Appendix C: Environmental and Geomorphological Baseline Summary Report

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OAKVILLE WATER PURIFICATION PLANT

ENVIRONMENTAL AND GEOMORPHOLOGICAL BASELINE SUMMARY REPORT

prepared for

HALTON REGION

on behalf of

exp SERVICES INC.

by

LGL LIMITED
environmental research associates

CHD

OCTOBER 2014

LGL PROJECT TATA8469-00

OAKVILLE WATER PURIFICATION PLANT

ENVIRONMENTAL AND GEOMORPHOLOGICAL BASELINE SUMMARY REPORT

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ABBREVIATIONS AND DEFINITIONS

CH – Conservation Halton

DFO – Department of Fisheries and Oceans Canada

EA – Environmental Assessment

ELC – Ecological Land Classification

LIO – Lands Information Ontario database, maintained by the Ministry of Natural Resources and Forestry

MNRF– Ministry of Natural Resources and Forestry

NHIC – Natural Heritage Information Centre Biodiversity database, maintained by the Ministry of Natural Resources and Forestry

1.0 INTRODUCTION

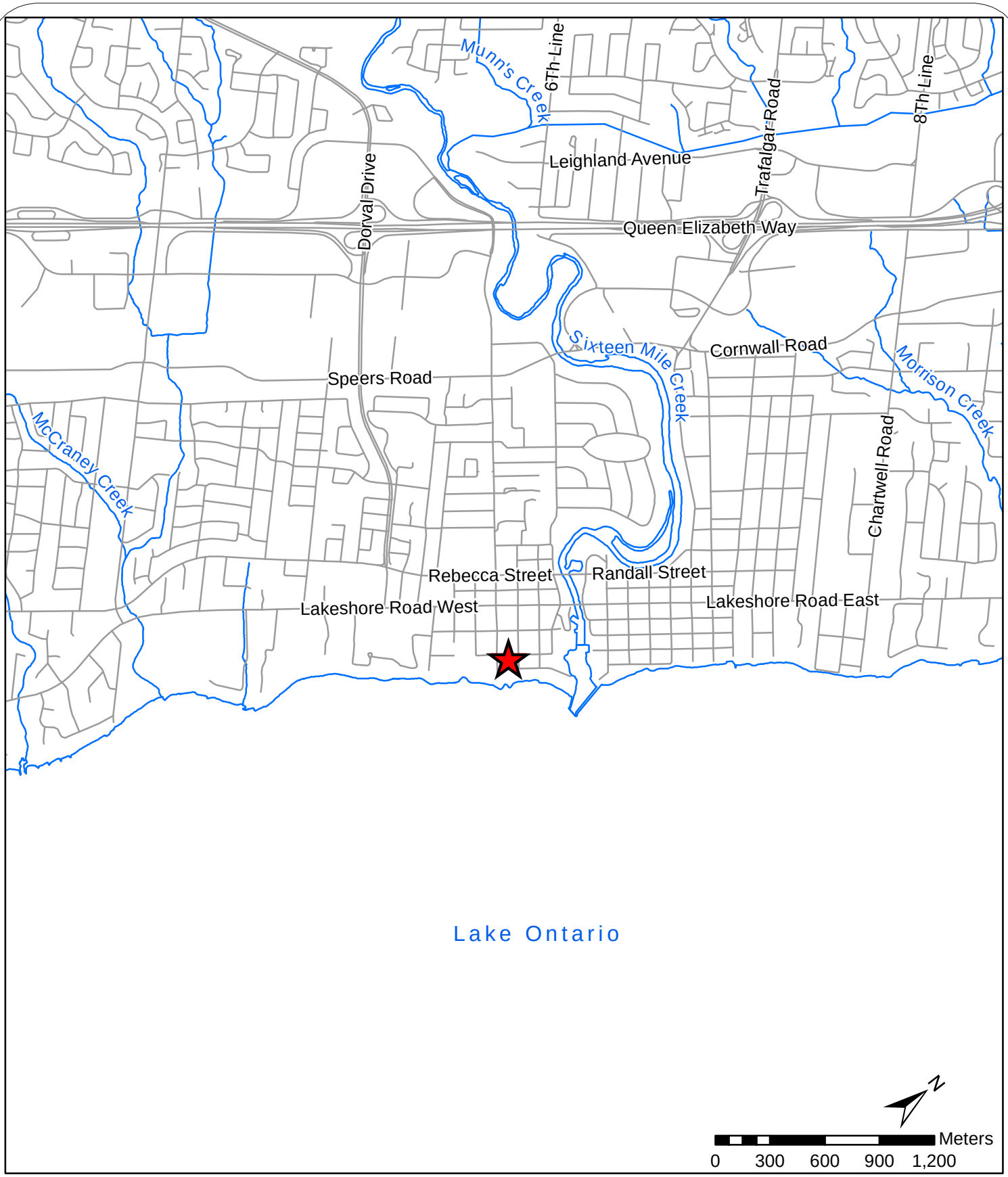
The Region of Halton (Region) has initiated a Schedule B Municipal Class Environmental Assessment (EA) for the re-rating of the Oakville Water Purification Plant. The Region has identified the need for increased capacity at the plant in the Sustainable Halton Water and Wastewater Master Plan, and is seeking to have the WPP officially re-rated from 109 ML/d to 130 ML/d. The need to extend the intake pipe further into Lake Ontario, in order to address the issue of elevated turbidity as it relates to high volumes of sediment discharged into the lake through the mouth of Sixteen Mile Creek after periods of heavy rainfall, is also under consideration.

LGL Limited has been retained by exp Services Inc. on behalf of the Region to conduct a desktop review of conditions within the WPP site on Kerr Street in Oakville and up to 3km offshore into Lake Ontario to characterize the natural environment. This effort, as documented in Section 2.0, is intended to describe existing conditions to provide a general inventory of natural heritage features and identify constraints for consideration in the development and evaluation of alternatives for the project.

In addition, GHD is undertaking an assessment of the sediment plume dispersion from Sixteen Mile Creek which periodically impacts the turbidity levels at the intake. Delineation of the plume will inform the development of alternative alignments for possible extension of the intake pipe. The Sixteen Mile Creek plume assessment appears as Section 3.0.

1.1 SITE LOCATION

The WPP is located along the Lake Ontario shoreline within a residential neighbourhood along the Oakville waterfront (**Figure 1**). The area includes a portion of the waterfront trail and associated parklands, including Burnett Park which borders the WPP property. Mature trees are associated with the parklands and residential property adjacent to the WPP. Plant infrastructure also includes an intake pipe in Lake Ontario that extends approximately 880 m offshore in a southeast direction. The mouth of Sixteen Mile Creek is also located within approximately 900 m of the intake pipe and 400m northeast of the WPP site itself.



Oakville Water Purification Plant Upgrade

Key Map

★ Oakville Water Purification Plant

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Project	TA8469	Figure	1
Date	September, 2014	Prepared By	KC
Scale	1:28,000	Verified By	LKR

2.0 EXISTING CONDITIONS – ENVIRONMENTAL

Documentation of existing conditions included a desktop assessment of orthoimagery and a review of background data from secondary sources to establish natural heritage conditions within the area. The review of existing background documentation and data layers, including the following resources:

- Site orthophotography;
- GIS data layers obtained from the Ministry of Natural Resources (MNRF), Lands Information Ontario (LIO), and Conservation Halton (CH);
- The Natural Heritage Information Centre (NHIC) database;
- Town of Oakville Official Plan;
- Background watershed and subwatershed studies;
- Agency consultation with MNRF;
- Mapping of physiography and soils; and,
- Online wildlife atlases and databases (reptiles, birds, species at risk).

Secondary source information was compiled and analyzed in order to develop a general description of the terrestrial and aquatic ecosystems, vegetation and wildlife within the study area. In addition, MNRF and CH were consulted to confirm information collected and/or to provide additional information regarding the natural heritage system and potential species at risk in the study area.

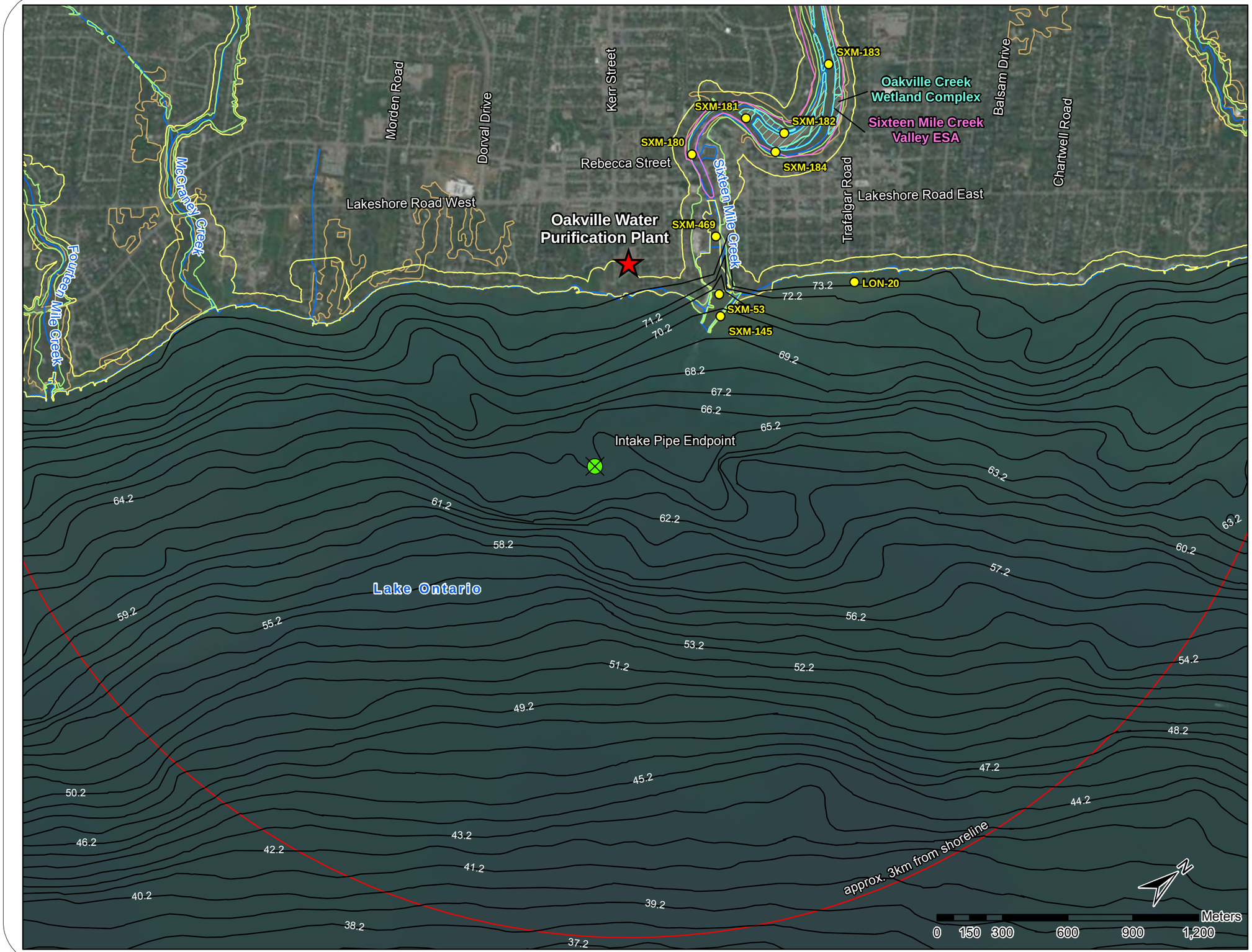
The study area was screened for significant natural areas in the form of significant wetlands, valleylands and woodlands, and Environmentally Significant Areas (ESA) as identified in the Official Plan for the City of Oakville. As well, agency resources were used to screen the area for Areas of Natural and Scientific Interest (ANSI), provincially significant wetlands (PSW), and waterbodies using data layers available from CH and MNRF.

The following subsections summarize the information obtained for the study area pertaining to natural environment.

2.1 DESIGNATED NATURAL AREAS

2.1.1 Areas of Natural and Scientific Interest (ANSI)

Areas of Natural and Scientific Interest (ANSI) are determined by the MNRF. Records contained within the MNRF LIO database did not indicate the presence of any provincially significant Life Science or Earth Science ANSIs within, or in close proximity to the study area (**Figure 2**).



LEGEND

- Oakville Water Purification Plant
- Endpoint of Intake Pipe (approximate)
- Fish Station (Conservation Halton)
- Environmentally Sensitive Area (Region of Halton)
- Regulation Limit (Region of Halton)
- Floodplain (Region of Halton)
- Evaluated Wetland (LIO)
- Wooded Area (LIO)
- Wtercourse (LIO)
- Waterbody (LIO)
- Bathymetric Contours (NOAA)

Oakville Water Purification Plant Upgrade

Natural Features

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Project	TA8469-00	**Figure**	2
Date	September, 2014	**Prepared By:**	KC
Scale	1:17,000	**Verified By:**	LKR

2.1.2 Wetlands

Wetland features were largely identified using GIS data layers available for the Study Area and provided by MNRF (through LIO) and GRCA as shown on **Figure 2**. Three types of wetland features can be identified through this process: provincially significant wetlands (PSW); unevaluated wetlands; and, other wetlands. PSWs are those for which an evaluation, according to the Ontario Wetland Evaluation System (OWES), has resulted in a score sufficient to qualify as a provincially significant feature. PSWs are identified by MNRF. Unevaluated wetlands have not undergone an OWES evaluation; while, those presented as evaluated wetlands are features where an OWES evaluation has determined them to be non-provincially significant.

Wetlands identified in proximity to the project area were restricted to one evaluated wetland: the Oakville Creek Wetland Complex. This feature is described by MNRF as a non-provincially significant, coastal wetland complex, made up of three individual wetlands, composed of two wetland types (27% swamp and 73% marsh). The wetland is associated with Sixteen Mile Creek and located approximately 700m from the WPP site (**Figure 2**).

2.1.3 Environmentally Sensitive Areas (ESA)

Within the Town's natural heritage system there are natural areas which are particularly significant or sensitive, and have been identified to warrant additional protection to preserve their environmental qualities. These areas are referred to as Environmentally Sensitive Areas (ESAs) in the Town's Official Plan. Sixteen Mile Creek is associated with one such ESA, namely the Sixteen Mile Creek Valley ESA (**Figure 3**). The ESA is described as an incised valley with a shale-walled gorge in its central and lower reaches (Halton Region and North - South Environmental Inc. 2005). The ravine is described as well-wooded with high quality deciduous and mixed forests of maple, oak, hickory, birch, hemlock and eastern white cedar. Also mentioned within the ESA report is that the site has been documented by Varga and Allen (1990) as one of the top botanical sites within the Region, with close to 400 vascular plant species identified. Animal species recorded in the ESA include 10 herptile species, 11 insects, 33 fish, 14 mammals, and 11 species of breeding birds. The ESA report also documents this location as a Regionally Significant Life Science ANSI.

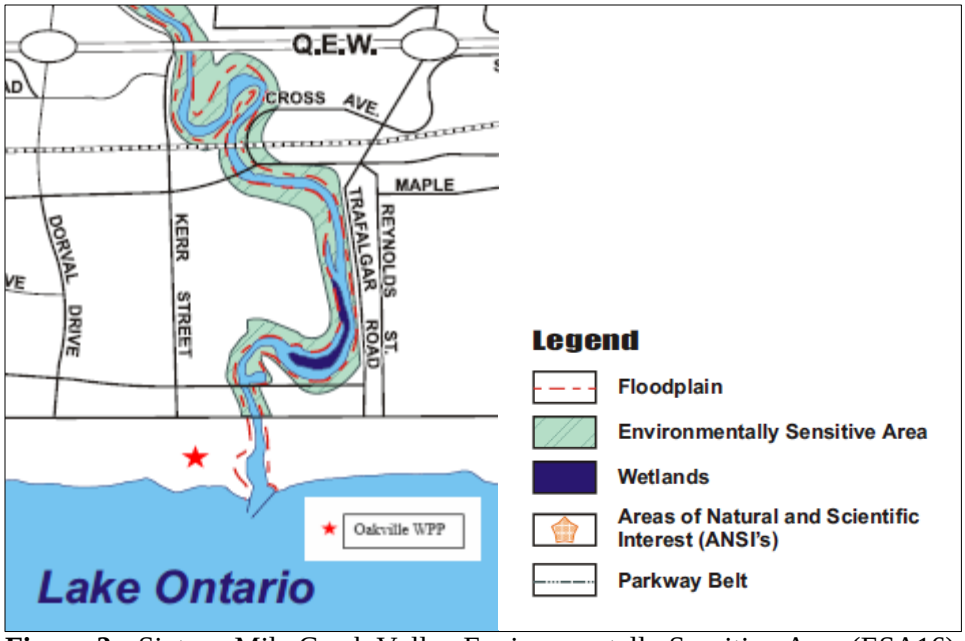

Figure 3: Sixteen Mile Creek Valley Environmentally Sensitive Area (ESA16) includes a portion of the creek and associated valleylands north of Lakeshore Road.

2.1.4 Natural Corridors

Natural corridors in the study area were considered to include areas designated as Natural Areas within the Town of Oakville's Official Plan to include rivers and streams, forests and other natural features. Lands designated Natural Area may contain one or more of the following natural features together with required buffers:

a) significant habitat of endangered species and threatened species;

b) wetlands;

c) woodlands;

d) valleylands;

e) significant wildlife habitat; Environmentally Sensitive Areas;

g) areas of natural and scientific interest;

h) fish habitat; or,

i) natural corridors.

Schedule B, Natural Features and Hazard Lands, indicates the general locations of the known natural features within the Natural Area designation in vicinity of the Project as shown below in **Figure 4**.

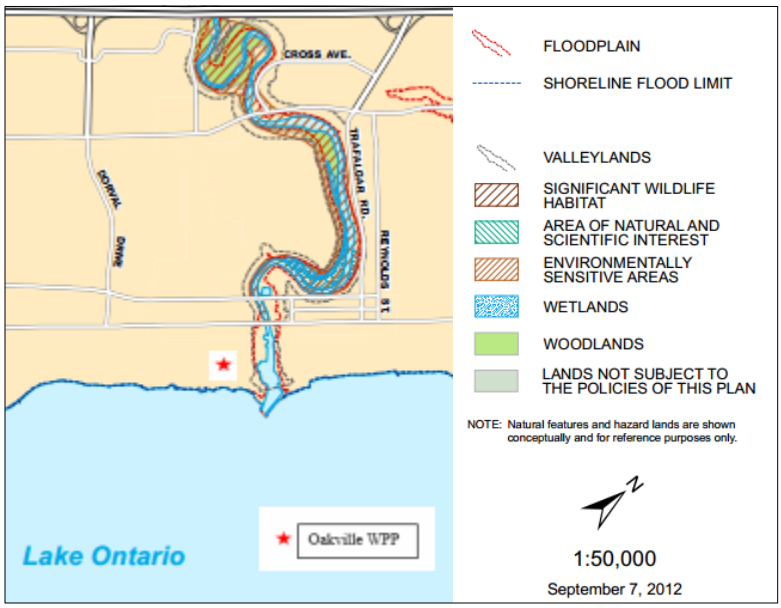

Figure 4: Natural Areas identified in the Town of Oakville's Official Plan (2012), Schedule B.

Natural Areas in the vicinity of the Oakville WPP are restricted to those associated with the Sixteen Mile Creek Valley. The Sixteen Mile Creek Valley ESA is described as a sheltered and continuous feature allowing for the movement of wildlife species, such as white-tailed deer (*Odocoileus virginianus*) and red fox (*Vulpes vulpes*), and likely important to the migration of birds (Halton Region and North - South Environmental Inc. 2005). The creek is also documented within the ESA report as important to fish migration.

2.2 VEGETATION AND VEGETATION COMMUNITIES

Background GIS layers as available from Conservation Halton (CH) and displayed in **Appendix A Figure 1** were used to describe the vegetation communities in the area.

2.2.1 Vegetation Communities

Available data to document conditions as they relate to vegetation was restricted to Sixteen Mile Creek in the area of the Oakville Creek Wetland Complex (**Appendix A, Figure 1**). Ecological Land Classification (ELC) data indicated the presence of deciduous forest (FOD), meadow marsh (MAM), deciduous swamp (SWD) and culturally influenced communities of meadow (CUM) and woodland (CUW).

2.2.2 Rare Species and Species at Risk

In order to determine the potential for rare species to occur within the project area a review of MNRF's NHIC Biodiversity Explorer database was conducted, the MNRF Aurora District office was consulted and background reports, data layers and available mapping were screened for records of rare species.

A preliminary desktop search for rare species using the NHIC Biodiversity Explorer database for a 25 km^2 area that included the project area (**Appendix A, Figure 3**), revealed records for Virginia Lungwort (*Mertensia virginica*) and Northern Hawthorn (*Crataegus pruinosa var. dissona*) from 1982. These species are designated as S3 species provincially to indicate that they are vulnerable, with relatively few populations (often 80 or fewer) recorded. No records of flora species listed on the Species at Risk in Ontario (SARO) list were included in the data obtained through the Biodiversity search.

LGL Limited contacted MNRF (Aurora District Office) to request additional information pertaining to Species at Risk (SAR) to supplement SAR records obtained from the NHIC database. The response received from MNRF did not indicate records for plant SAR in the project area (**Appendix D**).

2.3 WILDLIFE AND WILDLIFE HABITAT

Background GIS layers were requested from Conservation Halton (CH) to include any available data pertaining to wildlife records on September 16, 2014. At the time of reporting a response from CH had not yet been received.

2.3.1 Wildlife Habitat

As shown in Section 2.1.4, Schedule B of the Town's Official Plan displays areas designated as Natural Areas to include those determined to be Significant Wildlife Habitat. No areas of significant wildlife habitat as determined by the official plan are shown to occur in the area of the Oakville WPP site or the mouth of Sixteen Mile Creek (**Figure 4**). Of note however, is that the valley system does function as a wildlife corridor as documented in the ESA Report for Sixteen Mile Creek Valley ESA (Halton Region and North - South Environmental Inc. 2005).

2.3.2 Fauna

Background GIS layers were requested from Conservation Halton (CH) to include any available data pertaining to fauna on September 16, 2014. At the time of reporting a response from CH had not yet been received.

2.3.3 Species at Risk

In order to determine the potential for rare species to occur within the project area a review of MNRF's NHIC Biodiversity Explorer database was conducted, the MNRF Aurora District office was consulted and background reports, data layers and available mapping were screened for records of rare species.

A preliminary desktop search for rare species using the NHIC Biodiversity Explorer database for a 25 km^2 area that included the project area (**Appendix A, Figure 3**), revealed records for wildlife species as shown in **Table 1**. The last known record for Northern Bobwhite in the search area was from 1904, such that the species is considered extirpated from the area. The remaining two SAR listed in **Table 1** are designated as Special Concern.

Table 1: Records for wildlife Species at Risk obtained through NHIC Biodiversity Explorer (for the area shown in Appendix A).

Common Name	Scientific Name	S Rank	COSEWIC	MNR Status	Extirpated
Northern Bobwhite	*Colinus virginianus*	S1	END	END	Y
Northern Map Turtle	*Graptemys geographica*	S3	SC	SC	N
Snapping Turtle	*Chelydra serpentina*	S3	SC	SC	N

LGL Limited contacted MNRF (Aurora District Office) to request additional information pertaining to Species at Risk (SAR) to supplement SAR records obtained from the NHIC database. The response received from MNRF indicated that Black Tern (SC), Northern Map Turtle (SC) and Snapping Turtle (SC) have the potential to occur in the study area (**Appendix D**).

2.4 AQUATIC HABITAT

2.4.1 Regulated Areas – Conservation Halton

Regulated areas have been identified to direct the development or alteration of land within a floodplain where activities could be subject to flooding or erosion. The regulation that governs these areas is the Regulation of Development, Interference with Wetlands and Alterations to Shorelines and Watercourses (Ontario Regulation 166/06). The Regulation Limit (Conservation Halton) is shown in **Figure 2** to include portions of the Oakville WPP site, the adjacent waterfront and Sixteen Mile Creek. Any works conducted within these limits will require consultation with the Conservation Authority.

The portion of Lake Ontario in proximity to the intake pipe for the WPP is also included within the Source Water intake Protection Zone as shown in **Figure 5**.

Figure 5: Source Water Protection Zone (in red) established for the Oakville WPP water intake pipe in Lake Ontario.

2.4.2 Sixteen Mile Creek

The project area is located within the Main Branch of the Sixteen Mile Creek watershed as illustrated in **Figure 6**.

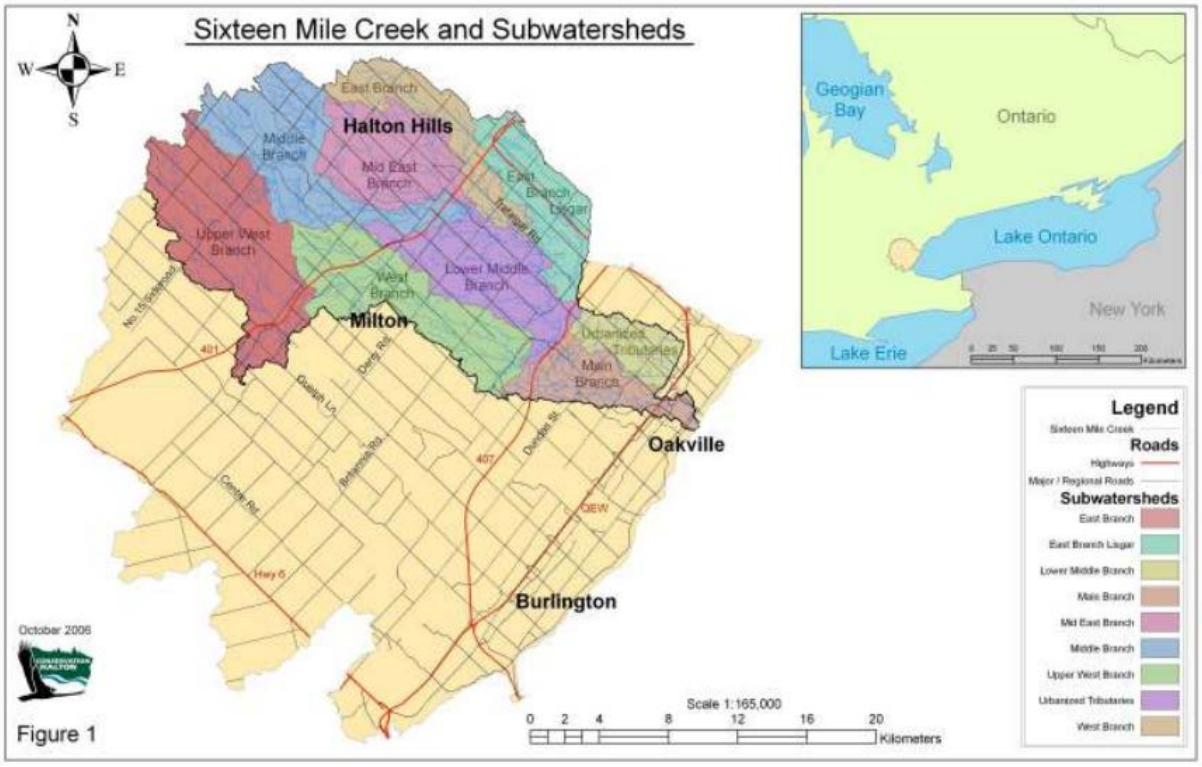

Figure 6: Sixteen Mile Creek Watershed.

Sixteen Mile Creek is the largest watershed within the Conservation Halton jurisdiction, draining approximately 372 km^2 across the Regional Municipality of Halton and the City of Mississauga. The main branches of the creek are formed in the wetlands and forested swamps of the Niagara Escarpment and flow approximately 150 km southward through natural, rural, urban and agricultural lands. While the creek is described in further detail with regard to its geology and impact on suspended sediment concentrations in Lake Ontario in Section 3.0, this section is intended to describe the creek's available aquatic habitat, largely as it relates to fish.

Wadeable aquatic habitats within Sixteen Mile Creek were sampled for fish in 2011 as part of the long-term monitoring efforts conducted by Conservation Halton. A total of 1,859 individuals representing 30 different species were caught in the 2011 survey (**Appendix B, Table 1**). A mix of warmwater forage fish and coldwater sport fish were collected, with Creek Chub (*Semotilus atromaculatus*), Blacknose Dace (*Rhinichthys atratulus*), White Sucker (*Catostomus commersoni*) and Pumpkinseed (*Lepomis gibbosus*) representing the most widely distributed species. The most abundant species collected within the watershed in 2011 were documented as Longnose Dace (*Rhinichthys cataractae*), Blacknose Dace and Creek Chub. The fish records listed in Appendix A include Silver Shiner (*Notropis photogensis*), a species considered Threatened provincially and Special Concern nationally. In the Lower Main Branch of the creek, at the site sampled within a few kilometres of Lake Ontario, diversity of fish species was considered to be high, while overall numbers of fish caught were considered low for the amount of area sampled. This was considered to indicate poor stream productivity and likely reflective of limited diverse habitat in these lower reaches of the creek (Conservation Halton 2013).

Fisheries data specific to the lower reaches of Sixteen Mile Creek was received from Conservation Halton in September 2014. Data includes a total of 21 fish species recorded primarily within the last ten years, to include a mix of warmwater, coolwater, and coldwater species. The data list is provided in **Appendix B, Table 1**.

2.4.3 Lake Ontario

Although Lake Ontario is the smallest of the Great Lakes, it measures approximately 193 km long and 53 km wide, with approximately 1,200 km of shoreline habitat (Conservation Halton 2013). Approximately 90 species of fish have been recorded in the lake to include warmwater, coldwater native and exotic species. In boat electrofishing surveys conducted by Conservation Halton along the shoreline of Lake Ontario within the agency's jurisdiction, more than 600 individual fish were captured, representing 27 different species (**Appendix B, Table 2**). The majority of fish caught were Emerald Shiner (*Notropis athernoides*), Gizzard Shad (*Dorosoma cepedianum*), White Sucker, Brown Trout (*Salmo trutta*) and the invasive Round Goby (*Neogobius melanostomus*). One Silver Shiner (*Notropis photogensis*), a species considered Threatened provincially and Special Concern nationally was caught in the Sixteen Mile Creek harbour. Should any works associated with the project be proposed to occur within, or in close proximity to the lake that are determined to impact fish habitat the Canadian Environmental Assessment Act (CEAA) might be triggered and an Authorization under the Fisheries Act may be necessary.

The Lake Ontario Management Unit (LOMU) describes the overall management goal for the nearshore fish community as the following:

> *To protect, restore and sustain the diversity of the nearshore fish community, with an emphasis on self-sustaining native fishes such as Walleye, Yellow Perch, Lake Sturgeon, Smallmouth Bass, Largemouth Bass, sunfish species, Northern Pike, Muskellunge and American Eel. Walleye provide a stabilizing influence on fish community trophic structure by virtue of its role as top predator. Important prey fish for nearshore predator species include Alewife and Round Goby. Round Goby abundance remains high* (MNRF 2014).

Fisheries data specific to the mouth of Sixteen Mile Creek and the Lake Ontario shoreline was received from Conservation Halton in September 2014. Data includes a total of 28 fish species recorded primarily within the last ten years, to include a mix of warmwater, coolwater, and coldwater species. The data list is provided in **Appendix B, Table 1**.

2.4.4 Species at Risk

To determine the potential for rare species to occur within the project area a review of MNRF's NHIC Biodiversity Explorer database was conducted, the MNRF Aurora District office was consulted and background reports, data layers and available mapping were screened for records of rare species.

The Department of Fisheries and Oceans (DFO) provides conservation authorities with mapping of aquatic species at risk distribution. These maps are publically available online (DFO 2014) and were consulted to screen the study area for aquatic species at risk. The mapping of areas documented for Redside Dace (END both COSEWIC and SARO), American Eel (THR/COSEWIC; END/SARO), Lake Sturgeon (THR both COSEWIC and SARO) and Silver Shiner (SC/Schedule 1; THR/SARO) are collectively displayed in the DFO mapping available for the mouth of Sixteen Mile Creek (**Figure 7**, in orange). No mussel SAR habitat was identified in the mapping available for the study area.

Conservation Authority Fish SAR Listing

Common Name (Population)	Colour
*Spotted Gar	Red
American Eel	Orange
Lake Sturgeon (DU 8 Grt Lakes/Upper St. Lawrence)	Orange
Redside Dace	Orange
Silver Shiner	Orange

Figure 7: DFO distribution map for aquatic SAR in Sixteen Mile Creek, in the area of the Oakville Harbour includes reference to Fish SAR.

A preliminary desktop search for rare species using the NHIC Biodiversity Explorer database for a 25 km^2 area as shown in **Appendix A Figure 3**, revealed records for Redside Dace (*Clinostomus elongates*) and Shortnose Cisco (*Coregonus reighardi*); both of which are listed provincially and federally as Endangered, as shown in **Table 2**. According to NHIC data, the last known record for Shortnose Cisco in the search area was from 1915, such that the species is considered extirpated from the area. The last known record for Redside Dace is dated 1960.

Table 2: Records for Aquatic Species at Risk obtained through NHIC Biodiversity Explorer (for the area shown in **Appendix A Figure 3**).

Common Name	Scientific Name	S Rank	COSEWIC	MNR Status	Extirpated
Redside Dace	*Clinostomus elongatus*	S2	END	END	N
Shortnose Cisco	*Coregonus reighardi*	SH	END	END	Y

LGL Limited contacted MNRF (Aurora District Office) request additional information pertaining to these Species at Risk (SAR) to supplement the information obtained from the NHIC database and to determine if the lower reaches of Sixteen Mile Creek are considered regulated habitat for fish SAR. The response received from MNRF indicated that records for Silver Shiner (*Notropis hudsonius*), a fish species listed provincially and federally as Threatened.

Fish data obtained from background reports and Conservation Halton data layers (**Appendix B**) indicates records for Silver Shiner along the Lake Ontario shoreline. This information is consistent with the information received from MNRF Aurora District in September 2014 and the DFO mapping shown above in **Figure 7**.

3.0 SIXTEEN MILE CREEK PLUME ASSESSMENT

3.1 BASELINE INFORMATION AND DATA GAPS

Sediment plumes within Lake Ontario at the mouths of creeks and rivers are naturally occurring features which are formed due the transport of sediment from the watershed to the lake. Plumes are composed of fine silt and clay which have been transported in suspension within watercourses. Plumes increase in size during large rainfall events due to the increase in the supply of sediment through erosion in the watershed and the increased flow within the creeks and tributaries to carry the sediment.

Sixteen Mile Creek transports a range of sediment sizes from gravel to clay. The coarser material is carried as bedload and is deposited as flow velocities decrease within Oakville Harbour. Silt and clay are transported in suspension and take a longer amount of time to settle to the bed. Most of the sand and a portion of the silt and clay settle out of suspension in the harbour. However, much of the fine silt and clay is transported through the harbour and out into the lake. It is this fine silt and clay which make up the sediment plume. The distribution and concentration of sediment within the plume is mainly determined by: suspended sediment concentrations at the creek mouth; flow within the creek; the temperature difference between the creek and the lake; temperature stratification within the lake; and lake currents.

The concentration of suspended sediment at the mouth of the creek depends on: the amount, intensity, and distribution of rainfall within the watershed as well as seasonal effects such as vegetation, ice and snow cover, and snow melt. Vegetation, ice and snow act to hold sediment in place and decrease the amount of erosion and supply of sediment to the watercourse. Snow melt in the spring increases the volume of flow which in turn is able to entrain and transport more sediment. This is particularly effective during heavy rains in the spring when vegetation has not yet established to stabilize the sediment. Suspended sediment concentrations can also increase due to poor erosion and sediment control practices on construction sites.

While the formation of the Sixteen Mile Creek plume is a largely a natural process, it can cause problems when high suspended sediment concentrations reach the intake for the Oakville Water Purification Plant located approximately 880 m offshore of Kerr Street at a depth of 9.6m. Knowledge of the plume processes including suspended sediment concentrations and distribution is required to assess the potential options to mitigate concentrations at the intake. The following sections summarize the known information on the Sixteen Mile Creek plume and provide an outline of a study to fill the data gaps.

3.1.1 Previous Studies

The following studies were reviewed:

- GHD, 2014. Sediment management study: Oakville and Bronte Harbours. Report prepared for the Town of Oakville, June 2014;
- Bowen, G.S. and Booty, W., 2011. Watershed pollutant load assessments for the Canadian side of the western basin of Lake Ontario: A report prepared for the CTC source protection region. Prepared by TRCA and Environment Canada, June 2011; and,
- Baird, 2009. Assimilative Capacity Study for the Mid-Halton WWTP Phase IV and V Expansion. Report prepared for The Regional Municipality of Halton.

A brief summary of each study is provided below focusing on the information relevant to the plume.

GHD, 2014. Sediment Management Study: Oakville and Bronte Harbours. Report prepared for the Town of Oakville, June 2014

This report summarizes the results of a sediment management study for Oakville Harbour and Bronte Harbours. The study was conducted due to the sediment deposition at the harbours which creates navigational issues within the harbours that impact harbour operation and boater safety. While not directly addressing the sediment plume outside of the harbour, the study contains relevant data and discussion with respect to understanding the dynamics of the plume. The report includes, with respect to Sixteen Mile Creek: an investigation into the sources of sediment for Sixteen Mile Creek; options to reduce sediment supply from the catchment; investigation into the processes of deposition at the harbours; and options to mitigate or manage sediment deposition and removal.

The following is a summary of the main findings and conclusions of the study that are of relevance to the investigation of the sediment plume exiting the harbour.

- The Sixteen Mile Creek watershed consists of 371 km^2 with 1,100 km of watercourse. Sixteen Mile Creek has three main branches (East, Middle and West) with a total length of 150 km. The watershed is divided by the Niagara Escarpment which consists of steep vertical cliffs of dolostone bedrock. Headwaters of the West and Middle branches originate above the Escarpment, and headwaters for the East branch originate in the northeast below the escarpment.
- The surficial geology mainly consists of fine-textured glaciolacustrine deposits interbedded flow till, rainout deposits and silt and clay and glaciolacustrine derived silty to clayey till.
- The majority of the Sixteen Mile Creek watershed consists of agricultural land with only 16% defined as urban within the Town of Milton and south of Dundas Street West within the Town of Oakville.
- Oakville Harbour acts as a sediment sink where sediment deposited at an average rate of 1,700 m^3/yr.

- Sediments deposited within Oakville Harbour were comprised of materials in the medium silt to fine sand class size. Fine silts and clay were transported through the harbour.
- Sediment deposition within the harbour was from the creek with very little sediment transported by waves to the mouth of the harbour.
- The shoreline between Burlington and Toronto has been classified as a 'non-drift zone' by MNR (1988) which is a section of shoreline where there is very limited availability of sediment for transport. The Oakville shoreline is composed of shale bedrock just below the lake level which is overlain by a thin layer of till and fine sand (MNR, 1988).
- Sediment is not supplied to the nearshore through shoreline erosion since the majority of the shoreline has also been armoured through urban development.
- Suspended sediment samples were collected at 18 locations within the watershed following a 26.4 mm watershed wide rain event on August 1st 2013. Total suspended solids (TSS) among the samples ranged from 4 to 215 mg/L.
- Flow and sediment transport monitoring data available for several hydrometric monitoring stations within the watershed from the Environment Canada HYDAT database was presented. The relevant data are provided below in **Section 3.1.2**
- The following recommendations were made with respect to reducing sediment generation and supply from the watersheds due to development and construction activities.
    - The focus should be on compliance rather than new technologies or techniques.
    - Monitoring requirements should be maintained at the current levels or increased.
    - The implementation of existing technologies could be improved.
    - There should be a focus on erosion control (keeping soil in place) in addition to sediment control (trapping soil prior to it being washed into a watercourse). Methods to reduce agricultural inputs should be explored (e.g. vegetated buffers, tillage methods and other farming practices).
- The volume of sediment that is transported through the harbour to form the offshore sediment plume was not estimated.
- Options for mitigation and management of sediment deposition within the harbours were investigated and included limiting sediment input, reducing sedimentation, reducing draft depth requirements, relocating the harbour, and a dredging program and alternative forms of dredging.
- A maintenance dredging program was proposed to remove the sediment deposited within the harbour every two years.

Bowen, G.S. and Booty, W., 2011. Watershed Pollutant Load Assessments for the Canadian Side of the Western Basin of Lake Ontario: A report prepared for the CTC source protection region. Prepared by TRCA and Environment Canada, June 2011

This study consists of estimates of pollutant loads for seven watersheds discharging into Lake Ontario. The study was intended to aid in the understanding of the transport mechanisms of pollutants from local watersheds to Lake Ontario with a focus on potential impacts to drinking water supplies. Sixteen Mile Creek was one of the watersheds studied. Total Phosphorus (TP), Filtered Reactive Phosphorus (FRP), nitrogen oxides (NO_x) and Total Suspended Solids (TSS) were estimated based on water samples specifically for this study and samples collected as part of the Provincial Water Quality Monitoring Network (PWQMN). Sixteen Mile Creek estimates were limited by the need to rely on monitoring stations from the upper reaches of the watershed.

The following information from the report is relevant for the study of the sediment plume. It should be noted that all TSS and total load values were rough estimates.

- Identifies snow melt as a dominant factor for sediment loading into the Lake.
- Most suspended solids loads are delivered by a small number of events.
- Event Mean Concentrations for wet weather events in Sixteen Mile Creek were estimated as approximately 220 mg/L in 2008 and 155 mg/L in 2009.
- Average daily suspended sediment load for Sixteen Mile Creek was estimated as 69,000 kg.
- Total suspended solids carried by Sixteen Mile Creek were approximately 22,000 t in 2008 and 21,000 t in 2009.

Baird, 2009. Assimilative Capacity Study for the Mid-Halton WWTP Phase IV and V Expansion. Report prepared for The Regional Municipality of Halton.

This report summarizes the Assimilative Capacity Study that was prepared in support of the Municipal Class Environmental Assessment (EA) Study Project for the Mid-Halton Wastewater Treatment Plant (WWTP) Phase IV and V expansion by Baird & Associates.

The report contains a detailed review of water quality data within Lake Ontario adjacent to Oakville. Background concentrations for temperature, pH, ammonia and total phosphorus were quantified for each season. Historic records of currents, TSS, turbidity and dissolved oxygen were also analyzed. The review was used to determine ambient conditions within Lake Ontario which were then used to establish numerical modelling scenarios for different seasons and current speed and directions.

Numerical modelling was used to assess the impacts of the effluent from the Mid-Halton and Oakville South West WWTP on the water quality within Lake Ontario, specifically at the shoreline and the Oakville and Burloak WTPs. The water quality model CORMIX was used to model the near-field mixing process dominated by the effluent jet. MIKE3 was used to model the far-field dispersion of the effluent plume where ambient currents determine the distribution of the plume. The MIKE 3 modelling showed that Provincial Water Quality Objectives (PWQO) were met at the Oakville and Burloak WTP intakes.

The summary of ambient lake conditions and the development of modelling scenarios to determine the dispersion of the plume from the WWTPs can provide a basis for numerical modelling of the Sixteen Mile Creek plume.

3.1.2 Creek Flow and Turbidity Data

Flow and sediment transport monitoring data was available for two hydrometric monitoring stations within the watershed from the Environment Canada HYDAT database. Unfortunately these stations are far upstream in the watershed and upstream of most of the developed areas and not likely representative of total flows and sediment entering the harbour. They do however provide information on temporal trends in flow and limited information on suspended sediment concentration for portions of the watershed. The location of the stations is shown in **Appendix E. Appendix E** also shows the surficial geology of the watershed.

The available data from each of the Environment Canada stations is summarized in **Table 3.** The table also includes PWQM data sampled near the mouth of the creek. Plots of the available TSS and discharge data are shown in **Appendix F** and PWQM data is shown in **Appendix G.**

Table 3: Discharge and suspended sediment concentration data for Sixteen Mile Creek.

Station	Type	Period	Location	Source
02HB004	Flow & Level (Continuous)	1956-2014	East 16 Mile Creek near Omagh	Water Survey of Canada
02HB005	Flow & Level (Continuous)	1957-2014	East 16 Mile Creek at Milton	Water Survey of Canada
02HB004	Suspended Sediment Concentration (Sporadic)	1990-1997	East 16 Mile Creek near Omagh	Water Survey of Canada
02HB005	Suspended Sediment Concentration (Sporadic)	1991-1997	East 16 Mile Creek at Milton	Water Survey of Canada
06006300102	Suspended Solids Concentration (Sporadic)	2002-2013	16 Mile Creek at Lakeshore Road	Provincial Water Quality Monitoring (PWQM)
02HB004	Water Temperature (Sporadic)	1990-1997	East 16 Mile Creek near Omagh	Water Survey of Canada
02HB005	Water Temperature (Sporadic)	1991-1997	East 16 Mile Creek at Milton	Water Survey of Canada

Flow velocities and discharges for different flow events near the mouth of Oakville Harbour are show in **Table 4.** The flow events were taken from the hydraulic model provided by Conservation Halton and reported in GHD (2014).

Table 4: Flow events at Oakville Harbour reported in GHD (2014) from the hydraulic model provided by Conservation Halton.

River Station	Event	Velocity (m/s)	Discharge (m^3/s)
142.0189	Regional	2.9	1198
142.0189	100Yr	0.9	311
142.0189	50Yr	0.8	279
142.0189	25Yr	0.7	237
142.0189	10Yr	0.6	190
142.0189	5Yr	0.5	160
142.0189	2Yr	0.3	100

3.1.3 WPP Inlet Turbidity

Turbidity data was available from the Region of Halton for flows entering the plant through the intake pipe. The turbidity data has been plotted along with flows at the mouth of Sixteen Mile Creek (**Appendix H**). The flows at the mouth of the creek were estimated from the flow monitoring stations within the watershed using the relationship for the transposition of flood discharges (MTO, 1997):

$$Q2 = Q1\ (A2/A1)^{0.75}$$

Where: Q1 = known peak discharge
Q2 = unknown peak discharge
A1 = known basin area
A2 = unknown basin area

Note that this technique only provides a rough estimate of flows at the mouth given that the monitoring stations are located far upstream. We understand that turbidity greater than 100 NTU has required plant adjustments in the past to cope with the extra turbidity. This value has been used to identify flow events that may impact the intake.

The largest peaks in turbidity in the plant generally correspond to high flows in the spring, particularly in 2011. The high turbidity was likely due to entrainment of sediment by the freshet after most of the snow and ice has melted and before vegetation had established. Large flow events were not always accompanied by high turbidity at the intake likely due to other factors such as lake currents and sediment supply. For example, lake currents from west to east would move the plume away from the intake location. Large rain events in the late summer likely entrain less sediment due to vegetation cover. Similar effects would occur in the winter due to the stabilization of sediment by ice and snow cover.

3.1.4 Lake Bathymetry

The most recent available bathymetric data for the mouth of Sixteen Mile Creek and the area surrounding the location of the WPP intake is summarized in **Table 5**. The NOAA (1999) data and GHD (2013) data was combined to produce bathymetry for use in the numerical model (**Appendix I**). The NOAA data was found to be inaccurate within approximately 100 m of the shoreline. However, spot measurements of depth further offshore showed good agreement with the NOAA data.

Table 5: Lake Bathymetry at the mouth of Sixteen Mile Creek and near the Oakville WPP intake.

Data Source	Year	Resolution	Extent	Comment
NOAA	1999	67m x 93m	Lake wide	
GHD	2013	DEM generated from dense sonar tracks	Oakville Harbour and in the vicinity of the harbour entrance	
MNR	2002	10m x 10m	Greater Toronto Area	MNR has confirmed that the SHOALS data for the study area is not available

3.1.5 Town of Oakville Proposed Shoreline Modifications

The Town of Oakville is considering improvements to the shoreline between Tannery Park and Waterworks Park adjacent to the mouth of Oakville Harbour as identified in their 2007 Oakville Harbour West Shore Master Plan. The Town of Oakville implemented the Tannery and Waterworks Parks Shoreline Improvements Project under the Municipal Class Environmental Assessment (Class EA) in 2013. The objectives of the project are to improve shoreline stability, access to the shoreline, and environmental conditions. The project is currently at the stage where alternative solutions have been developed and a draft preferred solution has been identified. The preferred solution includes construction of groynes and shoreline infill on the west side of the harbour mouth in front of Tannery Park. Two additional groynes are proposed in front of the Waterworks Park at Kerr Street.

It is assumed that the proposed shoreline modifications will have minimal impact on the development of the Sixteen Mile Creek plume. However, the modifications will need to be considered in the assessment of the plume processes.

3.2 PROPOSED STUDIES TO FILL THE DATA GAPS

The review of baseline data found that there is very little data available on the extent and concentration of the Sixteen Mile Creek sediment plume within Lake Ontario. Aerial photographs could be an ideal source of information to determine the typical extent of the plume, however an initial review of aerial photographs found that most photographs to not extend far enough offshore to identify the extent of the plume. They are also limited by the timing of the photography which does not necessarily coincide with peak plume events.

Field investigations and numerical modelling are proposed given the limited information currently available on the plume processes.

3.2.1 Field Assessment

Field assessments are proposed to enhance the limited available information on the plume concentrations and distribution. Field observations will provide valuable data for use in calibrating a 3D numerical model. Field sampling of total suspended solids (TSS) is proposed for 2 - 3 plume events. Sampling will be conducted with a pump sampler to allow sampling at multiple depths. This would also include discharge estimates and concentration measurements at the harbour entrance to determine the sediment loading from Sixteen Mile Creek.

3.2.2 Initial Results

Sampling for one plume event has already been conducted on July 28, 2014 following a 60 mm rainfall event (Town of Oakville Station 6155750). Photographs of the plume are shown in **Figure 8** and **Figure 9**. Samples were collected at the surface and at approximately 3 m depth. The results are shown in **Appendix J.** Concentrations ranged from 112 mg/L at the harbour entrance to 9 mg/L at the edge of the plume. Concentrations were generally greater at the surface and lower at depth. Ambient concentrations outside of the plume were between 4 and 15 mg/L. Turbidity recorded in the plant coinciding with this peak were only 11 NTU. This was expected given the intake was outside of the defined plume.

Figure 8: Plume conditions at the entrance to Oakville Harbour on July 28, 2014.

A suspended sediment sample from the harbour entrance was sent to a laboratory for particle size analysis using a computerized digital image system. Particle sizes ranged from fine sand to clay (1 µm to 237 µm). Median particle size was 7 µm and the mean size was 37 µm (silt). The sizes were used to establish the plume characteristics for the numerical modelling.

Figure 9: Plume extent offshore of Oakville Harbour on July 28, 2014**.**

3.2.3 Numerical Modelling

Numerical modelling will allow the simulation of sediment concentrations and distribution for multiple creek flow and lake circulation scenarios. The numerical modelling will build on the knowledge gained through the field observations and allow a determination of a potential area for relocating the intake.

The simulation of the Sixteen Mile Creek sediment plume discharged into the near shore region of Lake Ontario will be modelled with MIKE 3. MIKE 3 is used to model 3D free surface flows and associated sediment or water quality processes. It was developed by DHI and has been used in numerous environmental and ecological studies around the world. The hydrodynamic model will include:

- buoyancy effects due to differences in temperature between the creek and the nearshore lake region;
- typical currents for nearshore Lake Ontario; and,
- winds to simulate upwelling/downwelling in the nearshore lake region.

Modelling scenarios will use lake conditions similar to the scenarios used in the assessment of the Mid-Halton WWTP (Baird, 2009). The modelling will focus on the more frequently reoccurring creek discharge events that could be an issue on a regular basis. Model output will consist of 3D plume shape and sediment concentrations. Concentrations at potential intake locations will be compared for each modelling scenario.

The model will be calibrated based on the field measurements of suspended sediment concentrations collected on July 28, 2014. Another set of field samples were collected during a plume event on September 11, 2104. The second set of field measurements will be used to validate the model.

Overall the proposed work plan will determine the sediment plume extent and concentration for typical events which cause high levels of turbidity within the WPP intake. The results will be used to determine potential benefits of relocating the intake with respect to sediment contamination.

4.0 SUMMARY AND CONCLUSIONS

The information provided in this report is based on a desktop review of available data for the area including the Oakville WPP, adjacent parkland and Lake Ontario shoreline and nearshore areas. Through this desktop review it was determined that the most sensitive natural features in the vicinity of the project area are associated with the mouth of Sixteen Mile Creek and the contiguous aquatic habitat of Lake Ontario. Information relating to substrate and bathymetry of the lake has been included where available; however, data pertaining to available fish habitat in the lake within 3 km of the shoreline is considered limited. As a result, it is recommended that if project works are identified to include construction of a new or extended intake pipe, further survey of the area should be completed to assess substrates and bottom features as they relate to fish habitat. In addition recommendations have been made to collect additional field data to further define the extent of the Sixteen Mile Creek plume to allow for further consideration of how the problem of high turbidity within the existing intake might be addressed.

Records of Species at Risk have been found to include the study area such that further consultation with MNRF will be required once project works are further defined. As well, a Department of Fisheries and Oceans (DFO) screening may be required for any proposed construction within regulated flood lines to determine whether impacts to fish and/or fish habitat can be avoided.

5.0 REFERENCES

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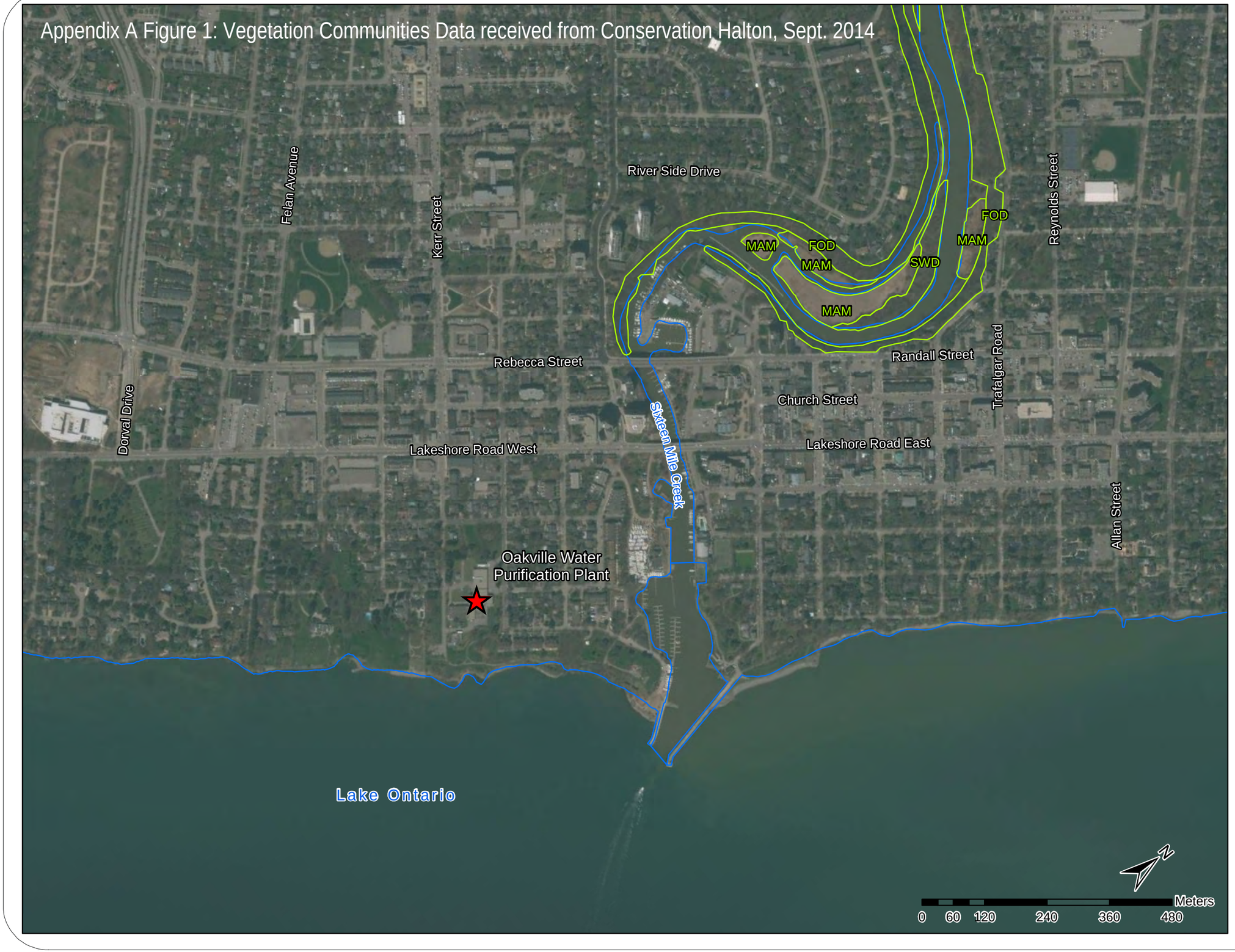
APPENDIX A
BACKGROUND REVIEW

Appendix A Figure 1: Vegetation Communities Data received from Conservation Halton, Sept. 2014



LEGEND

- Oakville Water Purification Plant
- Vegetation Communities (Conservation Halton)
  - FOD Deciduous Forest
  - MAM Meadow Marsh
  - SWD Deciduous Swamp
  - CUM Cultural Meadow
  - CUW Cultural Woodland
- Wtercourse (LIO)
- Waterbody (LIO)

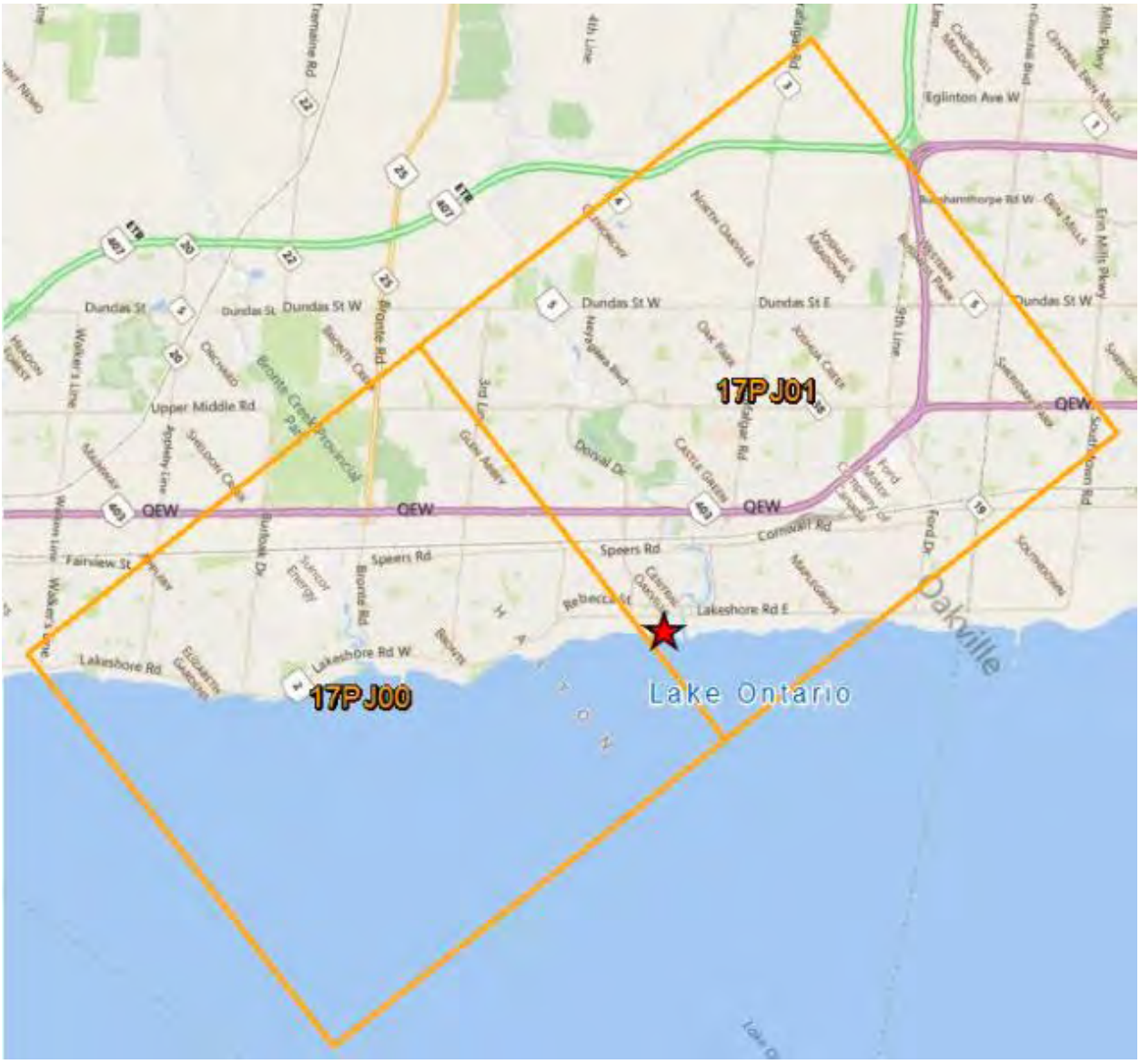
Oakville Water Purification Plant Upgrade

Vegetation Communities

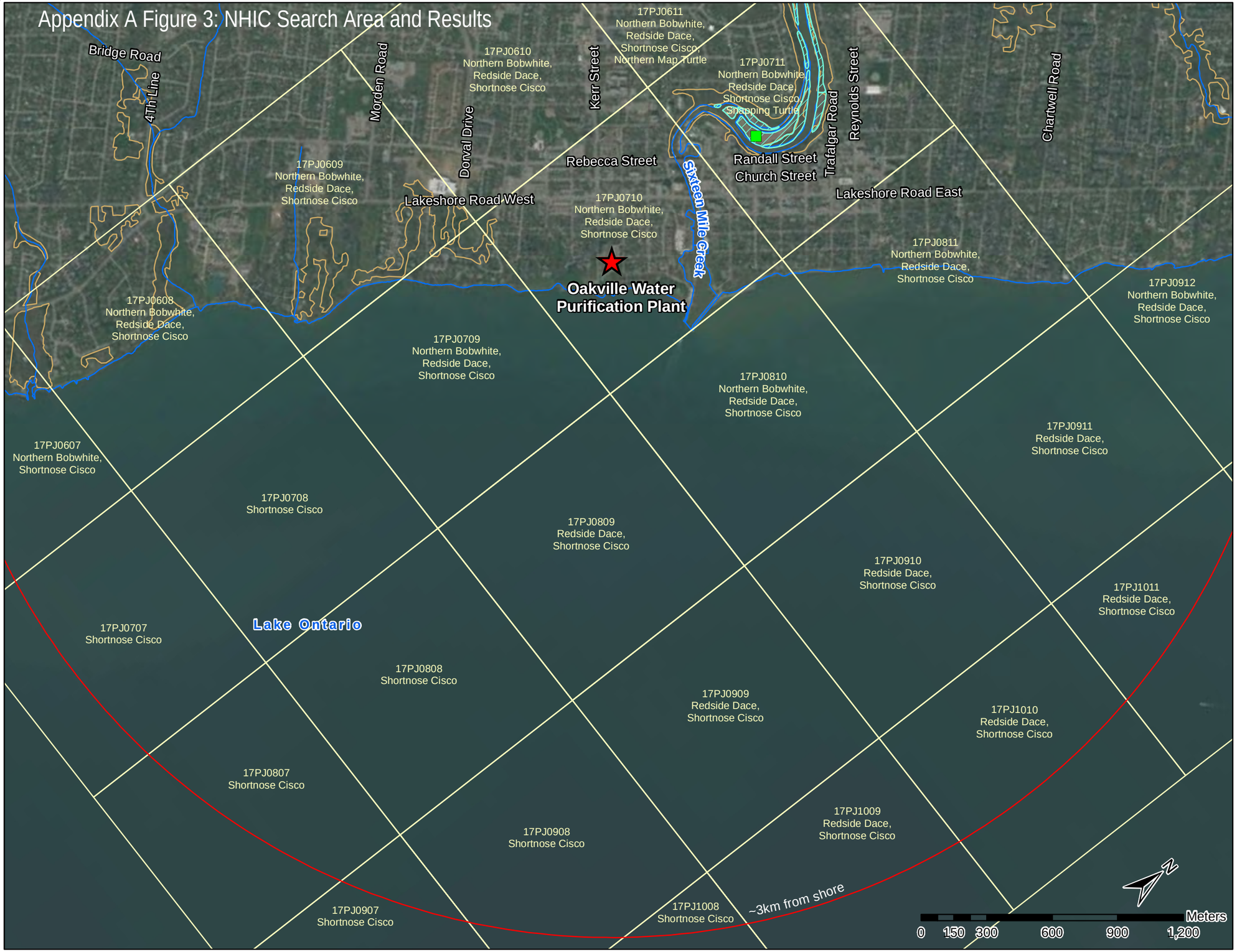
LGL LIMITED
environmental research associates

Project	TA8469-00	**Figure**	
Date	September, 2014	**Prepared By:**	KC
Scale	1:7,000	**Verified By:**	

Appendix A Figure 2: OBBA Search Area for records of Breeding Birds



Appendix A Figure 3: NHIC Search Area and Results



LEGEND

- Oakville Water Purification Plant
- Natural Area (NHIC, Oct 2013)
- 1km UTM Squares NHIC Search Area (LIO)
- Evaluated Wetland (LIO)
- Wooded Area (LIO)
- Waterbody (LIO)

Oakville Water Purification Plant Upgrade

LGL LIMITED environmental research associates

Project	TA8469-00	**Figure**	
Date	September, 2014	**Prepared By:**	KC
Scale	1:17,000	**Verified By:**	

APPENDIX B
FISH LIST

Appendix B, Table 1: Fisheries Data from Lake Ontario Shoreline and 16 Mile Creek. Station locations shown on following Figure.

Common Name	Scientific Name	Lake Ontario Shoreline	16 Mile Creek	Thermal Regime	Tolerance	G Rank	S Rank	COSEWIC Status	SARO Status
Alewife	*Alosa pseudoharengus*	X[1]	X[4], X[9]	coldwater	intermediate	G5	SNA	none	none
Black Crappie	*Pomoxis nigromaculatus*	X[1]	X[9]	coolwater	moderately tolerant of turbidity	G5	S4	none	none
Bluntnose Minnow	*Pimephales notatus*		X[5], X[8]	warmwater	moderately tolerant of turbidity	G5	S5	NAR	NAR
Brook Silverside	*Labidesthes sicculus*	X[1]	X[9]	warmwater	intermediate	G5	S4	NAR	NAR
Brown Bullhead	*Ameiurus nebulosus*	X[3]	X[5], X[6]	warmwater	intermediate	G5	S5	none	none
Brown Trout	*Salmo trutta*	X[1]		coldwater	intolerant of turbidity, siltation, pollution	G5	SNR	none	none
Chinook Salmon	*Oncorhynchus tshawytscha*	X[1]	X[9]	coldwater	intolerant	G5	SNA	none	none
Common Carp	*Cyprinus carpio*		X[6], X[7]	warmwater	tolerant of turbidity	G5	SNA	none	none
Common Shiner	*Luxilus cornutus*	X[1]	X[4], X[7], X[8], X[9]	coolwater	moderately tolerant	G5	S5	none	none
Emerald Shiner	*Notropis atherinoides*	X[1],X[2],X[3]	X[4], X[9]	coolwater	moderately tolerant	G5	S5	none	none
Freshwater Drum	*Aplodinotus grunniens*	X[1]		warmwater	tolerant	G5	S5	none	none
Gizzard Shad	*Dorosoma cepedianum*	X[1],X[2]	X[9]	coolwater	tolerant	G5	S4	none	none
Golden Shiner	*Notemigonus crysoleucas*	X[1]	X[9]	coolwater	moderately tolerant of turbidity	G5	S5	none	none
Johnny Darter	*Etheostoma nigrum*		X[4], X[5], X[7]	coolwater	moderately tolerant	G5	S5	none	none
Lake Chub	*Couesius plumbeus*	X[1]		coldwater	intermediate	G5	S5	none	none
Largemouth Bass	*Micropterus salmoides*	X[1]	X[6], X[7], X[8]	warmwater	tolerant but moderately tolerant of turbidity	G5	S5	none	none
Longnose Dace	*Rhinichthys cataractae*	X[1],X[2]		coolwater	moderately tolerant	G5	S5	none	none
Longnose Gar	*Lepisosteus osseus*	X[1]		warmwater	tolerant	G5	S4	none	none
Northern Hog Sucker	*Hypentelium nigricans*	X[1],X[2]		warmwater	intolerant of turbidity, siltation, pollution	G5	S4	none	none
Northern pike	*Esox lucius*		X[6]	coolwater	intermediate	G5	S5	none	none

Common Name	Scientific Name	Lake Ontario Shoreline	16 Mile Creek	Thermal Regime	Tolerance	G Rank	S Rank	COSEWIC Status	SARO Status
Pumpkinseed	*Lepomis gibbosus*	X[1]	X[4], X[5], X[6], X[7], X[8]	warmwater	intermediate	G5	S5	none	none
Rainbow Smelt	*Osmerus mordax*	X[1]		coldwater	intermediate	G5	S5	none	none
Rainbow Trout	*Oncorhynchus mykiss*	X[1],X[2]		coldwater		G5	S5	none	none
Rock Bass	*Ambloplites rupestris*	X[1]	X[4], X[5], X[7], X[8], X[9]	coolwater	intolerant of siltation	G5	S5	none	none
Round Goby	*Neogobius melanostomus*	X[1],X[2]	X[4], X[5], X[8]	coolwater	intermediate	G5	SNA	none	none
Shortnead Redhorse	*Moxostoma macrolepidotum*	X[1]		warmwater	intermediate	G5	S5	none	none
Silver Shiner	*Notropis photogenis*	X[1]		warmwater	intolerant	G5	S2S3	THR	THR
Smallmouth Bass	*Micropterus dolomieu*		X[4]	coolwater	moderately tolerant	G5	S5	none	none
Spotfin Shiner	*Cyprinella spiloptera*	X[1]	X[4], X[9]	warmwater	intermediate	G5	S4	none	none
Spottail Shiner	*Notropis hudsonius*	X[2]		coolwater	moderately tolerant	G5	S5	none	none
Trout-perch	*Percopsis omiscomaycus*		X[4]	coldwater	intermediate	G5	S5	none	none
White Bass	*Morone chrysops*	X[1]		warmwater	tolerant	G5	S4	none	none
White Sucker	*Catostomus commersonii*	X[1],X[2],X[3]	X[4], X[9]	coolwater	generally tolerant, but moderately tolerant of turbidity	G5	S5	none	none
Yellow Perch	*Perca flavescens*	X[1]		coolwater	moderately tolerant	G5	S5	none	none

[1]2013. Conservation Halton. Long Term Environmental Monitoring Program Grindstone Creek, Sixteen Mile Creek and Supplemental Monitoring. Conservation Halton, Burlington, ON. 176 pp. Data extracted for Lake Ontario shoreline electrofishing survey, Table 14 pg. 109.

[2]2011-2012. Conservation Halton. Station LON-20, Lake Ontario shoreline east of 16 MIle Creek. Data received from Conservation Halton Sept. 30, 2014

[3]2011. Tarandus and Associates. Station SXM-145, Lake Ontario at mouth of 16 Mile Creek. Data received from Conservation Halton Sept. 30, 2014

[4]1958-2012. Conservation Halton. Station SXM-180. Data received from Conservation Halton Sept. 30, 2014

[5]2005. Conservation Halton. Station SXM-181. Data received from Conservation Halton Sept. 30, 2014

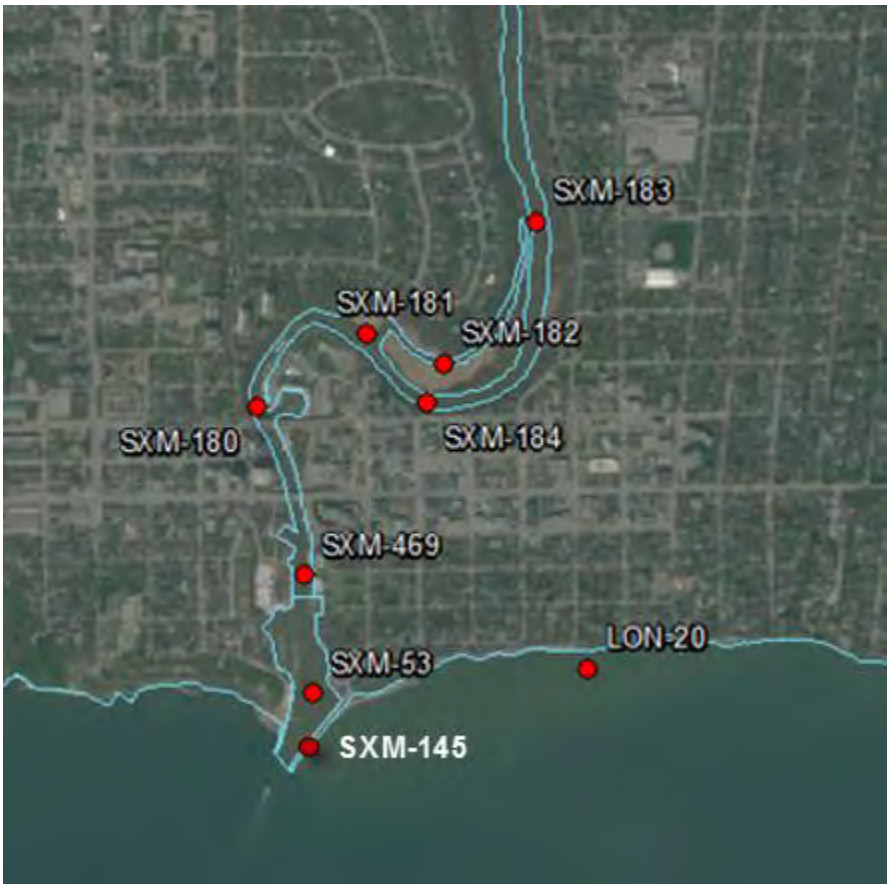
[6]2005. Conservation Halton. Station SXM-182. Data received from Conservation Halton Sept. 30, 2014

[7]2005. Conservation Halton. Station SXM-183. Data received from Conservation Halton Sept. 30, 2014

[8]2005. Conservation Halton. Station SXM-184. Data received from Conservation Halton Sept. 30, 2014

[9]2011-2012. Conservation Halton. Station SXM-469. Data received from Conservation Halton Sept. 30, 2014

Fish station locations in Sixteen Mile Creek and along Lake Ontario shoreline for data received from Conservation Halton on Sept. 30, 2014, as shown in Appendix B, Table 1.



SXM-53 – no fish found in sampling efforts conducted in 1975 by MNRF

APPENDIX C
WILDLIFE LIST

Appendix C: Wildlife List for Project Area

Group	Scientific Name	Common Name	G Rank	S Rank	COSEWIC	SARA	SARO	FWCA	MBCA	CH	SWHTG Area Sensitive Species	Interior Species	Habitat Size/ Range	Priority Species Halton (BSC)
Bird	*Empidonax alnorum*	Alder Flycatcher	G5	S5B					X					level 3
Bird	*Anas rubripes*	American Black Duck	G5	S4					X	U				level 2
Bird	*Corvus brachyhrynchos*	American Crow	G5	S5B										
Bird	*Carduelis tristis*	American Goldfinch	G5	S5B					X					level 3
Bird	*Falco sparverius*	American Kestrel	G5	S4				P						level 2
Bird	*Setophaga ruticilla*	American Redstart	G5	S5B					X		X (>100ha forest)			level 2
Bird	*Turdus migratorius*	American Robin	G5	S5B					X					
Bird	*Scolopax minor*	American Woodcock	G5	S4B					X					level 4
Bird	*Icterus galbula*	Baltimore Oriole	G5	S4B					X					
Bird	*Riparia riparia*	Bank Swallow	G5	S4B	THR		THR		X					level 2
Bird	*Tyto alba*	Barn Owl (Eastern)	G5	S1	END	END	END	P		EXT				level 1
Bird	*Ceryle alcyon*	Belted Kingfisher	G5	S4B				P						
Bird	*Coccyzus erythropthalmus*	Black-billed Cuckoo	G5	S5B					X	U				level 2
Bird	*Poecile atricapillus*	Black-capped Chickadee	G5	S5					X				1-2ha	level 4
Bird	*Dendroica caerulescens*	Black-throated Blue Warbler	G5	S5B					X	R	X (>100ha of dense forest)			
Bird	*Cyanocitta cristata*	Blue Jay	G5	S5				P						
Bird	*Polioptila caerulea*	Blue-gray Gnatcatcher	G5	S4B					X	U	X (30ha forest)	X		level 3
Bird	*Dolichonyx oryzivorus*	Bobolink	G5	S4B	THR		THR		X		X (>50ha dense grassland)			level 2
Bird	*Certhia americana*	Brown Creeper	G5	S5B					X	U	X (30ha mature forest)	X		level 2
Bird	*Toxostoma rufum*	Brown Thrasher	G5	S4B					X					level 1
Bird	*Molothrus ater*	Brown-headed Cowbird	G5	S4B										
Bird	*Branta canadensis*	Canada Goose	G5	S5					X	I		<100m from water		
Bird	*Thryothorus ludovicianus*	Carolina Wren	G5	S4					X	R				level 3
Bird	*Bombycilla cedrorum*	Cedar Waxwing	G5	S5B					X					
Bird	*Dendroica pensylvanica*	Chestnut-sided Warbler	G5	S5B					X	U				level 1
Bird	*Chaetura pelagica*	Chimney Swift	G5	S4B,S4N	THR	THR	THR		X	U				
Bird	*Spizella passerina*	Chipping Sparrow	G5	S5B					X					
Bird	*Petrochelidon pyrrhonota*	Cliff Swallow	G5	S4B					X					level 3
Bird	*Quiscalus quiscula*	Common Grackle	G5	S5B										
Bird	*Chordeiles minor*	Common Nighthawk	G5	S4B	THR	THR	SC		X	R				level 1
Bird	*Corvus corax*	Common Raven	G5	S5				P		R		X		
Bird	*Carduelis flammea*	Common Redpoll	G5	S4B					X					
Bird	*Gallinago gallinago*	Common Snipe							X	U				level 2
Bird	*Sterna hirundo*	Common Tern	G5	S4B	NAR				X					level 4
Bird	*Geothlypis trichas*	Common Yellowthroat	G5	S5B					X					
Bird	*Accipiter cooperii*	Cooper's Hawk	G5	S4	NAR			P		U	X (dense Carolinian forest habitat >50ha)	X	6-15ha	level 3
Bird	*Picoides pubescens*	Downy Woodpecker	G5	S5					X				2-4ha	
Bird	*Sialia sialis*	Eastern Bluebird	G5	S5B	NAR				X	U			4-8ha	level 1
Bird	*Tyrannus tyrannus*	Eastern Kingbird	G5	S4B					X				1ha	level 3
Bird	*Sturnella magna*	Eastern Meadowlark	G5	S4B	THR		THR		X		X (open grasslands >10ha)			level 3
Bird	*Sayornis phoebe*	Eastern Phoebe	G5	S5B					X					level 3
Bird	*Megascops asio*	Eastern Screech-Owl	G5	S4	NAR			P						
Bird	*Pipilo erythrophthalmus*	Eastern Towhee	G5	S4B					X	U				level 2
Bird	*Contopus virens*	Eastern Wood Pewee	G5	S4B	SC		SC		X					
Bird	*Sturnus vulgaris*	European Starling	G5	SNA						I				
Bird	*Spizella pusilla*	Field Sparrow	G5	S4B					X					level 3
Bird	*Ammodramus savannarum*	Grasshopper Sparrow	G5	S4B					X	U	X (>10ha grassland)			level 3
Bird	*Dumetella carolinensis*	Gray Catbird	G5	S4B					X				0.3ha	level 4
Bird	*Ardea herodias*	Great Blue Heron	G5	S4					X					
Bird	*Myiarchus crinitus*	Great Crested Flycatcher	G5	S4B					X				1ha	
Bird	*Bubo virginianus*	Great Horned Owl	G5	S4				P						
Bird	*Butorides virescens*	Green Heron	G5	S4B						U				level 4
Bird	*Picoides villosus*	Hairy Woodpecker	G5	S5					X		X (forests with tall trees/snags >25cm)		4-8ha	
Bird	*Wilsonia citrina*	Hooded Warbler	G5	S3B	NAR	THR			X	R		X		level 1
Bird	*Eremophila alpestris*	Horned Lark	G5	S5B					X	U				level 3
Bird	*Carpodacus mexicanus*	House Finch	G5	SNA					X	I				
Bird	*Passer domesticus*	House Sparrow	G5	SNA						I				
Bird	*Troglodytes aedon*	House Wren	G5	S5B					X				0.4ha	
Bird	*Passerina cyanea*	Indigo Bunting	G5	S4B					X					
Bird	*Charadrius vociferus*	Killdeer	G5	S5B,S5N					X					
Bird	*Empidonax minimus*	Least Flycatcher	G5	S4B					X	U	X (open habitat >100ha)			
Bird	*Anas platyrhynchos*	Mallard	G5	S5					X					
Bird	*Falco columbarius*	Merlin	G5	S5B	NAR			P						
Bird	*Zenaida macroura*	Mourning Dove	G5	S5					X					
Bird	*Oporornis philadelphia*	Mourning Warbler	G5	S4B					X	U				level 2
Bird	*Cygnus olor*	Mute Swan	G5	SNA					X	I; U				
Bird	*Cardinalis cardinalis*	Northern Cardinal	G5	S5					X					
Bird	*Colaptes auratus*	Northern Flicker	G5	S4B					X					
Bird	*Mimus polyglottos*	Northern Mockingbird	G5	S4					X	U				level 1
Bird	*Stelgidopteryx serripennis*	Northern Rough-winged Swallow	G5	S4B					X	U				level 2
Bird	*Icterus spurius*	Orchard Oriole	G5	S4B					X					level 3
Bird	*Seiurus aurocapilla*	Ovenbird	G5	S4B					X		X (>70ha continuous forest)	X		level 4
Bird	*Dryocopus pileatus*	Pileated Woodpecker	G5	S5					X	U	X (40-260ha mature decid/mixed	X		level 2
Bird	*Dendroica pinus*	Pine Warbler	G5	S5B					X	U	X (15-30ha white pine forest)	X		level 2
Bird	*Carpodacus purpureus*	Purple Finch	G5	S4B					X	U				level 2
Bird	*Progne subis*	Purple Martin	G5	S4B					X	U				level 2
Bird	*Melanerpes carolinus*	Red-bellied Woodpecker	G5	S4					X	R			4ha	level 3
Bird	*Sitta canadensis*	Red-breasted Nuthatch	G5	S5					X	U	X (10ha interior forest)	X		level 3
Bird	*Vireo olivaceus*	Red-eyed Vireo	G5	S5B					X			X		
Bird	*Melanerpes erythrocephalus*	Red-headed Woodpecker	G5	S4B	THR	THR	SC		X				4ha	level 1
Bird	*Podiceps grisegena*	Red-necked Grebe	G5	S3B,S4N	NAR				X	U	X (>4 ha of open water, wave disturbance)			
Bird	*Buteo jamaicensis*	Red-tailed Hawk	G5	S5	NAR			P						
Bird	*Agelaius phoeniceus*	Red-winged Blackbird	G5	S4										
Bird	*Columba livia*	Rock Dove (Pigeon)	G5	SNA						I				
Bird	*Pheucticus ludovicianus*	Rose-breasted Grosbeak	G5	S4B					X					
Bird	*Archilochus colubris*	Ruby-throated Hummingbird	G5	S5B					X					level 3
Bird	*Passerculus sandwichensis*	Savannah Sparrow	G5	S4B					X		X (>50ha grassland)		1.5-2ha	level 1
Bird	*Piranga olivacea*	Scarlet Tanager	G5	S4B					X		X (20ha mature forest)	X		level 2
Bird	*Accipiter striatus*	Sharp-shinned Hawk	G5	S5	NAR			P		U	X (4ha dense canopy, forest habitat >30ha)			level 2
Bird	*Melospiza melodia*	Song Sparrow	G5	S5B					X					
Bird	*Actitis macularius*	Spotted Sandpiper	G5	S5					X					level 3
Bird	*Tachycineta bicolor*	Tree Swallow	G5	S4B					X					
Bird	*Parus bicolor*	Tufted Titmouse	G5	S4					X	U	X (4ha shrub/sapling growth near water)			level 3
Bird	*Cathartes aura*	Turkey Vulture	G5	S5B				P						level 3
Bird	*Catharus fuscescens*	Veery	G5	S4B					X		X (10ha young forest, habitat fragmentation)	X		level 3
Bird	*Vireo gilvus*	Warbling Vireo	G5	S5B					X					
Bird	*Caprimulgus vociferus*	Whip-poor-will	G5	S4B	THR	THR	THR		X		X (dry, open forests >100ha)			level 2
Bird	*Sitta carolinensis*	White-breasted Nuthatch	G5	S5					X		X (10ha continuous forest)			
Bird	*Empidonax traillii*	Willow Flycatcher	G5	S5B					X	U				
Bird	*Aix sponsa*	Wood Duck	G5	S5					X					level 4
Bird	*Hylocichla mustelina*	Wood Thrush	G5	S4B	THR		SC		X			X		level 4
Bird	*Dendroica petechia*	Yellow Warbler	G5	S5B					X					
Bird	*Coccyzus americanus*	Yellow-billed Cuckoo	G5	S4B					X	R				level 3

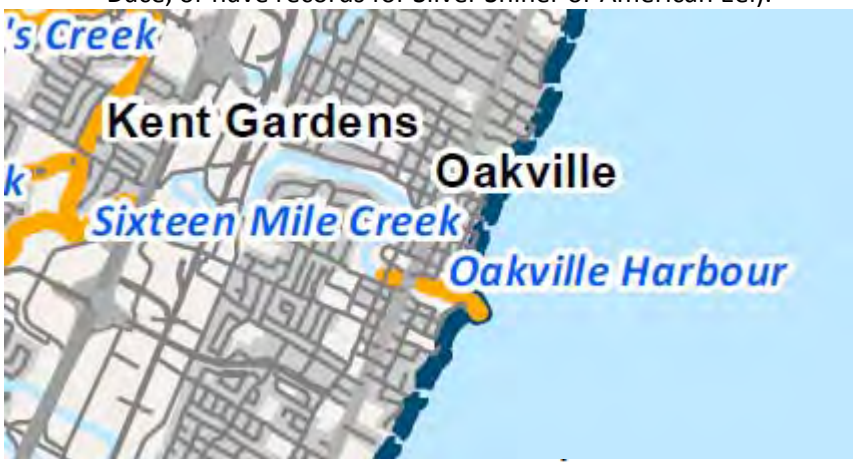
APPENDIX D
AGENCY CONSULTATION

Lynette Renzetti

From: Lynette Renzetti
Sent: September-11-14 12:32 PM
To: ESA Aurora (MNR)
Subject: Oakville Water Purification Plant Municipal Class EA
Attachments: AuroraMNRF_DataRequest.pdf; OakvilleWPP_NHIC_SAR.pdf; OakvilleWPP_LIO_NHIC.pdf

Good Afternoon
LGL Limited has been retained by exp Services Inc. on behalf of the Halton Region to conduct the natural heritage investigations associated with the Oakville Water Purification Plant Municipal Class EA in Oakville. The Oakville WPP is located at 21 Kerr Street, however there is potential for works to occur within the road right-of-way of adjacent streets and up to 2km offshore into Lake Ontario. We would like to request data pertaining to significant natural features (PSWs, ANSIs, etc.) wildlife, fish or rare species known to occur in the area. In particular we are hoping to access the following:

- Fish records for Sixteen Mile Creek below Rebecca Street and for Lake Ontario in the vicinity of Sixteen Mile Creek;
- Wetland Evaluation for Oakville Creek Wetland Complex;
- Any additional records of SAR beyond those accessed through NHIC (Northern Bobwhite, Redside Dace, and Shortnose Cisco, and Snapping Turtle); and,
- Confirmation of whether the lower reaches of Sixteen Mile Creek are considered regulated habitat for Redside Dace, or have records for Silver Shiner or American Eel).



Common Name (Population)	Colour
*Spotted Gar	Red
American Eel	Orange
Lake Sturgeon (DU 8 Grt Lakes/Upper St. Lawrence)	Orange
Redside Dace	Orange
Silver Shiner	Orange

Thank you in advance for any information you may be able to provide.
Kind Regards,
Lynette Renzetti
Planning Ecologist

Southern Region
Aurora District Office
50 Bloomington Road West
Aurora, ON L4G 0L8

Ontario

Ministry of Natural Resources and Forestry

Ministere des Richesses Naturelles et des Forêts

September 30, 2014

Lynette Renzetti, Planning Ecologist
LGL Limited
445 Thompson Drive, Unit 2
Cambridge, Ontario N1T 2K7
LRenzetti@lglcambridge.com

Re: Oakville Water Purification Plant, 21 Kerr Street

Dear Ms. Renzetti,

In your email dated September 11, 2014 you requested information on natural heritage features and element occurrences occurring on or adjacent to the above mentioned location. There are Species at Risk recorded from your study area and the immediate vicinity. As of the date of this letter, we have records of:

Silver Shiner	THR

Additionally, the species listed below have the potential to occur in your study area and may require further assessment or field studies to determine presence. We have records of the following species within the vicinity of your study area:

Black Tern	SC	Snapping Turtle	SC
Northern Map Turtle	SC		

These species may receive protection under the *Endangered Species Act 2007* and thus, an approval from MNRF may be required if the work you are proposing could cause harm to these species or their habitat. If the Species at Risk in Ontario List is amended, additional species may be listed and protected under the *ESA 2007* or the status and protection levels of currently listed species may change. Please provide additional information on your proposal to our office, and we will assess it to determine whether an authorization under the *ESA 2007* will be required for the works to proceed.

Natural heritage features recorded for your area include the Oakville Creek Wetland Complex.

Absence of information provided by MNRF for a given geographic area, or lack of current information for a given area or element, does not categorically mean the absence of sensitive species or features. Many areas in Ontario have never been surveyed and new plant and animal species records are still being discovered for many localities. For these reasons, the MNRF cannot provide a definitive statement on the presence, absence or condition of biological elements in any part of Ontario.

This species at risk information is highly sensitive and is not intended for any person or project unrelated to this undertaking. Please do not include any specific information in reports that will be available for public record. As you complete your fieldwork in these areas, please report all information related to any species at risk to our office. This will assist with updating our database and facilitate early consultation regarding your project.

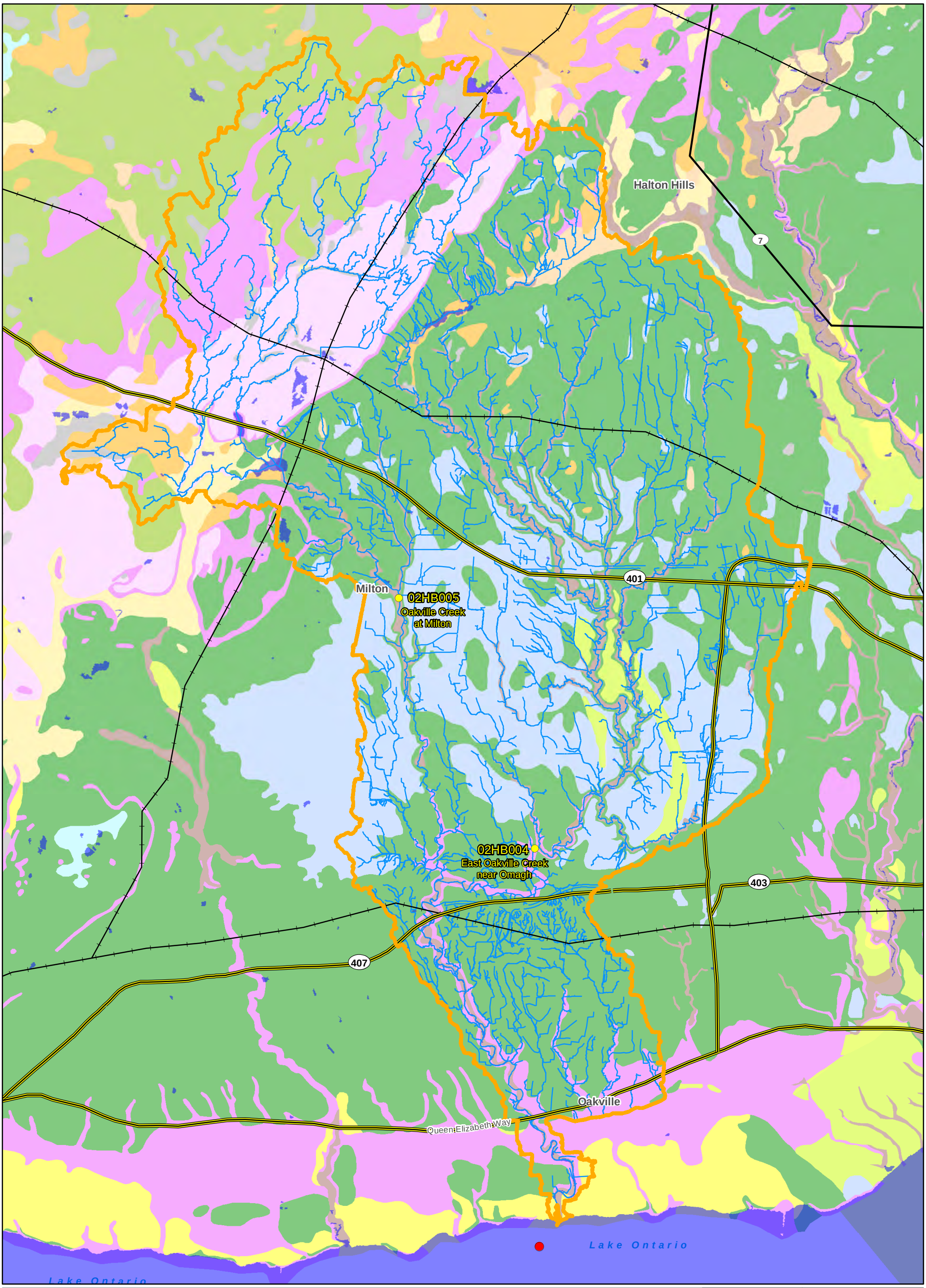
If you have any questions or comments, please do not hesitate to contact me at 905-713-6010 or ESA.Aurora@ontario.ca (Attention: Erika Nardone).

Sincerely,

E. Nardone

Erika Nardone
Fish and Wildlife Technical Specialist
Ontario Ministry of Natural Resources and Forestry, Aurora District

APPENDIX E
SURFICIAL GEOLOGY & FLOW GAUGE LOCATIONS



Legend

- Oakville WPP Intake
- Flow Gauge
- Highway
- Primary Road
- Railroad
- Watercourse
- Watershed

Surficial Geology

- 3: Paleozoic bedrock
- 4a: Mainly till veneer
- 5b: Stone-poor, carbonate-derived silty to sandy till
- 5d: Glaciolacustrine-derived silty to clayey till
- 6: Ice-contact stratified deposits
- 7a: Sandy deposits
- 7b: Gravelly deposits
- 8a: Massive-well laminated
- 8b: Interbedded flow till, rainout deposits and silt and clay
- 9: Coarse-textured glaciolacustrine deposits
- 9b: Littoral-foreshore deposits
- 9c: Foreshore-basinal deposits
- 12: Older alluvial deposits
- 19: Modern alluvial deposits
- 20: Organic deposits

Oakville WPP Intake: GHD 2014; Flow Gauge: Environment Canada, 2013; Watercourse, and Watershed: Conservation Halton, 2013;
Highway, Primary Road, and Railroad: ESRI, 2006; Ontario Geological Survey 2003. Surficial Geology of Southern Ontario; Ontario Geological Survey, Miscellaneous Release--Data 128.

Sixteen Mile Creek Watershed

Surficial Geology

0 1 2
Kilometres

APPENDIX E

DATE: SEPT. 2014

PROJECT: 8811884

DRAWN BY: J.D., L.P.

GHD

APPENDIX F
TSS & DISCHARGE DATA

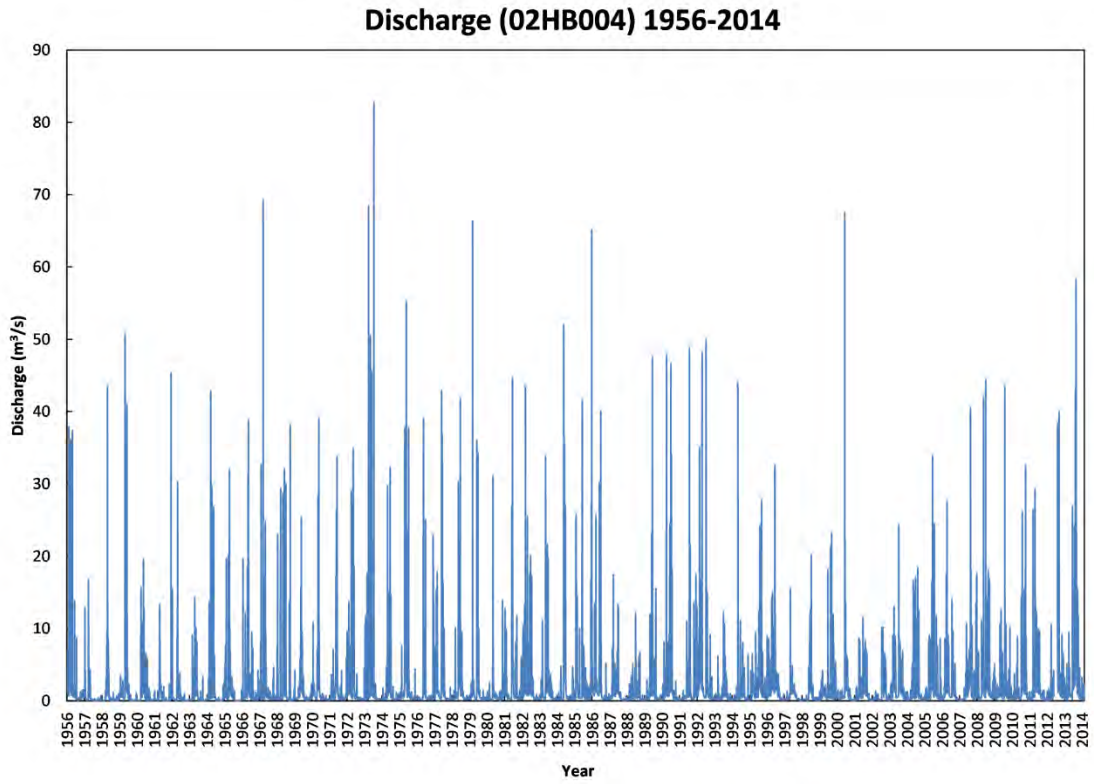


Figure 1: Daily discharge for Station 02HB004 from 1956 to 2014.

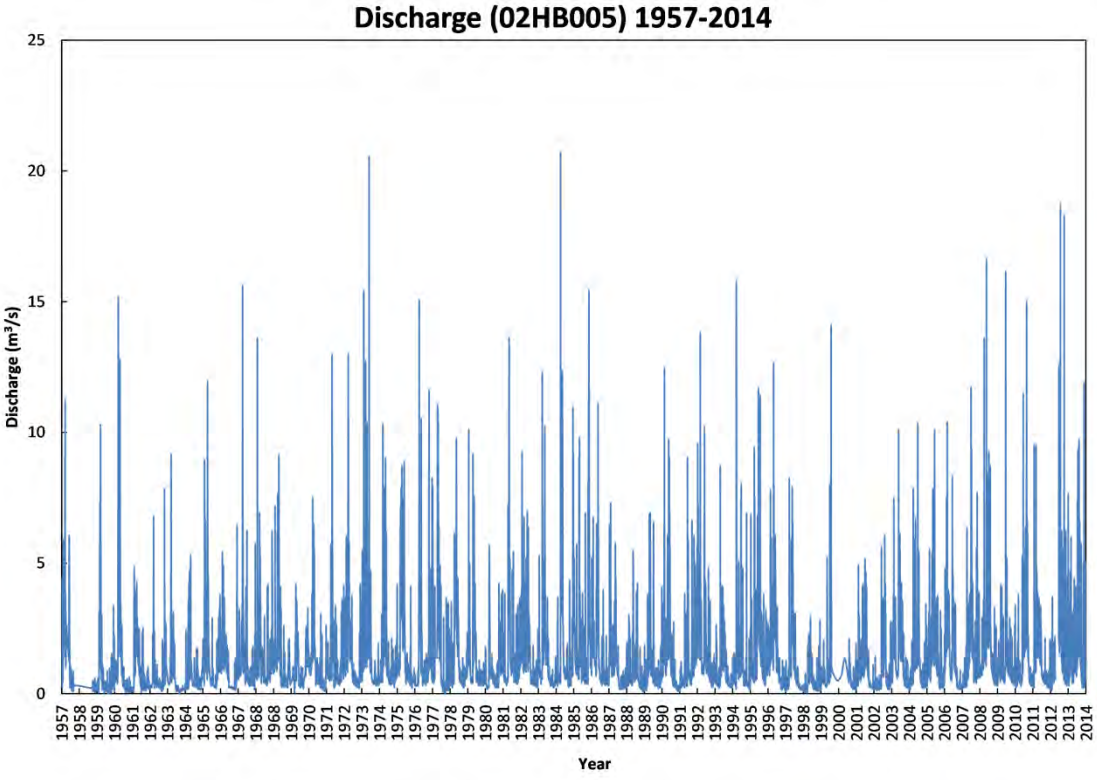


Figure 2: Daily discharge for Station 02HB005 from 2010 to 2014.

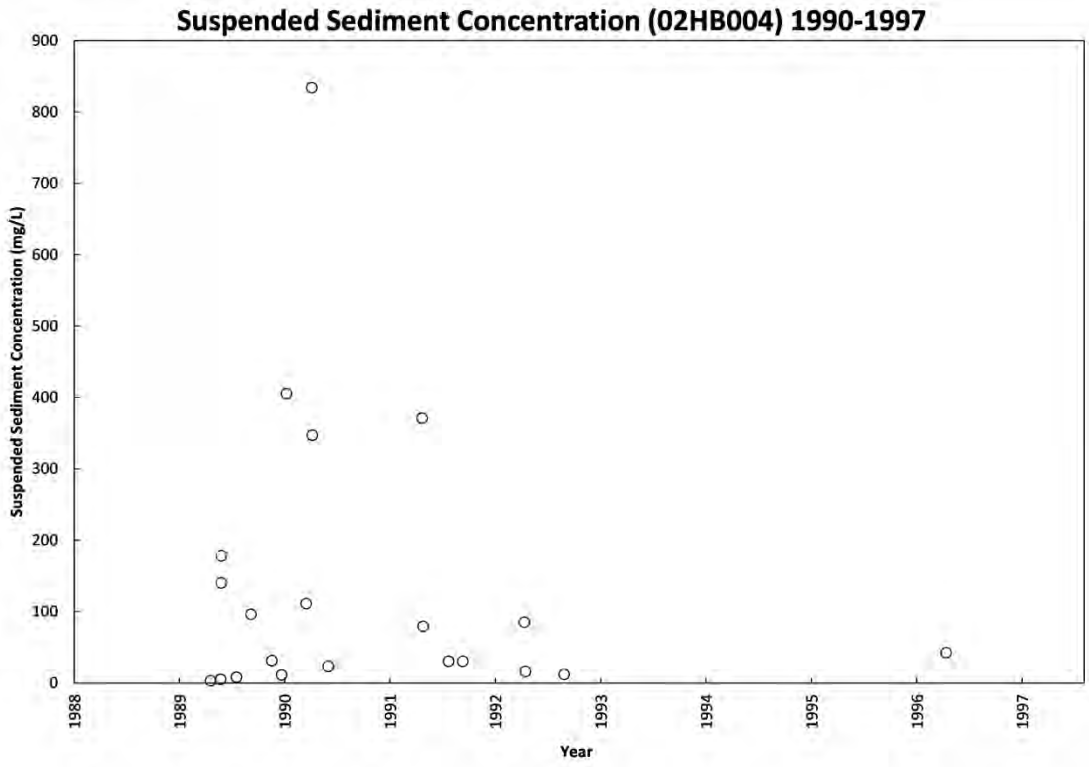


Figure 3: Suspended sediment concentration for Station 02HB004 from 1990 to 1997.

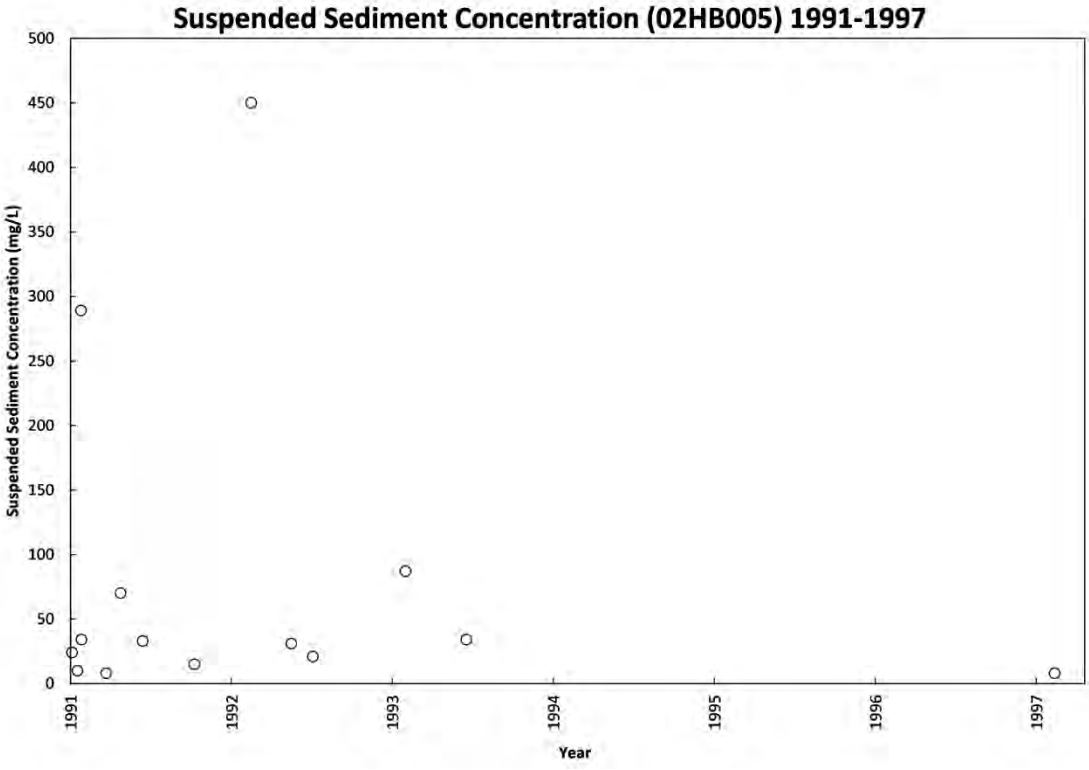


Figure 4: Suspended sediment concentration for Station 02HB005 from 1991 to 1997.

APPENDIX G
PWQM DATA

Appendix G: Suspended Sediment Concentration data for PWQM station 06006300102

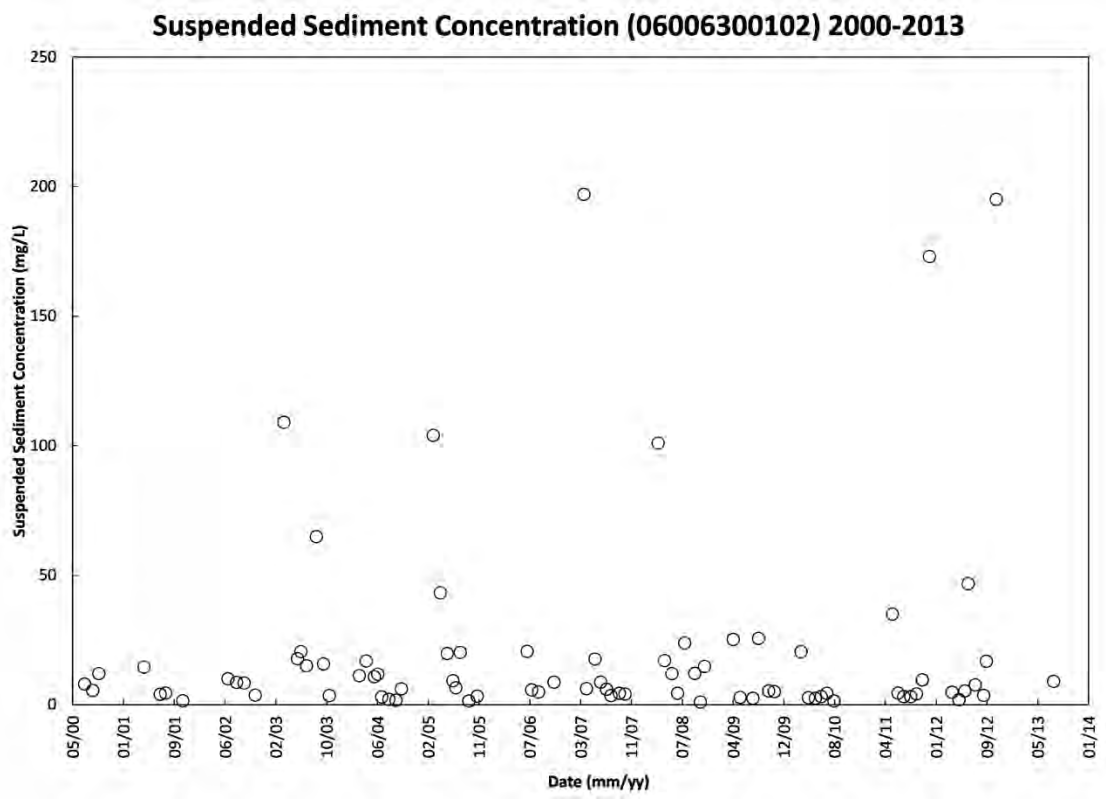


Figure 1: Suspended sediment concentration for Station 06006300102 from 2000 to 2013.

APPENDIX H
REGION OF HALTON TURBIDITY DATA

Appendix H: Region of Halton turbidity data for the Water Treatment Plant Intake and Discharge Data for 16 Mile Creek

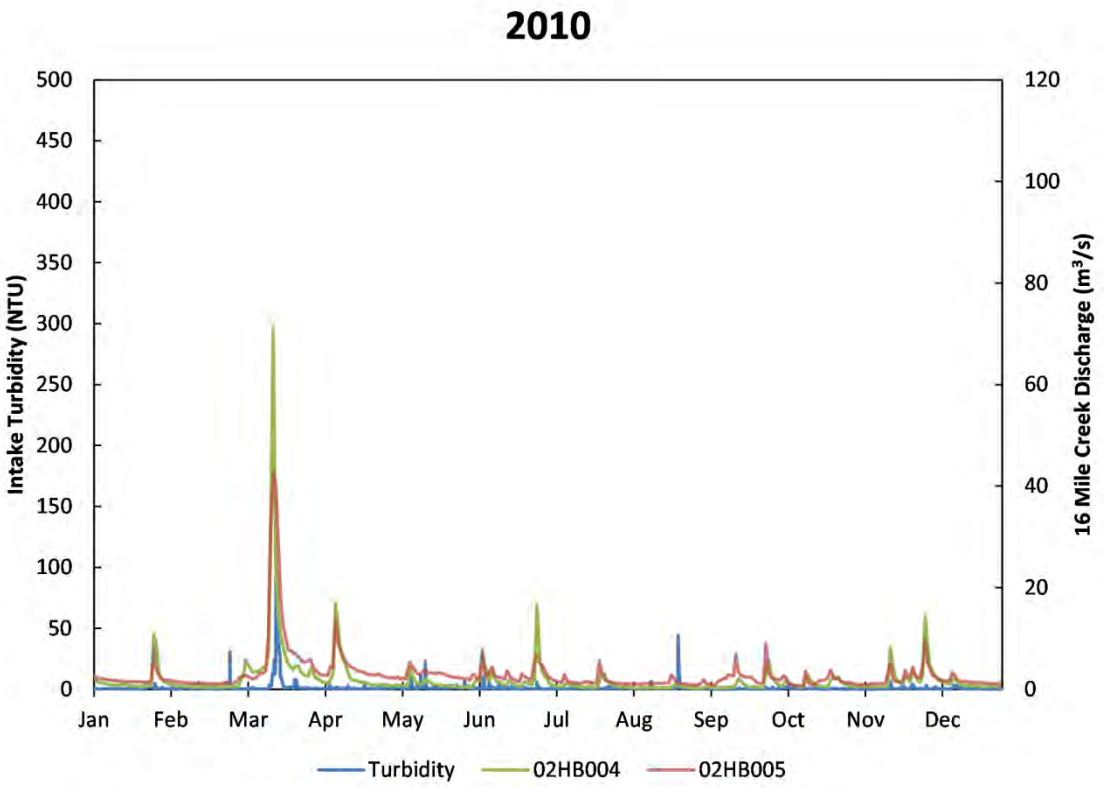


Figure 1: Turbidity at the Water Treatment Plant Intake and discharge for Sixteen Mile Creek estimated through transposition of flows at the two monitoring locations in 2010.

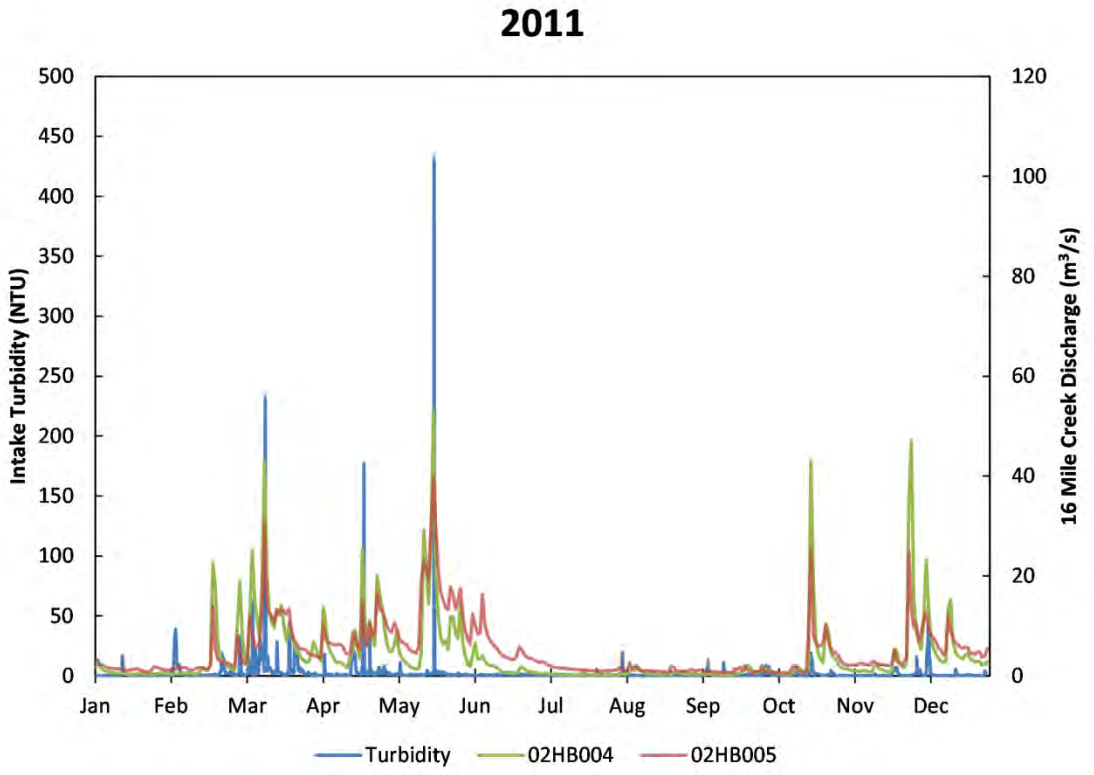


Figure 2: Turbidity at the Water Treatment Plant Intake and discharge for Sixteen Mile Creek estimated through transposition of flows at the two monitoring locations in 2011.

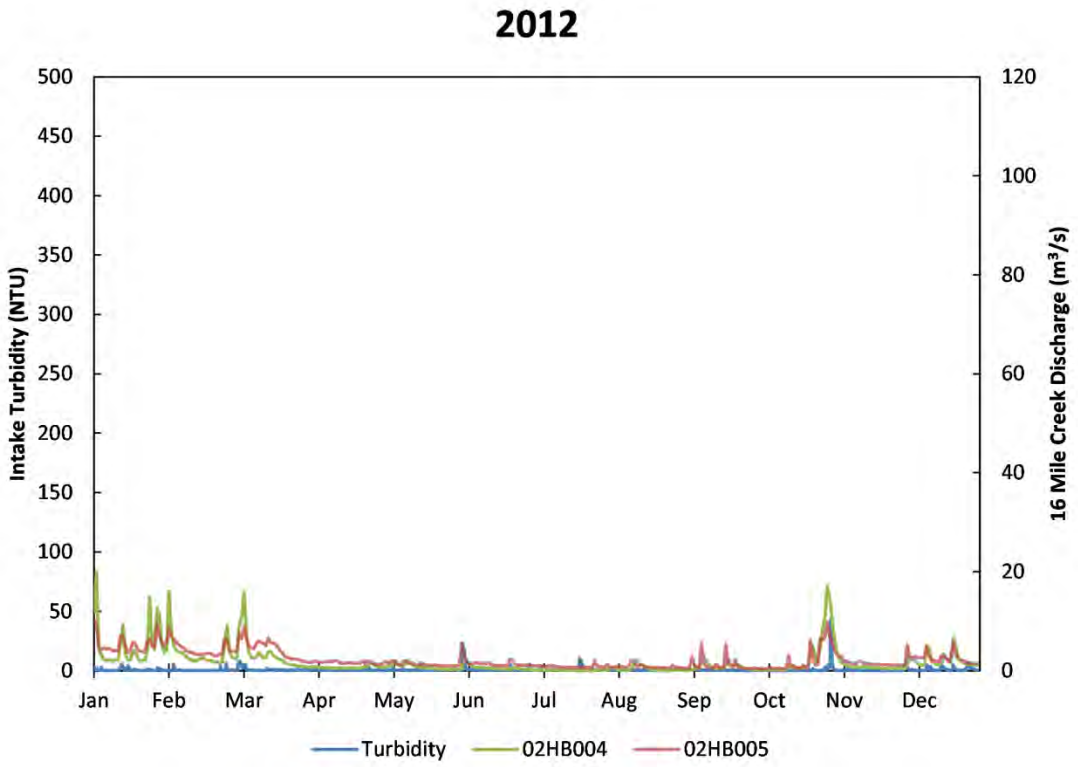


Figure 3: Turbidity at the Water Treatment Plant Intake and discharge for Sixteen Mile Creek estimated through transposition of flows at the two monitoring locations in 2012.

Appendix H: Region of Halton turbidity data for the Water Treatment Plant Intake and Discharge Data for 16 Mile Creek

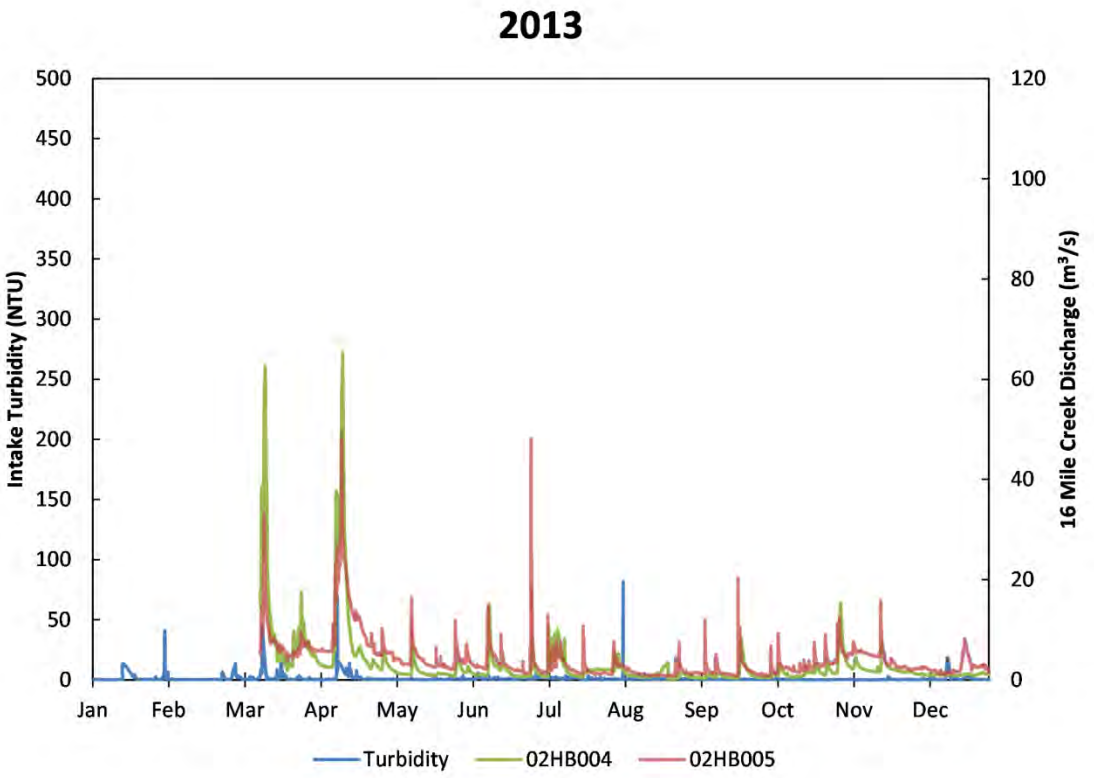
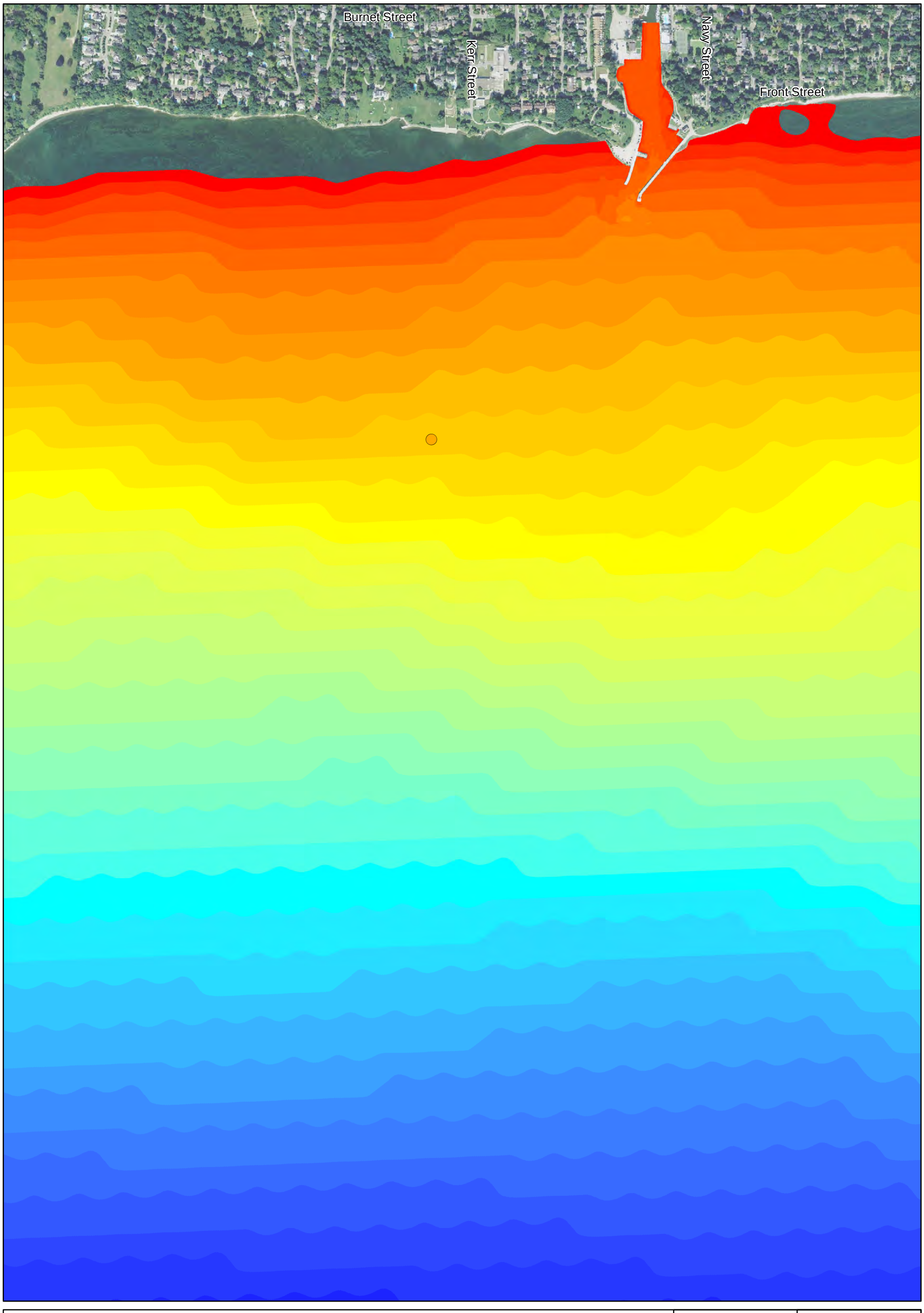


Figure 4: Turbidity at the Water Treatment Plant Intake and discharge for Sixteen Mile Creek estimated through transposition of flows at the two monitoring locations in 2013.

APPENDIX I
NOAA & GDH BATHYMETRY



Legend

Water Depth (m) *

- -1.00 - 0.00
- 0.00 - 5.00
- 5.00 - 1.00
- 10.00 - 15.00
- 15.00 - 20.00
- 20.00 - 25.00
- 25.00 - 30.00
- 30.00 - 35.00
- 35.00 - 40.00

Oakville WPP Intake

* Depths are relative to Chart Datum for Lake Ontario (74.2 metres above I.G.L.D. 1985)

Oakville WPP Intake: GHD, 2014; Water Depth: NOAA, 1999, and GHD, 2013-2014; Imagery: Google Earth Pro, 2009

Sixteen Mile Creek

Lake Ontario Bathymetry

0 100 200

Metres

APPENDIX I

DATE: SEPT. 2014

PROJECT: 8811884.100

DRAWN BY: J.D., L.P.

GHD

APPENDIX J
JULY 2014 TSS RESULTS

47.4 mg/L
57.2 mg/L
67.4 mg/L

Navy Street

Randall Street

Lakeshore Road West

Kerr Street

87.1 mg/L
112 mg/L

See Inset

46.8 mg/L
13.1 mg/L

3.4 mg/L
14.5 mg/L

15.2 mg/L
7.7 mg/L

28.6 mg/L
12.1 mg/L

16.1 mg/L
6.5 mg/L

15.6 mg/L
6.8 mg/L

15.3 mg/L
8.9 mg/L

12.9 mg/L
12 mg/L

9.1 mg/L
8.5 mg/L

Lake Ontario

11.8 mg/L
9.1 mg/L

8.3 mg/L
9.3 mg/L

13.4 mg/L
13.5 mg/L

26.6 mg/L
14.0 mg/L

7 mg/L
9.3 mg/L

6.8 mg/L
8.9 mg/L

Image © 2014 TerraMetrics
Image © 2014 DigitalGlobe

INSET

52.4 mg/L

116 mg/L
72.9 mg/L

111 mg/L
34.6 mg/L

76.5 mg/L
7.4 mg/L

3.4 mg/L
14.5 mg/L

NTS

©2010 Google™

Legend

- Oakville WPP Intake
- Sampling Location
- Approximate Edge of Plume
- Surface Layer TSS (mg/L)
- Subsurface Layer (~3 m depth) TSS (mg/L)

Oakville WPP Intake, Approximate Edge of Plume, Sampling Location,
Surface Layer and Subsurface Layer TSS: GHD, 2014; Imagery: Google Earth Pro, 2009

Sixteen Mile Creek

Total Suspended Solids

N

0 50 100

Metres

APPENDIX J
DATE: SEPT. 2014
PROJECT: 8811884.100
DRAWN BY: J.D., R.G.

GHD