the methodology of vulnerability scoring, variety of

data sources used in assigning vulnerability scores for the IPZs can be found in Section 4.2.1.3 and the Technical Memorandum prepared by Stantec Consulting Ltd (**Appendix VII**).

The area vulnerability factor (B) is assigned a value of 10 for the IPZ-1s of the Union WTP, which is a set value for IPZ-1s of all types of intakes. The B and C scores that were assigned to the IPZ-1s and IPZ-2s and the resulting overall vulnerability scores for the IPZ-1s and IPZ-2s of the Union WTP are summarized in **Table 4.55** and **Maps 4.53 and 4.54**.

Table 4.55: Vulnerability Scores Assigned to IPZ-1s and IPZ-2s of the Union WTP

Intake	Area Vulnerability Factor (B)		Source Vulnerability Factor (C)	Vulnerability Score (V=BXC)	
	IPZ-1	IPZ-2		IPZ-1	IPZ-2
Primary Intake	10	8	0.5	5.0	4.0
Emergency Intake	10	8	0.6	6.0	4.8

Finally, these V scores were used in combination with the MOE's Tables of Drinking Water Threats to determine the number and types of potential drinking water threats in the respective intake protection zone that are discussed in the following section. As per the MOE's Technical Rules, vulnerability scores are not applicable to IPZ-3s of type A intakes (intakes on Great Lakes). Therefore the Union IPZ-3s are not assigned vulnerability scores.

4.2.7.7. Drinking Water Threats

A drinking water threat is defined, according to the MOE, as a chemical or pathogen that poses a potential risk to the drinking water source. Please refer to Section 4.2.1.4 for the list of 21 types of activities that are considered as drinking water threats prescribed by the MOE. The following section describes the results of threats assessment obtained through the "threats approach" and the "events based approach".

4.2.7.7.1. Threats Based Approach

The threats approach is based on the quantitative risk score estimation for an activity that is or would be a drinking water threat in a specific vulnerable area. Refer to Section 4.2.1.4 for further details on methodology of the Threats approach. Based on the vulnerability

scores and the MOE's Tables of Drinking Water Threats, the lists of potential drinking water quality threats (significant, moderate and low) were generated for the Union WTP. The threats approach study including lists of potential treats based on zone and vulnerability score is provided in **Appendix VIII**.

Table 4.56 summarizes the number of possible drinking water quality threats (chemical and pathogen) that would be deemed as significant, moderate or low drinking water threat if they were to exist in the IPZ-1s and IPZ-2s of the Union WTP. These threats were further classified into chemical and pathogen types and are illustrated in **Map 4.55** and **Map 4.56** for Primary intake and Emergency intake, respectively.

Table 4.56: Number of Potential Drinking Water Quality Threats for the Union WTP

Intake Protection Zone	V Score	Number of Potential DW Threats			
		Significant	Moderate	Low	Total
Primary Intake					
IPZ-1	5.0	0	0	572	572
IPZ-2	4.0	0	0	0	
Emergency Intake					
IPZ-1	6.0	0	25	1213	1238
IPZ-2	4.8	0	0	447	447

NOTE: Number of potential DW threats are based on vulnerability scores and the MOE's Tables of Drinking Water Threats, and do not necessarily exist in the subject IPZs, but would be deemed as significant, moderate or low threats if they were to exist

The types of activities that may be classified as significant, moderate or low drinking water threats in the IPZ-1s and IPZ-2s of the Union WTP are listed in **Tables 4.57 to 4.59**. Activities listed in the tables may be identified as moderate or low drinking water threats depending upon various circumstances such as the quantity and type of chemicals used. The circumstances under which the listed activities would be deemed significant, moderate or low drinking water threats for both IPZ-1 and IPZ-2 are listed in **Appendix IX (F)**. The MOE Tables of Drinking Water Threats can be accessed using the following link: http://www.essexregionsourcewater.org/downloads/download_tables_of_drinking_water_threats.pdf The Tables of Circumstances can be accessed using the following link:

https://www.ontario.ca/environment-and-energy/provincial-tables-circumstances

Table 4.57: Summary of Prescribed Potential Drinking Water Threats Based on V Score of 5.0 for the IPZ-1 of the Union WTP (Primary Intake)

No.	Prescribed Drinking Water Threat	SIG	MOD	LOW
1	The establishment, operation or maintenance of a system that collects, stores, transmits, treats or disposes of sewage			√
2	The establishment, operation or maintenance of a waste disposal site within the meaning of Part V of the Environmental Protection Act			√
3	Application of agricultural source material to land			√
4	Storage of agricultural source material			√
5	Management of agricultural source material			
6	Application of non-agricultural source material to land			√
7	Handling and storage of non-agricultural source material			√
8	Application of commercial fertilizer			√
9	Handling and storage of commercial fertilizer			√
10	Application of pesticide			√
11	Handling and storage of pesticide			√
12	Application of road salt			√
13	Handling and storage of road salt			√
14	Storage of snow			√
15	Handling and storage of fuel			√
16	Handling and storage of non-aqueous dense phase liquids			√
17	Handling and storage of organic solvent			√
18	Management of runoff that contains chemicals used in the de-icing of aircraft			√
19	Use of land as livestock grazing or pasturing land, an outdoor confinement area or a farm-animal yard			√

NOTE: Types of potential DW threats are based on vulnerability scores and the MOE's Tables of Drinking Water Threats, and do not necessarily exist in the subject IPZs, but would be deemed as significant, moderate or low threats if they were to exist

Table 4.58: Summary of Prescribed Potential Drinking Water Threats Based on V Score of 6.0 for the IPZ-1 of the Union WTP (Emergency Intake)

No.	Prescribed Drinking Water Threat	SIG	MOD	LOW
1	The establishment, operation or maintenance of a system that collects, stores, transmits, treats or disposes of sewage		√	√
2	The establishment, operation or maintenance of a waste disposal site within the meaning of Part V of the Environmental Protection Act		√	√
3	Application of agricultural source material to land		√	√
4	Storage of agricultural source material		√	√
5	Management of agricultural source material			
6	Application of non-agricultural source material to land		√	√
7	Handling and storage of non-agricultural source material		√	√
8	Application of commercial fertilizer			√
9	Handling and storage of commercial fertilizer			√
10	Application of pesticide			√
11	Handling and storage of pesticide			√
12	Application of road salt			√
13	Handling and storage of road salt			√
14	Storage of snow			√
15	Handling and storage of fuel			√
16	Handling and storage of non-aqueous dense phase liquids			√
17	Handling and storage of organic solvent			√
18	Management of runoff that contains chemicals used in the de-icing of aircraft			√
19	Use of land as livestock grazing or pasturing land, an outdoor confinement area or a farm-animal yard		√	√

NOTE: Types of potential DW threats are based on vulnerability scores and the MOE's Tables of Drinking Water Threats, and do not necessarily exist in the subject IPZs, but would be deemed as significant, moderate or low threats if they were to exist

Table 4.59: Summary of Prescribed Potential Drinking Water Threats Based on V Score of 4.8 for the IPZ-2 of the Union WTP (Emergency Intake)

No.	Prescribed Drinking Water Threat	SIG	MOD	LOW
1	The establishment, operation or maintenance of a system that collects, stores, transmits, treats or disposes of sewage			√
2	The establishment, operation or maintenance of a waste disposal site within the meaning of Part V of the Environmental Protection Act			√
3	Application of agricultural source material to land			√
4	Storage of agricultural source material			√
5	Management of agricultural source material			
6	Application of non-agricultural source material to land			√
7	Handling and storage of non-agricultural source material			√
8	Application of commercial fertilizer			√
9	Handling and storage of commercial fertilizer			√
10	Application of pesticide			√
11	Handling and storage of pesticide			√
12	Application of road salt			√
13	Handling and storage of road salt			√
14	Storage of snow			√
15	Handling and storage of fuel			√
16	Handling and storage of non-aqueous dense phase liquids			√
17	Handling and storage of organic solvent			√
18	Management of runoff that contains chemicals used in the de-icing of aircraft			√
19	Use of land as livestock grazing or pasturing land, an outdoor confinement area or a farm-animal yard			√

NOTE: Types of potential DW threats are based on vulnerability scores and the MOE's Tables of Drinking Water Threats, and do not necessarily exist in the subject IPZs, but would be deemed as significant, moderate or low threats if they were to exist

4.2.7.7.2. Events Based Approach

As per Technical Rule 68 in conjunction with Rule 130, an activity is or would be a significant drinking water threat in a surface water intake protection zone at the location where an activity is or would be engaged in, if modeling demonstrates that a release of a chemical parameter or pathogen from the activity or proposed activity would be transported through the surface water intake protection zone to the intake and result in a deterioration of the water for use as a source of drinking water. The Essex Region SPC has accepted the Ontario Drinking Water Quality Standard (ODWQS) to identify deterioration of raw water quality at the intake.

The modeling that was completed to delineate the IPZ-3 for the Union WTP is described in Section 4.2.7.4, while the general methodology on the events based approach is described in Section 4.2.1.4.4. Further details are described in the modeling report from Baird & Associates (August 2013) addressing IPZ-3 delineation for this WTP in **Appendix XIV.**

The Essex Region SPC has expressed concern with the potential for fuel spills along transportation corridors, as well as the possible presence of fixed fuel tanks, in close proximity to watercourses and drains within the IPZ-2s and IPZ-3s. Consequently, spill locations of 34,000 L of 2% benzene gasoline were selected for contaminant modeling undertaken by Baird & Associates on Richmond Drain/Cedar Creek and Sturgeon Creek as described in section 4.2.7.4. The selection of the location and volume of gasoline is a simulated tanker truck spill that is also considered representative of potential fixed fuel storage locations. Simulated fuel tanker truck spills were used to represent potential fixed fuel storage locations near watercourses and drains within the local area. The modeling simulations identified that a spill location approximately 21,100 m upstream of the mouth of Richmond Drain/Cedar Creek and a fuel spill location approximately 12,500 m upstream of the mouth of Sturgeon Creek resulted in an exceedance of the ODWQS for benzene (by 10.7 times and 1.4 times respectively) at the Union WTP intakes.

From the results of the modeling and level of exceedance, it is reasonable to assume that a substantially reduced spill volume would also result in an exceedance at the intake in Richmond Drain/Cedar Creek and surrounding watercourses. The volume of spill and

concentration at the intake are not necessarily proportional but it is reasonable to deduce that a reduction of approximately 50% or more in spill volume would also result in a significant threat. Based upon the modeling completed to date and interpretation of the results it is logical to assume that a spill volume of approximately 15,000 L from existing or planned above ground fixed fuel storage sites be considered as significant threats. Because the modeled spill on Sturgeon Creek resulted in a mild exceedance at the Union WTP intake, a spill volume of approximately 34, 000 L from existing or planned above ground fixed fuel storage sites as well as transportation of fuel along shipping and ferries corridors should be considered as significant threats.

Consequently in the Cedar Creek, Wigle Creek, Mill Creek and Leamington Area Drainage watersheds of the Event Based Area for the Union WTP (**Maps 4.51c** and **4.52c**), existing and future fixed fuel storage sites and transportation of fuel along shipping and ferries corridors of 15,000 L or greater would be considered to be significant threats as they would inherently deteriorate the quality of source water in the event of a spill. In the Sturgeon Creek watershed of the EBA for the Union WTP (**Maps 4.51c** and **4.52c**), existing and future fixed fuel storage sites as well as transportation of fuel along shipping and ferries corridors of 34,000 L or greater would be considered to be significant threats. **Table 4.60** provides a summary of the potential significant threats criteria based on the modeling work as described above for the Union WTP.

Table 4.60: Potential Significant Threats Criteria for the Union WTP for 2% Benzene in Fuel

WTP	EBA (Cedar/Wigle/Mill Creeks, Leamington Area Drainage) Storage Volume (L)	EBA (Sturgeon Creek) Storage Volume (L)
Union	15,000 L	34,000 L

4.2.7.7.3. Local Threats

The transportation of fuel, organic solvents, DNAPLs, pesticides/herbicides and fertilizers was approved by the Director as a local threat in August 2011 (see **Section 4.2.1.4.5** and **Appendix XIII**). The threat level for all identified local threats in IPZs must be assessed using the vulnerability score, for more details see Director's Letter dated August 2011

(**Appendix XIII)**. Table **4.61** shows the classification of these local threats as moderate or low drinking water threats based on the vulnerability score of each IPZ for the Union WTP. Note that the transportation of fuel (2% benzene) was determined to be a significant threat in the EBA of Union WTP using the events based approach. No other substances have been modeled at this time.

Table 4.61: Threat level for Local Threats (transportation of various substances) for Union WTP

IPZ	Vulnerability Score	Significant	Moderate	Low
1 (Primary)	**5.0**			√
1 (Emergency)	**6.0**			√
2 (Primary)	**4.0**			
2 (Emergency)	**4.8**			
3	**N/A**			

4.2.7.7.4. Existing Significant Drinking Water Threats

Using the threats based approach, it is not possible to have any significant threats based on the vulnerability scores in IPZ-1 (vulnerability score = 5.0 (P); 6.0 (E)), IPZ-2 (vulnerability score = 4.0 (P); 4.8(E)) or IPZ-3 (no vulnerability score) of the Union WTP (see **Table 4.47).**

For the events based approach, a desktop GIS exercise was performed to identify existing sites with greater than 15,000 L or 34,000 L of above ground fuel storage in the EBA for Union WTP using established criteria (fuel with 2% benzene, at volumes of 15,000 L or 34,000 L see Table 4.60). Information from fuel providers in Essex County, Google Street View, and 2013 aerial photography overlaid with the EBA delineation using ESRI ArcGIS 10.2.2 for Desktop, were all used to determine the locations of fuel storage and approximate size of fuel storage tanks. For the Union WTP this resulted in 146 unconfirmed fuel threats for both the primary and emergency intakes. **Table 4.62** summarizes the existing significant drinking water threats for the EBA of the Union WTP. Also, **Maps 4.51c and 4.52c** show the number of existing significant threats in the EBA.

Table 4.62: Number of Unconfirmed Existing Significant Drinking Water Threats in the EBAs of the Union WTP

Specific Land Use Activity	Number of Threats	Uncertainty
Above ground fuel storage (Cedar/Wigle/Mill Creeks, Leamington Area Drainage)*	**95**	High
Above ground fuel storage (Sturgeon Creek Drainage) *	**51**	High

***Identified through events based modeling**

4.2.7.8. Drinking Water Issues

As further described in Section 4.2.1.5, a drinking water *issue* is defined as the presence of a parameter, listed in Schedules 1, 2, or 3 of O. Reg 170/03, or Table 4 of the Technical Support Document for the Ontario Drinking Water Quality Standards (ODWQS) Objectives and Guidelines, at a concentration, that may result in the deterioration of the quality of water for use as a source of drinking water. The process of issue evaluation is explained in more detail in the Proposed Issues Evaluation Methodology Report (June 2009) that was adopted by the Essex Region Source Protection Committee (**Appendix VI**).

Initial screening of the raw water quality data for the Union WTP flagged *E. coli*, total coliform (Schedule 1 Parameter), aluminum, colour, hardness, iron, organic nitrogen and turbidity (Table 4 Parameters). Further assessment of the raw water data for these flagged parameters identified only aluminum, turbidity and organic nitrogen as drinking water quality issues for the Union WTP. These identified issues are summarized for the Union WTP intake in **Table 4.63**. Further details on methodology, variety of data sets used and results of issues evaluation, can be found in the Technical Memorandum on Issue Evaluation for the Essex Region WTPs, prepared by Stantec Consulting Ltd (**Appendix X**). Sources contributing to these issues are yet to be determined.

In 2013, at the request of municipalities and the recommendation of the Source Protection Committee, and in response to the growing concerns related to re-emergence of blue-green algae and microcystins in the Great Lakes, ERCA received funding from the MOE through the Source Protection Program to complete additional technical studies to determine whether microcystin-LR should be considered a drinking water issue for Lake Erie intakes.

Microcystin-LR is a neurotoxin produced by blue-green algae (cyanobacteria). Cyanobacteria blooms occur annually in Lake Erie and are increasing in size and severity and affect the operations of drinking water treatment plants. Further details on methodology, data sets evaluated and results of issues evaluation can be found in the Technical Memorandum on Issue Evaluation for Microcystin-LR at Lake Erie Drinking Water intakes in the Essex Region (**Appendix XV)**. Using the issue evaluation methodology and available data, the Essex Region SPC determined that microcystin-LR is a drinking water issue under the Clean Water Act pursuant to rule 115.1 at all Lake Erie intakes, including the Union WTP, because total microcystins levels in the raw water at the Lake Erie drinking water intakes has, on occasion, been above 50% of the maximum allowable concentration (MAC) for drinking water (1.5 µg/L). Data from Harrow-Colchester, Union and Wheatley WTP were considered together in this decision. Phosphorus modelling was completed to determine the contribution from Lake Erie tributaries, however the results were inconclusive and the sources contributing to this issue are yet to be determined.

Table 4.63: Summary of Issues Identified at the Intake of the Union WTP

Identified Issues*	Data Source & Duration of Data	Result of Issue Evaluation	Natural or Anthropogenic Source
Aluminum	DWSP (1987-2006)	Approximately 52% of the raw water samples collected over a 10 year period exceeded the 100% OG benchmark for aluminum (0.1 mg/L). A linear increasing trend was also observed in the same dataset.	Possibly from both anthropogenic and natural sources.
Turbidity	DWSP (1987-2006)	Over 69% of the raw water samples collected over a 10 year period exceeded the 100% AO benchmark for turbidity (5 NTU). A linear increasing trend was also observed in the same dataset.	Possibly from both anthropogenic and natural sources.
Organic Nitrogen	DWSP (1987-2006)	100% of the raw water samples collected over a 10 year period exceeded the 100% OG benchmark. A linear increasing trend was also observed in the same dataset.	Possibly from both anthropogenic and natural sources.
Microcystin-LR	DWSP (2011-2013)	Total microcystins concentrations exceeded the maximum allowable concentration for drinking water (1.5 ug/L) in the raw water at drinking water intakes on a few occasions consistent with those expected to occur during algal blooms. Limited data did not allow for the evaluation of trends.	Predominantly from anthropogenic sources.

*Identified according to Technical Rule 115.1

Further studies may assist in identifying the sources of the identified issues. These investigations could include extensive sampling and analysis of the parameters of concern (i.e. turbidity, aluminum, organic nitrogen and microcystins). Studies of the correlation between wind and run-off events and turbidity levels at the intake as well as those which continue to examine the contribution of phosphorus from Lake Erie intakes may assist in determining the sources of issues. Currently, this information is a gap. Refer to Section 4.3.3 for further information on data gaps related to issues evaluation. If information becomes available to the SPC that indicates the sources of issues to be wholly or partially

anthropogenic, then issue contributing areas, and the activities contributing to the issues would be determined in a future assessment report.

4.2.7.9. Conditions

Conditions are areas, result of past activities, where there is an existing contamination, for example contaminated soil at an old industrial site that is no longer in use, that may be considered as a drinking water threat. Based on a preliminary investigation by Stantec Consulting (report from December 2010, in **Appendix X**) conducted on available surface water, groundwater, sediment and soil pollution data in the Region, some conditions have been identified in the Essex Region SPA. However there were no sediment or soil sample data within the Union Water Treatment Plant IPZ-1 or 2; therefore conditions identification in this IPZ was not done. The threats due to conditions in the Essex Region SPA may be further assessed as new information is gathered during future updates of the Assessment Report.

4.2.7.10. Percentage of Managed Lands and Livestock Density in IPZs

Please refer to Section 4.1.2.3 (Percentage of Managed Lands and Livestock Density in Vulnerable Areas) for a review of the requirements, definitions and methodology of the percentage of managed lands and livestock density within vulnerable areas.

Maps 4.57 and 4.58 show the percent managed lands in the IPZs of Primary and Emergency intakes, respectively, while livestock densities in the IPZs of Primary and Emergency intakes, respectively, are illustrated in **Maps 4.59 and 60.** Based on the percentage of managed land and livestock density in the IPZs, the hazard scores were estimated as per the Guidelines provided by the MOE (**Table 4.18**). These results are summarized in **Table 4.64**.

The risk scores calculated based on the hazard scores and the vulnerability scores of the respective IPZs indicated that the managed lands and livestock densities are considered to be low or no threat in the IPZ-1s and IPZ-2s of the Union WTP. There is no land in the Primary intake IPZ-1.

Table 4.64: Summary of the results of the percent managed land and livestock densities in the IPZs of the Union WTP

Intake Protection Zone	Managed Land Category	Livestock Density Category	Hazard Score	Vulnerability score	Risk Score
Primary Intake					
IPZ-1	NA	NA	NA	5.0	NA
IPZ-2	40% - 80%	< 0.5 NU/acre	7.6	4.0	30
Emergency Intake					
IPZ-1	40% - 80%	< 0.5 NU/acre	7.6	6.0	46
IPZ-2	40% - 80%	< 0.5 NU/acre	7.6	4.8	36

4.2.7.11. Percentage of Impervious Surfaces in IPZs

Please refer to Section 4.1.2.4 (Percentage of Impervious Surface Area in Vulnerable Areas: Groundwater Vulnerability Section of the AR) for a review of the requirements, definitions and methodology of the percentage of impervious surface areas within vulnerable areas. There are four possible categories for the percentage impervious surface area based on the MOE guidelines: < 1% impervious; 1% to <8% impervious; 8% to <80% impervious and ≥ 80% impervious.

The impervious surface areas for the IPZs of the Primary and Emergency intakes are shown in **Map 4.61 and Map 4.62,** respectively. Road salt application does not pose any drinking waters threat in the IPZ-1 of the Primary intake as it is entirely on the waters of the lake. The results are also summarized in **Table 4.95b**, located at the end of Section 4. Based on the vulnerability score of 6.0 the road salt application land use is considered as a low threat in the IPZ-1 of the Emergency intake. The road salt application is considered to be no threat in the IPZ-2s of both the intakes of the Union WTP.

4.2.8. Pelee Island West Shore Water Treatment Plant

This section summarizes the results of technical studies conducted by Stantec Consulting Ltd and Baird & Associates for the Pelee Island West Shore Water Treatment Plant (WTP) in the Essex Region Source Protection Area. The complete details of these technical studies can be found in **Appendix VII, VIII, IX** and **X**. Please refer to Section 4.2.1 of this Assessment Report for the details on concepts, methodology and requirements related to intake classification, intake protection zone delineation, vulnerability scoring, drinking water threats assessment and issues evaluation.

4.2.8.1. Intake Classification

The Pelee Island West Shore Water Treatment Plant (WTP) is located on West Shore Road on Pelee Island. It withdraws its source water from Lake Erie. The treatment processes at the plant include filtration, UV disinfection, and post chlorination. Other details such as intake pipe diameter, crib depth etc, are summarized in **Table 4.65**. The plant serves only a few homes and a small number of businesses in the vicinity of the plant (see **Map 1.1**).

Table 4.65: Overview of the Pelee Island West Shore Water Treatment Plant

Drinking Water System: Pelee Island West Shore Water Treatment Plant	
Operating Authority	The Township of Pelee Island
Location	West Shore Road, Pelee Island
System Classification	Type I
Rated (design) Capacity	153 m^3/day
UTM Coordinates	Not Available
Intake Depth	3 m
Distance of Intake from Shore	17 m

Since the Pelee Island West Shore WTP withdraws the source water from Lake Erie (Great Lakes System), the intake of the Pelee Island West Shore WTP was classified as a Type A intake and as per Rule 55 (Part VI.I) (*Technical Rules: Assessment Report CWA, 2006*). The intake protection zones (IPZs) for the Pelee Island West Shore WTP were delineated as per the guidelines described in **Table 4.10** (Section 4.2.1.2).

4.2.8.2. Intake Protection Zone -1 (IPZ-1)

As described in Section 4.2.1.2 (**Table 4.10**) the in-water portion of the IPZ-1 for a Type A intake is an area of 1 km radius drawn from the centre point of the intake. The upland component of the IPZ-1 extends perpendicular to the shoreline and follows the extent of the Regulation Limit. The boundary of the Regulated Limit for the IPZ-1 was truncated based on overland drainage flows and the topography of the land as described in detail in the following section. The major portion of the IPZ-1 for the Pelee Island West Shore WTP is the lake water surface, and a significant portion of the land is also included in the IPZ-1 (**Map 4.63)**.

4.2.8.3. Intake Protection Zone -2 (IPZ-2)

The IPZ-2 is a secondary protective zone around the IPZ-1 and is delineated based on the minimum response time required for the plant operator to respond to adverse conditions or a spill and the travel time in the lake and/or tributary. A 2-hour response time is adopted by the Essex Region Source Protection Area based on the Draft Guidance Module 4 (MOE, 2006a) as well as based on interviews with the plant operators and authorities in the Region. There are two components to the IPZ-2, namely the in-water IPZ-2 and upland IPZ-2, the extent of which are determined based on the 2-hour time of travel considering the estimated flow velocities.

The in-water component of the IPZ-2 for the Pelee Island West Shore WTP was delineated by Baird Associates using hydrodynamic modeling and reverse particle tracking method. Refer to Section 4.2.1 of this Assessment Report and **Appendix VII** for further information relating to the hydrodynamic modeling. The resulting in-water zone extends about 3.0 km north of the intake, 3.5 km south of the intake and 5 km offshore at its furthest extent as illustrated in **Map 4.63**.

As prescribed by the Technical Rules 61(2) and 65(3) the upland component of the IPZ-2 is to include setback of not more than 120 m inland along the abutted land or the area of the Regulation Limit along the abutted land. In the case of the delineation of the upland component of the IPZ-2 of the Pelee Island West Shore WTP, a special consideration was given for the area of Regulated Limit and the atypical floodplain area behind the dykes

which surround much of the island. The application of Technical Rules 61(2) and 65(3) would result in an extremely large upland IPZ-2 covering much of the area of the island. This approach would not consider the importance of the direction of water flow, or the effects of the major dyking system. After a careful review and discussions with the MOE and ERCA technical staff, Stantec Consulting Ltd recommended an approach which utilized both the Regulated Limit as well as the direction of water flow using topography. The drainage boundary was used to truncate the Regulated Limit for the IPZ-1 and the IPZ-2. More details on this approach can be found in the Technical Memo submitted by Stantec Consulting Ltd on July 8, 2009 (**Appendix VII**).

The resulting boundary of the IPZ-2 of the Pelee Island West Shore WTP is illustrated in **Map 4.63.** Transport pathways were included in the IPZ-2 as described in Section 4.2.1.2.2. Refer to the Technical Memorandum prepared by Stantec Consulting Ltd (**Appendix VII**) for further information on variety of data sources and approaches used to determine the up-land extent of the IPZ-2.

4.2.8.4. Intake Protection Zone-3 (IPZ-3)

As per Rule 68 (Part VI.5) (*Technical Rules: Assessment Report CWA, 2006*) an IPZ-3 may be delineated for *Type A* intakes which extend outward from IPZ-2 to include all rivers and tributaries that may contribute water to the intake under extreme storm event conditions up to a 100 year storm event. Appropriate guidelines for delineation of IPZ-3 are described in **Table 4.10** (Section 4.2.1.2). Baird & Associates conducted the modeling to determine if an IPZ-3 would be required for the Pelee Island West Shore WTP and the details of this study are in **Appendix XIV**.

The methodology is described in Section 4.2.1.2.3. The modeling incorporated both reverse particle tracking (boundary approach) and contaminant transport modeling to determine the boundaries of the in-water IPZ-3. The joint probability analysis previously undertaken by Baird was used to define the 100 year return period event. Five actual wind events and two year return period flow from the Detroit River and the modeled tributaries were used to model the impacts of spills on Lake Erie intakes. The intersection of East Shore Road and East-West Road was selected for the simulated tanker truck spill contaminant modeling. Spills from this location were modeled separately to the outlets of the West and

North Pumps. The spill location is shown in **Figure 2.1** of the Baird and Associates report (August 2013) in **Appendix XIV** and in **Map 4.63b**.

Based on model results, a fuel spill (with 2% benzene, and a volume of 34,000 L) from a tanker truck approximately 7,470 m upstream of the outlet of the West Pump would result in an exceedance of the ODWQS benchmark for benzene at the Pelee Island West Shore WTP. The modeling also indicated that a fuel spill approximately 9,460 m upstream of the outlet of the North Pump would result in an exceedance of the ODWQS benchmark at the intake.

Baird & Associates recommended that the IPZ-3 delineation be extended, as described in Section 4.2.1.2.3 (IPZ-3 delineation methodology). They recommended that the delineation be extended to the watershed limits of the modeled watercourse, thereby including the outer limits of Big Marsh because the time of travel to the spill location from the marsh is small and dilution unlikely to occur, which would still result in an exceedance at the intake. Baird & Associates also recommended that the delineation include all drainage canals located between the spill and the intake, as well as in the vicinity of the intake (i.e. closer to the intake) because these canals have a shorter flow path than the modeled locations. Although not modeled, Baird & Associates also recommended that the delineation be extended to include Curry Marsh and Round Marsh, which are both within the Regulation Limits on Pelee Island (Technical Rule 68-2(b)). Based on these recommendations, the IPZ-3 for the Pelee Island West Shore intake was extended to include all drainage canals between the spill location and the pump outlets as well as Big Marsh, Curry Marsh, and Round Marsh. The IPZ-3 encompassing most of Pelee Island. The areas that are not captured in the IPZ-3 are those areas not included in the Regulation Limits for the Island.

An off-bank setback of 120 m was applied to all watercourses; however this setback was truncated at subwatersheds as overland flow would be traveling away from the watercourse. As specified in the Technical Rules, the Floodplain Regulation Limit was also used in delineating the extent of the IPZ-3 along subject waterways, where this Limit exceeds the 120 m setback. The modeling report from Baird & Associates report (August

2013) addressing IPZ-3 delineation for Wheatley WTP is in **Appendix XIV**. Refer to **Map 4.63b** for the IPZ-3 delineations for the Pelee Island West Shore WTP**.**

4.2.8.5. Event Based Area

The Event Based Area for Pelee Island West Shore WTP is the combination of all on land portions and in water portions of IPZ-1, IPZ-2 and IPZ-3 (see **section 4.2.1.2.4**). Refer to **Map 4.63c** for the Event Based Area to which the significant drinking water threat policies for the handling and storage of fuel and transportation of fuel along shipping and ferries corridors apply.

4.2.8.6. Vulnerability Scoring of IPZs

The vulnerability score (V) is a numerical expression of the susceptibility of the intake to contamination. Vulnerability scores are assigned for each intake protection zone based on the attributes of the intakes (e.g. length and depth), type of source water body, and the physical characteristics of the environment it is situated in. The vulnerability score (V) is calculated by multiplying area vulnerability factor (B) factor by the source vulnerability factor (C) as expressed below:

$$V = B \times C$$

B is the area vulnerability factor relating to each IPZ and relates to features and processes in the local environment that may impact the intake. C is the source vulnerability factor relating to type of water body. The factors that drive the B score include: soil types; slope of the upland area; runoff generation potential; transportation routes; storm sewers; and wastewater discharges. The physical characteristics of the intake (e.g. offshore distance and crib depth), and the quality of raw water and other water quality concerns dictated the C score of the IPZs. Further details on the methodology of vulnerability scoring, variety of data sources used in assigning vulnerability scores for the IPZs can be found in Section 4.2.1.3 and the Technical Memorandum prepared by Stantec Consulting Ltd (**Appendix VII**).

The area vulnerability factor (B) is assigned a value of 10 for the IPZ-1 of the Pelee Island West Shore WTP, which is a set value for IPZ-1s of all types of intakes. The IPZ-2 is assigned a B score of 7. A C score of 0.6 is assigned based on a variety of characteristics

of the Pelee Island West Shore WTP intake. Based on these scores, the overall vulnerability score for the IPZ-1 and IPZ-2 of the Pelee Island West Shore WTP was calculated as 6 and 4.2, respectively (**Table 4.66** and **Map 4.64**).

Table 4.66: Vulnerability Scores Assigned to IPZ-1 and IPZ-2 of Pelee Island West Shore WTP

Intake Type	Area Vulnerability Factor (B)		Source Vulnerability Factor (C)	Vulnerability Score (V=BXC)	
	IPZ-1	IPZ-2		IPZ-1	IPZ-2
Type D	10	7	0.6	6	4.2

These V scores were finally used in combination with the MOE's Table of Drinking Water Threats to determine the number and types of potential drinking water threats in the respective intake protection zone that are discussed in the following section. As per the MOE's Technical Rules, vulnerability scores are not applicable to IPZ-3s of type A intakes (intakes on Great Lakes). Therefore the Pelee Island West Shore IPZ-3s are not assigned vulnerability scores.

4.2.8.7. Drinking Water Threats

A drinking water threat is defined, according to the MOE, as a chemical or pathogen that poses a potential risk to the drinking water source. Please refer to Section 4.2.1.4 for the list of 21 types of activities that are considered as drinking water threats prescribed by the MOE. These activities may be deemed as significant, moderate, or low drinking water threats in the vulnerable areas through four different approaches as described in Section 4.2.1.4. The following section describes the results of threats assessment obtained through the "threats approach" and the "events based approach"

4.2.8.7.1. Threats Based Approach

The threats approach is based on the quantitative risk score estimation for an activity that is or would be a drinking water threat in a specific vulnerable area. Refer to Section 4.2.1.4 for further details on methodology of the Threats approach. Based on the vulnerability scores of 6 and 4.2 that were assigned to IPZ-1 and IPZ-2, respectively, and the MOE's Tables of Drinking Water Threats, the lists of potential drinking water quality threats

(significant, moderate and low) were generated for the Pelee Island West Shore WTP. The threats approach study including lists of potential treats based on zone and vulnerability score is provided in **Appendix VIII**.

Table 4.67 summarizes the number of possible drinking water quality threats (chemical and pathogen) that would be deemed as significant, moderate or low drinking water threat if they were to exist in the IPZ-1 and IPZ-2 of the Pelee Island West Shore WTP. These threats were further classified into chemical and pathogen types and are illustrated in **Map 4.65**.

Table 4.67: Number of Potential Drinking Water Quality Threats for the Pelee Island West Shore WTP

Intake Protection Zone	V Score	Number of Potential DW Threats			
		Significant	Moderate	Low	Total
IPZ-1	6.0	0	25	1213	1238
IPZ-2	4.2	0	0	52	52

NOTE: Number of potential DW threats are based on vulnerability scores and the MOE's Tables of Drinking Water Threats, and do not necessarily exist in the subject IPZs, but would be deemed as significant, moderate or low threats if they were to exist

The types of activities that may be classified as significant, moderate or low drinking water threats in the IPZ-1 and IPZ-2 of the Pelee Island West Shore WTP are listed in **Table 4.68** and **Table 4.69,** respectively. These activities are also listed in **Appendix VIII**. Activities listed in the tables may be identified as moderate or low drinking water threats depending upon various circumstances such as the quantity and type of chemicals used. The circumstances under which the listed activities would be deemed significant, moderate or low drinking water threats for both IPZ-1 and IPZ-2 are listed in **Appendix IX (G)**. The MOE Tables of Drinking Water Threats can be accessed using the following link:

http://www.essexregionsourcewater.org/downloads/download_tables_of_drinking_water_threats.pdf The Tables of Circumstances can be accessed using the following link:

https://www.ontario.ca/environment-and-energy/provincial-tables-circumstances

Table 4.68: Summary of Prescribed Potential Drinking Water Threats Based on V Score of 6.0 for IPZ-1 of the Pelee Island West Shore WTP

No.	Prescribed Drinking Water Threat	SIG	MOD	LOW
1	The establishment, operation or maintenance of a system that collects, stores, transmits, treats or disposes of sewage		√	√
2	The establishment, operation or maintenance of a waste disposal site within the meaning of Part V of the Environmental Protection Act		√	√
3	Application of agricultural source material to land		√	√
4	Storage of agricultural source material		√	√
5	Management of agricultural source material			√
6	Application of non-agricultural source material to land		√	√
7	Handling and storage of non-agricultural source material		√	√
8	Application of commercial fertilizer			√
9	Handling and storage of commercial fertilizer			√
10	Application of pesticide			√
11	Handling and storage of pesticide			√
12	Application of road salt			√
13	Handling and storage of road salt			√
14	Storage of snow			√
15	Handling and storage of fuel			√
16	Handling and storage of non-aqueous dense phase liquids			√
17	Handling and storage of organic solvent			√
18	Management of runoff that contains chemicals used in the de-icing of aircraft			√
19	Use of land as livestock grazing or pasturing land, an outdoor confinement area or a farm-animal yard		√	√

NOTE: Types of potential DW threats are based on vulnerability scores and the MOE's Tables of Drinking Water Threats, and do not necessarily exist in the subject IPZs, but would be deemed as significant, moderate or low threats if they were to exist

Table 4.69: Summary of Prescribed Potential Drinking Water Threats Based on V Score of 4.2 for IPZ-2 of the Pelee Island West Shore WTP

No.	Prescribed Drinking Water Threat	SIG	MOD	LOW
1	The establishment, operation or maintenance of a system that collects, stores, transmits, treats or disposes of sewage			√
2	The establishment, operation or maintenance of a waste disposal site within the meaning of Part V of the Environmental Protection Act			√
3	Application of agricultural source material to land			√
4	Storage of agricultural source material			√
5	Management of agricultural source material			
6	Application of non-agricultural source material to land			√
7	Handling and storage of non-agricultural source material			√
8	Application of commercial fertilizer			
9	Handling and storage of commercial fertilizer			
10	Application of pesticide			√
11	Handling and storage of pesticide			
12	Application of road salt			
13	Handling and storage of road salt			
14	Storage of snow			
15	Handling and storage of fuel			
16	Handling and storage of non-aqueous dense phase liquids			
17	Handling and storage of organic solvent			
18	Management of runoff that contains chemicals used in the de-icing of aircraft			
19	Use of land as livestock grazing or pasturing land, an outdoor confinement area or a farm-animal yard			√

NOTE: Type of potential DW threats are based on vulnerability scores and the MOE's Tables of Drinking Water Threats, and do not necessarily exist in the subject IPZs, but would be deemed as significant, moderate or low threats if they were to exist

4.2.8.7.2. Event Based Threats Approach

As per Technical Rule 68 in conjunction with Rule 130, an activity is or would be a significant drinking water threat in a surface water intake protection zone at the location where an activity is or would be engaged in, if modeling demonstrates that a release of a chemical parameter or pathogen from the activity or proposed activity would be transported through the surface water intake protection zone to the intake and result in a deterioration of the water for use as a source of drinking water. The Essex Region SPC has accepted the Ontario drinking water quality standard (ODWQS) to identify deterioration of raw water quality at the intake.

The modeling that was completed to delineate the IPZ-3 for the Pelee Island West Shore WTP is described in Section 4.2.8.4, while the general methodology on the events based approach is described in Section 4.2.1.4.4. Further details are described in the modeling report from Baird & Associates (August 2013) addressing IPZ-3 delineation for this WTP in **Appendix XIV.**

The Essex Region SPC has expressed concern with the potential for fuel spills along transportation corridors, as well as the possible presence of fixed fuel tanks, in close proximity to watercourses and drains within the IPZ-2s and IPZ-3s. Consequently, spill locations of 34,000 L of 2% benzene gasoline were selected for contaminant modeling undertaken by Baird & Associates on Pelee Island as described in section 4.2.9.4. The selection of the location and volume of gasoline is a simulated tanker truck spill that is also considered representative of potential fixed fuel storage locations. Simulated fuel tanker truck spills were used to represent potential fixed fuel storage locations near watercourses and drains within the local area. The modeling simulations identified that spill locations approximately 7,470 m upstream of the outlet of the West Pump and 9,460 m upstream of the outlet of the North Pump resulted in an exceedance of the ODWQS for benzene (by 5.7 times) at the Wheatley WTP intake.

From the results of the modeling and level of exceedance, it is reasonable to assume that a substantially reduced spill volume would also result in an exceedance at the intake in Pelee Island drainage canals. The volume of spill and concentration at the intake are not necessarily proportional but it is reasonable to deduce that a reduction of approximately

50% or more in spill volume would also result in a significant threat. Based upon the modeling completed to date and interpretation of the results it is logical to assume that a spill volume of approximately 15,000 L from existing or planned above ground fixed fuel storage sites as well as transportation of fuel along shipping and ferries corridors be considered as significant threats.

Consequently, existing and future fixed fuel storage sites and transportation of fuel along shipping and ferries corridors of 15,000 L or greater in the Pelee Island West Shore EBA (**Map 4.63c**), would be considered to be significant threats as they would inherently deteriorate the quality of source water in the event of a spill. **Table 4.70a** provides a summary of the potential significant threats criteria based on the modeling work as described above for the Pelee Island West Shore WTP.

Table 4.70a: Potential Significant Threats Criteria for the Pelee Island West Shore WTP for 2% Benzene in Fuel

WTP	EBA Storage Volume (L)
Pelee Island West Shore	15,000 L

4.2.8.7.3. Local Threats

The transportation of fuel, organic solvents, DNAPLs, pesticides/herbicides and fertilizers was approved by the Director as a local threat in August 2011 (see **Section 4.2.1.4.5** and **Appendix XIII**). The threat level for all identified local threats in IPZs must be assessed using the vulnerability score, for more details see Director's Letter dated August 2011 (**Appendix XIII)**. Table **4.70b** shows the classification of these local threats as moderate or low drinking water threats based on the vulnerability score of each IPZ for the Pelee Island West Shore WTP. Note that the transportation of fuel (2% benzene) was determined to be a significant threat in the EBA of Pelee Island West Shore WTP using the events based approach. No other substances have been modeled at this time.

Table 4.70b: Threat level for Local Threats (transportation of various substances) for Pelee Island West Shore WTP

IPZ	Vulnerability Score	Significant	Moderate	Low
1	**6**			√
2	**4.2**			
3	**N/A**			

4.2.8.7.4. Existing Significant Drinking Water Threats:

Using the threats based approach, it is not possible to have any significant threats based on the vulnerability scores in IPZ-1 (6.0), IPZ-2 (4.2) or IPZ-3 (no vulnerability score) of Pelee Island West Shore WTP (see **Table 4.47).**

For the events based approach, A desktop GIS exercise was performed to identify existing sites with greater than 15,000 L of above ground fuel storage in the EBA for the Pelee Island West Shore WTP using established criteria (fuel with 2% benzene, at volumes of 15,000 L, see Table 4.70a). Information from fuel providers in Essex County, Google Street View, and 2010 aerial photography overlaid with the EBA delineation using ESRI ArcGIS 10.2.2 for Desktop, were all used to determine the locations of fuel storage and approximate size of fuel storage tanks. For the Pelee Island West Shore WTP this resulted in 3 unconfirmed fuel threats. **Table 4.71** summarizes the existing significant drinking water threats for the EBA for the Pelee Island West Shore WTP. Also, **Map 4.63c** shows the number of existing significant threats in the EBA.

Table 4.71: Number of *Unconfirmed Existing Significant Drinking Water Threats* in the EBA of the Pelee Island West Shore WTP

Specific Land Use Activity	Number of Threats	Uncertainty
Above ground fuel storage *	**3**	High

***Identified through events based modeling**

4.2.8.8. Drinking Water Issues

As further described in Section 4.2.1.5, a drinking water *issue* is defined as the presence of a parameter, listed in Schedules 1, 2, or 3 of O. Reg 170/03, or Table 4 of the Technical Support Document for the Ontario Drinking Water Quality Standards (ODWQS) Objectives and Guidelines, at a concentration, that may result in the deterioration of the quality of water for use as a source of drinking water. The process of issue evaluation is explained in more detail in the Proposed Issues Evaluation Methodology Report (June 2009) that was adopted by the Essex Region Source Protection Committee (**Appendix VI)**.

The issues evaluation methodology could not be applied for the West Shore WTP due to significant data gaps encountered in the raw water quality data for the intake. Some concerns regarding strong odour, algae and ammonia were expressed by the plant operator on numerous occasions in the past two years. Phosphorus and nitrogen seemed to be the major contributors to algal blooms. These parameters will be, therefore, considered for further analysis in the issues evaluation in a future Assessment Report. These points are further described in **Section 4.3.3.**

In 2013, at the request of municipalities and the recommendation of the Source Protection Committee, and in response to the growing concerns related to re-emergence of blue-green algae and microcystins in the Great Lakes, ERCA received funding from the MOE through the Source Protection Program to complete additional technical studies to determine whether microcystin-LR should be considered a drinking water issue for Lake Erie intakes. Microcystin-LR is a neurotoxin produced by blue-green algae (cyanobacteria). Cyanobacteria blooms occur annually in Lake Erie and are increasing in size and severity and affect the operations of drinking water treatment plants. Further details on methodology, data sets evaluated and results of issues evaluation can be found in the Technical Memorandum on Issue Evaluation for Microcystin-LR at Lake Erie Drinking Water intakes in the Essex Region (**Appendix XV)**. Using the issue evaluation methodology and available data, the Essex Region SPC determined that microcystin-LR is a drinking water issue under the Clean Water Act pursuant to rule 115.1 at all Lake Erie intakes, including the Pelee Island West Shore WTP, because total microcystins levels in the raw water at the Lake Erie drinking water intakes has, on occasion, been above 50% of

the maximum allowable concentration (MAC) for drinking water (1.5 µg/L). Data from Harrow-Colchester, Union and Wheatley WTP were considered together in this decision. Phosphorus modelling was completed to determine the contribution from Lake Erie tributaries, however the results were inconclusive and the sources contributing to this issue are yet to be determined.

Table 4.72: Summary of Issues Identified at the Intake of the Pelee Island West Shore WTP

Identified Issues*	Data Source & Duration of Data	Result of Issue Evaluation	Natural or Anthropogenic Source
Microcystin-LR	DWSP (2011-2013)	Total microcystins concentrations exceeded the maximum allowable concentration for drinking water (1.5 ug/L) in the raw water at Lake Erie drinking water intakes on a few occasions consistent with those expected to occur during algal blooms. Limited data did not allow for the evaluation of trends.	Predominantly from anthropogenic sources.

*Identified according to Technical Rule 115.1

4.2.8.9. Conditions

Conditions are areas, result of past activities, where there is an existing contamination, for example contaminated soil at an old industrial site that is no longer in use, that may be considered as a drinking water threat. Based on a preliminary investigation by Stantec Consulting (report from December 2010, in **Appendix X**) conducted on available surface water, groundwater, sediment and soil pollution data in the Region, some conditions have been identified in the sediments in the IPZ-2 of the West Shore Water Treatment Plant. However there was a lack of data to establish off-site contamination due to the conditions. Also there was no soil data. Based on a hazard score of 6, the conditions resulted in no drinking water threats. The threats due to conditions in the Essex Region SPA may be further assessed as new information is gathered during future updates of the Assessment Report.

4.2.8.10. Percentage of Managed Lands and Livestock Density in IPZs

Please refer to Section 4.1.2.3 (Percentage of Managed Lands and Livestock Density in Vulnerable Areas: Groundwater Vulnerability Section of the AR) for a review of the requirements, definitions and methodology of the percentage of managed lands and livestock density within vulnerable areas.

Maps 4.66 and **4.67** show the percent managed land category and the livestock density category in the IPZs of the Pelee Island West Shore WTP, respectively. The Guidelines provided by the MOE are shown in **Table 4.20.** For IPZ-1, the percentage of managed land was found to be 40-80% and the livestock density was < 0.5 NU/acre. The accompanying Chemical Hazard Score of 7.6 was multiplied by the Vulnerability Score of 6.0 resulting in a moderate risk score of 46. For the IPZ-2, the percentage of managed land was < 80% and the livestock density was < 0.5 NU/acre. The Chemical Hazard Score of 6.8 was multiplied by the Vulnerability Score of 4.2 resulting in a score of 29 (no risk). These scores indicate that the managed lands and livestock densities are low threats in the IPZ-1 and no threat in the IPZ-2 of the Pelee Island West Shore WTP.

4.2.8.11. Percentage of Impervious Surfaces in IPZs

Please refer to Section 4.1.2.4 (Percentage of Impervious Surface Area in Vulnerable Areas: Groundwater Vulnerability Section of the AR) for a review of the requirements, definitions and methodology of the percentage of impervious surface areas within vulnerable areas. There are four possible categories for the percentage impervious surface area based on the MOE guidelines: < 1% impervious; 1% to <8% impervious; 8% to <80% impervious and ≥ 80% impervious.

Map 4.68 shows the impervious surface areas in the IPZ-1 and IPZ-2 of the Pelee Island West Shore WTP. The results are also summarized in **Table 4.95b**, located at the end of Section 4. Based on the respective vulnerability scores and the percent impervious surface areas, the road salt application land use is considered as a low threat in the IPZ-1 and no threat in the IPZ-2 of the Pelee Island West Shore WTP.

4.2.9. Wheatley Water Treatment Plant

This section summarizes the results of technical studies conducted by Stantec Consulting Ltd and Baird & Associates for the Wheatley Water Treatment Plant (WTP). The Wheatley WTP is located in the Lower Thames Valley Source Protection Area (LTVSPA) of the Thames-Sydenham and Region Source Protection Region (TSRSPR); however, a significant portion of the Essex Region is within the intake protection zones of this WTP. It was therefore included in the Assessment Report of the Essex Region. In the following sections, the results of technical studies that are only pertaining to the portion of the Essex Region, are summarized and discussed. The complete details of these technical studies can be found in **Appendix VII, VIII, IX** and **X**. Please refer to Section 4.2.1 of this Assessment Report for the details on concepts, methodology and requirements related to intake classification, intake protection zone delineation, vulnerability scoring, drinking water threats assessment and issues evaluation.

4.2.9.1. Intake Classification

The Wheatley Water Treatment Plant (WTP) is located in the municipality of Chatham-Kent. It withdraws its source water from Lake Erie. The treatment processes at the plant include coagulation, flocculation, clarification, filtration, and primary & secondary disinfection. Other details such as intake pipe diameter, crib depth etc, are summarized in **Table 4.73**. The plant serves around 14,000 people in the Wheatley area, including a small portion of the municipality of Leamington in the Essex Region (see **Map 1.1**).

Table 4.73: Overview of the Wheatley Water Treatment Plant

Drinking Water System: Wheatley Water Treatment Plant	
Operating Authority	The Municipality of Chatham-Kent Public Utilities Commission
System Classification	Type I System (Municipal Residential)
Rated (design) Capacity	6,812 m^3/day
Intake Depth	Primary Intake: 4.5 m (lake bottom) Emergency Intake: 0.9 m(lake bottom)
Distance of Intake from Shore	Primary Intake: 747 m Emergency Intake: 291 m

The Wheatley WTP has two intakes namely a Primary intake and an Emergency intake; and both of these intakes are classified as Type A intakes, as per Rule 55 (Part VI.I) (*Technical Rules: Assessment Report CWA, 2006*). The IPZs for both intakes of the Wheatley WTP were delineated as per the guidelines described in **Table 4.10** (Section 4.2.1.2).

4.2.9.2. Intake Protection Zone -1 (IPZ-1)

As described in Section 4.2.1.2 (**Table 4.10**) the in-water portion of the IPZ-1 for a Type A intake is an area of 1 km radius drawn from the centre point of the intake, and if the circle extends onto land, the IPZ-1 includes land up to 120 meters from the high water mark of the water body, or the Regulation Limit, whichever is greater. The IPZ-1s for the Primary and Emergency intakes of the Wheatley WTP are shown in **Map 4.69** and **Map 4.70**, respectively. The major portion of the IPZ-1 for the Primary intake is in the waters of the lake, while a significant portion of the IPZ-1 for the Emergency intake is on land.

4.2.9.3. Intake Protection Zone -2 (IPZ-2)

The IPZ-2 is a secondary protective zone around the IPZ-1 and is delineated based on the minimum response time required for the plant operator to respond to adverse conditions or a spill and the travel time in the lake and/or tributary. A 2-hour response time is adopted by the Essex Region Source Protection Area based on the Draft Guidance Module 4 (MOE, 2006a) as well as based on interviews with the plant operators and authorities in the Region. There are two components to the IPZ-2, namely the in-water IPZ-2 and upland IPZ-2, the extent of which are determined based on the 2-hour time of travel considering the estimated flow velocities.

The in-water component of IPZ-2s for the Wheatley WTP was delineated by Baird Associates using hydrodynamic modeling and reverse particle tracking method. Refer to Section 4.2.1 of this Assessment Report and **Appendix VII** for further information relating to the hydrodynamic modeling. The in-water component of the IPZ-2 for the Primary intake extends about 2.2 km northeast of the intake and, 3 km southwest of the intake as illustrated in **Map 4.69**. The in-water component of the IPZ-2 for the Emergency intake

extends about 3 km northeast of the intake and 2 km southwest of the intake as illustrated in **Map 4.70**.

The upland IPZ-2 includes the following three major components:

1. Tributaries and streams including municipal drains etc.,
2. A 120 m set back or the area of the Regulation Limit, whichever is greater along the abutted land, and
3. Storm sewersheds; and transport pathways (such as storm sewersheds, tile drain networks and other drainage systems).

The extents of these components are delineated differently, based on the 2-hour time of travel, using different methods as described in Section 4.2.1. The resulting boundaries of the IPZ-2s of the Wheatley WTP with various components are illustrated in **Map 4.69** (Primary intake) and **Map 4.70** (Emergency intake). Refer to the Technical Memorandum (**Appendix VII**) for further information on the variety of data sources and approaches used to determine the upland extent of the IPZ-2.

4.2.9.4. Intake Protection Zone-3 (IPZ-3)

As per Rule 68 (Part VI.5) (*Technical Rules: Assessment Report CWA, 2006*) IPZ-3 may be delineated for the *Type A* intakes which extend outward from the IPZ-2 to include all rivers and tributaries that may contribute water to the intake under extreme storm event conditions up to a 100 year storm event. Appropriate guidelines for delineation of IPZ-3 are described in **Table 4.10** (Section 4.2.1.2). Baird & Associates conducted the modeling to determine if an IPZ-3 would be required for the Union WTP and the details of this study are in **Appendix XIV**.

The methodology is described in Section 4.2.1.2.3. The modeling incorporated both reverse particle tracking (boundary approach) and contaminant transport modeling to determine the boundaries of the in-water IPZ-3. The joint probability analysis previously undertaken by Baird was used to define the 100 year return period event. Five actual wind events and two year return period flow from the Detroit River and the modeled tributaries were used to model the impacts of spills on Lake Erie intakes. Pelee/Hillman Creek was selected for the simulated tanker truck spill contaminant modeling. A road crossing near the headwaters

was identified for a spill release. This spill location is shown in **Figure 2.1** of the Baird and Associates report (August 2013) in **Appendix XIV and in Maps 4.69c and 4.70c**.

Based on model results, a fuel spill (with 2% benzene, and a volume of 34,000 L) from a tanker truck approximately 12,300 m upstream of the mouth of Pelee/Hillman Creek would result in an exceedance of the ODWQS benchmark for benzene at the Wheatley WTP.

Baird & Associates recommended that the IPZ-3 delineation be extended, as described in Section 4.2.1.2.3 (IPZ-3 delineation methodology). They recommended that the delineation be extended to the watershed limits of the modeled watercourse, thereby including the headwaters of this watercourse and its tributaries because the time of travel to the spill location from the headwaters is small and dilution unlikely to occur, which would still result in an exceedance at the intake. Although not modeled, Baird & Associates also recommended that the delineation be extended to the tributaries north of the WTP intakes, which includes Hillman Creek, Muddy Creek and Atwell Drain watersheds. The headwaters of these tributaries have approximately equal time of travel to the mouth of Pelee/Hillman Creek as the headwaters upstream of the modeled spill location and it is therefore reasonable to assume that a spill in these tributaries would result in an exceedance of the ODWQS benchmark for benzene at the Wheatley WTP. Although the area south of the mouth of Pelee/Hillman Creek does not drain directly to this creek, Baird and Associates recommended including it in the IPZ-3 because it is pumped to outlets near the mouth of the creek. The time of travel from this area to the mouth of Pelee/Hillman Creek is shorter than that from the modeled spill location and it is therefore reasonable that a fuel spill would result in an exceedance at the Wheatley WTP intakes. It was also recommended to include the tributaries and in water area along the east shore of Point Pelee. Additionally, Point Pelee has been added to the IPZ-3 because the in water portion of both sides is included either in the Union IPZ-3 or Wheatley IPZ-3 and spills on land may also reach the intakes. Although these areas were not modeled, it was felt that it would be reasonable to include these areas in the IPZ-3. Based on these recommendations, the IPZ-3 for the Wheatley intake was extended to include the headwaters of Pelee/Hillman Creek, its tributaries as well as Muddy Creek, Atwell Drain, and Pelee Area Drainage watersheds.

An off-bank setback of 120 m was applied to all watercourses; however this setback was truncated at subwatersheds as overland flow would be traveling away from the watercourse. As specified in the Technical Rules, the Floodplain Regulation Limit was also used in delineating the extent of the IPZ-3 along subject waterways, where this Limit exceeds the 120 m setback. The modeling report from Baird & Associates report (August 2013) addressing IPZ-3 delineation for Wheatley WTP is in **Appendix XIV**. Refer to **Maps 4.69b and 4.70b** for the IPZ-3 delineations for the primary and emergency intakes of the Wheatley WTP**.**

4.2.9.5 Event Based Area

The Event Based Area for Wheatley WTP is the combination of most on land portions and in water portions of IPZ-1, IPZ-2 and IPZ-3 (see **section 4.2.1.2.4**). Point Pelee, the tributaries on the east shore of Point Pelee and the in water portion in Lake Erie east of Point Pelee have been excluded from the EBA because there is high uncertainty that fuel storage or transportation in these areas would result in a significant drinking water threat. Refer to **Map 4.69c** and **Map 4.70c** for the Event Based Area to which the significant drinking water threat policies for the handling and storage of fuel and transportation of fuel along shipping and ferries corridors apply.

4.2.9.6. Vulnerability Scoring of IPZs

The vulnerability score (V) is a numerical expression of the susceptibility of the intake to contamination. Vulnerability scores are assigned for each intake protection zone based on the attributes of the intakes (e.g. length and depth), type of source water body, and the physical characteristics of the environment it is situated in. The vulnerability score (V) is calculated by multiplying area vulnerability factor (B) factor by the source vulnerability factor (C) as expressed below:

$$V = B \times C$$

B is the area vulnerability factor relating to each IPZ and relates to features and processes in the local environment that may impact the intake. C is the source vulnerability factor relating to type of water body. The factors that drive the B score include: soil types; slope of the upland area; runoff generation potential; transportation routes; storm sewers; and wastewater discharges. The physical characteristics of the intake (e.g. offshore distance

and crib depth), and the quality of raw water and other water quality concerns dictated the C score of the IPZs. Further details on the methodology of vulnerability scoring, variety of data sources used in assigning vulnerability scores for the IPZs can be found in Section 4.2.1.3 and the Technical Memorandum prepared by Stantec Consulting Ltd (**Appendix VII**).

The area vulnerability factor (B) is assigned a value of 10 for the IPZ-1s of the Wheatley WTP, which is a set value for IPZ-1s of all types of intakes. The B and C scores that were assigned to the IPZ-1s and IPZ-2s and the resulting overall vulnerability scores for the IPZ-1s and IPZ-2s of the Wheatley WTP are summarized in **Table 4.74** and **Maps 4.71 and 4.72**.

Table 4.74: Vulnerability Scores Assigned to IPZ-1s and IPZ-2s of the Wheatley WTP

Intake	Area Vulnerability Factor (B)		Source Vulnerability Factor (C)	Vulnerability Score (V=BXC)	
	IPZ-1	IPZ-2		IPZ-1	IPZ-2
Primary Intake	10	8	0.6	6.0	4.8
Emergency Intake	10	8	0.7	7.0	5.6

Finally, these V scores were used in combination with the MOE's Tables of Drinking Water Threats to determine the number and types of potential drinking water threats in the respective intake protection zone that are discussed in the following section.

As per the MOE's Technical Rules, vulnerability scores are not applicable to IPZ-3s of type A intakes (intakes on Great Lakes). Therefore the Wheatley IPZ-3s are not assigned vulnerability scores.

4.2.9.7. Drinking Water Threats

A drinking water threat is defined, according to the MOE, as a chemical or pathogen that poses a potential risk to the drinking water source. Please refer to Section 4.2.1.4 for the list of 21 types of activities that are considered as drinking water threats prescribed by the

MOE. The following section describes the results of threats assessment obtained through the “threats approach” and “events based approach".

4.2.9.7.1. Threats Based Approach

The threats approach is based on the quantitative risk score estimation for an activity that is or would be a drinking water threat in a specific vulnerable area. Refer to Section 4.2.1.4 for further details on methodology of the Threats approach. Based on the vulnerability scores and the MOE’s Tables of Drinking Water Threats, the lists of potential drinking water quality were generated for the Wheatley WTP. The threats approach study including lists of potential threats based on zone and vulnerability score is provided in **Appendix VIII**.

Table 4.75 summarizes the number of possible drinking water quality threats (chemical and pathogen) that would be deemed as significant, moderate or low drinking water threat if they were to exist in the IPZ-1s and IPZ-2s of the Wheatley WTP. These threats were further classified into chemical and pathogen types and are illustrated in **Map 4.73** and **Map 4.74** for the Primary intake and Emergency intake, respectively.

The types of activities that may be classified as significant, moderate or low drinking water threats in the IPZ-1s and IPZ-2s of the Wheatley WTP are listed in **Tables 4.76 to 4.79**. Activities listed in the tables may be identified as moderate or low drinking water threats depending upon various circumstances such as the quantity and type of chemicals used. These activities are listed in **Appendix VIII**. The circumstances under which the listed activities would be deemed significant, moderate or low drinking water threats for both IPZ-1 and IPZ-2 are listed in **Appendix IX (H)**. The MOE Tables of Drinking Water Threats can be accessed using the following link:

http://www.essexregionsourcewater.org/downloads/download_tables_of_drinking_water_threats.pdf

The Tables of Circumstances can be accessed using the following link: https://www.ontario.ca/environment-and-energy/provincial-tables-circumstances

Table 4.75: Number of Potential Drinking Water Quality Threats for the Wheatley WTP

Intake Protection Zone	V Score	Number of Potential DW Threats			
		Significant	Moderate	Low	Total
Primary Intake					
IPZ-1	6.0	0	25	1213	1238
IPZ-2	4.8	0	0	447	447
Emergency Intake					
IPZ-1	7.0	0	367	1209	1576
IPZ-2	5.6	0	0	986	986

NOTE: Number of potential DW threats are based on vulnerability scores and the MOE's Tables of Drinking Water Threats, and do not necessarily exist in the subject IPZs, but would be deemed as significant, moderate or low threats if they were to exist

Table 4.76: Summary of Prescribed Potential Drinking Water Threats Based on V Score of 6.0 for the IPZ-1 of the Wheatley WTP (Primary Intake)

No.	Prescribed Drinking Water Threat	SIG	MOD	LOW
1	The establishment, operation or maintenance of a system that collects, stores, transmits, treats or disposes of sewage		√	√
2	The establishment, operation or maintenance of a waste disposal site within the meaning of Part V of the Environmental Protection Act		√	√
3	Application of agricultural source material to land		√	√
4	Storage of agricultural source material		√	√
5	Management of agricultural source material			√
6	Application of non-agricultural source material to land		√	√
7	Handling and storage of non-agricultural source material		√	√
8	Application of commercial fertilizer			√
9	Handling and storage of commercial fertilizer			√
10	Application of pesticide			√
11	Handling and storage of pesticide			√
12	Application of road salt			√
13	Handling and storage of road salt			√
14	Storage of snow			√
15	Handling and storage of fuel			√
16	Handling and storage of non-aqueous dense phase liquids			√
17	Handling and storage of organic solvent			√
18	Management of runoff that contains chemicals used in the de-icing of aircraft			√
19	Use of land as livestock grazing or pasturing land, an outdoor confinement area or a farm-animal yard		√	√

NOTE: Types of potential DW threats are based on vulnerability scores and the MOE's Tables of Drinking Water Threats, and do not necessarily exist in the subject IPZs, but would be deemed as significant, moderate or low threats if they were to exist

Table 4.77: Summary of Prescribed Potential Drinking Water Threats Based on V Score of 4.8 for the IPZ-2 of the Wheatley WTP (Primary Intake)

No.	Prescribed Drinking Water Threat	SIG	MOD	LOW
1	The establishment, operation or maintenance of a system that collects, stores, transmits, treats or disposes of sewage			√
2	The establishment, operation or maintenance of a waste disposal site within the meaning of Part V of the Environmental Protection Act			√
3	Application of agricultural source material to land			√
4	Storage of agricultural source material			√
5	Management of agricultural source material			
6	Application of non-agricultural source material to land			√
7	Handling and storage of non-agricultural source material			√
8	Application of commercial fertilizer			√
9	Handling and storage of commercial fertilizer			√
10	Application of pesticide			√
11	Handling and storage of pesticide			√
12	Application of road salt			√
13	Handling and storage of road salt			√
14	Storage of snow			√
15	Handling and storage of fuel			√
16	Handling and storage of non-aqueous dense phase liquids			√
17	Handling and storage of organic solvent			√
18	Management of runoff that contains chemicals used in the de-icing of aircraft			√
19	Use of land as livestock grazing or pasturing land, an outdoor confinement area or a farm-animal yard			√

NOTE: Types of potential DW threats are based on vulnerability scores and the MOE's Tables of Drinking Water Threats, and do not necessarily exist in the subject IPZs, but would be deemed as significant, moderate or low threats if they were to exist

Table 4.78: Summary of Prescribed Potential Drinking Water Threats Based on V Score of 7.0 for the IPZ-1 of the Wheatley WTP (Emergency intake)

No.	Prescribed Drinking Water Threat	SIG	MOD	LOW
1	The establishment, operation or maintenance of a system that collects, stores, transmits, treats or disposes of sewage		√	√
2	The establishment, operation or maintenance of a waste disposal site within the meaning of Part V of the Environmental Protection Act		√	√
3	Application of agricultural source material to land		√	√
4	Storage of agricultural source material		√	√
5	Management of agricultural source material			√
6	Application of non-agricultural source material to land		√	√
7	Handling and storage of non-agricultural source material		√	√
8	Application of commercial fertilizer		√	√
9	Handling and storage of commercial fertilizer			√
10	Application of pesticide		√	√
11	Handling and storage of pesticide		√	√
12	Application of road salt		√	√
13	Handling and storage of road salt		√	√
14	Storage of snow		√	√
15	Handling and storage of fuel		√	√
16	Handling and storage of non-aqueous dense phase liquids		√	√
17	Handling and storage of organic solvent		√	√
18	Management of runoff that contains chemicals used in the de-icing of aircraft		√	√
19	Use of land as livestock grazing or pasturing land, an outdoor confinement area or a farm-animal yard		√	√

NOTE: Types of potential DW threats are based on vulnerability scores and the MOE's Tables of Drinking Water Threats, and do not necessarily exist in the subject IPZs, but would be deemed as significant, moderate or low threats if they were to exist

Table 4.79: Summary of Prescribed Potential Drinking Water Threats Based on V Score of 5.6 for the IPZ-2 of the Wheatley WTP (Emergency intake)

No.	Prescribed Drinking Water Threat	SIG	MOD	LOW
1	The establishment, operation or maintenance of a system that collects, stores, transmits, treats or disposes of sewage			√
2	The establishment, operation or maintenance of a waste disposal site within the meaning of Part V of the Environmental Protection Act			√
3	Application of agricultural source material to land			√
4	Storage of agricultural source material			√
5	Management of agricultural source material			
6	Application of non-agricultural source material to land			√
7	Handling and storage of non-agricultural source material			√
8	Application of commercial fertilizer			√
9	Handling and storage of commercial fertilizer			√
10	Application of pesticide			√
11	Handling and storage of pesticide			√
12	Application of road salt			√
13	Handling and storage of road salt			√
14	Storage of snow			√
15	Handling and storage of fuel			√
16	Handling and storage of non-aqueous dense phase liquids			√
17	Handling and storage of organic solvent			√
18	Management of runoff that contains chemicals used in the de-icing of aircraft			√
19	Use of land as livestock grazing or pasturing land, an outdoor confinement area or a farm-animal yard			√

NOTE: Types of potential DW threats are based on vulnerability scores and the MOE's Tables of Drinking Water Threats, and do not necessarily exist in the subject IPZs, but would be deemed as significant, moderate or low threats if they were to exist

4.2.9.7.2. Event Based Threats Approach

As per Technical Rule 68 in conjunction with Rule 130, an activity is or would be a significant drinking water threat in a surface water intake protection zone at the location where an activity is or would be engaged in, if modeling demonstrates that a release of a chemical parameter or pathogen from the activity or proposed activity would be transported through the surface water intake protection zone to the intake and result in a deterioration of the water for use as a source of drinking water. The Essex Region SPC has accepted the Ontario Drinking Water Quality Standard (ODWQS) to identify deterioration of raw water quality at the intake.

The modeling that was completed to delineate the IPZ-3 for the Wheatley WTP is described in Section 4.2.9.4, while the general methodology on the events based approach is described in Section 4.2.1.4.4. Further details are described in the modeling report from Baird & Associates (August 2013) addressing IPZ-3 delineation for this WTP is in **Appendix XIV.**

The Essex Region SPC has expressed concern with the potential for fuel spills along transportation corridors, as well as the possible presence of fixed fuel tanks, in close proximity to watercourses and drains within the IPZ-2s and IPZ-3s. Consequently, spill locations of 34,000 L of 2% benzene gasoline were selected for contaminant modeling undertaken by Baird & Associates on Pelee/Hillman Creek as described in section 4.2.9.4. The selection of the location and volume of gasoline is a simulated tanker truck spill that is also considered representative of potential fixed fuel storage locations. Simulated fuel tanker truck spills were used to represent potential fixed fuel storage locations near watercourses and drains within the local area. The modeling simulations identified that a spill location approximately 12,300 m upstream of the mouth of Pelee/Hillman Creek resulted in an exceedance of the ODWQS for benzene (by 5.9 times) at the Wheatley WTP intakes.

From the results of the modeling and level of exceedance, it is reasonable to assume that a substantially reduced spill volume would also result in an exceedance at the intake in Pelee/Hillman Creek and surrounding watercourses. The volume of spill and concentration at the intake are not necessarily proportional but it is reasonable to deduce that a reduction

of approximately 50% or more in spill volume would also result in a significant threat. Based upon the modeling completed to date and interpretation of the results it is logical to assume that a spill volume of approximately 15,000 L from existing or planned above ground fixed fuel storage sites as well as transportation of fuel along shipping and ferries corridors be considered as significant threats.

Consequently, existing and future fixed fuel storage sites and transportation of fuel along shipping and ferries corridors of 15,000 L or greater in the Wheatley EBA (**Maps 4.69c and 4.70c**), would be considered to be significant threats as they would inherently deteriorate the quality of source water in the event of a spill. **Table 4.80** provides a summary of the potential significant threats criteria based on the modeling work as described above for the Wheatley WTP.

Table 4.80: Potential Significant Threats Criteria for the Wheatley WTP for 2% Benzene in Fuel

WTP	EBA Storage Volume (L)
Wheatley	15,000 L

4.2.9.7.3. Local Threats

The transportation of fuel, organic solvents, DNAPLs, pesticides/herbicides and fertilizers was approved by the Director as a local threat in August 2011 (see **Section 4.2.1.4.5** and **Appendix XIII**). The threat level for all identified local threats in IPZs must be assessed using the vulnerability score, for more details see Director's Letter dated August 2011 (**Appendix XIII)**. Table **4.81** shows the classification of these local threats as moderate or low drinking water threats based on the vulnerability score of each IPZ for the Wheatley WTP. Note that the transportation of fuel (2% benzene) was determined to be a significant threat in the EBA of Wheatley WTP using the events based approach. No other substances have been modeled at this time.

Table 4.81: Threat level for Local Threats (transportation of various substances) for Wheatley WTP

IPZ	Vulnerability Score	Significant	Moderate	Low
1 (Primary)	**6.0**			√
1 (Emergency)	**7.0**			√
2 (Primary)	**4.8**			
2 (Emergency)	**5.6**			√
3	**N/A**			

4.2.9.7.4. Existing Significant Drinking Water Threats:

Using the threats based approach, it is not possible to have any significant threats based on the vulnerability scores in IPZ-1 (6.0 (P); 7.0 (E)), IPZ-2 (4.8 (P); 5.6 (E)) or IPZ-3 (no vulnerability score) of Wheatley WTP (see **Table 4.47).**

For the events based approach, a desktop GIS exercise was performed to identify existing sites with greater than 15,000 L of above ground fuel storage in the EBA for Wheatley WTP using established criteria (fuel with 2% benzene, at volumes of 15,000 L see Table 4.80). Information from fuel providers in Essex County, Google Street View, and 2013 aerial photography overlaid with the EBA delineation using ESRI ArcGIS 10.2.2 for Desktop, were all used to determine the locations of fuel storage and approximate size of fuel storage tanks. For the Wheatley WTP this resulted in 50 unconfirmed fuel threats. **Table 4.82** summarizes the existing significant drinking water threats for the EBA of the Wheatley WTP. Also, **Map 4.70c** shows the number of existing significant threats in the EBA.

Table 4.82: Number of *Unconfirmed Existing Significant Drinking Water Threats* in the EBA of the Wheatley WTP

Specific Land Use Activity	Number of Threats	Uncertainty
Above ground fuel storage (primary intake) *	**50**	High
Above ground fuel storage (emergency intake) *	**50**	High

***Identified through events based modeling**

4.2.9.8. Drinking Water Issues

As further described in Section 4.2.1.5, a drinking water *issue* is defined as the presence of a parameter, listed in Schedules 1, 2, or 3 of O. Reg 170/03, or Table 4 of the Technical Support Document for the Ontario Drinking Water Quality Standards (ODWQS) Objectives and Guidelines, at a concentration, that may result in the deterioration of the quality of water for use as a source of drinking water. The process of issue evaluation is explained in more detail in the Proposed Issues Evaluation Methodology Report (June 2009) that was adopted by the Essex Region Source Protection Committee (**Appendix VI)**.

Initial screening of the raw water quality data for the Wheatley WTP flagged turbidity (Table 4 Parameters). Further assessment of the raw water data for these flagged parameters identified only turbidity as a drinking water quality issue for the Wheatley WTP. It is important to note that Schedule 2 and 3 (chemical and radiological) data for the Wheatley WTP were not available, and are a data gap. The identified issue is summarized for the Wheatley WTP intake in **Table 4.83**. Further details on methodology, variety of data sets used and results of issues evaluation, can be found in the Technical Memorandum on Issue Evaluation for the Essex Region WTPs, prepared by Stantec Consulting Ltd (**Appendix X**). Sources contributing to issues identified are yet to be determined.

In 2013, at the request of municipalities and the recommendation of the Source Protection Committee, and in response to the growing concerns related to re-emergence of blue-green algae and microcystins in the Great Lakes, ERCA received funding from the MOE through the Source Protection Program to complete additional technical studies to determine whether microcystin-LR should be considered a drinking water issue for Lake Erie intakes.

Microcystin-LR is a neurotoxin produced by blue-green algae (cyanobacteria). Cyanobacteria blooms occur annually in Lake Erie and are increasing in size and severity and affect the operations of drinking water treatment plants. Further details on methodology, data sets evaluated and results of issues evaluation can be found in the Technical Memorandum on Issue Evaluation for Microcystin-LR at Lake Erie Drinking Water intakes in the Essex Region (**Appendix XV)**. Using the issue evaluation methodology and available data, the Essex Region SPC determined that microcystin-LR is a drinking water issue under the Clean Water Act pursuant to rule 115.1 at all Lake Erie intakes, including the Wheatley WTP, because total microcystins levels in the raw water at the Lake Erie drinking water intakes has, on occasion, been above 50% of the maximum allowable concentration (MAC) for drinking water (1.5 µg/L). Data from Harrow-Colchester, Union and Wheatley WTP were considered together in this decision. Phosphorus modelling was completed to determine the contribution from Lake Erie tributaries, however the results were inconclusive and the sources contributing to this issue are yet to be determined.

Table 4.83: Summary of Issues Identified at the Intake of the Wheatley WTP

Identified Issues*	Data Source & Duration of Data	Result of Issue Evaluation	Natural or Anthropogenic Source
Turbidity	Chatham Kent Public Utilities Commission (2000-2006)	Over 86% of the raw water samples collected exceeded the 100% AO benchmark for turbidity (5 NTU).	Possibly from both anthropogenic and natural sources.
Microcystin-LR	DWSP (2011-2013)	Total microcystins concentrations exceeded the maximum allowable concentration for drinking water (1.5 ug/L) in the raw water at drinking water intakes on a few occasions consistent with those expected to occur during algal blooms. Limited data did not allow for the evaluation of trends.	Predominantly from anthropogenic sources.

*Identified according to Technical Rule 115.1

Further studies may assist in identifying the sources of the identified issues. These investigations could include extensive sampling and analysis of the parameters of concern

(i.e. turbidity, aluminum, organic nitrogen and microcystins). Studies of the correlation between wind and run-off events and turbidity levels at the intake as well as those which continue to examine the contribution of phosphorus from Lake Erie intakes may assist in determining the sources of issues. Currently, this information is a gap. Refer to Section 4.3.3 for further information on data gaps related to issues evaluation. If information becomes available to the SPC that indicates the sources of issues to be wholly or partially anthropogenic, then issue contributing areas, and the activities contributing to the issues would be determined in a future assessment report.

4.2.9.9. Conditions

Conditions are areas where, as a result of past activities, there is an existing contamination. For example, contaminated soil at an old industrial site that is no longer in use may be considered a drinking water threat. Based on a preliminary investigation by Stantec Consulting (report from December 2010, in **Appendix X**) conducted on available surface water, groundwater, sediment and soil pollution data in the Region, some conditions have been identified in the sediments in the IPZ-1 and IPZ-2 of the Wheatley Treatment Plant. However there was a lack of data to establish off-site contamination due to the conditions. Also there were no soil data. Based on a hazard score of 6, the conditions resulted in low drinking water threats. The threats due to conditions in the Essex Region SPA may be further assessed as new information is gathered during future updates of the Assessment Report.

4.2.9.10. Percentage of Managed Lands and Livestock Density in IPZs

Please refer to Section 4.1.2.3 (Percentage of Managed Lands and Livestock Density in Vulnerable Areas) for a review of the requirements, definitions and methodology of the percentage of managed lands and livestock density within vulnerable areas.

Maps 4.75 and 4.76 show the percent managed lands in the IPZ-1s and IPZ-2s of the Primary and Emergency intake, respectively, while livestock densities in the IPZ-1s and IPZ-2s of the Primary and Emergency intake are illustrated in **Maps 4.77 and 78** respectively. Based on the percentage of managed land and livestock density in the

Wheatley IPZs, the hazard scores were estimated as per the Guidelines provided by the MOE (**Table 4.18**). These results are summarized in **Table 4.84**.

Table 4.84: Summary of the results of the percent managed land and livestock densities in the IPZs of the Wheatley WTP

Intake Protection Zone	Managed Land Category	Livestock Density Category	Hazard Score	Vulnerability Score	Risk Score
Primary Intake					
IPZ-1	40% - 80%	< 0.5 NU/acre	7.6	6.0	46
IPZ-2	40% - 80%	< 0.5 NU/acre	7.6	4.8	36
Emergency Intake					
IPZ-1	40% - 80%	< 0.5 NU/acre	7.6	7.0	53
IPZ-2	40% - 80%	< 0.5 NU/acre	7.6	5.6	43

The risk scores calculated based on the hazard scores and the vulnerability scores of the respective IPZs indicated that the managed lands and livestock densities are considered to be a low threat in the IPZ-1 and no threat in the IPZ-2 of the Primary intake, while they are low threats in both IPZ-1 and IPZ-2 of the Emergency intake.

4.2.9.11. Percentage of Impervious Surfaces in IPZs

Please refer to Section 4.1.2.4 (Percentage of Impervious Surface Area in Vulnerable Areas: Groundwater Vulnerability Section of the AR) for a review of the requirements, definitions and methodology of the percentage of impervious surface areas within vulnerable areas. There are four possible categories for the percentage impervious surface area based on the MOE guidelines: < 1% impervious; 1% to <8% impervious; 8% to <80% impervious and ≥ 80% impervious.

The impervious surface areas for the IPZs of the Primary and Emergency intake are shown in **Map 4.79 and Map 4.80,** respectively. The results are also summarized in **Table 4.95b**, located at the end of Section 4. Based on the vulnerability scores and the percent impervious areas, road salt application is considered to be a low drinking water threat in

the IPZ-1s of both intakes, and in the IPZ-2 of the Emergency intake (where the percentage of impervious surface area is 8% to <80%). It is not considered to be a threat in the IPZ-2 of the Primary intake or in the IPZ-2 of the Emergency intake where the percentage of impervious surface area is < 1%.

4.2.10 Uncertainty Analysis

Delineation and Vulnerability Assessment of the IPZs

Uncertainty was determined for the delineation of IPZs based on a variety of factors listed below. The uncertainty level was characterized as "high" or "low".

- Distribution, variability, quality and relevance of the data
- Ability of the methods and models used to accurately reflect the flow processes in the hydrological systems
- The quality assurance and quality control procedures applied
- The extent and level of calibration and validation achieved for models used or calculation or general assessments completed and,
- The accuracy to which the area vulnerability factor and the source vulnerability factor effectively assesses the relative variability of the hydrological features.

In general, the level of confidence in the delineation of IPZ-1s is high, as the criteria and dimensions for IPZ-1 delineation are prescribed by the Technical Rules, and are straightforward. The IPZ-2 delineation required complex hydrodynamic modeling exercises as well as extensive data on land use, storm sewer network and upland topography. Due to the limitations on the quality and quantity of such data used for IPZ-2 delineation, the uncertainty was given high in most cases. The IPZ-3 model and analysis limitations include a limited number of spill scenarios, simple analytical approach to longitudinal dispersion calculations in some watercourses, and not considering decay of the contaminant due to chemical and physical processes. Due to the limitations, the uncertainty was assessed to be high. As per the Technical Rules, neither Detroit River nor Lake Erie intake IPZ-3s are assigned vulnerability scores. Stantec Consulting Ltd. assessed the above mentioned factors in the uncertainty analysis of the technical work conducted on the delineation and vulnerability assessment of all IPZs in the Essex Region Source Protection Area except IPZ-3s for Lake Erie intakes. Further details on Stantec Consulting Ltd's assessment of the factors listed above can be found in **Appendix VII** (Technical Memorandum by Stantec Consulting, and accompanying Report by Baird & Associates, January 2011 and April 2011). The limitations and uncertainty of the IPZ-3 delineations for Lake Erie intakes are discussed in **Appendix XIV** (IPZ□ 3 Delineation Support for ERCA Source Water Studies: Colchester, Union, Wheatley, and Pelee Island Intakes by Baird & Associates August 2013)

Tables 4.85 to 4.92 summarize the results of uncertainty analysis for each WTP in the Region.

Table 4.85: Uncertainty Level Rating for the Stoney Point WTP

Component		IPZ-1	IPZ-2	
IPZ Delineation	In-Water	LOW	HIGH	HIGH
	Upland/Up-Tributary	LOW	LOW	HIGH
	Overall	LOW	HIGH	HIGH
Vulnerability Score		LOW	LOW	LOW
Combined Rating*		**LOW**	**HIGH**	**HIGH**

*Combined rating defaults to high level with presence of *HIGH* uncertainty in any component

Table 4.86: Uncertainty Level Rating for the Lakeshore (Belle River) WTP

Component		IPZ-1	IPZ-2	IPZ-3
IPZ Delineation	In-Water	LOW	HIGH	HIGH
	Upland/Up-Tributary	LOW	LOW	HIGH
	Overall	LOW	HIGH	HIGH
Vulnerability Score		LOW	HIGH	LOW
Combined Rating*		**LOW**	**HIGH**	**HIGH**

*Combined rating defaults to high level with presence of *HIGH* uncertainty in any component

Table 4.87: Uncertainty Level Rating for the A. H. Weeks (Windsor) WTP

Component		IPZ-1	IPZ-2	IPZ-3
IPZ Delineation	In-Water	LOW	HIGH	HIGH
	Upland/Up-Tributary	LOW	LOW	HIGH
	Overall	LOW	HIGH	HIGH
Vulnerability Score		LOW	LOW	NA
Combined Rating*		**LOW**	**HIGH**	**HIGH**

*Combined rating defaults to high level with presence of *HIGH* uncertainty in any component

Table 4.88: Uncertainty Level Rating for the Amherstburg WTP

Component		IPZ-1	IPZ-2	IPZ-3
IPZ Delineation	In-Water	LOW	HIGH	HIGH
	Upland/Up-Tributary	LOW	HIGH	HIGH
	Overall	LOW	HIGH	HIGH
Vulnerability Score		LOW	LOW	NA
Combined Rating*		LOW	HIGH	HIGH

*Combined rating defaults to high level with presence of *HIGH* uncertainty in any component

Table 4.89: Uncertainty Level Rating for the Harrow-Colchester South WTP

Component		IPZ-1	IPZ-2	IPZ-3
IPZ Delineation	In-Water	LOW	HIGH	HIGH
	Upland/Up-Tributary	LOW	LOW	HIGH
	Overall	LOW	HIGH	HIGH
Vulnerability Score		LOW	LOW	NA
Combined Rating*		LOW	HIGH	HIGH

*Combined rating defaults to high level with presence of *HIGH* uncertainty in any component

Table 4.90: Uncertainty Level Rating for the Union WTP

Component		IPZ-1	IPZ-2	IPZ-3
IPZ Delineation	In-Water	LOW	HIGH	HIGH
	Upland/Up-Tributary	LOW	LOW	HIGH
	Overall	LOW	HIGH	HIGH
Vulnerability Score		LOW	LOW	NA
Combined Rating*		LOW	HIGH	HIGH

*Combined rating defaults to high level with presence of *HIGH* uncertainty in any component

Table 4.92: Uncertainty Level Rating for the Pelee Island West Shore WTP

Component	IPZ-1	IPZ-2	IPZ-3
IPZ Delineation	LOW	HIGH	HIGH
Vulnerability Score	LOW	LOW	NA
Combined Rating*	**LOW**	**HIGH**	**HIGH**

*Combined rating defaults to high level with presence of *HIGH* uncertainty in any component

Table 4.91: Uncertainty Level Rating for the Wheatley WTP

Component		IPZ-1	IPZ-2	IPZ-3
IPZ Delineation	**In-Water**	LOW	HIGH	HIGH
	Upland/Up-Tributary	LOW	LOW	HIGH
	Overall	LOW	HIGH	HIGH
Vulnerability Score		LOW	HIGH	NA
Combined Rating*		**LOW**	**HIGH**	**HIGH**

*Combined rating defaults to high level with presence of *HIGH* uncertainty in any component

4.3. Data & Knowledge Gaps and Future Steps

The following section describes the gaps in data and analysis to date, with respect to the various technical studies conducted in order to prepare the Assessment Report (e.g. IPZ delineation, vulnerability assessment, issues evaluation and drinking water threats assessment). Work to address some of the gaps and previously identified future steps was conducted through 2010 and early 2011, reflected in the approved Assessment Report so that it was available to the Source Protection Committee for use in developing the Source Protection Plan by August 2012 as required by the Ministry of the Environment. Additional technical work, conducted in 2013 and 2014 to address remaining data gaps, is included in the Updated Assessment Report and was used by the SPC to develop an updated Source Protection Plan by January 2015. Some data and knowledge gaps remain and as further information becomes available to the Source Protection Committee, these may be included in future Assessment Reports.

4.3.1. Drinking Water Threats Assessment

Existing Significant Drinking Water Threats Through 'Threats Approach': Through the threats approach, *significant drinking water threats* are only possible in the Intake Protection Zones for two of the Water Treatment Plants (WTPs) in the Essex Region Source Protection Area, namely, the Windsor WTP and the Amherstburg WTP, where Vulnerability Scores were determined to be greater than eight (8). Through additional analyses by Stantec Consulting, the number of previously identified existing significant drinking water threats in the IPZ-1s and IPZ-2s of the Windsor WTP and the IPZ-1 of the Amherstburg WTP is reduced. These land use activities (typically industrial/business sites, and municipal discharges) need to be further evaluated as more information becomes available in order to confirm them as existing significant drinking water threats.

Work to fill these gaps in a future Assessment Report would include the further collection of data associated with these land use activities, field verification, and communication with the property/business owners and municipalities.

Conditions Assessment: A review of the limited available data and information on potential existing contamination conditions in the Essex Region Source Protection Area

resulted in the identification of some conditions in the IPZs. During the conditions assessment, it was recognized that this assessment requires specific information on soil, sediment and aquifers which is not easily available. Soil and aquifer data were not available. Further, the MOE's recently amended 'Director's Rules' now require that there must be evidence of 'off-site' movement of contamination in assigning the hazard score to assess threats due to conditions. There is a lack of data to establish that the identified conditions in sediments of the IPZs caused off-site contamination. It is intended that further steps will be taken to determine whether additional information (e.g. contamination data) may be available from the MOE, Environment Canada, Municipalities, private consultants, etc. Further work on conditions threats assessment may be part of a future Assessment Report.

Significant Threats Assessment Through 'Event Based' Approach: The MOE 'Directors Rules' (Technical Rules) provide the opportunity for Source Protection Committees to consider whether various types of land use activities which are not identified as significant threats through the 'threats approach' may be further evaluated as potential significant threats. This additional threats assessment approach recognizes that there may be significant threats outside of the limited areas of the IPZ-1s and IPZ-2s, and that even within these areas, the ranges for vulnerability scores as prescribed by MOE, greatly limit and in most cases preclude, the possibility of identifying a significant threat through the 'threats approach', regardless of the nature or magnitude of a particular land use activity that may exist now or in the future.

This approach provides for a consideration of factors such as the volume of chemicals or pathogens that may be associated with a given land use activity, and modeling simulation of substantial spills, to determine whether unacceptable concentrations of contaminants could reach a municipal drinking water intake due to an 'extreme event' (rainfall and/or winds) within Intake Protection Zones.

Through the events based approach, large above ground storage tanks of fuels containing benzene, were determined to be Significant Threats in the Intake Protection Zones (IPZ-1, 2, or 3) of the Detroit River, Lake Erie and Lake St. Clair intakes. Through this process, a complete inventory of fuel tank storage locations was conducted as a desktop exercise

using GIS, which identified some existing significant threats in the IPZs of most intakes in the Essex Region. These sites will be assessed by the RMO/I to confirm whether they are significant drinking water threats.

Event based modeling involving other types of contaminant have yet to be generated. Further studies such as modeling additional spills scenarios, contaminant storage location identification and field verification would allow the filling of this gap and allow for the identification of other potential significant drinking water threats.

Cross jurisdictional matters: Consultation with the Michigan Department of Environmental Quality (MDEQ) and others on cross jurisdictional matters will assist in knowledge-sharing on similar work, if any, being conducted on the U. S. side.

4.3.2. Issues Evaluation

Source Identification of Water Quality Issues: Through the Issues Evaluation Methodology that was adopted by the Essex Region SPC, organic nitrogen, turbidity, aluminum, and microcystin-LR were identified as common source water quality *Issues* at most of the intakes in the ERSPA. These results are further described in detail in the respective sub-sections of Section 4, dealing with each WTP. It is yet to be determined if the sources of organic nitrogen, turbidity and aluminum are anthropogenic or natural, or both. The information needed to determine the sources of issues is a gap. In the case of microcystin-LR more monitoring data are needed from the drinking water intakes to fully understand the nature of the issue and to observe whether trends are occurring. In addition, more work is needed to identify the main contributions of phosphorus in order to delineate an Issue Contributing Area. The MOE Technical Rules require the identification of contributing activities and contributing areas for identified issues which are wholly or partially due to anthropogenic sources.

A review of the MOE *Tables of Drinking Water Threats* for the existing land use activities may provide information that may link a specific land use activity to a specific water quality issue (parameter). The extent to which the issues are caused by anthropogenic sources, and the extent to which they are affected by activities in the Intake Protection Zones in the Essex Region Source Protection Area (ERSPA), or beyond the ERSPA, such

as the Thames-Sydenham and Region Source Protection Region (TSRSPR) or elsewhere in the Great Lakes basin, for example, are yet to be determined.

Further studies may assist in identifying the sources of the identified issues. These studies may include extensive monitoring, pollution loadings estimation, and environmental data assessment (e.g. wind/wave and rainfall correlation with the turbidity spikes at the intakes, phosphorus contributions, microcystins monitoring, etc.). Currently, this information is a gap. Some details of how to fill this gap are provided in **Table 4.93**. Filling of this gap as more information becomes available to the SPC, would assist in identifying the sources of issues. If the issues are determined to be partially or wholly caused by anthropogenic sources, this could lead to identifying issue contributing areas, and the activities (Significant Threats) in the IPZs which may be contributing to the issues, and may be included in a future Assessment Report.

Raw Water Quality Data Gaps: No drinking water quality issues, other than microcystin-LR, were identified for the Pelee Island West Shore WTP, due to the lack of raw water quality data for the WTP, which is a significant data gap. Efforts will be made in the future to obtain raw water quality data for various parameters to allow an issues evaluation process.

For the Wheatley WTP, only turbidity was identified (by the Thames-Sydenham and Region SPC) as an Issue. Raw water quality data for chemical and radiological parameters for this WTP was not available. This is a significant data gap.

Other Water Quality Parameters of Interest

In the approved Assessment Report, the need to study microcystin-LR to determine whether it is a drinking water issue at Essex Region intakes was identified as a knowledge gap. In the updated Assessment Report, data were examined and it was determined that microcystin-LR is a drinking water issue at all Lake Erie intakes in the Essex Region and Wheatley WTP in the Thames-Sydenham and Region. In Appendix X a preliminary review of limited data noted the presence of microcystin-LR at the Stoney Point, Lakeshore (Belle River), A. H. Weeks (Windsor), Amherstburg, Harrow-Colchester South and the Union WTP intakes. In one sample each at the Lakeshore (Belle River) and Harrow-

Colchester South intakes, the level was above the standard. Further analysis for the Lake St. Clair and Detroit River intakes should be conducted to determine if microcystin-LR is a drinking water issue.

Ammonia data was also reviewed for the Stoney Point, Lakeshore (Belle River) and Union WTP intakes, with no exceedances at the intakes. Levels of ammonia above the WHO standard were found upstream of the WTPs. These concerns need to be further evaluated as further information becomes available, and potentially through site-specific water quality monitoring.

Groundwater Quality Issues: The MOE Technical Rules also provide for the identification of source water quality Issues in Highly Vulnerable Aquifers (HVAs). Based on very limited data available to date, no source water quality issues have been identified to date in the HVAs in the Essex Region Source Protection Area. It is intended to continue efforts to obtain further information, such as private well data from the Windsor-Essex County Health Unit, or other sources. It is recognized that there are confidentiality considerations which limits the availability of some of these data.

Summary of Knowledge and Data Gaps in Issues Evaluation Studies: Table 4.93 summarizes the knowledge and data gaps encountered while conducting the issues evaluation work for the Essex Region SPA. The table also provides suggestions on how to fill this gap in the future.

Table 4.93: Knowledge and Data Gaps in Issues Evaluation Studies

Gap	Brief Description
Source identification of **aluminum** (identified as an issue for the WTP intakes of Stoney Point, Lakeshore (Belle River), A. H. Weeks (Windsor), Amherstburg, Harrow-Colchester South and Union)	This issue is possibly due to both natural and anthropogenic causes. The amount of anthropogenic aluminum released nationally in Canada is small compared with estimated natural aluminum releases; however, anthropogenic releases can dominate near strong point sources (CEPA Environmental Registry Substance Lists. Environment Canada, 2008). In order to fill this gap, the aluminum levels in water and sediments near the intake, and the current land use activities that may cause aluminum to be released into the surface water can be investigated to help determine the source(s) of aluminum.
Source identification of **turbidity** (identified as an issue for the WTP intakes of Stoney Point, Lakeshore (Belle River), A. H. Weeks (Windsor), Amherstburg, Harrow-Colchester South, Union and Wheatley)	This issue is possibly due to both natural and anthropogenic causes. Natural causes of turbidity may be erosion, natural decay of plants and animals, and algal growth. Human activities that could contribute to turbidity include runoff from cultivated fields or construction sites, waste discharges and dredging. In order to fill this gap, a study of correlation between wind or runoff events and the intake turbidity levels may need to be conducted. Similarly, a correlation between the in-land drains (natural or man-made) turbidity just before the outlet, and the intake turbidity (after an event) may need to be done. Aerial photos showing plumes after an event may help or sampling along drains and at their outlets may be needed. An examination of the composition of the turbidity (organic, inorganic) and its occurrence with other naturally occurring substances may also assist in determining the cause of turbidity.
Source identification of **organic nitrogen** (identified as an issue for the WTP intakes of Stoney Point, Lakeshore (Belle River), A. H. Weeks (Windsor), Amherstburg, Harrow-Colchester South and Union)	This issue is possibly due to both natural and anthropogenic causes. Organic nitrogen may be attributed to natural sources such as forests and atmospheric deposition (dry deposits or in the form of precipitation) or by anthropogenic sources such as animal pastures, agricultural systems, urban/suburban storm water runoff (Bioavailability of DON from natural and anthropogenic sources to estuarine plankton. Limnology and Oceanography 47(2):353-366. Seitzinger S.P., R.W. Sanders, and R. Styles. 2002) and wastewater treatment plant effluent (Dissolved organic nitrogen characterization and bioavailability in wastewater effluents. Water Environment Research Foundation Report 02-CTS-1a. Pagilla, K. May 31 2010).

Gap	Brief Description
	In order to fill this gap, sampling for organic nitrogen at the sewer outfalls, in the sediments, near shore and in the intake raw water would need to be conducted to help determine the cause of organic nitrogen.
Raw water quality data (for the Pelee Island West Shore WTP intake)	No raw water quality data was available for the Pelee Island West Shore WTP intake. The issues evaluation work for this intake could not be conducted. Long term raw water quality sampling, analysis and data review for this intake would facilitate future issues evaluation.
Raw water quality chemical and radiological data (for the Wheatley WTP intake)	Schedule 2 (chemical) and Schedule 3 (radiological) raw water quality data for the Wheatley WTP intake was not available. Therefore the investigation of chemical and radiological issues for the Wheatley WTP intake could not be conducted. Long term raw water quality sampling, analysis and data review for this intake would facilitate future issues evaluation.
Ammonia data	The presence of ammonia has been detected at a few WTP intakes in the raw water. Levels higher than the WHO standard were found upstream of the WTPs. Further monitoring of this parameter in the intake raw water would help determine if they are issues at the intakes.
Microcystin-LR data	The presence of microcystin-LR (a toxin associated with blue-green algae) has been identified as a drinking water issue at Lake Erie intakes, however an ICA could not be delineated. Further monitoring of this parameter in the intake raw water would help determine if there are issues at the relevant intakes.
Groundwater quality data for Highly Vulnerable Aquifers	There is limited data available to determine issues in HVAs, and therefore the issues evaluation for these vulnerable areas could not be conducted. Collection of information such as private well data from the Windsor Essex County Health Unit may help facilitate issues evaluation in HVAs.

4.3.3. Edge Matching of Mapping with Lower Thames Valley SP Area

In order to generate seamless mapping between neighboring SPAs (such as Highly Vulnerable Aquifers and Significant Groundwater Recharge Areas), it is important to conduct an 'edge matching' exercise. This work will be considered when the respective maps are finalized and potentially further refined.

4.3.4. Summary of Gaps

Table 4.94 summarizes the gaps in the studies conducted, and a brief description of the work that would assist in filling those gaps in the future.

Table 4.94: Description of Gaps

Gap	Work That Would Assist in Filling Gaps
Threats and Risk Assessment (see Section 4.3.1)	
Information to confirm existing significant threats through threats based assessment	• Refine the identification of significant threats at the Windsor and Amherstburg IPZ-1 and IPZ-2 • Further collection of data associated with these land use activities, field verification, and communication with the property/business owners and municipalities to be done
Inventory of contaminant storage locations for events based threats assessment	• Modeling spills scenarios for additional contaminant types, in conjunction with contaminant storage location identification may assist in further significant threats assessment in the IPZs
Data to confirm conditions	• Further collection of data, especially soil and aquifer data, is needed • Data to show cause of off-site contamination due to conditions is needed to assist in assigning hazard scores
Livestock density, managed lands and impervious surface calculations and mapping for delineated IPZ-3s	• Livestock density, managed lands and impervious surfaces to be mapped for the IPZ-3s delineated for Lake St. Clair, Detroit River and Lake Erie intakes • Use these maps to analyze threats related to the land application of ASM, NASM, commercial fertilizer and road salt in the IPZ-3s
Issues Evaluation (see Section 4.3.2)	
Knowledge and data gaps	See **Table 4.93**
Edge matching of maps (see Section 4.3.3)	
Seamless maps with neighboring source protection authorities	• Vulnerable areas that span or abut SPA boundaries need to be edge matched in order to create seamless maps • Neighboring SPAs are being consulted on to complete this work

Table 4.95a Percent Managed Lands and Livestock Density for Vulnerable Areas

Vulnerable Area	Intake Type	Area	Percent Managed Land	Livestock Density (NU/acre)	Chemical Hazard Score	Vulnerability Score	Risk Score	Threat Level				Comment
								High	Moderate	Low	None	
Stoney Point	Type D	IPZ-1	n/a	n/a	n/a	9.0	n/a					No land-based IPZ-1
		IPZ-2	> 80%	< 0.5	8.8	6.3	55					Low risk
Lakeshore (Belle River)	Type D	IPZ-1	< 40%	< 0.5	6.8	9.0	61					No agriculture in zone
		IPZ-2	40 – 80%	< 0.5	7.6	6.3	48					Low risk
A. H. Weeks (Windsor) East	Type B	IPZ-1	40 – 80%	< 0.5	7.6	9.0	68					No agriculture in zone
		IPZ-2	< 40%	< 0.5	6.8	8.1	55					Low risk
A. H. Weeks (Windsor) West	Type B	IPZ-1	40 – 80%	< 0.5	7.6	9.0	68					No agriculture in zone
		IPZ-2	< 40%	< 0.5	6.8	8.1	55					Low risk
Amherstburg	Type B	IPZ-1	< 40%	< 0.5	6.8	9.0	61					No agriculture in zone
		IPZ-2	< 40%	< 0.5	6.8	7.2	49					Low risk
Harrow-Colchester South	Type A	IPZ-1	40 – 80%	< 0.5	7.6	6.0	46					Low risk
		IPZ-2	> 80%	< 0.5	8.8	4.8	42					Low risk
Union Primary	Type A	IPZ-1	n/a	n/a	n/a	5.0	n/a					No land-based IPZ-1
		IPZ-2	40 – 80%	< 0.5	7.6	4.0	30					No risk
Union Emergency	Type A	IPZ-1	40 – 80%	< 0.5	7.6	6.0	46					Low risk
		IPZ-2	40 – 80%	< 0.5	7.6	4.8	36					No risk
Pelee Island	Type A	IPZ-1	40 – 80%	< 0.5	7.6	6.0	46					Low risk
		IPZ-2	< 40%	< 0.5	6.8	4.2	29					No risk
Wheatley Primary	Type A	IPZ-1	40 – 80%	< 0.5	7.6	6.0	46					Low risk
		IPZ-2	40 – 80%	< 0.5	7.6	4.8	36					No risk
Wheatley Emergency	Type A	IPZ-1	40 – 80%	< 0.5	7.6	7.0	53					Low risk
		IPZ-2	40 – 80%	< 0.5	7.6	5.6	43					Low risk
Highly Vulnerable Aquifer		HVA	> 80%	< 0.5	8.0	6.0	48					Low risk
Significant GW Recharge Areas		SGRA	> 80%	< 0.5	8.0	6.0	48					Low risk

Table 4.95b Impervious Surface Areas for Vulnerable Areas (Threat Level for Application of Road Salt)

			Threat Level				
Vulnerable Area	**IntakeType**	**Area**	**High**	**Moderate**	**Low**	**None**	**Explanation**
Stoney Point	Type D	IPZ-1					NO land-based IPZ-1 for Stoney Point Intake
		IPZ-2					Areas of 8%-<80%, 1%-<8% and <1% = all **low** threats
Lakeshore (Belle River)	Type D	IPZ-1					Area of 8%-<80% = **moderate** threats
		IPZ-2					Areas of 8%-<80%, 1%-<8% and <1% = all **low** threats
Windsor East	Type B	IPZ-1					Area of 8%-<80% = **moderate** threat
		IPZ-2					Area of 8%-<80% = **moderate** threats; <1% = **low** threats
Windsor West	Type B	IPZ-1					Area of 8%-<80% = **moderate** threat
		IPZ-2					Area of 8%-<80% = **moderate** threats; <1% = **low** threats
Amherstburg	Type B	IPZ-1					Area of 8%-<80% = **moderate** threats
		IPZ-2					Areas of 8%-<80%, 1%-<8% and <1% = all **low** threats
Harrow-Colchester South	Type A	IPZ-1					Areas of 8%-<80% and 1%-<8% = both **low** threats
		IPZ-2					Areas of 8%-<80%, 1%-<8% and <1%= all **no** threat
Union Primary	Type A	IPZ-1					NO land-based IPZ-1 for Union Primary Intake
		IPZ-2					Areas of 8%-<80% and 1%-<8% = both **no** threat
Union Emergency	Type A	IPZ-1					Area of 8%-<80% = **low** threats
		IPZ-2					Areas of 8%-<80% and 1%-<8% = both **no** threat
Pelee Island	Type A	IPZ-1					Areas of 8%-<80%, 1%-<8% and <1% = all **low** threats
		IPZ-2					Areas of 8%-<80%, 1%-<8% and <1% = all **no** threats
Wheatley Primary	Type A	IPZ-1					Area of 8%-<80% = **low** threats
		IPZ-2					Areas of 8%-<80% and <1%= both **no** threat
Wheatley Emergency	Type A	IPZ-1					Areas of 8%-<80% and <1% = both **low** threats
		IPZ-2					Area of 8%-<80% = **low** threats; <1% = **no** threat
Highly Vulnerable Aquifers		HVA					Areas of 8%-<80% and 1%-<8% = both **low** threats; <1% = **no** threat
Significant GW Recharge Areas		SGR					Areas of 8%-<80% and 1%-<8% = both **low** threats; <1% = **no** threat

Note: These threat levels are based on Table 1 - Drinking Water Threats - Chemicals on Pages 23 and 24 of Appendix VII
Please note that this information should be read in conjunction with the maps of Percent Impervious Areas.