WATERSHED CHARACTERIZATION

March 2015

Essex Region Source Protection Area

Updated Assessment Report

APPROVED

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***Note:** The information contained in this section of the Essex Region Assessment Report was approved in 2011. Updates in this version have been restricted to grammatical corrections.

2.0 Watershed Characterization

The Watershed Characterization chapter provides an overview of the Essex Region Watershed's fundamental natural and human characteristics. The Watershed Description was developed by compiling available background information for the Essex Region Watershed, including natural characteristics such as topography, soils, hydrology, etc., and human characteristics such as population, land use, and water uses/systems. The entire report, prepared in 2006, can be found in **Appendix I**.

2.1 Essex Region Source Protection Area

The Essex Region Source Protection Area coincides with the watershed boundaries of the Essex Region Conservation Authority, or the "Essex Region Watershed." The Essex Region Watershed is bounded on three sides by the waters of the Great Lakes system and includes a peninsula in the extreme southwestern corner of the Province, as well as Pelee Island (Township of Pelee) in Lake Erie, and several smaller islands. As shown in **Map 2.1**, the Essex Region Watershed is comprised of approximately 28 smaller subwatersheds, flowing either generally northward into Lake St. Clair, westward into the Detroit River, or southward into Lake Erie; (or entirely into Lake Erie in the case of Pelee Island). The Lower Thames Valley Conservation Authority (part of the Thames-Sydenham and Region Source Protection Region) shares the eastern boundary of the Essex Region Watershed.

The Essex Region Watershed is approximately 1,681 square kilometres in size and predominantly consists of a relatively flat clay plain with the exception of some sandy areas, primarily in the southern portion of the Region. The predominant land use in the watershed is agriculture, due to the Region's excellent farmland and growing conditions. Although most of the urban land use is in the north-western area, in and around the City of Windsor, there are numerous smaller urban centres and settlement areas in other parts of the Watershed.

2.1.1 Population, Population Density and Future Projections

The seven municipalities in Essex County occupy an area of 1,471 km^2 (**Map 2.2**), with the City of Windsor having a land area of 146 km^2 square kilometers and the Township of Pelee occupying about 42 km^2. In addition, Point Pelee National Park has a land area of roughly 15 km^2 and the surrounding islands in Lake Erie and the Detroit River total approximately 7 km^2. The entire Essex County Region has a land area of 1,869 km^2 of which 188 km^2 are administered by the Lower Thames Valley Conservation Authority. **Table 2.1** shows the municipalities in the Essex Region Source Protection Area.

Table 2.1 Municipalities in the Essex Region Source Protection Area

Municipality	Comments
City of Windsor	Separate municipality
Township of Pelee	Separate municipality
County of Essex:	
Town of Amherstburg	Includes former Malden and Anderdon
Town of Essex	Includes former Harrow, Colchester North and South
Town of Kingsville	Includes former Gosfield North and South
Town of Lakeshore	Includes former Belle River, Maidstone, Rochester, Tilbury North and West
Town of LaSalle	Former Sandwich West
Town of Tecumseh	Includes former St. Clair Beach and Sandwich South
Municipality of Leamington	Includes former Mersea
Municipality of Chatham-Kent	A very small portion of Chatham-Kent extends into the Essex Region

Based on the 2006 Census of Canada, the City of Windsor, Essex County and the Township of Pelee have a combined population of 393,452, an increase of 4.9% from 2001 (**Table 2.2**). A very small portion of Chatham-Kent also extends into the Essex Region Watershed, and the residents living in this area are not included in the above population total nor in the tables below. The population breakdown is shown in **Table 2.2**, while the population density is displayed in **Table 2.3 and Map 2.3.** Please note that the information in these tables is for the entire area of respective municipalities, including small portions of Lakeshore and Leamington which lie outside the Essex Region Watershed as discussed previously.

Table 2.2 Population and Growth in Essex Region Municipalities

City/ Municipality	Population (2006)	Population (2001)	% Growth (2001-06)	Population (1996)	% Growth (1996-2001)
Windsor*	216,473	209,218	**+3.5%**	197,694	**+5.8%**
Lakeshore	33,245	28,746	**+15.7%**	26,127	**+10.0%**
Leamington	28,883	27,138	**+6.4%**	25,389	**+6.9%**
LaSalle	27,652	25,285	**+9.4%**	20,566	**+22.9%**
Tecumseh*	24,224	24,289	**-0.3%**	23,151	**+4.9%**
Amherstburg	21,748	20,339	**+6.9%**	19,273	**+5.5%**
Essex	20,032	20,085	**-0.3%**	19,437	**+3.3%**
Kingsville	20,908	19,619	**+6.6%**	18,409	**+6.6%**
Pelee	287	256	**+12.1%**	283	**-9.5%**
Total	393,452	374,975	**+4.9%**	350,329	**+7.0%**

Source: Statistics Canada, 2006, 2001 (*Boundary Change prior to 2001)

Table 2.3 Population Density in Essex Region Municipalities

City/Municipality	Population (2006)	Area (km^2)	Density (people/km^2)
Windsor	216,473	145.7	**1,485.7**
LaSalle	27,652	61.2	**451.8**
Tecumseh	24,224	95.5	**253.7**
Amherstburg	21,748	189.5	**114.8**
Leamington	28,883	254.4	**113.5**
Kingsville	20,908	248.2	**84.2**
Essex	20,032	278.3	**72.0**
Lakeshore	33,245	532.9	**62.4**
Pelee	287	41.7	**6.9**
Total	393,452	1,869.4	**210.5**

Source: Statistics Canada, 2001

Information for population trends and projections was taken from the September 2001 Working Report of the Windsor-Essex Regional Analysis prepared by the Planning Policy Section of the Provincial Planning and Environmental Services Branch of the Ministry of Municipal Affairs and Housing. Population projections for Essex Region municipalities indicate an increase of 50,620 to 90,538 residents between 1996 and 2016 (**Table 2.4**), with growth rates of 14% to 26% over this period. (**Table 2.2**).

Table 2.4 Population Projections for Essex Region Municipalities

Municipality	Pop (2001) Actual	Pop (2016) Medium	% Growth Projected
Windsor	208,402	213,217	**2.3%**
LaSalle	25,285	29,737	**17.6%**
Tecumseh	25,105	31,012	**23.5%**
Amherstburg	20,339	24,076	**18.4%**
Leamington	27,138	31,066	**14.5%**
Kingsville	19,619	22,339	**13.9%**
Essex	20,085	22,931	**14.2%**
Lakeshore	28,746	34,861	**21.3%**
Pelee	256	283	**10.5%**
Total	**374,975**	**409,522**	**9.2%**

Source: Working Report, 2001

2.1.2 Climate

The climate in the Essex Region Watershed may be characterized by warm, long summers, and cool, short winters. The Essex Region is referred to as the “Sun Parlour of Canada” (OMNR, 1975; Sanderson, 1980). The Essex Region receives hot humid air from the south during the summer and cooler air in the winter as a result of cold dry arctic air (Sanderson, 1980). Due to its geographical position, the area receives more precipitation than the Prairie Provinces and less than the east coast of Canada. The bounding water bodies of Lake Erie and Lake St. Clair; and the Metropolitan City of Detroit, Michigan are reported to have caused minor climatic effects in the area (Sanderson, 1980). The presence of Lake Erie affects the temperatures along the southern shore of the Essex Region and Pelee Island. Sanderson (1980) stated that a large city like Detroit also alters the climate of the area, increasing temperatures in the so-called “urban heat island”.

Temperatures range from less than -15^{o}C in winter to higher than 30^{o}C in summer. The mean annual temperature in the Essex Region is more than 9^{o}C and is the highest in southern Ontario. Annual means of daily maximum temperatures are found to vary between 13.0^{o}C and 14.7^{o}C, and the annual mean minimum temperatures ranged between 1.7^{o}C and 6.7^{o}C for different stations in the study area. For convenience, the year may be split into two different periods i.e., November to March and April to October. The normal temperatures during November to March fall below 5^{o}C. Mean daily temperatures during winter vary from -4^{o}C to 1.5^{o}C. The same exceeds 21^{o}C during the months from May to October. The mean daily temperatures are usually the highest in July, the normal temperatures being above 22^{o}C.

The area receives less precipitation in the form of snow in comparison to cold climate regions of Canada. Most of the rainfall during the summers comes in the form of showers and thunderstorms. Sanderson (1980, 2005), summarizing the climate of the Essex Region and climatic changes in southern Ontario, reported that the annual precipitation over the 25 years prior to 1980 has ranged from 533 mm to 1110 mm. The same is changed to 522 mm-1189 mm for the period 1971-2000.

The mean annual rainfalls recorded in the mainland of the study area ranged between 686 mm and 849 mm. The highest and the lowest annual rainfalls recorded at these stations in the mainland of the Essex Region are 1152 mm at the Windsor Ford plant station in 1983 and 569 mm at the Windsor Airport station in 1988, respectively. The highest and lowest annual rainfall recorded at the Pelee Island station are 1402 mm and 509 mm recorded, respectively, in 1892 and 1987.

2.1.3 Land Cover and Land Use

The Essex Region is predominately made up of flat, productive land with a small amount of forest and wetland habitat. About three-quarters of the area are used for agriculture, with cash crop farms, specialty crops, orchards and greenhouse farming being the most prevalent agricultural uses. The remainder of the area is roughly 18-19% urban land use and 8.5% natural heritage, i.e. forests and wetlands. Surrounding the Region is Lake St. Clair to the north, Lake Erie to the south, and the Detroit River to the west. The shoreline surrounding the area is mostly privately owned and developed, primarily with residential uses, and with numerous marinas, beaches and other water-based recreational activities available. In the City of Windsor, the shoreline includes a mixture of residential, industrial/commercial uses, as well as an extensive system of waterfront parklands (Prince & Associates, 2002). Another source of land cover data is the Southern Ontario Land Resource Information System (SOLRIS, 2000) mapping project (**Map 2.4** and **Table 2.5**). Lands owned by the Federal Government are shown in **Map 2.5.**

Information gathered through official land use plans for the County of Essex and the City of Windsor showed that 80-85% of the area in the county was designated as agricultural land use, with 10-12% designated settlement and the remainder natural; while for the City of Windsor 85% of the land was designated urban (60% residential, 25% commercial, industrial & business), 10% open field, recreational and natural, and the remaining 5% mixed use. **Table 2.6** shows the breakdown for the entire Region, with the above figures averaged. No projections were available for the Township of Pelee.

Table 2.5 Land Use in the Essex Region

Land Use Classification	Area (km^2)	Area (acres)	% Coverage
Urban Areas	243	60,100	**14.5%**
Woodlots	113	27,900	**6.8%**
Wetlands	26	6,500	**1.6%**
Agricultural/Other	1,291	319,100	**77.1%**

Source: SOLRIS, 2000

Table 2.6 Projected Land Use in the Essex Region

Land Use Classification	*Area (km²)*	*Area (acres)*	*% Coverage*
Urban Areas	285.8	70,622	**17.0%**
Natural Areas	142.9	35,311	**8.5%**
Agriculture	1,252.3	309,449	**74.5%**

Sources: County of Essex and City of Windsor Official Plans

Note: Urban areas include residential, commercial, industrial, mixed, open & recreational; natural areas include woodlots and wetlands)

Wetlands, forests and vegetated buffers can help to protect source waters by trapping sediments and reducing contaminant inputs (e.g. nutrients, pesticides, herbicides and pathogens) to surface and groundwater sources. A healthy watershed is characterized as having a diverse complement of natural heritage areas, including large core areas distributed across the landscape and which are connected to one another, as well as riparian systems which are well buffered from adjacent agricultural or urban land uses. Watersheds with these natural conditions are better able to keep soil and contaminants from entering surface and groundwater systems. The following are the key natural heritage features which are most likely to influence source water within the Essex Region.

2.1.3.1 Forest and Vegetation Cover

Table 2.7 depicts the results from the Essex Region Biodiversity Conservation Strategy (BCS) (ERCA, 2002) for forest coverage within each watershed. The base data utilized in the analysis are from the 1982 OBM 1:10,000 coverage. Forest cover based on 2000 aerial photography can be found in **Map 2.6**. In addition, the location of Areas of Natural and Scientific Interest (ANSI), as identified by the OMNR, and regionally significant Environmentally Significant Areas (ESA), as identified by the Essex Region Conservation Authority (ERCA) can be found in **Map 2.7**.

Table 2.7 Summary of Forest Area (greater than 0.5 ha)

Subwatershed	Type	ha	Ac	Percent
Atwell Drain	Upland	17.3	42.7	**3.2%**
East Marsh		12.5	30.8	**2.5%**
Hillman Marsh		288.3	712.5	**3.9%**
Marentette		0.0	0.0	**0.0%**
Muddy Creek		42.9	106.0	**5.1%**
Point Pelee		288.3	712.3	**19.5%**
Sturgeon Creek		81.9	202.3	**2.0%**
West Marsh		1.6	4.0	**0.1%**
Detroit River		320.8	792.7	**2.6%**
Little River		164.9	407.4	**2.5%**
River Canard		1536.9	3797.6	**4.5%**
Turkey Creek		620.8	1534.0	**10.2%**
Big Creek		494.7	1222.5	**6.9%**
Colchester Drains		189.7	468.8	**4.9%**
Fox/Dolson Creek		107.0	264.3	**8.3%**
Cedar Creek		1307.2	3230.1	**9.9%**
Wigle Creek		236.7	585.0	**7.7%**
Mill Creek		142.8	352.8	**6.5%**
Kingsville Drains		160.6	396.9	**6.9%**
Pike Creek		346.7	856.6	**3.5%**
Puce River		318.7	787.5	**3.5%**
Belle River		445.4	1100.6	**3.7%**
Duck & Moison		31.8	78.7	**0.8%**
Ruscom River		396.3	979.2	**2.0%**
Little Creek		17.3	42.8	**0.3%**
Pelee Island		831.5	2054.7	**20.0%**
Total Upland Forest Cover		**8402.4**	**20762.7**	**5.0%**

At the time this report was prepared, the total length of all streams in the Region was 2467 km. Of that, 117.5 km flow through forested areas. The amount of riparian habitat that is forested along first- to third-order streams is therefore 4.76%. This indicates that streams are degraded, and fisheries severely limited (Environment Canada et al., 1996). **Table 2.8** depicts the results from the Essex Region Biodiversity Conservation Strategy (BCS) (ERCA, 2002) for percent riparian forest within each watershed.

Riparian habitat and water quality would significantly increase if at least 75% of all first-, second- and third-order streams were restored to natural vegetation at least 30 m wide. This riparian habitat restoration should maintain functional warm water streams as well as relatively good wildlife corridors.

2.1.3.2 Wetlands

Table 2.9 shows the results from the Essex Region Biodiversity Conservation Strategy (BCS) (ERCA, 2002) for wetland coverage within each watershed. Detailed data for each of the different wetland types are available if required. The base data used in the analysis are from the 1982 OBM 1:10,000 coverage. Wetland coverage based on 2000 aerial photography can be found in **Map 2.6**. In addition, the location of Provincially Significant Wetlands (PSW), as identified by the Ontario Ministry of Natural Resources can be found in **Map 2.7**. Almost all wetlands within the Region are classified as riverine at mouth marsh or lacustrine wetlands. Very few areas of the Region are what are considered to be "upslope" wetlands. **Table 2.10** depicts those watersheds containing wetlands which are in the vicinity of Municipal Surface Water Intakes.

Table 2.8 Riparian Forests in Essex Region Watersheds

Stream	**Existing**		
	Riparian Forest (m)	Total Length (m)	**% Riparian**
Atwell Drain	299.9	11136.8	**2.7%**
East Marsh	0.0	13616.3	**0.0%**
Hillman Marsh	14483.8	117556.6	**12.3%**
Marentette	0.0	1209.3	**0.0%**
Muddy Creek	2259.9	13601.0	**16.6%**
Point Pelee	0.0	0.0	**0.0%**
Sturgeon Creek	7853.4	65602.0	**12.0%**
West Marsh	21.4	28130.8	**0.1%**
Detroit River	2743.8	38200.3	**7.2%**
Little River	2718.6	88870.4	**3.1%**
River Canard	29021.0	367867.3	**7.9%**
Turkey Creek	10214.8	73249.5	**14.0%**
Big Creek	8622.1	127954.8	**6.7%**
Colchester Drains	1081.6	47071.6	**2.3%**
Fox/Dolson Creek	1759.0	17120.2	**10.3%**
Cedar Creek	17935.6	197852.0	**9.1%**
Wigle Creek	4204.5	49914.7	**8.4%**
Mill Creek	3464.1	34253.4	**10.1%**
Kingsville Drains	5833.5	34518.5	**16.9%**
Pike Creek	1905.1	197961.2	**1.0%**
Puce River	259.8	150099.0	**0.2%**
Belle River	2583.2	218180.6	**1.2%**
Duck & Moison Creek	0.0	86663.5	**0.0%**
Ruscom River	219.5	369934.5	**0.1%**
Little Creek	0.0	116177.2	**0.0%**
Pelee Island	0.0	0.0	**N/A**
Total	**117484.7**	**2466741.2**	**4.8%**

Table 2.9 Summary of Existing Wetland Area

Watershed	Type	ha	ac	Percent
Atwell Drain	All Wetlands (Open Water + Marsh + Swamp)	0.0	0.0	**0.0%**
East Marsh		0.0	0.0	**0.0%**
Hillman Marsh		362.9	896.7	**4.9%**
Marentette		0.0	0.0	**0.0%**
Muddy Creek		10.7	26.5	**1.3%**
Point Pelee		1083.5	2677.4	**73.2%**
Sturgeon Creek		55.9	138.1	**1.4%**
West Marsh		0.0	0.0	**0.0%**
Detroit River		685.3	1693.4	**5.6%**
Little River		4.0	9.8	**0.1%**
River Canard		206.8	510.9	**0.6%**
Turkey Creek		23.2	57.2	**0.4%**
Big Creek		743.4	1837.0	**10.4%**
Colchester Drains		16.2	40.0	**0.4%**
Fox/Dolson Creek		20.6	50.9	**1.6%**
Cedar Creek		134.5	332.4	**1.0%**
Wigle Creek		17.1	42.2	**0.6%**
Mill Creek		0.01	0.0	**0.0%**
Kingsville Drains		0.0	0.0	**0.0%**
Pike Creek		13.6	33.6	**0.1%**
Puce River		0.0	0.0	**0.0%**
Belle River		18.5	45.8	**0.2%**
Duck & Moison		1.1	2.7	**0.1%**
Ruscom River		27.6	68.3	**0.1%**
Little Creek		21.6	53.4	**0.4%**
Pelee Island		85.1	210.2	**2.0%**
Total Wetland (Open Water + Marsh + Swamp)		**3531.5**	**8726.6**	**2.1%**

Table 2.10 Watersheds in the Vicinity of Municipal Intakes

Nearby Surface Water Intake	Watershed(s)
Amherstburg	**Canard River, Detroit River, Turkey Creek**
Belle River	**Belle River, Duck Creek, Moison Creek**
Harrow-Colchester	**Big Creek, Colchester Drains, Fox/Dolson Creek**
Stoney Point	**Little Creek, Ruscom River**
Union	**Cedar Creek, Wigle Creek, Mill Creek**
Windsor	**Little River, Pike Creek**
Wheatley*	**Hillman Marsh, Muddy Creek**

*outside Essex Region but serves part of Leamington and influenced by Essex Region Watershed.

2.1.4 Physiography

The Essex Region Watershed is a part of the Essex Clay Plain, which itself is a sub-division of the St. Clair Plain physiographic region (Chapman and Putnam, 1984). The area has much in common with the nearby Lower Thames Valley and St. Clair Region Conservation Authority areas in terms of specialized agricultural activities on the clay and sand plains of ancient lake bottoms and bedrock (Chapman and Putnam, 1984). The physiography of the Region is shown in **Map 2.8**. Most of the Region is made up of extensive sand and clay plains which extend down some 30 to 60 meters before encountering rock (Chapman and Putnam, 1984). Glaciers deposited unsorted stony materials. When the ice melted, deep glacial lakes were formed over most of the area. Large deposits of sediment and outwash material were left as a result of smoothening of ridges by waves.

The original relief in the Region was lowered by the wave action of ancient glacial lakes and the beveled till plain remains of these lakes were further smoothed over by the settling of lacustrine clays in the surrounding depressions (Chapman and Putnam, 1984).

In addition to the moraine near Leamington, there are a few other areas of concentrated relief. The Ruthven-Leamington hill area, which rises to a height of 35 meters above the surrounding plain, is composed of fluvio-glacial materials. Much of the sand and gravel was accumulated when the first glacial lake, Lake Maumee, was formed. As the ice receded and the lake diminished in size, the Ruthven-Leamington hill became an island and gravel beaches formed around it at two or more levels (**Map 2.8**). Near Harrow, there is a sandy extrusion which reaches 195 meters above sea level, while a low gravel ridge through Essex, Cottam and the hamlet of Maidstone also rises to 195 meters above sea level. Point Pelee, at the southeastern tip of the mainland of the Essex Region Watershed, is a spit of land extending out into Lake Erie. The surface is at or just-below lake level, favouring marshland and its accompanying fauna.

Pelee Island is also part of the Essex Region Watershed, lying some 13 km south of Point Pelee. It covers around 40 km² and is about 8 km from north to south, and 5 km east to west. Beveled till comprises most of the Pelee Island clay plain and is fine in texture with few large boulders (Chapman and Putnam, 1984). Made up of limestone, with a relief of 175-182 m above sea level, the island is only 10 m above Lake Erie's mean water level at its apex. Clay extends down 3m on 75% of the island, with an area on the western side extending down to 15 m, and another towards the northwest corner extending down to 29 m before hitting bedrock (Chapman and Putnam, 1984).

2.1.5 Ground Surface Topography

Topography describes the configuration of the earth's surface and the physiographic characteristics of land in terms of elevation, slopes and orientation. Topography generally determines the natural surface water flow directions. The elevation data were obtained in the form of a Digital Elevation Model (DEM), which was generated using the aerial photographic survey in 2004 (**Map 2.9)**. The Essex Region generally varies in elevation from approximately 173-196 m above sea level, with the exception of the moraine in Leamington, near County Road 31, which climbs to 227 m above sea level. The highest and the lowest elevations of land surface in this Region are 173 m and 227 m above mean sea level. The elevation on Pelee Island varies from 175-182 m. Generally, the land slopes range between 0-5% except in the areas of the moraine in Leamington. The flat terrain in the watershed Region poses challenges in terms of drainage.

2.1.6 Geology

2.1.6.1 Bedrock Geology

The bedrock in the Essex Region is underlain by a thick succession of Palaeozoic sedimentary rocks which are a part of the Michigan Basin sedimentary deposits (**Map 2.10**). The oldest formations are found in the southern part of the Region, generally along the Lake Erie shoreline, while the youngest formations are found primarily in the northern part of the Region.

The distribution of bedrock elevations in the Region were generated from well records by selecting all the wells that intersect bedrock and subtracting the depth of overburden material from the ground elevation from the NRVIS DEM (Strynatka et al., 2004). The lowest bedrock elevation is 120 m and the highest is 210 m above sea level (**Map 2.11**).

There are no known natural outcrops of Palaeozoic rock in the Essex Region other than on Pelee Island (OMNR-OGS, 1981). The Palaeozoic rocks that subcrop in the area range in age from Late Silurian to Middle Devonian (350-370 million years ago) and include (from oldest to youngest) the Bass Island Formation, the Detroit River Group, the Dundee Formation and the Hamilton Group (Sanford and Brady, 1956 and Johnson et al., 1992).

2.1.6.2 Quaternary Geology

The overburden stratigraphy in the Essex Region consists of several distinct types of material, which include tills, clays, fine to coarse-grained glaciolacustrine deposits and lacustrine sediments (Strynatka et al., 2004). The overburden material in the Region was formed as a result of several successive major glaciation events that occurred in the northern hemisphere during the past 80,000 years (Fulton and Prest, 1987). The branch of geology that deals with material formed during this period is referred to as quaternary geology. The sediment material transported and deposited during the advances and retreat of glaciers and their melt-water are referred to as “glacial overburden”. **Map 2.12** shows the quaternary geology and illustrates the distribution of various units in the overburden within the study area. The glacial stratigraphic column consists of interbedded clay, till, sand and gravel layers.

2.1.6.3 Overburden Thickness

Strynatka et al. (2004) obtained the overburden thickness surface by subtracting the generated bedrock surface from the ground surface in the NRVIS DEM (**Map 2.12**). The thickness of the overburden ranges from zero in parts of Pelee Island and Amherstburg to about 70 m in the southern part of Kingsville and is less than 40 m in thickness in 80% of the Region (**Map 2.13**). Areas of thick drift may be found west of Leamington and north of Colchester.

Tills are the sediments transported and deposited by or from glacial ice, with little or no sorting by water (Dreimanis, 1989). The oldest deposit and the lower most unit of the glacial overburden is Catfish Creek Till, a compact, stony, sandy silt till which lies directly on bedrock. Catfish Creek Till does not outcrop in Essex but is visible in quarry sections (Morris, 1994). Water well records indicate a hardpan or gravel layer lying directly over bedrock throughout the Region, interpreted to be Catfish Creek Till (Morris and Kelly, 1997). The column of the till varies from dark brown to light olive and greyish brown. The Catfish Creek Till in Essex County was deposited during severe ice flow events combining ice movements from Lake Huron and Lake Erie basins (Barnett, 1985 and Dreimanis, 1987).

Tavistock Till, which was formally named after the Town of Tavistock in the Stratford area (Arrow, 1974), directly overlies Catfish Creek Till throughout the Essex Region, except in the southwest where glaciolacustrine silt and clay separate the two tills. Tavistock Till varies in thickness between 15-28 m and is overlain by fine-grained glaciolacustrine deposits (Morris, 1994). This layer consists of fine-textured soil with high clay and silt content and has been classified as clayey silt to silty clay (Dreimanis and Reavely, 1953 and Morris, 1994).

A large body of buried sand and gravel ranging in thickness greater than 40 m extends from west of Colchester and Harrow, through the southern part of Kingsville to the Leamington area. Thinner layers of buried sand trend east west in the northern part of Essex Region. There are areas south and east of Harrow and around Leamington where the thickness of sand exceeds 10 m. MOE water well records indicate that there are many thin interbedded layers of fine to coarse sand ranging in thickness from 0-10 m found at various depths distributed throughout the Essex clay plain (Morris and Kelly, 1997). **Figure 1.2.5** also shows that drift thickness varies from north to south and from west to east.

2.2 Surface Water

The Essex Region Watershed consists of three major subwatershed areas that drain to Lake St. Clair, the Detroit River and Lake Erie. These major drainage areas may further be divided into approximately 28 subwatersheds as listed in **Table 2.11** and shown in **Map 2.1**. Most of the streams, rivers and creeks flow through the flat terrains of the clay or sand plains of the Essex Region. The flat terrain of the study area poses problems in delineating the subwatersheds exactly. However, the delineation is the best representation of the subwatersheds based on the structure and flow directions of first order drains. Surface drainage in much of the Region is influenced by a ridge, extending roughly from the southern part of Windsor, in a south-easterly direction through the central part of the Region. This ridge defines a drainage divide, north of which water flows mainly into Lake St. Clair, while south of the divide water flows westward into the Detroit River or southward into Lake Erie. Surface drainage of the till plain is predominately northward to Lake St. Clair (Chapman and Putnam, 1984). Another smaller ridge trending southeast to northwest about 5 km north of the Lake Erie shoreline is visible in the southwest part of the watershed. Valleys incised by Canard River, Cedar Creek and other water courses run parallel to these ridges. Many of the streams in the Region have extensive marsh areas at the mouth which fluctuate in size with the lake levels. Many have headwaters which periodically dry up in the summer due to extensive artificial drainage and historical clearing/removal of wetlands. Throughout most of the Essex Region, dredged ditches and tile drains were installed in order to improve the drainage and provide satisfactory conditions for crop growth and tillage (Chapman and Putnam, 1984). Thus, the natural drainage patterns of the watersheds have been extensively realigned by artificial means, primarily for agricultural purposes. Cedar Creek, Big Creek, Turkey Creek, and Canard River and its Long Marsh Drain tributary, have been substantially altered by major diversions of parts of their watershed areas, as shown in **Map 3.3** and as further discussed in **Section 3.3.2**. In several parts of the Region, lands have been artificially created and drained by a series of dykes and pumping schemes – this includes much of Pelee Island, the southeastern part of Leamington, and several areas along Lake St. Clair, particularly in the eastern part of Windsor and in the Belle River area.

Surface water and groundwater systems are discussed in more detail in **Section 3 (Water Quantity Risk Assessment)** of this Assessment Report.

Table 2.11 Subwatersheds in Essex Region Watershed

Essex Region Subwatersheds	Area (km^2)	Area (hectares)
Canard River	347.8	**34,776**
Ruscom River	174.7	**17,467**
Cedar Creek	128.0	**12,804**
Belle River	113.6	**11,364**
Pike Creek	89.9	**8,993**
Puce River	88.3	**8,835**
Hillman Creek	76.0	**7,600**
Big Creek	70.0	**7,003**
Little River	64.9	**6,490**
Turkey Creek	61.1	**6,112**
Sturgeon Creek	46.6	**4,659**
Wigle Creek	35.3	**3,530**
Little Creek	33.5	**3,349**
Moison Creek	27.7	**2,771**
Duck Creek	23.7	**2,370**
Mill Creek	21.6	**2,162**
Fox/Dolson's Creek	12.1	**1,212**
Marentette Drain	8.6	**861**
Muddy Creek	8.4	**837**
Windsor Area Drainage	46.8	**4,678**
Colchester Area Drainage	35.5	**3,546**
Stoney Point Area Drainage	25.8	**2,579**
Leamington Area Drainage	22.6	**2,261**
Pelee Area Drainage	20.6	**2,057**
Amherstburg Area Drains	17.1	**1,707**
Tecumseh Area Drainage	11.5	**1150**
Atwell Drain	5.6	**558**
Township of Pelee	41.7	**4,167**

2.2.1 Drinking Water Systems

Municipal drinking water supplies in the Essex Region Watershed are drawn from surface water sources – Great Lakes (Lake Erie and Lake St. Clair) and their connecting channel (Detroit River). There are seven (7) municipal Water Treatment Plants (WTPs) in the Region and an additional plant in Wheatley which serves part of Leamington in the Essex Region Watershed (**Map 1.1**). The population served by each drinking water system and the daily pumping rates (rated design capacities) are presented in **Table 2.12.**

Over 95% of the population in the Region is served by municipal water treatment plants. The remaining population depends on groundwater for domestic purposes. Even though treated water from the WTPs caters to the needs of vast majority of the population, groundwater is used occasionally for domestic consumption, mainly in the rural areas. Hence, both surface water and groundwater are important in this Region.

Table 2.12: Municipal Drinking Water Systems

DW System	Population Served	Daily Pumping Rate*, m^3/day
Stoney Point WTP	3,500	4,546
Belle River WTP	22,000	36,400
Windsor WTP	267,000	349,000
Amherstburg WTP	21,000	18,184
Harrow-Colchester South WTP	9,000	10,227
Union WTP	57,000	124,588
West Shore Pelee Island WTP	Approx. 30	153

*Rated Design Capacity

2.3. Surface Water Quality

This section of the report summarizes the key findings on ambient and long-term water quality trends from the Essex Region Watershed Characterization Report that was prepared in 2006 (**Appendix I**). It also includes updates on water quality data such as the results of monitoring during 2006 to 2007 (**Appendix II**).

2.3.1. Monitoring

2.3.1.1. Inland Streams, Creeks and Rivers

Table 2.13 summarizes the details of various surface water quality monitoring programs that are conducted in the Essex Region Watershed. Water quality data were compiled from all these programs, except the 4 Pilot Watershed Wet Weather Monitoring Program (4PW3MP) and the 2009 Enhanced Water Quality Monitoring Program, and used for the water quality assessment purpose. A total of 31 stations have historically been monitored in the Essex Region Watershed through the PWQMN program. Of these 31 stations, only 8 stations are currently monitored.

2.3.1.2. Raw Water Intakes of the Municipal Drinking Water Systems

There are seven municipal drinking water treatment plants (WTP) in the Region. The intakes for Stoney Point and Lakeshore (Belle River) WTPs are located in Lake St. Clair; the intakes for A.H. Weeks (Windsor) and Amherstburg WTPs are located in the Detroit River; and the intakes for Harrow-Colchester, Union and Pelee Township WTPs are located in Lake Erie. Most of these WTPs, besides their daily water testing, provide samples of raw and treated water from the plant on a quarterly basis to the MOE for analyses through a voluntary program called the Drinking Water Surveillance Program (DWSP). Under O. Reg. 170/03 of the Safe Drinking Water Act, 2002, enforced by the MOE, municipal drinking water systems are required to sample raw water supplies for microbiological parameters ranging from once per week to once per month.

2.3.1.3. Beach Water Quality Monitoring

The Windsor-Essex County Health Unit (WECHU) monitors 9 public beaches located on Lake St. Clair and Lake Erie, on a weekly basis for *E. coli* levels during June to September of every year. *E. coli* is the most common indicator of disease causing organisms in recreational water. Weekly water quality sampling results from 2000-2008 swimming seasons obtained from the health unit are discussed in this report.

Table 2.13 Summary of various monitoring programs active in the Essex Region Watershed

Monitoring Program	No. Sampling Sites	Sampling Frequency/ year	Parameters	Sampling Regime
Provincial Water Quality Monitoring Network	8	8-9	Basic Chemistry, nutrients and metals	Regular
Region-wide Surface Water Quality Monitoring Program	36	3	Basic chemistry, nutrients and *E. coli*	Regular
4-Pilot Watershed Wet Weather Monitoring Program	32	Approx. 16	Basic chemistry, nutrients, *E. coli* and flow	Event-Based and Regular
2009 Enhanced Water Quality Monitoring Program	56	Approx. 16	Basic chemistry, nutrients, *E. coli* and Flow	Event-Based and Regular
The Windsor-Essex Health Unit Beach Monitoring Program	9 beaches	Weekly (June-Sept)	*E. coli*	N/A
Drinking Water Surveillance Program (DWSP)	7 WTPs	Monthly and Daily	Inorganic, organic, microbial and radiological	N/A

2.3.2. Methodology

The Essex Region Watershed consists predominantly of agricultural land use except in the Turkey Creek and the Little River watersheds where urbanized land use constitutes approximately 83% and 46% of the watershed area, respectively. Therefore, the indicator parameters of such land use activities such as nutrients (e.g. phosphorus and nitrogen), suspended solids and *E. coli* are used for water quality assessment. Metals such as aluminum, cadmium, copper, lead, iron, and zinc were also included in analyzing the status of water quality in terms of their compliance with relevant standards, objectives and/or guidelines. Chloride concentrations were also used to assess the impact of road salt application on surface water and groundwater quality. The concentrations of selected parameters were compared to the Provincial Water Quality Objectives (PWQOs) and the Canadian Water Quality Guidelines (CWQGs).

Statistical and graphical methods were used to assess and interpret the water quality datasets. Box-plots, through SigmaPlot11, were used to compare and represent datasets in a graphical way. Box-plots show the 25th and 75th percentile, and the median values of the datasets. A computer program, kendall.exe, developed by USGS for the Kendall family of trend tests was used to examine trends in water quality parameters. The data for six key parameters that reflect land use activities are summarized below for both recent conditions (eight years of data from 2000 to 2008) and long-term trends (data over the previous 30 years).

2.3.3. Recent Water Quality Conditions (2000-2008) and Long-term Trends

A statistical summary of water quality results obtained for the eight PWQMN sites in the Essex Region SPA are presented in **Table 2.14**.

Table 2.14 Summary of Provincial Water Quality Monitoring Network (PWQMN) Sampling Results for 2001-2007

Parameter	Statistic	PWQMN Sites								Guideline/ Benchmark (mg/L)
		Canard River	Turkey Creek	Ruscom River	Sturgeon Creek	Lebo Drain	Muddy Creek-1	Muddy Creek-2	Cedar Creek	
Nitrates, mg/L	Mean	2.26	1.32	6.25	46.26	32.95	4.28	11.14	3.15	2.93
	Median	1.51	1.10	5.59	35.3	27.0	3.14	10.4	0.96	
	75th percentile	3.38	1.46	8.0	62.0	38	7.25	14.75	4.94	
Nitrite, mg/L	Mean	0.071	0.076	0.057	0.283	0.22	0.195	0.28	0.056	0.06
	Median	0.066	0.065	0.043	0.278	0.175	0.116	0.27	0.033	
	75th percentile	0.098	0.087	0.075	0.371	0.277	0.183	0.38	0.06	
Ammonia, mg/L	Mean	0.468	0.243	0.049	0.098	0.095	0.45	0.55	0.46	0.016
	Median	0.089	0.187	0.02	0.076	0.044	0.32	0.18	0.053	
	75th percentile	0.254	0.286	0.04	0.112	0.085	0.60	0.81	0.116	
Kjeldahl Nitrogen, mg/L	Mean	1.34	1.22	1.20	1.06	1.25	1.54	1.71	1.32	NA
	Median	1.20	1.09	0.87	0.95	1.06	1.37	1.34	0.79	
	75th percentile	1.62	1.42	1.06	1.23	1.39	1.73	1.97	1.12	
Total Phosphorus, mg/L	Mean	0.143	0.149	0.272	4.92	3.32	0.99	0.32	0.189	0.03
	Median	0.104	0.126	0.133	3.88	3.41	0.86	0.20	0.085	
	75th percentile	0.176	0.156	1.25	7.09	4.86	1.11	0.53	0.125	
Suspended Solids, mg/L	Mean	40	40	68	26	21	52	21	35	25
	Median	27	37	33	14	11	50	14	20	
	75th percentile	53	47	50	23	22	59	27	30	
Chloride, mg/L	Mean	203	178	69	100	65	34	122	67	250
	Median	139	148	68	98	64	35	77	61	
	75th percentile	335	205	75	118	75	37	183	70	

2.3.3.1 Total Phosphorus (TP)

In general, total phosphorus concentrations in the Essex Region Watershed tended to be high, exceeding the PWQO limit of 30 g/L in almost all samples from the majority of the inland streams sampled during 2000-2008. Highest levels of TP were found in Ruscom River, Turkey Creek, Canard River, Cedar Creek, Sturgeon Creek and Muddy Creek. Annual median levels in these subwatersheds were two to six times the PWQO. The maximum TP concentration of 18,000 g/L was found in the Sturgeon Creek watershed. **Figures 2.1 to 2.3** show long-term annual mean concentrations of TP in some of the inland streams that drain into Lake St. Clair, the Detroit River and Lake Erie, respectively. It is evident from these figures that, in general, there is a decreasing trend in annual mean TP concentrations from 1964 to 1996 in the streams that drain to the Detroit River and Lake Erie. Annual mean concentrations in the streams that drain to Lake St. Clair were consistently high and did not show any significant trend. A significant increasing trend was observed in TP concentrations at the Sturgeon Creek, Lebo Drain and Hillman Marsh water quality sampling sites during 1996 to 2007.

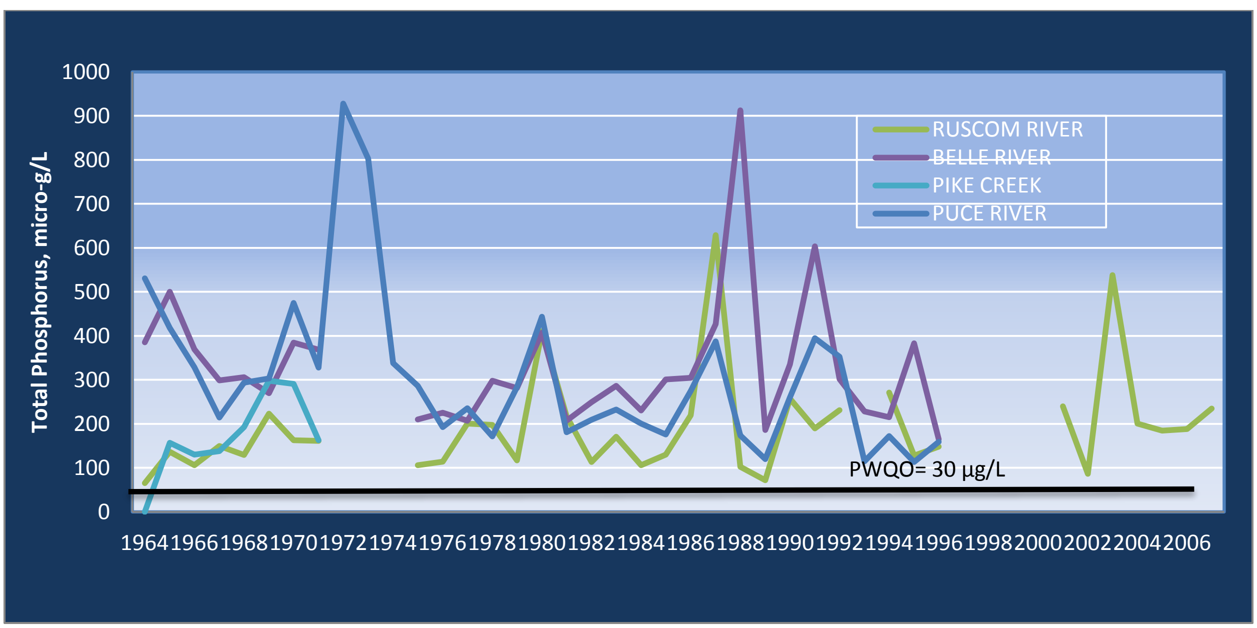

Figure 2.1: Long-term annual mean total phosphorus concentration trends in the streams of the Essex Region Watershed that drain into Lake St. Clair.

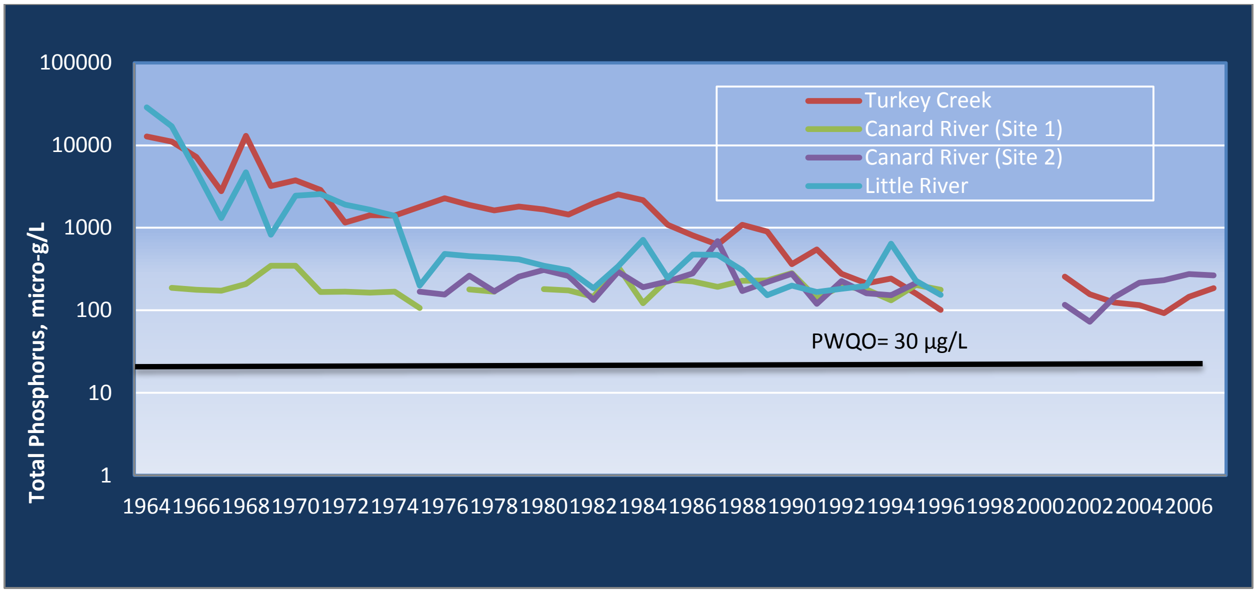

Figure 2.2: Long-term annual mean total phosphorus concentration trends in the streams of the Essex Region Watershed that drain into the Detroit River.

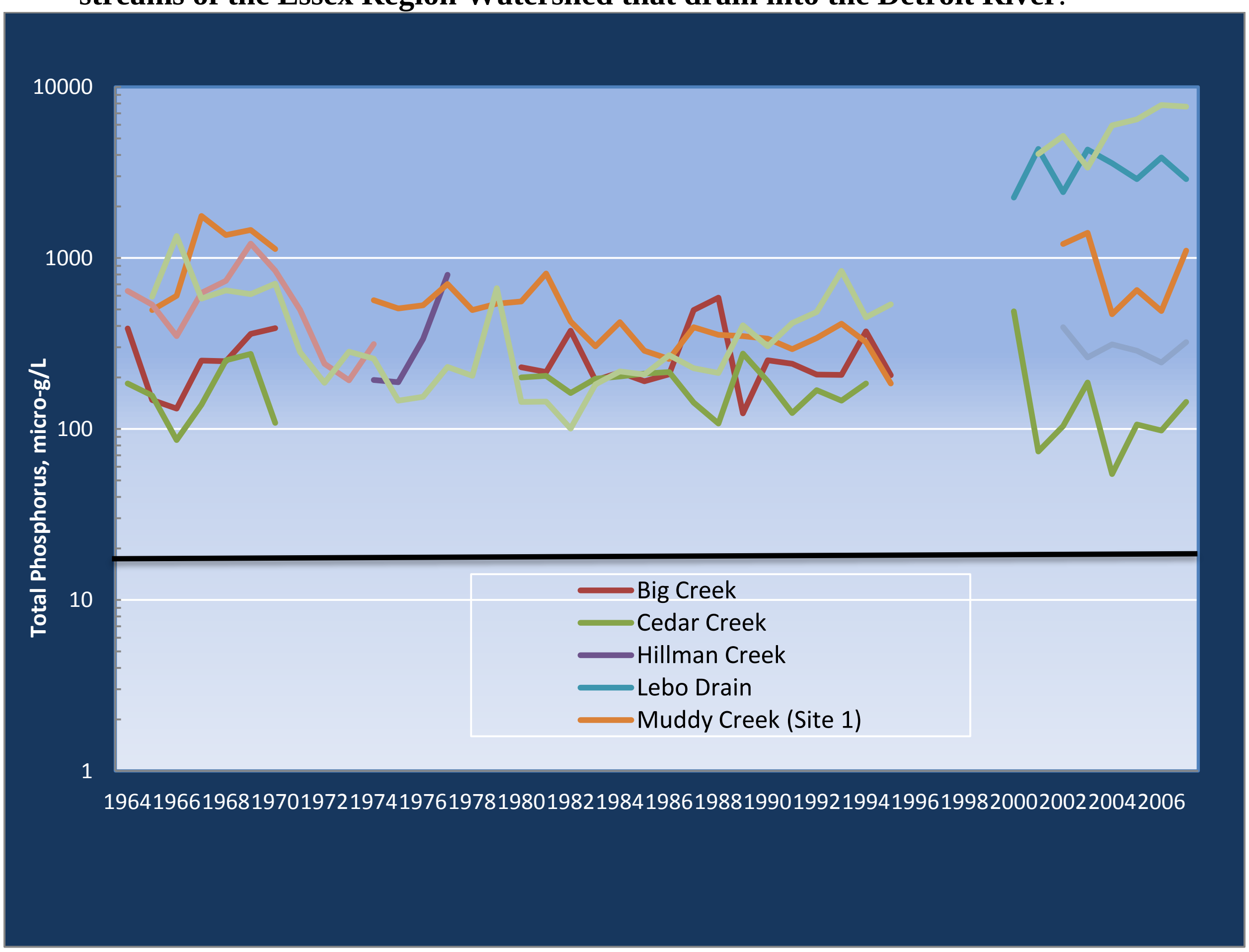

Figure 2.3: Long-term annual mean total phosphorus concentration trends in the streams of the Essex Region Watershed that drain into Lake Erie.

2.3.3.2 Total Nitrates

Concentrations of total nitrate routinely exceeded the Canadian Environmental Quality Guideline of 2.93 mg/L at all sites in the Essex Region Watershed except in Turkey Creek, Canard River and Cedar Creek (**Figure 2.4**). Sturgeon Creek and Lebo Drain showed the highest nitrate concentrations, with median level of nitrate concentrations around twelve and ten times the Canadian Guideline, respectively. The majority of concentrations in most of the streams were below the Ontario Drinking Water Standard (10 mg/L). A significant increasing trend was observed in the Sturgeon Creek watershed during 1965-2007 and in the Cedar Creek watershed during 1981 to 2007.

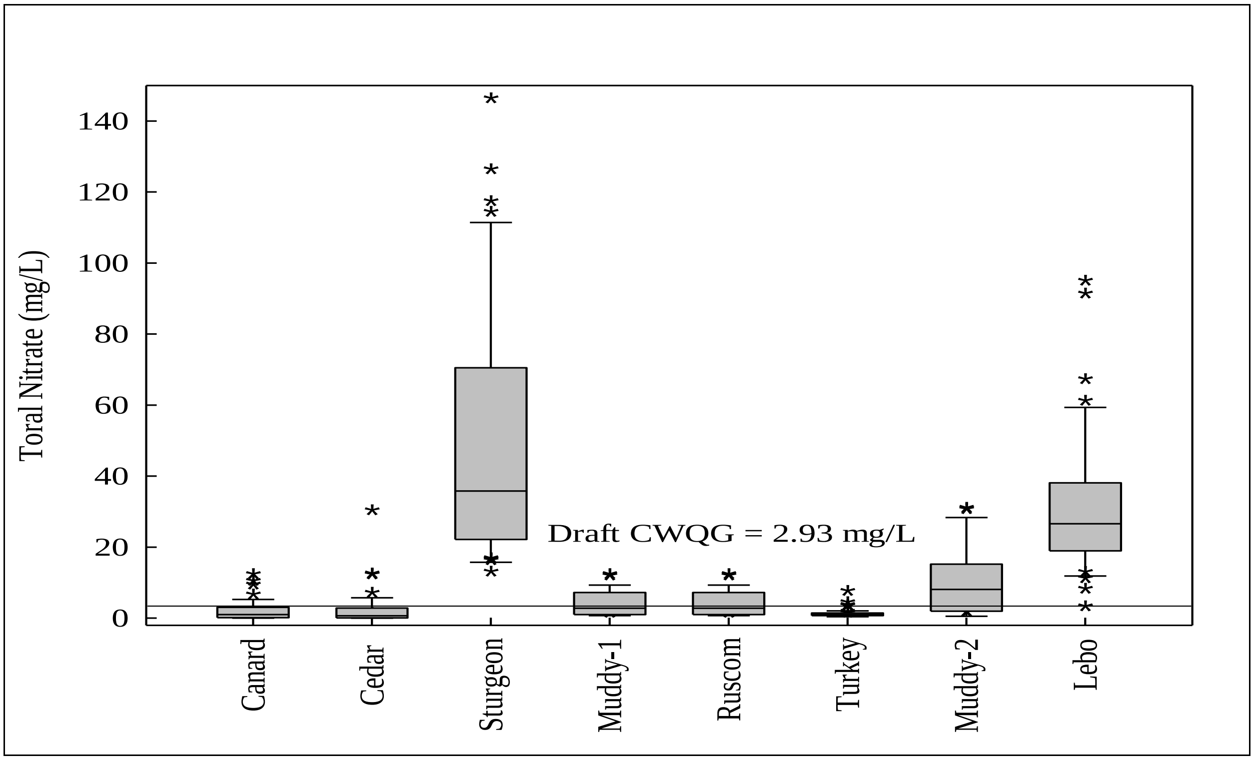

Figure 2.4: Box plot for total nitrate concentrations at PWQMN Stations during 2000-2007

2.3.3.3 Total Ammonium

Higher concentrations of total ammonium were frequently found in Turkey Creek, Canard River, Cedar Creek and Muddy Creek compared to other sites in the Region (**Figure 2.5**). Ammonia levels tended to be highest during the period of September to November in all the watersheds. The highest ammonia concentration of 9.72 mg/L was found in the Cedar Creek watershed. A significant decreasing trend was observed in the Turkey Creek watershed from 1975 to 1995 and concentration remained consistent after 1995. Concentrations at most of other sites remained consistent over this time frame.

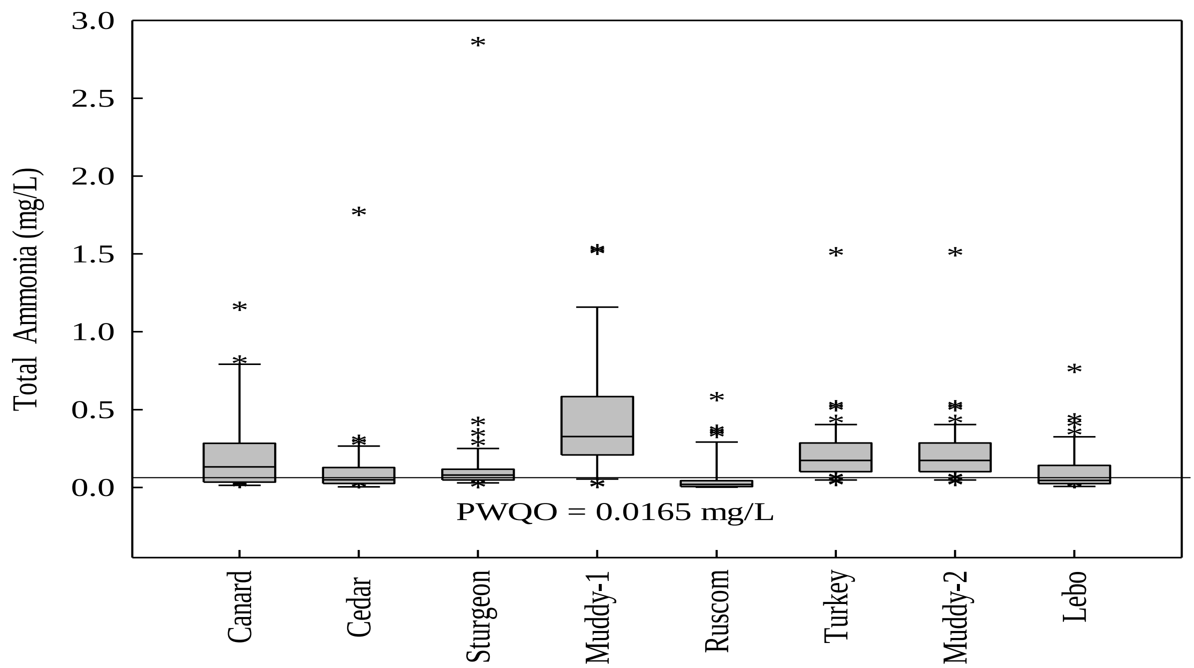

Figure 2.5: Box plot for total ammonia concentrations at PWQMN Stations (2000-2007)

2.3.3.4 Total Suspended Solids (TSS)

The highest levels of suspended solids were at the water quality sampling sites on Ruscom River, Turkey Creek, Canard River, Sturgeon Creek and Muddy Creek. All the sites in the Essex Region showed 100% exceedance of the benchmark value of 25 mg/L, during the study period. While there was fluctuation in concentrations, overall levels of suspended solids at most sites in the watershed remained consistent over the study period.

2.3.3.5 Chlorides

Most of the time, chloride concentrations were within the Canadian Guideline of 250 mg/L at all sites in the Essex Region Watershed. Higher concentrations of chloride were found from March to June in Turkey Creek, Canard River and Cedar Creek. Chloride levels ranged from 22 mg/L (Muddy Creek) to 624 mg/L (Turkey Creek). Significant increasing trends were observed in Little River and Puce River, though median chloride concentrations in these two watersheds were well below 250 mg/L. Concentrations at most of the other sites remained consistent over this time period.

2.3.3.6 Metals

Recent Conditions

- Mean aluminum concentrations at all the PWQMN stations exceeded the interim PWQO limit (75 µg/L) from 2000 to 2005. The highest aluminum level of 3490 µg/L was observed in Canard River.
- Sturgeon Creek and Lebo Drain showed higher number of exceedances of Cadmium and Zinc compared to other watersheds.
- Turkey Creek and Canard River showed elevated levels of iron, lead and copper.

Long-term Trends

- While there was fluctuation in concentrations, overall levels of suspended solids at most sites in the watershed remained consistent over the study period.

2.3.3.7 Bacteria (E. coli)

Long-term *E. coli* data was not available for any of the PWQMN water quality sites in the Essex Region Watershed. However, *E. coli* levels were routinely monitored at ERCA's surface water monitoring sites from 2000 to 2007. These sites were monitored 3 times a year (e.g. spring, summer and fall). **Figure 2.6** shows *E. coli* levels in the Essex Region Watershed from 2000 to 2007. It is evident from the figure that *E. coli* levels routinely exceeded the PWQO of 100 counts/100 mL at all sites. The frequency of these exceedances ranged from 40% (site 62 and site 67 on Canard River) to 100% (Site 2 on Ruscom River and both sites on Sturgeon Creek) from 2000 to 2007.

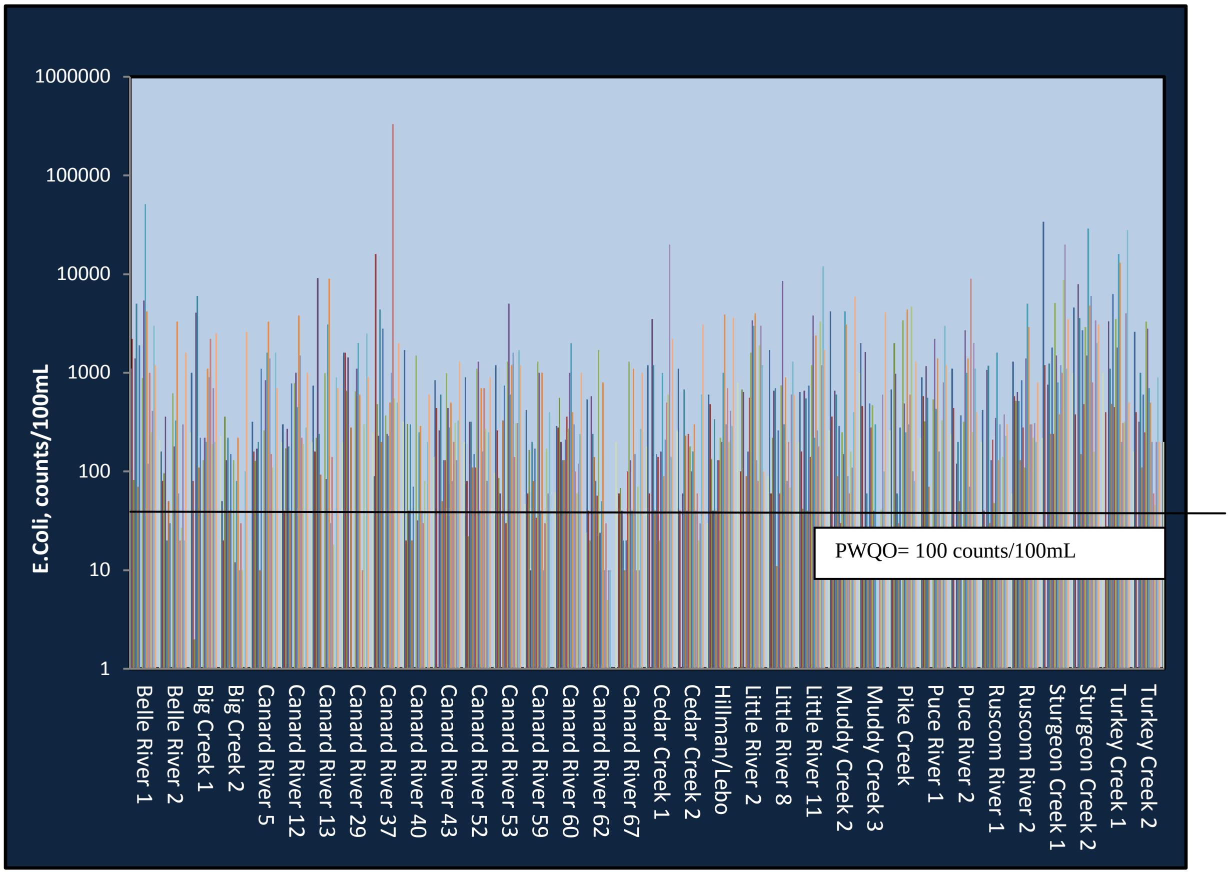

Figure 2.6 *E. coli* concentrations observed in the streams, creeks and rivers of the Essex Region Watershed during 2000-2007.

2.3.4 Impact of Local Watersheds on the Nearshore Water Quality

There is an obvious link between conditions in the lower reaches of tributaries and the nearshore. However, understanding the relative impacts of individual subwatersheds on the nearshore and/or lake water quality becomes quite complex and expensive due to the complexity involved with lake dynamics, winds and wave action, and large monitoring data requirements. The Essex Region drains into Lake St. Clair, the Detroit River and Lake Erie, and these discharges have immediate impacts on nearshore waters as well as long-term cumulative impacts on the water quality of the Western Basin of Lake Erie. In this study, turbidity was used as an indicator to determine potential impacts of tributaries on nearshore water quality. Frequency analysis was performed on turbidity data of raw water at the intakes (Amherstburg WTP, Harrow-Colchester South WTP and Union WTP), and discharge rates in the tributaries, as well as wind speed and wind direction data collected at the Lake St. Clair Buoy. The methodology was very similar to that conducted by Baird & Associates for the Belle River WTP Intake Siting (Belle River WTP Intake Siting, Draft Report, October 2007). Daily turbidity from 1998 to 2006 for the intakes was used for the frequency analysis except for the Belle River WTP where the data were available only for the period of 2002 to 2006. Details of these analyses are presented in the 2009 Water Quality Status Report (**Appendix II**). From these analyses, it was concluded that discharges from tributaries during extreme weather events (storms and precipitation) strongly affect the raw water quality at the intakes of nearby WTPs.

2.3.5 PCBS, Metals and other Contaminants in Sediment and Fish Tissue

As part of the Lake Erie Tributary Mouth Monitoring program, eight tributaries (in the Ontario portion of the study) were sampled during 1998 and 1999. Two of these sites, Turkey Creek and Canard River, are in the Essex Region. Both of these sites showed elevated median concentrations of total PAHs, PCBs, copper and zinc as compared to the other six sites. The PCB Track-down Study (2001) by OMOE and Environment Canada showed elevated levels of PCBs in sediments of Turkey Creek and Little River. In 2001, Environment Canada conducted a survey of sediment quality in the mouths of Canadian Lake Erie tributaries and published the results in 2002 (Dove et al., 2002). **Table 2.15** summarizes the results that are relevant to the Region.

The Lake Erie Index Stations in the Region also showed elevated maximum concentrations of PAHs, phosphorus, lead, mercury and zinc in the sediments during 1994-1998. One of the Great Lakes Index Stations in the Region (which is on the nearshore close to the mouth of Sturgeon Creek) showed very high concentrations of phosphorus and nitrates/nitrites.

The 1996 Detroit River Remedial Action Plan Report identified five locations in the Detroit River as hazardous sites based on high levels of mercury in sediments (MDEQ, 1996). This report also identified the Detroit River Wastewater Treatment Plant as the largest point source for both PCBs and mercury, while Ford Motor Company of Canada Ltd. was listed as one of the point sources on the Canadian side of the Detroit River.

Combined sewer overflows (CSOs) are also major sources of untreated human and industrial waste, toxic materials, and objectionable debris. In 2004, 126 sewage overflow events were reported by the City of Windsor, constituting around 1.81 billion litres of partially treated waste entering the Detroit River (Sierra Legal, 2006). The point sources from the Canadian side contributed less than 1.2% of the total point source PCB loading to the Detroit River. The Detroit Wastewater Treatment Plant was found to be the largest source of mercury (approximately 62%) to the Detroit River, while the Lou Romano Water Reclamation Plant contributed around 1.5% of the annual loading.

Table 2.15: Summary of sediment contamination at the mouths of various tributaries in the Essex Region (Source: Dove et al., 2002)

River/Creek/ Stream	Exceedance of Standards* set out by Environment Canada and MOE			
	PAHs	PCBs	Metals	Pesticides
Little River	Federal TEL	Federal PEL	Arsenic, chromium, copper, lead and zinc: TEL	None
Canard River	TEL	None	Arsenic, copper: TEL and LEL	DDE and DDT: LEL
Dolson Creek	None	None	Nickel: TEL	DDT: TEL and LEL
Fox Creek	None	None	Nickel: PEL	TEL and LEL
Ruscom River	None	PEL	Arsenic, Iron, Nickel, Lead, Zinc : TEL and LEL	None
Little Creek	None	None	Arsenic: TEL and LEL; Manganese: SEL	DDT: LEL
Belle River	TEL	None	Arsenic: TEL and LEL; Iron and Nickel: LEL; Lead and Zinc: LEL	DDD and DDE: TEL
Duck Creek	TEL	None	Arsenic: TEL and LEL Iron and Nickel: LEL	DDE: TEL

*TEL: *Threshold Effect Level*; LEL: *Lowest Effect Level*; PEL: *Probable Effect Level*; and SEL: *Severe Effect Level*;

These contaminants have serious environmental and human health implications as they can bind to organic matter and accumulate in biological tissue (i.e. human, fish, bird, invertebrate). Fish can be contaminated directly by ingestion of contaminant sediments or indirectly by consuming bottom-dwelling invertebrates which accumulate contaminants from sediments through the food-chain (Menzie, 1980). Fish consumption is one of the largest exposure pathways for bioaccumulative contaminants, such as PCBs, mercury and other metals, in humans (Hicks et al., 2000). It is therefore important for fish consumers to know about consumption advisories that recommend suitable species and amount of fish to be consumed without any health risks. The Ontario Ministry of the Environment (OMOE) publish the "Guide to Eating Ontario Sport Fish", every other year in order to alert the public to the potential risks of contaminated sport fish consumption. The Guide (2009-2010) showed that approximately 40% to 60% of advisories on sport fish given for the Lake St. Clair-Detroit River corridor and in Lake Erie respectively, results in a certain level of consumption restrictions. The majority of these advisories are based on high concentrations of dioxins, furans and dioxin-like PCBs in fish tissue while a small portion of these restrictions are caused by mercury. Contamination levels of PCBs found in carp and forage fish from the Detroit River collected in 1985 and during 1999-2001 were found to be similar and exceeded the criteria that would trigger the consumption advisories, which suggests that the level of contamination of fish in the Detroit River has not decreased noticeably over time (Drouillard et al., 2003, 2005). A study conducted in 2000/2001 found 30 and 36% of fish collected were contaminated with PCBs and mercury, respectively, at a level that could trigger a fish consumption advisory by the MOE.

2.3.6 Algal Blooms in the Region

An algal bloom is a rapid increase in the population of algae in an aquatic ecosystem. Excessive growth of aquatic plants and algae, specifically thick layers of *Cladophora* has been a problem in Lake St. Clair and the western basin of Lake Erie since 1994 and 1960, respectively. Nutrients, particularly nitrates and phosphorus contribute to increased plant growth and algal blooms.

Under the 1972 Great Lakes Water Quality Agreement, the U.S. and Canada reduced phosphorus inputs to the Great Lakes, including Lake Erie. Between the late 1960s and early 1980s there was an approximate 60% reduction in the phosphorus loading to Lake Erie. Despite these efforts, the concentrations of nutrients (main cause of algal blooms) still exceed the USEPA limit and frequent algal blooms are observed in Lake St. Clair (MCHD, 2007) and Western Lake Erie (State of the Great Lakes, 2007).

Six of the seven drinking water treatment plants in the Region reported the presence of algal blooms in the vicinity of their intakes. Algae can pose taste and odour issues in treated water, and they can adversely affect the water treatment process. The Belle River WTP operator reported that in the past, algal blooms have caused shortened filter runs which reduce the plant's supply capacity during summer months. Similar observations were reported at the Windsor, Union and Harrow-Colchester South WTPs, and West Shore Treatment Plant (Pelee Island).

Thick layers of green algae and excessive numbers of common duckweed have been observed in most of the tributaries in the Region during the summer months by water quality monitoring staff at ERCA. These sightings are especially prevalent in Sturgeon Creek (**Figure 2.7**), Lebo Drain, Belle River, Ruscom River, Turkey Creek and Canard River.

Figure 2.7: Photograph of green algae at one of the monitoring sites on Sturgeon Creek (Summer 2008)

2.3.7 Raw Water Intakes of the Municipal Drinking Water Systems

2.3.7.1Microbiological Contaminants

There is no Maximum Allowable Concentration (MAC) in the Ontario Drinking Water Quality Standards (ODWQS) for microbiological parameters or other parameters in raw water as the standard only applies to treated water. The ODWQS toxicity standards are based not on environmental considerations but on human health considerations. **Table 2.16** below illustrates a summary of DWIS microbiological data for the drinking water systems in the Essex Region between April 2001 and August 2005. All the maximum *E. coli* concentrations recorded at these intakes are highly correlated to rainfall events. The Amherstburg WTP intake showed the highest number of exceedances in the Region (60% of the samples tested) during 2001 to 2005.

Table 2.16: Summary of raw water *E. coli* data for the water treatment plants in the Essex Region

Water Treatment Plant	***E. Coli* (PWQO = 100 CFU/100mL)**			
	Number of Samples Tested	**Number of Samples exceeded PWQO**	**Percent exceeded PWQO**	**Maximum Value observed**
Stoney Point WTP	176	1	< 1%	140
Belle River WTP	114	9	8%	710
Windsor WTP	131	4	3%	400
Amherstburg WTP	162	97	60%	2900
Harrow-Colchester South WTP	146	3	2%	160
Union WTP	168	1	< 1%	1100

More recent data (2008 to 2010) collected showed substantially reduced levels of *E. coli* at the Amherstburg intake. This is described further in **Section 4.2.5.7**.

2.3.7.2 Raw Water Chemistry

2.3.7.2.1 Stoney Point WTP Intake

The raw water quality data for physical parameters such as temperature, turbidity, colour, and hardness showed exceedances in terms of Operational Guideline (OG) and Aesthetic Objectives (AO) almost every year. The mean turbidity concentration at the WTP was 27 FTU which is around 6 times the AO limit during the period of 1990 to 2006. In recent years (2002-2005), the turbidity levels increased up to 12 times the AO. Turbidity and TSS do not directly pose any human health risks; however, the suspended particulate matter can support bacterial growth and could interfere with the clarification and disinfection processes at the WTP.

Aluminum exceeded the OG in approximately 76% of results from 1990 to 2005; the highest concentration was about 5 times the limit in 2005. The other metals that exceeded respective OG or AO include antimony, cobalt and iron, but the detected levels were far less than those that are considered acceptable from a human health perspective. Copper, zinc and total phosphorus concentrations exceeded the PWQO limits in almost every year within the data period. The mean nitrate concentration was well below the CWQG (13 mg/L). The other important parameters such as pesticides, PAHs, volatile organics, chloroaromatics and radionuclides were not of concern in raw water during the study period at the Stoney Point WTP intake.

2.3.7.2.2 Belle River WTP Intake

Operational Guideline (OG) and Aesthetic Objectives (AO) violations were frequently observed in the data for temperature, turbidity, colour, and hardness during the period from 1990 to 2005. The mean turbidity level at the WTP was recorded around 60 FTU which is approximately 12 times the AO limit during the same period.

Total phosphorus (TP) concentration exceeded PWQO limit of 0.02 mg/L (for lakes) in every year throughout the period 1990 to 2005. The highest concentration of TP was found in 2003 which was 0.19 mg/L. Other parameters such as pesticides, PAHs, volatile organics, chloroaromatics and radionuclides were not of concern in raw water during the study period at the Belle River WTP intake.

2.3.7.2.3 Windsor WTP Intake

Violations of OGs and AOs were frequently observed in the data for physical parameters such as pH, temperature, turbidity, colour, and hardness during the period from 1990 to 2005. Iron concentrations were higher than the AO limit in almost 90% of the samples tested from 1990 to 2005, the highest concentration recorded was about 5 times the AO in 1996. Copper concentrations exceeded the PWQO limit by 5 to 20 times in all years during the sampling period from 1990 to 2005. Lead was found to exceed the Maximum Acceptable Concentration (MAC) in 1990 at the Windsor WTP. The subsequent year's data showed lead concentrations well below the MAC standard.

Total phosphorus concentrations exceeded PWQO limits in almost all years from 1990 to 2005. Volatile organics, chloroaromatics and radionuclides were not of concern in raw water during the study period at the Windsor WTP intake.

2.3.7.2.4 Amherstburg WTP Intake

Violations of OGs and AOs were observed in the data for physical parameters such as temperature, turbidity, colour, and hardness during the period from 1990 to 2005. The average turbidity level at the WTP was recorded around 48 FTU which is approximately 10 times the AO limit during the same period.

Iron concentrations were higher than the AO limit in 11 of 15 years sampled between 1990 and 2005; highest concentration recorded was about 2 times the AO limit in 1991 and 1995. Total phosphorus concentrations exceeded PWQO limits in 15 of 16 years sampled during 1990 to 2005. Volatile organics, chloroaromatics and radionuclides were not of concern.

2.3.7.2.5 Harrow-Colchester South WTP Intake

Violations of OGs and AOs were evident in the data for physical parameters such as pH, temperature, turbidity, colour, and hardness during the period from 1990 to 2005. The PWQO and AO for iron was exceeded up to 2 times the standard limit prior to 1997, however, recent data collected suggest decreased levels of iron. Prior to 2002, the concentrations of TP exceeded the PWQO limit and declined since then and remain below the guideline. Results of several chlorinated pesticides exceeded the PWQO by up to 2 to 5 times; however, these concentrations were well below the OWQS limit.

2.3.7.2.6 Union WTP Intake

Violations of OGs and AOs were evident in the data for physical parameters such as pH, temperature, turbidity, colour, and hardness, and metals such as aluminum, iron and manganese.

Mean turbidity concentrations were significantly higher in raw water prior to 1992, sometimes exceeding up to 17 times the ODWQS level. Raw water turbidity levels showed a declining trend after 2001. Copper concentrations were well below the PWQO limit (5 µg/L) before 2002; however, concentrations ranged from 35 µg/L to 115 µg/L between 2003 and 2005. Results of several chlorinated pesticides exceeded the PWQO by up to 2 to 5 times; however, these concentrations were well below the OWQS limit.

2.3.8 Public Beaches in the Essex Region

Provincial Water Quality Objective (PWQO) for *E. coli* in beach water is 100 CFU/100mL which is based on daily geometric means of 3 to 5 samples. However, the limits for safe swimming in different provinces and countries are different. In Ontario, beaches are posted at 100 CFU/100mL (individuals may enter at their own risk but warning signs are displayed) and closed at 1,000 CFU/100mL (the beach is closed to the public due to increased human health risks).

In general, water quality data of the 9 beaches that are monitored by the Windsor-Essex County Health Unit (WECHU) in the Region show numerous exceedances of the PWQO limit for beach postings from 2000 to 2008 (**Figure 2.8**). However, beaches were closed very few times due to increased levels of *E. coli* exceeding the beach closing standard of 1000 CFU/100mL during the same period. Hillman Beach was found to have the fewest beach postings and beach closings compared to other beaches in the Region. Sand Point beach was closed at least once per season from 2001 to 2007, and did not need to be closed in 2000 and 2008. Holiday Beach had no closings from 2003 to 2006, but was closed once in 2007. The rainfall data within 48 hours of beach water sampling for the study period showed a strong correlation between high *E. coli* incidents and rainfall events. This correlation suggests contribution of pollutants by local watersheds through runoff. Future studies need to focus on identification and quantification of different sources that cause the beach contamination issue. In the summer of 2007, the Michigan Department of Environmental Quality (MDEQ) and the US Environmental Protection Agency (EPA) in partnership with Environmental Consulting Technology Inc., conducted a study to determine the levels of fecal contamination and their source in water samples collected along the Detroit River during summer 2008. The study measured the number of *E. coli* colonies as an indicator of fecal contamination at 5 to 10 sites within each of 9 regions along the Detroit River. The highest *E. coli* counts were observed near the Rouge and Ecorse River (U.S.) and upstream of Turkey Creek (ECT, 2007). Most of the peak *E. coli* concentrations coincided with rainfall events. Human *E. coli* was found on the Canadian shoreline at 2 of the 4 sampling regions. These samples were collected during wet weather days; hence, combined sewer overflows (CSOs) are likely the main source of the human fecal contamination.

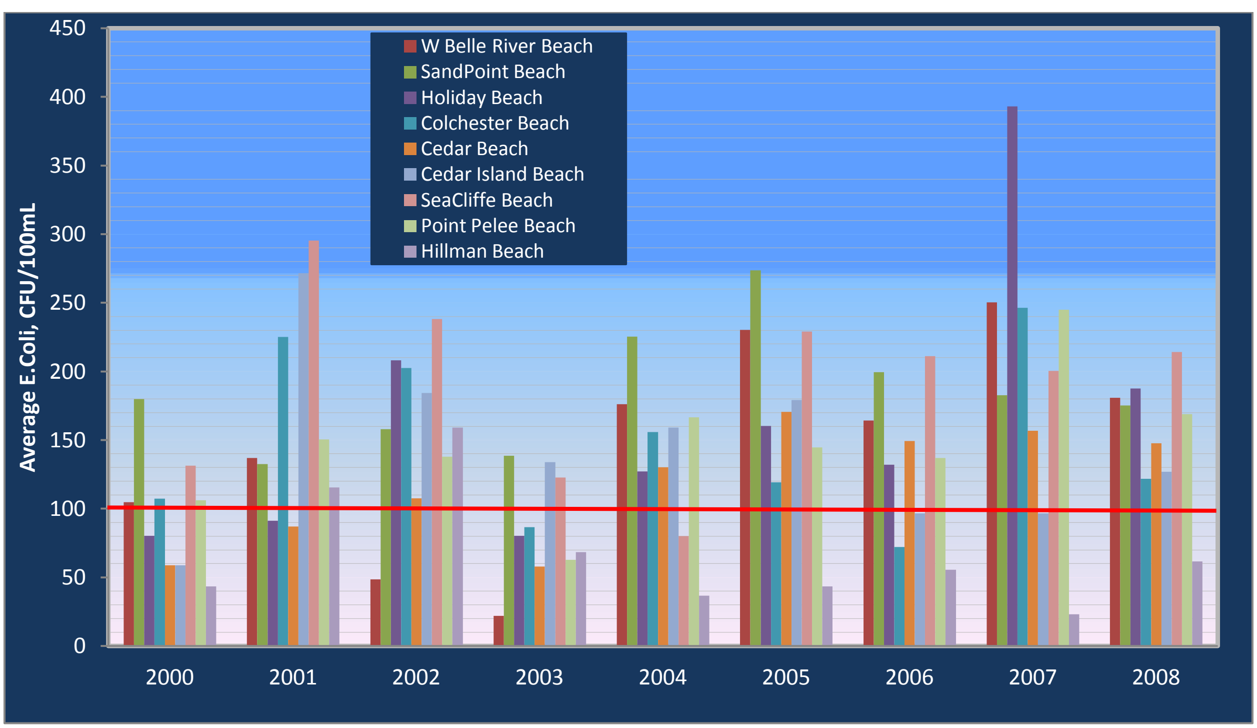

Figure 2.8: Annual mean *E. coli* levels observed at 9 of the public beaches in the Essex Region during summer seasons of 2000 to 2008

2.4. General Overview of Groundwater Quality

2.4.1 Provincial Groundwater Monitoring Network (PGMN) Data

Groundwater in the Essex Region has been monitored at 8 locations managed by ERCA in partnership with the MOE through the Provincial Groundwater Monitoring Network (PGMN) since 2003 (**Map 2.14**). Conductivity, temperature and water levels are monitored at these wells on a real-time basis through sensor technology. The water samples are also analyzed for specific water quality parameters once a year. Groundwater quality data, in terms of chemistry parameters, are available for the 8 groundwater monitoring wells that are managed by ERCA through the Provincial Groundwater Monitoring Network (PGMN).

In the beginning (2003), groundwater samples of the 8 PGMN wells were analyzed for an extensive list of water quality parameters that included routine chemical parameters, volatile organics (for example DCE and TCE), pesticides (such as Aldicarb, Carbofuran and 2,4-D etc.), nutrients and metals. Since then, groundwater samples were analysed, once every year, for selected chemical parameters including pH, nutrients and chlorides. There is very limited data on groundwater quality in this Region; hence it is inappropriate to draw any strong conclusions about groundwater quality. However, we chose to compare available data with the Ontario Drinking Water Standards and the relevant PWQOs. Chloride levels were well within the AO of 250 mg/L at all the well sites. Values ranged from as low as 0.6 to 40.6 mg/L. The IMAC (Interim Minimum Acceptable Concentration) for fluoride ions in drinking water is 1.5 mg/L. Well 203 (in Oldcastle, close to the Hwy. 3 and Walker Road intersection) showed a fluoride concentration of 1.74 mg/L, which is above the IMAC. Elevated levels for sodium were found at Well 358 (in Ruthven close to Colasanti's) and Well 203. The AO for sodium is 200 mg/L, however, if the water is used for drinking purposes, sodium levels above 20 mg/L should be reported to the local health unit. Potassium ions and nutrients were found to be well below the relevant objectives, guidelines and standards at all the wells. High levels of iron were found in all the well waters, except that of Well 205, ranging from 597 to 1880 µg/L, where the AO for iron is 300µg/L. Zinc concentrations were well below the AO of 5 mg/L, except at Well 203.

2.4.2 Microbiological Data of Private Wells from the MOH

Microbiological data (*E. coli* and total coliform presence) of private wells in the Essex Region were obtained from the Ontario Ministry of Health. This database lacks actual concentration values for microbiological parameters. Presence of *E. coli* and total coliform counts were compiled as per the postal codes of the private well properties and geographical coordinates. **Maps 2.15 and 2.16** illustrate the distribution of wells showing presence of *E. coli* and total coliform in groundwater in the Essex Region, respectively. It appears that presence of *E. coli* and total coliform is spatially widespread in the Region, however, information on actual levels of bacteria as well as frequency of their presence in well waters is lacking. These details are necessary to make any sound conclusion about quality of aquifers in the Region in terms of microbial contamination. ERCA is in the process of acquiring such information through the Drinking Water Source Protection Program (DWSP).

2.5 Data and Knowledge Gaps for Surface and Groundwater Quality

2.5.1 Data and Knowledge Gaps in Surface Water Quality

There are eight PWQMN long-term water quality monitoring sites in the Essex Region SPA. These sites are typically sampled 7-8 times a year and do not consider significant rain events. Also, microbial parameters were not historically monitored at these sites. Additional long-term ambient monitoring sites are required in addition to more intensive monitoring to identify local, watershed based water quality issues. The other 36 sites were monitored only 3 times a year for basic indicator parameters including *E. coli* and benthics. This sampling regime did not consider different flow conditions in all subwatersheds. At the time of preparation of this report, individual subwatershed or catchment basis pollution loading data were not available. Site specific monitoring studies need to be undertaken in the Region to understand and identify sources of pollution or water quality issues in the watershed. Further data and studies are required to understand the relationship between different land use and water quality in the Region.

Quantification of mass load from both point and non-point sources is also required to better understand and mitigate water quality issues. Identification and quantification of sources of *E. coli* in both inland streams and nearshore water is required.

At the time of preparation of this report, no data were available on pesticide concentrations in the inland streams of the Essex Region Watershed. Annual pesticide monitoring is required in both urban and agricultural tributaries targeting different pesticide application patterns in the Region. This may include pre- and post-application events, as well as high flow events.

2.5.2 Data and Knowledge Gaps in Groundwater Quality

Groundwater quality monitoring is conducted at eight monitoring wells in the Region. These wells are monitored for chemical parameters only one time a year, while continuous monitoring of water levels and temperature is conducted at these wells through leveloggers/telemetry systems. Very limited information is available on microbial contamination of private wells in the Region.

2.6 Aquatic Habitat

This section provides an overview of the location and types of aquatic habitats, including cold water, mixed and warm water fisheries, and macroinvertebrate communities. The watersheds of the Essex Region Conservation Authority are predominantly comprised of streams and rivers that have been heavily modified through surface and sub-surface drainage to encourage agricultural development.

The Fish Habitat Management Plan for the Essex Region was based on information gathered during multi-season backpack electro-fishing surveys across 90 sites in the Essex Region between 1999 and 2001 (Hayman et al. 2005). Sites were further grouped into three classes: river mouth, lake effect zone, and headwaters within each watercourse. This work provided an overview of the fish habitat conditions in each major watershed, summarized historical fish species presence, and documented the presence of individual species by watersheds across the Region. In total, 63 fish species have been reported from inland watercourses of the Essex Region. This report classified all watercourses within the Essex Region as warm-water, although the methods to arrive at this conclusion were not documented. This report did not discuss fish communities or habitat within the nearshore environment. Other studies do provide information on this environment, its processes, the fish communities present, and apparent changes occurring in this environment over time, as well as issues and specific monitoring needs for the future (Reid and Mandrak 2008; Reid and Mandrak 2009; and Yunker et al. 2009).

To document presence of cold-water, mixed and warm-water fisheries, the ERCA Fish Database was queried for all inland records of fish species. The process used to document fish species presence in the Essex Region follows the methods used in Chu et al. (2008). Species identified within inland watercourses of the Essex Region were assigned a thermal preference based on Coker et al. (2001) – either cold, cold/cool, cool, cool/warm, or warm. These thermal preferences were assigned to 207 freshwater fish species in Canada and generally represent the best available preferred summer preferences information. Fish species were grouped into cold-, cool-, and warm-water thermal guilds with preferences of $<19^{0}$C, 19-25^{o}C, and $>25^{0}$C, respectively. Species assigned to multiple guilds were excluded from the analysis as per Chu et al. (2008); these included common carp, fish records from outside of the buffer of inland watercourses, and species with thermal preferences intermediate between two thermal guilds (i.e., cold-/cool- and cool-/warm-water). A complete list of species considered for analysis in the Essex Region Source Protection Area is listed in **Table 2.17**.

Table 2.17: List of fish species and thermal classification (Coker et al. 2001) found in Essex Region Watercourses (Preferred temperature in brackets)

Cold-water ($<19^{0}$C): n=3	Cool-water (19-25^{0}C): n=16	Warm-water ($>25^{0}$C): n=19
Mottled sculpin (16.6)	Brook stickleback (21.3)	Bigmouth buffalo (32.5)
Rainbow trout (11.3)	Banded killifish (21)	Bluegill sunfish (30.9)
Trout-perch (15.5)	Black crappie (21.7)	Bluntnose minnow (29)
	Common shiner (21.9)	Bowfin (30.5)
	Creek chub (20.8)	Brown bullhead (26)

	Emerald shiner (24) Golden shiner (23.8) Johnny darter (22.8) Northern pike (22.5) Pugnose shiner (16.5) Quillback (22.1) Redfin shiner (20.5) River chub (21.7) Rock bass (20.5) White sucker (22.4) Yellow perch (21.4)	Channel catfish (25.2) Fathead minnow (29) Freshwater drum (26) Goldfish (27.9) Green sunfish (30.6) Largemouth bass (30.2) Longnose gar (33.1) Muskellunge (25.6) Northern hog sucker (26.6) Pumpkinseed sunfish (26) Smallmouth bass (30.3) Spotfin shiner (29.5) Spotted sucker (26) Yellow bullhead (28.3)

Chu et al. (2009) lists a total of 72 species and their respective thermal preferences commonly found in streams throughout the Great lakes basin. Of these 72 species, 38 are represented by records in the ERCA fish database (**Table 2.17**). A total of three cold-water species, sixteen cool-water species and a total of 19 warm-water species have records from the Essex Region, including Point Pelee National Park, waters along the nearshore areas of lakes St. Clair and Erie, and along the Canadian waters of the Detroit River. The distribution of cool- and warm-water species appears to be relatively uniform throughout the Region while the distribution of the three cold-water species are more distributed near the mouths of streams and creeks, likely representative of lake-bound individuals being captured in nearshore environments than of cold-water aquatic habitats.

Based on the thermal classes and thermal preferences of the 35 fish species found from the Essex Region watercourses, the aquatic habitats in the Essex Region support both cool-water and warm-water fish species (**Map 2.17**). It must be stressed that the level of fish sampling effort has been insufficient to clearly establish a direct connection between aquatic habitats and fish communities. Much of the distribution of known fish communities is in response to multiple factors including watershed land use, groundwater and surface water withdrawals, riparian deforestation, and watercourse conversion to municipal drains from natural watercourses. The second caution when using fish species distribution to reflect thermal classification of watercourses is that many species have temperature thresholds in that they can sustain periods of water temperature above and beyond their assigned thermal preference. For these two reasons, the thermal characterization of watercourses in the Essex Region should be viewed as tentative and requiring additional information and assessment to clarify.

Map 2.18 indicates the presence of warm-water streams in the Region. This information is based on a DFO Drain Classification which considered such information as species-presence, whether permanent water was found within a reach, the water temperature, and the presence of top-predator fish species. The methodology is not clearly defined and as such, the information used in this database cannot be used as a definitive thermal classification of aquatic habitat in the Region. However, until further assessment can be completed which would integrate drain segments and thermal assessment following appropriate criteria (e.g., Stoneman and Jones 1996, Chu et al. 2009), this information can be used in the interim.

A comparison of the communities in the above section to similar communities not impacted by anthropogenic factors is summarized as follows. Based on the history of very extensive changes in land use and land cover within the Essex Region, there remain no communities that have not been impacted by anthropogenic factors. The extent of surface and sub-surface tile drainage, extensive land use and land cover changes from a historically naturally vegetated ecosystem to the current fragmented, low natural cover ecosystem precludes such a comparison. In general, the composition of the fish communities present in the Region is strongly influenced by the large lakes (St. Clair and Erie) and connecting channel (Detroit River). Similar to other areas of southern Ontario, spring migrations of northern pike, walleye, bluntnose minnow, and other cyprinids are common throughout the Region's inland watercourses. Due to the extensive drainage of the Region, the duration of high standing water during the spring is expected to reduce the length of time that these migratory species can spend in the inland systems before returning to larger open streams/drains or the lake for refuge. A complete understanding of the primary factors influencing freshwater fish communities in the Essex Region must consider other significant factors including percent natural areas cover, percent riparian cover, relative contributions of surface water and groundwater takings, and thermal characteristics of watercourses (Chu et al. 2009). Other factors locally important include fish access (pumps and municipal drains), extent of municipal drains and influence of lake levels on inland surface water levels. Another potentially significant effect on fish, fish habitat and ecological processes in inland watercourses as a result of these extensive land use and land cover changes is that streams have been observed to dry up during summer months.

2.7 Species at Risk

This section presents information pertaining to species within the Source Protection Area that are on the Species at Risk in Ontario List as defined in the Endangered Species Act, 2007 and the locations of their habitats.

A total of 108 Species at Risk, including 4 amphibians, 24 birds, 13 fishes, 1 invertebrate, 2 mammals, 9 molluscs, 1 moss, 17 reptiles and 37 vascular plants, are listed as Species at Risk in the Essex Region Source Protection Area (**Table 2.18**). This list is based on the most recent SARO List – October 31, 2014 (*Endangered Species Act* 2007) and knowledge of Species at Risk distribution in the Essex Region. Abbreviations used in the table include END-Endangered, EXP-Extirpated, THR-Threatened, and SC-Special Concern.

Table 2.18 Species at Risk List as defined in the Endangered Species Act, 2007

Taxonomic Group	**SARO List**	**Common Name**	**Scientific Name**
Amphibian	END	Fowler's Toad	*Anaxyrus fowleri*
Amphibian	END	Small-mouthed Salamander	*Ambystoma texanum*
Amphibian	EXP	Eastern Tiger Salamander	*Ambystoma tigrinum*
Amphibian	EXP	Northern Cricket Frog	*Acris crepitanis*

Taxonomic Group	**SARO List**	**Common Name**	**Scientific Name**
Bird	END	Acadian Flycatcher	*Empidomax virescens*
Bird	END	Barn Owl	*Tyto alba*
Bird	END	Henslow's Sparrow	*Ammodramus henslowii*
Bird	END	King Rail	*Rallus elegans*
Bird	END	Loggerhead Shrike	*Lanius ludovicianus*
Bird	END	Northern Bobwhite	*Colinus virginianus*
Bird	END	Piping Plover	*Charadrius melodus*
Bird	END	Prothonotary Warbler	*Protonotaria citrea*
Bird	END	Yellow-breasted Chat	*Icteria virens*
Bird	THR	Bank Swallow	*Riparia riparia*
Bird	THR	Barn Swallow	*Hirundo rustica*
Bird	THR	Bobolink	*Dolichonyx oryzivorus*
Bird	THR	Cerulean Warbler	*Dendroica cerulea*
Bird	THR	Chimney Swift	*Chaetura pelagica*
Bird	THR	Common Nighthawk	*Chordeiles minor*
Bird	THR	Least Bittern	*Ixobrychus exilis*
Bird	THR	Whip-poor-will	*Caprimulgus vociferus*
Bird	SC	Bald Eagle	*Haliaeetus leucocephalus*
Bird	SC	Black Tern	*Chlidonias niger*
Bird	SC	Eastern Wood Pewee	*Contopus virens*
Bird	SC	Louisiana Waterthrush	*Seiurus motacilla*
Bird	SC	Peregrine Falcon	*Falco peregrinus*
Bird	SC	Red-headed Woodpecker	*Melanerpes erythrocephalus*
Bird	SC	Wood Thrush	*Hylocichla mustelina*
Fish	END	Eastern Sand Darter	*Ammocrypta pellucida*
Fish	END	Northern Madtom	*Noturus stigmosus*
Fish	THR	Channel Darter	*Percina copelandi*
Fish	THR	Lake Chubsucker	*Erimyzon sucetta*
Fish	THR	Lake Sturgeon (Great Lakes-Upper St. Lawrence River population)	*Acipenser fulvescens*
Fish	THR	Pugnose Minnow	*Opsopoeodus emiliae*
Fish	THR	Pugnose Shiner	*Notropis anogenus*
Fish	THR	Silver Chub	*Macrhybopsis storeriana*
Fish	THR	Spotted Gar	*Lepisosteus oculatus*

Taxonomic Group	**SARO List**	**Common Name**	**Scientific Name**
Fish	SC	Grass Pickerel	*Esox americanus vermiculatus*
Fish	SC	Northern Brook Lamprey	*Ichthyomyzon fossor*
Fish	SC	Spotted Sucker	*Minytrema melanops*
Fish	SC	Warmouth	*Lepomis gulosus*
Invertebrate	SC	Monarch	*Danaus plexippus*
Mammal	THR	Grey Fox	*Urocyon cinereoargenteus*
Mammal	SC	Eastern Mole	*Scalopus aquaticus*
Mollusc	END	Eastern Pondmussel	*Ligumia nasuta*
Mollusc	END	Fawnsfoot	*Truncilla donaciformis*
Mollusc	END	Northern Riffleshell	*Epioblasma torulosa rangiana*
Mollusc	END	Rayed Bean	*Villosa fabalis*
Mollusc	END	Salamander Mussel	*Simpsonaias ambigua*
Mollusc	END	Snuffbox	*Epioblasma triquetra*
Mollusc	THR	Mapleleaf Mussel (Great Lakes-Western St. Lawrence population)	*Quadrula quadrula*
Mollusc	THR	Rainbow Mussel	*Villosa iris*
Mollusc	THR	Wavy-rayed Lampmussel	*Lampsilis fasciola*
Moss	END	Spoon-leaved Moss	*Bryoandersonia illecebra*
Reptile	END	Blue Racer	*Coluber constrictor foxii*
Reptile	END	Butler's Gartersnake	*Thamnophis butleri*
Reptile	END	Common Five-lined Skink (Carolinian population)	*Plestiodon fasciatus*
Reptile	END	Eastern Foxsnake (Carolinian population)	*Pantherophis gloydi*
Reptile	END	Lake Erie Watersnake	*Nerodia sipedon insularum*
Reptile	END	Massasauga Rattlesnake (Carolinian population)	*Sistrurus catenatus*
Reptile	END	Queensnake	*Regina septemvittata*
Reptile	END	Spotted Turtle	*Clemmys guttata*
Reptile	THR	Blanding's Turtle	*Emydoidea blandingii*
Reptile	THR	Eastern Hog-nose Snake	*Heterodon platirhinos*
Reptile	THR	Spiny Softshell	*Apalone spinifera spinifera*
Reptile	SC	Eastern Musk Turtle	*Sternotherus odoratus*
Reptile	SC	Eastern Ribbonsnake	*Thamnophis sauritus*
Reptile	SC	Milksnake	*Lampropeltis triangulum triangulum*
Reptile	SC	Northern Map Turtle	*Graptemys geographica*

Taxonomic Group	**SARO List**	**Common Name**	**Scientific Name**
Reptile	SC	Snapping Turtle	*Chelydra serpentina*
Reptile	EXP	Timber Rattlesnake	*Crotalus horridus*
Vascular Plant	END	American Chestnut	*Castanea dentata*
Vascular Plant	END	American Ginseng	*Panax quinquefolius*
Vascular Plant	END	Butternut	*Juglans cinerea*
Vascular Plant	END	Drooping Trillium	*Trillium flexipes*
Vascular Plant	END	Eastern Flowering Dogwood	*Cornus florida*
Vascular Plant	END	Eastern Prairie Fringed-orchid	*Platanthera leucophaea*
Vascular Plant	END	Eastern Prickly Pear Cactus	*Opuntia humifusa*
Vascular Plant	END	False Hop Sedge	*Carex lupuliformis*
Vascular Plant	END	Heart-leaved Plantain	*Plantago cordata*
Vascular Plant	END	Nodding Pogonia	*Triphora trianthophora*
Vascular Plant	END	Pink Milkwort	*Polygala incarnata*
Vascular Plant	END	Red Mulberry	*Morus rubra*
Vascular Plant	END	Scarlet Ammannia	*Ammannia robusta*
Vascular Plant	END	Skinner's Agalinis	*Agalinis skinneriana*
Vascular Plant	END	Slender Bush-clover	*Lespedeza virginica*
Vascular Plant	END	Spotted Wintergreen	*Chimaphila maculata*
Vascular Plant	END	White Prairie Gentian	*Gentiana alba*
Vascular Plant	THR	American Water-willow	*Justicia americana*
Vascular Plant	THR	Colicroot	*Aletris farinosa*
Vascular Plant	THR	Common Hoptree	*Ptelea trifoliata*
Vascular Plant	THR	Dense Blazing Star	*Liatris spicata*
Vascular Plant	THR	Dwarf Hackberry	*Celtis tenuifolia*
Vascular Plant	THR	Goldenseal	*Hydrastis canadensis*
Vascular Plant	THR	Kentucky Coffee-tree	*Gymnocladus dioicus*
Vascular Plant	THR	Purple Twayblade	*Liparis liliifolia*
Vascular Plant	THR	Round-leaved Greenbrier	*Smilax rotundifolia*
Vascular Plant	THR	Small-flowered Lipocarpha	*Lipocarpha micrantha*
Vascular Plant	THR	Wild Hyacinth	*Camassia scilloides*
Vascular Plant	THR	Willowleaf Aster	*Symphyotrichum praealtum*
Vascular Plant	SC	Blue Ash	*Fraxinus quadrangulata*
Vascular Plant	SC	Broad Beech Fern	*Phegopteris hexagonoptera*
Vascular Plant	SC	Climbing Prairie Rose	*Rosa setigera*

Taxonomic Group	SARO List	Common Name	Scientific Name
Vascular Plant	SC	Dwarf Lake Iris	*Iris lacustris*
Vascular Plant	SC	Green Dragon	*Arisaema dracontium*
Vascular Plant	SC	Riddell's Goldenrod	*Solidago riddellii*
Vascular Plant	SC	Shumard Oak	*Quercus shumardii*
Vascular Plant	SC	Swamp Rose-mallow	*Hibiscus moscheutos*

Data Gaps with Respect to Aquatic Habitat and Species at Risk

Complete information pertaining to the aquatic habitat dependent upon water depth, flow and temperature is not available at this time. Further research related to the thermal classification of watercourses and segments within watercourses of the Essex Region has already been identified as a research gap. It is well documented the importance of relative contributions of baseflows to total surface water flows in inland watercourses. Within the Essex Region, this information has not been described in detail and without a better understanding of the freshwater fish assemblage within these waters and a proper characterization of the aquatic habitat upon which they depend, information on this section of the report is lacking. Of particular importance may be the important linkages between changes observed in aquatic habitat and nearshore environments over time – recent research documents the need to consider ongoing monitoring of high-quality nearshore habitats to enable early detection of changes that might impact nearshore aquatic habitat conditions and Species at Risk.

2.8 Interactions between Human and Physical Geography

Interactions between human and physical geography within the Essex Region Watershed, pertaining to drinking water and source protection, are numerous. Population growth in the outlying region is expected to continue to be considerable (refer to **Tables 2.2 and 2.4**). The Towns of Tecumseh, Lakeshore, Amherstburg and LaSalle were considered to see the most growth (**Table 2.4**). Although trends from 1996 to 2006 saw growth rates fall with the exception of Lakeshore (**Table 2.2**). In particular, the north-eastern part of the Town of Lakeshore saw considerable growth between 1996 and 2006. This increase in population growth may result in increased pressures to the local environment, including issues and concerns surrounding source water protection.

The water quality in the nearshore waters of the Essex Region is substantially affected by runoff from local watersheds. Loss of natural cover, due to urban development and agricultural land use, along with very extensive artificial drainage, is considered to have contributed substantially to water quality issues such as turbidity and nutrients, and concerns such as algae. The shallow nature of the nearshore waters of Lake St. Clair and the Western Basin of Lake Erie is also a consideration, as they tend to be more susceptible to the influences of watershed runoff, as compared to deeper lakes. These matters require further evaluation, as described in **Section 4.2 (Surface Water Vulnerability)** of this Assessment Report.

The Belle River is an example where the runoff from the watershed has affected the water quality at the water treatment intake near the mouth of the river. The Town of Lakeshore built a new water treatment plant and a new intake that is located farther offshore, which should help alleviate some of the concerns with source water quality.

In terms of water quantity, although not affecting the municipal drinking water systems, the very extensive historical clearing and drainage has substantially affected the surface water conditions in the Region, resulting in many streams running dry during summer months. This is discussed further in **Section 3 (Water Quantity Risk Assessment)**.

2.9 Watershed Characterization Data Gaps

Table 2.19 Preliminary draft table of data gaps for the Essex Region Watershed

WC Deliverable	Dataset Name	Data gap problem
Abandoned Wells	To identify possible pathways to aquifers	At this stage no information/data available.
Aggregate Resources		Do not have pumping rates of groundwater.
Bedrock Geology	Bedrock Geology Map from MNDM	The available map is accurate to 1:250000 scale and not to the scale required.
Climate	Precipitation	Precipitation gauges are not uniformly located in the Region. As a result we are getting oblique Theissen polygons.
Climate	Evaporation and Evapotranspiration	There is no systematic data available for this Region. ET data available only for some experimental farms/crops.
DEM	Priority data for modeling and analysis. At present, we have DEM developed based on 1:10000 Orthophotography.	Given the flat terrain, it will be helpful to get a better resolution data in the analysis of flow directions in flat terrains.
Future Development Areas	To determine the possible future sources of contamination, water use issues, etc.	
Hydrogeology	Aquifer Characteristics	There are limited data available on the aquifer characteristics.
Low flows	Baseflows	Need to get the low flows in different order streams to get an understanding of baseflows.

PTTWs	Water use (surface and groundwater)	There are no data available on actual usage of each of permit holders. This set appears to substantially under represent the actual usage.
Seepage Areas	Important hydrological features found in headwaters	
Septic Systems	Assist in isolating sources of contaminants and in populating surface water model	To delineate the point sources.
Soil Map	Soil Map of OMAF	At present we are using the map generated in 1949 which needs good field verification. Also, soil profile characteristics and organic characteristics are not available.
Stormwater Management	Point source locations, water quality and quantity for modeling	
Stream Gauges		Only four watersheds have flow gauges. We need to set up additional gauging stations.
Thermal Classification of Water Bodies	Identification of the various segments of drainage, gaining and losing reaches	
Tiles	Need to understand the impact of tile drains on the local hydrology	There is no information on its impact on hydrology.

PLEASE NOTE: Data gaps for Water Quality and Aquatic Habitat/Species at Risk are addressed in Sections 2.3, 2.4 & 2.7