

Sydenham River. Agricultural areas extending southeast to Swan Line, north to Dufferin Ave., and east to the community of Wallaceburg were included in the *IPZ-2*, in addition to two urban areas along Base Line and west of Forhan St.

4.2.5. *IPZ-3* Delineation **Methodology**

A third zone around intakes has been developed. This zone is referred to as an *Intake Protection Zone-3 (IPZ-3)*. For Great Lakes and connecting channel intakes (Type A and B), the *IPZ-3* includes areas which can contribute contaminants under an extreme event at a concentration which would result in a deterioration of the source water for the purpose of human consumption.

As per Rule 68 an *IPZ-3* may be delineated if modelling 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. In general, an *IPZ-3* is to be delineated if modelling 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 modelling were provided in the MOE's Technical Bulletin: *Delineation of Intake Protection Zone-3 Using Event Based Approach (EBA)* dated July 2009. The hydrodynamic modelling report from Baird & Associates, (May 2011) was used to address *IPZ-3* delineation for all intakes.

Formatted: Glossary Char

Formatted: Glossary Char

Formatted: Glossary Char

Formatted: Glossary Char

Formatted: Glossary Char

In order to delineate the extent of the *IPZ-3* it is necessary to establish the concentration of contaminant which would result in a deterioration of the water for use as a source of drinking water. The Ontario Drinking Water Quality Standards were selected as the benchmark to be applied to the *IPZ-3* delineation. This is consistent with the benchmarks used for identifying an *Issue*.

Formatted: Glossary Char

A Model was developed by Baird and Associates through the *IPZ-2* work which was used for the delineation of *IPZ-3*. This model was used to explore the possible extent of boundaries to an *IPZ-3* through reverse particle tracking. The model was then used to determine concentrations

Formatted: Glossary Char

Formatted: Glossary Char

Formatted: Glossary Char

of a contaminant which would arrive at an intake following a possible spill similar to the scenarios which were modeled. The model was used to simulate the contaminant travel within the great lakes and connecting channel while an analytic approach described in MOE's Technical Bulletin was used to consider the dispersion and dilution within the tributaries flowing towards the intakes.

4.2.5.1. LAWSS and Petrolia Intakes

The modelling completed for the intakes followed the general approach outlined in the MOE Technical Bulletin (July 2009) and incorporated both reverse particle tracking and contaminant transport modelling. Wind on Lake Huron is the main force driving contaminants to Petrolia and LAWSS intakes. Tributaries transport contaminants from the watershed and upstream to the lake, where they may then be transported by wind driven currents to the intakes. Because the intake is located at the upstream end of the St. Clair River, flow in the St. Clair River is not as important a consideration for event selection.

The model was run in reverse to determine the possible extent of the area where particles (representing contaminants) end up when travelling in reverse from intakes. This approach is referred to in the MOE Bulletin as the boundary approach. Within this area, spill locations were chosen that were representative of potential spill locations. The model was used to determine contaminant concentrations arriving at the intake under the extreme events modeled. The model was used for two runs of differing 100-year return periods determined using a joint probability analysis. The parameters considered in the joint probability analysis included the duration of wind, flow in St. Clair River, and flow in tributaries. Spill locations were selected to simulate a spill of a contaminant from a tanker truck, rail car and ship at locations where it is likely that a spill of this size could occur. This would be similar to a spill of a similar size from fixed storage locations, although none were inventoried as part of this work, Perch and Cow creeks were selected for the simulated tanker truck spill and Lake Huron was selected for the ship spill contaminant modelling. Gasoline (with 2% benzene) was chosen to be the contaminant. For each tributary, a road crossing near the mouth and a road crossing near the headwaters was identified for a spill release. The spill locations were also considered representative of potential fixed fuel locations in the area. If it was found that the contaminant reached the intake at a concentration above the benchmark (Ontario Drinking Water Quality Standard of 0.005mg/L for

Formatted: Heading 4, Don't adjust space between Latin and Asian text

Formatted: Glossary Char, English (U.S.)

benzene), an JPZ-3 would be delineated. In the instances where it was justified to delineate an JPZ-3, Baird and Associates recommended extending the delineation to the headwaters and watershed limits of the watercourses, and to include all smaller tributaries between said watercourses and the applicable intake as spills in these locations are expected to result in similar concentrations (above the Ontario Drinking Water Quality Standard) arriving at the intake. As specified in the Technical Rules, the Floodplain Regulation Limit was also used in delineating the extent of the JPZ-3 along subject waterways, where this limit exceeded the 120 metre setback.

Formatted: Glossary Char

Formatted: Glossary Char

Formatted: Glossary Char

Formatted: Heading 4, Don't adjust space between Latin and Asian text

4.2.5.2. Wallaceburg Intake

The modelling completed for the Wallaceburg intake followed the general approach outlined in the MOE Technical Bulletin (July 2009), and incorporated both reverse particle tracking and contaminant transport modelling. For the Wallaceburg Intake – flow in the St. Clair River and in the Sydenham River are the main driving forces for transporting contaminants to the intake. High flows in the Sydenham River can result in flow reversals in the Chenal Ecarte, where the Wallaceburg intake is located. The flow in the Sydenham also has a considerable affect on the velocity of flow past the intake even when water is flowing past the intake towards the Sydenham River.

A joint probability analysis was performed 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 modelling, with one event incorporating the reverse flow in Chenal Ecarte where water from the Sydenham flows up the Chenal Ecarte past the intake. The other event modeled used the mean from the Sydenham River and a high flow on the St Clair River. This combination of flows resulted in slower velocities past the intake than would be experienced in summer low flow periods. The effect of lower flows from the Sydenham River was also modeled to see the impact on travel times to the intake. Although travel times of spills were slower than previous studies had suggested, the modelling indicated that, under the event conditions modeled, the concentrations exceeded the benchmark used.

There were four spill locations modeled with the above listed events. Two of the spills were fertilizer spills at the Tupperville Bridge on East Sydenham River and the ferry crossing of the St. Clair River at Sombra. A pipeline spill on the St. Clair River (south of Sarnia) and Rail Tank Spill at Bear Creek (north of Petrolia) were also modelled. For those spills which the the contaminant was shown, through modelling to reach the intake at a concentration above the benchmark (Ontario Drinking Water Quality Standard of 0.005mg/L for benzene), an *IPZ-3* was delineated. In instances where an *IPZ-3* was delineated, Baird and Associates recommended extending the delineation to the headwaters and watershed limits of the modeled watercourses and to include all smaller tributaries located between said watercourses and the intakes as spills in these locations are likely to result in similar concentrations (above the Ontario Drinking Water Quality Standard) arriving 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.

Formatted: Glossary Char

Formatted: Glossary Char

Formatted: Glossary Char

Formatted: Heading 4, Don't adjust space between Latin and Asian text

4.2.5.3. LAWSS IPZ-3 Delineation

The *LAWSS* modelling work was completed by assessing two scenarios. The first scenario used in delineation involved simulating a fuel tanker truck spill (gasoline 2% benzene) at a road crossing (Highway 402) on Perch Creek and Cow Creek. Based on model results, the fuel tanker spill would result in an exceedance of the Ontario Drinking Water Standard benchmark for benzene. The second scenario involved simulating a fuel spill from a ship on Lake Huron. This modelling simulation also resulted in an exceedance of the Ontario Drinking Water Quality Standard benchmark at the *LAWSS* intake.

Formatted: Glossary Char

The resultant *IPZ-3* delineation was based upon a combination of both phases of work. The *IPZ-3* was truncated at Highway 402 as no spills were modeled to the south of the highway. Refer to **Map 4.2b** for the *IPZ-3* delineation.

Formatted: Glossary Char

Formatted: Glossary Char, English (U.S.)

Formatted: Heading 4, Don't adjust space between Latin and Asian text

4.2.5.4. Petrolia IPZ-3 Delineation

As per Rule 68 an *IPZ-3* may be delineated if modelling 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

Formatted: Glossary Char

source of drinking water. The Thames Sydenham Region SPC has accepted the Ontario Drinking Water Quality Standard to identify deterioration of raw water quality at the intake.

The delineation was based upon two fuel spills from a tanker truck at a road crossing (Highway 402) on each of Perch Creek and Cow Creek. These were determined through modelling to result in exceedances of the Ontario Drinking Water Quality Standard for benzene, at the Petrolia intake. As a result the JPZ-3 extends upstream along the Perch and Cow Creeks to include drainage from Highway 402. As specified in the Technical Rules, the Floodplain Regulation Limit was also used in delineating the extent of the JPZ-3 along subject waterways, where this Limit exceeds the 120 metre setback.

Formatted: Glossary Char

Formatted: Glossary Char

Baird recommended extending the JPZ-3 delineation to the east to include the drain on Lakeshore Road and all watercourses located between Lakeshore Road and Highway 402 that drain into Lake Huron. This recommendation was based on the expectation that similar concentrations would arrive at the intake from spills on Lakeshore Road and Boonie Doon Creek. The JPZ-3 delineation to the west of the intake was truncated at the narrow section of the regulation limit as overland flow beyond this location would flow away from this watercourse and therefore away from the Petrolia intake. Refer to Map 4.3b for the JPZ-3 delineation.

Formatted: Glossary Char

Formatted: Glossary Char

Formatted: Glossary Char

Formatted: Heading 4, Don't adjust space between Latin and Asian text

4.2.5.5. Wallaceburg IPZ-3 Delineation

The Wallaceburg modelling work was completed in two phases. The first phase involved simulating a pipeline spill (gasoline with 2% benzene) upstream of the St. Clair River. Based on model results, the pipeline spill would result in an exceedance of the Ontario Drinking Water Quality Standard benchmark for benzene at the Wallaceburg intake. The second phase involved simulating: 1) a fertilizer spill at the Sombra ferry crossing on the St.Clair River; and 2) a fertilizer spill at the Tupperville bridge crossing on the Sydenham River. The modelling simulation resulted with an exceedance of the Ontario Drinking Water Quality Standard benchmark of 1mg/l for Nitrite (as nitrogen) at the Wallaceburg intake. The resultant JPZ-3 delineation was based upon a combination of both phases of work. Baird recommended extending the JPZ-3 delineation along the north Sydenham River and 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

Formatted: Glossary Char

Formatted: Glossary Char

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. Refer to Map 4.4b for the IPZ-3 delineation.

Formatted: Glossary Char

Formatted: Glossary Char

4.2.6. Vulnerability Assessment of Intake Protection Zones

Within the *Intake Protection Zones*, the *vulnerability* must be assessed based on a number of factors. These factors include the *vulnerability* of the source and the area in the *Intake Protection Zone*:

Deleted: ¶

A third zone around intakes can also be developed. This zone is referred to as an *Intake Protection Zone-3 (IPZ-3)*. For Great Lakes intakes, the *IPZ-3* includes areas which can contribute contaminants under an extreme event at a concentration which would result in a deterioration of the source water for the purposes of human consumption. The *IPZ-3* work is yet to be undertaken and will be part of an amended Assessment Report. ¶

Area Vulnerability factor: According to the *Technical Rules*, *IPZ-1* is assigned an area *vulnerability* factor of 10, while the factor for *IPZ-2* is between 7 and 9. A higher number corresponds to a higher *vulnerability*. The area *vulnerability* factor for *IPZ-2* is dependent on the percentage of area that is land in the *IPZ-2*, land cover, soil type and permeability of the land, slope of any setbacks, and the hydrological and hydrogeological conditions in the area that contribute water to the area through *transport pathways*. The above mentioned evaluation factors have been given equal weight based on professional judgment.

Deleted: judgement

Area vulnerability factor for the LAWSS IPZ-2

Percentage of the Area of the IPZ-2 that is Composed of Land: Approximately 3% of the LAWSS IPZ-2 is located on land minimizing any impacts for land use activities; therefore the vulnerability can be considered low for this factor. Land Cover, Soil Type, Permeability of the Land, Slope of the Land: The land cover is predominately residential along the shores of Lake Huron. The land is generally flat with sand dunes and/or trees in the land portions of the IPZ-2. Overall, due to these considerations, the vulnerability can be considered low. Hydrological, Hydrogeological, and Transport Pathways: Predominately, Lake Huron flows to the mouth of the St. Clair River near the intake which produces high current and velocity value. There was found to be one storm sewer shed within IPZ-2 east of the LAWSS intake on Lake Huron that is counted as a transport pathway. This slightly increases the value of the factor. Based on these factors, the area vulnerability factor for the LAWSS IPZ-2 is selected to be 8 (from a range of 7 to 9).

Area vulnerability factor for the Petrolia IPZ-2

Percentage of the Area of the IPZ-2 that is Composed of Land: Approximately 40% of the Petrolia IPZ-2 is located on the land. The land component may increase the potential for contaminants from land to adversely affect the intake thereby increasing the vulnerability of the intake. Land Cover, Soil Type, Permeability of the Land, Slope of the Land: The land cover that is located in the IPZ-2 is predominately agricultural that would result in higher run-off during rain events. The area located in IPZ-2 is predominately tiled drained therefore any potential runoff would migrate to the tributaries and/or the intake quickly in a rain event. There land is generally flat in the IPZ-2 which would slow the overland flow. Overall, due to these considerations, the vulnerability of this intake was increased. Hydrological, hydrogeological, and Transport Pathways: The identified transport pathways include Cow Creek, Perch Creek, and local drainage ditches that drain either o the creeks or into Lake Huron. The presence of local tributaries and drainage ditches also contributes to the higher score. Considering these factors, an area vulnerability score of 9 (from a range of 7 to 9) was assigned to the Petrolia IPZ-2.

Deleted: At the LAWSS IPZ-2 less than 3% is land. The land cover is predominately residential along the shores of Lake Huron. The land is generally flat with sand dunes and/or trees in the land portions of the IPZ-2. Lake Huron flows to the mouth of the St. Clair River near the intake which produces high current and velocity value. There was found to be one storm sewer within IPZ-2 east of the LAWSS intake on Lake Huron that identified as a transport pathway. Based on these factors, the area vulnerability factor for the LAWSS IPZ-2 is selected to be 8 (from a range of 7 to 9).¶

Deleted: At the Petrolia IPZ-2 approximately 40% is land. The land cover is predominately agricultural, mainly tile drained and generally flat. The identified transport pathways include Cow Creek, Perch Creek, and local drainage ditches that drain either to the creeks or into Lake Huron. Considering these factors, an area vulnerability score of 9 (from a range of 7 to 9) was assigned to the Petrolia IPZ-2.

Area vulnerability factor for the Wallaceburg IPZ-2

Percentage of the Area of the IPZ-2 that is Composed of Land: A greater percentage of land area within an IPZ-2 may increase the potential for the area to contain more land use activities. Collectively or independently, land use activities may contribute contaminants to the source water. Therefore, a greater percentage of land area within the vulnerable area supports a higher area vulnerability factor. It was determined that the Wallaceburg IPZ-2 is comprised of 95% land and 5% of water. The percent of IPZ-2 that is land supports a high area vulnerability factor. Land Cover, Soil Type, Permeability of the Land, Slope of the Land: The upland area of the Wallaceburg IPZ-2 is characterized by flat topography exhibiting almost no relief. The upland IPZ-2 is composed of 95% land (1,068 ha) of which 14% (152 ha) is impervious land cover. The pervious portions of the land are comprised of sandy loam and silty clay loam. These poorly drained soils contribute to increased runoff; however, the low relief of the land lowers the potential for runoff in the area. The land cover, soil type, and permeability analysis support a low area vulnerability factor. Hydrological, hydrogeological, and Transport Pathways: Anthropogenic transport pathways such as storm sewers, municipal drains, tile drained areas, and natural transport pathways such as waterways may potentially transport contaminants to the source water. Therefore, a greater number of transport pathways support a higher area

Deleted: At the Wallaceburg IPZ-2 approximately 95% is land. Land use in this zone is mostly agricultural with pockets of residential and industrial areas in the outer areas of the zone. Six municipal drains and four storm sewer systems discharge within the in-water extent of the IPZ-2. Although few municipal drains and storm sewer networks are located in the vulnerable area, the area is comprised of an extensive system of transport pathways. Based on these factors, the area vulnerability factor for the Wallaceburg IPZ-2 is selected to be 8 (from a range of 7 to 9).¶

Formatted: Glossary Char

vulnerability factor. Few municipal drains and storm sewer networks are located in the vulnerable area, although six municipal drains and four storm sewer systems discharge within the in-water extent of the IPZ-2. The area is comprised of an extensive system of transport pathways. The complexities of the transport pathways support a higher vulnerability factor. Based on these factors, the area vulnerability factor for the Wallaceburg IPZ-2 is selected to be 8 (from a range of 7 to 9).

Source Vulnerability factor: According to the *Technical Rules*, for a Great Lakes intake, such as the Petrolia intake, the source *vulnerability* factor is between 0.5 and 0.7. For a connecting channel intake, such as the *LAWSS* and Wallaceburg intakes, the source *vulnerability* factor is between 0.7 and 0.9. A higher number corresponds to a higher *vulnerability*. According to the *Technical Rules*, this factor is dependent on depth of the intake, distance of the intake from shore, and the number of recorded *issues* related to the intake. In addition to the factors required to be considered by the *rules*, the Ministry of Environment (*MOE*) guideline for minimum submergence of an intake and the Michigan *vulnerability* categories for Great Lakes intakes (based on distance and depth) were considered in assessing the source *vulnerability* factor.

Table 4-2 summarizes the intake characteristics including depth and length of each municipal intake in the *SCRSPA*. The plant operators noted concerns of shipping activities as well as spills affecting the water quality at the *LAWSS* intake. The source *vulnerability* factor assigned to the *LAWSS* intake, considering the deepness and length of the intake as well as water quality concerns, is 0.8 (from a range of 0.7 to 0.9). At the Petrolia intake, a shallower depth and shorter length of the intake as well as plant operators concerns of sewer line break near the intake, and elevated turbidity in raw water contribute to a source *vulnerability* factor of 0.7 (from a range of 0.5 to 0.7). The Wallaceburg intake is shallow and short, and is susceptible to riverbank influences, surface contamination and water column mixing. The intake lies in the St. Clair River Area of Concern (*AOC*). Concerns noted by the plant operator include elevated nitrate and turbidity levels during precipitation events. Considering all of these factors, a source *vulnerability* factor of 0.9 (from a range of 0.7 to 0.9) was assigned to the Wallaceburg intake.

St. Clair Region Source Protection Area Assessment Report

The Source Vulnerability factor is then multiplied by the Area Vulnerability factor to determine the *Vulnerability Score* of the zone. The *vulnerability* factors and scores of the *Intake Protection Zones* of the St. Clair Region Source Protection Authority are summarized in Table 4-3.

Table 4-3 Summary of Vulnerability Score of Intakes

Intake	Area Vulnerability Factor		Source Vulnerability Factor	Vulnerability Score	
	IPZ-1	IPZ-2		IPZ-1	IPZ-2
LAWSS	10	8	0.8	8.0	6.4
Town of Petrolia	10	9	0.7	7.0	6.3
Wallaceburg	10	8	0.9	9.0	7.2

Due to the nature of the *Technical Rules* in assigning source vulnerability factors to Great Lakes intakes, the *vulnerability scores* would be below 8 in all cases. This influences the level of *threat* that could occur in a *vulnerable area* around a Great Lakes intake, as discussed in Section 7 - Threats and Risk Assessment Section of this Assessment Report. For an *activity* to be considered a *threat* it must occur in an area with a *vulnerability score* greater than 4. A *significant threat* may be identified in an area with *vulnerability scores* of 8 or more. In the *IPZ* of the Town of Petrolia intake (on Lake Huron), *activities* are not classified as *significant threats* because for a Great Lakes intake, the *vulnerability scores* that can be assigned are less than 8. However, for a connecting channel intake, according to the *Technical Rules*, *vulnerability scores* of 8 are possible. As seen from Table 4-3 above, *significant threats* may be identified in the *IPZ-1* of the *LAWSS* and Wallaceburg intakes.

4.2.7. Uncertainty in Intake Protection Zone delineation

The *Technical Rules* require that the degree of *uncertainty* in the *vulnerability* assessment of surface water *Intake Protection Zones* be assessed. The *uncertainty* can only be characterized as 'high' or 'low'. Baird and Associates Ltd. undertook the hydrodynamic modelling to delineate the in-water portion of the *IPZ-2* for the *LAWSS*, Petrolia and Wallaceburg intakes, using best available data. The *uncertainty* analysis is described in detail in Appendix 13 of this Assessment Report. Due to such things as data gaps and model limitations, there is *uncertainty* with the delineation of the *vulnerable areas*. In areas of lower *vulnerability*, this *uncertainty* would not affect assessment of *risk* or the types of policies which would be developed in the *Source*

Protection Plan. However, in areas of higher *vulnerability* which require *threats* assessments and policy development, the *Source Protection Committee* is satisfied that the *uncertainty* for all three intakes in the *SPA* is low enough for the purposes intended.

Similarly for JPZ-3 hydrodynamic modeling was used to model contaminant concentrations at the intake resulting from a spill at select locations during an extreme event. Appendix 13 details the factors used in assigning an uncertainty level to this work. Although the consultant indicates that the uncertainty level is high, the modelling demonstrates that these spills can result in a deterioration of the drinking water source. Additional work is required to assess the likelihood of lesser spill quantities and other locations also resulting in a deterioration of the drinking water source. Further calibration and validation of the model is required to be able to rely upon the model results as they pertain to the timing of the arrival and passing of the spill at the intake.

Formatted: Glossary Char

4.3 Wellhead Protection Areas

Wellhead Protection Areas or *WHPAs*, as they are often referred to, are the *vulnerable areas* which are delineated around groundwater sources of *drinking water*. Wells are used to extract the water from *aquifers* in the ground where water is contained in spaces, voids or fractures in the soil or rocks. Often many wells are used in an area to extract sufficient water to supply the needs of the customers. Multiple wells in an area are often referred to as a well field.

In the St. Clair Region Source Protection Area, there are no municipal wellheads, and therefore no *WHPAs* have been delineated. In the two other Source Protection Areas of the Thames-Sydenham and Region, *WHPAs* were delineated using computer based three-dimensional groundwater flow models.

The work related to *Wellhead Protection Areas* in the Thames-Sydenham and Region may be viewed in the Assessment Reports of the Lower Thames Valley Source Protection Area and the Upper Thames River Source Protection Area.