The Town of Petrolia
Waste Management of Canada
Class Environmental Assessment for
Wastewater Treatment and
Landfill Leachate Management

TECHNICAL MEMORANDUM NO.1 INVENTORY OF STUDY AREA, DESIGN CRITERIA AND PROBLEM/OPPORTUNITY STATEMENT

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November 29, 2011

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1. INTRODUCTION

1.1 BACKGROUND

The Town of Petrolia is situated within the County of Lambton, located in South Western Ontario.

Petrolia owns a wastewater treatment plant (WWTP) that services the properties within the Town. It is an extended aeration facility with tertiary filtration and ultraviolet disinfection, with a rated capacity of 3,800 m^3/d, discharging effluent to Bear Creek. The plant was originally constructed in 1975 and has undergone several improvements since that time. However, because most of the processes and structures are more than 35 years old, the plant requires major upgrades. Major tank processes do not provide adequate capacity to treat the Certificate of Approval rated flow and many of the plant processes continue to use equipment that is well past its useful life.

In addition to the major upgrades required, the Petrolia WWTP is operating at approximately 80% of its rated capacity, with flows in some months averaging between 85% and more than 100% . Recent growth and planning studies indicate that growth in the area within the next 25 years will require expansion of the plant capacity.

The Petrolia Landfill, also located within the Town, is owned and operated by Waste Management of Canada Corporation (WM). The site currently uses 26.02 hectares of land for disposal of municipal, industrial, commercial and institutional solid non-hazardous waste. Included in the Landfill are a gas management system for the collection of landfill gas and a leachate collection system. The leachate is currently hauled by truck to a number of alternative municipal treatment facilities. The landfill gas is utilized for electrical generation.

Since the Petrolia Landfill is located less than 1 km from the Petrolia wastewater collection system and approximately 2.5 km from the Petrolia WWTP, there is an opportunity to direct leachate through the wastewater collection system or a dedicated pipe from the landfill to the Petrolia WWTP for treatment. This would significantly reduce or eliminate the number of trucks, hauling distance and corresponding greenhouse gas emissions associated with the leachate disposal.

Currently the Petrolia WWTP does not have capacity or reliability to accept the additional loadings from the Petrolia Landfill leachate.

The Town of Petrolia and Waste Management of Canada are seeking the most environmentally sound and cost-effective solution to manage their wastewater and leachate and one solution that shows significant promise is to co-treat leachate with wastewater at the Petrolia WWTP. Completion of a Class Environmental Assessment (EA) study to plan for the management of wastewater and leachate will provide a sound, thorough approach evaluating a full range of solutions to identify preferred solutions for the Town and Waste Management, considering all potential environmental, community and cost impacts. This Schedule C Class EA is being undertaken to plan for the expansion of the Petrolia WWTP to meet growth needs in the Town, and to plan for long term management of the Petrolia Landfill leachate.

1.2 STUDY OBJECTIVES

This memo was prepared as the first step in the Schedule C Class EA study, to describe the study area, status of existing facilities and design criteria.

2. STUDY AREA

The following section provides a general description of the study area in close proximity to Petrolia outlining the existing natural, socio-economic and features within this defined area.

2.1 STUDY AREA

The study area consists of the geographical area that could be affected by the servicing and treatment project alternatives. This area is focused on the urban boundaries of Petrolia as shown in Figure 1.

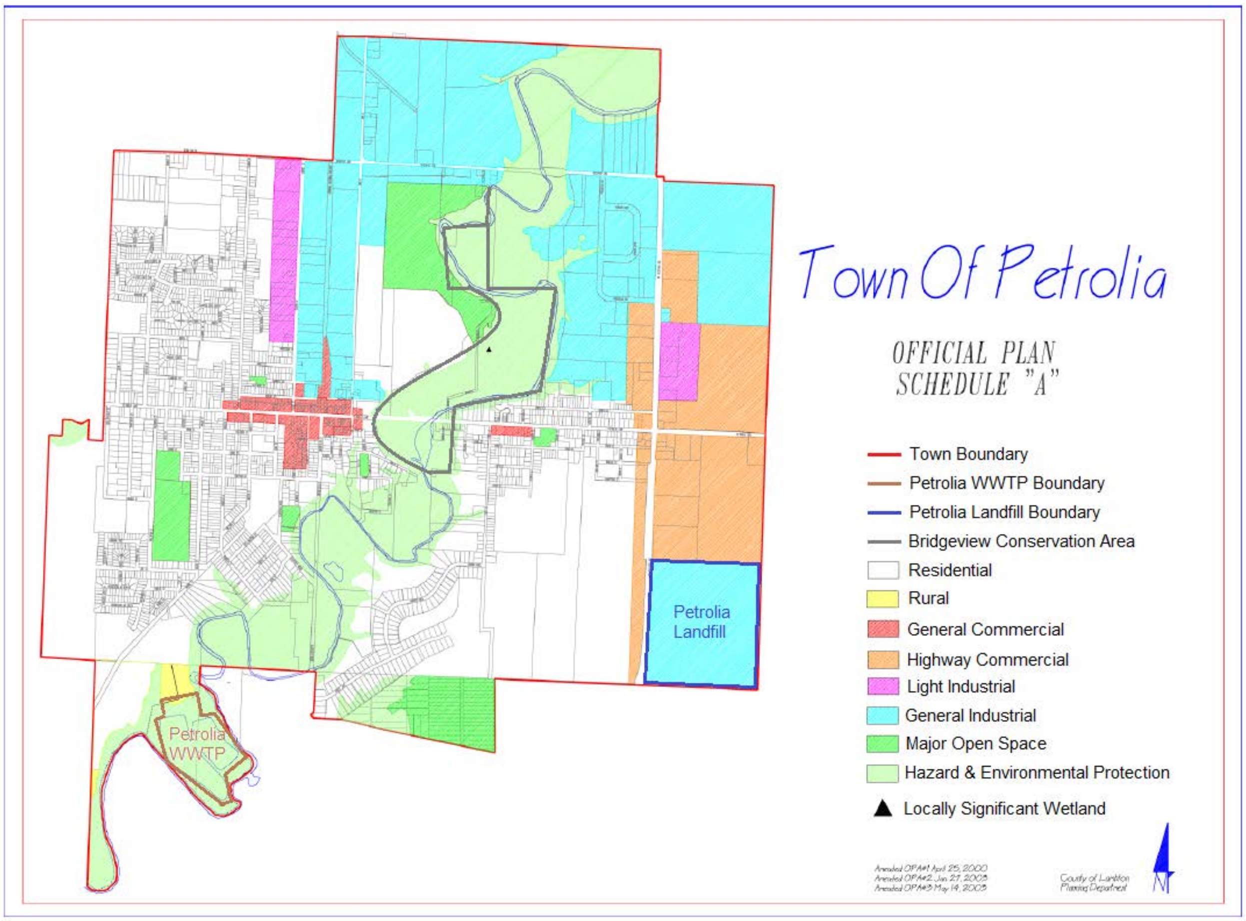

Figure 1 Map of Study Area (Town of Petrolia, 1999)

Petrolia lies within the Sydenham River watershed, and more specifically within two sub-watersheds; Bear Creek Headwaters and Lower Bear Creek.

Figure 2 shows an aerial photo of the study area, including the Petrolia WWTP and the Landfill.

Figure 2 Map of Petrolia WWTP and Petrolia Landfill Site (Google Maps, 2011)

2.2 NATURAL ENVIRONMENT

2.2.1 Climate

There is no Environment Canada weather monitoring station within Petrolia, however one is located about 10 km away on Rokeby Line, between Wanstead Road and Oakdale Road. This station was used to determine the climate conditions in Petrolia. Data are presented in Table 1.

Table 1 Climate Conditions in Petrolia (Environment Canada, 2006-2010)

Parameter	Value
Average annual precipitation (mm)	929.2
Snowfall (%)	13
Rainfall (%)	87
Driest Month	February
Wettest Month	August
Daily Average Temperature (°C)[1]	9
Highest recorded temperature on record (°C)[2]	36

Notes:
1. Daily temperature ranges from a high of 21.4 °C in July to a low of -4.9 °C in February.
2. Recorded in July 2007 & 2010.

The climate of Petrolia as part of Lambton County is moderated by the Great Lakes, specifically Lake Huron and Lake Erie. The addition of moisture from the Lakes increases precipitation amounts in autumn and winter, while the Lake heat leads to milder winters. Conversely in the summer, the cooler lake waters temper the tropical air from the south. The combination of these factors makes Lambton County's climate one of the most suitable in Canada for both agriculture and settlement.

2.2.2 Physiography, Geology and Soils

Figure 3 shows the aggregate resources of Lambton County and the current sand and gravel pit locations. These are primarily located in the east and northeast and there are no licensed aggregate operations in the Petrolia study area.

Petrolia lies within the Lambton Clay Plain which is mainly flat consisting mostly of clay and silt soils on top of bedrock. This is the result of fine-grained materials deposited at the bottom of ancient glacial lakes. The soil map presented in Figure 4 was developed from detailed county soil surveys.

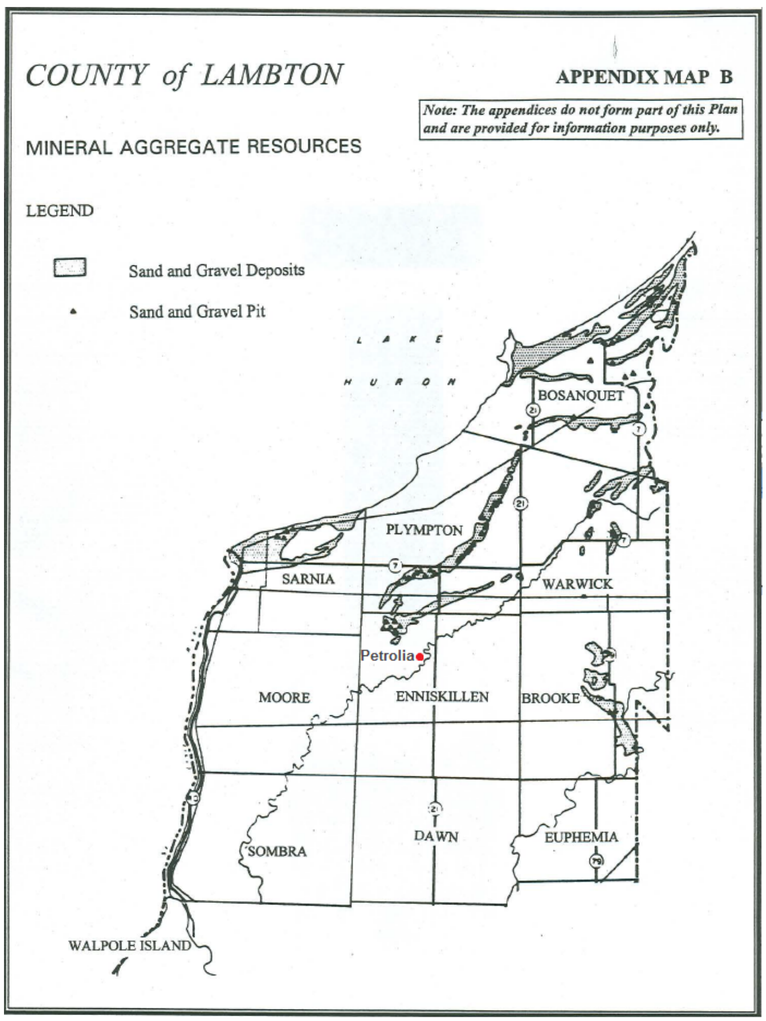

Figure 3 Aggregate Resources of Lambton County (County of Lambton, 2009)

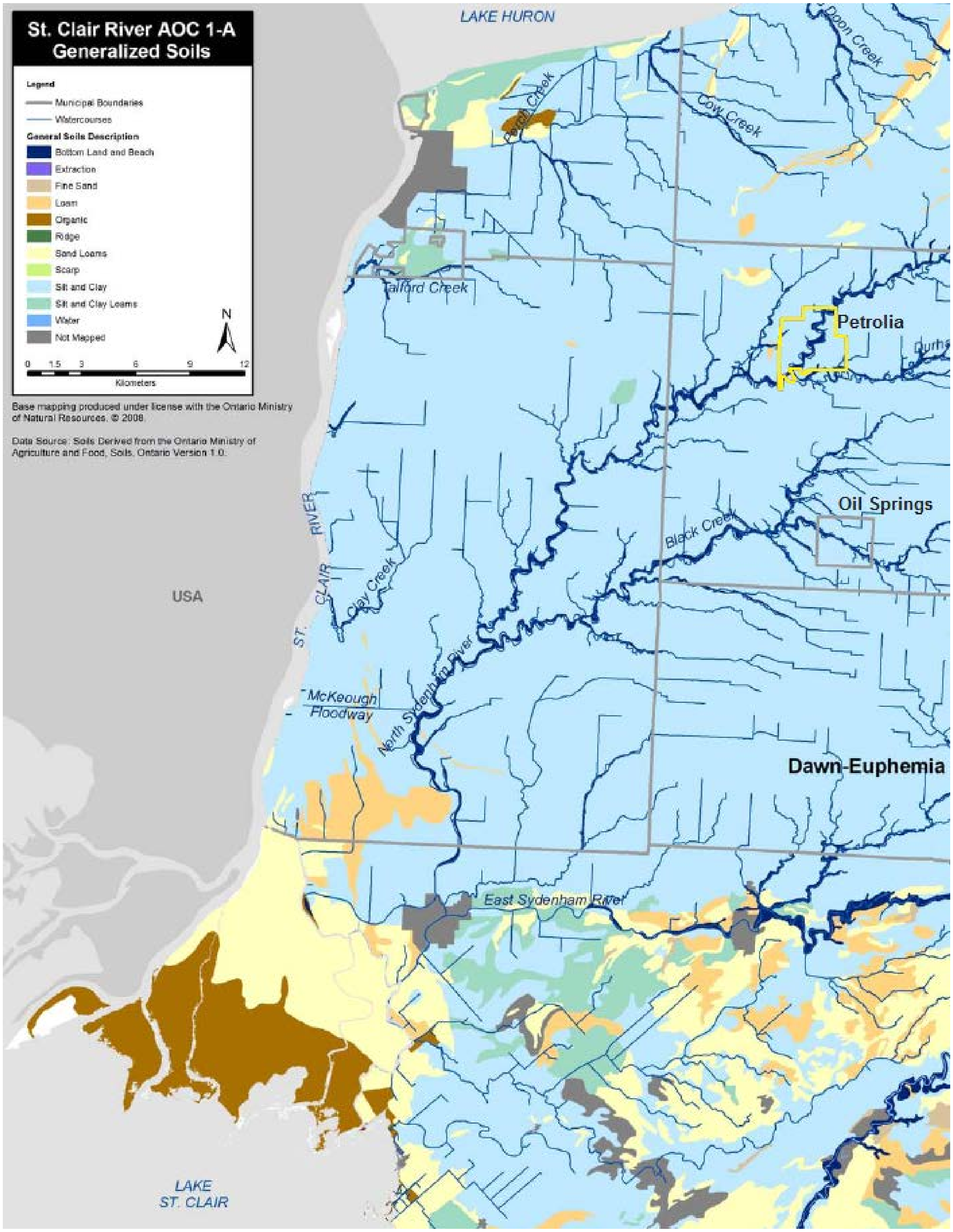

Figure 4 Soil Map (SCRCA, 2009)

2.2.3 Water Resources and Aquatic Ecology

2.2.3.1 Surface Water

Petrolia is located within the Sydenham watershed, specifically the sub-watersheds of Bear Creek Headwaters and Lower Bear Creek. Bear Creek is the primary water course flowing through Petrolia, and flows southwesterly through the centre of the Town and just south of the Petrolia WWTP, which discharges to this Creek. Durham Creek (listed as Little Bear Creek on some maps) is a westerly flowing stream falling just south of the Petrolia boundaries and the Petrolia Landfill, connecting with Bear Creek just before the Petrolia WWTP. At this confluence, the Bear Creek Headwaters sub-watershed ends and the Lower Bear Creek sub-watershed begins. The watercourse continues in a south-westerly direction as Bear Creek before emptying into the North Sydenham River and eventually discharging into Lake St. Clair. The main watercourses of the area can be seen in Figure 5.

The SCRCA Watershed Report Card, 2008, gave the surface water quality an overall grade of C, on a scale of A to F, for both the Bear Creek Headwaters and Lower Bear Creek sub-watersheds. This general assessment of surface water quality is based on three key indicators, benthic score, phosphorous and E. coli bacteria. This system for grading surface water quality was developed in 2003 by Ontario's Conservation Authorities.

2.2.3.2 Benthic Community

Benthic invertebrates are aquatic organisms that live in stream sediments and are used as indicators of water quality and stream health, as they are sensitive to pollution. A stream is scored based on the Family Biotic Index (FBI) and ranges from 1 (healthy) to 10 (degraded).

The Bear Creek Headwaters and Lower Bear Creek sub-watersheds were sampled approximately 15 km northeast and southwest of the Town of Petrolia. A FBI score of 5.7 and 5.5 was determined respectively, indicating Fair water quality in both sub-watersheds.

2.2.3.3 Groundwater

Petrolia residents and businesses are connected to a municipal water supply system which draws from Lake Huron. There is one aquifer within the study area, known as the Fresh Water Aquifer, and it lies between the overburden and bedrock layers. This aquifer is limited in quantity and contains high sodium and chloride. Insufficient data were collected at the time of the SCRCA Watershed Report Card, 2008, thus, grades were not applied to the groundwater quality within the specific watersheds.

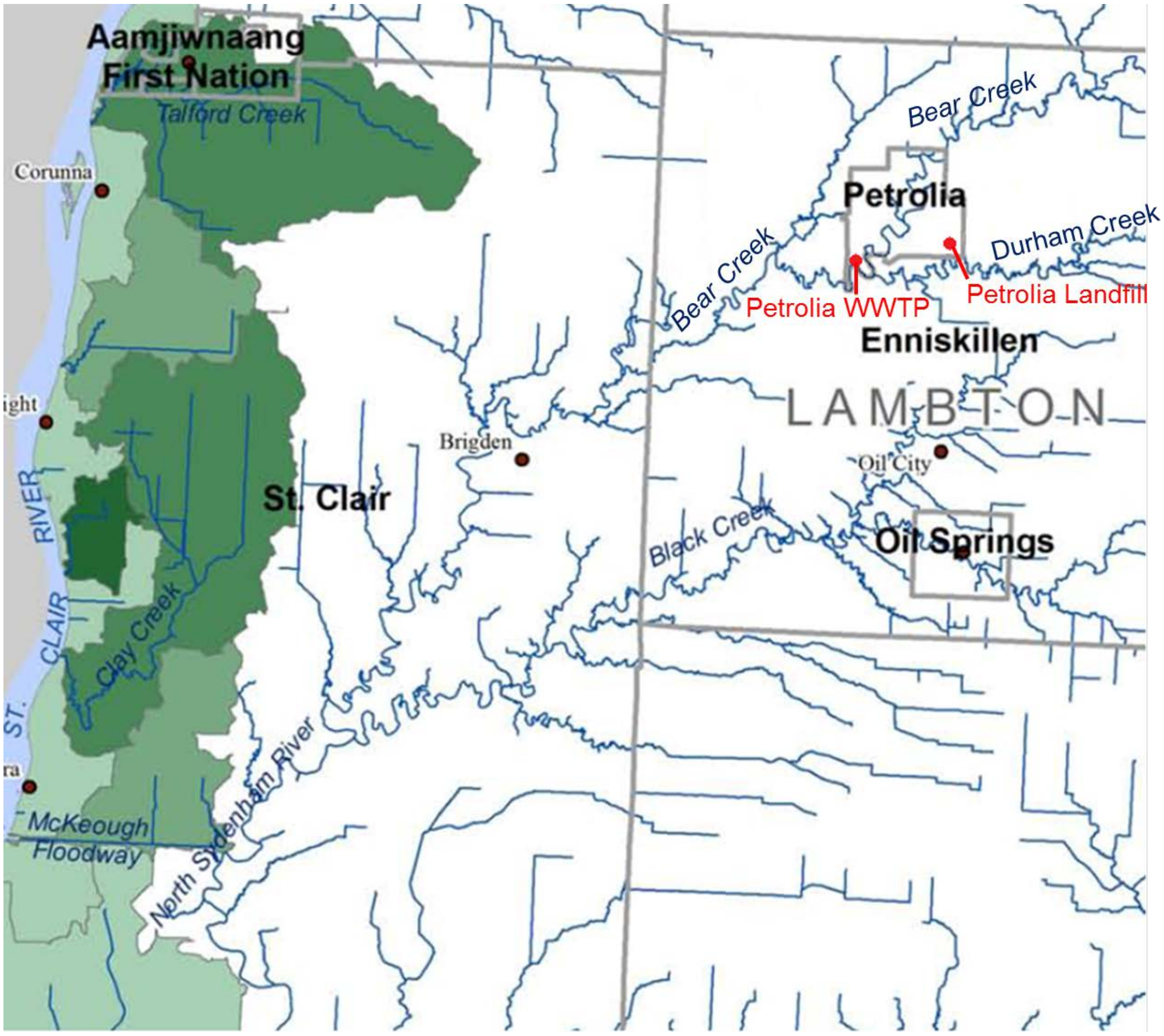

Figure 5 Major Watercourses Near the Study Area (SCRCA, 2009)

2.2.3.4 Fisheries & Species at Risk

Within the Bear Creek Headwaters and Lower Bear Creek sub-watershed regions there is a warm water fish community consisting of 46 species, including northern pike, largemouth, smallmouth and rock bass, walleye and sunfish.

Additionally, there are a number of fish, plants, birds, reptiles, mussels and mammals at risk within the sub-watersheds. Table 2 lists the species considered at risk by the Community on the Status of Endangered Wildlife in Canada (COSEWIC), a group that assesses species for their consideration for legal protection and recovery under the Species at Risk Act (SARA). The Round Pigtoe and Mudpuppy Mussel are considered S1 (extremely rare) according to a provincial rank from the Species at Risk in Ontario (SARO) List.

Table 2 Species at Risk in the Bear Creek Headwaters and Lower Bear Creek Sub-Watersheds (SCRCA, 2008)

Species Common Name	Species Scientific Name	COSEWIC
Fish		
Blackstripe Topminnow	*Fundulus notatus*	Special Concern
Spotted Sucker	*Minytrema melanops*	Special Concern
Brindled Madtom	*Noturus miuris*	Not at Risk
Bigmouth Buffalo	*Ictiobus cyprnellus*	Special Concern
Plants		
Green Dragon	*Arisaema dracontium*	Special Concern
Kentucky Coffeee-tree	*Gymnocladus dioicus*	Threatened
Butternut	*Juglans cinerea*	Endangered
Blue Ash	*Fraxinus quadrangulata*	Special Concern
Shumard Oak	*Quercus shumardii*	Special Concern
Birds		
Loggerhead Shrike	*Lanius ludovicianus*	Endangered
Reptiles		
Spiny Softshell Turtle	*Apalone spinifera*	Threatened
Butler's Gartersnake	*Thamnophis butlerii*	Threatened
Mussels		
Round Pigtoe	*Pleurobema sintoxia*	Endangered
Mudpuppy Mussel	*Simpsonaias ambigua*	Endangered
Mammals		
Gray Fox	*Urocyon cinereoargenteus*	Threatened

2.2.4 Terrestrial Ecology

2.2.4.1 Riparian Vegetation and Habitat

Healthy forests help to maintain good air and water quality as well as provide habitat for the diverse plant and wildlife in the area. Conservation Ontario uses two factors that provide strong indications of a forests health and are easily measured using aerial photography. They are forest cover and forest interior percentage. Forest cover refers to the total percentage of the watershed covered in forests, and the forest interior is defined as the percentage of forest more than 100 m from the forest edge. Forest interior is necessary for some bird species to nest successfully. Goals set by Environment Canada (2004) recommend a forest cover of 30% and forest interior of 10%. Bear Creek Headwaters and Lower Bear Creek were given grades of D and C, respectively, and are considered too low for sustainability (SCRCA, 2008).

2.2.4.2 Significant Natural Areas

Of specific interest within Petrolia's municipal boundaries are the Bridgeview Conservation Area, a locally significant wetland, and the environmentally protected primary corridor located along Bear Creek, as shown in Figure 1. According to the Town's Official Plan, these areas will be protected from development.

There may be other natural features located outside the designated areas and the Town will work with residents and service groups to identify and protect these natural features. These may include rare trees, tree rows, cemetery landscaping and vegetated areas. The Town will also work to reduce the amount of contaminants, such as pesticides, herbicides and salts, entering receiving watercourses.

Also of note is the Lorne C. Henderson Conservation Area, another locally significant wetland, located just west of Petrolia's boundaries.

2.3 SOCIO-ECONOMIC ENVIRONMENT

2.3.1 Existing Population

Petrolia is one of eleven municipalities making up Lambton County in Southern Ontario, and one of four that has experienced growth in recent years. The most up to date data available were from the 2006 Census, and according to the results, Petrolia's population increased 7.5% from 4,849 people in 2001 to 5,215 people in 2006, for a growth rate of 1.5% per year. Table 3 shows the population change from 2001 to 2006 for all the municipalities of Lambton County.

Table 3 Population Growth for the Municipalities of Lambton County (2001 to 2006)

Municipality	2001 Population	2006 Population	Percent Growth 2001 to 2006
Brooke-Alvinston	2,785	2,665	- 4.3%
Dawn-Euphemia	2,369	2,200	- 7.7%
Enniskillen	3,259	3,120	- 4.3%
Lambton Shores	10,571	11,150	5.2%
Oil Springs	758	715	- 5.7%
Petrolia	4,849	5,215	7.5%
Plympton-Wyoming	7,359	7,506	2.0%
Point Edward	2,101	2,020	- 3.9%
Sarnia	70,876	71,420	0.8%
St. Clair	14,659	14,640	- 0.1%
Warwick	4,025	3,945	- 2.0%

2.3.2 Land Use and Zoning

Figure 1 shows the land use plan for Petrolia from the Town's Official Plan adopted in 1999. There are a variety of specific land use designations including residential, rural, general and highway commercial, general and light industrial, major open space and hazard & environmentally protected areas. Also visible in the figure are the Petrolia Landfill, Petrolia WWTP and a locally significant wetland, known as the Bridgeview Conservation Area.

Hazard and environmentally protected areas may be subject to flooding and instability due to erosion and excessive slopes and/or they may contain significant natural features such as wetlands and woodlands. Development within these areas is prohibited or restricted, as it could result in the loss of life, property damage, or destruction of significant natural features. However, special uses of this land can include conservation, forestry, parks, golf courses or other passive outdoor recreational uses.

2.3.3 Municipal Infrastructure

Within Petrolia the following major infrastructure exists:

- Municipal water supply system and elevated water storage tank
- Petrolia Wastewater Treatment Plant (WWTP)
- Petrolia Landfill owned and operated by Waste Management of Canada
- Charlotte Eleanor Englehart Hospital of Bluewater Health
- Lambton Central Collegiate and Vocational Institute.

All of Petrolia is serviced by municipal water piped from the Water Treatment Plant (WTP), with a rated capacity of 12,000 m^3/d, located in Sarnia at Bright's Grove, about 20 km north of the Town. This WTP services a number of other municipalities, with a total serviceable population of 9,639.

Water drawn from Lake Huron is treated using membrane filtration, fluoridation and chlorination.

2.3.4 Heritage Resources

Petrolia is known as 'Canada's Victorian Oil Town' as it was a focal point of the oil industry back in the mid-to-late 1800's and early-to-mid 1900's. With this came the development of institutional, commercial and residential buildings of very high quality. Figure 6 (Wendy Shearer et al., 2009) shows the concentrations of pre-1946 buildings in downtown Petrolia that may be designated as heritage resources as well as those properties already designated Heritage Resources under part IV of the Ontario Heritage Act.

Any redevelopment or public works must be sensitive to these heritage resources. These properties are all located more than 800 m north of the Petrolia WWTP, and even further from the Petrolia Landfill, which lies to the east.

2.3.5 Recreation

According to the Town's Official Plan, major open spaces as well as some portions of the lands listed as hazards and environmental protection areas, shown in Figure 1, are to be used for recreation, such as parks or other specific recreational facilities, to meet the needs and wants of the residents.

For the most part, the environmentally protected area around Bear Creek and the Bridgeview Conservation Area contain trails and parks that are used by the residents. These trails are interconnected throughout the Town.

Recreation facilities exist to the southwest of central Petrolia and include the Greenwood Recreation Centre, soccer fields and baseball diamonds. This is also the location of the Petrolia and Enniskillen Fall Fair, which takes place every year during the first weekend after Labour Day. Additionally, there is a track and field facility located at the Lambton Central Collegiate and Vocational Institute towards the centre of the Town, and the Heritage Heights Golf and Curling Club located to the southwest. All of these facilities are more than 800 m from the Petrolia WWTP and Petrolia Landfill.

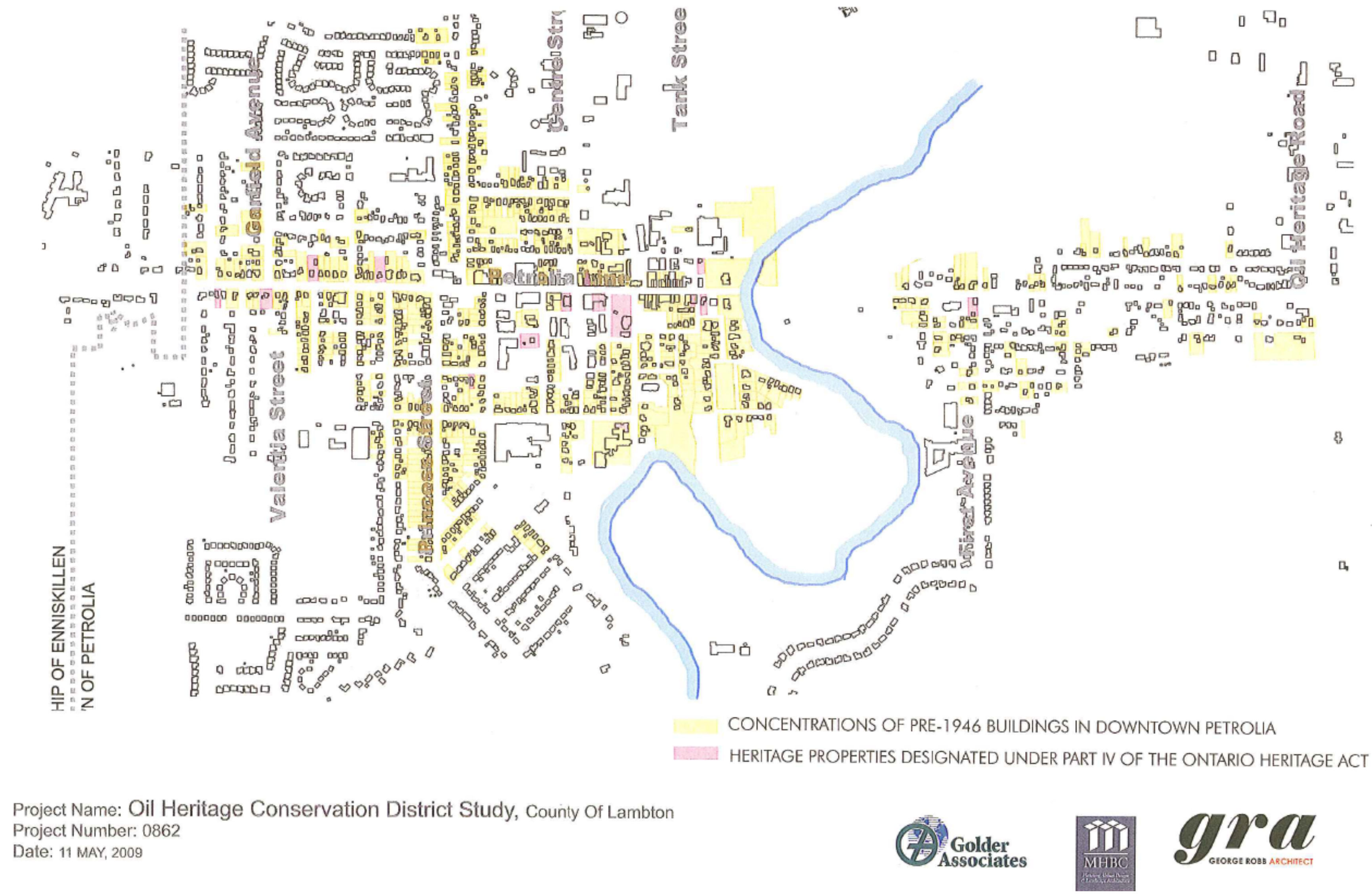

Figure 6 Location of Heritage Resources Within Petrolia (Wendy Shearer et al., 2009)

3. STATUS OF THE EXISTING FACILITIES

3.1 PETROLIA WASTEWATER TREATMENT PLANT

3.1.1 Serviceable Population of Petrolia WWTP

The Town of Petrolia has a municipal wastewater collection, treatment and disposal system, and it is anticipated that in the long term, all lands or new development within the municipal boundaries will be serviced by this system. The Town's Official Plan recognizes that some areas of the municipality may not be feasibly serviced, and individual septic systems may be permitted for certain, limited development. Additionally, some industrial areas within the service area may be permitted to develop their own systems where specialized treatment is required. This will be allowed at the discretion of the Municipality in consultation with the Province. For the purposes of this study, the entire population of Petrolia is considered to be serviced by the municipal sewage treatment system.

3.1.2 Description of Existing Facilities

An aerial view of the Petrolia WWTP is presented in Figure 7.

Figure 7 Aerial View of the Petrolia WWTP

Raw wastewater to the Petrolia WWTP is pumped to the headworks from an off-site pumping station and forcemain. The headworks consists of a single automatically-cleaned step-screen and an aerated grit tank. A manually raked coarse bar rack is available when the automatic screen is off-line for maintenance.

Flow from the grit removal process is directed to two parallel aeration tanks in an extended aeration process. Each aeration tank is equipped with two mechanical surface aerators, as well as one self-aspirating jet aerator, which was installed more recently to supplement air to the tanks.

Alum is added to mixed liquor from the aeration tanks for phosphorous precipitation before flowing to two square secondary clarifiers, each equipped with a circular scraper mechanism. Return activated sludge from each clarifier flows to a common sump for pumping activated sludge back to the aeration inlet channel. Waste activated sludge is intermittently wasted from the forcemain to aerobic sludge holding tanks.

Secondary effluent flows by gravity to a surge tank to equalize flows upstream of a single travelling bridge sand filter and the ultraviolet disinfection system. Disinfection is run year round at the request of the MOE, even though it is not required by the Certificate of Approval. Final effluent is discharged continuously through an outfall to Bear Creek.

Two aerobic sludge holding tanks are available to partially stabilize waste sludge before discharge to the east lagoon (88,220 m^3) for stabilization and long-term storage. Additionally a west lagoon (126,540 m^3) is available for emergency storage and treatment of raw wastewater. These lagoons are approved for seasonal discharge between April 1 and May 31 and between October 1 and November 30. The lagoon discharge flow rates must be regulated so the loadings to Bear Creek do not exceed Certificate of Approval limits.

3.1.3 Physical Condition and Capacity Assessment

A physical condition and capacity assessment of the Petrolia WWTP was completed by CIMA in August 2011. That report is provided in Appendix A. Based on that review, the following deficiencies pose a risk to the plant achieving reliable operation and performance based on the existing Certificate of Approval rated capacity, or pose a health and safety risk:

- Structural condition: Deficiencies include cracks in aeration tanks, administration building leaks and other safety features.
- Capacity: Capacity is not adequate for Certificate of Approval rated flows in screen/grit removal, aeration, oxygenation and tertiary filtration processes.
- Equipment condition: Most major equipment is operating well beyond its normal service life, resulting in significant risk of failure and long periods of major process shut-down for repair, due to the difficulty in finding replacement parts.
- Electrical system: The motor control centre is over 30 years old and requires dangerous access to reset equipment. There is no stand-by power for critical processes.
- Flows in numerous months over the past 3 years have exceeded 100% of the plant's rated capacity. MOE policy requires the initiation of planning for plant expansion once 85% of the rated capacity is reached.

3.1.4 Raw Wastewater Flows

Historic flow data were summarized from the 2008, 2009 and 2010 Annual Reports (CH2M HILL, 2009, 2010, 2011). Figure 8 charts the historic average day and maximum day flows to the Petrolia WWTP. Additional data are presented in Table 4. Raw wastewater flow was measured using a Parshall flume.

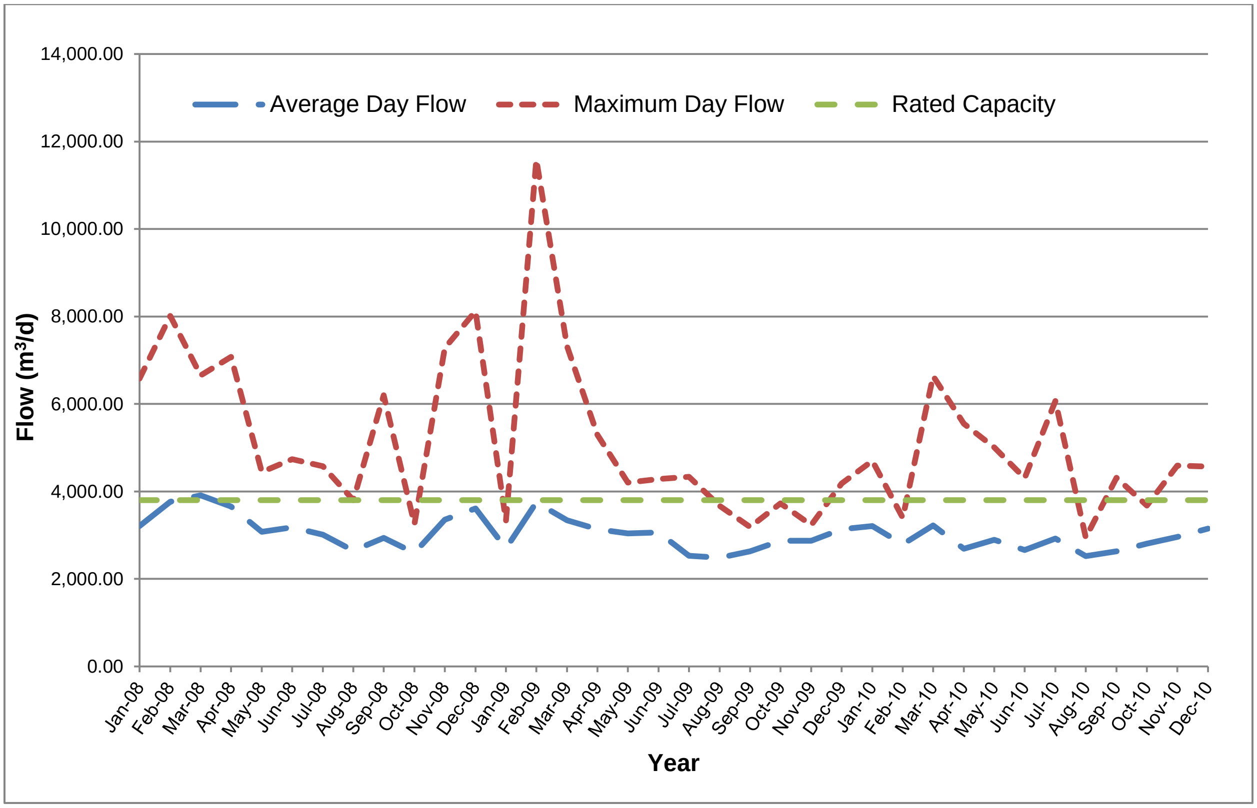

Figure 8 Historic Average Day and Maximum Day Flows to the Petrolia WWTP

Table 4 Historic Flows to Petrolia WWTP (2008 – 2010)

Parameters	Flows (% of Rated Capacity)
Average Day Flow (m^3/d)	3,028 (80%)
Average Per Capita Flow (L/cap.d)	556[1]
Maximum Month Flow (m^3/d)	3,909 (103%)
Maximum Day Flow (m^3/d)[2,3]	8,126 (201%)

Notes:
1 Based on an average projected population for 2008 to 2010 of 5,450 using the 2001 to 2006 growth rate of 1.5% per year presented in Table 3.
2 Based on the maximum day flow reported for each month.
3 One of the 36 maximum day flows did not fall below this value but appeared to be an anomaly.

The average day flow from 2008 to 2010 was 3,028 m^3/d, which represents 80% of the rated plant capacity of 3,800 m^3/d. Average flows in 3 months met or exceeded the plant rated capacity.

The average per capita flow was 556 L/cap.d, which is within a typical range, allowing for some level of infiltration and inflow in an older system, as well as daytime residents from local rural areas for schools, employment and other urban activities.

The maximum day flow was calculated from the maximum day flow reported for each of the 36 months, from 2008 to 2010. All but one value fell below 8,126 m^3/d during the three year monitoring period. The highest maximum day flow value was 11,590 m^3/d reported in February 2009. Peak instantaneous flow data are not available for the Petrolia WWTP.

3.1.5 Raw Wastewater Quality

Historic concentration data were gathered from the 2008, 2009 and 2010 Annual Report of Operations for the Petrolia WWTP (CH2M HILL, 2009, 2010, 2011). Table 5 presents the average concentrations and raw wastewater loadings to the plant between 2008 and 2010.

Table 5 Historic Raw Wastewater Average Concentrations and Loadings to Petrolia WWTP (2008 to 2010)

Parameters	Historic Average Concentrations (mg/L)	Historic Average Day Flow (m^3/d)	Historic Average Loadings (kg/d)
Biochemical Oxygen Demand (BOD_5)	226	3,028	679
Total Kjeldhal Nitrogen (TKN)	37.6		113
Total Suspended Solids (TSS)	199		595
Total Phosphorous (TP)	5.6		17.0

Table 6 provides a comparison of the historical per capita loadings to typical per capita loadings (Metcalf & Eddy 2003).

Table 6 Comparison of Historic and Typical Per Capita Loadings (2008 to 2010)

Parameters	Historical Per Capita Loadings Based on a Population of 5,450[2] (g/cap.d)	Typical Per Capita Loadings (g/cap.d)[1]
BOD_5	125	80
TKN	21	13
TSS	109	90
TP	3.1	3.2

Notes:
1 From Metcalf & Eddy Fourth Edition, 2003, Table 3-12 page 182.
2 Estimated population in 2009.

From Table 6, it can be seen that the historical per capita loadings are higher than typical per capita loadings for both BOD_5, TKN and TSS. As stated above, Petrolia is a central town and experiences incoming rural population during the day; this is a likely cause for the higher than typical results.

3.1.6 Effluent Quality Standards and Performance

Effluent data for the period of 2008 to 2010 are presented in Table 7 (CH2M HILL, 2009, 2010, 2011). The Petrolia WWTP has consistently produced excellent effluent quality, with concentrations well below the effluent compliance requirements. During the monitoring period the plant slightly exceeded the effluent objectives for BOD_5 twice and the TSS and TP once, but not the effluent limits.

Table 7 Historic Effluent Quality (2008 to 2010)

Parameters	Average (mg/L)	Peak Month (mg/L)	Effluent Objective (mg/L)	Effluent Compliance (mg/L)
BOD_5	1.8	6.8[1]	5	10
NH_3-N				
May 1 – Nov. 30	0.2	0.41	2	3
Dec. 1 – Apr. 30	0.37	1.58	5	7
TSS	1.0	8.9[2]	5	10
TP	0.48	0.63[3]	0.5	1.0
pH (at all times)	7.38	8.01	6.5 – 8.5	6.5 – 9.5
E. Coli (Apr 1 – Nov 30)	3 organisms / 100 ml	5 organisms / 100 ml	150 organisms / 100 ml	200 organisms / 100 ml

Notes:
1 Peak month exceeded effluent objective in March and April 2009.
2 Peak month exceeded effluent objective in March 2009.
3 Peak month exceeded effluent objective in Aug 2009.

The Petrolia WWTP is also allowed to discharge from the east and west lagoons during April 1st to May 31st and October 1st to November 31st of each year. In 2008, the west lagoon was discharged for 4 days during May, and for 22 days in March of 2009, both the east and west lagoons were discharged according to a Provincial Officer's Order (POO), 0348-7PMJPG. The west lagoon was also discharged for 12 days during May 2010, but the sampling results were unavailable and thus not included in this section.

The effluent objectives and compliance limits for lagoon discharge are the same as those for discharge from the plant. Table 8 summarizes the average plant effluent concentrations, while Table 9 summarizes the lagoon effluent concentrations during these months. During March 2009 the plant exceeded effluent objectives for BOD_5 and TSS but not compliance limits, as shown in Table 8. Discharge from the lagoons also resulted in effluent objectives not being met for TSS in 2008 and BOD_5, TSS and E. Coli in 2009, while TSS and E. Coli also exceeded the compliance limits in 2009 as shown in Table 9.

In discharging from the lagoons, the Petrolia WWTP is required to meet the waste loading compliance limits, which included the total monthly loading from the plant and the lagoons. The limits as well as the loading results are summarized in Table 10.

The effluent during May of 2008 met both the waste loading objectives and compliance limits. However, during March of 2009 both TP and NH_3-N met the compliance limit but did not meet the objective limit and BOD_5, TSS and E. Coli did not meet the compliance limits.

Table 8 Plant Average Effluent Concentration during 2008 and 2009 Lagoon Discharge Periods

Parameters	May 2008	March 2009	Effluent Objective	Effluent Compliance
BOD_5 (mg/L)	1.2	6.1	5	10
NH_3-N (mg/L) May 1 – Nov. 30 Dec. 1 – Apr. 30	 0.1 NA	 NA 1.6	 2 5	 3 7
TSS (mg/L)	0.6	8.9	5	10
TP (mg/L)	0.62	0.3	0.5	1.0
pH (at all times)	7.18	7.37	6.5 – 8.5	6.5 – 9.5
E. Coli (Apr 1 – Nov 30) (organisms per 100 ml)	3	25	150	200

Table 9 Lagoon Average Effluent Concentration during 2008 and 2009 Lagoon Discharge Periods

Parameters	2008	2009	Effluent Objective	Effluent Compliance
Discharge Period	May[1]	March[2]		
BOD_5 (mg/L)	2.8	7.2	5	10
NH_3-N (mg/L) May 1 – Nov. 30 Dec. 1 – Apr. 30	 1.4 NA	 NA 2.4	 2 5	 3 7
TSS (mg/L)	9.2	13	5	10
TP (mg/L)	0.33	0.33	0.5	1.0
pH (at all times)	7.26	7.34	6.5 – 8.5	6.5 – 9.5
E. Coli (Apr 1 – Nov 30) (organisms per 100 ml)	49	934	150	200

Notes:
1 Discharge occurred from May 23rd to May 26th.
2 Discharge occurred from February 27th to March 20th.

Table 10 Total Loading during Lagoon Discharge from 2008 to 2009

	Average Day Lagoon Loading		Average Day Plant Loading		Approximate Total Loading During Lagoon Discharge		Waste Loading Objective	Waste Loading Compliance
Parameters	**2008**	**2009**	**2008**	**2009**	**2008**	**2009**		
Discharge Date	May[1]	March[2]	May[1]	March[2]	May[1]	March[2]		
Discharge Volume (m^3)	15,817	197,483	95,347	103,663	111,164	301,146		
BOD_5 (kg/d)	1.4	45.9	3.7	20.4	5.1	66.3	19	38
NH_3-N (kg/d)								
May 1 – Nov. 30	0.7	NA	0.3	NA	1.0	NA	7.2	11.4
Dec. 1 – Apr. 30	NA	15.2	NA	5.4	NA	20.6	19	26.6
TSS (kg/d)	4.7	82.8	1.9	29.8	6.6	112. 6	19	38
TP (kg/d)	0.17	2.1	1.9	1.0	2.07	3.1	1.9	3.8
E. Coli (Apr 1 – Nov 30) (organisms per 100 ml)	49	934	3	25	9.5	621	150	200

Notes:
1 Discharge occurred from May 23rd to May 26th.
2 Discharge occurred from February 27th to March 20th.

3.2 PETROLIA LANDFILL

3.2.1 Serviceable Population of the Petrolia Landfill

The Petrolia Landfill currently accepts solid non-hazardous municipal, industrial, commercial and institutional solid waste from within the Province of Ontario.

3.2.2 Description of Existing Facilities

The Petrolia Landfill is owned and operated by Waste Management Corporation of Canada (WM) and is a solid non-hazardous waste landfill located at 4052 Oil Heritage Road in Petrolia, as was previously shown in Figure 1. The site is approximately 41.23 ha, with 26.02 ha licensed for waste disposal.

Incoming waste is deposited into excavated cells below grade in the local clayey soil. Leachate is currently collected by underdrains and toedrains that are connected to a pumping station. From there leachate is transported by truck to a number of alternative municipal treatment facilities. A gas management system is installed for the collection and use of landfill gas for energy generation.

Figure 9 shows a drawing of the layout of the Petrolia Landfill.

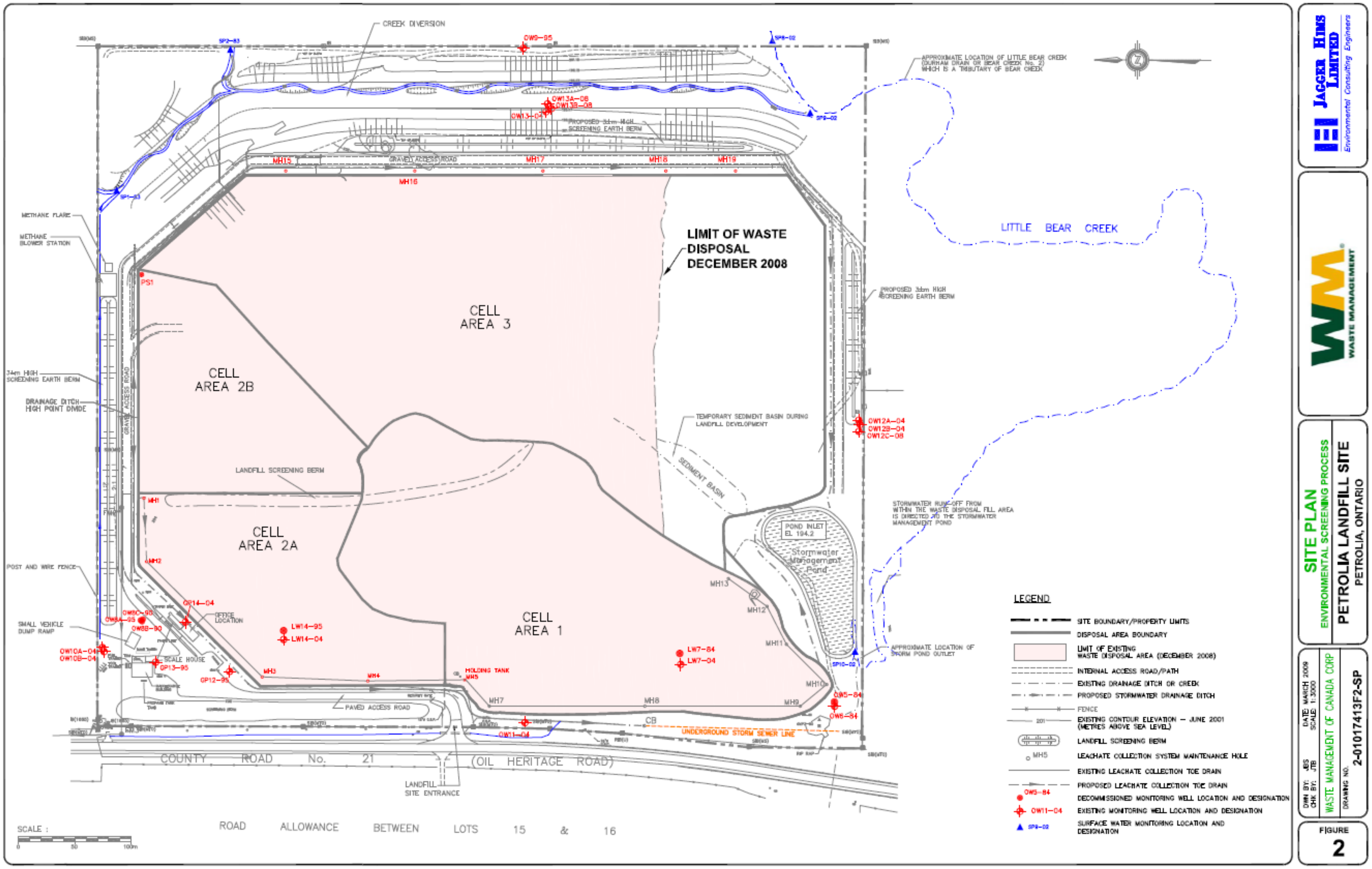

Figure 9 **Petrolia Landfill Site (Jagger Hims Ltd. 2009)**

3.2.3 Incoming Waste

The Petrolia Landfill is currently approved to receive 365,000 tonnes per year of solid non-hazardous municipal, industrial, commercial and institutional waste. The site has a daily maximum of 2,000 tonnes and cannot exceed an annual average of 1,000 tonnes per day over a 365 day period. The site is also approved for the storage of 1,200 m^3 of whole tires and tire shred for use as a supplemental drainage layer for the leachate collection system.

3.2.4 Leachate Flows and Cost

Leachate is defined as any liquid that extracts solids as it passes through matter. Landfill leachate helps promote decomposition and is generated by precipitation falling on and flowing through the waste material while gaining dissolved and suspended contaminants along the way. In order to prevent the leachate from contaminating groundwater or surface water, an impermeable liner or membrane must be used to contain the leachate. This leachate can then be collected and treated.

Leachate collected at the Petrolia Landfill is hauled away for treatment, at an average cost 2.43¢ per litre. Flows are calculated based on the volume of leachate shipped. Daily volumes were provided by WM for 2010 and 2011, while monthly volumes were provided for 2008 and 2009. Leachate volumes are presented in Figure 10 and Table 11.

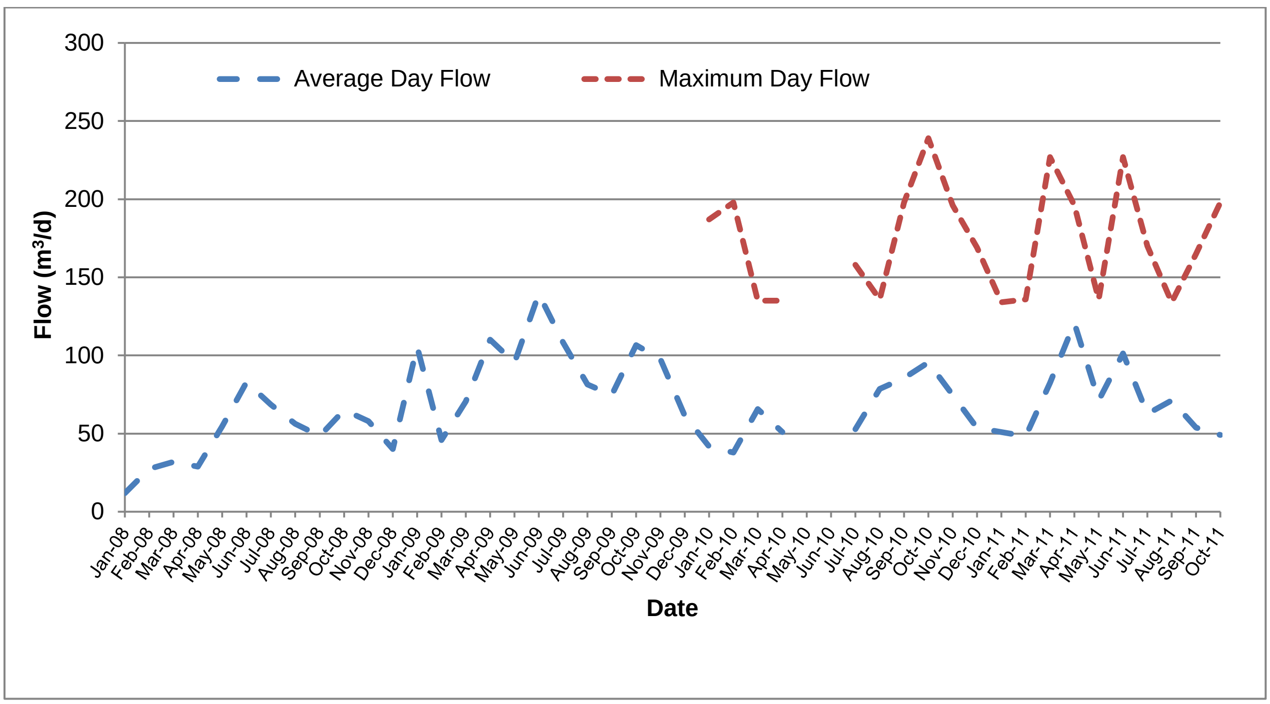

Figure 10 Historic Average Day and Maximum Day Leachate Flows from the Petrolia Landfill (Jan 2008 to Oct 2011)

Table 11 Historic Leachate Flows

Parameter	Volume of Leachate Shipped
Average Day Flow (m^3/d)[1,2]	68
Maximum Day Flow (m^3/d)[1,2]	239
Average Total Month (m^3)[3]	2,012
Average Total Year (m^3)[4]	23,140

Notes:

1. Based on daily leachate shipping volumes from 2010 to October 2011, however leachate was not hauled every day.
2. May and June 2010 were excluded as outliers.
3. Based on monthly leachate hauling volumes from 2008 up to and including October 2011.
4. Based on monthly leachate hauling volumes from 2008 to 2010.
5. Current average haulage and disposal rate of 2.43¢ per L.

During this historic period leachate was typically not hauled on weekends or holidays, and there were many other days throughout 2010 and 2011 when leachate was not hauled. In order to determine a useful average day flow, the value of 68 m^3/d was calculated based on leachate being collected and hauled every day. The maximum day flow of 239 m^3/d was based upon the actual maximum hauled volume recorded for a single day.

A review of the historical monthly volume indicates that the warmer, wetter, months from March to October produced a higher volume of leachate, while less was generated during colder, dryer, months from November to February. June had the highest average day flow of 108 m^3/d (excluding June 2010 where no leachate was hauled), which was anticipated as historically June is among the wettest months. February produced the lowest average day flow of 40 m^3/d, which was expected as February has historically been the driest month.

It should be noted that these variations may be due to an inability to haul leachate during the colder months, as leachate was only hauled on average 14 days per month from November to February versus 19 days per month from March to October, based on data from 2010 and 2011.

3.2.5 Leachate Quality

The leachate sampling program at the Petrolia Landfill began on October 19th, 2011 and will run for a minimum of 45 weeks. BOD_5, COD, NH_3-N, TKN, TSS and TP are sampled every week and metals are sampled once per month. To date, five samples have been collected, two including metals. Results are summarized in Table 12. Three historic sampling results exist for BOD_5 and NH_3-N, and are also presented. For NH_3-N there appears to be great variation in results, however it should be noted that the three most recent results from 2008 and 2011 were all above 900 mg/L. Comparing these values to those of the raw wastewater presented in Table 5, it can be seen that the Petrolia Landfill leachate is greater in strength for BOD_5 and TKN, while it has lower concentrations of TP and TSS.

Table 12 Leachate Quality[1]

Parameters	Minimum Concentrations (mg/L)	Maximum Concentrations (mg/L)	Average Concentrations (mg/L)
BOD_5[2]	420	918	678
COD	460	2,800	1,852
NH_3-N[2]	87	1,150	849
TKN	1,050	1,920	1,254
TSS	28	77	42
TP	0.31	3.55	1.56

Notes:

1. Based on 5 samples collected in 2011 on October 19th and 26th and November 2nd, 9th and 16th collected from the leachate pumping station wet well.
2. Includes 3 historic samples from Nov 2003, Sep 2005 and June 2008.

4. DESIGN CRITERIA

4.1 POPULATION

In October of 2010, a study was completed by the County of Lambton projecting population to the year 2031 (Lambton County, 2010). Projections suggested for planning purposes were based on a weighted growth scenario. The weighted growth scenario takes into account the past three census periods of the individual municipality with more emphasis placed on the most recent census. A maximum growth scenario is also presented, based on the best growth rates of the last three census periods being achieved consistently.

Population data for Petrolia are presented in Table 13, showing extrapolated projections to the year 2041 for the purposes of this Class EA study.

Table 13 Weighted Population Growth for the Town of Petrolia Projected to 2041

Growth Scenario	2006 Population	2031 Projected Population	Percent Growth 2006 to 2031	2041 Extrapolated Population	Percent Growth 2006-2041
Weighted	5,215	6,204	19.0%	6,602	26.6%
Maximum	5,215	8,071	54.8%	9,216	76.7%

Petrolia is expected to experience growth into 2041 based on both scenarios. The weighted scenario projects growth of 26.6% from 5,215 people in 2006 to 6,602 people 2041, or an annual growth rate of 0.67% per year. The maximum growth scenario projects a population increase from 5,215 people in 2006 to 9,216 people in 2041 for a total growth of 76.7%, or an average growth rate of 1.6% per year. These trends are plotted in Figure 11.

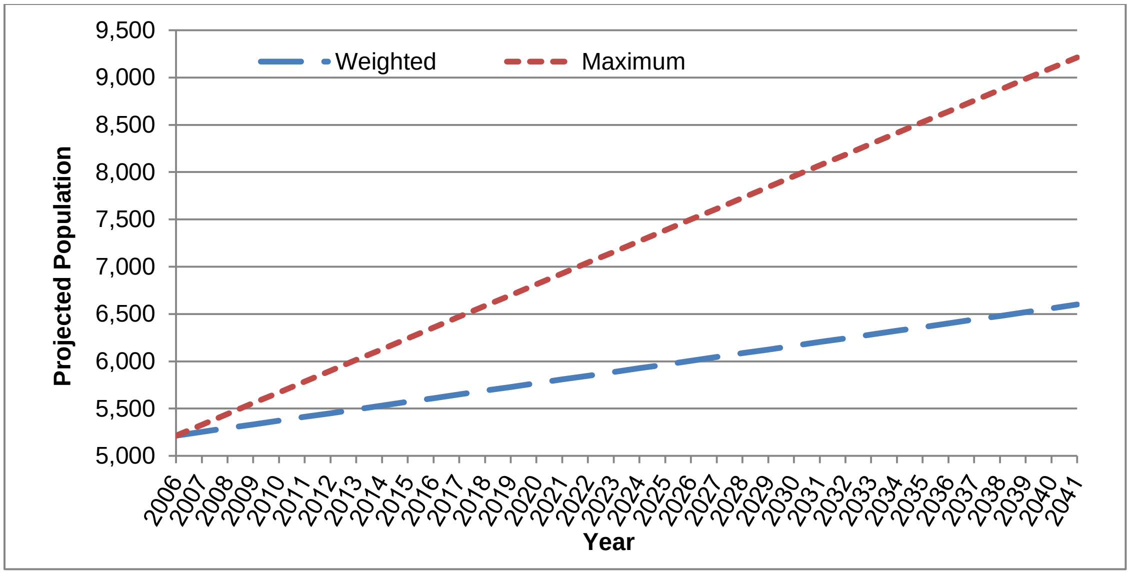

Figure 11 Predicted Population Based on a Weighted and Maximum Growth Scenario to 2041

For the purposes of planning municipal infrastructure facilities, a conservative approach should be taken in determining capacity needs. This will ensure capacity will be available for a reasonable planning period (20 to 30 years), and will avoid the need for several construction phases.

4.2 PETROLIA WASTEWATER TREATMENT PLANT

4.2.1 Projected Wastewater Flows

Population data for the Town of Petrolia are not available for 2007 to present. For the purposes of developing alternative solutions for the Class EA, flows from population between the weighted and maximum growth scenario were used. In later phases, the actual design flow for the preferred solution may be refined to reflect more up-to-date population data.

The average per capita flow of 556 m^3/cap.d previously presented in Table 4 was used to calculate projected wastewater flows. This value was based on the 2008 to 2010 average day flow data and the projected average population from 2008 to 2010.

The projected average day flow to the Petrolia WWTP for the weighted and maximum growth scenarios are presented in Figure 12, showing the average of the weighted and maximum flow projections to be used as design criteria for the purposes of this Class EA.

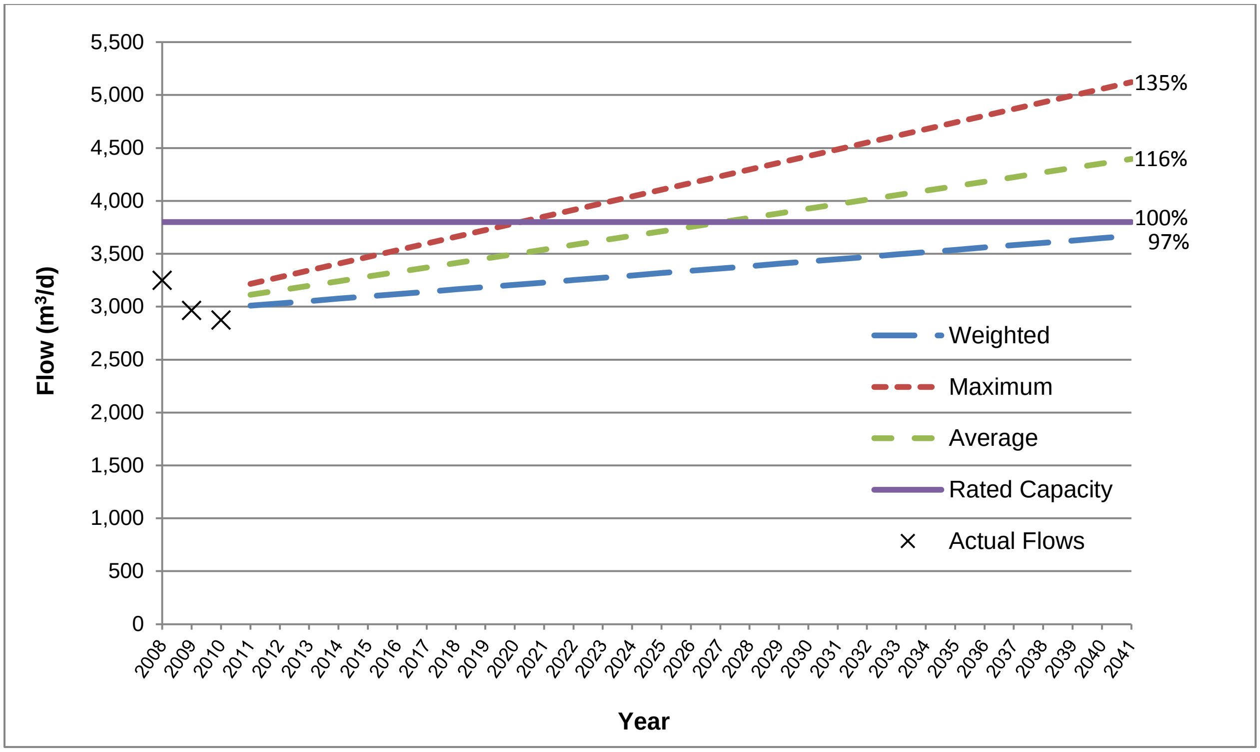

Figure 12 Average Day Flows to the Petrolia WWTP Based on a Weighted, Maximum and Average Growth Scenario to 2041

It is expected that the average day flow of wastewater to the Petrolia WWTP will increase to between 3,669 and 5,123 m^3/d by 2041, which would correspond to 97 to 135 % of the current rated plant capacity of 3,800 m^3/d. The conservative flows to be used for the purpose of evaluating alternative solutions in this Class EA are presented in Table 14.

Table 14 2041 Wastewater Flows from Petrolia Service Area and Peak Flow Factors

Parameters	Factors	Flows (m^3/d)
Average Day Flow	1	4,396
Peak Day Flow	2.7[1]	11,869
Peak Instantaneous Flow	4.0[2]	17,584

Notes:
1 Calculated from the maximum day flow and average day flow presented in Table 4.
2 Typical peak instantaneous factor.

4.2.2 Design Wastewater Quality

Historic concentration and average flow data from 2008 to 2010 were used to determine the 2041 design average loadings based on the average day flow rate of 4,396 m^3/d. The data are presented in Table 15. This information is from historic Table 5.

Table 15 2041 Petrolia Wastewater Concentrations and Loadings

Parameters	Design Concentrations (mg/L)	2041 Average Day Flow (m^3/d)	2041 Design Average Loadings (kg/d)
BOD_5	226	4,396	993
TKN	37.6		165
TSS	199		875
TP	5.6		24.6

4.3 PETROLIA LANDFILL

4.3.1 Leachate Flows and Cost

According to WM, it is expected that leachate volumes collected at the Petrolia Landfill will begin to decrease beyond 2012. The projected leachate volumes are provided in Table 16.

Table 16 Projected Leachate Collection Volumes from 2012 to Post-Closure

Year	Annual Volume (m^3)	Average Daily Volume (m^3)
2012	20,000	55
2013	15,000	42
2014	15,000	42
2015	10,000	28
2016	10,000	28
2017	7,000	20
2018	7,000	20
2019	7,000	20
Post Closure	5,000	14

In order to remain conservative, and due to the high variability in the leachate hauling volume data, an average day flow, maximum day flow and maximum week flow of leachate from the Petrolia Landfill are presented in Table 17 for the purposes of this Class EA. This info is from historic Table 11.

Table 17 Leachate Design Flows

Parameter	Volume of Leachate Shipped
Average Day Flow (m^3/d)[1,2]	68
Maximum Day Flow (m^3/d)[1,2]	239
Maximum Week Flow (m^3/week)[1,2]	982
Notes: 1. Based on daily leachate shipping volumes from 2010 to October 2011, however leachate was not shipped every day.	

4.3.2 Leachate Quality

It is anticipated that leachate quality will remain relatively unchanged during the site operating period and then begin to decrease in concentration. To remain conservative, historic and current concentrations are used. Available data were used to develop leachate quality for the purposes of developing alternatives for the Class EA, as presented earlier in Table 12. Leachate design loadings were calculated based on the flow for average day, maximum day and maximum week presented in Table 17, and are summarized and presented in Table 18. As additional sampling results are obtained, these values will be refined.

Table 18 Leachate Design Concentrations and Loadings

Parameters	Historic Average Concentrations (mg/L)	Design Average Loadings at a Flow of 68 m^3/d (kg/d)	Design Maximum Day Loadings at a Flow of 239 m^3/d[1] (kg/d)	Design Maximum Week Loadings at a Flow of 140 m^3/d[1] (kg/d)
BOD_5	678	46	162	95
TKN	1,254	85	300	176
TSS	42	2.9	10	5.9
TP	1.56	0.11	0.37	0.22

Notes:
1 Based on daily leachate shipping volumes from 2010 to October 2011, however leachate was not shipped every day.

5. PROBLEM/OPPORTUNITY STATEMENT

The Petrolia WWTP is a 3,800 m^3/d extended aeration plant servicing the Town of Petrolia. Most components of the plant are more than 35 years old, and require major upgrading. In addition, a review of the capacity of the plant processes indicates that many processes do not provide adequate capacity to reliably treat the approved flow of 3,800 m^3/d to consistently achieve effluent objectives and effluent compliance. Projected growth for the Town, as well as the significant deficiencies at the plant, require that planning for expansion and upgrade of the plant be initiated through a Schedule C Class Environmental Assessment (EA).

The Petrolia Landfill, owned and operated by Waste Management of Canada Corporation (WM), is located within the Town of Petrolia. The Landfill is equipped with a leachate collection system to collect leachate. This leachate is currently trucked to a number of alternative municipal treatment facilities.

Since the Petrolia Landfill is located a short distance from the Petrolia WWTP, an opportunity exists to direct leachate to the Petrolia WWTP through the current wastewater collection system or a dedicated pipe. Currently the Petrolia WWTP does not have capacity or reliability to accept the additional loadings from leachate.

The Town of Petrolia and Waste Management are both seeking a cost-effective solution to manage their wastewater into the future. One solution that shows significant promise is to co-treat leachate with raw wastewater at the Petrolia WWTP. Planning for the management of wastewater and leachate through the Schedule C Class EA will provide a sound, thorough approach to evaluating a full range of solutions for the Town of Petrolia and Waste Management, considering all potential environmental, community and cost impacts.

6. REFERENCES

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APPENDIX 1
CONDITION AND ASSESSMENT REPORT

The Town of Petrolia

PETROLIA WASTEWATER TREATMENT PLANT CONDITION ASSESSMENT

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August 17, 2011

TP000001A-200

DRAFT

Report Preparation and Review Log

Version	Date	Prepared by	QC Reviewer
1.0	August 16, 2011	Troy Briggs	Deborah Ross

EXECUTIVE SUMMARY

The Petrolia Wastewater Treatment Plant (WWTP) is an extended aeration facility with tertiary treatment and seasonal ultraviolet disinfection. Final effluent is discharged through an outfall to Bear Creek. The plant includes two lagoons, for emergency treatment of wastewater and sludge stabilization and storage, respectively.

The Petrolia WWTP was originally constructed in 1977 with a rated capacity of 3,180 m^3/d, and was subsequently rerated to 3,800 m^3/d in 2002. Average flow to the plant represents 80% of its re-rated capacity of 3,800 m^3/d, although flows in some months have exceeded 85%.

The Town recognizes that many of the plant components are deteriorating and operating well beyond their service life. Major upgrade is required to for the Petrolia WWTP to continue to perform reliably, and to minimize risk of non-compliance and to operator health and safety.

Due to planned growth in the Town, a Schedule C Class Environmental Assessment to plan for the expansion needs for the Petrolia WWTP will be initiated in fall 2011. Due to the age, condition and reliability concerns of the existing plant, the expansion project will need to incorporate and be compatible with upgrades to address existing deficiencies.

The purpose of this evaluation was to assess the existing Petrolia WWTP, to identify factors that pose a risk to the plant achieving reliable operation and performance, or pose a health and safety risk. Based on this evaluation, a preliminary capital cost estimate was developed for upgrades to provide long-term reliability to achieve performance and comply with current standards and regulations.

Based on a physical condition assessment and process capacity review, the following deficiencies were identified at the existing Petrolia WWTP:

- Structural condition: Deficiencies include cracks in aeration tanks, administration building leaks and other safety features.
- Capacity: Capacity is not adequate for Certificate of Approval flows in screen, grit removal, aeration, oxygenation and tertiary filtration processes.
- Equipment condition: Most major equipment is operating well beyond its normal service life, resulting in significant risk of failure and long periods of major process shut-down for repair, due to the difficulty in finding replacement parts.
- Electrical system: The MCC is over 30 years old and requires dangerous access to reset equipment. There is no stand-by power for critical systems processes.

For the purposes of developing a capital cost that reflects the investment required into the existing infrastructure to reliably achieve performance and comply with current standards, a program of plant upgrading needs was developed based on upgrading the plant at the existing Certificate of Approval rated capacity. The total estimate cost to upgrade the plant to address deficiencies is $12.8 million, including a 35% allowance for engineering and contingencies.

The Petrolia WWTP upgrading project will be developed in consideration of the plant capacity needs, to be determined though the planned Schedule C Class EA study.

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1. INTRODUCTION

1.1 BACKGROUND

The Petrolia Wastewater Treatment Plant (WWTP) is an extended aeration plant with tertiary filtration and seasonal ultraviolet disinfection. Final effluent is discharged through an outfall to Bear Creek. Two lagoons are available: the east lagoon (126,540 m^3) is used for emergency treatment of wastewater, and the west lagoon (88,200 m^3) is used for biosolids stabilization and storage. The lagoons are approved to discharge seasonally between April 1 and May 31 and between October 1 to November 30.

The Petrolia WWTP was originally constructed in 1977 with a rated capacity of 3,180 m^3/d, and was subsequently rerated to 3,800 m^3/d in 2002. The plant is currently operating at 80% of it re-rated capacity of 3,800 m^3/d, although flows in some months have exceeded 85%.

The Town recognizes that many of the plant components are deteriorating and operating well beyond their service life. Major upgrade is required to ensure consistent reliable operation, and minimize risk of non-compliance and risk to operator health and safety. As a recent example, in August 2011, the return sludge pipe deteriorated to cause a spill, resulting in shut-down and bypass of the treatment process for several days.

Due to planned growth in the Town, a Schedule C Class Environmental Assessment will be initiated in fall 2011 to plan for the expansion needs for the Petrolia WWTP. Because of the age, condition and reliability concerns of the existing facility, the expansion project will need to incorporate and be compatible with upgrades to address existing deficiencies.

1.2 PURPOSE OF REPORT

The purpose of this evaluation was to assess the existing Petrolia WWTP to identify factors that pose a risk to the plant achieving reliable operation and performance, or pose a health and safety risk. Based on this evaluation, a preliminary capital cost estimate is provided for upgrades to provide long-term reliability to achieve performance and comply with current standards and regulations.

2. PLANT DESCRIPTION

2.1 DESCRIPTION

Raw wastewater to the Petrolia WWTP is pumped to the headworks from an off-site pumping station and forcemain. The headworks consist of a single automatically-cleaned step-screen and an aerated grit tank. A manually raked coarse bar rack is available when the automatic screen is off-line for maintenance.

Flow from the grit removal process is directed to two parallel aeration tanks in an extended aeration process. Each aeration tank is equipped with two mechanical surface aerators, as well as one self-aspirating jet aerator, which was installed more recently to supplement air to the tanks. Mixed liquor from the aeration tanks flows to two square secondary clarifiers, each equipped with a circular scraper mechanism. Return activated sludge (RAS) from each clarifier flows through a telescopic valve to a common RAS sump for pumping activated sludge back to the aeration inlet channel. Waste activated sludge is intermittently wasted from the RAS forcemain to aerobic sludge holding tanks.

Alum is added to the mixed liquor upstream of the secondary clarifiers for phosphorus precipitation and removal in the clarifiers.

Secondary effluent flows by gravity to a surge tank to equalize flows upstream of a single travelling bridge sand filter and UV disinfection system. Final effluent is discharged continuously to Bear Creek.

Two (2) aerobic sludge holding tanks are available to partially stabilize waste sludge before discharge to the east lagoon for further stabilization and storage. Supernatant from the lagoon is discharged seasonally. The west lagoon is available for emergency storage and treatment of raw wastewater to the Petrolia WWTP.

The Certificate of Approval only allows for seasonal discharge from the lagoons, from April 1 to May 31 and October 1 to November 30. In addition, the lagoon discharge flow rates needs to be regulated, so that total loadings to Bear Creek do not exceed Certificate of Approval limits.

Figure 1 shows an aerial view of the Petrolia WWTP. Table 1 presents unit process design criteria for major processes.

Figure 1 Aerial View of Petrolia WWTP

Table 1 Unit Process Design Criteria

Process	Description	
Screen		
Type	6 mm Step Screen	Manually cleaned coarse bar rack
Number	1	1
Capacity	6,000 m^3/d	>12,000 m^3/d
Grit Removal		
Type	Aerated grit tank	
Number	1	
Dimensions	3.05 m by 2.74 m by 3.05 m SWD	
Volume	25.5 m^3	
Aeration Tanks		
Number	2	
Dimensions	24.7 m by 12.2 m x 3.96 m SWD	
Total Volume	2,388 m^3	
Oxygenation		
Type	Mechanical Surface Aerator	Self-aspirating jet type
Number	4	2
Size	7.5 kW each	22 kW
Phosphorus Removal		
Storage Tank	1 – 27.3 m^3 storage tank	
Chemical Pumps	1 – 0.2 kW chemical feed pump	
Secondary Clarifiers		
Type	Square with circular scraper	
Dimensions	12.2 m x 12.2 m x 3.0 m SWD	
Total Surface Area	288 m^2	
RAS Pumping		
Number	2 (1 duty/1 standby)	
Capacity	3,273 m^3/d @ 7.6 m TDH	
Equalization/Surge Tank		
Number	1	
Dimensions	18.3 m by 15.2 m by 1.83 m deep	
Volume	510 m^3	
Tertiary Filtration		
Type	Travelling Bridge Sand Filter	
Number	1	
Dimensions	11.58 m x 2.74 m	
Surface Area	31.8 m^2	
UV Disinfection		
Type	Low pressure, low intensity	
Number of Lamps	40	
UV Output	26 W per lamp (1040 W total)	
Sludge Holding Tanks		
Number	2	
Dimensions	22.25 m by 4.88 m by 3.05 m SWD	
Total Volume	312 m^3	
Aeration Type	Coarse bubble sparger	
Blower Size	Two (2) 15 kW blowers rated at 9.46 L/s each	
Emergency Storage Lagoon (East)	126,540 m^3	
Sludge Stabilization Lagoon (West)	88,200 m^3	

2.2 RAW WASTEWATER FLOWS AND LOADINGS

The recent average raw wastewater flow data for the Petrolia WWTP for the period from 2008 to 2010 are presented in Table 2. The 3 year average flow was 3,028 m^3/d or 80% of the Certificate of Approval rated capacity. Higher monthly flows have been experience, for example, in 2010, average flow in 3 months exceeded 84% of the rated capacity.

Table 2 Historic Plant Flow (2008 to 2010)

Parameter	Value
Average	3,027 m^3/d
Peak Day	11,590 m^3/d

The peak day flow of 11,590 m^3/d was extreme and occurred on only one occasion. For the purpose of assessing the capacity of the Petrolia WWTP for this report, a typical peak day flow factor of 2.5 was used. Peak instantaneous flow data are not recorded at the plant and therefore, this assessment was based on a typical peak instantaneous flow factor of 4.0.

Raw wastewater concentrations for 2009 are summarized in Table 3. Concentrations are typical of a medium strength domestic wastewater.

Table 3 Historic Average Raw Wastewater Concentrations and Loadings (2009)

Parameter	Concentration (mg/L)	Loading (kg/d)
BOD_5	237	702
TSS	209	619
TKN	38.3	114
TP	6.0	18

2.3 EFFLUENT QUALITY

Effluent quality data for the period of 2009 to 2010 are presented in Table 4. The Petrolia WWTP has consistently produced excellent effluent quality; well below effluent compliance requirements. During one single month, the plant slightly exceeded the effluent objective for BOD_5 and TP.

Table 4 Historic Effluent Quality (2009-2010)

Parameter	Average	Peak Month	Effluent Objective	Effluent Compliance
BOD5	1.9 mg/L	6.8 mg/L	5 mg/L	10 mg/L
TSS	0.7 mg/L	1.3 mg/L	5 mg/L	10 mg/L
NH3-N				
May 1 – Nov. 30	0.19 mg/L	0.41 mg/L	2 mg/L	3 mg/L
Dec. 1 – Apr. 30	0.30 mg/L	1.15 mg/L	5 mg/L	7 mg/L
TP	0.49 mg/L	0.63 mg/L	0.5 mg/L	1.0 mg/L

3. STRUCTURAL/ARCHITECTURAL CONDITION ASSESSMENT

A visual structural inspection of the Petrolia WWTP was undertaken on April 26, 2011. The following points outline structural and architectural deficiencies noted, and rehabilitation requirements:

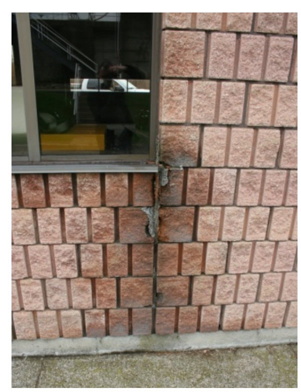
- The concrete sewage tankage structure that sits at least partially above grade at the rear of the facility is in fair condition. The concrete material itself appears in fair to good condition and should last many more years if maintained. Due to its above grade exposure to the sun, wind and cold during the winter months, the tank has experienced expected thermal expansion and contraction cracks; some of which are visibly leaking. These cracks require repair through polyurethane injection, epoxy injection or routed and sealed with a flexible caulking.

Aeration Tank Cracks and Leaking

- The caulking in all of the expansion and control joints in the tankage has failed and requires replacement.
- The stairs from the top level of the tank exiting to grade at the rear of the tankage do not meet minimum code requirements for width or load resistance, and require replacement.
- The aluminum handrails at the front stairs to the aeration tanks should be modified to meet minimum building code requirements for access.

Non-code Compliant RearAccess Stairs

- The galvanized steel garage shed fixed to the side of the tanks requires localized cleaning and touch-ups in spots where it is beginning to rust, especially around the door frame. Also, along the side of the garage, sludge has built up along the base, which could damage the steel and accelerate the aging of the structure.
- The top steel riser on the manhole towards the front of the sewage tanks is not secured and poses a safety risk.
- Water is entering the wall cavity around the perimeter of the administration building, and bleeding through to the exterior around many doors and windows. This has caused localized spalling of the exposed split face concrete block during freeze thaw cycles during the winter and spring. The source of this water issue needs to be located and repaired to avoid further damage to the exterior block work. Localized repair to the block, as attempted previously, will not stop the issue from reoccurring. It is possible that a failed roof membrane has caused this issue, and the building may require a roofing replacement.



Leaking and Brick Spalling in Administration Building

4. PROCESS CONDITION ASSESSMENT AND PROCESS CAPACITY EVALUATION

4.1 INTRODUCTION

A visual inspection of process equipment was undertaken on August 11, 2011. During the inspection, CIMA staff discussed unit process operation with plant operating staff. Representative plant operating data for 2008 to 2010 were collected during the site visit to assist in the unit process evaluation.

4.2 HEADWORKS

The existing mechanically cleaned step-screen is located outdoors within a plywood enclosure to help protect against the elements and freezing. Screenings are manually removed from an elevated platform by plant staff. The screen has a rated peak capacity of 6,000 m^3/d, which is less than peak flows experienced at the plant. As a result, the screen is regularly hydraulically limited and bypassed. This has resulted in a significant accumulation of screenings downstream processes, that have resulted in plugging and maintenance issues.

The aerated grit tank is 25.5 m^3 in volume, providing a detention time of 2.4 minutes at peak design flow. This is at the low end of the Design Guideline (MOE, 2008) range of 2 to 5 minutes for aerated grit tanks. The grit tank also has a very low length to width ratio of 1.1 and does not have any inlet or outlet baffling. These factors together cause short-circuiting and poor grit collection. In addition, the existing air lift mechanism for grit removal from the bottom of the tank is broken and not functioning. Plant staff noted significant downstream grit accumulation in the aeration tanks.

A properly functioning headworks facility is essential to improve downstream equipment reliability and minimize maintenance. Due to the screening capacity limitations and poor grit tank design, upgrades to headworks would not be considered to provide a reliable solution, and therefore, a new headworks facility the recommended upgrade approach for the Petrolia WWTP. This facility would incorporate screening and grit removal capacity for the full range of flows encountered at the facility, and would include screenings and grit handling systems.

4.3 SECONDARY TREATMENT

4.3.1 Overview

A capacity assessment of the extended aeration process components is presented in this section, as well as a physical condition assessment of the process equipment, including oxygenation equipment, return sludge pumping system and clarifier equipment.

4.3.2 Aeration

The capacity of the aeration tanks was assessed to confirm that it can operate effectively to achieve removal of BOD and provide full nitrification on a year round basis, to meet ammonia objectives in the Certificate of Approval.

Table 5 presents aeration tank operating parameters compared to MOE Design Guidelines.

Table 5 Aeration Tank Operating Parameters

Parameter	Historic (2008-2010)	Rated Capacity	MOE Design Guideline (2008)
HRT (h)	18.9	15	15
BOD_5 VLR (kg/m^3.d)	0.30	0.38	0.17-0.24
MLSS (mg/L)[1]	3,500	3,500	3,000-5,000
F:M (gBOD/gVSS.d)[2]	0.13	0.17	0.05-0.15
SRT (days)[3]	11.7	9.3	>15 days

Note:

1. Upper end of typical operating range of 2,500 to 3,500 mg/L reported by plant operator.
2. Based on a typical MLVSS/MLSS ratio of 0.65 in an extended aeration facility.
3. Based on a sludge yield of 1 gTSS per $gBOD_5$ with chemical addition for phosphorus removal.

Using a mixed liquor concentration at the high end of the normal operating range, a solids retention time (SRT) of 12 days would be provided at current average flows and 9 days would be provided at the design capacity. These values compare to a minimum of 15 days recommended by the MOE Design Guidelines.

As demonstrated through historical plant performance, a 12 day SRT is sufficient to achieve a high level of year-round nitrification. However, as the plant flows increase, or during high flow periods, the operating SRT will shorten, increasing the risk non-compliance with respect to ammonia during the winter months.

Estimation of the upgrade costs for the Petrolia WWTP to reliably achieve effluent ammonia limits at design flow was based on the construction of one additional aeration tank, similar in size to the existing tanks.

4.3.3 Oxygenation

Oxygen is supplied to the aeration tanks using a combination of mechanical aerators and self-aspirating jet aerators, the latter which were added to supplement air to the tanks to meet demand that could not be provided by the mechanical aerators alone. The mechanical aerators are almost 35 years old and are operating beyond their normal service life. Due to the age of this equipment, it is difficult to obtain repair parts and there is a risk of long out-of-service periods if repair is required. During these periods, there would not be adequate oxygenation capacity to achieve nitrification requirements.

Existing Mechanical Aerators

Table 6 presents the oxygen demand and oxygenation capacity of the Petrolia WWTP. Oxygenation capacity is slightly less than required to meet historic peak oxygen demands. As the plant approaches design flow, there is a risk that there will not be sufficient oxygen to provide complete nitrification during peak loading periods, resulting in ammonia breakthrough and a risk of exceeded effluent ammonia concentration objectives.

Table 6 Oxygenation Capacity

Parameter	Historic (2008-2010)	Rated Capacity	Oxygenation Capacity[3]
Oxygen Demand			
Average[1]	67 kg/h	84 kg/h	
Peak[2]	100 kg/h	125 kg/h	88 kg/h

Note:
1. Based on 1.5 times influent BOD load plus 4.5 times influent TKN load.
2. Based on typical peak factor of 1.5 times the average load to accommodate diurnal and daily loading fluctuations.
3. Based on a typical field transfer efficiency of 1.2 kg O_2/kWh for mechanical aerators and self-aspirating jet aerators.

In consideration of the age and capacity limitations of the mechanical aerators, for the purposes of estimating the cost up upgrading requirements for the Petrolia WWTP, a new fine bubble diffused aeration system would be recommended to replace the oxygenation equipment.

4.3.4 Secondary Clarification

Mixed liquor from the aeration tanks is settled in two (2) square secondary clarifiers. The existing clarifier sludge collection mechanisms are in poor condition and the scum collectors have completely corroded and are not functional.

Corroded Clarifier Mechanism

The existing RAS pumps are almost 35 years old and buried RAS piping is corroded. The Town recently had to complete emergency repairs to stop a leak in the buried RAS piping, which resulted in bypass of the treatment process for several days.

Corroded RAS Piping

Plant staff have observed carryover of solids from the secondary clarifier and biosolids accumulation in the downstream surge tank. In addition, under peak flow conditions the level in the aeration tanks can raise significantly due to a hydraulic bottleneck in the influent to the secondary clarifiers.

Table 7 summarizes secondary clarifier process operating parameters. The existing clarifiers provide adequate surface area for the plant design flow. Typically square clarifiers do not perform as well as circular or rectangular units, and therefore, additional clarifier capacity may be required to reliably achieve good secondary effluent quality to avoid impacts on downstream filters

Table 7 Secondary Clarifier Operating Parameters

Parameter	Historic (2008-2010)	Rated Capacity	MOE Design Guideline (2008)
Peak SOR ($m^3/m^2.d$)[1]	36	45	40
Peak SLR ($kg/m^2.d$)[2]	125	162	170
RAS Rate (% average flow)	108%	100%	50-200%

Note:
1. Based on peak instantaneous flow factor of 4.0.
2. Based on peak day flow factor of 2.5 with RAS rate equivalent to 100% of average flow and 3,500 mg/L mixed liquor concentration.

For the purposes of developing costs for upgrading the existing plant, a new secondary clarifier is recommended to address performance limitations and hydraulic bottlenecks. Replacement of the existing sludge and scum collection mechanisms is also included, as well as replacement of the existing RAS pumps and piping system.

4.4 TERTIARY FILTRATION

The existing single travelling bridge sand filter and mechanism is almost 35 years old and operating beyond its normal service life.

Secondary effluent flows to a 510 m^3 surge tank upstream of the filter. The discharge pipe from the surge tank is sized to help to buffer peak flow to the filter. An evaluation of filter capacity was based on the surge tank buffering peak hourly flows, so that the peak flow to the filter would not exceed the peak day flow.

Tertiary filter process operating parameters are presented in Table 8, based on a secondary effluent TSS concentration of 15 mg/L. As shown, the hydraulic loading rate at existing and rated capacity exceeds the MOE Design Guideline.

Table 8 Tertiary Filter Operating Parameters

Parameter	Historic (2008-2010)	Rated Capacity	MOE Design Guideline (2008)
Peak Hydraulic Loading Rate ($L/m^2.s$)	2.8	3.5	2.1
Peak Solids Loading Rate ($mg/m^2.s$)	41	52	51

Due to the high hydraulic loading rate to the filter, and the age and risk to service due to maintenance, the upgrade needs are based on replacement the existing filter with a larger unit. There is potential to retrofit the existing filter with a newer cloth media type filter within the existing filter tank and building, which could provide up to double the filtration area in the same footprint. This lower cost alternative would be investigated during a later pre-design phase of the upgrades..

4.5 UV DISINFECTION

The existing UV disinfection system was installed in 1995 and is in good overall condition. This system has adequate capacity to disinfection peak design flow to the Petrolia WWTP.

4.6 SLUDGE HANDLING

There are two sludge holding tanks used to aerate and partially stabilize sludge before it is transferred to the stabilization and storage lagoon. These tanks are equipped with aeration systems consisting of coarse bubble spargers fed by two blowers. A large portion of the aeration system is either broken, corroded or seized and requires replacement.

4.7 PHOSPHORUS REMOVAL

The phosphorus removal system consists of an outdoor chemical storage tank feeding a single chemical feed pump. The storage tank is surrounded by a concrete secondary containment area.

The chemical pump is located in a dedicated room within the administration building.

To provide adequate pump capacity over the full range of plant flows, and to provide standby capacity, upgrade costs to the Petrolia WWTP were based on replacing the existing pump with two (2) new pumps (duty/stand-by) with a larger operating range and turn-down capacity. In addition, to bring the room up to current standards, upgrades including provision of a secondary containment area to capture any chemical spills from chemical panel leaks or a broken pump suction or discharge line.

4.8 ELECTRICAL AND CONTROL SYSTEMS

Power supply to all unit processes is from a single MCC located in the administration building. The MCC is almost 35 years old and a number of the operating buttons (reset, etc.) on the front of the MCC no longer function, requiring staff to remove protective covers and manually reset equipment adjacent to live 600 V power.

There is no provision for stand-by power at the Petrolia WWTP. Stand-by power should be provided for critical unit processes such as the headworks and UV disinfection to ensure hydraulic capacity and disinfection is provided during any power outage.

To address safety concerns and ensure long-term reliability of the electrical distribution equipment, upgrade costs were based on a new MCC and a new standby power facility.

Most equipment is manually controlled at the Petrolia WWTP with auto-dialer call-out of critical alarms. A new automation and SCADA system is included with the estimate of upgrade costs to allow staff to better monitor and control all unit processes within the plant.

5. ESTIMATED COST TO UPGRADE PETROLIA WWTP

Overall, the Petrolia WWTP is in fair condition, considering the age of most equipment in the facility. However, a number of components are operating beyond the end of their service life and some processes do not have adequate process capacity for the design flow, introducing a risk to performance during peak flow periods. In addition, there it will be difficult to find replacement parts for many of the major process components due to their age, so equipment failure could result in long out-of-service periods that would reduce the treatment effectiveness, potentially significantly.

The Petrolia WWTP upgrading project will be developed in consideration of the plant capacity needs, to be determined though a Schedule C Class EA study that will be initiated in fall 2011. However, for the purposes of developing a capital cost that reflects the investment required into the existing infrastructure to reliably achieve performance and comply with current standards, a program of plant upgrading needs was developed based on upgrading the plant at the existing Certificate of Approval rated capacity.

Table 9 presents a list of the major deficiencies, upgrade requirements and estimated capacity capital costs for upgrading the existing Petrolia WWTP. The total estimate cost to upgrade the plant to address deficiencies is $12.8 million.

Table 9 Estimated Capacity Cost to Address Deficiencies at Petrolia WWTP

Item	Deficiency	Upgrade Basis	Estimated Capital Cost
Structural Refurbishment	• Aeration tank stair do not meet code • Minor leaks/spalling in concrete	• Replace aeration tank stairs • Repair concrete spalling, leaks, handrails	$250,000
Headworks	• Inadequate capacity • Significant rag accumulation in downstream processes • Ineffective grit removal and grit accumulation in aeration tanks	• New headworks with screening and grit removal sized for peak design flow	$2,700,000
Aeration	• Insufficient volume for ammonia removal at design flow	• One (1) new aeration tank	$1,500,000
Oxygenation	• Mechanical aerators operating beyond normal life • Insufficient capacity • Technology is not energy efficient	• New energy efficient fine bubble aeration system	$1,800,000
Secondary Clarifier	• Existing equipment is broken and corroded • RAS pumps and piping are over 30 years old • There is a hydraulic bottleneck	• One (1) new secondary clarifier • New clarifier mechanisms in existing clarifiers • New RAS system	$1,125,000
Tertiary Filtration	• Insufficient capacity for peak flow • Filters are operating beyond normal life	• Replace and expand to provide for rate capacity	$3,975,000
Biosolids Handling	• Diffusers broken and valves seized • Blowers over 30 years old	• Replace blowers, diffusers, valves and piping	$375,000
Phosphorus Removal	• Only one chemical metering pump • No secondary containment in metering pump room	• New chemical pump panel and containment	$100,000
Electrical and Controls	• MCC over 30 years old and requires dangerous access to reset equipment • No stand-by power for critical systems • No automation or SCADA controls	• Replace existing MCC • Provide stand-by power for critical systems • Automation and SCADA system for process control of key equipment	$975,000
Total			**$12,800,000**

Note:
1. All capital costs include a 35% contingency and 15% for engineering.