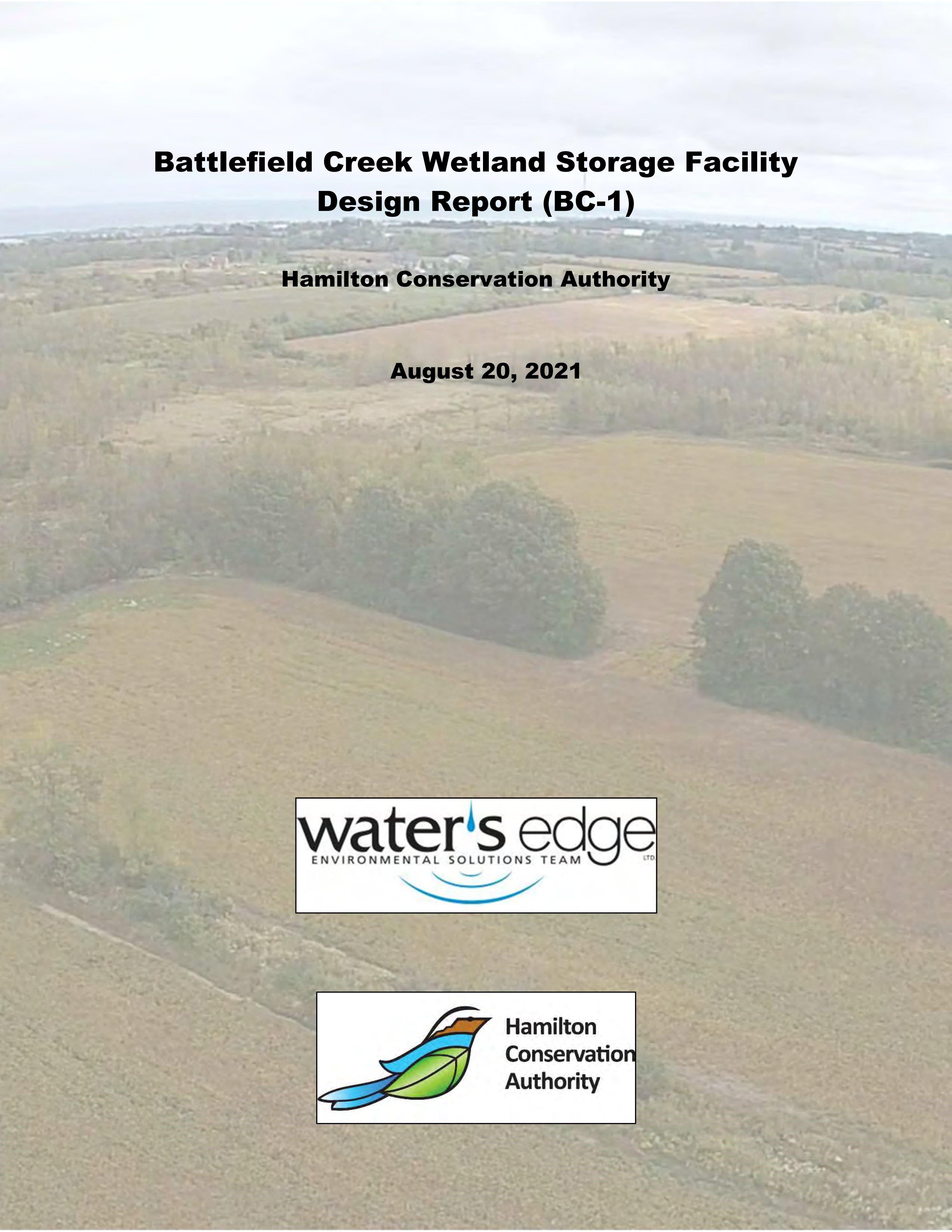

Battlefield Creek Wetland Storage Facility Design Report (BC-1)

Hamilton Conservation Authority

August 20, 2021

water's edge
ENVIRONMENTAL SOLUTIONS TEAM LTD.

WE19008
August 20, 2021

Mr. T. Scott Peck, B.A., DPA, MCIP, RPP, CMMIII
Deputy Chief Administrative Officer and Director, Watershed Planning & Engineering
Hamilton Region Conservation Authority
838 Mineral Springs Road
Ancaster, ON
L9G 4X1

Dear Mr. Scott:

RE: BC-1 Wetland Storage Design Project
Design Report

Please find attached our report for the above noted project entitled "*Battlefield Creek Wetland Storage Facility Design Report (BC-1)*". This report includes the plans prepared by Water's Edge in support of the design.

It was a pleasure working with you and the HCA team in preparing this design and we look forward to its implementation.

Respectfully submitted,

Ed Gazendam, Ph.D., P.Eng.,
President, Sr. Geomorphologist
Water's Edge

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1.0 INTRODUCTION

The Saltfleet Conservation Area, one of many Conservation Areas owned and operated by the Hamilton Region Conservation Authority (HCA), is comprised of several properties in the upper Stoney Creek and Battlefield Creek watersheds. One of parcels is located on the east side of First Road East, Hamilton (see **Figure 1-1**). This particular property is located south of the Niagara Escarpment and was recently purchased by the HCA specifically to create wetland areas to address flooding and erosion downstream within the urban area of Stoney Creek while creating natural heritage features associated with the wetland and creating passive recreational opportunities and links to conservation lands in this area. The property, Battlefield Creek 1 (BC-1) is currently vacant with no active management or visitor use on site.

1.1 Project Objectives

HCA has initiated the Saltfleet Conservation Area Wetland Restoration Program to undertake the creation of multiple wetlands in the upper Battlefield Creek and Stoney Creek watersheds to retain water to reduce flood and erosion risks downstream below the Niagara Escarpment in the urban area of Stoney Creek. Furthermore, the objectives also desired to enhance and enlarge existing wetland areas and to create new wetland areas where enhanced wetland hydrologic functions could reduce the impacts of high-water events and provide water to area watercourses during low flow periods. In addition, HCA desired to 1) restore the natural features and functions of the relatively degraded watercourses in the area; 2) restore, enhance and enlarge the natural heritage features associated with the floodplains, wetlands and watercourses of the area; 3) provide linkages within and between conservation area lands by utilizing the Dofasco Trail; and 4) enhance and create passive recreational opportunities along the Dofasco Trail.

In support, the HCA completed the 2011 ‘Draft’ Conservation Ontario Class Environmental Assessment (Class EA) for the Lower Stoney Creek and Lower Battlefield Creek (AMEC, 2011), the Program Overview (East Escarpment Conservation Area Watershed Restoration Program, 2015) and subsequently the Flood and Erosion Control Project Class Environmental Assessment (Amec Foster Wheeler, 2018). The *2011 ‘Draft’ Conservation Ontario Class Environmental Assessment (Class EA) for the Lower Stoney Creek and Lower Battlefield Creek,* recommended further determined assessment of flood and erosion controls above the Niagara Escarpment. The 2018 Flood and Erosion Control Class EA provided further detailed analyses of the preferred project alternatives, preferred locations for the wetlands and associated supporting engineering, floodplain hydrology and hydraulics information. In particular, the Class EA also detailed the design requirements for the proposed BC-1 facility with the end result being a passively-functioning, natural wetland that contributes to addressing downstream flooding and erosion.

1.2 Project Scope:

Building on the completed environmental assessment, the main objectives (scope) of this project are as follows:

a) complete the engineering and geomorphology design of the wetland, grading, any required berm and watercourse meandering/relocation;
b) prepare a design of the wetland to function naturally including habitat and planting considerations;
c) provide a Preliminary Design Report which includes solutions and associated budget costs for the project for HCA consideration and approval;
d) provide Detailed Design based on the Preliminary Design Report. This report must include Construction Plans and Specifications for all necessary aspects for the proposed work, with suitable detail for construction tendering purposes;
e) acquire approval from various governmental agencies including the City of Hamilton (for a site alteration permit for any area not located in HCA’s regulated areas), MECP and DFO; and,
f) In consultation with the Ministry of Natural Resources and Forestry. address all applicable requirements of the Lakes and Rivers Improvement Act, R.S.O., 1990 and the associated Technical Guidelines for the proposed facility.

In support of the design process, the 2018 Class EA stipulated that the following detailed assessments would need to be conducted:

a) Topographic survey of the storage facility and adjacent lands;
b) Geotechnical assessment to determine bedrock and groundwater elevations.
c) Soil quality assessment as material may be relocated off-site;
d) Hydrogeological assessment to determine groundwater fluctuations and potential recharge areas;
e) Terrestrial ecology (Vegetation) assessment, including ELC mapping, vegetation inventory, tree inventory, SAR survey, and significant wildlife habitat (SWH) screening, including bats;
f) Terrestrial ecology (Wildlife) assessment, including breeding bird survey, nocturnal amphibian survey, turtle surveys, SWH screening and SAR survey;
g) Fisheries and aquatic habitat mapping;
h) Stream morphology of the creek reaches within the storage facility;
i) Refined hydrologic and hydraulic assessment;
j) Cultural heritage assessment; and,
k) Archaeological Stage 1 assessment.

The proposed design, including all planning, design, construction plans and specifications, is to be completed in accordance with all applicable legislation, permit requirements, codes, and standards. Details of the specific project requirements were presented in the Project Terms of Reference and include:

a) Detailed grading including the wetland depths;
b) Storage volumes and elevations;
c) Flooding durations including the wetland wet period;
d) Baseflow attenuation through the control of storm runoff response;
e) Wetland terrestrial habitat requirements;
f) Aquatic habitat enhancements; and,
g) Bedrock and ground water elevations.

In addition, the study will re-evaluate the reduction in flooding and erosion downstream under the proposed wetland design (using the Wood 2018 preliminary analysis as a basis) and update the Floodplain Mapping to document the changes in the Regional Floodplain.

1.3 Flood and Erosion Control Project Class EA Vision for BC-1:

Figure 1-2 shows the proposed BC-1 wetland facility as envisioned by the previous study. The proposed facility would use the existing 1.75 m span by 0.9 m rise concrete box culvert on First Road East as the ultimate outlet for the proposed BC-1 facility. However, due to the limited depth of storage, it was proposed to raise the road by 1.8 m to 189.30 m or create an equivalent standalone berm upstream of the crossing. Approximately 346 m of road would have to be raised. The maximum elevation and depth of storage would be 189.00 m and 2.70 m based on providing 0.30 m to freeboard to the First Road East. No excavation would be required to achieve storage requirements. Portions of the ponding would be within HCA's property, but significant portions would also be on non-HCA property and across the Dofasco Trail. The total storage envisioned would be 200,000 m^3 in a single, on-line facility.

However, HCA subsequently realized that the possibility of using First Road East as a berm to contain the flood storage volumes would provide to be problematic, given the additional requirements and costs of using a municipal road for this purpose.

1.4 Study Team:

The Water's Edge team was engaged by the Hamilton Conservation Area (HCA) to complete necessary studies and prepare a Preliminary and Detailed Design Report for the BC-1 water retention facility, wetland and creek restoration within the Upper Battlefield Creek watershed. The Study Team consisted of the following key members (**Table 1-1**):

Table 1-1: Study Team Members

Scott Peck	Hamilton Conservation Authority (HCA)	Study Team Lead
Jonathan Bastian	HCA	Water Resources Engineering
Ed Gazendam, Ph.D., P.Eng.	Water's Edge	Consultant Team Project Manager and Senior Technical Specialist
Charles Mitz, Ph.D., P.Eng.	Greer Galloway	Sr. Hydrogeologist
Bernard Lee, P.Eng.-	Soil Engineers	Sr. Geotechnical Engineer
Basim Al-Ali, P.Eng.	Soil Engineers	Geotechnical Engineer
Ahmed Hassan, P.Eng.	Soil Engineers	Geotechnical Engineer
Tara Brenton	Natural Resource Solutions Inc. (NRSI)	Senior Terrestrial & Wetland Biologist /
Patrick Deacon	NRSI	Terrestrial and Wetland Biologist
Elaine Gosnell	NRSI	Terrestrial and Wetland Biologist
Gina McVeigh	NRSI	Aquatic Biologist
Ryan Good, M.A.Sc (Eng).	Water's Edge	Water Resources Engineering
Jangsoo Lee, M.Eng., P.Eng.	Water's Edge	Water Resources Engineer
Nik Gazendam, C.Tech, CISEC	Water's Edge	Sr. Technician
Garth Grimes	Detritus	Sr. Archaeologist

1.5 Study Area

The subject property is located at Part Lot 21 and Lot 22, Concession 5 in the former Saltfleet Township (amalgamated by the City of Hamilton in 2001). The property is approximately 73 hectares in area and is bounded by First Road East, the Dofasco 2000 Trail, Second Road East and Green Mountain Road East. It was previously a farm field in a low-lying area and is no longer farmed and is reverting to natural habitat.

The roughly rectangular site contains about 400 m of the main channel of Battlefield Creek which flows from east to west across the northern portion of the property.

The south half of the property forms a gently undulating plateau with elevations ranging from about 206 metres above mean sea level (mASL) along Green Mountain Road to about 201 mASL along the crest of a low escarpment (the Eramosa escarpment) oriented east-west and transecting the approximate mid-point of the property. From the escarpment, the ground surface slopes steeply to a second plateau at about 190 mASL elevation.

Within the broader area, the dominant topographic feature is the Niagara Escarpment which is located between 750 and 800 m north of the subject property and which marks the boundary between the resistant dolostone bedrock to the south and the more easily eroded shales which occur at the base of the escarpment and underlie the lake plain north of the Escarpment. Elevations drop over 100 m between the crest of the Escarpment and the shores of Lake Ontario.

Vegetation cover in the south half of the property is predominantly composed of row crops and hedgerows while the crest of the low escarpment is vegetated with a variety of trees and grasses. To the north of the low escarpment, the vegetation is more varied and consists of deciduous swamp, cultural thicket, meadow marsh, and cultural meadow. With the exception of the wooded area in the northwest corner of the property, referred to as a Green Ash Deciduous Swamp (see Ecological Land Classification by Natural Resource

Solutions Inc., in prep), the entire north part of the property was cleared and in agricultural use in 1943 based on aerial photographs obtained from the McMaster University Air Photo collection.

The Rural Hamilton Official Plan (OP, City of Hamilton 2018) identifies several natural heritage designations within the subject property (Map 1), including:

- The treed feature in the northwest is considered a Natural Heritage Features Core Area, Key Natural Heritage Feature - Significant Woodlands and is part of the Greenbelt Natural Heritage System;
- The treed feature in the southeast, as well as a treed feature on private land fronting onto Green Mountain Road East are considered Natural Heritage Feature - Linkages;
- The property contains a portion of the headwaters of Battlefield Creek which are considered Key Hydrologic Feature - Streams;
- The entire property is part of the Greenbelt Protected Countryside; and
- The Niagara Escarpment Plan Area is immediately north of the property, adjacent to the Dofasco 2000 Trail.

1.6 Applicable Policies, Legislation and Planning Studies

Table 1-2 summarizes the legislation, policies and planning studies that are specifically relevant to the proposed wetland, channel and flood mitigation works in relation to requirements for protection and mitigation during the completion of this work within the City of Hamilton.

Table 1-2 – Relevant Policies, Legislation and Planning Studies

Policy/Legislation	Description	Project Relevance
Provincial Policy Statement (PPS) (MMAH 2014)	• Issued under the authority of Section 3 of the Planning Act and came into effect on April 30, 2014, replacing the 2005 PPS (MMAH 2005). • Section 2.1 of the PPS – Natural Heritage establishes clear direction on the adoption of an ecosystem approach and the protection of resources that have been identified as 'significant'. • Provincial Plans including the Greenbelt Plan and Niagara Escarpment Plan take precedence over the PPS. • Section 3.1.4 states that: "*Development and site alteration may be permitted in certain areas associated with the flooding hazard along river, stream and small inland lake systems … where the development is limited to uses which by their nature must locate within the floodway, including flood and/or erosion control works or minor additions or passive non-structural uses which do not affect flood flows.*" • Section 3.1.6 states that "*Where the two zone concept for flood plains is applied, development and site alteration may be permitted in the flood fringe, subject to appropriate floodproofing to the flooding hazard elevation or another flooding hazard standard approved by the Minister of Natural Resources.*" • Section 3.1.7 states that development and site alteration may occur within hazard lands where the effects can be mitigated and no adverse environmental impacts will occur. • The Natural Heritage Reference Manual (MNRF 2010) and the Significant Wildlife Habitat Technical Guide (OMNR 2000, MNRF 2012) were prepared by the MNRF to provide guidance on identifying natural features and in interpreting the Natural Heritage sections of the PPS.	• Based on a preliminary analysis and field surveys, natural features were identified within the study area which have implications under the PPS: o Significant Woodland o Fish habitat o Confirmed and candidate SWH o Candidate habitat for Species at Risk (SAR).

Policy/Legislation	Description	Project Relevance
Endangered Species Act (ESA) (Government of Ontario 2007)	• The ESA prohibits killing, harming, harassing or capturing Endangered and Threatened species and protects their habitats from damage and destruction.	• Based on a preliminary analysis, 80 SAR or SCC were identified as having the potential to occur within the Study Area based on habitat present. • Based on field surveys, 2 SAR birds and a SAR bat or bats belonging to the Myotis species grouping were observed. • Habitat may be present for SAR bat roosting, foraging and travel corridors (flyways). Regulated habitat for the 2 SAR birds is not present within the property. • The limit of disturbance associated with the proposed berms and wetland habitats will not directly impact these habitats.
Migratory Birds Convention Act *(Government of Canada 1994)*	• The MBCA protects migratory game birds, insectivorous birds, and several other migratory non-game birds from persecution in the form of harassment. • The schedule of on-site work must consider the MBCA window, with timing of breeding bird season generally extending between late March to late August. • “Incidental take” is considered illegal, with the exception of a permit obtained by the Canadian Wildlife Service (CWS).	• Numerous species protected by the Migratory Birds Convention Act were identified in background screening for the study area and confirmed as present during surveys. • The timing of construction activities, especially vegetation clearing must have consideration for the MBCA.

Policy/Legislation	Description	Project Relevance
The Canadian Fisheries Act *(Government of Canada 2019b)*	• Under the updated federal Fisheries Act, fish are protected through 2 core prohibitions: Section 34.4(1) the death of fish by means other than fishing, and Section 35(1) the harmful alteration, disruption, or destruction (HADD) of fish habitat (Government of Canada 2019). • Any proposed work, undertaking, or activity should aim to avoid causing the death of fish, or the harmful alteration, disruption or destruction of fish habitat through the course or as a result of any proposed undertaking. Fish habitat is defined as “spawning grounds and any other areas, including nursery, rearing, food supply and migration areas, on which fish depend directly or indirectly in order to carry out their life processes”. • If there is any proposed work below the high-water mark or channel itself, a proponent-led Department of Fisheries and Oceans (DFO) assessment must be completed for the proposed works to determine if the works have the potential to contravene the Fisheries Act and require a request for review by the Fisheries Protection Program. • If impacts to fish or fish habitat cannot be mitigated effectively, a Fisheries Act Authorization may be required.	• If any work is to be completed in the vicinity of the watercourse within the subject property, a proponent-led DFO assessment is required (detailed design is completed) to ensure that the works will result in no residual negative effects to fish or fish habitat. • Based on the preliminary design, an assessment was completed and indicated that a request for review should be submitted. • An RfR will be submitted to the Fisheries Protection Program in November 2020. Once submitted, it is currently taking 4-5 months for a biologist to be assigned to the project. • DFO should be consulted as early in the process as feasible. • Pending the works and result of the DFO review, an Authorization may be required. This will result in off-setting being needed and a Letter of Credit from HCA.

Policy/Legislation	Description	Project Relevance
Fish and Wildlife Conservation Act *(Government of Ontario 1997)*	• The FWCA provides protection for certain bird species, not protected under the MBCA (i.e. raptors), as well as furbearing mammals and their dens or habitual dwellings, aside from the Red Fox (Vulpes vulpes) and Striped Skunk (Mephitis mephitis). • The FWCA provides protection for fish.	• The timing of construction activities, especially vegetation removal, must have consideration for bird nesting and den sites for furbearing mammals. • A permit may be required from the MNRF to remove fish and other wildlife species prior to any de-watering during construction if required. • No dens (active or inactive) were noted within the proposed development area. • Wildlife sweeps by qualified biologists may be warranted prior to any vegetation removals/clearing.
Greenbelt Plan (MMAH 2017)	• The Greenbelt Plan was prepared under the authority of the Greenbelt Act (Government of Ontario 2005a) and builds upon the existing policy framework established in the PPS. • The Plan identifies where urbanization should not occur to provide permanent protection to the agricultural land base and the natural ecological features in the Greater Golden Horseshoe area. • The Plan identifies the "Protected Countryside" which is further divided into the: o Agricultural System, o Natural System and o Settlement Areas. • The "Natural System" consists of the "Natural Heritage System" and the "Water Resources System".	• The entire subject property falls within the Greenbelt Protected Countryside. • The treed area in the northwest extent of the subject property is considered part of the Natural Heritage System (NHS). • A minimum 30m vegetation protection zone from the dripline of the woodland is typically required. A proposal for new development or site alteration within 120 metres of a significant woodland within the NHS requires an evaluation to identify any extension beyond the 30 metre minimum vegetation protection zone sufficient for the protection and maintenance of the feature and its functions (Government of Ontario 2005b). • Notwithstanding the previous point, development or site alterations is permitted within a key natural heritage feature or key hydrological feature for conservation and flood or erosion control projects, but only if they have been demonstrated to be necessary in the public interest and after all alternatives have been considered.

Policy/Legislation	Description	Project Relevance
HCA Ontario Regulation 161/06 *(Government of Ontario 2013)*	• Regulation issued under Conservation Authorities Act, R.S.O. 1990. • Through this regulation, the HCA has the responsibility to regulate activities in natural and hazardous areas (i.e., areas in and near rivers, streams, floodplains, wetlands, and slopes), and in areas where development could interfere with the hydrologic function of a wetland, including areas up to 120m of all Provincially Significant Wetlands (PSWs).	• Regulated watercourses, floodplain, and unevaluated wetlands are present within the subject property. • No PSWs are present within the study area. • In accordance with this policy, the detailed design plans have been prepared to avoid negative impacts to the regulated natural features and their ecological functions.
Rural Hamilton Official Plan (RHOP) *(City of Hamilton 2018)*	• The RHOP does not permit new developments or site alterations within PSW boundaries, or within or adjacent to Significant Woodlands, Environmentally Significant Areas or Streams. • If developments or site alterations are being proposed within or adjacent to (within 120m of) Core Areas under the RHOP, an EIS, to the satisfaction of the City in consultation with the HCA, is required.	• The treed feature in the northwestern extent of the property is considered a Core Area (Significant Woodland) under the RHOP. • A section of Battlefield Creek bisects the property and alterations are proposed to this feature and a tributary to this feature.
City of Hamilton - Rural Private Tree By-law (2000)	• Restricts and regulates the destruction of trees by cutting, burning, or other means in woodlands, and lists protected tree species based on tree circumference and diameter. • An application for minor exceptions from the by-law must be submitted and permitted prior to cutting, burning or otherwise destroying trees within the municipal limits.	• A general inventory of trees by vegetation community was conducted by a NRSI arborist to inform the preliminary design. • Within the vicinity of the development, a variety of mature trees were identified for protection within the swamp in the northwest and the H2 hedgerow. • A detailed tree inventory is being conducted by NRSI Certified Arborists. Potential removals and impacts to trees based on the detailed design will be provided under separate cover.

Policy/Legislation	Description	Project Relevance
Ministry of Natural Resources and Forestry – Lakes and Rivers Improvement Act *(RSO 1990 Chapter L.3)*	• The Lakes and Rivers Improvement Act (LRIA) provides the Minister of Natural Resources and Forestry with the legislative authority to govern the design, construction, operation, maintenance and safety of dams in Ontario.	• The proposed dam and its control structures do not meet the criteria and are not subject to Ministry Approval. As Battlefield Creek through the proposed wetland area is an intermittent river, the designed dam is subject to very specific criteria under Section 4, Table 1 of the LRIA Administrative Guide. The designed dam for Battlefield Creek does not qualify for any of the criteria under intermittent river with a reservoir surface area is <2 ha, <1.5 km^2 watershed area, and a dam height of <3 m above stream bed.
Ministry of Environment, Conservation and Parks *(Environmental Protection Act, RSO 1990 Chapter E.19 and Ontario Water Resources Act, RSO 1990 Chapter O.40)*	• Environmental Protection Act (specifically Section 9 of the Act for discharge of contaminants) and/or the Ontario Water Resources Act (specifically Section 53 of the Act for sewage works) require that the proponent receive an Environmental Compliance Approval	• Stormwater controls will require an ECA (previously known as a C of A).

2.0 EXISTING CONDITIONS

2.1 General Watershed Characteristics

The Upper Battlefield Creek watershed is located in the east end of the Hamilton Conservation Authority (HCA) watershed above the Niagara Escarpment. This area is comprised of agricultural uses, residential uses, fallow lands and remnant natural heritage features (wetlands, forest areas and watercourses). Battlefield Creek has a total area of 784 hectares with most of this area located above (i.e. south of) the Niagara Escarpment. Runoff from the southern half of the property (i.e. south of the Eramosa scarp) flows along two intermittent (and disappearing) channels. The westerly channel flows in a northwesterly direction (316o) to a doline (i.e. sinkhole) located at 601310 m E; 4783666 m N (Zone 17). The easterly channel follows a similar orientation (304o) before gradually cascading into the fractured bedrock at and to the east of the doline at 601344 m E; 4783656 m N. Both channels join in the subsurface near the first referenced doline and then flow in a north-northeasterly direction (005o) to their discharge at the base of the Eramosa Escarpment at approximately 601327 m E; 4783822 m N. Additional smaller discharge points occur locally along the full length of the scarp where they are visible as small seeps or areas of dense vegetation.

From the base of the Eramosa scarp, runoff follows an intermittent channel initially east and then north to its confluence with the main channel of Battlefield Creek along the south margin of the woodland in the northwest corner of the property.

The subject area is characterized by mild winters and relatively cool humid summers reflecting the lake effect from Lake Erie to the west and Lake Ontario to the east. Snow typically occurs during 4 to 5 months of the year. Modelling carried out by Aquafor Beech Ltd. for the nearby Elfrida Subwatershed (Aquafor Beech, 2018) suggests that the area receives approximately 930 mm of precipitation per year with groundwater recharge concentrated during the spring and fall seasons when precipitation exceeds evapotranspiration and when the ground is generally unfrozen.

The annual volume of surplus water is estimated at approximately 335 mm which is made up of both infiltration and runoff. In this area, infiltration and runoff are difficult to separate owing to the effects of karst which may lead infiltrated precipitation to break out in springs as secondary runoff, and runoff that is captured in solution-enlarged joints. Projected changes to the climate in the Great Lakes region, based on modelled scenarios, include a rise in average annual temperature (Dove-Thompson et al, 2011) along with an increase in annual precipitation. Based on the seasonal recharge patterns, it is likely that the two effects will largely counteract each other leaving annual groundwater recharge relatively unchanged.

2.2 Geology & Physiography

The City of Hamilton is located on the Waterdown moraine where glacial tills dominate the soil stratigraphy. The tills extend onto dolomite bedrock of Amabel Formation. In places, the tills have been partly eroded by the water action of glacial Lake Whittlesey, filled with lacustrine sand, silt, clay and water-laid till.

During the waning stages of the Wisconsinan glaciation, a series of glacial deposits were laid down over older strata and bedrock within the area. Menzies and Taylor (1998) described the following quaternary stratigraphy:

- Upper glacial lacustrine deposits
- Halton till (not known to occur within the subject lands)
- Lower glacial lacustrine deposits (not known to occur within the subject lands)

The upper glaciolacustrine deposits are predominantly fine textured silts and clays laid down when the area was inundated by a series of ponds during the deglaciation of the area when ice within the Lake Ontario basin prevented northward drainage. Sandy lacustrine deposits also occur but these are typically less widespread. Halton Till forms the upper glacial till in the area. Where present, Halton Till is fine textured and a reddish or grey/brown in colour. The till often contains silt or fine sand laminae/partings indicative of subaqueous deposition.

The surficial geology at the site is dominated by a stratum of glaciolacustrine silty clay with accumulations of organic soils (topsoil and peat) in low-lying areas, pavement structure and fill along the roads, and exposed bedrock in small areas where water erosion has removed the overburden cover.

During geotechnical drilling (see **Figure 2-1** for location of boreholes), the silty clay deposit was contacted in each of the boreholes beneath surface topsoil or road fill. The deposit extended to bedrock which was encountered at depths ranging from 0.6 to 5.5 m. Geotechnical testing (see **Appendix A**) indicated that the natural Water Content of the material ranged from 6% to 33% (median 19%) while the plastic and liquid limits were 21 and 43% respectively. Moisture contents below the plastic limit will normally allow for the formation and preservation of soil fractures and hence secondary fracture-related permeability.

2.3 Bedrock Geology

The project area is underlain by a sequence of gently south-dipping Paleozoic sedimentary rocks that were laid down as marine sediments in the Iapetus Ocean (pre-cursor to the Atlantic) While younger bedrock formations once covered the area, these have been entirely removed by erosion over time. The Niagara Escarpment, the dominant topographic feature in the area, was created by differential erosion within the softer more easily erodible shales of the Queenston Formation which outcrops at the base of the escarpment bordering the lake, and the hard resistant dolostones of the Lockport Group which forms the crest of the Escarpment. The Ordovician-age Queenston Formation is composed of alternating red and green shales and mudstones. It is easily eroded and weathers readily to a sticky red clay material and is prone to formation of “badlands” topography. It has a total reported thickness of 150 m (Menzies and Taylor, 1998) and is overlain by a series of Silurian-age strata that are generally well exposed along the Niagara Escarpment. These include the mixed siliciclastics and carbonates of the Clinton and Cataract Groups and the overlying shales and carbonates of the Lockport Group (Johnson et al. 1992).

The Clinton-Cataract Group includes, in ascending order: quartz sandstones of the Whirlpool Formation, dolostones of the Manitoulin Formation, grey to red shales of the Cabot Head Formation, red sandstones and shales of the Grimsby Formation, grey-green to white sandstones of the Thorold Formation, dark to green-grey shales of the Neahga Formation, dolostones and argillaceous dolostones of the Reynales Formation, crinoidal limestones of the Irondequoit Formation, grey shales and limestones of the Rochester Formation and argillaceous dolostones of the Decew Formation. The overlying Lockport Group (nomenclature after Brunton and Brintnell, 2011) contains the Gasport, Goat Island, and Eramosa Formations with the Eramosa Formation forming the cap rock of the Escarpment in the study area. The bedrock geology of the area is shown on **Figure 2-2**.

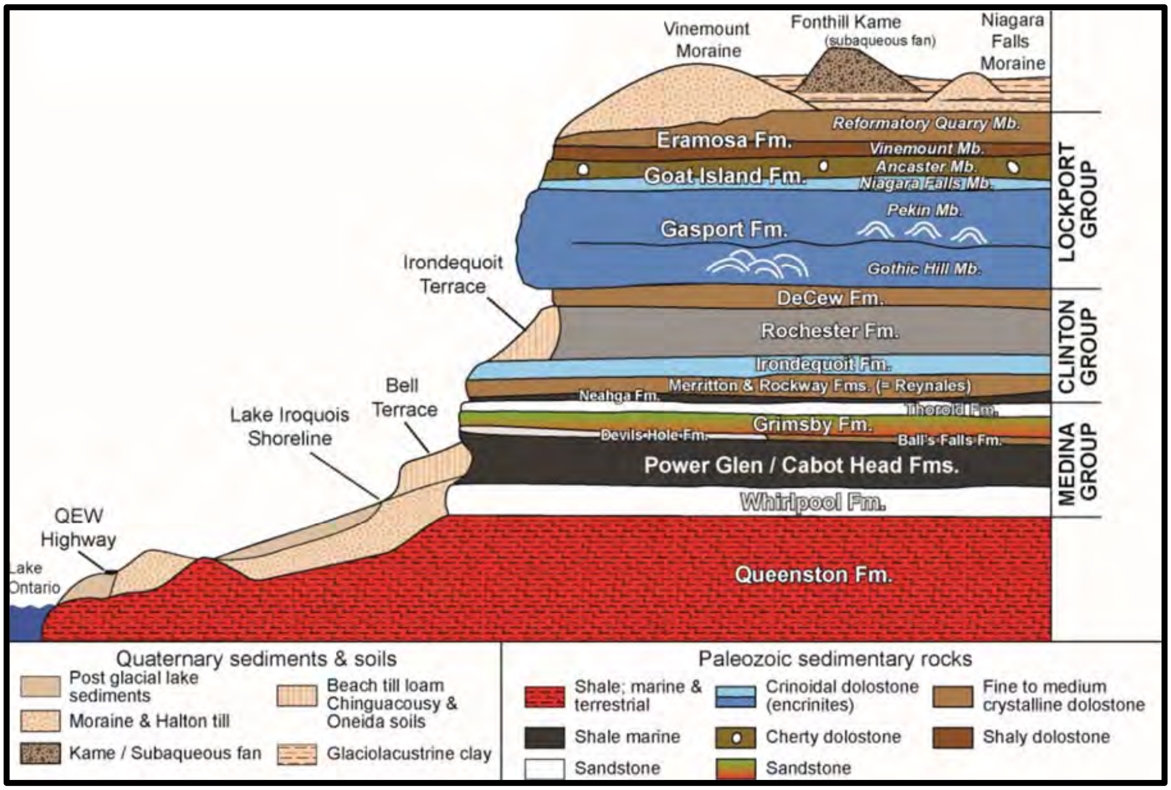

Figure 2-2 – Conceptual Geological Section (from Brett and Brunton, 2018)

Within the study area, the Eramosa Formation has been divided into two members: the Vinemount shale beds which are locally developed above the Goat Island Formation; and the Reformatory Quarry member. The Vinemount member comprises thinly bedded, fine-crystalline shaley dolostone. These beds are black to dark grey in freshly cut core and blasted outcrops but are a light grey colour in weathered outcrops (Brunton, 2009). There is a sharp contact between the Vinemount member and the overlying thicker bedded dolostones of the Reformatory Quarry member. The contact between the softer and more erodible Vinemount member and the more resistant Reformatory Quarry member is marked by a low scarp, referred to as the Eramosa scarp) located about 1 to 2 km south of the main Niagara Escarpment.

2.4 Geotechnical

A geotechnical investigation was completed by Soil Engineers Ltd and the full report, with relevant figures and appendices, can be found in **Appendix A**.

The field work, consisting of nine (9) sampled boreholes, was performed between March 26 and April 4, 2019. Groundwater monitoring wells, 50-mm in diameter, were installed in 6 selected boreholes to facilitate a hydrogeological study

2.4.1 Subsurface Conditions

The investigation has disclosed that beneath a topsoil veneer or road pavement, with a layer of earth fill in places, the area of investigation is underlain by silty clay, overlying dolomite and limestone bedrock at a depth ranging from 0.6 to 5.5 m from the prevailing ground surface.

Detailed descriptions of the encountered subsurface conditions are presented on the Borehole Logs. The revealed stratigraphy is plotted on the Subsurface Profile (see **Appendix A**). The engineering properties of the disclosed soils and bedrock are discussed herein.

2.4.2 Silty Clay

The silty clay deposit was contacted as the native stratum in the area of investigation. It is a glaciolacustrine deposit, laminated with silt and sand seams. Accordingly, its engineering properties pertaining to the project are given below:

- High frost susceptibility and soil-adfreezing potential.
- Low water erodibility.
- Low permeability, with an estimated coefficient of permeability of less than 10-7 cm/sec, a percolation rate above 80 min/cm and runoff coefficients of:

Slope	
0% - 2%	0.15
2% - 6%	0.20
6% +	0.28

- A cohesive-frictional soil, the shear strength is derived from consistency and augmented by the internal friction of the sand and silt.
- The clay will be stable in relatively steep slopes. However, prolonged exposure will allow infiltrating precipitation to saturate the silt layers and causing the wet silt to slough slowly.
- A poor pavement-supportive material, with an estimated California Bearing Ratio (CBR) value of 3%.
- Moderately high corrosivity to buried metal, with an estimated electrical resistivity of 2500 ohm·cm.

The obtainable degree of compaction is primarily dependent on the soil moisture and, to a lesser extent, on the type of compactor used and the effort applied. As a general guide, the typical water content values of the revealed soils for Standard Proctor compaction are presented in **Table 2-1**.

Table 2-1 - Estimated Water Content for Compaction

Soil Type	**Determined Natural Water Content (%)**	**Water Content (%) for Standard Proctor Compaction**	
		100% (optimum)	**Range for 95% or +**
Granular Fill	**4 to 10**	**7**	**4 to 10**
Earth Fill/Silty Clay	**6 to 33**	**20**	**16 to 24**

The above values show that the contacted soils are mostly suitable for a 95% or + Standard Proctor compaction. Wet or weathered soils will require aeration prior to structural compaction. The existing earth fill must be sorted free of any deleterious materials prior to its use as structural backfill. The lifts for compaction should be limited to 20 cm, or to a suitable thickness as assessed by test strips performed by the equipment which will be used at the time of construction.

2.4.3 Bedrock

Refusal to auger drilling was contacted in the boreholes, at 0.6 to 5.5 m from the prevailing ground surface, or between El. 182.4 m and El. 187.5 m. It represents bedrock in this vicinity

2.4.4 Construction Recommendations

All excavation should be carried out in accordance with Ontario Regulation 213/91. For excavation purposes, the types of soils are classified in **Table 2-2**.

Table 2-2 - Classification of Soils for Excavation

Material	Type
Bedrock	1
Silty Clay	2
Earth Fill	3

Bedrock excavation is not expected nor required based on the current design. If necessary, bedrock excavation within 1.0 to 1.5 m into the bedrock will require a heavy-duty excavator equipped with a rock-ripper and pneumatic hammer. Any excavation into the sound bedrock will require rock blasting. A blasting specialist must be consulted, and the surrounding structures must be carefully inspected and surveyed before blasting to prevent unwarranted damage claims arising from blasting. The yield of groundwater in excavation is anticipated to be slow in rate and limited in quantity. Any groundwater yield from the rock fractures may be appreciable initially but will decrease with conventional pumping from sumps.

Earth fill to be used for the embankment around the wetland shall consist of low permeability clay material. Selected on site native silty clay, free of organics, is suitable for the construction of the embankment. The earth fill for an embankment should be compacted in lifts not exceeding 200 mm, to a minimum of 98% of the Standard Proctor Maximum Dry Density (SPMDD), with the water content close to its optimum moisture content.

In preparation of the subgrade for embankment, topsoil and organic soils should be removed. The weathered soils shall be sub-excavated and the ground shall be proof-rolled. The fill placement and compaction should be inspected by either a geotechnical engineer, or a geotechnical technician under the supervision of a geotechnical engineer under full-time basis. The sides of earth embankment should be sloped at 1 vertical:3+ horizontal in the dry zone and 1 vertical:4+ horizontal in the wet zone and within 1 m above the design water level. All the exposed slopes must be vegetated or sodded to protect from erosion.

Rock fragments and granular fill can be used in areas where water retention is not necessary. Water channels and spillways should be provided with a liner for erosion resistance, consisting of rip-rap stone or gabion mattress above a filter fabric. The lining should extend from the walls over the entire basin. Service pipes in the earth embankment should be provided with anti-seepage collars in 25 m intervals, consisting of either clay or concrete plugs to protect the subsoils from water seepage through the bedding, which can result in loss of ground and creating a cavity in the embankment.

2.5 Chemical Analysis of Soil Samples

Soil Engineers completed the sampling and chemical analyses of soil samples collected from geotechnical boreholes (see Section 2.3 for locations). The purpose of the investigation was to determine the environmental quality of the soil within the Study Area should removal of the soil be required.

The field work, consisting of drilling of eight (8) geotechnical boreholes, was performed on April 4 and 9, 2019. The boreholes were drilled to depths ranging from 0.6 m to 7.1 m below ground surface. The boreholes were excavated to the sampling depths by a drilling rig. Soil samples were retrieved from the test pits using a split spoon for soil classification and visual and olfactory observations. The sampling tool (i.e., steel shovel) is decontaminated prior to initial use, between the sampling locations and at the completion of sampling activities. The sampling tool is manually scrubbed with a brush using a phosphate-free solution and power washed to remove any adhered soils, foreign material and potential contaminants.

The analytical results of the soil sampling were compared to the following Ministry of the Environment Conservation and Parks (MOECP) Standards:

1) Table 1, Full Depth Background Site Condition Standards for Residential/Parkland/Institutional/Industrial/Commercial/Community uses, in accordance with

the "Soil, Ground Water and Sediment Standards for Use Under Part XV.I of the Environmental Protection Act" (EPA), April 15, 2011 (hereinafter referred to as "**Table 1 Standards**");

2) Table 2, Full Depth Generic Site Condition Standards in a Potable Ground Water Condition for Residential/Parkland/Institutional Property uses, for coarse textured soil, in accordance with the "Soil, Ground Water and Sediment Standards for Use Under Part XV.1 of the Environmental Protection Act" (EPA), April 15, 2011 (hereinafter referred to as "**Table 2 RPI Standards**"); and,
3) Table 2, Full Depth Generic Site Condition Standards in a Potable Ground Water Condition for Industrial/Community/Commercial Property uses, for coarse textured soil, in accordance with the "Soil, Ground Water and Sediment Standards for Use Under Part XV.1 of the Environmental Protection Act" (EPA), April 15, 2011 (hereinafter referred to as "**Table 2 ICC Standards**").

A total of ten (10) representative soil samples were retrieved from boreholes excavated at the site. No evidence of potential contamination was documented in any of the retrieved soil samples. Head space vapour screening was also conducted for the retrieved soil samples using combustible gas detector (RKI Eagle) in methane elimination mode, having a minimum detection of 2 ppm (parts per million by volume). Soil vapour measurements of 0 ppm were recorded for the soil samples, indicating non-detectable combustible gases in the soil samples retrieved from the sampling locations.

Based on the soil vapour measurements and visual and olfactory observations, representative soil samples from the sampling locations were submitted to the laboratory for chemical analyses.

The samples were tested for chemical analysis of Metals and Inorganics (M&I), Petroleum Hydrocarbons (PHCs), and Organochlorine Pesticides (OCPs) parameters. A review of the results of the soil samples indicates that the tested parameters at the tested locations meet the Table 1 and Table 2 RPI Standards with the exception of the following parameters (**Table 2-3**):

Table 2-3: Results of Chemical Analysis of Soil Samples

Sample Name	Parameter	Unit	Table 1 Standards	Table 2 RPI Standards	Table 2 ICC Standards	Measured Value
BH 1/1	Cadmium	μgig	1.2	1.2	1.9	1.7
	Lead	μgig	120	120	120	**605**
	Zinc	μgig	290	340	340	**502**
BH 6/2	Cadmium	μgig	1.2	1.2	1.9	**2.6**
	Electrical Conductivity	mS/cm	O.S7	0.7	1.4	1.22
	Lead	μgig	120	120	120	**134**
	Sodium Adsorption Ratio	–	2.4	5	12	6.61
	Zinc	μgig	290	340	340	**516**
BH 7/2	Electrical Conductivity	mS/cm	0.57	0.7	1.4	**1.54**
	Sodium Adsorption Ratio	-	2.4	5	12	2.49

The results of the soil sample analyses indicates that the tested parameters at the sampling locations meet Table 2 ICC Standards, with the exception of Lead and Zinc concentrations in soil sample BH I/1 and BH6/2, and Electrical Conductivity in soil sample BH7/2, which does not meet any of the above motioned Standards (see Measured values in **red** in **Table 2-3** above). The heavy metal contaminants likely originated from vehicles as brake pads and coatings degrade and are washed into the watercourse during storm events. The low velocities of the storage facilities will allow some contaminants to settle to the bottom of the facility and improve the downstream water quality.

Further details can be found in the Soil Engineers Ltd. report in **Appendix B**.

2.6 Hydrogeology

Hydrogeological conditions were assessed and analyzed by Soil Engineers Ltd and more fully by Greer Galloway Ltd. whose full reports can be found in **Appendix A** and **Appendix C** respectively.

Groundwater and/or cave-in were evident in some boreholes. The groundwater level and occurrence of cave-in were recorded upon completion of drilling and sampling. The data are plotted on the Borehole Logs.

Groundwater was evident near the ground surface at the location of Boreholes 1 and 2. In Boreholes 3, 5A and 5B, groundwater and cave-in were recorded at a depth of 0.3 to 2.4 m, or El. 185.4 to 187.5 m. The groundwater represents perched water in the sand seams within the clay and above the bedrock. It is subject to seasonal fluctuation.

2.6.1 Hydrostratigraphy

Groundwater is encountered within the shallow overburden deposits and bedrock. Groundwater may be divided into three systems:

- A shallow silty clay aquitard (Aquitard 1)
- The overburden/weathered bedrock interface (Aquifer 1)
- A deep aquifer comprising fractured bedrock (Aquifer 2)

The silty clay overburden is mostly continuous across the site except on the Eramosa scarp and in places underlain by karst features where the soil has been washed into solution-widened fractures. This layer acts as an aquitard that limits recharge into the underlying aquifer(s) except where karst features capture runoff. The contact between the overburden and the weathered upper surface of the bedrock forms a thin and poor yielding aquifer (Aquifer 1) that is relatively continuous across the site. This aquifer is locally under-drained by fractures and karst in the underlying bedrock (Aquifer 2). Where fractured, especially where such fractures have been enlarged through the dissolution of carbonate minerals (i.e. karst), permeabilities and yields are very high. The unfractured bedrock, in contrast, is relatively impermeable.

The fine-textured glaciolacustrine silty clay deposits are relatively impermeable (reported hydraulic conductivity values (k) ranging from 10-6 to less than 10-8 m s-1). The overburden/bedrock interface generally exhibits a higher conductivity of 1 to 3 x 10-4 m s-1 but with localized lenses of higher permeability likely present where sedimentary structures have enhanced weathering. No measurements of bedrock permeability are available for the site, but solution-enlarged fractures will behave as open channels in the subsurface where present. The development of karst is largely limited to the Reformatory Quarry member of the Eramosa Formation which is the host rock for all karst features observed at the subject site, as well as numerous features such as sinking streams, dolines, springs and caves at the Eramosa Karst Conservation Area approximately 4 km to the southwest of the BC-1 property (Buck et al., 2002).

Substantially fewer karst features have been reported in the shaley Vinemount member that forms the upper bedrock beneath the north part of the BC-1 property where the constructed wetland is planned.

No karst features were observed in this part of the subject property during the current assessment.

2.6.2 Groundwater Flow

Precipitation falling on the BC-1 property contributes to recharge to the bedrock aquifer through either slow infiltration through the low permeability silty clay strata or through the capture of runoff by karst features. Shallow groundwater (i.e. within the silty clay and bedrock interface) will typically follow a flow path closely approximating that of the surface water drainage although the proximity of the subject site to the Niagara Escarpment will tend to cause a deviation from this rule of thumb where the bedrock interface intersects more penetrative fracture systems. The actual flow direction of the deeper groundwater flow is expected to be variable and controlled by the location of discharge points (i.e. springs) on the escarpment face and the geometry of interconnected bedrock fractures.

2.6.3 Groundwater – Surfacewater interactions

The average annual precipitation for the area is about 930 mm, with roughly 80% occurring as rainfall and the remainder as snowfall. Based on the moderate to deep-rooted vegetation over much of the site, we estimate that approximately 60% of precipitation will be lost through evaporation and transpiration with the balance available for runoff and infiltration. This water surplus will vary seasonally: during hot dry periods, the evapotranspiration will exceed the precipitation resulting in a moisture deficit and little groundwater recharge except for the capture of runoff in karst features such as dolines. Conversely, precipitation (and snowmelt) will typically exceed evapotranspiration in the spring and fall resulting in increased runoff and infiltration. This seasonal variability in recharge may result in wetland areas acting as groundwater discharge zones during the dry summer months and as recharge zones during the balance of the year.

Seasonal effects are apparent in the extended monitoring of Piezometers 1 to 5 (see Appendix B). Initial measurements taken in early May 2019 indicate that the groundwater table is located close to or slightly above ground elevation. During the balance of the spring and summer, the groundwater levels are observed to decline before recovery with increased precipitation and reduced evapotranspiration in the fall. MW-1 and MW-5B experienced a gradual decline beginning in early to mid-June and then fluctuating at a generally low level until recovery in October. Groundwater levels in MW-2 and MW-3 declined rapidly and fell below the piezometer tip by early July before recovering in early November.

MW-4 exhibited a rapid decline in water level to below the bottom of the piezometer by early August. No autumn data is available for this location. Water levels in MW-5A declined at a relatively constant rate until they fell below the bottom of the piezometer in early September. Rapid water level recovery occurred in early November. These seasonal fluctuations suggest that groundwater (except for discharge from karst features) contributes little if any significant baseflow to Battlefield Creek during the summer months, although low rates of recharge to the underlying bedrock aquifer occurs throughout.

Response to precipitation events was rapid in each of the wells but the rate at which the water level decreased following the rainfall events varied. Water level recovery was generally slow in MW-1 and MW-5B and rapid in MW-2 and MW-3. The absolute magnitude of the water level increase was generally similar in all piezometers.

With the construction of the new wetland areas in the north part of BC-1, the amount of evapotranspiration will increase as will the amount of water lost through infiltration into the underlying bedrock. However, these water losses are expected to be greatly outweighed by the increased storage provided by the ponds and the persistent saturation of the overburden/bedrock interface is likely to result in a more consistent contribution to groundwater and to baseflow to Battlefield Creek throughout the year.

2.7 Hydrology

The contributing drainage areas of the BC-1 site are predominantly agricultural, with some residential areas along Green Mountain Rd and Second Rd E. The headwaters are located above a small escarpment, referred to elsewhere as the Eramosa scarp. The headwaters that will contribute to the West Pond includes a karst formation where flows disappear into a depression upstream of the escarpment and reappear at the base of the escarpment. The drainage area contributing to the culvert at First Rd. E is about 2.2 km^2, with just under 1.5 km^2 draining to the location of the East Pond and 0.5 km^2 draining to the location of the West Pond.

The runoff characteristics are not natural and have be heavily influenced by agriculture in the area. Compared to natural areas, agricultural land uses will produce more runoff, and the use of agricultural ditches will reduce the Time of Concentration and increase peak flows downstream. Agricultural areas are also more prone to erosion and soil loss that can lead to water quality issues and excess sediment downstream. Satellite photos show minimal riparian areas along the agricultural ditches, so deposition is expected downstream where flow velocities are reduced, likely the open field downstream of the proposed East Pond. Phosphorus and Nitrogen pollution are also associated with agricultural runoff and soil loss, but the current depositional area in BC-1 likely removes much of the phosphorus with the sediment, and the natural vegetation in the area will likely uptake nitrogen, providing some natural treatment and reducing the risk of algal blooms in slow moving water. To fully understand the hydrologic conditions at key locations of the site, a hydrologic model was developed.

2.7.1 Methodology

Channel flows within the site were determined using HEC-HMS based on geomorphic survey data, orthoimagery-derived digital elevation model (DEM), and background data provided by HCA. A runoff curve number grid had previously been produced for the area as part of the Stoney and Battlefield Creek Floodplain Mapping Project based on the land use and soil drainage characteristics. Precipitation volumes were determined from the Hamilton RBG Gauge IDF curve. The 24-hour Chicago Storm distribution was used for all return period events, based on the Hamilton RBG IDF curve, and an R-value of 0.38 was used to determine peak rainfall timing. Parameters form the HCA Floodplain Mapping Standards were generally used, except for using the TR-55 method for determining the Time of Concentration. The TR-55 method is applicable to small rural watersheds but could introduce errors if applied to larger systems where the conditions are more heterogeneous.

2.7.1.1 Terrain Model Development

The digital terrain model (DTM) used for watershed delineation was developed based on five shapefiles provided by a mapping consultant retained by HCA. The topographic data was based on recent orthoimagery data collected as part of another project. The terrain data was delivered as 1m contour lines, DTM lines, DTM points, vector lines, and vector points. The vector lines and points are effectively breaklines and breakpoints that represent artificial features within the watershed. The DTM points and lines represent the underlying topography and may not accurately represent artificial features. The contour lines are a product of combining the other data into a cohesive representation of the actual topography including artificial features.

A proposed index of the floodplain mapping sheets was submitted to HCA for the selection of locations for detailed survey to verify the accuracy of the provided mapping data. At each of the two selected verification sites, ten points were surveyed to verify vertical spot accuracy, ten points were surveyed for contour accuracy, and three points were surveyed for horizontal accuracy. For the horizontal accuracy verification, features with well-defined boundaries were selected so that the location could be determined by looking at the intersection of breaklines, such as at the corner of a concrete headwall. The verification showed that the provided topographic data met the accuracy requirements from the HCA Floodplain Mapping Standards.

The topographic data was provided in the obsolete CRCS28:78 datum and was converted to CRCS2013 to be consistent with federal floodplain mapping guidelines. Since the Stoney Creek drainage area is relatively small compared to scale which the new datum applies, the elevations were adjusted linearly based on the average difference between the CRCS28:78 and CRCS2013 elevations of official MNRF survey benchmarks within the watershed.

Following the conversion of the data into CRCS2013, a DTM was developed for further hydrologic analysis. AutoCAD Civil 3D was used to create a surface using the provided data without the contours. The surface was then exported as a raster file for use in ArcGIS. The resulting raster had a resolution of 1 m^2 per pixel.

2.7.1.2 Terrain Pre-processing

Following the development of the DTM, additional manipulations were necessary to prepare the surface for use in the hydrologic model. HEC-GeoHMS version 10.1 was used for pre-processing and model development within ArcGIS. The first step was to ensure that flow paths were accurately represented in the DTM. This was accomplished using shapefiles of the storm sewer network and the creek centerlines and burning-in a channel through apparent obstructions such as bridges. The next step was to fill in depressions without apparent outlets. This step ensures that every cell within the watershed contributes flow to the outlet and there is no depression storage to attenuate peak flows, resulting in a more conservative representation of surface conditions. Following the above steps, a linear workflow was followed that started with creating a flow direction raster that indicated which direction a given cell would drain to. Next, a flow accumulation raster was created that represented the number of upstream cells contributing to a given cell. A stream network was then defined based on a minimum number of contributing cells, in this case streams were initially defined if the upstream drainage area was greater than 50 ha. The streams were then segmented based on significant flow change locations, and catchments were delineated based on the flow change locations. The catchment grid was converted into a polygon shapefile and metadata was added providing information on the connectivity of adjacent catchments. The stream raster was also converted into a polyline shapefile. Shapefiles were necessary to allow modelling information to be represented spatially in the attribute tables.

2.7.1.3 Model Preparation

Following the preprocessing steps, the automatically delineated catchments needed to be divided further based on critical locations, such as the east and west facility inlet and outlet locations. Once the subcatchments were satisfactory, several parameters were extracted based on the surface properties, listed below:

- River length
- River slope
- Basin slope
- Longest flowpath
- Basin centroid
- Centroid elevation
- Centroidal longest flowpath

2.7.1.4 Curve Number Grid

A Curve Number grid was created to assign each raster cell a Curve Number based on the soil and landuse characteristics of that point. Curve Numbers were selected from the TR-55 document from the NRCS (NRCS, 1986). This ensures accurate geospatial representation of runoff characteristics. Ontario soil survey data was used to define soil characteristics. The landuse data was adapted from SOLRIS v.3 land use data and corrected based on aerial imagery. Some assumptions were made based on the landuse description and the information needed to assign a Curve Number in the NRCS document. Landuses existed for commercial, industrial, open space/parks, forest, pasture, and water, but the remaining landuses required more information. All landuses were assumed to be in good condition. For residential districts, it was assumed that the average lot size was 1/4 of an acre based on lot measurements of several houses in the city from satellite imagery. It was assumed that rural areas could be represented by straight row crops in good condition without any additional best management practices (BMPs).

Following the preparation of the soil and landuse data, the layers were combined to create a layer that included both landuse and soil data. A lookup table was created to assign a Curve Number based on the landuse and the hydrologic soil group. The lookup table is shown in **Table -4**. The output yielded a Curve Number raster that was used to determine a weighted-average Curve Number for each subcatchment, which was then recorded in the attribute table of the subcatchment shapefile.

Table 2-4: Curve Number Lookup Table

Land use	Hydrologic Soil Group			
	A	B	C	D
Open Space/Lawns	56	71	81	85
Residential	61	75	83	87
Agriculture	66	74	82	86
Farmstead	59	74	82	86
Roads	98	98	98	98
Orchard/Tree Farm	43	65	76	82
Water	100	100	100	100
Forest	30	55	70	77
Meadow	46	66	77	82

2.7.1.5 HEC-HMS Model

Following the model preparation in HEC-GeoHMS, the basin model was exported from ArcGIS and then imported into HEC-HMS 4.3. This step automatically assigned all data from the shapefile attribute tables to the appropriate locations in HEC-HMS. The main components of the hydrologic model are the loss method, the transform method, and the routing method. Each of these components are discussed below.

2.7.1.6 Loss Method

The loss method selected was SCS Curve Number, due its relatively small data requirements and ease of calibration. The development of the Curve Number grid was described in section 0. In addition to the Curve Number and Percent Impervious determined previously, an Initial Abstraction was also calculated automatically in HEC-HMS. This calculation used the SCS method:

$$I_a = 0.2 * \frac{1000}{CN} - 10$$

2.7.1.7 Routing Method

The Muskingum-Cunge method for channel routing was selected because it is based on physical parameters and therefore do not require extensive calibration to use. According to the US Army Corps of Engineers, the Muskingum-Cunge routing method is applicable for use in large drainage networks with compound cross-sections (US Army Corps of Engineers, 1991). The Muskingum-Cunge method is a modification of the Muskingum method where the main channel and overbank flows are decoupled. The required data for Muskingum-Cunge includes the reach length, average slope, cross-section data, and Manning’s roughness coefficients. The reach lengths and slopes were determined during preprocessing, and a representative cross-section was cut from the DTM for each reach. Manning’s roughness coefficient (Manning’s n) was assigned to the main channel as well as left- and right-overbank areas. Estimates of Manning’s n were determined by analyzing the reach characteristics including riparian vegetation to determine the most appropriate roughness coefficient from Open Channel Hydraulics (Chow, 1959). The initial values of Manning’s n were selected as 0.035 for the main channel and 0.08 for overbank areas.

2.7.1.8 Transform Method

The Clark Unit Hydrograph was used as the transform method in the model. This method uses linear reservoir storage calculations to determine how the input hydrograph is translated and attenuated through a subcatchment. The two input parameters needed for these calculations are the Time of Concentration and a Storage Coefficient.

The Time of Concentration was determined using the TR-55 method for small agricultural watersheds. This method would not be accurate for large areas with varied land uses but is efficient for evaluating the small subcatchment draining to the BC-1 site.

The Storage Coefficient is dependent on the Time of Concentration and was calculated following the method described by Sabol (1988):

$$\frac{T_c}{R} = 1.46 - 0.0867\frac{L^2}{A}$$

Where, R is the Storage Coefficient (hr), L is the longest flow path (km) and A is the subcatchment area (km^2).

2.7.1.9 Detention Storage

No existing detention storage areas were present within the contributing drainage areas. The stage-storage-discharge relationship was programmed into HEC-HMS to facilitate comparison between existing and proposed conditions.

2.7.1.10 Precipitation Data

Once the basin had been set up in the model, the precipitation data was entered. The provided IDF table for the Environment Canada precipitation gauge at the Royal Botanical Gardens was used to develop the design storms. The IDF table is based on precipitation data from 1962-2003.

The Chicago Storm distribution uses separate functions to define the rising and falling limbs of the hyetograph. Rather than a rainfall volume, the Chicago Storm distribution uses three dimensionless parameters, a, b, and c, that are derived from an IDF curve (Alegre, 2016). In addition to those parameters, the ratio of peak timing to the total storm duration is needed. This value is recommended to be 0.38 in Ontario, according to the MTO Drainage Design Manual (Ministry of Transportation Ontario, 1997).

For continuous modelling to assess the erosion impacts of the proposed facility, continuous daily precipitation data from 1958-1997 at the Royal Botanical Gardens was used.

2.7.1.11 Time Steps

Both the precipitation events and channel routing used a time step of 10 minutes. This level of precision ensures that the peak flows are accurately represented in the modelling results.

The continuous modelling used much larger timesteps since the precipitation data intervals were much greater than the synthetic hyetographs. 24-hour precipitation data was used, while 1-hour modelling time steps were used.

2.7.1.12 Frequency Analysis

A single-station flood frequency analysis was conducted to provide flood return period estimates for Stoney Creek. The flood magnitudes are considered to be accurate if the period of record is at least as half long as the return period flow that is being calculated (MNRF, 2002). Flow records started on Stoney Creek and continued until 2010, when the station was converted to water level only due to rating curves becoming obsolete too quickly. There was also a gap in the data from June 1994 to April 1997. In total, there are 17 years of flow data that has some degree of quality control. Since the period of record on Stoney Creek is 17 years the 34-year return period flow is the largest that could be considered accurate. The unreliability of the rating curves and the recorded flows will compound with the errors associated with the short period of record, so the extreme events are certainly unreliable, while the more frequent events are only as accurate as the rating curve.

The frequency analysis was conducted using the Consolidated Frequency Analysis (CFA) version 3.1 from Environment Canada. The program uses the hydraulic database from the ECCC Data Explorer as its data source. The analysis therefore does not include the newest flow records since HCA took over management of the gauge in 2014. The analysis was conducted on the Stoney Creek gauge downstream of Queenston Rd., which is significantly upstream from the creek mouth, and upstream of the confluence with Battlefield Creek. Therefore, the flows resulting from the frequency analysis do not represent the ultimate peak flows in the watershed but can still be used for calibration. The peak flows determined for Stoney Creek at Queenston Rd. are shown in **Table 2-5**, with flows that were not considered reliable due to the period of record highlighted. A plot of the frequency analysis results is shown in **APPENDIX A.**

Table 2-5: Stoney Creek Flood Frequency Analysis

Return Period (years)	Generalized Extreme Value (m^3/s)	3 Parameter Lognormal (m^3/s)	Log-Pearson Type 3 (m^3/s)
1.05	2.77	4.13	4.13
1.25	6.06	5.86	6.11
2	11.1	9.96	10.1
5	19.2	19.6	18.8
10	25.6	29	27.3
20	32.7	40.7	38.2
50	43.4	60.1	57.7
100	52.8	78.3	77.3
200	63.5	100	102
500	79.8	135	147

The lack of large events in the period of record can also skew the entire return period flow curve. The largest peak flow in the period of record was 37.7 m^3/s, which occurred on March 14, 2007. There was no recorded precipitation in during the flood and only 1.8 mm in the preceding week, indicating that the flood event was driven entirely by snowmelt and is not indicative of the watershed response to a precipitation event. The large flow due to snowmelt will increase the return period flows in the frequency analysis, which are likely overestimating the peak flows for precipitation-driven events. Therefore, the actual return period flows for precipitation events will likely be lower than indicated in the above table.

To obtain more reliable estimates of the extreme events, OFAT was used to conduct regional flood frequency analysis, which incorporates data from other stations to produce a more robust estimate. The watershed delineated in OFAT was significantly smaller than the HEC-HMS delineation, with drainage areas of 15.5 and 21.1 m^3/s, respectively. OFAT also provides single station frequency analysis results using the same data that was used in CFA 3.1. The results produced in OFAT are shown in **Table 2-6**. It is noted that the primary multiple regression is the only method that is not affected by the short period of record. The other return period flows included in the primary multiple regression are significantly lower than the results of the single station flood frequency analysis and can be considered a lower bound on the return period flow estimates.

Table 2-6: OFAT Flood Frequency Analysis

Return Period (years)	Index Flood Flow (m^3/s)	Primary Multiple Regression (m^3/s)	Flood Flow Statistics (m^3/s)
2	7.6	6.85	12
5	9.96	10.97	21.3
10	11.66	13.97	29.1
20	13.37	16.98	37.8
50	15.98	23.59	51

100	17.82	27.35	62.3
200	19.65		74.8
500	22.02		93.6

To increase the confidence in the return period flows, frequency analysis was also conducted on the Red Hill Creek at Albion Falls gauge and pro-rated to Stoney Creek based on the contributing area of each flow gauge. The results of the pro-rated frequency analysis are shown in **Table 2-7**. It is noted that the Redhill Creek Watershed is regulated with stormwater controls, which serve to reduce the peak flows. Therefore, the unregulated peak flows will likely be higher than those shown in the table.

Table 2-7: Redhill Creek Frequency Analysis Pro-Rated for Stoney Creek

Return Period (years)	Generalized Extreme Value (m^3/s)	3 Parameter Lognormal (m^3/s)	Log-Pearson Type 3 (m^3/s)
1.05	9.42	8.13	10.68
1.25	13.37	14.09	13.73
2	17.23	17.95	17.05
5	20.82	20.37	20.37
10	22.53	21.27	22.08
20	23.69	21.90	23.42
50	24.86	22.44	24.95
100	25.49	22.71	25.85
200	25.94	22.97	26.65
500	26.38	23.24	27.55

2.7.1.12 Calibration and Validation

The available flow and water surface elevation data for Stoney Creek was determined by Water Survey Canada to be unreliable due to the highly dynamic nature of the creek caused by the sediment transport regime. The rapidly changing cross-sections led to rating curves developed for the site to quickly become obsolete and produce erroneous results. Calibrating the model based on unreliable data will skew the results and introduce a source of systematic error.

Instead, model validation was performed by taking all available flow frequency data to narrow down the range of expected flows, and if the new model flows are within that range, then the model can be considered valid. The significant limitations of each of the frequency analysis methods as well as the general lack of agreement between the methods leads to a large range of expected flows. Based on the frequency analysis results, the expected range for the 100-year flow is 17.8 m^3/s to 78.3 m^3/s, although associated errors in the single station frequency analysis suggest that the actual 100-year flow is closer to the low end of the range. The modelled 100-year flow rate at the flow gauge was 32.0 m^3/s, which is within the expected range and can be considered valid.

While calibration and validation against other models is not a precise method for determining peak flows, the degree of consistency between models combined with an assessment of their underlying methods can provide important information about expected results. **Table 2-8** shows the 2018 study flows compared to the BC-1 model flows at First Road East. The flow comparison shows that the 2020 model produces slightly higher peak flows for frequent events, and slightly lower peak flows for extreme events compared to the 2018 model.

The modelling parameters selected in the 2020 modelling are based on HCA Floodplain Mapping Standards. A key difference between the 2020 model and the 2018 model is the rainfall distribution used to produce the return period rainfall hyetographs. The 2020 model used the 24-hour Chicago Storm distribution, which is asymmetrical, with the most intense rainfall occurring before the midway point of the storm. The 2018 model used the 12-hour SCS Type II distribution, which is a symmetrical distribution and will likely lead to delayed peak flows compared to a Chicago Storm distribution of the same return period and duration. The Chicago Storm is also developed based on three dimensionless parameters that are a function of the local IDF curve, so the exact shape of the hyetograph varies based on local precipitation data. For the SCS Type II distribution, a unit hyetograph is multiplied by a rainfall volume from the IDF curve, so the magnitude of the rainfall event is based on local conditions, but the shape of the hydrograph is the same for most locations in North America. Due to the larger influence of local precipitation data on the Chicago Storm distribution, it can be considered to better represent the local climate variability and should produce more accurate peak flows. MTO requires the Chicago Storm distribution to be used to size drainage infrastructure for similar reasons (Ministry of Transportation Ontario, 1997).

Both models used the same rainfall distribution to model the Regional Storm, which led to peak flows that were within 2.5% of each other. The differences in peak flows for the Regional Storm are likely caused by different Time of Concentration methods and different subcatchment delineations needed to represent the two Wetland Storage Facilities within the site rather than the single one that was assessed in the 2018 model. The Time of Concentration in the BC-1 model was calibrated against the 2020 floodplain model. The increased discretization resulted in more subcatchments, which each needed new Time of Concentration parameters. All other model parameters had been maintained despite the added discretization, so any difference in flows at a common outlet could be attributed to the Time of Concentration. Time of Concentration parameters, primarily flow lengths and cross section geometry, were adjusted based on terrain data, and the Manning's Roughness Coefficients were adjusted so the total Time of Concentration upstream of the BC-1 outlet at First Rd. E would be maintained between the models.

Table 2-8: Comparison of 2018 and 2020 Study Flow Rates at First Rd. E

Storm Event	Wood 2018	WEEST 2020
2	0.74	2
5	1.44	3
10	2.7	3.6
25	4.29	4.5
50	5.67	5.2
100	6.99	6
Regional	18.56	18.1

Overall, thedifferences in return period peaks flows are small given the large range of expected peak flows from the frequency analysis. The Chicago Storm provides a more conservative estimate of frequent storms, which corroborates its use for determining stormwater infrastructure sizing for minor systems. For the more extreme events (i.e. ≥50-year event), the Chicago Storm distribution produces lower peak flows at First Road East. The differences can be attributed to the peak rainfall intensity and storm duration. For both rainfall distributions, The Time of Concentration at First Road East occurs before the peak rainfall intensity, so all areas of the watershed are contributing flow to the outlet. A 12-hour storm will produce higher intensity rainfall compared to a 24-hour event with the same return period, leading to greater spikes in the flow hydrograph for the 12-hour storm. The lower peak rainfall intensity of the 24-hour storm also allows for more precipitation to be infiltrated and reduces the portion of rainfall that becomes runoff. The peak rainfall intensity and storm duration are the primary factors that led to differences in peak flow between the 2018 and 2020 models.

The general agreement between the 2018 and 2020 models, combined with using improved methods in the 2020 model, as well as the 2020 model peak flows falling in the expected range indicates that the 2020 modelling results are valid.

2.7.2 Results

Comparisons between existing and proposed conditions are included in **Section 4.1**. Additional discussion about the watershed hydrology model can be found in the Stoney and Battlefield Creek Floodplain Mapping Project Hydrology Report.

2.8 Fluvial Geomorphology

The following sections discuss the geomorphic conditions within the BC-1 study area, and assesses downstream erosion in key locations in the Stoney and Battlefield Creek Watersheds.

2.8.1 BC-1 Study Area

As part of the site survey, the channels within BC-1 were assessed. A representative cross-section within Reach 1 (see Map 3), upstream of First Rd. E, was surveyed and its geomorphic parameters were calculated in RiverMorph. This cross-section was selected for more in-depth assessment due to the lower degree of channel modification compared to the upstream reaches, and because it is more applicable to the channel design in Reach 3. The geomorphic parameters for Reach 1 are shown in **Table 2-9**.

Table 2-9: Reach 1 Geomorphic Parameters

Parameter	Existing Channel U/S First Rd. E
Bankfull Width (m)	3.43
Bankfull Mean Depth (m)	0.17
Bankfull Max Depth (m)	0.34
Bankfull Area (m^2)	0.58
Wetted Perimeter (m)	1.95
Hydraulic Radius (m)	0.09
Width-Depth Ratio	10
Entrenchment Ratio	>2
Bankfull Slope (m/m)	0.005
Channel Substrate D_{50} (mm)	Silt/Clay
Channel Substrate D_{84} (mm)	Sand/Gravel
Rosgen Classification	E6

Reach 1 was classified as a Rosgen E6 channel based on its high entrenchment ratio and low width/depth ratio. Although the sinuosity was lower than the typical E-type channel, it was likely an E-type channel before its historical realignment.

The geomorphic parameters in Reach 2 are very similar to Reach 1, there is not a clear channel in Reach 3, and Reach 4 has been realigned and will not influence the hydraulics downstream of the proposed pond. Reaches 1 and 2 both had exposed areas of firm clays on the banks without significant downcutting or bank erosion, showing that the native materials are stable under the current flow regime and that significant planform alteration in the reach is unlikely. Large-scale erosion processes were not observed in Reach 1 or 2, although Reach 4 showed some signs of downcutting.

Overall, the reaches within the BC-1 study area are generally stable. Signs of significant erosion were not observed between the proposed facilities and First Road East. Analysis of erosion hours under existing and proposed conditions is included in **Section 4.2**.

2.9 Natural Heritage

Natural Resource Solutions Inc. undertook a complete analysis of the natural heritage features of the site and the complete report can be found in **Appendix D**.

2.9.1 Field Methods

Terrestrial and aquatic field surveys were undertaken within the Subject Property to characterize natural features and identify significant and sensitive features and species that have potential to be adversely affected by the proposed development. A comprehensive field program was developed in consultation with HCA staff. The field program was initiated April 12, 2019 and was completed October 8, 2019. Included in the field program were:

- Terrestrial Surveys
- Bird Surveys
- Herpetofaunal Surveys
- Bat Surveys
- Additional Wildlife (Incidental observations of odonates (damselflies and dragonflies) and butterflies.
- Aquatic Surveys

2.9.2 Significance and Sensitivity of Natural Features

2.9.2.1 Watercourses and Fish Habitat

The intermittent main channel of Battlefield Creek, as well as Tributary 1 up to the karst feature, are considered fish habitat. Fish were found within these features during the electrofishing, indicating that they provide direct habitat for at least a portion of the year. The additional aquatic features on site may still be considered fish habitat under the Fisheries Act, as they would provide indirect habitat through providing flow and food supply to the fish downstream. All of the aquatic features within the site would be considered to have low sensitivity to change as they have been modified from agricultural practices, are intermittent or ephemeral, and have limited substrate sorting.

The HCA indicates within the Planning & Regulation Policies and Guidelines (HCA 2011) that a vegetated buffer should be a minimum of 30m total for all Important or Marginal fish habitats. The fish habitat as per HCA for Battlefield Creek would be considered marginal for the intermittent features. The ephemeral features within the subject property would not receive a protective buffer.

The Fisheries Act protects fish habitat up to the high-water mark. If work is to occur within this area, then a proponent driven assessment should be completed to determine if further review under the Act is required. If there is potential for impacts to fish and fish habitat, a request for review should be completed and should contain detailed design information. NRSI has completed an assessment of the works, as well as an aquatic effects table to determine the likelihood of an impact (Appendix IX). Through this process it was identified that the project should be sent for further review to the fisheries protection program at DFO. The Request for Review (RfR) will be submitted to the DFO in November 2020. It is expected it will take 4-5 months for the RfR to get triaged and assigned to a biologist.

2.9.2.2 Wetlands

The subject property contains a large wetland in the northern half of the site (Map 2) comprised of a contiguous network of swamp and marsh habitats which extend off of the property to the west (downstream) and east (upstream). Photographs are provided in Appendix X. The wetlands on the property are associated with the watercourse and receive overland flow from offsite with drainage entering the property through the culvert on Second Road East. Additional flow is directed from the southern half of the property (agricultural fields and forest) whereby surface water infiltrates bedrock crevices and flows northward from the seepage feature as groundwater exiting the Eramosa scarp formation.

In general, the swamp and marsh habitats are typical of wetlands on silty-clay soils in the Hamilton and Niagara area. Plant species diversity is low to moderate with no species of high coefficient of conservatism value (i.e. species with a high fidelity to intact, high quality habitats). Given the channelized section of the creek and signs of recent tillage within the cultural thickets and marshes, it appears that the wetland has a recent history of disturbance that extends back a number of decades (much of the northern portion of the site in agriculture in the 1940s based on air photography). It is inferred that the present-day vegetation communities are a result of succession which has occurred in the last 25-50 years. The only mature trees present are Bur Oaks found along First Road East (with regeneration extending eastward into the swamp), along the Dofasco 2000 Trail and within hedgerows. In recent years, the spread of Emerald Ash Borer has reduced the canopy in the swamp features which has resulted in a flush of European Buckthorn and Glossy Buckthorn. The predominance of Green Ash, with other trees scattered along feature edges, limits the potential for recolonization of the swamp with native tree species and, left alone, it is likely that the treed swamp will continue to transition toward a mosaic of Buckthorn and Hawthorn swamp thicket and marsh in time.

The wetlands below the berm will still receive large seasonal flows from the upstream catchment that will maintain their wetland form. Much of the length of Battlefield Creek has been channelized or exists as well-defined watercourse with high banks; however, sizable wetlands include the swamp bisected by First road East and the large wetland bisected by Barton Street East (4km downstream and below the escarpment). Conversely, wetland above the eastern berm is likely to become larger and contain deeper water for a longer period than the current conditions. By design, the increase in wetland size above the berm will not result in any flooding or inundation on properties located above the site (to the east of 2nd Road East).

The wetlands within the study area are unevaluated. The nearest Provincially Significant Wetland complex is the Vinemount Swamp PSW which is more than 2km east of the subject property and within the Stoney Creek watershed. As well, wetland in the vicinity of Rymal Road East is present approximately 2.75km south of the property but is part of the Twenty Mile Creek watershed. As surveys did not document wetland-dependent SAR presence within the subject property, and given the distance from other PSWs to consider wetland complexing, it is unlikely that the wetlands within the subject property warrant PSW designation. The swamp features within the subject property have been identified as confirmed SWH for Migratory Landbird Stopover habitat and candidate Bat Maternity Colony habitat. Additionally, the central meadow marsh feature is considered SWH for Monarch butterfly which uses the habitat for nectaring and rearing of larva. These SWH types are discussed further in the NRSI report (**Appendix D**).

2.9.2.3 Woodlands

The Green Ash swamp (SWD2-2) in the northwest corner of the site is designated as significant woodland (Key Natural Heritage Feature) under the RHOP (City of Hamilton 2018). As discussed above, the Green Ash canopy is in decline and the feature is characterized by a low to moderate diversity of wetland species. The Greenbelt Plan states that significant woodlands experiencing changes such as tree mortality are still considered woodlands as these changes are considered temporary whereby the forest still retains its long-term ecological value (Government of Ontario 2005b). The detailed design plan prepared by Water's Edge identifies heavy duty Erosion and Sediment Control (ESC) fence to protect the treed area during construction. The ESC fence will be located within 30m of the dripline (approximately 10m at some locations) to accommodate necessary grading for the berms and created wetland, therefore, some tree root loss is possible.

Under the ownership of the HCA, the subject property will be retained in a natural state and despite current pressures and proposed hydrological changes occurring within the significant woodland, it is anticipated that this feature is resilient and will continue to provide valuable services including water quality improvement and wildlife habitat. Naturalization plantings of trees and shrubs among the berm and created wetlands will provide a seed source to enhance diversity within the declining Green Ash stands on the subject property.

2.9.2.4 Significant Wildlife Habitat

Based on background information review, desktop analysis and field studies completed in 2019, 4 SWH types were confirmed for the study area and 3 types remain as candidate, specifically:

Confirmed SWHs:

1. Seasonal Concentration - Landbird Migratory Stopover Area
2. Specialized Wildlife - Seeps and Springs
3. Habitat for Species of Conservation Concern - Shrub/Early Successional Bird Breeding Habitat
4. Special Concern and Rare Wildlife Species

Candidate SWHs:

1. Seasonal Concentration - Snake Hibernacula
2. Raptor Wintering Area
3. Bat Maternity Colonies

2.9.2.5 Habitat of Species at Risk

Based on the presence of bat pass sequences identified to the *Myotis* and 40 kHz species groupings, there is potential for four bat SAR to occur within the subject property: Little Brown Myotis, Northern Myotis, Eastern Small-footed Myotis and Tri-colored Bat.

Based on species preferences, it is most likely that Little Brown Myotis and/or Northern Myotis may be roosting within the vicinity of monitoring station BAT-001. The location of monitoring station BAT-001 not only captured a potential roost tree, but also candidate foraging habitat and a potential travel/movement corridor along the pathway. Based on the number and timing of recorded bat pass sequences, the cultural savannah community is also considered candidate foraging and movement/travel corridor habitat for SAR bats. Foraging, movement or travel corridor habitats are considered the least sensitive to alteration (MNRF 2012).

This report assumes that the entirety of the cultural savannah associated with the karst feature, constitutes SAR bat roosting, foraging and travel corridor (flyway) habitat. This community is far removed from the proposed berm and wetland development area and will not be impacted. The restoration of the subject property, including the creation of new wetlands is likely to benefit SAR bats by providing additional foraging opportunities within the vicinity of the candidate SAR bat habitat.

2.9.3 Impact Analysis

Potential impacts arising from the proposed wetland creation project are determined by comparing the details of the proposed berm and wetland development with the characteristics of the existing natural features and their functions. Where the detailed design plan overlaps with natural features or their vegetation protection zones, impacts may arise. The following is a description of the types of impacts which will be discussed:

- Direct impacts to the natural features within the study area associated with disruption or displacement caused by the actual proposed ‘footprint’ of the undertaking.
- Indirect impacts associated with changes in site conditions such as drainage and water quantity/quality, construction noise, dust and light pollution.
- Induced and cumulative impacts associated with impacts after the berms and wetland areas are constructed such as subsequent demand on the resources created by increased habitation/use of the area and vicinity over time.

A summary of the potential impacts and recommended mitigation measures for each significant natural feature within the wetland creation footprint area is provided in **APPENDIX D.**

Table 2-10: Summary of Significant Natural Features, Potential Impacts and Recommended Mitigation

Significant Natural Feature	Relevant Policies	Potential Impacts	Recommended Mitigation
Watercourses and Fish Habitat	• HCA Ontario Regulation 161/06 (Government of Ontario 2013) • Rural Hamilton Official Plan (City of Hamilton 2018) • *Fisheries Act* (Government of Canada 2019) • *Fish and Wildlife Conservation Act* (Government of Ontario 1997)	**Direct Impacts** • The proposed berm creation will directly impact intermittent features, Battlefield Creek and Tributary 1 through altered flow regimes, removal of fish habitat and the creation of barriers to fish passage. • Recommended mitigation aims to restore the natural function of the channelized watercourse providing a direct positive impact on aquatic habitat. **Indirect Impacts** • Indirect impacts to the watercourse and fish habitat may include changes to water quality (temperature) and quantity (reduced flow below berms), as well as erosion and sedimentation, contamination, nutrient concentrations during construction. • The project will meet the HCA objective of utilizing the floodplain to improve flood attenuation capacity and reduce downstream erosion. **Induced Impacts** • None	• The control structures include flow dispersal features at the outlets to help control erosion potential. • The Pathways of Effects (PoE) outlined by DFO were reviewed, and the potential stressor and potential effect on fish and fish habitat determined. Mitigation measures (both land-based and in-water) should be provided to determine if there are residual effects. If there are residual effects and a HADD is possible, then a Request for Review will be required. Appendix IX is the Aquatic Effects Summary Table which outlines the PoEs, potential impacts, mitigation measures, residual effects and preliminary designs indicate that a Request for Review is required. The Request for Review will be submitted to DFO in November 2020. Once the RfR has been submitted, it is likely to take 4-5 months for a FPP biologist to be assigned to the project to determine if a Letter of Advice will be issued or if an Authorization is needed. • Monitoring of fish habitat and fish populations should occur post construction. This should include identifying if fish are coming into the wetland feature from upstream. The control feature will be a barrier downstream, but the wetland feature is already acting as a barrier. Large fish populations within the wetland are not a primary object, as they could impact the anuran spawning. • The wetlands are expected to decrease less frequent storm event peaks and reduce erosion, and also are expected to provide more consistent groundwater and baseflow throughout the year. • Implement a vegetation rehabilitation plan following construction to re-vegetate the construction area. The establishment of vegetation along the berms and within the created wetlands will enhance water quality and reduce water temperature, in time, through shading.

Significant Natural Feature	Relevant Policies	Potential Impacts	Recommended Mitigation
			• All berm construction should be completed during dry conditions and within the in-water timing window (and outside of breeding bird window) – September through March ideally. Installing enhancement measures by hand may be done within the water, but still preferably during low-dry periods to minimize disruption to substrates and water conditions. • Implement an Erosion and Sediment Control Plan. • Develop a Spill Response Plan. • Equipment operation and maintenance in designated areas away from natural features. • While works should occur under dry conditions, a fish and wildlife salvage should be conducted by experienced biologists where any suitable habitat exists (prior to vegetation clearing). • A Monitoring Program, which includes parameters identified in the EA (stream morphology, natural heritage system, hydrometeorologic and water quality/biophysical) should be undertaken following the completion of the proposed works. • In the event that the outlet structure requires repair in the future, or water is drawn down or pumped within the wetland, a wildlife salvage should be completed by trained biologists prior to work commencing.
Wetlands	• Rural Hamilton Official Plan (City of Hamilton 2018) • HCA Ontario Regulation 161/06 (HCA 2013)	**Direct Impacts** • The east berm will directly impact the unevaluated wetland feature (Green Ash swamp). • The existing wetland below both berms will be subject to altered flow regimes. **Indirect Impacts** • Changes to water quality and quantity during and following berm construction.	• In order to preserve the hydrology of wetlands below the berms, the control structure maintains some amount of surface water flow to the extent possible. Sizable wetlands below the berm include the swamp on-site and a large wetland area bisected by Barton Street East (approximately 4km downstream in the Riverdale East neighbourhood). • Both berms will result in a net increase in wetland area. Native plantings and seeding will be completed to enhance the diversity of the created habitats. This aligns with the HCA objective of enhancing and enlarging the existing wetland areas and creating additional wetlands as well as improving flood

Significant Natural Feature	Relevant Policies	Potential Impacts	Recommended Mitigation
	• Provincial Policy Statement (MMAH 2014)	• Potential for erosion and sedimentation to impact the wetland during construction. • Increased floodplain area will result in faster evapotranspiration. • Any site access lanes (existing or constructed) may become areas for garbage and yard waste dumping. **Induced Impacts** • The potential for spread of the existing patches of Common Reed, or introduction of new non-native species.	attenuation capacity and reducing erosion downstream. • The planting of a diversity of native trees and shrubs, both as part of the wetland creation and future HCA activities will offset the removal of declining Ash in the footprint of the east berm. Creation of wetland habitat meets the HCA objective to enhance and enlarge the existing wetland. • The wetlands created at the east berm will improve opportunity for enhancing passive recreation along the Dofasco 2000 Trail (accessible viewing platform potential for nature appreciation). • The limit of grading will be delineated with heavy duty ESC fencing, which will double as vegetation/tree protection fence. • ESC fencing is to be removed once soils are stable on site to the satisfaction of on-site inspector / environmental monitor. • Implement the Erosion and Sediment Control Plan. • Develop a Spill Response Plan. • Equipment operation and maintenance in designated areas away from natural features. • Stabilization of temporary soil stockpiles within 30 days of being inactive/idle and berms using a nurse crop. • In order to prevent the spread of Common Reed or other non-native species, equipment should arrive on site clean and free of plant materials and mud. • Existing or introduced stands of Common Reed should be managed through herbicide application, monitoring and re-application over a series of several years. Stands that are present within the proposed grading area are likely to be graded and relocated within the site, but proactive management is not recommended given project timelines.

Significant Natural Feature	**Relevant Policies**	**Potential Impacts**	**Recommended Mitigation**
Significant Woodland	• Rural Hamilton Official Plan (City of Hamilton 2018) • Provincial Policy Statement (MMAH 2014)	**Direct Impacts** • Enhancement to Battlefield Creek will utilize passive methods to restore the watercourse (coir logs, live staking) and will not require any tree cutting or earth works within the significant woodland in the northwest corner of the property. • Berm construction will occur outside of the significant woodland dripline, thus eliminating a direct impact. • The Green Belt Plan stipulates a 30m vegetation protection zone which may not be feasible; however, the long-term naturalization of the west berm and wetland is seen as a net benefit to the feature which will ultimately expand in size through naturalization processes. **Indirect Impacts** • Indirect impacts include disturbance to woodland wildlife during construction (noise, dust) and the potential for minimal tree root damage during site grading. • Changes to water quantity reaching the significant woodland (swamp), may lead to drier conditions and a shift toward lowland forest conditions at the fringe of the feature. **Induced impacts** • None	• The limit of grading and a reduced vegetation protection zone (less than 30m from dripline) will be delineated with heavy ESC fence. • The west berm location is intended to provide a setback from the root zone of the adjacent treed feature to the extent possible therefore minimizing impacts to the significant woodland. A similar design approach has been taken with the east berm and the adjacent hedgerow vegetation. During grading, care should be taken to avoid unnecessary damage to the root systems of mature trees, as feasible. • Dust resulting from earth works will be managed including the wetting of bare soils where machinery and vehicle traffic on site creates dusty conditions. • Equipment maintenance and re-fuelling will occur outside of the wetland creation and away from natural features. • Disturbance to wildlife during construction will be temporary and is not anticipated to be significant.
Significant Wildlife Habitat	• Provincial Policy Statement (MMAH 2014)	**Direct Impacts** • Direct impacts to SWH will include removal of a portion of Landbird	• In order to mitigate impacts to Landbird Migratory Stopover habitat, the section of the east berm which passes through the Green Ash swamp will be

Significant Natural Feature	Relevant Policies	Potential Impacts	Recommended Mitigation
	• Rural Hamilton Official Plan (City of Hamilton 2018)	Migratory Stopover Area (east berm) and Bat Maternity Colony Habitat (candidate SWH). • None of the other identified SWH types will be impacted directly or indirectly. **Indirect Impacts** The creation of the east berm may result in deeper or more prolonged inundation. Although many of these trees are dead or declining Ash, conditions may become less suitable for tree establishment inside the berm. **Induced impacts** • Introduction of non-native or invasive species.	restored with native tree and shrub plantings to maintain a contiguous habitat. Due to berm slopes, tree and shrub planting has been limited to level ground adjacent to the berm. • An assessment of trees did not identify candidate bat maternity colony trees within the location where the east berm will pass through the swamp feature. A targeted tree inventory and assessment will be conducted by NRSI Certified Arborists based on the detailed design grading envelope to confirm the absence of suitable trees. Trees in the swath to be cleared are almost entirely all dying Green Ash with few (if any) greater than 20cm Diameter at Breast Height suggesting the stand is not likely to support a colony of bats. • Tree removals should occur outside of the bat active period (April 1 – September 30). If this timing is not feasible, a detailed assessment of available roost trees is recommended to be completed within treed areas proposed to be impacted. Following identification of potential roost trees, targeted exit surveys at identified roost trees must be completed during appropriate weather conditions and within 24 hours prior to their removal to avoid direct impacts to the species through confirming the absence of any roosting bats (MNRF 2014). • The HCA has identified that the enhancement of linkage opportunities associated with the Dofasco 2000 Trail as an objective of this project. Naturalization plantings in the eastern wetland area will result in a more structurally diverse corridor where a recently fallow agricultural field currently exists. • It is recommended to provide temporary habitat compensation in the form of artificial roosts prior to tree removals, in the event that a suitable cavity tree is identified during the tree inventory.

Significant Natural Feature	**Relevant Policies**	**Potential Impacts**	**Recommended Mitigation**
			• The restoration plans for the site include the use of native tree species preferred by bats for roosting (e.g. Shagbark Hickory) which may provide future, more permanent, roost habitats.
Breeding Bird Window	• Migratory Birds Convention Act (Government of Canada 1994) • Fish and Wildlife Conservation Act (Government of Ontario 1997)	• Vegetation removal within the breeding bird season may result in incidental take of bird species protected under the MBCA. • Although none were observed, active raptor nests are protected under the FWCA.	• Vegetation removal is recommended to occur outside of the breeding and nesting season for migratory birds as established by the Canadian Wildlife Service. • The peak breeding period for birds in southern Ontario extends from approximately late March to late August (Government of Canada 2017). • Due to the complexity of habitats on site, nest sweeps are not recommended as a means to confirm the absence of nesting birds. • Future works should consider active raptor nests and wildlife sweeps by qualified biologists should be undertaken to ensure that nests are not impacted.

2.10 Archaeology

The Stage 1 background research indicated that portions of the Study Area exhibited moderate to high potential for the identification and recovery of archaeological resources. These include all areas with the exception of steep or disturbed portions of the Study Area. As such, a **Stage 2 archaeological assessment is recommended for these areas.**

The various treed or otherwise vegetated areas throughout the Study Area that are inaccessible for ploughing, will be subject to a typical Stage 2 test pit assessment at a 5m interval, conducted according to Section 2.1.2 of the *Standards and Guidelines* (Government of Ontario 2011). The test pit survey will be conducted until test pits show evidence of disturbance according to Section 2.1.2, Standard 4 of the *Standards and Guidelines* (Government of Ontario 2011). Each test pit must be approximately 30 centimetres (cm) in diameter and excavated 5cm into sterile subsoil. The soil and test pits will then be examined for stratigraphy, cultural features, or evidence of fill. All soil will be screened through six-millimetre (mm) mesh hardware cloth to facilitate the recovery of small artifacts and then used to backfill the pit.

In accordance with Section 2.1.3 Standard 1 of the *Standards and Guidelines* (Government of Ontario 2011), if archaeological resources are encountered during the Stage 2 test pit survey, the test pit excavation will continue on the survey grid to determine the extent of further positive test pits. If insufficient archaeological resources are found through a continued survey of the grid to meet the criteria for continuing to Stage 3, the survey coverage will be intensified around the positive test pits using either Option A or Option B of Section 2.1.3, Standard 2 of the *Standards and Guidelines*(Government of Ontario 2011). UTM coordinates will then be recorded for all positive test pit in addition to a fixed reference landmark using a Garmin eTrex 10 GPS unit with a minimum accuracy 1-2.5m (North American Datum 1983 (‘NAD83’) and Universal Transverse Mercator (‘UTM’) Zone 17T). All artifacts will be collected and recorded according to their associated positive test pit or 1m test unit.

The portions of the Study Area maintained as agricultural fields and accessible for ploughing will be subject to a typical Stage 2 pedestrian survey at a 5m interval, conducted according to Section 2.1.1 of the *Standards and Guidelines* (Government of Ontario 2011). This area will be ploughed until 80% surface visibility is attained, then allowed to weather prior to assessment. As per Section 2.1.1, Standard 7 of the *Standards and Guidelines*(Government of Ontario 2011), if archaeological resources are found, the survey transects will be decreased to 1m intervals over a 20m radius around each find to determine whether it is an isolated find or part of a larger scatter. All formal artifact types and diagnostic categories will be collected for laboratory analysis and cataloguing, including all refined ceramic sherds for 19thcentury archaeological sites.

The remainder of the Study Area comprises gravel, asphalt or concrete-hardened surfaces within the farmstead areas or steep grades. These areas have been evaluated as having no or low potential due to extensive and deep land alteration that has severely damaged the integrity of archaeological resources or steep grade and are exempt from additional assessment as per Section 2.1 Standard 2b of the *Standards and Guidelines* (Government of Ontario 2011). Instead, **these areas will be mapped and photo documented during the Stage 2 assessment** as per Section 2.1, Standard 6 and Section 7.8.6, Standard 1b of the *Standards and Guidelines* (Government of Ontario 2011).

3.0 WETLAND AND CHANNEL DESIGN

3.1 Wetland Storage Facility

3.1.1. Design Rationale

The Wetland storage facility envisioned by the Flood and Erosion Control Class EA, as discussed in Section 1.9, has three significant issues:

1 The wetland storage facility suggested the use of the First Road East berm as the primary control structure. The roadway was also to be raised to provide the necessary storage;
2 As an alternate to using the road as a berm, the study recommended an independent berm set back from the road. The location of this berm would have been in the central part of the existing wetland; and,
3 In either scenario, the primary location of the wetland storage facility was within the existing wetland. This resultant use of the wetland would have impacted the form and function of this wetland.

As such, the Study Team conceptually proposed a 2-cell storage facility to HCA. The two-cell option would have resulted in achieving the goal of runoff storage, creating new wetland, and would result in the extension of fish habitat . This concept was approved by HCA and this report provides a summary of the proposed design.

The two wetland facilities and the proposed channel will together provide erosion control for downstream reaches in Battlefield Creek. A secondary goal of the project is to provide habitat improvement for the many species present at the site. The wetland facilities provide significant habitat for wetland species, as well as birds, but are a potential barrier to fish migration. Fish can only intermittently migrate to the location of the east facility and a few small fish species were observed in the existing channel where the west facility will be located. To compensate for the potential habitat loss and improve the overall biodiversity of the site, a natural channel is proposed to connect the outflow from the east facility to the existing channel. This is an improvement over the existing conditions, as more than 250 m of new channel will be added allowing fish to travel to the outfall of the east facility.

Apart from the habitat improvements, the channel also serves to concentrate flows and bring the flow regime into a stable and predictable form. The proposed single-threaded channel will help to mitigate the heating effect that reservoirs produce by minimizing the surface area of flow exposed to sunlight compared to the flow being spread over the whole field.

The existing flow path through the field is a depositional area, leading to relatively low sediment concentrations downstream. The proposed wetland facility will become a depositional area since the flow velocities are reduced to near zero. To avoid altering the sediment transport regime beyond what was necessary, the existing depositional area can be removed by concentrating the flows into one channel and increasing the sediment transport capacity. Removing too much entrained sediment from the flow could negatively impact fish species that rely on somewhat cloudy water for protection from predators. When the stage is greater than bankfull, the flows will spill into the floodplains, which will again act as depositional areas and provide some storage. The deposition in the field during high flow events is less concerning because the reservoir detention time is lower, so less sediment will be settled out before the flow enters the field.

Finally, concentrating the flows into a channel will make the floodplains much easier to traverse following rain events as less water will pool there. This will make BC-1 a more attractive place to visit for casual outdoors enthusiasts. The stream will follow a natural meandering path and provide a habitat feature for public enjoyment where there currently isn't one.

To summarize, the proposed natural channel will help to mitigate the impacts of the wetland facility on the temperature and sediment transport regime, while also creating aquatic habitat and improving the usability to park-goers.

3.1.2 Design Summary

The proposed design includes the following:

1. Construction of two wetland storage facilities at the BC-1 site, consisting of site regrading, berms, outlet control structures, and constructed wetland areas below the outlet invert;
2. Construction of a channel connecting the outlet of the east facility to the existing channel, using natural channel design techniques;
3. Inclusion of natural vegetation on the berms, banks and other disturbed areas;
4. Removal of in channel debris and other fish passage barriers; and,
5. Inclusion of potential access routes for pedestrian trails to be added later.

3.1.3 Wetland Storage Facility Design

The proposed design calls for the construction of two impoundments referred to as the west pond and the east pond. The east pond is to be created through the construction of a low berm oriented north-south across the main branch of Battlefield Creek and extending east-west along the Dofasco trail and east as far as Second Road. The west pond is to be created through the construction of a sinuous east-west berm impounding flows from a tributary stream that emerges from karst features along the base of the small escarpment that transects the central part of the property (referred to as the Eramosa Scarp). Three permanent water features (1 to 2 m deep) are to be constructed in each of the two impoundments to provide enhanced wetland habitat and overwintering areas for turtles and amphibians. Each of the permanent water features is composed of an irregularly shaped depression with localized high points and slopes intended to provide basking areas and edge-type habitats. It is anticipated that the base of these features will be on, or close, to the surface of the dolostone bedrock.

The two wetland storage facilities are designed to provide an equivalent level of attenuation and erosion reduction as the single facility proposed as part of the 2018 Class EA. The decision to separate the facility into two separate facilities was based on design constraints that would have required the berm to be placed in an existing forested wetland, which would not have supported the design goals and may have led to difficultly obtaining approvals. The sites of the two proposed facilities were selected based on minimizing the necessary vegetation removals and sensitive habitat disturbances. Both facilities are located on predominantly agricultural land, so the habitat considerations were minimal. The west facility and all inundated lands are located on HCA property for all return periods. The east facility is located entirely on HCA lands, although backwatering of Second Rd. E and private property does occur during the 100-year and Regional events. The east facility was designed so that the 100-year and Regional storm floodplains are not altered upstream of Second Rd. E.

The hydrologic conditions of the site were evaluated through a HEC-HMS model. The level of discretization of the subcatchments is much higher than what was used for Floodplain Mapping in order to accurately characterize the local conditions and determine flows at each of the wetland facility inflow locations. Since the Class EA evaluated the outflow at an assumed outlet at First Rd. E, the hydrologic model was extended to include the receiving reaches form each facility to First Rd. E to facilitate direct comparison between the Class EA and the proposed multiple-facility design. The choice to use two wetland facilities was based on the need to protect sensitive ecosystems within the project area. Each facility is located on a different tributary of Battlefield Creek, so the facilities were divided and sized based on the relative watershed area of each tributary. The east facility was found to receive flows from about three-quarters of contributing area and the west facility received about one quarter. The overall storage volume and peak outflow were proportionally divided between the two sites to produce two facilities that had equivalent performance to the single facility proposed in the Class EA.

The elevation-storage relationship was substantially different from the one in the Class EA due to the different facility layout, so achieving an exact match was not possible. Since the primary design goal of the facilities at BC-1 was to reduce downstream erosion issues, attention was paid to the attenuation of frequent events (~25mm), in order to reduce erosion issues from the most common storms. The large available area at BC-1 allowed for a larger facility that could also provide downstream flood control. While flooding wasn't as much of a concern on BC-1 compared to SC-8, the ability of the facility to attenuate flood flows will reduce risk to property owners and provide a secondary benefit at a reduced cost compared to constructing flood control infrastructure independently. The Stage-Storage-Discharge relationships for the East and West ponds are shown in **Table 3-1** and **Table 3-2**, respectively.

Multiple rainfall distributions were used to assess the facility performance. The 6-hour SCS, 24-hour SCS, and 24-hour Chicago Storm distributions were used for the return period events. A 4-hour Chicago Storm distribution was used to assess the 25 mm event that is typically used to assess water quality treatment in stormwater facilities. Both facilities could contain the 100-year storms without the reservoir level reaching the overflow weir. The drawdown times were approximately 48-hours for the 24-hour storm distribution, although the outlet structure significantly restricts flow at low storage levels leading to a small amount of water being detained for a longer period of time. Both facilities have enough storage volume to attenuate a 100-year storm even if the small volume is present at the start of the storm. The wetlands in each facility (i.e. areas with elevations lower than the outlet invert) are effectively wet pools and will remain wet for much longer periods as there is now natural outflow, so the pond level can only be reduced through infiltration or evaporation.

Overall, the HEC-HMS model showed that both facilities would reduce peak flows at First Rd E for both small and large storm events. The existing conditions model showed that the peak flow of the 100-year 24-hour Chicago storm would be 5.98 m^3/s and the peak flow from the 25 mm event would be 0.81 m^3/s at First Rd. E. The proposed conditions model showed that the peak flow from the 100-year 24-hour Chicago storm would be 1.41 m^3/s and the peak flow from the 25 mm event would be 0.17 m^3/s. The amounts to a 76% peak flow decrease for the 100-year storm and a 79% reduction for the 25 mm storm.

Table 3-1: BC-1 East Pond Stage-Storage-Discharge Relationship

Elevation (m)	Storage (1000 m^3)	Discharge (m^3/s)
188.5	0.0	0.0
189	21.2	0.2
189.5	58.2	0.7
189.7	76.5	1.0
190	106.5	4.9
190.4	106.5	17.3

Table 3-2: BC-1 West Pond Stage-Storage-Discharge Relationship

Elevation (m)	Storage (1000 m^3)	Discharge (m^3/s)
188.1	5.7	0.0
188.5	13.5	0.1
189	29.8	0.3
189.4	48.0	0.9
189.6	59.8	1.7
189.9	59.8	3.9

3.1.4 Outlet Structures

The outlet structures of both facilities will consist of a perforated riser pipe connected to a corrugated steel pipe (CSP) running through the berm. The flow is controlled during small events by the perforations on the riser pipe, with each facility having a 2 m diameter riser pipe with a different number of perforations to provide the desired level of flow attenuation. Once the reservoir stage reaches the top of the perforated pipe, water enters the pipe freely, but flow is controlled by the outlet CSP up to the 100-year return period storm. The overflow weir is only intended to be used for storms in excess of the 100-year event, or where multiple large events occur within 48 hours.

The existing and proposed peak flows at the outlet of BC-1 at First Rd. E are shown in **Table 3-3**.

Table 3-3: Existing and Proposed Peak Flows at First Rd. E

Storm Event	Rainfall Distribution	Existing Conditions Flow (m^3/s)	Proposed Conditions Flow (m^3/s)
25mm	4-hour Chicago	0.8	0.2
2-year	24-hour Chicago	2	0.5
5-year	24-hour Chicago	3	0.7
10-year	24-hour Chicago	3.6	0.9
25-year	24-hour Chicago	4.5	1.1
50-year	24-hour Chicago	5.2	1.2
100-year	24-hour Chicago	6	1.4
Regional	Hazel 12-hour	18.1	14.7

A reduction in peak flows from all storms would certainly reduce the erosion downstream of the facility as lower flow depths would reduce the shear stress exerted on the bed of the channel. Additionally, the lower flows increase the effect of roughness elements in the channel, which creates turbulence and reduces the energy of flows, leading to less energy being available to entrain and transport sediment. The highest rate of sediment transport would be expected to occur at the peak flow of the largest storm, so reducing the peak flood flow of a large, infrequent event could dramatically reduce the total quantity of erosion and sediment transport. The erosion reduction on a per-event basis would be greatest for large flood events and lowest for small frequent events. By addressing erosion caused by both large, infrequent events, and small, common events, we have taken a balanced approach that alters the entire flow regime to reduce erosion rather than focusing on a single event or magnitude. The erosion benefits of the receiving channel will diminish further downstream as uncontrolled tributaries join the channel, reducing the difference between controlled and uncontrolled flows. The impacts of the proposed facility on downstream flooding and erosion are discussed in more detail in **Section 4**.

Outlet Substrate

The downstream side of the constructed berms we will include riprap lining to dissipate energy and prevent sediment from being entrained in the high velocity areas. The west facility will outlet into a channel, so the riprap at the outlet will be extended far enough downstream so that the flow has fully transitioned to its natural flow regime. The east facility will outlet to a wide floodplain area without a defined channel, so the riprap will be positioned to spread the flow over a wide area to ensure that a channel is not carved as a result of pressurized or spillway flows coming from the facility.

4.0 FURTHER DISCUSSION OF DESIGN ASPECTS

The proposed creation of berms, wetlands and the naturalization of the retention area present numerous constraints but also opportunities for the creation and enhancement of wildlife habitat on the property. The following are high-level recommendations to address constraints and proposed enhancement that should be considered both as part of mitigation efforts and the long-term stewardship of the property.

4.1 Flood Risk Impacts

The flood risk impacts of the proposed BC-1 facility were assessed by comparing the number of properties, buildings, and roads that would be impacted by a return period storm for both existing and proposed conditions in lower Battlefield Creek. The floodplain mapping HEC-RAS model was completed as part of the Stoney and Battlefield Creek Floodplain Mapping Project. The existing subcatchments and reaches upstream of First Rd E in the floodplain mapping HEC-HMS model were disconnected and replaced with the outflow hydrograph from the more discretized BC-1 model and the resulting flows were used to create a proposed conditions HEC-RAS model. The lot fabric geospatial data provided by HCA was used to determine the number of properties impacted and each lot was classified as either residential, commercial, industrial, institutional, or public/open space. The classifications were based on the apparent use of the properties from aerial imagery and Google Street View. The number of buildings impacted was determined through aerial imagery; minor buildings such as sheds were not counted and properties with more than one building were counted as one building if any or all the significant buildings were impacted by flooding. In many cases, the low flow channel was located on private property, which resulted in the property being impacted by all flood events. Locations of depression storage that were not directly connected to the main channel were not considered to be part of the floodplain and were not considered in the counts. The reaches for this assessment were determined based on the reaches used in the 2018 Flood and Erosion Control Class EA. The number of affected properties differs between the Class EA and this assessment primarily due to the Chicago Storm distribution being used rather than the SCS Type II distribution. **Table 4-1** shows the existing and proposed peak flows and percent reduction at selected locations downstream of the BC-1 facility. **Table 4-2** shows the count of affected properties under existing conditions, while **Table 4-3** shows the count under proposed conditions. **Table 4-4** shows the reduction in affected properties under proposed conditions.

The results of the flood risk assessment show slight reductions in the number of properties and buildings inundated for all return period events and the Regional event. The primary goal of the BC-1 wetland facility design was to reduce erosion in Battlefield Creek, so flood flow reduction was not an objective for frequent events. The available area within the BC-1 wetland site allowed for the facilities to reduce erosion for the most frequent events while also providing attenuation for storms larger than the 100-year event. The reduced peak flow for the Regional event will also reduce flooding in Lower Stoney Creek downstream of the confluence with Battlefield Creek, where flood control is a high priority.

Table 4-1: Downstream Peak Flows and Percent Reduction

Location	Return Period			
	2-year	25-year	100-year	Regional (Hazel)
Existing Flows (m^3/s)				
Battlefield Creek - Edge of Escarpment	5.4	11.4	14.9	42.2
Battlefield Creek - King St.	7.0	13.9	18.3	51.9
Battlefield Creek at Stoney Confluence	9.7	19.7	25.4	65.0
Lake Ontario	22.8	45.3	58.2	183.6
Proposed Flows (with BC-1 Storage facility) (m^3/s)				
Battlefield Creek - Edge of Escarpment	4.2	8.7	11.4	34.6
Battlefield Creek - King St.	6.4	12.5	16.4	40.2
Battlefield Creek at Stoney Confluence	9.1	18.2	23.3	53.3
Lake Ontario	21.6	44.1	56.1	172.2
Percent Reduction in Flows between Existing and Proposed				
Battlefield Creek - Edge of Escarpment	22.2	23.7	23.5	18.0
Battlefield Creek - King St.	8.6	10.1	10.4	22.5
Stoney - Battlefield Confluence	6.2	7.6	8.3	18.0
Lake Ontario	5.3	2.6	3.6	6.2

Table 4-2: Lower Battlefield Creek Flood Characterization – Existing Conditions (Number of Properties/Building/Roads Inundated)

	Storm Event:	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	Regional	Comments
Reach BC-1	Flow (m^3/s)	9.8	13.7	16.2	19.6	22.5	25.3	65	
Property Type	Residential							15	
	Public/Open Space					1	1	2	
Building Type	Residential								
Roadway	Huckleberry Dr. (Local)							1	
	Jackson Ln. (Local-Private)	1	1	1	2	2	2	2	
Reach BC-2	Flow (m^3/s)	9.8	13.7	16.2	19.6	22.5	25.3	65	Portion of Reach located within private property (high density residential - apartments)
Property Type	Residential	2	2	4	4	4	4	6	
	Public/Open Space	1	1	1	1	1	1	1	
Building Type	Residential				1	1	1	1	
Roadway	Lake Ave. N (Collector)					1	1	1	
Reach BC-3	Flow (m^3/s)	9.8	13.7	16.2	19.6	22.5	25.3	65	Portion of Reach located within private property (commercial)
Property Type	Residential	1	1	1	3	5	6	8	
	Commercial	1	1	1	1	1	1	1	
	Public/Open Space	1	1	1	2	2	2	2	
	Utility - Hydro				1	1	1	1	
Building Type	Public	1	1	1	1	1	1	1	
	Utility - Hydro						1	1	
Roadway	Valley Dr. (Local)							1	
	Queenston Rd. (Arterial)								
Reach BC-4	Flow (m^3/s)	7.0	10.1	12	13.9	16.1	18.3	51.9	Portions of Reach located within private property (low density residential - houses, commercial) & within Green Acres School yard
Property Type	Residential	13	14	14	14	20	20	32	
	Commercial	3	3	3	3	3	3	4	
	Institutional	1	1	1	1	1	1	1	
	Public/Open Space	1	1	1	1	1	1	1	

Building Type	Residential	2	4	4	4	5	6	20	
	Commercial	1	1	1	1	1	1	2	
	Institutional							1	
	Faircourt Dr. (Local)							1	
Roadway	Randall Ave. (Local)	1	1	1	1	1	1	1	
Reach BC-5	Flow (m^3/s)	7.0	10.1	12	13.9	16.1	18.3	51.9	Entire Reach located within Battlefield Heritage site
Property Type	Residential							3	
	Commercial					1	1	1	
	Public/Open Space	1	1	1	1	1	1	4	
Building Type	Residential							1	
	Commercial					1	1	1	
Roadway	King St. W (Arterial)					1	1	1	
	Laneway Crossing	1	1	1	1	1	1	1	

Table 4-3: Lower Battlefield Creek Flood Characterization – Proposed Conditions (Number of Properties/Building/Roads Inundated)

	Storm Event:	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	Regional	Comments
Reach BC-1	Flow (m^3/s)	9.1	12.5	14.7	18.2	22.7	26.1	53.3	
Property Type	Residential							15	
	Public/Open Space					1	1	2	
Building Type	Residential								
Roadway	Huckleberry Dr. (Local)							1	
	Jackson Ln. (Local-Private)	1	1	1	2	2	2	2	
Reach BC-2	Flow (m^3/s)	9.1	12.5	14.7	18.2	22.7	26.1	53.3	Portion of Reach located within private property (high density residential - apartments)
Property Type	Residential	2	2	2	4	4	4	6	
	Public/Open Space	1	1	1	1	1	1	1	
Building Type	Residential				1	1	1	1	
Roadway	Lake Ave. N (Collector)					1	1	1	
Reach BC-3	Flow (m^3/s)	9.1	12.5	14.7	18.2	22.7	26.1	53.3	Portion of Reach located within private property (commercial)
Property Type	Residential	1	1	1	3	5	6	8	
	Commercial	1	1	1	1	1	1	1	
	Public/Open Space	1	1	1	1	2	2	2	
	Utility - Hydro					1	1	1	
Building Type	Public		1	1	1	1	1	1	
	Utility - Hydro						1	1	
Roadway	Valley Dr. (Local)							1	
	Queenston Rd. (Arterial)								
Reach BC-4	Flow (m^3/s)	6.4	8.9	10.5	12.5	16.3	19.1	40.2	Portions of Reach located within private property (low density residential - houses, commercial) & within Green Acres School yard
Property Type	Residential	13	14	14	14	20	20	32	
	Commercial	3	3	3	3	3	3	4	
	Institutional	1	1	1	1	1	1	1	

	Public/Open Space	1	1	1	1	1	1	1	
Building Type	Residential	2	4	4	4	5	6	18	
	Commercial	1	1	1	1	1	1	1	
	Institutional							1	
	Faircourt Dr. (Local)							1	
Roadway	Randall Ave. (Local)	1	1	1	1	1	1	1	
Reach BC-5	Flow (m^3/s)	6.4	8.9	10.5	12.5	16.3	19.1	40.2	Entire Reach located within Battlefield Heritage site
Property Type	Residential							2	
	Commercial					1	1	1	
	Public/Open Space	1	1	1	1	1	1	4	
Building Type	Residential								
	Commercial					1	1	1	
Roadway	King St. W (Arterial)					1	1	1	
	Laneway Crossing	1	1	1	1	1	1	1	

Table 4-4: Reductions in Inundated Properties/Buildings/Roads under Proposed Conditions

	Storm Event:	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	Regional	Comments
Reach BC-1	Flow (m^3/s)	9.1	12.5	14.7	18.2	22.7	26.1	53.3	
Property Type	Residential								
	Public/Open Space								
Building Type	Residential								
Roadway	Huckleberry Dr. (Local)								
	Jackson Ln. (Local-Private)								
Reach BC-2	Flow (m^3/s)	9.1	12.5	14.7	18.2	22.7	26.1	53.3	Portion of Reach located within private property (high density residential - apartments)
Property Type	Residential			2					
	Public/Open Space								
Building Type	Residential								
Roadway	Lake Ave. N (Collector)								
Reach BC-3	Flow (m^3/s)	9.1	12.5	14.7	18.2	22.7	26.1	53.3	Portion of Reach located within private property (commercial)
Property Type	Residential								
	Commercial								
	Public/Open Space				1				
	Utility - Hydro				1				
Building Type	Public	1							
	Utility - Hydro								
Roadway	Valley Dr. (Local)								
	Queenston Rd. (Arterial)								
Reach BC-4	Flow (m^3/s)	6.4	8.9	10.5	12.5	16.3	19.1	40.2	Portions of Reach located within private property (low density residential - houses, commercial) & within Green Acres School yard
Property Type	Residential								
	Commercial								
	Institutional								

	Public/Open Space								
Building Type	Residential							2	
	Commercial							1	
	Institutional								
	Faircourt Dr. (Local)								
Roadway	Randall Ave. (Local)								
Reach BC-5	Flow (m^3/s)	6.4	8.9	10.5	12.5	16.3	19.1	40.2	Entire Reach located within Battlefield Heritage site
Property Type	Residential							1	
	Commercial								
	Public/Open Space								
Building Type	Residential							1	
	Commercial								
Roadway	King St. W (Arterial)								
	Laneway Crossing								

4.2 Erosion Risk Impacts

The 2018 Wood study included an assessment of geomorphic conditions throughout the Stoney and Battlefield Creek Watershed, completed by Matrix Solutions Inc. The critical areas were identified as Battlefield Reach 1 and Stoney Creek Reach 4 in that report. Both reaches are located immediately upstream of the confluence of Stoney and Battlefield Creeks. The critical reach on Stoney Creek will not be affected by the construction of the BC-1 facility. Most of the areas assessed were classified as transitional, indicating that while erosion is not a constant issue, geomorphic evidence shows that most reaches are in the process of adjusting to the altered hydrologic regime. The hydrologic alterations are primarily a result of land use changes and channel straightening, leading to increased flows.

The flows in the critical reach were analyzed to determine the existing and proposed peak flows as well as the duration of time that the flows exceeded the erosion threshold of 1.93 m3/s. This analysis was completed using both continuous modelling and return period design storms. The 24-hour Chicago Storm rainfall distribution was used for all return period events. For continuous modelling, a daily precipitation dataset from the Hamilton Royal Botanical Gardens gauge was used with data between 1958 and 1997.

The erosion threshold is the shear force associated with the initiation of motion of the median particle size. This is the flow at which significant geomorphic alterations are expected to occur. Some sediment will still be conveyed during lower flows, although it is likely to be replaced by sediment washed into the channel. This creates a system of dynamic stability and preventing the cross-section from being altered substantially, although bed forms will continue to migrate downstream.

Calculating erosion hours is a typical assessment of erosion impacts but does not take into account the degree of which the erosion threshold is exceeded. Flows that are greater than the critical flow by a significant margin will lead to more erosion than small exceedances, therefore the peak flow is also a consideration in erosion evaluations. **Table 4-4** shows the peak flows in reach BC-1, while **Table 4-5** shows the number of erosion hours for a given storm event in reach BC-1, calculated at 5-minute intervals. **Table 4-6** shows the number of erosion hours over the entire continuous model hydrograph from September 1958 to January 1997.

Table 4-4: Reach BC-1 Peak Flows (m^3/s)

Storm Event	2-year	5-year	10-year	25-year	50-year	100-year	Regional
Existing Conditions	9.7	13.7	16.2	19.7	22.5	25.4	65
Proposed Conditions	9.1	12.5	14.7	18.2	22.7	26.1	53.3

Table 4-5: Reach BC-1 Design Storm Erosion Hours

Storm Event	2-year	5-year	10-year	25-year	50-year	100-year	Regional
Existing Conditions	8.92	11.08	12.08	13.5	14.83	15.83	17
Proposed Conditions	8.17	11.42	13.08	15.33	15.92	16.42	21.17

Table 4-6: Reach BC-1 Continuous Modelling Erosion Hours

Erosion Hours		Percent Reduction
Existing Conditions	Proposed Conditions	
3068	1828	40.4

For the design storms, the results show reduced peak flows for the 2- to 25-year events as well as the Regional event. The percent reduction is about 6-9% for the 2- to 25-year events and 18% for the Regional event. For the 50- and 100-year events, the peak flows are slightly increased by 1%

and 3%, respectively. The erosion hours have been reduced for the 2-year event, and moderately increased for the 5-year to Regional events.

The continuous modelling results are a more realistic representation of the overall sediment transport regime as it includes much more frequent rainfall events than the design storms. The BC-1 facility was primarily designed to attenuate flows with less than a 2-year return period, so analyzing only the design storms would underestimate the erosion reductions that the facility provides. The 40% erosion reduction is quite large and will greatly reduce the number of events in which erosion occurs. The storms that do cause erosion will be less frequent and the magnitude of erosion will likely be reduced.

The major reductions in erosion hours for frequent events, combined with modest reductions of peak flows and erosion hours for design storms will create a sediment transport regime that better reflects pre-development conditions and reduces the erosion risk to property and infrastructure both in the critical reach, as well as the other reaches downstream of the BC-1 facility.

4.3 Construction Aspects

The silty clay glaciolacustrine sediments encountered beneath surficial topsoil in the north portion of the property are characterized by a low hydraulic conductivity and a natural water content at or slightly below the plastic limit. This material is considered compactible (see Soil Engineers Ltd. Geotechnical Report in Appendix D) and secondary permeability resulting from fractures in the soil will be effectively eliminated when the material is remoulded as when compacted by a heavy sheepsfoot roller-type compactor. For these reasons, the native silty clay is considered to be a suitable material for the construction of the berms needed to impound water for the constructed wetlands.

Monitoring of groundwater levels across the site demonstrate a seasonal variability in groundwater levels (Δh) ranging from 0.8 to 2.4 m for piezometers founded on the overburden bedrock interface. If we assume that soils remained in a fully saturated state (a reasonable assumption) and we treat the shallow silty clay aquitard as a porous medium (an unreasonable assumption) then the amount of water loss through the base of the wetland may be crudely estimated by multiplying the observed groundwater Δh by the effective porosity of the soils. Assuming an effective porosity of 20% and a Δh of 2.4 m, we estimate that water levels in the wetland will fall by less than 0.5 m over the summer months due to the infiltration of water through the base of the wetland into the underlying bedrock aquifer. Water losses due to evapotranspiration and water gains through the capture of surface water runoff must also be taken into account when predicting water level fluctuations in the constructed wetland.

Permanent water features should be sited in areas of relatively thick overburden where at least 0.3 m (0.5 m or more would be preferable) of clayey soil can be maintained between the bottom of the water features and the underlying bedrock. This soil layer should be composed of at least 0.2 m of the in-place native silty clay material which should be thoroughly proofrolled using a heavy sheepsfoot roller. Additional soil fill must be free of any organic material and compacted to 95% of standard Proctor maximum dry density (or as determined by the Engineer). The best results will be obtained if the material is compacted slightly wet of optimum using 6 to 8 passes with the heavy sheepsfoot roller on a non-vibratory setting. We recommend that contract documents for the project anticipate the need to modify the location of the permanent water features based on conditions encountered in the field at the time of construction.

Excavations for permanent water features and borrow material will intersect groundwater but the yield will be low and is expected to remain well below the 50,000 L/day threshold beyond which a Permit to Take Water (PTTW) or registration under Environmental Activity and Sector Registry (EASR) is required.

4.4 Karst Risk Factors

Karst features such as caves, sinkholes and solution-enlarged fractures are present within the Reformatory Quarry member of the Eramosa Formation in the south part of the subject property. Available mapping of karst for southern Ontario and Manitoulin Island (Brunton and Dodge, 2008) shows this area and the entire BC-1 property as an area of known or potential karst. A number of Ontario-specific karst risk factors are present at the site (Brunton and Dodge, 2008; Brunton, 2013). These are:

- karst-susceptible geology consisting of carbonate rocks or evaporites;
- thin or absent soil cover;
- proximity to significant sequence stratigraphic boundaries; and,
- proximity to margins of escarpments near major rivers, particularly at bends in major rivers/

Karst features have the potential to adversely affect the functioning of the planned constructed wetlands. While the potential for a sudden collapse of an underground cave is an obvious hazard (especially in areas of the world such as Florida, Mexico, Spain etc.) this kind of hazard is rare in Ontario. More common is the potential for karst features to cause zones of abnormal permeability that, if present and connected to the wetland ponds, could result in the rapid loss of impounded water.

We note that the north part of the property (i.e. the area proposed for the constructed wetlands) is underlain by the Vinemount member of the Eramosa Formation which is less susceptible to karst development than the Reformatory Quarry member owing to its greater shale content (F. Brunton, personal communication). No karst features were noted in this area and a direct hydraulic connection between the impounded water in the wetland and any undiscovered karst-related high-permeability zones in bedrock can be prevented by maintaining a layer of low permeability silty clay between the base of the wetland ponds and the underlying bedrock.

4.5 Potential for Adverse Effects

The planned construction of wetland ponds to provide stormwater control and wildlife habitat enhancement will reduce flooding in lands downstream of the wetland area while both evapotranspiration and groundwater recharge will increase. In the absence of a connection between the pond and high-permeability karst zones, the amount of the groundwater recharge will be modest and insufficient to cause flooding off site or to adversely impact off site groundwater quality (since much of the relevant area is already functionally wetland but deficient in storage capacity). No karst features were observed within the proposed wetland areas and any karst hazards that might be encountered during (or following construction) could be mitigated though the strategic placement of low permeability fill materials.

4.6 Re-planting of Berm

In order to mitigate for the removal of swamp for the east berm and to generally soften the visual impact of both berms, it is recommended that native trees and shrubs be planted beside and (as feasible) atop these features. Planting along First Road East will provide a visual screen which will enhance the wildlife value of the western wetlands and berm feature. A mixture of caliper trees and smaller potted stock should be used.

Planting locations should consider soil moisture relative to the tolerance of a given species, the potential for snow throw damage from plows, buried utilities (if applicable) and maintaining safe sightlines within the road right of way. The geotechnical report (Soil Engineers Ltd. 2019) notes that the native silty-clay soils which are present on site are suitable for the construction of the berms, therefore limiting the need to introduce soil to the site. The geotechnical report recommends the removal of topsoil and organics for berm construction. It is noted that the stockpiling of these materials for top-dressing will be important for the establishment of trees and shrubs following construction. In order for the successful establishment of plantings, topsoil compaction (at least in the upper strata) should be minimized to provide a suitable growing medium for tree root establishment. Excessive soil compaction of the re-instated A-horizon will limit the success of naturalization efforts

Species which are hardy, fast-establishing and produce fruit in abundance should be included in the planting to enhance survival and act as an early seed source for unplanted areas. In order to ensure the long-term stability of the berm, and given the potentially challenging growing conditions, tree plantings should not occur on the berm itself. Hardy and clonal shrub species would be best suited to this area.
As White-tailed Deer and rodent browse will be heavy within the property, tree protection measures may include the application of Skoot™ browse protectant to stems and the installation of tree coils or tree tubes. The use of enclosure fencing would not be suitable in this application as rodents and rabbits could still access the vegetation leading to a high planting mortality rate. Large trees (caliper or otherwise tall stock) should be tethered and staked using biodegradable straps and wooden stakes to prevent wind damage and shifting following the planting. The use of biodegradable tether will ensure trees are not girdled in time (as is often the case with metal wire).

Based upon species which are present in the study area and the clay-heavy soils, suitable species include:

- Bur Oak (*Quercus macrocarpa*)
- Eastern Cottonwood (*Populus deltoides*)
- Trembling Aspen (*Populus tremuloides*)
- Silver Maple (*Acer saccharinum*)
- Shagbark Hickory (*Carya ovata*)
- Black Cherry (*Prunus serotina*)
- White Pine (*Pinus strobus*)
- Grey Dogwood (*Cornus foemina* ssp. *ra*cemosa)
- Red Osier Dogwood (*Cornus sericea*)
- Staghorn Sumac (*Rhus typhina*)
- Nannyberry (*Viburnum lentago*)
- Native Hawthorns (*Crataegus* spp.)

4.7 Naturalization of Wetlands and Retention Area

Within the berm retention areas, several types of wetland may be restored. Deeper excavations with a clay lining are likely to retain standing water for much or all of the year which will support emergent marsh vegetation and provide ideal habitat for anuran breeding. The evapotranspiration rate is expected to exceed the precipitation during the summer months, potentially leading to the wetland areas drying out between significant rainfall events. The evapotranspiration losses from the wetland areas will be mitigated through vegetation plantings that will provide shade and retain moisture. It is unlikely that the wetland areas will dry out at other times during the year. Infiltration losses could also lead to the wetland areas drying out, but this is unlikely to be a significant issue due to the low hydraulic conductivity of the soils and the additional compaction to occur during construction and grading. Areas of shallow excavation will establish as mixed marsh or mud flat which dry out by late spring and may provide nesting habitat for waterfowl or foraging habitat for shorebirds. Thicket plantings may be reasonable atop high elevations within the ponds but are better suited to the areas surrounding the ponds as shown on the planting plans within the drawing set.

In order to prevent erosion and retain soil moisture, the entire graded area should be seeded with a non-allelopathic nurse crop such as Buckwheat (*Fagopyrum esculentum*) as well as a native seed mixture. Seeding should be focused along 10m (or greater) on either side of the re-instated watercourse to effectively filter sediment and runoff entering the watercourse. Application may be completed using hydro-seeding or terra-seeding (more costly), seed drill equipment, or hand-broadcasting (in particular within any steep or wet excavations). The seed mixtures applied within the various habitats should adhere to the species lists outlined in the document Seed Mixes

Suitable for our Watershed (HCA 2019), to the extent which these species are commercially available or may be collected from other HCA properties. In order to properly stratify seed, increase germination and reduce seed predation, the native seed mixture should be installed in late fall, prior to ground freeze-up. Subject to available funds and staffing, plug planting may also be considered, in particular within the saturated soils of the created wetlands.

The inclusion of upland ridges in the site grading and the placement of tree root masses, logs, boulders and rock piles among the wetlands will improve the heterogeneity of the site and enhance wildlife habitat in general. Where possible, the planting of trees and shrubs along the watercourse and surrounding the wetland features will help to cool water temperatures and make these features more attractive to wildlife. Tree planting throughout the retention area will help to cool water temperatures and reduce evapotranspiration. Species such as Silver Maple and Eastern Cottonwood are tolerant of wet soil and seasonal inundation and are among the fastest growing tree species suited to the property.

The seeding of Milkweed (*Asclepias* spp.) and native forbs can enhance habitat for Monarch butterflies and other insects. Seed may be scattered across the created wetland area, or concentrated plots can be installed to act as a seed source to disperse through the site in the years to follow.

4.8 Channel Naturalization

Spot treatments in the existing channel within the study area are likely needed to address localized erosion issues. The application of erosion control measures within this area is recommended and may include hydro-seeding or terra-seeding of a non-allelopathic nurse crop and native seed mixture. To avoid vegetation removal and machinery impacts associated with a full re-alignment of the section of channel within the significant woodland in the northwest extent of the site, channel work will be limited to areas that can easily be accessed upstream of the forest. The placement of coir logs and planting of shrub stock along the banks will improve this section of the creek.

4.9 Invasive Species Management

Invasive species management will be required prior to construction and periodically following the creation of the berms and wetlands. Management will be both active (herbicide application) and passive (native species plantings to alter conditions where invasive species thrive).

Common Reed is the priority species for immediate management as this species could spread from existing stands into the created wetlands resulting in low diversity and reduced habitat value for wildlife. This species can only be effectively managed through the application of herbicide. It is recommended that HCA restoration technicians licensed to apply herbicides target the existing stands as soon as possible. Although treatment prior to the commencement of earth works is ideal, this work can also be undertaken immediately following the completion of the berms in the event timing is a constraint. The existing stands are sparse and separated from one another which allows for effective and efficient management. A preliminary treatment will need to be followed up by a monitoring visit and one or more subsequent treatments to address persistent stems.

Reed Canary Grass is abundant in the central marsh feature and will outcompete any herbaceous vegetation within the created wetlands if it begins to colonize those areas. It is recommended that management of the existing stands be passively managed through the planting of trees and shrubs tolerant of wet soils. Fast-growing species including Silver Maple and Eastern Cottonwood are well-suited to growing among Reed Canary Grass and establishing canopy in a relatively short amount of time.

As a prolific seed producer, there is potential that Reed Canary Grass will establish within the created wetlands in time. Early detection and treatment using herbicides during dry conditions will be important to controlling the spread of this species.

Management of European Buckthorn and Glossy Buckthorn within the property should focus on the control of female, seed producing shrubs in the vicinity of the created wetlands as a temporary measure to reduce the spread of this species. As the agricultural fields have been left fallow, these shrubs will begin to seed into open areas including the berms and wetlands.

Herbicide treatment of seed-producing shrubs should focus on the hedgerows, along the Dofasco 2000 Trail, within the cultural thickets and at the perimeter of forest and swamp communities near the created wetlands. Due to the presence of a seedbank, treatment will require an ongoing effort of monitoring and herbicide application. Once the shrubs adjacent to the created wetlands are effectively controlled, management may consider addressing shrubs in other portion of the property. For areas where Buckthorn seedlings are abundant, such as the cultural thicket in the northwest portion of the property, the planting of Black Walnut may be effective in reducing Buckthorn and should be considered by HCA as an additional passive management tool.

Although removal of seed-producing shrubs and passive management through tree planting will reduce Buckthorn stems and spread, a large-scale treatment and native species planting effort is required in the long term to reinstate resilient habitats where the large stands of Green Ash are currently in decline.

Following the installation of plantings and seeding at the site, HCA staff should monitor for the re-establishment of these invasive species (and others). The presence of disturbed soil within the created wetlands provides increased opportunity for invasive species to establish while the native plantings mature. An annual assessment by HCA staff during the growing season will detect problematic species early which will allow for small-scale spot treatment where necessary.

4.10 Barn Swallow Habitat Enhancement

Observation of Barn Swallow foraging in 2019 suggests that the species utilizes the marshes and declining swamp areas for foraging. It is likely that pairs nest on structures located on nearby residential lots. HCA should consider the installation of Barn Swallow nesting structures in areas adjacent to the created wetlands. The requirement for compensation of removed nest habitat under the Endangered Species Act, 2007 is likely to present an opportunity to have such structures installed (and funded) as part of local development applications. The site may support several of these structures which should be installed away from the road corridor to prevent road mortality. The posts of the structure should be covered with sheet metal to a height of 1m to deter mammals from climbing the posts and predating nests. Design drawings for these structures are available (MNRF 2016).

4.11 Turtle Nesting Feature Installation

Although surveys in 2019 did not observe turtles or evidence of turtle nesting within the property, the proposed creation of wetland has the opportunity to create suitable habitat for turtle basking and nesting in the coming years. The design drawings have incorporated a constructed turtle nesting feature at each of the 6 created wetlands. The nesting features can be created through the installation of deep beds of coarse sand and fine stone in sunny areas adjacent to the created wetlands. Basking habitat can be enhanced through the placement of logs or flat stones within the deeper areas of created wetland. Further guidance relating to the construction of turtle nesting features is available through the Toronto Zoo (Toronto Zoo 2019).

Turtle overwintering habitat was not identified within the property during the surveys but may be present on adjacent properties such as the pond to the west of First Road East. As it is anticipated that the base depth of the created wetlands will be on or close to the surface of the underlying dolostone bedrock, ideally with 0.3m or more of heavily compacted soil retained (Greer Galloway 2020), the potential for turtle overwintering within the created ponds is limited. In time, the settling of sediment and organics may provide suitable over-wintering habitat for turtles.

4.12 Conclusions

For these above reasons, no significant adverse environmental effects are envisaged for the project.

5.0 MONITORING PROGRAM

The Flood and Erosion Control Class EA recommended that monitoring of the proposed works be completed upon implementation. The proposed works result in the creation of wetlands, improved aquatic habitat and riparian and upland terrestrial habitats. To assess the performance of the storage facilities requires an appropriate level of monitoring, prior to, and after, construction by the HCA. The monitoring plan should evaluate the performance of the storage facilities and allow for adjustments and/or optimization through Adaptive Management.

The duration of the monitoring is recommended to be 7 to 10 years in length with frequent reporting in the first few years and intermittent reporting in the last few years.

Monitoring of the performance of the storage facilities could include:

A - Stream Morphology:
To be conducted downstream of the storage facilities and at downstream erosion sites:

1) Stream Cross-sections (Controls)
2) Erosion pins (Tractive Force, Critical Shear Stress)
3) Bank Properties (Height, Angle, Material, Vegetation, Root Depth, Undercuts and In-situ Shear Strength)
4) Longitudinal Profile Survey (Energy Gradient, Top and Bottom Riffles, Max Pool Depth)
5) Photographic record

B - Natural Heritage System:

1) Community Structure/Health – Ecological Integrity, Habitat Boundary Integrity, Problem Species, Overall Species and Habitat Diversity, Buffer Effectiveness, Human Activity Impacts
2) Local Hydrology (water levels, soil moisture, etc.)

C - Hydrometeorologic:

1) Rainfall - Continuous
2) Streamflow- Storm Response
3) Baseflow – Flow Rate (Spot measurements)
4) Pond Inflow and Outflow (both facilities)

D - Water Quality/Biophysical:

1) Benthic Invertebrates – Community Structure
2) Water Temperature – Continuous
3) Sediment- Total Suspended Solids
4) Fisheries- (Electrofishing)

It is proposed that the final monitoring plan specifics be determined once the proposed design is approved, but prior to construction.

6.0 CONCLUSIONS AND RECOMMENDATIONS

6.1 Flood and Erosion Control Class EA Conclusions and Recommendations

Based on the requirements of the Flood and Erosion Control Class EA, the following can be noted:

1) The HEC-RAS model from the Flood and Erosion Control Class EA was used as the basis for the final Floodplain Mapping prepared by Water's Edge. While this current study has examined and changed the hydrologic responses of these particular subwatersheds, the actual floodplain modelling has been included in the Battlefield and Stoney Creek Floodplain Mapping Study (Water's Edge, 2020). According to the MNRF *River and Stream Systems: Flood Hazard Limit Technical Guide*, the reductions of peak flows from stormwater facilities will not affect the downstream flow rates or the resultant floodplain maps;

2) A HEC-HMS model was developed for the catchment area upstream of First Rd. E to assess the effectiveness and impacts of the proposed facilities. The results of the small-scale HEC-HMS model were implemented into the HEC-HMS model that was developed for the Stoney and Battlefield Creek Floodplain Mapping Project (Water's Edge, 2020) to assess downstream impacts.

3) The flow-duration analysis completed in the Flood and Erosion Control Class EA (AFW, 2018) has been re-examined and the results of this analysis conclude that the intent of the Flood and Erosion Control Class EA (AFW, 2018) has been achieved;

4) Water's Edge has updated / refined the hydraulic, hydrologic, and erosion assessment and confirm that the proposed design results in the potential benefits to the receiving systems (in terms of flood and erosion risk reduction), envisioned by the Flood and Erosion Control Class EA, have been realized;

5) The assessment and design of the wetland storage facility, wetlands and channel meet terrestrial, aquatic and hydrogeological requirements and goals as required by the Flood and Erosion Control Class EA;

6.2 Current Study Conclusions and Recommendations

1. The results of this assessment indicate that the north portion of the BC-1 property is underlain by a continuous deposit of silty clay glaciolacustrine sediments having a low hydraulic conductivity when in an unfractured state. These characteristics are considered favourable for the impoundment of stormwater flows in a constructed wetland that will then lose water slowly though direct discharge, evapotranspiration and infiltration into the underlying bedrock aquifer.

2. Monitoring of groundwater levels across the site demonstrate a seasonal variability in groundwater levels ranging from 0.8 to 2.4 m for piezometers founded on the overburden bedrock interface. The corresponding seasonal variation in pond levels is expected to be of a lesser magnitude reflecting the absence of porosity effects in standing water, and because of the ongoing capture of surface water runoff throughout the summer months. Nevertheless, permanent water features should be sited in areas of relatively thick overburden and at least 0.3 m of clayey soil should be maintained between the bottom of the water features and the underlying bedrock.

3. Numerous karst features were observed in the south part of the BC-1 property, but Greer Galloway found no evidence of karst development in the area proposed for the constructed wetland ponds. This part of the property is underlain by shaley dolostones of the Vinemount member of the Eramosa Formation which are less susceptible to karst development than the Reformatory Quarry member located south of the Eramosa scarp. Based on the results of our assessment we conclude that there is a low risk that karstic features would pose a

hazard and constraint to the planned constructed wetland development, and that any karst hazards that might be discovered could be mitigated though the strategic placement of low permeability fill materials.

4. The impoundment of stormwater flows is predicted to result in a modest increase in groundwater recharge and a more significant increase in stream baseflows while reducing peak storm flows. No adverse effects are anticipated to offsite groundwater users or ecological receptors along the escarpment and practical mitigation measures exist to mitigate any unpredicted effects that might be encountered during or following construction.

5. The subject property contains several natural features with significant local designations, including unevaluated wetland, a section of Battlefield Creek which provides fish habitat and an associated tributary, and significant woodland.

6. Habitat for SAR is limited to candidate roosting habitat for SAR bats outside of the development footprint. Several SWH types were identified; Landbird Migratory Stopover Habitat, Shrub/Early Successional Bird Breeding Habitat, Seeps and Springs and Special Concern/Rare Wildlife Species Habitat (Eastern Wood-pewee, Common Nighthawk and Monarch). Additionally, Bat Maternity Roost habitat, Snake Hibernacula and Raptor Wintering Area were determined to be candidate SWH types for the property. Based on the proposed development footprint, Landbird Migratory Stopover habitat, habitat for Monarch and Bat Maternity Roost habitat (candidate) will be directly impacted.

7. Direct impacts to fish and fish habitat can be identified as the direct loss of habitat, harmful alteration of habitat, or a harmful disruption to habitat (i.e. effecting flow during spawning), as well as the direct injury to fish as a result of the proposed works and construction. Direct impacts to fish associated with this undertaking include fish passage, potential for death of fish, destruction of fish habitat by creation of the wetland and berms (i.e. placing fill below the high-water mark and fording the watercourse). Appendix IX of the NRSI report (**Appendix D**) provides a summary of the potential impacts to fish and fish habitat, both for on land and in-water activities, the mitigation measures and if there are any residual effects expected from the activities. Based on this assessment, the project should contact DFO for review.

8. Other direct impacts associated with this undertaking include grading and vegetation removal. The design of the berms largely avoids treed areas and grading will occur outside of the dripline where the berm nears the edges of swamp and hedgerow features. Vegetation removal is required for the east berm which overlaps an area of declining Green Ash swamp (SWD2-2).

9. Project impacts can be mitigated by adhering to timing windows including the breeding bird window and bat active period as well as completing grading works during the dry period. Any tree removal which must occur within the bat active period should have an assessment of potential roost trees completed prior to removals commencing. Restoration plantings should be installed both within the wetlands and watercourse as well as within riparian habitat to restore the form and function of the impacted features.

10. Indirect impacts to fish and fish habitat can include long term changes to the watercourse (i.e. temperature, flow, passage), erosion and sediment control, grading, and the entry of deleterious substances in the water which may also result in a HADD.

11. Other potential indirect impacts as a result of the proposed development include changes to wetland hydrology both above and below the berms as well as disturbance to wildlife during construction. As the areas above the berms which will retain standing water are agricultural or recently fallow fields, there are no major impacts to high quality and well-

established, natural habitats. The wetland and riparian habitat below the berms will likely encounter a decrease in surface water input; however, the design of the control structures and the retained catchment and tributary inputs will continue to direct flow to these habitats to maintain their form.

12. Identified induced impacts as a result of the proposed development may include the establishment of non-native invasive species to the site during the completion of grading. The development of formal laneway entrances from First Road East. or Second Road East. may result in increased yard waste and garbage dumping.

13. This report provides a detailed characterization of the natural features and wildlife habitat which are present within the study area. This information has been incorporated into the design of the berms and flow control structures in a manner that minimizes impacts to sensitive features. Recommendations are provided to minimize direct, indirect, and induced impacts that may arise during the proposed development and to ensure that mitigation measures are effective.

14. Battlefield Creek is a 2nd order stream that flows through the Lincoln and Haldimand Silty Clay Loams. The geomorphic assessment was carried out on the most natural and representative reach within the study area, which was found to be stable with no signs of significant erosion.

15. Based on our evaluation of geomorphic parameters within the reaches in the study area show that the bankfull flow is between 0.2 and 0.5 m^3/s. Based on hydrologic modelling, the 100-year flow is about 5.99 m^3/s and the Regional Storm (Hurricane Hazel) peak flow is 16.98 m^3/s. The wetland storage facilities will reduce the peak flows of return period events by at least 70%, and will reduce the Regional Storm peak flow by 20%. The proposed bankfull flows match the observed bankfull indicators in the forested wetland reach.

16. The number of erosion hours in the reach downstream of First Rd. E will be dramatically reduced for all return period storms, and slightly reduced for the regional storm.

17. Spot repairs based on natural channel design principles will be completed to the existing channel in the forested wetland.

The detailed design is presented in the attached drawing set in Appendix E.

6.3. Permit Approvals

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SYMBOLS:

g	Unit weight of water (approximated as 9810 N/m^3),
R	Hydraulic radius of the channel (m)
d	Bankfull flow depth in the channel (m)
S	Slope of the channel (m/m)
g	Acceleration due to gravity (9.81 m/s^2)
r_s	Density of substrate (kg/m^3)
r_w	Density of water (kg/m^3)
D_{50}	Median grain size (m)

APPENDIX A:

Geotechnical Report

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A REPORT TO
WATER'S EDGE ENVIRONMENTAL SOLUTIONS TEAM LTD.

A GEOTECHNICAL INVESTIGATION FOR PROPOSED WETLAND

FIRST ROAD EAST AND GREEN MOUNTAIN ROAD EAST

CITY OF HAMILTON

REFERENCE NO. 1902-S100

MAY 2019

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ENCLOSURES

1.0 INTRODUCTION

In accordance with written authorization from Dr. Ed Gazendam, P.Eng., of Water's Edge Environmental Solutions Team Ltd., a geotechnical investigation was carried out in the conservation area located on the east side of First Road East, north of Green Mountain Road East in the City of Hamilton.

The purpose of the investigation was to reveal the subsurface conditions and to determine the engineering properties of the disclosed soils for the design and construction of Wetland, for potential flood water storage in the upper Battlefield Creek and Stoney Creek watersheds.

The geotechnical findings and resulting recommendations are presented in this Report.

2.0 SITE AND PROJECT DESCRIPTION

The City of Hamilton is located on Waterdown moraine where glacial tills dominate the soil stratigraphy. The tills extend onto dolomite bedrock of Amabel Formation. In places, the tills have been partly eroded by the water action of glacial Lake Whittlesey, filled with lacustrine sand, silt, clay and water-laid till.

The site of investigation is located on the east side of First Road East, approximately 500 m north of Green Mountain Road East in the City of Hamilton. It was previously a farm field in a low-lying area. The site is currently vacant with weed cover and trees.

We understand that the area of investigation will be designed to create a wetland, as part of the Saltfleet Conservation Area Wetland Restoration Program.

3.0 FIELD WORK

The field work, consisting of nine (9) sampled boreholes, was performed between March 26 and April 4, 2019, at the locations shown on the Borehole Location Plan, Drawing No. 1. The initial boreholes were numbered from Borehole 1 to 5 on-site, having Boreholes 6 and 7 located off-site on First Road East. Two additional boreholes were drilled on site afterwards and they were numbered as Boreholes 5B and 5C; Borehole 5 was re-numbered to 5A. The ground elevation at each borehole location was established using a hand-held Trimble Geoexplorer 6000 Series Global Navigation Satellite System (GNSS) surveying equipment.

The boreholes were performed by augering to the depth of refusal at 0.6 to 5.5 m from grade, using a track-mounted drill rig, with continuous-flight power-auger and equipment for soil sampling. Standard Penetration Tests, using the procedures described on the enclosed “List of Abbreviations and Terms”, were performed at the sampling depths. The test results are recorded as the Standard Penetration Resistance (or ‘N’ values) of the subsoil. The relative density of the granular strata and the consistency of the cohesive strata are inferred from the ‘N’ values. Split-spoon samples were recovered for soil classification and laboratory testing.

‘NQ’ size rock coring was carried out below the auger refusal depths in 2 selected boreholes to establish the quality and continuity of bedrock, as assessed by applying the sample recovery and the ‘Rock Quality Designation (RQD)’. The results are shown on the corresponding Borehole Logs.

Groundwater monitoring wells, 50-mm in diameter, were installed in 6 selected boreholes to facilitate a hydrogeological study by another consultant. The depth and details of monitoring wells are shown on the borehole logs. The remaining boreholes were backfilled to the ground surface using hole plug of bentonite.

4.0 SUBSURFACE CONDITIONS

The investigation has disclosed that beneath a topsoil veneer or road pavement, with a layer of earth fill in places, the area of investigation is underlain by silty clay, overlying dolomite and limestone bedrock at a depth ranging from 0.6 to 5.5 m from the prevailing ground surface.

Detailed descriptions of the encountered subsurface conditions are presented on the Borehole Logs, comprising Figures 1 to 9, inclusive. The revealed stratigraphy is plotted on the Subsurface Profile, Drawing No. 2. The engineering properties of the disclosed soils and bedrock are discussed herein.

4.1 **Topsoil** (All Boreholes; except Boreholes 6 and 7)

The revealed topsoil is 15 to 30 cm thick. It is dark brown in colour, indicating appreciable amounts of roots and humus. Buried topsoil will produce volatile gases and may generate an offensive odour under anaerobic conditions.

4.2 **Pavement Structure** (Boreholes 6 and 7)

The pavement structure on First Road East, as shown in Boreholes 6 and 7, consists of 230 mm and 180 mm asphaltic concrete, overlying a granular base course of 230 mm and 330 mm in thickness, respectively. It should be noted that the lower portion of the granular base was mixed with the subgrade soils, causing difficulty in delineating the interface between the granular base and the subgrade. Grain size analysis was performed on a sample of the granular base. The result is plotted on Figure 10, indicating its gradation meets the OPS Specifications for Granular ‘A’ and Granular ‘B’.

4.3 **Earth Fill** (Boreholes 6 and 7)

A layer of earth fill was contacted beneath the pavement structure on First Road East. It consists of silty clay with sand, gravel and occasional topsoil inclusions. The earth fill extends to a depth of 0.8 m and 1.5 m below the pavement level.

The water content values of the soil samples were determined at 25% and 27%, indicating very moist conditions. The obtained 'N' values are 13 and 17 blows per 30 cm of penetration, indicating the fill was compacted or self consolidated under the road structure.

4.4 **Silty Clay** (All Boreholes)

The silty clay deposit was contacted as the native stratum in the area of investigation. It is a glaciolacustrine deposit, laminated with silt and sand seams. Grain size analyses were performed on 2 representative samples and the results are plotted on Figure 11.

The obtained 'N' values range from 5 to more than 100, with a median of 26 blows per 30 cm of penetration, indicating the consistency of the deposit is firm to hard, being generally very stiff. The firm clay at the upper stratum is generally weathered, extending to depths of 0.6 m and 0.8 m from grade.

Due to the presence of rock debris near the interface of bedrock, the obtained 'N' values at the lower stratum could have been exaggerated and do not represent the actual consistency of the deposit.

The Atterberg Limits of a representative sample and the water content values of all the clay samples were determined. The results are plotted on the Borehole Logs and summarized below:

Liquid Limit	43%
Plastic Limit	21%
Natural Water Content	6% to 33% (median 19%)

The above results show that the silty clay is medium plasticity. The water content is generally below its plastic limit, confirming the consistency of the clay deposit as revealed by the 'N' values.

Accordingly, its engineering properties pertaining to the project are given below:

- High frost susceptibility and soil-adfreezing potential.
- Low water erodibility.
- Low permeability, with an estimated coefficient of permeability of less than 10^{-7} cm/sec, a percolation rate above 80 min/cm and runoff coefficients of:

Slope	
0% - 2%	0.15
2% - 6%	0.20
6% +	0.28

- A cohesive-frictional soil, the shear strength is derived from consistency and augmented by the internal friction of the sand and silt.
- The clay will be stable in relatively steep slopes. However, prolonged exposure will allow infiltrating precipitation to saturate the silt layers and causing the wet silt to slough slowly.

- A poor pavement-supportive material, with an estimated California Bearing Ratio (CBR) value of 3%.
- Moderately high corrosivity to buried metal, with an estimated electrical resistivity of 2500 ohm·cm.

4.5 **Bedrock** (All Boreholes)

Refusal to auger drilling was contacted in the boreholes, at 0.6 to 5.5 m from the prevailing ground surface, or between El. 182.4 m and El. 187.5 m. It represents bedrock in this vicinity.

Rock coring was conducted below the refusal depths of 1.2 m and 5.5 m, at Boreholes 5C and 7, respectively. The bedrock is dolomite or limestone, a grey sedimentary rock of Amabel formation. According to the Rock Quality Designation (RQD) values, the bedrock is poor quality, becoming good to excellent quality at the deeper level.

The bedrock is hard to excavate. Effective rock excavation will require blasting. A rock blasting expert must be consulted to assess the zone of influence of the shock waves created by the blasting to prevent any damage of the nearby structures.

Where excavation is to be carried out in sound bedrock, slight lateral displacement of the excavation walls is often experienced. This is due to the release of residual stress stored in the bedrock mantle.

Depending on the continuity of rock fractures, groundwater yield from bedrock is generally limited.

4.6 Compaction Characteristics of the Revealed Soils

The obtainable degree of compaction is primarily dependent on the soil moisture and, to a lesser extent, on the type of compactor used and the effort applied. As a general guide, the typical water content values of the revealed soils for Standard Proctor compaction are presented in Table 1.

Table 1 - Estimated Water Content for Compaction

Soil Type	Determined Natural Water Content (%)	Water Content (%) for Standard Proctor Compaction	
		100% (optimum)	**Range for 95% or +**
Granular Fill	4 and 10	7	4 to 10
Earth Fill/Silty Clay	6 to 33	20	16 to 24

The above values show that the contacted soils are mostly suitable for a 95% or + Standard Proctor compaction. Wet or weathered soils will require aeration prior to structural compaction. The existing earth fill must be sorted free of any deleterious materials prior to its use as structural backfill. The lifts for compaction should be limited to 20 cm, or to a suitable thickness as assessed by test strips performed by the equipment which will be used at the time of construction.

The presence of rock boulders will prevent transmission of the compactive energy into the underlying material to be compacted. If an appreciable amount of rock fragments over 15 cm in size is mixed with the material, it must either be sorted or must not be used for structural backfill and engineered fill. Shattered rock from blasting is not an ideal material for structural backfill due to the amount of oversized boulders.

5.0 GROUNDWATER CONDITIONS

Groundwater and/or cave-in were evident in some boreholes. The groundwater level and occurrence of cave-in were recorded upon completion of drilling and sampling. The data are plotted on the Borehole Logs and listed in Table 2.

Table 2 - Groundwater Levels

Borehole No.	Ground Elevation (m)	Borehole Depth (m)	Measured Groundwater/ Cave-in* Level On Completion	
			Depth (m)	Elevation (m)
1	187.8	0.9	At Ground Level	187.8
2	188.1	0.6	At Ground Level	188.1
3	187.6	0.8	0.5	187.1
4	188.0	0.9	Dry	Below 187.1
5A	189.5	2.4	2.1*	187.4*
5B	187.8	2.9	0.3/2.4*	187.5/185.4*
5C	188.0	3.0	-**	-**
6	187.5	1.8	Dry	Below 185.7
7	187.9	7.1	-**	-**

* Cave-in depth

** Water was supplied for rock coring, record of groundwater was not possible upon completion.

Groundwater was evident near the ground surface at the location of Boreholes 1 and 2. In Boreholes 3, 5A and 5B, groundwater and cave-in were recorded at a depth of 0.3 to 2.4 m, or El. 185.4 to 187.5 m. The groundwater represents perched water in the sand seams within the clay and above the bedrock. It is subject to seasonal fluctuation.

It should be noted that the groundwater will be further assessed by the Hydrogeological Consultant in a separate report.

6.0 DISCUSSION AND RECOMMENDATIONS

The investigation has disclosed that beneath a topsoil veneer or road pavement, with a layer of earth fill in places, the area of investigation is underlain by firm to hard, generally very stiff silty clay, overlying dolomite and limestone bedrock at a depth ranging from 0.6 to 5.5 m from the prevailing ground surface, or between El. 182.4 m and El. 187.5 m.

As part of the Saltfleet Conservation Area Wetland Restoration Program, the area of investigation will be designed to create a wetland for storage of stormwater to reduce peak flows of the upper Battlefield Creek for flood and erosion control. Based on the Flood and Erosion Control Study prepared by Amec Foster Wheeler, the existing road grade will be raised by 1.8 m (from the current elevation of 187.5 m to approximately 189.3 m) and the basin of the proposed wetland will be at El. 186.3± m to accommodate the high stormwater events.

6.1 Wetland Construction

All excavation should be carried out in accordance with Ontario Regulation 213/91. For excavation purposes, the types of soils are classified in Table 3.

Table 3 - Classification of Soils for Excavation

Material	Type
Bedrock	1
Silty Clay	2
Earth Fill	3

Excavation within 1.0 to 1.5 m into the bedrock will require a heavy-duty excavator equipped with a rock-ripper and pneumatic hammer. Any excavation into the sound bedrock will require rock blasting. A blasting specialist must be consulted, and the surrounding structures must be carefully inspected and surveyed before blasting to prevent unwarranted damage claims arising from blasting.

The yield of groundwater in excavation is anticipated to be slow in rate and limited in quantity. Any groundwater yield from the rock fractures may be appreciable initially but will decrease with conventional pumping from sumps.

Earth fill to be used for the embankment around the wetland shall consist of low permeability clay material. Selected on site native silty clay, free of organics, is suitable for the construction of the embankment. The earth fill for an embankment should be compacted in lifts not exceeding 200 mm, to a minimum of 98% of the Standard Proctor Maximum Dry Density (SPMDD), with the water content close to its optimum moisture content.

In preparation of the subgrade for embankment, topsoil and organic soils should be removed. The weathered soils shall be sub-excavated and the ground should shall be proof-rolled. The fill placement and compaction should be inspected by either a geotechnical engineer, or a geotechnical technician under the supervision of a geotechnical engineer under full-time basis.

The sides of earth embankment should be sloped at 1 vertical:3+ horizontal in the dry zone and 1 vertical:4+ horizontal in the wet zone and within 1 m above the design water level. All the exposed slopes must be vegetated or sodded to protect from erosion.

Rock fragments and granular fill can be used in areas where water retention is not necessary.

Water channels and spillways should be provided with a liner for erosion resistance, consisting of rip-rap stone or gabion mattress above a filter fabric. The lining should extend from the walls over the entire basin.

Service pipes in the earth embankment should be provided with anti-seepage collars in 25 m intervals, consisting of either clay or concrete plugs to protect the subsoils from water seepage through the bedding, which can result in loss of ground and creating a cavity in the embankment.

6.2 Road Reconstruction

The road section in the vicinity of the proposed wetland will be raised by 1.8 m, from the current elevation of 187.5 m to approximately 189.3 m.

The road subgrade is anticipated to consist of on-site excavated material of silty clay, generally a poor pavement-supportive material with CBR value of 3%. Since the subject road will be for local and rural uses, the recommended pavement structure is presented in Table 4.

Table 4 - Pavement Design

Course	Thickness (mm)	OPS Specifications
Asphalt Surface	40	HL-3
Asphalt Binder	80	HL-8
Granular Base	150	OPSS Granular 'A' or equivalent
Granular Sub-base	350	OPSS Granular 'B' or equivalent

The existing asphalt pavement can be pulverized or removed off-site. Pulverized asphalt and the existing granular bases can be reused as the road sub-base for the new road. Bulk samples should be collected and tested for the OPS Specification before reuse.

Prior to placement of the granular bases, the final subgrade should be inspected and proof-rolled. Any soft spot as identified should be subexcavated and replaced by properly compacted inorganic material. The subgrade soil in the zone within 1.0 m below the pavement must be compacted to 98% or + of SPMDD, with the moisture content close to the optimum water content. In the lower zone, a 95% or + SPMDD is considered adequate.

The pavement subgrade will suffer a strength regression if water is allowed to infiltrate prior to paving. The following measures should therefore be incorporated in the construction procedures and road design:

- If the road construction does not immediately follow the subgrade preparation and trench backfill, the subgrade should be properly crowned and smooth-rolled to allow interim precipitation to be properly drained.
- If the pavement is to be constructed during the wet seasons and extensively soft subgrade occurs, the granular sub-base may require thickening. This can be further assessed during construction.
- The road boundaries should be properly graded to prevent ponding of water. Swales and ditches should be provided to drain the water away from the road pavement towards the low-lying area for ponding. Otherwise, the water will seep into the subgrade mantle and induce a regression of the subgrade strength, with costly consequences for the pavement construction.

- Curb subdrains may be required in areas where swales or ditches are not possible. The invert of the subdrains should be at least 0.4 m beneath the underside of the granular sub-base and should be backfilled with free-draining granular material. The subdrains should consist of filter-sleeved weepers to prevent blockage by silting.

6.3 Soil Parameters

The recommended soil parameters for the project design are given in Table 5.

Table 5 - Soil Parameters

Unit Weight and Bulk Factor	**Unit Weight (kN/m^3)**	**Estimated Bulk Factor**	
	Bulk	**Loose**	**Compacted**
Earth Fill/Granular Fill	21.5	1.25	1.00
Silty Clay	22.5	1.30	1.05
Rock Fragments	24.5	1.40	1.30
Lateral Earth Pressure Coefficients	**Active K_a**	**At Rest K_o**	**Passive K_p**
Silty Clay and compacted Earth Fill	0.45	0.55	2.50
Compacted Rock Fragments	0.30	0.45	3.30
Bedrock	0.20	0.30	5.00
Coefficients of Friction			
Between Concrete and Granular Base			0.50
Between Concrete and Sound Natural Soils			0.35

7.0 LIMITATIONS OF REPORT

This report was prepared by Soil Engineers Ltd. for the account of Water's Edge Environmental Solutions Team Ltd., and for review by the designated consultants and government agencies. Use of the report is subject to the conditions and limitations of the contractual agreement.

The material in the report it reflects the judgement of Basim Al Ali, P.Eng., and Bennett Sun, P.Eng., in light of the information available to it at the time of preparation. Any use which a Third Party makes of this report, or any reliance on decisions to be made based on it, are the responsibility of such Third Parties. Soil Engineers Ltd. accepts no responsibility for damages, if any, suffered by any Third Party as a result of decisions made or actions based on this report.

SOIL ENGINEERS LTD.

B.A.A. AL-ALI
June 3, 2019

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BAA/BS:dd

CHUN C. B. SUN
June 3, 2019

LIST OF ABBREVIATIONS AND DESCRIPTION OF TERMS

The abbreviations and terms commonly employed on the borehole logs and figures, and in the text of the report, are as follows:

SAMPLE TYPES

AS	Auger sample
CS	Chunk sample
DO	Drive open (split spoon)
DS	Denison type sample
FS	Foil sample
RC	Rock core (with size and percentage recovery)
ST	Slotted tube
TO	Thin-walled, open
TP	Thin-walled, piston
WS	Wash sample

PENETRATION RESISTANCE

Dynamic Cone Penetration Resistance:

A continuous profile showing the number of blows for each foot of penetration of a 2-inch diameter, 90° point cone driven by a 140-pound hammer falling 30 inches.

Plotted as '—•—'

Standard Penetration Resistance or 'N' Value:

The number of blows of a 140-pound hammer falling 30 inches required to advance a 2-inch O.D. drive open sampler one foot into undisturbed soil.

Plotted as '○'

WH	Sampler advanced by static weight
PH	Sampler advanced by hydraulic pressure
PM	Sampler advanced by manual pressure
NP	No penetration

SOIL DESCRIPTION

Cohesionless Soils:

'N' (blows/ft)	Relative Density
0 to 4	very loose
4 to 10	loose
10 to 30	compact
30 to 50	dense
over 50	very dense

Cohesive Soils:

Undrained Shear Strength (ksf)	'N' (blows/ft)	Consistency
less than 0.25	0 to 2	very soft
0.25 to 0.50	2 to 4	soft
0.50 to 1.0	4 to 8	firm
1.0 to 2.0	8 to 16	stiff
2.0 to 4.0	16 to 32	very stiff
over 4.0	over 32	hard

Method of Determination of Undrained Shear Strength of Cohesive Soils:

x 0.0	Field vane test in borehole; the number denotes the sensitivity to remoulding
△	Laboratory vane test
☐	Compression test in laboratory

For a saturated cohesive soil, the undrained shear strength is taken as one half of the undrained compressive strength

METRIC CONVERSION FACTORS

1 ft = 0.3048 metres
1lb = 0.454 kg
1 inch = 25.4 mm
1ksf = 47.88 kPa

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CONSULTING ENGINEERS
GEOTECHNICAL • ENVIRONMENTAL • HYDROGEOLOGICAL • BUILDING SCIENCE

JOB NO.: 1902-S100

LOG OF BOREHOLE NO.: 1

FIGURE NO.: 1

PROJECT DESCRIPTION: Proposed Wetland Design

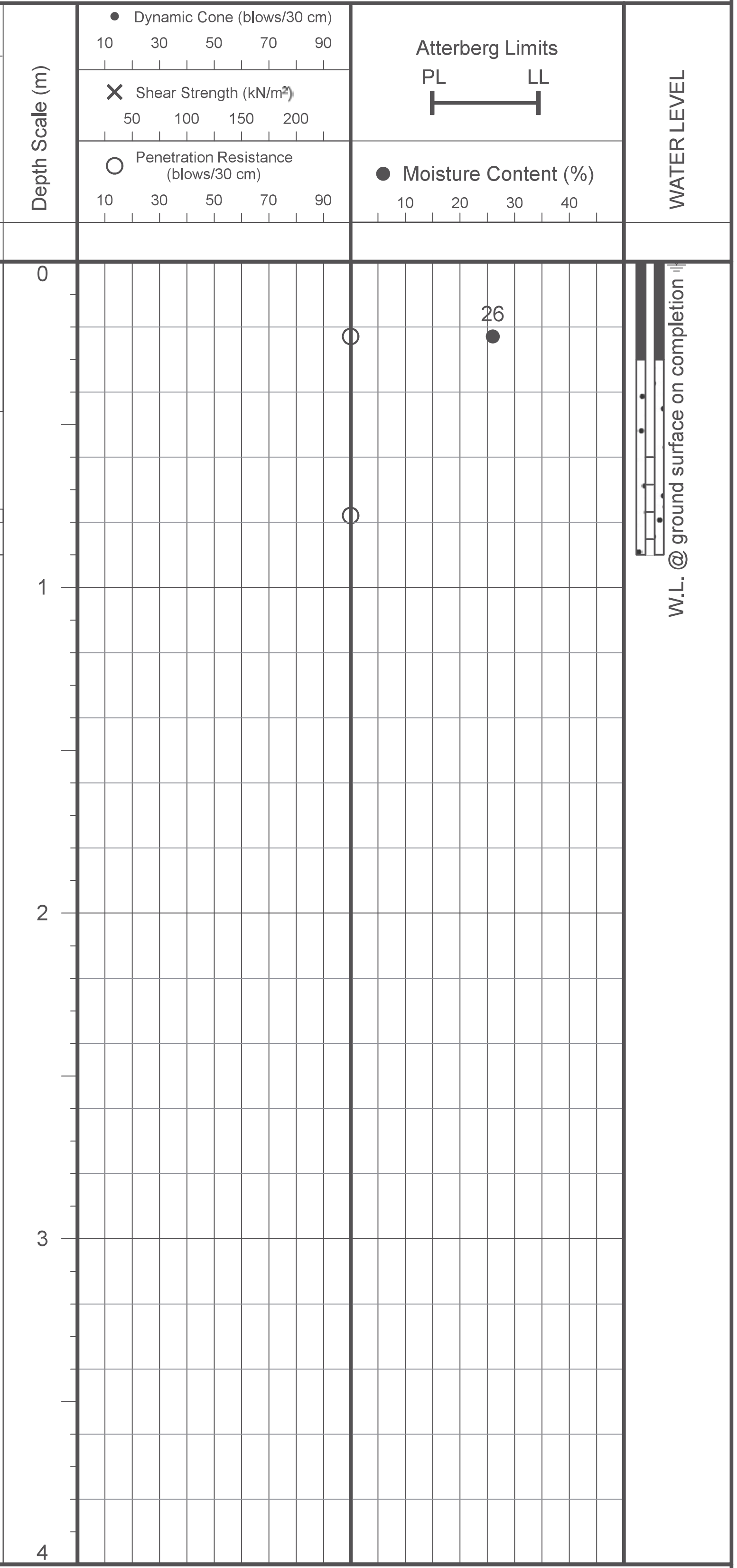
METHOD OF BORING: Flight-Auger

PROJECT LOCATION: First Road East and Green Mountain Road East
City of Hamilton

DRILLING DATE: March 27, 2019

El. (m) Depth (m)	SOIL DESCRIPTION	SAMPLES Number	SAMPLES Type	SAMPLES N-Value
187.8	Ground Surface			
0.0	**15 cm TOPSOIL**			
187.7 0.1	Greyish-brown, hard **SILTY CLAY** a tr. of sand and organics occ. silt seams and rock fragments	1 2	DO DO	50/25 50/0
186.9 0.9	**Refusal to Augering** **Inferred Bedrock** **END OF BOREHOLE**	-	-	-

Installed 50 mm Ø monitoring well to 0.9 m
completed with 0.3 m screen
Sand backfill from 0.3 m to 0.9 m
Bentonite seal from 0.0 m to 0.3 m.
Provided with steel casing and lock.



JOB NO.: 1902-S100

LOG OF BOREHOLE NO.: 2

FIGURE NO.: 2

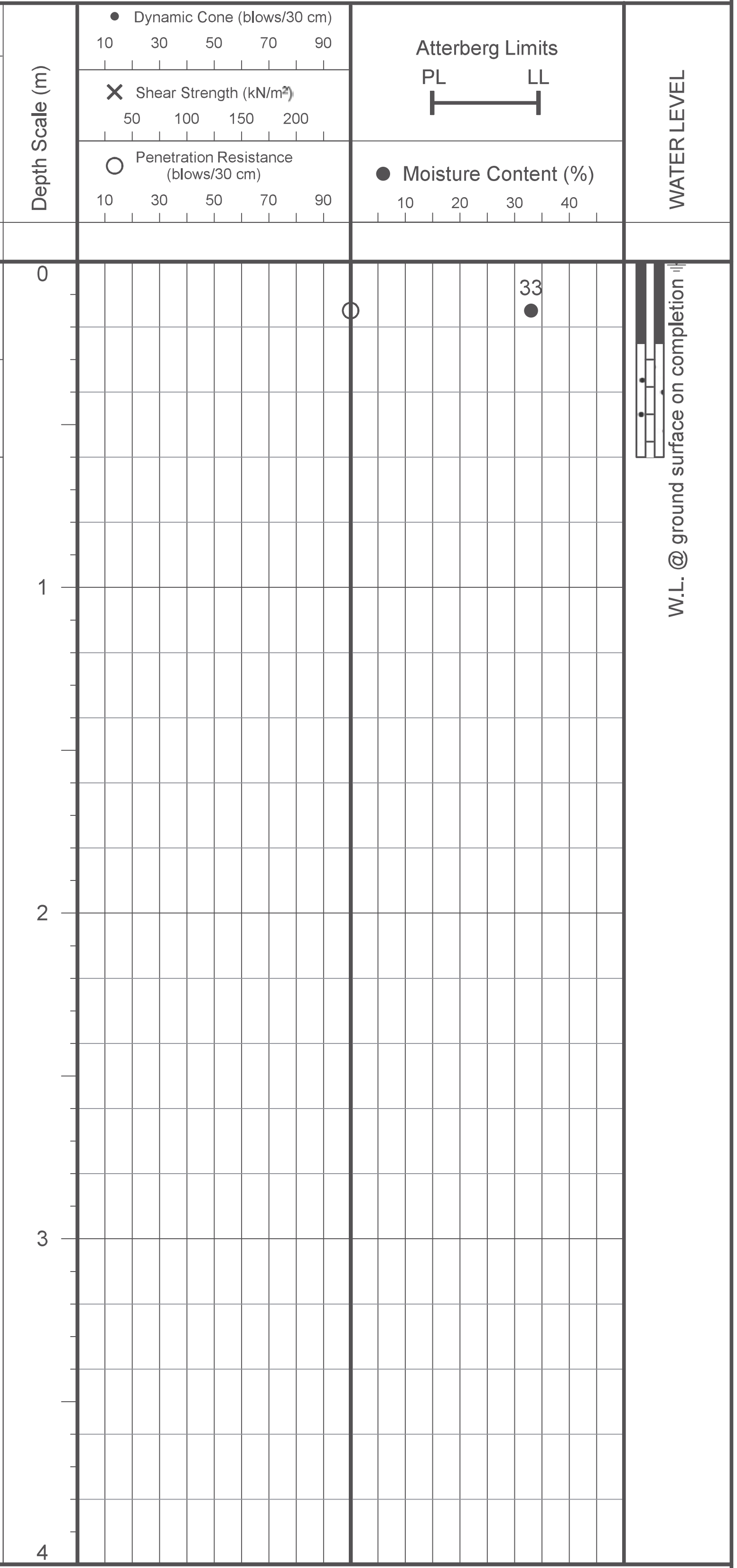
PROJECT DESCRIPTION: Proposed Wetland Design

METHOD OF BORING: Flight-Auger

PROJECT LOCATION: First Road East and Green Mountain Road East
City of Hamilton

DRILLING DATE: March 27, 2019

El. (m) Depth (m)	SOIL DESCRIPTION	SAMPLES Number	SAMPLES Type	SAMPLES N-Value
188.1	Ground Surface			
0.0	**15 cm TOPSOIL**			
188.0 0.1	Greyish-brown, hard **SILTY CLAY** a tr. of sand and organics occ. silt seams and rock fragments	1	DO	50/15
187.5 0.6	**Refusal to Augering** **Inferred Bedrock** **END OF BOREHOLE** Installed 50 mm Ø monitoring well to 0.6 m completed with 0.3 m screen Sand backfill from 0.25 m to 0.6 m Bentonite seal from 0.0 m to 0.25 m. Provided with steel casing and lock.			



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JOB NO.: 1902-S100

LOG OF BOREHOLE NO.: 3

FIGURE NO.: 3

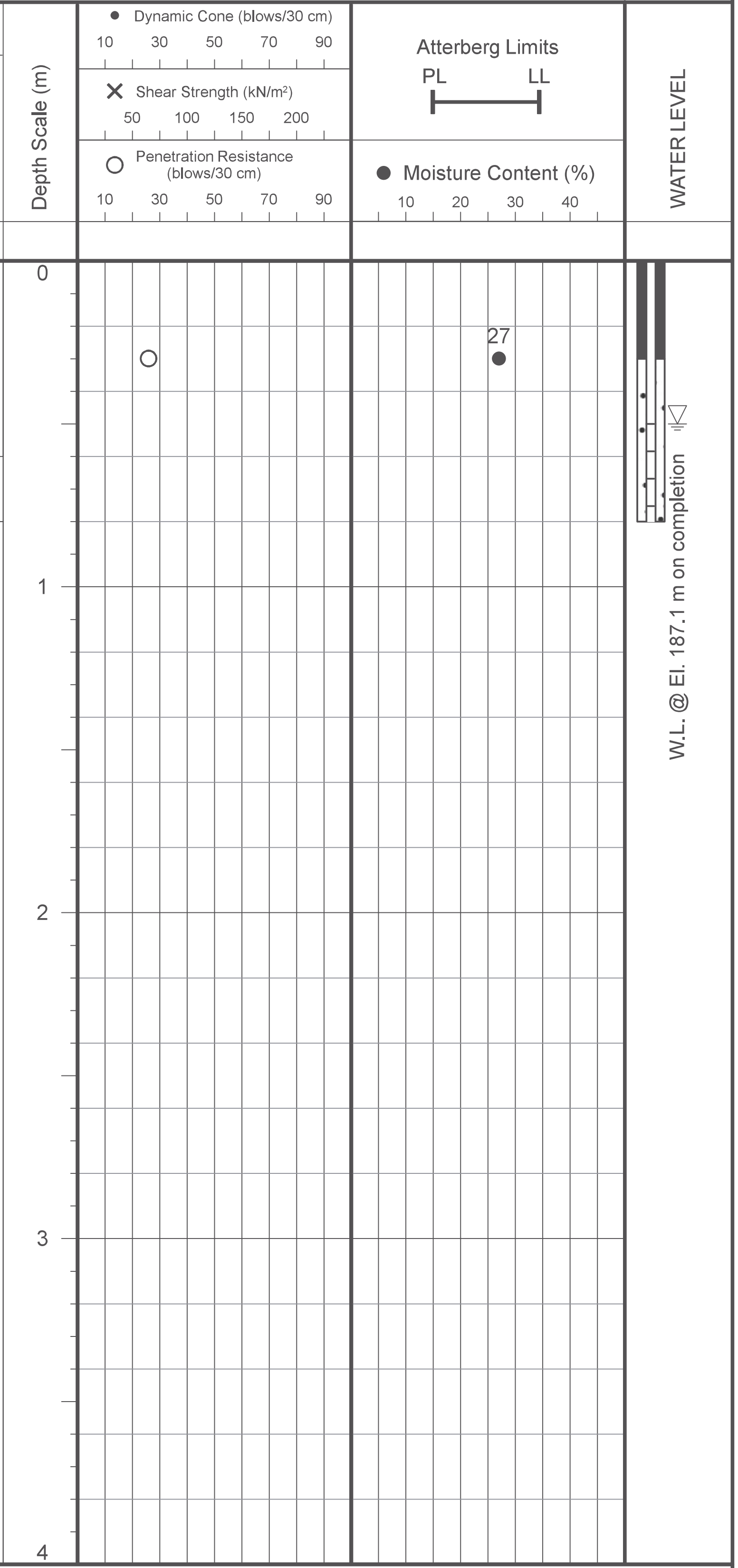
PROJECT DESCRIPTION: Proposed Wetland Design

METHOD OF BORING: Flight-Auger

PROJECT LOCATION: First Road East and Green Mountain Road East
City of Hamilton

DRILLING DATE: March 27, 2019

El. (m) Depth (m)	SOIL DESCRIPTION	SAMPLES		
		Number	Type	N-Value
187.6	Ground Surface			
0.0	**30 cm TOPSOIL**			
187.3 0.3	Greyish-brown, very stiff to hard **SILTY CLAY** a tr. of sand and organics occ. silt seams and rock fragments	1	DO	26
186.8 0.8	**Refusal to Augering** **Inferred Bedrock** **END OF BOREHOLE** Installed 50 mm Ø monitoring well to 0.8 m completed with 0.3 m screen Sand backfill from 0.3 m to 0.8 m Bentonite seal from 0.0 m to 0.3 m. Provided with steel casing and lock.	-	-	-



JOB NO.: 1902-S100

LOG OF BOREHOLE NO.: 4

FIGURE NO.: 4

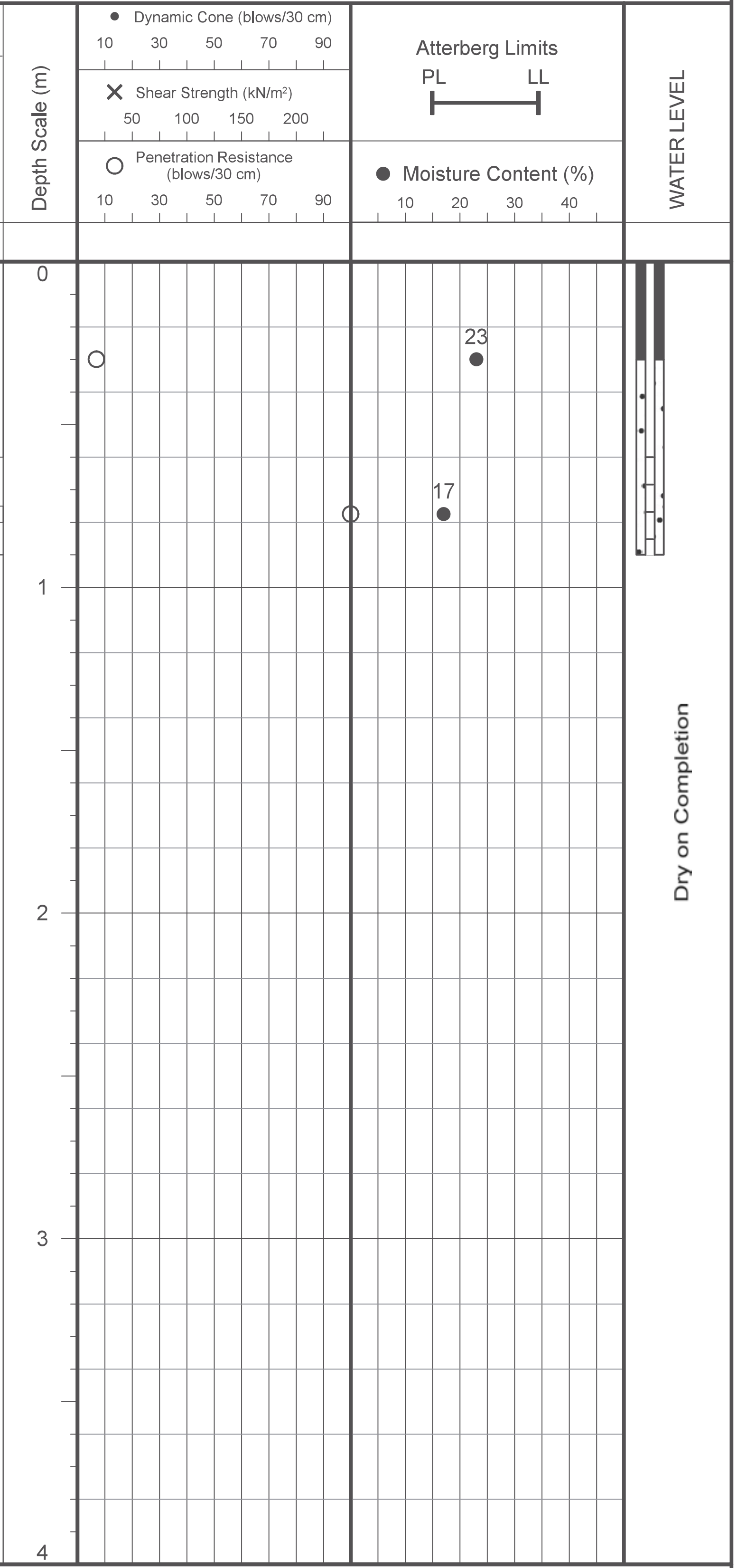
PROJECT DESCRIPTION: Proposed Wetland Design

METHOD OF BORING: Flight-Auger

PROJECT LOCATION: First Road East and Green Mountain Road East
City of Hamilton

DRILLING DATE: March 26, 2019

El. (m) Depth (m)	SOIL DESCRIPTION	SAMPLES Number	SAMPLES Type	SAMPLES N-Value
188.0	Ground Surface			
0.0	**23 cm TOPSOIL**			
187.8 0.2	Greyish-brown, firm to hard weathered **SILTY CLAY** a tr. of sand and organics occ. silt seams and rock fragments	1 2	DO DO	7 50/15
187.1 0.9	**Refusal to Augering** **Inferred Bedrock** **END OF BOREHOLE** Installed 50 mm Ø monitoring well to 0.9 m completed with 0.3 m screen Sand backfill from 0.3 m to 0.9 m Bentonite seal from 0.0 m to 0.3 m. Provided with steel casing and lock.	-	-	-



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JOB NO.: 1902-S100

LOG OF BOREHOLE NO.: 5A

FIGURE NO.: 5

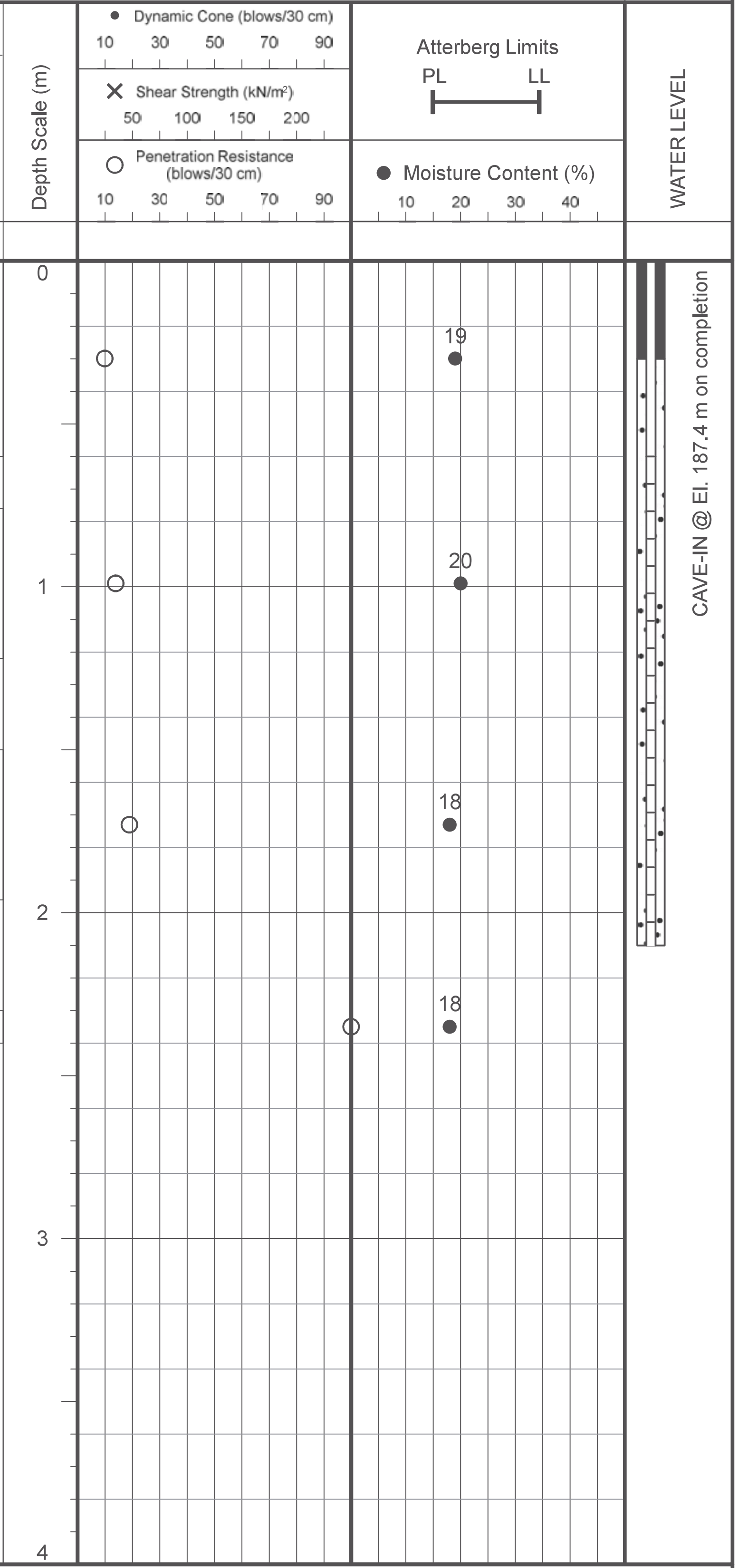
PROJECT DESCRIPTION: Proposed Wetland Design

METHOD OF BORING: Flight-Auger

PROJECT LOCATION: First Road East and Green Mountain Road East
City of Hamilton

DRILLING DATE: March 26, 2019

El. (m) Depth (m)	SOIL DESCRIPTION	SAMPLES Number	SAMPLES Type	SAMPLES N-Value
189.5 0.0	Ground Surface **23 cm TOPSOIL**			
189.3 0.2	Greyish-brown, stiff to hard	1	DO	10
	weathered			
	SILTY CLAY a tr. of sand occ. silt seams and rock fragments	2	DO	14
		3	DO	19
		4	DO	50/3
187.1 2.4	**Refusal to Augering** **Inferred Bedrock** **END OF BOREHOLE** Installed 50 mm Ø monitoring well to 2.1 m completed with 1.5 m screen Sand backfill from 0.3 m to 2.1 m Bentonite seal from 0.0 m to 0.3 m. Provided with steel casing and lock.			



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JOB NO.: 1902-S100

LOG OF BOREHOLE NO.: 5B

FIGURE NO.: 6

PROJECT DESCRIPTION: Proposed Wetland Design

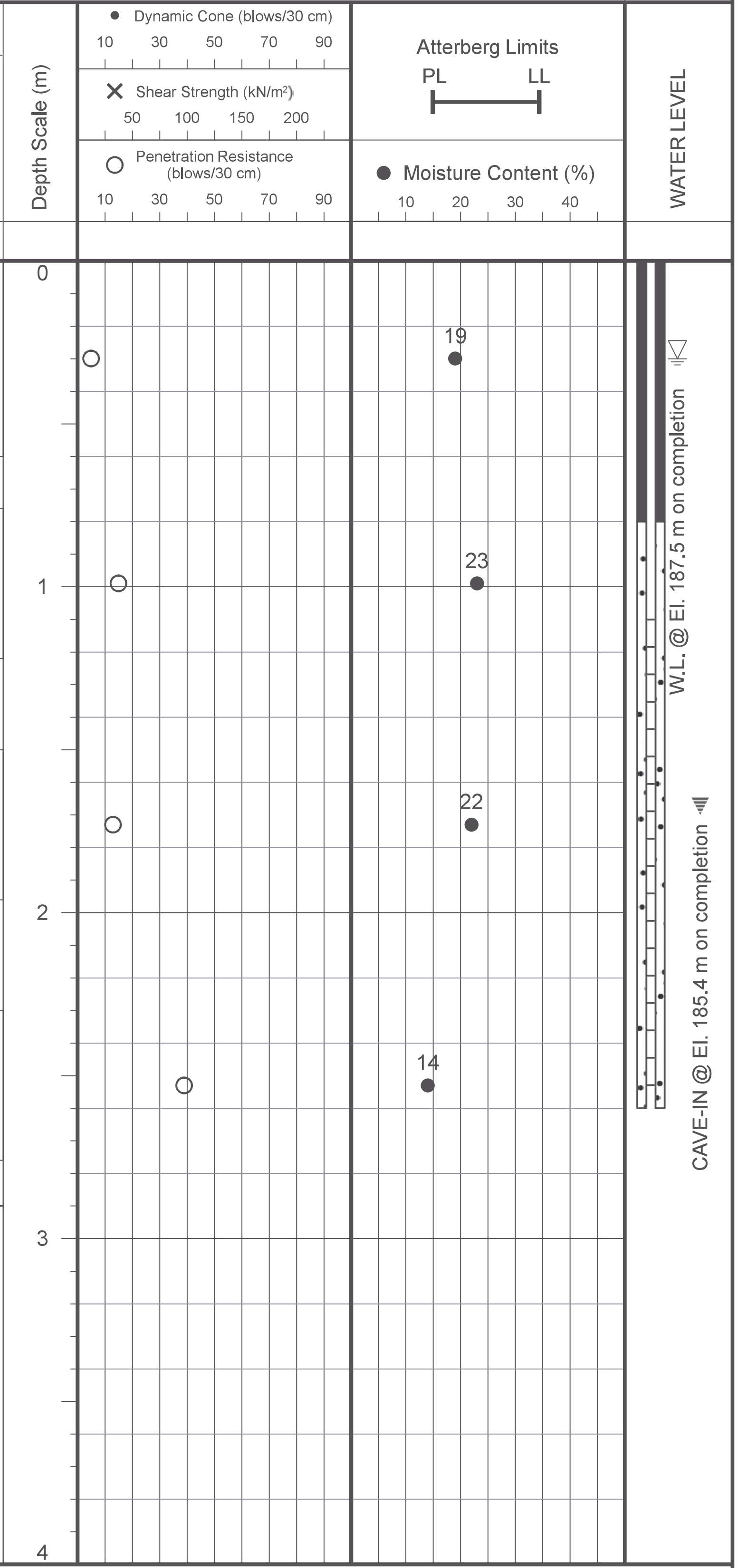
METHOD OF BORING: Flight-Auger

PROJECT LOCATION: First Road East and Green Mountain Road East
City of Hamilton

DRILLING DATE: March 26, 2019

El. (m) Depth (m)	SOIL DESCRIPTION
187.8	Ground Surface
0.0	**30 cm TOPSOIL**
187.5 0.3	Greyish-brown, firm to hard weathered **SILTY CLAY** a tr. of sand occ. silt seams and rock fragments
184.9 2.9	**Refusal to Augering** **Inferred Bedrock** **END OF BOREHOLE**

SAMPLES Number	Type	N-Value	Moisture Content (%)
1	DO	5	19
2	DO	15	23
3	DO	13	22
4	DO	39	14



Installed 50 mm Ø monitoring well to 2.6 m
completed with 1.5 m screen
Sand backfill from 0.8 m to 2.6 m
Bentonite seal from 0.0 m to 0.8 m.
Provided with steel casing and lock.

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JOB NO.: 1902-S100

LOG OF BOREHOLE NO.: 5C

FIGURE NO.: 7

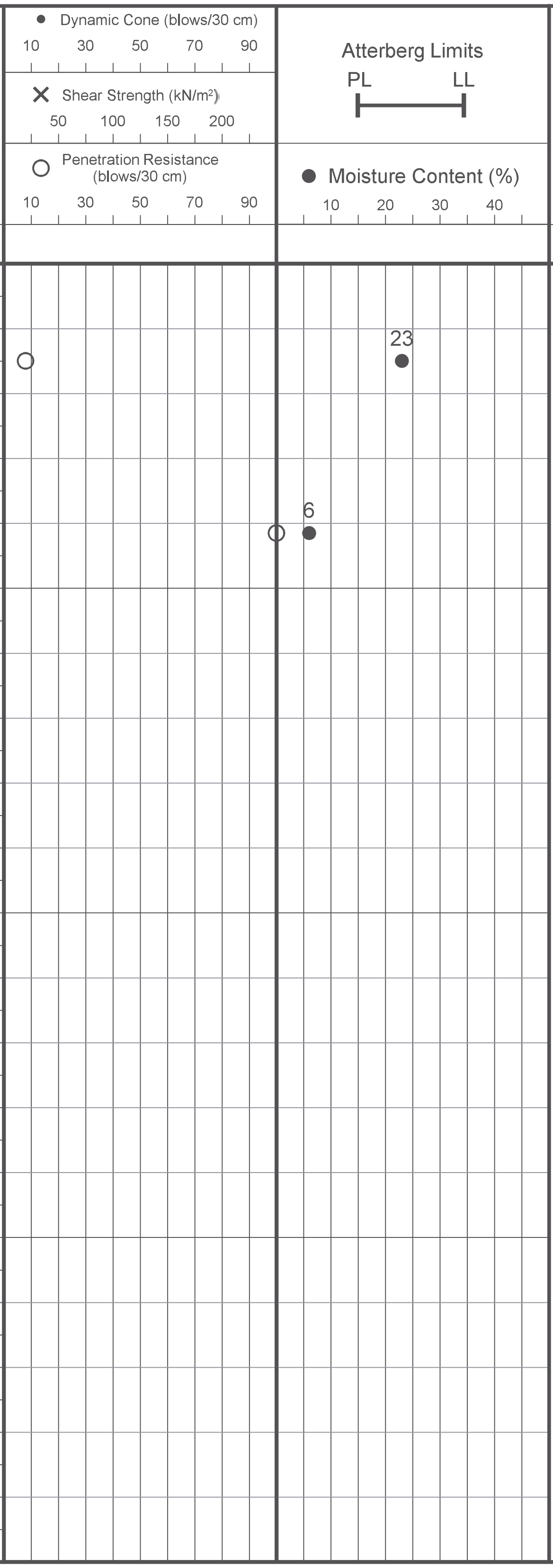
PROJECT DESCRIPTION: Proposed Wetland Design

METHOD OF BORING: Flight-Auger

PROJECT LOCATION: First Road East and Green Mountain Road East
City of Hamilton

DRILLING DATE: April 4, 2019

El. (m) Depth (m)	SOIL DESCRIPTION	SAMPLES Number	SAMPLES Type	SAMPLES N-Value	Depth Scale (m)	WATER LEVEL
188.0	Ground Surface					
0.0	**15 cm TOPSOIL**				0	
187.9 0.1	Greyish-brown, firm to hard **SILTY CLAY** a tr. of sand, organics and rock fragments	1	DO	8		
	weathered	2	DO	50/15	1	
186.8 1.2	Grey, weathered **DOLOMITE/LIMESTONE BEDROCK**	3	RC RQD	80% 0%	2	
		4	RC RQD	100% 0%		
185.0 3.0	**END OF BOREHOLE**				3	
					4	



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JOB NO.: 1902-S100

LOG OF BOREHOLE NO.: 6

FIGURE NO.: 8

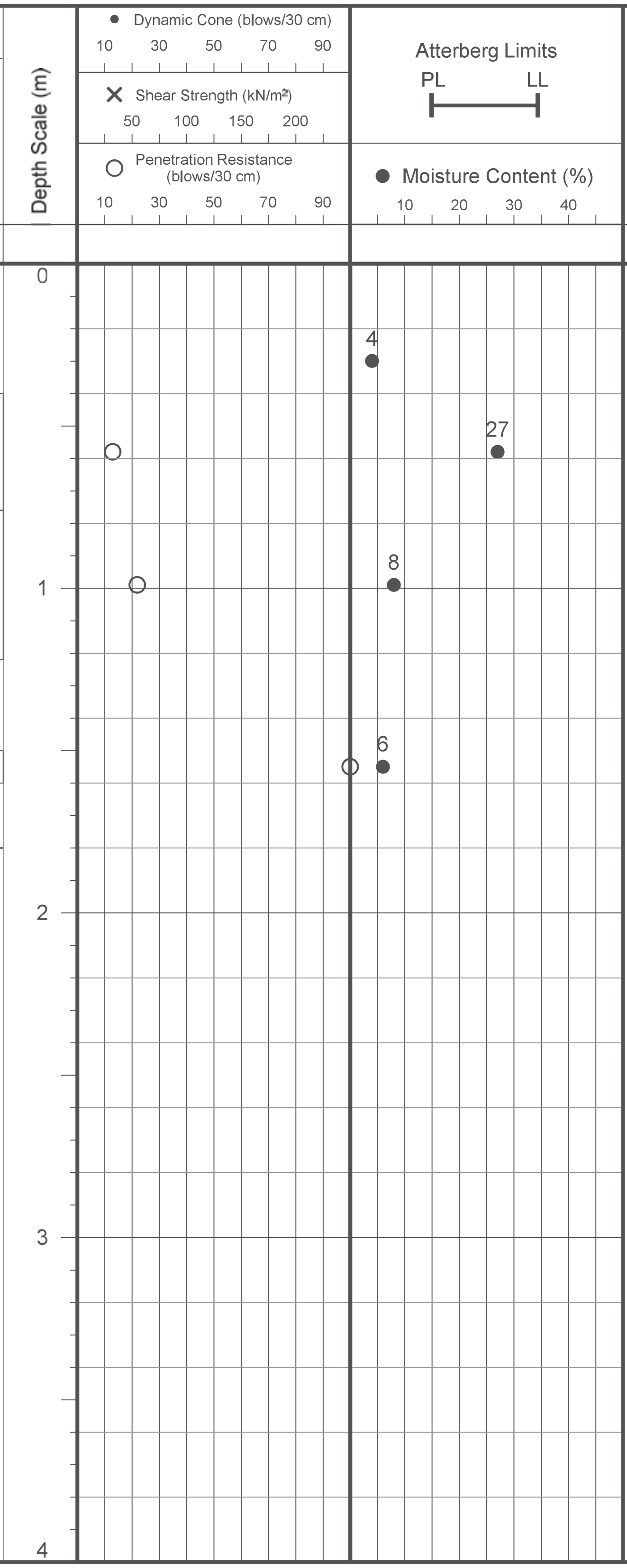
PROJECT DESCRIPTION: Proposed Wetland Design

METHOD OF BORING: Flight-Auger

PROJECT LOCATION: First Road East and Green Mountain Road East
City of Hamilton

DRILLING DATE: April 4, 2019

El. (m) Depth (m)	SOIL DESCRIPTION	SAMPLES Number	SAMPLES Type	SAMPLES N-Value	WATER LEVEL
187.5	Ground Surface				
0.0	**23 cm ASPHALTIC CONCRETE**				Dry on Completion
187.3 0.2	**230 mm GRANULAR FILL**	1A	-		
187.0 0.5	Grey **EARTH FILL** silty clay a tr. of sand and gravel	1B	DO	13	
186.7 0.8	Brown, very stiff to hard **SILTY CLAY** a tr. of sand occ. rock fragments	2	DO	22	
		3	DO	50/10	
185.7 1.8	**Refusal to Augering** **Inferred Bedrock** **END OF BOREHOLE**	-	-	-	



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Page: 1 of 1

JOB NO.: 1902-S100

LOG OF BOREHOLE NO.: 7

FIGURE NO.: **9**

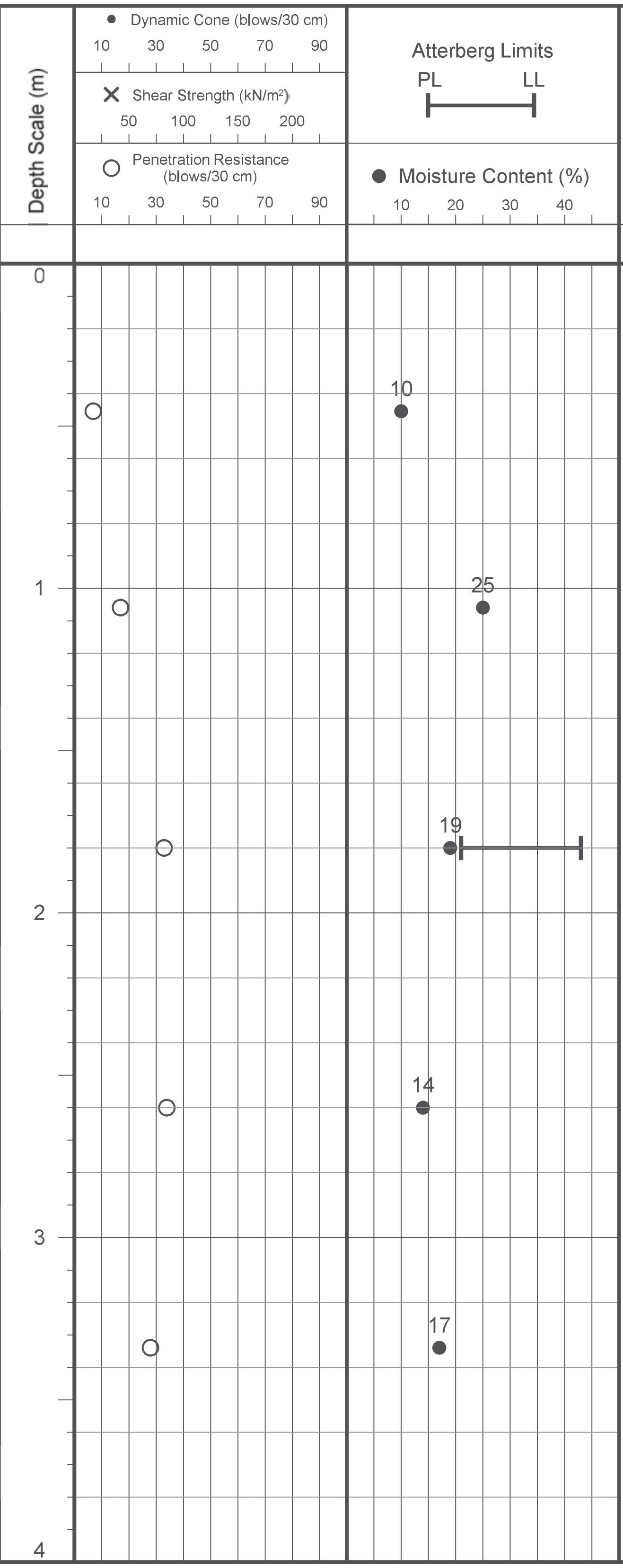
PROJECT DESCRIPTION: Proposed Wetland Design

METHOD OF BORING: Flight-Auger

PROJECT LOCATION: First Road East and Green Mountain Road East
City of Hamilton

DRILLING DATE: April 4, 2019

El. (m) Depth (m)	SOIL DESCRIPTION	SAMPLES Number	SAMPLES Type	SAMPLES N-Value	WATER LEVEL
187.9	Ground Surface				
0.0	**18 cm ASPHALTIC CONCRETE**				
0.2	**330 mm GRANULAR FILL**	1	DO	7	
187.4 0.5	Grey **EARTH FILL** silty clay a tr. of sand, gravel and organics	2	DO	17	
186.4 1.5	Very stiff to hard **SILTY CLAY** a tr. of sand and gravel rock fragments	3	DO	33	
		4	DO	34	
	brown grey	5	DO	28	



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JOB NO.: 1902-S100

LOG OF BOREHOLE NO.: 7

FIGURE NO.: 9

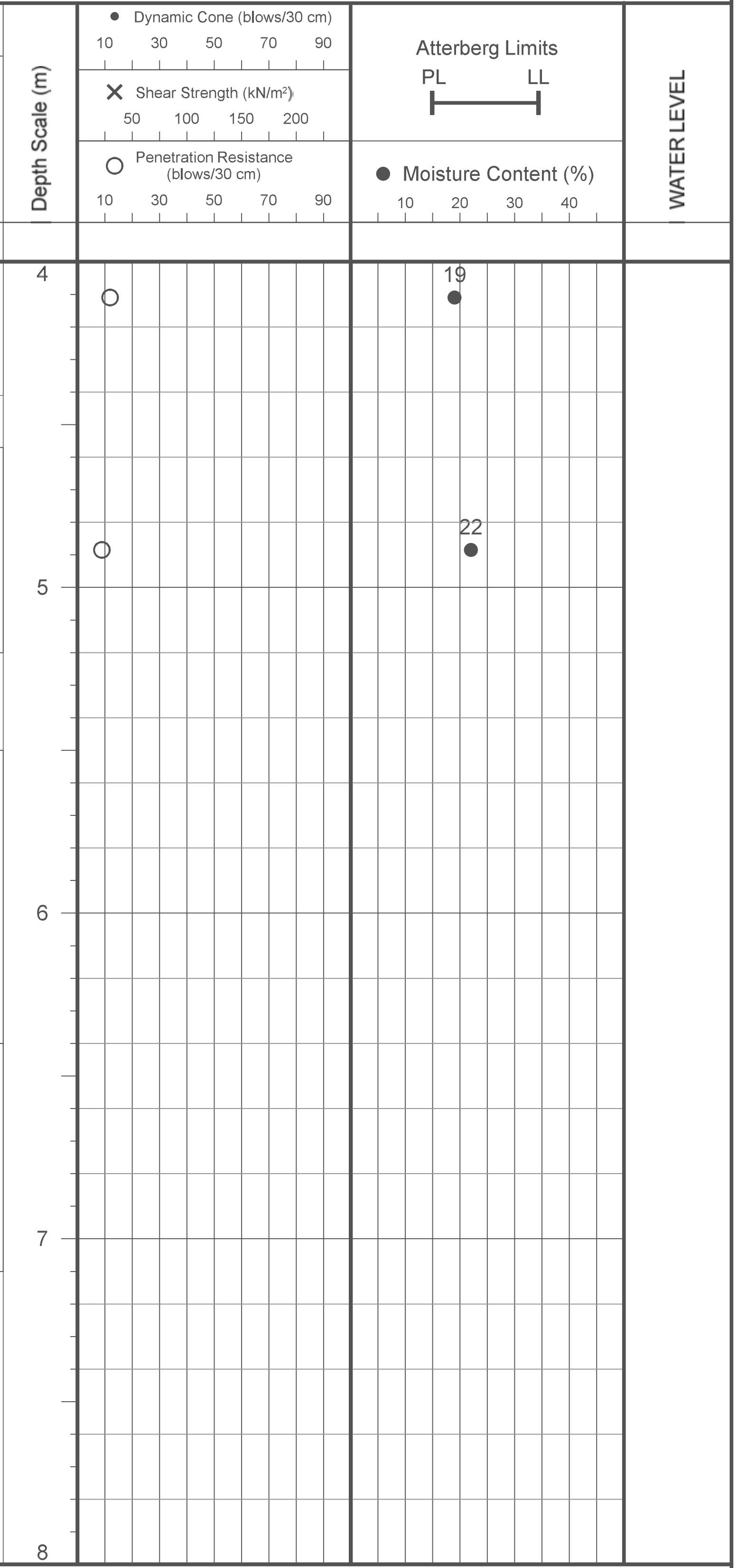
PROJECT DESCRIPTION: Proposed Wetland Design

METHOD OF BORING: Flight-Auger

PROJECT LOCATION: First Road East and Green Mountain Road East
City of Hamilton

DRILLING DATE: April 4, 2019

El. (m) Depth (m)	SOIL DESCRIPTION	SAMPLES		
		Number	Type	N-Value
	Grey, stiff **SILTY CLAY** a tr. of sand and gravel rock fragments	6	DO	12
		7	DO	9
182.4 5.5	Grey **DOLOMITE/LIMESTONE BEDROCK**	8	RC RQD	95% 95%
		9	RC RQD	100% 85%
180.8 7.1	**END OF BOREHOLE**			



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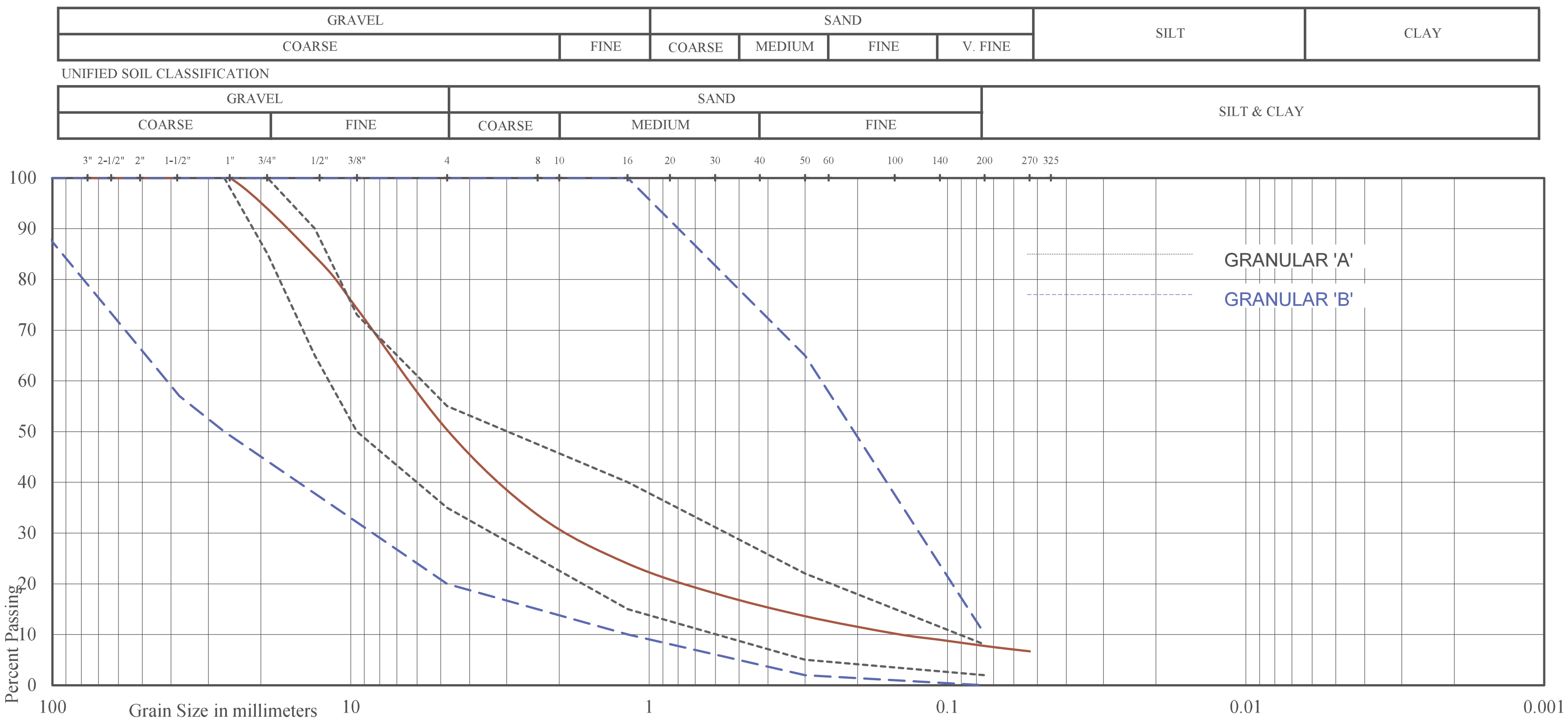
GRAIN SIZE DISTRIBUTION

Reference No: 1902-S100



Project: Proposed Wetland Design

Location: First Road East and Green Mountain Road East, City of Hamilton

Borehole No: 6

Sample No: 1A

Depth (m): 0.3

Elevation (m): 187.2

Liquid Limit (%) = -

Plastic Limit (%) = -

Plasticity Index (%) = -

Moisture Content (%) = 4

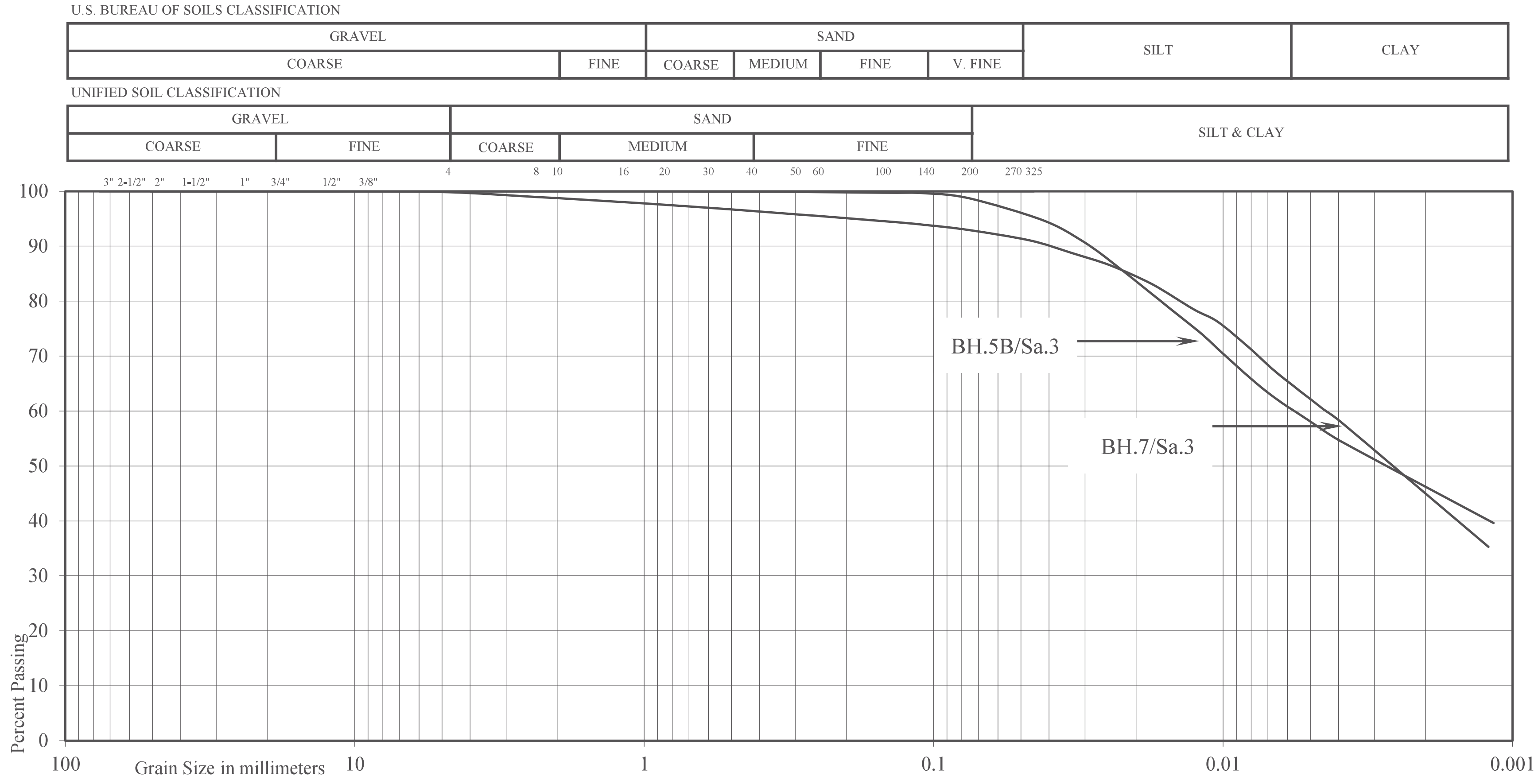
Estimated Permeability (cm./sec.) = 10^{-2}

Classification of Sample [& Group Symbol]: GRANULAR FILL

Figure: 10

GRAIN SIZE DISTRIBUTION

Reference No: 1902-S100



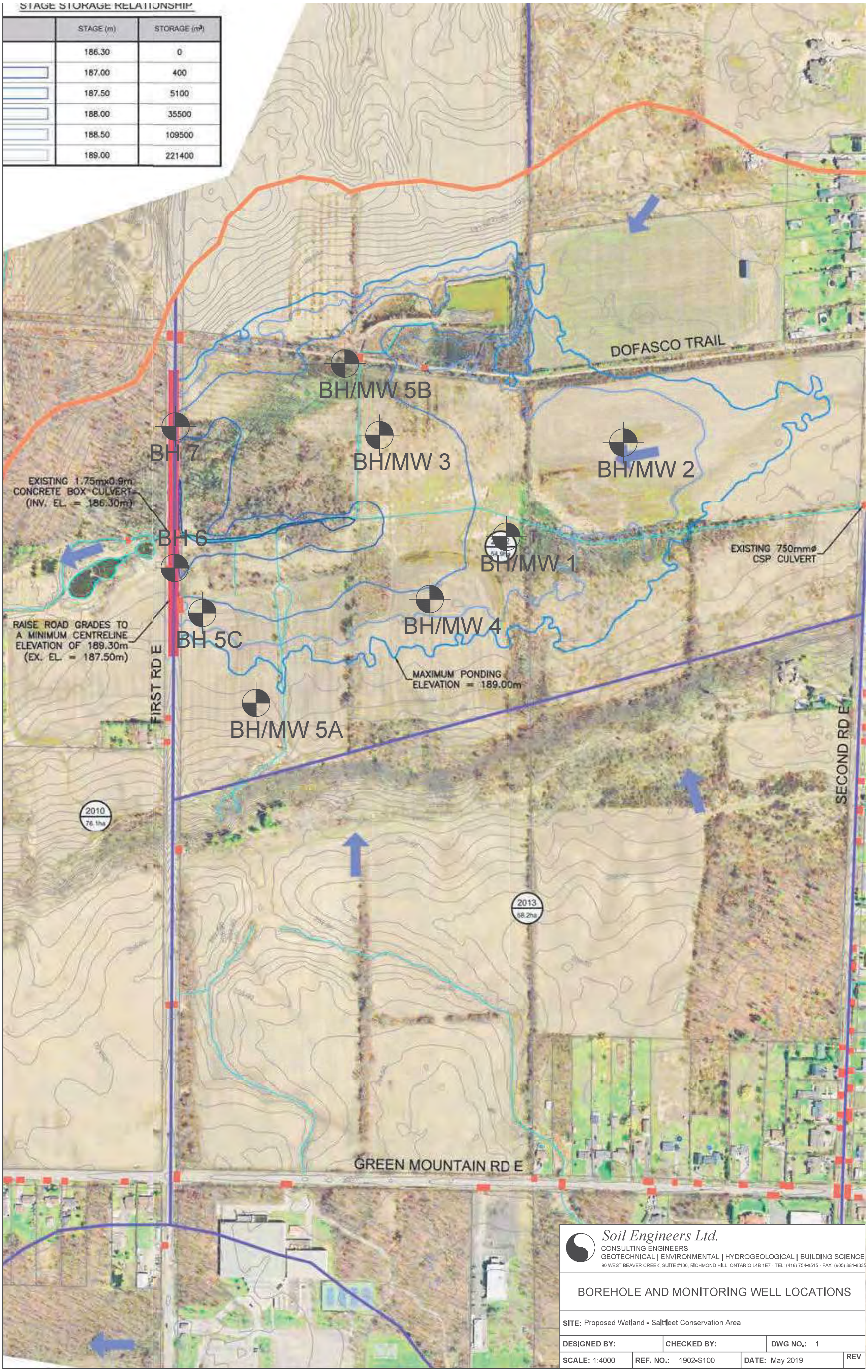
Project:	Proposed Wetland Design	
Location:	First Road East and Green Mountain Road East, City of Hamilton	

Borehole No:	5B	7
Sample No:	3	3
Depth (m):	1.8	1.8
Elevation (m):	186.0	186.1

BH./Sa.	5B/3	7/3
Liquid Limit (%) =	-	43
Plastic Limit (%) =	-	21
Plasticity Index (%) =	-	22
Moisture Content (%) =	22	19
Estimated Permeability (cm./sec.) =	10^{-7}	10^{-7}

Classification of Sample [& Group Symbol]: SILTY CLAY, traces of sand and fine sand

Figure: 11



STAGE STORAGE RELATIONSHIP

	STAGE (m)	STORAGE (m³)
	186.30	0
▭	187.00	400
▭	187.50	5100
▭	188.00	35500
▭	188.50	109500
▭	189.00	221400

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90 WEST BEAVER CREEK, SUITE #100, RICHMOND HILL, ONTARIO L4B 1E7 · TEL: (416) 754-8515 · FAX: (905) 881-8335

BOREHOLE AND MONITORING WELL LOCATIONS

SITE: Proposed Wetland - Saltfleet Conservation Area

DESIGNED BY:
CHECKED BY:
DWG NO.: 1
SCALE: 1:4000
REF. NO.: 1902-S100
DATE: May 2019
REV

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SUBSURFACE PROFILE
DRAWING NO. 2
SCALE: AS SHOWN

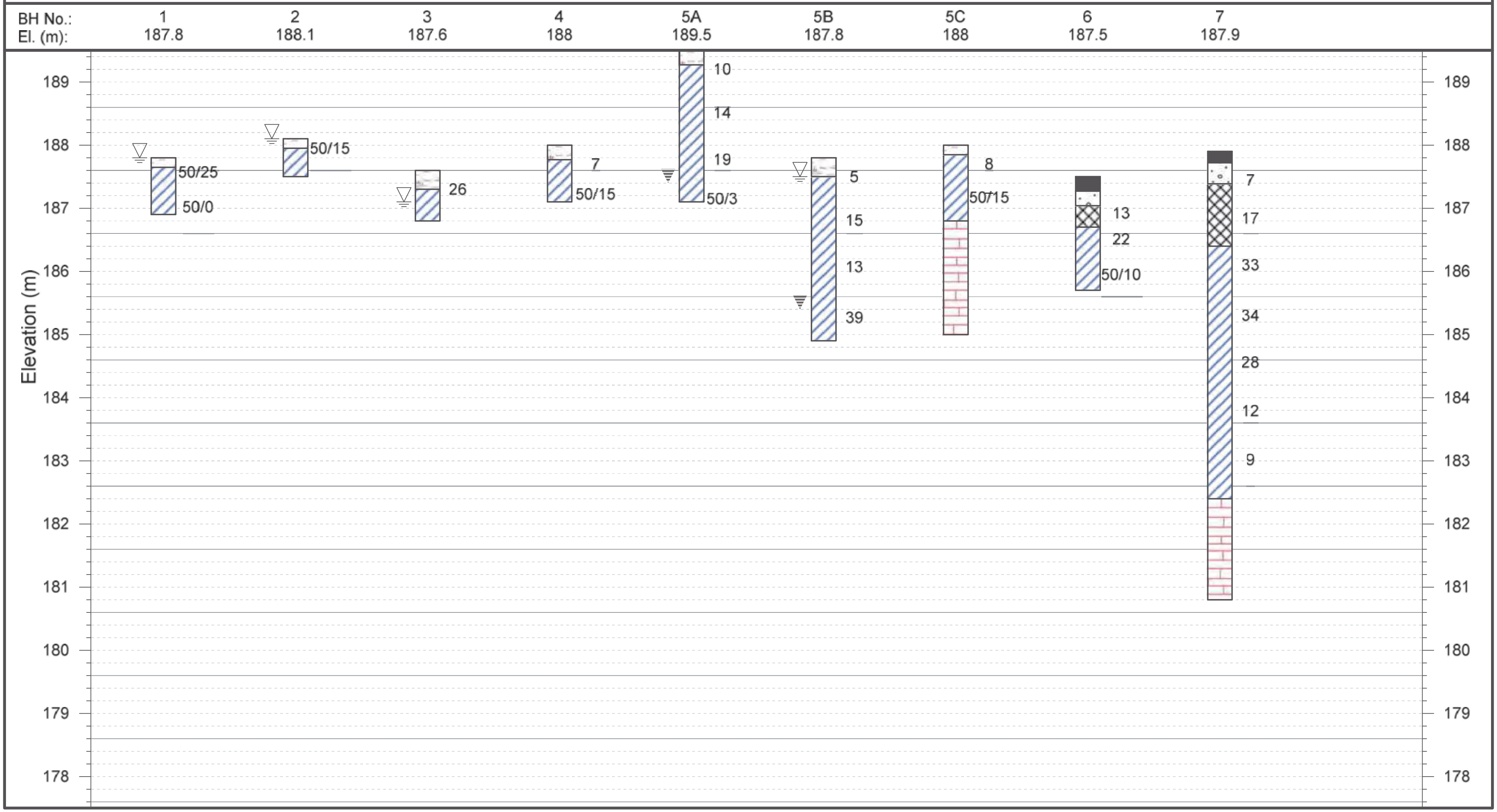
JOB NO.: 1902-S100
REPORT DATE: May 2019
PROJECT DESCRIPTION: Proposed Wetland Design

PROJECT LOCATION: First Road East and Green Mountain Road East
City of Hamilton

LEGEND

▨	ROCK FILL	⁘	GRANULAR	▨	SILTY CLAY	▦	DOLOSTONE
■	ASPHALT	▩	FILL				

▽ WATER LEVEL (END OF DRILLING) ≡ CAVE-IN ▼ WATER LEVEL (STABILIZED)



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ENVIRONMENTAL SOLUTIONS TEAM LTD.

Fluvial Geomorphology

Natural Channel Design

Stream Restoration

Monitoring

Erosion Assessment

Sediment Transport

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APPENDIX B:

Soil Chemistry Report

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BARRIE	MISSISSAUGA	OSHAWA	NEWMARKET	GRAVENHURST	PETERBOROUGH	HAMILTON
TEL: (705) 721-7863	TEL: (905) 542-7605	TEL: (905) 440-2040	TEL: (905) 853-0647	TEL: (705) 684-4242	TEL: (905) 440-2040	TEL: (905) 777-7956
FAX: (705) 721-7864	FAX: (905) 542-2769	FAX: (905) 725-1315	FAX: (905) 881-8335	FAX: (705) 684-8522	FAX: (905) 725-1315	FAX: (905) 542-2769

April 30, 2019

Reference No. 1902-E100

Water's Edge Environmental Solutions Team Ltd.
25 Water Street South
Cambridge, Ontario
N1R 3C7

Attention: Mr. Ed Gazendam

Re: Results of Chemical Analysis of Soil Samples
Proposed Wetland Design
Northeast Corner of First East Road and Green Mountain Road East
City of Hamilton

Dear Sir:

As requested, we have completed the sampling and chemical analyses of soil samples collected from geotechnical boreholes at the captioned project and herein present our findings and recommendations.

The subject site is located on the east side of First Road East, approximately 550 m north of Green Mountain Road East in the City of Hamilton. The purpose of the investigation was carried out to determine the environmental quality of the soil at the captioned site.

Field Work

The field work, consisting of drilling of eight (8) geotechnical boreholes at the captioned property was performed on April 4 and 9, 2019. The boreholes were drilled to depths ranging from 0.6 m to 7.1 m below ground surface. The borehole locations are shown on the Borehole Location Plan, Drawing No. 1

The boreholes were excavated to the sampling depths by a drilling rig. Soil samples were retrieved from the test pits using a split spoon, for soil classification and visual and olfactory observations. The sampling tool (i.e., steel shovel) is decontaminated prior to initial use, between the sampling locations and at the completion of sampling activities. The sampling tool is manually scrubbed with a brush using a phosphate-free solution and power washed to remove any adhered soils, foreign material and potential contaminants.

The field work was conducted by a Soil Engineers Ltd. environmental technician who recorded the findings and observations in the field.

Subsurface Condition

The investigation revealed that beneath a veneer of topsoil or earth fill in places, the site is underlain by strata of silty clay followed by dolomite bedorck. Detailed descriptions of the encountered subsurface conditions are presented on the Borehole Logs, comprising Figures 1 to 8, inclusive.

Site Condition Standard

SEL has selected to compare the analytical results of the soil samples to the following Ministry of the Environment Conservation and Parks (MOECP) Standards:

- Table 1, Full Depth Background Site Condition Standards for Residential/Parkland/Institutional/Industrial/Commercial/Community uses, in accordance with the "Soil, Ground Water and Sediment Standards for Use Under Part XV.1 of the Environmental Protection Act" (EPA), April 15, 2011 (hereinafter referred to as "Table 1 Standards").

- Table 2, Full Depth Generic Site Condition Standards in a Potable Ground Water Condition for Residential/Parkland/Institutional Property uses, for coarse textured soil, in accordance with the "Soil, Ground Water and Sediment Standards for Use Under Part XV.1 of the Environmental Protection Act" (EPA), April 15, 2011 (hereinafter referred to as "Table 2 RPI Standards").

- Table 2, Full Depth Generic Site Condition Standards in a Potable Ground Water Condition for Industrial/Community/Commercial Property uses, for coarse textured soil, in accordance with the "Soil, Ground Water and Sediment Standards for Use Under Part XV.1 of the Environmental Protection Act" (EPA), April 15, 2011 (hereinafter referred to as "Table 2 ICC Standards").

Soil Sampling and Soil Quality

A total of ten (10) representative soil samples were retrieved from boreholes excavated at the captioned site. No evidence of potential contamination was documented in any of the retrieved soil samples. Head space vapour screening was also conducted for the retrieved soil samples using combustible gas detector (RKI Eagle) in methane elimination mode, having a minimum detection of 2 ppm (parts per million by volume). Soil vapour measurements of 0 ppm were recorded for the soil samples, indicating non-detectable combustible gases in the soil samples retrieved from the sampling locations.

Based on the soil vapour measurements and visual and olfactory observations, representative soil samples from the sampling locations were submitted to the laboratory for chemical analyses.

The samples were sent to AGAT Laboratories, accredited by the Canadian Association for Laboratory Accreditation Inc. (CALA), for chemical analysis of Metals and Inorganics (M&I), Petroleum Hydrocarbons (PHCs), and Organochlorine Pesticides (OCPs) parameters.

The sampling program is as follows:

Borehole Number	Sample Number	Laboratory ID	Soil Type	Depth (*mbgs)	Gas Reading (ppm**)	Test Conducted
1	BH1/1	103339	Silty Clay	0.15 – 0.45	0	M&I, OCPs
3	BH3/1	115554	Topsoil	0.1 – 0.3	0	OCPs
4	BH4/1	103342	Topsoil	0.1 – 0.25	0	M&I, OCPs
5A	BH5A/1	103343	Topsoil	0.1 – 0.3	0	OCPs
	BH5A/2	103344	Silty Clay	0.75 – 1.2	0	M&I, PHCs
5B	BH5B/1	115553	Silty Clay	0.3 – 0.6	0	M&I
	BH5B/2	103345	Silty Clay	0.8 – 1.2	0	PHCs
6	BH6/2	115549	Silty clay	0.75 – 1.2	0	M&I
7	BH7/3	115550	Silty Clay	1.5 – 2.1	0	M&I, PHCs

*mbgs = meters below ground surface **ppm = part per million by volume

A review of the results of the soil samples indicates that, the tested parameters at the tested locations meet the Table 1 and Table 2 RPI Standards with the exception of the following parameters:

Sample Name	Parameter	Unit	Table 1 Standards	Table 2 RPI Standards	Table 2 ICC Standards	Measured Value
BH1/1	Cadmium	µg/g	1.2	1.2	1.9	1.7
	Lead	µg/g	120	120	120	**605**
	Zinc	µg/g	290	340	340	**502**
BH6/2	Cadmium	µg/g	1.2	1.2	1.9	**2.6**
	Electrical Conductivity	mS/cm	0.57	0.7	1.4	1.22
	Lead	µg/g	120	120	120	**134**
	Sodium Adsorption Ratio	-	2.4	5	12	6.61
	Zinc	µg/g	290	340	340	**516**
BH7/2	Electrical Conductivity	mS/cm	0.57	0.7	1.4	**1.54**
	Sodium Adsorption Ratio	-	2.4	5	12	2.49

In reviewing the results of the soil samples indicates that the tested parameters at the sampling locations meet Table 2 ICC Standards, with the exception of Lead and Zinc concentrations in soil sample BH1/1 and BH6/2, and Electrical Conductivity in soil sample BH7/2, which does not meet any of the above motioned Standards.

One must be aware that soil conditions at the subject site may vary between sampling locations. Please note that the acceptance of soil material along with the frequency of sampling and testing are at the discretion of the receiving site.

Should any queries arise, please feel free to contact this office.

Yours very truly,

SOIL ENGINEERS LTD.

Efua Khumbah, EP, M. Sc.

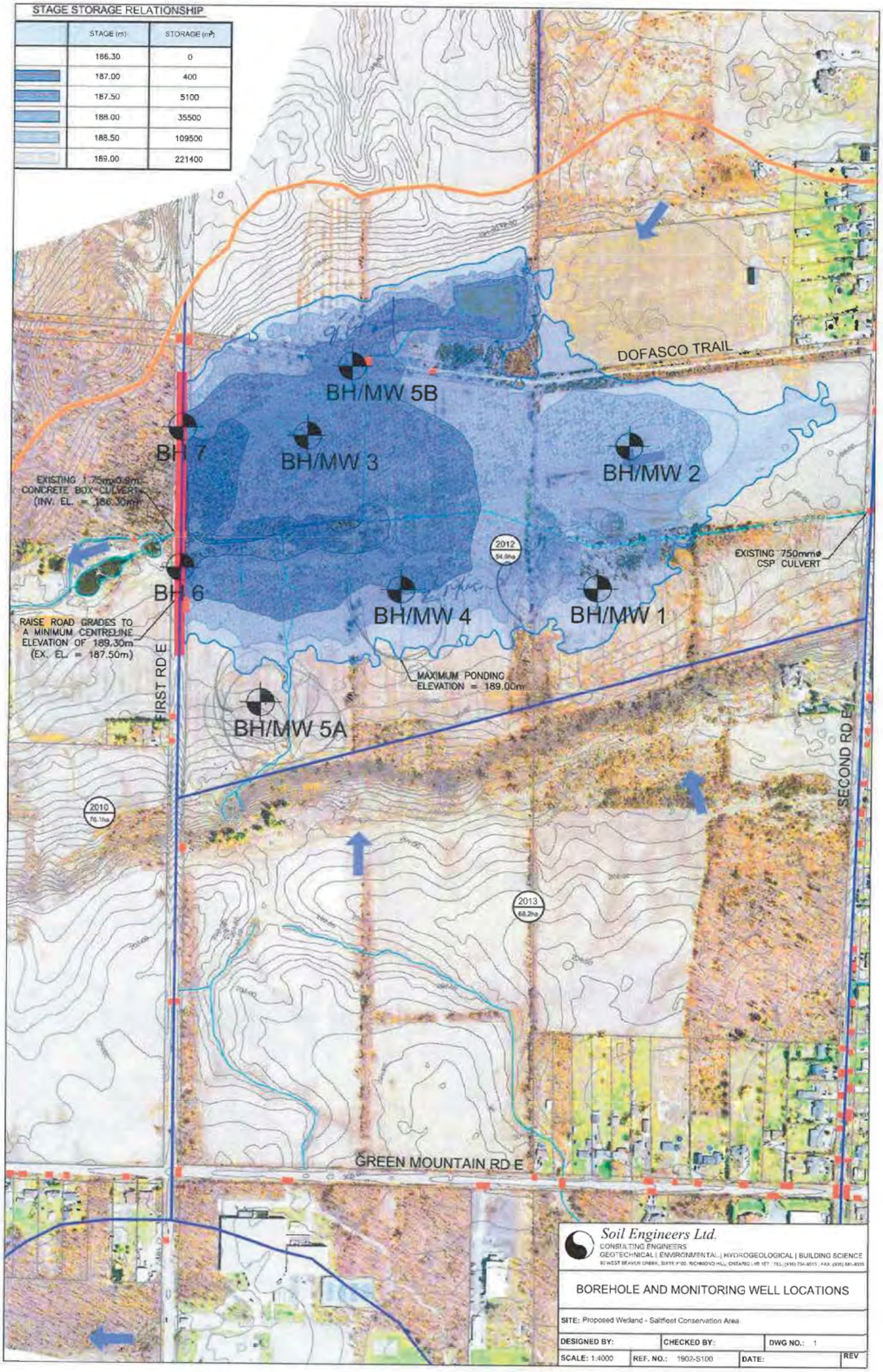
Ahmed Hassan, P.Eng.
EK/AH:ek

LICENSED PROFESSIONAL ENGINEER
A. M. HASSAN
100124527
Apri|30, 2019
PROVINCE OF ONTARIO

Enclosed

- Borehole Location Plan (1 Page)
- Borehole Logs (8)
- Certificate of Analysis (20 Pages)

Borehole Location Plan



STAGE STORAGE RELATIONSHIP

	STAGE (m)	STORAGE (m³)
	186.30	0
🟦	187.00	400
🟦	187.50	5100
🟦	188.00	35500
🟦	188.50	109500
🟦	189.00	221400

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BOREHOLE AND MONITORING WELL LOCATIONS

SITE: Proposed Wetland - Saltfleet Conservation Area

DESIGNED BY:	**CHECKED BY:**	**DWG NO.:** 1	
SCALE: 1:4000	**REF. NO.:** 1902-S100	**DATE:**	**REV**

Borehole Logs

JOB NO.: 1902-S100

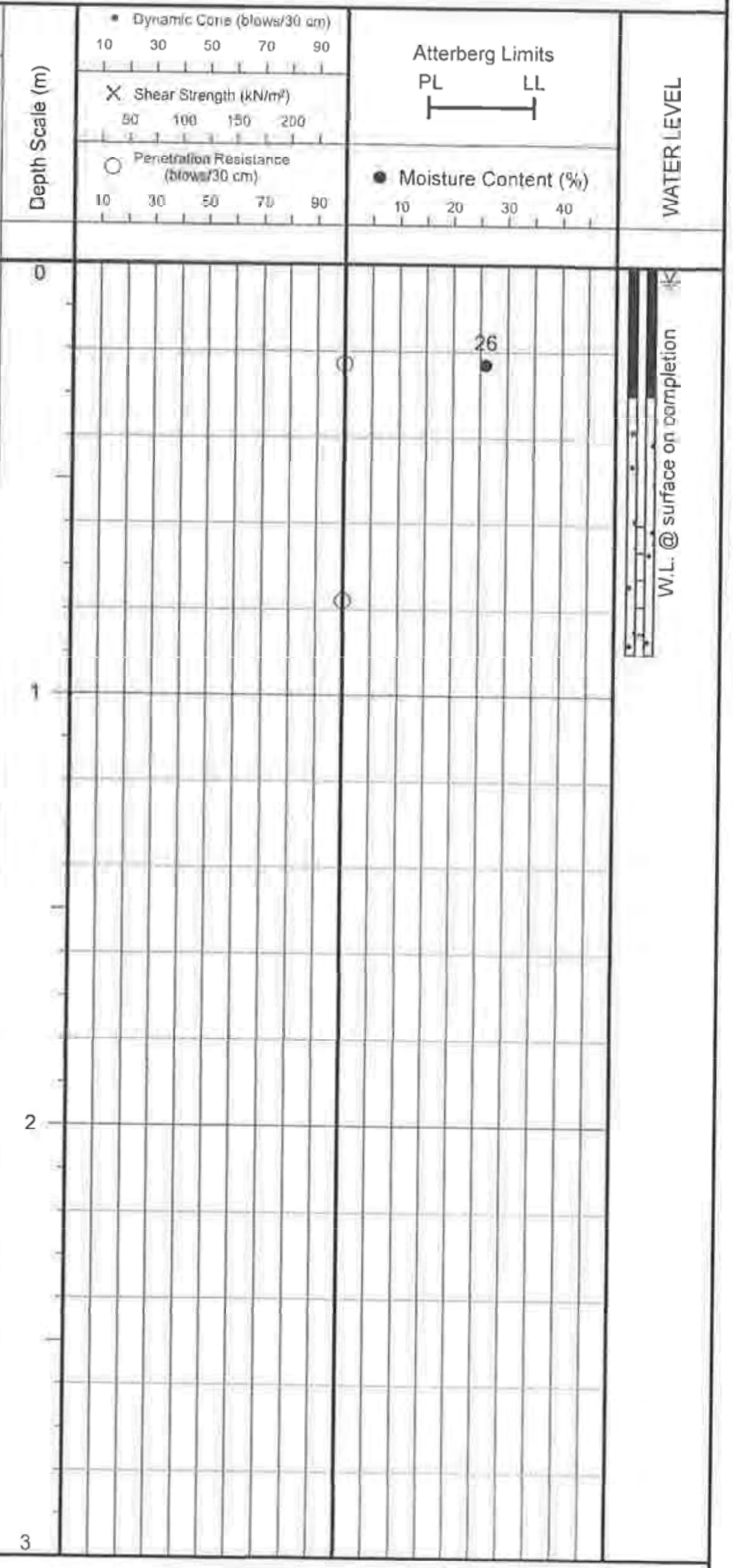
LOG OF BOREHOLE NO.: 1

FIGURE NO.: 1

PROJECT DESCRIPTION: Getechncial Investigation for Proposed Wetland Design **METHOD OF BORING:** Flight-Auger

PROJECT LOCATION: NE Corner of First Road and Green Mountain Road East
Saltfleet Conservation Area, City of Hamilton **DRILLING DATE:** March 27, 2019

El. (m) Depth (m)	SOIL DESCRIPTION	SAMPLES Number	SAMPLES Type	SAMPLES N-Value
187.8	Ground Surface			
0.0	**15 cm TOPSOIL**			
0.1	Brown/Grey, hard **SILTY CLAY** a tr. of sand, organics and rock debris	1 2	DO DO	50/25 50/0
0.9	**Refusal to Augering** **Inferred Bedrock** **END OF BOREHOLE** Installed 50 mm Ø monitoring well to 0.9 m completed with 0.3 m screen Sand backfill from 0.3 m to 0.9 m Bentonite seal from 0.0 m to 0.3 m. Provided with steel casing and lock.			



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JOB NO.: 1902-S100

LOG OF BOREHOLE NO.: 2

FIGURE NO.: 2

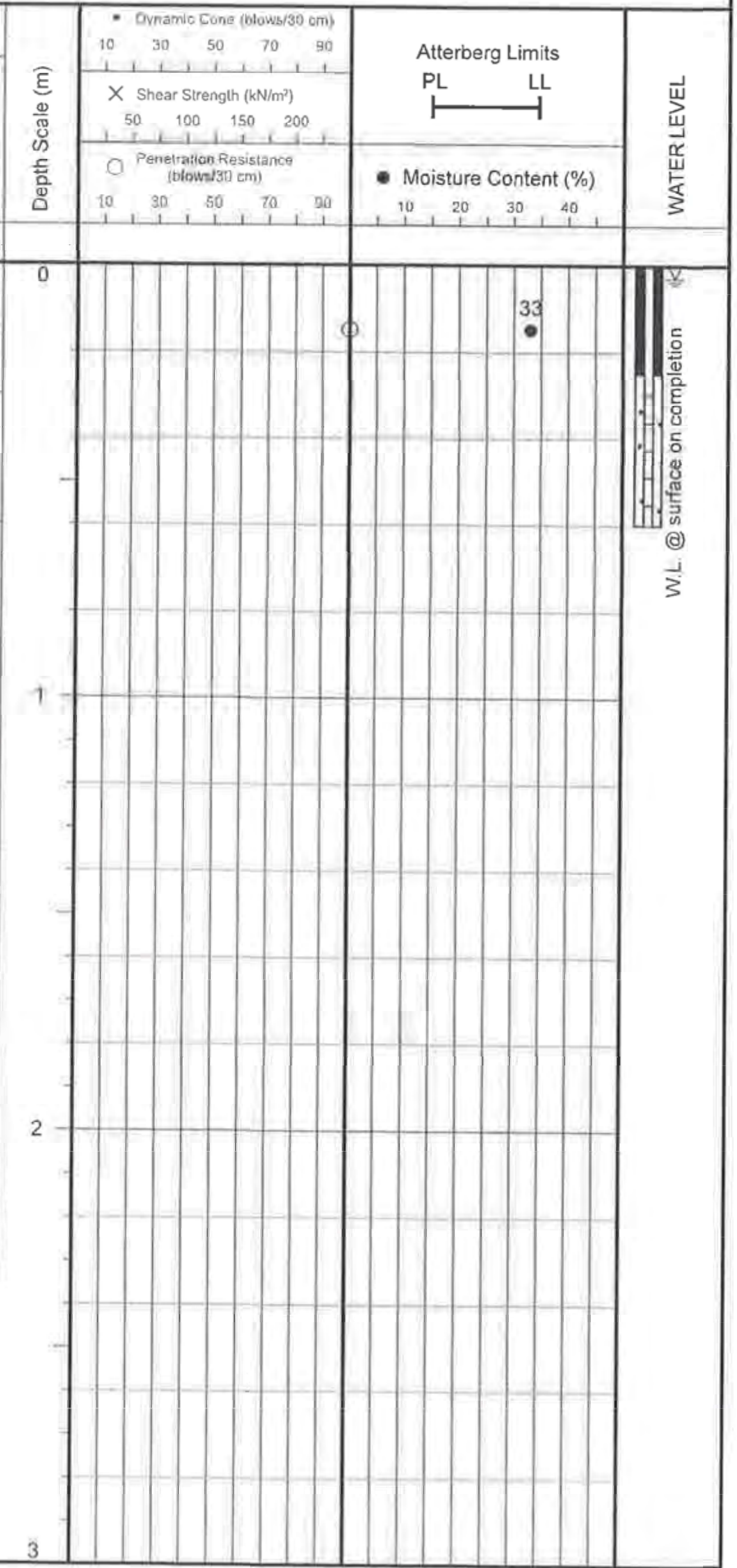
PROJECT DESCRIPTION: Getechncial Investigation for Proposed Wetland Design

METHOD OF BORING: Flight-Auger

PROJECT LOCATION: NE Corner of First Road and Green Mountain Road East
Saltfleet Conservation Area, City of Hamilton

DRILLING DATE: March 27, 2019

El. (m) Depth (m)	SOIL DESCRIPTION	SAMPLES Number	SAMPLES Type	SAMPLES N-Value
188.1	Ground Surface			
0.0	**15 cm TOPSOIL**			
0.1	Brown/Grey, hard **SILTY CLAY** a tr. of sand, organics and rock debris	1	DO	50/15
0.6	**Refusal to Augering** **Inferred Bedrock** **END OF BOREHOLE** Installed 50 mm Ø monitoring well to 0.6 m completed with 0.3 m screen Sand backfill from 0.25 m to 0.6 m Bentonite seal from 0.0 m to 0.25 m. Provided with steel casing and lock.			



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JOB NO.: 1902-S100

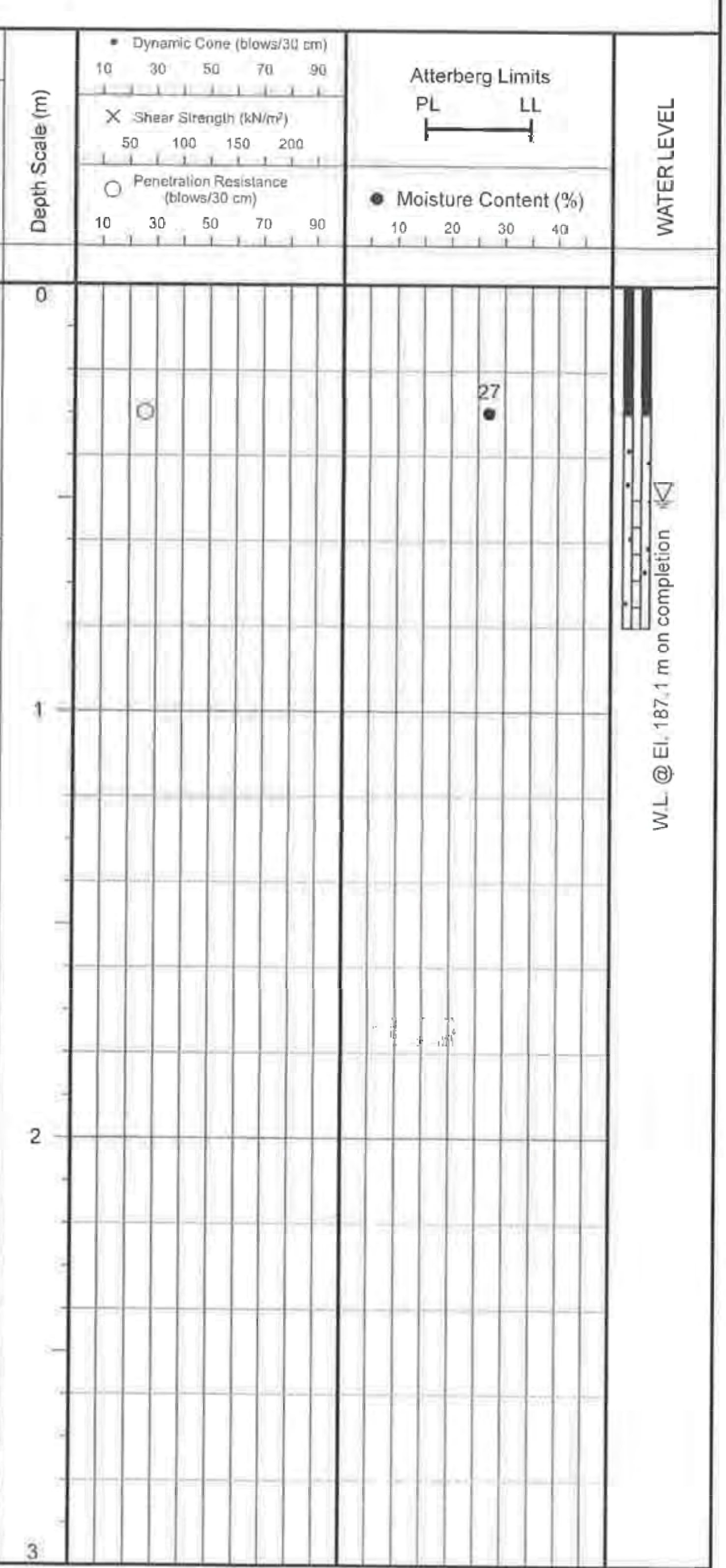
LOG OF BOREHOLE NO.: 3

FIGURE NO.: 3

PROJECT DESCRIPTION: Getechncial Investigation for Proposed Wetland Design **METHOD OF BORING:** Flight-Auger

PROJECT LOCATION: NE Corner of First Road and Green Mountain Road East
Saltfleet Conservation Area, City of Hamilton **DRILLING DATE:** March 27, 2019

El. (m) Depth (m)	SOIL DESCRIPTION	SAMPLES Number	SAMPLES Type	SAMPLES N-Value
187.6	Ground Surface			
0.0	**30 cm TOPSOIL**			
0.3	Brown/Grey, very stiff **SILTY CLAY** a tr. of sand, organics and rock debris	1	DO	26
0.8	**Refusal to Augering** **Inferred Bedrock** END OF BOREHOLE Installed 50 mm Ø monitoring well to 0.8 m completed with 0.3 m screen Sand backfill from 0.3 m to 0.8 m Bentonite seal from 0.0 m to 0.3 m. Provided with steel casing and lock.			



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JOB NO.: 1902-S100

LOG OF BOREHOLE NO.: 4

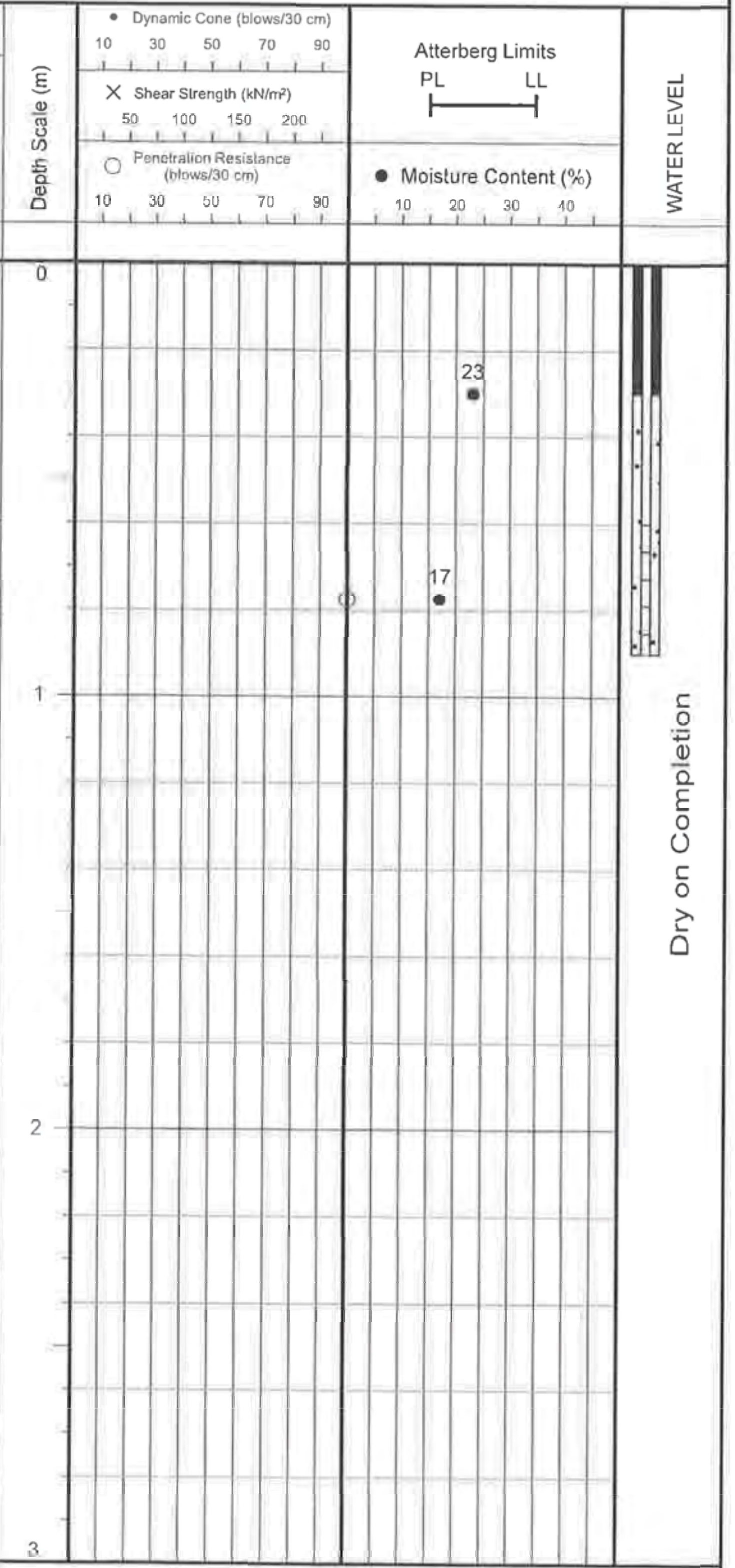
FIGURE NO.: 4

PROJECT DESCRIPTION: Getechncial Investigation for Proposed Wetland Design **METHOD OF BORING:** Flight-Auger

PROJECT LOCATION: NE Corner of First Road and Green Mountain Road East
Saltfleet Conservation Area, City of Hamilton **DRILLING DATE:** March 26, 2019

El. (m) Depth (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value
188.0	Ground Surface			
0.0	**23 cm TOPSOIL**			
0.2	Brown/Grey, firm to hard **SILTY CLAY** a tr. of sand, organics and rock debris	1	DO	7
		2	DO	50/15
0.9	**Refusal to Augering** **Inferred Bedrock** **END OF BOREHOLE**			

Installed 50 mm Ø monitoring well to 0.9 m
completed with 0.3 m screen
Sand backfill from 0.3 m to 0.9 m
Bentonite seal from 0.0 m to 0.3 m.
Provided with steel casing and lock.



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JOB NO.: 1902-S100

LOG OF BOREHOLE NO.: 5A

FIGURE NO.: 5A

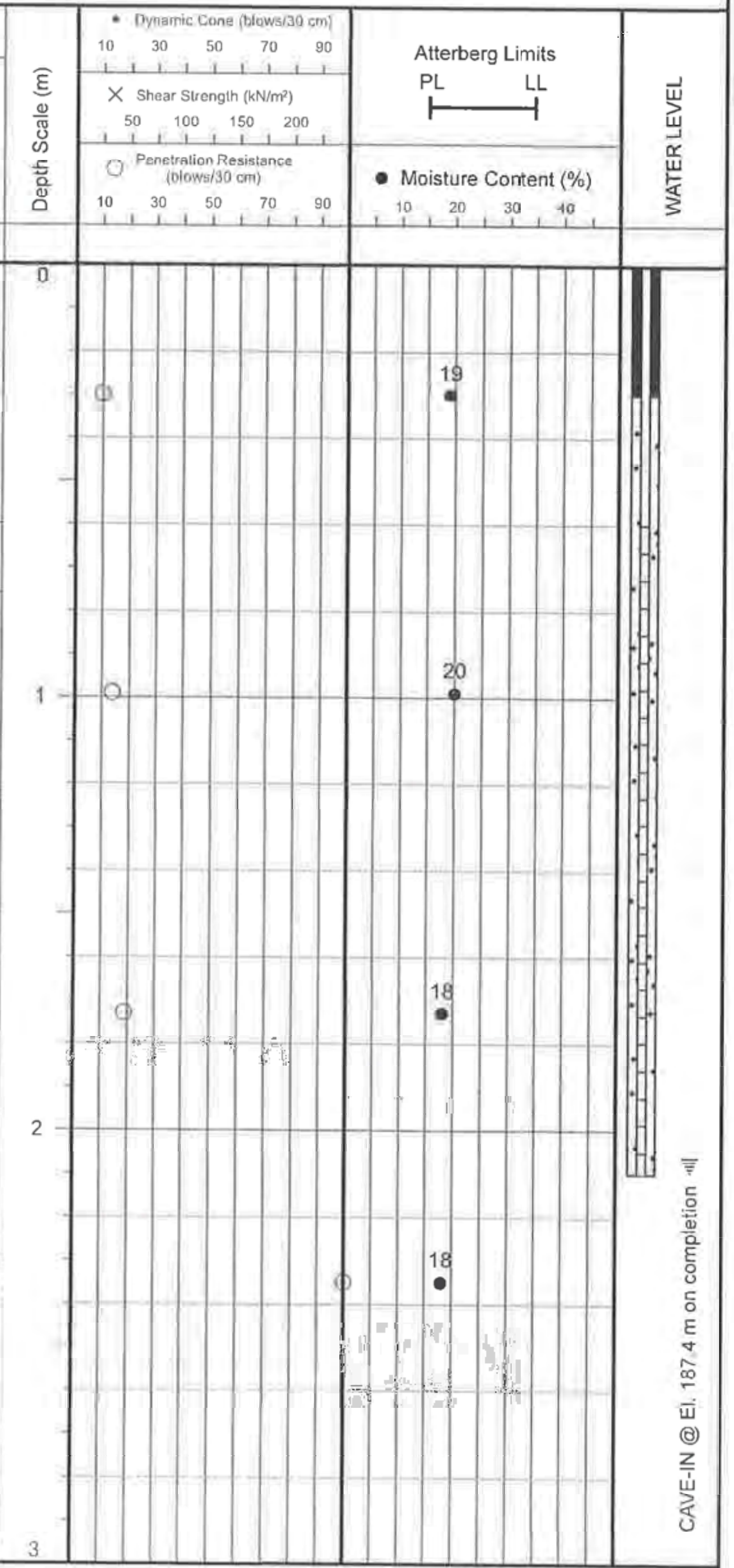
PROJECT DESCRIPTION: Getechncial Investigation for Proposed Wetland Design

METHOD OF BORING: Flight-Auger

PROJECT LOCATION: NE Corner of First Road and Green Mountain Road East
Saltfleet Conservation Area, City of Hamilton

DRILLING DATE: March 26, 2019

El. (m) Depth (m)	SOIL DESCRIPTION	SAMPLES		
		Number	Type	N-Value
189.5	Ground Surface			
0.0	**23 cm TOPSOIL**			
0.2	Brown/Grey, stiff to hard **SILTY CLAY** a tr. of sand, organics and rock debris	1	DO	10
		2	DO	14
		3	DO	19
		4	DO	50/3
2.4	**Refusal to Augering** **Inferred Bedrock** **END OF BOREHOLE** Installed 50 mm Ø monitoring well to 2.1 m completed with 1.5 m screen Sand backfill from 0.3 m to 2.1 m Bentonite seal from 0.0 m to 0.3 m. Provided with steel casing and lock.			



Soil Engineers Ltd.

JOB NO.: 1902-S100

LOG OF BOREHOLE NO.: 5B

FIGURE NO.: 5B

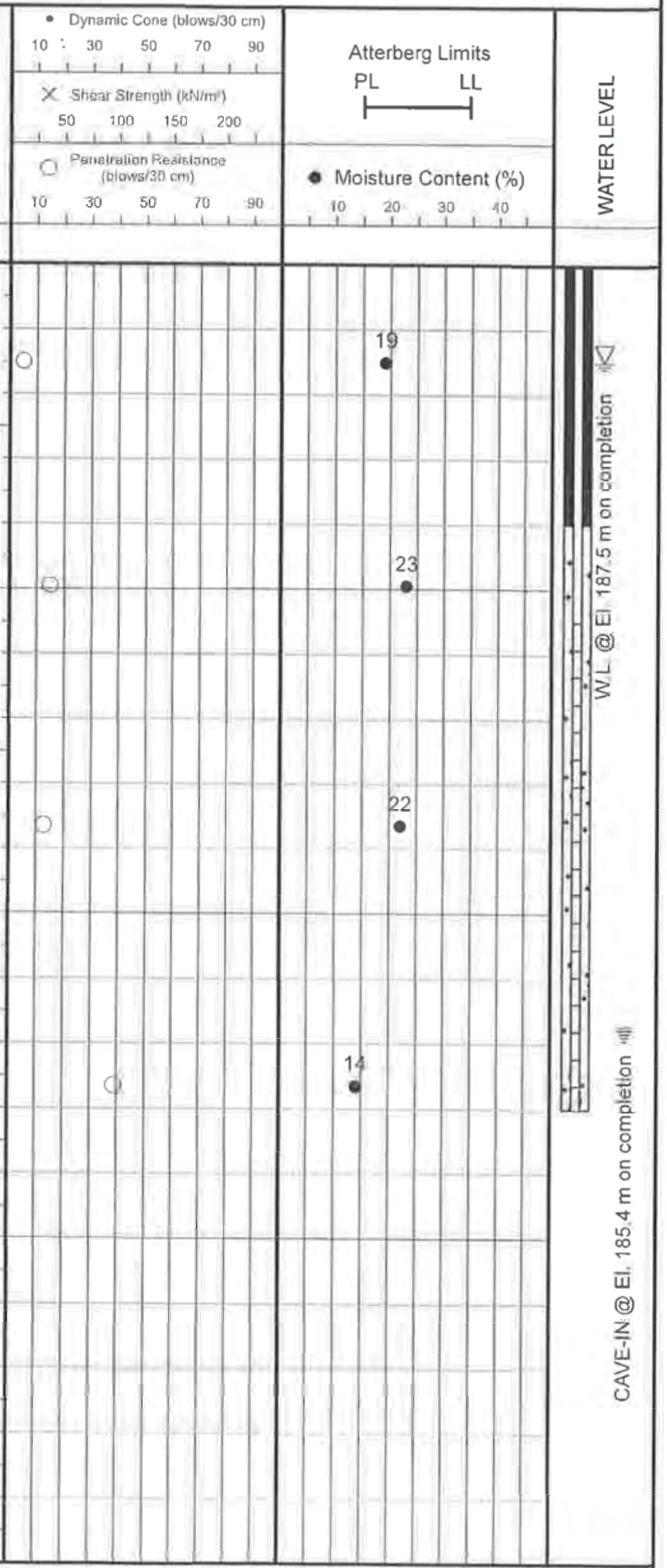
PROJECT DESCRIPTION: Getechncial Investigation for Proposed Wetland Design

METHOD OF BORING: Flight-Auger

PROJECT LOCATION: NE Corner of First Road and Green Mountain Road East
Saltfleet Conservation Area, City of Hamilton

DRILLING DATE: March 26, 2019

El. (m) Depth (m)	SOIL DESCRIPTION	SAMPLES Number	SAMPLES Type	SAMPLES N-Value	Depth Scale (m)
187.8	Ground Surface				
0.0	**30 cm TOPSOIL**				0
0.3	Brown/Grey, firm to hard	1	DO	5	
	SILTY CLAY a tr. of sand, organics and rock debris	2	DO	15	1
		3	DO	13	
					2
		4	DO	39	
2.9	**Refusal to Augering** **Inferred Bedrock** **END OF BOREHOLE**				3
	Installed 50 mm Ø monitoring well to 2.6 m completed with 1.5 m screen Sand backfill from 0.8 m to 2.6 m Bentonite seal from 0.0 m to 0.8 m. Provided with steel casing and lock.				4



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JOB NO.: 1902-S100

LOG OF BOREHOLE NO.: 6

FIGURE NO.: 6

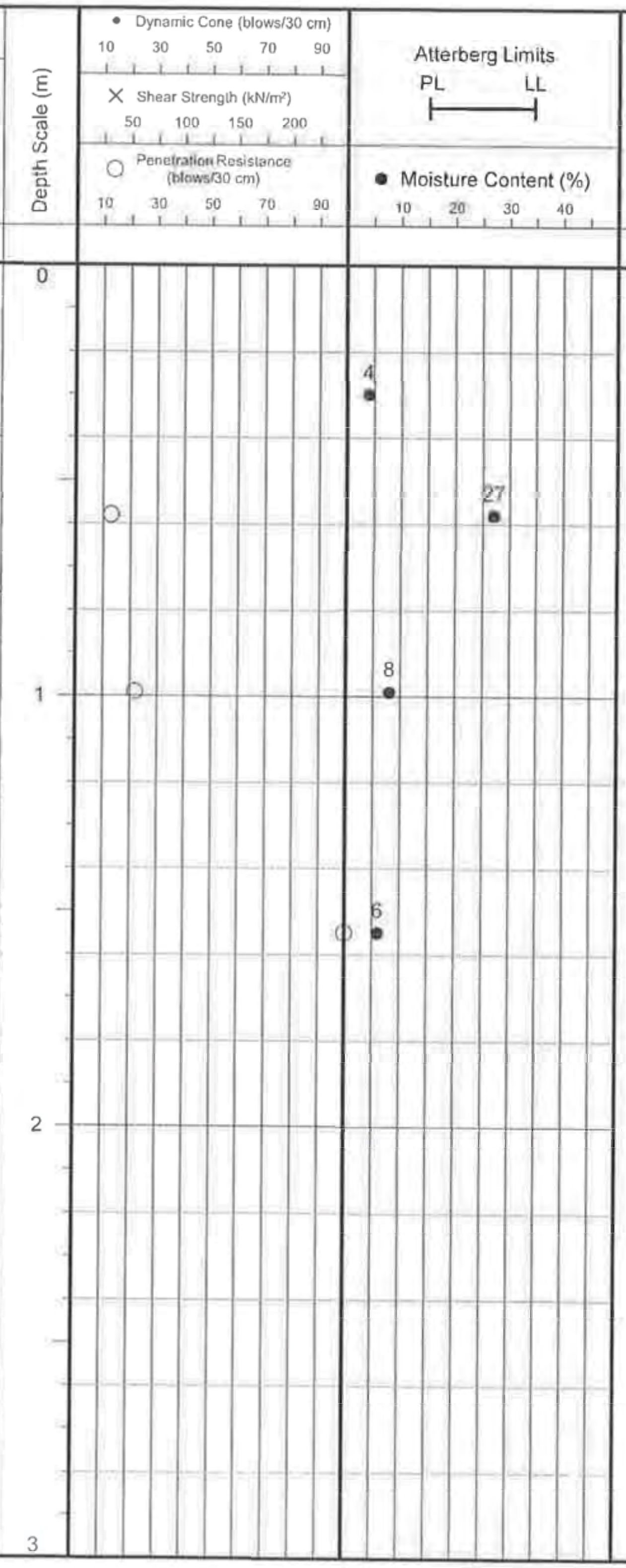
PROJECT DESCRIPTION: Getechncial Investigation for Proposed Wetland Design

METHOD OF BORING: Flight-Auger

PROJECT LOCATION: NE Corner of First Road and Green Mountain Road East
Saltfleet Conservation Area, City of Hamilton

DRILLING DATE: April 4, 2019

El. (m) Depth (m)	SOIL DESCRIPTION	SAMPLES Number	SAMPLES Type	SAMPLES N-Value	WATER LEVEL
187.5	Ground Surface				
0.0	**23 cm GRANULAR FILL**				
0.2	**230 mm GRANULAR FILL**	1A	-		
0.5	Brown/Grey **EARTH FILL** silty clay a tr. of sand and gravel	1B	DO	13	
0.8	Brown, very stiff to hard **SILTY CLAY** a tr. of sand, organics and rock debris	2	DO	22	Dry on Completion
		3	DO	50/10	
1.8	**Refusal to Augering** **Inferred Bedrock** **END OF BOREHOLE**				



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JOB NO.: 1902-S100

LOG OF BOREHOLE NO.: 7

FIGURE NO.: 7

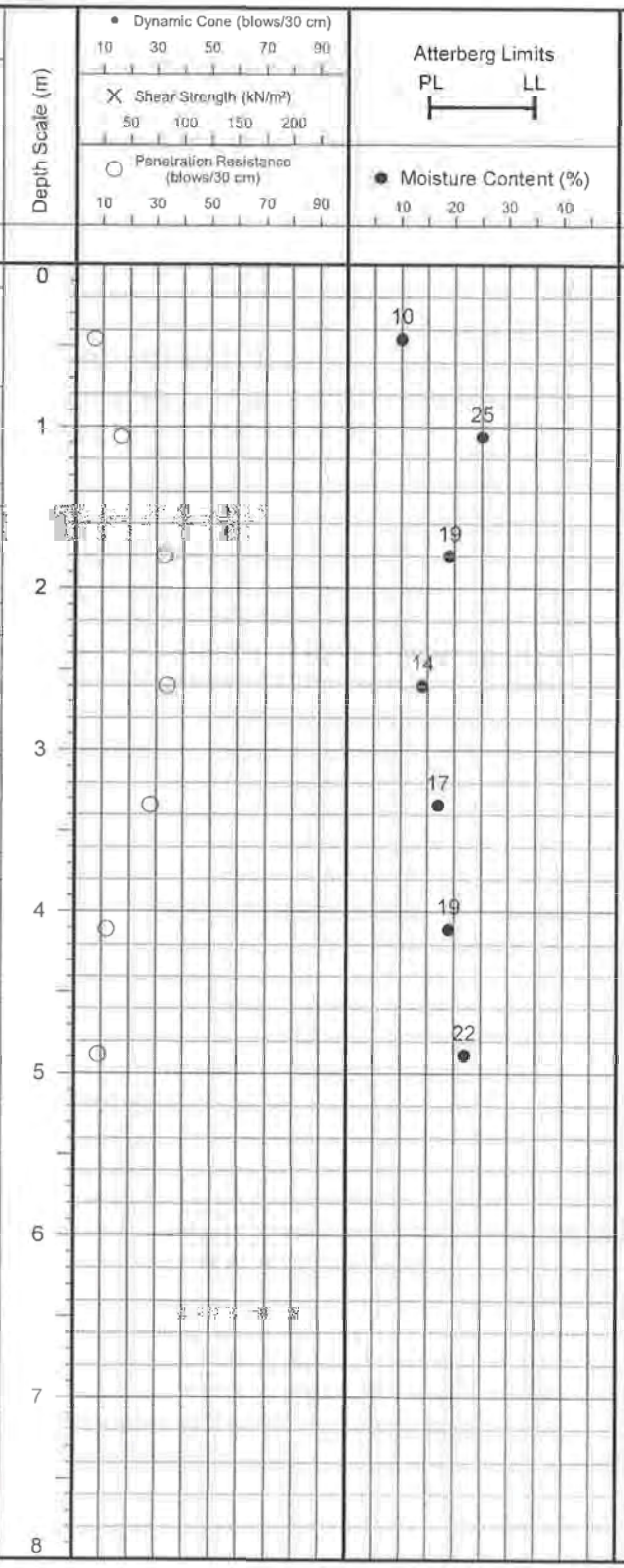
PROJECT DESCRIPTION: Getechncial Investigation for Proposed Wetland Design

METHOD OF BORING: Flight-Auger

PROJECT LOCATION: NE Corner of First Road and Green Mountain Road East
Saltfleet Conservation Area, City of Hamilton

DRILLING DATE: April 4, 2019

El. (m) Depth (m)	SOIL DESCRIPTION	SAMPLES Number	SAMPLES Type	SAMPLES N-Value	WATER LEVEL
187.9	Ground Surface				
0.0	**18 cm GRANULAR FILL**				
0.2	**330 mm GRANULAR FILL**	1	DO	7	
0.5	Brown/Grey **EARTH FILL** silty clay a tr. of sand and gravel				
0.8		2	DO	17	
	Stiff to hard	3	DO	33	
	SILTY CLAY a tr. of sand, organics and rock debris	4	DO	34	Dry on Completion
	brown grey	5	DO	28	
		6	DO	12	
		7	DO	9	
5.5	Grey **DOLOMITE BEDROCK**	8	RC RQD	100% 100%	
		9	RC RQD	95% 85%	
7.1	**END OF BOREHOLE**				



Soil Engineers Ltd.

Soil Engineers Ltd.
CONSULTING ENGINEERS
GEOTECHNICAL • ENVIRONMENTAL • HYDROGEOLOGICAL • BUILDING SCIENCE
90 WEST BEAVER CREEK ROAD, SUITE #100, RICHMOND HILL, ONTARIO L4B 1E7 · TEL (416) 754-8515 · FAX (905) 881-8335

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Certificate of Analysis

AGAT Laboratories

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
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CLIENT NAME: SOIL ENGINEERS LIMITED
90 WEST BEAVER CREEK ROAD, UNIT 100
RICHMOND HILL , ON L4B 1E7
(416) 754-8515

ATTENTION TO: Ahmed Hassan

PROJECT: 1902-E100

AGAT WORK ORDER: 19T451929

SOIL ANALYSIS REVIEWED BY: Amanjot Bhela, Inorganic Supervisor

TRACE ORGANICS REVIEWED BY: Pinkal Patel, Report Reviewer

DATE REPORTED: Apr 04, 2019

PAGES (INCLUDING COVER): 10

VERSION*: 1

Should you require any information regarding this analysis please contact your client services representative at (905) 712-5100

*__*NOTES__*

All samples will be disposed of within 30 days following analysis. Please contact the lab if you require additional sample storage time.

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Certificate of Analysis

AGAT WORK ORDER: 19T451929
PROJECT: 1902-E100

CLIENT NAME: SOIL ENGINEERS LIMITED
SAMPLING SITE:

ATTENTION TO: Ahmed Hassan
SAMPLED BY:

O. Reg. 153(511) - Metals & Inorganics (Soil)

DATE RECEIVED: 2019-03-29

DATE REPORTED: 2019-04-04

			SAMPLE DESCRIPTION:	BH1/1	BH4/1	BH5A/2
			SAMPLE TYPE:	Soil	Soil	Soil
			DATE SAMPLED:	2019-03-26	2019-03-26	2019-03-26
Parameter	Unit	G / S	RDL	103339	103342	103344
Antimony	µg/g	1.3	0.8	<0.8	<0.8	<0.8
Arsenic	µg/g	18	1	11	7	5
Barium	µg/g	220	2	28	92	118
Beryllium	µg/g	2.5	0.5	<0.5	1.0	0.8
Boron	µg/g	36	5	15	7	8
Boron (Hot Water Soluble)	µg/g	NA	0.10	0.25	0.18	<0.10
Cadmium	µg/g	1.2	0.5	**1.7**	<0.5	<0.5
Chromium	µg/g	70	2	8	27	25
Cobalt	µg/g	21	0.5	4.3	16.2	13.6
Copper	µg/g	92	1	12	37	25
Lead	µg/g	120	1	**605**	18	13
Molybdenum	µg/g	2	0.5	0.5	<0.5	<0.5
Nickel	µg/g	82	1	8	34	27
Selenium	µg/g	1.5	0.4	1.1	0.9	0.8
Silver	µg/g	0.5	0.2	<0.2	<0.2	<0.2
Thallium	µg/g	1	0.4	<0.4	<0.4	<0.4
Uranium	µg/g	2.5	0.5	<0.5	<0.5	<0.5
Vanadium	µg/g	86	1	12	37	33
Zinc	µg/g	290	5	**502**	81	77
Chromium VI	µg/g	0.66	0.2	<0.2	<0.2	<0.2
Cyanide	µg/g	0.051	0.040	<0.040	<0.040	<0.040
Mercury	µg/g	0.27	0.10	<0.10	<0.10	<0.10
Electrical Conductivity	mS/cm	0.57	0.005	0.190	0.308	0.155
Sodium Adsorption Ratio	NA	2.4	NA	0.635	0.195	0.176
pH, 2:1 CaCl2 Extraction	pH Units		NA	7.56	7.58	7.63

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard: Refers to Table 1: Full Depth Background Site Condition Standards - Soil - Residential/Parkland/Institutional/Industrial/Commercial/Community Property Use
Guideline values are for general reference only. The guidelines provided may or may not be relevant for the intended use. Refer directly to the applicable standard for regulatory interpretation.

103339-103344 EC & SAR were determined on the DI water extract obtained from the 2:1 leaching procedure (2 parts DI water:1 part soil). pH was determined on the 0.01M CaCl2 extract prepared at 2:1 ratio.

Analysis performed at AGAT Toronto (unless marked by *)

Certified By:

Certificate of Analysis

AGAT WORK ORDER: 19T451929
PROJECT: 1902-E100

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CLIENT NAME: SOIL ENGINEERS LIMITED
SAMPLING SITE:

ATTENTION TO: Ahmed Hassan
SAMPLED BY:

O. Reg. 153(511) - OC Pesticides (Soil)

DATE RECEIVED: 2019-03-29

DATE REPORTED: 2019-04-03

			SAMPLE DESCRIPTION:	BH1/1	BH4/1	BH5A/1
			SAMPLE TYPE:	Soil	Soil	Soil
			DATE SAMPLED:	2019-03-26	2019-03-26	2019-03-26
Parameter	Unit	G / S	RDL	103339	103342	103343
Hexachloroethane	µg/g	0.01	0.01	<0.01	<0.01	<0.01
Gamma-Hexachlorocyclohexane	µg/g	0.01	0.005	<0.005	<0.005	<0.005
Heptachlor	µg/g	0.05	0.005	<0.005	<0.005	<0.005
Aldrin	µg/g	0.05	0.005	<0.005	<0.005	<0.005
Heptachlor Epoxide	µg/g	0.05	0.005	<0.005	<0.005	<0.005
Endosulfan	µg/g	0.04	0.005	<0.005	<0.005	<0.005
Chlordane	µg/g	0.05	0.007	<0.007	<0.007	<0.007
DDE	µg/g	0.05	0.007	<0.007	<0.007	<0.007
DDD	µg/g	0.05	0.007	<0.007	<0.007	<0.007
DDT	µg/g	1.4	0.007	<0.007	<0.007	<0.007
Dieldrin	µg/g	0.05	0.005	<0.005	<0.005	<0.005
Endrin	µg/g	0.04	0.005	<0.005	<0.005	<0.005
Methoxychlor	µg/g	0.05	0.005	<0.005	<0.005	<0.005
Hexachlorobenzene	µg/g	0.01	0.005	<0.005	<0.005	<0.005
Hexachlorobutadiene	µg/g	0.01	0.01	<0.01	<0.01	<0.01
Moisture Content	%		0.1	28.7	14.7	18.2
Surrogate	**Unit**	**Acceptable Limits**				
TCMX	%	50-140		74	95	88
Decachlorobiphenyl	%	60-130		96	106	97

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard: Refers to Table 1: Full Depth Background Site Condition Standards - Soil - Residential/Parkland/Institutional/Industrial/Commercial/Community Property Use
Guideline values are for general reference only. The guidelines provided may or may not be relevant for the intended use. Refer directly to the applicable standard for regulatory interpretation.

103339-103343 Results are based on the dry weight of the soil.
DDT total is a calculated parameter. The calculated value is the sum of op'DDT and pp'DDT.
DDD total is a calculated parameter. The calculated value is the sum of op'DDD and pp'DDD.
DDE total is a calculated parameter. The calculated value is the sum of op'DDE and pp'DDE.
Endosulfan total is a calculated parameter. The calculated value is the sum of Endosulfan I and Endosulfan II.
Chlordane total is a calculated parameter. The calculated value is the sum of Alpha-Chlordane and Gamma-Chlordane

Analysis performed at AGAT Toronto (unless marked by *)

Certified By:

Certificate of Analysis

AGAT WORK ORDER: 19T451929
PROJECT: 1902-E100

CLIENT NAME: SOIL ENGINEERS LIMITED
SAMPLING SITE:

ATTENTION TO: Ahmed Hassan
SAMPLED BY:

O. Reg. 153(511) - PHCs F1 - F4 (Soil)

DATE RECEIVED: 2019-03-29

DATE REPORTED: 2019-04-03

			SAMPLE DESCRIPTION:	BH5A/2	BH5B/2
			SAMPLE TYPE:	Soil	Soil
			DATE SAMPLED:	2019-03-26	2019-03-26
Parameter	**Unit**	**G / S**	**RDL**	**103344**	**103345**
Benzene	µg/g	0.02	0.02	<0.02	<0.02
Toluene	µg/g	0.2	0.05	<0.05	<0.05
Ethylbenzene	µg/g	0.05	0.05	<0.05	<0.05
Xylene Mixture	µg/g	0.05	0.05	<0.05	<0.05
F1 (C6 to C10)	µg/g	25	5	<5	<5
F1 (C6 to C10) minus BTEX	µg/g	25	5	<5	<5
F2 (C10 to C16)	µg/g	10	10	<10	<10
F3 (C16 to C34)	µg/g	240	50	<50	<50
F4 (C34 to C50)	µg/g	120	50	<50	<50
Gravimetric Heavy Hydrocarbons	µg/g	120	50	NA	NA
Moisture Content	%		0.1	19.8	20.8
Surrogate	**Unit**	**Acceptable Limits**			
Terphenyl	%	60-140		100	106

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard: Refers to Table 1: Full Depth Background Site Condition Standards - Soil - Residential/Parkland/Institutional/Industrial/Commercial/Community Property Use
Guideline values are for general reference only. The guidelines provided may or may not be relevant for the intended use. Refer directly to the applicable standard for regulatory interpretation.

103344-103345 Results are based on sample dry weight.
The C6-C10 fraction is calculated using Toluene response factor.
Xylenes is a calculated parameter. The calculated value is the sum of m&p-Xylene and o-Xylene.
C6–C10 (F1 minus BTEX) is a calculated parameter. The calculated value is F1 minus BTEX.
The C10 - C16, C16 - C34, and C34 - C50 fractions are calculated using the average response factor for n-C10, n-C16, and n-C34.
Gravimetric Heavy Hydrocarbons are not included in the Total C16-C50 and are only determined if the chromatogram of the C34 – C50 hydrocarbons indicates that hydrocarbons >C50 are present.
The chromatogram has returned to baseline by the retention time of nC50.
Total C6 - C50 results are corrected for BTEX contribution.
This method complies with the Reference Method for the CWS PHC and is validated for use in the laboratory.
nC6 and nC10 response factors are within 30% of Toluene response factor.
nC10, nC16 and nC34 response factors are within 10% of their average.
C50 response factor is within 70% of nC10 + nC16 + nC34 average.
Linearity is within 15%.
Extraction and holding times were met for this sample.
Fractions 1-4 are quantified with the contribution of PAHs. Under Ontario Regulation 153, results are considered valid without determining the PAH contribution if not requested by the client.
Quality Control Data is available upon request.

Analysis performed at AGAT Toronto (unless marked by *)

Certified By:

Guideline Violation

AGAT WORK ORDER: 19T451929

PROJECT: 1902-E100

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CLIENT NAME: SOIL ENGINEERS LIMITED

ATTENTION TO: Ahmed Hassan

SAMPLEID	SAMPLE TITLE	GUIDELINE	ANALYSIS PACKAGE	PARAMETER	UNIT	GUIDEVALUE	RESULT
103339	BH1/1	ON T1 S RPI/ICC	O. Reg. 153(511) - Metals & Inorganics (Soil)	Cadmium	µg/g	1.2	1.7
103339	BH1/1	ON T1 S RPI/ICC	O. Reg. 153(511) - Metals & Inorganics (Soil)	Lead	µg/g	120	805
103339	BH1/1	ON T1 S RPI/ICC	O. Reg. 153(511) - Metals & Inorganics (Soil)	Zinc	µg/g	290	502

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Quality Assurance

CLIENT NAME: SOIL ENGINEERS LIMITED
PROJECT: 1902-E100
SAMPLING SITE:

AGAT WORK ORDER: 19T451929
ATTENTION TO: Ahmed Hassan
SAMPLED BY:

Soil Analysis

RPT Date:			DUPLICATE				REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD	Method Blank	Measured Value	Acceptable Limits		Recovery	Acceptable Limits		Recovery	Acceptable Limits	
								Lower	Upper		Lower	Upper		Lower	Upper
O. Reg. 153(511) - Metals & Inorganics (Soil)															
Antimony	100693		<0.8	<0.8	NA	< 0.8	103%	70%	130%	101%	80%	120%	103%	70%	130%
Arsenic	100693		4	3	NA	< 1	113%	70%	130%	101%	80%	120%	105%	70%	130%
Barium	100693		56	55	1.8%	< 2	99%	70%	130%	101%	80%	120%	97%	70%	130%
Beryllium	100693		0.6	<0.5	NA	< 0.5	86%	70%	130%	95%	80%	120%	91%	70%	130%
Boron	100693		<5	<5	NA	< 5	74%	70%	130%	100%	80%	120%	85%	70%	130%
Boron (Hot Water Soluble)	103360		0.29	0.29	NA	< 0.10	89%	60%	140%	90%	70%	130%	91%	60%	140%
Cadmium	100693		<0.5	<0.5	NA	< 0.5	95%	70%	130%	95%	80%	120%	89%	70%	130%
Chromium	100693		16	15	6.5%	< 2	83%	70%	130%	96%	80%	120%	98%	70%	130%
Cobalt	100693		7.3	7.1	2.8%	< 0.5	100%	70%	130%	97%	80%	120%	100%	70%	130%
Copper	100693		17	16	6.1%	< 1	100%	70%	130%	100%	80%	120%	95%	70%	130%
Lead	100693		9	8	11.8%	< 1	101%	70%	130%	99%	80%	120%	93%	70%	130%
Molybdenum	100693		<0.5	<0.5	NA	< 0.5	99%	70%	130%	97%	80%	120%	95%	70%	130%
Nickel	100693		15	14	6.9%	< 1	100%	70%	130%	97%	80%	120%	96%	70%	130%
Selenium	100693		<0.4	<0.4	NA	< 0.4	98%	70%	130%	93%	80%	120%	91%	70%	130%
Silver	100693		<0.2	<0.2	NA	< 0.2	90%	70%	130%	93%	80%	120%	83%	70%	130%
Thallium	100693		<0.4	<0.4	NA	< 0.4	86%	70%	130%	97%	80%	120%	92%	70%	130%
Uranium	100693		0.5	<0.5	NA	< 0.5	97%	70%	130%	99%	80%	120%	99%	70%	130%
Vanadium	100693		23	22	4.4%	< 1	93%	70%	130%	93%	80%	120%	100%	70%	130%
Zinc	100693		43	40	7.2%	< 5	103%	70%	130%	102%	80%	120%	96%	70%	130%
Chromium VI	103356		<0.2	<0.2	NA	< 0.2	107%	70%	130%	100%	80%	120%	98%	70%	130%
Cyanide	109619		<0.040	<0.040	NA	< 0.040	93%	70%	130%	96%	80%	120%	99%	70%	130%
Mercury	100693		0.12	0.11	NA	< 0.10	109%	70%	130%	100%	80%	120%	101%	70%	130%
Electrical Conductivity	100093		0.415	0.409	1.5%	< 0.005	103%	90%	110%	NA			NA		
Sodium Adsorption Ratio	100093		1.44	1.43	0.7%	NA	NA			NA			NA		
pH, 2:1 CaCl2 Extraction	109619		7.51	7.55	0.5%	NA	100%	80%	120%	NA			NA		

Comments: NA signifies Not Applicable.
Duplicate Qualifier: As the measured result approaches the RL, the uncertainty associated with the value increases dramatically, thus duplicate acceptance limits apply only where the average of the two duplicates is greater than five times the RL

Certified By: Amanjot Bhela

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Quality Assurance

CLIENT NAME: SOIL ENGINEERS LIMITED
PROJECT: 1902-E100
SAMPLING SITE:

AGAT WORK ORDER: 19T451929
ATTENTION TO: Ahmed Hassan
SAMPLED BY:

Trace Organics Analysis

RPT Date:			DUPLICATE			Method Blank	REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD		Measured Value	Acceptable Limits		Recovery	Acceptable Limits		Recovery	Acceptable Limits	
								Lower	Upper		Lower	Upper		Lower	Upper
O. Reg. 153(511) - OC Pesticides (Soil)															
Hexachloroethane	103343	103343	< 0.01	< 0.01	NA	< 0.01	93%	50%	140%	88%	50%	140%	82%	50%	140%
Gamma-Hexachlorocyclohexane	103343	103343	< 0.005	< 0.005	NA	< 0.005	88%	50%	140%	80%	50%	140%	100%	50%	140%
Heptachlor	103343	103343	< 0.005	< 0.005	NA	< 0.005	88%	50%	140%	83%	50%	140%	96%	50%	140%
Aldrin	103343	103343	< 0.005	< 0.005	NA	< 0.005	94%	50%	140%	82%	50%	140%	104%	50%	140%
Heptachlor Epoxide	103343	103343	< 0.005	< 0.005	NA	< 0.005	91%	50%	140%	84%	50%	140%	103%	50%	140%
Endosulfan	103343	103343	< 0.005	< 0.005	NA	< 0.005	95%	50%	140%	84%	50%	140%	98%	50%	140%
Chlordane	103343	103343	< 0.007	< 0.007	NA	< 0.007	98%	50%	140%	90%	50%	140%	108%	50%	140%
DDE	103343	103343	< 0.007	< 0.007	NA	< 0.007	95%	50%	140%	91%	50%	140%	102%	50%	140%
DDD	103343	103343	< 0.007	< 0.007	NA	< 0.007	94%	50%	140%	84%	50%	140%	108%	50%	140%
DDT	103343	103343	< 0.007	< 0.007	NA	< 0.007	97%	50%	140%	97%	50%	140%	107%	50%	140%
Dieldrin	103343	103343	< 0.005	< 0.005	NA	< 0.005	88%	50%	140%	85%	50%	140%	103%	50%	140%
Endrin	103343	103343	< 0.005	< 0.005	NA	< 0.005	87%	50%	140%	94%	50%	140%	100%	50%	140%
Methoxychlor	103343	103343	< 0.005	< 0.005	NA	< 0.005	87%	50%	140%	107%	50%	140%	109%	50%	140%
Hexachlorobenzene	103343	103343	< 0.005	< 0.005	NA	< 0.005	98%	50%	140%	82%	50%	140%	104%	50%	140%
Hexachlorobutadiene	103343	103343	< 0.01	< 0.01	NA	< 0.01	103%	50%	140%	85%	50%	140%	83%	50%	140%
O. Reg. 153(511) - PHCs F1 - F4 (Soil)															
Benzene	1193		< 0.02	< 0.02	NA	< 0.02	80%	60%	130%	103%	60%	130%	88%	60%	130%
Toluene	1193		< 0.05	< 0.05	NA	< 0.05	79%	60%	130%	109%	60%	130%	89%	60%	130%
Ethylbenzene	1193		< 0.05	< 0.05	NA	< 0.05	89%	60%	130%	94%	60%	130%	83%	60%	130%
Xylene Mixture	1193		< 0.05	< 0.05	NA	< 0.05	85%	60%	130%	95%	60%	130%	85%	60%	130%
F1 (C6 to C10)	1193		< 5	< 5	NA	< 5	87%	60%	130%	105%	85%	115%	91%	70%	130%
F2 (C10 to C16)	9986874		< 10	< 10	NA	< 10	104%	60%	130%	102%	80%	120%	78%	70%	130%
F3 (C16 to C34)	9986874		< 50	< 50	NA	< 50	105%	60%	130%	104%	80%	120%	88%	70%	130%
F4 (C34 to C50)	9986874		53	50	NA	< 50	94%	60%	130%	89%	80%	120%	87%	70%	130%

Comments: When the average of the sample and duplicate results is less than 5x the RDL, the Relative Percent Difference (RPD) will be indicated as Not Applicable (NA).

Certified By: Jinkal Patel

Method Summary

CLIENT NAME: SOIL ENGINEERS LIMITED
PROJECT: 1902-E100
SAMPLING SITE:

AGAT WORK ORDER: 19T451929
ATTENTION TO: Ahmed Hassan
SAMPLED BY:

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Soil Analysis			
Antimony	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Arsenic	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Barium	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Beryllium	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Boron	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Boron (Hot Water Soluble)	MET-93-6104	EPA SW 846 6010C; MSA, Part 3, Ch.21	ICP/OES
Cadmium	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Chromium	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Cobalt	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Copper	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Lead	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Molybdenum	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Nickel	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Selenium	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Silver	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Thallium	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Uranium	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Vanadium	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Zinc	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Chromium VI	INOR-93-6029	SM 3500 B; MSA Part 3, Ch. 25	SPECTROPHOTOMETER
Cyanide	INOR-93-6052	MOE CN-3015 & E 3009 A;SM 4500 CN	TECHNICON AUTO ANALYZER
Mercury	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Electrical Conductivity	INOR-93-6036	McKeague 4.12, SM 2510 B	EC METER
Sodium Adsorption Ratio	INOR-93-6007	McKeague 4.12 & 3.26 & EPA SW-846 6010C	ICP/OES
pH, 2:1 CaCl2 Extraction	INOR-93-6031	MSA part 3 & SM 4500-H+ B	PH METER

Method Summary

CLIENT NAME: SOIL ENGINEERS LIMITED
PROJECT: 1902-E100
SAMPLING SITE:

AGAT WORK ORDER: 19T451929
ATTENTION TO: Ahmed Hassan
SAMPLED BY:

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Trace Organics Analysis			
Hexachloroethane	ORG-91-5113	EPA SW-846 3541,3620 & 8081	GC/ECD
Gamma-Hexachlorocyclohexane	ORG-91-5113	EPA SW-846 3541,3620 & 8081	GC/ECD
Heptachlor	ORG-91-5113	EPA SW-846 3541,3620 & 8081	GC/ECD
Aldrin	ORG-91-5113	EPA SW-846 3541,3620 & 8081	GC/ECD
Heptachlor Epoxide	ORG-91-5113	EPA SW-846 3541,3620 & 8081	GC/ECD
Endosulfan	ORG-91-5113	EPA SW-846 3541,3620 & 8081	GC/ECD
Chlordane	ORG-91-5113	EPA SW-846 3541,3620 & 8081	GC/ECD
DDE	ORG-91-5113	EPA SW-846 3541,3620 & 8081	GC/ECD
DDD	ORG-91-5113	EPA SW-846 3541,3620 & 8081	GC/ECD
DDT	ORG-91-5113	EPA SW-846 3541,3620 & 8081	GC/ECD
Dieldrin	ORG-91-5113	EPA SW-846 3541,3620 & 8081	GC/ECD
Endrin	ORG-91-5113	EPA SW-846 3541,3620 & 8081	GC/ECD
Methoxychlor	ORG-91-5113	EPA SW-846 3541,3620 & 8081	GC/ECD
Hexachlorobenzene	ORG-91-5113	EPA SW-846 3541,3620 & 8081	GC/ECD
Hexachlorobutadiene	ORG-91-5113	EPA SW-846 3541,3620 & 8081	GC/ECD
TCMX	ORG-91-5112	EPA SW-846 3541,3620 & 8081	GC/ECD
Decachlorobiphenyl	ORG-91-5113	EPA SW-846 3541,3620 & 8081	GC/ECD
Moisture Content		MOE E3139	BALANCE
Benzene	VOL-91-5009	EPA SW-846 5035 & 8260D	P&T GC/MS
Toluene	VOL-91-5009	EPA SW-846 5035 & 8260D	P&T GC/MS
Ethylbenzene	VOL-91-5009	EPA SW-846 5035 & 8260D	P&T GC/MS
Xylene Mixture	VOL-91-5009	EPA SW-846 5035 & 8260D	P&T GC/MS
F1 (C6 to C10)	VOL-91-5009	CCME Tier 1 Method	P&T GC/FID
F1 (C6 to C10) minus BTEX	VOL-91-5009	CCME Tier 1 Method	P&T GC/FID
F2 (C10 to C16)	VOL-91-5009	CCME Tier 1 Method	GC/FID
F3 (C16 to C34)	VOL-91-5009	CCME Tier 1 Method	GC/FID
F4 (C34 to C50)	VOL-91-5009	CCME Tier 1 Method	GC/FID
Gravimetric Heavy Hydrocarbons	VOL-91-5009	CCME Tier 1 Method	BALANCE
Moisture Content	VOL-91-5009	CCME Tier 1 Method	BALANCE
Terphenyl	VOL-91-5009		GC/FID

AGAT Laboratories

5835 Coopers Avenue
Mississauga, Ontario L4Z 1Y2
Ph: 905.712.5100 Fax: 905.712.5122
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Chain of Custody Record

If this is a Drinking Water sample, please use Drinking Water Chain of Custody Form (potable water consumed by humans)

Laboratory Use Only

Work Order #: 19T451929

Cooler Quantity: Med

Arrival Temperatures: 3.5 | 3.3 | 3.7
2.9 | 2.6 | 2.3

Custody Seal Intact: ☐Yes ☐No ☐N/A

Notes:

Report Information:

Company: SEL

Contact: Ahmed Hassan, Steve Chen

Address: 90 West Beaver Creek Rd
Unit 100

Phone: 416 754 8515 Fax:

Reports to be sent to:

1. Email: a.hassan@selengineersltd.com

2. Email: Steve.Chen@—

Project Information:

Project: 1902-E100

Site Location:

Sampled By: SC

AGAT Quote #: PO:

Please note: If quotation number is not provided, client will be billed full price for analysis.

Invoice Information: Bill To Same: Yes ☒ No ☐

Company:

Contact:

Address:

Email:

Regulatory Requirements: ☐ No Regulatory Requirement

(Please check all applicable boxes)

☒ Regulation 153/04

Table 1 (Indicate One)

☐ Ind/Com

☒ Res/Park

☐ Agriculture

Soil Texture (Check One)

☐ Coarse

☐ Fine

☐ Sewer Use

☐ Sanitary

☐ Storm

Region (Indicate One)

☐ MISA

☐ Regulation 558

☐ CCME

☐ Prov. Water Quality Objectives (PWQO)

☐ Other

(Indicate One)

Is this submission for a **Record of Site Condition?**

☐ Yes ☐ No

Report Guideline on Certificate of Analysis

☒ Yes ☐ No

Turnaround Time (TAT) Required:

Regular TAT ☒ 5 to 7 Business Days

Rush TAT (Rush Surcharges Apply)

☐ 3 Business Days ☐ 2 Business Days ☐ Next Business Day

OR Date Required (Rush Surcharges May Apply):

Please provide prior notification for rush TAT
**TAT is exclusive of weekends and statutory holidays*

For 'Same Day' analysis, please contact your AGAT CPM

Sample Matrix Legend

B	Biota
GW	Ground Water
O	Oil
P	Paint
S	Soil
SD	Sediment
SW	Surface Water

Sample Identification	Date Sampled	Time Sampled	# of Containers	Sample Matrix	Comments/ Special Instructions	Field Filtered - Metals, Hg, CrVI Y/N	O. Reg 153 Metals and Inorganics	☐ All Metals ☐ 153 Metals (excl. Hydrides) ☐ Hydride Metals ☐ 153 Metals (incl. Hydrides)	ORPs: ☐ B-HWS ☐ Cl ☐ CN⁻ ☐ Cr⁶⁺ ☐ EC ☐ FOC ☐ Hg ☐ pH ☐ SAR	Full Metals Scan	Regulation/Custom Metals	Nutrients: ☐ TP ☐ NH_3 ☐ TKN ☐ NO_3 ☐ NO_2 ☐ NO_3+NO_2	Volatiles: ☐ VOC ☒ BTEX ☐ THM	PHCs F1 - F4	ABNs	PAHs	PCBs: ☐ Total ☐ Aroclors	Organochlorine Pesticides	TCLP: ☐ M&I ☐ VOCs ☐ ABNs ☐ B(a)P ☐ PCBs	Sewer Use						
BH V1	3/26/19	9:00	2	S			X											X								
BH 4/1		11:00	2				X											X								
BH 5A1		12:00	1															X								
BH 5A2		13:00	3				X						X	X												
BH 5B/2		14:00	2										X	X												

Samples Relinquished By (Print Name and Sign):	Date	Time	Samples Received By (Print Name and Sign):	Date	Time	
Steve	19. March 27	12:00		Mar 29/19	9:57	
Samples Relinquished By (Print Name and Sign):	Date	Time	Samples Received By (Print Name and Sign):	Date	Time	Page 1 of 1
	Mar 29/19	9:54				
Samples Relinquished By (Print Name and Sign):	Date	Time	Samples Received By (Print Name and Sign):	Date	Time	Nº: T 085111

Pink Copy - Client | Yellow Copy - AGAT | White Copy - AGAT

AGAT Laboratories

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CLIENT NAME: SOIL ENGINEERS LIMITED
90 WEST BEAVER CREEK ROAD, UNIT 100
RICHMOND HILL , ON L4B 1E7
(416) 754-8515

ATTENTION TO: Ahmed Hassan

PROJECT: 1902-E100

AGAT WORK ORDER: 19T454036

SOIL ANALYSIS REVIEWED BY: Amanjot Bhela, Inorganic Supervisor

TRACE ORGANICS REVIEWED BY: Neli Popnikolova, Senior Chemist

DATE REPORTED: Apr 11, 2019

PAGES (INCLUDING COVER): 10

VERSION*: 1

Should you require any information regarding this analysis please contact your client services representative at (905) 712-5100

**NOTES*

All samples will be disposed of within 30 days following analysis. Please contact the lab if you require additional sample storage time.

Certificate of Analysis

AGAT WORK ORDER: 19T454036
PROJECT: 1902-E100

CLIENT NAME: SOIL ENGINEERS LIMITED
SAMPLING SITE:

ATTENTION TO: Ahmed Hassan
SAMPLED BY:

O. Reg. 153(511) - Metals & Inorganics (Soil)

DATE RECEIVED: 2019-04-05

DATE REPORTED: 2019-04-11

		SAMPLE DESCRIPTION:		BH6/2	BH7/2	BH5B/1
		SAMPLE TYPE:		Soil	Soil	Soil
		DATE SAMPLED:		2019-04-04	2019-04-04	2019-04-04
Parameter	Unit	G / S	RDL	115549	115550	115553
Antimony	µg/g	1.3	0.8	<0.8	<0.8	<0.8
Arsenic	µg/g	18	1	7	5	12
Barium	µg/g	220	2	32	101	15
Beryllium	µg/g	2.5	0.5	<0.5	0.7	<0.5
Boron	µg/g	36	5	16	12	23
Boron (Hot Water Soluble)	µg/g	NA	0.10	0.45	0.11	0.43
Cadmium	µg/g	1.2	0.5	**2.6**	<0.5	1.0
Chromium	µg/g	70	2	23	26	8
Cobalt	µg/g	21	0.5	4.0	12.2	4.1
Copper	µg/g	92	1	8	23	8
Lead	µg/g	120	1	**134**	12	94
Molybdenum	µg/g	2	0.5	<0.5	<0.5	<0.5
Nickel	µg/g	82	1	8	26	7
Selenium	µg/g	1.5	0.4	<0.4	<0.4	<0.4
Silver	µg/g	0.5	0.2	<0.2	<0.2	0.3
Thallium	µg/g	1	0.4	<0.4	<0.4	<0.4
Uranium	µg/g	2.5	0.5	<0.5	0.6	<0.5
Vanadium	µg/g	86	1	20	38	9
Zinc	µg/g	290	5	**516**	56	271
Chromium VI	µg/g	0.66	0.2	<0.2	<0.2	<0.2
Cyanide	µg/g	0.051	0.040	<0.040	<0.040	<0.040
Mercury	µg/g	0.27	0.10	<0.10	<0.10	<0.10
Electrical Conductivity	mS/cm	0.57	0.005	**1.22**	**1.54**	0.216
Sodium Adsorption Ratio	NA	2.4	NA	**6.61**	**2.49**	0.299
pH, 2:1 CaCl2 Extraction	pH Units		NA	7.87	7.63	7.51

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard: Refers to Table 1: Full Depth Background Site Condition Standards - Soil - Residential/Parkland/Institutional/Industrial/Commercial/Community Property Use
Guideline values are for general reference only. The guidelines provided may or may not be relevant for the intended use. Refer directly to the applicable standard for regulatory interpretation.

115549-115553 EC & SAR were determined on the DI water extract obtained from the 2:1 leaching procedure (2 parts DI water:1 part soil). pH was determined on the 0.01M CaCl2 extract prepared at 2:1 ratio.

Analysis performed at AGAT Toronto (unless marked by *)

Certified By: Amanjot Bhel

Certificate of Analysis

AGAT WORK ORDER: 19T454036
PROJECT: 1902-E100

CLIENT NAME: SOIL ENGINEERS LIMITED
SAMPLING SITE:

ATTENTION TO: Ahmed Hassan
SAMPLED BY:

O. Reg. 153(511) - OC Pesticides (Soil)

DATE RECEIVED: 2019-04-05

DATE REPORTED: 2019-04-08

			SAMPLE DESCRIPTION:	BH3/1
			SAMPLE TYPE:	Soil
			DATE SAMPLED:	2019-04-04
Parameter	**Unit**	**G / S**	**RDL**	**115554**
Hexachloroethane	µg/g	0.01	0.01	<0.01
Gamma-Hexachlorocyclohexane	µg/g	0.01	0.005	<0.005
Heptachlor	µg/g	0.05	0.005	<0.005
Aldrin	µg/g	0.05	0.005	<0.005
Heptachlor Epoxide	µg/g	0.05	0.005	<0.005
Endosulfan	µg/g	0.04	0.005	<0.005
Chlordane	µg/g	0.05	0.007	<0.007
DDE	µg/g	0.05	0.007	<0.007
DDD	µg/g	0.05	0.007	<0.007
DDT	µg/g	1.4	0.007	<0.007
Dieldrin	µg/g	0.05	0.005	<0.005
Endrin	µg/g	0.04	0.005	<0.005
Methoxychlor	µg/g	0.05	0.005	<0.005
Hexachlorobenzene	µg/g	0.01	0.005	<0.005
Hexachlorobutadiene	µg/g	0.01	0.01	<0.01
Moisture Content	%		0.1	34.2
Surrogate	**Unit**	**Acceptable Limits**		
TCMX	%	50-140		74
Decachlorobiphenyl	%	60-130		98

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard: Refers to Table 1: Full Depth Background Site Condition Standards - Soil - Residential/Parkland/Institutional/Industrial/Commercial/Community Property Use
Guideline values are for general reference only. The guidelines provided may or may not be relevant for the intended use. Refer directly to the applicable standard for regulatory interpretation.

115554 Results are based on the dry weight of the soil.
DDT total is a calculated parameter. The calculated value is the sum of op'DDT and pp'DDT.
DDD total is a calculated parameter. The calculated value is the sum of op'DDD and pp'DDD.
DDE total is a calculated parameter. The calculated value is the sum of op'DDE and pp'DDE.
Endosulfan total is a calculated parameter. The calculated value is the sum of Endosulfan I and Endosulfan II.
Chlordane total is a calculated parameter. The calculated value is the sum of Alpha-Chlordane and Gamma-Chlordane.

Analysis performed at AGAT Toronto (unless marked by *)

Certified By:

AGAT Laboratories

Certificate of Analysis

AGAT WORK ORDER: 19T454036
PROJECT: 1902-E100

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MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
TEL (905)712-5100
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http://www.agatlabs.com

CLIENT NAME: SOIL ENGINEERS LIMITED
SAMPLING SITE:

ATTENTION TO: Ahmed Hassan
SAMPLED BY:

O. Reg. 153(511) - PHCs F1 - F4 (Soil)

DATE RECEIVED: 2019-04-05

DATE REPORTED: 2019-04-11

			SAMPLE DESCRIPTION:	BH7/3
			SAMPLE TYPE:	Soil
			DATE SAMPLED:	2019-04-04
Parameter	**Unit**	**G / S**	**RDL**	**115551**
Benzene	µg/g	0.02	0.02	<0.02
Toluene	µg/g	0.2	0.05	<0.05
Ethylbenzene	µg/g	0.05	0.05	<0.05
Xylene Mixture	µg/g	0.05	0.05	<0.05
F1 (C6 to C10)	µg/g	25	5	<5
F1 (C6 to C10) minus BTEX	µg/g	25	5	<5
F2 (C10 to C16)	µg/g	10	10	<10
F3 (C16 to C34)	µg/g	240	50	<50
F4 (C34 to C50)	µg/g	120	50	<50
Gravimetric Heavy Hydrocarbons	µg/g	120	50	NA
Moisture Content	%		0.1	13.7
Surrogate	**Unit**	**Acceptable Limits**		
Terphenyl	%	60-140		93

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard: Refers to Table 1: Full Depth Background Site Condition Standards - Soil - Residential/Parkland/Institutional/Industrial/Commercial/Community Property Use
Guideline values are for general reference only. The guidelines provided may or may not be relevant for the intended use. Refer directly to the applicable standard for regulatory interpretation.

115551 Results are based on sample dry weight.
The C6-C10 fraction is calculated using Toluene response factor.
Xylenes is a calculated parameter. The calculated value is the sum of m&p-Xylene and o-Xylene.
C6–C10 (F1 minus BTEX) is a calculated parameter. The calculated value is F1 minus BTEX.
The C10 - C16, C16 - C34, and C34 - C50 fractions are calculated using the average response factor for n-C10, n-C16, and n-C34.
Gravimetric Heavy Hydrocarbons are not included in the Total C16-C50 and are only determined if the chromatogram of the C34 - C50 hydrocarbons indicates that hydrocarbons >C50 are present.
The chromatogram has returned to baseline by the retention time of nC50.
Total C6 - C50 results are corrected for BTEX contribution.
This method complies with the Reference Method for the CWS PHC and is validated for use in the laboratory.
nC6 and nC10 response factors are within 30% of Toluene response factor.
nC10, nC16 and nC34 response factors are within 10% of their average.
C50 response factor is within 70% of nC10 + nC16 + nC34 average.
Linearity is within 15%.
Extraction and holding times were met for this sample.
Fractions 1-4 are quantified with the contribution of PAHs. Under Ontario Regulation 153, results are considered valid without determining the PAH contribution if not requested by the client.
Quality Control Data is available upon request.

Analysis performed at AGAT Toronto (unless marked by *)

Certified By: N Popruk

AGAT Laboratories

Guideline Violation

AGAT WORK ORDER: 19T454036

PROJECT: 1902-E100

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
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FAX (905)712-5122
http://www.agatlabs.com

CLIENT NAME: SOIL ENGINEERS LIMITED

ATTENTION TO: Ahmed Hassan

SAMPLEID	SAMPLE TITLE	GUIDELINE	ANALYSIS PACKAGE	PARAMETER	UNIT	GUIDEVALUE	RESULT
115549	BH6/2	ON T1 S RPI/ICC	O. Reg. 153(511) - Metals & Inorganics (Soil)	Cadmium	µg/g	1.2	2.6
115549	BH6/2	ON T1 S RPI/ICC	O. Reg. 153(511) - Metals & Inorganics (Soil)	Electrical Conductivity	mS/cm	0.57	1.22
115549	BH6/2	ON T1 S RPI/ICC	O. Reg. 153(511) - Metals & Inorganics (Soil)	Lead	µg/g	120	134
115549	BH6/2	ON T1 S RPI/ICC	O. Reg. 153(511) - Metals & Inorganics (Soil)	Sodium Adsorption Ratio	NA	2.4	6.61
115549	BH6/2	ON T1 S RPI/ICC	O. Reg. 153(511) - Metals & Inorganics (Soil)	Zinc	µg/g	290	516
115550	BH7/2	ON T1 S RPI/ICC	O. Reg. 153(511) - Metals & Inorganics (Soil)	Electrical Conductivity	mS/cm	0.57	1.54
115550	BH7/2	ON T1 S RPI/ICC	O. Reg. 153(511) - Metals & Inorganics (Soil)	Sodium Adsorption Ratio	NA	2.4	2.49

Quality Assurance

CLIENT NAME: SOIL ENGINEERS LIMITED
PROJECT: 1902-E100
SAMPLING SITE:

AGAT WORK ORDER: 19T454036
ATTENTION TO: Ahmed Hassan
SAMPLED BY:

Soil Analysis

RPT Date:			DUPLICATE				REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD	Method Blank	Measured Value	Acceptable Limits		Recovery	Acceptable Limits		Recovery	Acceptable Limits	
								Lower	Upper		Lower	Upper		Lower	Upper
O. Reg. 153(511) - Metals & Inorganics (Soil)															
Antimony	120740		<0.8	<0.8	NA	< 0.8	121%	70%	130%	114%	80%	120%	82%	70%	130%
Arsenic	120740		4	4	NA	< 1	124%	70%	130%	110%	80%	120%	100%	70%	130%
Barium	120740		49	50	2.0%	< 2	100%	70%	130%	99%	80%	120%	96%	70%	130%
Beryllium	120740		<0.5	<0.5	NA	< 0.5	120%	70%	130%	94%	80%	120%	95%	70%	130%
Boron	120740		6	6	NA	< 5	89%	70%	130%	107%	80%	120%	100%	70%	130%
Boron (Hot Water Soluble)	120756		0.32	0.30	NA	< 0.10	110%	60%	140%	95%	70%	130%	92%	60%	140%
Cadmium	120740		<0.5	<0.5	NA	< 0.5	115%	70%	130%	110%	80%	120%	107%	70%	130%
Chromium	120740		11	11	0.0%	< 2	104%	70%	130%	103%	80%	120%	109%	70%	130%
Cobalt	120740		6.4	6.5	1.6%	< 0.5	104%	70%	130%	98%	80%	120%	99%	70%	130%
Copper	120740		31	31	0.0%	< 1	98%	70%	130%	101%	80%	120%	101%	70%	130%
Lead	120740		7	7	0.0%	< 1	102%	70%	130%	98%	80%	120%	94%	70%	130%
Molybdenum	120740		<0.5	<0.5	NA	< 0.5	104%	70%	130%	104%	80%	120%	101%	70%	130%
Nickel	120740		14	13	7.4%	< 1	107%	70%	130%	104%	80%	120%	102%	70%	130%
Selenium	120740		<0.4	0.5	NA	< 0.4	102%	70%	130%	104%	80%	120%	101%	70%	130%
Silver	120740		<0.2	<0.2	NA	< 0.2	108%	70%	130%	116%	80%	120%	106%	70%	130%
Thallium	120740		<0.4	<0.4	NA	< 0.4	113%	70%	130%	109%	80%	120%	107%	70%	130%
Uranium	120740		<0.5	<0.5	NA	< 0.5	123%	70%	130%	99%	80%	120%	102%	70%	130%
Vanadium	120740		19	19	0.0%	< 1	115%	70%	130%	103%	80%	120%	108%	70%	130%
Zinc	120740		43	44	2.3%	< 5	103%	70%	130%	100%	80%	120%	99%	70%	130%
Chromium VI	115553	115553	<0.2	<0.2	NA	< 0.2	107%	70%	130%	97%	80%	120%	93%	70%	130%
Cyanide	116840		<0.040	<0.040	NA	< 0.040	98%	70%	130%	105%	80%	120%	89%	70%	130%
Mercury	120740		<0.10	<0.10	NA	< 0.10	115%	70%	130%	99%	80%	120%	98%	70%	130%
Electrical Conductivity	120771		0.214	0.222	3.7%	< 0.005	104%	90%	110%	NA			NA		
Sodium Adsorption Ratio	120771		0.388	0.385	0.8%	NA	NA			NA			NA		
pH, 2:1 CaCl2 Extraction	115553	115553	7.51	7.53	0.3%	NA	100%	80%	120%	NA			NA		

Comments: NA signifies Not Applicable.
Duplicate Qualifier: As the measured result approaches the RL, the uncertainty associated with the value increases dramatically, thus duplicate acceptance limits apply only where the average of the two duplicates is greater than five times the RL.

Certified By: Amanjot Bhella

AMANJOT BHELLA

Quality Assurance

CLIENT NAME: SOIL ENGINEERS LIMITED
PROJECT: 1902-E100
SAMPLING SITE:

AGAT WORK ORDER: 19T454036
ATTENTION TO: Ahmed Hassan
SAMPLED BY:

Trace Organics Analysis

RPT Date:			DUPLICATE				REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD	Method Blank	Measured Value	Acceptable Limits		Recovery	Acceptable Limits		Recovery	Acceptable Limits	
								Lower	Upper		Lower	Upper		Lower	Upper
O. Reg. 153(511) - PHCs F1 - F4 (Soil)															
Benzene	11[redacted]	[redacted]	< 0.02	[redacted]	NA	< 0.02	85%	60%	130%	99%	60%	130%	74%	60%	130%
Toluene	112653		< 0.05	< 0.05	NA	< 0.05	85%	60%	130%	81%	60%	130%	76%	60%	130%
Ethylbenzene	112653		< 0.05	< 0.05	NA	< 0.05	104%	60%	130%	92%	60%	130%	83%	60%	130%
Xylene Mixture	112653		< 0.05	< 0.05	NA	< 0.05	98%	60%	130%	92%	60%	130%	83%	60%	130%
F1 (C6 to C10)	112653		< 5	< 5	NA	< 5	76%	60%	130%	89%	85%	115%	82%	70%	130%
F2 (C10 to C16)	106790		< 10	< 10	NA	< 10	98%	60%	130%	90%	80%	120%	82%	70%	130%
F3 (C16 to C34)	106790		< 50	< 50	NA	< 50	101%	60%	130%	89%	80%	120%	85%	70%	130%
F4 (C34 to C50)	106790		< 50	< 50	NA	< 50	105%	60%	130%	108%	80%	120%	93%	70%	130%
O. Reg. 153(511) - OC Pesticides (Soil)															
Hexachloroethane	114786		< 0.01	< 0.01	NA	< 0.01	100%	50%	140%	92%	50%	140%	82%	50%	140%
Gamma-Hexachlorocyclohexane	114786		< 0.005	< 0.005	NA	< 0.005	103%	50%	140%	100%	50%	140%	96%	50%	140%
Heptachlor	114786		< 0.005	< 0.005	NA	< 0.005	107%	50%	140%	113%	50%	140%	109%	50%	140%
Aldrin	114786		< 0.005	< 0.005	NA	< 0.005	102%	50%	140%	94%	50%	140%	93%	50%	140%
Heptachlor Epoxide	114786		< 0.005	< 0.005	NA	< 0.005	105%	50%	140%	102%	50%	140%	104%	50%	140%
Endosulfan	114786		< 0.005	< 0.005	NA	< 0.005	110%	50%	140%	95%	50%	140%	102%	50%	140%
Chlordane	114786		< 0.007	< 0.007	NA	< 0.007	104%	50%	140%	91%	50%	140%	105%	50%	140%
DDE	114786		< 0.007	< 0.007	NA	< 0.007	104%	50%	140%	98%	50%	140%	96%	50%	140%
DDD	114786		< 0.007	< 0.007	NA	< 0.007	112%	50%	140%	96%	50%	140%	97%	50%	140%
DDT	114786		< 0.007	< 0.007	NA	< 0.007	104%	50%	140%	107%	50%	140%	99%	50%	140%
Dieldrin	114786		< 0.005	< 0.005	NA	< 0.005	103%	50%	140%	98%	50%	140%	95%	50%	140%
Endrin	114786		< 0.005	< 0.005	NA	< 0.005	107%	50%	140%	100%	50%	140%	103%	50%	140%
Methoxychlor	114786		< 0.005	< 0.005	NA	< 0.005	91%	50%	140%	107%	50%	140%	95%	50%	140%
Hexachlorobenzene	114786		< 0.005	< 0.005	NA	< 0.005	105%	50%	140%	89%	50%	140%	90%	50%	140%
Hexachlorobutadiene	114786		< 0.01	< 0.01	NA	< 0.01	101%	50%	140%	97%	50%	140%	81%	50%	140%

Comments: When the average of the sample and duplicate results is less than 5x the RDL, the Relative Percent Difference (RPD) will be indicated as Not Applicable (NA).

Certified By: NPopukoloff

AGAT Laboratories

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
TEL (905)712-5100
FAX (905)712-5122
http://www.agatlabs.com

Method Summary

CLIENT NAME: SOIL ENGINEERS LIMITED

PROJECT: 1902-E100

SAMPLING SITE:

AGAT WORK ORDER: 19T454036

ATTENTION TO: Ahmed Hassan

SAMPLED BY:

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Soil Analysis			
Antimony	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Arsenic	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Barium	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Beryllium	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Boron	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Boron (Hot Water Soluble)	MET-93-6104	EPA SW 846 6010C; MSA, Part 3, Ch.21	ICP/OES
Cadmium	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Chromium	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Cobalt	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Copper	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Lead	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Molybdenum	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Nickel	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Selenium	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Silver	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Thallium	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Uranium	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Vanadium	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Zinc	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Chromium VI	INOR-93-6029	SM 3500 B; MSA Part 3, Ch. 25	SPECTROPHOTOMETER
Cyanide	INOR-93-6052	MOE CN-3015 & E 3009 A;SM 4500 CN	TECHNICON AUTO ANALYZER
Mercury	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Electrical Conductivity	INOR-93-6036	McKeague 4.12, SM 2510 B	EC METER
Sodium Adsorption Ratio	INOR-93-6007	McKeague 4.12 & 3.26 & EPA SW-846 6010C	ICP/OES
pH, 2:1 CaCl2 Extraction	INOR-93-6031	MSA part 3 & SM 4500-H+ B	PH METER

Method Summary

CLIENT NAME: SOIL ENGINEERS LIMITED
PROJECT: 1902-E100
SAMPLING SITE:

AGAT WORK ORDER: 19T454036
ATTENTION TO: Ahmed Hassan
SAMPLED BY:

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Trace Organics Analysis			
Hexachloroethane	ORG-91-5113	EPA SW-846 3541,3620 & 8081	GC/ECD
Gamma-Hexachlorocyclohexane	ORG-91-5113	EPA SW-846 3541,3620 & 8081	GC/ECD
Heptachlor	ORG-91-5113	EPA SW-846 3541,3620 & 8081	GC/ECD
Aldrin	ORG-91-5113	EPA SW-846 3541,3620 & 8081	GC/ECD
Heptachlor Epoxide	ORG-91-5113	EPA SW-846 3541,3620 & 8081	GC/ECD
Endosulfan	ORG-91-5113	EPA SW-846 3541,3620 & 8081	GC/ECD
Chlordane	ORG-91-5113	EPA SW-846 3541,3620 & 8081	GC/ECD
DDE	ORG-91-5113	EPA SW-846 3541,3620 & 8081	GC/ECD
DDD	ORG-91-5113	EPA SW-846 3541,3620 & 8081	GC/ECD
DDT	ORG-91-5113	EPA SW-846 3541,3620 & 8081	GC/ECD
Dieldrin	ORG-91-5113	EPA SW-846 3541,3620 & 8081	GC/ECD
Endrin	ORG-91-5113	EPA SW-846 3541,3620 & 8081	GC/ECD
Methoxychlor	ORG-91-5113	EPA SW-846 3541,3620 & 8081	GC/ECD
Hexachlorobenzene	ORG-91-5113	EPA SW-846 3541,3620 & 8081	GC/ECD
Hexachlorobutadiene	ORG-91-5113	EPA SW-846 3541,3620 & 8081	GC/ECD
TCMX	ORG-91-5112	EPA SW-846 3541,3620 & 8081	GC/ECD
Decachlorobiphenyl	ORG-91-5113	EPA SW-846 3541,3620 & 8081	GC/ECD
Moisture Content		MOE E3139	BALANCE
Benzene	VOL-91-5009	EPA SW-846 5035 & 8260D	P&T GC/MS
Toluene	VOL-91-5009	EPA SW-846 5035 & 8260D	P&T GC/MS
Ethylbenzene	VOL-91-5009	EPA SW-846 5035 & 8260D	P&T GC/MS
Xylene Mixture	VOL-91-5009	EPA SW-846 5035 & 8260D	P&T GC/MS
F1 (C6 to C10)	VOL-91-5009	CCME Tier 1 Method	P&T GC/FID
F1 (C6 to C10) minus BTEX	VOL-91-5009	CCME Tier 1 Method	P&T GC/FID
F2 (C10 to C16)	VOL-91-5009	CCME Tier 1 Method	GC/FID
F3 (C16 to C34)	VOL-91-5009	CCME Tier 1 Method	GC/FID
F4 (C34 to C50)	VOL-91-5009	CCME Tier 1 Method	GC/FID
Gravimetric Heavy Hydrocarbons	VOL-91-5009	CCME Tier 1 Method	BALANCE
Moisture Content	VOL-91-5009	CCME Tier 1 Method	BALANCE
Terphenyl	VOL-91-5009		GC/FID

AGAT Laboratories

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Mississauga, Ontario L4Z 1Y2
Ph: 905.712.5100 Fax: 905.712.5122
webearth.agatlabs.com

Laboratory Use Only

Work Order #: 19T454036
Cooler Quantity: Med
Arrival Temperatures: 3.7 | 3.5 | 3.9
3.3 | 2.8 | 2.6
Custody Seal Intact: ☐ Yes ☐ No ☐ N/A
Notes:

Chain of Custody Record

If this is a Drinking Water sample, please use Drinking Water Chain of Custody Form (potable water consumed by humans)

Report Information:
Company: SEC
Contact: AHMED HASSAN
Address: 90 West Beaver Creek RD
RICHMOND HILL ON
Phone: Fax:
Reports to be sent to:
1. Email: a.hassan@ , etun.khumba@
2. Email: steve.chan@, tremaine.blanchette@

Regulatory Requirements: ☐ No Regulatory Requirement
(Please check all applicable boxes)

☑ Regulation 153/04
Table (Indicate One)
☐ Ind/Com
☑ Res/Park
☐ Agriculture
Soil Texture (Check One)
☑ Coarse
☐ Fine

☐ Sewer Use
☐ Sanitary
☐ Storm
Region (Indicate One)
☐ MISA

☐ Regulation 558
☐ CCME
☐ Prov. Water Quality Objectives (PWQO)
☐ Other
(Indicate One)

Turnaround Time (TAT) Required:

Regular TAT ☑ 5 to 7 Business Days

Rush TAT (Rush Surcharges Apply)
☐ 3 Business Days ☐ 2 Business Days ☐ Next Business Day

OR Date Required (Rush Surcharges May Apply):

Please provide prior notification for rush TAT
**TAT is exclusive of weekends and statutory holidays*

For 'Same Day' analysis, please contact your AGAT CPM

Project Information:
Project: 1902-E100
Site Location: Hamilton
Sampled By: TREMAINE
AGAT Quote #: PO:
Please note: If quotation number is not provided, client will be billed full price for analysis

Is this submission for a Record of Site Condition?
☐ Yes ☐ No

Report Guideline on Certificate of Analysis
☑ Yes ☐ No

Invoice Information: Bill To Same: Yes ☑ No ☐
Company:
Contact:
Address:
Email:

Sample Matrix Legend
- B Biota
- GW Ground Water
- O Oil
- P Paint
- S Soil
- SD Sediment
- SW Surface Water

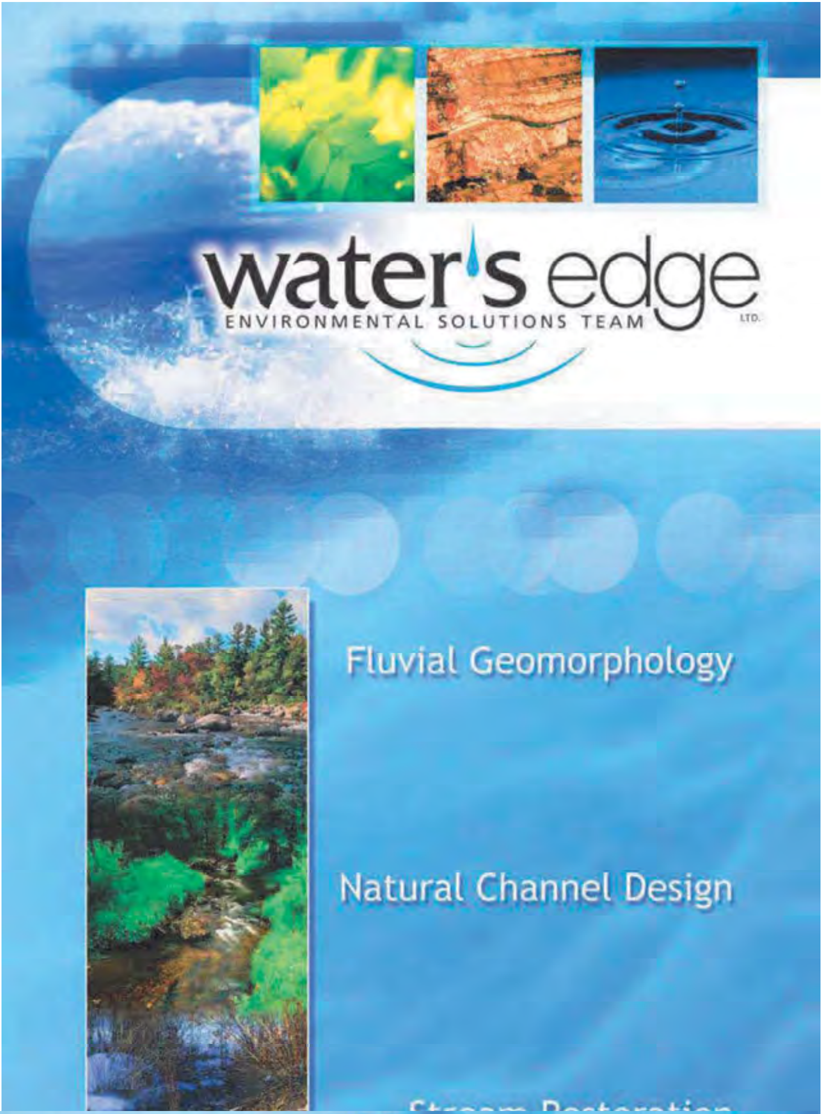
Sample Identification	Date Sampled	Time Sampled	# of Containers	Sample Matrix	Comments/ Special Instructions	Field Filtered - Metals, Hg, CrVI	O. Reg 153			Full Metals Scan	Regulation/Custom Metals	Nutrients: ☐ TP ☐ NH₃ ☐ TKN ☐ NO₂ ☐ NO₃ ☐ NO₃+NO₂	Volatiles: ☐ VOC ☒ BTEX ☐ THM	PHCs F1 - F4	ABNs	PAHs	PCBs: ☐ Total ☐ Aroclors	Organochlorine Pesticides	TCLP: ☐ M&I ☐ VOCs ☐ ABNs ☐ B(a)P ☐ PCBs	Sewer Use
						Y/N	Metals and Inorganics	☐ All Metals ☐ 153 Metals (excl. Hydrides) ☐ Hydride Metals ☐ 153 Metals (incl. Hydrides)	ORPs: ☐ B-HWS ☐ Cl⁻ ☐ CN⁻ ☐ Cr⁶⁺ ☐ EC ☐ FOC ☐ Hg ☐ pH ☐ SAR											
BH 6/2	4APR19	13:00	1	S			X													
BH 9/2		10:00	1				X													
BH 7/3		10:15	2										X	X						
BH5B/1		11:10	1				X													
BH3/1		11:35	1															X		

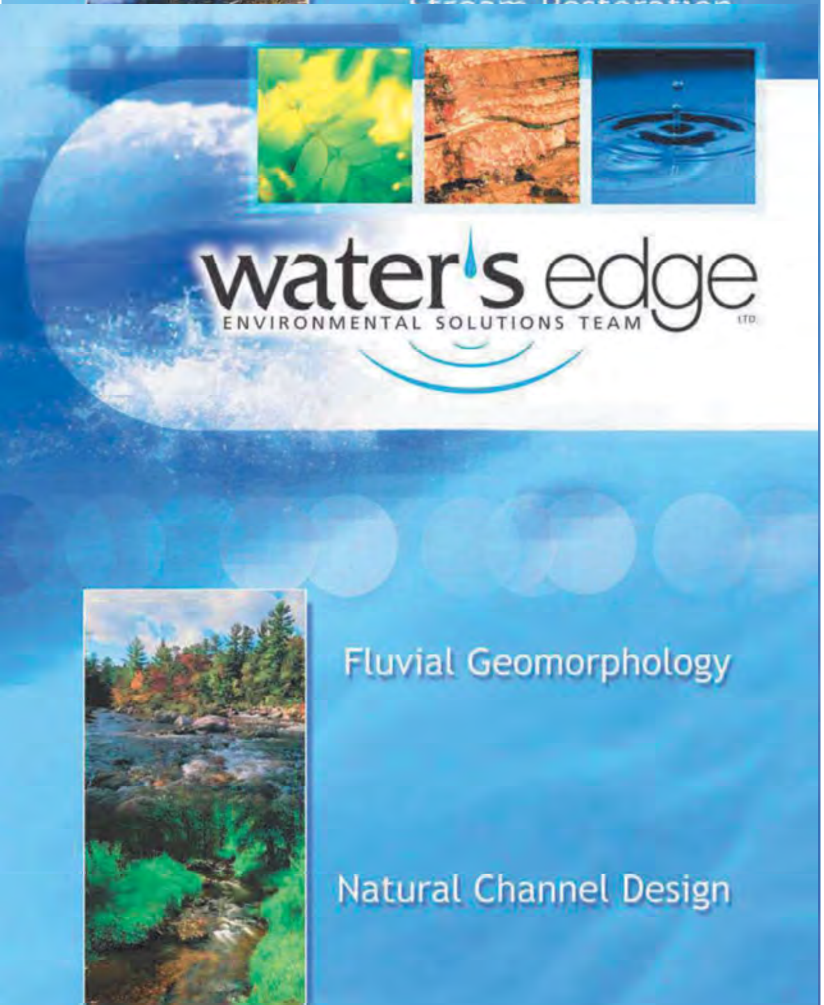
Samples Relinquished By (Print Name and Sign): TREMAINE Date: 4Apr19 Time: 16:00
Samples Received By (Print Name and Sign): Date: Apr15/19 Time: 10:12
Samples Relinquished By (Print Name and Sign): Date: Apr15/19 Time: 12:17
Samples Received By (Print Name and Sign): Date: Time:
Samples Relinquished By (Print Name and Sign): Date: Time:
Samples Received By (Print Name and Sign): Date: Time:

Page 1 of ___

Nº: T 086267

Pink Copy - Client | Yellow Copy - AGAT | White Copy- AGAT





APPENDIX C:

Hydrogeological Report

Hydrogeological Assessment

Proposed Wetland (Area BC-1)
North of Green Mountain Road and east of First Road East
City of Hamilton

Prepared for:

Water's Edge
Environmental Solutions
Team Ltd.
25 Water Street South
Cambridge, Ontario
N1R 3C7

Submitted by:

GREER GALLOWAY
CONSULTING ENGINEERS

1620 Wallbridge Loyalist Road R.R. #5
Belleville, ON K8N 4Z5

T: (613) 966-3068
www.greergalloway.com

Project: 19383111938333

February 2020

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Tables

Figures (in-text)

Appendices

1. Introduction

The Greer Galloway Group was retained by Water's Edge Environmental Solutions Team Ltd. (Water's Edge) to carry out a hydrogeological assessment in support of a planned constructed wetland intended to provide stormwater control and habitat enhancement at the Saltfleet Conservation Area along the Battlefield Creek watershed above the Niagara Escarpment.

As per the Terms of Reference of the project, specific objectives are:

- To utilize the floodplain areas of Upper Battlefield Creek to retain water to provide flood attenuation.
- To enhance and enlarge existing wetland areas and to create new wetland areas to provide enhanced wetland hydrologic function to reduce the impacts of flooding events and provide water to area watercourses during low flow periods.
- To restore the natural features and functions of the watercourses in the area.
- To restore, enhance and enlarge the natural heritage features associated with the floodplains, wetlands and watercourses of the area.
- To provide linkages within and between conservation area lands by utilizing the Dofasco Trail
- To enhance and create passive recreational opportunities along the Dofasco Trail.

The purpose of the current work is to support preliminary and detailed design for a functioning natural wetland able to meet the above-referenced objectives. The focus of the hydrogeological assessment was to determine groundwater fluctuations and potential recharge/discharge areas along with the identification of hydrogeological constraints and hazards that must be dealt with as part of the design process.

Authorization to proceed with this work was provided by Water's Edge via email on February 15, 2019.

2. Investigation Methods

The investigation was closely integrated with the geotechnical and natural environment components completed by Soil Engineers Ltd. and Natural Resource Solutions Inc., respectively. The hydrogeology component included a review of available geological and hydrogeological information for the area, a site reconnaissance, mini-piezometer installation, four-season monitoring of groundwater fluctuations, and interpretation and reporting. These work components are further described below.

2.1 Information Review

A review of published information sources was carried out for the site and adjacent lands where activities may affect or influence groundwater conditions. Information sources included topographic and geologic mapping, aerial photography and MECP Water Well Records, precipitation and climatic data, and site-specific reports prepared by others. Specific geological/ hydrogeological characteristics included topography and drainage, surficial geology, bedrock geology, groundwater elevations, groundwater flow patterns, location of water wells and permitted water takings, and potential recharge and discharge areas (including springs/seepage).

2.2 Site Reconnaissance

A visual field reconnaissance of the study area was conducted on May 10, 2019 to "ground truth" the information obtained from published maps and reports, and to identify any sensitive features in the vicinity of the site.. This reconnaissance included a cursory "drive-by" observation of the general area along with a more in-depth walkthrough field reconnaissance of the study area. The site visit followed shortly after a period of heavy rainfall and offered ideal conditions to observe areas of recharge, areas of low soil permeability, groundwater discharge areas, and karst features. Photographs taken during the site reconnaissance are provided in Sections 3 and 4 of this report.

2.3 Mini-piezometer Installation and Monitoring

The field work for this investigation was carried out between March 26 and April 4, 2019 at which time eight boreholes were drilled to depths ranging from 0.6 to 7.1 m using a track-mounted drilling rig operated under the supervision of Soil Engineer's Ltd. Standard Penetration Testing (SPT) and sampling were carried out at regular intervals of depth in the boreholes using conventional 35 mm internal diameter split spoon sampling equipment advanced using an automatic hammer in accordance with ASTM D1586 99. Six 50-mm monitoring wells were installed in Boreholes 1 through 4 and in Boreholes 5B and 5B. Borehole 5C was cored to asses bedrock conditions while Boreholes 6 and 7 were located off-site on First Road East. 'NQ' size rock coring was carried out below the auger refusal depths in Boreholes 5C and 7 to establish the quality and continuity of bedrock. The results are shown on the corresponding Borehole Logs in Appendix A.

In situ hydraulic conductivity tests (falling head) were carried out for the standpipe piezometers on July 22, 2019. An instantaneous slug of a known volume was deployed down the standpipe piezometer and the falling hydraulic head was recorded with pressure transducers below the slug. The data obtained from the datalogger during the falling head testing is presented in Appendix B. Following completion of the falling head tests, each mini-piezometer was instrumented with a datalogging transducer to record changes in groundwater levels and temperatures.

The purpose of the extended monitoring was to investigate seasonal changes in groundwater levels and assess the response to precipitation events. Rainfall and ambient air temperature data were obtained for the Hamilton Airport and used in conjunction with the groundwater monitoring which is summarized on the hydrographs presented in Appendix C.

2.4 Interpretation and Reporting

The work was summarized in this report which includes a general description of the area including a description of the general geology and hydrogeology of the area, topography, drainage, and landforms, The potential for permanent and temporary impacts of the wetland design alternatives on groundwater wells and sensitive ecological components/features is discussed along with the potential effect of the site hydrogeology on the function of the wetland.

3. Background and Physical Setting

3.1 The Project

The Hamilton Region Conservation Authority (HRCA) envisions the creation of a constructed wetland in the upper Battlefield Creek watershed to retain water to reduce flood and erosion risks downstream below the Niagara Escarpment and to provide enhanced wildlife habitat. The area is adjacent to the Dofasco 2000 Trail and is part of a larger project that was subject to an Environmental Assessment which was completed in 2018 (Amec Foster Wheeler, 2018) and includes another constructed wetland further to the east (SC-8) to allow for more natural stream flow through the subwatershed.

The current design concept calls for the construction of two impoundments referred to as the west pond and the east pond. The east pond is to be created through the construction of a low berm oriented north-south across the main branch of Battlefield Creek and extending east-west along the Dofasco trail and east as far as Second Road. The west pond is to be created through the construction of a sinuous east-west berm impounding flows from a tributary stream that emerges from karst features along the base of the small escarpment that transects the central part of the property (referred to as the Eramosa Scarp). Three permanent water features (1 to 2 m deep) are to be constructed in each of the two impoundments to provide enhanced wetland habitat and overwintering areas for turtles and amphibians. Each of the permanent water features is composed of an irregularly shaped depression with localized high points and slopes intended to provide basking areas and edge-type habitats. It is anticipated that the base of these features will be on, or close, to the surface of the dolostone bedrock.

3.2 Site Description

The BC-1 property is located on the east side of First Road East and north of Green Mountain Road in the east part of Hamilton Ontario. The roughly rectangular site is approximately 42 ha in area and contains about 400 m of the main channel of Battlefield Creek which flows from east to west across the northern portion of the property.

The south half of the property forms a gently undulating plateau with elevations ranging from about 206 metres above mean sea level (mASL) along Green Mountain Road to about 201 mASL along the crest of a low escarpment (the Eramosa escarpment) oriented east-west and transecting the approximate mid-point of the property. From the escarpment, the ground surface slopes steeply to a second plateau at about 190 mASL elevation.

Within the broader area, the dominant topographic feature is the Niagara Escarpment which is located between 750 and 800 m north of the subject property and which marks the boundary between the resistant dolostone bedrock to the south and the more easily eroded shales which occur at the base of the escarpment and underlie the lake plain north of the Escarpment. Elevations drop over 100 m between the crest of the Escarpment and the shores of Lake Ontario.

Vegetation cover in the south half of the property is predominantly composed of row crops and hedgerows while the crest of the low escarpment is vegetated with a variety of trees and grasses. To the north of the low escarpment, the vegetation is more varied and consists of deciduous swamp, cultural thicket, meadow marsh, and cultural meadow. With the exception of the wooded area in the northwest corner of the property, referred to as a Green Ash Deciduous Swamp (see Ecological Land Classification by Natural Resource Solutions Inc., in prep), the entire north part of the property was cleared and in agricultural use in 1943 based on aerial photographs obtained from the McMaster University Air Photo collection.

Photos showing the general topography and vegetation cover across the site are shown in Figures 1 and 2, below:

Figure 1 – Site Photos (1 to 4) **Upper Left:** Looking east-northeast along the crest of the low escarpment in the central portion of the property (i.e. the Eramosa scarp). The remains of a former house/barn are visible in the foreground while the wooded scarp slope is visible in the background; **Upper Right**: Looking to the north from the crest of the low escarpment toward the deciduous swamp wooded area visible in the background; **Lower Left**: Surface water runoff originating from karst discharge at the base of the low escarpment at the point where it enters the flooded meadow marsh in the northwest corner of the property; **Lower Right**: Piezometer MW-1 showing the saturated ground conditions present following heavy rainfall.

Figure 2 – Site Photos (5 to 8) **Upper Left:** Pooled runoff within the deciduous swamp area in the northwest portion of the property near the main channel of Battlefield Creek; **Upper Right**: Runoff flows entering the deciduous swamp from the cultural meadow in the north central part of the property; **Lower Left**: Surface water runoff originating from karst discharge at the base of the low escarpment at the point where it enters the flooded meadow marsh in the northwest corner of the property; **Lower Right**: Flooded conditions within the deciduous swamp in the northwest corner of the property.

3.3 Climate and Water Balance

The subject area is characterized by mild winters and relatively cool humid summers reflecting the lake effect from Lake Erie to the west and Lake Ontario to the east. Snow typically occurs during 4 to 5 months of the year. Modelling carried out by Aquafor Beech Ltd. for the nearby Elfrida Subwatershed (Aquafor Beech, 2018) suggests that the area receives approximately 930 mm of precipitation per year with groundwater recharge concentrated during the spring and fall seasons when precipitation exceeds evapotranspiration (see Table 1) and when the ground is generally unfrozen.

Table 1: Climate Normals (Hamilton Airport Meteorological Station)

Month	P (mm)	T_{ave} (°C)	ET_{ave} (mm)
January	64.0	-6.1	9.2
February	57.8	-5.0	10.5
March	68.4	-2.7	18.7
April	79.1	4.7	40.1
May	79.4	14.4	72.5
June	84.9	18.5	108.1
July	100.7	21.6	122.5
August	79.2	20.7	95.8
September	81.9	18.5	60.2
October	77.4	13.1	32.4
November	84.3	4.7	17.4
December	73.0	-1.6	10.9

The annual volume of surplus water is estimated at approximately 335 mm which is made up of both infiltration and runoff. In this area, infiltration and runoff are difficult to separate owing to the effects of karst which may lead infiltrated precipitation to break out in springs as secondary runoff, and runoff that is captured in solution-enlarged joints. Projected changes to the climate in the Great Lakes region, based on modelled scenarios, include a rise in average annual temperature (Dove-Thompson et al, 2011) along with an increase in annual precipitation. Based on the seasonal recharge patterns, it is likely that the two effects will largely counteract each other leaving annual groundwater recharge relatively unchanged.

3.4 Drainage

The Upper Battlefield Creek watershed is located in the east end of the Hamilton Conservation Authority (HCA) watershed above the Niagara Escarpment. This area is comprised of agricultural uses, residential uses, fallow lands and remnant natural heritage features (wetlands, forest areas and watercourses). Battlefield Creek has a total area of 784 hectares with most of this area located above (i.e. south of) the Niagara Escarpment.

Runoff from the southern half of the property (i.e. south of the Eramosa scarp) flows along two intermittent (and disappearing) channels. The westerly channel flows in a northwesterly direction (316°) to a doline (i.e. sinkhole) located at 601310 m E; 4783666 m N (Zone 17). The easterly channel follows a similar orientation (304°) before gradually cascading into the fractured bedrock at and to the east of the doline at 601344 m E; 4783656 m N. Both channels join in the subsurface near the first referenced doline and then flow in a north-northeasterly direction (005°) to their discharge at the base of the Eramosa Escarpment at approximately 601327 m E; 4783822 m N. Additional smaller discharge points occur locally along the full length of the scarp where they are visible as small seeps or areas of dense vegetation.

From the base of the Eramosa scarp, runoff follows an intermittent channel initially east and then north to its confluence with the main channel of Battlefield Creek along the south margin of the woodland in the northwest corner of the property.

Portions of the north part of the BC-1 property are poorly drained and classified as deciduous swamp or meadow marsh (refer to NSRI, 2020). During periods of high precipitation, runoff spreads within these low areas and does not necessarily follow a discrete channel.

4. Geological Setting

4.1 Quaternary Geology

During the waning stages of the Wisconsinan glaciation (roughly 13,000 years ago), a series of glacial deposits were laid down over older strata and bedrock within the area. Menzies and Taylor (1998) described the following quaternary stratigraphy:

- Upper glacial lacustrine deposits
- Halton till (not known to occur within the subject lands)
- Lower glacial lacustrine deposits (not known to occur within the subject lands)

The upper glaciolacustrine deposits are predominantly fine textured silts and clays laid down when the area was inundated by a series of ponds during the deglaciation of the area when ice within the Lake Ontario basin prevented northward drainage. Sandy lacustrine deposits also occur but these are typically less widespread. Halton Till forms the upper glacial till in the area. Where present, Halton Till is fine textured and a reddish or grey/brown in colour. The till often contains silt or fine sand laminae/partings indicative of subaqueous deposition.

The surficial geology at the site is dominated by a stratum of glaciolacustrine silty clay with accumulations of organic soils (topsoil and peat) in low-lying areas, pavement structure and fill along the roads, and exposed bedrock in small areas where water erosion has removed the overburden cover. During geotechnical drilling, the silty clay deposit was contacted in each of the boreholes beneath surface topsoil or road fill. The deposit extended to bedrock which was encountered at depths ranging from 0.6 to 5.5 m. Geotechnical testing (see Appendix D) indicated that the natural Water Content of the material ranged from 6% to 33% (median 19%) while the plastic and liquid limits were 21 and 43% respectively. Moisture contents below the plastic limit will normally allow for the formation and preservation of soil fractures and hence secondary fracture-related permeability.

4.2 Bedrock Geology

The project area is underlain by a sequence of gently south-dipping Paleozoic sedimentary rocks that were laid down as marine sediments in the Iapetus Ocean (pre-cursor to the Atlantic) more than 400 million years ago. While younger bedrock formations once covered the area, these have been entirely removed by erosion over millions of years. The Niagara Escarpment, the dominant topographic feature in the area, was created by differential erosion within the softer more easily erodible shales of the Queenston Formation which outcrops at the base of the escarpment bordering the lake, and the hard resistant dolostones of the Lockport Group which forms the crest of the Escarpment.

The Ordovician-age Queenston Formation is composed of alternating red and green shales and mudstones. It is easily eroded and weathers readily to a sticky red clay material and is prone to formation of “badlands” topography. It has a total reported thickness of 150 m (Menzies and Taylor, 1998) and is overlain by a series of Silurian-age strata that are generally well exposed along the Niagara Escarpment. These include the mixed siliciclastics and carbonates of the Clinton and Cataract Groups and the overlying shales and carbonates of the Lockport Group (Johnson et al. 1992).

The Clinton-Cataract Group includes, in ascending order: quartz sandstones of the Whirlpool Formation, dolostones of the Manitoulin Formation, grey to red shales of the Cabot Head Formation, red sandstones and shales of the Grimsby Formation, grey-green to white sandstones of the Thorold Formation, dark to green-grey shales of the Neahga Formation, dolostones and argillaceous dolostones of the Reynales Formation, crinoidal limestones of the Irondequoit Formation, grey shales and limestones of the Rochester Formation and argillaceous dolostones of the Decew Formation. The overlying Lockport Group (nomenclature after Brunton and Brintnell, 2011) contains the Gasport, Goat Island, and Eramosa Formations with the Eramosa Formation forming the cap rock of the Escarpment in the study area.

The bedrock geology of the area is shown on Figure 3.

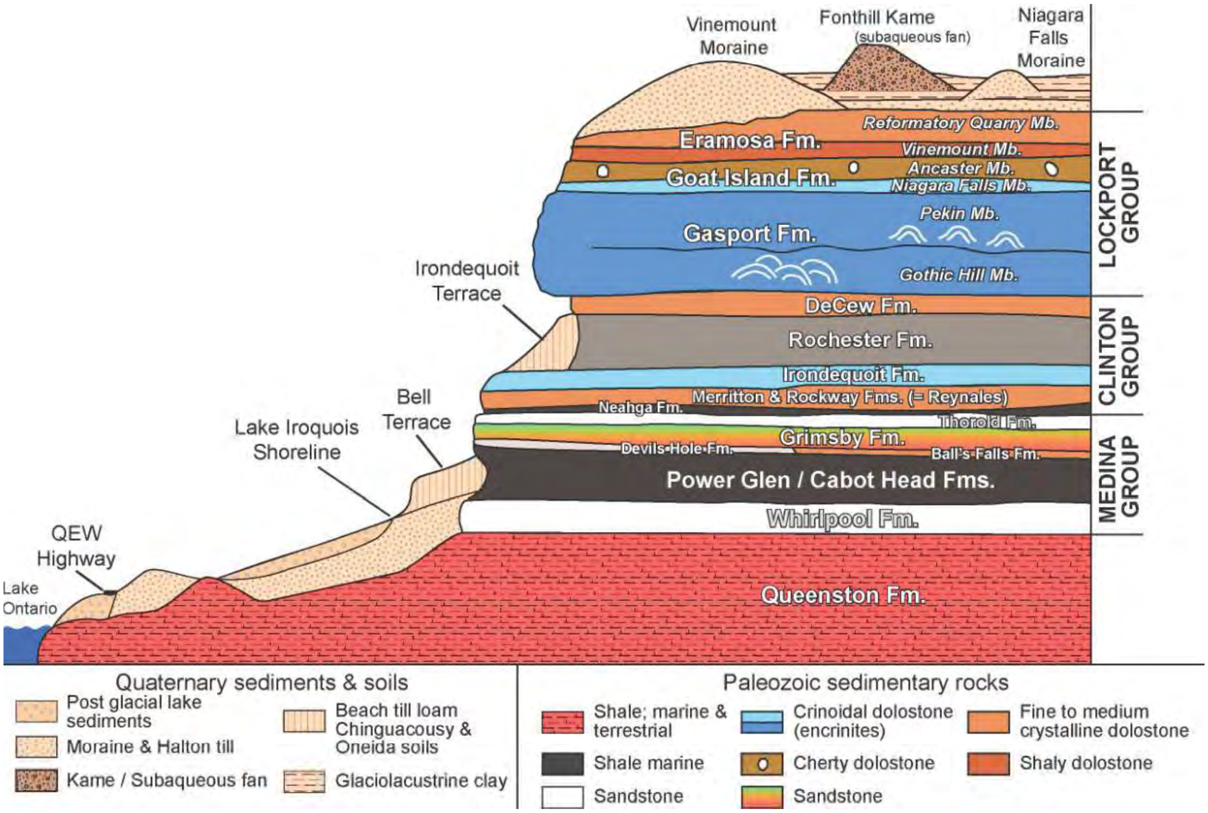

Figure 3 – Conceptual Geological Section (from Brett and Brunton, 2018)

Within the study area, the Eramosa Formation has been divided into two members: the Vinemount shale beds which are locally developed above the Goat Island Formation; and the Reformatory Quarry member. The Vinemount member comprises thinly bedded, fine-crystalline shaley dolostone. These beds are black to dark grey in freshly cut core and blasted outcrops but are a light grey colour in weathered outcrops (Brunton, 2009). There is a sharp contact between the Vinemount member and the overlying thicker bedded dolostones of the Reformatory Quarry member. The contact between the softer and more erodible Vinemount member and the more resistant Reformatory Quarry member is marked by a low scarp, referred to as the Eramosa scarp) located about 1 to 2 km south of the main Niagara Escarpment.

4.3 Hydrostratigraphy

Groundwater is encountered within the shallow overburden deposits and bedrock. Groundwater may t be divided into three systems:

- A shallow silty clay aquitard (Aquitard 1)
- The overburden/weathered bedrock interface (Aquifer 1)
- A deep aquifer comprising fractured bedrock (Aquifer 2)

The silty clay overburden is mostly continuous across the site except on the Eramosa scarp and in places underlain by karst features where the soil has been washed into solution-widened fractures. This layer acts as an aquitard that limits recharge into the underlying aquifer(s) except where karst features capture runoff. The contact between the overburden and the weathered upper surface of the bedrock forms a thin and poor yielding aquifer (Aquifer 1) that is relatively continuous across the site. This aquifer is locally under-drained by fractures and karst in the underlying bedrock (Aquifer 2). Where fractured, especially where such fractures have been enlarged through the dissolution of carbonate minerals (i.e. karst), permeabilities and yields are very high. The unfractured bedrock, in contrast, is relatively impermeable.

A summary of estimated hydraulic conductivity values is provided on Table 2, below:

Table 2: Summary of Hydraulic Conductivity Estimates

Borehole	Sample	Depth (m)	K (m s^{-1})	Soil Description	Method
1	…	0.6 – 0.9	1.9×10^{-4}	Silty Clay and Bedrock Aquifer 1	Hvorslev
2	…	0.3 – 0.6	2.2×10^{-4}	Silty Clay and Bedrock Aquifer 1	Hvorslev
3	…	0.5 – 0.8	3.1×10^{-5}	Silty Clay and Bedrock Aquifer 1	Hvorslev
4	…	0.6 – 0.9	1×10^{-8}	Silty Clay and Bedrock Aquitard 1	Hvorslev
5A	…	1.1 – 2.6	1×10^{-6}	Silty Clay Aquitard 1	Hvorslev
5B	3	1.8	$<1 \times 10^{-8}$	Silty Clay Aquifer 1	Hazen
7	3	1.8	$<1 \times 10^{-8}$	Silty Clay Aquifer 1	Hazen

The fine-textured glaciolacustrine silty clay deposits are relatively impermeable (reported hydraulic conductivity values (k) ranging from 10^{-6} to less than 10^{-8} m s^{-1}). The overburden/bedrock interface generally exhibits a higher conductivity of 1 to 3 x 10^{-4} m s^{-1} but with localized lenses of higher permeability likely present where sedimentary structures have enhanced weathering. No measurements of bedrock permeability are available for the site, but solution-enlarged fractures will behave as open channels in the subsurface where present. The development of karst is largely limited to the Reformatory Quarry member of the Eramosa Formation which is the host rock for all karst features observed at the subject site, as well as numerous features such as sinking streams, dolines, springs and caves at the Eramosa Karst Conservation Area approximately 4 km to the southwest of the BC-1 property (Buck et al., 2002).

Substantially fewer karst features have been reported in the shaley Vinemount member that forms the upper bedrock beneath the north part of the BC-1 property where the constructed wetland is planned. No karst features were observed in this part of the subject property during the current assessment.

Photos taken during the site reconnaissance are provided in Figures 4 and 5, below:

Figure 4 – Site Photos (9 to 12) **Upper Left:** Looking to the west along a disappearing stream which cascades into solution-enlarged joints in the Eramosa member dolostone bedrock in the south central part of the property; **Upper Right**: Subsurface flow along a solution-enlarged bedding plane in the Eramosa member dolostone (location is in the background in the upper left panel); **Lower Left**: Sinkhole development over a solution-enlarged joint in the southwest portion of the property south of the Eramosa scarp; **Lower Right**: Sinkhole development on farm field in the south part of the property .

Figure 1 – Site Photos **Upper Left:** Groundwater discharge from karst near the base of the Eramosa scarp in the west-central part of the property. Flow appears to follow solution-enlarged bedding planes near the contact between the Eramosa and the underlying Vinemount member; **Upper Right**: Groundwater discharge downstream from the discharge point along the base of the scarp; **Lower Left**: Surface water runoff originating from karst discharge at the base of the low escarpment at the point where it enters the flooded meadow marsh n the northwest corner of the property; **Lower Right**: Runoff channel showing glaciolacustrine silty clay strata in the channel bank.

4.4 Groundwater Flow

Precipitation falling on the BC-1 property contributes to recharge to the bedrock aquifer through either slow infiltration through the low permeability silty clay strata or through the capture of runoff by karst features. Shallow groundwater (i.e. within the silty clay and bedrock interface) will typically follow a flow path closely approximating that of the surface water drainage although the proximity of the subject site to the Niagara Escarpment will tend to cause a deviation from this rule of thumb where the bedrock interface intersects more penetrative fracture systems. The actual flow direction of the deeper groundwater flow is expected to be variable and controlled by the location of discharge points (i.e. springs) on the escarpment face and the geometry of interconnected bedrock fractures.

4.5 Groundwater – Surface Water interactions

The average annual precipitation for the area is about 930 mm, with roughly 80% occurring as rainfall and the remainder as snowfall. Based on the moderate to deep-rooted vegetation over much of the site, we estimate that approximately 60% of precipitation will be lost through evaporation and transpiration with the balance available for runoff and infiltration. This water surplus will vary seasonally: during hot dry periods, the evapotranspiration will exceed the precipitation resulting in a moisture deficit and little groundwater recharge except for the capture of runoff in karst features such as dolines. Conversely, precipitation (and snowmelt) will typically exceed evapotranspiration in the spring and fall resulting in increased runoff and infiltration. This seasonal variability in recharge may result in wetland areas acting as groundwater discharge zones during the dry summer months and as recharge zones during the balance of the year.

Seasonal effects are apparent in the extended monitoring of Piezometers 1 to 5 (see Appendix B). Initial measurements taken in early May 2019 indicate that the groundwater table is located close to or slightly above ground elevation. During the balance of the spring and summer, the groundwater levels are observed to decline before recovery with increased precipitation and reduced evapotranspiration in the fall. MW-1 and MW-5B experienced a gradual decline beginning in early to mid-June and then fluctuating at a generally low level until recovery in October. Groundwater levels in MW-2 and MW-3 declined rapidly and fell below the piezometer tip by early July before recovering in early November. MW-4 exhibited a rapid decline in water level to below the bottom of the piezometer by early August. No autumn data is available for this location. Water levels in MW-5A declined at a relatively constant rate until they fell below the bottom of the piezometer in early September. Rapid water level recovery occurred in early November. These seasonal fluctuations suggest that groundwater (except for discharge from karst features) contributes little if any significant baseflow to Battlefield Creek during the summer months, although low rates of recharge to the underlying bedrock aquifer occurs throughout.

Response to precipitation events was rapid in each of the wells but the rate at which the water level decreased following the rainfall events varied. Water level recovery was generally slow in MW-1 and MW-5B and rapid in MW-2 and MW-3. The absolute magnitude of the water level increase was generally similar in all piezometers.

With the construction of the new wetland areas in the north part of BC-1, the amount of evapotranspiration will increase as will the amount of water lost through infiltration into the underlying bedrock. However, these water losses are expected to be greatly outweighed by the increased storage provided by the ponds and the persistent saturation of the overburden/bedrock interface is likely to result in a more consistent contribution to groundwater and to baseflow to Battlefield Creek throughout the year.

5. Discussion

5.1 Construction Aspects

The silty clay glaciolacustrine sediments encountered beneath surficial topsoil in the north portion of the property are characterized by a low hydraulic conductivity and a natural water content at or slightly below the plastic limit. This material is considered compactible (see Soil Engineers Ltd. Geotechnical Report in Appendix D) and secondary permeability resulting from fractures in the soil will be effectively eliminated when the material is remoulded as when compacted by a heavy sheepsfoot roller-type compactor. For these reasons, the native silty clay is considered to be a suitable material for the construction of the berms needed to impound water for the constructed wetlands.

Monitoring of groundwater levels across the site demonstrate a seasonal variability in groundwater levels (Δh) ranging from 0.8 to 2.4 m for piezometers founded on the overburden bedrock interface. If we assume that soils remained in a fully saturated state (a reasonable assumption) and we treat the shallow silty clay aquitard as a porous medium (an unreasonable assumption) then the amount of water loss through the base of the wetland may be crudely estimated by multiplying the observed groundwater Δh by the effective porosity of the soils. Assuming an effective porosity of 20% and a Δh of 2.4 m, we estimate that water levels in the wetland will fall by less than 0.5 m over the summer months due to the infiltration of water through the base of the wetland into the underlying bedrock aquifer. Water losses due to evapotranspiration and water gains through the capture of surface water runoff must also be taken into account when predicting water level fluctuations in the constructed wetland.

Permanent water features should be sited in areas of relatively thick overburden where at least 0.3 m (0.5 m or more would be preferable) of clayey soil can be maintained between the bottom of the water features and the underlying bedrock. This soil layer should be composed of at least 0.2 m of the in-place native silty clay material which should be thoroughly proofrolled using a heavy sheepsfoot roller. Additional soil fill must be free of any organic material and compacted to 95% of standard Proctor maximum dry density (or as determined by the Engineer). The best results will be obtained if the material is compacted slightly wet of optimum using 6 to 8 passes with the heavy sheepsfoot roller on a non-vibratory setting. We recommend that contract documents for the project anticipate the need to modify the location of the permanent water features based on conditions encountered in the field at the time of construction.

Excavations for permanent water features and borrow material will intersect groundwater but the yield will be low and is expected to remain well below the 50,000 L/day threshold beyond which a Permit to Take Water (PTTW) or registration under Environmental Activity and Sector Registry (EASR) is required.

5.2 Karst Risk Factors

Karst features such as caves, sinkholes and solution-enlarged fractures are present within the Reformatory Quarry member of the Eramosa Formation in the south part of the subject property. Available mapping of karst for southern Ontario and Manitoulin Island (Brunton and Dodge, 2008) shows this area and the entire BC-1 property as an area of known or potential karst. A number of Ontario-specific karst risk factors are present at the site (Brunton and Dodge, 2008; Brunton, 2013). These are:

- karst-susceptible geology consisting of carbonate rocks or evaporites
- thin or absent soil cover
- proximity to significant sequence stratigraphic boundaries
- proximity to margins of escarpments near major rivers, particularly at bends in major rivers

Karst features have the potential to adversely affect the functioning of the planned constructed wetlands. While the potential for a sudden collapse of an underground cave is an obvious hazard (especially in areas of the world such as Florida, Mexico, Spain etc.) this kind of hazard is rare in Ontario. More common is the potential for karst features to cause zones of abnormal permeability that, if present and connected to the wetland ponds, could result in the rapid loss of impounded water.

We note that the north part of the property (i.e. the area proposed for the constructed wetlands) is underlain by the Vinemount member of the Eramosa Formation which is less susceptible to karst development than the Reformatory Quarry member owing to its greater shale content (F. Brunton, personal communication). No karst features were noted in this area and a direct hydraulic connection between the impounded water in the wetland and any undiscovered karst-related high-permeability zones in bedrock can be prevented by maintaining a layer of low permeability silty clay between the base of the wetland ponds and the underlying bedrock.

5.3 Potential for Adverse Effects

The planned construction of wetland ponds to provide stormwater control and wildlife habitat enhancement will reduce flooding in lands downstream of the wetland area while both evapotranspiration and groundwater recharge will increase. In the absence of a connection between the pond and high-permeability karst zones, the amount of the groundwater recharge will be modest and insufficient to cause flooding off site or to adversely impact off site groundwater quality (since much of the relevant area is already functionally wetland but deficient in storage capacity). No karst features were observed within the proposed wetland areas and any karst hazards that might be encountered during (or following construction) could be mitigated though the strategic placement of low permeability fill materials.

For these above reasons, no significant adverse environmental effects are envisaged for the project.

6. Summary

The results of this assessment indicate that the north portion of the BC-1 property is underlain by a continuous deposit of silty clay glaciolacustrine sediments having a low hydraulic conductivity when in an unfractured state. These characteristics are considered favourable for the impoundment of stormwater flows in a constructed wetland that will then lose water slowly though direct discharge, evapotranspiration and infiltration into the underlying bedrock aquifer.

Monitoring of groundwater levels across the site demonstrate a seasonal variability in groundwater levels ranging from 0.8 to 2.4 m for piezometers founded on the overburden bedrock interface. The corresponding seasonal variation in pond levels is expected to be of a lesser magnitude reflecting the absence of porosity effects in standing water, and because of the ongoing capture of surface water runoff throughout the summer months. Nevertheless, permanent water features should be sited in areas of relatively thick overburden and at least 0.3 m of clayey soil should be maintained between the bottom of the water features and the underlying bedrock.

Numerous karst features were observed in the south part of the BC-1 property, but Greer Galloway found no evidence of karst development in the area proposed for the constructed wetland ponds. This part of the property is underlain by shaley dolostones of the Vinemount member of the Eramosa Formation which are less susceptible to karst development than the Reformatory Quarry member located south of the Eramosa scarp. Based on the results of our assessment we conclude that there is a low risk that karstic features would pose a hazard and constraint to the planned constructed wetland development, and that any karst hazards that might be discovered could be mitigated though the strategic placement of low permeability fill materials.

The impoundment of stormwater flows is predicted to result in a modest increase in groundwater recharge and a more significant increase in stream baseflows while reducing peak storm flows. No adverse effects are anticipated to offsite groundwater users or ecological receptors along the escarpment and practical mitigation measures exist to mitigate any unpredicted effects that might be encountered during or following construction.

We trust that this report is complete within our terms of reference and sufficient for your present requirements. Please call us if you have any questions or points that require clarification.

Respectfully Submitted,

THE GREER GALLOWAY GROUP INC.
CONSULTING ENGINEERS

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CWM/SB

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Appendix A

Borehole/Piezometer Logs

LIST OF ABBREVIATIONS AND DESCRIPTION OF TERMS

The abbreviations and terms commonly employed on the borehole logs and figures, and in the text of the report, are as follows:

SAMPLE TYPES

AS	Auger sample
CS	Chunk sample
DO	Drive open (split spoon)
DS	Denison type sample
FS	Foil sample
RC	Rock core (with size and percentage recovery)
ST	Slotted tube
TO	Thin-walled, open
TP	Thin-walled, piston
WS	Wash sample

PENETRATION RESISTANCE

Dynamic Cone Penetration Resistance:

A continuous profile showing the number of blows for each foot of penetration of a 2-inch diameter, 90° point cone driven by a 140-pound hammer falling 30 inches.

Plotted as '—●—'

Standard Penetration Resistance or 'N' Value:

The number of blows of a 140-pound hammer falling 30 inches required to advance a 2-inch O.D. drive open sampler one foot into undisturbed soil.

Plotted as '○'

WH	Sampler advanced by static weight
PH	Sampler advanced by hydraulic pressure
PM	Sampler advanced by manual pressure
NP	No penetration

SOIL DESCRIPTION

Cohesionless Soils:

'N' (blows/ft)	Relative Density
0 to 4	very loose
4 to 10	loose
10 to 30	compact
30 to 50	dense
over 50	very dense

Cohesive Soils:

Undrained Shear Strength (ksf)	'N' (blows/ft)	Consistency
less than 0.25	0 to 2	very soft
0.25 to 0.50	2 to 4	soft
0.50 to 1.0	4 to 8	firm
1.0 to 2.0	8 to 16	stiff
2.0 to 4.0	16 to 32	very stiff
over 4.0	over 32	hard

Method of Determination of Undrained Shear Strength of Cohesive Soils:

x 0.0 Field vane test in borehole; the number denotes the sensitivity to remoulding

△ Laboratory vane test

□ Compression test in laboratory

For a saturated cohesive soil, the undrained shear strength is taken as one half of the undrained compressive strength

METRIC CONVERSION FACTORS

1 ft = 0.3048 metres

1lb = 0.454 kg

1 inch = 25.4 mm

1ksf = 47.88 kPa

Soil Engineers Ltd.
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GEOTECHNICAL • ENVIRONMENTAL • HYDROGEOLOGICAL • BUILDING SCIENCE

JOB NO.: 1902-S100

LOG OF BOREHOLE NO.: 1

FIGURE NO.: 1

PROJECT DESCRIPTION: Proposed Wetland Design

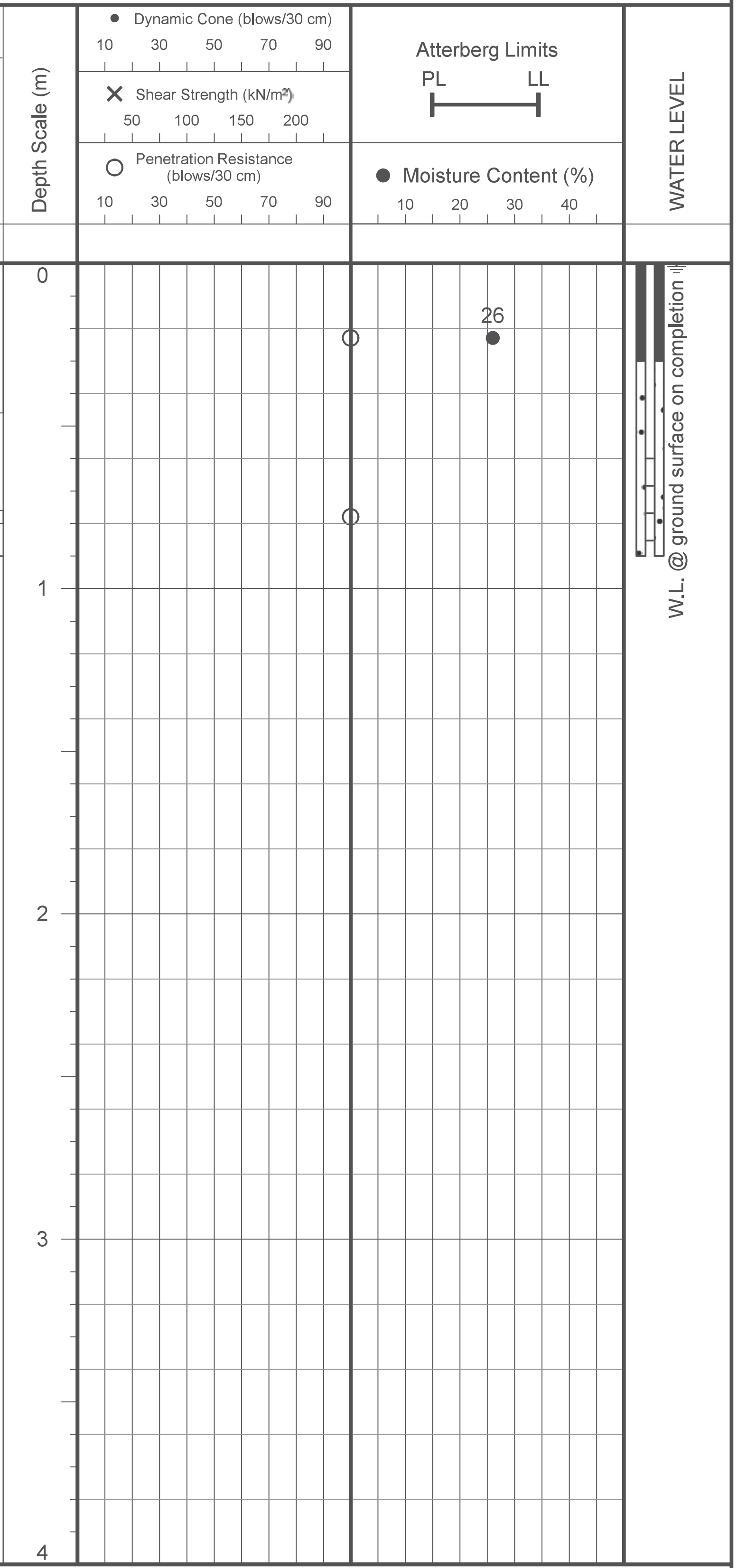
METHOD OF BORING: Flight-Auger

PROJECT LOCATION: First Road East and Green Mountain Road East
City of Hamilton

DRILLING DATE: March 27, 2019

El. (m) Depth (m)	SOIL DESCRIPTION	SAMPLES Number	SAMPLES Type	SAMPLES N-Value
187.8	Ground Surface			
0.0	**15 cm TOPSOIL**			
187.7 0.1	Greyish-brown, hard **SILTY CLAY** a tr. of sand and organics occ. silt seams and rock fragments	1	DO	50/25
		2	DO	50/0
186.9 0.9	**Refusal to Augering** **Inferred Bedrock** **END OF BOREHOLE**	-	-	-

Installed 50 mm Ø monitoring well to 0.9 m
completed with 0.3 m screen
Sand backfill from 0.3 m to 0.9 m
Bentonite seal from 0.0 m to 0.3 m.
Provided with steel casing and lock.



Soil Engineers Ltd.

JOB NO.: 1902-S100

LOG OF BOREHOLE NO.: 2

FIGURE NO.: 2

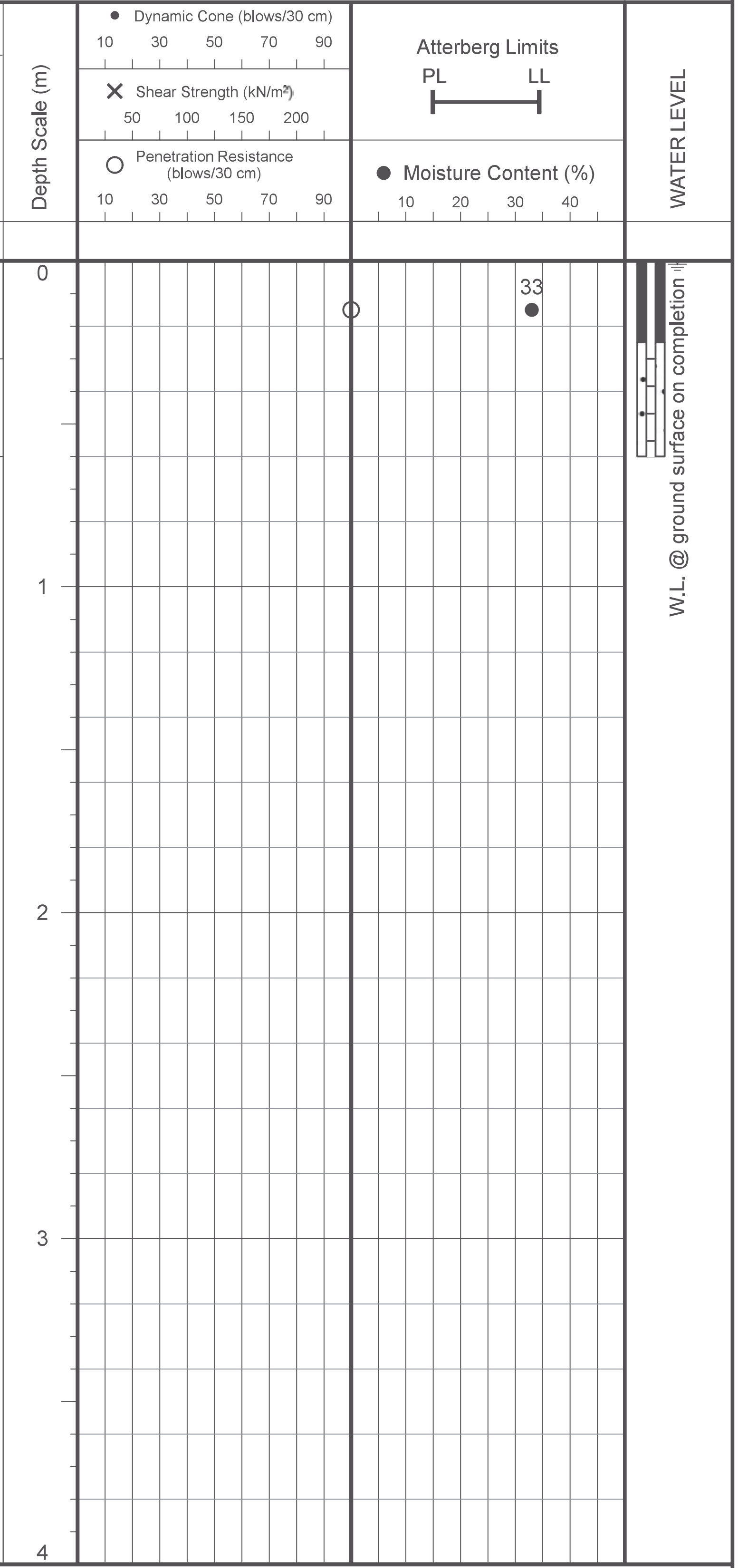
PROJECT DESCRIPTION: Proposed Wetland Design

METHOD OF BORING: Flight-Auger

PROJECT LOCATION: First Road East and Green Mountain Road East
City of Hamilton

DRILLING DATE: March 27, 2019

El. (m) Depth (m)	SOIL DESCRIPTION	SAMPLES Number	SAMPLES Type	SAMPLES N-Value
188.1	Ground Surface			
0.0	**15 cm TOPSOIL**			
188.0 0.1	Greyish-brown, hard **SILTY CLAY** a tr. of sand and organics occ. silt seams and rock fragments	1	DO	50/15
187.5 0.6	**Refusal to Augering** **Inferred Bedrock** **END OF BOREHOLE** Installed 50 mm Ø monitoring well to 0.6 m completed with 0.3 m screen Sand backfill from 0.25 m to 0.6 m Bentonite seal from 0.0 m to 0.25 m. Provided with steel casing and lock.			



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JOB NO.: 1902-S100

LOG OF BOREHOLE NO.: 3

FIGURE NO.: 3

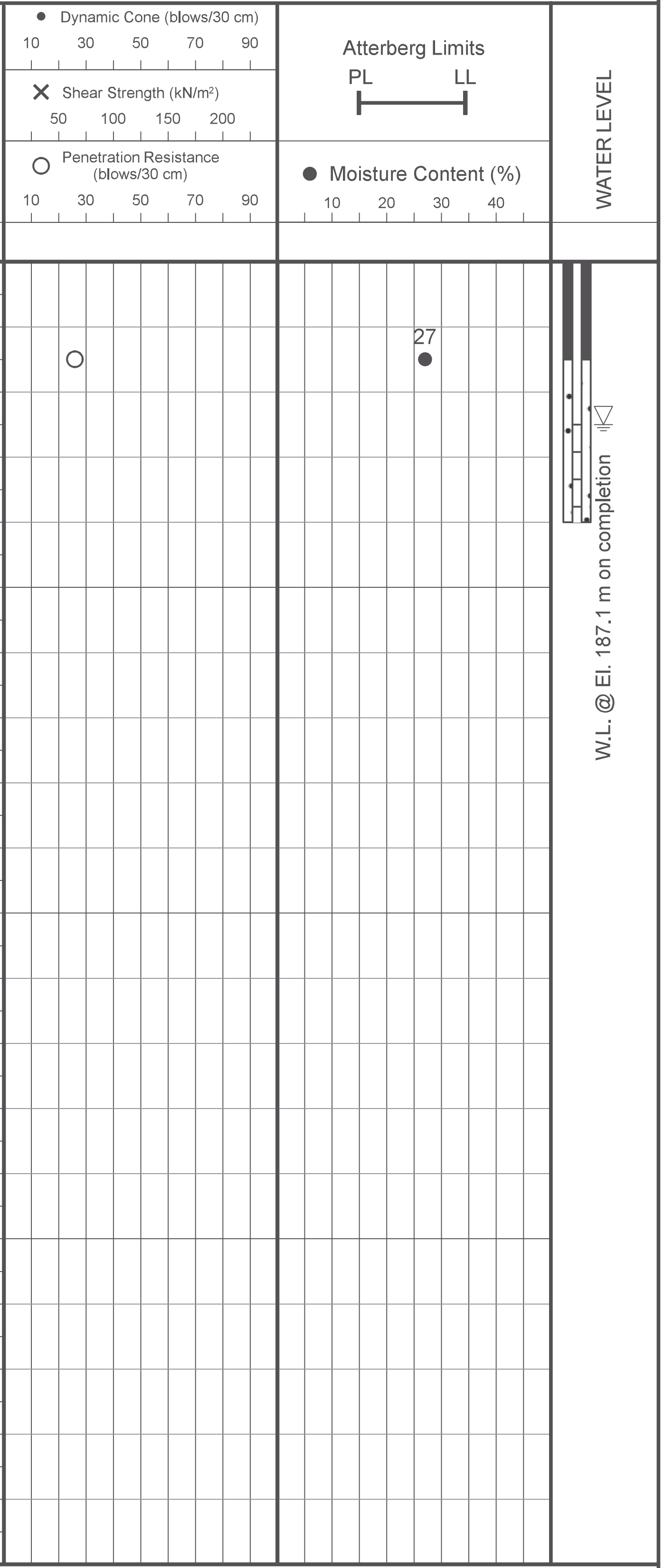
PROJECT DESCRIPTION: Proposed Wetland Design

METHOD OF BORING: Flight-Auger

PROJECT LOCATION: First Road East and Green Mountain Road East
City of Hamilton

DRILLING DATE: March 27, 2019

El. (m) Depth (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value	Depth Scale (m)
187.6	Ground Surface				
0.0	**30 cm TOPSOIL**				0
187.3 0.3		1	DO	26	
	Greyish-brown, very stiff to hard **SILTY CLAY** a tr. of sand and organics occ. silt seams and rock fragments				
186.8 0.8	**Refusal to Augering** **Inferred Bedrock** **END OF BOREHOLE** Installed 50 mm Ø monitoring well to 0.8 m completed with 0.3 m screen Sand backfill from 0.3 m to 0.8 m Bentonite seal from 0.0 m to 0.3 m. Provided with steel casing and lock.	-	-	-	
					1
					2
					3
					4



Soil Engineers Ltd.

JOB NO.: 1902-S100

LOG OF BOREHOLE NO.: 4

FIGURE NO.: 4

PROJECT DESCRIPTION: Proposed Wetland Design

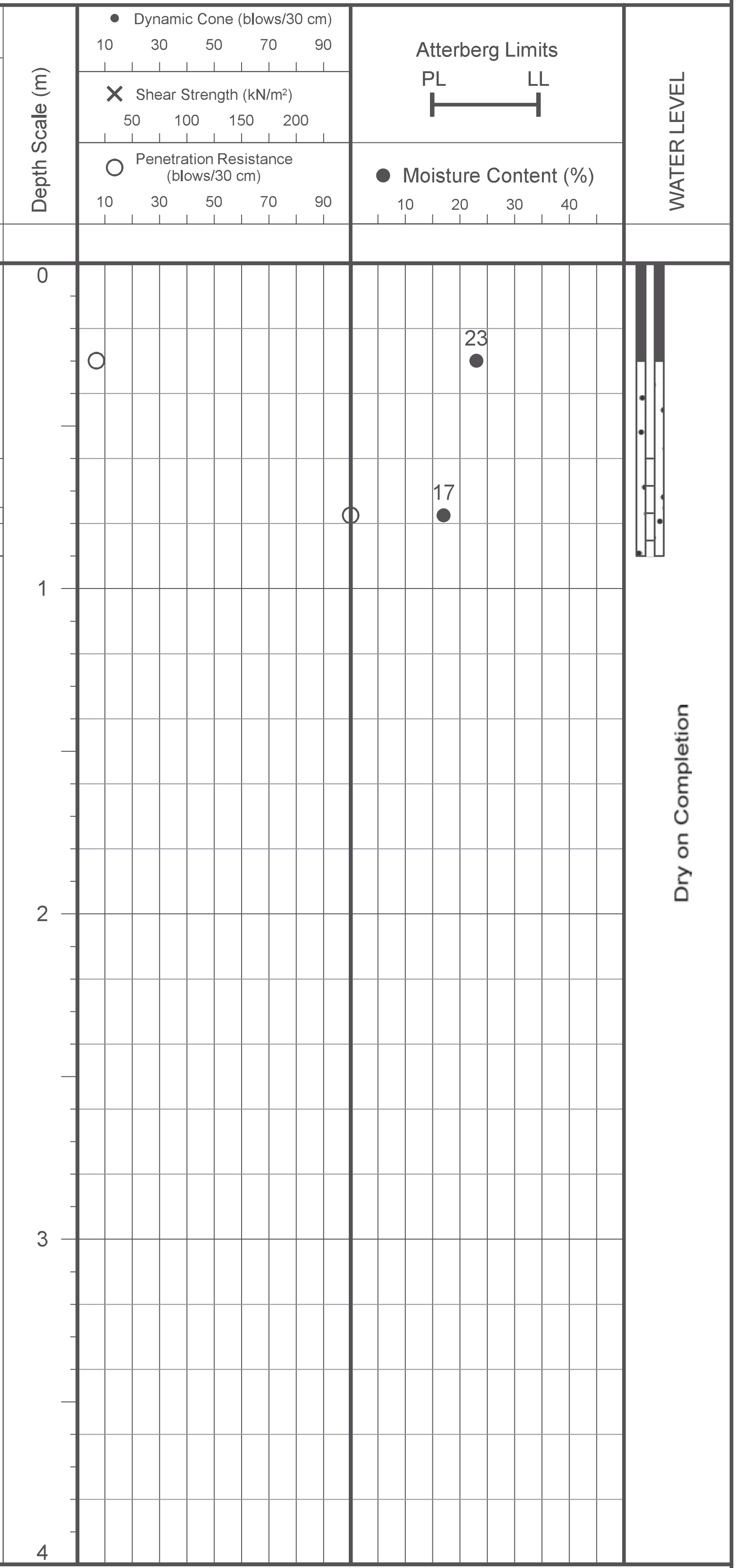
METHOD OF BORING: Flight-Auger

PROJECT LOCATION: First Road East and Green Mountain Road East
City of Hamilton

DRILLING DATE: March 26, 2019

El. (m) Depth (m)	SOIL DESCRIPTION	SAMPLES Number	SAMPLES Type	SAMPLES N-Value
188.0	Ground Surface			
0.0	**23 cm TOPSOIL**			
187.8 0.2	Greyish-brown, firm to hard weathered **SILTY CLAY** a tr. of sand and organics occ. silt seams and rock fragments	1	DO	7
		2	DO	50/15
187.1 0.9	**Refusal to Augering** **Inferred Bedrock** **END OF BOREHOLE**	-	-	-

Installed 50 mm Ø monitoring well to 0.9 m completed with 0.3 m screen
Sand backfill from 0.3 m to 0.9 m
Bentonite seal from 0.0 m to 0.3 m.
Provided with steel casing and lock.



Soil Engineers Ltd.

JOB NO.: 1902-S100

LOG OF BOREHOLE NO.: 5A

FIGURE NO.: 5

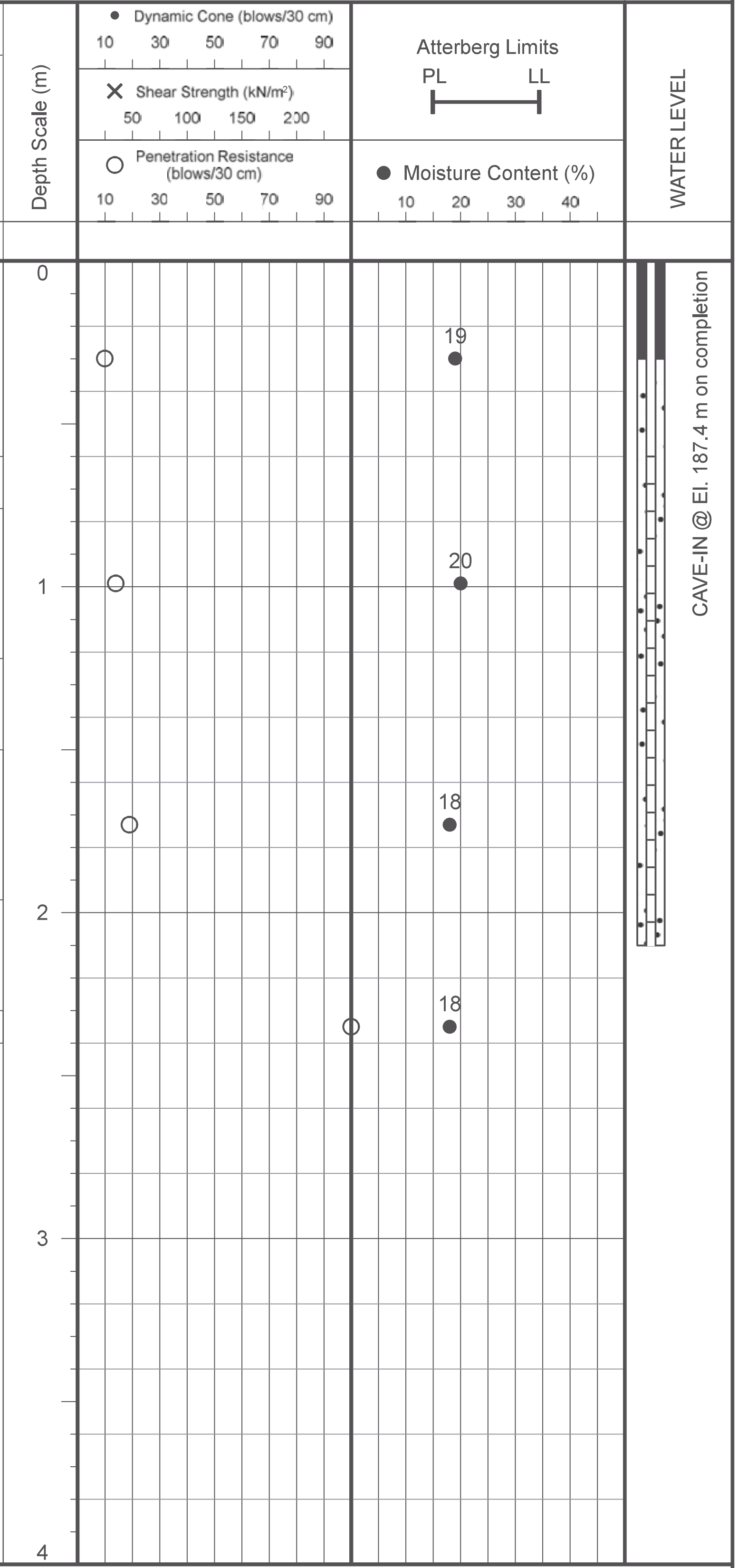
PROJECT DESCRIPTION: Proposed Wetland Design

METHOD OF BORING: Flight-Auger

PROJECT LOCATION: First Road East and Green Mountain Road East
City of Hamilton

DRILLING DATE: March 26, 2019

El. (m) Depth (m)	SOIL DESCRIPTION	SAMPLES		
		Number	Type	N-Value
189.5	Ground Surface			
0.0	**23 cm TOPSOIL**			
189.3 0.2	Greyish-brown, stiff to hard	1	DO	10
	weathered			
	SILTY CLAY a tr. of sand occ. silt seams and rock fragments	2	DO	14
		3	DO	19
		4	DO	50/3
187.1 2.4	**Refusal to Augering** **Inferred Bedrock** **END OF BOREHOLE** Installed 50 mm Ø monitoring well to 2.1 m completed with 1.5 m screen Sand backfill from 0.3 m to 2.1 m Bentonite seal from 0.0 m to 0.3 m. Provided with steel casing and lock.			



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JOB NO.: 1902-S100

LOG OF BOREHOLE NO.: 5B

FIGURE NO.: 6

PROJECT DESCRIPTION: Proposed Wetland Design

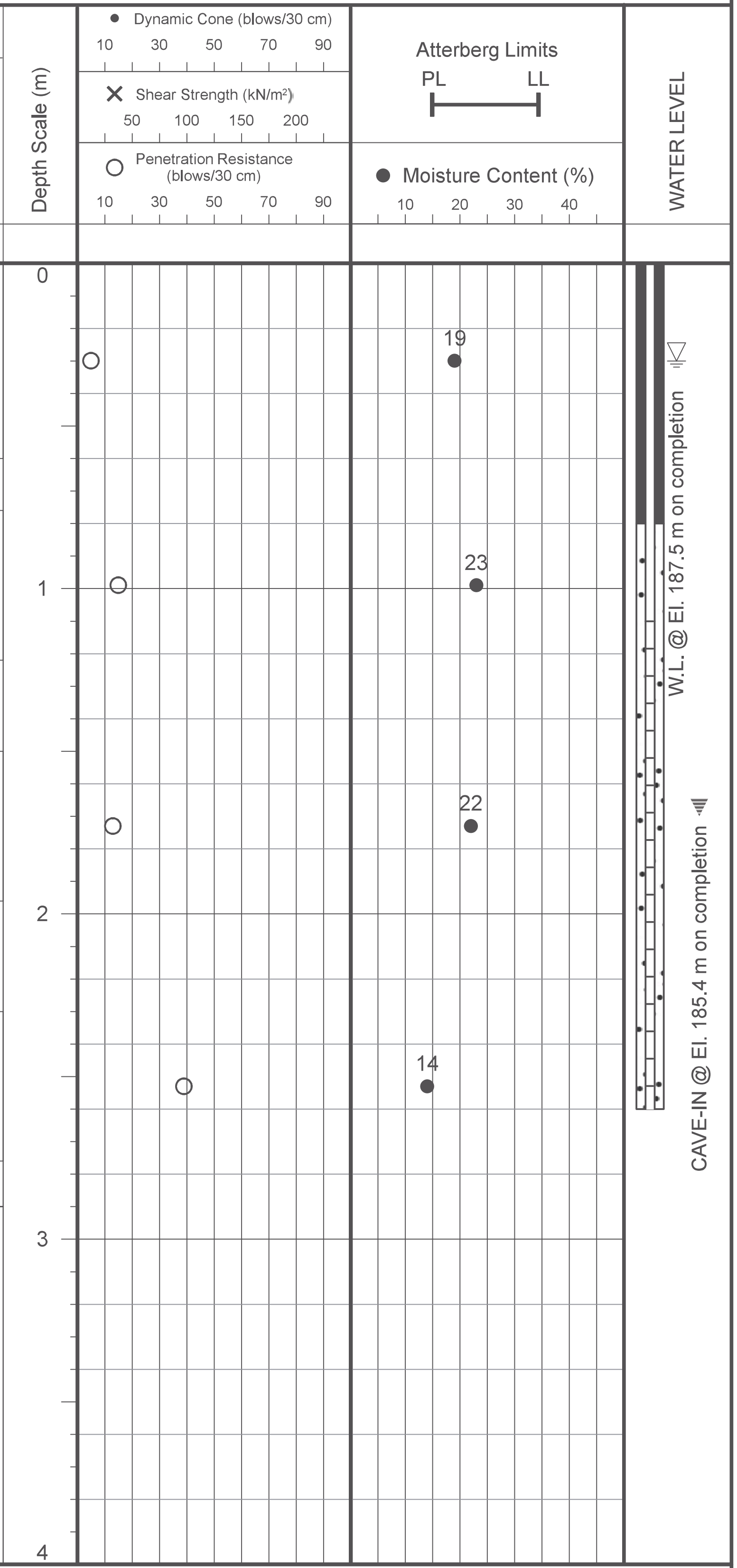
METHOD OF BORING: Flight-Auger

PROJECT LOCATION: First Road East and Green Mountain Road East
City of Hamilton

DRILLING DATE: March 26, 2019

El. (m) Depth (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value
187.8	Ground Surface			
0.0	**30 cm TOPSOIL**			
187.5 0.3	Greyish-brown, firm to hard weathered **SILTY CLAY** a tr. of sand occ. silt seams and rock fragments	1	DO	5
		2	DO	15
		3	DO	13
		4	DO	39
184.9 2.9	**Refusal to Augering** **Inferred Bedrock** **END OF BOREHOLE**			

Installed 50 mm Ø monitoring well to 2.6 m
completed with 1.5 m screen
Sand backfill from 0.8 m to 2.6 m
Bentonite seal from 0.0 m to 0.8 m.
Provided with steel casing and lock.



JOB NO.: 1902-S100

LOG OF BOREHOLE NO.: 5C

FIGURE NO.: 7

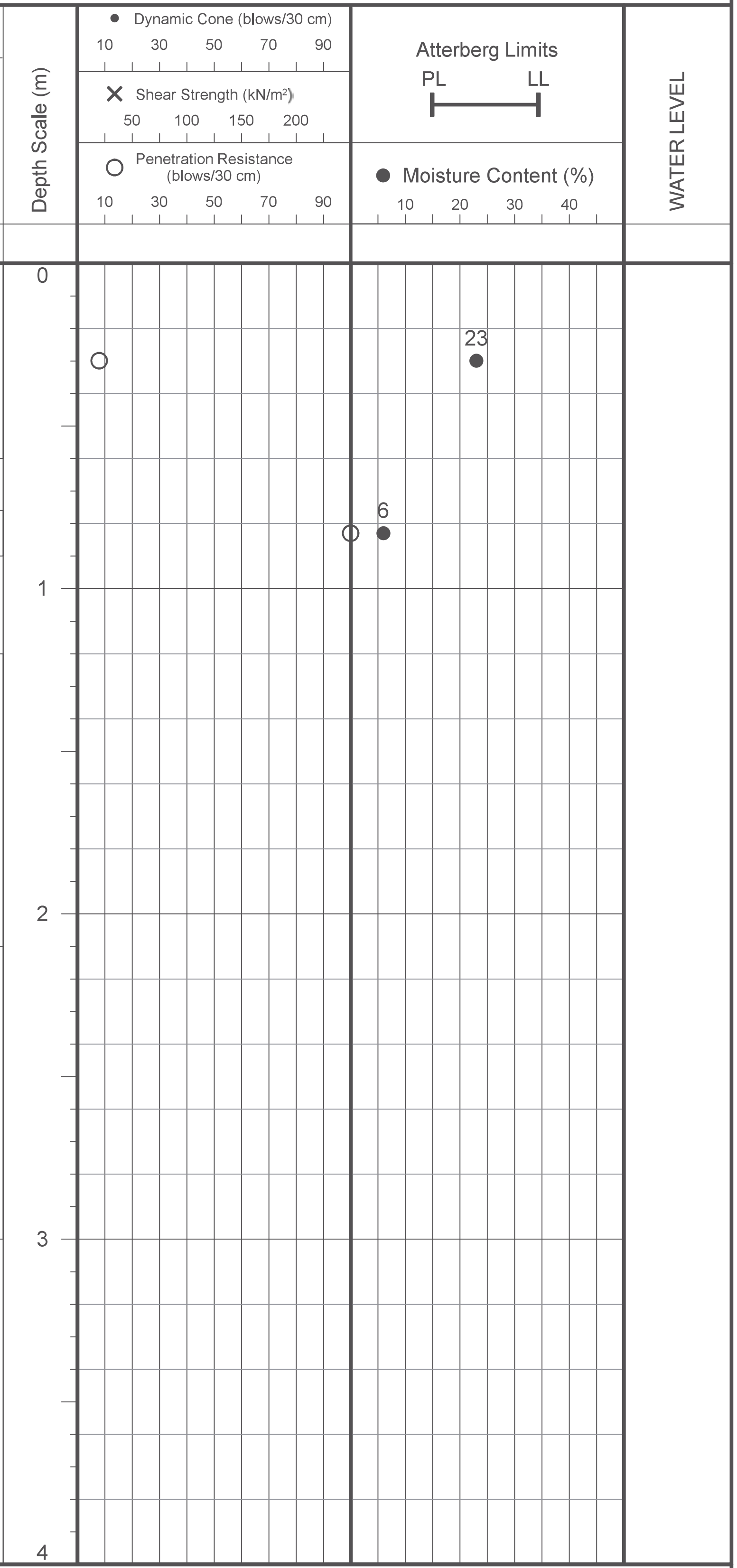
PROJECT DESCRIPTION: Proposed Wetland Design

METHOD OF BORING: Flight-Auger

PROJECT LOCATION: First Road East and Green Mountain Road East
City of Hamilton

DRILLING DATE: April 4, 2019

El. (m) Depth (m)	SOIL DESCRIPTION	SAMPLES Number	SAMPLES Type	SAMPLES N-Value
188.0	Ground Surface			
0.0	**15 cm TOPSOIL**			
187.9 0.1	Greyish-brown, firm to hard **SILTY CLAY** a tr. of sand, organics and rock fragments	1	DO	8
	weathered	2	DO	50/15
186.8 1.2	Grey, weathered **DOLOMITE/LIMESTONE BEDROCK**	3	RC RQD	80% 0%
		4	RC RQD	100% 0%
185.0 3.0	**END OF BOREHOLE**			



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JOB NO.: 1902-S100

LOG OF BOREHOLE NO.: 6

FIGURE NO.: 8

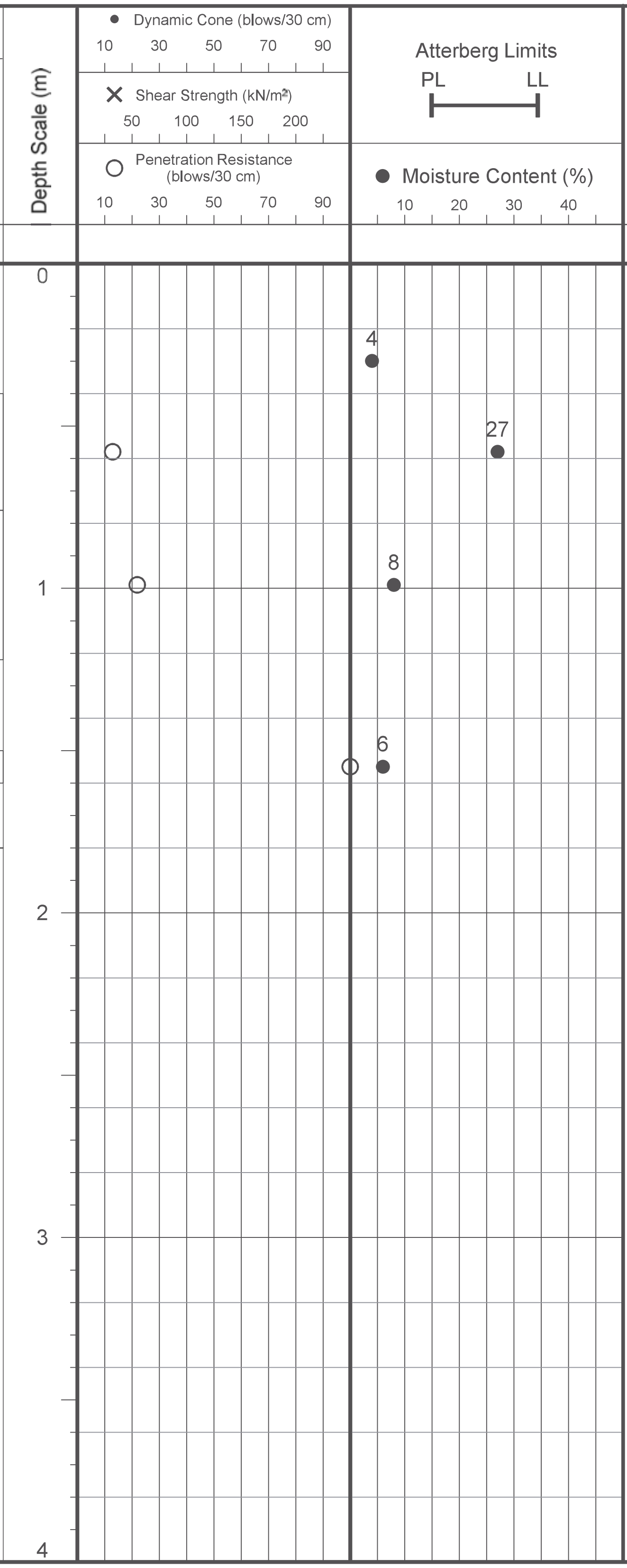
PROJECT DESCRIPTION: Proposed Wetland Design

METHOD OF BORING: Flight-Auger

PROJECT LOCATION: First Road East and Green Mountain Road East
City of Hamilton

DRILLING DATE: April 4, 2019

El. (m) Depth (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value
187.5	Ground Surface			
0.0	**23 cm ASPHALTIC CONCRETE**			
187.3 0.2	**230 mm GRANULAR FILL**	1A	-	
187.0 0.5	Grey **EARTH FILL** silty clay a tr. of sand and gravel	1B	DO	13
186.7 0.8	Brown, very stiff to hard	2	DO	22
	SILTY CLAY a tr. of sand occ. rock fragments	3	DO	50/10
185.7 1.8	**Refusal to Augering** **Inferred Bedrock** **END OF BOREHOLE**	-	-	-



WATER LEVEL

Dry on Completion

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Page: 1 of 1

JOB NO.: 1902-S100

LOG OF BOREHOLE NO.: 7

FIGURE NO.: 9

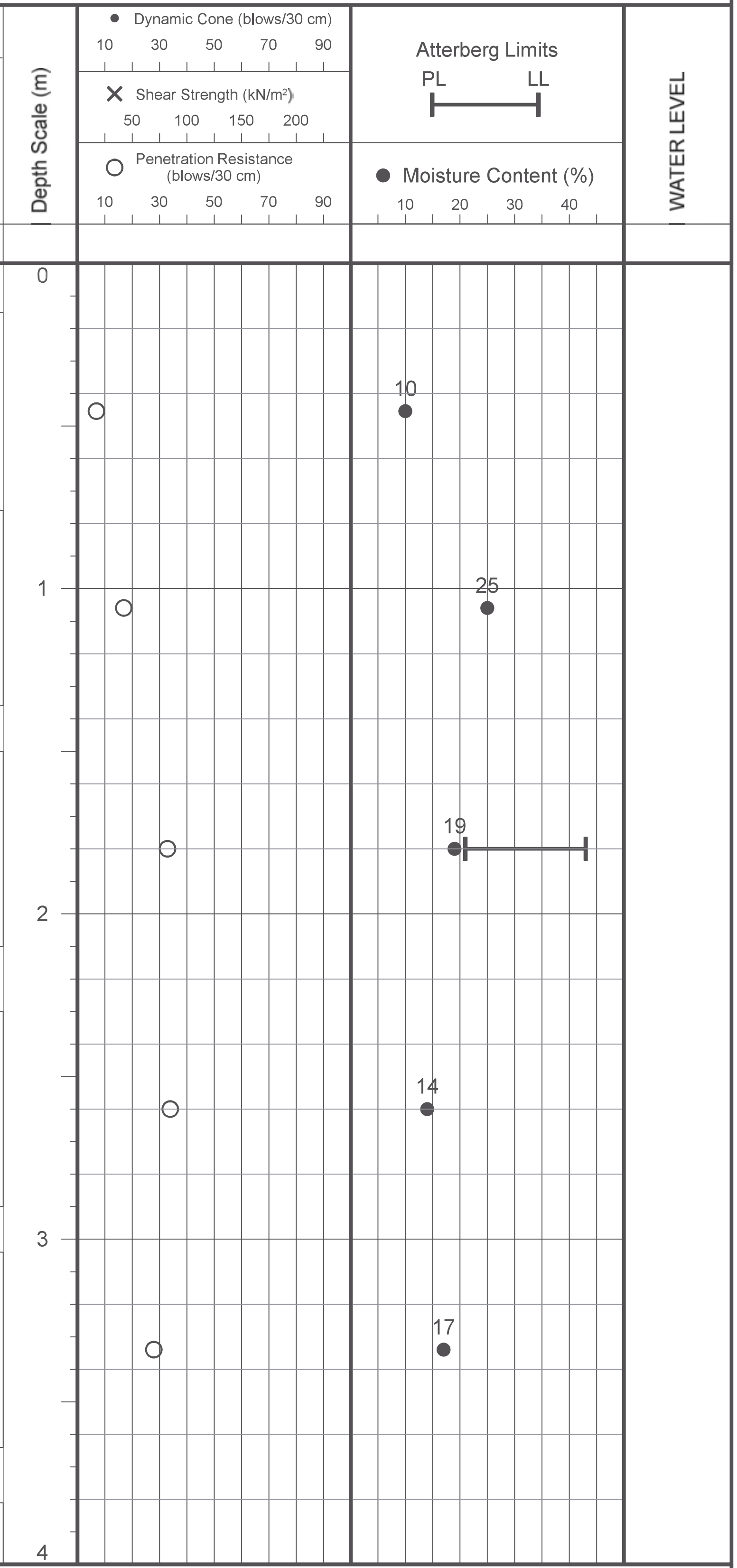
PROJECT DESCRIPTION: Proposed Wetland Design

METHOD OF BORING: Flight-Auger

PROJECT LOCATION: First Road East and Green Mountain Road East
City of Hamilton

DRILLING DATE: April 4, 2019

El. (m) Depth (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value
187.9	Ground Surface			
0.0	**18 cm ASPHALTIC CONCRETE**			
0.2	**330 mm GRANULAR FILL**	1	DO	7
187.4 0.5	Grey **EARTH FILL** silty clay a tr. of sand, gravel and organics	2	DO	17
186.4 1.5	Very stiff to hard **SILTY CLAY** a tr. of sand and gravel rock fragments	3	DO	33
		4	DO	34
	brown grey	5	DO	28



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JOB NO.: 1902-S100

LOG OF BOREHOLE NO.: 7

FIGURE NO.: 9

PROJECT DESCRIPTION: Proposed Wetland Design

METHOD OF BORING: Flight-Auger

PROJECT LOCATION: First Road East and Green Mountain Road East
City of Hamilton

DRILLING DATE: April 4, 2019

● Dynamic Cone (blows/30 cm) 10 30 50 70 90

✕ Shear Strength (kN/m²) 50 100 150 200

○ Penetration Resistance (blows/30 cm) 10 30 50 70 90

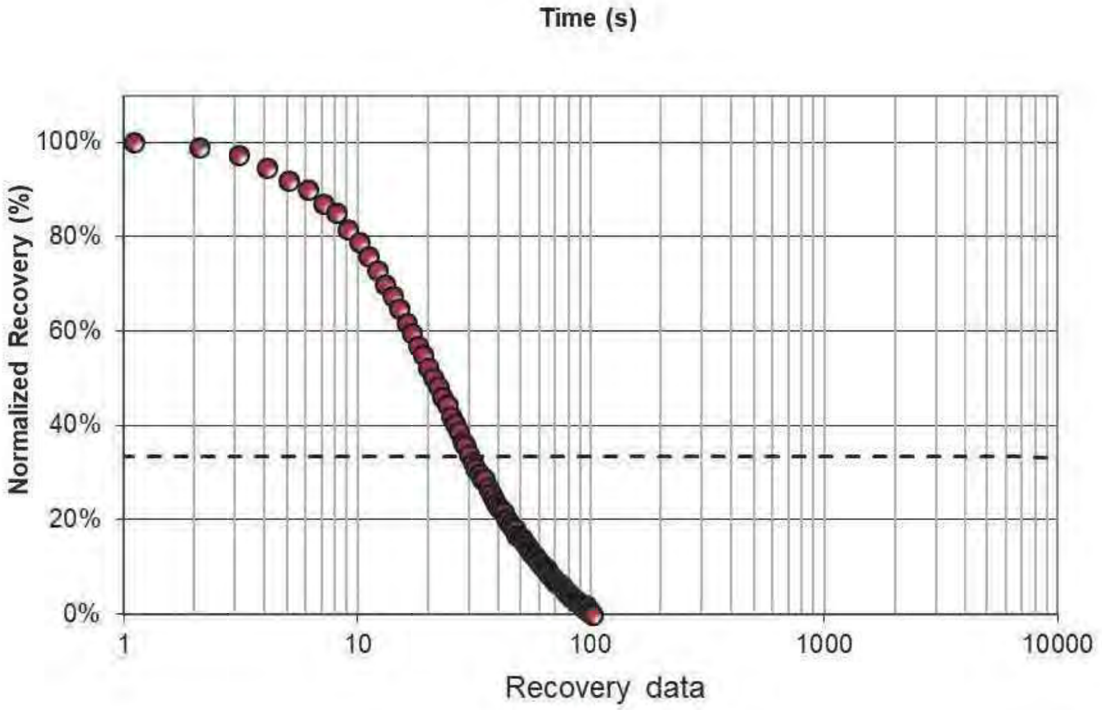
Atterberg Limits PL LL

● Moisture Content (%) 10 20 30 40

El. (m) Depth (m)	SOIL DESCRIPTION	SAMPLES Number	SAMPLES Type	SAMPLES N-Value	Depth Scale (m)	Penetration Resistance ○	Moisture Content (%) ●	WATER LEVEL
	Grey, stiff **SILTY CLAY** a tr. of sand and gravel rock fragments	6	DO	12	4	○	19	
		7	DO	9	5	○	22	
182.4 5.5	Grey **DOLOMITE/LIMESTONE BEDROCK**	8	RC RQD	95% 95%	6			
		9	RC RQD	100% 85%	7			
180.8 7.1	**END OF BOREHOLE**				8			

Appendix B

Hydraulic Testing



Hydraulic conductivity was estimated using the hydrostatic time-lag method of Hvorslev (1951) as described in Freeze and Cherry (1979). Hvorslev's method is described by the following equation:

$$K = \frac{r^2 Ln\left(\frac{L}{R}\right)}{2LT_0}$$

Where K = hydraulic conductivity of the tested material, r = radius of the well riser pipe, R = radius of the sand pack, L = length of screen and sand pack, and T_0 = time lag which is determined graphically as the time it takes for the water level to rise or fall to 37 percent of the initial change (i.e. $H/H_0 = 0.37$).

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FAX: 613-966-3087

KEY PLAN:

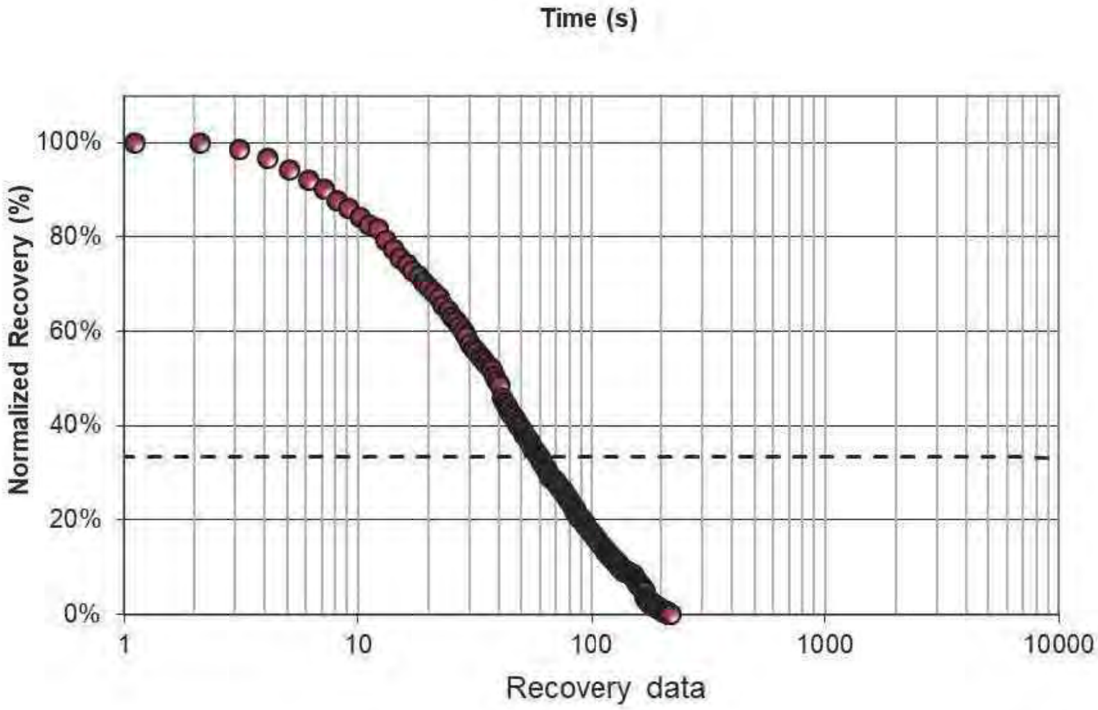
PROJECT:

**HYDROGEOLOGICAL ASSESSMENT
PROPOSED WETLAND (AREA BC-1)**

FIGURE B-1:

**SINGLE WELL HYDRAULIC RESPONSE
(SLUG) TEST – MW1**

Scale: as shown



Hydraulic conductivity was estimated using the hydrostatic time-lag method of Hvorslev (1951) as described in Freeze and Cherry (1979). Hvorslev's method is described by the following equation:

$$K = \frac{r^2 Ln\left(\frac{L}{R}\right)}{2LT_0}$$

Where K = hydraulic conductivity of the tested material, r = radius of the well riser pipe, R = radius of the sand pack, L = length of screen and sand pack, and T_0 = time lag which is determined graphically as the time it takes for the water level to rise or fall to 37 percent of the initial change (i.e. $H/H_0 = 0.37$).

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KEY PLAN:

PROJECT:

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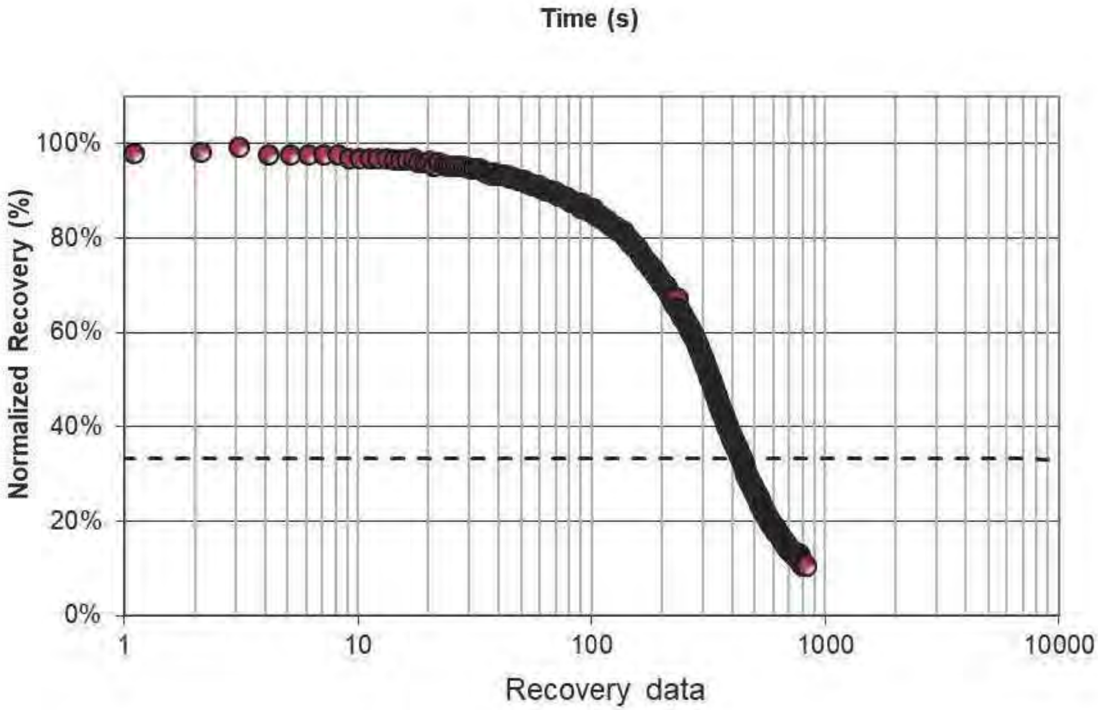
FIGURE B-2:

SINGLE WELL HYDRAULIC RESPONSE
(SLUG) TEST – MW2

Scale: as shown



Hydraulic conductivity was estimated using the hydrostatic time-lag method of Hvorslev (1951) as described in Freeze and Cherry (1979). Hvorslev's method is described by the following equation:

$$K = \frac{r^2 Ln\left(\frac{L}{R}\right)}{2LT_0}$$

Where K = hydraulic conductivity of the tested material, r = radius of the well riser pipe, R = radius of the sand pack, L = length of screen and sand pack, and T_0 = time lag which is determined graphically as the time it takes for the water level to rise or fall to 37 percent of the initial change (i.e. $H/H_0 = 0.37$).

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KEY PLAN:

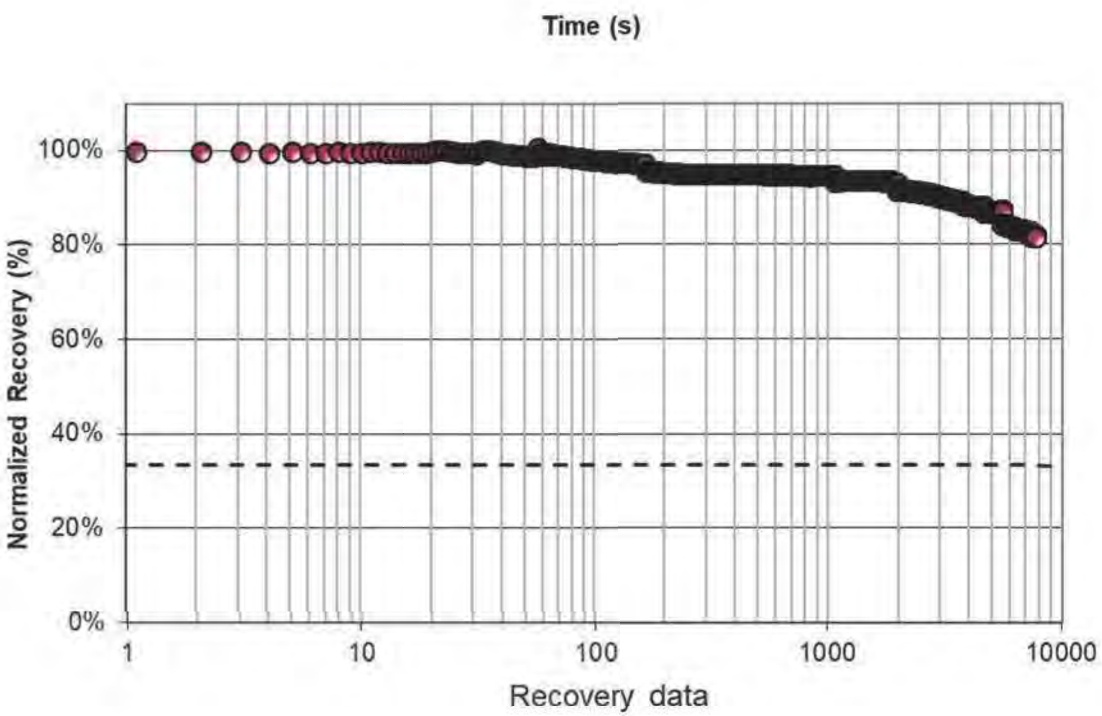
PROJECT:

HYDROGEOLOGICAL ASSESSMENT
PROPOSED WETLAND (AREA BC-1)

FIGURE B-3:

SINGLE WELL HYDRAULIC RESPONSE
(SLUG) TEST – MW3

Scale: as shown



Hydraulic conductivity was estimated using the hydrostatic time-lag method of Hvorslev (1951) as described in Freeze and Cherry (1979). Hvorslev's method is described by the following equation:

$$K = \frac{r^2 Ln\left(\frac{L}{R}\right)}{2LT_0}$$

Where K = hydraulic conductivity of the tested material, r = radius of the well riser pipe, R = radius of the sand pack, L = length of screen and sand pack, and T_0 = time lag which is determined graphically as the time it takes for the water level to rise or fall to 37 percent of the initial change (i.e. $H/H_0 = 0.37$).

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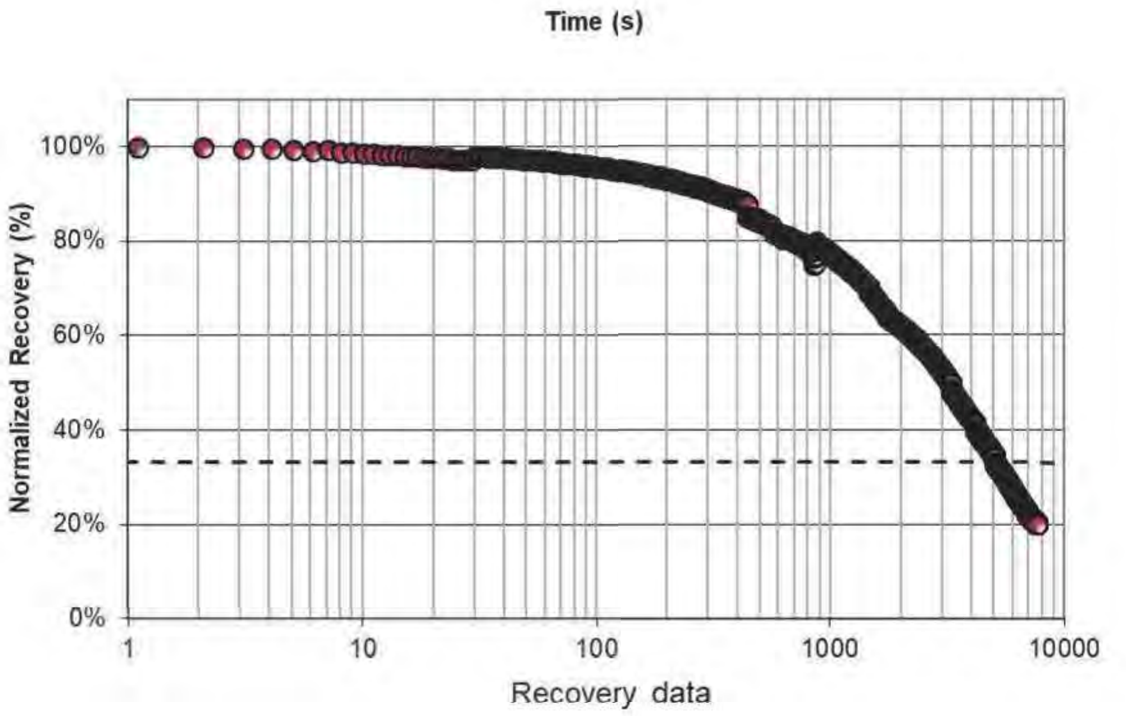
PROJECT:

HYDROGEOLOGICAL ASSESSMENT
PROPOSED WETLAND (AREA BC-1)

FIGURE B-4:

SINGLE WELL HYDRAULIC RESPONSE
(SLUG) TEST – MW4

Scale: as shown



Hydraulic conductivity was estimated using the hydrostatic time-lag method of Hvorslev (1951) as described in Freeze and Cherry (1979). Hvorslev's method is described by the following equation:

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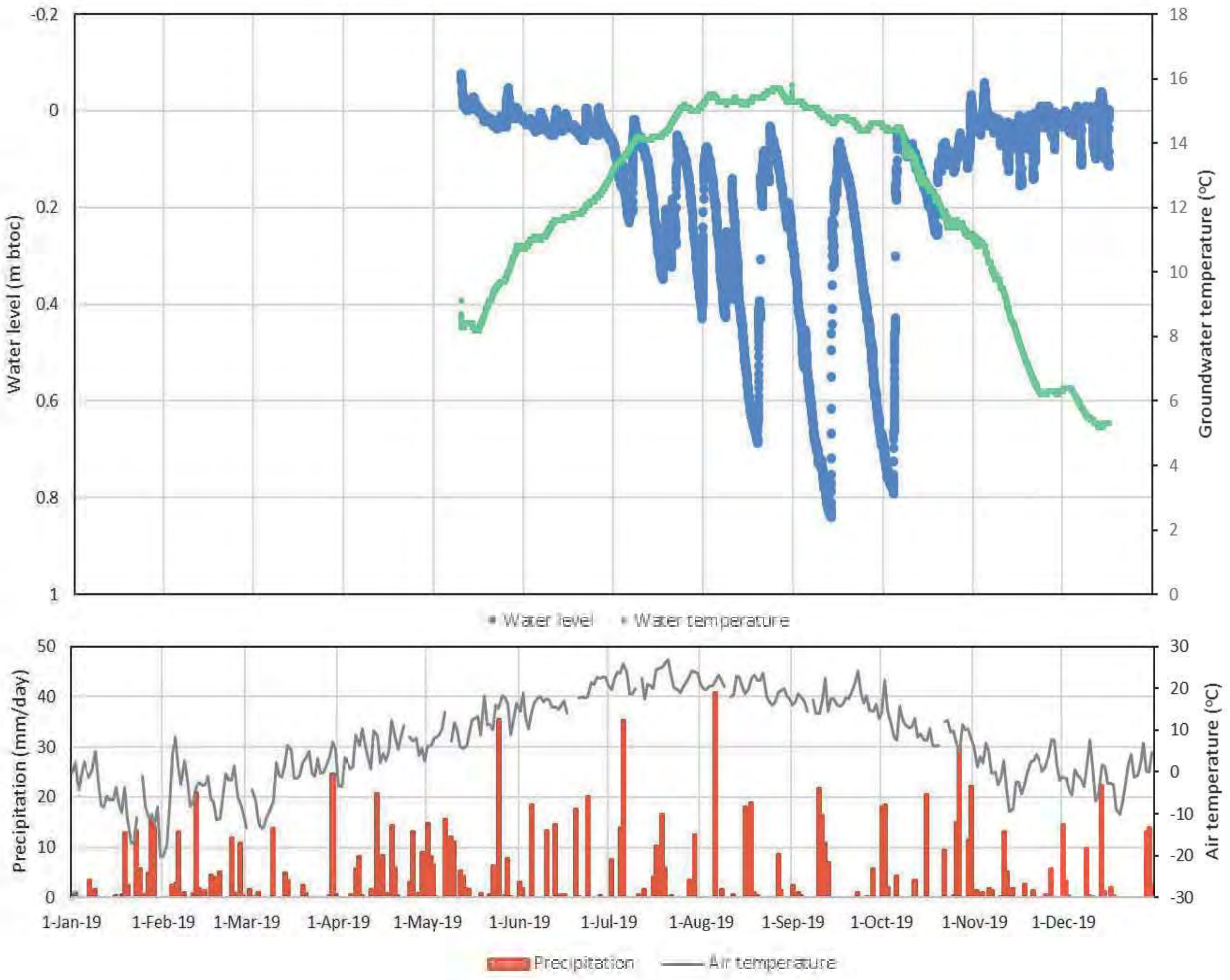
FIGURE B-5:

SINGLE WELL HYDRAULIC RESPONSE
(SLUG) TEST – MW5A

Scale: as shown

Appendix C

Hydrographs



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KEY PLAN:

NOTES:

1) Meteorological data from Environment and Climate Change Canada – Hamilton Airport (Station 6104142)

2) On-site pressure and temperature data collected using a Solinst Model 3001 datalogging transducer

PROJECT:

HYDROGEOLOGICAL ASSESSMENT PROPOSED WETLAND (AREA BC-1)

FIGURE C-1:

WELL HYDROGRAPH – MW1

Scale: as shown

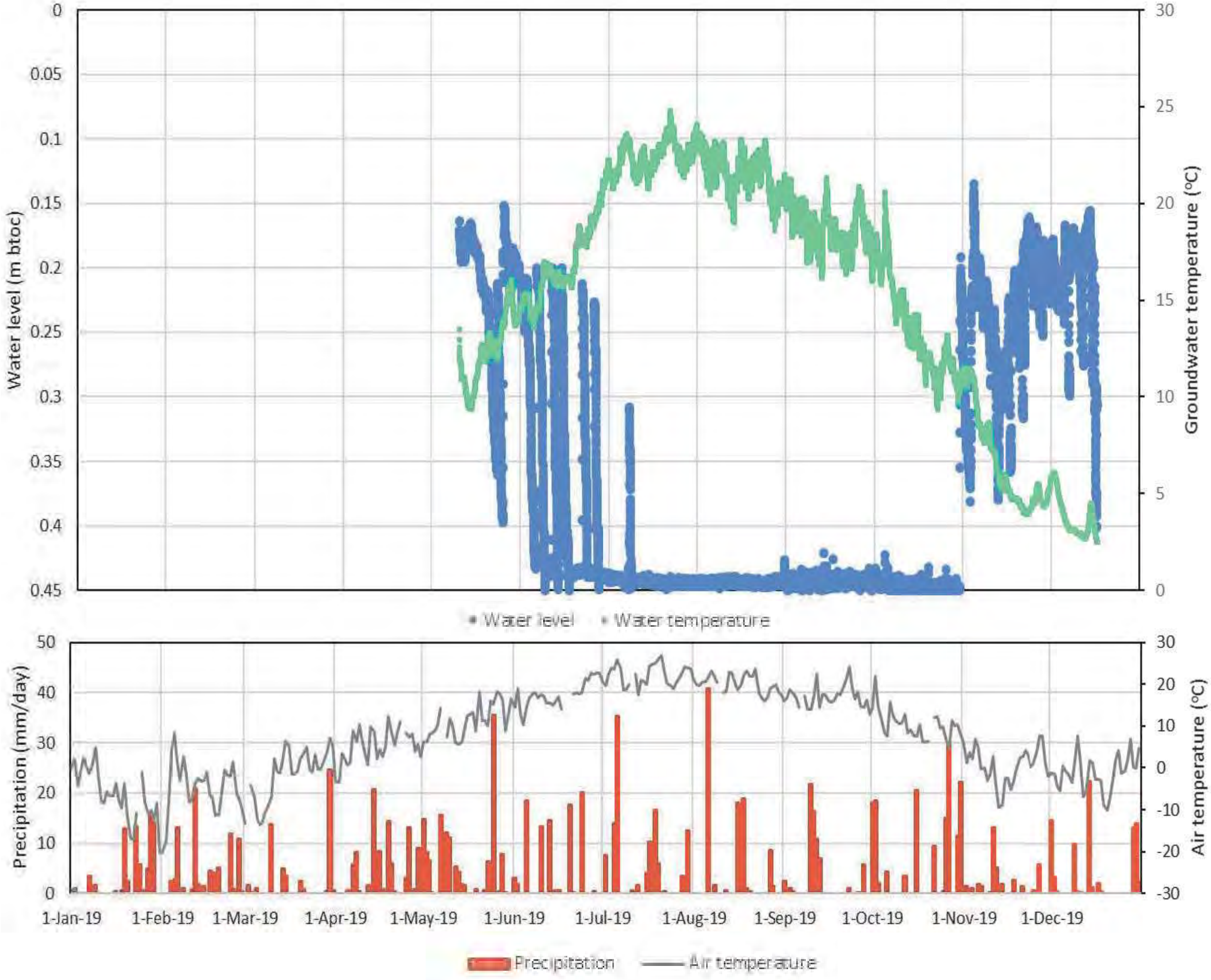

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FIGURE C-2:

WELL HYDROGRAPH – MW2

Scale: as shown

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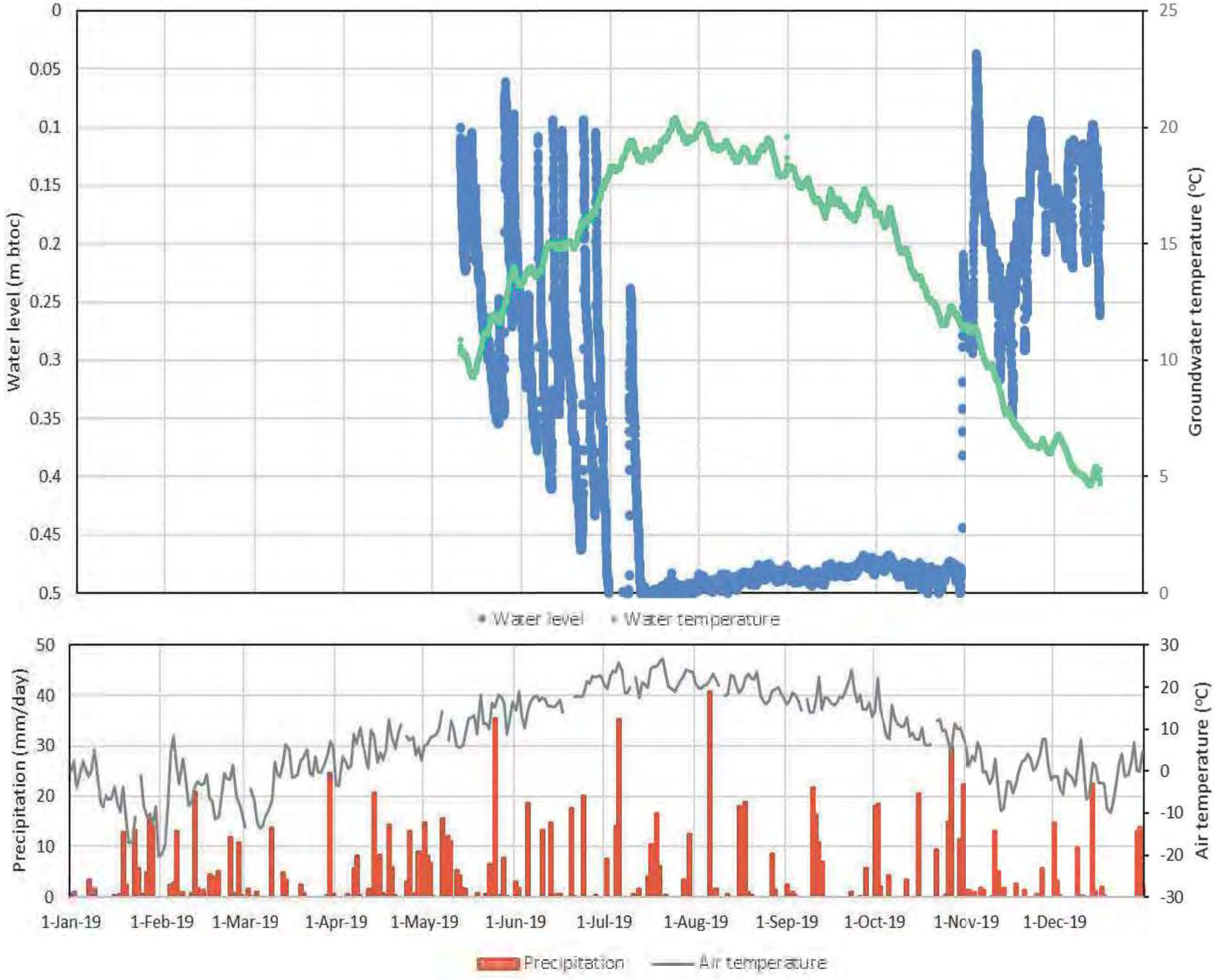

KEY PLAN:

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2) On-site pressure and temperature data collected using a Solinst Model 3001 datalogging transducer

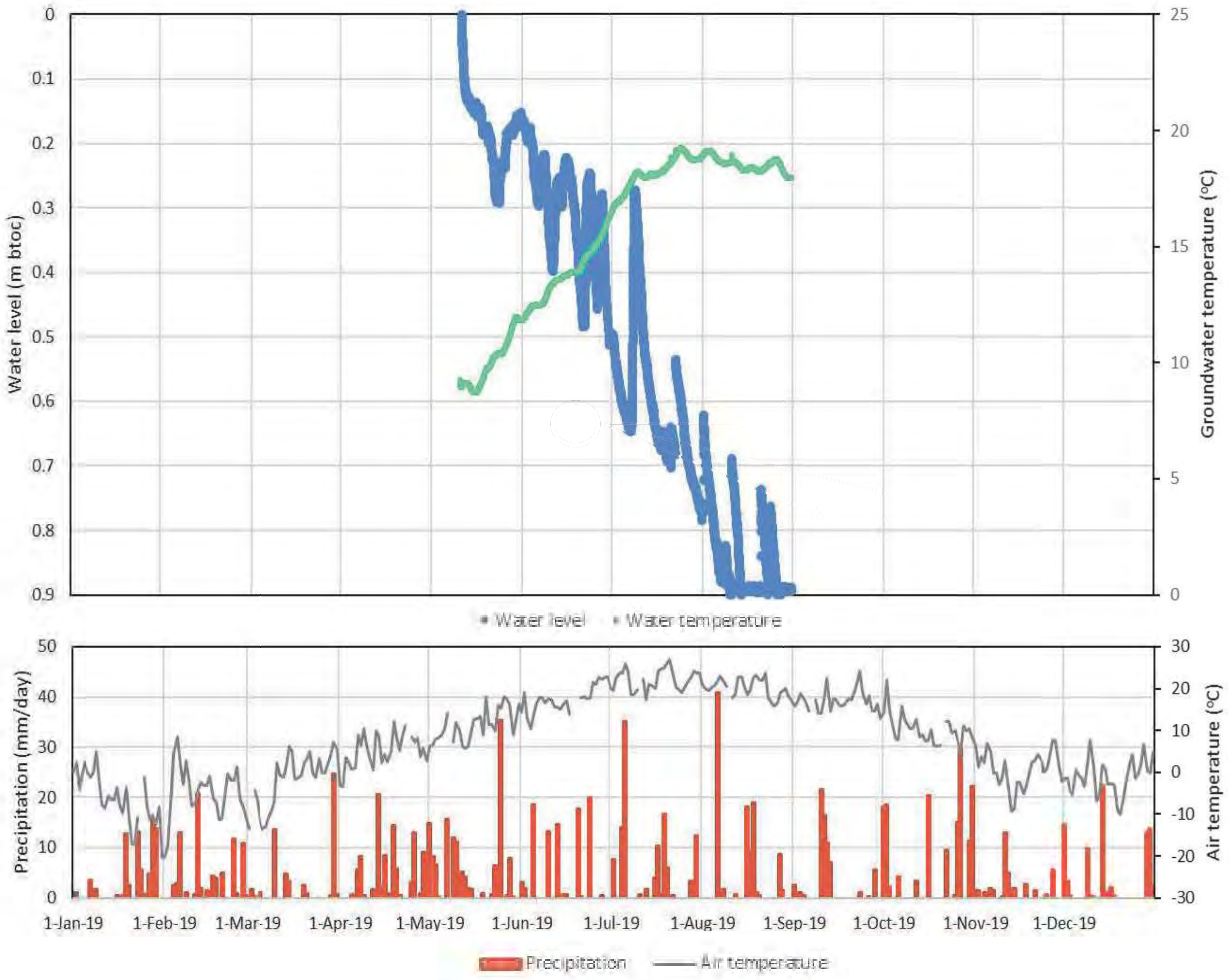
PROJECT:

HYDROGEOLOGICAL ASSESSMENT PROPOSED WETLAND (AREA BC-1)

FIGURE C-3:

WELL HYDROGRAPH – MW3

Scale: as shown



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2) On-site pressure and temperature data collected using a Solinst Model 3001 datalogging transducer

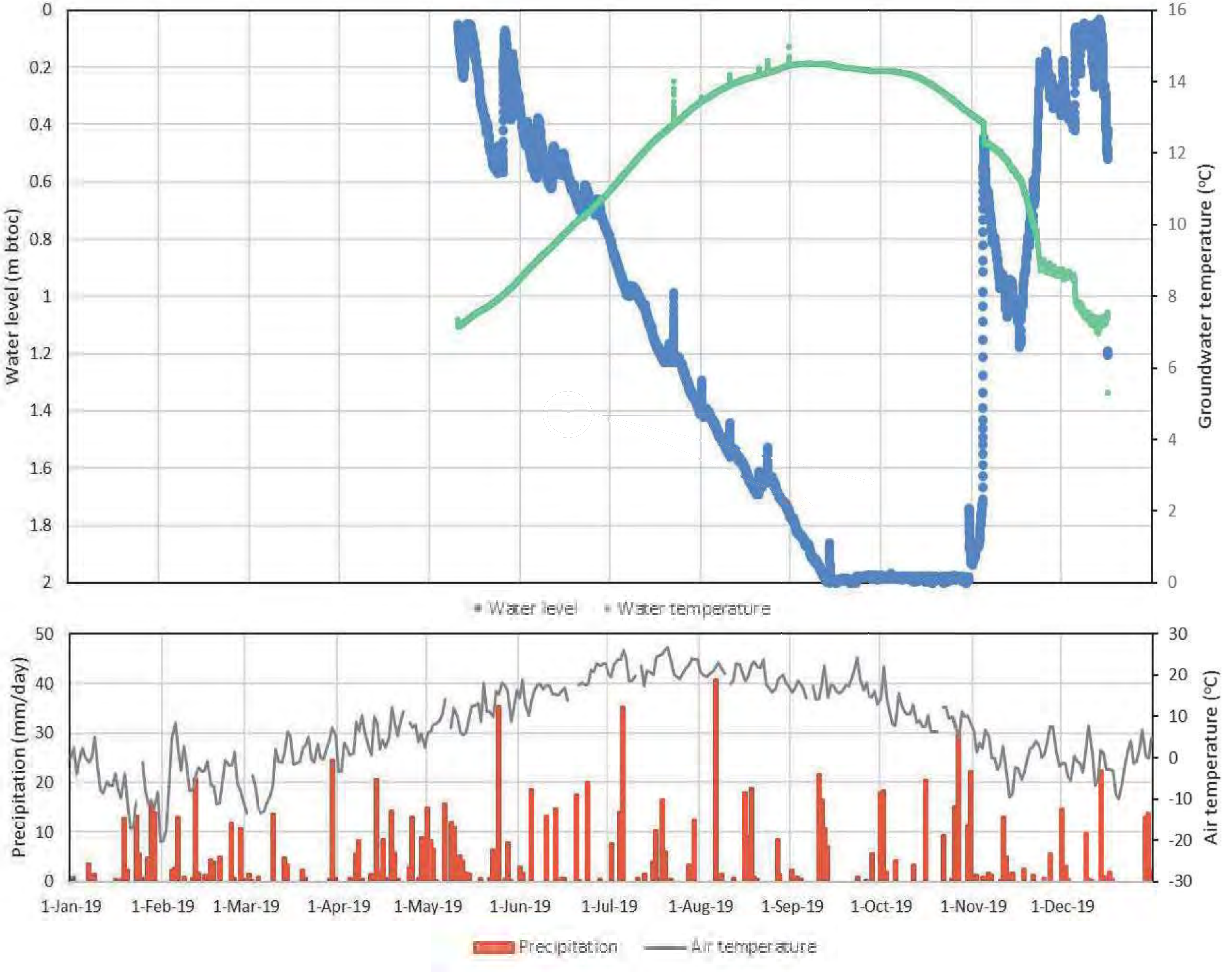
PROJECT:

HYDROGEOLOGICAL ASSESSMENT PROPOSED WETLAND (AREA BC-1)

FIGURE C-4:

WELL HYDROGRAPH – MW4

Scale: as shown



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KEY PLAN:

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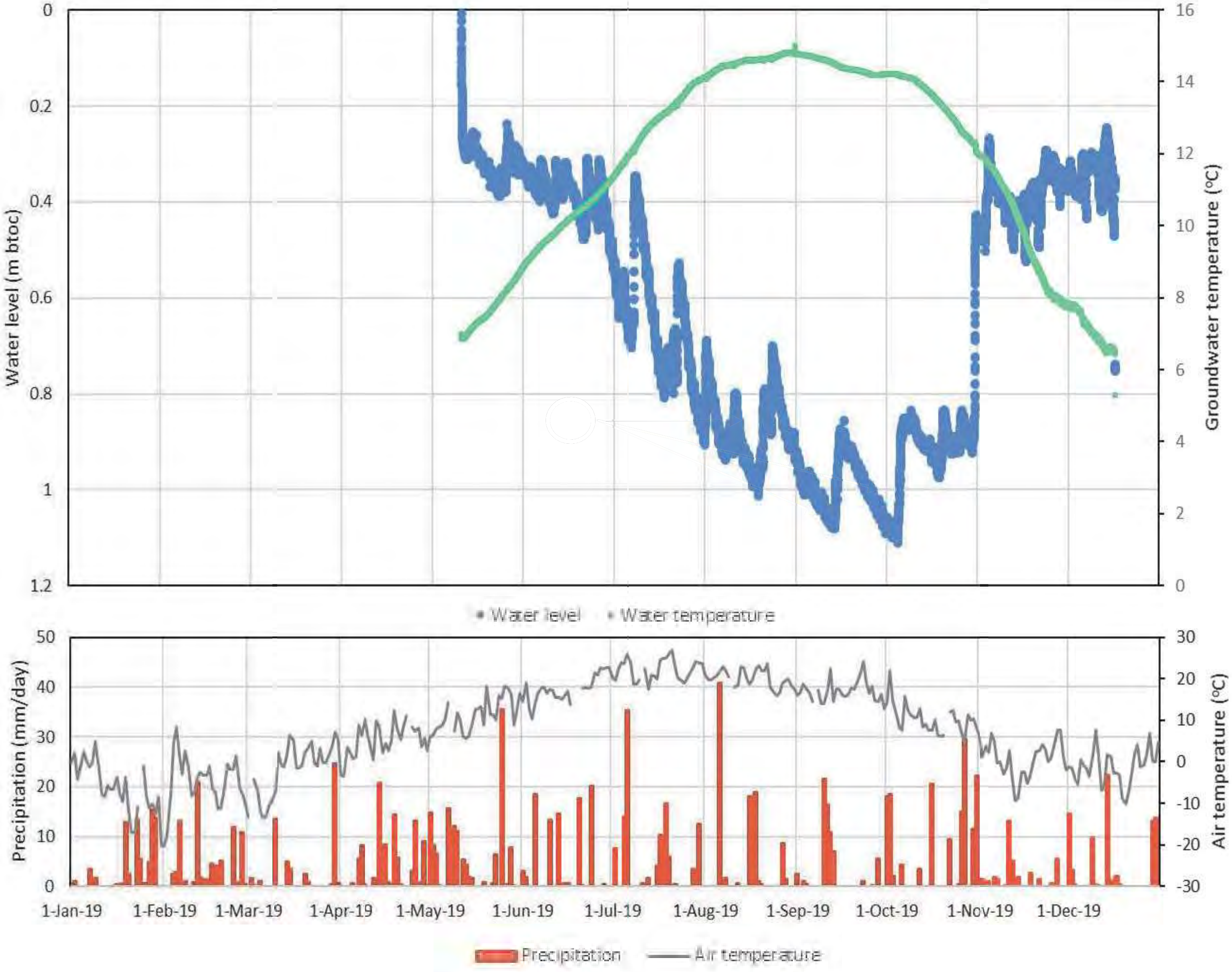
PROJECT:

HYDROGEOLOGICAL ASSESSMENT PROPOSED WETLAND (AREA BC-1)

FIGURE C-5:

WELL HYDROGRAPH – MW5A

Scale: as shown



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KEY PLAN:

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PROJECT:

HYDROGEOLOGICAL ASSESSMENT PROPOSED WETLAND (AREA BC-1)

FIGURE C-6:

WELL HYDROGRAPH – MW5B

Scale: as shown

Appendix D

Soil Engineers Ltd. Geotechnical Report

Soil Engineers Ltd.
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A REPORT TO
WATER’S EDGE ENVIRONMENTAL SOLUTIONS TEAM LTD.

A GEOTECHNICAL INVESTIGATION FOR PROPOSED WETLAND

FIRST ROAD EAST AND GREEN MOUNTAIN ROAD EAST

CITY OF HAMILTON

REFERENCE NO. 1902-S100

MAY 2019

DISTRIBUTION

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TABLE OF CONTENTS

TABLES

ENCLOSURES

1.0 INTRODUCTION

In accordance with written authorization from Dr. Ed Gazendam, P.Eng., of Water's Edge Environmental Solutions Team Ltd., a geotechnical investigation was carried out in the conservation area located on the east side of First Road East, north of Green Mountain Road East in the City of Hamilton.

The purpose of the investigation was to reveal the subsurface conditions and to determine the engineering properties of the disclosed soils for the design and construction of Wetland, for potential flood water storage in the upper Battlefield Creek and Stoney Creek watersheds.

The geotechnical findings and resulting recommendations are presented in this Report.

2.0 SITE AND PROJECT DESCRIPTION

The City of Hamilton is located on Waterdown moraine where glacial tills dominate the soil stratigraphy. The tills extend onto dolomite bedrock of Amabel Formation. In places, the tills have been partly eroded by the water action of glacial Lake Whittlesey, filled with lacustrine sand, silt, clay and water-laid till.

The site of investigation is located on the east side of First Road East, approximately 500 m north of Green Mountain Road East in the City of Hamilton. It was previously a farm field in a low-lying area. The site is currently vacant with weed cover and trees.

We understand that the area of investigation will be designed to create a wetland, as part of the Saltfleet Conservation Area Wetland Restoration Program.

3.0 FIELD WORK

The field work, consisting of nine (9) sampled boreholes, was performed between March 26 and April 4, 2019, at the locations shown on the Borehole Location Plan, Drawing No. 1. The initial boreholes were numbered from Borehole 1 to 5 on-site, having Boreholes 6 and 7 located off-site on First Road East. Two additional boreholes were drilled on site afterwards and they were numbered as Boreholes 5B and 5C; Borehole 5 was re-numbered to 5A. The ground elevation at each borehole location was established using a hand-held Trimble Geoexplorer 6000 Series Global Navigation Satellite System (GNSS) surveying equipment.

The boreholes were performed by augering to the depth of refusal at 0.6 to 5.5 m from grade, using a track-mounted drill rig, with continuous-flight power-auger and equipment for soil sampling. Standard Penetration Tests, using the procedures described on the enclosed "List of Abbreviations and Terms", were performed at the sampling depths. The test results are recorded as the Standard Penetration Resistance (or 'N' values) of the subsoil. The relative density of the granular strata and the consistency of the cohesive strata are inferred from the 'N' values. Split-spoon samples were recovered for soil classification and laboratory testing.

'NQ' size rock coring was carried out below the auger refusal depths in 2 selected boreholes to establish the quality and continuity of bedrock, as assessed by applying the sample recovery and the 'Rock Quality Designation (RQD)'. The results are shown on the corresponding Borehole Logs.

Groundwater monitoring wells, 50-mm in diameter, were installed in 6 selected boreholes to facilitate a hydrogeological study by another consultant. The depth and details of monitoring wells are shown on the borehole logs. The remaining boreholes were backfilled to the ground surface using hole plug of bentonite.

4.0 SUBSURFACE CONDITIONS

The investigation has disclosed that beneath a topsoil veneer or road pavement, with a layer of earth fill in places, the area of investigation is underlain by silty clay, overlying dolomite and limestone bedrock at a depth ranging from 0.6 to 5.5 m from the prevailing ground surface.

Detailed descriptions of the encountered subsurface conditions are presented on the Borehole Logs, comprising Figures 1 to 9, inclusive. The revealed stratigraphy is plotted on the Subsurface Profile, Drawing No. 2. The engineering properties of the disclosed soils and bedrock are discussed herein.

4.1 Topsoil (All Boreholes; except Boreholes 6 and 7)

The revealed topsoil is 15 to 30 cm thick. It is dark brown in colour, indicating appreciable amounts of roots and humus. Buried topsoil will produce volatile gases and may generate an offensive odour under anaerobic conditions.

4.2 Pavement Structure (Boreholes 6 and 7)

The pavement structure on First Road East, as shown in Boreholes 6 and 7, consists of 230 mm and 180 mm asphaltic concrete, overlying a granular base course of 230 mm and 330 mm in thickness, respectively. It should be noted that the lower portion of the granular base was mixed with the subgrade soils, causing difficulty in delineating the interface between the granular base and the subgrade. Grain size analysis was performed on a sample of the granular base. The result is plotted on Figure 10, indicating its gradation meets the OPS Specifications for Granular ‘A’ and Granular ‘B’.

4.3 **Earth Fill** (Boreholes 6 and 7)

A layer of earth fill was contacted beneath the pavement structure on First Road East. It consists of silty clay with sand, gravel and occasional topsoil inclusions. The earth fill extends to a depth of 0.8 m and 1.5 m below the pavement level.

The water content values of the soil samples were determined at 25% and 27%, indicating very moist conditions. The obtained 'N' values are 13 and 17 blows per 30 cm of penetration, indicating the fill was compacted or self consolidated under the road structure.

4.4 **Silty Clay** (All Boreholes)

The silty clay deposit was contacted as the native stratum in the area of investigation. It is a glaciolacustrine deposit, laminated with silt and sand seams. Grain size analyses were performed on 2 representative samples and the results are plotted on Figure 11.

The obtained 'N' values range from 5 to more than 100, with a median of 26 blows per 30 cm of penetration, indicating the consistency of the deposit is firm to hard, being generally very stiff. The firm clay at the upper stratum is generally weathered, extending to depths of 0.6 m and 0.8 m from grade.

Due to the presence of rock debris near the interface of bedrock, the obtained 'N' values at the lower stratum could have been exaggerated and do not represent the actual consistency of the deposit.

The Atterberg Limits of a representative sample and the water content values of all the clay samples were determined. The results are plotted on the Borehole Logs and summarized below:

Liquid Limit	43%
Plastic Limit	21%
Natural Water Content	6% to 33% (median 19%)

The above results show that the silty clay is medium plasticity. The water content is generally below its plastic limit, confirming the consistency of the clay deposit as revealed by the 'N' values.

Accordingly, its engineering properties pertaining to the project are given below:

- High frost susceptibility and soil-adfreezing potential.
- Low water erodibility.
- Low permeability, with an estimated coefficient of permeability of less than 10^{-7} cm/sec, a percolation rate above 80 min/cm and runoff coefficients of:

Slope	
0% - 2%	0.15
2% - 6%	0.20
6% +	0.28

- A cohesive-frictional soil, the shear strength is derived from consistency and augmented by the internal friction of the sand and silt.
- The clay will be stable in relatively steep slopes. However, prolonged exposure will allow infiltrating precipitation to saturate the silt layers and causing the wet silt to slough slowly.

- A poor pavement-supportive material, with an estimated California Bearing Ratio (CBR) value of 3%.
- Moderately high corrosivity to buried metal, with an estimated electrical resistivity of 2500 ohm·cm.

4.5 **Bedrock** (All Boreholes)

Refusal to auger drilling was contacted in the boreholes, at 0.6 to 5.5 m from the prevailing ground surface, or between El. 182.4 m and El. 187.5 m. It represents bedrock in this vicinity.

Rock coring was conducted below the refusal depths of 1.2 m and 5.5 m, at Boreholes 5C and 7, respectively. The bedrock is dolomite or limestone, a grey sedimentary rock of Amabel formation. According to the Rock Quality Designation (RQD) values, the bedrock is poor quality, becoming good to excellent quality at the deeper level.

The bedrock is hard to excavate. Effective rock excavation will require blasting. A rock blasting expert must be consulted to assess the zone of influence of the shock waves created by the blasting to prevent any damage of the nearby structures.

Where excavation is to be carried out in sound bedrock, slight lateral displacement of the excavation walls is often experienced. This is due to the release of residual stress stored in the bedrock mantle.

Depending on the continuity of rock fractures, groundwater yield from bedrock is generally limited.

4.6 Compaction Characteristics of the Revealed Soils

The obtainable degree of compaction is primarily dependent on the soil moisture and, to a lesser extent, on the type of compactor used and the effort applied. As a general guide, the typical water content values of the revealed soils for Standard Proctor compaction are presented in Table 1.

Table 1 - Estimated Water Content for Compaction

Soil Type	Determined Natural Water Content (%)	Water Content (%) for Standard Proctor Compaction	
		100% (optimum)	Range for 95% or +
Granular Fill	4 and 10	7	4 to 10
Earth Fill/Silty Clay	6 to 33	20	16 to 24

The above values show that the contacted soils are mostly suitable for a 95% or + Standard Proctor compaction. Wet or weathered soils will require aeration prior to structural compaction. The existing earth fill must be sorted free of any deleterious materials prior to its use as structural backfill. The lifts for compaction should be limited to 20 cm, or to a suitable thickness as assessed by test strips performed by the equipment which will be used at the time of construction.

The presence of rock boulders will prevent transmission of the compactive energy into the underlying material to be compacted. If an appreciable amount of rock fragments over 15 cm in size is mixed with the material, it must either be sorted or must not be used for structural backfill and engineered fill. Shattered rock from blasting is not an ideal material for structural backfill due to the amount of oversized boulders.

5.0 GROUNDWATER CONDITIONS

Groundwater and/or cave-in were evident in some boreholes. The groundwater level and occurrence of cave-in were recorded upon completion of drilling and sampling. The data are plotted on the Borehole Logs and listed in Table 2.

Table 2 - Groundwater Levels

Borehole No.	Ground Elevation (m)	Borehole Depth (m)	Measured Groundwater/ Cave-in* Level On Completion	
			Depth (m)	Elevation (m)
1	187.8	0.9	At Ground Level	187.8
2	188.1	0.6	At Ground Level	188.1
3	187.6	0.8	0.5	187.1
4	188.0	0.9	Dry	Below 187.1
5A	189.5	2.4	2.1*	187.4*
5B	187.8	2.9	0.3/2.4*	187.5/185.4*
5C	188.0	3.0	-**	-**
6	187.5	1.8	Dry	Below 185.7
7	187.9	7.1	-**	-**

* Cave-in depth

** Water was supplied for rock coring, record of groundwater was not possible upon completion.

Groundwater was evident near the ground surface at the location of Boreholes 1 and 2. In Boreholes 3, 5A and 5B, groundwater and cave-in were recorded at a depth of 0.3 to 2.4 m, or El. 185.4 to 187.5 m. The groundwater represents perched water in the sand seams within the clay and above the bedrock. It is subject to seasonal fluctuation.

It should be noted that the groundwater will be further assessed by the Hydrogeological Consultant in a separate report.

6.0 DISCUSSION AND RECOMMENDATIONS

The investigation has disclosed that beneath a topsoil veneer or road pavement, with a layer of earth fill in places, the area of investigation is underlain by firm to hard, generally very stiff silty clay, overlying dolomite and limestone bedrock at a depth ranging from 0.6 to 5.5 m from the prevailing ground surface, or between El. 182.4 m and El. 187.5 m.

As part of the Saltfleet Conservation Area Wetland Restoration Program, the area of investigation will be designed to create a wetland for storage of stormwater to reduce peak flows of the upper Battlefield Creek for flood and erosion control. Based on the Flood and Erosion Control Study prepared by Amec Foster Wheeler, the existing road grade will be raised by 1.8 m (from the current elevation of 187.5 m to approximately 189.3 m) and the basin of the proposed wetland will be at El. 186.3± m to accommodate the high stormwater events.

6.1 Wetland Construction

All excavation should be carried out in accordance with Ontario Regulation 213/91. For excavation purposes, the types of soils are classified in Table 3.

Table 3 - Classification of Soils for Excavation

Material	Type
Bedrock	1
Silty Clay	2
Earth Fill	3

Excavation within 1.0 to 1.5 m into the bedrock will require a heavy-duty excavator equipped with a rock-ripper and pneumatic hammer. Any excavation into the sound bedrock will require rock blasting. A blasting specialist must be consulted, and the surrounding structures must be carefully inspected and surveyed before blasting to prevent unwarranted damage claims arising from blasting.

The yield of groundwater in excavation is anticipated to be slow in rate and limited in quantity. Any groundwater yield from the rock fractures may be appreciable initially but will decrease with conventional pumping from sumps.

Earth fill to be used for the embankment around the wetland shall consist of low permeability clay material. Selected on site native silty clay, free of organics, is suitable for the construction of the embankment. The earth fill for an embankment should be compacted in lifts not exceeding 200 mm, to a minimum of 98% of the Standard Proctor Maximum Dry Density (SPMDD), with the water content close to its optimum moisture content.

In preparation of the subgrade for embankment, topsoil and organic soils should be removed. The weathered soils shall be sub-excavated and the ground should shall be proof-rolled. The fill placement and compaction should be inspected by either a geotechnical engineer, or a geotechnical technician under the supervision of a geotechnical engineer under full-time basis.

The sides of earth embankment should be sloped at 1 vertical:3+ horizontal in the dry zone and 1 vertical:4+ horizontal in the wet zone and within 1 m above the design water level. All the exposed slopes must be vegetated or sodded to protect from erosion.

Rock fragments and granular fill can be used in areas where water retention is not necessary.

Water channels and spillways should be provided with a liner for erosion resistance, consisting of rip-rap stone or gabion mattress above a filter fabric. The lining should extend from the walls over the entire basin.

Service pipes in the earth embankment should be provided with anti-seepage collars in 25 m intervals, consisting of either clay or concrete plugs to protect the subsoils from water seepage through the bedding, which can result in loss of ground and creating a cavity in the embankment.

6.2 Road Reconstruction

The road section in the vicinity of the proposed wetland will be raised by 1.8 m, from the current elevation of 187.5 m to approximately 189.3 m.

The road subgrade is anticipated to consist of on-site excavated material of silty clay, generally a poor pavement-supportive material with CBR value of 3%. Since the subject road will be for local and rural uses, the recommended pavement structure is presented in Table 4.

Table 4 - Pavement Design

Course	Thickness (mm)	OPS Specifications
Asphalt Surface	40	HL-3
Asphalt Binder	80	HL-8
Granular Base	150	OPSS Granular ‘A’ or equivalent
Granular Sub-base	350	OPSS Granular ‘B’ or equivalent

The existing asphalt pavement can be pulverized or removed off-site. Pulverized asphalt and the existing granular bases can be reused as the road sub-base for the new road. Bulk samples should be collected and tested for the OPS Specification before reuse.

Prior to placement of the granular bases, the final subgrade should be inspected and proof-rolled. Any soft spot as identified should be subexcavated and replaced by properly compacted inorganic material. The subgrade soil in the zone within 1.0 m below the pavement must be compacted to 98% or + of SPMDD, with the moisture content close to the optimum water content. In the lower zone, a 95% or + SPMDD is considered adequate.

The pavement subgrade will suffer a strength regression if water is allowed to infiltrate prior to paving. The following measures should therefore be incorporated in the construction procedures and road design:

- If the road construction does not immediately follow the subgrade preparation and trench backfill, the subgrade should be properly crowned and smooth-rolled to allow interim precipitation to be properly drained.
- If the pavement is to be constructed during the wet seasons and extensively soft subgrade occurs, the granular sub-base may require thickening. This can be further assessed during construction.
- The road boundaries should be properly graded to prevent ponding of water. Swales and ditches should be provided to drain the water away from the road pavement towards the low-lying area for ponding. Otherwise, the water will seep into the subgrade mantle and induce a regression of the subgrade strength, with costly consequences for the pavement construction.

- Curb subdrains may be required in areas where swales or ditches are not possible. The invert of the subdrains should be at least 0.4 m beneath the underside of the granular sub-base and should be backfilled with free-draining granular material. The subdrains should consist of filter-sleeved weepers to prevent blockage by silting.

6.3 Soil Parameters

The recommended soil parameters for the project design are given in Table 5.

Table 5 - Soil Parameters

Unit Weight and Bulk Factor	**Unit Weight (kN/m^3)**	**Estimated Bulk Factor**	
	Bulk	**Loose**	**Compacted**
Earth Fill/Granular Fill	21.5	1.25	1.00
Silty Clay	22.5	1.30	1.05
Rock Fragments	24.5	1.40	1.30
Lateral Earth Pressure Coefficients	**Active K_a**	**At Rest K_o**	**Passive K_p**
Silty Clay and compacted Earth Fill	0.45	0.55	2.50
Compacted Rock Fragments	0.30	0.45	3.30
Bedrock	0.20	0.30	5.00
Coefficients of Friction			
Between Concrete and Granular Base			0.50
Between Concrete and Sound Natural Soils			0.35

7.0 LIMITATIONS OF REPORT

This report was prepared by Soil Engineers Ltd. for the account of Water's Edge Environmental Solutions Team Ltd., and for review by the designated consultants and government agencies. Use of the report is subject to the conditions and limitations of the contractual agreement.

The material in the report it reflects the judgement of Basim Al Ali, P.Eng., and Bennett Sun, P.Eng., in light of the information available to it at the time of preparation. Any use which a Third Party makes of this report, or any reliance on decisions to be made based on it, are the responsibility of such Third Parties. Soil Engineers Ltd. accepts no responsibility for damages, if any, suffered by any Third Party as a result of decisions made or actions based on this report.

SOIL ENGINEERS LTD.

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June 3, 2019

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June 3, 2019
PROVINCE OF ONTARIO

LIST OF ABBREVIATIONS AND DESCRIPTION OF TERMS

The abbreviations and terms commonly employed on the borehole logs and figures, and in the text of the report, are as follows:

SAMPLE TYPES

AS	Auger sample
CS	Chunk sample
DO	Drive open (split spoon)
DS	Denison type sample
FS	Foil sample
RC	Rock core (with size and percentage recovery)
ST	Slotted tube
TO	Thin-walled, open
TP	Thin-walled, piston
WS	Wash sample

PENETRATION RESISTANCE

Dynamic Cone Penetration Resistance:

A continuous profile showing the number of blows for each foot of penetration of a 2-inch diameter, 90° point cone driven by a 140-pound hammer falling 30 inches.

Plotted as '—●—'

Standard Penetration Resistance or 'N' Value:

The number of blows of a 140-pound hammer falling 30 inches required to advance a 2-inch O.D. drive open sampler one foot into undisturbed soil.

Plotted as '○'

WH	Sampler advanced by static weight
PH	Sampler advanced by hydraulic pressure
PM	Sampler advanced by manual pressure
NP	No penetration

SOIL DESCRIPTION

Cohesionless Soils:

'N' (blows/ft)	Relative Density
0 to 4	very loose
4 to 10	loose
10 to 30	compact
30 to 50	dense
over 50	very dense

Cohesive Soils:

Undrained Shear Strength (ksf)	'N' (blows/ft)	Consistency
less than 0.25	0 to 2	very soft
0.25 to 0.50	2 to 4	soft
0.50 to 1.0	4 to 8	firm
1.0 to 2.0	8 to 16	stiff
2.0 to 4.0	16 to 32	very stiff
over 4.0	over 32	hard

Method of Determination of Undrained Shear Strength of Cohesive Soils:

x 0.0 Field vane test in borehole; the number denotes the sensitivity to remoulding

△ Laboratory vane test

□ Compression test in laboratory

For a saturated cohesive soil, the undrained shear strength is taken as one half of the undrained compressive strength

METRIC CONVERSION FACTORS

1 ft = 0.3048 metres
1lb = 0.454 kg
1 inch = 25.4 mm
1ksf = 47.88 kPa

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GEOTECHNICAL • ENVIRONMENTAL • HYDROGEOLOGICAL • BUILDING SCIENCE

JOB NO.: 1902-S100

LOG OF BOREHOLE NO.: 1

FIGURE NO.: 1

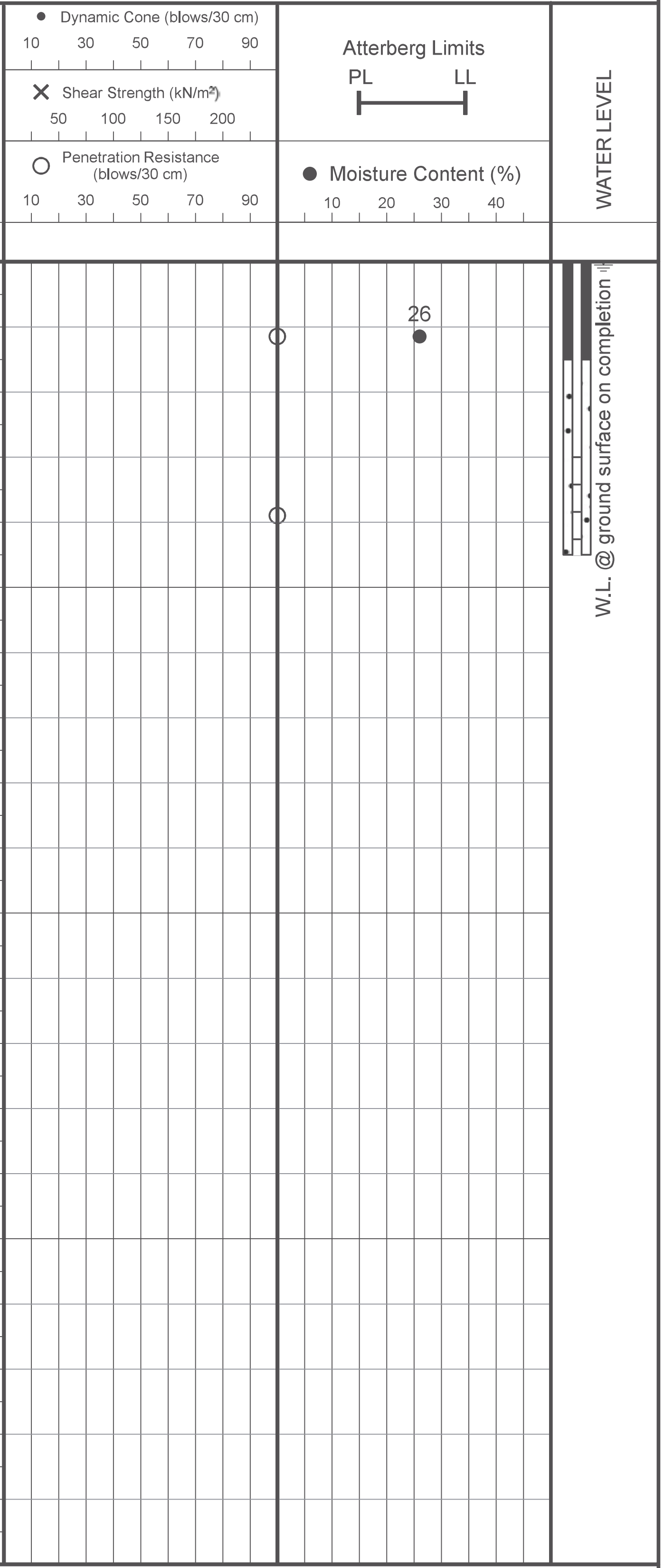
PROJECT DESCRIPTION: Proposed Wetland Design

METHOD OF BORING: Flight-Auger

PROJECT LOCATION: First Road East and Green Mountain Road East
City of Hamilton

DRILLING DATE: March 27, 2019

El. (m) Depth (m)	SOIL DESCRIPTION	SAMPLES Number	SAMPLES Type	SAMPLES N-Value	Depth Scale (m)
187.8	Ground Surface				
0.0	**15 cm TOPSOIL**				0
187.7 0.1	Greyish-brown, hard **SILTY CLAY** a tr. of sand and organics occ. silt seams and rock fragments	1	DO	50/25	
		2	DO	50/0	
186.9 0.9	**Refusal to Augering** **Inferred Bedrock** **END OF BOREHOLE** Installed 50 mm Ø monitoring well to 0.9 m completed with 0.3 m screen Sand backfill from 0.3 m to 0.9 m Bentonite seal from 0.0 m to 0.3 m. Provided with steel casing and lock.	-	-	-	1
					2
					3
					4



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JOB NO.: 1902-S100

LOG OF BOREHOLE NO.: 2

FIGURE NO.: 2

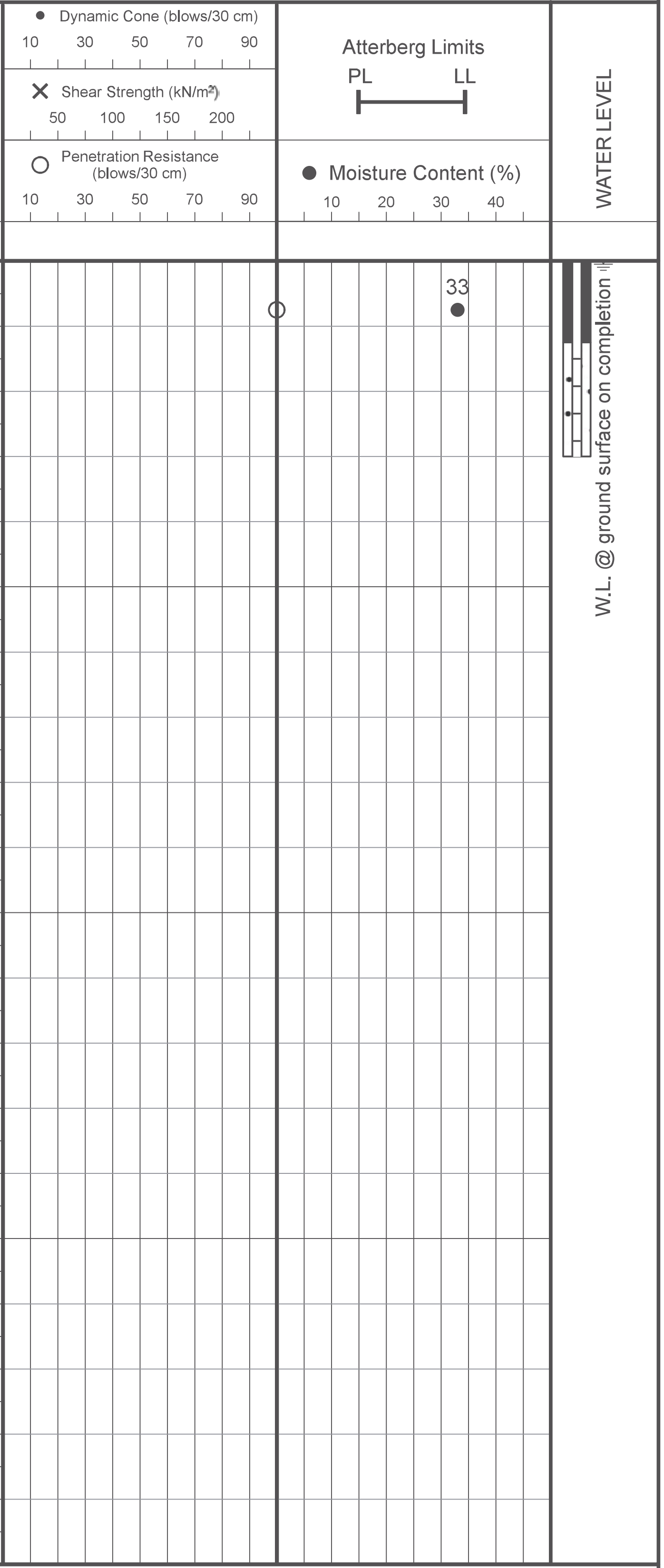
PROJECT DESCRIPTION: Proposed Wetland Design

METHOD OF BORING: Flight-Auger

PROJECT LOCATION: First Road East and Green Mountain Road East
City of Hamilton

DRILLING DATE: March 27, 2019

El. (m) Depth (m)	SOIL DESCRIPTION	SAMPLES Number	SAMPLES Type	SAMPLES N-Value	Depth Scale (m)
188.1	Ground Surface				
0.0	**15 cm TOPSOIL**				0
188.0 0.1	Greyish-brown, hard **SILTY CLAY** a tr. of sand and organics occ. silt seams and rock fragments	1	DO	50/15	
187.5 0.6	**Refusal to Augering** **Inferred Bedrock** **END OF BOREHOLE** Installed 50 mm Ø monitoring well to 0.6 m completed with 0.3 m screen Sand backfill from 0.25 m to 0.6 m Bentonite seal from 0.0 m to 0.25 m. Provided with steel casing and lock.	-	-	-	1 2 3 4



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JOB NO.: 1902-S100

LOG OF BOREHOLE NO.: 3

FIGURE NO.: 3

PROJECT DESCRIPTION: Proposed Wetland Design

METHOD OF BORING: Flight-Auger

PROJECT LOCATION: First Road East and Green Mountain Road East
City of Hamilton

DRILLING DATE: March 27, 2019

El. (m) Depth (m)	SOIL DESCRIPTION	SAMPLES Number	SAMPLES Type	SAMPLES N-Value	Depth Scale (m)	● Dynamic Cone (blows/30 cm) 10 30 50 70 90 ✕ Shear Strength (kN/m²) 50 100 150 200 ○ Penetration Resistance (blows/30 cm) 10 30 50 70 90	Atterberg Limits PL LL ● Moisture Content (%) 10 20 30 40	WATER LEVEL
187.6	Ground Surface							
0.0	**30 cm TOPSOIL**				0			
187.3 0.3	Greyish-brown, very stiff to hard **SILTY CLAY** a tr. of sand and organics occ. silt seams and rock fragments	1	DO	26		○	● 27	▽
186.8 0.8	**Refusal to Augering** **Inferred Bedrock** **END OF BOREHOLE** Installed 50 mm Ø monitoring well to 0.8 m completed with 0.3 m screen Sand backfill from 0.3 m to 0.8 m Bentonite seal from 0.0 m to 0.3 m. Provided with steel casing and lock.	-	-	-	1 2 3 4			W.L. @ El. 187.1 m on completion

JOB NO.: 1902-S100

LOG OF BOREHOLE NO.: 4

FIGURE NO.: 4

PROJECT DESCRIPTION: Proposed Wetland Design

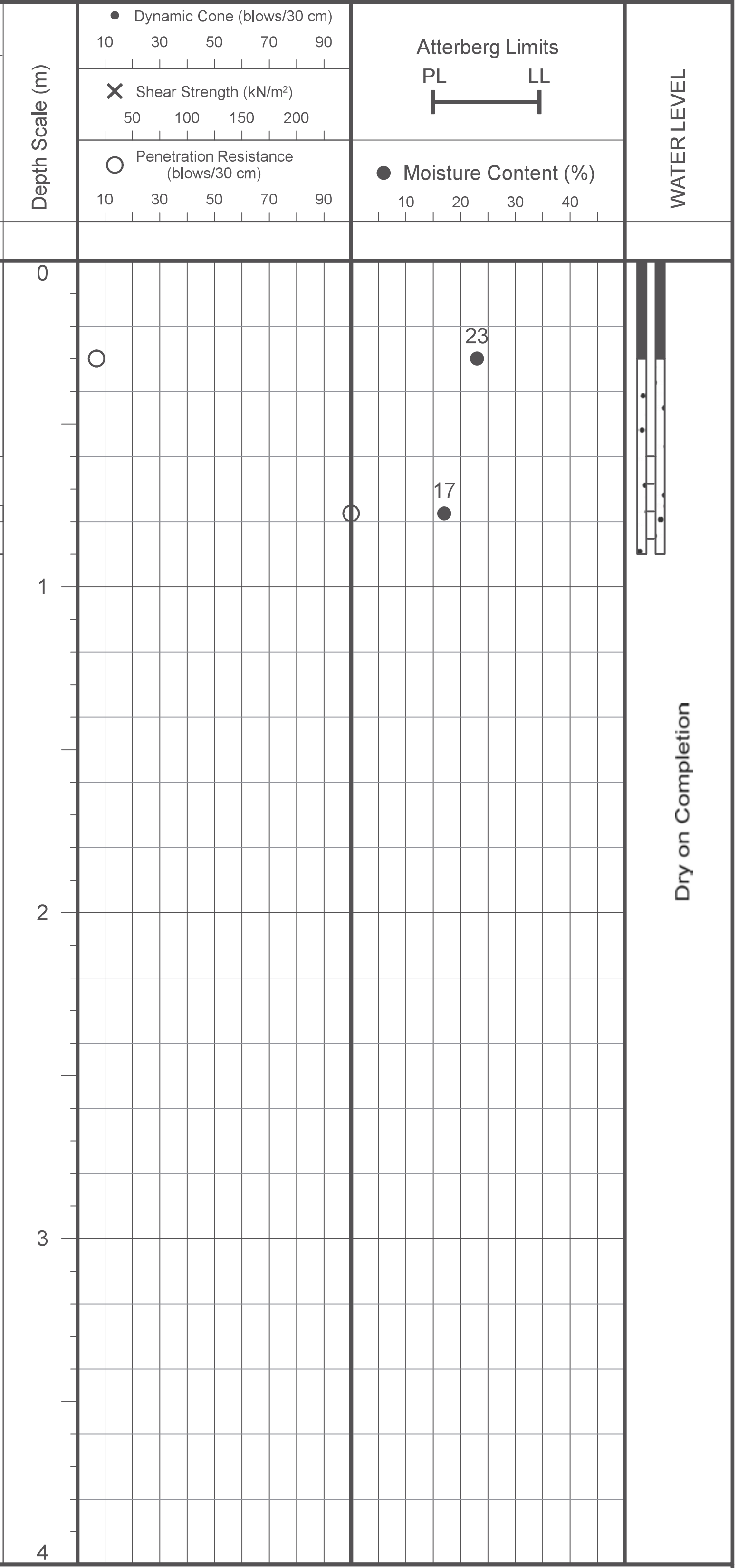
METHOD OF BORING: Flight-Auger

PROJECT LOCATION: First Road East and Green Mountain Road East
City of Hamilton

DRILLING DATE: March 26, 2019

El. (m) Depth (m)	SOIL DESCRIPTION	SAMPLES Number	SAMPLES Type	SAMPLES N-Value
188.0	Ground Surface			
0.0	**23 cm TOPSOIL**			
187.8 0.2	Greyish-brown, firm to hard weathered **SILTY CLAY** a tr. of sand and organics occ. silt seams and rock fragments	1	DO	7
		2	DO	50/15
187.1 0.9	**Refusal to Augering** **Inferred Bedrock** **END OF BOREHOLE**	-	-	-

Installed 50 mm Ø monitoring well to 0.9 m
completed with 0.3 m screen
Sand backfill from 0.3 m to 0.9 m
Bentonite seal from 0.0 m to 0.3 m.
Provided with steel casing and lock.



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JOB NO.: 1902-S100

LOG OF BOREHOLE NO.: 5A

FIGURE NO.: 5

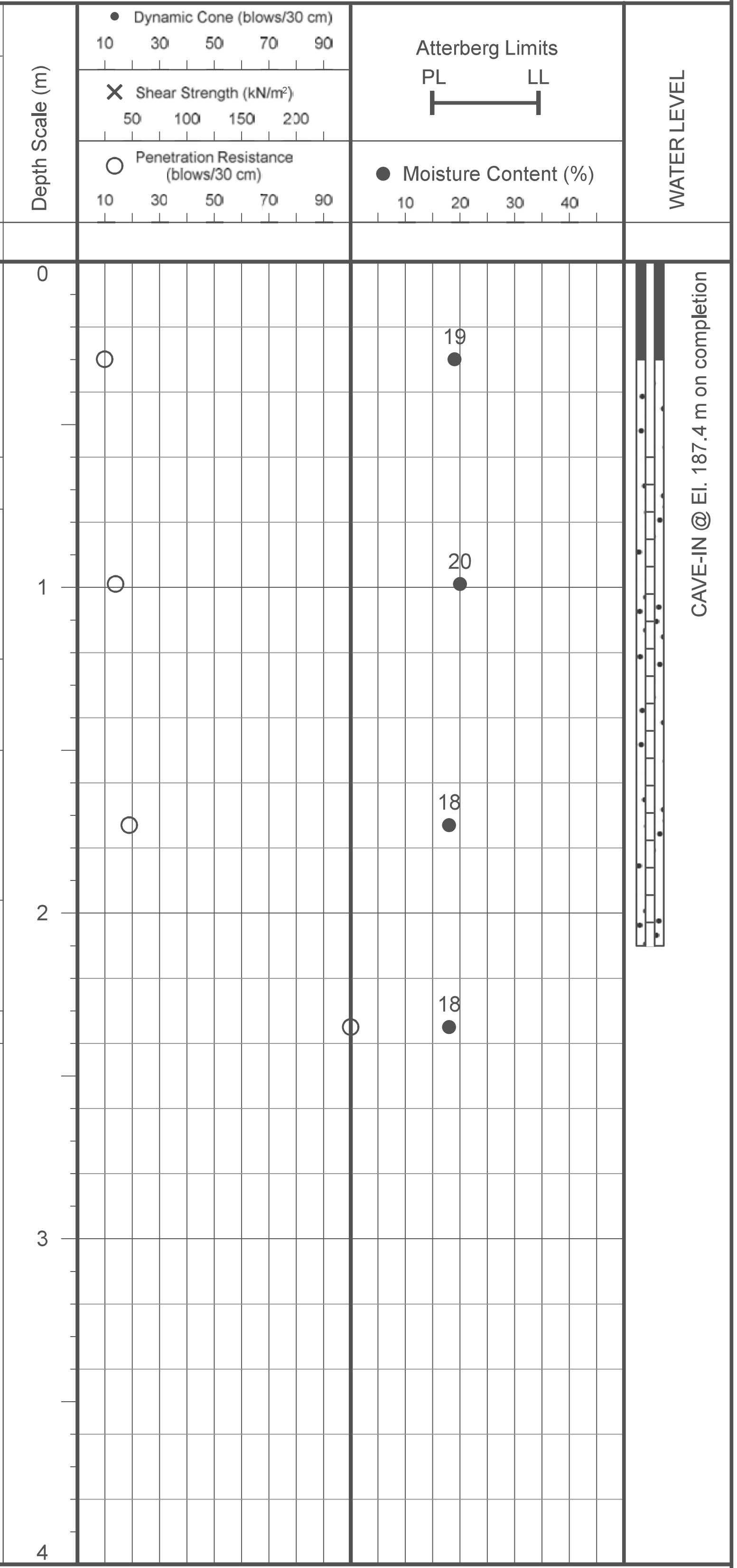
PROJECT DESCRIPTION: Proposed Wetland Design

METHOD OF BORING: Flight-Auger

PROJECT LOCATION: First Road East and Green Mountain Road East
City of Hamilton

DRILLING DATE: March 26, 2019

El. (m) Depth (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value
189.5	Ground Surface			
0.0	**23 cm TOPSOIL**			
189.3 0.2	Greyish-brown, stiff to hard	1	DO	10
	weathered			
	SILTY CLAY a tr. of sand occ. silt seams and rock fragments	2	DO	14
		3	DO	19
		4	DO	50/3
187.1 2.4	**Refusal to Augering** **Inferred Bedrock** **END OF BOREHOLE** Installed 50 mm Ø monitoring well to 2.1 m completed with 1.5 m screen Sand backfill from 0.3 m to 2.1 m Bentonite seal from 0.0 m to 0.3 m. Provided with steel casing and lock.			



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JOB NO.: 1902-S100

LOG OF BOREHOLE NO.: 5B

FIGURE NO.: 6

PROJECT DESCRIPTION: Proposed Wetland Design

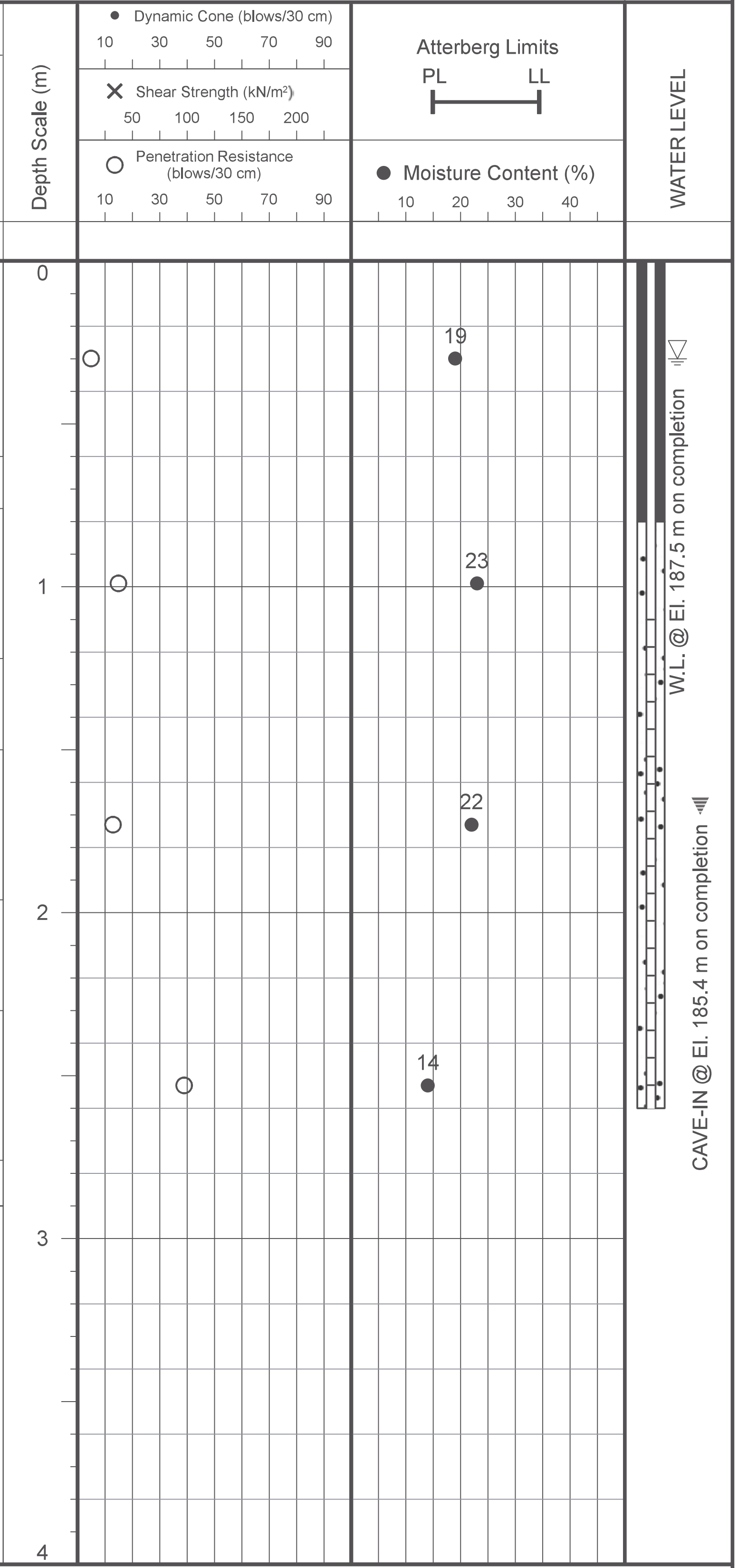
METHOD OF BORING: Flight-Auger

PROJECT LOCATION: First Road East and Green Mountain Road East
City of Hamilton

DRILLING DATE: March 26, 2019

El. (m) Depth (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value
187.8	Ground Surface			
0.0	**30 cm TOPSOIL**			
187.5 0.3	Greyish-brown, firm to hard	1	DO	5
	weathered			
	SILTY CLAY a tr. of sand occ. silt seams and rock fragments	2	DO	15
		3	DO	13
		4	DO	39
184.9 2.9	**Refusal to Augering** **Inferred Bedrock** **END OF BOREHOLE**			

Installed 50 mm Ø monitoring well to 2.6 m
completed with 1.5 m screen
Sand backfill from 0.8 m to 2.6 m
Bentonite seal from 0.0 m to 0.8 m.
Provided with steel casing and lock.



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Page: 1 of 1

JOB NO.: 1902-S100

LOG OF BOREHOLE NO.: 5C

FIGURE NO.: 7

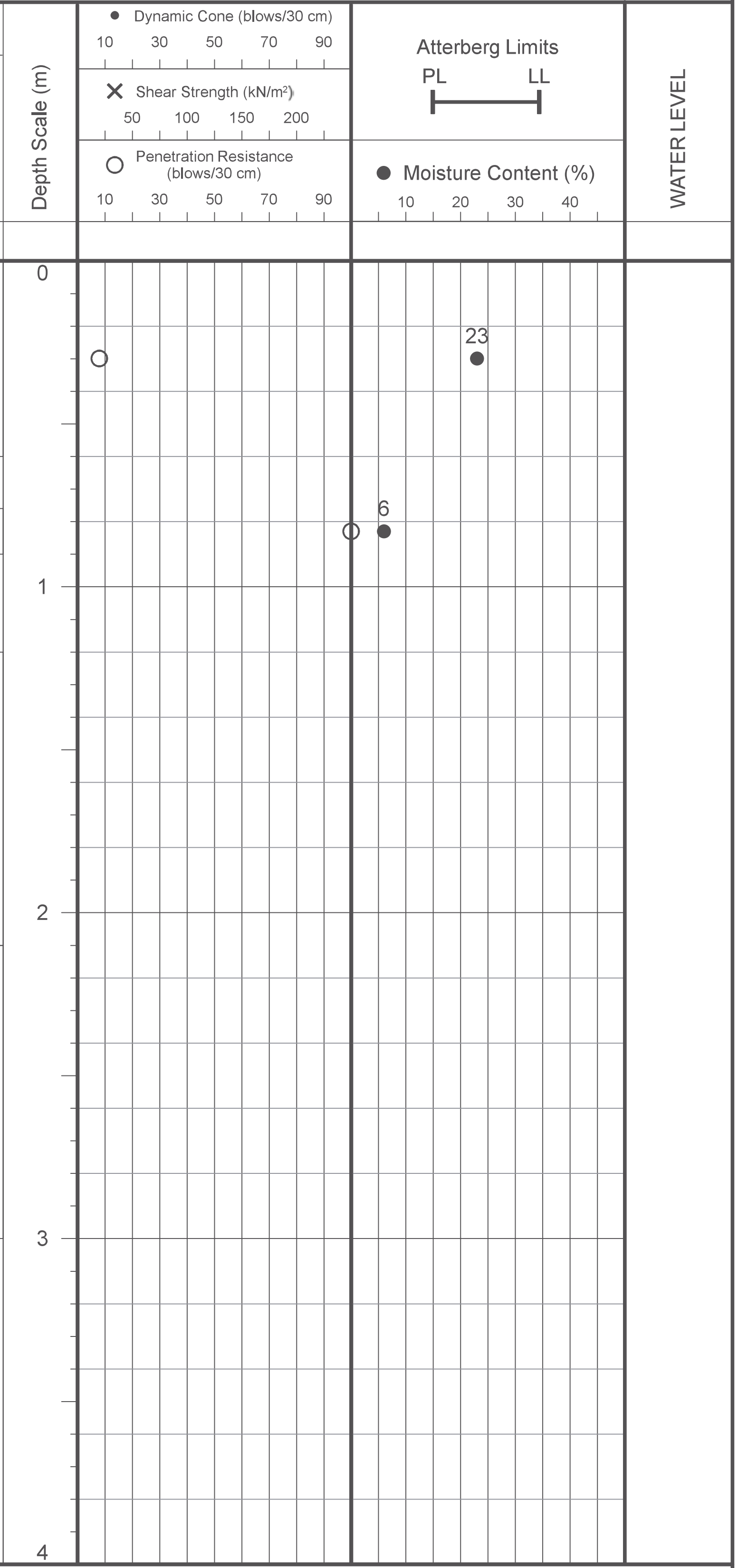
PROJECT DESCRIPTION: Proposed Wetland Design

METHOD OF BORING: Flight-Auger

PROJECT LOCATION: First Road East and Green Mountain Road East
City of Hamilton

DRILLING DATE: April 4, 2019

El. (m) Depth (m)	SOIL DESCRIPTION	SAMPLES Number	SAMPLES Type	SAMPLES N-Value
188.0	Ground Surface			
0.0	**15 cm TOPSOIL**			
187.9 0.1	Greyish-brown, firm to hard **SILTY CLAY** a tr. of sand, organics and rock fragments	1	DO	8
	weathered	2	DO	50/15
186.8 1.2	Grey, weathered **DOLOMITE/LIMESTONE BEDROCK**	3	RC RQD	80% 0%
		4	RC RQD	100% 0%
185.0 3.0	**END OF BOREHOLE**			



JOB NO.: 1902-S100

LOG OF BOREHOLE NO.: 6

FIGURE NO.: 8

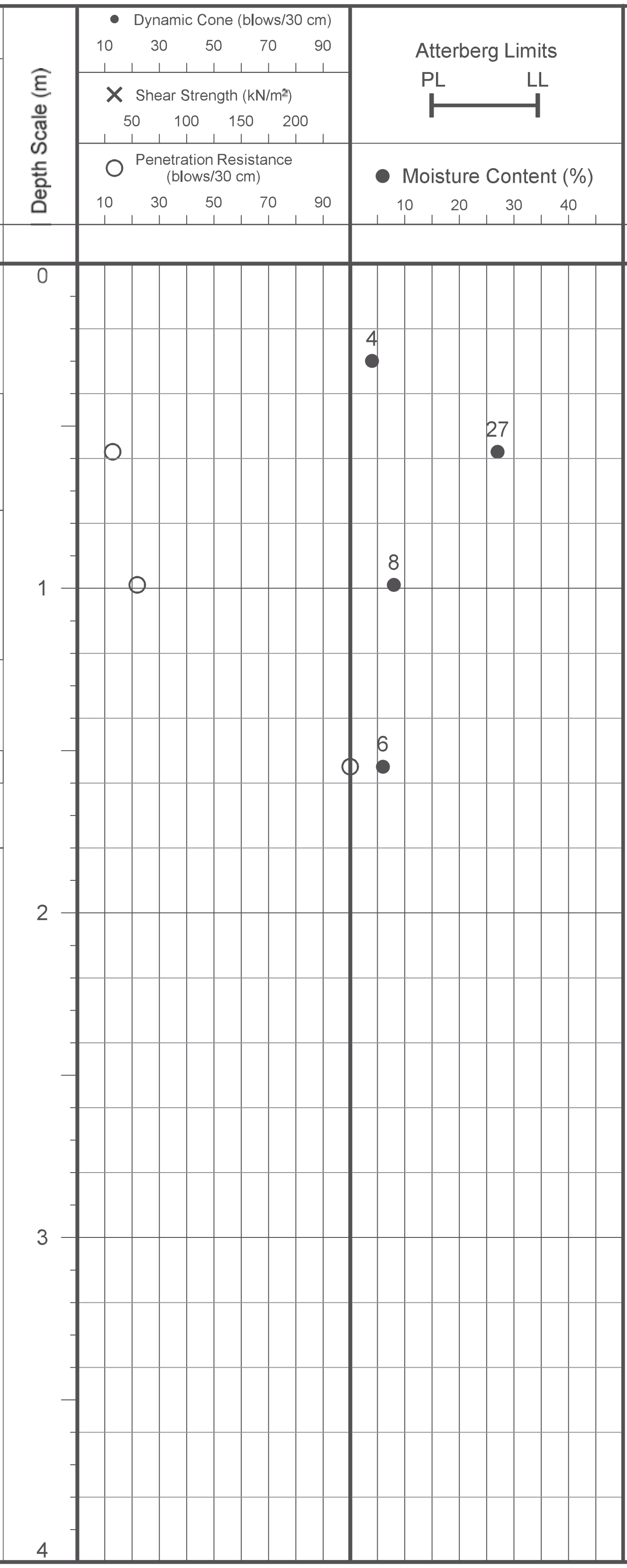
PROJECT DESCRIPTION: Proposed Wetland Design

METHOD OF BORING: Flight-Auger

PROJECT LOCATION: First Road East and Green Mountain Road East
City of Hamilton

DRILLING DATE: April 4, 2019

El. (m) Depth (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value	WATER LEVEL
187.5	Ground Surface				
187.5 0.0	**23 cm ASPHALTIC CONCRETE**				Dry on Completion
187.3 0.2	**230 mm GRANULAR FILL**	1A	-		
187.0 0.5	Grey **EARTH FILL** silty clay a tr. of sand and gravel	1B	DO	13	
186.7 0.8	Brown, very stiff to hard **SILTY CLAY** a tr. of sand occ. rock fragments	2	DO	22	
		3	DO	50/10	
185.7 1.8	**Refusal to Augering** **Inferred Bedrock** **END OF BOREHOLE**				



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JOB NO.: 1902-S100

LOG OF BOREHOLE NO.: 7

FIGURE NO.: 9

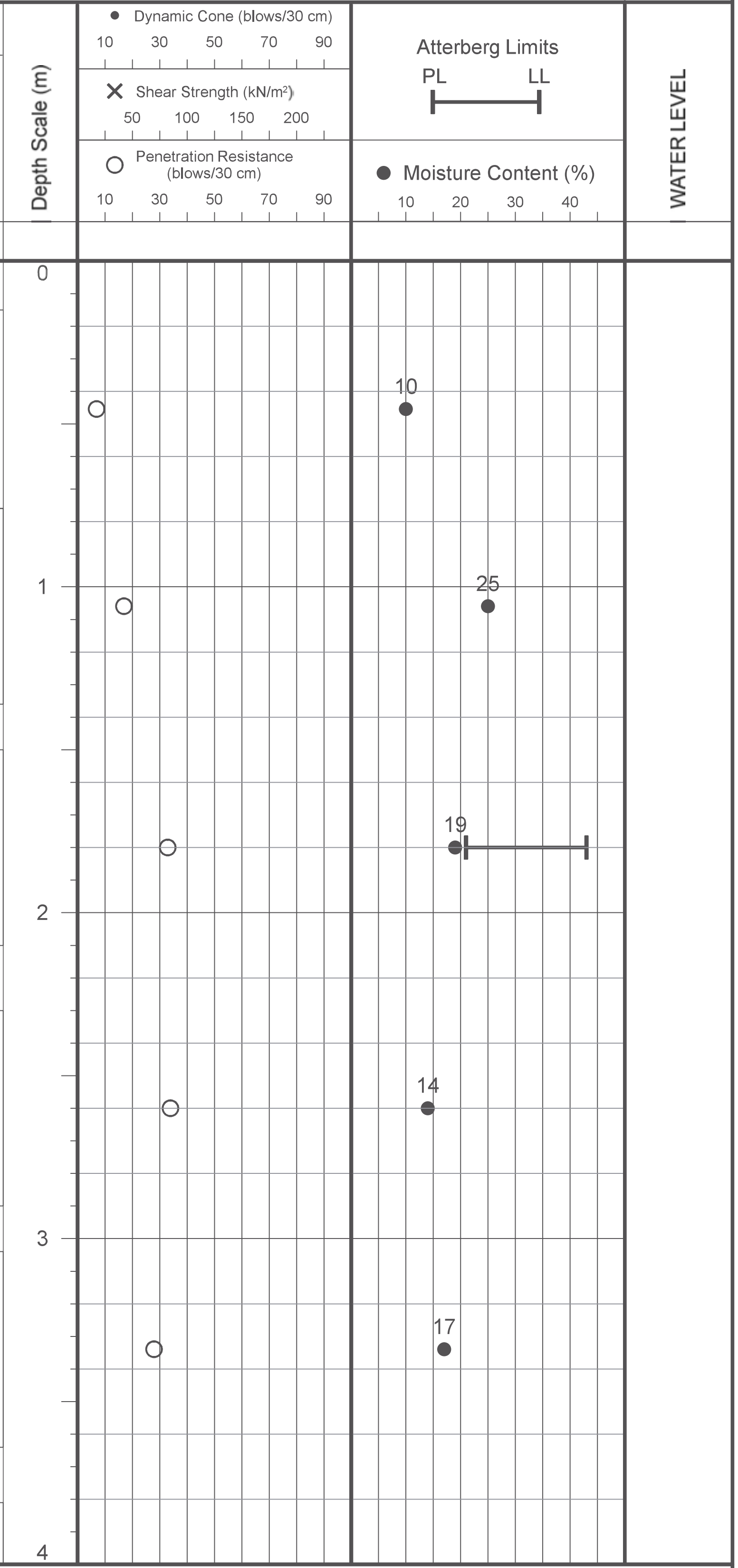
PROJECT DESCRIPTION: Proposed Wetland Design

METHOD OF BORING: Flight-Auger

PROJECT LOCATION: First Road East and Green Mountain Road East
City of Hamilton

DRILLING DATE: April 4, 2019

El. (m) Depth (m)	SOIL DESCRIPTION	SAMPLES Number	SAMPLES Type	SAMPLES N-Value
187.9	Ground Surface			
0.0	**18 cm ASPHALTIC CONCRETE**			
0.2	**330 mm GRANULAR FILL**	1	DO	7
187.4 0.5	Grey **EARTH FILL** silty clay a tr. of sand, gravel and organics	2	DO	17
186.4 1.5	Very stiff to hard **SILTY CLAY** a tr. of sand and gravel rock fragments	3	DO	33
		4	DO	34
	brown grey	5	DO	28



Soil Engineers Ltd.

JOB NO.: 1902-S100

LOG OF BOREHOLE NO.: 7

FIGURE NO.: 9

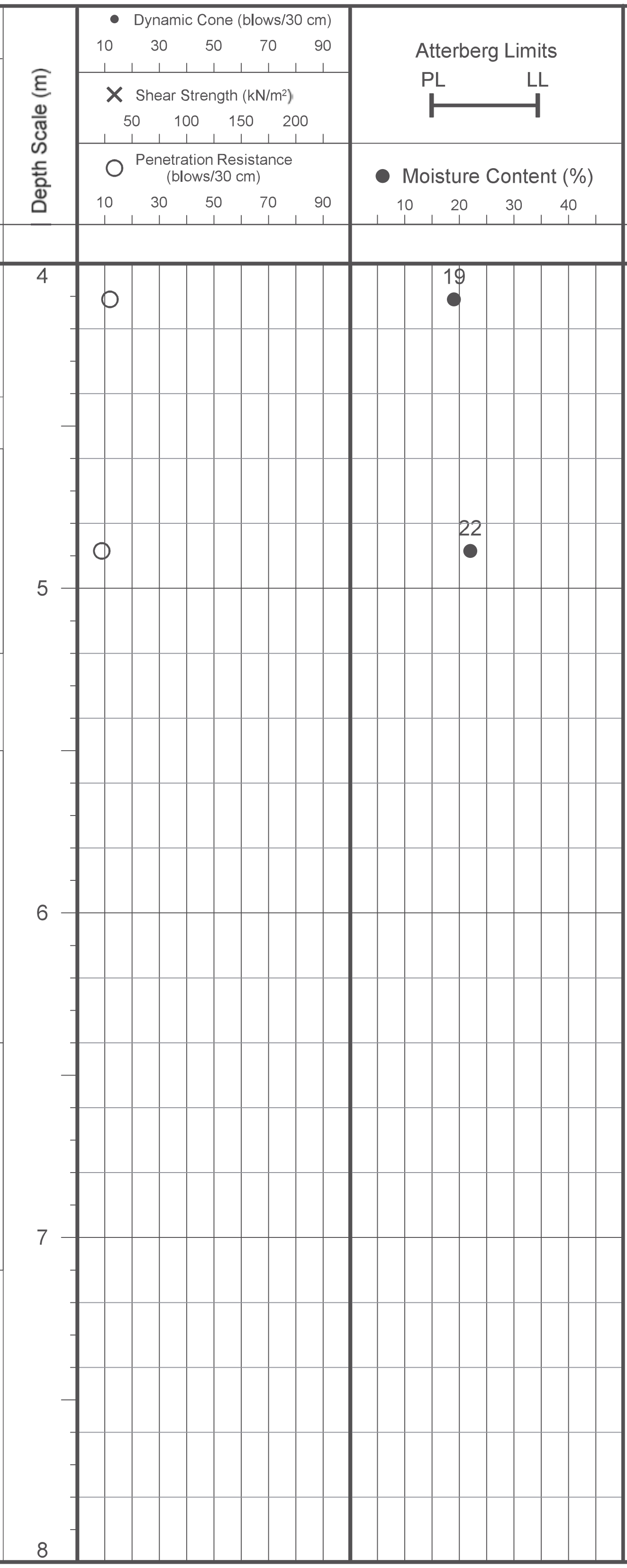
PROJECT DESCRIPTION: Proposed Wetland Design

METHOD OF BORING: Flight-Auger

PROJECT LOCATION: First Road East and Green Mountain Road East
City of Hamilton

DRILLING DATE: April 4, 2019

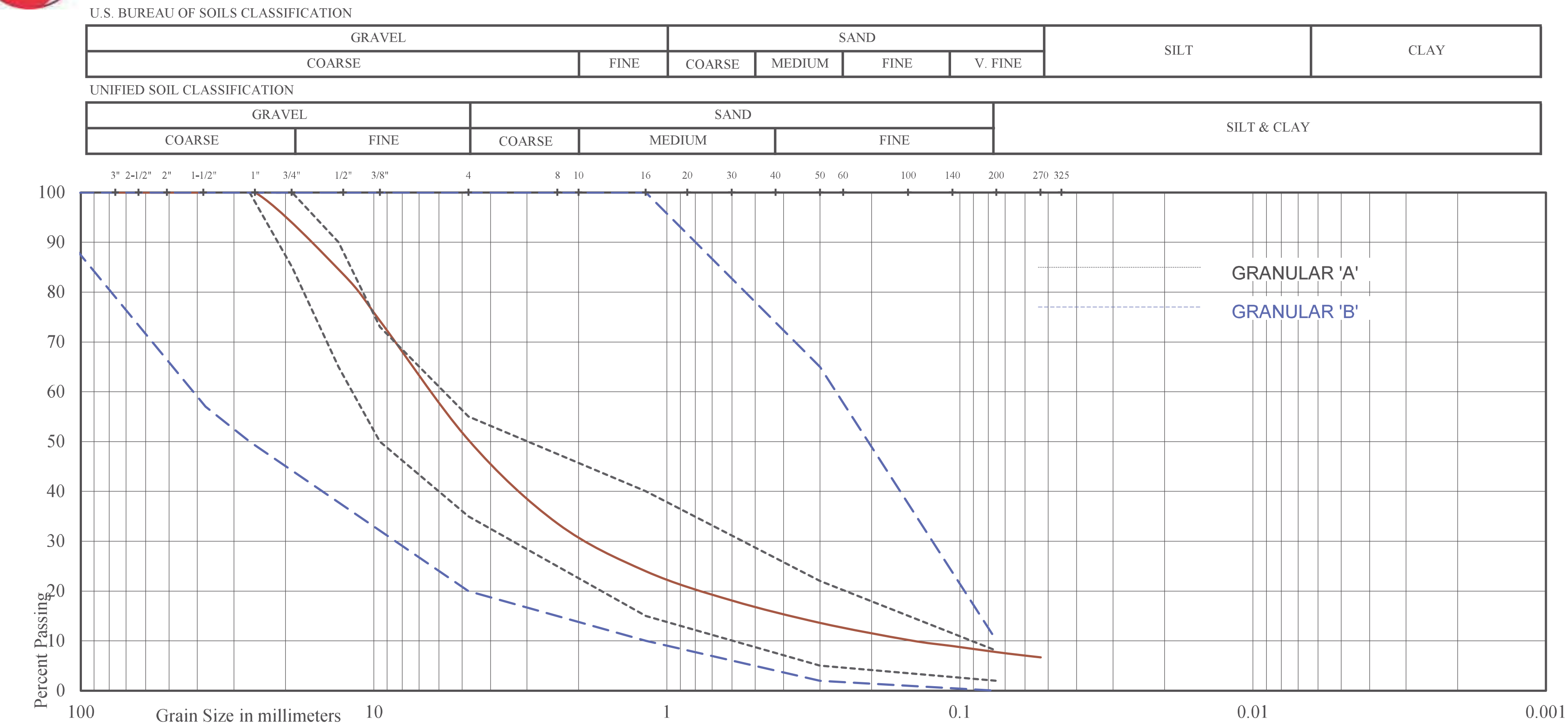
El. (m) Depth (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value	WATER LEVEL
	Grey, stiff **SILTY CLAY** a tr. of sand and gravel rock fragments	6	DO	12	
		7	DO	9	
182.4 5.5	Grey **DOLOMITE/LIMESTONE BEDROCK**	8	RC RQD	95% 95%	
		9	RC RQD	100% 85%	
180.8 7.1	**END OF BOREHOLE**				



Soil Engineers Ltd.

GRAIN SIZE DISTRIBUTION

Reference No: 1902-S100



Project:	Proposed Wetland Design
Location:	First Road East and Green Mountain Road East, City of Hamilton
Borehole No:	6
Sample No:	1A
Depth (m):	0.3
Elevation (m):	187.2

Liquid Limit (%) = -

Plastic Limit (%) = -

Plasticity Index (%) = -

Moisture Content (%) = 4

Estimated Permeability (cm./sec.) = 10^{-2}

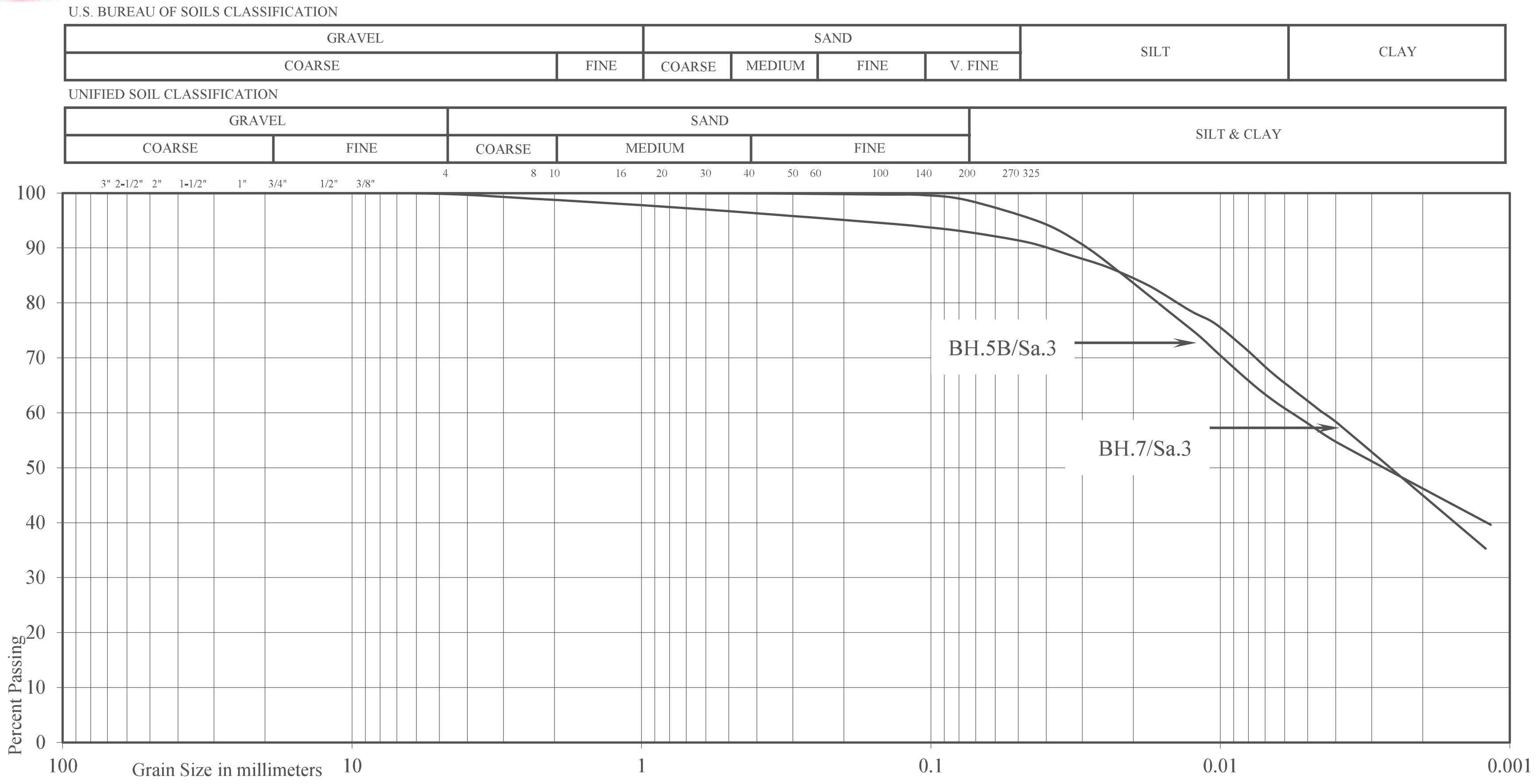
Classification of Sample [& Group Symbol]: GRANULAR FILL

Figure: 10

Soil Engineers Ltd.

GRAIN SIZE DISTRIBUTION

Reference No: 1902-S100



Project: Proposed Wetland Design

Location: First Road East and Green Mountain Road East, City of Hamilton

Borehole No:	5B	7
Sample No:	3	3
Depth (m):	1.8	1.8
Elevation (m):	186.0	186.1

BH./Sa.	5B/3	7/3
Liquid Limit (%) =	-	43
Plastic Limit (%) =	-	21
Plasticity Index (%) =	-	22
Moisture Content (%) =	22	19
Estimated Permeability (cm./sec.) =	10^{-7}	10^{-7}

Classification of Sample [& Group Symbol]: SILTY CLAY, traces of sand and fine sand

Figure: 11

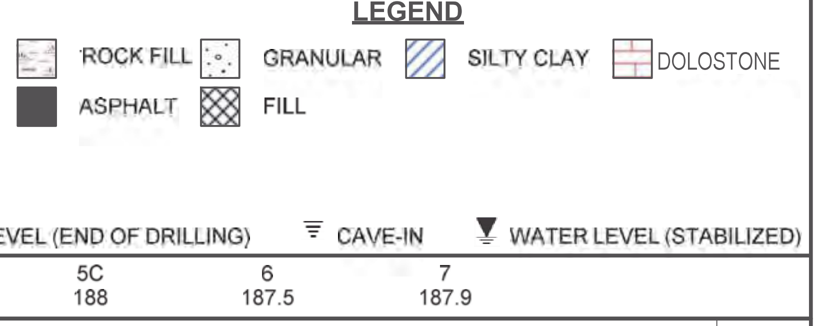
Soil Engineers Ltd.
CONSULTING ENGINEERS
GEOTECHNICAL | ENVIRONMENTAL | HYDROGEOLOGICAL | BUILDING SCIENCE

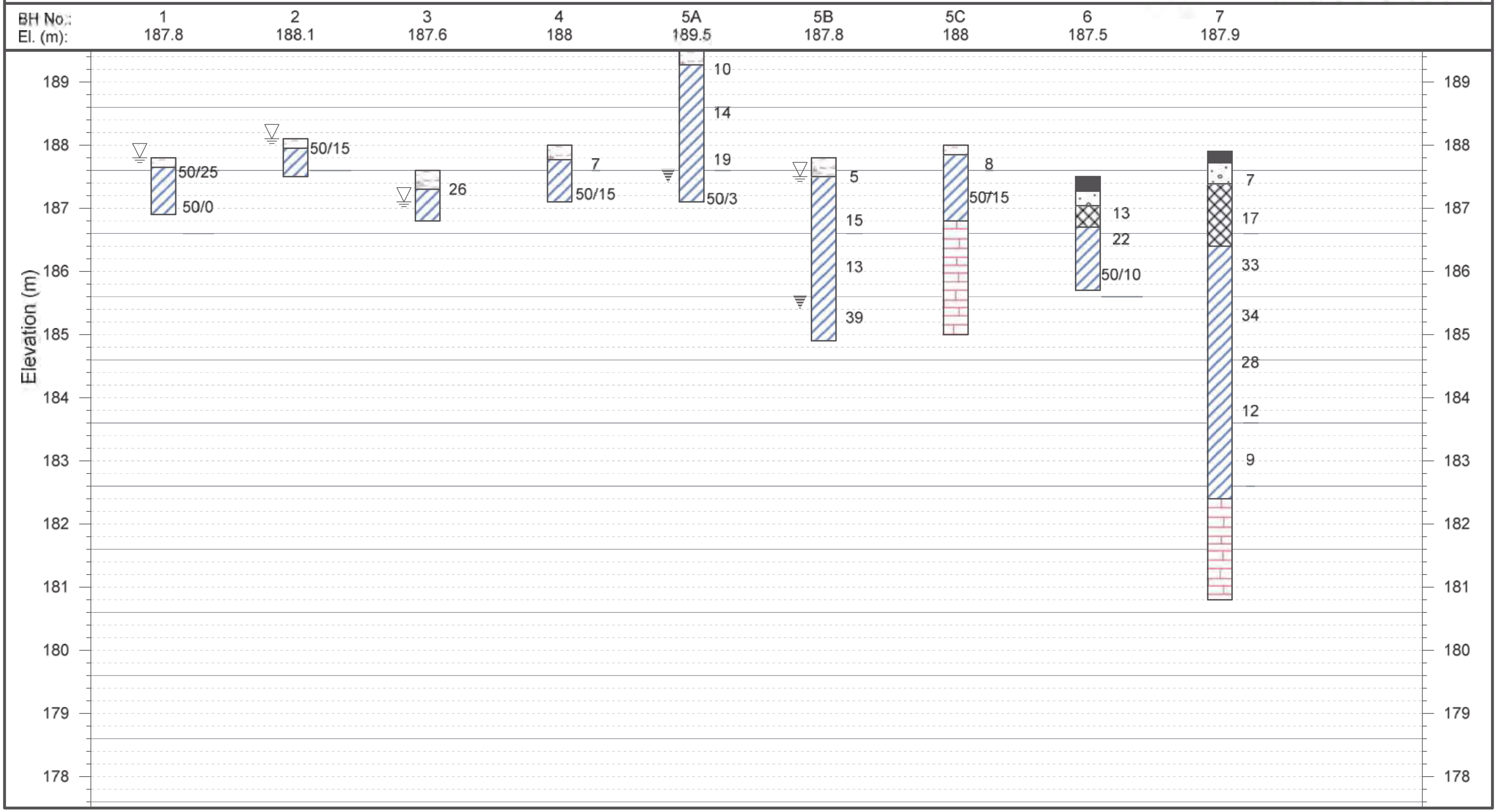
SUBSURFACE PROFILE
DRAWING NO. 2
SCALE: AS SHOWN

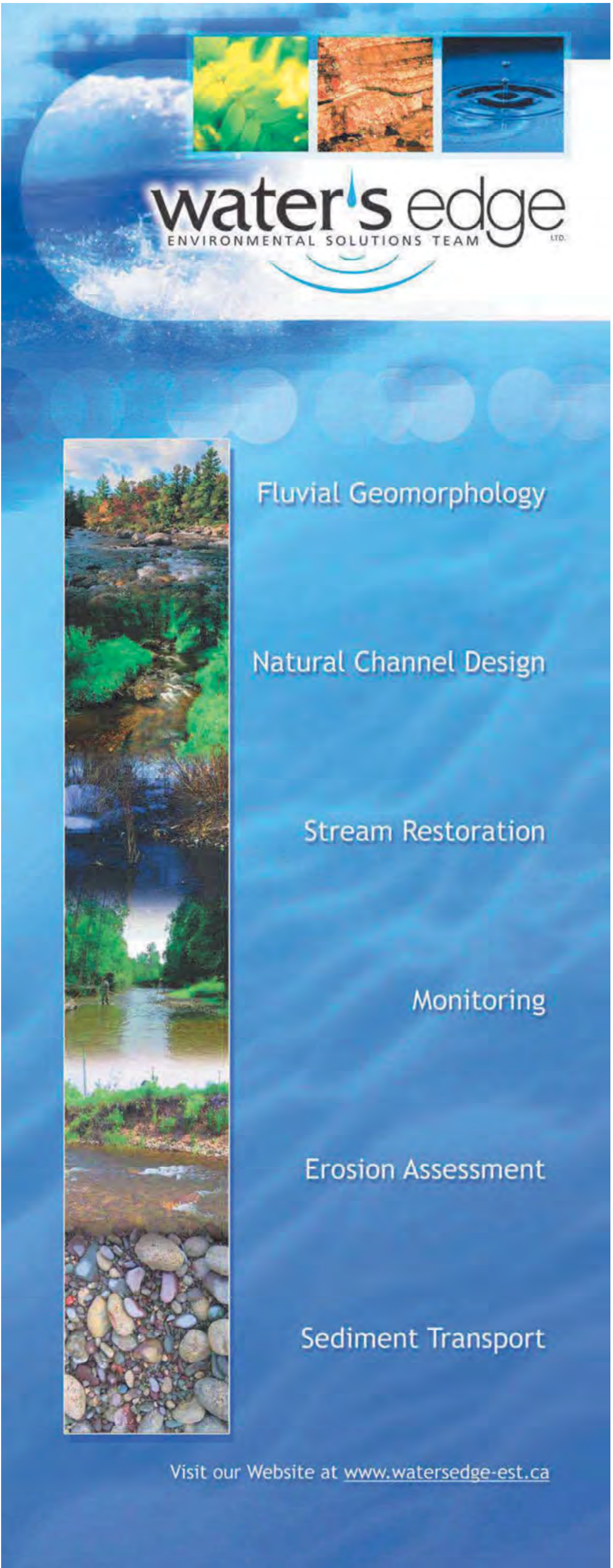
JOB NO.: 1902-S100
REPORT DATE: May 2019
PROJECT DESCRIPTION: Proposed Wetland Design

PROJECT LOCATION: First Road East and Green Mountain Road East
City of Hamilton

LEGEND







APPENDIX D:

Natural Heritage Report

Saltfleet Conservation Area Wetland BC-1 Design

Natural Heritage Assessment Report

Prepared for:

Hamilton Region Conservation Authority
838 Mineral Springs Road
Ancaster, ON
L9G 4X1

Project No. 2237A | November 2020

Natural Resource Solutions Inc.
Aquatic, Terrestrial and Wetland Biologists

Saltfleet Conservation Area Wetland BC-1 Design

Natural Heritage Assessment Report

Project Team

Tara Brenton	Project Advisor, Senior Terrestrial & Wetland Biologist / Certified Arborist
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Josh Pickering	Terrestrial and Wetland Biologist
Amy Reinert	Terrestrial and Wetland Biologist
Gerry Schaus	G.I.S. Analyst

Report submitted on November 16, 2020

Patrick Deacon
Project Manager, Terrestrial and Wetland Biologist

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1.0 Introduction

Natural Resource Solutions Inc. (NRSI) was retained by Hamilton Region Conservation Authority (HCA) to prepare a Natural Heritage Characterization Report to inform the design of flood mitigation works being completed at the Saltfleet BC-1 Conservation Area. The study team is being led by Water's Edge (fluvial geomorphology and design), with supporting studies being conducted by Soil Engineers Ltd. (soil analysis), Greer Galloway (hydrogeology and engineering) and Detritus Consulting Ltd. (archaeological). This report is to be read in conjunction with the supporting reports and drawings prepared by the study team.

1.1 Background and HCA Objectives

The HCA's goal for the Saltfleet BC-1 subject property is to create a new conservation area that will help alleviate natural hazards (flooding, erosion), enhance natural heritage components on site and provide recreation opportunities for the public. The objectives of the project include:

- Utilizing the floodplain area within the property to improve flood attenuation capacity and reduce erosion downstream;
- Enhancing and enlarging the existing wetland areas and creating additional wetland habitat;
- Restoring natural function of watercourses in the study area;
- Providing linkage opportunities within the property and between properties using the Dofasco 2000 Trail; and
- Enhancing or creating passive recreation opportunities along the Dofasco 2000 Trail.

The HCA undertook a Program Overview (HCA 2015) and Environmental Assessment (EA) (Amec Foster Wheeler 2018) that resulted in identifying preferred project alternatives, locations for the wetlands and supporting discipline information, including engineering, floodplain hydrology, and hydraulics. The Saltfleet Conservation Area (Upper Battlefield Creek parcel), also referred to as BC-1, is 1 of 4 properties where wetland creation was recommended in the EA.

1.2 Proposed Undertaking

The proposed works will include the creation of soil berms and associated outlet control structures, as well as enhancements to aquatic, wetland and terrestrial habitats. This report identifies the potential direct, indirect and induced impacts related to the proposed works and outlines how the proposed enhancement aligns with HCA goals and objectives.

This report also recommends specific mitigation measures intended to enhance wildlife habitat on site, including those habitats which may be impacted by the construction of the berms and expansion of wetland habitats and mitigation intended to alleviate impacts downstream of the subject property.

2.0 Project Scoping

2.1 Study Area

The subject property is located at Part Lot 21 and Lot 22, Concession 5 in the former Saltfleet Township (amalgamated by the City of Hamilton in 2001) (Map 1). The property is approximately 73 hectares in area and is bounded by First Road East, the Dofasco 2000 Trail, Second Road East and Green Mountain Road East.

The study area includes the subject property where the wetland habitat creation and natural hazard control is proposed, and the lands within 120m of the property to ensure contiguous and adjacent natural heritage features were considered. A karst ridge, known as the Eramosa Scarp, bisects the property in a west-east alignment and this report refers to the north half of the property (low-lying and where the development is proposed) and the south half of the property (upland and not subject to development).

The Rural Hamilton Official Plan (OP, City of Hamilton 2018) identifies several natural heritage designations within the subject property (Map 1), including;

- The treed feature in the northwest is considered a Natural Heritage Features Core Area, Key Natural Heritage Feature - Significant Woodlands and is part of the Greenbelt Natural Heritage System;
- The treed feature in the southeast, as well as a treed feature on private land fronting onto Green Mountain Road East are considered Natural Heritage Feature - Linkages;
- The property contains a portion of the headwaters of Battlefield Creek which are considered Key Hydrologic Feature - Streams;
- The entire property is part of the Greenbelt Protected Countryside; and
- The Niagara Escarpment Plan Area is immediately north of the property, adjacent to the Dofasco 2000 Trail.

An extensive review of background information and screening exercise was conducted by NRSI to determine if habitat for Species at Risk (SAR), Species of Conservation Concern (SCC), or Significant Wildlife Habitat (SWH) occurred in the study area. The results of the screening exercise are provided in Appendix I.

2.2 Relevant Policies, Legislation and Planning Studies

Table 1 summarizes the legislation, policies and planning studies that are specifically relevant to the proposed flood mitigation works in relation to requirements for protection and mitigation during the completion of this work within the City of Hamilton.

Table 1. Relevant Policies, Legislation and Planning Studies

Policy/Legislation	Description	Project Relevance
Provincial Policy Statement (PPS) (MMAH 2014)	• Issued under the authority of Section 3 of the Planning Act and came into effect on April 30, 2014, replacing the 2005 PPS (MMAH 2005). • Section 2.1 of the PPS – Natural Heritage establishes clear direction on the adoption of an ecosystem approach and the protection of resources that have been identified as 'significant'. • Provincial Plans including the Greenbelt Plan and Niagara Escarpment Plan take precedence over the PPS. • Section 3.1.4 states that: "*Development and site alteration may be permitted in certain areas associated with the flooding hazard along river, stream and small inland lake systems … where the development is limited to uses which by their nature must locate within the floodway, including flood and/or erosion control works or minor additions or passive non-structural uses which do not affect flood flows.*" • Section 3.1.6 states that "*Where the two zone concept for flood plains is applied, development and site alteration may be permitted in the flood fringe, subject to appropriate floodproofing to the flooding hazard elevation or another flooding hazard standard approved by the Minister of Natural Resources.*" • Section 3.1.7 states that development and site alteration may occur within hazard lands where the effects can be mitigated and no adverse environmental impacts will occur. • The Natural Heritage Reference Manual (MNRF 2010) and the Significant Wildlife Habitat Technical Guide (OMNR 2000, MNRF 2012) were prepared by the MNRF to provide guidance on identifying natural features and in interpreting the Natural Heritage sections of the PPS.	• Based on a preliminary analysis and field surveys, natural features were identified within the study area which have implications under the PPS: o Significant Woodland o Fish habitat o Confirmed and candidate SWH o Candidate habitat for Species at Risk (SAR).
Endangered Species Act (ESA) (Government of Ontario 2007)	• The ESA prohibits killing, harming, harassing or capturing Endangered and Threatened species and protects their habitats from damage and destruction.	• Based on a preliminary analysis, 80 SAR or SCC were identified as having the potential to occur within the Study Area based on habitat present (Appendix I). • Based on field surveys, 2 SAR birds and a SAR bat or bats belonging to the Myotis species grouping were observed.

Policy/Legislation	Description	Project Relevance
		• Habitat may be present for SAR bat roosting, foraging and travel corridors (flyways). Regulated habitat for the 2 SAR birds is not present within the property. • The limit of disturbance associated with the proposed berms and wetland habitats will not directly impact these habitats.
Migratory Birds Convention Act (Government of Canada 1994)	• The MBCA protects migratory game birds, insectivorous birds, and several other migratory non-game birds from persecution in the form of harassment. • The schedule of on-site work must consider the MBCA window, with timing of breeding bird season generally extending between late March to late August. • "Incidental take" is considered illegal, with the exception of a permit obtained by the Canadian Wildlife Service (CWS).	• Numerous species protected by the *Migratory Birds Convention Act* were identified in background screening for the study area and confirmed as present during surveys. • The timing of construction activities, especially vegetation clearing must have consideration for the MBCA.
The Canadian Fisheries Act (Government of Canada 2019b)	• Under the updated federal *Fisheries Act*, fish are protected through 2 core prohibitions: Section 34.4(1) the death of fish by means other than fishing, and Section 35(1) the harmful alteration, disruption, or destruction (HADD) of fish habitat (Government of Canada 2019). • Any proposed work, undertaking, or activity should aim to avoid causing the death of fish, or the harmful alteration, disruption or destruction of fish habitat through the course or as a result of any proposed undertaking. Fish habitat is defined as "spawning grounds and any other areas, including nursery, rearing, food supply and migration areas, on which fish depend directly or indirectly in order to carry out their life processes". • If there is any proposed work below the high-water mark or channel itself, a proponent-led Department of Fisheries and Oceans (DFO) assessment must be completed for the proposed works to determine if the works have the potential to contravene the *Fisheries Act* and require a request for review by the Fisheries Protection Program. • If impacts to fish or fish habitat cannot be mitigated effectively, a *Fisheries Act* Authorization may be required.	• If any work is to be completed in the vicinity of the watercourse within the subject property, a proponent-led DFO assessment is required (detailed design is completed) to ensure that the works will result in no residual negative effects to fish or fish habitat. • Based on the preliminary design, an assessment was completed and indicated that a request for review (RfR) should be submitted. • A RfR will be submitted to the Fisheries Protection Program in November 2020. Once submitted it is currently taking 4-5 months for a biologist to be assigned to the project. • DFO should be consulted as early in the process as feasible. • Pending the works and result of the DFO review, an Authorization is likely to be required. This will result in off-setting being needed and a Letter of Credit from HCA.

Policy/Legislation	Description	Project Relevance
Fish and Wildlife Conservation Act (Government of Ontario 1997)	• The FWCA provides protection for certain bird species, not protected under the MBCA (i.e. raptors), as well as furbearing mammals and their dens or habitual dwellings, aside from the Red Fox (*Vulpes vulpes*) and Striped Skunk (*Mephitis mephitis*). • The FWCA provides protection for fish.	• The timing of construction activities, especially vegetation removal, must have consideration for bird nesting and den sites for furbearing mammals. • A permit may be required from the MNRF to remove fish and other wildlife species prior to any de-watering during construction if required. • No dens (active or inactive) were noted within the proposed development area. • Wildlife sweeps by qualified biologists may be warranted prior to any vegetation removals/clearing.
Greenbelt Plan (MMAH 2017)	• The Greenbelt Plan was prepared under the authority of the Greenbelt Act (Government of Ontario 2005a) and builds upon the existing policy framework established in the PPS. • The Plan identifies where urbanization should not occur to provide permanent protection to the agricultural land base and the natural ecological features in the Greater Golden Horseshoe area. • The Plan identifies the "Protected Countryside" which is further divided into the: o Agricultural System, o Natural System and o Settlement Areas. • The "Natural System" consists of the "Natural Heritage System" and the "Water Resources System".	• The entire subject property falls within the Greenbelt Protected Countryside. • The treed area in the northwest extent of the subject property is considered part of the Natural Heritage System (NHS). • A minimum 30m vegetation protection zone from the dripline of the woodland is typically required. A proposal for new development or site alteration within 120 metres of a significant woodland within the NHS requires an evaluation to identify any extension beyond the 30 metre minimum vegetation protection zone sufficient for the protection and maintenance of the feature and its functions (Government of Ontario 2005b). • Notwithstanding the previous point, development or site alterations is permitted within a key natural heritage feature or key hydrological feature for conservation and flood or erosion control projects, but only if they have been demonstrated to be necessary in the public interest and after all alternatives have been considered.

Policy/Legislation	Description	Project Relevance
HCA Ontario Regulation 161/06 (Government of Ontario 2013)	- Regulation issued under *Conservation Authorities Act,* R.S.O. 1990. - Through this regulation, the HCA has the responsibility to regulate activities in natural and hazardous areas (i.e., areas in and near rivers, streams, floodplains, wetlands, and slopes), and in areas where development could interfere with the hydrologic function of a wetland, including areas up to 120m of all Provincially Significant Wetlands (PSWs).	- Regulated watercourses, floodplain, and unevaluated wetlands are present within the subject property. - No PSWs are present within the study area. - In accordance with this policy, the detailed design plans have been prepared to avoid negative impacts to the regulated natural features and their ecological functions.
Rural Hamilton Official Plan (RHOP) (City of Hamilton 2018)	- The RHOP does not permit new developments or site alterations within PSW boundaries, or within or adjacent to Significant Woodlands, Environmentally Significant Areas or Streams. - If developments or site alterations are being proposed within or adjacent to (within 120m of) Core Areas under the RHOP, an EIS, to the satisfaction of the City in consultation with the HCA, is required.	- The treed feature in the northwestern extent of the property is considered a Core Area (Significant Woodland) under the RHOP. - A section of Battlefield Creek bisects the property and alterations are proposed to this feature and a tributary to this feature.
City of Hamilton - Rural Private Tree By-law (2000)	- Restricts and regulates the destruction of trees by cutting, burning, or other means in woodlands, and lists protected tree species based on tree circumference and diameter. - An application for minor exceptions from the by-law must be submitted and permitted prior to cutting, burning or otherwise destroying trees within the municipal limits.	- A general inventory of trees by vegetation community was conducted by a NRSI arborist to inform the preliminary design. - Within the vicinity of the development, a variety of mature trees were identified for protection within the swamp in the northwest and the H2 hedgerow. - A detailed tree inventory is being conducted by NRSI Certified Arborists. Potential removals and impacts to trees based on the detailed design will be provided under separate cover.
Ministry of Natural Resources and Forestry – Lakes and Rivers Improvement Act (RSO 1990 Chapter L.3)	- The *Lakes and Rivers Improvement Act* (LRIA) provides the Minister of Natural Resources and Forestry with the legislative authority to govern the design, construction, operation, maintenance and safety of dams in Ontario.	- The proposed dam and its control structures will be subject to the Act and will require Ministry approval.

Policy/Legislation	Description	Project Relevance
Ministry of Environment, Conservation and Parks (Environmental Protection Act, RSO 1990 Chapter E.19 and Ontario Water Resources Act, RSO 1990 Chapter O.40)	• Environmental Protection Act (specifically Section 9 of the Act for discharge of contaminants) and/or the Ontario Water Resources Act (specifically Section 53 of the Act for sewage works) require that the proponent receive an Environmental Compliance Approval	• Stormwater controls will require an ECA (previously known as a C of A).

3.0 Field Methods

Terrestrial and aquatic field surveys were undertaken within the Subject Property to characterize natural features and identify significant and sensitive features and species that have potential to be adversely affected by the proposed development. A comprehensive field program was developed in consultation with HCA staff. The field program was initiated April 12, 2019 and was completed October 8, 2019. Details of each site visit are summarized in Table 2.

The monitoring station locations are shown on Map 2 (terrestrial) and Map 3 (aquatic). Avian surveys were conducted as area searches of the Ecological Land Classification (ELC) communities and no stations were established for these surveys.

3.1 Terrestrial Field Surveys

3.1.1 Vegetation Surveys

All vegetation communities were mapped using the ELC for southern Ontario (Lee et al. 1998). An inventory of vascular plants was completed for each ELC community including composition, dominance and uncommon species. During these surveys, the soils in each community were characterized, general topography and surface drainage noted, and evidence of human impacts was described. Vegetation surveys were completed on 3 visits; in spring, mid-summer, and late summer.

3.1.2 Tree Inventory

A preliminary tree inventory documented the approximate count of trees ≥10cm Diameter at Breast Height (DBH) by species and diameter class in each ELC polygon within the northern portion of the property. The general location of these trees was provided to the study team to help inform the layout of the proposed berms and wetland areas so as to minimize impacts.

A comprehensive inventory of trees proposed for removal for the construction of the berms and wetland areas will be completed by NRSI Certified Arborists in early summer 2020. The trees will be inventoried with a sub-metre accuracy GPS unit to assess all trees within the detailed design footprint. Data collected for each tree will include location data, species, DBH (cm), number of stems, crown radius (m), health (excellent, good, fair, poor, very poor, dead) and potential for structural failure (improbable, possible, probable, imminent).

3.1.3 Bird Surveys

Breeding Bird Surveys

Early morning breeding bird surveys were conducted on 2 dates in June through early July with favourable weather conditions. An area search of the entire property was conducted on each visit with breeding evidence recorded as per the Ontario Breeding Bird Atlas protocol (OBBA 2001). Locations of all SAR or Species of Conservation Concern (SCC) were documented.

Migratory Bird Surveys

Due to the proximity of the subject property to Lake Ontario (less than 5km) and the potential for SWH designation, a total of 8 migratory bird surveys were completed (4 visits in the spring, 4 visits in the fall). Similar to the breeding bird surveys, early morning area searches were conducted. A count was compiled for each species within the units within the subject property.

3.1.4 Herpetofaunal Surveys

Anuran Call Surveys

Evening anuran call surveys were conducted once in the latter half of April, May and June following the Marsh Monitoring Program protocol (BSC 2009). A total of 4 stations were surveyed based on the presence of suitable habitats throughout the subject property (areas with seasonal standing water). A 3-minute point-count was conducted with species, call intensity, estimated number of individuals, air and water temperature, pH, wind speed, and cloud cover recorded.

Turtle and Snake Emergence Surveys

Surveys in late April through early May focused on turtle and snake emergence through habitat searches which were combined with other wildlife surveys. Search effort focused on areas of standing water suitable for turtle basking and the vicinity of the karst formation and building foundations where snake hibernacula may be present. All incidental observations of wildlife were documented during surveys throughout the year.

3.1.5 Bat Surveys

Bat acoustic monitoring was completed at 4 locations within the northern half of the subject property (Map 2). Survey locations included the cultural savannah (CUS), cultural meadow (CUM), meadow marsh (MAM2, MAM3) and swamp (SWD, SWD2-2) habitats. Bat acoustic monitoring methodology followed the guidelines outlined within the MNRF Survey Protocol for Species at Risk Bats within Treed Habitats for Little Brown Myotis (*Myotis lucifugus*), Northern

Myotis (*M. septentrionalis*) and Tri-Colored Bat (*Perimyotis subflavus*) (MNRF 2017) and is described in detail below.

Acoustic Monitoring Station Locations

NRSI placed 4 acoustic monitoring stations in areas of suitable bat habitat to assess the potential presence of SAR bats within the subject property. One station was located within close proximity to a candidate bat roost tree identified during the tree inventory and 3 stations were located within suitable foraging habitat (Map 2). Microphones were placed along the edge of the habitat in candidate foraging areas to conceal the microphones from any bats to avoid recording inspection calls.

Acoustic Detector Settings

Bat activity was monitored with the use of an omnidirectional SMM-U1 microphone and Song Meter SM4 acoustic recorder (Wildlife Acoustics Inc., Massachusetts, USA). Table 3 summarizes the unit settings used for this project.

Table 2. Bat Acoustic Monitoring SM4 Settings

Parameter	Setting Used
Detector Type	Wildlife Acoustics Song Meter SM4BAT-FS [Full-spectrum]
Microphone Type	Wildlife Acoustics SMM-U1 [omnidirectional]
Microphone Attachments	Windscreen [no horn or other weather proofing]
Gain	12 dB
16 kHz High Pass Filter	On
Sample Rate	384 kHz
Min Duration	1.5 ms
Max Duration	Off
Minimum Trigger Frequency	16 kHz
Trigger Level	12 dB
Trigger Window	3 sec
Maximum Length	00:15 min
Sunrise/Sunset Type	Solar
Timezone	UTC -04:00
Latitude	43.19989 N
Longitude	79.74868 W
Delay Start	Off
Schedule Start	Sunset + 00:00hrs
Schedule End	Sunset + 05:00hrs

Table 3. Field Survey Summary

Survey Type	Protocol	Date[1]	Start and End Time (24 hrs)	Temp. (°C)	Wind Speed (Beaufort Scale)	Cloud Cover (%)	Precipitation	Observers
Vegetation								
Vegetation Community Mapping	Lee et al. 1998	May 14	0630-1230	6	0	100	Light rain	T. Brenton, P. Deacon
Vascular Flora Inventories	Systematic search by ELC polygon	May 14	0630-1230	6	0	100	Light rain	T. Brenton, P. Deacon
		June 19	0630-1223	13	1	20	-	T. Brenton, C. Teat
		August 23	1023	19	0	10	-	P. Deacon, M. Heyming, M. Zago
Tree Inventory	Assessment of stand by ELC polygon	May 15-16	-	-	-	-	-	J. Lance, A. Cantwell, H. Manoharan
Bird Surveys								
Breeding Bird Survey	OBBA 2001	June 19	0630-1223	13	1	20	-	T. Brenton, C. Teat
		July 5	0602-0834	21-27	2	15	-	N. Miller
Migratory Bird Survey	OMNR 2011	April 12	0713-0930	4	1	80	-	E. Gosnell, E. Gosnell
		April 29	0645-0920	1	3	30	-	T. Brenton, D. Frey
		May 10	0630-1055	16	3	100	-	T. Brenton
		May 14	0630-0940	6	0	100	Light rain	T. Brenton, P. Deacon
		September 19	0704-1011	13-19	2	10	-	N. Miller
		September 24	0720-0940	13-16	0-2	0	-	K. Burrell
		October 4	0718-0933	10	3	95	-	N. Miller
		October 8	0727-1031	10-17	1	0	-	J. Pickering
Reptile and Amphibian Surveys								
Anuran Call Survey	BSC 2009	April 18	2039-2127	18-17	1-2	100	Light rain	C. Teat, G. MacVeigh
		May 15	2117-2228	13-12	1-2	40-60	-	J. Lance, A. Cantwell, H. Manoharan

Survey Type	Protocol	Date[1]	Start and End Time (24 hrs)	Temp. (°C)	Wind Speed (Beaufort Scale)	Cloud Cover (%)	Precipitation	Observers
		June 19	2132-2203	19	1	70-40	-	G. MacVeigh, A. Reinert
Herpetofauna Area Search	Area search for turtles and snakes focusing on emergence period.	Conducted during each daytime survey						
Mammal Surveys								
Bat Cavity Habitat Assessment	OMNR 2011, MNRF 2014	May 15-16	-	-	-	-	-	J. Lance, A. Cantwell, H. Manoharan
Bat Acoustic Monitoring	MNRF 2017	May 29 - June 26	-	-	-	-	-	A. Reinert, H. Fotherby, G. MacVeigh
Insect Surveys								
Insect Survey	Systematic search by ELC polygon	Incidental observations during each daytime survey						
Aquatic Habitat Assessment								
Aquatic Habitat Assessment	OSAP Rapid Transect Methodology (Stanfield 2017), Modified OSAP Methodology	June 7	0815- 1745	22-26	1	0	0	G. MacVeigh, A. Cantwell, K. Davis
		September 30	1320-1615	18	2-3	70	0	G. MacVeigh
Fish Community Survey	OSAP Screening Level Methodology (Stanfield 2017)	June 12	0915-1415	19-21	1	20	0	G. MacVeigh, K. Davis

[1]All surveys were completed in 2019.

Acoustic Monitoring Frequency and Timing

Passive acoustic monitoring was conducted between May 29 and June 26, 2019 for a total of 29 nights at all monitoring stations. Acoustic detectors were set to record bat passes for a total of 5 hours each night during the monitoring period, commencing at sunset.

Upon review of weather conditions during the monitoring period, bat echolocation calls recorded on the 20 evenings with the most ideal weather conditions for bat activity (ambient temperature greater than10°C, low wind and no precipitation) were selected for further analyses. As per MNRF (2017), at least 10 monitoring nights that align with the above weather conditions where no SAR bat activity is detected are required to confirm their absence from a given habitat.

Acoustic Data Analysis

The acoustic recorders used for this study employ direct digital recording technology and are designed to collect records from the full spectrum of bat calls (15-120 kHz) for the entire duration of the monitoring period. This allows for a full analysis of activity in the vicinity of each acoustic monitoring station. Identification of call sequences to species level are typically possible with a quality ultrasound microphone (as used in this study) when recordings of bat echolocation calls are made in the open, the bat approaches close to the microphone, the bat produces echolocation calls typical for that species, and there are few things interfering with the passage of ultrasound from the bat to the microphone (wind, proximity to the ground, type and abundance of vegetation, etc.). However, this perfect scenario rarely exists. All of the above factors can influence the ability to identify a call sequence to the species level. In addition to these conditional factors, many of the sounds produced by a particular species of bat are also produced by other species (i.e. they have overlapping ranges of call characteristics). The degree of overlap in call characteristics varies by species. These factors must all be taken into consideration when acoustic bat monitoring is undertaken.

Bat echolocation calls recorded during passive acoustic surveys were visualized with the software program SonoBat 4.2.2 for the north/northeastern US, southern Ontario Region and identified to species with the SonoBat Auto-classifier. Settings for the auto-classification of the acoustic data included the following:

- Autofilter: 5 kHz;
- Acceptable call quality: 0.70;
- Decision threshold: 0.90; and

- Maximum number of calls to consider per file: 16.

All bat call sequences with 1 or more of the following auto-classification results were manually vetted by NRSI biologists to bat species or species grouping (Table 4):

- Classified as a high frequency call sequence (potential SAR) and not confidently classified to species level;
- Classified as a SAR;
- A SAR was identified as 1 of the second or third suggested species identifications; and/or
- Not assigned a classification by the auto-classifier or classified as “No ID”.

Once the required files were manually vetted, the auto-classification program provided an estimated likelihood of presence for each species, also known as a maximum likelihood estimate (MLE). An MLE value provides an indication of the strength of evidence for the presence of a species. An MLE value of ‘0’ suggests that the data presents stronger evidence of species presence and a value of 1 suggests that the data presents weaker evidence of species presence. These values are discussed in the results section of this report. It is important to note that the likelihood estimate provides a probabilistic estimate and does not convey certainty.

Table 4. Call classifications for Ontario bat species.

Species Groupings			Species	Typical Characteristic Frequency (kHz)	Call Sequence Classification			
20 kHz			Hoary Bat (*Lasiurus cinereus*)	20 (~to 30)	Low Frequency			Hoary Bat
30 kHz			Big Brown Bat (*Eptesicus fuscus*)	~30		30 kHz		Big Brown Bat
			Silver-haired Bat (*Lasionycteris noctivagans)*	~30				Silver-haired Bat
40 kHz			Eastern Red Bat (*Lasiurus borealis*)	~40	High Frequency	40 kHz		Eastern Red Bat
	Species at Risk		Tricolored Bat (*Perimyotis subflavus*)	~40				Tri-colored Bat
		Myotis	Eastern Small-footed Myotis (*Myotis leibii*)	~40			Myotis spp.	Eastern Small-footed Myotis
			Little Brown Myotis (*Myotis lucifugus*)	~40				Little Brown Myotis
			Northern Myotis (*Myotis septentrionalis*)	~40				Northern Myotis

3.1.6 Additional Wildlife

Incidental observations of all wildlife were recorded on each site visit. In addition to the biota listed above, observations included odonates (damselflies and dragonflies) and butterflies.

3.2 Aquatic Field Surveys

3.2.1 Aquatic Habitat Assessment

To characterize the aquatic habitat conditions within the subject property, NRSI biologists assessed the aquatic habitat on site on 2 separate occasions; June 6, 2019 and September 30, 2019. As the subject property is large, with different types of watercourses (i.e. ephemeral, intermittent, etc.), different methods were utilized to obtain the needed information to characterize the feature appropriately. The watercourses and reaches assessed, including sampling stations, are shown on Map 3.

Battlefield Creek was divided into different sampling reaches and 1 of the reaches was then characterized following the Ontario Stream Assessment Protocol (OSAP) Rapid Transect methodology using Section 4, Module 1 (Stanfield 2017). This reach (Reach 2) was defined following the methods outlined in Section 1, Module 1 of OSAP as follows: the boundaries were established at thalweg crossovers that were at least 40m apart. As the tributary was uniform in width and flow, a representative 40m reach was used. The number of transects, longitudinal spacing and points per transect were determined based on minimum wetted width and length of the sampling site. In-stream habitat and adjacent lands were assessed using both qualitative and quantitative parameters including wetted width, depth, hydraulic head, substrate size, available cover, bank angle, bank composition, and riparian and aquatic vegetation communities present. This protocol was identified within the work plan as it provides repeatable quantitative measurements that facilitate accurate habitat comparisons for each sampling site from year to year.

The additional 3 reaches of the Battlefield Creek and the ephemeral features within the subject property were assessed following a modified OSAP. This included recording the following:

- Substrate type;
- Channel depth, width, bankfull width, etc.;
- General bank stability;
- Riparian and aquatic vegetation;
- Cover type and quality; and
- Flow conditions.

3.2.2 Fish Community Assessments

Fish communities within the study area were characterized following the screening level assessment protocol as described in OSAP, Section 3, Module 1 (Stanfield 2017). The screening level assessment uses a comparatively low level of sampling intensity, assessing all habitat types within the sampling reach through a single pass of electrofishing. This protocol is designed to provide a qualitative assessment of species abundance and characterize the fish communities throughout each sampling reach. A license to collect fish for scientific purposes was issued to NRSI to conduct this work on April 15, 2019 by the MNRF Guelph District – Vineland Field Office (No. 1092592).

Fish sampling was conducted using a Smith-Root backpack electrofisher (LR-20B), set to a pulsating frequency of 60Hz, and an electric potential of 100 – 150 volts. The sampling was conducted on available habitats within the subject property on June 12, 2019.

Sampling involved one biologist with the backpack electrofisher and one alongside with a dip net walking in transects from the downstream end of the site to the upstream end of the Battlefield Creek. Sampling also occurred within Tributary A and spot shocking at the culvert crossings along the Dofasco 2000 Trail, as shown on Map 3.

No electrofishing occurred upstream of the driveway (within the southern portion of the site) as there was no connection under the driveway and it was primarily dry at the time of the assessment. No electrofishing occurred within the majority of the ephemeral features as they were either dry, or had too limited water.

The observed electrofishing conditions, settings and total sampling time are summarized in Table 5 for each sampling site. All captured fish were identified, enumerated and released.

Table 5. Electrofishing Conditions, Settings, and Shocking Time

	Battlefield Creek Station EMS-001	Battlefield Creek Station EMS-002	Trib. to Battlefield Creek Station EMS-003	Culverts along Dofasco Trail Station EMS-004
Date	June 12, 2019			
Sampling start time	0915hrs			
Sampling end time	1415hrs			
Air temperature (°C)	19 - 21			
Water temperature (°C)	15	16	16	17
Time water temp. taken	950hrs	1145hrs	1245hrs	1420hrs
Number of Netters	1			
Voltage (V)	150-200			
Pulsating Frequency (Hz)	60			
Ampere (Amps)	40			
Shocking time (sec.)	1,744	1,198	507	41

4.0 Existing Conditions

4.1 Soil, Terrain and Drainage

The study area is situated within the northern margin of the Haldimand Clay Plain physiographic region, which is generally a broad flat clay plain (Chapman and Putnam 1984). The underlying bedrock surface within the study area is the Lockport Amabel formation, which is a buff and gray dolomite (Presant et al 1965).

The soil types vary widely within the subject property. The network of swamp and marsh communities in the northwest are underlain by Lincoln silty-clay-loam, with Haldimand silty-clay-loam comprising the southern half of the site and field areas in the north. Borehole samples across the low-lying northern half of the property documented topsoil depths of 15-30cm underlain by silty-clay varying from approximately 60cm to over 550cm atop bedrock (Soil Engineers Ltd. 2019). The silty-clay soils in the north portion of the property act as an aquitard which limits aquifer recharge with the exception of locations where karst features allow for infiltration (Greer Galloway 2020).

The subject property is bisected in a west-east orientation by a section of bedrock escarpment (The Ontario Geological Survey 2003). Along the ridge, soils are Farmington loam and Smithville silt-loam (Presant et al. 1965). In general, soils in the flat northern portion of the subject property have limited infiltration capacity and are prone to holding water on the surface and concentrating flows toward the lower reach of Battlefield Creek during rainfall events. The soil above the karst feature is more well-drained and has relatively good infiltration capacity on gently rolling topography.

The subject property is located within the 784ha Battlefield Creek sub-watershed which is comprised of agricultural lands, residences, fallow land and natural areas throughout (Greer Galloway 2020). Surface drainage moves from east to west with the headwaters in the south of the site flowing north over the ridge feature.

Monitoring well data indicates that the groundwater level was at or slightly above the surface in the northern portion of the property in May 2019 and gradually declining through the spring and summer before recharging in the fall (Greer Galloway 2020). Surveys conducted in April and May encountered standing water within the wetlands to a maximum depth of 40cm.

4.2 Vegetation

4.2.1 Vegetation Communities

The vegetation communities identified within the subject property are summarized in Table 6 and are shown on Map 2.

4.2.2 Vascular Flora

A total of 150 species of vascular plants were recorded during detailed vegetation inventories within the subject property. The highest diversity of plant species was recorded in the forest features in the southeast corner of the site. The 53 non-native species comprise more than one third of the plants documented from the site. The high proportion of non-native species is typical of a site with a cultural history including recently retired agricultural lands, a decommissioned road right of way (Dofasco 2000 Trail) and a homestead site.

Problematic non-native species that could compromise wetland creation works include Common Reed (*Phragmites australis* ssp. *australis*), Glossy Buckthorn and Reed Canary Grass. The approach to site preparation in advance of restoration seeding and planting will need to address how these species are to be managed prior to and following the wetland creation.

No SAR or SCC vascular plant species were observed. Two species which are considered rare in Hamilton (Oldham 2017) include Narrow-leaved Sedge (*Carex grisea*) and False Mermaid. Narrow-leaved Sedge was observed in the Green Ash swamp adjacent to First Road East and False Mermaid was observed within the deciduous forest in the southeast corner of the property.

A complete list of the vascular flora species reported for the study area and observed by NRSI in 2019 is provided in Appendix II.

Table 6. Vegetation Communities Identified within the Study Area

Ecosite Type	Community Description	Vegetation Composition
Cultural		
CUM	Cultural Meadow	A complex of meadows is present in the northern half of the subject property. The meadow to the north of the residence on Second Road East is well-established with young White Ash (*Fraxinus americana*) and clones of Grey Dogwood (*Cornus foemina* ssp. *racemosa*) occurring sporadically throughout. The groundcover is dominated by Smooth Brome (*Bromus inermis*). The other3 meadow areas appear to have been in row crop agriculture recently and these fields have transitioned to early successional meadow habitat. Dominant native species include Canada Goldenrod (*Solidago canadensis*), New England Aster (*Symphyotrichum novae-angliae*), Hairy Aster (*S. pilosum*) and Lance-leaved Aster (*S. lanceolatum*). Non-native species including Wild Carrot (*Daucus carota*), Orchard Grass (*Dactylis glomerata*) and Smooth Brome are also present throughout.
CUT	Cultural Thicket	The subject property contains three areas of cultural thicket communities. It is presumed that all of these features were used for agriculture within the last 25 years and have regenerated in dense stands of Hawthorn, European Buckthorn (*Rhamnus cathartica*), Grey Dogwood and Black Walnut (*Juglans nigra*). The thicket fronting onto Second Road East contains dry open areas as well as wetter areas receiving seasonal flow from the deciduous forest (FOD) feature to the south. It appears that surface flow may infiltrate the bedrock somewhere within the thicket. Both thickets in the northern half of the site are adjacent to marsh features and contain some herbaceous species indicative of wetland or wetland fringe habitat including Swamp Milkweed (*Asclepias incarnata*), Purple Loosestrife (*Lythrum salicaria*), Fowl Meadow Grass (*Glyceria striata*) and Red-Osier Dogwood (*Cornus sericea*).
CUS	Cultural Savannah	A linear strip of cultural savannah exists along the crest of the ridge which bisects the subject property. The remains of a driveway and building foundation are present in the west and a barn foundation is present in the east, behind the residence fronting onto Second Road East. Mid-age Black Walnut is dominant throughout this area, with sparse stands of European Buckthorn, Black Raspberry (*Rubus occidentalis*) and Bell's Honeysuckle (*Lonicera* X *bella*) lining the informal path that runs the length of the feature. The groundcover is largely cool season grasses; Smooth Brome, Orchard Grass, and Kentucky Bluegrass (*Poa pratensis*). In close proximity to the karst formations, soil depths were limited to 15-25cm.
Deciduous Forest		
H	Naturalized Hedgerows	A total of 6 hedgerows are present within the subject property. H1 and H3 are comprised of European Buckthorn and young, declining Green Ash (*Fraxinus pennsylvanica*). The remaining hedgerows contain mid-age to mature hardwoods;

Ecosite Type	Community Description	Vegetation Composition
		largely Red Oak (*Quercus rubra*) with some Shagbark Hickory (*Carya ovata*) also present. European Buckthorn is also common throughout these features.
FOD7	Fresh - Moist Lowland Deciduous Forest	A treed area in the southeast corner of the subject property directs overland flow from the FOD community and into the CUT community. The tree and shrub composition reflects a mixture of the two features and is situated in a topographic depression. The feature contains shallow, braided channels which direct seasonal flows northward.
FOD	Deciduous Forest	The forest in the southeast corner of the site is comprised of an unusual species assemblage of American Beech (*Fagus grandifolia*), Eastern White Pine (*Pinus strobus*), White Oak (*Quercus alba*), White Ash, Red Oak and Shagbark Hickory. The feature contains pit and mound topography indicative of mature forest conditions with drier ridges interspersed with wetter depressions. American Beech and Hop Hornbeam (*Ostrya virginiana*) are common in the understorey with a typical groundcover of spring ephemerals including White Trillium (*Trillium grandiflorum*), Bloodroot (*Sanguinaria canadensis*) Jack-in-the-pulpit (*Arisaema triphyllum*) and Virginia Waterleaf (*Hydrophyllum virginianum*). Species indicative of high-quality habitats such as False Mermaid (*Floerkea proserpinacoides*) and Wood Reed Grass (*Cinna arundinacea*) are present. Drainage within the forest flows north through the FOD7 community. This feature is identified as a Natural Heritage Features Linkage (City of Hamilton 2018).
Wetland		
MAM2	Mineral Meadow Marsh	Three areas of mineral marsh are present in the northern half of the site. All are dominated by Reed Canary Grass (*Phalaris arundinacea*), a non-native and invasive species, with small areas of Narrow-leaved Cattail (*Typha angustifolia*) along in areas which remain wet into the summer. Common wetland forbs are interspersed such as Dark Green Bulrush (*Scirpus atrovirens*) and Swamp Milkweed. The central MAM2 unit contained water depths up to 40cm into late May before drying up through the month of June.
MAM3	Organic Meadow Marsh	An area of marsh adjacent to First Road East is comprised of saturated Reed Canary Grass growing on organic soil. This area contains sparse Red Osier Dogwood and Green Ash saplings. Drainage from much of the subject property is directed into this feature before continuing west of the subject property.
SWD2-2	Green Ash Mineral Deciduous Swamp	The two areas of swamp in the northern half of the site are comprised almost entirely of declining and regenerating Green Ash with scattered Bur Oak (*Quercus macrocarpa*) throughout the western portion. The feature in the northwest corner of the property is considered a Natural Heritage Features Core Area, Key Natural Heritage Feature Significant Woodland and is part of the Greenbelt Natural Heritage System (City of Hamilton 2018). Based on air photographs available from the

Ecosite Type	Community Description	Vegetation Composition
		McMaster University air photo collection, this treed area was surrounded by farmed lands in 1943 (Greer Galloway 2020). The impacts of Emerald Ash Borer (*Agrilus planipennis*) (EAB) are reflected in the patchy canopy which has resulted in a dense groundcover of graminoids. Patches of Glossy Buckthorn (*Frangula alnus*) and European Buckthorn are present throughout and are very dense along the Dofasco 2000 Trail. Both features contained standing water into late spring. An intermittent channel runs east to west across the site and passes through each of these areas of swamp.
SWD	Deciduous Swamp	At the toe of slope extending north of the karst formation, a mid-age stand of Black Walnut, hawthorn (*Crataegus* spp.) and planted White Spruce (*Picea glauca*) reflects an extension of the cultural savannah community to the south. The understorey includes patches of European Buckthorn and Black Raspberry with a low diversity groundcover. Soils were saturated throughout the 2019 surveys as this area receives groundwater flow which collects in this area with overflow continuing north through the meadows toward the channel.
Agricultural		
-	Annual Row Crop	A series of 4 fields are present in the southern portion of the subject property which were in annual row crops (soybeans) in 2019. These fields direct surface water toward Battlefield Creek and do not hold large areas of standing water in the spring. Surface water in the southwest field of the subject property appears to infiltrate the bedrock and flow from the escarpment ridge to the north of the old residence site.

Tree Inventory

The preliminary tree inventory provided a high-level description of the composition of the swamp and hedgerow features in the northern portion of the property. While mature trees were noted in the hedgerows (H2, H4, H5 and H6) and within the western portion of the Green Ash swamp (SWD2-2), no significant trees (rare species or trees of notable size and stature) were observed.

The Green Ash swamp was found to be comprised largely of Bur Oak (30%), Green Ash (16%) and Hawthorn species (26%), with small numbers of Red Oak, White Ash, Black Walnut and American Basswood also present. Species diversity appears to be higher near First Road East and transitions to a near monoculture of young Green Ash toward Second Road East. It is noted that Green Ash ≤10cm DBH are dominant in the understorey and shrub layer but the species is in decline throughout the site.

Early successional species including Manitoba Maple (*Acer negundo*) and Black Walnut are common along the saturated base of the karst slope and several introduced species including Red Pine (*Pinus resinosa*), Sweet Cherry (Prunus avium), White Mulberry (*Morus alba*), Common Lilac (*Syringa vulgaris*) and Norway Spruce (*Picea abies*) are present in the vicinity of the old residence and barn.

A detailed tree inventory within the footprint of the east berm, where a number of trees may be removed or injured based on the detailed design plan, will be completed by NRSI Certified Arborists in early summer 2020. This information, along with recommended mitigation, will be compiled under a separate cover.

4.3 Wildlife

4.3.1 Birds

A total of 101 bird species are reported from the study area based on the OBBA (BSC et al. 2006). The data found in the OBBA includes those species that have been observed in the area (10 x 10km overlapping atlas square 17PH08), are known to nest in the area, and/or have exhibited some evidence of breeding in the area. During 2019 bird surveys, 105 bird species were observed by NRSI biologists within the subject property.

One SAR bird, Barn Swallow (*Hirundo rustica*) was observed foraging above marsh areas within the subject property on several dates. This species is listed as Threatened provincially and federally (MNRF 2019b, Government of Canada 2019a). As typical nesting habitat is not present within the subject property (buildings, bridges or other structures), and tree cavity nesting was not observed, regulated habitat is not present. It is likely that Barn Swallows are nesting on nearby barns or houses close to the property.

A second SAR bird, Bobolink (*Dolichonyx oryzivorus*) was observed as a fly-over on July 5; similarly, breeding evidence was not observed. It is noted that suitable grassland bird habitat for both Bobolink and Eastern Meadowlark (*Sturnella magna*) is present in the cultural meadow/fallow field areas in the northern portion of the site and active or passive grassland or meadow restoration of the southern fields would increase suitable habitat.

Three SCC, Eastern Wood-pewee (*Contopus virens*), Common Nighthawk (*Chordeiles minor*) and Wood Thrush (*Hylocichla mustelina*) were documented from the property. Eastern Wood-pewee was observed showing probable breeding evidence on July 5 within the forest in the southeast corner of the property (FOD/FOD7) and through the cultural savannah (CUS) along the ridge feature. A Common Nighthawk was observed foraging and performing aerial displays on May 15 during the calling anuran survey. The areas of thicket and cultural savannah within the subject property provide suitable nesting habitat for this species. Common Nighthawk is a cryptic, nocturnal species and observation of breeding evidence is difficult to confirm. For the purpose of this study it is assumed that the species was nesting on site given the extent of suitable habitat. Wood Thrush was observed on May 10 and May 14 during migration surveys and was not present during the breeding bird season.

Rusty Blackbird (*Euphagus carolinus*) was observed on May 10 and May 14 during migration surveys along the southern edge of the Green Ash Swamp (SWD2-2) along First Road East. This species is listed as Special Concern federally but has no provincial designation. This species breeds in bogs and marshes in northern Ontario but utilizes fields and swamp edges during migration through southern Ontario (Avery 2013).

A number of locally rare bird species (HCA 2014) were observed during both the migration and breeding seasons; Yellow-billed Cuckoo (*Coccyzus americanus*), Common Nighthawk, Wilson's Snipe (*Gallinago delicata*), Yellow-bellied Sapsucker (*Sphyrapicus varius*), Merlin (*Falco columbarius*), Blue-headed Vireo (*Vireo solitarius*), Common Raven (*Corvus corax*), Carolina Wren (*Thryothorus ludovicianus*), Golden-crowned Kinglet (*Regulus satrapa*), Magnolia Warbler (*Setophaga magnolia*), Blackburnian Warbler (*Setophaga fusca*), Black-throated Blue Warbler (*Setophaga caerulescens*), Yellow-rumped Warbler (*Setophaga coronata*), Black-throated

Green Warbler (*Setophaga virens*). During the migration surveys, an exceptional diversity of species, including most warbler observations, was noted from the cultural savannah and swamp feature along the ridge.

A full list of bird species reported from the study area during 2019 surveys, is provided in Appendix III.

4.3.2 Herpetofauna

According to the ORAA (Ontario Nature 2019), 22 species of herpetofauna are known from the 10 x 10km square overlapping the study area. Additionally, historic records of Timber Rattlesnake (*Crotalus horridus*) are known from the study area (NHIC 2019) as well as the Unisexual Ambystoma Jefferson Salamander dependent population (*Ambystoma laterale* - (2) *jeffersonianum*) (MNRF 2019c). NRSI field investigations confirmed the presence of 8 species of reptiles and amphibians within the subject property. No SAR or SCC were documented from the site. None of the reptile and amphibian species observed are considered locally rare (HCA 2014). A full list of the reptile and amphibian species reported from the Study Area is provided in Appendix IV.

Calling anuran surveys documented 5 species of anurans (frogs and toads) within the subject property. Table 7 provides a summary of the frog call survey results for 2019. Northern Leopard Frog (*Lithobates pipiens*) was observed incidentally, on several occasions, during other surveys.

Turtle Overwintering Habitat

An assessment of turtle overwintering habitat (deep ponds or wetlands with mucky substrates) was completed on April 12, 2019. The assessment did not document suitable habitat within the subject property. Area searches for turtles were conducted during spring surveys and no turtles were observed.

Table 7. Anuran Call Survey Results from 2019

Anuran Call Station	Species	Anuran Call Survey[1]			Number of Species	Total Number of Individuals	SWH?
		1	2	3			
ANR-001	American Toad		2 (2)		2	8+	No
	Gray Treefrog			*			
	Spring Peeper						
	Western Chorus Frog	2 (2)	2 (6)				
ANR-002	American Toad	*	2 (3)		3	9+	No
	Gray Treefrog			*			
	Spring Peeper		1 (1)				
	Western Chorus Frog	2 (5)					
ANR-003	American Toad				2	3	No
	Gray Treefrog						
	Spring Peeper		1 (1)				
	Western Chorus Frog	1 (1)	1 (2)				
ANR-004	American Toad				2	8+	No
	Gray Treefrog			*			
	Spring Peeper	2 (2)	2 (5)				
	Western Chorus Frog	2 (3)	2 (3)				

*Species calling from outside of plot.

[1] Marsh monitoring anuran call code with estimated number of individuals in brackets.

4.3.3 Mammals

According to the Mammal Atlas of Ontario (Dobbyn 1994), 38 mammal species are reported from the 10 x 10km square which overlaps the study area. Surveys in 2019 documented 14 species from the subject property. Additionally, bat acoustic data identified that one or more unidentified SAR bat species (*Myotis* spp.) was present at the site. Appendix V provides a list of the mammal species reported from the study area.

Bat Survey Results

Four bat species were documented as present within the subject property during passive acoustic monitoring. All of the confirmed species are relatively common throughout Ontario In addition to the confirmed species, bat pass sequences were also identified to the *Myotis* species grouping, which includes Little Brown Myotis, Eastern Small-footed Myotis (*M. leibii*) and Northern Myotis, as well as the 40 kHz species grouping which includes the *Myotis* species, Tri-colored Bat and Eastern Red Bat (*Lasiurus borealis*). All Myotis species which occur in Ontario and the Tri-colored Bat are listed as SAR. A summary of the acoustic monitoring results is provided in Figure 1.

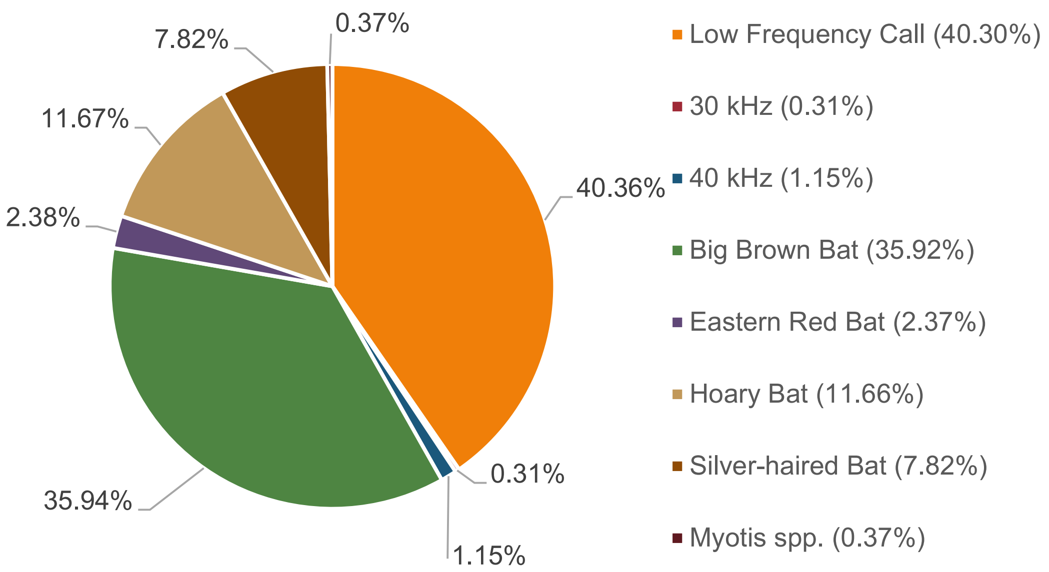

Figure 1. Bat species and species grouping classification results (all stations)

A total of 6,775 bat pass sequences were recorded throughout the acoustic monitoring period that were of high enough quality that they could be classified to either the species level or a species grouping. The majority of these bat pass sequences that were classified to the species level were identified as Big Brown Bat (*Eptesicus fuscus*) (35.92%). Several sequences were classified to Hoary Bat (*Lasiurus cinereus*) (11.66%) and Silver-haired Bat (*Lasionycteris noctivagans*) (7.82%). A small proportion of calls were classified to Eastern Red Bat (*Lasiurus borealis*) (2.37%).

Consistent with these findings, the site-level MLE values (across all monitoring stations throughout the entire monitoring period) for each species suggest that there is strong evidence for the presence of Big Brown Bat (MLE=0), Hoary Bat (MLE=0), Eastern Red Bat (MLE=0) and Silver-haired Bat (MLE=0) within the subject property.

Of those bat pass sequences that were classified to species groupings, 2,733 (40.34%) were identified to the Low Frequency species grouping, 21 (0.31%) to the 30 kHz species grouping, 78 (1.15%) to the 40 kHz species grouping and 25 (0.37%) to the Myotis spp. species grouping. While SAR bats are included in the 40 kHz species grouping, this species grouping also includes non-SAR bats (Eastern Red Bat) and should not independently be considered probable evidence of the presence of SAR.

Slight differences in the species detected and number of call sequences recorded was noted among all monitoring stations, as illustrated in Figure 2 and described in the following sections.

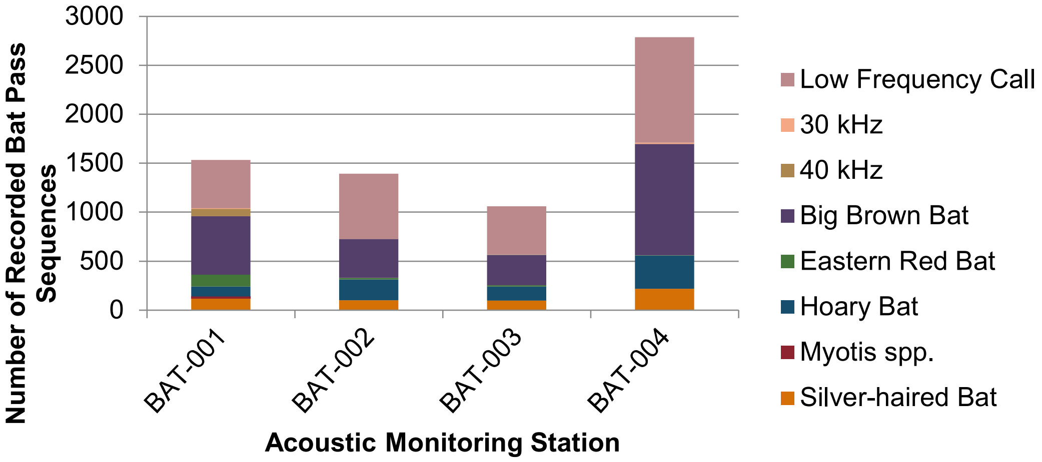

Figure 2. Bat species detected and relative abundance (all stations)

Species at Risk

Bat pass sequences identified to the *Myotis* spp. and 40 kHz species groupings were detected at monitoring station BAT-001. Two bat pass sequences identified to the 40 kHz species grouping were also detected at monitoring station BAT-003 during the monitoring period. While bat SAR are included in the 40 kHz species grouping, this species grouping also includes Eastern Red Bat, and should therefore not be considered probable evidence of the presence of bat SAR. The timing of bat pass sequence recordings can provide information on how bats are using available habitats within the subject property. Bat pass sequences recorded early in the evening can indicate the presence of roosting and maternity colony habitat while sequences recorded later in the evening can indicate the presence of foraging habitat and movement or travel corridors (flyways). Due to the timing and number of recorded sequences at BAT-001, it is likely that SAR bats are roosting within the vicinity of monitoring station BAT-001 (Figure 3). They are also likely using the trail and/or savannah habitat for foraging or as a movement or travel corridor between key habitats. Because so few bat pass sequences were identified to the 40 kHz species grouping, none were identified to the *Myotis* spp. grouping or a SAR and sequences were identified to Eastern Red Bat at monitoring station BAT-003, it is likely that the two bat pass sequences identified to the 40 kHz species grouping are Eastern Red Bats and not bat SAR. However, the absence of bat SAR at this station is not confirmed.

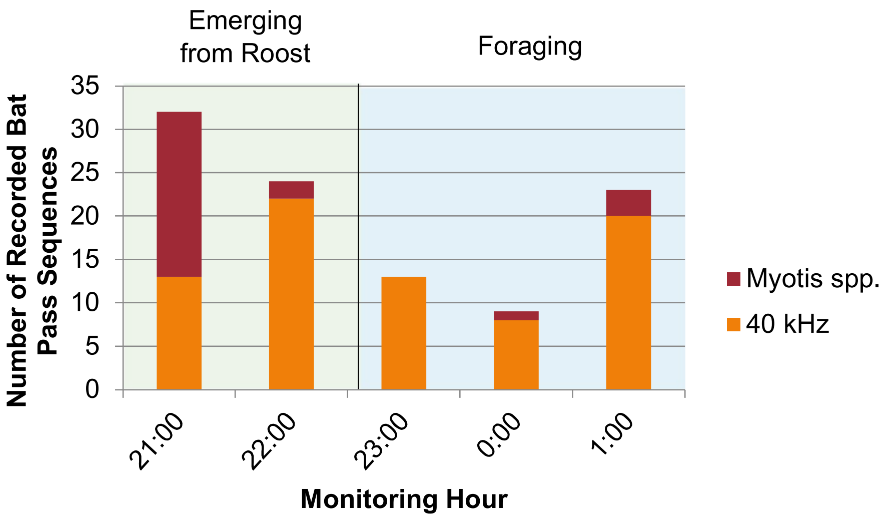

Figure 3. Bat SAR and potential bat SAR detected and relative abundance per hour

Significant Wildlife Habitat

Big Brown Bat and Silver-haired Bat were detected in relatively high numbers at all monitoring stations during every night of the monitoring period. The majority of these recordings were documented during the first and second monitoring hours, indicating that these species are potentially using habitats within the vicinity of these monitoring stations for roosting habitat, including for maternity roost colonies, or at the very least foraging in these areas shortly after leaving nearby roosts (Figure 4). The number and timing of Big Brown Bat and Silver-haired Bat recordings indicate that these species are also likely using the subject property for foraging and/or as a movement or travel corridor between key habitats.

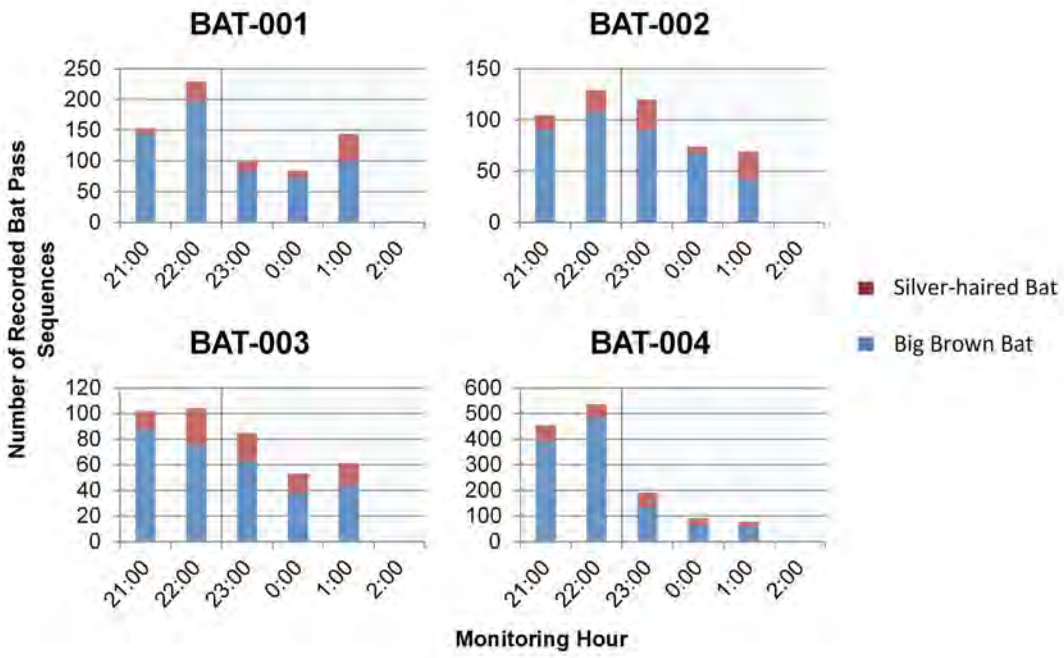

Figure 4. Bat species detected and relative abundance per hour[1] (all stations)

4.3.4 Insects

Odonata

According to the Ontario Odonata Atlas Database (MNRF 2019d), 7 species of Odonata (dragonfly and damselfly) are reported from the study area. During field surveys conducted within the subject property in 2019, 4 species of Odonata were observed: Common green Darner (*Anax junius*), Calico Pennant (*Celithemis elisa*), Eastern Pondhawk (*Erythemis simplicicollis*), White-faced Meadowhawk (*Sympetrum obtrusum*) and Widow Skimmer (*Libellula luctuosa*). These species are all considered common in Hamilton (HCA 2014) and can be found near marshes and wet meadows. Much of the northern half of the property contains seasonal standing water, marsh habitat and Battlefield Creek, all of which provide suitable habitat for dragonflies and damselflies.

A complete list of Odonate species reported from the study area is provided in Appendix VI.

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[1] Detected sequences during 21:00 and 22:00 hrs are likely recorded while emerging from roost. Detected sequences between 23:00 and 2:00 hrs are likely recorded during foraging or movement activity.

Butterflies

According to the Ontario Butterfly Atlas (Macnaughton et al. 2019), 41 butterfly species have been reported from the study area. Additionally, Mottled Duskywing (*Erynnis martialis*) and West Virginia White (*Pieris virginiensis*) are known from the vicinity (NHIC 2019). NRSI staff observed 14 species during 2019 surveys.

Monarch (*Danaus plexippus*) was documented from the subject property and is listed as Special Concern provincially and federally (MNRF 2019b, Government of Canada 2019). Several adults were observed throughout the summer and early fall as well as caterpillars and pupae with most observations made in the vicinity of the cultural meadow and meadow marsh in the northwest portion of the subject property. The Monarch's larval foodplant, Common Milkweed (*Asclepias syriaca*) and Swamp Milkweed are both present in small numbers across the site. No other significant butterfly species were observed.

A complete list of the butterfly species reported from the Study Area is provided in Appendix VII.

4.4 Aquatic Resources

Battlefield Creek originates to the east of the site, although the exact location or route it travels is difficult to discern due to wetland pockets and agricultural practices changing the flow patterns. Above the escarpment, the creek has previously been characterized within the EA as a low-gradient, mainly ditched and channelized watercourse that has generally broad and shallow channels, with few riffle habitats or deep sections (Amec Foster Wheeler 2018). The EA identifies the substrates as fine clay and/or silt, and that the watercourse has an annual lack of flow, leaving most dry except for standing water in the vicinity of road culverts, ditched deep sections, or in the dugout ponds. It also identifies that Battlefield Creek is heavily vegetated with emergent aquatic plants that can tolerate drier conditions in the summer. NRSI field assessments confirmed the findings from the EA. Erosion was also noted along the banks of Battlefield Creek, indicating that high flows are present during different times of the year.

4.4.1 Aquatic Habitat

Battlefield Creek

Reach 1 is located from the culvert crossing under First Road East (downstream extent), to where the representative OSAP was completed (Map 3). This reach is approximately 150m in length and has been channelized in the past for agricultural purposes. At the culvert the channel is wide and less defined, with dense vegetation present. The channel upstream begins to become channelized with a uniform width and depth. No riffles or pools were identified within this reach. The average wetted width was 2.1m and the average bankfull was 2.6m during the June assessment when the feature was flowing. During the September field visit, a pool of water was present at the culvert and then there were additional pockets of water (less than 3cm depth) with no flow or connectivity within the remaining reach. There was no flow from or to this pool, and the water was clear. The channel substrate consists primarily of fine clay, silt and detritus. In-stream vegetation was comprised of Water Plantain (*Alisma plantago-aquatica*), Pondweed sp. (*Potamogeton* sp.), and some Duckweed sp. (*Lemna* sp.), with algae also being identified during the second visit. Dominant riparian vegetation observed to be meadow on the right bank and forest on the left bank. The banks were stable and densely vegetated which provides shading to the watercourse. Fish were observed throughout the reach during the June visit, and within the pockets of water during the September visit (Appendix VIII).

Reach 2 is the representative OSAP site chosen and is shown on Map 3. This section is very similar to Reach 1 in that it is channelized and straight, with a uniform width and depth profile. There were no riffles or crossovers, so a representative 40m reach was chosen. The average active channel width during the June assessment was 2.5m with depths ranging from 3 to 23cm. There was limited flow with 0mm hydraulic head present. During the September visit the active channel ranged from 0.6 to 1.1m wide, with pockets of water or no water present close to the upstream end of the reach. Substrates were primarily silt with fine clay and minimal sand. In-stream cover included woody debris and detritus. In-stream vegetation was the same as the previous reach, although was not as prominent. Dominant vegetation was forest on both banks, which provided great shading to the reach. Fish were observed within the channel during the June visit, and within the pockets of water during the September visit.

Reach 3 represent the feature through the meadow marsh. Upstream of the OSAP reach, the channel becomes less defined with more grasses, then becomes braided with no definition. During the June assessment there was minimal diffuse flow throughout the marsh area, and the feature was dry in September. No fish were observed throughout this section during either site assessment. Further review of background aerial imagery also shows that even during high flow there is no channel throughout the watercourse, which makes fish passage unlikely through this section.

Reach 4 extends from the upstream end of the meadow marsh (as shown on Map 3) to the culvert crossing at Second Road East. This section is similar to the first two reaches, as it has a low-gradient, uniform depth and width and has been channelized in the past. Immediately upstream of the marsh, the channel had slack flow and meandered slightly during the June assessment. In some sections, there were two channelized ditches present, with small connection points. This made it difficult to determine where the main channel was. The active channel width (wetted width) ranged from 0.5 to 1.4m, with the bankfull range being 1.1 to 2.4m. During the second visit, this entire reach was dry. Erosion was noted in some areas along both banks, indicating that high flow has been present in the past. Limited aquatic vegetation was present within the channel, with emergent grasses being the primary vegetation present. More emergent grasses lined the channel during the second visit. During the first visit, there was evidence of the channel starting to meander within the channelized confines. Substrates consisted mainly of silt, with some clay, sand and gravel. Dominant riparian vegetation was observed to be thicket/ swamp. The channel was well shaded throughout this reach and fish were observed during the June visit, although none were noted with the second assessment. Limited cover was present in the channel, including woody debris and detritus.

Tributary 1

Tributary 1 was assessed from its confluence with Battlefield Creek to the driveway/karst feature that bisects the property. Upstream of the driveway the features were also assessed and are identified as Tributary 1A and 1B, as shown on Map 3. Upstream of the confluence with Battlefield Creek, the channel is similar to what was identified for Reach 1 and 2 within the main channel. It has a higher gradient as it approaches the field edge, with a slight drop. The feature as it runs along the agricultural field is lower gradient, and there was evidence that agricultural equipment drove through it. This feature had previously been channelized and moved to along the hedgerow to facilitate agricultural practices. Erosion was noted within the channel. The majority of the channel was straight, with an average wetted width of 0.4m. There was minimal depth and limited flow during the June visit. The feature starts at the karst feature at the driveway and also has a small side channel with runoff from the road (First Rd East). A small patch of Common Reed is present downstream of the karst feature, which may have been a small pond feature at some time in the past. Substrates throughout were comprised of silt, sand, karst, and gravel substrates, with algae growing within the channel as well. Fish were observed within a portion of the field area during the June assessment. The feature was completely dry during the September visit.

Tributary 1A and 1B

Tributary 1A and 1B are present within the agricultural fields upstream of the driveway. They are headwater features that both convey surface flow during wet periods or after significant rainfall events. Both of the tributaries disappear into a sinkhole (doline) feature within the agricultural field and exit from the karst feature beside the driveway. As shown on Map 3, the channels are defined and do not get ploughed, indicating that they do convey water through various points of the year.

Both features had limited flow during the June site visit, and erosion was noted within the channels. Substrates within the tributaries was primarily silt, sand and limited gravel. As the features were through or along agricultural fields, there was little to no shading. Aquatic vegetation was limited to algae in some locations. No fish were observed within these features and it is unlikely they would be present due to the underground section of the channel. These tributaries were dry in September. No electrofishing was completed on these features.

Additional Aquatic Features

Numerous small ephemeral channels are present along the southern edge of Battlefield Creek (Map 3). These channels convey surface flow during high water events. They were defined, but disappeared within the agricultural/ meadow features. Limited water was present within these channels during the June assessment, and both were dry during the September assessment. No fish were observed, or are believed to be present within the features due to the lack of flow or water depth.

As shown on a site map provided by HCA, an additional drainage feature is present within the northeast corner of the subject property. This feature conveys surface water, but no defined channel was observed. There is a gradient change into the meadow marsh features. No flow was present during the June assessment, and the feature was completely vegetated with meadow species during the September visit.

As part of the Dofasco 2000 Trail creation, it appears that a ditch was created along the southern edge to help facilitate water movement. Multiple equalization culverts are present along the trail, as shown on Map 3. These culverts convey water from an upstream pond into channelized ditches that have varying degrees of definition that ultimately connect to Battlefield Creek. Pockets of water with no flow were found at the culvert locations and within the ditch during the June assessment. Limited water was present at the culverts during the September assessment.

4.5 Fish Community

Fish community was assessed within two reaches of Battlefield Creek at stations EMS-001 and, EMS-002 (Map 3). The first reach was electrofished from First Road East to the marsh (MAM2). The second reach (EMS-002) was electrofished from the eastern edge/upstream edge of the marsh (MAM2) through the swamp (SWD2-2) feature, up to the Second Road East crossing. Tributary 1 was electrofished from the confluence with Battlefield Creek upstream to the karst feature at the driveway. This feature is a barrier to fish during all seasons. Three culvert crossing locations (EMS-003) were also electrofished along the Dofasco 2000 Trail. A complete list of species reported in background information sources and species observed in 2019 by NRSI is provided in Appendix VIII.

Three species of fish were captured within EMS-001, the downstream reach of Battlefield Creek. A total of 38 Brook Stickleback (*Culaea inconstans*), 18 Fathead Minnow (*Pimephales promelas*), and 4 Pumpkinseed (*Lepomis gibbosus*) were captured through the single pass backpack electrofishing. Some of the Fathead Minnow captured were in adult spawning condition, and an abundance of small young-of-year (YOY) fish were observed but not captured due to size. At the time of the second aquatic habitat, only pockets of water were present, with no flow or connection. Fish were observed within these pockets during the second assessment.

Within the upper reach (EMS-002), five Brook Stickleback, four Fathead Minnow, and one Brown Bullhead (*Ameiurus nebulosus*) was captured. The Brown Bullhead was captured in a deeper pocket of water, and it is unclear how the system would be able to support a fish of this size which is typically found in deeper areas of warm-water systems. As the meadow marsh downstream of this reach has no channel even during higher flows, it is likely that the fish from this section are actually washed down from upstream (outside of the subject property), which is connected during high water levels (as identified through aerial imagery). The upper reach was primarily dry, with very few small pockets of water, during the second habitat assessment. No fish were observed within the pockets of water at the second assessment.

Tributary 1 (EMS-003) also resulted in the capture of the same three species as the downstream reach of Battlefield Creek. This included 8 Brook Stickleback, 13 Fathead Minnow, and 4 Pumpkinseed. An abundance of YOY fish were also observed. This reach was dry and no fish were observed at the time of the second assessment.

Electrofishing at the culverts along the Dofasco 2000 Trail (EMS-004), resulted in the capture of one species, a Pumpkinseed.

The species known from within Battlefield Creek and the tributaries, are all considered native and common. They are considered primarily warmwater species, with Brook Stickleback having a coolwater thermal preference. They also make up a combination of highly tolerant and moderately tolerant species. None of the fish species known from within Battlefield Creek and the subject property are considered to be SAR. The background review did not indicate the presence of any SAR fish or mussel species (DFO 2019).

5.0 Significance and Sensitivity of Natural Features

5.1 Watercourses and Fish Habitat

The intermittent main channel of Battlefield Creek, as well as Tributary 1 up to the karst feature, are considered fish habitat. Fish were found within these features during the electrofishing, indicating that they provide direct habitat for at least a portion of the year. The additional aquatic features on site may still be considered fish habitat under the *Fisheries Act*, as they would provide indirect habitat through providing flow and food supply to the fish downstream. All of the aquatic features within the site would be considered to have low sensitivity to change as they have been modified from agricultural practices, are intermittent or ephemeral, and have limited substrate sorting.

The HCA indicates within the Planning & Regulation Policies and Guidelines (HCA 2011) that a vegetated buffer should be a minimum of 30m total for all Important or Marginal fish habitats. The fish habitat as per HCA for Battlefield Creek would be considered marginal for the intermittent features. The ephemeral features within the subject property would not receive a protective buffer.

The *Fisheries Act* protects fish habitat up to the high-water mark. If work is to occur within this area, then a proponent driven assessment should be completed to determine if further review under the Act is required. If there is potential for impacts to fish and fish habitat, a request for review should be completed and should contain detailed design information. NRSI has completed an assessment of the works, as well as an aquatic effects table to determine the likelihood of an impact (Appendix IX). Through this process it was identified that the project should be sent for further review to the fisheries protection program at DFO. The Request for Review (RfR) will be submitted to the DFO in November 2020. It is expected that it will take 4-5 months for the RfR to get triaged and assigned to a biologist.

5.2 Wetlands

The subject property contains a large wetland in the northern half of the site (Map 2) comprised of a contiguous network of swamp and marsh habitats which extend off of the property to the west (downstream) and east (upstream). Photographs are provided in Appendix X. The wetlands on the property are associated with the watercourse and receive overland flow from offsite with drainage entering the property through the culvert on Second Road East. Additional flow is directed from the southern half of the property (agricultural fields and forest) whereby surface water infiltrates bedrock crevices and flows northward from the seepage feature as groundwater exiting the Eramosa scarp formation.

In general, the swamp and marsh habitats are typical of wetlands on silty-clay soils in the Hamilton and Niagara area. Plant species diversity is low to moderate with no species of high coefficient of conservatism value (i.e. species with a high fidelity to intact, high quality habitats). Given the channelized section of the creek and signs of recent tillage within the cultural thickets and marshes, it appears that the wetland has a recent history of disturbance that extends back a number of decades (much of the northern portion of the site in agriculture in the 1940s based on air photography). It is inferred that the present-day vegetation communities are a result of succession which has occurred in the last 25-50 years. The only mature trees present are Bur Oaks found along First Road East (with regeneration extending eastward into the swamp), along the Dofasco 2000 Trail and within hedgerows. In recent years, the spread of Emerald Ash Borer has reduced the canopy in the swamp features which has resulted in a flush of European Buckthorn and Glossy Buckthorn. The predominance of Green Ash, with other trees scattered along feature edges, limits the potential for recolonization of the swamp with native tree species and, left alone, it is likely that the treed swamp will continue to transition toward a mosaic of Buckthorn and Hawthorn swamp thicket and marsh in time.

The wetlands below the berm will still receive large seasonal flows from the upstream catchment that will maintain their wetland form. Much of the length of Battlefield Creek has been channelized or exists as well-defined watercourse with high banks; however, sizable wetlands include the swamp bisected by First Road East and the large wetland bisected by Barton Street East (4km downstream and below the escarpment). Conversely, wetland above the eastern berm is likely to become larger and contain deeper water for a longer period than the current conditions. By design, the increase in wetland size above the berm will not result in any flooding or inundation on properties located above the site (to the east of 2nd Road East).

The wetlands within the study area are unevaluated. The nearest Provincially Significant Wetland complex is the Vinemount Swamp PSW which is more than 2km east of the subject property and within the Stoney Creek watershed. As well, wetland in the vicinity of Rymal Road East is present approximately 2.75km south of the property but is part of the Twenty Mile Creek watershed. As surveys did not document wetland-dependent SAR presence within the subject property, and given the distance from other PSWs to consider wetland complexing, it is unlikely that the wetlands within the subject property warrant PSW designation.

The swamp features within the subject property have been identified as confirmed SWH for Migratory Landbird Stopover habitat and candidate Bat Maternity Colony habitat. Additionally, the central meadow marsh feature is considered SWH for Monarch butterfly which uses the habitat for nectaring and rearing of larva. These SWH types are discussed further in Section 5.4.

5.3 Woodlands

The Green Ash swamp (SWD2-2) in the northwest corner of the site is designated as significant woodland (Key Natural Heritage Feature) under the RHOP (City of Hamilton 2018). As discussed above, the Green Ash canopy is in decline and the feature is characterized by a low to moderate diversity of wetland species. The Greenbelt Plan states that significant woodlands experiencing changes such as tree mortality are still considered woodlands as these changes are considered temporary whereby the forest still retains its long-term ecological value (Government of Ontario 2005b). The detailed design plan prepared by Water's Edge identifies heavy duty Erosion and Sediment Control (ESC) fence to protect the treed area during construction. The ESC fence will be located within 30m of the dripline (approximately 10m at some locations) to accommodate necessary grading for the berms and created wetland, therefore, some tree root loss is possible.

Under the ownership of the HCA, the subject property will be retained in a natural state and despite current pressures and proposed hydrological changes occurring within the significant woodland, it is anticipated that this feature is resilient and will continue to provide valuable services including water quality improvement and wildlife habitat. Naturalization plantings of trees and shrubs among the berm and created wetlands will provide a seed source to enhance diversity within the declining Green Ash stands on the subject property.

5.4 Significant Wildlife Habitat

Based on background information review, desktop analysis and field studies completed in 2019, 4 SWH types were confirmed for the study area and 3 types remain as candidate. These are discussed in further detail below.

5.4.1 Confirmed SWH

Wildlife seasonal concentration areas are defined as areas where animals occur in relatively high densities for all, or portions, or their life cycle (OMNR 2000). These areas are generally relatively small in size, particularly when compared to areas used by these species during other times of the year.

Seasonal Concentration

Landbird Migratory Stopover Area

Surveys conducted in the spring and fall to document migratory birds within the subject property recorded a high diversity of species and high numbers of birds overall. The treed feature in the southern half of the site, as well as the feature in the northwest corner, including forest to the west of First Road East, are approximately 10 hectares and 12 hectares in size respectively and 4.5 km from Lake Ontario. Criteria used to define this SWH type (MNRF 2015) also notes the importance of a variety of habitats (forest, grassland and wetland), all of which are present.

Migratory bird surveys documented well over the 35 species required for this SWH type including 19 Wood Warblers, 9 Emberizid Sparrows, 7 Thrushes, 5 Woodpeckers, 5 Flycatchers and 4 Vireos. All 8 targeted surveys documented greater than 10 migratory species and numbers greater than 200 birds per day. Surveyors noted that bird diversity was very high within the cultural savannah and swamp located along the karst formation. It is inferred that the combination of upland and wetland habitat at this groundwater seepage location may result in higher numbers of insects during bird migration and provides a diversity of habitat which is desirable for migratory birds.

It is noted that in comparison to woodlots which are both larger and closer to the lake (features along the escarpment and east toward Beamsville), the subject property may not be as significant; however, the criteria for SWH are fulfilled with forest and swamp habitats within the subject property considered significant (Map 4). Given the limited area of vegetation clearing within the Green Ash swamp and fallow fields and the future restoration of those areas with extensive tree and shrub planting, this SWH type is not sensitive to the proposed works. The seeded areas, in conjunction with tree and shrub plantings will increase native vegetation and provide food and nectar sources for avian species. The karst slope will not be impacted.

Specialized Wildlife

Seeps and Springs

Numerous sections of the karst formation which bisects the property contain evident groundwater seepage areas. The headwater feature between hedgerows H4 and H6 (Map 2) directs water into a bedrock fissure in the middle of the field which then exits the karst slope and flows north toward Battlefield Creek in Tributary 1. Surveys in April and May observed water rushing out of the karst while seepage pooled at the toe of the slope at locations further east in pockets of soft and saturated soil. The abundance of allelopathic Black Walnut trees may limit the establishment of herbaceous seepage indicators such as Watercress (*Nasturtium officinale*) or Skunk Cabbage (*Symplocarpus foetidus*) as none were observed. The presence of both Wild Turkey (*Meleagris gallopavo*) feathers and tracks and congregations of White-tailed Deer (*Odocoileus virginianus*) tracks in the vicinity of the slope suggest that these species may utilize the feature as a mineral lick and as a water source in the winter.

The proposed works are situated below the seepage slope and are not anticipated to have any effect on this SWH type. Any future development that may be proposed in the southern half of the property could affect the groundwater recharge capacity and would need to consider the potential for impacts to the feature.

Habitat for Species of Conservation Concern

Shrub/Early Successional Bird Breeding Habitat

The subject property contains several areas of thicket (both in low-lying and upland habitats) and cultural savannah along the karst feature. Breeding bird surveys documented 1 indicator species – Brown Thrasher (*Toxostoma rufum*) and all 4 of the common species noted in the SWH criteria (MNRF 2015), including Field Sparrow (*Spizella pusilla*), Black-billed Cuckoo (*Coccyzus erythropthalmus*), Eastern Towhee (*Pipilo erythrophthalmus*) and Willow Flycatcher (*Empidonax traillii*). The Brown Thrasher and Field Sparrow showed probable breeding evidence with the other species showing possible breeding evidence.

As the retired agricultural fields continue to transition from meadow to thicket, it is likely that shrub and early successional habitat will increase within the subject property. The proposed location of the berms does not overlap with existing thicket habitat.

Special Concern and Rare Wildlife Species

Surveys confirmed 3 SCC, Eastern Wood-pewee, Monarch and Common Nighthawk within the subject property during field surveys in 2019. According to the MNRF guidelines, for SCC habitat to qualify as SWH, it needs to be easily mapped and cover an important life stage component for the species (e.g. specific nesting habitat, foraging habitat, etc.) (MNRF 2015). Based on a review of the criteria included in Appendix Q of the SWH Technical Guide (SWHTG)

(OMNR 2000) for the determination of significance of habitat for SCC, all of these species have confirmed SWH within the subject property (Map 4).

The mature deciduous forest (FOD/FOD7) in the southeast extent of the property provides habitat for Eastern Wood-pewee. Breeding bird surveys documented a singing male showing probable breeding evidence. This flycatcher species breeds in deciduous, mixed and coniferous forests of various sizes and prefers forest with thin canopy, openings and edge habitat (Watt et al. 2017). Suitable habitat for Eastern Wood-pewee is not present within the northern half of the subject property where the berm development is proposed and this species will not be impacted by the development. The long-term conversion of the retired agricultural fields to forest (through active restoration or passive naturalization) would increase the area of suitable habitat for this species.

Habitat for Common Nighthawk is indicated on Map 4 as all areas of cultural thicket and savannah, with the exception of the northern-most thicket community which approaches swamp thicket conditions (with standing water through April and into May) and was determined to not be suitable for nesting. A single Common Nighthawk was observed foraging and performing aerial displays during the May 15 calling anuran survey. This species nests in open forest and woodland, thickets, clearings and on building rooftops (Brigham et al. 2011). The marsh and swamp habitat along Battlefield Creek are likely to support high numbers of insects which provide suitable foraging habitat for Common Nighthawk. In general, the meadow and thicket succession occurring in various parts of the property will continue to provide habitat for this species.

Habitat for Monarch butterfly is present within areas of cultural meadow and marsh in the northwest portion of the site (Map 4). Surveys documented adults, caterpillars and pupae within these features where nectar plants are abundant. The larval foodplant, Milkweed, was found in small numbers throughout the site. The habitat is resilient to disturbance with Milkweed and other nectar-producing forbs tending to recolonize bare soils following a disturbance. The relatively low numbers of Milkweed present an opportunity to enhance habitat for this species, both in mitigation relating to the proposed works and through ongoing ecological restoration efforts implemented by HCA on the property. As Monarch requires a variety of wildflowers as a nectar source, the seeding of Milkweed and other forbs such as Goldenrod (*Solidago* spp.), Asters (*Symphyotrichum* spp.), Black-eyed Susan (*Rudbeckia hirta*), Wild Bergamot (*Monarda fistulosa*) within wetland and meadow areas will enhance habitat for this species. Situated between Lake Ontario and Lake Erie, the property has potential to be a valuable stopover location for Monarchs during their spring and fall migration.

5.4.2 Candidate SWH

Seasonal Concentration

Snake Hibernacula

The observation of 3 snake species in the vicinity of the old residence and karst feature during the emergence period suggests that SWH for snake hibernacula may be present. Observations of snake diversity and numbers which were made by NRSI biologists approach the defining criteria for SWH and given the difficulty in surveying steep portions of the karst slope, this report assumes that a hibernacula is present. This feature may exist within one of the field stone foundations, or within rock crevices along the slope. The proposed works will not include rock blasting or other construction-related disturbances which would directly impact this feature. While it is unlikely that overwintering snakes would be impacted by equipment vibration during the winter, the use of equipment in close proximity to the karst slope should be avoided.

The potential snake hibernacula is very likely located along the karst slope or in the vicinity of the old residence and out-building foundations accessed from First Road East. There were no indications of potential habitat within the low-lying northern portion of the site. The karst and foundation features are well above potential inundation elevations once the berms are constructed. NRSI staff have not reviewed any inundation modelling, but in general water would be overtopping First Road East before water levels would reach the karst ridge feature.

Raptor Wintering Area

Significant Raptor Wintering Areas are defined as areas where the habitat consists of a combination of fields and woodlands that provide roosting, foraging and resting habitats for wintering raptors (MNRF 2015). This SWH is confirmed by the observation of one or more Short-eared Owls (*Asio flammeus*), one or more Bald Eagles (*Haliaeetus leucocephalus*), or at least 10 individuals of two listed hawk/owl species (Rough-legged Hawk (*Buteo lagopus*), Red-tailed Hawk (*Buteo jamaicensis*), Northern Harrier (*Circus cyaneus*), American Kestrel (*Falco sparverius*), Snowy Owl (*Nyctea scandiaca*), Short-eared Owl, Bald Eagle) (MNRF 2015). To be significant, a site must be used regularly (three out of every five years) for a minimum of 20 days by the listed raptor species (MNRF 2015). One of the listed raptor species, Red-tailed Hawk, was observed in the Subject Property on numerous surveys (April 12, April 18, May 14, May 15, May 16, August 23, October 4). As winter raptor surveys were not completed, this SWH type remains as candidate.

As the subject property has treed habitats situated within a landscape matrix of agricultural lands, there is some potential that this SWH type may be present, although it is unlikely that the above-mentioned criteria would be met at this time. The proposed works will retain and enhance natural cover across the property and as such it is unlikely that there would be any lasting impact to potential raptor wintering habitat.

Bat Maternity Colonies

Big Brown Bat and Silver-haired Bat were detected in relatively high numbers at all monitoring stations during every night of the monitoring period. The majority of these recordings were documented during the first and second monitoring hours, indicating that these species are potentially using woodlands throughout the subject property for roosting habitat, including for maternity roost colonies, or at the very least foraging shortly after leaving nearby roosts.

Big Brown Bats primarily form maternity colonies in buildings and other man-made structures but will also roost in tree cavities, although less frequently (Agosta 2002, Gerson 1984). Therefore, given the presence of several farm houses and barn structures in the area, this species is likely not using the woodlands as maternity roost colony habitat. At this time, no candidate bat roost trees are present within the footprint of the proposed berms; however, an assessment of suitable habitat is recommended should HCA undertake other activities on the property that have the potential to impact treed features and may contain Big Brown Bat maternity colony roosts.

Silver-haired Bats are solitary or may form small maternity colonies under loose bark and in cavities of trees and snags (van Zyll de Jong 1985). It is likely that Silver-haired Bat are using the treed features within the subject property for roosting and potentially as maternity colony roost habitat.

Sites are considered SWH if greater than 10 Big Brown Bats and/or greater than 5 female Silver-haired Bats are using the site as maternity roost habitat. Based on the results of the acoustic monitoring, all SWD and FOD vegetation communities within the subject property are considered Candidate Bat Maternity Colony SWH. Targeted exit surveys at potential roost trees within the woodlands would be required to confirm the presence of this SWH type within the subject property.

The number and timing of Big Brown Bat and Silver-haired Bat recordings indicate that these species are also likely using the subject property for foraging and/or as a movement or travel corridor between key habitats.

Similar to the candidate snake hibernacula, the candidate bat roost tree(s) which appear to be within the cultural savannah (CUS) associated with the karst ridge, will not be affected by inundation within the created wetlands. Swamp (SWD) features in the northern portion of the property were also identified as candidate bat roost habitat. The eastern Green Ash swamp (SWD2-2), in the vicinity of the eastern berm is comprised almost entirely of young to mid-age declining Green Ash. No suitable cavity trees were documented within this feature during the 2019 surveys. With few trees greater than 20cm DBH and showing limited recruitment, the potential for bat roosting habitat in the future is low and not likely to be impacted by vegetation clearing or inundation. As a swamp already in decline, the planting of other tree species tolerant of periodic inundation will greatly enhance the potential for cavity trees to form in the future.

The swamp to the north of the western berm does contain a number of large Bur Oak which may provide suitable roosting habitat. These large DBH trees have a wide range of tolerance in soil moisture and the potential for drier conditions will not impact these trees or the potential bat habitat they provide. Similar to the Green Ash swamp to the east, there are numerous young to mid-age Green Ash that are in decline and are unlikely to be providing bat roost habitat. Tree planting and natural succession will help to supplement the species diversity and increase the potential for bat roost habitat.

5.5 Habitat of Species at Risk

Bat pass sequences identified to the *Myotis* species grouping and the 40 kHz species grouping were detected at monitoring station BAT-001 within the cultural savannah (CUS) during the monitoring period. A small number of sequences identified to the 40 kHz species grouping were also recorded at BAT-003. Due to the timing and low number of recorded sequences at BAT-003, it is not likely that bat SAR are using habitats within the vicinity of this monitoring station as maternity colony or roosting habitat. However, based on the timing of bat pass sequences at monitoring station BAT-001, the cultural savannah community is considered candidate roosting habitat for SAR bats. Monitoring station BAT-001 was located within close proximity to a potential roost tree within this community; however, no candidate bat SAR roost trees are present within the footprint of the proposed berms.

Based on the presence of bat pass sequences identified to the *Myotis* and 40 kHz species groupings, there is potential for four bat SAR to occur within the subject property: Little Brown Myotis, Northern Myotis, Eastern Small-footed Myotis and Tri-colored Bat.

- Little Brown Myotis are known to use buildings and other anthropogenic structures to roost but will also use cavities, bark and crevices in trees. They most often forage in open habitats such as at ponds, within open canopy forests and along linear features such as roads and woodland (treed) edges (Environment and Climate Change Canada 2018).
- Northern Myotis roost singly or in small groups and favour tree roosts under raised bark and in tree cavities and crevices, but can also be found in anthropogenic structures (e.g., under shingles). They often forage in heavily forested landscapes including within forest gaps and along tails in forests (Environment and Climate Change Canada 2018).
- Although little information is available, Eastern Small-footed Myotis seems to prefer open, sunny and rocky habitats for roosting and maternity colonies and has primarily been observed to forage in forests, but will also forage over water bodies, within riparian forests and occasionally in open fields (Humphrey 2017).
- Tri-colored Bat prefers to roost in mature forests and occasionally will use barns or other man-made structures for roosts. They forage primarily in forested riparian areas, over water and in relatively open areas (Environment and Climate Change Canada 2018).

Based on species preferences, it is most likely that Little Brown Myotis and/or Northern Myotis may be roosting within the vicinity of monitoring station BAT-001.

The location of monitoring station BAT-001 not only captured a potential roost tree, but also candidate foraging habitat and a potential travel/movement corridor along the pathway. Based on the number and timing of recorded bat pass sequences, the cultural savannah community is also considered candidate foraging and movement/travel corridor habitat for SAR bats. Foraging, movement or travel corridor habitats are considered the least sensitive to alteration (MNRF 2012).

This report assumes that the entirety of the cultural savannah associated with the karst feature, constitutes SAR bat roosting, foraging and travel corridor (flyway) habitat. This community is far removed from the proposed berm and wetland development area and will not be impacted. The restoration of the subject property, including the creation of new wetlands is likely to benefit SAR bats by providing additional foraging opportunities within the vicinity of the candidate SAR bat habitat.

6.0 Impact Analysis

Potential impacts arising from the proposed wetland creation project are determined by comparing the details of the proposed berm and wetland development with the characteristics of the existing natural features and their functions, as shown on Map 4. Where the detailed design plan overlaps with natural features or their vegetation protection zones, impacts may arise. The following is a description of the types of impacts which will be discussed:

- Direct impacts to the natural features within the study area associated with disruption or displacement caused by the actual proposed ‘footprint’ of the undertaking.
- Indirect impacts associated with changes in site conditions such as drainage and water quantity/quality, construction noise, dust and light pollution.
- Induced and cumulative impacts associated with impacts after the berms and wetland areas are constructed such as subsequent demand on the resources created by increased habitation/use of the area and vicinity over time.

A summary of the potential impacts and recommended mitigation measures for each significant natural feature within the wetland creation footprint area is provided in Table 8.

Table 8. Significant Natural Features, Potential Impacts and Recommended Mitigation

Significant Natural Feature	Relevant Policies	Potential Impacts	Recommended Mitigation
Watercourses and Fish Habitat	• HCA Ontario Regulation 161/06 (Government of Ontario 2013) • Rural Hamilton Official Plan (City of Hamilton 2018) • *Fisheries Act* (Government of Canada 2019) • *Fish and Wildlife Conservation Act* (Government of Ontario 1997)	**Direct Impacts** • The proposed berm creation will directly impact intermittent features, Battlefield Creek and Tributary 1 through altered flow regimes, and the removal of limited fish habitat. • Baseflow will be increased, which may result in the feature becoming permanently wetted downstream. • Appendix IX outlines the potential impacts, mitigation measures and Pathways of Effects, and if there will be any residual effects. • Wet ponds have the potential to become additional fish habitat if they remain wet for the whole year, which will not be known until actual construction. **Indirect Impacts** • Indirect impacts to the watercourse and fish habitat may include changes to water quality (temperature) and quantity (reduced flow below berms), as well as erosion and sedimentation, contamination, nutrient concentrations during construction. • The project will meet the HCA objective of utilizing the floodplain to improve flood attenuation capacity and reduce downstream erosion. **Induced Impacts** • None	• The control structures include flow dispersal features at the outlets to help control erosion potential. • The Pathways of Effects (PoE) outlined by DFO were reviewed, and the potential stressor and potential effect on fish and fish habitat determined. Mitigation measures (both land-based and in-water) should be provided to determine if there are residual effects. If there are residual effects and a HADD is possible, then a Request for Review will be required. Appendix IX is the Aquatic Effects Summary Table which outlines the PoEs, potential impacts, mitigation measures, residual effects and preliminary designs indicate that a Request for Review is required. The Request for Review will be submitted to DFO in November 2020. Once the RfR has been submitted it is likely to take 4-5 months for a FPP biologist to be assigned to the project to determine if a Letter of Advice will be issued or if an Authorization is needed. • Monitoring of fish habitat and fish populations should occur post construction. This should include identifying if fish are coming into the wetland feature from upstream. The control feature will be a barrier downstream, but the wetland feature is already acting as a barrier. Large fish populations within the wetland are not a primary objective, as they could impact the anuran spawning. • The baseflow is expected to increase with will provide more permanent habitat for fish. • The wetlands are expected to decrease less frequent storm event peaks and reduce erosion, and also are expected to provide more consistent groundwater and baseflow throughout the year. • Implement a vegetation rehabilitation plan following construction to re-vegetate the construction area. The establishment of vegetation along the berms and

Significant Natural Feature	Relevant Policies	Potential Impacts	Recommended Mitigation
			within the created wetlands will enhance water quality and reduce water temperature, in time, through shading. • All berm construction should be completed during dry conditions and within the in-water timing window (and outside of breeding bird window) – September through March ideally. Installing enhancement measures by hand may be done within the water, but still preferably during low-dry periods to minimize disruption to substrates and water conditions. • Implement an Erosion and Sediment Control Plan. • Develop a Spill Response Plan. • Equipment operation and maintenance in designated areas away from natural features. • While works should occur under dry conditions, a fish and wildlife salvage should be conducted by experienced biologists where any suitable habitat exists (prior to vegetation clearing). • A Monitoring Program, which includes parameters identified in the EA (stream morphology, natural heritage system, hydrometeorologic and water quality/biophysical) should be undertaken following the completion of the proposed works. • In the event that the outlet structure requires repair in the future, or water is drawn down or pumped within the wetland, a wildlife salvage should be completed by trained biologists prior to work commencing.
Wetlands	• Rural Hamilton Official Plan (City of Hamilton 2018) • HCA Ontario Regulation 161/06 (HCA 2013)	**Direct Impacts** • The east berm will directly impact the unevaluated wetland feature (Green Ash swamp). • The existing wetland below both berms will be subject to an altered flow regime. **Indirect Impacts**	• In order to preserve the form and function of wetlands below the berms, the control structure maintains some amount of surface water flow leaving the created wetlands. • Both berms will result in a net increase in wetland area. Native plantings and seeding will be completed to enhance the diversity of the created habitats. This aligns with the HCA objective of enhancing and enlarging the existing wetland areas and creating

Significant Natural Feature	Relevant Policies	Potential Impacts	Recommended Mitigation
	• Provincial Policy Statement (MMAH 2014)	• Changes to water quality and quantity during and following berm construction. • Potential for erosion and sedimentation to impact the wetland during construction. • Increased floodplain area will result in faster evapotranspiration. • Any site access lanes (existing or constructed) may become areas for garbage and yard waste dumping. **Induced Impacts** • The potential for spread of the existing patches of Common Reed, or introduction of new non-native species.	additional wetlands as well as improving flood attenuation capacity and reducing erosion downstream. • The planting of a diversity of native trees and shrubs, both as part of the wetland creation and future HCA activities will offset the removal of declining Ash in the footprint of the east berm. Creation of wetland habitat meets the HCA objective to enhance and enlarge the existing wetland. • The wetland created at the east berm will improve opportunity for enhancing passive recreation along the Dofasco 2000 Trail (accessible viewing platform potential for nature appreciation). • The limit of grading will be delineated with heavy duty ESC fencing, which will double as vegetation/tree protection fence. • ESC fencing is to be removed once soils are stable on site to the satisfaction of on-site inspector / environmental monitor. • Implement the Erosion and Sediment Control Plan. • Develop a Spill Response Plan. • Equipment operation and maintenance in designated areas away from natural features. • Stabilization of temporary soil stockpiles within 30 days of being inactive/idle and berms using a nurse crop. • In order to prevent the spread of Common Reed or other non-native species, equipment should arrive on site clean and free of plant materials and mud. • Existing or introduced stands of Common Reed should be managed through herbicide application, monitoring and re-application over a series of several years. Stands that are present within the proposed grading area are likely to be graded and relocated within the site, but proactive management is not recommended given project timelines.

Significant Natural Feature	Relevant Policies	Potential Impacts	Recommended Mitigation
Significant Woodland	• Rural Hamilton Official Plan (City of Hamilton 2018) • Provincial Policy Statement (MMAH 2014)	**Direct Impacts** • Enhancement to Battlefield Creek will utilize passive methods to restore the watercourse (coir logs, live staking) and will not require any tree cutting or earth works within the significant woodland in the northwest corner of the property. • Berm construction will occur outside of the significant woodland dripline, thus eliminating a direct impact. • The Green Belt Plan stipulates a 30m vegetation protection zone which may not be feasible; however, the long-term naturalization of the west berm and wetland is seen as a net benefit to the feature which will ultimately expand in size through naturalization processes. **Indirect Impacts** • Indirect impacts include disturbance to woodland wildlife during construction (noise, dust) and the potential for minimal tree root damage during site grading. • Changes to water quantity reaching the significant woodland (swamp), may lead to drier conditions and a shift toward lowland forest conditions at the fringe of the feature. **Induced impacts** • None	• The limit of grading and a reduced vegetation protection zone (less than 30m from dripline) will be delineated with heavy ESC fence. • The west berm location is intended to provide a setback from the root zone of the adjacent treed feature to the extent possible therefore minimizing impacts to the significant woodland. A similar design approach has been taken with the east berm and the adjacent hedgerow vegetation. During grading, care should be taken to avoid unnecessary damage to the root systems of mature trees, as feasible. • Dust resulting from earth works will be managed including the wetting of bare soils where machinery and vehicle traffic on site creates dusty conditions. • Equipment maintenance and re-fueling will occur outside of the wetland creation and away from natural features. • Disturbance to wildlife during construction will be temporary and is not anticipated to be significant.

Significant Natural Feature	Relevant Policies	Potential Impacts	Recommended Mitigation
Significant Wildlife Habitat	• Provincial Policy Statement (MMAH 2014) • Rural Hamilton Official Plan (City of Hamilton 2018)	**Direct Impacts** • Direct impacts to SWH will include removal of a portion of Landbird Migratory Stopover Area (east berm) and Bat Maternity Colony Habitat (candidate SWH). • None of the other identified SWH types will be impacted directly or indirectly. **Indirect Impacts** • The creation of the east berm may result in deeper or more prolonged inundation. Although many of these trees are dead or declining Ash, conditions may become less suitable for tree establishment inside the berm. **Induced impacts** • Introduction of non-native or invasive species.	• In order to mitigate impacts to Landbird Migratory Stopover habitat, the section of the east berm which passes through the Green Ash swamp will be restored with native tree and shrub plantings to maintain a contiguous habitat. Due to berm slopes, tree and shrub planting has been limited to level ground adjacent to the berm. • An assessment of trees did not identify candidate bat maternity colony trees within the location where the east berm will pass through the swamp feature. A targeted tree inventory and assessment will be conducted by NRSI Certified Arborists based on the detailed design grading envelope to confirm the absence of suitable trees. Trees in the swath to be cleared are almost entirely all dying Green Ash with few (if any) greater than 20cm Diameter at Breast Height suggesting the stand is not likely to support a colony of bats. • Tree removals should occur outside of the bat active period (April 1 – September 30). If this timing is not feasible, a detailed assessment of available roost trees is recommended to be completed within treed areas proposed to be impacted. Following identification of potential roost trees, targeted exit surveys at identified roost trees must be completed during appropriate weather conditions and within 24 hours prior to their removal to avoid direct impacts to the species through confirming the absence of any roosting bats (MNRF 2014). • The HCA has identified that the enhancement of linkage opportunities associated with the Dofasco 2000 Trail as an objective of this project. Naturalization plantings in the eastern wetland area will result in a more structurally diverse corridor where a recently fallow agricultural field currently exists. • It is recommended to provide temporary habitat compensation in the form of artificial roosts prior to

Significant Natural Feature	Relevant Policies	Potential Impacts	Recommended Mitigation
			tree removals, in the event that a suitable cavity tree is identified during the tree inventory. • The restoration plans for the site include the use of native tree species preferred by bats for roosting (e.g. Shagbark Hickory) which may provide future, more permanent, roost habitats.
Breeding Bird Window	• Migratory Birds Convention Act (Government of Canada 1994) • Fish and Wildlife Conservation Act (Government of Ontario 1997)	• Vegetation removal within the breeding bird season may result in incidental take of bird species protected under the MBCA. • Although none were observed, active raptor nests are protected under the FWCA.	• Vegetation removal is recommended to occur outside of the breeding and nesting season for migratory birds as established by the Canadian Wildlife Service. • The peak breeding period for birds in southern Ontario extends from approximately late March to late August (Government of Canada 2017). • Due to the complexity of habitats on site, nest sweeps are not recommended as a means to confirm the absence of nesting birds. • Future works should consider active raptor nests and wildlife sweeps by qualified biologists should be undertaken to ensure that nests are not impacted.

7.0 Restoration and Enhancement

The proposed berms, wetlands, naturalization of the existing watercourse and the naturalization of the retention area present numerous opportunities for the creation and enhancement of wildlife and potential fish habitat on the property. High-level recommendations and enhancements were outlined in the Natural Heritage Characterization Report prepared by NRSI (February 2020). These mitigation and enhancement measures, where affordable and feasible, were brought forward and are shown in the detailed design plans prepared by Water's Edge. The following restoration and enhancement measures have been incorporated in the detailed designs to satisfy HCA's goals and visions for the created wetland areas and to provide for the long-term stewardship of the property.

Invasive Species Monitoring

In order to ensure that the restoration works are successful, HCA staff should conduct site monitoring pre- and post-construction for invasive species stands within the property. The focus of the pre-construction monitoring for invasive species should concentrate on the western fence line where Common Reed and European Buckthorn are present at this time. A portion of the stands may exist on the neighbouring property and HCA may wish to contact the landowner to determine if they would support invasive species control work extending onto their property. Once the extent of these invasive species has been verified, an initial treatment with herbicide should be implemented in 2021. Pre-construction monitoring of the central feature associated with the watercourse is not necessary as this entire area will be graded.

Post-construction monitoring for invasive species should be conducted by HCA staff annually during the growing season for at least 5 years following the grading and planting and periodically thereafter. Focus should be placed on assessing the effectiveness of invasive species management along the western fence line and identifying new stands of invasive species throughout the recently created wetland area and on the berm. The monitoring of invasive species may be combined with a general assessment of the plantings and seeded areas.

Invasive Species Management

Invasive species management will be required prior to construction and periodically following the creation of the berms and wetlands. Management will be both active (herbicide application) and passive (native species plantings to alter conditions where invasive species thrive).

Common Reed is the priority species for immediate management as this species could spread from existing stands into the created wetlands resulting in low diversity and reduced habitat value for wildlife. This species can only be effectively managed through the application of herbicide. It is recommended that HCA restoration technicians licensed to apply herbicides target the existing stands as soon as possible. Although treatment prior to the commencement of earth works is ideal, this work can also be undertaken immediately following the completion of the berms in the event timing is a constraint. The existing stands are sparse and separated from one another which allows for effective and efficient management. A preliminary treatment will need to be followed up by a monitoring visit and one or more subsequent treatments to address persistent stems.

Reed Canary Grass is abundant in the central marsh feature and will outcompete any herbaceous vegetation within the created wetlands if it begins to colonize those areas. It is recommended that management of the existing stands be passively managed through the planting of trees and shrubs tolerant of wet soils. Fast-growing species including Silver Maple and Eastern Cottonwood are well-suited to growing among Reed Canary Grass and establishing canopy in a relatively short amount of time.

As a prolific seed producer, there is potential that Reed Canary Grass will establish within the created wetlands in time. Early detection and treatment using herbicides during dry conditions will be important to controlling the spread of this species.

Management of European Buckthorn and Glossy Buckthorn within the property should focus on the control of female, seed producing shrubs in the vicinity of the created wetlands as a temporary measure to reduce the spread of this species. As the agricultural fields have been left fallow, these shrubs will begin to seed into open areas including the berms and wetlands.

Herbicide treatment of seed-producing shrubs should focus on the hedgerows, along the Dofasco 2000 Trail, within the cultural thickets and at the perimeter of forest and swamp communities near the created wetlands. Due to the presence of a seedbank, treatment will require an ongoing effort of monitoring and herbicide application. Once the shrubs adjacent to the created wetlands are effectively controlled, management may consider addressing shrubs in other portion of the property. For areas where Buckthorn seedlings are abundant, such as the cultural thicket in the northwest portion of the property, the planting of Black Walnut may be effective in reducing Buckthorn and should be considered by HCA as an additional passive management tool.

Although removal of seed-producing shrubs and passive management through tree planting will reduce Buckthorn stems and spread, a large-scale treatment and native species planting effort is required in the long term to reinstate resilient habitats where the large stands of Green Ash are currently in decline.

Following the installation of plantings and seeding at the site, HCA staff should monitor for the re-establishment of these invasive species (and others). The presence of disturbed soil within the created wetlands provides increased opportunity for invasive species to establish while the native plantings mature. An annual assessment by HCA staff during the growing season will detect problematic species early which will allow for small-scale spot treatment where necessary.

Re-planting of Berm

In order to mitigate for the removal of swamp for the east berm and to generally soften the visual impact of both berms, native trees and shrubs will be planted beside these features. Planting along First Road East will provide a visual screen which will enhance the wildlife value of the western wetlands and berm feature. A mixture of caliper trees and smaller potted stock has been identified in the planting plan drawings.

Exact planting locations will consider soil moisture relative to the tolerance of a given species, the potential for snow throw damage from plows, buried utilities (if applicable) and maintaining safe sightlines within the road right of way. The geotechnical report (Soil Engineers Ltd. 2019) notes that the native silty-clay soils which are present on site are suitable for the construction of the berms, therefore limiting the need to introduce soil to the site. The geotechnical report recommends the removal of topsoil and organics for berm construction. It is noted that the stockpiling of these materials for top-dressing will be important for the establishment of trees and shrubs following construction. In order for the successful establishment of plantings, topsoil compaction (at least in the upper strata) should be minimized to provide a suitable growing medium for tree root establishment. Excessive soil compaction of the re-instated A-horizon will limit the success of naturalization efforts

Species which are hardy, fast-establishing and produce fruit in abundance have been included in the planting to enhance survival and act as an early seed source for unplanted areas. In order to ensure the long-term stability of the berm, and given the potentially challenging growing conditions, tree plantings should not occur on the berm itself. Many of the selected shrub species are hardy and clonal.

As White-tailed Deer and rodent browse will be heavy within the property, tree protection measures may include the application of Skoot™ browse protectant to stems and the installation of tree coils or tree tubes. Large trees (wire basket caliper trees) will be tethered and staked using biodegradable straps and wooden stakes to prevent wind damage and shifting following the planting. The use of biodegradable tether will ensure trees are not girdled in time (as is often the case with metal wire).

Based upon species which are present in the study area and the clay-heavy soils, suitable species include:

- Bur Oak (*Quercus macrocarpa*)
- Eastern Cottonwood (*Populus deltoides*)
- Trembling Aspen (*Populus tremuloides*)
- Silver Maple (*Acer saccharinum*)
- Shagbark Hickory (*Carya ovata*)
- Black Cherry (*Prunus serotina*)
- Black Walnut (*Juglans nigra*)
- White Pine (*Pinus strobus*)
- Grey Dogwood (*Cornus foemina* ssp. *ra*cemosa)
- Red Osier Dogwood (*Cornus sericea*)
- Staghorn Sumac (*Rhus typhina*)
- Nannyberry (*Viburnum lentago*)
- Native Hawthorns (*Crataegus* spp.)

In order to increase tree establishment, the panting of acorns and nuts, at random throughout the wetland and adjacent meadow areas, is encouraged both on the berm and in areas within and around the created wetlands. Bur Oak acorns and Shagbark Hickory nuts would be best suited to much of the low-lying portion of the site with Red Oak suitable for areas of higher elevation.

The exposed soils on the berms will require stabilization to prevent erosion and will require that fast-establishing species be seeded to stabilize the soils. The planting plan identifies a site-appropriate native meadow seed mixture that will be applied to the berms.

The exposed soils on the berms will require stabilization with a fast-establishing nurse crop to prevent erosion. The nurse crop may be applied by hydro-seeding or terra-seeding, or broadcast seeded with an annual nurse crop of White Proso Millet (*Panicum miliaceum*) or Buckwheat (*Fagopyrum esculentum*) seeded at 25kg/ha to provide early cover and stabilization that will dissipate in several years. Other nurse crops including Oats (*Avena sativa*) or Annual Ryegrass (*Lolium multiflorum*) may be considered as substitutes to Millet or Buckwheat.

The nurse crop should be applied in conjunction with a native meadow seed mixture. The meadow species will provide diversity and a nectar source for insects. The drawing set prepared by Water’s Edge identifies that the Ontario Seed Company “Early Succession Dry Prairie Meadow Native Seed Mixture 8115” or “Native Prairie Meadow Seed Mixture 8135” mixture be applied. Both tolerate dry soils and contain site-appropriate species.   An alternative to the OSC mixture would be to have wild seed collected from HCA properties or approaching local native plant nurseries to inquire about filling a large seed order.

Naturalization of Wetlands and Retention Area

Within the berm retention areas, several types of wetland may be restored. Deeper excavations with a clay lining are likely to retain standing water for much or all of the year which will support emergent marsh vegetation and provide ideal habitat for anuran breeding. Areas of shallow excavation will establish as mixed marsh or mud flat which dry out by late spring and may provide nesting habitat for waterfowl or foraging habitat for shorebirds. Thicket plantings may be reasonable atop high elevations within the ponds but are better suited to the areas surrounding the ponds as shown on the planting plans within the drawing set.

In order to prevent erosion and retain soil moisture, the entire graded area will be seeded with a non-allelopathic nurse crop such as White Millet or Buckwheat as well as a native wetland seed mixture. Seeding should be focused along 10m (or greater) on either side of the re-instated watercourse to effectively filter sediment and runoff entering the watercourse. Application may be completed using hydro-seeding or terra-seeding (more costly), seed drill equipment, or hand-broadcasting (in particular within any steep or wet excavations). The seed mixture indicated on the Water’s Edge drawing adheres to the species lists outlined in the document Seed Mixes

Suitable for our Watershed (HCA 2019). In order to properly stratify seed, increase germination and reduce seed predation, the native seed mixture should be installed in late fall, prior to ground freeze-up.

Live aquatic plant material has been specified on the Water's Edge drawings and will be installed within the deeper permanently inundated or saturated areas. These deeper areas with aquatic plants could provide fish habitat and refuge pools during drier periods.

The inclusion of upland ridges in the site grading and the placement of tree root masses, logs, boulders and rock piles among the wetlands will improve the heterogeneity of the site and enhance wildlife habitat in general. Where possible, the planting of trees and shrubs along the watercourse and surrounding the wetland features will help to cool water temperatures and make these features more attractive to wildlife. Tree planting throughout the retention area will help to cool water temperatures and reduce evapotranspiration. Species such as Silver Maple and Eastern Cottonwood are tolerant of wet soil and seasonal inundation and are among the fastest growing tree species suited to the property.

Additional tree planting may occur on site following the initial restoration plantings. HCA may wish to consider setting areas aside, adjacent to the naturalized wetlands, where Butternut compensation plantings can be installed as part of Endangered Species Act permitting. These areas would ideally be accessible from the road to allow for easy installation and maintenance. These undertakings are funded through a third party (typically developers) and would allow for increased tree planting, cost savings and potentially an income opportunity for the HCA.

The seeding of Milkweed (*Asclepias* spp.) and native forbs can enhance habitat for Monarch butterflies and other insects. Seed may be scattered across the created wetland area, or concentrated plots can be installed to act as a seed source to disperse through the site in the years to follow.

Barn Swallow Habitat Enhancement

Observation of Barn Swallow foraging in 2019 suggests that the species utilizes the marshes and declining swamp areas for foraging. It is likely that pairs nest on structures located on nearby residential lots. HCA should consider the installation of Barn Swallow nesting structures in areas adjacent to the created wetlands. The requirement for compensation of removed nest habitat under the Endangered Species Act, 2007 is likely to present an opportunity to have such structures installed (and funded) as part of local development applications. The site may support several of these structures which should be installed away from the road corridor to prevent road mortality. The posts of the structure should be covered with sheet metal to a height of 1m to deter mammals from climbing the posts and predating nests. Design drawings for these structures are available (MNRF 2016).

Turtle Nesting Feature Installation

Although surveys in 2019 did not observe turtles or evidence of turtle nesting within the property, the proposed creation of wetland has the opportunity to create suitable habitat for turtle basking and nesting. Wetlands that are connected to the site by the watercourse and natural cover in the vicinity, suggest that turtles may reach the created wetland and nesting features would be complimentary to the created wetland habitats. The design drawings have incorporated 6 constructed turtle nesting features among the deeper wetland features. The features have been located where they can be accessed by an off-road UTV (from First Road East or Second Road East) to perform periodic maintenance. The nesting features can be created through the installation of deep beds of coarse sand and fine stone in sunny areas adjacent to the created wetlands. Basking habitat can be enhanced through the placement of logs or flat stones within the deeper areas of created wetland. Further guidance relating to the construction of turtle nesting features is available through the Toronto Zoo (Toronto Zoo 2019).

Turtle overwintering habitat was not identified within the property during the surveys but may be present on adjacent properties such as the pond to the west of First Road East. As it is anticipated that the base depth of the created wetlands will be on or close to the surface of the underlying dolostone bedrock, ideally with 0.3m or more of heavily compacted soil retained (Greer Galloway 2020), the potential for turtle overwintering within the created ponds is limited. In time, the settling of sediment and organics may provide suitable over-wintering habitat for turtles.

General Monitoring

Given the large scale of the wetland creation project at this site, there would be value in conducting monitoring of site conditions and in particular wildlife use of the wetlands and associated riparian habitat. There are numerous parameters that would best inform the success of the project, the most valuable being the monitoring of anuran breeding, conducting a fish community assessment and potentially marsh bird surveys, or breeding bird surveys in general. The 2019 field surveys completed by NRSI offer a single-season of baseline data for anuran abundance and diversity as well as data for breeding bird and migratory bird presence.

As outlined previously, pre- and post-construction monitoring of invasive species, with follow-up treatment as necessary, will also be important to ensure that the site remains diverse following the installation of plantings and seed mixtures. Other monitoring relating to vegetation communities could include plot-based sampling of herbaceous cover establishment within the wetland cells or on the berms. Fixed point photo-monitoring can provide a qualitative assessment of vegetation change over time and would complement a quantitative data set.

8.0 Summary

NRSI was retained by HCA in February 2019 to complete a Natural Heritage Characterization Report in support of the construction of berms at the Saltfleet BC-1 property. The berms are intended to retain surface water on the property in order to alleviate flooding in the lower reach of Battlefield Creek. The intent of this report is to identify and characterize the natural features within the subject property, identify potential impacts associated with the detailed design plan and recommend appropriate mitigation measures.

The subject property contains several natural features with significant local designations, including unevaluated wetland, a section of Battlefield Creek which provides fish habitat and an associated tributary, and significant woodland.

Habitat for SAR is limited to candidate roosting habitat for SAR bats outside of the development footprint. Several SWH types were identified; Landbird Migratory Stopover Habitat, Shrub/Early Successional Bird Breeding Habitat, Seeps and Springs and Special Concern/Rare Wildlife Species Habitat (Eastern Wood-pewee, Common Nighthawk and Monarch). Additionally, Bat Maternity Roost habitat, Snake Hibernacula and Raptor Wintering Area were determined to be candidate SWH types for the property. Based on the proposed development footprint, Landbird Migratory Stopover habitat, habitat for Monarch and Bat Maternity Roost habitat (candidate) will be directly impacted.

Direct impacts to fish and fish habitat can be identified as the direct loss of habitat, harmful alteration of habitat, or a harmful disruption to habitat (i.e. effecting flow during spawning), as well as the direct injury to fish as a result of the proposed works and construction. Direct impacts to fish associated with this undertaking include, potential for death of fish, destruction of fish habitat by creation of the wetland and berms (i.e. placing fill below the high-water mark and fording the watercourse). Appendix IX provides a summary of the potential impacts to fish and fish habitat, both for on land and in-water activities, the mitigation measures and if there are any residual effects expected from the activities. Based on this assessment, the project will be submitted under a RfR form to DFO in November 2020, and it is likely that the project will require an Authorization under the *Fisheries Act*.

Other direct impacts associated with this undertaking include grading and vegetation removal. The design of the berms largely avoids treed areas and grading will occur outside of the dripline where the berm nears the edges of swamp and hedgerow features. Vegetation removal is required for the east berm which overlaps an area of declining Green Ash swamp (SWD2-2).

Project impacts can be mitigated by adhering to timing windows including the breeding bird window and bat active period as well as completing grading works during the dry period. Any tree removal which must occur within the bat active period should have an assessment of potential roost trees completed prior to removals commencing. Restoration plantings will be installed both within the wetlands and watercourse as well as within riparian habitat to restore the form and function of the impacted features.

Indirect impacts to fish and fish habitat can include long term changes to the watercourse (i.e. temperature, flow, passage), erosion and sediment control, grading, and the entry of deleterious substances in the water which may also result in a HADD.

Other potential indirect impacts as a result of the proposed development include changes to wetland hydrology both above and below the berms as well as disturbance to wildlife during construction. As the areas above the berms which will retain standing water are agricultural or recently fallow fields, there are no major impacts to high quality and well-established, natural habitats. The wetland and riparian habitat below the berms will likely encounter a decrease in surface water input; however, the design of the control structures and the retained catchment and tributary inputs will continue to direct flow to these habitats to maintain their form.

Identified induced impacts as a result of the proposed development may include the establishment of non-native invasive species to the site during the completion of grading. Prior to site grading, the treatment of existing stands of Common Reed and fruit-bearing female European and Glossy Buckthorn plants through herbicide application is recommended. The entire wetland creation area beyond just the pre-construction treatment areas should be monitored during the post-construction phase with herbicide applied or re-applied as necessary.

In the absence of formal trails (except for the Dofasco 2000 Trail to the north), it is unlikely that the development will result in increased human presence on the site. The development of formal laneway entrances from First Road East. or Second Road East. may result in increased yard waste and garbage dumping.

This report provides a detailed characterization of the natural features and wildlife habitat which are present within the study area. This information has been incorporated into the design of the berms and flow control structures in a manner that minimizes impacts to sensitive features. Recommendations are provided to minimize direct, indirect, and induced impacts that may arise during the proposed development and to ensure that mitigation measures are effective.

The extensive planting of native trees, shrubs and herbaceous species, along with the creation of habitat enhancements such as turtle nesting features, will greatly enhance the diversity of the site in contrast to the fallow fields that are currently present.

9.0 References

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Appendix I
Species at Risk and Significant Wildlife Habitat Screening

Scientific Name	Common Name	S-RANK[1]	SARO[2]	COSEWIC[3]	SARA[3]	Background Source	Habitat Preference[4,5,6]	Suitable Habitats within Subject Property	Rationale	NRSI Observed
Birds										
Ammodramus henslowii	Henslow's Sparrow	SHB	END	E	Schedule 1	MNRF 2019c	Large, fallow, grassy area with ground mat of dead vegetation, dense herbaceous vegetation, ground litter and some song perches; neglected weedy fields; wet meadows; cultivated uplands; a moderate amount of moisture needed; requires a minimum tract of grassland of 40 ha, but usually in areas >100 ha	No	Grasslands greater than 40 ha in size are not present within the study area.	No
Ammodramus savannarum	Grasshopper Sparrow	S4B	SC	SC		BSC et al. 2006, MNRF 2019c	Well-drained grassland or prairie with low cover of grasses, taller weeds on sandy soil; hayfields or weedy fallow fields; uplands with ground vegetation of various densities; perches for singing; requires tracts of grassland > 10 ha	Yes	Meadow with small trees is present within the study area.	No
Asio flammeus	Short-eared Owl	S2N, S4B	SC	SC	Schedule 3	BSC et al. 2006, MNRF 2019c	Grasslands, open areas or meadows that are grassy or bushy; marshes, bogs or tundra; both diurnal and nocturnal habits; ground nester; destruction of wetlands by drainage for agriculture is an important factor in the decline of this species; home range 25 -125 ha; requires 75-100 ha of contiguous open habitat	No	Contiguous grasslands greater than 75 ha in size are not present within the study area.	No
Calidris canutus rufa	Red Knot (*rufa* subspecies)		END	E	No Schedule	MNRF 2019c	Open beaches, mudflats, and coastal lagoons, where they feast on molluscs, crustaceans, and other invertebrates. Also occur in small numbers during the fall in southern Ontario, along Great Lakes beaches and mudflats	No	The study area is 4.5 km from Lake Ontario and does not contain any beaches or sandy areas.	No
Caprimulgus vociferus	Eastern Whip-poor-will	S4B	THR	T	Schedule 1	MNRF 2019c	Dry, open, deciduous woodlands of small to medium trees; oak or beech with lots of clearings and shaded leaflitter; wooded edges, forest clearings with little herbaceous growth; pine plantations; associated with >100 ha forests; may require 500 to 1000 ha to maintain population	No	Deciduous forests are present within the study area but contiguous forests are only >30 ha in size.	No
Cardellina canadensis	Canada Warbler	S4B	SC	T	Schedule 1	BSC et al. 2006, MNRF 2019c	Interior forest habitats with a dense, well-developed shrub and vegetation understory; along riparian zones or wet bottomland habitat. require tracts of land which are >30ha	No	Due to the relatively small and fragmented nature of the forest patches within the study area there is not interior forest habitat.	No
Chaetura pelagica	Chimney Swift	S4B, S4N	THR	T	Schedule 1	BSC et al. 2006, MNRF 2019c	Commonly found in urban areas near buildings; nests in hollow trees, crevices of rock cliffs, chimneys; highly gregarious; feeds over open water	Yes	Hollow trees within forested areas of the study area may provide suitable nesting habitat. Small ponds are present within the study area but are not likely to provide suitable foraging habitat due to their small size.	No

Scientific Name	Common Name	S-RANK[1]	SARO[2]	COSEWIC[3]	SARA[3]	Background Source	Habitat Preference[4,5,6]	Suitable Habitats within Subject Property	Rationale	NRSI Observed
Charadrius melodus (ssp. circumcinctus)	Piping Plover	S1B	END	E	Schedule 1	MNRF 2019c	Dry, sandy outer beaches; upper stretches near dunes, usually large open, grassless areas, but sometimes with sparse scattering of beach grass; recreational uses of beaches results in habitat loss	No	No beaches or sandy areas present within the study area.	No
Chlidonias niger	Black Tern	S3B	SC	NAR		MNRF 2019c	Wetlands, coastal or inland marshes; large cattail marshes, marshy edges of rivers, lakes or ponds, wet open fens, wet meadows; returns to same area to nest each year in loose colonies; must have shallow (0.5 to 1 m deep) water and areas of open water near nests; requires marshes >20 ha in size; feeds over adjacent grasslands for insects; also feeds on fish, crayfish and frogs	No	No wetlands or marshes are known from within the study area. There are two ponds present within the study area but their edges do not provide suitable nesting habitat due to their small size.	No
Chordeiles minor	Common Nighthawk	S4B	SC	T	Schedule 1	MNRF 2019c	Open ground; clearings in dense forests; ploughed fields; gravel beaches or barren areas with rocky soils; open woodlands; flat gravel roofs	Yes	Ploughed fields and open woodlands are present within the study area.	**Yes**
Contopus virens	Eastern Wood-Pewee	S4B	SC	SC		BSC et al. 2006, MNRF 2019c	Open, deciduous, mixed or coniferous forest; predominated by oak with little understory; forest clearings, edges; farm woodlots, parks	Yes	Deciduous forest is present within the study area. Forest clearings and edges are also present.	**Yes**
Dolichonyx oryzivorus	Bobolink	S4B	THR	T	No Schedule	BSC et al. 2006, MNRF 2019c	Large, open expansive grasslands with dense ground cover; hayfields, meadows or fallow fields; marshes; requires tracts of grassland >50 ha	Yes	Large tracts of grassland greater than 50 ha in size are not present within the study area (only small patches). The cultural meadows in the north half of the property are small and lack structure for nesting but provide suitable foraging habitat for the species.	**Yes**
Empidonax virescens	Acadian Flycatcher	S2S3B	END	E	Schedule 1	MNRF 2019c	Mature, shady, deciduous forests; heavily wooded ravines; creek bottoms or river swamps; availability of good quality habitat is limiting factor; needs at least 30 ha of forest	No	Forest on site is mid-age, fragmented and not associated with a sizable watercourse.	No
Falco peregrinus anatum/tundrius	Peregrine Falcon	S3B	SC	SC	Schedule 1	MNRF 2019c	Rock cliffs, crags, especially situated near water; tall buildings in urban centres; threatened by chemical contamination; reintroduction efforts have been attempted in numerous locations throughout Ontario	No	No rock cliffs or tall buildings are present within the study area.	No
Haliaeetus leucocephalus	Bald Eagle	S2N, S4B	SC	NAR		MNRF 2019c	Require large continuous area of deciduous or mixed woods around large lakes, rivers; require area of 255 ha for nesting, shelter, feeding, roosting; prefer open woods with 30 to 50% canopy cover; nest in tall trees 50 to 200 m from shore; require tall, dead, partially dead trees within 400 m of nest for perching; sensitive to toxic chemicals	No	The study area is located 4.5 km from Lake Ontario, the nearest large open body of water.	No

Scientific Name	Common Name	S-RANK[1]	SARO[2]	COSEWIC[3]	SARA[3]	Background Source	Habitat Preference[4,5,6]	Suitable Habitats within Subject Property	Rationale	NRSI Observed
Hirundo rustica	Barn Swallow	S4B	THR	T		BSC et al. 2006, MNRF 2019c	Farmlands or rural areas; cliffs, caves, rock niches; buildings or other man-made structures for nesting; open country near body of water	Yes	The study area is located in a rural area. Buildings and other man-made structures (on adjacent properties) may provide suitable nesting habitat. The inundated marshes in the north end of the property provide foraging habitat..	**Yes**
Hylocichla mustelina	Wood Thrush	S4B	SC	T		BSC et al. 2006, MNRF 2019c	Carolinian and Great Lakes-St. Lawrence forest zones; undisturbed moist mature deciduous or mixed forest with deciduous sapling growth; near pond or swamp; hardwood forest edges; must have some trees higher than 12 m	Yes	Deciduous forests near wet areas are present within the study area.	**Yes**
Icteria virens	Yellow-breasted Chat	S2B	END	E	Schedule 1	MNRF 2019c	Thickets, tall tangles of shrubbery beside streams, ponds; overgrown bushy clearings with deciduous thickets; nests above ground in bush, vines etc.	Yes	Thickets alongside the watercourse are present within the study area.	No
Ixobrychus exilis	Least Bittern	S4B	THR	T	Schedule 1	MNRF 2019c	Deep marshes, swamps, bogs; marshy borders of lakes, ponds, streams, ditches; dense emergent vegetation of cattail, bulrush, sedge; nests in cattails; intolerant of loss of habitat and human disturbance	No	No marshes or areas with dense emergent vegetaion are present within the study area.	No
Lanius ludovicianus (ssp. migrans)	Loggerhead Shrike	S2B	END	E	Schedule 1	MNRF 2019c	Grazed pasture, marginal farmland with scattered hawthorn shrubs, hedgerows; fence posts, wires and associated low-lying wetland; located on core areas of limestone plain adjacent to Canadian Shield; greatest threat is fragmentation of suitable habitat due to natural succession; probably needs at least 25 ha of suitable habitat	No	Farmland with shrubs, hedgrerows and fence posts is present within the study area but it is approximately 10 ha in size. The most recent observation within the vicinity of the study area was in 1963 (eBird 2019).	No
Melanerpes erythrocephalus	Red-headed Woodpecker	S4B	SC	T	Schedule 1	BSC et al. 2006, MNRF 2019c	Open, deciduous forest with little understory; fields or pasture lands with scattered large trees; wooded swamps; orchards, small woodlots or forest edges; groves of dead or dying trees; feeds on insects and stores nuts or acorns for winter; loss of habitat is limiting factor; requires cavity trees with at least 40 cm dbh; require about 4 ha for a territory	Yes	Deciduous forest greater than 4 ha is present within the study area and may provide suitable nesting and foraging habitat.	No
Pelecanus erythrorhynchos	American White Pelican	S2B	THR	NAR		MNRF 2019c	Small, remote bedrock islands in freshwater permanent lakes; sparsely vegetated with grasses, nettles, shrubs, trees; intolerant of disturbance; colonial nester often with Double-crested Cormorants and Herring Gulls	No	The study area is located 4.5 km from Lake Ontario, the nearest large open body of water.	No
Phalaropus lobatus	Red-necked Phalarope	S3S4B	SC			MNRF 2019c	Coastal and inland marshes where it feeds in shallow ponds and nests on the grassy edges. It avoids mud and dense shrubs. Nests are located on the ground in dense grasses and sedges. During migration and in the winter, the Red-necked Phalarope is always near water, either saltwater, or freshwater ponds, lakes, ditches or lagoons.	No	No sizable marshes are present within the study area.	No

Scientific Name	Common Name	S-RANK[1]	SARO[2]	COSEWIC[3]	SARA[3]	Background Source	Habitat Preference[4,5,6]	Suitable Habitats within Subject Property	Rationale	NRSI Observed
Podiceps auritus	Horned Grebe	S1B, S4N	SC	SC	No Schedule	MNRF 2019c	Deep water marshes or sloughs with a mix of open water, emergent vegetation; small freshwater ponds or protected bays of larger lakes with emergent vegetation; territories are about 1 ha, but birds are very territorial	No	No large marshes are present within the study area. Two small freshwater ponds are present within the study area but are not known to contain emergent vegeation.	No
Protonotaria citrea	Prothonotary Warbler	S1B	END	E	Schedule 1	BSC et al. 2006, MNRF 2019c	Area sensitive species preferring 100 ha of flooded or swampy woodlands with standing or flowing water and more than 25% canopy cover with numerous stumps and snags; stream borders or flooded bottomlands; soft, dead trees with dbh >10 cm; Carolinian species	No	Only approximately 30 ha of contiguous forest is present within the study area. Swamp habitat within the study area is relatively small and the structure not suitable for this species.	No
Rallus elegans	King Rail	S2B	END	E	Schedule 1	MNRF 2019c	Large, shallow, fresh water marshes, shrubby swamps, marshy borders of lakes and ponds with abundant vegetation; an 'edge' species; territories are 0.3 to 0.5 ha; loss of large marshes in the south is limiting to this species	No	No large marshes or ponds with abundant vegetation are present within the study area.	No
Riparia riparia	Bank Swallow	S4B	THR	T		BSC et al. 2006, MNRF 2019c	Sand, clay or gravel river banks or steep riverbank cliffs; lakeshore bluffs of easily crumbled sand or gravel; gravel pits, road-cuts, grassland or cultivated fields that are close to water; nesting sites are limiting factor for species presence	No	No suitable nesting riverbanks, cliffs or bluffs are known within the study area. No foraging habitat is present as grasslands and cultivated fields are not located close to a waterbody.	No
Setophaga cerulea	Cerulean Warbler	S3B	THR	E	Schedule 1	MNRF 2019c	Mature deciduous woodland of Great Lakes- St. Lawrence and Carolinian forests, sometimes coniferous; swamps or bottomlands with large trees; area sensitive species needing extensive areas of forest (>100 ha)	No	Deciduous forests are present within the study area but contiguous forests are only >30 ha in size.	No
Sturnella magna	Eastern Meadowlark	S4B	THR	T	No Schedule	BSC et al. 2006, MNRF 2019c	Open, grassy meadows, farmland, pastures, hayfields or grasslands with elevated singing perches; cultivated land and weedy areas with trees; old orchards with adjacent, open grassy areas >10 ha in size	Yes	Cultural meadow and cultivated land approximately 10 ha in size is present within the study area.	No
Tyto alba	Barn Owl	S1	END	E	Schedule 1	MNRF 2019c	Open areas such as fields, agricultural lands with scattered woodlots, buildings and/or orchards; grasslands, sedge meadows, marshes; snow-cover limits ability to catch prey; species has intolerance to severe cold; nests in hollow trees and live trees >46 cm dbh; also nests in barns, abandoned buildings	Yes	The study area contains agricultural fields with scattered woodlots and buildings (on adjacent properties) that may provide suitable nesting habitat. Meadow habiats within the study area may provide suitable foraging habitat.	No
Vermivora chrysoptera	Golden-winged Warbler	S3B	SC	T	Schedule 1	MNRF 2019c	Early successional habitat; shrubby, grassy abandoned fields with small deciduous trees bordered by low woodland and wooded swamps; alder bogs; deciduous, damp woods; shrubbery clearings in deciduous woods with saplings and grasses; brier-woodland edges; requires >10 ha	Yes	Meadow and thicket habitats are present (approximately 10 ha in size).	No

Scientific Name	Common Name	S-RANK[1]	SARO[2]	COSEWIC[3]	SARA[3]	Background Source	Habitat Preference[4,5,6]	Suitable Habitats within Subject Property	Rationale	NRSI Observed
Herpetofauna										
Ambystoma jeffersonianum	Jefferson Salamander	S2	END	E	Schedule 1	Ontario Nature 2018, MNRF 2019c	Damp shady deciduous forest, swamps, moist pasture, lakeshores; temporary woodland pools for breeding; hides under leaf litter, stones or in decomposing logs	No	Forest cover within the study area is not suitable for this species.	No
Ambystoma laterale - (2) jeffersonianum	Unisexual*Ambystoma* Jefferson dependent population	S2	END	E	No Schedule	MNRF 2019c	Damp shady deciduous forest, swamps, moist pasture, lakeshores; temporary woodland pools for breeding; hides under leaf litter, stones or in decomposing logs	No	Forest cover within the study area is not suitable for this species.	No
Apalone spinifera spinifera	Spiny Softshell	S3	THR	E	Schedule 1	MNRF 2019c	Intolerant of pollution; large river systems, shallow lakes and ponds with muddy bottoms and aquatic vegetation; basks on sandbars, mud flats, grassy beaches, logs or rocks; eggs are laid near water on sandy beaches or gravel banks in areas with sun; requires acceptable feeding, nesting, habitat and natural, undisturbed corridors between these critical habitats	No	No large bodies of water are present within the study area.	No
Chelydra serpentina serpentina	Common Snapping Turtle	S2B	SC	SC	Schedule 1	Ontario Nature 2018, MNRF 2019c	Permanent or semi-permanent fresh water; marshes, swamps or bogs; rivers and streams with soft muddybanks or bottoms. The species often uses soft soil or clean dry sand on south-facing slopes for nest sites and may nest at some distance from water.	Yes	Two small ponds are present within the study area that may provide suitable habitat. Suitable nesting habitat is confined to road shoulders.	No
Crotalus horridus	Timber Rattlesnake	SX	EXP	XT		MNRF 2019c	The Timber rattlesnake was consciously eradicated from Ontario by humans. This rattlesnake was found along the Niagara Escarpment, primarily in the Niagara River Gorge.	No	This species is extripated from the area.	No
Emydoidea blandingii	Blanding's Turtle (Great Lakes/St Lawrence population)	S3	THR	T	Schedule 1	Ontario Nature 2018, MNRF 2019c	Shallow water marshes, bogs, ponds or swamps, or coves in larger lakes with soft muddy bottoms and aquatic vegetation; basks on logs, stumps or banks; surrounding natural habitat is important in summer as they frequently move from aquatic habitat to terrestrial habitats; hibernates in bogs; not readily observed.	Yes	Two small ponds are present within the study area that may provide suitable habitat. Suitable nesting habitat is confined to road shoulders.	No
Graptemys geographica	Northern Map Turtle	S3B	SC	SC	Schedule 1	MNRF 2019c	Large bodies of water with soft bottoms, and aquatic vegetation; basks on logs or rocks or on beaches and grassy edges, will bask in groups; uses soft soil or clean dry sand for nest sites; may nest at some distance from water.	No	No large bodies of water are present within the study area.	No
Heterodon platirhinos	Eastern Hog-nosed Snake	S3	THR	T	Schedule 1	MNRF 2019c	Sandy upland fields, pastures, savannahs, sandy beaches; dry open oak-pine-maple forest with sandy soils; prefer forest areas > 5ha	No	Beaches or sandy fields are not present within the study area.	No
Pantherophis spiloides pop. 2	Gray Ratsnake (*Carolinian population*)	S1	END	E	Schedule 1	MNRF 2019c	Shrubby, old field, deciduous or mixed forests, thickets, field edges, rocky hillsides, river bottoms; talus slopes; uses talus slopes, unused wells or cisterns for hibernation; will hibernate in groups with other snakes	Yes	Shrub thickets, recently retired agricultural fields, open areas, deciduous forest and field edges are present within the study area.	No
Sternotherus odoratus	Eastern Musk Turtle	S3	SC	SC	Schedule 1	Ontario Nature 2018, MNRF 2019c	Aquatic, except when laying eggs; shallow slow moving water of lakes, streams, marshes and ponds; hibernate in underwater mud, in banks or in muskrat lodges; eggs are laid in debris or under stumps or fallen logs at waters edge; often share nest sites; sometimes congregate at hibernation sites; not readily observed	Yes	Two small ponds are present within the study area that may provide suitable habitat. Suitable nesting habitat is confined to road shoulders.	No

Scientific Name	Common Name	S-RANK[1]	SARO[2]	COSEWIC[3]	SARA[3]	Background Source	Habitat Preference[4,5,6]	Suitable Habitats within Subject Property	Rationale	NRSI Observed
Thamnophis sauritus septentrionalis	Eastern Ribbonsnake (Great Lakes population)	S3	SC	SC	Schedule 1	MNRF 2019c	Sunny grassy areas with low dense vegetation near bodies of shallow permanent quiet water; wet meadows grassy marshes or sphagnum bogs; borders of ponds, lakes or streams; hibernates in groups	Yes	Open grassy areas adjacent to ponds are present within the study area.	No
Mammals										
Microtus pinetorum	Woodland Vole		SC	SC	Schedule 1	Dobbyn 1994, MNRF 2019c	Mature deciduous forest in the Carolinian forest zone, with loose sandy soil and deep humus; grasslands, meadows and orchards with groundcover of duff or grass	Yes	Deciduous forest and meadows are present within the study area.	No
Myotis leibii	Eastern Small-footed Myotis	S2S3	END			MNRF 2019c	Hibernates in cool caves and abandoned mines; roosts in rocky habitats including talus slopes and open rock barrens. May also roost in man-made structures, however, very rarely; foraging habitat poorly understood in Ontario. Within the U.S, it feeds primarily in forests, but also over waterbodies, within riparian forests, and occasionally open fields.	Yes	Man-made structures throughout the study area may provide possible roosting habitat and the forests and open fields within the study area may provide suitable foraging habitat.	Possible
Myotis lucifungus	Little Brown Myotis	S5	END	E	Schedule 1	Dobbyn 1994, MNRF 2019c	Uses caves, quarries, tunnels, hollow trees or buildings for roosting; winters in humid caves; maternity sites in dark warm areas such as attics and barns; feeds primarily in wetlands, forest edges	Yes	Hollow trees within forested areas, and buildings within the study area may provide suitable roosting habitat. Forest edges within the study area may provide suitable foraging habitat.	Possible
Myotis septentrionalis	Northern Myotis	S3	END	E	Schedule 1	MNRF 2019c	Hibernates during winter in mines or caves; during summer males roost alone and females form maternity colonies of up to 60 adults; roosts in houses, man-made structures but prefers hollow trees or under loose bark; hunts within forest, below canopy	Yes	Hollow trees within forested areas, and buildings within the study area may provide suitable roosting habitat. Forests within the study area may provide suitable foraging habitat.	Possible
Perimyotis subflavus	Tri-colored Bat	S3?	END	E	Schedule 1	Dobbyn 1994, MNRF 2019c	Variety of forested habitats. Older forests and occasionally in barns or other structures may be used for roosts. They forage over water and along streams in the forest.	Yes	Forested areas and buildings within the study area may provide suitable roosting habitat. A possible forested stream within the study area may also provide suitable foraging habitat.	Possible
Taxidea taxus jacksoni	American Badger *(jacksoni subspecies)*	S2	END	E	Schedule 1	MNRF 2019c	Open grasslands and oak savannahs; dens in new hole or enlarged existing hole.	Yes	Open meadows are present within the study area.	No
Urocyon cinereoargenteus	Gray Fox	S1	THR	T	Schedule 1	Dobbyn 1994, MNRF 2019c	Hardwood forests with a mix of fields and woods; swamps; wooded, brushy or rocky habitats; woodland farmland edge; old fields with thickets; dens in hollow log or tree; individual has numerous winter dens throughout its range which is > 40 ha	Yes	A mix of fields, deciduous forests, swamps, woodland-farmland edges and thicket communities are present within the study area.	No
Insects										
Danaus plexippus	Monarch	S2N, S4B	SC	SC	Schedule 1	McNaughton et al. 2018, MNRF 2019c	Exist primarily wherever milkweed and wildflowers exist; abandoned farmland, along roadsides, and other open spaces	Yes	Small patches of Common Milkweed and Swamp Milkweed are present within the subject property.	Yes

Scientific Name	Common Name	S-RANK[1]	SARO[2]	COSEWIC[3]	SARA[3]	Background Source	Habitat Preference[4,5,6]	Suitable Habitats within Subject Property	Rationale	NRSI Observed
Erynnis martialis	Mottled Duskywing	S2	END	E		MNRF 2019c	Oak or pine savannas or open woodlands; also non-coastal pine barrens or grassy openings within these communities	No	Savannas or pine barrens are not present within the study area.	No
Euphyes conspicua	Black Dash	S3				McNaughton et al. 2018	Wet sedge meadows; also, open shrubby or partially-wooded wetlands with red maple	Yes	Moist grassy meadows are present within the study area.	No
Pieris virginiensis	West Virginia White	S3	SC	SC		MNRF 2019c	Mesic hardwood or hardwood-northern conifer-mixed forests on rich soils, including hardwood swamps. An important feature is plentiful suppply of the foodplants, generally toothworts	Yes	Toothwort was not observed within the subject property and mesic hardwood forest is limited to the feature in the southeast corner of the property.	No
Fishes										
Acipenser fulvescens	Lake Sturgeon (GL-USL Pop.)	S2	THR			MNRF 2019c	Generally inhabits the bottoms of shallow areas of large freshwater lakes and rivers.	No	The section of Battlefield Creek crossing the property is poorly defined and has intermittent flow making it unsuitable for this species.	No
Anguilla rostrata	American Eel	S1?	END	T		MNRF 2019c	All fresh water, estuaries and coastal marine waters that are accessible to the Atlantic Ocean; 12-mile Creek watershed and Lake Ontario.	No	The study area does not contain any estuaries or coastal waters and is not located within Lake Ontario or 12-Mile Creek Watershed.	No
Clinostomus elongatus	Redside Dace	S2	END	E	Schedule 1	MNRF 2019c	Prefers pools and slow-moving sections of relatively small (<10 m width), clear, cool, streams with sand or gravel bottoms , riffle/pool habitat and overhanging vegetation; preferred water temperature range 14-23°C	No	The section of Battlefield Creek crossing the property is poorly defined and has intermittent flow making it unsuitable for this species.	No
Esox americanus vermiculatus	Grass Pickerel	S3	SC	SC	Schedule 1	MNRF 2019c	Generally occur in wetlands with warm, shallow water and an abundance of aquatic plants; occur in the St. Lawrence River, Lake Ontario, Lake Erie, and Lake Huron.	No	No wetlands with open water are present within the study area. The study area is not contiguous with Lake Ontario.	No
Ichthyomyzon fossor	Northern Brook Lamprey (GL-USL Pop.)	S3	SC	SC	Schedule 1	MNRF 2019c	Generally inhabits small rivers and clear streams of varying sizes. Adults spawn in gravelly riffles.	No	The section of Battlefield Creek crossing the property is poorly defined and has intermittent flow making it unsuitable for this species.	No
Ichthyomyzon unicuspis	Silver Lamprey (GL-USL Pop.)	S3	SC	SC		MNRF 2019c	Clean stream beds of sand and organic debris for larvae to live in, and unrestricted migration routes for spawning.	No	The section of Battlefield Creek crossing the property is poorly defined and has intermittent flow making it unsuitable for this species.	No
Moxostoma duquesnei	Black Redhorse	S2	THR	T	No Schedule	MNRF 2019c	Lives in pools and riffle areas of medium-sized rivers and streams that are usually less than two metres deep. These rivers usually have few aquatic plants, a moderate to fast current, and a sandy or gravel bottom. In the spring, it migrates to breeding habitat where eggs are laid on gravel in fast water. The winter is spent in deeper pools. Adults feed on crustaceans and aquatic insects, while the young fish feed on plankton.	No	The section of Battlefield Creek crossing the property is poorly defined and has intermittent flow making it unsuitable for this species.	No

Scientific Name	Common Name	S-RANK^1	SARO^2	COSEWIC^3	SARA^3	Background Source	Habitat Preference^{4,5,6}	Suitable Habitats within Subject Property	Rationale	NRSI Observed
Notropis photogenis	Silver Shiner	S2S3	SC	SC	Schedule 3	MNRF 2019c	Silver shiners prefer moderate to large size streams with swift currents that are free of weeds and have clean gravel or boulder bottoms.	No	The section of Battlefield Creek crossing the property is poorly defined and has intermittent flow making it unsuitable for this species.	No
Molluscs										
Ligumia nasuta	Eastern Pondmussel	S1	END	SC	Schedule 1	MNRF 2019c	Generally inhabit sheltered areas of lakes or slow streams in substrates of fine sand and mud.	No	The section of Battlefield Creek crossing the property is poorly defined and has intermittent flow making it unsuitable for this species.	No
Quadrula quadrula	Mapleleaf	S2	THR	SC	Schedule 1	MNRF 2019c	Generally found in medium to large rivers in firmly packed substrate.	No	The section of Battlefield Creek crossing the property is poorly defined and has intermittent flow making it unsuitable for this species.	No
Toxolasma parvus	Lilliput	S1	THR	E		MNRF 2019c	Found in a variety of habitats including small to large rivers, wetlands, shallows of lakes, ponds and reservoirs. They are common in soft substrates with over 50% of the substrate type comprised of sand and a mud/muck/silt combination. Typically occur with or near Green Sunfish, Bluegill, White Crappie, and Johnny Darter.	No	The section of Battlefield Creek crossing the property is poorly defined and has intermittent flow making it unsuitable for this species.	No
Villosa iris	Rainbow	S2S3	SC	E	Schedule 1	MNRF 2019c	Most abundant in shallow, well oxygenated reaches of small- to medium-sized rivers and sometimes lakes, on substrates of cobble, gravel, sand and occasionally mud.	No	The section of Battlefield Creek crossing the property is poorly defined and has intermittent flow making it unsuitable for this species.	No
Plants										
Aesculus glabra var. glabra	Ohio Buckeye	S1				Oldham and Brinker 2009	Mesic deciduous, riparian woods and roadsides	Yes	Deciduous forests and roadsides are present within the study area.	No
Allium burdickii	Wild Leek	S1?				Oldham and Brinker 2009	Rich woods	Yes	Woods are present within the study area.	No
Amelanchier amabalis	Large-flowered Juneberry	S2S3				Oldham and Brinker 2009	Open rocky or sandy woods and edges	No	Suitable habitat is not present.	No
Aplectrum hyemale	Putty-root	S2				Oldham and Brinker 2009	Moist deciduous woods	Yes	Moist deciduous woods are present within the study area.	No
Arisaema dracontium	Green Dragon	S3	SC	SC	Schedule 3	Oldham and Brinker 2009, MNRF 2019c	Wet bottomlands along rivers and creeks	No	Suitable habitat is not present.	No
Aureolaria flava	Smooth Yellow False Foxglove	S2?				Oldham and Brinker 2009	Open oak woods	Yes	Open woods are present within the study area.	No
Aureolaria pedicularia	Fern-leaved False Foxglove	S2?		T		Oldham and Brinker 2009	Dry, open pine and oak woods and thickets; often on sand and along disturbed woodland margins; hosts frequently include woody species other than pines and oaks	No	Suitable habitat is not present.	No
Aureolaria virginica	Downy Yellow False Foxglove	S1		END		Oldham and Brinker 2009	Dry, open, deciduous woods	No	Suitable habitat is not present.	No
Azolla caroliniana	Water Fern	S1?				Oldham and Brinker 2009	Floating on still water of lakes, ponds, creeks and streams; often assoicated with Lemna; may form dense mats on water's surface	Yes	Two small ponds are present within the study area.	No
Baptisia tinctoria	Wild Indigo	S2				Oldham and Brinker 2009	Prairies, roadsides and sandy open woods	No	Suitable habitat is not present.	No
Betula lenta	Cherry Birch	S1	END	E	Schedule 1	MNRF 2019c	Woods	Yes	Woodlands are present within the study area	No

Scientific Name	Common Name	S-RANK[1]	SARO[2]	COSEWIC[3]	SARA[3]	Background Source	Habitat Preference[4,5,6]	Suitable Habitats within Subject Property	Rationale	NRSI Observed
Boechera grahamii	Purple Rockcress	S2?				Oldham and Brinker 2009	Sandy or gravelly clearings and borders of forests (especially aspen) and shores, rock outcrops and rocky summits.	No	Suitable habitat is not present.	No
Botrychium oneidense	Blunt-lobed Grape Fern	S3?				Oldham and Brinker 2009	Open woods, sandy old fields	No	Suitable habitat is not present.	No
Carex albicans var. albicans	Closely-covered Sedge	S3				Oldham and Brinker 2009	Open sandy or rocky woods	No	Woodlands within the study area are not sandy or rocky.	No
Carex bicknellii var. bicknellii	Bicknell's Sedge	S2				Oldham and Brinker 2009	Open prairie and open oak woods, usually dry	No	Suitable habitat is not present.	No
Carex mesochorea	Midland Sedge	S1				Oldham and Brinker 2009	Dry, open woodland	No	Suitable habitat is not present.	No
Carex oligocarpa	Few-fruited Sedge	S3				Oldham and Brinker 2009	Dry woods and banks, alvar woodland	No	Suitable habitat is not present.	No
Carex virescens	Ribbed Sedge	S3				Oldham and Brinker 2009	Dry and mesic hardwood forests	Yes	Hardwood forests are present within the study area.	No
Carya glabra	Pignut Hickory	S3				Oldham and Brinker 2009	Usually in upland, often sandy, forests, associated with oaks.	Yes	Forests are present within the study area.	No
Castanea dentata	American Chestnut	S2	END	E	Schedule 1	Oldham and Brinker 2009, MNRF 2019c	Moist to well drained forests on sand, occasionally heavy soils	Yes	Forests are situated on clay-loam soils. The forest in the southeast may provide suitable habitat.	No
Chimaphila maculata var. maculata	Spotted Wintergreen	S1	END	E	Schedule 1	Oldham and Brinker 2009, MNRF 2018b	Dry, sandy woods	No	Suitable habitat is not present.	No
Cimicifuga racemosa	Black Cohosh	S2				Oldham and Brinker 2009	Open, rich, moist woods	Yes	Moist forests are present within the study area.	No
Cornus florida	Eastern Flowering Dogwood	S2?	END	E	Schedule 1	Oldham and Brinker 2009, MNRF 2019a, MNRF 2019c	Dry (usually oak) to rich deciduous forests, especially on hillsides and river banks	Yes	Deciduous forests are present within the study area.	No
Crataegus brainerdii	Brainerd's Hawthorn	S2				Oldham and Brinker 2009	Old fields, poorly managed pastures, fencelines and roadsides	Yes	Old fields, fencelines and roadsides are present within the study area.	No
Crataegus dissona	Hawthorn	S3				Oldham and Brinker 2009	Old fields, poorly managed pastures, fencelines and roadsides	Yes	Old fields, fencelines and roadsides are present within the study area.	No
Crataegus formosa	Beautiful Hawthorn	S2				Oldham and Brinker 2009	Old fields, poorly managed pastures, fencelines and roadsides	Yes	Old fields, fencelines and roadsides are present within the study area.	No
Crataegus fulleriana	Fuller's Hawthorn	S2?				Oldham and Brinker 2009	Forest edges, forests, meadows and fields	Yes	Forest edgres, forests, meadows and fields are present within the study area.	No
Crataegus pennsylvanica	Pennsylvania Hawthorn	S1S2				Oldham and Brinker 2009	Forest edges, forests, meadows and fields	Yes	Forest edgres, forests, meadows and fields are present within the study area.	No
Crataegus scabrida	Rough Hawthorn	S3?				Oldham and Brinker 2009	Forest edges, forests, meadows and fields	Yes	Forest edgres, forests, meadows and fields are present within the study area.	No
Cyperus schweinitzii	Schweinitz's Umbrella Sedge	S3				Oldham and Brinker 2009	Dry open sandy areas	No	Suitable habitat is not present.	No
Cystopteris protrusa	Creeping Fragile Fern	S2				Oldham and Brinker 2009	Open deciduous woodlands on sandy loam; alluvial river terraces and hillsides that border streams or rivers	Yes	Open deciduous woodlands are present within the study area.	No
Desmodium cuspidatum	Toothed Tick-trefoil	S3				Oldham and Brinker 2009	Rich, open woodlands	Yes	Open woods are present within the study area.	No

Scientific Name	Common Name	S-RANK^{1}	SARO^{2}	COSEWIC^{3}	SARA^{3}	Background Source	Habitat Preference^{4,5,6}	Suitable Habitats within Subject Property	Rationale	NRSI Observed
Dichanthelium dichotomum var. dichotomum	Spreading Panic Grass	S2				Oldham and Brinker 2009	Dry to mesic sandy or rocky deciduous forest	No	Suitable habitat is not present.	No
Dichanthelium ovale ssp. praecocius	Hairy Panic Grass	S3				Oldham and Brinker 2009	Dry open, usually sandy ground; prairies, open oak savannas, borders and fields.	No	Suitable habitat is not present.	No
Euonymus atropurpurea var. atropurpurea	Burning Bush	S3				Oldham and Brinker 2009	Dry to moist thickets and woods	Yes	Moist thickets and forests are present within the study area.	No
Eupatorium altissimum	Tall Joe-pyeweed	S1				Oldham and Brinker 2009	Alvars, open woodlands and savannah, adventive along railways and roadsides	No	Suitable habitat is not present.	No
Eurybia divaricata	White Wood Aster	S2	THR	T	Schedule 1	Oldham and Brinker 2009, MNRF 2019c	Mesic to dry deciduous woods	Yes	Deciduous woods are present within the study area.	No
Eurybia schreberi	Schreber's Aster	S2S3				Oldham and Brinker 2009	Woods	Yes	Woods are present within the study area.	No
Frasera caroliniensis	American Columbo	S2	END	E	Schedule 1	Oldham and Brinker 2009, MNRF 2019c	Woodlands on sandy and clay soils	No	Suitable habitat is not present.	No
Fraxinus profunda	Pumpkin Ash	S2?				Oldham and Brinker 2009	Moist woods	Yes	Moist woods are present within the study area.	No
Gentianella quinquefolia ssp. quinquefolia	Stiff Gentian	S2				Oldham and Brinker 2009	Moist soil, roadsides, streambanks and edges of woods; prairies	Yes	Moist soil, roadsides and woodland edges are present within the study area.	No
Gymnocladus dioicus	Kentucky Coffee-tree	S2	THR	T	Schedule 1	Oldham and Brinker 2009, MNRF 2019c	Floodplains, edges of marshes and shallow soil over limestone	No	Suitable habitat is not present.	No
Helianthemum canadense	Long-branched Frostweed	S3				Oldham and Brinker 2009	Dry sandy plains, hillsides, dunes, usually open or with thin tree cover (pines, oak, and/or aspen) or scattered junipers.	No	Suitable habitat is not present.	No
Hieracium paniculatum	Panicled Hawkweed	S2?				Oldham and Brinker 2009	Dry open woods and sandy slopes	No	Suitable habitat is not present.	No
Hybanthus concolor	Green Violet	S2				Oldham and Brinker 2009	Rich, wet-mesic floodplain forests and mesic forests over limestone	Yes	No limestone is present within the study area.	No
Hymenoxys herbacea	Lakeside Daisy	S3	THR	T	Schedule 1	MNRF 2019c	Open limestone pavement	No	Suitable habitat is not present.	No
Hypoxis hirsuta	Yellow Stargrass	S3				Oldham and Brinker 2009	Dry open sandy woods; wet to dry meadows and prairies	Yes	Wet meadows and open woods are present within the study area.	No
Juglans cinerea	Butternut	S2?	END	E	Schedule 1	Oldham and Brinker 2009, MNRF 2019c	Stream banks and swamps, as well as upland beech-maple, oak-hickory, and mixed hardwood stands	Yes	Swamp and forest is present within the study area.	No
Juncus acuminatus	Sharp-fruited Rush	S3				Oldham and Brinker 2009	Sandy and gravelly shorelines, ditches and gravel pits	Yes	Ditches are present within the study area.	No
Lilium canadense	Canada Lily	S1?				Oldham and Brinker 2009	Woodlands	Yes	Woodlands are present within the study area	No
Lindernia dubia var. anagallidea	Doubtful False Pimpernel	S1				Oldham and Brinker 2009	Moist shores	No	No shorelines present within the study area.	No
Linum sulcatum	Grooved Yellow Flax	S3				Oldham and Brinker 2009	Prairies and dry, sandy open sites	No	Suitable habitat is not present.	No
Lithospermum incisum	Incised Puccoon	S1				Oldham and Brinker 2009	Dune,savannah, sandy woods and dry ground	No	Suitable habitat is not present.	No
Lycopus virginicus	Virginia Water-horehound	S3				Oldham and Brinker 2009	Wet ground	Yes	Wet ground is present within the study area.	No

Scientific Name	Common Name	S-RANK[1]	SARO[2]	COSEWIC[3]	SARA[3]	Background Source	Habitat Preference[4,5,6]	Suitable Habitats within Subject Property	Rationale	NRSI Observed
Lythrum alatum	Wing-angled Loosestrife	S3				Oldham and Brinker 2009	Wet meadows, moist prairies, open woods and wet, disturbed areas	Yes	Wet meadows and open woods are present within the study area.	No
Magnolia acuminata	Cucumber Tree	S2	END	E	Schedule 1	MNRF 2019c	Rich, partly open, moist to wet woods	No	Suitable habitat is not present.	No
Mertensia virginica	Virginia Bluebells	S3				Oldham and Brinker 2009	Moist or wet deciduous woods and thickets, usually on floodplains, occasional escape from cultivation	Yes	Moist forests and thickets are present within the study area.	No
Monarda didyma	Oswego-tea	S3				Oldham and Brinker 2009	Moist woods, swampy thickets and roadsides	Yes	Moist woods and roadsides are present within the study area.	No
Monarda X media	Purple Horsemint	S1				Oldham and Brinker 2009	Woods and edges	Yes	Woods and edges are present within the study area.	No
Morus rubra	Red Mulberry	S2	END	E	Schedule 1	Oldham and Brinker 2009, MNRF 2019c	Moist woods and wooded river valleys	Yes	Moist woods are present within the study area.	No
Muhlenbergia tenuiflora var. tenuiflora	Slender Satin Grass	S2				Oldham and Brinker 2009	Rich deciduous forest, often on rocky or sandy soil	Yes	Deciduous forests are present within the study area.	No
Nuphar advena	Large Yellow Pond-lily	S3				Oldham and Brinker 2009	Alkaline and neutral water 0.5 to 2 m deep	Yes	Two small ponds are present within the study area.	No
Nyssa sylvatica	Black Gum	S3				Oldham and Brinker 2009	Dry to wet woods and savannahs	No	Suitable habitat is not present.	No
Oenothera pilosella ssp. pilosella	Finely-pilose Evening-primrose	S2				Oldham and Brinker 2009	Moist edges of woods and waste ground, prairie	Yes	Moist woodland edges are present within the study area.	No
Onosmodium molle ssp. hispidissimum	Soft Hairy False Gromwell	S2				Oldham and Brinker 2009	River banks and flats and dry rocky woods, fields, gravelly soil; stable sand dune ridges	No	Suitable habitat is not present.	No
Panax quinquefolius	Ginseng	S3	END	E	Schedule 1	Oldham and Brinker 2009, MNRF 2019c	Deep leaf litter in rich, moist deciduous woods, especially on rocky, shaded cool slopes in sweet soil	Yes	Moist deciduous woods are present within the study area.	No
Persicaria arifolium	Halberd-leaved Tearthumb	S3				Oldham and Brinker 2009	Wet mucky soil under alders at margin of peat bogs; wet, shaded ground along streams, ponds, swamps and lakes; rick thickets and marshy borders; wet depressions and seepage areas In mature hardwood forests	Yes	Swamp and marsh habitat may be suitable for this species.	No
Phegopteris hexagonoptera	Broadbeech Fern	S3	SC	SC	Schedule 3	Oldham and Brinker 2009, MNRF 2019c	Rich, moist soil in mature deciduous forests	Yes	Moist deciduous forests are present within the study area.	No
Phlox subulata ssp. subulata	Moss Phlox	S1?				Oldham and Brinker 2009	Open, sandy woods, and sandy roadsides and lakeshores	No	Suitable habitat is not present.	No
Platanthera leucophaea	Prairie White-fringed Orchid	S2	END	E	Schedule 1	Oldham and Brinker 2009	Fens, wet meadows, marshes and prairies	Yes	Wet meadows are present within the study area.	No
Poa saltuensis ssp. languida	Two-rayed Poa	S3				Oldham and Brinker 2009	Forests, shores, and thickets.	Yes	Forests and thickets are present within the study area.	No
Potentilla canadensis	Canada (Dwarf) Cinquefoil	S2?				Oldham and Brinker 2009	Dry to moist open savannas, apparently in sandy soils	No	Suitable habitat is not present.	No
Ptelea trifoliata	Common Hop-tree	S3	SC	T	Schedule 1	Oldham and Brinker 2009, MNRF 2019c	Shorelines and other dry sites	No	No shorelines present within the study area.	No
Pterospora andromedea	Giant Bird's Nest	S2				Oldham and Brinker 2009	Conifer woods, under pine	No	Suitable habitat is not present.	No
Pycnanthemum incanum var. incanum	Hoary Mountain-mint	S1	END	E	Schedule 1	Oldham and Brinker 2009, MNRF 2019c	Dry woodlands in partial shade of oaks and in openings	No	Suitable habitat is not present.	No
Quercus ellipsoidalis	Northern Pin Oak	S3				Oldham and Brinker 2009	Open habitats or on edges of closed forests	No	Suitable habitat is not present.	No
Salix myricoides	Blue-leaf Willow	S3				Oldham and Brinker 2009	Dunes	No	Suitable habitat is not present.	No

Scientific Name	Common Name	S-RANK[1]	SARO[2]	COSEWIC[3]	SARA[3]	Background Source	Habitat Preference[4,5,6]	Suitable Habitats within Subject Property	Rationale	NRSI Observed
Sanicula canadensis var. grandis	Long-styled Canada Snakeroot	S2				Oldham and Brinker 2009	Rich deciduous woods	Yes	Moist deciduous woods are present within the study area.	No
Saururus cernuus	Lizard's-tail	S3				Oldham and Brinker 2009	Shores and shallow water	No	Suitable habitat is not present.	No
Silphium perfoliatum var. perfoliatum	Cup-plant	S2				Oldham and Brinker 2009	Riverbanks, floodplains and moist fields; planted, escaped elsewhere	Yes	Moist fields are present within the study area.	No
Solidago rigida ssp. rigida	Stiff-leaved Goldenrod	S3				Oldham and Brinker 2009	Dry, sandy soil, prairies and waste places	No	Suitable habitat is not present.	No
Sphenopholis nitida	Slender Eaton's Grass	S1				Oldham and Brinker 2009	Rich deciduous forests	Yes	Deciduous forests are present within the study area.	No
Suaeda calceoliformis	Western Seablite	S2				Oldham and Brinker 2009	Saline and alkaline areas, rarley adventive on saline roadsides in S. Ont.	Yes	Roadsides are present within the study area.	No
Thalictrum thalictroides	Rue-anemone	S3				Oldham and Brinker 2009	Rich or sometimes dry deciduous forests.	Yes	Deciduous forests are present within the study area.	No
Torreyochloa pallida	Torrey's Manna Grass	S2				Oldham and Brinker 2009	Shallow water and wet shores at edges of streams and ponds; boggy depressions in forests	No	Suitable habitat is not present.	No
Trichophorum clintonii	Clinton's Club-rush	S2S3				Oldham and Brinker 2009	Prairie and open woods in south; shorelines, rock crevices in north	Yes	Open woods are present within the study area.	No
Trichophorum planifolium	Bashful Bulrush	S1	END	E	Schedule 1	Oldham and Brinker 2009, MNRF 2019c	Dry to moist woodlands, usually under oak	Yes	Moist woodlands are present within the study area.	No
Uvularia perfoliata	Perfoliate Bellwort	S1				Oldham and Brinker 2009	Rich, mesic woodlands; dry oak-pine woods and thickets	Yes	Moist woodlands are present within the study area.	No
Vicia caroliniana	Carolina Vetch	S2				Oldham and Brinker 2009	Dry woods, thickets and prairies	Yes	Woods and thickets are present within the study area.	No
Vitis labrusca	Fox Grape	S1				Oldham and Brinker 2009	Woods	Yes	Woods are present within the study area.	No
Zizania aquatica var. aquatica	Southern Wild-rice	S3				Oldham and Brinker 2009	Wetlands, marshes	No	Suitable habitat is not present.	No

[1]MNRF2019a, [2]MNRF 2019b, [3]Government of Canada 2019, [4]MNRF 2000, [5]Oldham and Brinker 2009, [6]Michigan Flora Online 2011

Significant Wildlife Habitat Assessment Tables

Table 1. Characteristics of Seasonal Concentration Areas for Ecoregion 7E.

	Wildlife Species[1]	**Candidate SWH**		**Confirmed SWH**	**Study Area**
		ELC Ecosite Codes[1]	**Habitat Criteria and Information Sources[1]**	**Defining Criteria[1]**	**Assessment Details**
Wildlife Habitat: Waterfowl Stopover and Staging Areas (Terrestrial)					
Rationale: Habitat important to migrating waterfowl	American Black Duck Northern Pintail Gadwall Blue-winged Teal Green-winged Teal American Wigeon Northern Shoveler Tundra Swan	CUM1 CUT1 - Plus evidence of annual spring flooding from melt water or run-off within these Ecosites. - Fields with seasonal flooding and waste grain in the Long Point, Rondeau, Lake. St. Clair, Grand Bend and Pt. Pelee areas may be important to Tundra Swans.	Fields with sheet water during Spring (mid March to May). • Fields flooding during spring melt and run-off provide important invertebrate foraging habitat for migrating waterfowl. • Agricultural fields with waste grains are commonly used by waterfowl, these are not considered SWH unless they have spring sheet water available[cxlviii] Information Sources • Anecdotal information from the landowner, adjacent landowners or local naturalist clubs may be good information in determining occurrence. • Reports and other information available from Conservation Authorities (CAs) • Sites documented through waterfowl planning processes (eg. EHJV implementation plan) • Field Naturalist Clubs • Ducks Unlimited Canada • Natural Heritage Information Centre (NHIC) Waterfowl Concentration Area	Studies carried out and verified presence of an annual concentration of any listed species, evaluation methods to follow "Bird and Bird Habitats: Guidelines for Wind Power Projects"[ccxi] • Any mixed species aggregations of 100[l] or more individuals required. • The area of the flooded field ecosite habitat plus a 100-300m radius buffer dependant on local site conditions and adjacent land use is the significant wildlife habitat[cxlviii]. • Annual use of habitat is documented from information sources or field studies (annual use can be based on studies or determined by past surveys with species numbers and dates). • SWHMIST[cxlix] Index #7 provides development effects and mitigation measures.	CUM and CUT are present. Agricultural fields within the study area contain small areas of sheet water during spring. None of the target species have been observed within the study area or vicinity (BSC et al. 2008, NHIC 2019, MNRF 2019c). Migratory bird surveys were completed within the study area and no indicator species were documented. **Not SWH**

Table 1. Characteristics of Seasonal Concentration Areas for Ecoregion 7E.

	Wildlife Species[1]	**Candidate SWH**		**Confirmed SWH**	**Study Area**
		ELC Ecosite Codes[1]	**Habitat Criteria and Information Sources[1]**	**Defining Criteria[1]**	**Assessment Details**
Wildlife Habitat: Waterfowl Stopover and Staging Areas (Aquatic)					
Rationale: Important for local and migrant waterfowl populations during the spring or fall migration or both periods combined. Sites identified are usually only one of a few in the eco-district	Canada Goose Cackling Goose Snow Goose Green-winged Teal American Black Duck Northern Pintail Northern Shoveler American Wigeon Gadwall Blue-winged Teal Hooded Merganser Common Merganser Red-breasted Merganser Lesser Scaup Greater Scaup Common Goldeneye Bufflehead Long-tailed Duck Surf Scoter White-winged Scoter Black Scoter Canvasback Redhead Ruddy Duck Brant White-winged Scoter Black Scoter	MAS1 MAS2 MAS3 SAS1 SAM1 SAF1 SWD1 SWD2 SWD3 SWD4 SWD5 SWD6 SWD7	• Ponds, marshes, lakes, bays, coastal inlets, and watercourses used during migration. Sewage treatment ponds and storm water ponds do not qualify as a SWH, however a reservoir managed as a large wetland or pond/lake does qualify. • These habitats have an abundant food supply (mostly aquatic invertebrates and vegetation in shallow water). Information Sources • Environment Canada • Naturalist clubs often are aware of staging/stopover areas • OMNRF Wetland Evaluations indicate presence of locally and regionally significant waterfowl staging. • Sites documented through waterfowl planning processes (eg. EHJV implementation plan) • Ducks Unlimited projects • Element occurrence specification by Nature Serve: http://www.natureserve.org • Natural Heritage Information Centre (NHIC) Waterfowl Concentration Area	Studies carried out and verified presence of: • Aggregations of 100[i] or more of listed species for 7 days[i], results in >700 waterfowl use days. • Areas with annual staging of ruddy ducks, canvasbacks, and redheads are SWH[cxlix] • The combined area of the ELC ecosites and a 100m radius area is the SWH[cxlviii] • Wetland area and shorelines associated with sites identified within the SWHTG[cxlviii] Appendix K[cxlix] are significant wildlife habitat. • Evaluation methods to follow "Bird and Bird Habitats: Guidelines for Wind Power Projects"[ccxi] • Annual Use of Habitat is Documented from Information Sources or Field Studies (Annual can be based on completed studies or determined from past surveys with species numbers and dates recorded). • SWHMIST[cxlix] Index #7 provides development effects and mitigation measures.	Vegetation community classification and delineation was completed and SWD2 communities are present. Two small ponds are present within the study area but they are likely too small to provide suitable stopover and staging habitat. Canada Goose has been observed within the study area or vicinity (BSC et al. 2008). Migratory bird surveys were completed within the study area and small numbers of Canada Goose were documented. **Not SWH**

Table 1. Characteristics of Seasonal Concentration Areas for Ecoregion 7E.

	Wildlife Species[1]	Candidate SWH		Confirmed SWH	Study Area
		ELC Ecosite Codes[1]	Habitat Criteria and Information Sources[1]	Defining Criteria[1]	Assessment Details
Wildlife Habitat: Shorebird Migratory Stopover Area					
Rationale: High quality shorebird stopover habitat is extremely rare and typically has a long history of use	Greater Yellowlegs Lesser Yellowlegs Marbled Godwit Hudsonian Godwit Black-bellied Plover American Golden-Plover Semipalmated Plover Solitary Sandpiper Spotted Sandpiper Semipalmated Sandpiper Pectoral Sandpiper White-rumped Sandpiper Baird's Sandpiper Least Sandpiper Purple Sandpiper Stilt Sandpiper Short-billed Dowitcher Red-necked Phalarope Whimbrel Ruddy Turnstone Sanderling Dunlin	BBO1 BBO2 BBS1 BBS2 BBT1 BBT2 SDO1 SDS2 SDT1 MAM1 MAM2 MAM3 MAM4 MAM5	Shorelines of lakes, rivers and wetlands, including beach areas, bars and seasonally flooded, muddy and un-vegetated shoreline habitats. Great Lakes coastal shorelines, including groynes and other forms of armour rock lakeshores, are extremely important for migratory shorebirds in May to mid-June and early July to October. Sewage treatment ponds and storm water ponds do not qualify as a SWH. Information Sources • Western hemisphere shorebird reserve network • Canadian Wildlife Service (CWS) Ontario Shorebird Survey • Bird Studies Canada • Ontario Nature • Local birders and naturalist clubs • Natural Heritage Information Center (NHIC) Shorebird Migratory Concentration Area	Studies confirming: • Presence of 3 or more of listed species and > 1000[l] shorebird use days during spring or fall migration period (shorebird use days are the accumulated number of shorebirds counted per day over the course of the fall or spring migration period). • Whimbrel stop briefly (<24hrs) during spring migration, any site with >100[l] Whimbrel used for 3 years or more is significant. • The area of significant shorebird habitat includes the mapped ELC shoreline ecosites plus a 100m radius area[cxlviii] • Evaluation methods to follow "Bird and Bird Habitats: Guidelines for Wind Power Projects"[ccxi] • SWHMIST[cxlix] Index #8 provides development effects and mitigation measures.	Vegetation community classification and delineation was completed and several areas of MAM2 are present. No large shorelines are present within the study area. Spotted Sandpiper has been observed within the study area or vicinity (BSC et al. 2008). Red-necked Phalarope has the potential to occur in Hamilton Region (MNRF 2019b). Migratory bird surveys were completed and small numbers of Spotted Sandpiper were documented. **Not SWH**

Table 1. Characteristics of Seasonal Concentration Areas for Ecoregion 7E.

	Wildlife Species[1]	**Candidate SWH**		**Confirmed SWH**	**Study Area**
		ELC Ecosite Codes[1]	**Habitat Criteria and Information Sources[1]**	**Defining Criteria[1]**	**Assessment Details**
Wildlife Habitat: Raptor Wintering Area					
Rationale: Sites used by multiple species, a high number of individuals and used annually are most significant	Rough-legged Hawk Red-tailed Hawk Northern Harrier American Kestrel Snowy Owl Special Concern: Short-eared Owl Bald Eagle	Hawks/Owls: Combination of ELC Community Series; need to have present one Community Series from each land class. Forest: FOD, FOM, FOC Upland: CUM, CUT, CUS, CUW Bald Eagle: Forest Community Series: FOD, FOM, FOC, SWD, SWM, or SWC, on shoreline areas adjacent to large rivers or adjacent to lakes with open water (hunting area).	The habitat provides a combination of fields and woodlands that provide roosting, foraging and resting habitats for wintering raptors. Raptor wintering (hawk/owl) sites need to be > 20ha[cxlviii, cxlix] with a combination of forest and upland[xvi, xvii, xviii, xix, xx, xxi]. Least disturbed sites, idle/fallow or lightly grazed field/meadow (>15ha) with adjacent woodlands[cxlix] Field area of the habitat is to be wind swept with limited snow depth or accumulation. Eagle sites have open water and large trees and snags aviable for roosting[cxlix] Information Sources • OMNRF Districts • Natural clubs • Natural Heritage Information Centre (NHIC) Raptor Winter Concentration Area • Data from Bird Studies Canada • Reports and other information available from CAs • Results of Christmas Bird Counts	Studies confirm the use of these habitats by: • One or more Short-eared Owls, or, One of more Bald Eagles or; at least 10 individuals and two listed hawk/owl species • To be significant a site must be used regularly (3 in 5 years)[cxlix] for a minimum of 20 days by the above number of birds[i]. • The habitat area for an Eagle winter site is the shoreline forest ecosites directly adjacent to the prime hunting area. • Evaluation methods to follow "Bird and Bird Habitats: Guidelines for Wind Power Projects"[ccxi] • SWHMIST[cxlix] Index #10 and #11 provides development effects and mitigation measures.	Vegetation community classification and delineation was completed and a mixture of FOD, CUM, CUT and CUS communities are present. The contiguous area of forest and cultural communities is greater than 20ha in size. Suitable Bald Eagle habitat is not present as the study area is located 4.5 km from Lake Ontario, the nearest shoreline. Red-tailed Hawk, Northern Harrier, Short-eared Owl and American Kestrel have been observed within the study area or vicinity (BSC et al. 2008). Wintering raptor surveys have not been completed within the study area. Red-tailed hawk was observed on multiple surveys. **Candidate SWH**

Table 1. Characteristics of Seasonal Concentration Areas for Ecoregion 7E.

	Wildlife Species[1]	**Candidate SWH**		**Confirmed SWH**	**Study Area**
		ELC Ecosite Codes[1]	**Habitat Criteria and Information Sources[1]**	**Defining Criteria[1]**	**Assessment Details**
Wildlife Habitat: Bat Hibernacula					
Rationale: Bat hibernacula, are rare habitats in all Ontario landscapes.	Big Brown Bat Eastern Pipistrelle/Tri-colored Bat	Bat Hibernacula may be found in these ecosites: CCR1 CCR2 CCA1 CCA2 (Note: buildings are not considered to be SWH)	Hibernacula may be found in caves, mine shafts, underground foundations and Karsts. Active mine sites should not be considered The locations of bat hibernacula are relatively poorly known. Information Sources • OMNRF for possible locations and contact for local experts • Natural Heritage Information Centre (NHIC) Bat Hibernaculum • Ministry of Northern Development and Mines for location of mine shafts • Clubs that explore caves (eg. Sierra Club) • University Biology Departments with bat experts	• All sites with confirmed hibernating bats are SWH[i]. • The area includes 200m radius around the entrance of the hibernaculum[cxlviii, ccvii, i]. for the development types and 1000m for wind farms [ccv]. • Studies are to be conducted during the peak swarming period (Aug. – Sept.). Surveys should be conducted following methods outlined in the[ccv]."Bats and Bat Habitats: Guidelines for Wind Power Projects" [ccv] • SWHMIST[cxlix] Index #1 provides development effects and mitigation measures.	None of the listed ecosites are present within the study area. Big Brown Bat and Tri-colored Bat have been documented within the study area or vicinity of the study area (Dobbyn 1994). Targeted bat surveys were conduted with Big Brown Bat and unidentified species (potentially Tri-coloured Bat) recorded from the study area. **Not SWH**

Table 1. Characteristics of Seasonal Concentration Areas for Ecoregion 7E.

	Wildlife Species[1]	**Candidate SWH**		**Confirmed SWH**	**Study Area**
		ELC Ecosite Codes[1]	**Habitat Criteria and Information Sources[1]**	**Defining Criteria[1]**	**Assessment Details**
Wildlife Habitat: Bat Maternity Colonies					
Rationale: Known locations of forested bat maternity colonies are extremely rare in all Ontario landscapes.	Big Brown Bat Silver-haired Bat	Maternity colonies considered SWH are found in forested Ecosites. All ELC Ecosites in ELC Community Series: FOD FOM SWD SWM	Maternity colonies can be found in tree cavities, vegetation and often in building [sxxii, xxv, xxvi, xxvii, xxxi] (buildings are not considered to be SWH). • Maternity roosts are not found in caves and mines in Ontario[xxii]. • Maternity colonies located in Mature deciduous or mixed forest stands[ccix, ccx] with >10/ha large diameter (>25cm dbh) wildlife trees[ccvii]. • Female Bats prefer wildlife tree (snags) in early stages of decay, class 1-3[ccxiv] or class 1 or 2[ccxii]. • Silver-haired Bats prefer older mixed or deciduous forest and form maternity colonies in tree cavities and small hollows. Older forest areas with at least 21 snags/ha are preferred[ccx]. Information Sources • OMNRF for possible locations and contact for local experts • University Biology Departments with bat experts	Maternity Colonies with confirmed use by: • >10 Big Brown Bats[i] • >5 Adult Female Silver-haired Bats[i] • The area of the habitat includes the entire woodland or the forest stand ELC Ecosite containing the maternity colonies[i]. • Evaluation methods for maternity colonies should be conducted following methods outlined in the "Bats and Bat Habitats: Guidelines for Wind Power Projects"[ccv]. • SWHMIST[cxlix] Index #12 provides development effects and mitigation measures.	Vegetation community classification and delineation was completed and FOD and SWD communities are present. Declining Ash trees are common throughout the site and many provide candidate habitat for bat hibernacula. Big Brown Bat and Silver-haired Bat have been observed within the study area or vicinity (Dobbyn 1994). Targeted bat surveys were conduted with large numbers of calls of Big Brown and Silver-haired Bat recorded from the study area. **Candidate SWH**

Table 1. Characteristics of Seasonal Concentration Areas for Ecoregion 7E.

	Wildlife Species[1]	**Candidate SWH**		**Confirmed SWH**	**Study Area**
		ELC Ecosite Codes[1]	**Habitat Criteria and Information Sources[1]**	**Defining Criteria[1]**	**Assessment Details**
Wildlife Habitat: Turtle Wintering Area					
Rationale: Generally sites are the only known sites in the area. Sites with the highest number of individuals are most significant.	Midland Painted Turtle Special Concern: Northern Map Turtle Snapping Turtle	Snapping and Midland Painted Turtles: ELC Community Classes: SW, MA, OA and SA ELC Community Series: FEO and BOO Northern Map Turtle: Open Water areas such as deeper rivers or streams and lakes with current can also be used as over-wintering habitat.	• For most turtles, wintering areas are in the same general area as their core habitat. Water has to be deep enough not to freeze and have soft mud substrates. • Over-wintering sites are permanent water bodies, large wetlands, and bogs or fens with adequate Dissolved Oxygen[cix, cx, cxi, cxviii]. • Man-made ponds such as sewage lagoons or storm water ponds should not be considered SWH Information Sources • EIS studies carried out by Conservation Authorities • Field naturalists clubs • OMNRF Ecologist or Biologist • Natural Heritage Information Centre (NHIC)	• Presence of 5 over-wintering Midland Painted Turtles is significant[l]. • One or more Northern Map Turtle or Snapping Turtle over-wintering within a wetland is significant[l]. • The mapped ELC ecosite area with the over wintering turtles is the SWH. If the hibernation site is within a stream or river, the deep-water pool where the turtles are over wintering is the SWH. • Over wintering areas may be identified by searching for congregations (Basking Areas) of turtles on warm, sunny days during the fall (Sept. – Oct.) or spring (Mar. – Apr)[cvii]. Congregation of turtles is more common where wintering areas are limited and therefore significant[cix, cx, cxi, cxii]. • SWHMIST[cxlix] Index #28 provides development effects and mitigation measures for turtle wintering habitat.	Vegetation community classification and delineation was completed and SWD and MAM communities are present. Neither provides deep water or soft substrate conditions conducive to turtle overwintering. Habitat for Northern Map Turtle is not present as there are no deep bodies of water within the study area. Midland Painted Turtle and Snapping Turtle have been observed within the study area or vicinity (Ontario Nature 2018). Northern Map Turtle has the potential to occur within Hamilton Region (MNRF 2019b). Turtle emergence surveys were completed within the subject property. No turtles were observed incidentally during 2019 surveys. **Not SWH**

Table 1. Characteristics of Seasonal Concentration Areas for Ecoregion 7E.

	Wildlife Species[1]	**Candidate SWH**		**Confirmed SWH**	**Study Area**
		ELC Ecosite Codes[1]	**Habitat Criteria and Information Sources**[1]	**Defining Criteria**[1]	**Assessment Details**
Wildlife Habitat: Reptile Hibernaculum					
Rationale: Generally sites are the only known sites in the area. Sites with the highest number of individuals are most significant	Snakes: Eastern Gartersnake Northern Watersnake Northern Red-bellied Snake Northern Brownsnake Smooth Green Snake Northern Ring-necked Snake Special Concern: Milksnake Eastern Ribbonsnake	For all snakes, habitat may be found in any ecosite in southern Ontario other than very wet ones. Talus, Rock Barren, Crevice and Cave, and Alvar sites may be directly related to these habitats. Observations of congregations of snakes on sunny warm days in the spring or fall is a good indicator. The existence of rock piles or slopes, stone fences, and crumbling foundations assist in identifying candidate SWH.	For snakes, hibernation takes place in sites located below frost lines in burrows, rock crevices and other natural locations. Areas of broken and fissured rock are particularly valuable since they provide access to subterranean sites below the frost line[xliv, l, li, lii, cxii]. Wetlands can also be important over-wintering habitat in conifer or shrub swamps and swales, poor fens, or depressions in bedrock terrain with sparse trees or shrubs with sphagnum moss or sedge hummock ground cover. Information Sources • In spring, local residents or landowners may have observed the emergence of snakes on their property (e.g. old dug wells). • Reports and other information available from CAs • Local naturalists and experts, as well as university herpetologists may also know where to find some of these sites. • Natural Heritage Information Centre (NHIC)	Studies confirming: • Presence of snake hibernacula used by a minimum of five individuals of a snake sp., or, individuals of two or more snake spp. • Congregations of a minimum of five individuals of a snake sp., or, individuals of two or more snake spp. near potential hibernacula (eg. foundation or rocky slope) on sunny warm days in Spring (Apr/May) and Fall (Sept/Oct)[l]. • Note: If there are Special Concern Species present, then site is SWH • Note: Sites for hibernation possess specific habitat parameters (e.g. temperature, humidity, etc.) and consequently are used annually, often by many of the same individuals of a local population (i.e. strong hibernation site fidelity). Other critical life processes (e.g. mating) often take place in close proximity to hibernacula. The feature in which the hibernacula is located plus a 30m buffer is the SWH[l]. • SWHMIST[cxlix] Index #13 provides development effects and mitigation measures for snake hibernacula.	Eastern Gartersnake, Northern Watersnake, Northern Red-bellied Snake, Northern Brownsnake, Smooth Green Snake and Eastern Milksnake have been observed within the study area or vicinity (Ontario Nature 2018). Eastern Ribbonsnake has the potential to occur within Hamilton Region (MNRF 2019b). Snake area searchs and incidental observations documented Northern Brownsake and Eastern Gartersnake present within the subject property. No large congregations were observed near the foundation of the barn, residence or the karst formation. **Not SWH**

Table 1. Characteristics of Seasonal Concentration Areas for Ecoregion 7E.

	Wildlife Species[1]	**Candidate SWH**		**Confirmed SWH**	**Study Area**
		ELC Ecosite Codes[1]	**Habitat Criteria and Information Sources[1]**	**Defining Criteria[1]**	**Assessment Details**
Wildlife Habitat: Colonially - Nesting Bird Breeding Habitat (Bank and Cliff)					
Rationale: Historical use and number of nests in a colony make this habitat significant. An identified colony can be very important to local populations. All swallow population are declining in Ontario.	Cliff Swallow Northern Rough-winged Swallow (this species is not colonial but can be found in Cliff Swallow colonies)	Eroding banks, sandy hills, borrow pits, steep slopes, and sand piles Cliff faces, bridge abutments, silos, barns Habitat found in the following ecosites: CUM1 CUT1 CUS1 BLO1 BLS1 BLT1 CLO1 CLS1 CLT1	• Any site or areas with exposed soil banks, undisturbed or naturally eroding that is not a licensed/permitted aggregate area. • Does not include man-made structures (bridges or buildings) or recently (2 years) disturbed soil areas, such as berms, embankments, soil or aggregate stockpiles. • Does not include a licensed/permitted Mineral Aggregate Operation. Information Sources • Reports and other information available from CAs • Ontario Breeding Bird Atlas[ccv]. • Bird Studies Canada: Nature Counts http://www.birdscanada.org/birdmon/ • Field Naturalist clubs	Studies confirming: • Presence of 1 or more nesting sites with 8[cxlvix] or more cliff swallow pairs and/or rough-winged swallow pairs during the breeding season. • A colony identified as SWH will include a 50m radius habitat area from the peripheral nests[ccvii]. • Field surveys to observe and count swallow nests are to be completed during the breeding season. Evaluation methods to follow "Bird and Bird Habitats: Guidelines for Wind Power Projects"[ccxi]. • SWHMIST[cxlix] Index #4 provides development effects and mitigation measures.	Vegetation community classification and delineation was completed and identified CUM communities. No exposed soil banks occur within the study area. Northern Rough-winged Swallow has been observed within the study area or vicinity (BSC et al. 2009). Targeted bird surveys were completed and Northern Rough-winged Swallow was documented, presumably foraging over the site and nesting along the Escarpment to the north. **Not SWH**

Table 1. Characteristics of Seasonal Concentration Areas for Ecoregion 7E.

	Wildlife Species[1]	Candidate SWH		Confirmed SWH	Study Area
		ELC Ecosite Codes[1]	Habitat Criteria and Information Sources[1]	Defining Criteria[1]	Assessment Details
Wildlife Habitat: Colonially - Nesting Bird Breeding Habitat (Tree/Shrubs)					
Rationale: Large colonies are important to local bird population, typically sites are only known colony in area and are used annually.	Great Blue Heron Black-crowned Night-Heron Great Egret Green Heron	SWM2 SWM3 SWM5 SWM6 SWD1 SWD2 SWD3 SWD4 SWD5 SWD6 SWD7 FET1	• Nests in live or dead standing trees in wetlands, lakes, islands, and peninsulas. Shrubs and occasionally emergent vegetation may also be used. • Most nests in trees are 11 to 15 m from ground, near the top of the tree. Information Sources • Ontario Breeding Bird Atlas[ccv], colonial nest records. • Ontario Heronry Inventory 1991 available from Bird Studies Canada or NHIC (OMNRF). • Natural Heritage Information Centre (NHIC) Mixed Wader Nesting Colony • Aerial photographs can help identify large heronries. • Reports and other information available from CAs • MNRF District Offices • Field naturalist clubs	Studies confirming: • Presence of 2 or more active nests of Great Blue Heron or other list species. • The habitat extends from the the edge of the colony and a minimum 300m radius or extent of the Forest Ecosite containing the colony or any island <15.0ha with a colony is the SWH[cc, ccvii]. • Confirmation of active colonies must be achieved through site visits conducted during the nesting season (April to August) or by evidence such as the presence of fresh guano, dead young and/or eggshells • SWHMIST[cxlix] Index #5 provides development effects and mitigation measures.	Vegetation community classification and delineation was completed and identified SWD2 communities. Great Blue Heron and Green Heron have been observed within the study area or vicinity (BSC et al. 2008). Targeted bird surveys were completed and Great Blue Heron was observed but not nesting within the study area. **Not SWH**

Table 1. Characteristics of Seasonal Concentration Areas for Ecoregion 7E.

	Wildlife Species[1]	Candidate SWH		Confirmed SWH	Study Area
		ELC Ecosite Codes[1]	Habitat Criteria and Information Sources[1]	Defining Criteria[1]	Assessment Details
Wildlife Habitat: Colonially - Nesting Bird Breeding Habitat (Ground)					
Rationale: Colonies are important to local bird population, typically sites are only known colony in area and are used annually.	Herring Gull Great Black-backed Gull Little Gull Ring-billed Gull Common Tern Caspian Tern Brewer's Blackbird	Any rocky island or peninsula (natural or artificial) within a lake or large river (two-lined on a 1:50,000 NTS map). Close proximity to watercourses in open fields or pastures with scattered trees or shrubs (Brewer's Blackbird) MAM1 – 6 MAS1 – 3 CUM CUT CUS	• Nesting colonies of gulls and terns are on islands or peninsulas associated with open water or in marshy areas. • Brewers Blackbird colonies are found loosely on the ground in or in low bushes in close proximity to streams and irrigation ditches within farmlands. Information Sources • Ontario Breeding Bird Atlas[ccv], rare/colonial species records. • Canadian Wildlife Service • Reports and other information available from CAs • Natural Heritage Information Centre (NHIC) Colonial Waterbird Nesting Area • MNRF District Offices • Field naturalist clubs	Studies confirming: • Presence of >25 active nests for Herring Gulls, >5 active nests for Common Tern or >2 active nests for Caspian Tern[i]. • Any active nesting colony of one or more Little Gull, and Great Black-backed Gull is significant[i]. • Presence of 5 or more pairs for Brewer's Blackbird[i]. • The edge of the colony and a minimum 150m radius area of the habitat, or the extent of the ELC ecosites containing the colony or any island <3.0ha with a colony is the SWH[cc, ccvii]. • Studies would be done during May/June when actively nesting. Evaluation methods to follow "Bird and Bird Habitats: Guidelines for Wind Power Projects"[ccxi]. • SWHMIST[cxlix] Index #6 provides development effects and mitigation measures.	The study area is not located on an island or peninsula. The study area is not in close proximity to any large water bodies. Ring-billed Gull has been observed within the study area or vicinity (BSC et al. 2008). Breeding bird surveys were completed and incidental observations of gull species were noted (fly-over). **Not SWH**

Table 1. Characteristics of Seasonal Concentration Areas for Ecoregion 7E.

	Wildlife Species[1]	**Candidate SWH**		**Confirmed SWH**	**Study Area**
		ELC Ecosite Codes[1]	**Habitat Criteria and Information Sources**[1]	**Defining Criteria**[1]	**Assessment Details**
Wildlife Habitat: Migratory Butterfly Stopover Areas					
Rationale: Butterfly stopover areas are extremely rare habitats and are biologically important for butterfly species that migrate south for the winter	Painted Lady Red Admiral Special Concern: Monarch	Combination of ELC Community Series; need to have present one Community Series from each landclass: Field: CUM CUT CUS Forest: FOC FOD FOM CUP Anecdotally, a candidate sight for butterfly stopover will have a history of butterflies being observed.	A butterfly stopover area will be a minimum of 10ha in size with a combination of field and forest habitat present, and will be located within 5km of Lake Ontario and Erie[cxlix]. • The habitat is typically a combination of field and forest, and provides the butterflies with a location to rest prior to their long migration south [xxxii, xxxiii, xxxiv, xxxv, xxxvi]. • The habitat should not be disturbed, fields/meadows with an abundance of preferred nectar plants and woodland edge providing shelter are requirements for this habitat [cxlviii, cxlix]. • Staging areas usually provide protection from the elements and are often spits of land or areas with the shortest distance to cross the Great Lakes [xxxvii, xxxviii, xxxix, xl, xli]. Information Sources • MNRF District Offices • Natural Heritage Information Centre (NHIC) • Agriculture Canada in Ottawa may have list of butterfly experts. • Field Naturalist Clubs • Toronto Entomologists Association • Conservation Authorities	Studies confirm: • The presence of Monarch Use Days (MUD) during fall migration (Aug/Oct)[xliii]. MUD is based on the number of days a site is used by Monarchs, multiplied by the number of individuals using the site. Numbers of butterflies can range from 100-500/day[xxxvii], significant variation can occur between years and multiple years of sampling should occur[xl, xlii]. • Observational studies are to be completed and need to be done frequently during the migration period to estimate MUD • MUD of >5000 or >3000 with the presence of Painted Ladies or White Admiral's is to be considered significant[i]. • SWHMIST[cxlix] Index #16 provides development effects and mitigation measures.	Vegetation community classification and delineation was completed and a combination of CUM, CUT, CUS and FOD communities are present within the study area and total more than 10ha. The study area is approximately 4.5 km from Lake Ontario. Painted Lady, Red Admiral and Monarch have been observed within the study area or vicinity (MacNaughton et al. 2018). Butterflies were documented during the surveys including Red Admiral and Monarch, both in low numbers. Milkweed is present in low numbershes throughout the site and utilized by Monarch. **Not SWH**

Table 1. Characteristics of Seasonal Concentration Areas for Ecoregion 7E.

	Wildlife Species[1]	**Candidate SWH**		**Confirmed SWH**	**Study Area**
		ELC Ecosite Codes[1]	**Habitat Criteria and Information Sources[1]**	**Defining Criteria[1]**	**Assessment Details**
Wildlife Habitat: Landbird Migratory Stopover Areas					
Rationale: Sites with a high diversity of species as well as high numbers are most significant	All migratory songbirds Canadian Wildlife Service Ontario website: http://www.on.ec.gc.ca/wildlife_e.html All migrant raptors species Ontario Ministry of Natural Resources: Fish and Wildlife Conservation Act, 1997. Schedule 7: Specially Protected Birds (Raptors)	All Ecosites associated with these ELC Community Series: FOC FOM FOD SWC SWM SWD	Woodlots need to be >5 ha[i] in size and within 5km [iv, v, vi, vii, viii, ix, x, xi, xii, xiii, xiv, xv] of Lake Ontario and Erie. If woodlands are rare in an area of shoreline, woodland fragments 2-5ha can be considered for this habitat • If multiple woodlands are located along the shoreline those Woodlands <2km from Lake Erie or Ontario are more significant[cxlix]. • Sites have a variety of habitats: forest, grassland and wetland complexes[cxlix]. • The largest sites are more significant[cxlix] • Woodlots and forest fragments are important habitats to migrating birds[ccxviii], these features located along the shore and located within 5km of Lake Ontario and Lake Erie are Candidate SWH[cxlviii]. Information Sources • Bird Studies Canada • Ontario Nature • Local birders and naturalist clubs • Ontario Important Bird Areas (IBA) Program	Studies confirm: • Use of the habitat by >200 birds/day and with >35 spp. with at least 10 bird spp. recorded on at least 5 different survey dates[i]. This abundance and diversity of migrant bird species is considered above average and significant. • Studies should be completed during spring (March/May) and fall (Aug/Oct) migration using standardized assessment techniques. Evaluation methods to follow "Bird and Bird Habitats: Guidelines for Wind Power Projects"[ccxi]. • SWHMIST[cxlix] Index #9 provides development effects and mitigation measures.	Vegetation community classification and delineation was completed and FOD and SWD communities are present and greater than 5 ha in size. The woodlots are approximately 4.5 km from Lake Ontario. A variety of migratory songbirds have been observed within the study area or vicinity (BSC et al. 2008) and confirmed to be present on site. Targeted landbird migratory surveys were completed within the study area and documented a large diversity of species in high numbers. **Confirmed SWH**

Table 1. Characteristics of Seasonal Concentration Areas for Ecoregion 7E.

	Wildlife Species[1]	Candidate SWH		Confirmed SWH	Study Area
		ELC Ecosite Codes[1]	**Habitat Criteria and Information Sources[1]**	**Defining Criteria[1]**	**Assessment Details**
Wildlife Habitat: Deer Winter Congregation Areas					
Rationale: Deer movement during winter in the southern areas of Ecoregion 7E are not constrained by snow depth, however deer will annually congregate in large numbers in suitable woodlands to reduce or avoid the impacts of winter conditions [cxlviii]	White-tailed Deer	All Forested Ecosites with these ELC Community Series: FOC FOM FOD SWC SWM SWD Conifer plantations (CUP) smaller than 50 ha may also be used.	• Woodlots >100 ha in size or if large woodlots are rare in a planning area woodlots>50ha[l]. • Deer movement during winter in Ecoregion 7E are not constrained by snow depth, however deer will annually congregate in large numbers in suitable woodlands[cxlviii]. • Large woodlots > 100ha and up to 1500 ha are known to be used annually by densities of deer that range from 0.1-1.5 deer/ha[ccxxiv]. • Woodlots with high densities of deer due to artificial feeding are not significant[l]. Information Sources • MNRF District Offices • LIO/NRVIS	Studies confirm: • Deer management is an MNRF responsibility, deer winter congregation areas considered significant will be mapped by MNRF[cxlviii]. • Use of the woodlot by white-tailed deer will be determined by MNRF, all woodlots exceeding the area criteria are significant, unless determined not to be significant by MNRF[l]. • Studies should be completed during winter (Jan/Feb) when >20cm of snow is on the ground using aerial survey techniques[ccxxiv], ground or road surveys, or a pellet count deer density survey[ccxxv]. • SWHMIST[cxlix] Index #2 provides development effects and mitigation measures.	Vegetation community classification and delineation was completed and FOD and SWD communities are present. The mosaic of treed habitats totals approximately 30 ha in size. No Deer Wintering Areas have been mapped by the MNRF in the study area. **Not SWH**

Table 2. Characteristics of Rare Vegetation Communities for Ecoregion 7E.

Rare Vegetation Community[1]	Candidate SWH			Confirmed SWH	Study Area
	ELC Ecosite Codes[1]	Habitat Description[1]	Detailed Information and Sources[1]	Defining Criteria[1]	Assessment Details
Cliff and Talus Slopes					
Rationale Cliffs and Talus Slopes are extremely rare habitats in Ontario.	Any ELC Ecosite within Community Series: TAO CLO TAS CLS TAT CLT	A Cliff is vertical to near vertical bedrock >3m in height. A Talus Slope is rock rubble at the base of a cliff made up of coarse rocky debris.	Most cliff and talus slopes occur along the Niagara Escarpment. Information Sources • The Niagara Escarpment Commission has detailed information on location of these habitats. • OMNRF Districts • Natural Heritage Information Centre (NHIC) has location information available on their website • Field naturalist clubs • Conservation Authorities	• Confirm any ELC Vegetation Type for Cliffs or Talus Slopes[lxxviii] • SWHMIST[cxlix] Index #21 provides development effects and mitigation measures.	Based on field surveys, none of the listed ELC Communities are present. The karst formation does not constitute a cliff community at this site. **Not SWH**

Table 2. Characteristics of Rare Vegetation Communities for Ecoregion 7E.

Rare Vegetation Community[1]	Candidate SWH			Confirmed SWH	Study Area
	ELC Ecosite Codes[1]	Habitat Description[1]	Detailed Information and Sources[1]	Defining Criteria[1]	Assessment Details
Sand Barrens					
Rationale: Sand barrens are rare in Ontario and support rare species. Most Sand Barrens have been lost due to cottage development and forestry.	ELC Ecosites: SBO1 SBS1 SBT1 Vegetation cover varies from patchy and barren to continuous meadow (SBO1), thicket-like (SBS1), or more closed and treed (SBT1). Tree cover always ≤ 60%.	Sand Barrens typically are exposed sand, generally sparsely vegetated and caused by lack of moisture, periodic fires and erosion. They have little or no soil and the underlying rock protrudes through the surface. Usually located within other types of natural habitat such as forest or savannah. Vegetation can vary from patchy and barren to tree covered but less than 60%.	A sand barren area >0.5ha in size Information Sources • OMNRF Districts • Natural Heritage Information Centre (NHIC) has location information available on their website • Field naturalist clubs • Conservation Authorities	• Confirm any ELC Vegetation Type for Sand Barrens[lxxviii] • Site must not be dominated by exotic or introduced species (<50% vegetative cover are exotics sp)[l]. • SWHMIST[cxlix] Index #20 provides development effects and mitigation measures.	Based on field surveys, none of the listed ELC Communities are present. **Not SWH**

Table 2. Characteristics of Rare Vegetation Communities for Ecoregion 7E.

Rare Vegetation Community[1]	Candidate SWH			Confirmed SWH	Study Area
	ELC Ecosite Codes[1]	**Habitat Description[1]**	**Detailed Information and Sources[1]**	**Defining Criteria[1]**	**Assessment Details**
Alvar					
Rationale: Alvars are extremely rare habitats in Ecoregion 7E	ALO1 ALS1 ALT1 FOC1 FOC2 CUM2 CUS2 CUT2-1 CUW2 **Five Alvar Indicator Species:** 1) Carex crawei 2) Panicum philadelphicum 3) Eleocharis compressa 4) Scutellaria parvula 5) Trichostema brachiatum These indicator species are very specific to Alvars within Ecoregion 7E[cxlix]	An alvar is typically a level, mostly unfractured calcareous bedrock feature with a mosaic of rock pavements and bedrock overlain by a thin veneer of soil. The hydrology of alvars is complex, with alternating periods of inundation and drought. Vegetation cover varies from sparse lichen-moss associations to grasslands and shrublands and comprising a number of characteristic or indicator plant. Undisturbed alvars can be phyto- and zoogeographically diverse, supporting many uncommon or are relict plant and animals species. Vegetation cover varies from patchy to barren with a less than 60% tree cover[lxxviii].	An Alvar site > 0.5ha in size[lxxv]. Alvar is particularly rare in Ecoregion 7E where the only known sites are found in the western islands of Lake Erie[cxcix]. Information Sources • Alvars of Ontario (2000), Federation of Ontario Naturalists[lxxvi]. • Ontario Nature – Conserving Great Lakes Alvars[ccviii]. • Natural Heritage Information Centre (NHIC) has location information available on their website • OMNRF Staff • Field Naturalist clubs • Conservation Authorities	Field studies identify four of the five **Alvar indicator species**[lxxv] at a candidate Alvar site is Significant • Site must not be dominated by exotic or introduced species (<50% vegetative cover exotics). • The alvar must be in excellent condition and fit in with surrounding landscape with few conflicting land uses[lxxv]. • SWHMIST[cxlix] Index #17 provides development effects and mitigation measures.	Based on field surveys, none of the listed ELC Communities are present. **Not SWH**

Table 2. Characteristics of Rare Vegetation Communities for Ecoregion 7E.

Rare Vegetation Community[1]	Candidate SWH			Confirmed SWH	Study Area
	ELC Ecosite Codes[1]	**Habitat Description[1]**	**Detailed Information and Sources[1]**	**Defining Criteria[1]**	**Assessment Details**
Old Growth Forest					
Rationale: Due to historic logging practices and land clearance for agriculture, old growth forest is rare in Ecoregion 7E.	Forest Community Series: FOD FOC FOM SWD SWC SWM	Old growth forests are characterized by heavy mortality or turnover of overstorey trees resulting in a mosaic of gaps that encourage development of a multi-layered canopy and an abundance of snags and downed woody debris.	Woodland area is >0.5ha Information Sources • OMNRF Forest Resource Inventory mapping • OMNRF Districts • Field naturalist clubs • Conservation Authorities • Sustainable Forestry Licence (SFL) companies will possibly know locations through field operations. • Municipal forestry departments	Field Studies will determine: • If dominant trees species of the ecosite are >140 years old, then stand is Significant Wildlife Habitat[cxlviii]. • The forested area containing the old growth characteristics will have experienced no recognizable forestry activities [cxlviii] (cut stumps will not be present) • Determine ELC Vegetation Type for forest area containing the old growth characteristics[lxxviii]. • SWHMIST[cxlix] Index #23 provides development effects and mitigation measures.	Based on field surveys, old growth forest is not present. **Not SWH**

Table 2. Characteristics of Rare Vegetation Communities for Ecoregion 7E.

Rare Vegetation Community[1]	Candidate SWH			Confirmed SWH	Study Area
	ELC Ecosite Codes[1]	Habitat Description[1]	Detailed Information and Sources[1]	Defining Criteria[1]	Assessment Details
Savannah					
Rationale: Savannahs are extremely rare habitats in Ontario.	TPS1 TPS2 TPW1 TPW2 CUS2	A Savannah is a tallgrass prairie habitat that has tree cover between 25 – 60%. In Ecoregion 7E, known Tallgrass Prairie and savannah remnants are scattered between Lake Huron and Lake Erie, near Lake St. Clair, north of and along the Lake Erie shoreline, in Brantford and in the Toronto area (north of Lake Ontario)[cc].	No minimum size to site[i] Site must be restored or a natural site. Remnant sites such as railway right of ways are not considered to be SWH. Information Sources • OMNRF Districts • Natural Heritage Information Centre (NHIC) has location data available on their website • Field naturalists clubs • Conservation Authorities	Field studies confirm one or more of the Savannah indicator species listed in[lxxv] Appendix N should be present[i]. Note: Savannah plant spp. list from Ecoregion 7E should be used. • Area of the ELC Vegetation type is the SWH[lxxviii]. • Site must not be dominated by exotic or introduced species (<50% vegetative cover exotics). • SWHMIST[cxlix] Index #18 provides development effects and mitigation measures.	Based on field surveys, none of the listed ELC Communities are present. **Not SWH**

Table 2. Characteristics of Rare Vegetation Communities for Ecoregion 7E.

Rare Vegetation Community[1]	Candidate SWH			Confirmed SWH	Study Area
	ELC Ecosite Codes[1]	Habitat Description[1]	Detailed Information and Sources[1]	Defining Criteria[1]	Assessment Details
Tallgrass Prairie					
Rationale: Tallgrass Prairies are extremely rare habitats in Ontario.	TPO1 TPO2	A Tallgrass Prairie has ground cover dominated by prairie grasses. An open Tallgrass Prairie habitat has < 25% tree cover. In Ecoregion 7E, known Tallgrass Prairie and savannah remnants are scattered between Lake Huron and Lake Erie, near Lake St. Clair, north of and along the Lake Erie shoreline, in Brantford and in the Toronto area (north of Lake Ontario)[cc].	No minimum size to site[l]. Site must be restored or a natural site. Remnant sites such as railway right of ways are not considered to be SWH. Information Sources • Natural Heritage Information Centre (NHIC has location information available on their website • OMNRF Districts • Field naturalists clubs • Conservation Authorities	Field studies confirm one or more of the Prairie indicator species listed in[lxxv] Appendix N should be present[l]. Note: Prairie plant spp. list from Ecoregion 7E should be used. • Area of the ELC Vegetation Type is the SWH[lxxviii]. • Site must not be dominated by exotic or introduced species (<50% vegetative cover exotics). • SWHMIST[cxlix] Index #19 provides development effects and mitigation measures.	Based on field surveys, none of the listed ELC Communities are present. **Not SWH**

Table 2. Characteristics of Rare Vegetation Communities for Ecoregion 7E.

Rare Vegetation Community[1]	Candidate SWH			Confirmed SWH	Study Area
	ELC Ecosite Codes[1]	**Habitat Description[1]**	**Detailed Information and Sources[1]**	**Defining Criteria[1]**	**Assessment Details**
Other Rare Vegetation Communities					
Rationale: Plant communities that often contain rare species which depend on the habitat for survival.	Provincially Rare S1, S2 and S3 vegetation communities are listed in Appendix M of the SWHTG[cxlviii]. Any ELC Ecosite Code that has a possible ELC Vegetation Type that is Provincially Rare is Candidate SWH.	Rare Vegetation Communities may include beaches, fens, forest, marsh, barrens, dunes and swamps.	ELC Ecosite codes that have the potential to be a rare ELC Vegetation Type as outlined in appendix M[cxlviii]. The OMNRF/NHIC will have up to date listing for rare vegetation communities. Information Sources • Natural Heritage Information Centre (NHIC) has location information available on their website • OMNRF Districts • Field naturalists clubs • Conservation Authorities	Field studies should confirm if an ELC Vegetation Type is a rare vegetation community based on listing within Appendix M of SWHTG[cxlviii]. • Area of the ELC Vegetation Type polygon is the SWH. • SWHMIST[cxlix] Index #37 provides development effects and mitigation measures.	No other rare vegetation communities are present within the study area based on field surveys. **Not SWH**

Table 3. Characteristics of Specialized Wildlife Habitat for Ecoregion 7E.

	Wildlife Species[1]	**Candidate SWH**		**Confirmed SWH**	**Study Area**
		ELC Ecosite Codes[1]	**Habitat Criteria and Information Sources[1]**	**Defining Criteria[1]**	**Assessment Details**
Wildlife Habitat: Waterfowl Nesting Area					
Rationale: Important to local waterfowl populations, sites with greatest number of species and highest number of individuals are significant	American Black Duck Northern Pintail Northern Shoveler Gadwall Blue-winged Teal Green-winged Teal Wood Duck Hooded Merganser Mallard	All upland habitats located adjacent to these wetland ELC Ecosites are Candidate SWH: MAS1 MAS2 MAS3 SAS1 SAM1 SAF1 MAM1 MAM2 MAM3 MAM4 MAM5 MAM6 SWT1 SWT2 SWD1 SWD2 SWD3 SWD4 **Note: includes adjacency to Provincially Significant Wetlands**	A waterfowl nesting area extends: 120m[cxlix] from a wetland (>0.5ha) or a wetland (>0.5ha) with small wetlands (0.5ha) within 120m or a cluster of 3 or more small (<0.5 ha) wetlands within 120m of each individual wetland where waterfowl nesting is known to occur[cxlix]. • Upland areas should be at least 120m wide so that predators such as racoons, skunks, and foxes have difficulty finding nests. • Wood Ducks and Hooded Mergansers utilize large diameter trees (>40cm dbh) in woodlands for cavity nest sites. Information Sources • Ducks Unlimited staff may know the locations of particularly productive nesting sites. • OMNRF Wetland Evaluations for indication of significant waterfowl nesting habitat. • Reports and other information available from CAs	Studies confirmed: • Presence of 3 or more nesting pairs for listed species excluding Mallards[l], or, • Presence of 10 or more nesting pairs for listed species including Mallards[l]. • Any active nesting site of an American Black Duck is considered significant. • Nesting studies should be completed during the spring breeding season (April - June). Evaluation methods to follow “Bird and Bird Habitats: Guidelines for Wind Power Projects”[ccxi] • A field study confirming waterfowl nesting habitat will determine the boundary of the waterfowl nesting habitat for the SWH, this may be greater or less than 120m[cxlviii] from the wetland and will provide enough habitat for waterfowl to successfully nest. • SWHMIST[cxlix] Index #25 provides development effects and mitigation measures.	Vegetation community classification and delineation was completed and MAM2 and SWD2 communities are present and adjacent to natural upland areas. Wood Duck and Mallard have been documented within the study area or vicinity (BSC et al. 2009). Targeted bird surveys documented Wood Duck and Mallard in small numbers within the study area. **Not SWH**

Table 3. Characteristics of Specialized Wildlife Habitat for Ecoregion 7E.

	Wildlife Species[1]	**Candidate SWH**		**Confirmed SWH**	**Study Area**
		ELC Ecosite Codes[1]	**Habitat Criteria and Information Sources[1]**	**Defining Criteria[1]**	**Assessment Details**
Wildlife Habitat: Bald Eagle and Osprey Nesting, Foraging and Perching Habitat					
Rationale: Nest sites are fairly uncommon in Ecoregion 7E and are used annually by these species. Many suitable nesting locations may be lost due to increasing shoreline development pressures and scarcity of habitat.	Osprey Special Concern: Bald Eagle	ELC Forest Community Series: FOD, FOM, FOC, SWD, SWM and SWC directly adjacent to riparian areas – rivers, lakes, ponds and wetlands.	Nests are associated with lakes, ponds, rivers or wetlands along forested shorelines, islands, or on structures over water. Osprey nests are usually at the top a tree whereas Bald Eagle nests are typically in super canopy trees in a notch within the tree's canopy. Nests located on man-made objects are not to be included as SWH (e.g. telephone poles and constructed nesting platforms). Information Sources • Natural Heritage Information Center (NHIC) compiles all known nesting sites for Bald Eagles in Ontario • MNRF values information (LIO/NRVIS) will list known nesting locations, Note: data from NRVIS is provided as a point format and does not include all the habitat. • Nature Counts, Ontario Nest Records Scheme data • OMNRF Districts • Check the Ontario Breeding Bird Atlas[ccv] or Rare Breeding Birds in Ontario for species documented • Reports and other information available from CAs • Field naturalists clubs	Studies confirm the use of these nests by: • One or more active Osprey or Bald Eagle nests in an area[cxlviii]. • Some species have more than one nest in a given area and priority is given to the primary nest with alternate nests included within the area of the SWH. • For an Osprey, the active nest and a 300m radius around the nest or the contiguous woodland stand is the SWH[ccvii], maintaining undisturbed shorelines with large trees within this area is important[cxlviii]. • For a Bald Eagle the active nest and a 400-800m radius around the nest is the SWH[cvi, ccvii]. Area of the habitat from 400-800m is dependant on site lines from the nest to the development and inclusion of perching and foraging habitat[cvi]. • To be significant a site must be used annually. When found inactive, the site must be known to be inactive for ≥3 years or suspected of not being used for >5 years before being considered not significant[ccvii]. • Observational studies to determine nest site use, perching sites and foraging areas need to be done from mid March to mid August. • Evaluation methods to follow "Bird and Bird Habitats: Guidelines for Wind Power Projects"[ccxi] • SWHMIST[cxlix] Index #26 provides development effects and mitigation measures.	Vegetation community classification and delineation was completed and FOD and SWD communities are present. None of the targeted species have been documented within the study area or vicinity (BSC et al. 2009). Bald Eagle has the potential to occur within Hamilton Region (MNRF 2019b). Targeted bird surveys did not document Bald Eagle or Osprey within the study area. **Not SWH**

Table 3. Characteristics of Specialized Wildlife Habitat for Ecoregion 7E.

	Wildlife Species[1]	Candidate SWH		Confirmed SWH	Study Area
		ELC Ecosite Codes[1]	Habitat Criteria and Information Sources[1]	Defining Criteria[1]	Assessment Details
Wildlife Habitat: Woodland Raptor Nesting Habitat					
Rationale: Nests sites for these species are rarely identified; these area sensitive habitats are often used annually by these species.	Northern Goshawk Cooper's Hawk Sharp-shinned Hawk Red-shouldered Hawk Barred Owl Broad-winged Hawk	May be found in all forested ELC Ecosites. May also be found in SWC, SWM, SWD and CUP3	All natural or conifer plantation woodland/forest stands combined >30ha or with >4ha of interior habitat[lxxxviiii, lxxxix, xc, xci, xciii, xciv, xcv,xcvi, cxxxiii]. Interior habitat determined with a 200m buffer[cxlviii]. • Stick nests found in a variety of intermediate-aged to mature conifer, deciduous or mixed forests within tops or crotches of trees. Species such as Coopers hawk nest along forest edges sometimes on peninsulas or small off-shore islands. • In disturbed sites, nests may be used again, or a new nest will be in close proximity to old nest. Information Sources • OMNRF Districts • Check the Ontario Breeding Bird Atlas[ccv] or Rare Breeding Birds in Ontario for species documented. • Check data from Bird Studies Canada • Reports and other information available from CAs	Studies confirm: • Presence of 1 or more active nests from species list is considered significant[cxlviii]. • Red-shouldered Hawk and Northern Goshawk – A 400m radius around the nest or 28 ha of habitat is the SWH[ccvii].(the 28ha habitat area would be applied where optimal habitat is irregularly shaped around the nest) • Barred Owl – A 200m radius around the nest is the SWH[ccvii]. • Broad-winged Hawk and Coopers Hawk – A 100m radius around the nest is the SWH[ccvii]. • Sharp-Shinned Hawk – A 50m radius around the nest is the SWH[ccvii]. • Conduct field investigations from early March to end of May. The use of call broadcasts can help in locating territorial (courting/nesting) raptors and facilitate the discovery of nests by narrowing down the search area. • SWHMIST[cxlix] Index #27 provides development effects and mitigation measures.	Vegetation community classification and delineation was completed and FOD and SWD communities are present. the size of these habitats, including off-property portions, does not total 30ha with greater than 4ha of interior habitat due to the forest shape. Cooper's Hawk and Sharp-shinned Hawk have been documented within the study area or vicinity (BSC et al. 2009). Targeted bird surveys noted Cooper's Hawk and Red-tailed Hawk. **Not SWH**

Table 3. Characteristics of Specialized Wildlife Habitat for Ecoregion 7E.

	Wildlife Species[1]	**Candidate SWH**		**Confirmed SWH**	**Study Area**
		ELC Ecosite Codes[1]	**Habitat Criteria and Information Sources[1]**	**Defining Criteria[1]**	**Assessment Details**
Wildlife Habitat: Turtle Nesting Area					
Rationale: These habitats are rare and when identified will often be the only breeding site for local populations of turtles.	Midland Painted Turtle Special Concern: Northern Map Turtle Snapping Turtle	Exposed mineral soil (sand or gravel) areas adjacent (<100m)[cxlviii] or within the following ELC Ecosites: MAS1 MAS2 MAS3 SAS1 SAM1 SAF1 BOO1 FEO1	• Best nesting habitat for turtles are close to water and away from roads and sites less prone to loss of eggs by predation from skunks, raccoons or other animals. • For an area to function as a turtle-nesting area, it must provide sand and gravel that turtles are able to dig in and are located in open, sunny areas. Nesting areas on the sides of municipal or provincial road embankments and shoulders are not SWH. • Sand and gravel beaches adjacent to undisturbed shallow weedy areas of marshes, lakes, and rivers are most frequently used. Information Sources • Use Ontario Soil Survey reports and maps to help find suitable substrate for nesting turtles (well-drained sands and fine gravels). • Check the Ontario Herpetofaunal Summary Atlas records or other similar atlases for uncommon turtles; location information may help to find potential nesting habitat for them. • Natural Heritage Information Center (NHIC) Field naturalist clubs	Studies confirm: • Presence of 5 or more nesting Midland Painted Turtles[l] • One or more Northern Map Turtle or Snapping Turtle nesting is a SWH[l] • The area or collection of sites within an area of exposed mineral soils where the turtles nest, plus a radius of 30-100m around the nesting area dependant on slope, riparian vegetation and adjacent land use is the SWH[cxlviii]. • Travel routes from wetland to nesting area are to be considered within the SWH as part of the 30-100m area of habitat[cxlix]. • Field investigations should be conducted in prime nesting season typically late spring to early summer. Observation studies observing the turtles nesting is a recommended method. • SWHMIST[cxlix] Index #28 provides development effects and mitigation measures for turtle nesting habitat.	Vegetation community classification and delineation did not identify any of the required ELC communities. No wetland or pond features with soft substrates are present. Midland Painted Turtle and Snapping Turtle have been documented within the study area or vicinity (Ontario Nature 2018). Northern Map Turtle has the potential to occur within Hamilton Region (MNRF 2019b). Turtle nesting surveys have not been completed within the study area. **Not SWH**

Table 3. Characteristics of Specialized Wildlife Habitat for Ecoregion 7E.

	Wildlife Species[1]	**Candidate SWH**		**Confirmed SWH**	**Study Area**
		ELC Ecosite Codes[1]	**Habitat Criteria and Information Sources**[1]	**Defining Criteria**[1]	**Assessment Details**
Wildlife Habitat: Seeps and Springs					
Rationale: Seeps/Springs are typical of headwater areas and are often at the source of coldwater streams	Wild Turkey Ruffed Grouse Spruce Grouse White-tailed Deer Salamander spp.	Seeps/Springs are areas where ground water comes to the surface. Often they are found within headwater areas within forested habitats. Any forested Ecosite within the headwater areas of a stream could have seeps/springs.	Any forested area (with <25% meadow/field/pasture) within the headwaters of a stream or river system[cxvii, cxlix]. • Seeps and springs are important feeding and drinking areas especially in the winter will typically support a variety of plant and animal species[cxix, cxx, cxxi, cxxii, cxiii, cxiv]. <u>Information Sources</u> • Topographical Map • Thermography • Hydrological surveys conducted by CAs and MOE • Field naturalists and landowners • Municipalities and Conservation Authorities may have drainage maps and headwater areas mapped	Field Studies confirm: • Presence of a site with 2 or more[l] seeps/springs should be considered SWH. • The area of a ELC forest ecosite containing the seeps/springs is the SWH. The protection of the recharge area considering the slope, vegetation, height of trees and groundwater condition need to be considered in delineation of the habitat[cxlviii]. • SWHMIST[cxlix] Index #30 provides development effects and mitigation measures.	The karst formation that bisects the property (west-east ridge) has numerous seepage areas with flowing water near the old residence off of 1st road East. Wild Turkey, White-tailed Deer and Salamander spp. have been observed within the study area or vicinity (BSC et al. 2008, Dobbyn 1994, Ontario Nature 2018). Wild Turkey and White-tailed Deer were observed within the subject property and may use the seepage. **Confirmed SWH**

Table 3. Characteristics of Specialized Wildlife Habitat for Ecoregion 7E.

	Wildlife Species[1]	**Candidate SWH**		**Confirmed SWH**	**Study Area**
		ELC Ecosite Codes[1]	**Habitat Criteria and Information Sources[1]**	**Defining Criteria[1]**	**Assessment Details**
Wildlife Habitat: Amphibian Breeding Habitat (Woodland)					
<u>Rationale:</u> These habitats are extremely important to amphibian biodiversity within a landscape and often represent the only breeding habitat for local amphibian populations	Eastern Newt Blue-spotted Salamander Spotted Salamander Gray Treefrog Spring Peeper Western Chorus Frog Wood Frog	All Ecosites associated with these ELC Community Series: FOC FOM FOD SWC SWM SWD Breeding pools within the woodland or the shortest distance from forest habitat are more significant because they are more likely to be used due to reduced risk to migrating amphibians.	• Presence of a wetland, pond or woodland pool (including vernal pools) >$500m^2$ (about 25m diameter) [ccvii] within or adjacent (within 120m) to a woodland (no minimum size)[clxxxii, lxiii, lxv, lxvi, lxvii, lxviii, lxix, lxx]. Some small wetlands may not be mapped and may be important breeding pools for amphibians. • Woodlands with permanent ponds or those containing water in most years until mid-July are more likely to be used as breeding habitat[cxlviii]. <u>Information Sources</u> • Ontario Herpetofaunal Summary Atlas (or other similar atlases) for records • Local landowners may also provide assistance as they may hear spring-time choruses of amphibians on their property. • OMNRF Districts and wetland evaluations • Field naturalist clubs • Canadian Wildlife Service Amphibian Road Call Survey • Ontario Vernal Pool Association: http://www.ontariovernalpools.org	Studies confirm: • Presence of breeding population of 1 or more of the listed newt/salamander species or 2 or more of the listed frog/toad species with at least 20 individuals (adults or eggs masses) or 2 or more of the listed frog/toad species with Call Level Codes of 3. • A combination of observational study and call count surveys [cviii] will be required during the spring (March-June) when amphibians are concentrated around suitable breeding habitat within or near the woodland/wetlands. • The habitat is the wetland area plus a 230m radius of woodland area[lxiii, lxv, lxvi, lxvii, lxviii, lxix, lxx, lxxi]. If a wetland area is adjacent to a woodland, a travel corridor connecting the wetland to the woodland is to be included in the habitat. • SWHMIST[cxlix] Index #14 provides development effects and mitigation measures.	Vegetation community classification and delineation was completed with SWD and FOD communities present. The FOD community is separated from the nearest SWD communnity by approximately 200m. Eastern Newt, Blue-spotted Salamander, Gray Treefrog, Spring Peeper and Wood Frog have been documented within the study area or vicinity (Ontario Nature 2018). Targeted amphibian surveys were conducted and noted the presence of 5 anuran species; however no call code of 3 was recorded for any species on any survey night and the total numbers of calling individuals are estimated to be less than 20. **Not SWH**

Table 3. Characteristics of Specialized Wildlife Habitat for Ecoregion 7E.

	Wildlife Species[1]	Candidate SWH		Confirmed SWH	Study Area
		ELC Ecosite Codes[1]	Habitat Criteria and Information Sources[1]	Defining Criteria[1]	Assessment Details
Wildlife Habitat: Amphibian Breeding Habitat (Wetland)					
Rationale: Wetlands supporting breeding for these amphibian species are extremely important and fairly rare within Central Ontario Landscapes	Eastern Newt American Toad Spotted Salamander Four-toed Salamander Blue-spotted Salamander Gray Treefrog Western Chorus Frog Northern Leopard Frog Pickerel Frog Green Frog Mink Frog Bullfrog	ELC Community Classes SW, MA, FE, BO, OA and SA. Typically these wetland ecosites will be isolated (>120m) from woodland ecosites, however larger wetlands containing predominantly aquatic species (e.g. Bull Frog) may be adjacent to woodlands.	• Wetlands >500m^2 (about 25m diameter)[ccvii] supporting high species diversity are significant: some small or ephemeral habitats may not be identified on MNR mapping and could be important amphibian breeding habitats[clxxxiv]. • Presence of shrubs and logs increase significance of pond for some amphibian species because of available structure for calling, foraging, escape and concealment from predators. • Bullfrogs require permanent water bodies with abundant emergent vegetation. Information Sources • Ontario Herpetofaunal Summary Atlas (or other similar atlases) • Canadian Wildlife Service Amphibian Road Surveys and Backyard Amphibian Call Count. • OMNRF Districts and wetland evaluations • Reports and other information available from CAs	Studies confirm: • Presence of breeding population of 1or more of the listed newt/salamander species or 2 or more of the listed frog or toad species and with at least 20 breeding individuals (adults and eggs masses)[lxxi, lxxiii] or 2 or more of the listed frog/toad species with Call Level of 3. or; Wetland with confirmed breeding Bullfrogs are significant[l]. • The ELC ecosite wetland area and the shoreline are the SWH. • A combination of observational study and call count surveys cviii to determine breeding/larval stages will be required during the spring (May March-June) when amphibians are concentrated around suitable breeding habitat within or near the woodland/wetlands. • If a SWH is determined for Amphibian Breeding Habitat (Wetlands) then Movement Corridors are to be considered as outlined in Table 1.4.1 of this Schedule. • SWHMIST[cxlix] Index #15 provides development effects and mitigation measures.	Vegetation community classification and delineation was completed and SWD and MAM communities are present. Eastern Newt, American Toad, Blue-spotted Salamander, Gray Treefrog, Northern Leopard Frog, Green Frog and Bullfrog have been documented within the study area or vicinity (Ontario Nature 2018). Targeted amphibian surveys documented 5 species; however no call code of 3 was recorded for any species on any survey night and the total numbers of calling individuals are estimated to be less than 20. **Not SWH**

Table 3. Characteristics of Specialized Wildlife Habitat for Ecoregion 7E.

	Wildlife Species[1]	**Candidate SWH**		**Confirmed SWH**	**Study Area**
		ELC Ecosite Codes[1]	**Habitat Criteria and Information Sources[1]**	**Defining Criteria[1]**	**Assessment Details**
Wildlife Habitat: Woodland Area-Sensitive Bird Breeding Habitat					
Rationale: Large, natural blocks of mature woodland habitat within the settled areas of Southern Ontario are important habitats for area sensitive interior forest song birds.	Yellow-bellied Sapsucker Red-breasted Nuthatch Veery Blue-headed Vireo Northern Parula Black-throated Green Warbler Blackburnian Warbler Black-throated Blue Warbler Ovenbird Scarlet Tanager Winter Wren Pileated Woodpecker Special Concern: Cerulean Warbler Canada Warbler	All Ecosites associated with these ELC Community Series: FOC FOM FOD SWC SWM SWD	• Habitats where interior forest breeding birds are breeding, typically large mature (>60 yrs. old) forest stands or woodlots >30ha[cv, cxxxi, cxxxii, cxxxiii, cxxxiv, cxxxv, cxxxvi, cxxxvii, cxxxviii, cxxxix, cxl, cxli, cxlii, cxliii, cxliv, cxlv, cxlvi, cl, cli, clii, cliii, cliv, clv, clvi, clvii, clviii, clix]. • Interior forest habitat is at least 200m from forest edge habitat[clxiv]. Information Sources • Local birder clubs • Canadian Wildlife Service (CWS) for the location of forest bird monitoring • Bird Studies Canada conducted a 3-year study of 287 woodlands to determine the effects of forest fragmentation on forest birds and to determine what forests were of greatest value to interior species. • Reports and other information available from CAs	Studies confirm: • Presence of nesting or breeding pairs of 3 or more of the listed wildlife species[l]. • Note: any site with breeding Cerulean Warblers or Canada Warbler is to be considered SWH[l]. • Conduct field investigations in early summer when birds are singing and defending their territories. • Evaluation methods to follow "Bird and Bird Habitats: Guidelines for Wind Power Projects"[ccxi] • SWHMIST[cxlix] Index #34 provides development effects and mitigation measures.	Vegetation community classification and delineation was completed with FOD and SWD communities present. Little to no interior forest habitat is present. Red-breasted Nuthatch, Veery, Ovenbird, Scarlet Tanager, Winter Wren and Canada Warbler have been documented within the study area or vicinity (BSC et al. 2009). Cerulean Warbler has the potential to occur within Hamilton Region (MNRF 2019b). Breeding bird surveys have been completed and did not document any area-sensitive species within the study area. **Not SWH**

Table 4. Characteristics of Habitat for Species of Conservation Concern for Ecoregion 7E.

	Wildlife Species[1]	Candidate SWH		Confirmed SWH	Study Area
		ELC Ecosite Codes[1]	Habitat Criteria and Information Sources[1]	Defining Criteria[1]	Assessment Details
Wildlife Habitat: Marsh Bird Breeding Habitat					
Rationale: Wetlands for these bird species are typically productive and fairly rare in Southern Ontario landscapes.	American Bittern Virginia Rail Sora Common Gallinule American Coot Pied-billed Grebe Marsh Wren Sedge Wren Common Loon Green Heron Trumpeter Swan Special Concern: Black Tern Yellow Rail	MAM1 MAM2 MAM3 MAM4 MAM5 MAM6 SAS1 SAM1 SAF1 FEO1 BOO1 For Green Heron: All SW, MA and CUM1 sites	• Nesting occurs in wetlands • All wetland habitat is to be considered as long as there is shallow water with emergent aquatic vegetation present[cxxiv]. • For Green Heron, habitat is at the edge of water such as sluggish streams, ponds and marshes sheltered by shrubs and trees. Less frequently, it may be found in upland shrubs or forest a considerable distance from water. Information Sources • OMNRF Districts and wetland evaluations • Field naturalist clubs • Natural Heritage Information Centre (NHIC) • Reports and other information available from CAs • Ontario Breeding Bird Atlas[ccv]	Studies confirm: • Presence of 5 or more nesting pairs of Sedge Wren or Marsh Wren or breeding by any combination of 4 or more of the listed species[i]. • Note: any wetland with breeding of 1 or more Trumpeter Swans, Black Terns, Green Heron or Yellow Rail is SWH[i]. • Area of the ELC ecosite is the SWH • Breeding surveys should be done in May/June when these species are actively nesting in wetland habitats. • Evaluation methods to follow "Bird and Bird Habitats: Guidelines for Wind Power Projects"[ccxi] • SWHMIST[cxlix] Index #35 provides development effects and mitigation measures	Vegetation community classification and delineation was completed and MAM2 communities are present. Little to no open water or emergent vegetation is present. Virginia Rail, Sora, Marsh Wren, Sedge Wren and Green Heron have been documented within the study area or vicinity (BSC et al. 2009). Black Tern has the potential to occur within Hamilton Region (MNRF 2019b). Breeding bird surveys did not document the presence of any indicator species within the study area. **Not SWH**

Table 4. Characteristics of Habitat for Species of Conservation Concern for Ecoregion 7E.

	Wildlife Species[1]	Candidate SWH		Confirmed SWH	Study Area
		ELC Ecosite Codes[1]	Habitat Criteria and Information Sources[1]	Defining Criteria[1]	Assessment Details
Wildlife Habitat: Open Country Bird Breeding Habitat					
Rationale: This wildlife habitat is declining throughout Ontario and North America. Species such as the Upland Sandpiper have declined significantly the past 40 years based on CWS (2004) trend records.	Upland Sandpiper Grasshopper Sparrow Vesper Sparrow Northern Harrier Savannah Sparrow Special Concern: Short-eared Owl	CUM1 CUM2	Large grassland areas (includes natural and cultural fields and meadows) >30ha[clx, clxi, clxii, clxiii, clxiv, clxv, clxvi, clxvii, clxviii, clxix]. Grasslands not Class 1 or 2 agricultural lands, and not being actively used for farming (i.e. no row cropping or intensive hay or livestock pasturing in the last 5 years)[i]. Grassland sites considered significant should have a history of longevity, either abandoned fields, mature hayfields and pasturelands that are at least 5 years or older. The Indicator bird species are area sensitive requiring larger grassland areas than the common grassland species. Information Sources • Agricultural land classification maps Ministry of Agriculture • Local birder clubs • Ontario Breeding Bird Atlas[ccv] • EIS Reports and other information available from CAs	Field Studies confirm: • Presence of nesting or breeding of 2 or more of the listed species[i]. • A field with 1 or more breeding Short-eared Owls is to be considered SWH. • The area of SWH is the contiguous ELC ecosite field areas. • Conduct field investigations of the most likely areas in spring and early summer when birds are singing and defending their territories. • Evaluation methods to follow "Bird and Bird Habitats: Guidelines for Wind Power Projects"[ccxi] • SWHMIST[cxlix] Index #32 provides development effects and mitigation measures	Vegetation community classification and delineation was completed and several areas of CUM are present. these areas are fragmented but could offer habitat for open country bird species. All of the target species have been documented within the study area or vicinity (BSC et al. 2009). Breeding bird surveys documented Savannah Sparrow within the study area. **Not SWH**

Table 4. Characteristics of Habitat for Species of Conservation Concern for Ecoregion 7E.

	Wildlife Species[1]	**Candidate SWH**		**Confirmed SWH**	**Study Area**
		ELC Ecosite Codes[1]	**Habitat Criteria and Information Sources[1]**	**Defining Criteria[1]**	**Assessment Details**
Wildlife Habitat: Shrub/Early Successional Bird Breeding Habitat					
Rationale: This wildlife habitat is declining throughout Ontario and North America. The Brown Thrasher has declined significantly over the past 40 years based on CWS (2004) trend records.	Indicator Spp: Brown Thrasher Clay-coloured Sparrow Common Spp. Field Sparrow Black-billed Cuckoo Eastern Towhee Willow Flycatcher Special Concern: Yellow-breasted Chat Golden-winged Warbler	CUT1 CUT2 CUS1 CUS2 CUW1 CUW2 Patches of shrub ecosites can be complexed into a larger habitat such as woodland area for some bird species.	Large natural field areas succeeding to shrub and thicket habitats >10ha[clxiv] in size. Shrub land or early successional fields, not class 1 or 2 agricultural lands, not being actively used for farming (i.e. no row-cropping, haying or live-stock pasturing in the last 5 years)[i]. Shrub thicket habitats (>10 ha) are most likely to support and sustain a diversity of these species[clxiii]. Shrub and thicket habitat sites considered significant should have a history of longevity, either abandoned fields or pasturelands. Information Sources • Agricultural land classification maps, Ministry of Agriculture. • Local bird clubs • Ontario Breeding Bird Atlas[ccv] • Reports and other information available from CAs	Field Studies confirm: • Presence of nesting or breeding of 1 of the indicator species and at least 2 of the common species[i]. • A field with breeding Yellow-breasted Chat or Golden-winged Warbler is to be considered as Significant Wildlife Habitat[i]. • The area of the SWH is the contiguous ELC ecosite field/thicket area. • Conduct field investigations of the most likely areas in spring and early summer when birds are singing and defending their territories • Evaluation methods to follow "Bird and Bird Habitats: Guidelines for Wind Power Projects"[ccxi] • SWHMIST[cxlix] Index #33 provides development effects and mitigation measures.	Vegetation community classification and delineation was completed and CUT and CUS communities are present. Thicket and shrub habitats within the study area are less than 10 ha in size (5ha at most). Brown Thrasher, Field Sparrow, Black-billed Cuckoo, Eastern Towhee and Willow Flycatcher have been documented within the study area or vicinity (BSC et al. 2009). Yellow-breasted Chat and Golden-winged Warbler have the potential to occur within Hamilton Region (MNRF 2019b). Breeding bird surveys have documented Brown thrasher (probable breeding), Willow Flycatcher (possible breeding), Field Sparrow (probable breeding), Black-billed Cuckoo (possible breeding) and Eastern Towhee (possible breeding) within the study area. **Confirmed SWH**
Wildlife Habitat: Terrestrial Crayfish					
Rationale: Terrestrial Crayfish are only found within SW Ontario in Canada and their habitats are very rare. [Ccii]	Chimney or Digger Crayfish (*Fallicambarus fodiens*) Devil Crawfish or Meadow Crayfish (*Cambarus Diogenes*)	MAM1 MAM2 MAM3 MAM4 MAM5 MAM6 MAS1 MAS2 MAS3 SWD SWT SWM CUM1 with inclusions of above meadow marsh ecosites can be used by terrestrial crayfish	Wet meadow and edges of shallow marshes (no minimum size) identified should be surveyed for terrestrial crayfish. • Constructs burrows in marshes, mudflats, meadows, the ground can't be too moist. Can often be found far from water. • Both species are a semi-terrestrial burrower which spends most of its life within burrows consisting of a network of tunnels. Usually the soil is not too moist so that the tunnel is well formed. Information Sources • Information sources from "Conservation Status of Freshwater Crayfishes" by Dr. Premek Hamr for the WWF and CNF March 1998.	Studies Confirm: • Presence of 1 or more individuals of species listed or their chimneys (burrows) in suitable marsh meadow or terrestrial sites[cci]. • Area of ELC Ecosite or an ecoelement area of meadow marsh or swamp within the large ecosite area is the SWH • Surveys should be done April to August in temporary or permanent water. Note the presence of burrows or chimneys are often the only indicator of presence, observance or collection of individuals is very difficult [cci] • SWHMIST[cxlix] Index #36 provides development effects and mitigation measures.	Vegetation community classification and delineation was completed and MAM2, SWD and CUM communities are present. Targeted surveys have not been completed within the study area. No incidental observations of crayfish chimneys were documented. **Not SWH**

Table 4. Characteristics of Habitat for Species of Conservation Concern for Ecoregion 7E.

	Wildlife Species[1]	**Candidate SWH**		**Confirmed SWH**	**Study Area**
		ELC Ecosite Codes[1]	**Habitat Criteria and Information Sources[1]**	**Defining Criteria[1]**	**Assessment Details**
Wildlife Habitat: Special Concern and Rare Wildlife Species					
Rationale: These species are quite rare or have experienced significant population declines in Ontario	All Special Concern and Provincially Rare (S1-S3, SH) plant and animal species. Lists of these species are tracked by the Natural Heritage Information Centre (NHIC).	All plant and animal element occurrences (EO) within a 1 or 10km grid. Older element occurrences were recorded prior to GPS being available, therefore location information may lack accuracy.	When an element occurrence is identified within a 1 or 10 km grid for a Special Concern or provincially Rare species; linking candidate habitat on the site needs to be completed to ELC Ecosites[lxxviii]. Information Sources • Natural Heritage Information Centre (NHIC) will have the Special Concern and Provincially Rare (S1-S3, SH) species lists and element occurrences for these species. • NHIC Website: "Get Information" http://nhic.mnr.gov.on.ca • Ontario Breeding Bird Atlas[ccv] • Expert advice should be sought as many of the rare spp. have little information available about their requirements.	Studies Confirm: • Assessment/inventory of the site for the identified special concern or rare species needs to be completed during the time of year when the species is present or easily identifiable. • The area of the habitat to the finest ELC scale that protects the habitat form and function is the SWH, this must be delineated through detailed field studies. The habitat neess to be easily mapped and cover an important life stage component for a species e.g. specific nesting habitat for foraging habitat. • SWHMIST[cxlix] Index #37 provides development effects and mitigation measures.	Several Special Concern and Provincially Rare species have been documented within the study area or vicinity. Refer to Species of Conservation Concern Screening for details relating to Eastern Wood-pewee and Common Nighthawk (both documented within subject property). **Confirmed SWH**

Significant Wildlife Habitat Assessment Tables

Table 5. Characteristics of Animal Movement Corridors for Ecoregion 7E.

	Wildlife Species[1]	**Candidate SWH**		**Confirmed SWH**	**Study Area**
		ELC Ecosite Codes[1]	**Habitat Criteria and Information Sources**[1]	**Defining Criteria**[1]	**Assessment Details**
Wildlife Habitat: Amphibian Movement Corridors					
Rationale: Movement corridors for amphibians moving from their terrestrial habitat to breeding habitat can be extremely important for local populations.	Eastern Newt American Toad Blue-spotted Salamander Spotted Salamander Four-toed Salamander Gray Treefrog Northern Leopard Frog Pickerel Frog Western Chorus Frog	Corridors may be found in all ecosites associated with water. • Corridors will be determined based on identifying the significant breeding habitat for these species in Table 1.1.	Movement corridors between breeding habitat and summer habitat[clxxiv, clxxv, clxxvi, clxxvii, clxxviii, clxxix, clxxx, clxxxi] Movement corridors must be considered when Amphibian breeding habitat is confirmed as SWH from Table 1.2.2 (Amphibian Breeding Habitat – Wetland) of this Schedule[i]. Information Sources • MNRF District Office • Natural Heritage Information Centre NHIC • Reports and other information available from CAs • Field naturalist Clubs	• Field Studies must be conducted at the time of year when species are expected to be migrating or entering breeding sites. • Corridors should consist of native vegetation, with several layers of vegetation. Corridors unbroken by roads, waterways or bodies, and undeveloped areas are most significant[cxlix]. • Corridors should have at least 15m of vegetation on both sides of waterwaycxlix or be up to 200m widecxlix of woodland habitat and with gaps <20m[cxlix] • Shorter corridors are more significant than longer corridors, however amphibians must be able to get to and from their summer and breeding habitat[cxlix]. • SWHMIST[cxlix] Index #40 provides development effects and mitigation measures.	Candidate amphibian breeding SWH was identified as present within the study area. Movement corridors may be present along the watercourse within the study area. Eastern Newt, Blue-spotted Salamander, Gray Treefrog, Spring Peeper, Northern Leopard Frog, Green Frog and Bullfrog have been documented from the study area or vicinity (Ontario Nature 2018). Surveys documented American Toad, Gray Treefrog and Western Chorus Frog within the study area. **Not SWH**

Appendix II

Vascular Plant Species Observed within the Subject Property

Vascular Plant Species Reported From the Study Area

Scientific Name	Common Name	CC	CW	Weed	SRANK[1]	SARO[2]	COSEWIC[3]	SARA Schedule[3]	Hamilton Status[4]	MNRF SAR List[5]	NHIC Data[6]	NRSI Observed
Pteridophytes	**Ferns & Allies**											
Dryopteridaceae	**Wood Fern Family**											
Dryopteris carthusiana	Spinulose Wood Fern	5	-2		S5				X			X
Onoclea sensibilis	Sensitive Fern	4	-3		S5				X			X
Equisetaceae	**Horsetail Family**											
Equisetum arvense	Field Horsetail	0	0		S5				X			X
Thelypteridaceae	**Beech Fern Family**											
Phegopteris hexagonoptera	Broadbeech Fern	9	1		S3	SC	SC	Schedule 3	R5	X		
Gymnosperms	**Conifers**											
Cupressaceae	**Cypress Family**											
Juniperus virginiana	Eastern Red Cedar	4	3		S5				X			X
Pinaceae	**Pine Family**											
Picea abies	Norway Spruce		5	-1	SE3				I			X
Picea glauca	White Spruce	6	3		S5				X			X
Pinus resinosa	Red Pine	8	3		S5				X			X
Dicotyledons	**Dicots**											
Aceraceae	**Maple Family**											
Acer negundo	Manitoba Maple	0	-2		S5				X			X
Acer rubrum	Red Maple	4	0		S5				X			X
Acer saccharum ssp. saccharum	Sugar Maple	4	3		S5				X			X
Acer saccharum ssp. nigrum	Black Maple	7	3		S4?				X			X
Anacardiaceae	**Sumac or Cashew Family**											
Rhus hirta	Staghorn Sumac	1	5		S5				X			X
Toxicodendron rydbergii	Poison-ivy	0	0		S5				X			X
Apiaceae	**Carrot or Parsley Family**											
Anthriscus sylvestris	Woodland Chervil		5	-2	SE4?							X
Daucus carota	Wild Carrot		5	-2	SE5				I			X
Araliaceae	**Ginseng Family**											
Panax quinquefolius	Ginseng	9	5		S3	END	E	Schedule 1	R2	X		
Asclepiadaceae	**Milkweed Family**											
Asclepias incarnata ssp. incarnata	Swamp Milkweed	6	-5		S5				X			X
Asclepias syriaca	Common Milkweed	0	5		S5				X			X
Asteraceae	**Composite or Aster Family**											
Ambrosia artemisiifolia	Common Ragweed	0	3		S5				X			X

Scientific Name	Common Name	CC	CW	Weed	SRANK[1]	SARO[2]	COSEWIC[3]	SARA Schedule[3]	Hamilton Status[4]	MNRF SAR List[5]	NHIC Data[6]	NRSI Observed
Arctium minus ssp. minus	Common Burdock		5	-2	SE5				I			X
Cirsium arvense	Canada Thistle		3	-1	SE5				I			X
Cirsium vulgare	Bull Thistle		4	-1	SE5				I			X
Erigeron annuus	Daisy Fleabane	0	1		S5				X			X
Erigeron philadelphicus ssp. philadelphicus	Philadelphia Fleabane	1	-3		S5				X			X
Eurybia divaricata	White Wood Aster	10	5		S2	THR	T	Schedule 1	R1	X		
Euthamia graminifolia	Flat-topped Bushy Goldenrod	2	-2		S5				X			X
Hieracium caespitosum ssp. caespitosum	Field Hawkweed		5	-2	SE5				I			X
Hymenoxys herbacea	Lakeside Daisy	10	5		S3	THR	T	Schedule 1		X		
Leucanthemum vulgare	Ox-eye Daisy		5	-1	SE5				I			X
Matricaria discoidea	Pineapple-weed				SE5				I			X
Rudbeckia triloba	Brown-eyed Coneflower		1	-1	SE4				I			X
Solidago altissima var. altissima	Tall Goldenrod	1	3		S5				X			X
Solidago canadensis	Canada Goldenrod	1	3		S5				X			X
Solidago juncea	Early Goldenrod	3	5		S5				X			X
Solidago nemoralis ssp. nemoralis	Gray Goldenrod	2	5		S5				X			X
Sonchus arvensis ssp. arvensis	Field Sow-thistle				SE5				I			X
Symphyotrichum ericoides var. ericoides	White Heath Aster				S5				X			X
Symphyotrichum novae-angliae	New England Aster	2	-3		S5				X			X
Symphyotrichum pilosum var. pilosum	Hairy Aster	4	2		S5				X			X
Symphyotrichum urophyllum	Arrow-leaved Aster	6	5		S4				X			X
Taraxacum officinale	Common Dandelion		3	-2	SE5				I			X
Balsaminaceae	**Touch-me-not Family**											
Impatiens capensis	Spotted Touch-me-not	4	-3		S5				X			X
Berberidaceae	**Barberry Family**											
Podophyllum peltatum	May-apple	5	3		S5				X			X
Betulaceae	**Birch Family**											
Betula lenta	Cherry Birch	9	3		S1	END	E	Schedule 1		X		
Carpinus caroliniana ssp. virginiana	Blue Beech	6	0		S5				X			X
Ostrya virginiana	Hop Hornbeam	4	4		S5				X			X
Brassicaceae	**Mustard Family**											
Alliaria petiolata	Garlic Mustard		0	-3	SE5				I			X
Hesperis matronalis	Dame's Rocket		5	-3	SE5				I			X
Caprifoliaceae	**Honeysuckle Family**											
Lonicera dioica	Glaucous Honeysuckle	5	3		S5				X			X
Lonicera tatarica	Tartarian Honeysuckle		3	-3	SE5				I			X
Viburnum lentago	Nannyberry	4	-1		S5				X			X
Celastraceae	**Staff-tree Family**											
Euonymus obovata	Running Strawberry-bush	6	5		S5				X			X

Scientific Name	Common Name	CC	CW	Weed	SRANK[1]	SARO[2]	COSEWIC[3]	SARA Schedule[3]	Hamilton Status[4]	MNRF SAR List[5]	NHIC Data[6]	NRSI Observed
Cornaceae	**Dogwood Family**											
Cornus florida	Eastern Flowering Dogwood	7	4		S2?	END	E	Schedule 1	X	X	X	
Cornus foemina ssp. racemosa	Red Panicled Dogwood	2	-2		S5				X			X
Dipsacaceae	**Teasel Family**											
Dipsacus fullonum ssp. sylvestris	Wild Teasel		5	-1	SE5				I			X
Elaeagnaceae	**Oleaster Family**											
Elaeagnus umbellata	Autumn Olive		3	-3	SE3				I			X
Euphorbiaceae	**Spurge Family**											
Acalypha virginica var. rhomboidea	Three-seeded Mercury	0	3		S5				X			X
Fabaceae	**Pea Family**											
Gymnocladus dioicus	Kentucky Coffee-tree	6	5		S2	THR	T	Schedule 1	I	X		
Lotus corniculatus	Bird's-foot Trefoil		1	-2	SE5				I			X
Medicago lupulina	Black Medick		1	-1	SE5				I			X
Melilotus officinalis	Yellow Sweet-clover		3	-1	SE5				I			X
Trifolium pratense	Red Clover		2	-2	SE5				I			X
Trifolium repens	White Clover		2	-1	SE5				I			X
Vicia cracca	Tufted Vetch		5	-1	SE5				I			X
Fagaceae	**Beech Family**											
Castanea dentata	American Chestnut	8	5		S2	END	E	Schedule 1	U	X		
Fagus grandifolia	American Beech	6	3		S5				X			X
Quercus alba	White Oak	6	3		S5				X			X
Quercus macrocarpa	Bur Oak	5	1		S5				X			X
Quercus rubra	Red Oak	6	3		S5				X			X
Gentianaceae	**Gentian Family**											
Frasera caroliniensis	American Columbo	10	5		S2	END	E	Schedule 1	R1	X		
Geraniaceae	**Geranium Family**											
Geranium maculatum	Spotted Crane's-bill	6	3		S5				X			X
Geranium robertianum	Herb Robert		5	-2	SE5				I			X
Guttiferae	**St. John's-wort Family**											
Hypericum perforatum	Common St. John's-wort		5	-3	SE5				I			X
Hydrophyllaceae	**Water-leaf Family**											
Hydrophyllum virginianum	Virginia Water-leaf	6	-2		S5				X			X
Juglandaceae	**Walnut Family**											
Carya cordiformis	Bitternut Hickory	6	0		S5				X			X
Carya ovata var. ovata	Shagbark Hickory	6	3		S5				X			X
Juglans cinerea	Butternut	6	2		S2?	END	E	Schedule 1	X	X		

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Juglans nigra	Black Walnut	5	3		S4				X			X
Lamiaceae	**Mint Family**											
Lamium purpureum	Purple Dead-nettle		5	-2	SE3				I			X
Lycopus uniflorus	Northern Water-horehound	5	-5		S5				X			X
Pycnanthemum incanum var. incanum	Hoary Mountain-mint	10	5		S1	END	E	Schedule 1	R1	X		
Limnanthaceae	**False Mermaid Family**											
Floerkea proserpinacoides	False Mermaid	9	-1		S4		NAR		U			X
Lythraceae	**Loosestrife Family**											
Lythrum salicaria	Purple Loosestrife		-5	-3	SE5				I			X
Magnoliaceae	**Magnolia Family**											
Magnolia acuminata	Cucumber Tree	10	1		S2	END	E	Schedule 1		X		
Moraceae	**Mulberry Family**											
Morus alba	White Mulberry		0	-3	SE5				I			X
Morus rubra	Red Mulberry	10	1		S2	END	E	Schedule 1	R4	X		
Oleaceae	**Olive Family**											
Fraxinus americana	White Ash	4	3		S5				X			X
Fraxinus pennsylvanica	Green Ash	3	-3		S5				X			X
Ligustrum vulgare	Common Privet		1	-2	SE5				I			X
Syringa vulgaris	Common Lilac		5	-2	SE5				I			X
Onagraceae	**Evening-primrose Family**											
Circaea lutetiana ssp. canadensis	Yellowish Enchanter's Nightshade	3	3		S5				X			X
Epilobium hirsutum	Great Hairy Willow-herb		-4	-2	SE5				I			X
Oenothera biennis	Common Evening-primrose	0	3		S5				X			X
Papaveraceae	**Poppy Family**											
Chelidonium majus	Celandine		5	-3	SE5				I			X
Sanguinaria canadensis	Bloodroot	5	4		S5				X			X
Plantaginaceae	**Plantain Family**											
Plantago major	Common Plantain		-1	-1	SE5				I			X
Polygonaceae	**Smartweed Family**											
Polygonum persicaria	Lady's-thumb		-3	-1	SE5				I			X
Rumex crispus	Curly-leaf Dock		-1	-2	SE5				I			X
Portulacaceae	**Purslane Family**											
Claytonia virginica	Virginia Spring Beauty	5	3		S5				X			X
Ranunculaceae	**Buttercup Family**											

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Ranunculus abortivus	Kidney-leaf Buttercup	2	-2		S5				X			X
Rhamnaceae	**Buckthorn Family**											
Rhamnus cathartica	European Buckthorn		3	-3	SE5				I			X
Frangula alnus	Glossy Buckthorn		-1	-3	SE5				I			X
Rosaceae	**Rose Family**											
Agrimonia gryposepala	Tall Hairy Agrimony	2	2		S5							X
Amelanchier arborea	Downy Juneberry		3		S5				X			X
Crataegus species	Hawthorn species											X
Fragaria virginiana	Wild Strawberry				S5							X
Geum laciniatum	Rough Avens		-3		S4				X			X
Malus domestica	Apple											X
Potentilla recta	Rough-fruited Cinquefoil		5	-2	SE5				I			X
Prunus avium	Cherry Plum		5	-2	SE4				I			X
Prunus virginiana ssp. virginiana	Choke Cherry	2	1		S5				X			X
Pyrus communis	Common Pear		5	-1	SE4				I			X
Rosa multiflora	Multiflora Rose		3	-3	SE4				I			X
Rubus occidentalis	Black Raspberry	2	5		S5				X			X
Rubiaceae	**Madder Family**											
Galium aparine	Cleavers	4	3		S5				X			X
Rutaceae	**Rue Family**											
Ptelea trifoliata	Common Hop-tree	9	2		S3	SC	T	Schedule 1	I	X		
Zanthoxylum americanum	American Prickly-ash	3	5		S5				X			X
Scrophulariaceae	**Figwort Family**											
Verbascum thapsus	Common Mullein		5	-2	SE5				I			X
Veronica officinalis	Common Speedwell		5	-2	SE5				I			X
Solanaceae	**Nightshade Family**											
Solanum dulcamara	Bitter Nightshade		0	-2	SE5				I			X
Tiliaceae	**Linden Family**											
Tilia americana	American Basswood	4	3		S5				X			X
Ulmaceae	**Elm Family**											
Ulmus americana	White Elm	3	-2		S5				X			X
Ulmus rubra	Slippery Elm	6	0		S5				X			X
Verbenaceae	**Vervain Family**											
Verbena urticifolia	White Vervain	4	-1		S5				X			X
Violaceae	**Violet Family**											
Viola sororia	Woolly Blue Violet	4	1		S5				X			X

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Vitaceae	**Grape Family**											
Parthenocissus vitacea	Woodbine	3	3		S5				X			X
Vitis riparia	Riverbank Grape	0	-2		S5				X			X
Monocotyledons	**Monocots**											
Araceae	**Arum Family**											
Arisaema dracontium	Green Dragon	9	-3		S3	SC	SC	Schedule 3	R5	X		
Arisaema triphyllum	Jack-in-the-pulpit	5	-2		S5				X			X
Calla palustris	Wild Calla	8	-5		S5				X			X
Cyperaceae	**Sedge Family**											
Carex cristatella	Crested Sedge	3	-4		S5				X			X
Carex grisea	Narrow-leaved Sedge	8	1		S4				U			X
Carex lupulina	Hop Sedge	6	-5		S5				X			X
Carex normalis	Larger Straw Sedge	6	-3		S4				X			X
Carex pellita	Woolly Sedge	4	-5		S5				X			X
Carex pensylvanica	Pennsylvania Sedge	5	5		S5				X			X
Carex retrorsa	Retrorse Sedge	5	-5		S5				X			X
Carex stipata	Awl-fruited Sedge	3	-5		S5				X			X
Carex vulpinoidea	Fox Sedge	3	-5		S5				X			X
Scirpus cyperinus	Wool-grass	4	-5		S5				X			X
Trichophorum planifolium	Bashful Bulrush	10	5		S1	END	E	Schedule 1		X		
Juncaceae	**Rush Family**											
Juncus articulatus	Jointed Rush	5	-5		S5				X			X
Juncus tenuis	Path Rush	0	0		S5				X			X
Liliaceae	**Lily Family**											
Erythronium americanum ssp. americanum	Yellow Dog's-tooth Violet	5	5		S5				X			X
Hemerocallis fulva	Orange Day-lily		5	-3	SE5				I			X
Lilium michiganense	Michigan Lily	7	-1		S5				X			X
Maianthemum racemosum ssp. racemosum	False Solomon's Seal	4	3		S5				X			X
Narcissus pseudonarcissus	Daffodil				SE2							X
Scilla siberica	Squill		5	-1	SE2				I			X
Trillium grandiflorum	White Trillium	5	5		S5				X			X
Orchidaceae	**Orchid Family**											
Liparis loeselii	Fen Twayblade	5	-4		S4S5				X			X
Poaceae	**Grass Family**											
Agrostis stolonifera	Redtop		-3		S5				X			X
Bromus inermis ssp. inermis	Awnless Brome		5	-3	SE5				I			X
Bromus secalinus ssp. secalinus	Cheat Chess		5	-1	SE4				I			X
Cinna arundinacea	Wood Reed Grass	7	-3		S4				X			X
Dactylis glomerata	Orchard Grass		3	-1	SE5				I			X

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Elymus repens	Quack Grass		3	-3	SE5				I			X
Glyceria striata	Fowl Meadow Grass	3	-5		S5				X			X
Leersia virginica	White Cut Grass	6	-3		S4				X			X
Phalaris arundinacea	Reed Canary Grass	0	-4		S5				X			X
Phleum pratense	Timothy		3	-1	SE5				I			X
Phragmites australis ssp. australis	European Common Reed				SNA				I			X
Poa pratensis ssp. pratensis	Kentucky Bluegrass	0	1		S5				I			X
Setaria pumila	Yellow Foxtail		0	-1	SE5				I			X
Typhaceae	**Cattail Family**											
Typha angustifolia	Narrow-leaved Cattail	3	-5		S5				X			X
									Total	**16**	**1**	**150**

[1]MNRF 2019a, [2]MNRF 2019b, [3]Gov. of Canada 2019, [4]HCA 2014, [5]NHIC 2019, [6]MNRF 2019c

Appendix III
Bird Species Report from the Study Area

Bird Species Reported From the Study Area

Scientific Name	Common Name	SRANK[1]	SARO[2]	COSEWIC[3]	SARA Schedule[3]	Hamilton Status[4]	OBBA (17PH08)[5]	NHIC Data[6]	MNRF SAR List[7]	NRSI Observed
Anatidae	**Ducks, Geese & Swans**									
Branta canadensis	Canada Goose	S5				C	CO			X
Cygnus olor	Mute Swan	SNA				R (I)	CO			
Aix sponsa	Wood Duck	S5				U	CO			X
Anas platyrhynchos	Mallard	S5				C	CO			X
Phasianidae	**Partridges, Grouse & Turkeys**									
Phasianus colchicus	Ring-necked Pheasant	SNA				R (I)	PR			
Meleagris gallopavo	Wild Turkey	S5				C	CO			X
Podicipediformes	**Grebes**									
Podiceps auritus	Horned Grebe	S1B, S4N	SC	SC	No Schedule				X	
Columbidae	**Pigeons & Doves**									
Columba livia	Rock Pigeon	SNA				A	CO			X
Zenaida macroura	Mourning Dove	S5				A	CO			X
Cuculiformes	**Cuckoos & Anis**									
Coccyzus americanus	Yellow-billed Cuckoo	S4B				R	PR			X
Coccyzus erythropthalmus	Black-billed Cuckoo	S5B				U	PO			X
Caprimulgidae	**Goatsuckers**									
Chordeiles minor	Common Nighthawk	S4B	SC	SC	Schedule 1	R			X	X
Caprimulgus vociferus	Eastern Whip-poor-will	S4B	THR	T	Schedule 1	R			X	
Apodidae	**Swifts**									
Chaetura pelagica	Chimney Swift	S4B, S4N	THR	T	Schedule 1	U	PR		X	
Trochilidae	**Hummingbirds**									
Archilochus colubris	Ruby-throated Hummingbird	S5B				U	PR			
Rallidae	**Railes, Gallinules & Coots**									
Rallus elegans	King Rail	S2B	END	E	Schedule 1	EX			X	
Rallus limicola	Virginia Rail	S5B				U	PR			
Porzana carolina	Sora	S4B				U	PR			
Charadriidae	**Plovers**									
Charadrius melodus	Piping Plover	S1B	END	E	Schedule 1	EX			X	
Charadrius vociferus	Killdeer	S5B, S5N				A	CO			X
Scolopacidae	**Waders**									
Bartramia longicauda	Upland Sandpiper	S4B				R	CO			
Calidris canutus rufa	Red Knot (rufa subspecies)		END	E	No Schedule				X	
Gallinago delicata	Wilson's Snipe	S5B				R				X
Scolopax minor	American Woodcock	S4B				C	CO			X
Actitis macularia	Spotted Sandpiper	S5				C	CO			X
Phalaropus lobatus	Red-necked Phalarope	S3S4B	SC						X	

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Laridae	**Gulls, Terns & Skimmers**									
Larus delawarensis	Ring-billed Gull	S5B, S4N				A	CO			X
Larus argentatus	Herring Gull	S5B, S5N				C				X
Chlidonias niger	Black Tern	S3B	SC	NAR		EX			X	
Phalacrocoracidae	**Cormorants**									
Phalacrocorax auritus	Double-crested Cormorant	S5B	NAR	NAR		A				X
Pelecanidae	**Pelicans**									
Pelecanus erythrorhynchos	American White Pelican	S2B	THR	NAR					X	
Ardeidae	**Herons & Bitterns**									
Ixobrychus exilis	Least Bittern	S4B	THR	T	Schedule 1	R			X	
Ardea herodias	Great Blue Heron	S4B				U	PR			X
Butorides virescens	Green Heron	S4B				U	CO			
Cathartidae	**Vultures**									
Cathartes aura	Turkey Vulture	S5B				U	PR			X
Accipitridae	**Hawks, Kites, Eagles & Allies**									
Haliaeetus leucocephalus	Bald Eagle	S2N, S4B	SC	NAR		R			X	
Circus cyaneus	Northern Harrier	S4B	NAR	NAR		R	PR			
Accipiter striatus	Sharp-shinned Hawk	S5	NAR			R	PO			
Accipiter cooperii	Cooper's Hawk	S4	NAR	NAR		U	CO			X
Buteo jamaicensis	Red-tailed Hawk	S5	NAR	NAR		C	CO			X
Tytonidae	**Barn Owls**									
Tyto alba	Barn Owl	S1	END	E	Schedule 1	EX			X	
Strigidae	**Typical Owls**									
Megascops asio	Eastern Screech-Owl	S4	NAR	NAR		U	PO			
Bubo virgianus	Great Horned Owl	S4				C	CO			X
Asio flammeus	Short-eared Owl	S2N, S4B	SC	SC	Schedule 3	R	PR		X	
Alcedinidae	**Kingfishers**									
Megaceryle alcyon	Belted Kingfisher	S4B				U	PO			X
Picidae	**Woodpeckers**									
Melanerpes erythrocephalus	Red-headed Woodpecker	S4B	SC	END	Schedule 1	R	CO		X	
Melanerpes carolinus	Red-bellied Woodpecker	S4				U	CO			X
Sphyrapicus varius	Yellow-bellied Sapsucker	S5B				R				X
Picoides pubescens	Downy Woodpecker	S5				C	CO			X
Picoides villosus	Hairy Woodpecker	S5				U	PR			X
Colaptes auratus	Northern Flicker	S4B				C	CO			X
Falconidae	**Caracaras & Falcons**									
Falco sparverius	American Kestrel	S4				U	CO			X
Falco columbarius	Merlin	S5B	NAR	NAR		R				X
Falco peregrinus anatum/tundrius	Peregrine Falcon	S3B	SC	SC	Schedule 1	R			X	

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Tyrannidae	**Tyrant Flycatchers**									
Contopus virens	Eastern Wood-Pewee	S4B	SC	SC		C	PR		X	X
Empidonax virescens	Acadian Flycatcher	S2S3B	END	E	Schedule 1	R			X	
Empidonax alnorum	Alder Flycatcher	S5B				U	PR			
Empidonax traillii	Willow Flycatcher	S5B				C	CO			X
Empidonax minimus	Least Flycatcher	S4B				U	PO			
Sayornis phoebe	Eastern Phoebe	S5B				U	CO			X
Myiarchus crinitus	Great Crested Flycatcher	S4B				C	CO			X
Tyrannus tyrannus	Eastern Kingbird	S4B				A	CO			X
Laniidae	**Shrikes**									
Lanius ludovicianus	Loggerhead Shrike	S2B	END	E (ssp. *migran*	Schedule 1	EX			X	
Vireonidae	**Vireos**									
Vireo solitarius	Blue-headed Vireo	S5B				R				X
Vireo philadelphicus	Philadelphia Vireo	S5B								X
Vireo gilvis	Warbling Vireo	S5B				C	PR			X
Vireo olivaceus	Red-eyed Vireo	S5B				C	CO			X
Corvidae	**Crows & Jays**									
Cyanocitta cristata	Blue Jay	S5				A	CO			X
Corvus brachyrhynchos	American Crow	S5B				C	CO			X
Corvus corax	Common Raven	S5				R				X
Alaudidae	**Larks**									
Eremophila alpestris	Horned Lark	S5B				C	CO			
Hirundinidae	**Swallows**									
Progne subis	Purple Martin	S4B				U	CO			
Tachycineta bicolor	Tree Swallow	S4B				A	CO			X
Stelgidopteryx serripennis	Northern Rough-winged Swallow	S4B				C	CO			X
Riparia riparia	Bank Swallow	S4B	THR	T		U	PO		X	
Hirundo rustica	Barn Swallow	S4B	THR	T		C	CO		X	X
Paridae	**Chickadees & Titmice**									
Poecile atricapillus	Black-capped Chickadee	S5				A	CO			X
Baeolophus bicolor	Tufted Titmouse	S4				R	PO			
Sittidae	**Nuthatches**									
Sitta canadensis	Red-breasted Nuthatch	S5				U	CO			X
Sitta carolinensis	White-breasted Nuthatch	S5				C	PR			X
Certhiidae	**Creepers**									
Certhia americana	Brown Creeper	S5B				U				X
Troglodytidae	**Wrens**									
Troglodytes aedon	House Wren	S5B				C	CO			X
Troglodytes hiemalis	Winter Wren	S5B				U	PO			X
Cistothorus platensis	Sedge Wren	S4B	NAR	NAR		R	PO			
Cistothorus palustris	Marsh Wren	S4B				U	PO			
Thryothorus ludovicianus	Carolina Wren	S4				R	PR			X

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Polioptilidae	**Gnatcatchers**									
Polioptila caerulea	Blue-gray Gnatcatcher	S4B				U	PR			
Regulidae	**Kinglets**									
Regulus satrapa	Golden-crowned Kinglet	S5B				R				X
Regulus calendula	Ruby-crowned Kinglet	S4B								X
Turdidae	**Thrushes**									
Sialia sialis	Eastern Bluebird	S5B	NAR	NAR		U	CO			X
Catharus fuscescens	Veery	S4B				C	PR			X
Catharus minimus	Gray-cheeked Thrush	S2S4B								X
Catharus ustulatus	Swainson's Thrush	S4B								X
Catharus guttatus	Hermit Thrush	S5B								X
Hylocichla mustelina	Wood Thrush	S4B	SC	T		C	PR		X	X
Turdus migratorius	American Robin	S5B				A	CO			X
Mimidae	**Mockingbirds, Thrashers & Allies**									
Dumetella carolinensis	Gray Catbird	S4B				A	CO			X
Toxostoma rufum	Brown Thrasher	S4B				U	CO			X
Mimus polyglottos	Northern Mockingbird	S4				U	CO			
Sturnidae	**Starlings**									
Sturnus vulgaris	European Starling	SNA				A (I)	CO			X
Bombycillidae	**Waxwings**									
Bombycilla cedrorum	Cedar Waxwing	S5B				C	CO			X
Passeridae	**Old World Sparrows**									
Passer domesticus	House Sparrow	SNA				A (I)	CO			X
Motacillidae	**Pipits**									
Anthus rubescens	American Pipit	S4								X
Fringillidae	**Finches & Allies**									
Carpodacus mexicanus	House Finch	SNA				A (I)	CO			X
Spinus tristis	American Goldfinch	S5B				A	CO			X
Parulidae	**Wood Warblers**									
Seiurus aurocapillus	Ovenbird	S4B				C	PO			X
Parkesia noveboracensis	Northern Waterthrush	S5B				C				X
Vermivora chrysoptera	Golden-winged Warbler	S4B	SC	T	Schedule 1	R			X	
Mniotilta varia	Black-and-white Warbler	S5B				U				X
Protonotaria citrea	Prothonotary Warbler	S1B	END	E	Schedule 1	R	PO		X	
Oreothlypis peregrina	Tennessee Warbler	S5B								X
Oreothlypis ruficapilla	Nashville Warbler	S5B				U				X
Geothylpis trichas	Common Yellowthroat	S5B				C	PR			X
Setophaga ruticilla	American Redstart	S5B				U	PO			X
Setophaga tigrina	Cape May Warbler	S5B								X
Setophaga cerulea	Cerulean Warbler	S3B	THR	E	Schedule 1	R			X	
Setophaga americana	Northern Parula	S4B								X
Setophaga magnolia	Magnolia Warbler	S5B				R				X
Setophaga castanea	Bay-breasted Warbler	S5B								X

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Setophaga fusca	Blackburnian Warbler	S5B				R				X
Setophaga petechia	Yellow Warbler	S5B				A	CO			X
Setophaga pensylvanica	Chestnut-sided Warbler	S5B				U	PO			
Setophaga striata	Blackpoll Warbler	S4B								X
Setophaga caerulescens	Black-throated Blue Warbler	S5B				R				X
Setophaga palmarum	Palm Warbler	SNRB								X
Setophaga coronata	Yellow-rumped Warbler	S5B				R				X
Setophaga virens	Black-throated Green Warbler	S5B				R				X
Cardellina canadensis	Canada Warbler	S4B	SC	T	Schedule 1	R	PO		X	
Cardellina pusilla	Wilson's Warbler	S4B								X
Icteria virens	Yellow-breasted Chat	S2B	END	E	Schedule 1	R			X	
Emberizidae	**New World Sparrows & Allies**									
Pipilo erythrophthalmus	Eastern Towhee	S4B				U	PO			X
Spizella arborea	American Tree Sparrow	S4B								X
Spizella passerina	Chipping Sparrow	S5B				A	CO			X
Spizella pusilla	Field Sparrow	S4B				C	CO			X
Pooecetes gramineus	Vesper Sparrow	S4B				U	PR			
Passerculus sandwichensis	Savannah Sparrow	S4B				A	CO			X
Ammodramus savannarum	Grasshopper Sparrow	S4B	SC	SC		U	PO		X	
Ammodramus henslowii	Henslow's Sparrow	SHB	END	E	Schedule 1	EX			X	
Melospiza melodia	Song Sparrow	S5B				A	CO			X
Melospiza georgiana	Swamp Sparrow	S5B				C	PR			X
Zonotrichia albicollis	White-throated Sparrow	S5B				U				X
Junco hyemalis	Dark-eyed Junco	S5B								X
Cardinalidae	**Cardinals, Grosbeaks & Allies**									
Piranga olivacea	Scarlet Tanager	S4B				U	PO			
Cardinalis cardinalis	Northern Cardinal	S5				A	CO			X
Pheucticus ludovicianus	Rose-breasted Grosbeak	S4B				C	CO			X
Passerina cyanea	Indigo Bunting	S4B				C	CO			X
Icteridae	**Blackbirds**									
Dolichonyx oryzivorus	Bobolink	S4B	THR	T	No Schedule	U	CO		X	X
Agelaius phoeniceus	Red-winged Blackbird	S4				A	CO			X
Sturnella magna	Eastern Meadowlark	S4B	THR	T	No Schedule	U	CO	X	X	
Euphagus carolinus	Rusty Blackbird	S4B	NAR	SC	Schedule 1					X
Quiscalus quiscula	Common Grackle	S5B				A	CO			X
Molothrus ater	Brown-headed Cowbird	S4B				A	CO			X
Icterus spurius	Orchard Oriole	S4B				U	PR			
Icterus galbula	Baltimore Oriole	S4B				C	CO			X
						Total	**101**	**1**	**31**	**105**

[1]MNRF 2019a, [2]MNRF 2019b, [3]Gov. of Canada 2019, [4]HCA 2014, [5]BSC et al. 2006, [6]NHIC 2019; [7]MNRF 2019c

Appendix IV

Reptile and Amphibian Species Reported from the Study Area

Reptile and Amphibian Species Reported From the Study Area

Scientific Name	Common Name	SRANK[1]	SARO[2]	COSEWIC[3]	SARA Schedule[3]	Hamilton Status[4]	ORAA[5]	NHIC Data[6]	MNRF SAR List[7]	NRSI Observed
Turtles										
Apalone spinifera spinifera	Spiny Softshell	S3	THR	E	Schedule 1	R			X	
Chelydra serpentina serpentina	Snapping Turtle	S3	SC	SC	Schedule 1	C	X		X	
Chrysemys picta marginata	Midland Painted Turtle	S5		SC		C	X			
Emydoidea blandingii	Blanding's Turtle (*GLSL pop.*)	S3	THR	T	Schedule 1	R	X		X	
Graptemys geographica	Northern Map Turtle	S3	SC	SC	Schedule 1	R			X	
Sternotherus odoratus	Eastern Musk Turtle	S3	SC	SC	Schedule 1	R	X		X	
Snakes										
Crotalus horridus	Timber Rattlesnake	SX	EXP	XT	Schedule 1	EX		X		
Pantherophis spiloides pop. 2	Gray Ratsnake (*Carolinian pop.*)	S1	END	E	Schedule 1				X	
Heterodon platirhinos	Eastern Hog-nosed Snake	S3	THR	T	Schedule 1				X	
Lampropeltis triangulum	Eastern Milksnake	S4	NAR	SC	Schedule 1	U	X			
Opheodrys vernalis	Smooth Greensnake	S4				R	X			
Nerodia sipedon sipedon	Northern Watersnake	S5	NAR	NAR		R	X			
Storeria dekayi dekayi	Northern Brownsnake	S5	NAR	NAR		U	X			X
Storeria occipitomaculata occipitomaculata	Northern Red-bellied Snake	S5				R	X			X
Thamnophis sauritus septentrionalis	Eastern Ribbonsnake	S3	SC	SC	Schedule 1	R			X	
Thamnophis sirtalis sirtalis	Eastern Gartersnake	S5				C	X			X
Salamanders										
Ambystoma jeffersonianum	Jefferson Salamander	S2	END	E	Schedule 1	R	X	X	X	
Ambystoma laterale - (2) jeffersonianum	Unisexual Ambystoma Jefferson Salamander	S2	END	E					X	
Ambystoma sp.	Jefferson/Blue-spotted Salamander Comp.	S2					X			
Ambystoma laterale	Blue-spotted Salamander	S4				R	X			
Notophthalmus viridescens viridescens	Red-spotted Newt	S5				R	X			
Plethodon cinereus	Eastern Red-backed Salamander	S5				C	X			
Toads and Frogs										
Anaxyrus americanus	American Toad	S5				C	X			X
Hyla versicolor	Tetraploid Gray Treefrog	S5				C	X			X
Pseudacris triseriata pop. 1	Western Chorus Frog *(Carolinian pop.)*	S4	NAR	NAR		C				X
Pseudacris crucifer	Spring Peeper	S5				C	X			X
Lithobates catesbeiana	American Bullfrog	S4				U	X			
Lithobates clamitans melanota	Northern Green Frog	S5				C	X			
Lithobates pipiens	Northern Leopard Frog	S5	NAR	NAR		C	X			X
Lithobates sylvaticus	Wood Frog	S5				C	X			
						Total	**22**	**2**	**10**	**8**

[1]MNRF 2019a; [2]MNRF 2019b; [3]Gov. of Canada 2019; [4]HCA 2014; [5]Ontario Nature 2018; [6]NHIC 2019; [7]MNRF 2019c

Appendix V
Mammal Species Reported from the Study Area

Mammal Species Reported From the Study Area

Scientific Name	Common Name	SRANK[1]	SARO[2]	COSEWIC[3]	SARA Schedule[3]	Ontario Mammal Atlas[5]	NHIC Data[6]	MNRF SAR List[7]	NRSI Observed
Didelphimorphia	**Opossums**								
Didelphis virginiana	Virginia Opossum	S4				X			X
Insectivora	**Shrews and Moles**								
Blarina brevicauda	Northern Short-tailed Shrew	S5				X			X
Condylura cristata	Star-nosed Mole	S5				X			
Parascalops breweri	Hairy-tailed Mole	S4				X			
Sorex cinereus	Masked Shrew	S5				X			
Sorex fumeus	Smoky Shrew	S5				X			
Chiroptera	**Bats**								
Eptesicus fuscus	Big Brown Bat	S4				X			X
Lasionycteris noctivagans	Silver-haired Bat	S4				X			X
Lasiurus borealis	Eastern Red Bat	S4				X			X
Lasiurus cinereus	Hoary Bat	S4				X			X
Myotis sp.	Unidentified Myotis species*								X*
Myotis leibii	Eastern Small-footed Myotis	S2S3	END					X	*
Myotis lucifugus	Little Brown Myotis	S4	END	E	Schedule 1	X		X	*
Myotis septentrionalis	Northern Myotis	S3	END	E	Schedule 1			X	*
Perimyotis subflavus	Tri-colored Bat	S3?	END	E	Schedule 1	X		X	*
Lagomorpha	**Rabbits and Hares**								
Lepus europaeus	European Hare	SNA				X			
Sylvilagus floridanus	Eastern Cottontail	S5				X			X
Rodentia	**Rodents**								
Castor canadensis	Beaver	S5				X			
Erethizon dorsatum	Porcupine	S5				X			
Glaucomys volans	Southern Flying Squirrel	S4	NAR	NAR		X			
Marmota monax	Woodchuck	S5				X			
Microtus pennsylvanicus	Meadow Vole	S5				X			
Microtus pinetorum	Woodland Vole	S3?	SC	SC	Schedule 1	X		X	
Napaeozapus insignis	Woodland Jumping Mouse	S5				X			
Ondatra zibethicus	Muskrat	S5				X			
Peromyscus leucopus	White-footed Mouse	S5				X			
Peromyscus maniculatus	Deer Mouse	S5				X			
Rattus norvegicus	Norway Rat	SNA				X			

Scientific Name	**Common Name**	**SRANK[1]**	**SARO[2]**	**COSEWIC[3]**	**SARA Schedule[3]**	**Ontario Mammal Atlas[5]**	**NHIC Data[6]**	**MNRF SAR List[7]**	**NRSI Observed**
Sciurus carolinensis	Eastern Gray Squirrel	S5				X			X
Tamiasciurus hudsonicus	Red Squirrel	S5				X			
Tamias striatus	Eastern Chipmunk	S5				X			X
Zapus hudsonius	Meadow Jumping Mouse	S5				X			
Carnivora	**Carnivores**								
Canis latrans	Coyote	S5				X			X
Mephitis mephitis	Striped Skunk	S5				X			
Mustela erminea	Ermine	S5				X			
Mustela frenata	Long-tailed Weasel	S4				X			
Mustela vison	American Mink	S4				X			X
Procyon lotor	Northern Raccoon	S5				X			X
Taxidea taxus jacksoni	American Badger	S2	END	E	Schedule 1			X	
Urocyon cinereoargenteus	Grey Fox	S1	THR	T	Schedule 1	X		X	
Vulpes vulpes	Red Fox	S5				X			X
Artiodactyla	**Deer and Bison**								
Odocoileus virginianus	White-tailed Deer	S5				X			X
					Total	**38**	**0**	**7**	**15**

[1]MNRF 2019a, [2]MNRF 2019b, [3]Gov. of Canada 2019, [4]HCA 2014, [5]Dobbyn 1994, [6]NHIC 2019, [7]MNRF 2019c

*See discussion of bat survey results.

Appendix VI

Dragonfly and Damselfly Species Reported from the Study Area

Butterfly Species Reported From the Study Area

Scientific Name	Common Name	SRANK[1]	SARO[2]	COSEWIC[3]	SARA Schedule[3]	Hamilton Status[5]	TEA Atlas[6] (17PH08)	NHIC Data[1]	MNRF SAR List[7]	NRSI Observed
Hesperiidae	**Skippers**									
Anatrytone logan	Delaware Skipper	S4				C	X			
Ancyloxypha numitor	Least Skipper	S5				C	X			
Epargyreus clarus	Silver-spotted Skipper	S4				C	X			
Erynnis baptisiae	Wild Indigo Duskywing	S4				U	X			X
Erynnis martialis	Mottled Duskywing	S2	END	E		R			X	
Euphyes conspicua	Black Dash	S3				C	X			
Euphyes dion	Dion Skipper	S4				U	X			
Pholisora catullus	Common Sootywing	S4				U	X			
Poanes viator	Broad-winged Skipper	S4				C	X			
Polites peckius	Peck's Skipper	S5				C	X			
Polites themistocles	Tawny-edged Skipper	S5				C	X			
Thymelicus lineola	European Skipper	SNA				C	X			X
Papilionidae	**Swallowtails**									
Papilio glaucus	Eastern Tiger Swallowtail	S5				C	X			X
Papilio polyxenes	Black Swallowtail	S5				C	X			
Papilio troilus	Spicebush Swallowtail	S4				R	X			
Pieridae	**Whites and Sulphurs**									
Colias eurytheme	Orange Sulphur	S5				C	X			
Colias philodice	Clouded Sulphur	S5					X			X
Pieris rapae	Cabbage White	SNA				C	X			X
Pieris virginiensis	West Virginia White	S3		SC		U			X	
Zerene cesonia	Southern Dogface	SNA					X			
Lycaenidae	**Harvesters, Coppers, Hairstreaks, Blues**									
Celastrina neglecta	Summer Azure	S5				C				X
Cupido comyntas	Eastern Tailed Blue	S5				C	X			
Satyrium calanus	Banded Hairstreak	S4				C	X			
Satyrium caryaevorus	Hickory Hairstreak	S4				U	X			
Satyrium edwardsii	Edwards' Hairstreak	S4				R	X			
Satyrium liparops	Striped Hairstreak	S5				C	X			

Scientific Name	Common Name	SRANK[1]	SARO[2]	COSEWIC[3]	SARA Schedule[3]	Hamilton Status[5]	TEA Atlas[6] (17PH08)	NHIC Data[1]	MNRF SAR List[7]	NRSI Observed
Nymphalidae	**Brush-footed Butterflies**									
Cercyonis pegala	Common Wood-Nymph	S5				C	X			
Coenonympha tullia	Common Ringlet	S5				C	X			X
Danaus plexippus	Monarch	S2N, S4B	SC	E	Schedule 1	C	X		X	X
Junonia coenia	Common Buckeye	SNA				U	X			
Lethe anthedon	Northern Pearly-Eye	S5				C	X			
Lethe appalachia	Appalachian Brown	S4				C	X			X
Lethe eurydice	Northern Eyed Brown	S5				C	X			
Limenitis archippus	Viceroy	S5				C	X			
Limenitis arthemis astyanax	Red-spotted Purple	S5				C	X			
Megisto cymela	Little Wood-Satyr	S5				C				X
Nymphalis antiopa	Mourning Cloak	S5				C	X			
Phyciodes cocyta	Northern Crescent	S5					X			
Phyciodes tharos	Pearl Crescent	S4				C				X
Polygonia comma	Eastern Comma	S5				C	X			
Polygonia comma	Eastern Comma/Hop	S5					X			
Polygonia interrogationis	Question Mark	S5				C	X			X
Speyeria cybele	Great Spangled Fritillary	S5				C	X			
Vanessa atalanta	Red Admiral	S5				C	X			X
Vanessa cardui	Painted Lady	S5				C	X			X
Vanessa virginiensis	American Lady	S5				C	X			
						Total	**41**	**0**	**3**	**14**

[1]MNRF 2019a, [2]MNRF 2018a, [3]Gov. of Canada 2018, [4]HCA 2014, [5]MacNaughton et al. 2018, [6]MNRF 2019c

Appendix VII

Butterfly Species Reported from the Study Area

Dragonfly and Damselfly Species Reported From the Study Area

Scientific Name	Common Name	SRANK[1]	SARO[2]	COSEWIC[3]	SARA Schedule[3]	Hamilton Status[4]	Odonate Atlas[5]	NHIC[6]	MNRF SAR List[7]	NRSI Observed
Coenagrionidae	**Narrow-winged Damselflies**									
Enallagma anna	River Bluet	S2				U	X			
Ischnura verticalis	Eastern Forktail	S5				C	X			
Aeshnidae	**Darners**									
Anax junius	Common Green Darner	S5				C	X			X
Libellulidae	**Skimmers**									
Celithemis elisa	Calico Pennant	S5				C				X
Erythemis simplicicollis	Eastern Pondhawk	S5				C	X			X
Libellula luctuosa	Widow Skimmer	S5				C	X			X
Libellula pulchella	Twelve-spotted Skimmer	S5				C	X			
Plathemis lydia	Common Whitetail	S5				C	X			
Sympetrum obtrusum	White-faced Meadowhawk	S5				C				X
						Total	**7**	**0**	**0**	**5**

[1] MNRF 2019a, [2] MNRF 2019b, [3] Gov. of Canada 2019, [4] HCA 2014, [5] MNRF 2019d, [6] NHIC 2019, [7] MNRF 2019c

Appendix VIII

Fish Species Reported from the Study Area

Fish Species Reported from the Study Area

Scientific Name	Common Name	SRANK[1]	SARO[2]	COSEWIC[3]	SARA Schedule[3]	NHIC Data[4]	MNRF SAR List[5]	NRSI Observed
Petromyzontidae	**Lampreys**							
Ichthyomyzon fossor	Northern Brook Lamprey (GL-USL Pop.)	S3	SC	SC	Schedule 1		X	
Ichthyomyzon unicuspis	Silver Lamprey (GL-USL Pop.)	S3	SC	SC			X	
Acipenseridae	**Sturgeons**							
Acipenser fulvescens	Lake Sturgeon (GL-USL Pop.)	S2	THR	Non-active	NONE		X	
Anguillidae	**Freshwater Eels**							
Anguilla rostrata	American Eel	S1?	END	THR	NONE		X	
Cyprinidae	**Carps and Minnows**							
Clinostomus elongatus	Redside Dace	S2	END	E	Schedule 1		X	
Notropis photogenis	Silver Shiner	S2S3	THR	T	Schedule 3		X	
Pimephales promelas	Fathead Minnow	S5						X
Catostomidae	**Suckers**							
Moxostoma duquesnei	Black Redhorse	S2	THR	T			X	
Ictaluridae	**North American Catfishes**							
Ameiurus nebulosus	Brown Bullhead	S5						X
Esocidae	**Pikes**							
Esox americanus vermiculatus	Grass Pickerel	S3	SC	SC	Schedule 1		X	
Gasterosteidae	**Sticklebacks**							
Culaea inconstans	Brook Stickleback	S5						X
Centrarchidae	**Sunfishes and Basses**							
Lepomis gibbosus	Pumpkinseed	S5						X
					Total	**0**	**8**	**4**

[1]MNRF 2019a, [2]MNRF 2019b, [3]Gov. of Canada 2019, [4]NHIC 2019, [5]MNRF 2019c

LEGEND			
SRANK		**Hamilton NAI**	
S1	Critically Imperiled	A	Abundant
S2	Imperiled	X	Native and common
S3	Vulnerable	U	Native and uncommon
S4	Apparently Secure	R	Rare
S5	Secure	I/(I)	Introduced and persisting outside of cultivation
SU	Unrankable	CI	Commin and introduced
SNA	Unranked	EX	Extirpated
SX	Presumed Extirpated	EXT	Extinct
SH	Possibly Extirpated (Historical)	UNK	Uncertain
S#?	Rank Uncertain		
B	Breeding population (birds)		
N	Non-breeding population (birds)		
COSSARO/COSEWIC		**Bird Breeding Codes**	
END/E	Endangered	X	Observed (fly-over, no breeding evidence)
THR/T	Threatened	PO	Possible breeding evidence
SC/SC	Special Concern	PR	Probable breeding evidence
NAR/NAR	Not at Risk	CO	Confirmed breeding evidence
DD/DD	Data Deficient		
EXP/XT	Extirpated		
SARA Schedule			
Schedule 1	Officially protected under SARA		
Schedule 2	Threatened/Endangered; may be reassessed for consideration for inclusion to Schedule 1		
Schedule 3	Special Concern; may be reassessed for consideration for inclusion to Schedule 1		

Appendix IX
Aquatic Effects Summary Table

Aquatics Effects Assessment Summary Table – Battlefield Creek (BC-1)

Waterbody	Pathway of Effect(s)	Potential Stressor	(Potential Effect on Fish and Fish Habitat)	Mitigation Measures	Residual Effects	Harmful Alteration, Disruption or Destruction (HADD) (Y/N)
	Land-Based Activities					
Battlefield Creek	**Excavation**	Alteration of groundwater flows to surface water Creation and dewatering of pit and/or trench Bank stability and exposed soils Change in slope or drainage Removal of topsoil Exposed soils Increased erosion potential	Change in baseflow Change in water temperature Change in sediment concentrations	The detailed design (from Water's Edge) allows for baseflow to continue into the downstream system. System is intermittent. The control structures on the berms will maintain some amount of surface water flow to the extent possible to preserve the hydrology of the downstream wetlands. Riparian plantings are included in the detail design. Vegetation within the berms will enhance water quality and water temperature, in time, through shading. Works will be carried out in the dry, within confines of coffer dams (if necessary). If dewatering is required, a fish salvage will be completed, as well fish screens will be utilized and the water will be directed to a flat vegetated area at least 30m from the watercourse and/or outlet into a filter bag to allow sediment to settle prior to re-entry into the watercourse. The works will be carried out within the in-water timing window between July 1 to March 31 outside of spawning and rearing times for fish. An erosion and sediment control plan (ESC) including the use of effective erosion control measures such as topsoil and seed, silt fencing, and erosion control blanket will be implemented. Re-instate and re-stabilize edges of the berms disturbed during construction to pre-construction or better condition will be completed. Soil stockpiles and berms to be stabilized using a nurse crop.	No residual effects are anticipated. Water quality should increase and sediment concentration should decrease with the creation of the wetland and limited stream restoration.	**NO**

Waterbody	Pathway of Effect(s)	Potential Stressor	(Potential Effect on Fish and Fish Habitat)	Mitigation Measures	Residual Effects	Harmful Alteration, Disruption or Destruction (HADD) (Y/N)
	Grading	Addition or removal of in stream organic structure Change in slope Change in land drainage patterns Bank stability and exposed soils Increased erosion potential	Change in habitat structure and cover Change in sediment concentration	Limit of grading will be protected with heavy duty sediment fence which will double as vegetation protection fence. Fence will be removed once soils are stable on site. An ESC plan will be designed and implemented prior to any grading or earth moving. Standard ESC measures to be followed (as per DFO measures). Work will occur in the dry and heed weather advisories and works will be scheduled to avoid wet, windy and raining periods. Regular monitoring of the watercourse and meadow marsh for signs of sedimentation during all phases of the work will occur ands corrective actions will be taken if required. Heavy machinery access and staging will be limited to pre-defined areas.	Yes – the land drainage patterns will be changed with the creation of the berms. Erosion potential will decrease with the wetland design.	**Potential**

Waterbody	Pathway of Effect(s)	Potential Stressor	(Potential Effect on Fish and Fish Habitat)	Mitigation Measures	Residual Effects	Harmful Alteration, Disruption or Destruction (HADD) (Y/N)
	Riparian Planting	Site preparation Bank stability and exposed soils Increased erosion potential Increase in riparian and bank vegetation Improved canopy Increased shade Change in vegetation species composition	Change in sediment concentrations Change in nutrient concentrations Change in water temperature Change in habitat structure and cover Change in food supply	Detailed design allows for baseflow to continue into the downstream system. System is intermittent. Control structure on the berm will maintain some amount of surface water flow to the extent possible to preserve the hydrology of the downstream wetlands. Riparian plantings are included in the detail design. Vegetation within the berms will enhance water quality and water temperature, in time, through shading. An undisturbed vegetated buffer zone between areas of on-land activity and the high-water mark of the Creek will be maintained. Existing trails, roads, or cut lines will be used where possible. Avoid tree removals where possible. Methods to prevent soil compaction, such as swamp mats or pads will be used. An erosion and sediment control plan (ESC) including the use of effective erosion control measures such as topsoil and seed, silt fencing, and erosion control blanket will be implemented. Edges of berms will be re-instated and re-stabilized during construction to pre-construction or better condition. Enhancement measure within downstream reach will help naturally improve channel. Soil stockpiles and berms will be stabilized using a nurse crop.	Following construction, minor short-term residual impacts may occur to riparian areas as seed and natural vegetation (grasses/forbs) will take some time to re-establish along work/staging areas. However, erosion control measures will be utilized to cover exposed soils until seed can germinate and all sediment and erosion controls will remain in place until the area is stable. Water quality will increase and sediment concentration should decrease with the creation of the wetland and stream enhancements. Change in nutrient concentrations should be minimal but positive. As the system is intermittent food supply is not expected to change. No residual effects are anticipated in the long term.	**NO**

Waterbody	Pathway of Effect(s)	Potential Stressor	(Potential Effect on Fish and Fish Habitat)	Mitigation Measures	Residual Effects	Harmful Alteration, Disruption or Destruction (HADD) (Y/N)
	Use of Industrial Equipment	Oil, grease and fluid leaks from equipment Bank stability and exposed soils Increased erosion potential Resuspension and entrainment of sediment	Change in sediment concentrations Change in contaminant concentrations Potential mortality of fish/eggs/ova from equipment	Ensure machinery is not leaking fuels or lubricants on a daily basis. Design and implement erosion and sediment controls to contain/isolate the construction zone, manage site drainage/runoff and prevent erosion of exposed soils and migration of sediment into Creek. Ensure machinery is stored/fuelled 30 m away from the watercourse. Develop a Spill Response Plan and have spill kits onsite and drip pans under all non-mobile machinery. Work in the dry and during timing windows. Use methods to prevent soil compaction, such as swamp mats or pads.	No residual effects anticipated	**NO**
	Vegetation Clearing	Alteration of riparian vegetation Addition or removal of in stream organic structure Change in shade Change in external nutrient/energy inputs Bank stability and exposed soils Increased erosion potential	Change in habitat structure and cover Change in sediment concentrations Change in food supply Change in nutrient concentrations Change in water temperature	Vegetation removal has been minimized. ESC plan to be prepared prior to construction. Disturbed banks will be stabilized with native seed mixture and/or exposed areas will be covered with erosion control measures until seeding can occur.	Following construction, minor short-term residual impacts may occur to riparian areas as seed and natural vegetation (grasses/forbs) will take some time to re-establish along work/staging areas. However, erosion control measures will be utilized to cover exposed soils until seed can germinate and all sediment and erosion controls will remain in place until the area is stable. Water quality should increase and sediment concentration should decrease with the creation of the wetland and stream enhancement. Change in nutrient concentrations should be minimal but positive. As the system is intermittent food supply is not expected to change. No residual effects are anticipated in the long term.	**NO**

Waterbody	Pathway of Effect(s)	Potential Stressor	(Potential Effect on Fish and Fish Habitat)	Mitigation Measures	Residual Effects	Harmful Alteration, Disruption or Destruction (HADD) (Y/N)
	In-Water Activities					
	Addition or Removal of Aquatic Vegetation	Removal of emergent vegetation Change in nutrient inputs Resuspension and entrainment of sediment	Change in habitat structure and cover Change in food supply Change in nutrient concentrations Change in water temperature Change in dissolved oxygen Change in water temperature	The removal of aquatic vegetation has been minimized where possible to retain adequate cover and habitat for aquatic species (limited aquatic vegetation exists presently). In-water timing windows will be followed and work will occur in the dry where possible. If possible, native species will be replanted.	No residual effects anticipated	**NO**
	Change in timing, duration and frequency of flow	Dewatering Bank erosion Change of substrate composition	Change in migration/access to habitats Displacement or stranding of fish Change in substrate composition Change in water temperature Change in dissolved oxygen	Work will be carried out within the in-water work window of July 1 to March 31. De-water work area into grassed area or filter bag 30 m from the watercourse. Fish to be removed from all work areas and released downstream prior to dewatering. Limited fish are expected, especially if work is conducted in the dry. Creating the berms with outlet structures is to help with flow downstream of the escarpment.	Residual effects are expected due to the addition of the berms to create the wetlands. The residual effects are slated to be small for fish, as the watercourses are intermittent, and barriers exist to limit fish passage within the tributaries. The frequency of flow will also change as this berm will reduce flooding and erosion downstream of the site. Frequency of baseflow will increase which is a positive for the intermittent feature.	**Potential but limited. Potential positive effect as the baseflow will increase, which will allow for more permanent wetted areas downstream for fish habitat.**
	Use of industrial equipment	See land-based activities section				

Waterbody	Pathway of Effect(s)	Potential Stressor	(Potential Effect on Fish and Fish Habitat)	Mitigation Measures	Residual Effects	Harmful Alteration, Disruption or Destruction (HADD) (Y/N)
	Fish Passage Issues	Obstruction (berms) to upstream and passage of fish Flow alteration (timing, duration, intensity)	Change in access to habitats	Fish passage will be removed from Tributary 1. There is a small chance of fish passage being removed from Battlefield Creek where the berms will be placed, although it is very unlikely that fish are able to pass through the meadow marsh even during high water events. There is limited fish habitat present within the upstream sections of these features as the systems are intermittent. Fish passage is already an issue during low/no water events. A base or minimal flow should be maintained to allow for fish to continue to survive with. In the downstream section of Battlefield Creek.	As the creation of the wetland habitats includes berms which go across the existing Battlefield Creek and Tributary 1 (which are intermittent features) there will be a residual effect as fish will no longer be able to utilize those areas at any points of the year. For Battlefield Creek fish passage is unlikely through the meadow marsh. The wetlands should provide fish habitat once established but there will be no connectivity to the downstream reaches (rise culverts at outlets).	**YES** The addition of the berm and wetland will result in the loss of habitat within the channel.

Appendix X

Subject Property Photographs

Aquatic Habitat Photographs

Battlefield Creek

Reach 1 – June

Reach 1 – September

Reach 2 – OSAP

June

September

Reach 3 – Meadow

June

September

Reach 4

June

September

Tributary 1

June

September

Ephemeral Features
June

Tributary 1A

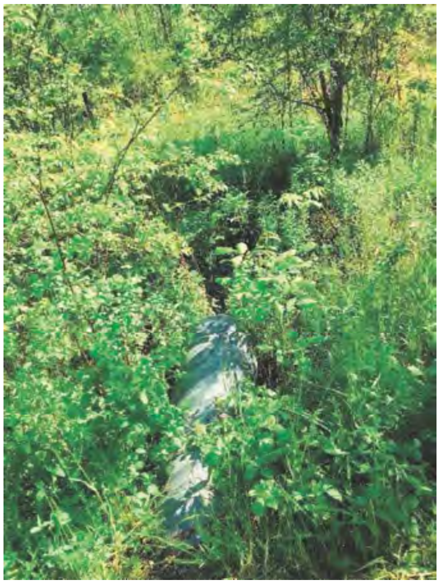
Tributary 1B

Ephemeral Channel (East of Tributary 1)
June

Ephemeral Channel (Northeast corner)
June

Culverts Along Dofasco Trail

June



Terrestrial Habitat Photographs

Photograph 1: Cultural meadow where west berm is proposed (facing southwest). H2 hedgerow gap evident in centre of photograph with karst slope in top left.

Photograph 2: Cultural meadow where east berm is proposed (facing northeast). Dofasco trail in background and Second Road E. to right.

Photograph 3: Bur Oaks along First Road E. The west berm would approach this corner roughly parallel to the road and bend to run along the edge of the swamp.

Photograph 4: Location of proposed vegetation removal for east berm within Green Ash swamp (SWD2-2), facing north towards Dofasco Trail.

Photograph 5: Bat acoustic monitoring equipment.

Photograph 6: Karst formation with flowing water near old residence.

Photograph 7: Groundwater outlet from karst feature below old residence. This flow is the upper reach of Tributary 1 which would be contained within the proposed west berm.

Photograph 8: The karst slope provides a variety of habitat for birds, snakes, White-tailed Deer and bats.

Photograph 9: Vegetation composition within the Green Ash Swamp with abundant standing water present into early June. The decline of tree canopy has resulted in an abundance of herbaceous plants.

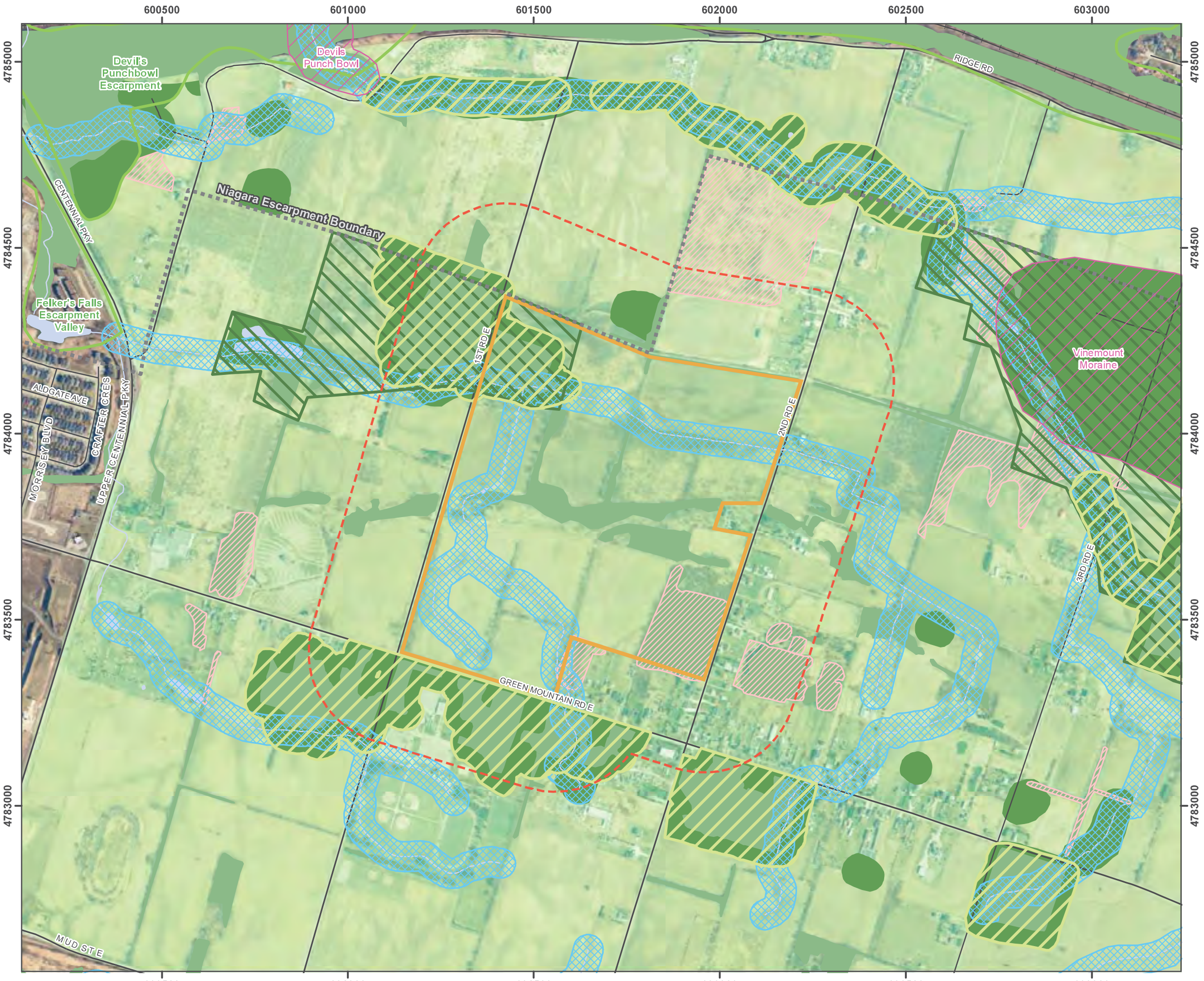
Photograph 10: The significant woodland in the northwest extent of the site is comprised of young to mid-age trees with some mature Bur Oak present throughout.

Photograph 11: Areas of Dogwood thicket are present in the northern half of the site and reflect early succession conditions indicative of fallow fields which have been left to naturalize 10-20 years.

Photograph 12: Mature deciduous forest in the southeast extent of the site. This forest has hummocky topography and directs flow northward toward the karst slope.

Photograph 13: A stone foundation near the old residence provides wildlife habitat. Several snake observations were made at this location. A barn foundation and silo is present at the east end of the slope.

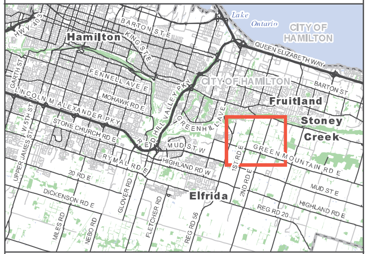
Maps



Map 1

Saltfleet Conservation Area BC-1 Wetland Design

Study Area and Natural Features



Legend

- ▭ Subject Property
- ⬚ Study Area
- — Primary Road
- — Secondary Road
- ┼ Railway
- ∼ Watercourse
- ▬ Water Body
- ▬ Wooded Area
- ▨ ANSI, Earth Science
- ▭ ESA Boundary
- ⬚ Niagara Escarpment Boundary
- ▩ Key Hydrologic Feature Streams (City of Hamilton Official Plan, 2018)
- ▨ Key Natural Heritage Feature Significant Woodlands (City of Hamilton Official Plan, 2018)
- ▨ Greenbelt Natural Heritage System (City of Hamilton Official Plan, 2018)
- ▭ Greenbelt Protected Countryside (City of Hamilton Official Plan, 2018)
- ▬ Core Areas (City of Hamilton Official Plan, 2018)
- ▨ Linkages (City of Hamilton Official Plan, 2018)

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Aquatic, Terrestrial and Wetland Biologists

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Project: 2237A
Date: December 5, 2019

NAD83 - UTM Zone 17
Size: 11x17"
1:10,000

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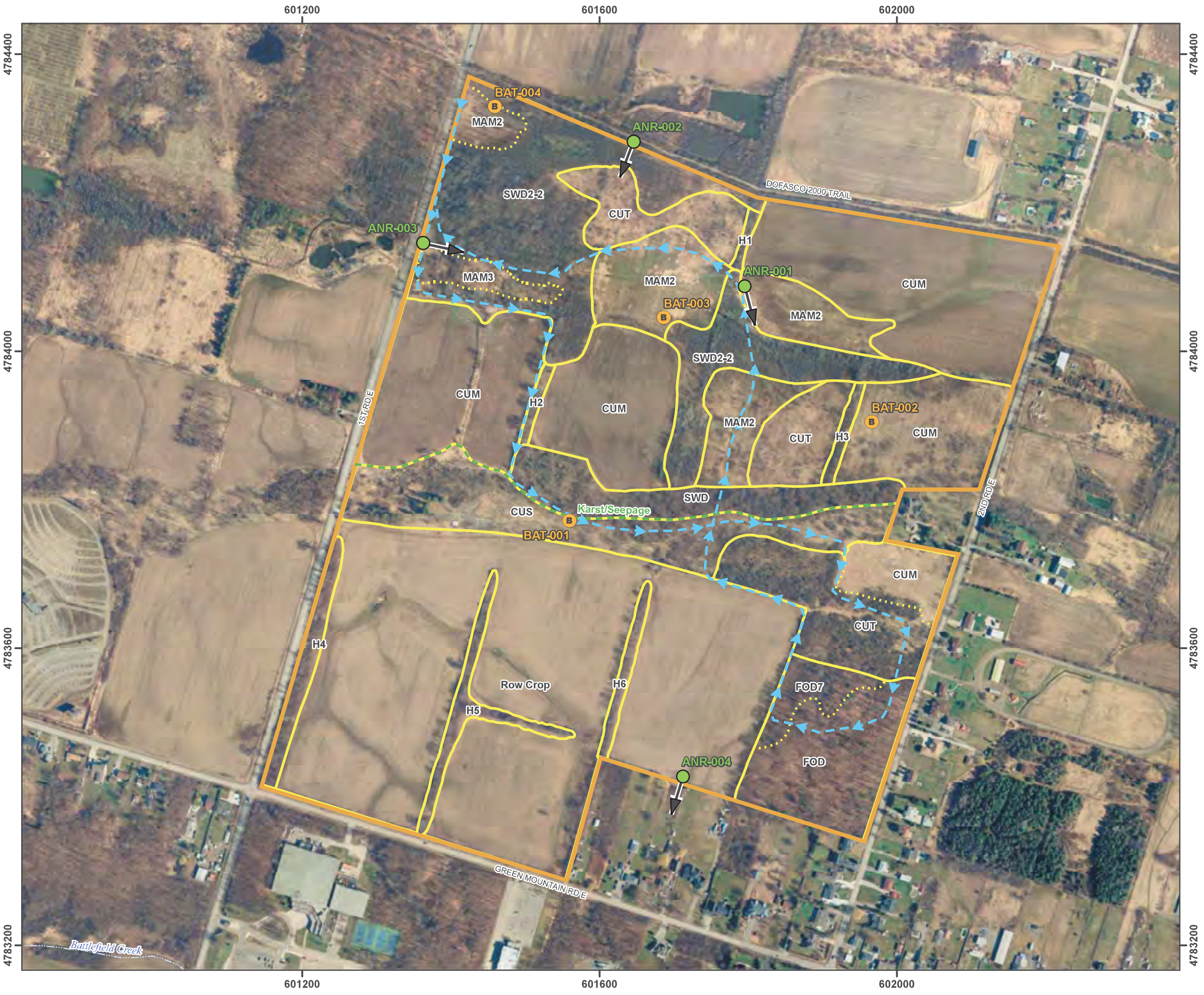
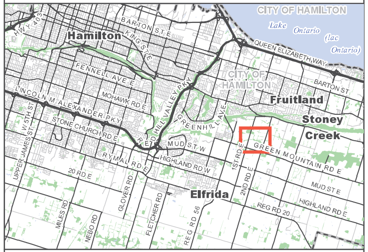


Map 2

Saltfleet Conservation Area BC-1 Wetland Design

Vegetation Communities and Terrestrial Survey Stations



Legend

▭ Subject Property
● Calling Anuran Survey Station
➤ Direction of Survey
Ⓑ Bat Acoustic Survey Station
➤ - Migratory and Breeding Bird Transect
～ Intermittent Watercourse
- - Seepage
▭ Ecological Land Classification (ELC)
(CUM) Cultural Meadow
(CUS) Cultural Savannah
(CUT) Cultural Thicket
(FOD) Deciduous Forest
(FOD7) Fresh - Moist Lowland Deciduous Forest Ecosite
(H) Hedgerow
(MAM2) Mineral Meadow Marsh Ecosite
(MAM3) Organic Meadow Marsh Ecosite
(SWD) Deciduous Swamp
(SWD2-2) Green Ash Mineral Deciduous Swamp Type
⬚ ELC Inclusion

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Project: 2237A
Date: June 19, 2020

NAD83 - UTM Zone 17
Size: 11x17"
1:5,000

0 100 200 300 Metres

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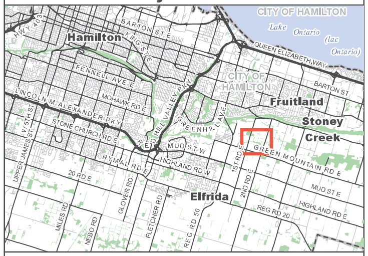
Map 3

Saltfleet Conservation Area BC-1 Wetland Design

Aquatic Habitat and Survey Locations



Legend

- ▭ Subject Property
- ～ Contour (5m Interval)
- ┅ Intermittent Watercourse
- ┄ Ephemeral Feature
- ▬ Electrofishing Station (EMS)
- ⊢⊣ Habitat Reach
- ● Culvert
- ▨ Hole in Ground
- ▨ Karst Feature

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Project: 2237A
Date: June 19, 2020

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Map 4

Saltfleet Conservation Area
BC-1 Wetland Design

Natural Heritage Constraints

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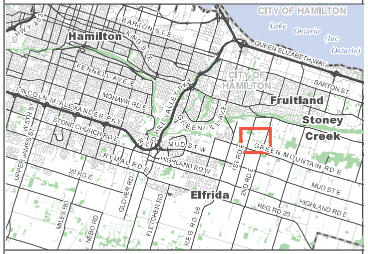

Legend

▭	Subject Property
┈	Intermittent Watercourse
- -	Ephemeral Feature
▬	Fish Habitat
—	Proposed Berm and Wetland
—	Proposed Outlet
- -	Extent of Disturbance
—	Extent of Flooding
—	Proposed Grading
▭	Ecological Land Classification (ELC)

(CUM) Cultural Meadow
(CUS) Cultural Savannah
(CUT) Cultural Thicket
(FOD) Deciduous Forest
(FOD7) Fresh - Moist Lowland Deciduous Forest Ecosite
(H) Hedgerow
(MAM2) Mineral Meadow Marsh Ecosite
(MAM3) Organic Meadow Marsh Ecosite
(SWD) Deciduous Swamp
(SWD2-2) Green Ash Mineral Deciduous Swamp Type

⬚	ELC Inclusion
▨	Significant Woodland

Significant Wildlife Habitat*

🟪	Landbird Migratory Stopover Area
🟩	Shrub/Early Successional Bird Breeding Habitat
🟦	Seeps and Springs
▨	Bat Maternity Colonies (Candidate)
▨	Special Concern and Rare Wildlife Species (Eastern Wood-pewee)
▨	Snake Hibernacula (Candidate)
▨	Special Concern and Rare Wildlife Species (Common Nighthawk)
🟧	Special Concern and Rare Wildlife Species (Monarch)

Species at Risk Habitat

▨	Bat SAR Roosting Habitat

*Entire property may constitute Raptor Wintering Area - surveys not completed.

NATURAL RESOURCE SOLUTIONS INC.
Aquatic, Terrestrial and Wetland Biologists

Project: 2237A
Date: June 19, 2020

NAD83 - UTM Zone 17
Size: 11x17"
1:5,000

0 100 200 300 Metres

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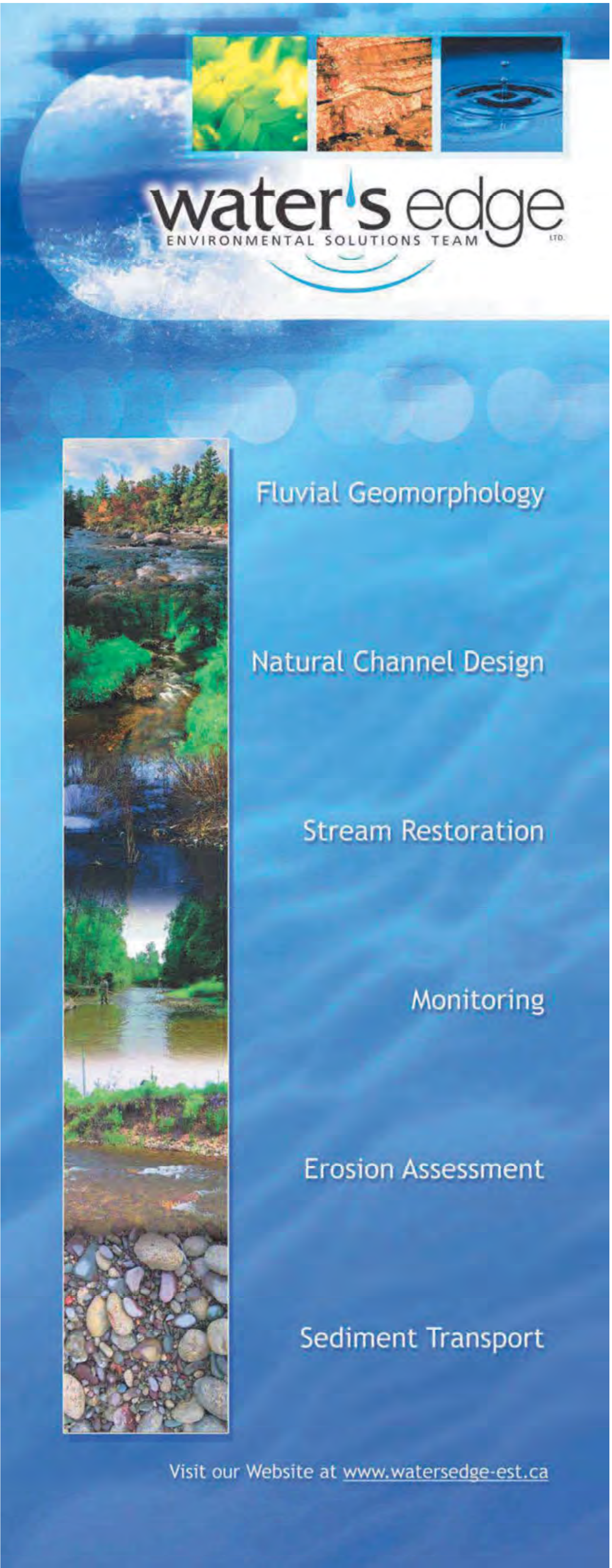

APPENDIX E:

Archaeology Report

Stage 1 Archaeological Assessment,

Part of Lots 21 and 22, Concession 5, Saltfleet Township,
Historical County of Wentworth, now in the City of Hamilton,
Ontario

Submitted to:

Water's Edge
Environmental Solutions Team
25 Water St South,
Cambridge, Ontario N1R 3C7
519-651-2390

and the

Ontario's Ministry of Tourism, Culture and Sport

Submitted by:

Detritus
CONSULTING LTD.
archaeology · heritage

69 Claremont Avenue, Kitchener Ontario, N2M 2P5
Mobile/Office: 519-744-7018
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Licensee: Mr. Garth Grimes
License Number: P017
PIF Number: P017-0697-2019
CP Number: 2018-018

ORIGINAL REPORT

May 21, 2019

Executive Summary

Detritus Consulting Ltd. ('Detritus') was retained by Water's Edge ('the Proponent') to conduct a Stage 1 archaeological assessment of part of Lots 21 and 22, Concession 5, Township of Saltfleet, historical Wentworth County, now in the City of Hamilton, Ontario, which is proposed for the establishment of a wetland conservation area. The Study Area is a roughly 73 hectare, irregularly shaped parcel of land. It is bound on the west by First Road East, on the east by Second Road East, on the south by Green Mountain Road East and on the north by a section of the Dofasco 2000 Trail.

At the time of assessment, the Study Area consisted of fallow agricultural land, scrub, mature and immature forest, wetlands, a section of Battlefield Creek and its minor tributaries, and the remains of a former farmstead, including hardened surfaces and ruined structures. A section of escarpment cuts through the Study area creating a narrow band of steep grade and dividing the Study Area into a higher region of glacio-lacustrine deposits and a lower region of Paleozoic bedrock.

The assessment was triggered by the Provincial Policy Statement ('PPS') that is informed by the *Planning Act* (Government of Ontario 1990a), which states that decisions affecting planning matters must be consistent with the policies outlined in the larger *Ontario Heritage Act* (1990b). According to Section 2.6.2 of the PPS, "development and site alteration shall not be permitted on lands containing archaeological resources or areas of archaeological potential unless significant archaeological resources have been conserved." To meet the conditions of this legislation, a Stage 1 assessment was conducted during the Site Plan Application ('SPA') under archaeological consulting license P017 issued to Mr. Garth Grimes by the Ministry of Tourism, Culture and Sport ('MTCS') and adheres to the archaeological license report requirements under subsection 65 (1) of the *Ontario Heritage Act* (Government of Ontario 1990b) and the MTCS' 2011 *Standards and Guidelines for Consultant Archaeologists* ('*Standards and Guidelines*'; Government of Ontario 2011).

The Stage 1 archaeological assessment, involving background research and property inspection, resulted in the determination that the Study Area exhibits medium to high potential for the identification and recovery of archaeological resources with the exception of the escarpment, and disturbed areas. (Figure 3). **As such, a stage 2 archaeological assessment is recommended.**

The Executive Summary highlights key points from the report only; for complete information and findings, the reader should examine the complete report.

Table of Contents

Project Personnel

Project Manager:	Garth Grimes, P017
Field Photography:	Laura Savoie, Mathew Gibson
Report Preparation:	Mathew Gibson, R1160, Garth Grimes P017
Mapping and GIS:	Mathew Gibson, R1160
Licensee and Senior Review:	Garth Grimes, P017

Acknowledgments

Generous contributions by the following individuals and agencies made this report possible.

- Mr. Ed Gazendam, Waters Edge

1.0 Project Context

1.1 Development Context

Detritus Consulting Ltd. ('Detritus') was retained by Water's Edge ('the Proponent') to conduct a Stage 1 archaeological assessment of part of Lot 21 and 22, Concession 5, Saltfleet Township, historical Wentworth County, now in the City of Hamilton, Ontario, which is proposed for the establishment of a wetland conservation area. The Study Area is a roughly 73 hectare (ha), irregularly shaped parcel of land. It is bound on the west by First Road East, on the east by Second Road East, on the south by Green Mountain Road East and on the north by a section of the Dofasco 2000 Trail.

Residential properties at the east end of Green Mountain Road East and single residential property along Second Road East do not form part of the Study Area.

At the time of assessment, the Study Area consisted of fallow agricultural land, scrub, mature and immature forest, wetlands, a section of Battlefield Creek and its minor tributaries, and the remains of a former farmstead, including hardened surfaces and the remains of various structures.

The assessment was triggered by the Provincial Policy Statement ('PPS') that is informed by the *Planning Act* (Government of Ontario 1990a), which states that decisions affecting planning matters must be consistent with the policies outlined in the larger *Ontario Heritage Act* (1990b). According to Section 2.6.2 of the PPS, "development and site alteration shall not be permitted on lands containing archaeological resources or areas of archaeological potential unless significant archaeological resources have been conserved." To meet the conditions of this legislation, a Stage 1 assessment was conducted during the Site Plan Application ('SPA') under archaeological consulting license P017 issued to Mr. Garth Grimes by the Ministry of Tourism, Culture and Sport ('MTCS') and adheres to the archaeological license report requirements under subsection 65 (1) of the *Ontario Heritage Act* (Government of Ontario 1990b) and the MTCS' 2011 *Standards and Guidelines for Consultant Archaeologists* ('*Standards and Guidelines*'; Government of Ontario 2011).

The purpose of the Stage 1 Background Study was to compile all available information about the known and potential archaeological heritage resources within the Study Area and to provide specific direction for the protection, management and/or recovery of these resources. In compliance with the *Standards and Guidelines* (Government of Ontario 2011), the objectives of the Stage 1 assessment were as follows:

- To provide information about the Study Area's geography, history, previous archaeological fieldwork and current land conditions;
- to evaluate in detail, the Study Area's archaeological potential which will support recommendations for Stage 2 survey for all or parts of the property; and
- to recommend appropriate strategies for Stage 2 survey.

To meet these objectives Detritus archaeologists employed the following research strategies:

- A review of relevant archaeological, historic and environmental literature pertaining to the Study Area;
- a review of the land use history, including pertinent historic maps; and
- an examination of the Ontario Archaeological Sites Database ('ASDB') to determine the presence of known archaeological sites in and around the Study Area.

The licensee received permission from the Proponent to enter the land and conduct all required archaeological fieldwork activities.

1.2 Historical Context

1.2.1 Post-Contact Aboriginal Land Use

Prior to the arrival of European settlers, the Niagara region was occupied by the Neutral or Attawandaron tribe. The earliest recorded visit to the Niagara region was undertaken by Etienne Brûlé, an interpreter and guide for Samuel de Champlain. In June 1610, Brûlé requested permission to live among the Algonquin people and to learn their language and customs. In return, Champlain agreed to take on a young Huron named Savignon and teach him the language and customs of the French. The purpose of this endeavour was to establish good relations with Aboriginal communities in advance of future military and colonial enterprises in the area. In 1615, Brûlé joined twelve Huron warriors on a mission to cross enemy territory and seek out the Andaste people, allies of the Huron, to ask their assistance in an expedition being planned by Champlain. The mission was a success, but took much longer than anticipated. Brûlé returned with the Andaste, but arrived two days too late to help Champlain and the Hurons, who had already been defeated by the Iroquois (Heidenreich 1990).

Throughout the middle of the 17th century, the Iroquois sought to expand upon their territory and to monopolise the local fur trade as well as trade between the European markets and the tribes of the western Great Lakes region. A series of bloody conflicts followed known as the Beaver Wars, or the French and Iroquois Wars, contested between the Iroquois confederacy and the Algonkian speaking communities of the Great Lakes region. Many communities were destroyed including the Huron, Neutral, Susquehannock, and Shawnee leaving the Iroquois as the dominant group in the region. By 1653 after repeated attacks, the Niagara peninsula and most of Southern Ontario had been vacated (Heidenreich 1990).

The late 17th and early 18th centuries represent a turning point in the evolution of the post-contact Aboriginal occupation of Southern Ontario. It was at this time that various Iroquoian-speaking communities began migrating from New York State, followed by the arrival of new Algonkian-speaking groups from northern Ontario (Konrad 1981; Schmalz 1991). More specifically, this period marks the arrival of the Mississaugas into Southern Ontario and, in particular, the watersheds of the lower Great Lakes. The oral traditions of the Mississaugas, as recounted by Chief Robert Paudash and recorded in 1904, suggest that the Mississaugas defeated the Mohawk Nation, who retreated to their homeland south of Lake Ontario. Following this conflict, a peace treaty was negotiated between the two groups and, at the end of the 17th century, the Mississaugas' settled permanently in Southern Ontario, including the York region (Praxis Research Associates n.d.). Around this same time, members of the Three Fires Confederacy (Chippewa, Ottawa, and Potawatomi) began immigrating from Ohio and Michigan into southwestern Ontario (Feest and Feest 1978:778-79).

The study area first entered the record as a result of Treaty No. 3, which…

> *…was made with the Mississa[ug]a Indians 7th December, 1792, though purchased as early as 1784. This purchase in 1784 was to procure for that part of the Six Nation Indians coming into Canada a permanent abode. The area included in this Treaty is, Lincoln County excepting Niagara Township; Saltfleet, Binbrook, Barton, Glanford and Ancaster Townships, in Wentworth County; Brantford, Onondaga, Tusc[a]r[o]ra, Oakland and Burford Townships in Brant County; East and West Oxford, North and South Norwich, and Dereham Townships in Oxford County; North Dorchester Township in Middlesex County; South Dorchester, Malahide and Bayham Township in Elgin County; all Norfolk and Haldimand Counties; Pelham, Wainfleet, Thorold, Cumberland and Humberstone Townships in Welland County.*

Morris 1943:17-18

The size and nature of the Pre-contact aboriginal settlements and the subsequent spread and distribution of Aboriginal material culture in Southern Ontario began to shift with the establishment of European settlers. Lands in the Lower Grand River area were surrendered by the Six Nations to the British Government in 1832, at which point most Six Nations people moved into Tuscarora Township in Brant County and a narrow portion of Oneida Township (Page & Co. 1879:8; Tanner 1987:127; Weaver 1978:526). Despite the encroachment of European settlers on previously established Aboriginal territories, "written accounts of material life and livelihood, the correlation of historically recorded villages to their archaeological manifestations, and the similarities of those sites to more ancient sites have revealed an antiquity to documented cultural expressions that confirms a deep historical continuity to Iroquoian systems of ideology and thought" (Ferris 2009:114). As Ferris observes, despite the arrival of a competing culture, First Nations communities throughout Southern Ontario have left behind archaeologically significant resources that demonstrate continuity with their pre-contact predecessors, even if they have not been recorded extensively in historical Euro-Canadian documentation.

1.2.2 Euro-Canadian Land Use

The current Study Area is located in the Geographic Township of Saltfleet, Historical County of Wentworth, now in the City of Hamilton, Ontario.

In July 1792, Simcoe divided Upper Canada into 19 counties stretching from Essex in the west to Glengarry in the east. Later that year, the four districts originally established in 1788 were renamed as the Western, Home, Midland and Eastern Districts. The current Study Area is situated in the historic Home District, which comprised lands obtained in the 'Between the Lakes Purchases' of 1784 and 1792 (Archives of Ontario 2009).

As population levels in Upper Canada increased, smaller and more manageable administrative bodies were needed resulting in the establishment of many new counties and townships. As part of this realignment, the boundaries of the Home and Western Districts were shifted and the London and Niagara Districts were established.

The Township of Saltfleet was established in Lincoln County in 1791 and became part of Wentworth County in 1816. The name Saltfleet was taken from the village of Saltfleet in Lincolnshire England (Hamilton Public Library 2017). Settlement began to trickle into the region in 1786, with an influx of loyalist immigrants from New York State began immigrating to Upper Canada in the years following the Revolutionary War. The Township of Saltfleet was laid out in eight concessions between Lake Ontario and the Township of Binbrook to the south. After the American Revolutionary War, Crown Patents were granted to United Empire Loyalists who settled at first below the escarpment but soon spread south of the escarpment creating small hamlets such as Albion and Elfrida.

The *Illustrated Historical Atlas of the County of Wentworth, Ont (Historical Atlas*), demonstrates the extent to which Saltfleet Township had been settled by 1875 (Page & Smith 1875; Figure 2). Landowners are listed for every lot within the township. Many of the lots had been subdivided into smaller parcels to accommodate an increasing population throughout the late 19th century. Structures and orchards are prevalent throughout the township, almost all of which front early roads. Also visible is the community of Stoney Creek, located northwest of the Study Area. To the southwest of the Study Area is the community of Elfrida, to the west Mt. Albion and to the southeast, Tapleytown.

According to the *Historical Atlas*, in 1875 Lot 21, Concession 5 is owned by Wesley Marshall and a building is indicated on the western side fronting the road, potentially in the location of the extant property at 492 Second Road East. Lot 22, Concession 5 is divided in two parts, the western portion owned by Mrs. and Dr. Henwood. No buildings are indicated on the map. The eastern portion is owned by G.R. Davis and a s structure and orchard are indicated toward the southern end of the lot. (Page & Co. 1875). It is possible that the remains of the farmstead is that indicated on the Davis property (as its location on the *Historical Atlas* is only approximate) and that Davis farmed the Henwood lot in addition to his own.

It must be recognized that historical county atlases were produced primarily to identify factories, offices, residences and landholdings of subscribers and were funded by subscriptions fees. Therefore, landowners who did not subscribe were not always listed on the maps (Caston 1997:100). Moreover, associated structures were not necessarily depicted or placed accurately (Gentilcore and Head 1984).

1.3 Archaeological Context

1.3.1 Property Description and Physical Setting

The Study Area is a roughly 73 ha, irregularly shaped parcel of land. It is bound on the west by First Road East, on the east by Second Road East, on the south by Green Mountain Road East and on the north by a section of the Dofasco 2000 Trail.

The Study Area is located within Haldimand Clay Plain physiographic region (Chapman and Putnam 1984). During pre-contact and early contact times, this area comprised a mixture of deciduous trees and open areas. In the early 19th century, Euro-Canadian settlers began to clear the forests for agricultural purposes, which have been ongoing in the vicinity of the four sites for over 100 years.

Haldimand Clay is slowly permeable, imperfectly drained with medium to high water-holding capacities. Surface runoff is usually rapid, but water retention of the clayey soils can cause it to be droughty during dry periods (Kingston and Presant 1989). According to Chapman and Putnam,

> *…although it was all submerged in Lake Warren, the till is not all buried by stratified clay; it comes to the surface generally in low morainic ridges in the north. In fact, there is in that area a confused intermixture of stratified clay and till. The northern part has more relief than the southern part where the typically level lake plains occur.*
>
> Chapman and Putnam 1984:156

Physiographic landforms are a mix of clay soil in the northern position of the study area and till moraine in the south. The primary divider between these two landforms is a minor bench escarpment of bedrock located 1.3km south of the Niagara Escarpment running through the Study Area creating a sudden elevation change of 10m. Elevations at the north end of the Study area vary between 188 and 192m a.s.l. while elevations at the southern end vary between 203 and 205m a.s.l.

Huffman and Dumanski add that the soil within the region is suitable for corn and soy beans in rotation with cereal grains as well as alfalfa and clover (Huffman and Dumanski 1986).

The majority of the region surrounding the Study Area has been subject to European-style agricultural practices for over 100 years, having been settled by Euro-Canadian farmers by the mid-19th century. Much of the region today continues to be used for agricultural purposes.

During pre-contact and early contact times, the land in the vicinity of the Study Area comprised a mixture of hardwood trees such as sugar maple, beech, oak and cherry. This pattern of forest cover is characteristic of areas of clay soil within the Maple-Hemlock Section of the Great Lakes-St. Lawrence Forest Province-Cool Temperate Division (McAndrews and Manville 1987). In the early 19th century Euro-Canadian settlers began to clear the forests for agricultural purposes.

The closest historical sources of potable water is Battlefield Creek (and several small tributaries) that runs east-west through the Study Area.

1.3.2 Pre-Contact Aboriginal Land Use

This portion of southern Ontario has been demonstrated to have been occupied by people as far back as 11,000 years ago as the glaciers retreated. For the majority of this time, people were practicing hunter gatherer lifestyles with a gradual move towards more extensive farming practices. Table 1 provides a general outline of the cultural chronology of Saltfleet Township, based on Ellis and Ferris (1990).

Table 1: Cultural Chronology for Saltfleet Township

Time Period	Cultural Period	Comments
9500 – 7000 BC	Paleo Indian	first human occupation hunters of caribou and other extinct Pleistocene game nomadic, small band society
7500 - 1000 BC	Archaic	ceremonial burials increasing trade network hunter gatherers
1000 - 400 BC	Early Woodland	large and small camps spring congregation/fall dispersal introduction of pottery
400 BC – AD 800	Middle Woodland	kinship based political system incipient horticulture long distance trade network
AD 800 - 1300	Early Iroquoian (Late Woodland)	limited agriculture developing hamlets and villages
AD 1300 - 1400	Middle Iroquoian (Late Woodland)	shift to agriculture complete increasing political complexity large palisaded villages
AD 1400 - 1650	Late Iroquoian	regional warfare and political/tribal alliances destruction of Huron and Neutral

1.3.3 Previous Identified Archaeological Work

In order to compile an inventory of known archaeological resources in the vicinity of the Study Area, Detritus consulted the ASDB. The ASDB, which is maintained by the MTCS (Government of Ontario n.d.), contains information concerning archaeological sites that have been registered according to the Borden system. Under the Borden system, Canada is divided into grid blocks based on latitude and longitude. A Borden Block is approximately 13km east to west and approximately 18.5km north to south. Each Borden Block is referenced by a four-letter designator and sites within a block are numbered sequentially as they are found. The Study Area lies within blocks AhHa, AhGx and AhGw.

Information concerning specific site locations is protected by provincial policy, and is not fully subject to the *Freedom of Information and Protection of Privacy Act* (Government of Ontario 1990c). The release of such information in the past has led to looting or various forms of illegally conducted site destruction. Confidentiality extends to all media capable of conveying location, including maps, drawings, or textual descriptions of a site location. The MTCS will provide information concerning site location to the party or an agent of the party holding title to a property, or to a licensed archaeologist with relevant cultural resource management interests.

An examination of the ASDB has shown that there are 8 registered archaeological sites within 1km of the Study Area (Table 2). One of the sites is pre-contact Aboriginal, three are post-contact Euro-Canadian sites and two are multi-component sites.

Table 2: Archaeological Sites Database Records

Borden Number	Site Name	Time Period	Affinity	Site Type
AhHa-128	Griffin/ Costello House	Post-Contact	Afro-Canadian	homestead
AhGx-735	H1	Post-Contact	Euro-Canadian	Unknown, scatter
AhGw-267		Post-Contact	Euro-Canadian	Unknown
AhGw-265	Upper Centennial P3	Pre-Contact	Aboriginal	camp/ campsite, scatter
AhGw-250				
AhGw-249				
AhGw-101	Stoney Creek Monument	Post-Contact, Woodland, Middle	Aboriginal, Euro-Canadian	Unknown
AhGw-100	Battlefield Park	Post-Contact, Woodland	Aboriginal, Euro-Canadian	battlesite, camp / campsite, farmstead

To the best of Detritus’ knowledge, no other assessments have been conducted on adjacent properties nor have sites been found within 50m of the Study Area.

2.0 Field Methods

The Stage 1 assessment compiled all available information concerning any known and/or potential archaeological heritage resources within the Study Area. A property inspection was conducted under archaeological consulting licence P017 issued to Mr. Garth Grimes by the MTCS.

The property inspection was completed on April 9, 24 and May 10 2019. In accordance with Section 1.2 of the MTCS' 2011 *Standards and Guidelines* (Government of Ontario 2011), the property inspection involved photography and mapping of the Study Area. During the property inspection, the weather was cool and cloudy on April 9, partly sunny on April 24 and overcast on May 10. Visibility of land features was excellent. At no time were field or weather conditions detrimental to the identification of features of archaeological potential.

The results of the Stage 1 background research and optional property inspection indicate that the entire Study Area retains archaeological potential with the exception of steep areas along the escarpment, and disturbed areas associated with the former farmstead. The photography from the property inspection is presented in Section 8 below and confirms that the requirement for a Stage 1 property inspection were met, as per Section 1.2 and Section 7.7.2 Standard 1 of the *Standards and Guidelines* (Government of Ontario 2011).

Photos 1 to 12 illustrate observed areas of archaeological potential, disturbance and specific features of the Study Area.

3.0 Analysis and Conclusions

Detritus was retained by the Proponent to conduct a Stage 1 archaeological assessment of part of Lot 21 and 22, Concession 5, Township of Saltfleet, Historical Wentworth County, now in the City of Hamilton, Ontario, which is proposed for the establishment of a wetland conservation area. The Study Area is a roughly 73 hectare (ha), irregularly shaped parcel of land. It is bound on the west by First Road East, on the east by Second Road East, on the south by Green Mountain Road East and on the north by a section of the Dofasco 2000 Trail.

Archaeological potential is established by determining the likelihood that archaeological resources may be present on a subject property. Detritus applied archaeological potential criteria commonly used by the MTCS (Government of Ontario 2011) to determine areas of archaeological potential within Study Area. These variables include proximity to previously identified archaeological sites, distance to various types of water sources, soil texture and drainage, glacial geomorphology, elevated topography, and the general topographic variability of the area.

Distance to modern or ancient water sources is generally accepted as the most important determinant of past human settlement patterns and, when considered alone, may result in a determination of archaeological potential. However, any combination of two or more other criteria, such as well-drained soils or topographic variability, may also indicate archaeological potential. When evaluating distance to water it is important to distinguish between water and shoreline, as well as natural and artificial water sources, as these features affect sites locations and types to varying degrees. The MTCS (Government of Ontario 2011) categorizes water sources in the following manner:

- Primary water sources: lakes, rivers, streams, creeks;
- secondary water sources: intermittent streams and creeks, springs, marshes and swamps;
- past water sources, glacial lake shorelines, relic river or stream channels, cobble beaches, shorelines of drained lakes or marshes; and
- accessible or inaccessible shorelines: high bluffs, swamp or marshy lake edges, sandbars stretching into marsh.

As was discussed above, the closest historical sources of potable water is the Battlefield Creek that runs east-west through the Study Area.

Soil texture is also an important determinant of past settlement, usually in combination with other factors such as topography. The Study Area is situated within the Haldimand Clay Plain physiographic region. As was discussed earlier, the soils within this region are well drained and suitable for pre-contact and post contact Aboriginal agricultural. A physiographic feature – a bench escarpment is situated within the Study Area. Given this, the distance to potable water, the single pre-contact Aboriginal site and two multi-component sites registered within 1km of the Study Area and the length of occupation of Saltfleet Township prior to the arrival of Euro-Canadian settlers, the pre-contact and post-contact Aboriginal archaeological potential of the Study Area would be judged to be moderate to high.

For Euro-Canadian sites, archaeological potential can be extended to areas of early Euro-Canadian settlement, including places of military or pioneer settlements; early transportation routes; and properties listed on the municipal register or designated under the *Ontario Heritage Act* (Government of Ontario 1990b) or property that local histories or informants have identified with possible historical events. The *Historical Atlas* (Page & Co 1875) map of Saltfleet Township has revealed that the Study Area is in close proximity to a number of historical roads and the early communities of Stoney Creek, Elfrida, Albion and Tapleytown. Considering also the presence of three Euro-Canadian sites and two multi-component sites within 1km of the Study Area, the potential for post-contact Euro-Canadian archaeological resources would be judged to be moderate to high.

Detritus determined that the Study Area demonstrates medium to high potential for the recovery of pre-contact Aboriginal, post-contact Aboriginal, and Euro-Canadian archaeological resources. Areas of steep slope and disturbed areas such as hardened surfaces within the former farmstead areas are low in archaeological potential. Overall the Study Area **is recommended for additional assessment**.

4.0 Recommendations

The Stage 1 background research indicated that portions of the Study Area exhibited moderate to high potential for the identification and recovery of archaeological resources. These include all areas with the exception of steep or disturbed portions of the Study Area. As such, a **Stage 2 archaeological assessment is recommended for these areas.**

The various treed or otherwise vegetated areas throughout the Study Area that are inaccessible for ploughing, will be subject to a typical Stage 2 test pit assessment at a 5m interval, conducted according to Section 2.1.2 of the *Standards and Guidelines* (Government of Ontario 2011). The test pit survey will be conducted until test pits show evidence of disturbance according to Section 2.1.2, Standard 4 of the *Standards and Guidelines* (Government of Ontario 2011). Each test pit must be approximately 30 centimetres (cm) in diameter and excavated 5cm into sterile subsoil. The soil and test pits will then be examined for stratigraphy, cultural features, or evidence of fill. All soil will be screened through six-millimetre (mm) mesh hardware cloth to facilitate the recovery of small artifacts and then used to backfill the pit.

In accordance with Section 2.1.3 Standard 1 of the *Standards and Guidelines* (Government of Ontario 2011), if archaeological resources are encountered during the Stage 2 test pit survey, the test pit excavation will continue on the survey grid to determine the extent of further positive test pits. If insufficient archaeological resources are found through a continued survey of the grid to meet the criteria for continuing to Stage 3, the survey coverage will be intensified around the positive test pits using either Option A or Option B of Section 2.1.3, Standard 2 of the *Standards and Guidelines* (Government of Ontario 2011). UTM coordinates will then be recorded for all positive test pit in addition to a fixed reference landmark using a Garmin eTrex 10 GPS unit with a minimum accuracy 1-2.5m (North American Datum 1983 ('NAD83') and Universal Transverse Mercator ('UTM') Zone 17T). All artifacts will be collected and recorded according to their associated positive test pit or 1m test unit.

The portions of the Study Area maintained as agricultural fields and accessible for ploughing will be subject to a typical Stage 2 pedestrian survey at a 5m interval, conducted according to Section 2.1.1 of the *Standards and Guidelines* (Government of Ontario 2011). This area will be ploughed until 80% surface visibility is attained, then allowed to weather prior to assessment. As per Section 2.1.1, Standard 7 of the *Standards and Guidelines* (Government of Ontario 2011), if archaeological resources are found, the survey transects will be decreased to 1m intervals over a 20m radius around each find to determine whether it is an isolated find or part of a larger scatter. All formal artifact types and diagnostic categories will be collected for laboratory analysis and cataloguing, including all refined ceramic sherds for 19th century archaeological sites.

The remainder of the Study Area comprises gravel, asphalt or concrete hardened surfaces within the farmstead areas or steep grades. These areas have been evaluated as having no or low potential due to extensive and deep land alteration that has severely damaged the integrity of archaeological resources or steep grade and are exempt from additional assessment as per Section 2.1 Standard 2b of the *Standards and Guidelines* (Government of Ontario 2011). Instead, **these areas will be mapped and photo documented during the Stage 2 assessment** as per Section 2.1, Standard 6 and Section 7.8.6, Standard 1b of the *Standards and Guidelines* (Government of Ontario 2011).

5.0 Advice on Compliance with Legislation

This report is submitted to the Minister of Tourism, Culture and Sport as a condition of licensing in accordance with Part VI of the *Ontario Heritage Act*, R.S.O. 1990, c 0.18. The report is reviewed to ensure that it complies with the standards and guidelines that are issued by the Minister, and that the archaeological fieldwork and report recommendations ensure the conservation, protection and preservation of the cultural heritage of Ontario. When all matters relating to archaeological sites within the project area of a development proposal have been addressed to the satisfaction of the Ministry of Tourism and Culture, a letter will be issued by the ministry stating that there are no further concerns with regard to alterations to archaeological sites by the proposed development.

It is an offence under Sections 48 and 69 of the *Ontario Heritage Act* for any party other than a licensed archaeologist to make any alteration to a known archaeological site or to remove any artifact or other physical evidence of past human use or activity from the site, until such time as a licensed archaeologist has completed archaeological fieldwork on the site, submitted a report to the Minister stating that the site has no further cultural heritage value or interest , and the report has been filed in the Ontario Public Register of Archaeology Reports referred to in Section 65.1 of the *Ontario Heritage Act*.

Should previously undocumented archaeological resources be discovered, they may be a new archaeological site and therefore subject to Section 48 (1) of the *Ontario Heritage Act*. The proponent or person discovering the archaeological resources must cease alteration of the site immediately and engage a licensed consultant archaeologist to carry out archaeological fieldwork, in compliance with Section 48 (1) of the *Ontario Heritage Act*.

The *Cemeteries Act*, R.S.O. 1990 c. C.4 and the *Funeral, Burial and Cremation Services Act*, 2002, S.O. 2002, c.33 (when proclaimed in force) require that any person discovering human remains must notify the police or coroner and the Registrar of Cemeteries at the Ministry of Consumer Services.

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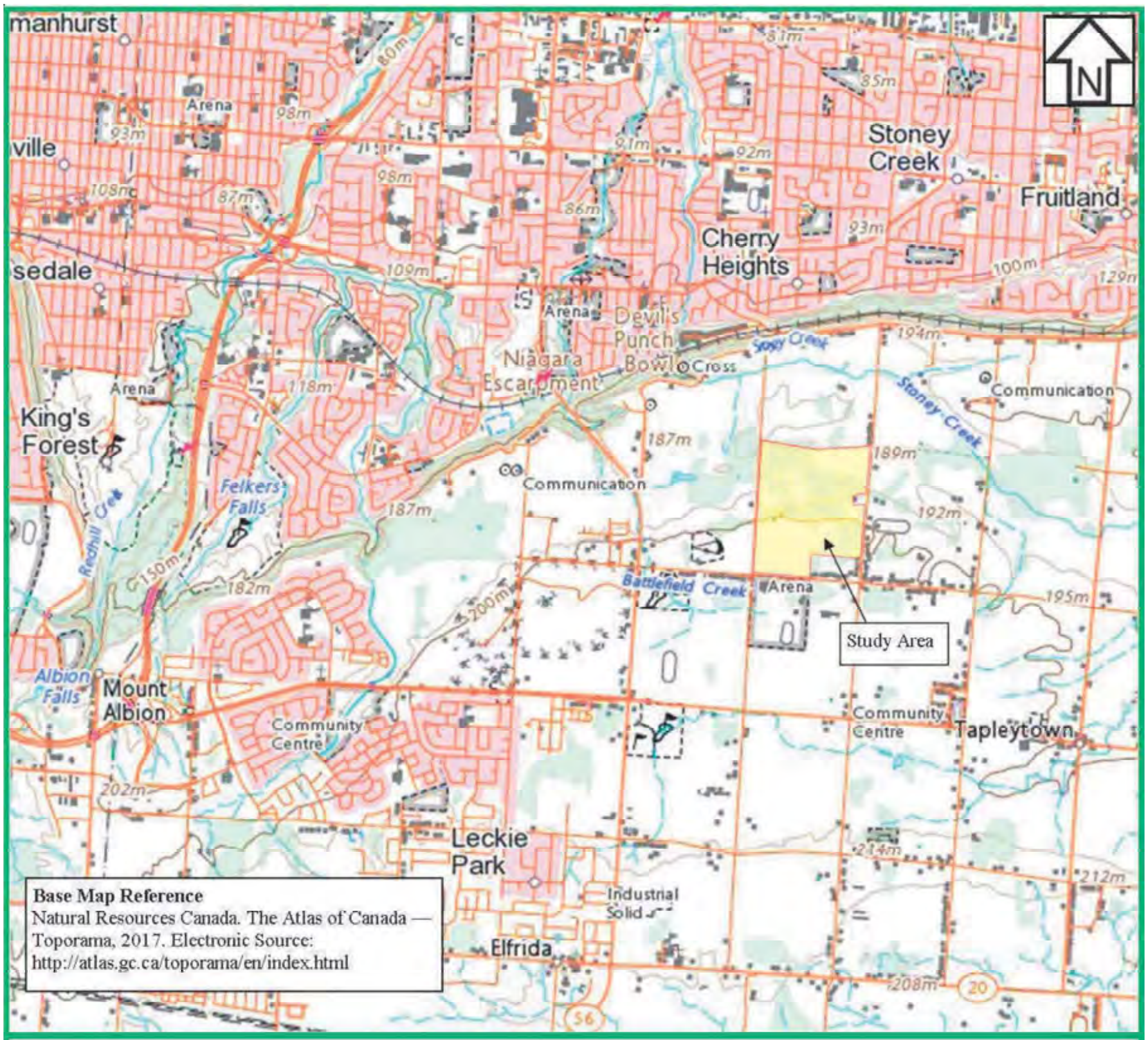
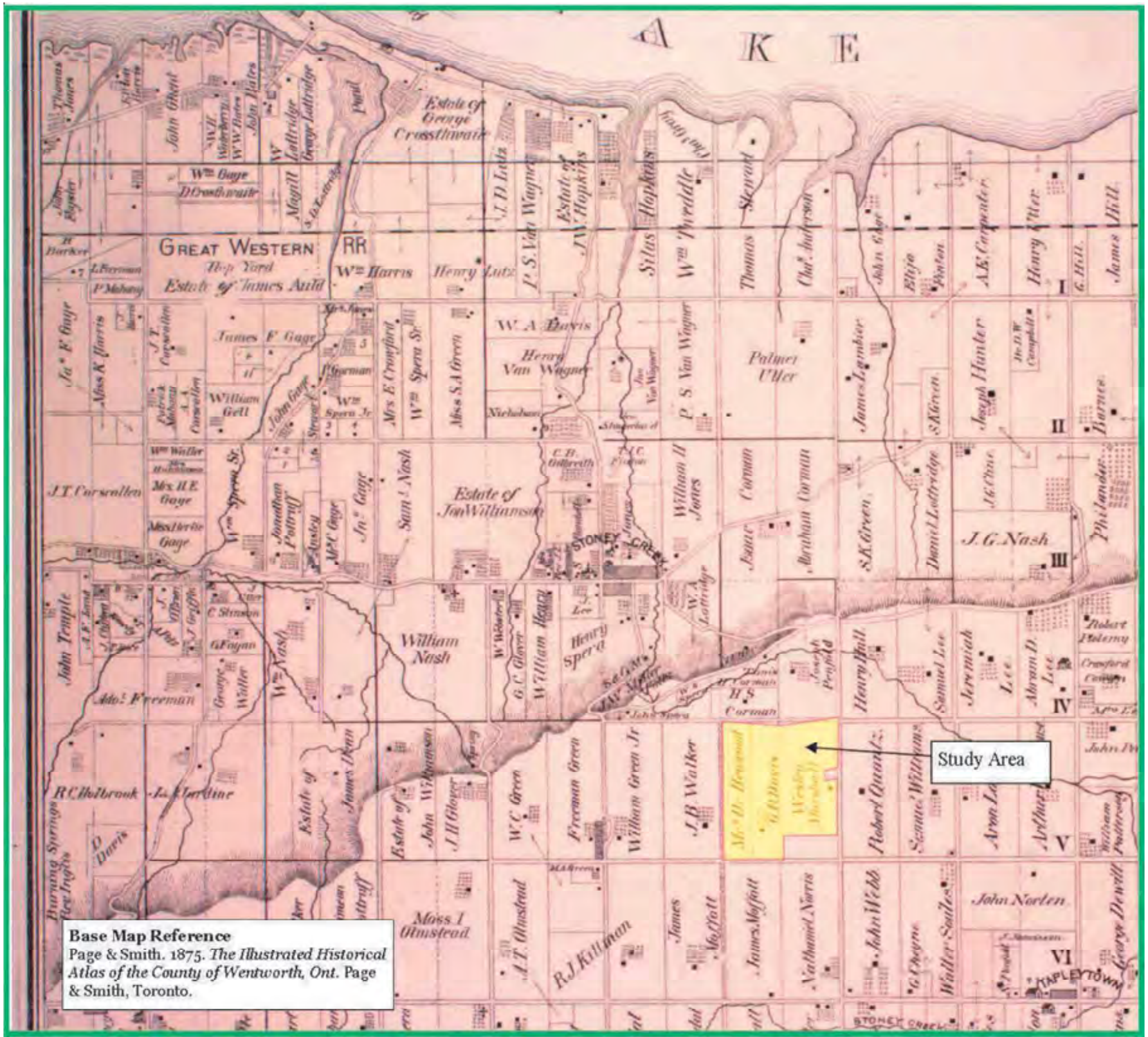
7.0 Maps



Base Map Reference
Natural Resources Canada. The Atlas of Canada — Toporama, 2017. Electronic Source: http://atlas.gc.ca/toporama/en/index.html

Scale 1:40 000

Figure 1: Study Area



Base Map Reference
Page & Smith. 1875. *The Illustrated Historical Atlas of the County of Wentworth, Ont.* Page & Smith, Toronto.

Not to scale

Figure 2: Portion of the 1875 *Historical Atlas* map of Saltfleet Township

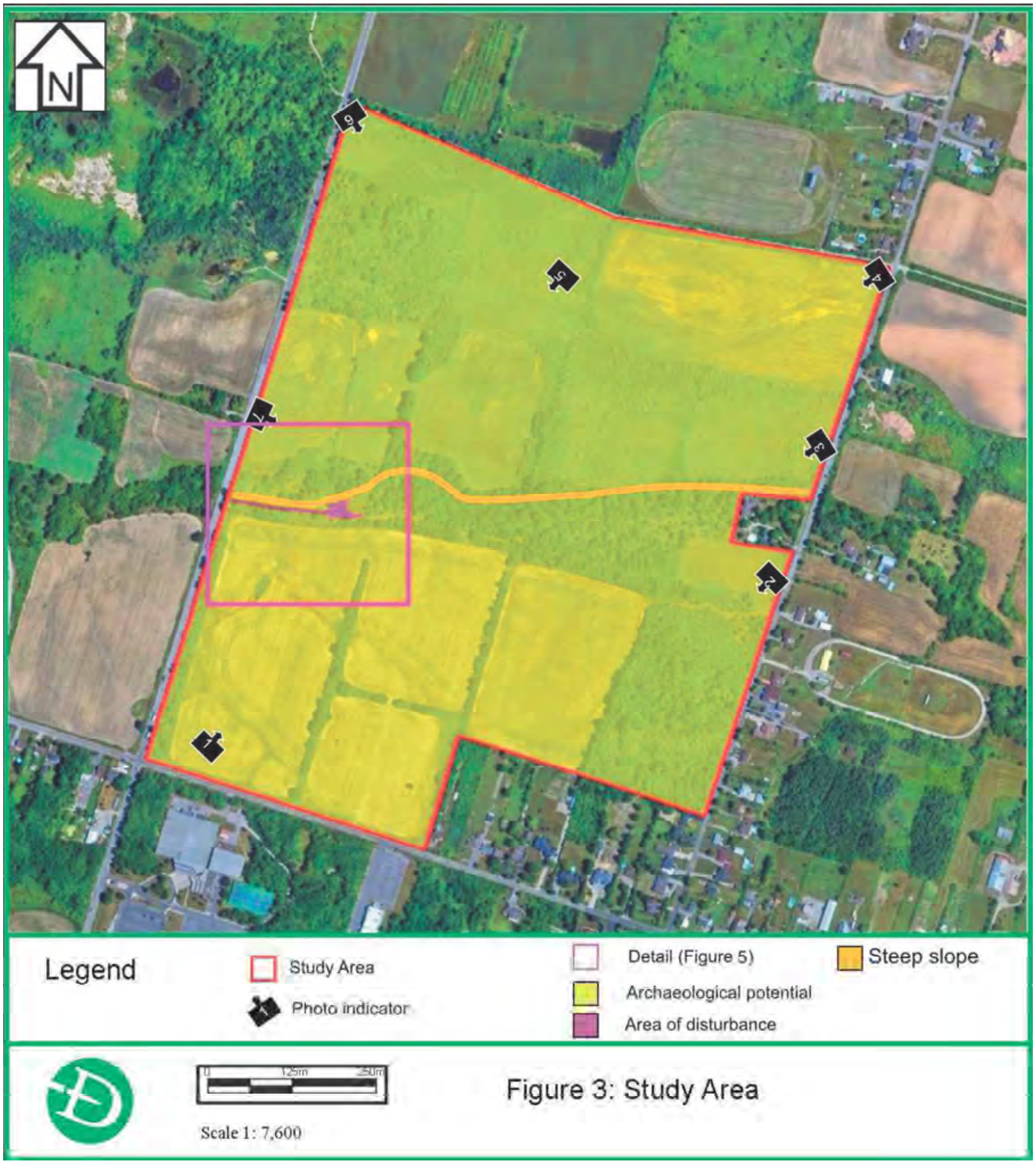


Figure 3: Study Area

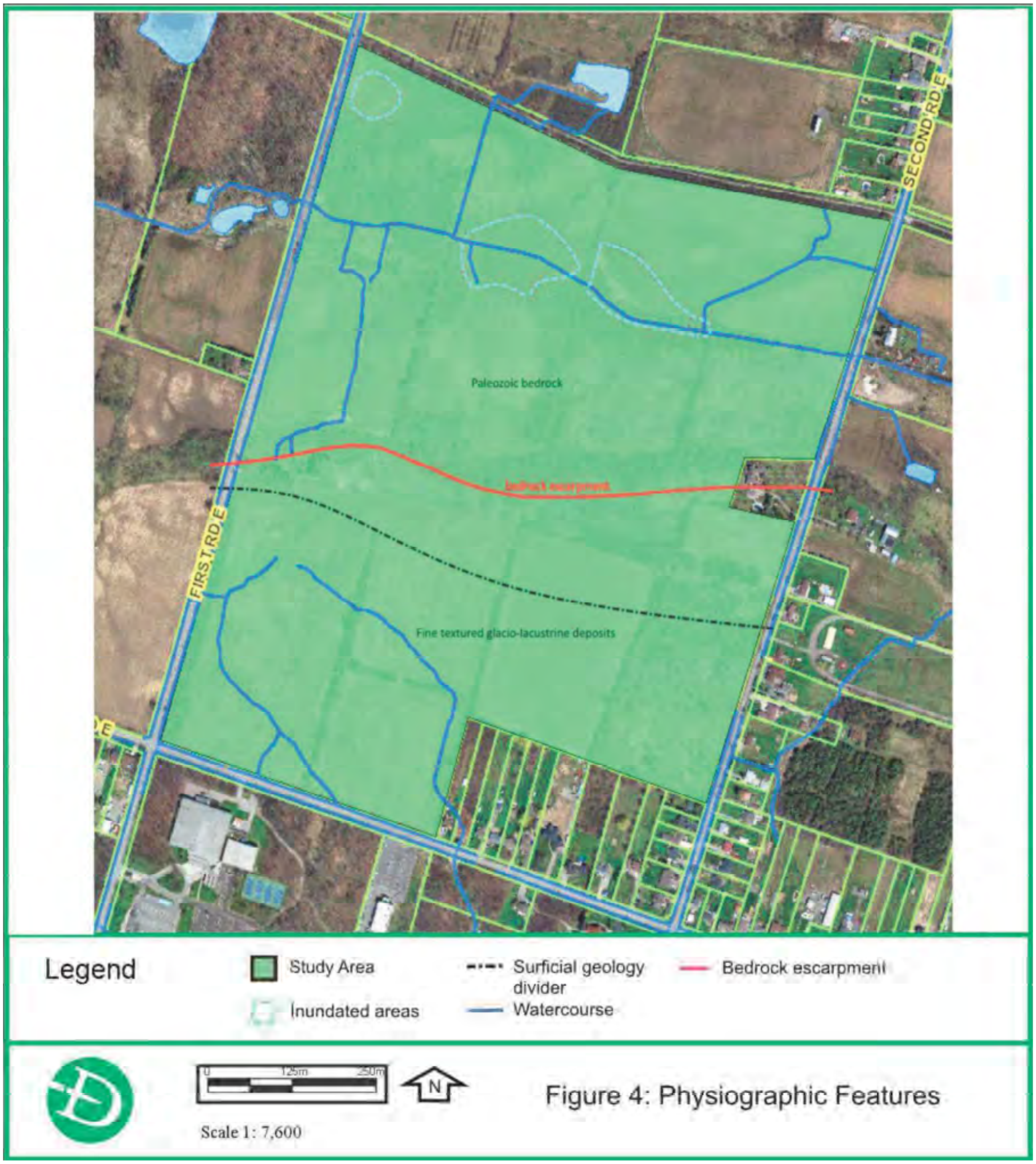


Figure 4: Physiographic Features

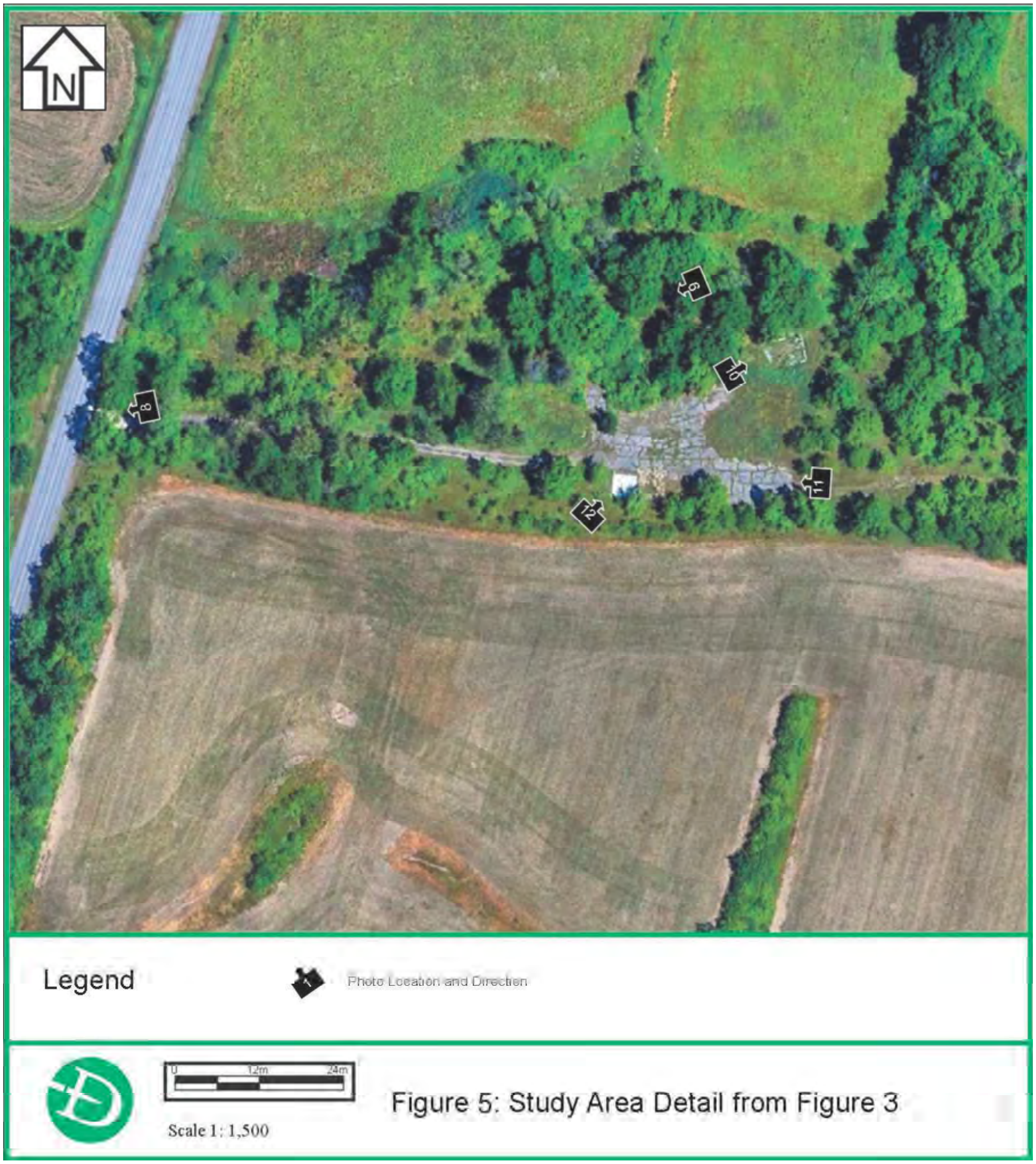


Figure 5: Study Area Detail from Figure 3

8.0 Images

Photo 1: Looking north east over fallow agricultural field.

Photo 2: Looking south over open scrub

Photo 3: Looking southwest over open scrub

Photo 4: Looking southwest over open scrub

Photo 5: Looking southwest over immature forest

Photo 6: Looking southeast over open scrub, wetland and Battlefield Creek

Photo 7: Looking southeast over fallow agricultural land

Photo 8: Entrance to farmstead, looking southwest

Photo 9: Concrete over rubble stone foundation

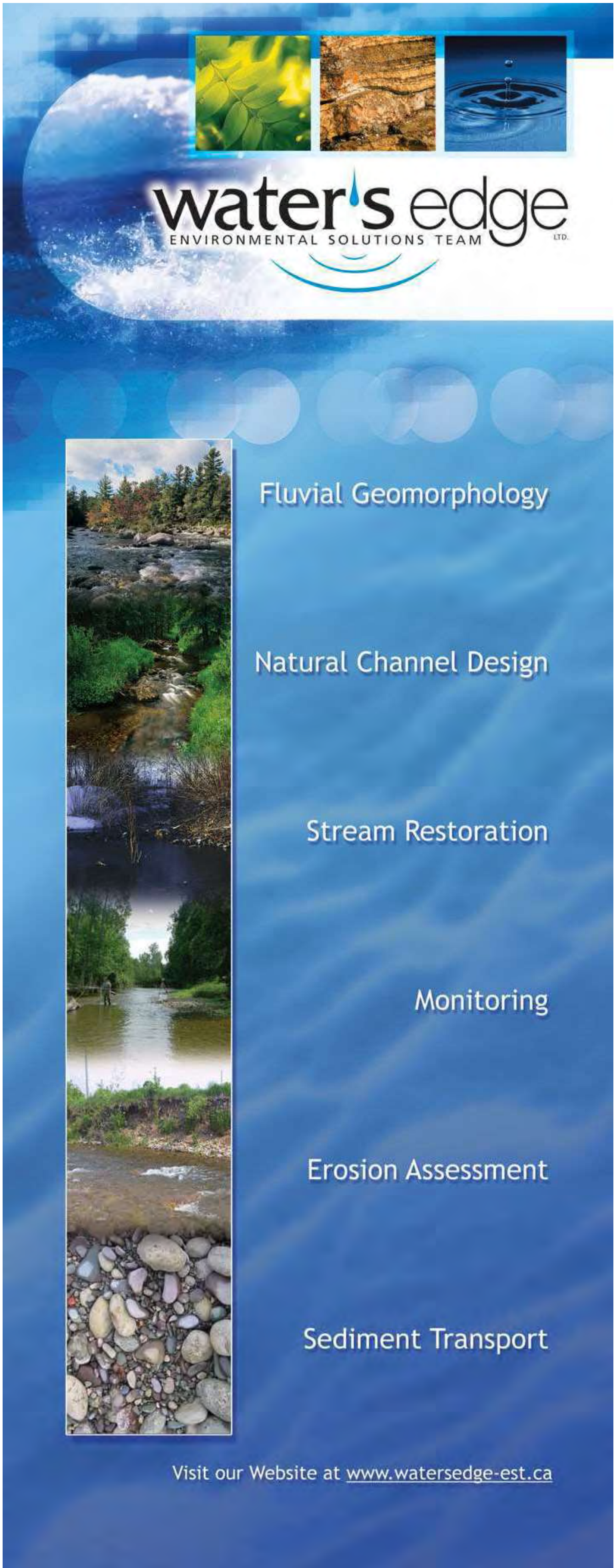
Photo 10: Rubble stone foundation

Photo 11: Hardened surfaces

Photo 12: Concrete pad

APPENDIX F:

Hydrological Modelling



APPENDIX G:

Wetland Design SSDs

Stage-Storage-Discharge Relationships

BC-1 East Pond

Elevation m	Storage 1000 m^3	Discharge m^3/s
188.5	0.00	0.00
188.6	3.10	0.00
188.7	6.74	0.00
188.8	10.94	0.04
188.9	15.75	0.10
189	21.16	0.18
189.1	27.80	0.27
189.2	34.78	0.37
189.3	42.18	0.48
189.4	49.99	0.60
189.5	58.20	0.73
189.6	67.17	0.86
189.7	76.48	0.97
189.8	86.14	1.87
189.9	96.14	2.99
190	106.50	4.95
190.4	106.5	17.34

BC-1 West Pond

Elevation m	Storage 1000 m^3	Discharge m^3/s
188.1	5.65	0
188.2	7.13	0
188.3	8.82	0.01
188.4	10.93	0.04
188.5	13.50	0.06
188.6	16.36	0.10
188.7	19.44	0.13
188.8	22.72	0.17
188.9	26.16	0.21
189	29.80	0.26
189.1	33.76	0.31
189.2	38.11	0.35
189.3	42.86	0.38
189.4	48.04	0.90
189.5	53.68	1.19
189.6	59.81	1.70
189.9	59.81	3.93

APPENDIX H:

Design Plan Package