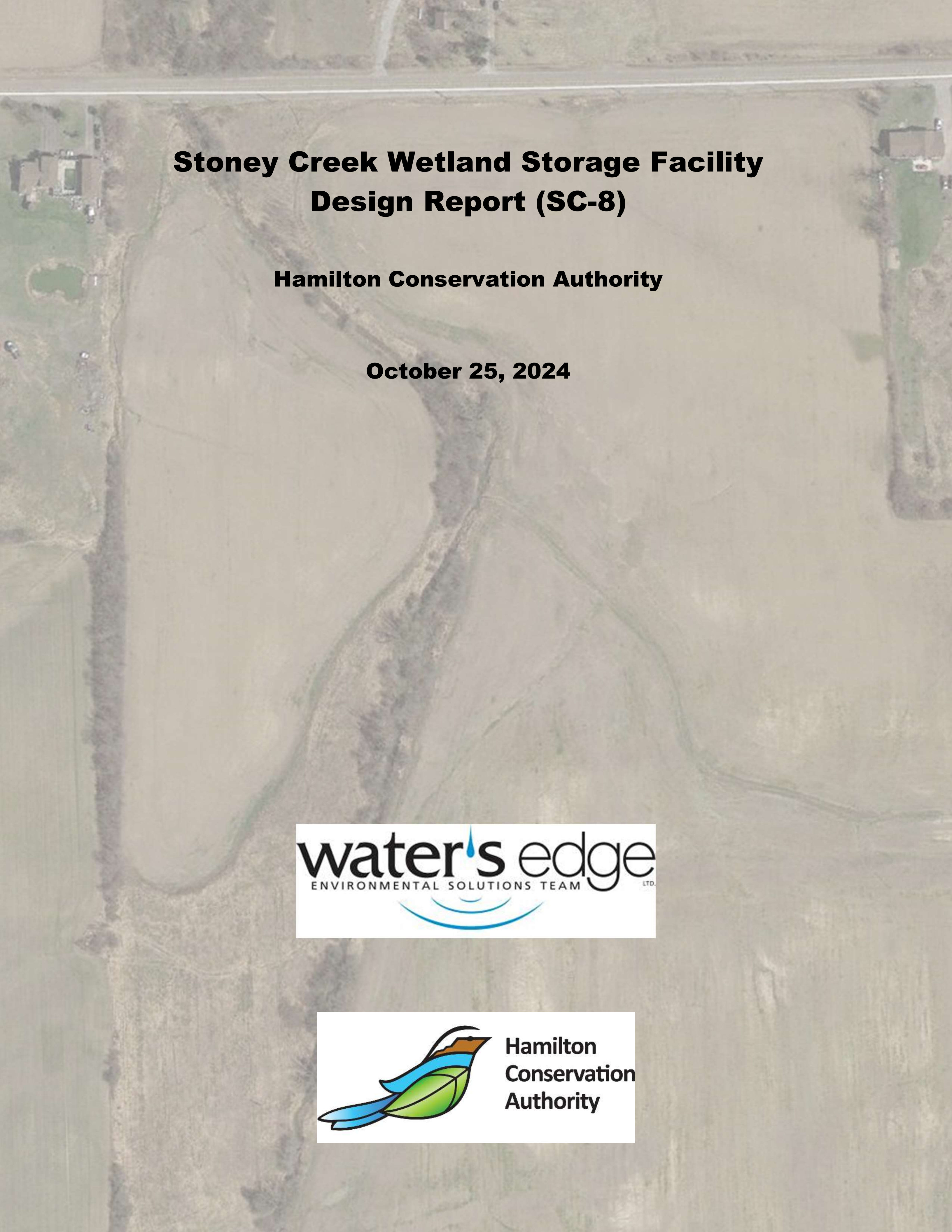


Stoney Creek Wetland Storage Facility Design Report (SC-8)

Hamilton Conservation Authority

October 25, 2024

water's edge
ENVIRONMENTAL SOLUTIONS TEAM LTD.

Hamilton
Conservation
Authority

water's edge
ENVIRONMENTAL SOLUTIONS TEAM LTD.

October 25, 2024
WE: 19028

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

Dear Mr. Peck:

RE: Saltfleet Wetland SC-8, Hamilton, ON

Please find attached our report for the above noted project entitled "Stoney Creek Wetland Storage Facility Design Report (SC-8)". 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,

LICENSED PROFESSIONAL ENGINEER
E. GAZENDAM
PROVINCE OF ONTARIO

Ed Gazendam, Ph.D., P.Eng.,
President, Sr. Geomorphologist
Water's Edge Environmental Solutions Team Ltd.

Eric Gazendam
Project Manager and Senior Technician

25 WATER STREET SOUTH, CAMBRIDGE, ONTARIO N1R 3C7 • T.519.651.2390 • www.watersedge-est.ca

TABLE OF CONTENTS

FIGURES, TABLES, MAPS, AND APPENDICES

Figures:

Maps:

Appendices:

1 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. This particular property is located at the intersection of Green Mountain Rd E. and Fifth Rd E (see **Map 1**)..which is 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, Stoney Creek 8 (SC-8) is currently vacant with no active management or visitor use on site.

2 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; and 4) enhance and create passive recreational opportunities.

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 SC-8 facility with the end result being a passively-functioning, natural wetland that partially contributes to addressing downstream flooding and erosion.

2.1 Project Scope:

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

a) complete the design of the wetland, grading, and required berms 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) Road alterations such as raising road grades and associated drainage impacts;
c) Culvert structure alterations or replacement (which may include weir structures to reduce peak flows);
d) Storage volumes and elevations;
e) Flooding durations including the wetland wet period;
f) Baseflow attenuation through the control of storm runoff response;
g) Wetland terrestrial habitat requirements;
h) Aquatic habitat enhancements; and,
i) Bedrock and groundwater 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.

2.2 Flood and Erosion Control Project Class EA Vision for SC-8:

Figure 1-1 shows the proposed SC-8 wetland facility as envisioned by the previous study. The proposed facility would use the existing 6.0 m span by 1.0 m rise concrete box culvert on Green Mountain Road East as the ultimate outlet for the proposed SC-8 facility. However, due to the limited depth of storage, it was proposed to raise the road by 0.5 m to 194.00 m or create an equivalent standalone berm upstream of the crossing. Approximately 100 m of road would have to be raised. The maximum elevation and depth of storage would be 193.70 m and 1.20 m based on providing 0.30 m to freeboard to the Green Mountain Road East. No excavation was envisioned to achieve storage requirements. Portions of the ponding would be within HCA's property, but portions would also be on non-HCA property. The total storage envisioned would be 31,400 m^3 in a single, on-line facility.

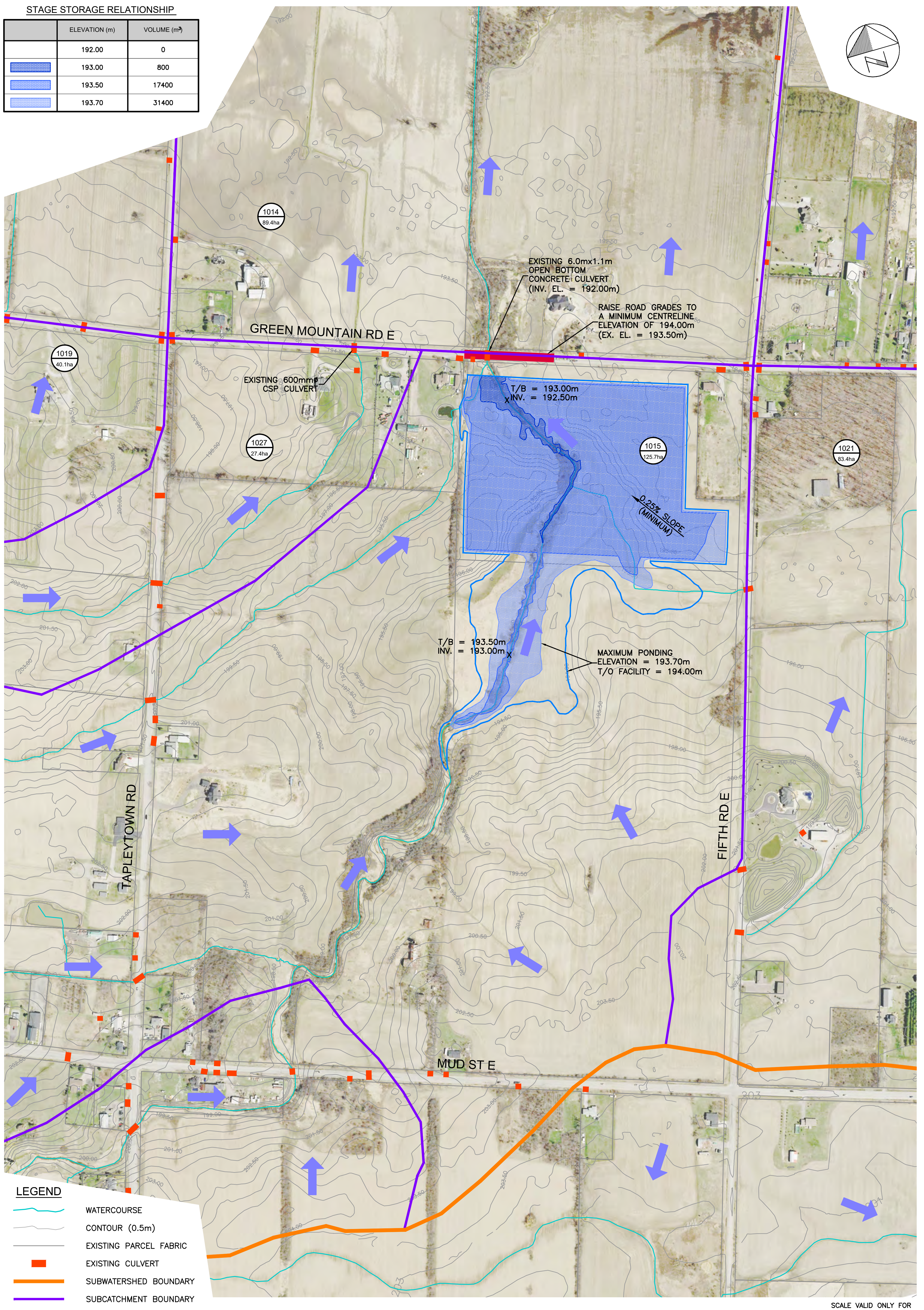
However, HCA subsequently realized that the possibility of using Green Mountain Road East as a berm to contain the flood storage volumes would provide to be problematic, given the additional requirements and costs of using a municipal road for this purpose. In addition, land acquisition has not occurred so the amount of area for storage is currently limited.

2.3 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 SC-8 water retention facility, wetland and creek restoration within the Upper Battlefield Creek watershed. The Study Team consisted of the key members noted in **Table 2-1**:

STAGE STORAGE RELATIONSHIP

	ELEVATION (m)	VOLUME (m^3)
	192.00	0
▦	193.00	800
▦	193.50	17400
▦	193.70	31400



EXISTING 6.0mx1.1m
OPEN BOTTOM
CONCRETE CULVERT
(INV. EL. = 192.00m)

RAISE ROAD GRADES TO
A MINIMUM CENTRELINE
ELEVATION OF 194.00m
(EX. EL. = 193.50m)

EXISTING 600mmø
CSP CULVERT

T/B = 193.00m
INV. = 192.50m

T/B = 193.50m
INV. = 193.00m

MAXIMUM PONDING
ELEVATION = 193.70m
T/O FACILITY = 194.00m

LEGEND

〰	WATERCOURSE
〰	CONTOUR (0.5m)
—	EXISTING PARCEL FABRIC
🟥	EXISTING CULVERT
🟧	SUBWATERSHED BOUNDARY
🟪	SUBCATCHMENT BOUNDARY
100	SUBCATCHMENT ID#
25.0ha	SUBCATCHMENT AREA
⬅	OVERLAND FLOW DIRECTION
▭	LIMIT OF STORAGE

SCALE VALID ONLY FOR
24"x36" VERSION

FLOOD & EROSION CONTROL PROJECT
UPPER BATTLEFIELD & UPPER STONEY CREEK
CLASS EA

HAMILTON CONSERVATION AUTHORITY

STORAGE FACILITY
SC-8
(SCENARIO 1)

amec
foster
wheeler

Scale 1:2500
0 25 50 100

Consultant File No.
TPB168024

Figure No.
18

Last Saved: 2018-02-12 Last Saved By: richard.bartolo Plotted: 2018-02-14 Plotted By: richard.bartolo Path: P:\2016\Projects\TPB168024 - Stoney Creek HCA Study\06_DES-ENG\01_CAD\02_DWGS\05_WR\18-02(RepDrfFin)\Fig13-19 StageStoragePlans(SC5-8).dwg

Figure 1-1 SC-8 Conceptual Design from the Class EA Document

Table 2-1 Study Team Members

Scott Peck	Hamilton Conservation Authority (HCA)	Study Team Lead
Jonathan Bastian	HCA	Sr. Water Resources Engineer
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
Bennett Sun, P.Eng.	Soil Engineers	Geotechnical Engineer
Tara Brenton	Natural Resource Solutions Inc. (NRSI)	Project Manager, Sr. Terrestrial & Wetland Biologist / Certified Arborist
Patrick Deacon	NRSI	Terrestrial and Wetland Biologist
Amy Reinert	NRSI	Terrestrial and Wetland Biologist
Kaitlin Filippov	NRSI	G.I.S. Analyst
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
Tim Antonio	Water's Edge	Water Resources Engineer
Garth Grimes, P017	Detritus	Sr. Archaeologist

2.4 Study Area

The SC-8 property is located at Part Lot 15, Concession 6 in the former Saltfleet Township (amalgamated by the City of Hamilton in 2001) **(Map 1)**. The property is 9.05 hectares in area and fronts onto Green Mountain Road East with Tapleytown Road to the west, Mud Street East to the south and Fifth Road East to the east. The area contains roughly 400 m of the main channel of the Upper Stoney Creek which flows from south to north across the western portion of the property with additional intermittent tributary watercourses draining to the main channel from agricultural fields in the eastern half of the property. Lands within the general area are a mixture of agricultural lands, rural residential lots and the natural corridor associated with Stoney Creek.

The property forms a gently undulating plateau with elevations ranging from a high of approximately 196 metres above mean sea level (mASL) along Fifth Line East to a low of about 193 mASL along the creek channel immediately south of Green Mountain Road. Within the broader area, the dominant topographic feature is the Niagara Escarpment which is located approximately 2.1 km 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 consists of marsh and swamp thicket along the watercourse and agricultural fields and hedgerows over the balance of the property.

2.5 Applicable Policies, Legislation and Planning Studies

Table 2-2 Error! Reference source not found. 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 2-2 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: ○ Significant Woodland ○ Fish habitat ○ Confirmed and candidate SWH ○ 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, 91 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, 1 SAR bird was observed (Barn Swallow). • Regulated habitat for the SAR bird is not present within the property

Policy/Legislation	Description	Project Relevance
		• Based on field surveys, habitat is not present for SAR bat roosting
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. o 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.	• As any work is to be completed in the vicinity of the watercourse within the subject property, a proponent-led DFO assessment was required (once the final design is known) to ensure that the works will result in no residual effects to fish or fish habitat. • Based on the detailed design, an assessment was completed and indicated that a request for review should be submitted. The request for review (RfR) was submitted to DFO in November 2020. Once submitted it is currently taking 4-5 months for a biologist to be assigned to the project. • 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.
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.

Policy/Legislation	Description	Project Relevance
		• 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: ○ Agricultural System, ○ Natural System and ○ 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. • None of the features within the subject property are considered part of the Natural Heritage System (NHS).
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 proposed development must demonstrate no negative impacts to the regulated natural features or 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 main watercourse corridor and associated vegetation through the subject property is identified as a Natural Heritage Feature Core Area and two Key Natural Heritage Feature layers (Significant Woodland and Streams) under the RHOP. • A section of Battlefield Creek bisects the property and alterations are proposed to this feature and a tributary to this feature.

Policy/Legislation	Description	Project Relevance
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 tree inventory and Tree Protection Plan, following the City of Hamilton's Tree Protection Guidelines (2010) will be required if any trees need to be removed for the proposed development.
Ministry of Natural Resources and Forestry – Lakes and Rivers Improvement Act (RSO 1990 Chapter L3)	• 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
Ministry of Environment, Conservation and Parks – (Environmental Protection Act, RSO 1990 Chapter E.19 and the 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) required that the proponent receive an Environmental Compliance Approval	• Stormwater controls will require an ECA (previously known as a C of A)

3 EXISTING CONDITIONS

3.1 General Watershed Characteristics

The Upper Stoney 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). Stoney Creek has a total drainage area of 33.6 km^2 with most of this area located above (i.e. south of) the Niagara Escarpment. The SC-8 site has a drainage area of 7.4 km^2 upstream of Green Mountain Road. The headwaters of the SC-8 drainage area include a residential area in the Leckie Park neighbourhood, but is predominantly agricultural. The flow is primarily from west to east and then turns to the north before flowing into the SC-8 site. The main channel flows to the north through the site, and two additional tributaries flow from the west and join the main channel within the site. The upstream of the two tributaries will contribute to the wetland storage facility, while the downstream tributary will join the main channel downstream of the storage facility. The downstream tributary that does not contribute to the SC-8 wetland has a drainage area of 0.25 km^{2,} so the total drainage area that will be attenuated by the proposed facility will be 7.1 km^2. The downstream tributary has been subject to unauthorized modifications by a property owner and may be restored and connected to the storage facility in the future.

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.

3.2 Geology & Physiography

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.

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 (**Figure 2-1** Location of Boreholes) for location of boreholes), the investigation has disclosed that beneath a topsoil veneer the area of investigation is underlain by silty clay, overlying dolomite and limestone bedrock at a depth ranging from 2.4 to 5.8 m from the prevailing ground surface. Geotechnical testing (see **Appendix A**) indicated that the natural Water Content of the material ranged from 16% to 33% (median 23%) while the plastic limit was 16 and 22% and liquid limits were 29 and 47 The above results show that the silty clay is medium plasticity. The water content is slightly above its plastic limit, confirming the consistency of the clay deposit as revealed by the 'N' values.

3.3 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 3-1**.

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 Reformatory Quarry member forms the upper bedrock unit beneath the SC-8 site. Rock coring revealed a grey dolostone bedrock with Rock Quality Designation (RQD) values ranging from 30 to 83% (see **Appendix A**). 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.

3.4 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 seven (7) sampled boreholes, was performed on August 13 and 14, 2019. Groundwater monitoring wells, 50-mm in diameter, were installed in 6 selected boreholes to facilitate a hydrogeological study.

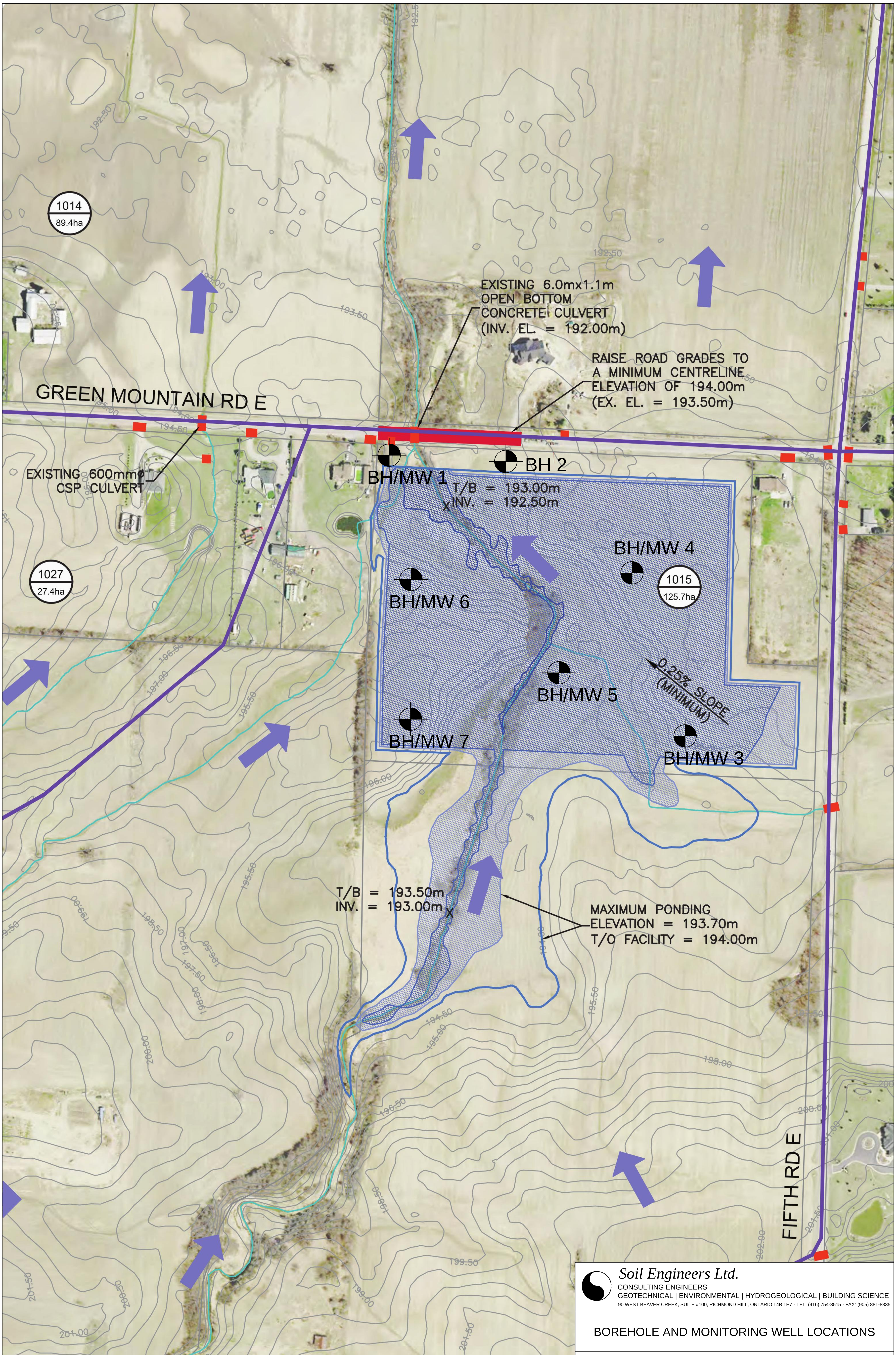


Figure 2-1 Borehole Location Plan

Soil Engineers Ltd.
CONSULTING ENGINEERS
GEOTECHNICAL | ENVIRONMENTAL | HYDROGEOLOGICAL | BUILDING SCIENCE
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 Phase II (Area SC-8)

DESIGNED BY:
CHECKED BY:
DWG NO.: 1
SCALE: 1:3000
REF. NO.: 1907-S107
DATE: JULY 2019
REV

3.4.1 Subsurface Conditions

The investigation has disclosed that beneath a topsoil veneer the area of investigation is underlain by silty clay, overlying dolomite and limestone bedrock at a depth ranging from 2.4 to 5.8 m from the prevailing ground surface. The bedrock is poor quality up to the depth of investigation, probably becoming good to excellent quality at the deeper level.

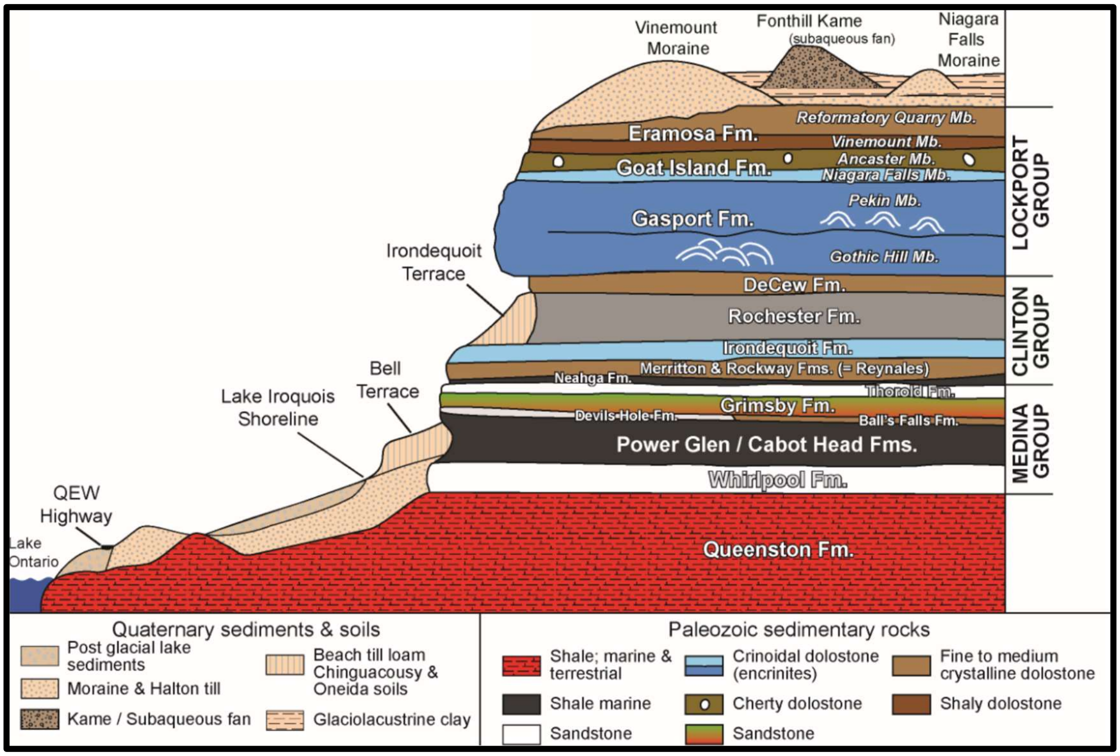


Figure 3-1 Conceptual Geological Section (from Brett and Brunton, 2018

As part of the Saltfleet Conservation Area Wetland Restoration Program, the area of investigation will be designed to create a wetland for strage of stormwater to reduce peak flows of the upper Stoney Creek for flood and erosion control. The basin of the proposed wetland will be at about El. 192.0 m.

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.

3.4.2 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:

Table 3-1 Runoff Coefficients

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 3-2.

Table 3-2 Estimated Water Content for Compaction

Soil Type	Determined Natural Water Content (%)	Water Content (%) for Standard Proctor Compaction	
		100% (optimum)	Range for 95% or +
Earth Fill/Silty Clay	16 to 30	20	16 to 24

The above values show that the silty clay is generally suitable for a 95% or + Standard Proctor compaction. Wet or weathered soils will require aeration prior to structural compaction. The silty clay should be compacted using a heavy-weight, kneading-type roller. When compacting the hard silty clay on the dry side of the optimum, the compactive energy will frequently bridge over the chunks in the soils and be transmitted laterally into the soil mantle. Therefore, the lifts must be limited to 20 cm or less (before compaction).

3.4.3 Bedrock

Refusal to auger drilling was contacted in the boreholes, at 2.4 to 5.8 m from the prevailing ground surface, or between El. 188.8 m and El. 191.5 m. It represents bedrock in this vicinity.

3.4.4 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 3-3**.

Table 3-3 Classification of Soils for Excavation

Material	Type
Bedrock	1
Silty Clay	2

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.

No continuous groundwater is anticipated within the depth of investigation. The yield of groundwater in any excavation is probably from the percolation of surface water. It can be drained towards sumps and removed by conventional pumping.

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.

3.4.5 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 seven (7) boreholes at the subject site was conducted on August 14, 2019. The boreholes were drilled to depths ranging from 4.3 to 6.1 m below ground surface. The borehole and sampling locations are shown on the Sampling Location Plan, Drawing No. I .

The boreholes were drilled to the sampling depths by a drilling rig. Soil samples were retrieved from the boreholes using a split spoon sampler, for soil classification and visual and olfactory observations. The sampling tool (i.e., split spoon) 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 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 (MECP) 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 thirteen (13) representative soil samples were retrieved from boreholes drilled 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. 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 3-4**):

Table 3-4 Results of Chemical Analysis of Soil Samples

Sample Name	Parameter	Unit	Table 1 Standards	Table 2 RPI Standards	Measured Value
BH1/3	Electrical Conductivity	mS/cm	O.57	0.7	0.624

In reviewing the results of the soil samples indicates that the tested parameters at the sampling locations meet Table 2 RPI Standards.

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

3.5 Hydrogeology

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

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

The majority of the boreholes remained dry upon completion of the field work and prior to rock coring. Groundwater was recorded at a depth of 5.5 m from grade or El. 190.9 m in Borehole 7. It should be noted that water was used for rock coring in Boreholes 2 and 5; therefore, record of groundwater in these boreholes after rock coring was not possible upon completion.

3.5.1 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 continuous across the site. 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 7 x 10^{-6} to less than 10^{-8} m s^{-1}). No measurements of bedrock permeability are available for the site, but solution-enlarged fractures will behave as open channels in the subsurface where present. We note that the development of karst is largely limited to the Reformatory Quarry member of the Eramosa Formation which is the host rock for karst development in the south part of the nearby BC-1 site, and for numerous karst features such as sinking streams, dolines, springs and caves at the Eramosa Karst Conservation Area approximately 7 km to the southwest of the SC-8 property (Buck et al., 2002).

3.5.2 Groundwater Flow

Precipitation falling on the SC-8 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.

3.5.3 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. 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 Monitoring Wells 1, 4, 5 and 7. Initial measurements taken in late August 2019 indicate that the groundwater table is located between 1.2 and 3 m below ground surface. During the autumn, the groundwater levels are observed to rise at all locations in response to the seasonal increase in precipitation and reduced evapotranspiration. The groundwater level in MW-1 fluctuated between about 1 and 1.5 m until late October when the level rose to about 0.3 m below ground surface. Response to precipitation events was rapid with a slow gradual decline in water levels over the week or so following the event. Groundwater temperature reached a peak of approximately 13^{o}C in mid-October before declining thereafter. Water levels in MW-4 declined steadily from about 2.5 m depth at the end of August to about 3.2 m depth at the beginning of November. During December, the groundwater levels recovered to about 2 m below ground surface. No response to precipitation events was apparent at this location. Groundwater temperature in MW-4 increased slowly from about 10^{o}C at the end of August to 11^{o}C at the end of December with the slow thermal response being consistent with very low permeability soils and generally low groundwater recharge. In MW-5, groundwater levels fluctuated around 1.4 m below ground surface between the end of August to the beginning of November when the level abruptly rose to ground surface during a period of heavy rainfall. The abrupt water level change is interpreted to represent the flooding of the wellhead as this well is located in a low area near the confluence of the Stoney Creek tributary and the channel draining the agricultural fields in the east part of the site. A response to rainfall events similar to that in MW-1 was observed at this location. Groundwater temperatures declined slowly from a peak of approximately 15^{o}C at the end of August to about 8^{o}C at the end of December. The water levels in MW-7 varied similarly to MW-4 with a marked thermal lag and no obvious response to precipitation events.

No signs of rapid recharge that might be consistent with undertraining by karst features was noted in any of the wells. Overall, the seasonal changes in groundwater level and temperatures are consistent with low permeability soils and low rates of groundwater recharge. The construction of a new wetland impoundment in this area will increase both evapotranspiration and recharge to the overburden and underlying bedrock aquifer but the low permeability of the soils will limit the amount of water exfiltrating through the base of the wetland and the majority of water losses from an permanent water features are predicted to be from evapotranspiration.

3.6 Hydrology

The contributing drainage areas of the SC-8 site are predominantly agricultural, with some residential areas in the southwest portion of the contributing area. This area is comprised of agricultural uses, residential uses, fallow lands and remnant natural heritage features (wetlands, forest areas and watercourses). Stoney Creek has a total drainage area of 33.6 km^2 with most of this area located above (i.e. south of) the Niagara Escarpment. The SC-8 site has a drainage area of 7.4 km^2. The headwaters of the SC-8 drainage area include a residential area in the Leckie Park neighbourhood but is predominantly agricultural.

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. Phosphorus and Nitrogen pollution are also associated with agricultural runoff and soil loss, but the increased floodplain connectivity and wetland vegetation in the storage facility will provide additional avenues for nitrogen fixing and phosphorus mineralization, which will reduce the potential for algal blooms downstream. To fully understand the hydrologic conditions at key locations of the site, a hydrologic model was developed.

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. The subcatchments used in the model are shown in the Appendix. Details of the methodology of developing the hydrologic model are included below.

3.6.1 Methodology

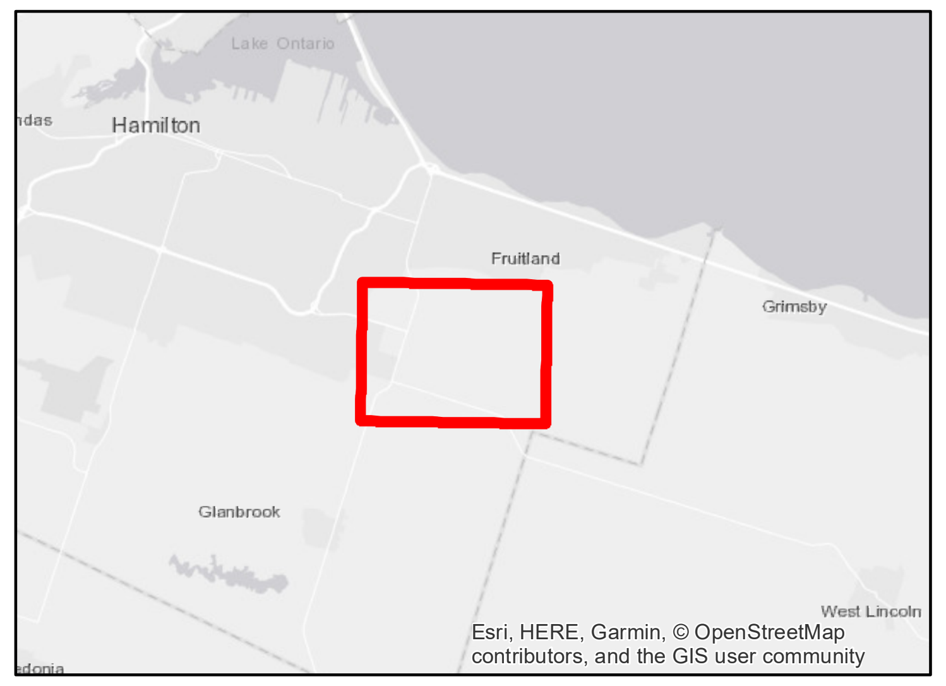
Channel flows within the site were determined using HEC-HMS based on geomorphic survey data, orthoimagery-derived digital elevation model (DEM), and background data provided by HCA. The subcatchments used in the model are shown in **Figure 2-3**. A runoff curve number grid had previously been produced 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. Parameters form the HCA Floodplain Mapping Standards were generally used, except for using the TR-55 method for determining the Time of Concentration and using the Chicago Storm.

3.6.2 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.



Esri, HERE, Garmin, © OpenStreetMap contributors, and the GIS user community

Legend

🟥 Subbasin

— River

Scale 0 270 540 810 1,080
Meters
1:10,525
Projection: CRCS UTM Zone 17
Datum: CGVD2013

North Arrow
N

Approved By:

THIS IS NOT A PLAN OF SURVEY

REVISIONS

NO.	DESCRIPTION	BY	DATE
1	Original	RG	June 3, 2020

Consultant

water's edge
ENVIRONMENTAL SOLUTIONS TEAM LTD.

Hamilton Conservation Authority

SC-8 Wetland Storage Facility Design

HEC-HMS Subcatchments

Date:
June 3, 2020

Drawn By:
RG

File No.:
WE19028

Figure: 2-3

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.

3.6.3 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.

3.6.4 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

3.6.5 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 3-5**. 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 3-5 Curve Number Lookup Table

Landuse	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

3.6.6 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.

3.6.7 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 3.6.5. 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:

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

3.6.8 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.

3.6.9 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).

3.6.10 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.

3.6.11 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).

3.6.12 Time Steps

Both the precipitation events and channel routing used a time step of five (5) minutes. This level of precision ensures that the peak flows are accurately represented in the modelling results.

The existing peak flows of Battlefield Creek at First Rd. E, and the inflows of the two proposed facilities are shown in **Table 2-5**.

3.6.13 Results

To validate the results of the hydrologic modelling, the peak flows of the current model were compared to the flows determined as part of the 2018 Wood study. Differences in peak flows were expected due to the 2018 study using the 12-hour SCS Type II distribution rather than the 24-hour Chicago Storm distribution that is required based on HCA Floodplain Mapping Standards. **Table 2-4** shows the 2018 study flows compared to the SC-8 model flows at Green Mountain Road. Comparisons between existing and proposed conditions are included in **Section 4.1**.

The comparison of existing conditions peak flows of Stoney Creek at Green Mountain Road between the 2018 Flood and Erosion Control Class EA and the HEC-HMS model used to size the wetland facility are shown in **Table 3-6**. This location is located upstream of the escarpment and spills with Battlefield Creek and is not influenced by the proposed BC-1 facility. Further modelling parameters and results are provided in **Appendix F.**

Table 3-6 Comparison of Existing Conditions Peak Flows with Previous Modelling

Storm	WOOD 2018 (SCS Type II 12-hour)	WEEST 2020 (Chicago 24-hour)
2-year	2.92	7.1
5-year	6.28	10.5

10-year	9.49	12.7
25-year	13.31	15.7
50-year	16.67	18.2
100-year	20.06	20.7
Regional (Hazel)	58.07	59.3

3.7 Fluvial Geomorphology

The existing channel within the SC-8 site and the downstream receiving reach have been historically aligned to maximize the useful agricultural land but lead to faster conveyance and higher downstream flood risks. Since it is not feasible to restore much of the channel due to its natural meandering state due to property constraints, lowering the peak flows would help to mitigate the effects of channelization. Both the channel within the proposed facility and in the reach downstream of Green Mountain Road have similar geomorphic conditions and appear to be a Rosgen C-type channel, except that the sinuosity is lower than the defining criteria. Therefore, the channel can be classified as an anthropogenically-altered Rosgen C-Type channel. Attention was paid to the reach downstream of the facility, as that reach would be subject to the largest change in hydraulic regime. The geomorphic parameters for the reach downstream of the facility are shown in **Table 3-7**.

The channel is largely vegetated, and exposed bank areas consist mostly of compacted clays that show no significant evidence of erosion. It is unlikely that the existing channel will erode following the construction of the wetland storage facility, but the existing channel should be monitored for five years post-construction to confirm this.

Table 3-7 Geomorphic Parameters for the Existing and Proposed Channels

Parameter	Existing Channel
Bankfull Width (m)	4.84
Bankfull Mean Depth (m)	0.24
Bankfull Max Depth (m)	0.48
Bankfull Area (m^2)	1.17
Wetted Perimeter (m)	4.94
Hydraulic Radius (m)	0.24
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	C6

Overall, the reaches within the SC-8 study area are generally stable. Signs of significant erosion were not observed downstream of the proposed facility, and the altered site hydrology is not likely to have a detrimental effect on geomorphic processes.

3.8 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**.

3.8.1 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. Authorization to proceed with the study was received in June 2019. The field program was initiated on June 19, 2019 and was completed by September 30, 2019. Included in the field program were:

- Vegetation Surveys
- Bird Surveys
- Herpetofaunal Surveys
- Reptile and Amphibian Surveys
- Bat Surveys
- Insect Survey.
- Aquatic Habitat Assessments

3.8.2 Significance and Sensitivity of Natural Features

3.8.2.1 Watercourses and Fish Habitat

The portion of Stoney Creek which crosses the subject property is considered fish habitat and is identified as a Key Hydrologic Feature Stream (City of Hamilton 2018). Fish were found within this feature during the electrofishing, indicating that it provides direct habitat for at least a portion of the year. The additional aquatic features on site (Tributary 1 and 2) may still be considered fish habitat under the *Fisheries Act* (Government of Canada 2019b) as they would provide indirect habitat through directing 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. As per these guidelines, the fish habitat would be considered marginal for the intermittent features.

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 will need to be completed. If there is potential for impacts to fish and fish habitat then a request for review should be completed once design details are known (at least 60%). NRSI has completed an assessment of the works, as well as an aquatic effects table to determine the likelihood of an impact. 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 form was submitted to DFO in November 2020. It is expected to take 4-5 months for the RfR to be triaged and a biologist to be assigned to the project. If determined through the review that an Authorization is required, an application form will need to be completed. Once the application form is deemed to be complete, a 90 day time frame begins to get the Authorization.

3.8.2.2 Wetlands

The subject property contains a complex of marsh and swamp thicket along the watercourse and extending beyond the property to the north and south (**Map 2**). These unevaluated features are part of the Natural Heritage System (Core Area) (City of Hamilton 2018). The hydrology of these features is dependent upon the hydrologic regime of the watercourse which receives headwater flow from the south in the vicinity of Tapleytown. Any sizable reduction in the surface water input to the wetland is likely to induce drier conditions and result in a shift toward mesic thicket and lowland forest conditions, likely to be most evident at the perimeter of the feature.

In general, the wetland are typical of low-lying riparian features on silty-clay soils in the Hamilton and Niagara area. Plant species diversity is low to moderate with no species having a high Coefficient of Conservatism (CC) value (i.e. species with a high fidelity to intact, high quality habitats). The predominance of European Buckthorn along the watercourse limits the vegetation diversity but does provide a corridor of natural cover to aid in wildlife refuge and movement. The sparse tree cover, dominated by fast-growing Crack Willow with some mid-age American Elm and Bur Oak indicates that the woody riparian vegetation has established relatively recently and the watercourse vegetation was very likely cleared historically.

The construction of the berm is likely to result in a larger area of wetland as a greater depth of surface water will be held on site for a longer period than the current conditions. Additionally, the design incorporates the creation of several wetland features within the retention area where upland row crop agriculture currently exists. Site grading to the west and east of the existing wetland to increase capacity within the retention area could result in a drying effect on the wetland whereby the water contained within the feature is spread over a greater area. It is also noted that a reduction in tree and shrub canopy will result in increased evapotranspiration, in particular where standing water is distributed over a wide, unvegetated area.

The wetland within the study area is unevaluated. The nearest evaluated wetland complex is the Vinemount Swamp PSW which is approximately 750m northeast of the subject property (and occurs within the Stoney Creek watershed). As surveys did not document SAR presence within the subject property, and given the distance from other PSWs to consider wetland complexing, it is unlikely that the wetland on site warrants PSW designation.

The marsh and swamp thicket features within the subject property have been identified as candidate SWH for Amphibian Breeding (Wetland), candidate Amphibian Movement Corridor and candidate habitat for terrestrial crayfish habitat. The observation of a Monarch caterpillar feeding on Swamp Milkweed was made within the marsh to the south of Green Mountain Road East; however, this report has not identified the habitat as significant for this species. These SWH types are discussed further in the NRSI report (**Appendix D**).

3.8.2.3 Woodlands

A large portion of the vegetated corridor is identified on **Map 1** as a Key Natural Heritage Feature Significant Woodland and is part of the Natural Heritage System (Core Area) (City of Hamilton 2018). ELC surveys in 2019 found this feature to be comprised predominantly of non- native European Buckthorn with a patchy and limited tree canopy. The tree and shrub cover along the watercourse serves to cool water temperatures and reduce erosion and sediment deposition. The cover of Buckthorn, as well as Reed Canary Grass and Broad-leaved Cattail within the channel, is very tolerant of grading disturbance and fluctuations in hydrology and this feature would quickly adapt to alterations in site hydrology.

Although it would appear that the feature does not constitute a woodland, based on the limited tree cover and discontinuous canopy, this designation is supported as there is high potential for the enhancement of this feature. Following site restoration, it is anticipated that this feature will continue to provide valuable services including water quality improvement and wildlife habitat.

3.8.2.4 Significant Wildlife Habitat

Based on background information review, desktop analysis and field studies completed in 2019, 3 SWH types were determined to be candidate for the study area with no habitat types confirmed.

3.8.2.5 Habitat of Species at Risk

Suitable habitat for SAR bat roosting and foraging is limited within the subject property. Bat acoustic survey data suggests that bat calls recorded within the subject property are likely (although not certainly) attributed to Eastern Red Bat and not SAR *Myotis* species.

Based on the number and timing of recorded sequences, these bats are likely using habitats within the vicinity of the monitoring station for foraging or as a movement or travel corridor between key habitats. The swamp (SWT2-13) and marsh (MAM2) communities along the watercourse corridor are considered candidate foraging and movement/travel corridor habitat for bat species. Foraging, movement or travel corridor habitats are considered the least sensitive to alteration as opposed to maternal roost features (MNRF 2012). This report assumes that SAR bats and their regulated habitat (roosting features) are not present and naturalization of the property will result in enhanced habitat which may support SAR bats once vegetation cover has established.

3.8.3 Impact Analysis

Potential impacts arising from the proposed development are determined by comparing the details of the proposed development with the characteristics of the existing natural features and their functions, as shown on **Map 3**. Where the berm creation works overlap with natural features or their vegetation protection zones, impacts may arise. The following is a description of the types of impacts that are 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.
- Induced and cumulative impacts associated with impacts after the berm creation is complete 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 development area is provided in **Table 3-8.**

Table 3-8 Summary of Significant Natural Features, Impacts and 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 berm construction and wetland creation will directly impact Stoney Creek as well as Tributary 1 and 2 through altered flow regimes, removal of fish habitat and the creation of a barrier to fish passage. Indirect Impacts • Indirect impacts to the watercourse and fish habitat may include changes to water quality (temperature) and quantity (reduced flow below berm), as well as erosion and sedimentation, contamination, nutrient concentrations during construction. Induced Impacts • Potential for induced impacts to fish through the creation of the barrier	• Creek naturalization should be a focus for restoration and should include the creation of meander and pools of varying depths. This mitigation aligns with the HCA objective to restore natural function to the watercourse. • The establishment of vegetation on the berm and within the created wetlands will enhance water quality and reduce water temperature, in time, through shading. • Tributary 1 has limited vegetation cover and the re-instated alignment should be a focus for restoration to reduce sediment transport. • The Pathways of Effects (PoE) outlined by DFO should be reviewed, and the potential stressor and potential effect of fish and fish habitat determined. Mitigation measures (both land-based and in-water) should be provided to determine if there are residual effects. Based on the works proposed, a RfR form was submitted to the DFO in November 2020. Appendix IX (of **Appendix D**) is the Aquatic Effects Summary Table which outlines the PoEs, potential impacts, mitigation measures, and residual effects that have been updated based on the detail designs. • Monitoring of fish habitat and fish populations should occur post construction. • The wetland I expected to decrease less frequent storm event peaks and reduce erosion, and is expected to provide more consistent groundwater and baseflow • throughout the year. • All berm construction and creek enhancement should be completed during dry conditions and within the in-water timing window (and outside of breeding bird window) – September through March, ideally. • Implement a Erosion and Sediment Control Plan as per the drawing provided by Water's Edge. • Develop a Spill Response Plan.

Significant Natural Feature	Relevant Policies	Potential Impacts	Recommended Mitigation
			- Equipment operation, refueling and maintenance in designated areas away from existing natural features. - Stabilization of soil stockpiles and berms using a nurse crop. - 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, hydrometeorological 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) - Provincial Policy Statement (MMAH 2014)	Direct Impacts - The berm will directly impact the unevaluated wetland feature in the vicinity of the Green Mountain Road East culvert and extending south (berm footprint and excavated retention area). Indirect Impacts - The design of the wetland and total area excavated will ensure that private property upstream of the site will not be flooded. Wetland to the north of Green Mountain Road East may receive lower volume and less frequent surface water flow given that the berm is intended to hold water on the HCA property.	- In order to preserve the hydrology of riparian wetland below the berms, the control structure should maintain some amount of surface water flow to the extent possible. - The berm will result in a net increase in wetland area and native plantings or seeding should be completed to enhance the diversity of the created habitat. This aligns with the HCA objective of enhancing and enlarging the existing wetland areas and creating additional wetlands as well as improving flood attenuation capacity and reducing erosion downstream. - The planting of a diversity of nature trees and shrubs, both as part of the wetland creation and future HCA activities will offset the removal of a small number of trees and shrubs in the footprint of the berm. - Created wetland, as shown on the Water's Edge drawings, includes open water marsh or deeper vernal pool areas, meadow marsh. The planting of trees and shrubs will create areas of swamp or lowland forest

Significant Natural Feature	Relevant Policies	Potential Impacts	Recommended Mitigation
		• The Hydrogeological Assessment (Greer Galloway 2020) states that 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. • Potential for erosion and sedimentation to impact the wetland during construction. Induced Impacts • The potential for spread of the existing patches of Common Reed and European Buckthorn, or introduction of new non- native species.	once the plantings mature and canopy begins to form. A combination of habitats will enhance the value of the site to a wide range of wildlife. • The limit of grading should be protected with heavy duty sediment fence which will double as vegetation protection fence. The fence will be removed once soils are stable on site. • Implement an Erosion and Sediment Control Plan. • Develop a Spill Response Plan. • Equipment operation and maintenance should occur in designated areas. • Stabilization of soil stockpiles 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.
Significant Woodland	• Rural Hamilton Official Plan (City of Hamilton 2018) • Provincial Policy Statement (MMAH 2014)	Direct Impacts • Berm construction may require the removal of trees along the watercourse to achieve the desired grading in the retention area above the berm. The RHOP indicates that the Significant Woodland does not extend to Green Mountain Road East, but ends roughly central in the subject property. 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	• To the extent possible, native trees and shrubs should be retained and incorporated into the design. • The removal of European Buckthorn (through grading or herbicide application, or a combination) is recommended. • The limit of grading should be delineated with heavy duty sediment fence which will be maintained until the nurse crop has established. • Disturbance to wildlife during construction will be temporary and is not anticipated to be significant

Significant Natural Feature	Relevant Policies	Potential Impacts	Recommended Mitigation
		- Indirect impacts include disturbance to woodland wildlife during construction (noise, dust) and the potential for minimal 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	
Significant Wildlife Habitat	- Provincial Policy Statement (MMAH 2014) - Rural Hamilton Official Plan (City of Hamilton 2018)	Direct Impacts - Direct impacts to candidate SWH may include removal of Amphibian Breeding Habitat (Wetland) and the associated amphibian movement corridor. Both features may be restored, but the quality of habitat may be compromised for a number of years until naturalization efforts become effective. Indirect Impacts - The creation of the berm may result in deeper or more prolonged inundation which is likely to benefit amphibians. Induced impacts - Introduction or proliferation of non-native or invasive species may reduce the quality of habitat and in turn reduce the suitability for anuran breeding and movement.	- In order to mitigate impacts to amphibian habitat, it is recommended that the retention area above the berm and the deeper wetland features be naturalized to provide a variety of wetland habitat types (marsh, thicket, swamp). - While much of the property will comprise natural habitat in time, native species plantings should focus on enhancing the corridor along the watercourse to facilitate wildlife movement in a north-south direction. - In order to prevent the spread of Common Reed or other non-native species, equipment is to 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. - The installation of wildlife fencing along Green Mountain Road East and the use of the existing culvert as a wildlife passage structure would help to reduce road mortality. In the long term, installation of a formal eco-passage should be considered. These undertakings will require the HCA staff to work with the City of Hamilton Roads Department.

Significant Natural Feature	Relevant Policies	Potential Impacts	Recommended Mitigation
Breeding Bird Window	• Migratory Birds Convention Act (Government of Canada 1994)	• Vegetation removal within the breeding bird season may result in incidental take of bird species protected under the MBCA.	• 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 the wetland habitats on site, where vegetation clearing is proposed within the breeding bird window, nest sweeps are not likely to be effective. If necessary, sweeps may be conducted within areas of fallow field; however, the presence of an active nest will delay works.

3.9 Archaeology

The Stage 1 archaeological assessment compiled the available information concerning any known and/or potential archaeological heritage resources within the Study Area. A property inspection was conducted under PIF P017-0735-2019 issued to Mr. Garth Grimes by the MTCS. The property inspection was completed on July 21, 2019.

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 areas include all areas were limited to the overgrown weed and grass area and the overgrown areas with small trees and shrubs on either side of Stoney Creek. As such, a **Stage 2 archaeological assessment was recommended for these areas and was completed directly under HCA.**

In accordance with Section 2.1.2 of the Standards and Guidelines (Government of Ontario 2011), if portions of the Study Area retaining archaeological potential are inaccessible for ploughing, they will be subject to a typical test pit assessment at a 5m interval. Each test pit must be approximately 30 centimetres (cm) in diameter and excavated 5cm into sterile subsoil. The soils 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.

If portion of the overgrown weeds and grass that retains archaeological potential and is accessible for ploughing it 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.

Furthermore, the remainder of the Study Area which comprises a portion of Stoney Creek and a tributary of Stoney Creek were evaluated as being permanently wet and therefore were determined to retain no potential, as per Section 2.1, Standard 2a of the Standards and Guidelines (Government of Ontario 2011). This permanently wet area was photo documented during the Stage 1 assessment as per Section 2.1, Standard 6 and Section 7.8.6, Standard 1b of the Standards and Guidelines (Government of Ontario 2011).

Lastly, if any of the areas recommended for Stage 2 assessment are determined to be previously disturbed or permanently wet during the course of the Stage 2 assessment, they will be photo documented as per Section 2.1, Sections 2b and 6 of the Standards and Guidelines (Government of Ontario 2011).

It is noted that Detritus carried out a Stage 2 assessment directly for HCA. Please refer to HCA for updated archeological information on SC-8.

4 WETLAND STORAGE FACILITY DESIGN

4.1 Wetland Storage Facility

4.1.1 Design Rationale

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

1 The wetland storage facility suggested the use of the Green Mountain Road berm as the primary control structure. The roadway was also to be raised to provide the necessary storage; and,
2 A portion of the lands assessed in the Class EA at the southeast corner of the site are not owned by HCA and will not be a part of the wetland storage area.

The study team proposed a wetland storage facility that included a berm along the west, north, and east sides of the site. The berm will cross the existing channel about 36m upstream of the culvert on Green Mountain Road in order to create a pool that will dissipate energy from the storage facility outlet. This area will also contain large stone to prevent erosion from high-velocity outflows or flows over the weir.

The primary design goal of the SC-8 wetland storage facility is to reduce flooding in the lower reaches of Stoney Creek. SC-8 will be one of three facilities that will collectively attenuate an equivalent volume to a standard stormwater management facility. Currently, fish can travel unimpeded through the existing channel, so a box culvert was selected to provide a link between the reaches upstream and downstream of the berm. The box culvert was sized to control the 25mm storm and will allow fish passage in most scenarios below the 25mm storm. The box culvert will contain 0.4m of large substrate to resist high-velocity flows during major events.

On-line storage facilities will inherently increase the water temperature to some degree, but since it is a warm water system and the facility will only be inundated occasionally, the increase in temperature is unlikely to create any substantial impacts on aquatic species.

Inside of the proposed reservoir area the existing channel and riparian area will remain undisturbed to maintain the existing habitat. In the floodplains of Reach 1 (**Map 2**) two wetland areas have been designed. The wetlands will be graded so that the minimum elevation is below the outlet invert to prevent groundwater flow from emptying standing water. The wetlands will fill when the reservoir level is higher than the existing bankfull stage. An irregular shape was used as the wetland footprint to make it appear more natural. Typical wetland flora will be added to help create a functioning ecosystem that will support a more diverse range of species including amphibians and a wider variety of birds.

Outside of the main channel and the riparian areas there is very little habitat value currently, so adding wetlands and improving the connection between the channel and the floodplains will significantly improve the habitat value and provide additional water quality benefits. By dispersing flow over the floodplains and wetlands, the vegetation will be able to uptake nutrients including nitrogen and phosphorus and reduce the potential for algal blooms downstream or in Lake Ontario.

To summarize, the proposed wetland facility will be able to meet the design goal of attenuating peak flows for the 25mm storm while also maintaining fish passage, augmenting the quality and diversity of habitat, and providing water quality benefits. The pond may also increase the temperature slightly, but this should not substantially impact aquatic species.

4.1.2 Design Summary

The proposed design includes the following:

1. Construction of a wetland storage facility at the SC-8 site, consisting of site regrading, a berm, outlet control structures, and constructed wetland areas below the outlet invert;

2. Inclusion of natural vegetation on the berms, banks and other disturbed areas; and,
3. Removal of in channel debris and other fish passage barriers.

4.1.3 Wetland Storage Facility Design

The proposed design calls for the construction of an impoundment upstream of Green Mountain Road. The impoundment will follow a meandering pattern to look more natural and will be vegetated except for the spillway, which will include rip-rap protection. The berm will be located along the west, north, and east sides of the site and will tie in with the existing surface on the south side of the site. The stage-storage-discharge relationship summary for the facility is shown in **Table 4-1.**

Within the storage facility, the existing channel and riparian areas with native vegetation will be maintained, while the agricultural overbank areas will be regraded to meet the storage targets. Four wetland areas will be included in the overbank areas. The wetland areas will be graded to have an invert lower than the facility outlet in order to remain inundated after the active storage areas have emptied following a storm. The existing channel would typically only spill over its banks during events larger than a 1.5-year return period. The wetland facility will increase the frequency at which the channel will spill over its banks and fill the wetland areas, which will create a sustainable wetland ecosystem and provide habitat and over wintering areas for a wider range of species than what is currently supported, including turtles and amphibians. The native soils in the area have a low hydraulic conductivity and will provide limited groundwater recharge. The corollary of this is that the wetlands will empty slowly following a storm event and losses will be largely due to evaporation.

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. The original size of the wetland was reduced in order to not increase flooding upstream. As a result, reduction of flows was subject to the more frequent return periods. The available storage areas were constrained by adjacent properties, so the storage in the available area needed to be maximized to meet the design goals in the Class EA. The maximum reservoir level is 51 cm higher than recommended in the Class EA to account for required freeboard for the 100 year flood. The increased elevation is not expected to impact the surrounding area based on HEC-RAS modelling. The slight increase in flood risk upstream of the facility will be offset by the reduced flooding of more sensitive land uses downstream.

The 100-year 24hr Chicago storm was used to evaluate the performance of the facility. The facility will draw down within 48-hours in order to attenuate events occurring in close succession. Small, frequent events will be drawn down quickly as the box culvert will convey the entire flow below a 1:1.5-year event. This will ensure that fish passage is maintained through the facility, but will reduce the attenuation of small events. Due to the requirement of fish passage, there is a need for a minimum flow. The potential for the facility to mitigate erosion issues is reduced because of this.

Overall, the HEC-HMS model showed that the facility would perform well for the flood control objectives, based on its ability to attenuate the 25mm storm The existing conditions model showed that the peak flow of the 25-mm storm would be 5.8 m^3/s at the facility outlet. The proposed conditions model showed that the peak flow from the 25 mm event would be 4.9 m^3/s. The amounts to a 15.5% reduction for the 25mm storm. The impact of the reduction in the more frequent return periods means that downstream will more often see a reduction in peak flow events and erosion potential.

4.1.4 Updated Stoney Creek HEC-HMS model.

In order to determine the impacts of the SC-8 and BC-1 on the downstream reaches (SC-4), the SC-8 and BC-1 models developed in 2019 were merged with the floodplain mapping model, water's edge developed for all of Stoney and Battlefield creek. This allows for the modelling of controlled and uncontrolled flows. Additionally, this updated model has more discrete subbasins for the wetland facilities. As a result, the uncontrolled flows downstream SC-8 and BC-1 will be marginally different from the original 2019 HEC-HMS model for Stoney Creek. Please see **Figure 4-1** for schematic of merged HEC-HMS model.

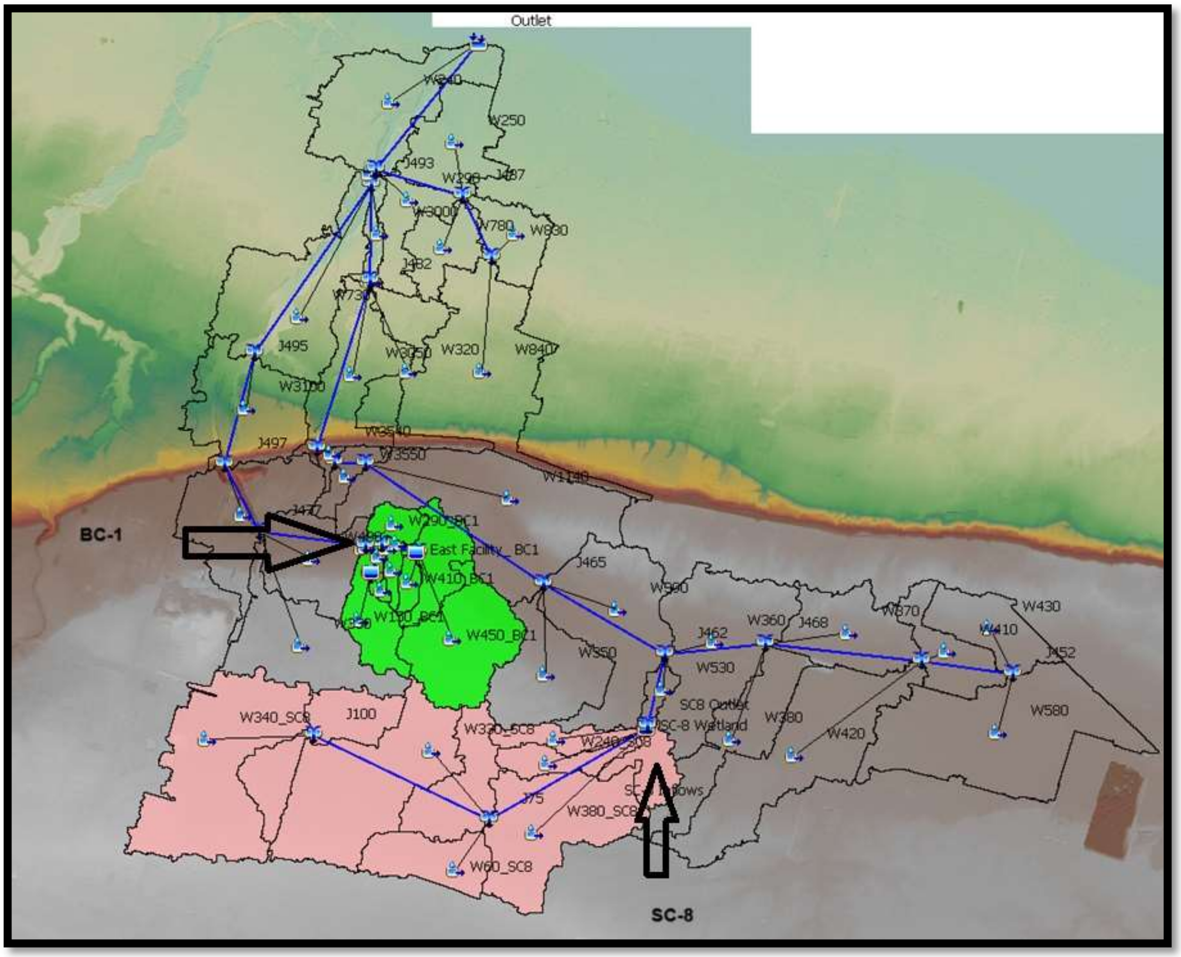


Figure 4-1 Merged HEC-HMS Model 2024

4.1.5 Site Specific HEC-RAS Model

A site specific HEC-RAS model using HEC-RAS 6.4.1 was developed for this project in order to precisely determine the impact of this wetland on the upstream and down stream of this project. Due to lack of version back up capability, the full stoney creek model was not updated with SC-8 wetland. Cross sections we drawn parallel to the proposed berm. More frequent cross section spacing was drawn compared to the full stoney creek HEC-RAS model. The same Mannings N values (0.035 for channel and 0.055 for overbank) were used in the new model. Ineffective flow areas were added based on the curvature of the floodplain. Downstream boundary conditions were selected as having a known water level based on the Stoney Creek HEC-RAS model. The model was run in mixed flow regime with the upstream water level being normal depth. The existing conditions terrain was based on the 2021 GEOHUB LiDAR (CGVD 2013 datum). The Proposed Terrain was created based on the watershed design surface in AutoCAD combined with the 2021 GEOHUB LiDAR. See **Figure 4-2** & **Figure 4-3** for schematic of site specific HEC-RAS model.

The rating curve used for the storage-discharge relationship in HEC-HMS was developed in HEC-RAS. This is because the berm discharge is outlet controlled. There is significant backwater from downstream Green Mountain Road. As, a result, simple orifice and weir equations would not accurately predict the SSD relationship alone to what would take place in the real world.

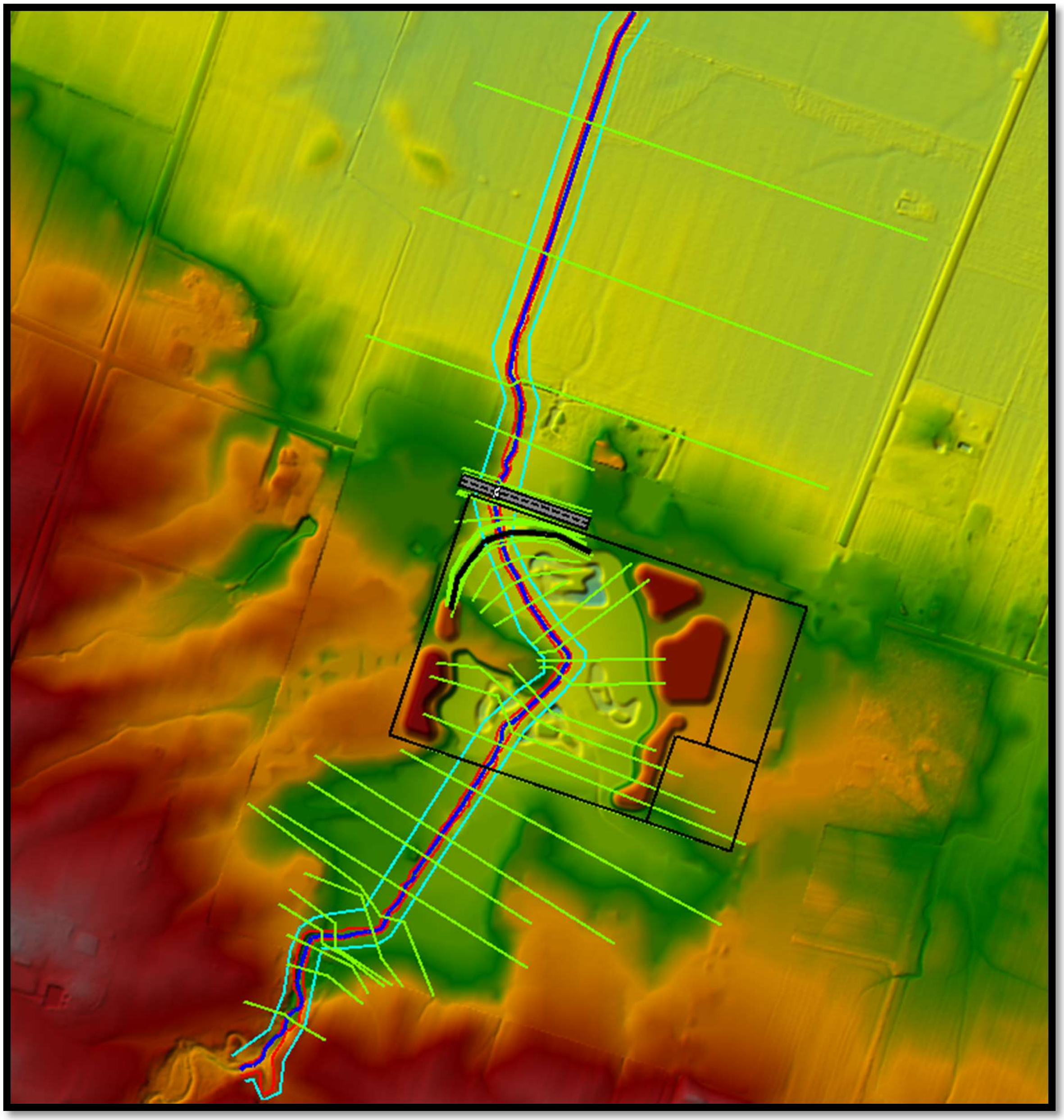


Figure 4-2 2024 HEC-RAS Model Extents

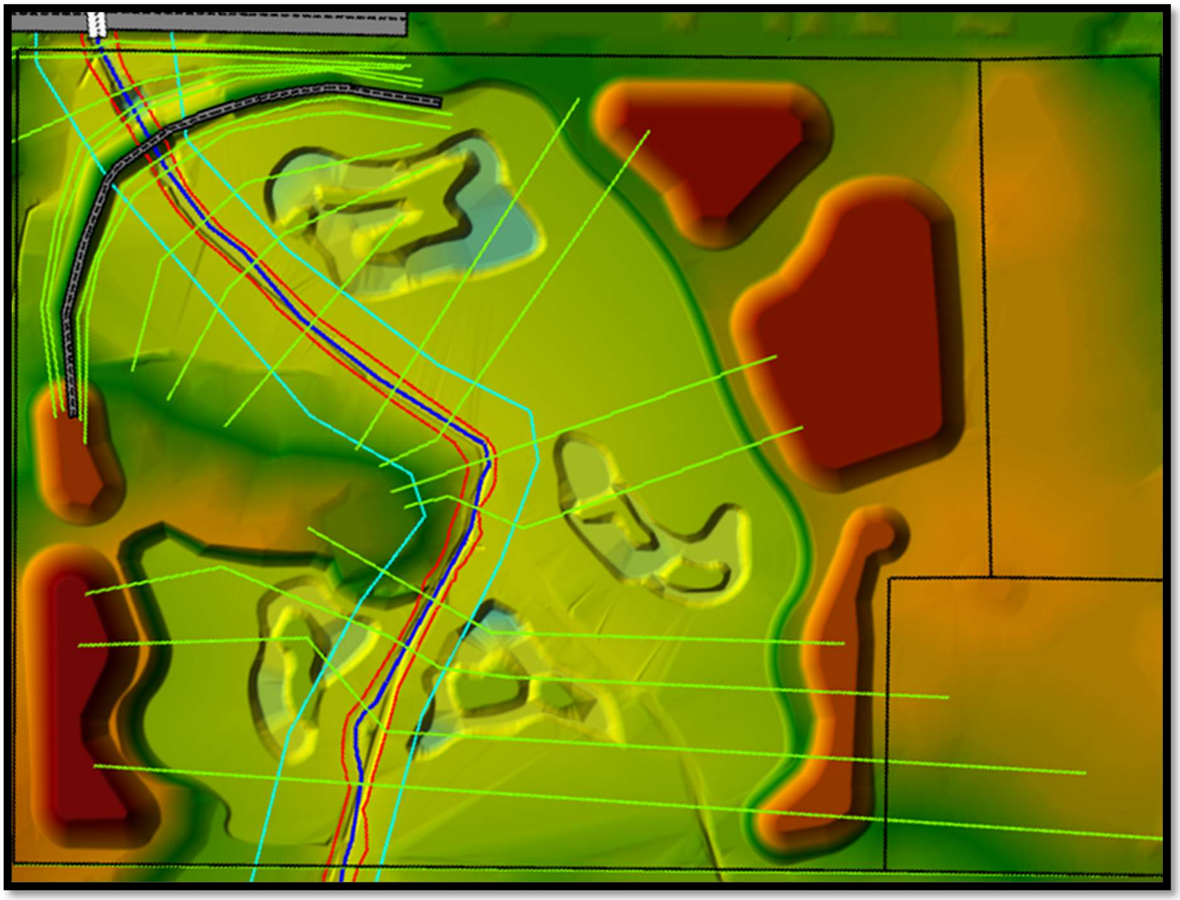


Figure 4-3 2024 HEC-RAS Close Up

Table 4-1 SC-8 Proposed Stage-Storage-Discharge Relationship Summary

Elevation (m)	Storage (1000 m^3)	Discharge (m^3/s)
191.400	0	0
192.250	18.38	0.5
192.389	21.85	1
192.656	28.48	2.5
192.876	33.97	5.6
193.432	47.78	11.3
193.613	52.29	15.5
193.678	53.89	18
193.752	55.75	21.4
193.799	56.92	24.1
193.845	58.07	26.8
194.020	62.42	40.0
194.186	66.53	57.4

4.1.6 Outlet Structures

The outlet of the facility will consist of a box culvert that ties into the up- and downstream channel to allow fish passage and an overflow weir. At the top of the berm is an overflow weir that will begin to flow at about the 2-year storm and will provide enough conveyance to ensure that the rest of the berm will not be over-topped, except during the regional event. The overflow spillway and a portion of the receiving channel will be lined with stone of varying sizes in order to resist erosion during high water events.

The existing and proposed peak flows at the outlet of SC-8 at the facility outlet are shown in **Table 4-2**.

Table 4-2 Existing and Proposed Conditions Peak Flows at Green Mountain Road

Storm	Peak Flow (m^3/s)		Percent Reduction
	Existing	Proposed	
25mm Event	5.8	4.9	15.52
2-year	11.7	10.4	11.11
5-year	16	15	6.25
10-year	18.5	17.9	3.24
25-year	22	21.7	1.36
50-year	24.7	24.6	0.40
100-year	27.6	27.4	0.72
Regional (Hazel)	59.3	59.2	0.17

4.1.7 Culvert Substrate

The facility outlet includes a box culvert lined with substrate for the purpose of fish passage. The bed shear stress in the culvert has the potential to be much greater than the channel during flood events, due to the possibility of it pressurizing, particularly during extreme events. The pressure drop across the berm creates an energy slope of about 0.9% when the reservoir is full, which is greater than the 0.5% slope in the existing open channel.

The box culvert was assessed in HEC-RAS to determine the velocities that would occur assuming the substrate is stable. The peak velocity was determined to be just over 1.67 m/s with a discharge of 5.2 m^3/s. The culvert will be embedded using riverstone with a D_{50} = 200 mm to a depth of 0.4m. This is more than sufficient to provide a factor of safety of 1.75 to provide long lasting erosion control.

4.1.7.1 Floodline Delineation and Results

HEC-RAS results can be seen below in **Table 4-3**. It is noted that water levels upstream the site decrease as the floodplain volume has been increased. In the middle of the wetland, the water levels increase because of the berm backing the water up. Downstream Green Mountain Road there is a slight water level decrease due to the flow being reduced. Overall, the flooded area is not increased, and the neighboring properties are will not be negatively affected.

Table 4-3 HEC-RAS Water Level Comparison (m)

	XS 924			XS 694			XS434		
Storm	Upstream Water Property Boundary		Difference	Middle of Wetland		Difference	Downstream Green Mountain Road		Difference
	Existing	Proposed		Existing	Proposed		Existing	Proposed	
2-year	193.52	193.44	-0.08	193.25	193.43	0.18	192.6	192.55	-0.05
5-year	193.66	193.62	-0.04	193.49	193.61	0.12	192.71	192.64	-0.07
10-year	193.72	193.69	-0.03	193.56	193.68	0.12	192.78	192.77	-0.01
25-year	193.79	193.77	-0.02	193.62	193.75	0.13	192.83	192.83	0
50-year	193.84	193.82	-0.02	193.67	193.8	0.13	192.86	192.86	0
100-year	193.89	193.86	-0.03	193.71	193.85	0.14	192.87	192.87	0
Regional (Hazel)	194.24	194.23	-0.01	193.99	194.19	0.2	193.07	193.07	0

4.1.8 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 conservation efforts and the long-term stewardship of the property.

4.2 Flood Risk Impacts

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 4-4** shows the existing and proposed peak flows and percent reduction at selected locations downstream of the SC-8 facility.

The primary goal of the SC-8 facility was to reduce downstream flooding and reducing the peak flows for all return period events will assure that this is achieved. The reduction in peak flows was weighted to the 25mm storm due to constraints of not extending the flood plain at the SC-8 site onto private properties and retaining fish passage. Downstream of the confluence with Battlefield Creek, the flows will also be influenced by the proposed BC-1 wetland facility and SC-5.

Table 4-4 Downstream Peak Flows and Percent Reduction

Location	Return Period			
	2-year	25-year	100-year	Regional (Hazel)
Existing (Uncontrolled) Flows (m³/s)				
Stoney Creek - Edge of Escarpment (479)	16.4	31.2	39.5	103.3
Stoney Creek - King St.(J482)	17.3	32.4	41.1	106.6
Stoney Creek at Battlefield Confluence (J493)	21.6	39.4	50	143.3
Lake Ontario (Outlet)	27.9	53.7	67.7	183.5
Proposed Flows (with BC-1 and SC-8 Storage facilities) (m³/s)				
Stoney Creek - Edge of Escarpment (479)	15	29.6	38	102.9
Stoney Creek - King St.(J482)	15.8	30.8	39.5	106.2
Stoney Creek at Battlefield Confluence (J493)	18.5	35.4	45.6	134.9
Lake Ontario (Outlet)	27.6	51.7	64.8	174.9
Percent Reduction in Flows between Existing and Proposed				
Stoney Creek - Edge of Escarpment (479)	8.5	5.1	3.8	0.4
Stoney Creek - King St.(J482)	8.7	4.9	3.9	0.4
Stoney Creek at Battlefield Confluence (J493)	14.4	10.2	8.8	5.9
Lake Ontario (Outlet)	1.1	3.7	4.3	4.7

4.3 Erosion Risk Impacts

The erosion risk was determined for the critical reach in Lower Stoney Creek as determined in the 2018 Flood and Erosion Control Class EA. The critical reach was determined to be SC-4(2018 EA) or R50 (in 2019 HEC-HMS), which is the first reach of Stoney Creek upstream of the confluence with Battlefield Creek and is bounded at the upstream end by Queenston Road. The critical flow for the reach was determined to be 7.53 m^3/s. The erosion risk was quantified by calculating the duration that return period storm flows exceeded the critical flow in the SC-4 reach for both existing and proposed conditions. 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 4-5** shows the peak flows in reach SC-4, while **Table 4-6** shows the number of excess erosion hours for a given storm event, calculated at 5-minute intervals.

Table 4-5 Reach SC-4 Peak Flows (m^3/s)

Storm Event	25 mm	2-year	5-year	10-year	25-year	50-year	100-year	Regional
Uncontrolled 2024	7.7	17.3	23.4	27.3	32.4	36.7	41.1	106.6
Proposed 2024	6.3	15.8	21.9	25.7	30.8	35.2	39.5	106.2
% Decrease	18.2	8.7	6.4	5.9	4.9	4.1	3.9	0.4

Table 4-6 Reach SC-4 Excess Erosion Hours

Storm Event	25 mm	2-year	5-year	10-year	25-year	50-year	100-year	Regional
Uncontrolled 2024	0.9	8.6	12.5	14.3	15.6	16.8	17.8	23.1
Proposed 2024	0.0	9.1	12.8	14.6	15.9	17.1	17.9	23.7
% increase	0	5.6	2.7	2.3	2.2	1.7	0.9	2.5

The results show reduced peak flows for all events, with 3.9-18.2% reductions for all return period events and 0.4% reduction for the Regional event. The attenuation of flows leads to a longer period of elevated flows, which led to a slight increase of erosion hours for all return period events. SC-8 wetland facility will increase the amount of erosion at SC-4 on a more frequent basis, but SC-4 will see more hours of erosion during the higher return periods, however the shear stress will decrease as the peak flows have been reduced.

4.4 Construction Aspects

The silty clay glaciolacustrine sediments encountered beneath surficial topsoil at the site are characterized by a low hydraulic conductivity, and a natural water content at or slightly above the plastic limit. This material is considered compactible (see Soil Engineers Ltd. Geotechnical Report in **Appendix A**) 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 (∆h) of about 1 m. If we treat the shallow silty clay as a porous medium (a somewhat unreasonable assumption) then the amount of water loss through the base of the wetland may be crudely estimated by multiplying the observed groundwater ∆h by the effective porosity of the soils. Assuming an effective porosity of 20% and a ∆h of 1 m, we estimate that water levels in the wetland will fall by about 0.2 to 0.3 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.

Any permanent water features should be sited in areas of relatively thick overburden where at least 1.5 m of clayey soil can be maintained between the bottom of the water features and the underlying bedrock. This thickness is significantly greater than that recommended for the nearby BC-1 site because of the presence of the karst-susceptible Reformatory Quarry Member of the Eramosa Formation as the upper bedrock unit at the SC-8 site. Soil surfaces beneath permanent wetland areas and borrow excavations should be thoroughly proof rolled using a heavy sheepsfoot roller in order to eliminate any preferential conduits for groundwater flow into the deeper strata. This is especially important along the north part of the planned impoundment where standing water will be commonly impounded. It is less important toward the south of the property where surface waters will be impounded only infrequently and only to a shallow depth.

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.

4.5 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 SC-8 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 Reformatory Quarry member of the Eramosa Formation forms the bedrock beneath the SC-8 site and this member is susceptible to karst formation. However, 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 the layer of low permeability silty clay between the base of the wetland pond and the underlying bedrock.

4.6 Potential for Adverse Effects

The planned construction of a wetland 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. No karst features were observed on the site and any karst hazards that might be encountered during (or following construction) could be mitigated though the strategic placement of low permeability fill materials.

4.7 Re-planting of Berm

In order to soften the visual impact of the berm, nearly 2500 trees and shrubs will be planted within the created wetland in areas adjacent to the berm (within the berm). Planting on the berm will be limited to the application of seed. In order to ensure the long term stability of the berm, and given the potentially challenging growing conditions, tree and shrub plantings have been excluded from the berm itself. However, it is anticipated that Poplar trees (*Populus* spp.) and other species with wind-borne seeds will colonize the berm in time. 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;
- The hydro wires along the road; 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. During site grading, topsoil and organics should be sorted and retained for top-dressing to facilitate the establishment of trees and shrubs following construction.

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; however, hardy and clonal shrub species would be suited to this area. Tree protection measures may include the application of Skoot™ browse protectant to stems, the installation of tree coils or tree tubes, and the staking and tethering of caliper trees using biodegradable straps and wooden stakes to ensure long-term survival of the trees and limit waste material left on site.

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. racemosa)
- Red Osier Dogwood (*Cornus sericea*)
- Staghorn Sumac (*Rhus typhina*)
- Nannyberry (Viburnum lentago)
- Hawthorn (*Crataegus* spp.)

4.8 Naturalization of Wetlands and Retention Area

Within the berm retention area several types of wetland may be restored. This undertaking aligns with the HCA goal of enhancing the natural heritage components on site and the objective of enhancing and enlarging the wetland within the property. Deeper excavations with a clay lining are likely to retain standing water for much or all of the year and provide ideal habitat for anuran breeding. Areas of shallow excavation will be seeded or planted to establish as seasonally inundated marsh which dries out by late spring and may provide nesting habitat for waterfowl.. Some areas should be planted in trees extensively to establish a seed source on the property and to create a swamp component. A planting plan that incorporates these considerations has been prepared as part of the Water's Edge drawing package.

In order to prevent erosion and retain soil moisture, the entire graded area should be seeded with a nurse crop such as White Millet or Buckwheat 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 indicated on Water's Edge drawing adheres 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.

The inclusion of upland ridges in the site grading and 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.

4.9 Channel Re-instatement and Naturalization

As a section of Stoney Creek and its floodplain will be graded, the design recommends that a meandering channel of varying depths be recreated. The HCA has identified restoring the natural function of the watercourse as an objective of this undertaking. The application of erosion control measures within this area is strongly recommended and may include hydro- seeding or terra-seeding of a nurse crop and native seed mixture. The Erosion and Sediment Control drawing provided by Water's Edge indicates that silt fence will be installed around much of the perimeter of the property with coir log placement used in the southern extent where the watercourses direct flow north toward Green Mountain Road. To the extent possible, existing native trees, shrubs and herbaceous vegetation should be retained. Recommendations relating to channel naturalization are outlined in the previous section. Photographs of the existing site conditions are provided in Appendix X of the NRSI Report in **Appendix D**.

4.10 Invasive Species Management

Management of European Buckthorn within the property should be considered. Those sections of the watercourse which are retained will harbor the species and will act as a seed source for the shrub to proliferate into areas of bare soil and meadow. Graded topsoil from along the corridor which is stockpiled and re-distributed will likely contain a seed bank which will germinate once the soils are redistributed. It is recommended that HCA undertake or contract the application of herbicide to the thickets and regrowth of European Buckthorn. Untreated, a large portion of the site is likely to transition to low-diversity thicket dominated by this species which will limit the potential for the establishment of diverse natural habitats. In comparison to the BC-1 property, the stands on the SC-8 property are practical to manage with reduced potential for re-introduction as the site is limited in natural features and hedgerows where the species could recolonize from.

Similarly, stands of Common Reed along the western property boundary have the potential to spread and should be managed. At a minimum, areas of grading which occur where this species is present should dispose of the topsoil and root materials at a location where the species will not establish and spread further. Burying this material at a depth of several metres is ideal if on-site management with herbicides cannot be undertaken.

Reed Canary Grass is the dominant species in the meadow marsh communities along the existing watercourse. This species is likely the non-native European type is likely to outcompete any herbaceous vegetation within the created wetland if it begins to colonize those areas. It is recommended that the 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 time.

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

Following the installation of plantings and seeding at the site, HCA staff should monitor for the establishment of invasive species annually for several years and periodically thereafter.

4.11 Barn Swallow Habitat Enhancement

Observation of Barn Swallow foraging in 2019 suggests that the species utilizes the creek corridor and marsh 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 Green Mountain Road East 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).

4.12 Road Ecology Mitigation

The naturalization of the property will result in increased wildlife presence and movement across Green Mountain Road East. The installation of wildlife exclusion fencing (directional fencing) should be considered along both sides of the road for a length of approximately 50m (or greatest extent feasible) on either side of the existing culvert. This undertaking would require that HCA discusses the feasibility of fence installation with the City of Hamilton Roads Department. In order to reduce the potential for wildlife standing on the roadway, if fencing cannot be installed on both sides of the road, no fencing should be installed at all. As fencing would be installed along the municipal right-or-way and would require maintenance, it will be necessary for the City and HCA to have discussion about fence type/length, installation costs and on-going maintenance.

In the long-term, HCA should work with the city to advocate for the installation of an eco-passage when the road culvert requires replacement.

4.13 Conclusions

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

5 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 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) A site-specific HEC-RAS Model was created to determine the flood impacts at the proposed SC-8 site and develop a rating curve for HEC-HMS pond routing to determine the downstream flows.

2) The QUALHYMO hydrologic model prepared for the *Flood and Erosion Control Class Environmental Assessment (AMEC, 2018)* should be updated by the HCA to reflect the changes that will be created by the implementation of the proposed works;

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, albeit restrained to meet flood requirements on site;

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

- The results of this assessment indicate that the SC-8 property is underlain by a continuous deposit of silty clay glaciolacustrine sediments having a low hydraulic conductivity. These characteristics are considered favourable for the impoundment of stormwater flows in a constructed wetland that will then lose water slowly through direct discharge, evapotranspiration and infiltration into the underlying bedrock aquifer.
- The investigation has disclosed that beneath a topsoil veneer, the area of investigation is underlain by a stratum of stiff to hard, generally very stiff silty clay, overlying dolomite and limestone bedrock at a depth ranging from 2.4 to 5.8 m from the prevailing ground surface, or between El. 188.8 m and El. 191.5 m. The bedrock is poor quality up to the depth of investigation, probably becoming good to excellent quality at the deeper level.
- 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 Stoney Creek for flood and erosion control. The basin of the proposed wetland will be at about El. 192.2 m.

- Any excavation extending 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 underlying sound rock 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.
- Earth fill will be used for the creation of earth berms around the wetland. Selected on site silty clay, free of organics, is suitable for the construction of the berms and embankment. It 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 subexcavated and the ground should 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. All the exposed slopes must be vegetated or seeded 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 create a cavity in the embankment.
- No karst features were observed at the site and the relatively thick overburden (2.4 to 5.8 m) will protect the planned wetland impoundment from catastrophic water losses through drainage into karst features. 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 features 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.
- The subject property contains a section of Stoney Creek and an associated corridor of swamp thicket and marsh vegetation. In general, the feature provides a natural corridor for wildlife movement within the sub-watershed.
- Regulated habitat for SAR is not present within the subject property; however, Barn Swallow were documented foraging within the site and are likely nesting nearby. Bat acoustic surveys identified a small number of calls in the 40 kHz species grouping which are likely attributed to Eastern Red Bat and not SAR. Surveys identified 2 candidate SWH types; Amphibian Breeding (wetland) and Amphibian Movement Corridor. Based on the

proposed development footprint, both of these candidate habitat types would be impacted but these effects can be mitigated through restoration and enhancement.

- 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 **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.

- Other direct impacts associated with this undertaking include grading and vegetation removal. The design of the berm will not require the removal of trees; however, grading within the retention area may require the removal of trees and shrubs along the watercourse (within the non-native thicket swamp SWT2-13 communities and area identified as Significant Woodland).

- Recommended mitigation includes the naturalization of the berm, wetland features and within the retention area through plantings of native trees and shrubs and the application of meadow and wetland seed mixtures. Disturbed sections of the watercourse will also be naturalized with a focus on creating meanders and variable depths of the channel bed. Timing windows including the breeding bird window and completing grading works during the dry period are also recommended.

- 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 berm as well as disturbance to wildlife during construction. The area above the berm includes both fallow agricultural field and graminoid marsh. Both communities are seen as resilient and unlikely to be negatively affected by temporary inundation in the spring. The wetland and riparian habitat below the berm will likely encounter a decrease in surface water input; however, the design of the control structure and the retained catchment and tributary inputs will continue to direct flow to these habitats to maintain their form.

- Induced impacts as a result of the proposed development may include the establishment or proliferation of non-native invasive species to the site during the completion of grading. In the absence of parking or trails, the site is not likely to see increases in human use. Any laneways which are installed may create issues with waste 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 berm and flow control structure 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.

- Stoney 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.

- Based on modelling, the existing 25mm peak flow is 5.8 m^3/s and the proposed flow is 4.9 m^3/s. The existing 100-year flow is 27.6m^3/s and the Regional Storm (Hurricane Hazel) peak flow is 59.3m^3/s. The proposed 100-year flow is 27.4 m^3/s and the Regional Storm (Hurricane Hazel) peak flow is 59.2 m^3/s.

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

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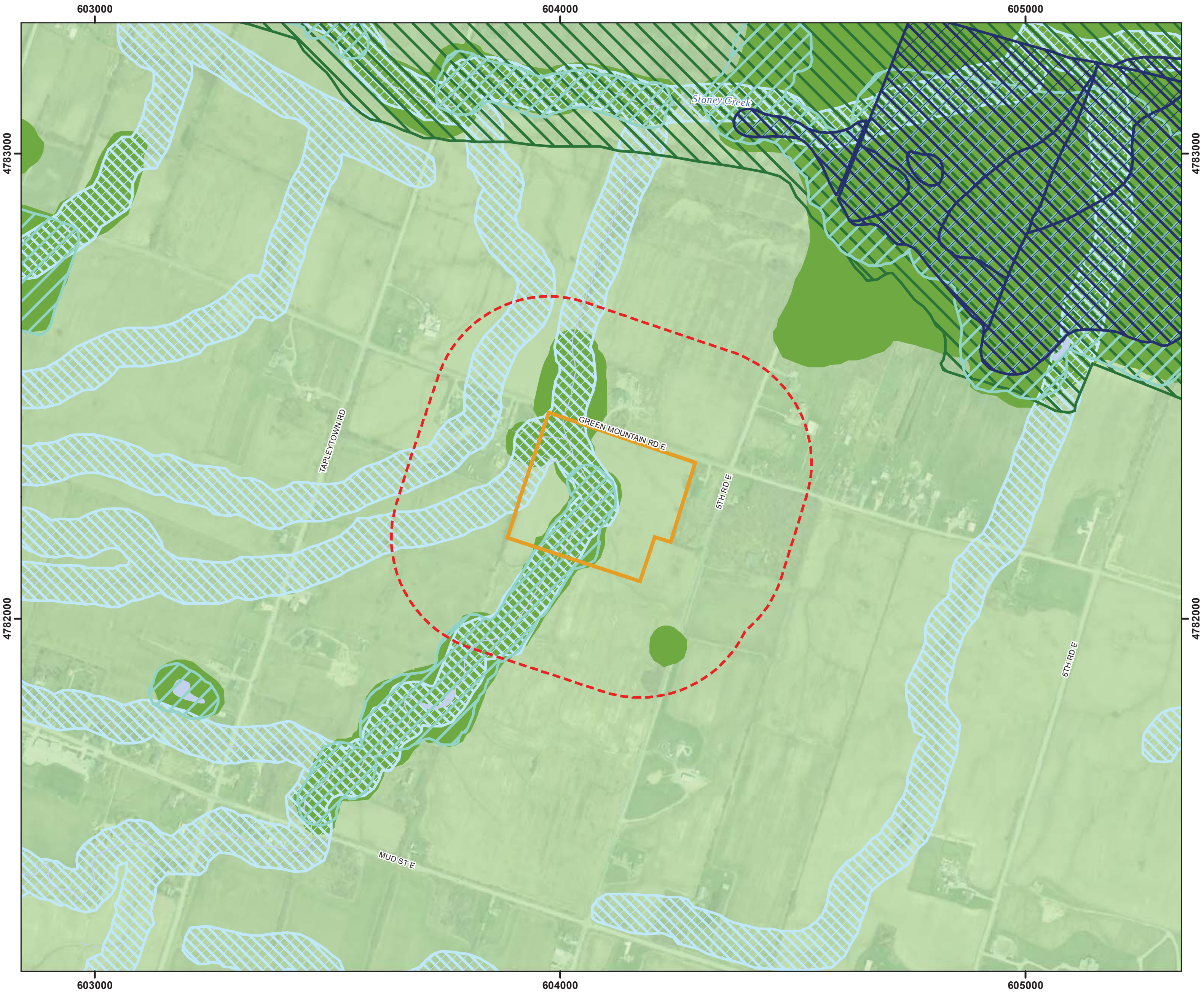
8 SYMBOLS:

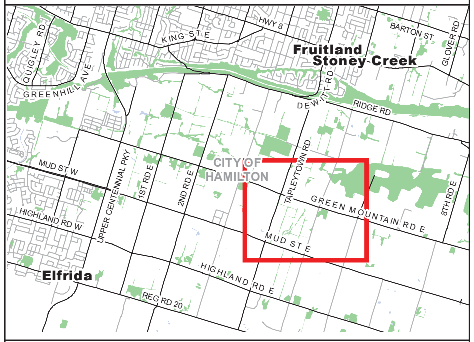
g	Unit weight of water (approximated as 9810 N/m^3),
R	Hydraulic radius of the channel (m)
d	Bankfull flow depth in the channel (m)
S	Slope of the channel (m/m)
g	Acceleration due to gravity (9.81 m/s^2)
r_s	Density of substrate (kg/m^3)
r_w	Density of water (kg/m^3)
D_{50}	Median grain size (m)



Map 1

Saltfleet Conservation Area Green Mountain Road Wetland Design

Study Area and Natural Features



Legend

- 🟧 Subject Property
- 🟥 Study Area
- Permanent Watercourse
- Intermittent Watercourse
- Provincially Significant Wetland (PSW)
- 🟩 Core Areas (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)
- ▨ Key Hydrologic Feature Streams (City of Hamilton Official Plan, 2018)
- ▨ Key Natural Heritage Feature Significant Woodlands (City of Hamilton Official Plan, 2018)

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Aquatic, Terrestrial and Wetland Biologists

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Project: 2286A
Date: November 13, 2019

NAD83 - UTM Zone 17
Size: 11x17"
1:8,000

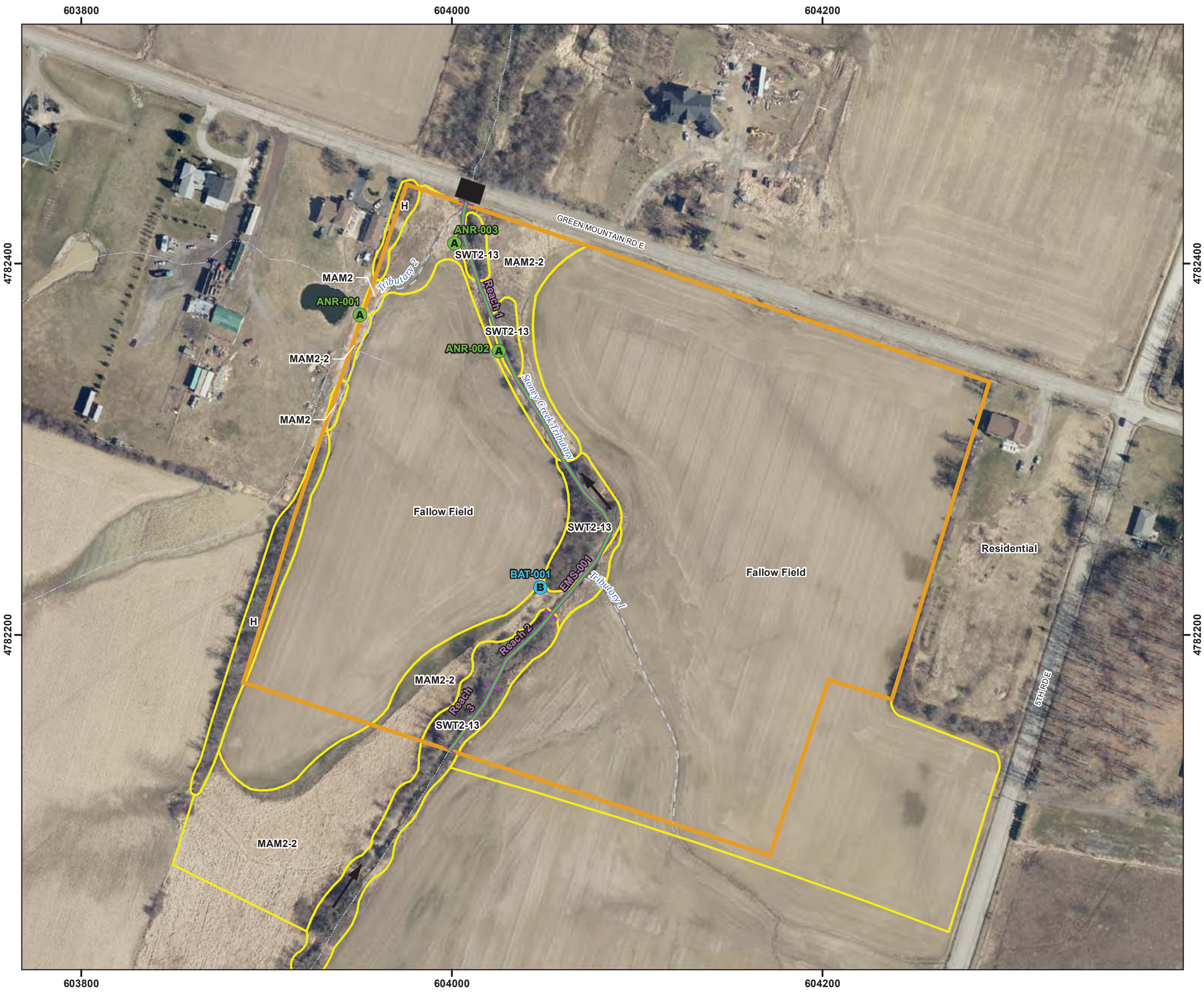
0 100 200 300 400 500 Meters

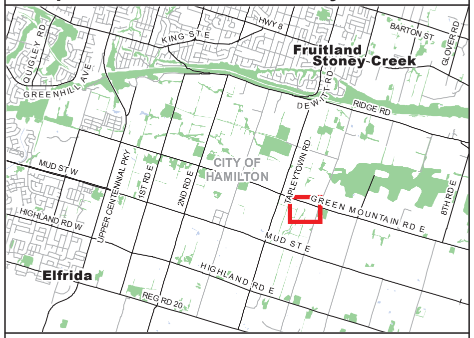
N

Map 2

Saltfleet Conservation Area Green Mountain Road Wetland Design

Vegetation Communities, Aquatic Habitat and Survey Stations





Legend

🟧 Subject Property

Intermittent Watercourse

Ephemeral Watercourse

■ Culvert

➔ Flow Arrow

Aquatic Habitat

Habitat Reach

Electrofishing Station (EMS)

Survey Stations

Ⓐ Anuran Monitoring Station (ANR)

Ⓑ Bat Acoustic Monitoring Station (BAT)

Vegetation Communities

🟨 Ecological Land Classification (ELC)

(H) Hedgerow

(MAM2) Mineral Meadow Marsh Ecosite

(MAM2-2) Reed-canary Grass Mineral Meadow Marsh Type

(SWT2-13) Non-native Mineral Thicket Swamp Type

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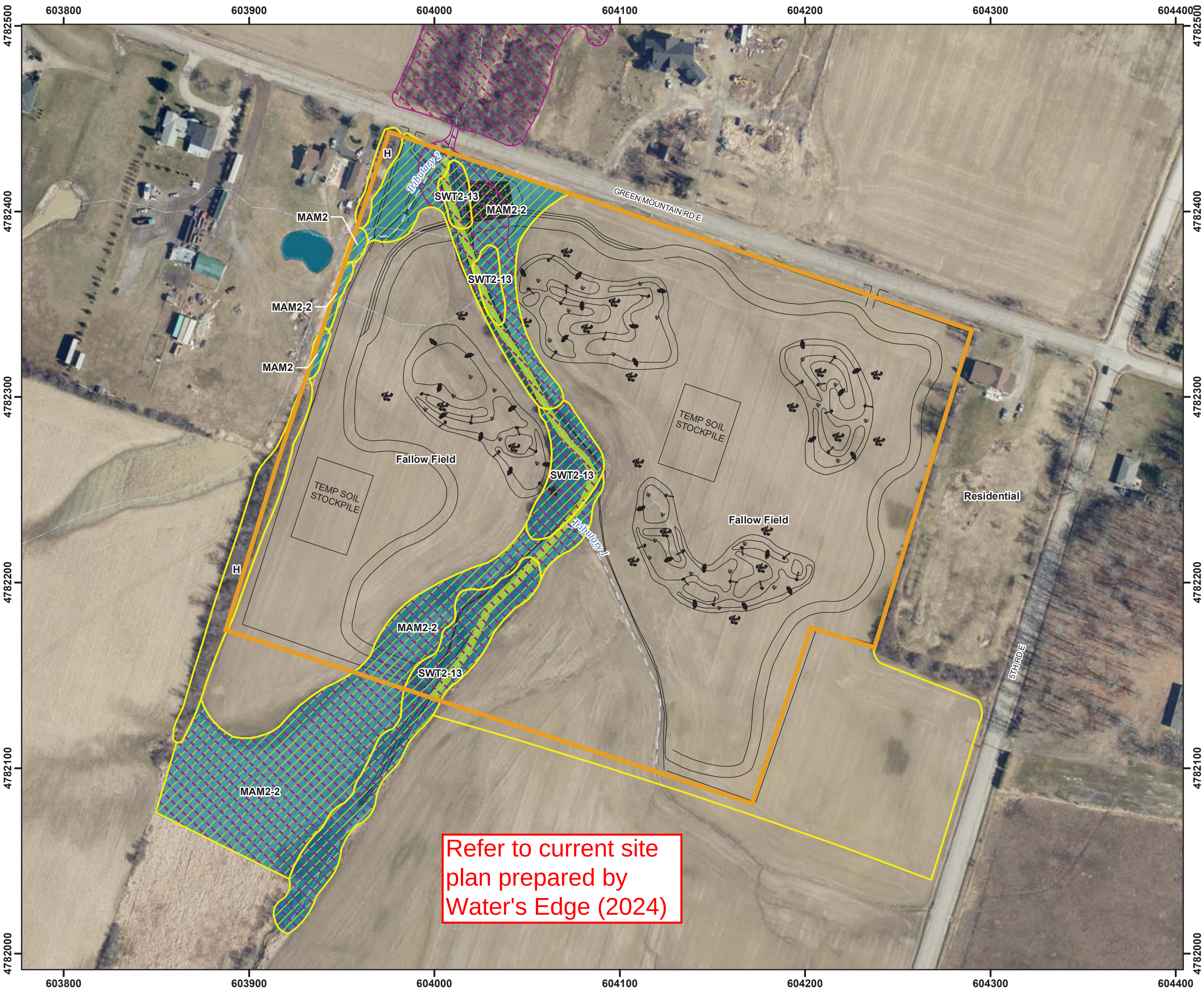
Project: P3465
Date: January 22, 2020

NAD83 - UTM Zone 17
Size: 11x17"
1:2,000

0 20 40 60 80 100 120 Meters

N

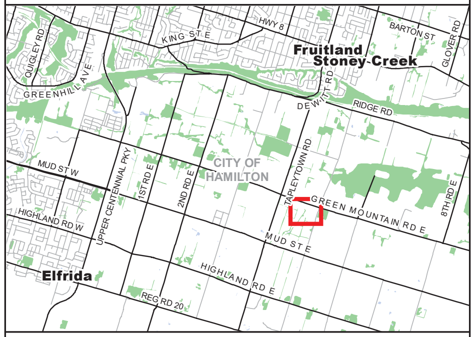


Refer to current site plan prepared by Water's Edge (2024)

Map 3

Saltfleet Conservation Area Green Mountain Road Wetland Design

Natural Heritage Constraints



Legend

- 🟧 Subject Property
- — Proposed Site Plan
- ◌ Intermittent Watercourse
- ◌ Ephemeral Watercourse
- ▬ Fish Habitat
- ☐ Ecological Land Classification (ELC)

(H) Hedgerow

(MAM2) Mineral Meadow Marsh Ecosite

(MAM2-2) Reed-canary Grass Mineral Meadow Marsh Type

(SWT2-13) Non-native Mineral Thicket Swamp Type

Significant Wildlife Habitat

- ▨ Candidate Terrestrial Crayfish Habitat
- ▨ Candidate Amphibian Movement Corridor
- 🟦 Candidate Amphibian Breeding Habitat (Wetland)

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Project: 2286
Date: June 2, 2020

NAD83 - UTM Zone 17
Size: 11x17"
1:2,000

0 20 40 60 80 100 120 Meters

N

Legend

- — HEC-RAS Cross Sections
- — Property Line
- ☐ Existing Conditions Regional (Hazel)
- ☐ Proposed Conditions Regional (Hazel)

0 100 m **Scale: 1:2000**

Projection: NAD83 (CRS) UTM Zone 17N
Datum: CGVD2013
Orthophotography captured under the Southwestern Ontario Orthophotography Project (SWOOP) between April 12th and May 23rd, 2015.

Orthophotgraphy provided by MNRF, downloadable from GeoHub.

Cross Section Number → 475
Existing Conditions Regional Flood Water Surface Elevation (m) → 200.55
Proposed Conditions Regional Flood Water Surface Elevation (m) → 200.66

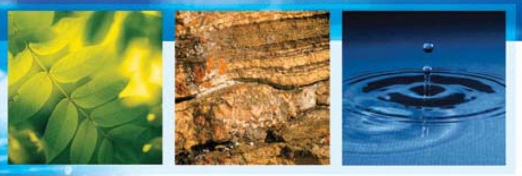
water's edge ENVIRONMENTAL SOLUTIONS TEAM LTD.

Saltfleet Conservation Area Wetland Storage and Natural Channel Design Study

Hamilton Conservation Authority

REGIONAL STORM FLOODLINE MAP

Date: 2024-10-18	Drawn By: MB Checked By: TA
File No.: WE19028	Map No.: 4



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Fluvial Geomorphology

Natural Channel Design

Stream Restoration

Monitoring

Erosion Assessment

Sediment Transport

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APPENDIX A:

Geotechnical Report

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

BARRIE	MISSISSAUGA	OSHAWA	NEWMARKET	GRAVENHURST	HAMILTON
TEL: (705) 721-7863	TEL: (905) 542-7605	TEL: (905) 440-2040	TEL: (905) 853-0647	TEL: (705) 684-4242	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) 542-2769

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

A GEOTECHNICAL INVESTIGATION FOR PROPOSED WETLAND (AREA SC-8)

SOUTH OF GREEN MOUNTAIN ROAD EAST
BETWEEN TAPLEYTOWN ROAD AND FIFTH ROAD EAST

CITY OF HAMILTON

REFERENCE NO. 1907-S107

OCTOBER 2019

DISTRIBUTION

3 Copies	- Water's Edge Environmental Solutions Team Ltd.
1 Copy	- Soil Engineers Ltd. (Mississauga)
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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 south side of Green Mountain Road East, between Tapleytown Road and Fifth 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 south side of Green Mountain Road East, between Tapleytown Road and Fifth 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. A tributary of Stoney Creek is traversing the site in south-north direction.

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 seven (7) sampled boreholes, was performed on August 13 and 14, 2019, at the locations shown on the Borehole Location Plan, Drawing No. 1. 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 2.4 to 5.8 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 the area of investigation is underlain by silty clay, overlying dolomite and limestone bedrock at a depth ranging from 2.4 to 5.8 m from the prevailing ground surface.

Detailed descriptions of the encountered subsurface conditions are presented on the Borehole Logs, comprising Figures 1 to 7, 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)

The revealed topsoil is 10 cm and 15 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 **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 4 representative samples and the results are plotted on Figure 8.

The obtained 'N' values range from 9 to 40, with a median of 17 blows per 30 cm of penetration, indicating the consistency of the deposit is stiff to hard, being generally very stiff. The silty clay near the ground surface is generally weathered, with fractures and roots inclusions, extending to a depth of 0.8± m from grade.

The Atterberg Limits of two representative samples 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	29% and 47%
Plastic Limit	16% and 22%
Natural Water Content	16% to 30% (median 23%)

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

Accordingly, the 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 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.

4.3 **Bedrock** (All Boreholes)

Refusal to auger drilling was contacted in the boreholes, at 2.4 to 5.8 m from the prevailing ground surface, or between El. 188.8 m and El. 191.5 m. It represents bedrock in this vicinity.

Rock coring was conducted below the refusal depths of 4.7 m and 2.4 m, at Boreholes 2 and 5, 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 to the depth of investigation, probably 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.

4.4 **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 +
Silty Clay	16 to 30 (median 23)	20	16 to 24

The silty clay is generally suitable for a 95% or + Standard Proctor compaction. Wet or weathered soils will require aeration prior to structural compaction.

The silty clay should be compacted using a heavy-weight, kneading-type roller. When compacting the hard silty clay on the dry side of the optimum, the compactive energy will frequently bridge over the chunks in the soils and be transmitted laterally into the soil mantle. Therefore, the lifts must be limited to 20 cm or less (before compaction).

The presence of rock fragments 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

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

The majority of the boreholes remained dry upon completion of the field work and prior to rock coring. Groundwater was recorded at a depth of 5.5 m from grade or El. 190.9 m in Borehole 7. It should be noted that water was used for rock coring in Boreholes 2 and 5; therefore, record of groundwater in these boreholes after rock coring was not possible upon completion.

In excavation, any groundwater yield from the silty clay due to percolation of surface water is expected to be slow in rate and limited in quantity. Depending on the continuity of rock fractures, groundwater yield from bedrock is generally limited.

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, the area of investigation is underlain by a stratum of stiff to hard, generally very stiff silty clay, overlying dolomite and limestone bedrock at a depth ranging from 2.4 to 5.8 m from the prevailing ground surface, or between El. 188.8 m and El. 191.5 m. The bedrock is poor quality up to the depth of investigation, probably becoming good to excellent quality at the deeper level.

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 Stoney Creek for flood and erosion control. The existing road grade will be raised by 0.5 m (from the current elevation of 193.5 m) and new earth berms will be created to approximately194.0 m. The basin of the proposed wetland will be at El. 192.0± m.

6.1 Wetland Construction

The excavation will extend to El. 192.0± m. The invert and the walls of excavation are anticipated to consist of silty clay deposit.

All excavation should be carried out in accordance with Ontario Regulation 213/91. The types of soils are classified in Table 2.

Table 2 - Classification of Soils for Excavation

Material	Type
Bedrock	1
Silty Clay	2

Any excavation extending 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 underlying sound rock 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.

No continuous groundwater is anticipated within the depth of investigation. The yield of groundwater in any excavation is probably from the percolation of surface water. It can be drained towards sumps and removed by conventional pumping.

Earth fill will be used for the creation of earth berms around the wetland. Selected on site silty clay, free of organics, is suitable for the construction of the berms and embankment. It 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 subexcavated and the ground should 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 create a cavity in the embankment.

6.2 Soil Parameters

The recommended soil parameters for the project design are given in Table 3.

Table 3 - Soil Parameters

Unit Weight and Bulk Factor	**Unit Weight (kN/m^3)**	**Estimated Bulk Factor**	
	Bulk	**Loose**	**Compacted**
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

Table 3 - Soil Parameters (cont'd)

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. I. J. AL-ALI
100083356
Oct 17, 2019

Basim Al-Ali, P.Eng.

CHUN C. B. SUN
Oct 17, 2019

Bennett Sun, P.Eng.
BAA/BS:dd

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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JOB NO.: 1907-S107

LOG OF BOREHOLE NO.: 1

FIGURE NO.: 1

PROJECT DESCRIPTION: Proposed Wetland Design
Area SC-8

METHOD OF BORING: Flight-Auger

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

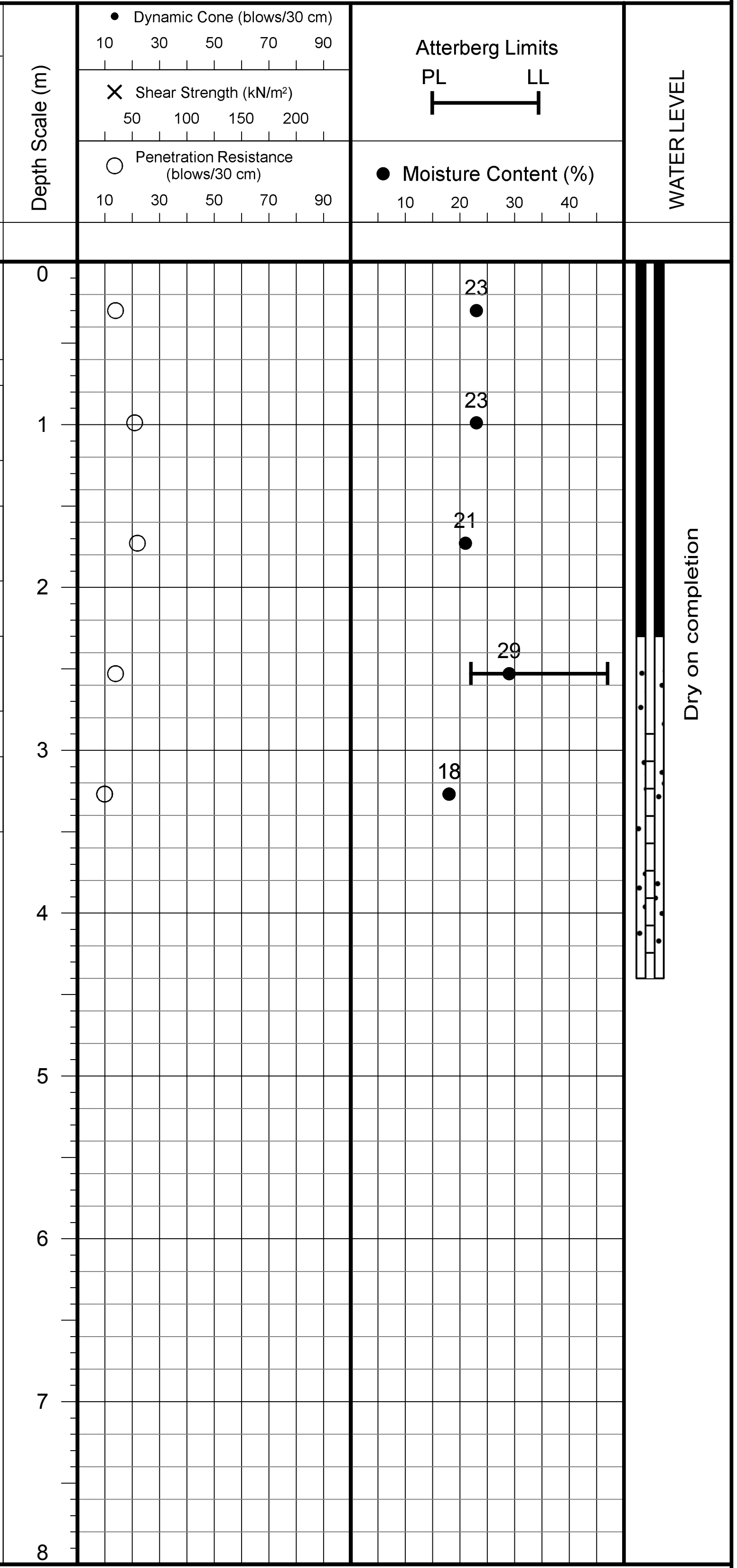
DRILLING DATE: August 14, 2019

El. (m) Depth (m)	SOIL DESCRIPTION
193.2	Ground Surface
0.0	**10 cm TOPSOIL**
0.1	Stiff to very stiff weathered **SILTY CLAY** medium plasticity occ. sand seams and layers brown grey
188.8 4.4	**Refusal to Augering** **Inferred Bedrock** **END OF BOREHOLE**

Installed 50 mm Ø monitoring well to 4.4 m
completed with 1.5 m screen
Sand backfill from 2.3 m to 4.4 m
Bentonite seal from 0.0 m to 2.3 m.
Provided with steel casing and lock.

SAMPLES

Number	Type	N-Value
1	DO	14
2	DO	21
3	DO	22
4	DO	14
5	DO	10



Soil Engineers Ltd.

JOB NO.: 1907-S107

LOG OF BOREHOLE NO.: 2

FIGURE NO.: 2

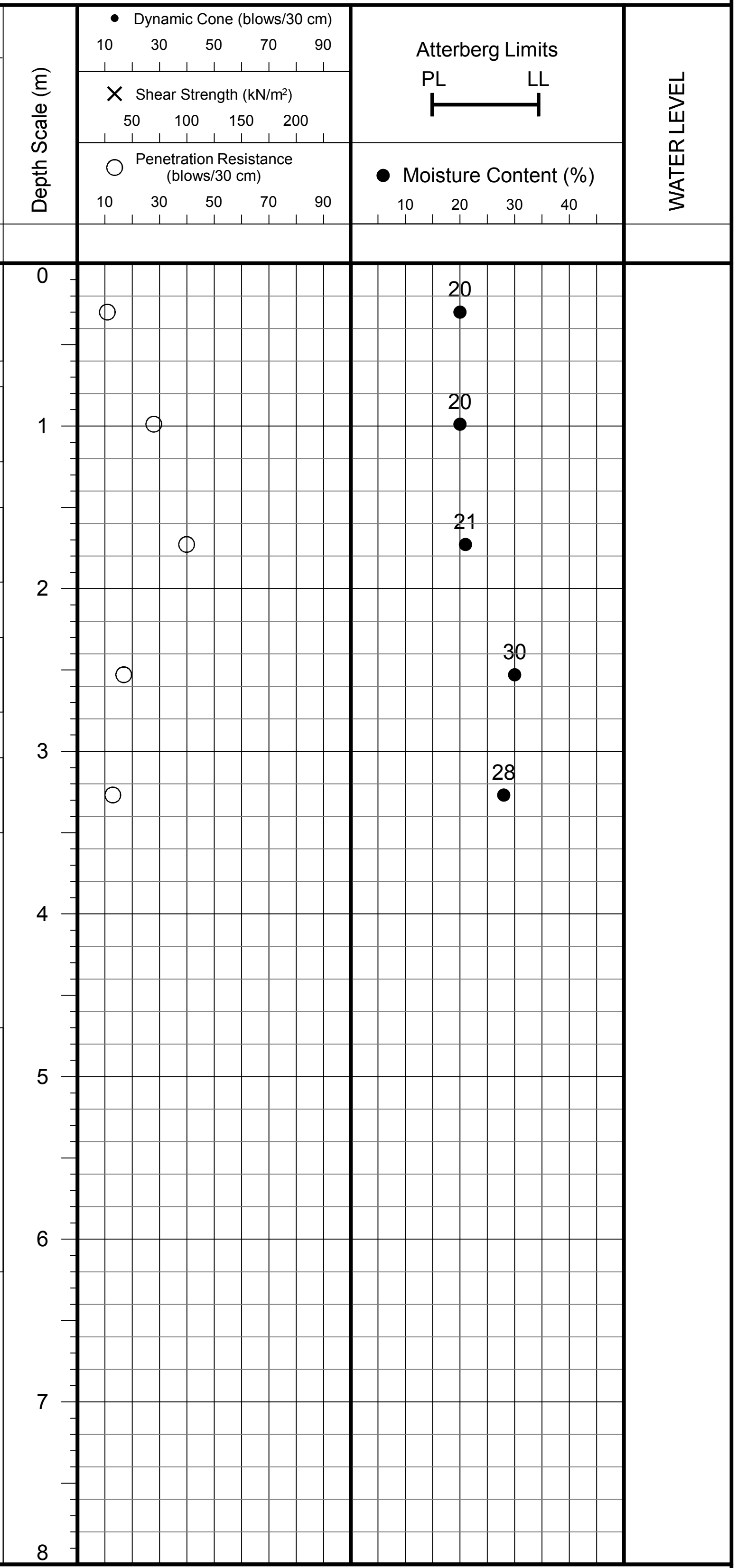
PROJECT DESCRIPTION: Proposed Wetland Design
Area SC-8

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

METHOD OF BORING: Flight-Auger

DRILLING DATE: August 13, 2019

El. (m) Depth (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value
193.7	Ground Surface			
0.0	**15 cm TOPSOIL**			
0.1	Stiff to hard	1	DO	11
	weathered			
		2	DO	28
	SILTY CLAY medium plasticity occ. sand seams and layers	3	DO	40
		4	DO	17
	brown grey			
		5	DO	13
189.0 4.7	Grey **DOLOMITE/LIMESTONE BEDROCK**	6	RC RQD	89% 83%
187.5 6.2	**END OF BOREHOLE**			



Soil Engineers Ltd.

JOB NO.: 1907-S107

LOG OF BOREHOLE NO.: 3

FIGURE NO.: 3

PROJECT DESCRIPTION: Proposed Wetland Design
Area SC-8

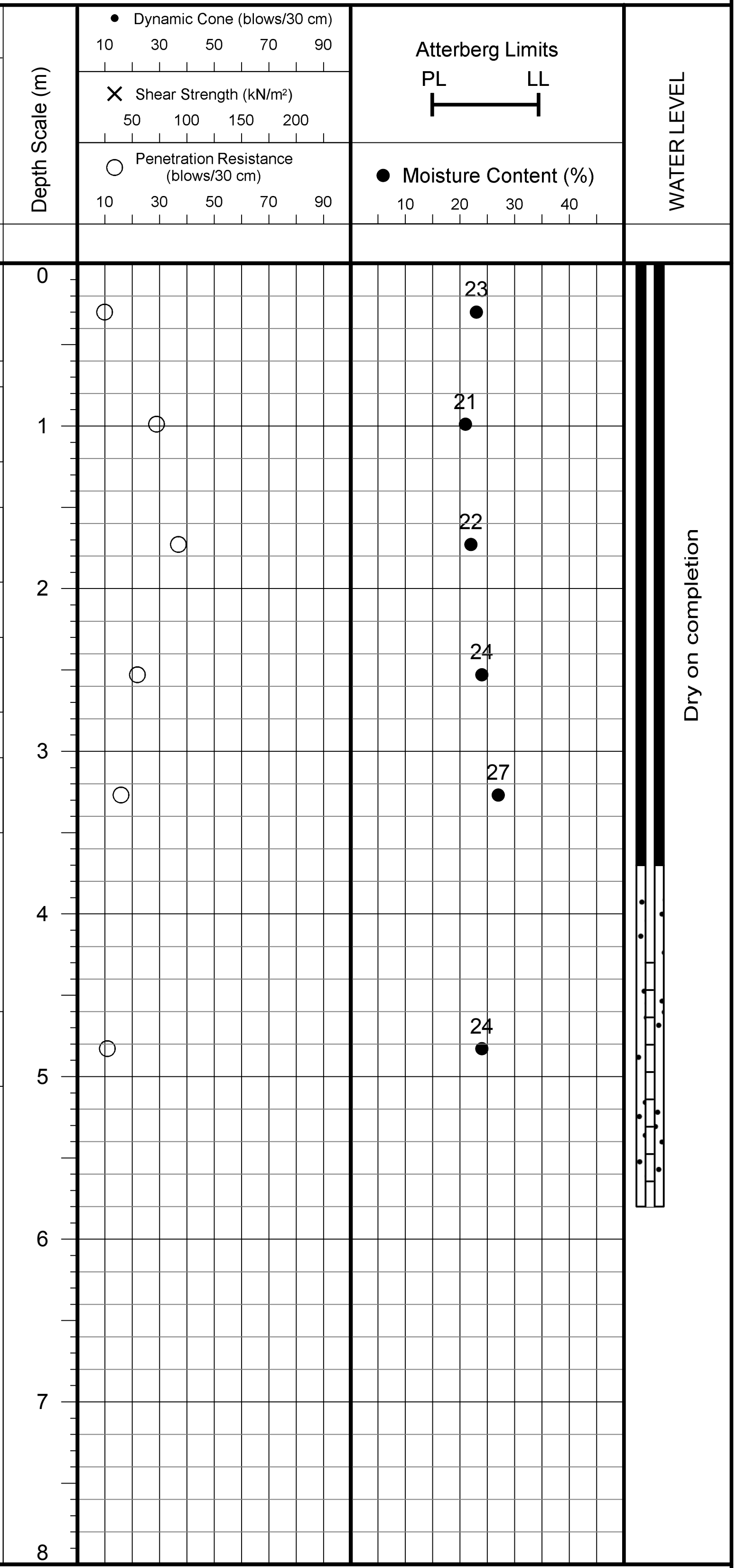
METHOD OF BORING: Flight-Auger

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

DRILLING DATE: August 13, 2019

El. (m) Depth (m)	SOIL DESCRIPTION	SAMPLES Number	SAMPLES Type	SAMPLES N-Value
194.9	Ground Surface			
0.0	**15 cm TOPSOIL**			
0.1	Stiff to hard	1	DO	10
	weathered	2	DO	29
	SILTY CLAY medium plasticity occ. sand seams and layers	3	DO	37
		4	DO	22
	brown grey	5	DO	16
		6	DO	11
189.1 5.8	**Refusal to Augering** **Inferred Bedrock** **END OF BOREHOLE**			

Installed 50 mm Ø monitoring well to 5.8 m
completed with 1.5 m screen
Sand backfill from 3.7 m to 5.8 m
Bentonite seal from 0.0 m to 3.7 m.
Provided with steel casing and lock.



JOB NO.: 1907-S107

LOG OF BOREHOLE NO.: 4

FIGURE NO.: 4

PROJECT DESCRIPTION: Proposed Wetland Design
Area SC-8

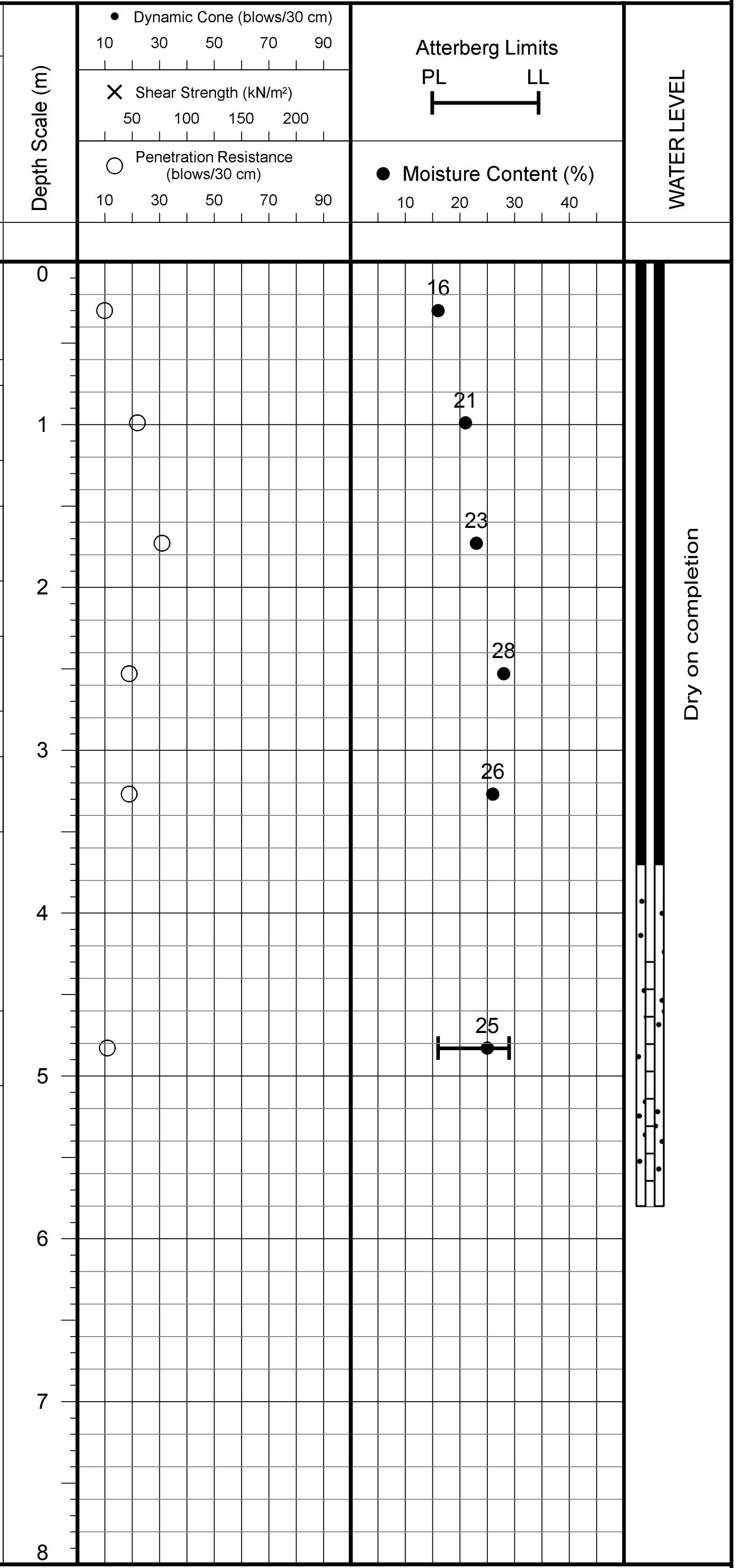
METHOD OF BORING: Flight-Auger

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

DRILLING DATE: August 13, 2019

El. (m) Depth (m)	SOIL DESCRIPTION
195.2	Ground Surface
0.0	**15 cm TOPSOIL**
0.1	Stiff to very stiff weathered **SILTY CLAY** medium plasticity occ. sand seams and layers brown grey
189.4 5.8	**Refusal to Augering** **Inferred Bedrock** **END OF BOREHOLE** Installed 50 mm Ø monitoring well to 5.8 m completed with 1.5 m screen Sand backfill from 3.7 m to 5.8 m Bentonite seal from 0.0 m to 3.7 m. Provided with steel casing and lock.

SAMPLES		
Number	Type	N-Value
1	DO	10
2	DO	22
3	DO	31
4	DO	19
5	DO	19
6	DO	11



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JOB NO.: 1907-S107

LOG OF BOREHOLE NO.: 5

FIGURE NO.: 5

PROJECT DESCRIPTION: Proposed Wetland Design
Area SC-8

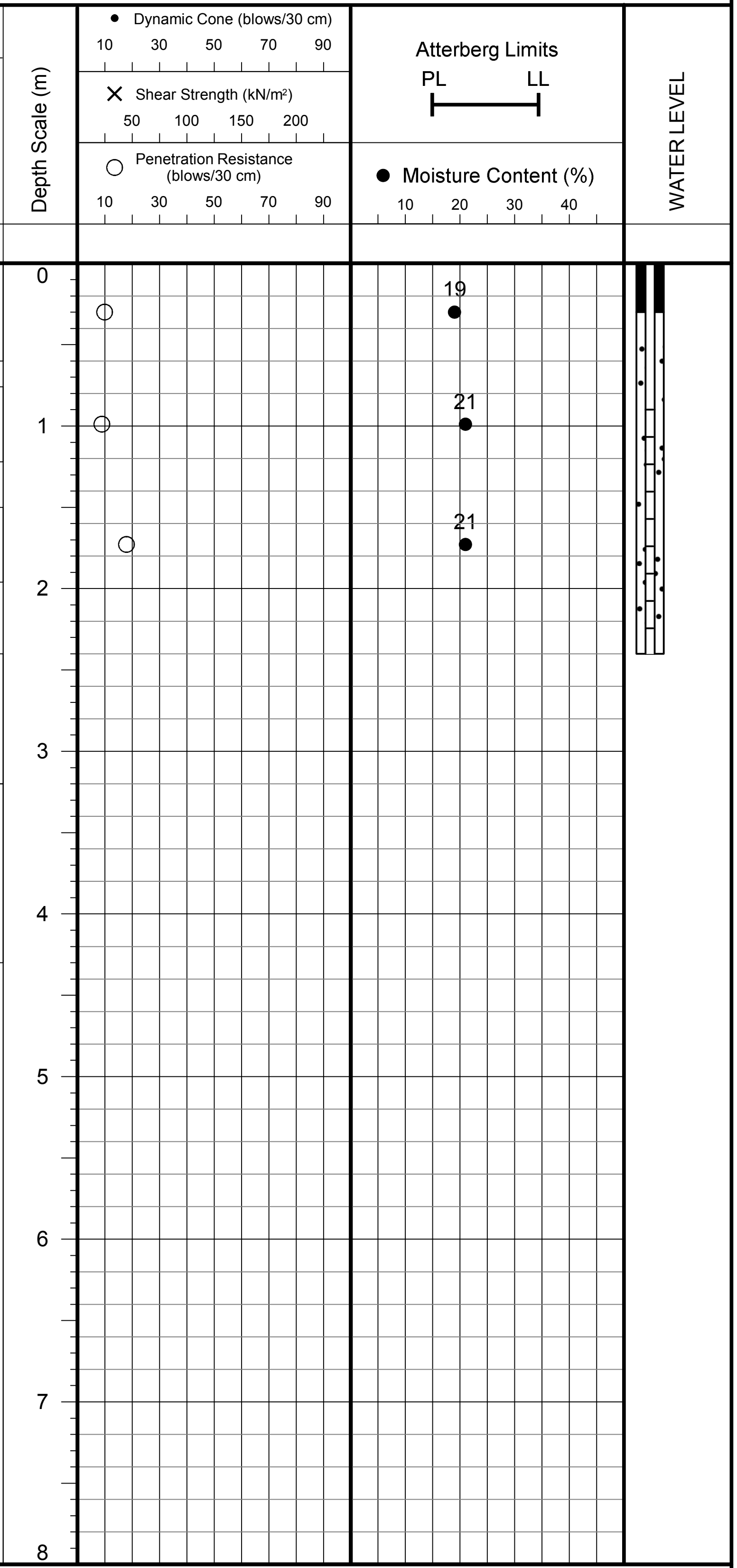
PROJECT LOCATION: Fifth Road East and Green Mountain Road East
City of Hamilton

METHOD OF BORING: Flight-Auger

DRILLING DATE: August 13, 2019

El. (m) Depth (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value
193.3	Ground Surface			
0.0	**10 cm TOPSOIL**			
0.1	Brown, stiff to very stiff	1	DO	10
	weathered	2	DO	9
	SILTY CLAY medium plasticity occ. sand seams and layers	3	DO	18
190.9 2.4	Grey	4	RC RQD	100% 31%
	DOLOMITE/LIMESTONE BEDROCK	5	RC RQD	100% 39%
189.0 4.3	**END OF BOREHOLE**			

Installed 50 mm Ø monitoring well to 2.4 m
completed with 1.5 m screen
Sand backfill from 0.3 m to 2.4 m
Bentonite seal from 0.0 m to 0.3 m.
Provided with steel casing and lock.



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JOB NO.: 1907-S107

LOG OF BOREHOLE NO.: 6

FIGURE NO.: 6

PROJECT DESCRIPTION: Proposed Wetland Design
Area SC-8

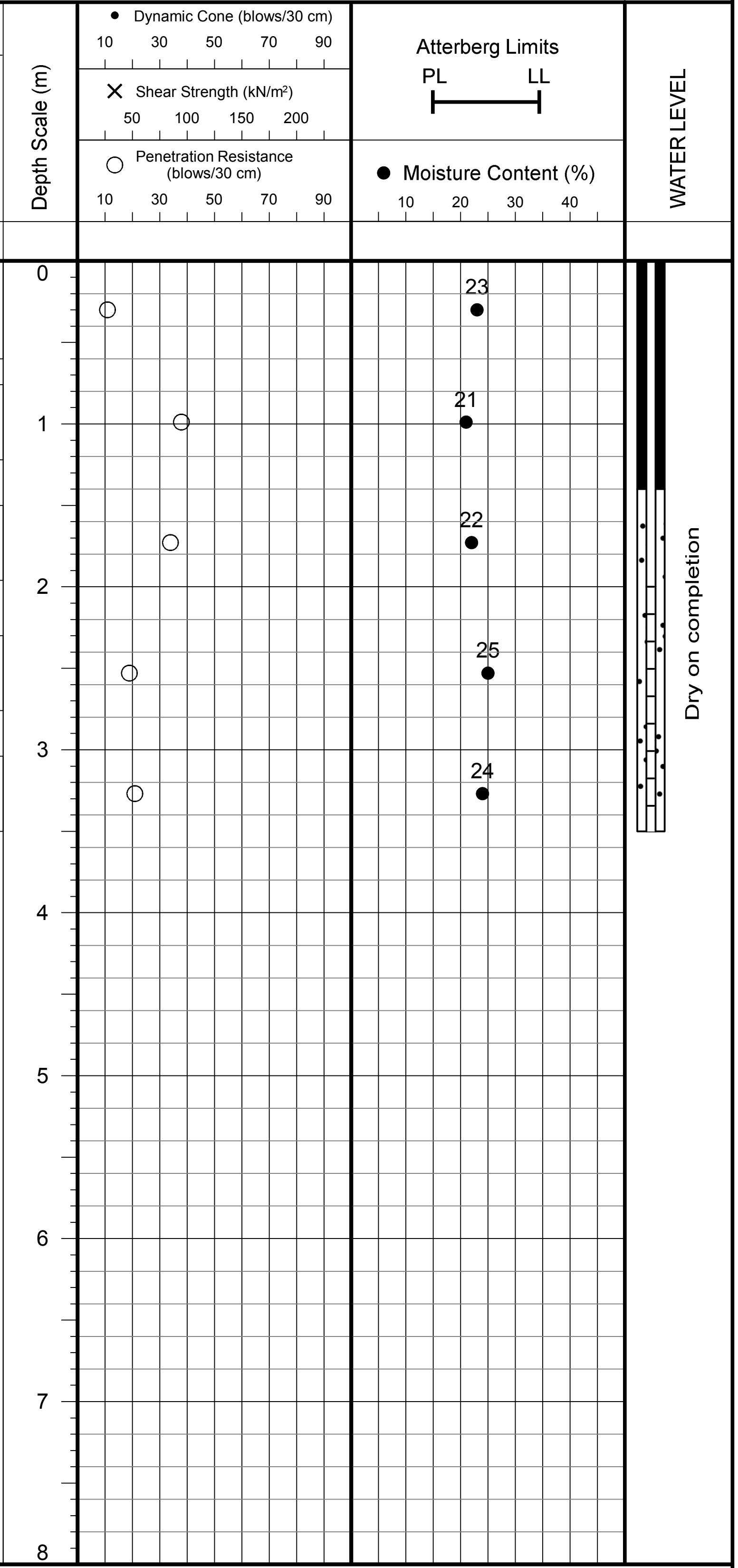
METHOD OF BORING: Flight-Auger

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

DRILLING DATE: August 14, 2019

El. (m) Depth (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value
195.0	Ground Surface			
0.0 0.1	**10 cm TOPSOIL**			
	Brown, stiff to hard	1	DO	11
	weathered			
	SILTY CLAY medium plasticity occ. sand seams and layers	2	DO	38
		3	DO	34
		4	DO	19
		5	DO	21
191.5 3.5	**Refusal to Augering** **Inferred Bedrock** **END OF BOREHOLE**			

Installed 50 mm Ø monitoring well to 3.5 m
completed with 1.5 m screen
Sand backfill from 1.4 m to 3.5 m
Bentonite seal from 0.0 m to 1.4 m.
Provided with steel casing and lock.



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JOB NO.: 1907-S107

LOG OF BOREHOLE NO.: 7

FIGURE NO.: 7

PROJECT DESCRIPTION: Proposed Wetland Design
Area SC-8

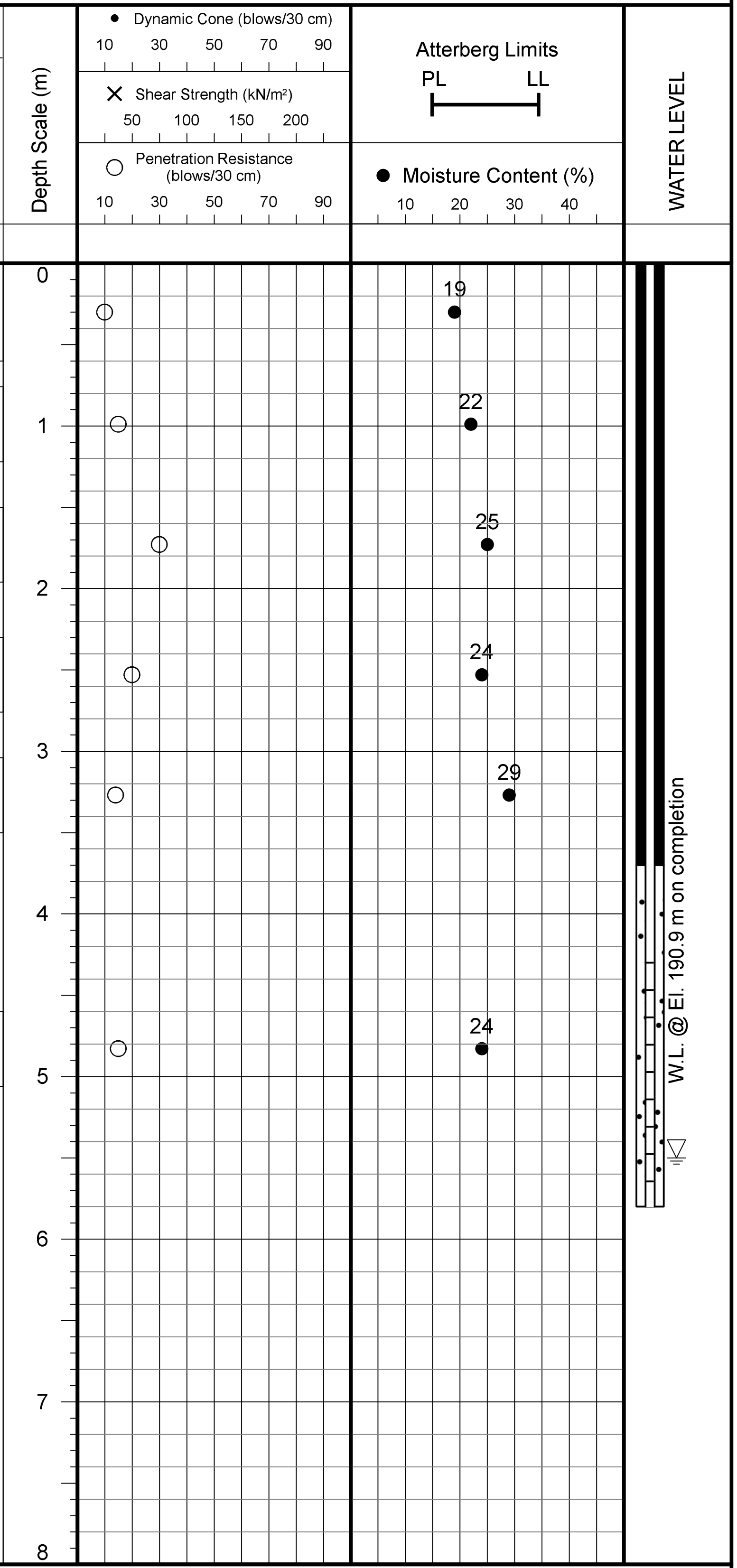
METHOD OF BORING: Flight-Auger

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

DRILLING DATE: August 14, 2019

El. (m) Depth (m)	SOIL DESCRIPTION	SAMPLES		
		Number	Type	N-Value
196.4	Ground Surface			
0.0 0.1	**10 cm TOPSOIL**			
	Stiff to very stiff	1	DO	10
	weathered			
		2	DO	15
	SILTY CLAY medium plasticity occ. sand seams and layers	3	DO	30
		4	DO	20
		5	DO	14
	brown grey			
		6	DO	15
190.6 5.8	**Refusal to Augering** **Inferred Bedrock** **END OF BOREHOLE**			

Installed 50 mm Ø monitoring well to 5.8 m
completed with 1.5 m screen
Sand backfill from 3.7 m to 5.8 m
Bentonite seal from 0.0 m to 3.7 m.
Provided with steel casing and lock.



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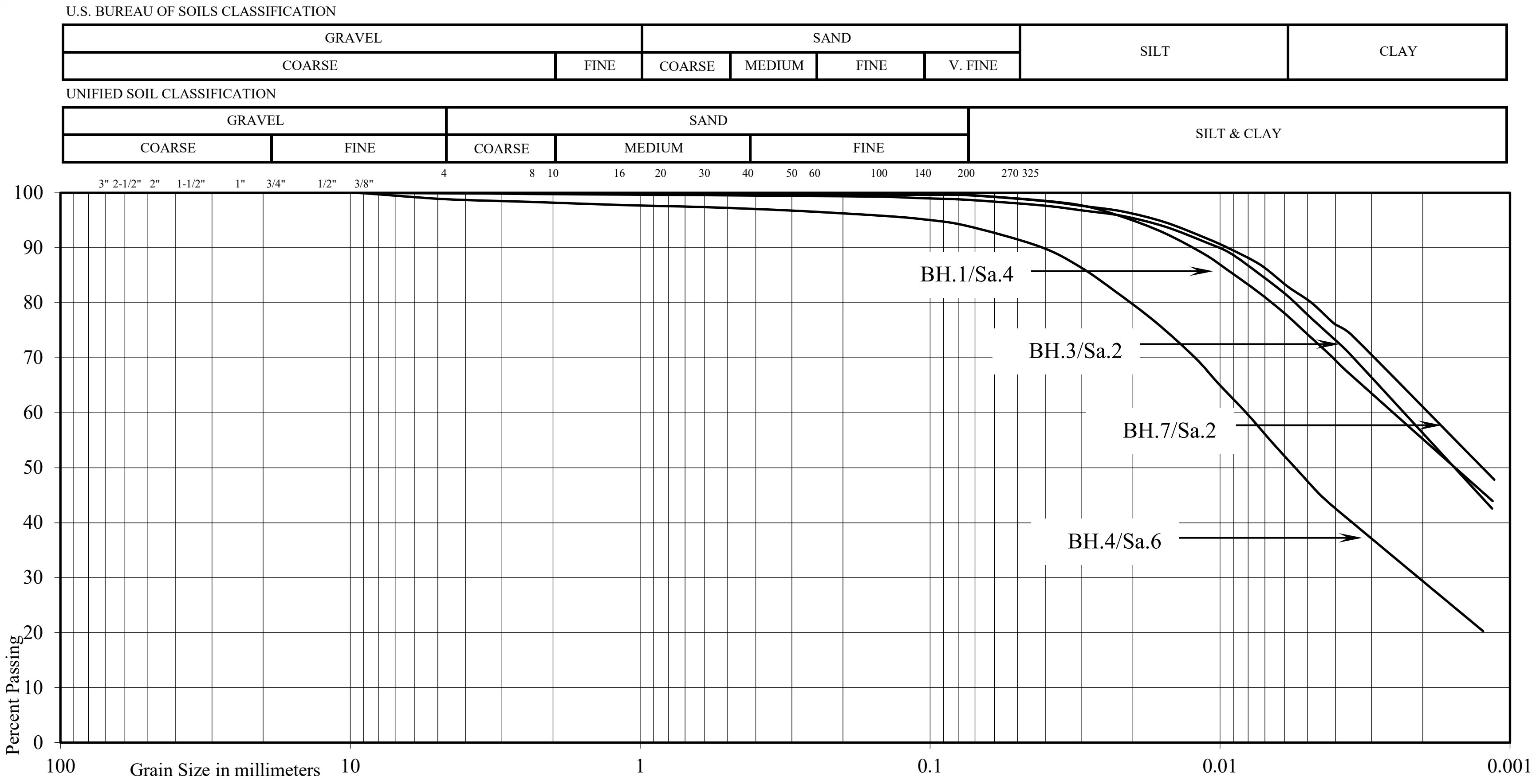
GRAIN SIZE DISTRIBUTION

Reference No: 1907-S107



Project: Proposed Wetland Design Area SC-8

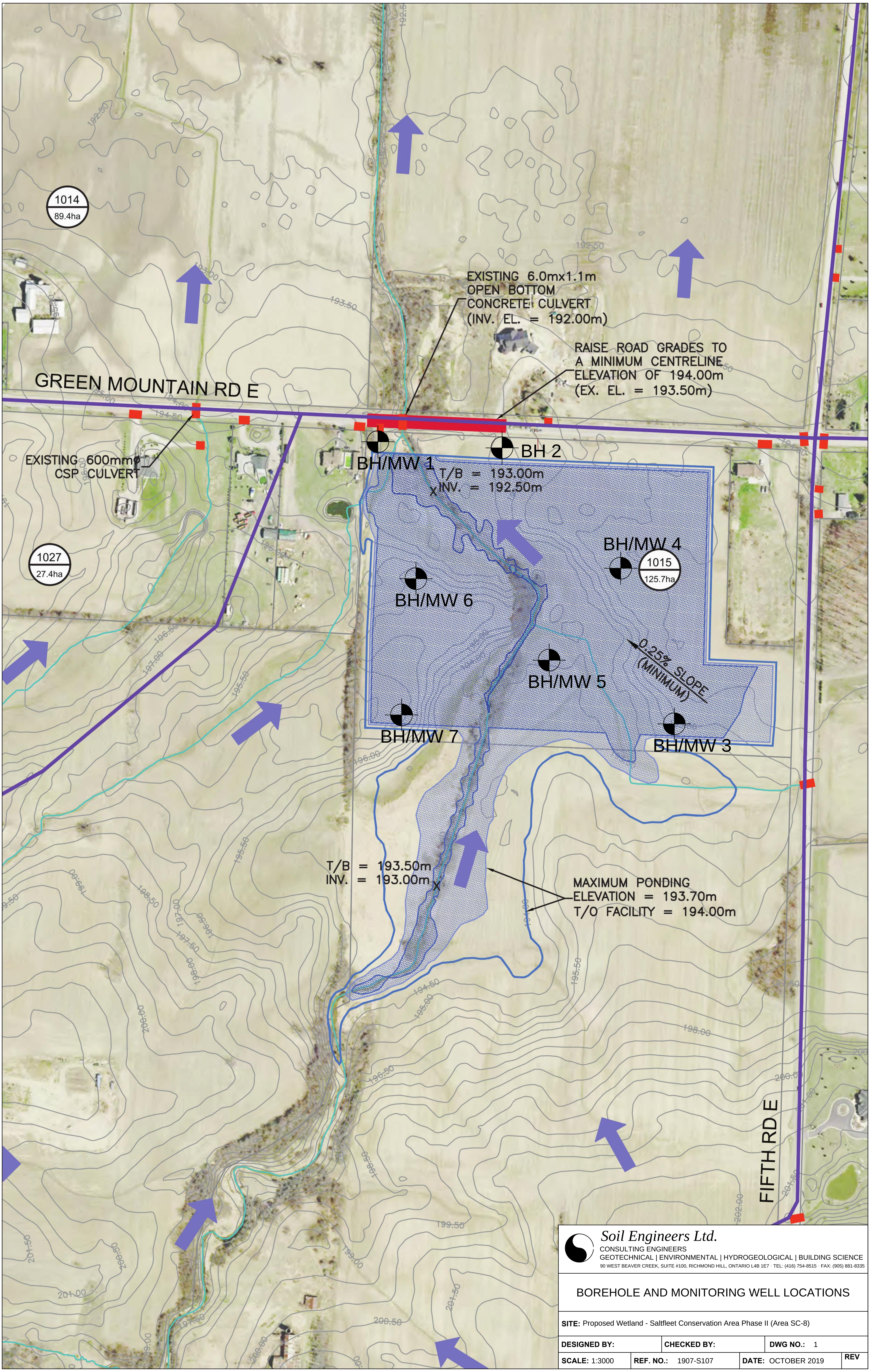
Location: Fifth Road East and Green Mountain Road East, City of Hamilton

Borehole No:	1	3	4	7
Sample No:	4	2	6	2
Depth (m):	2.5	1.0	4.8	1.0
Elevation (m):	190.7	193.9	190.4	195.4

BH./Sa.	1/4	3/2	4/6	7/2
Liquid Limit (%) =	47	-	29	-
Plastic Limit (%) =	22	-	16	-
Plasticity Index (%) =	25	-	13	-
Moisture Content (%) =	29	21	25	22
Estimated Permeability (cm./sec.) =	10^{-7}	10^{-7}	10^{-7}	10^{-7}

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

Figure: 8



EXISTING 6.0mx1.1m
OPEN BOTTOM
CONCRETE CULVERT
(INV. EL. = 192.00m)

RAISE ROAD GRADES TO
A MINIMUM CENTRELINE
ELEVATION OF 194.00m
(EX. EL. = 193.50m)

EXISTING 600mmφ
CSP CULVERT

T/B = 193.00m
INV. = 192.50m

T/B = 193.50m
INV. = 193.00m

MAXIMUM PONDING
ELEVATION = 193.70m
T/O FACILITY = 194.00m

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BOREHOLE AND MONITORING WELL LOCATIONS

SITE: Proposed Wetland - Saltfleet Conservation Area Phase II (Area SC-8)

DESIGNED BY:
CHECKED BY:
DWG NO.: 1
SCALE: 1:3000
REF. NO.: 1907-S107
DATE: OCTOBER 2019
REV

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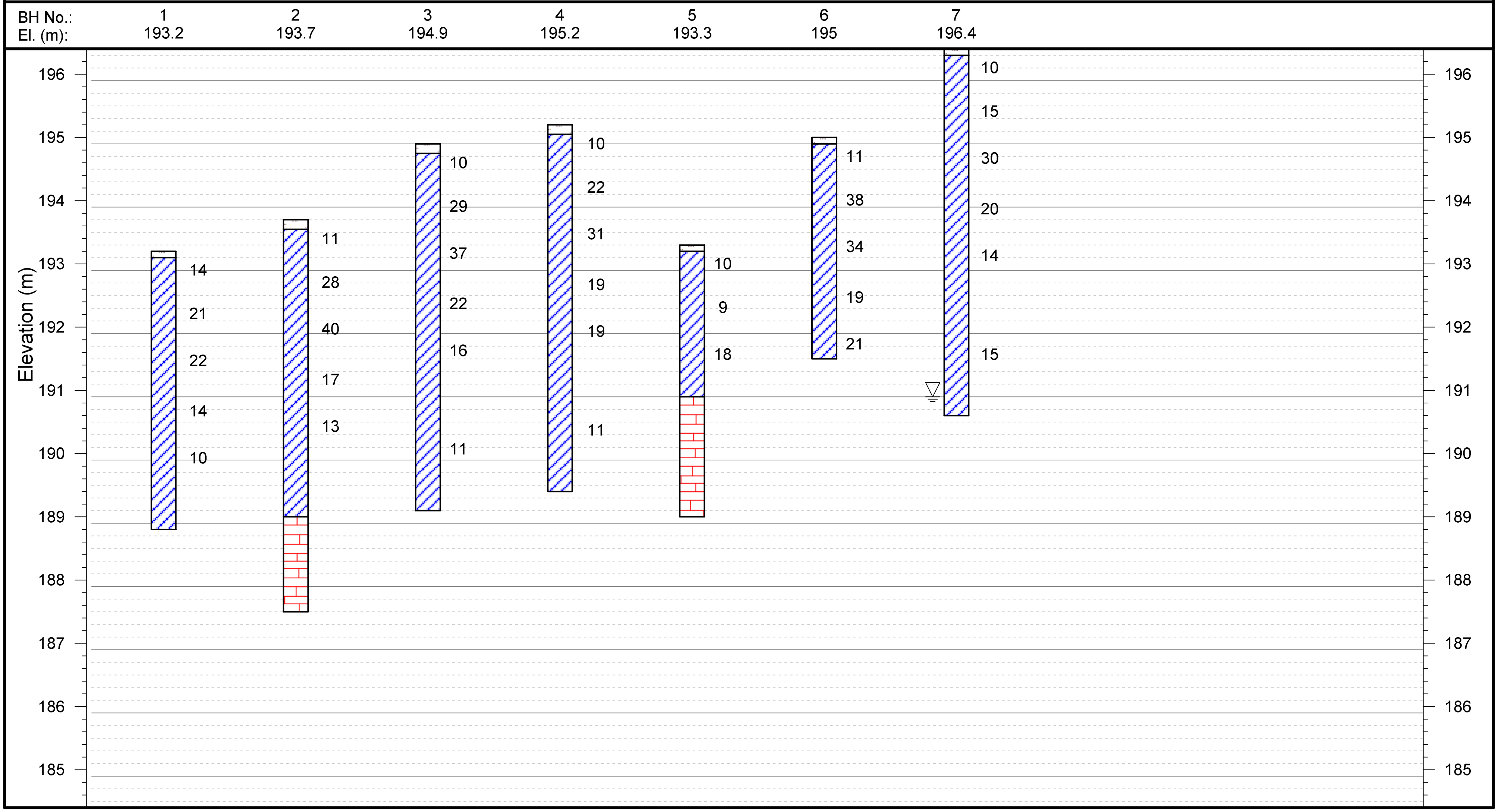
SUBSURFACE PROFILE
DRAWING NO. 2
SCALE: AS SHOWN

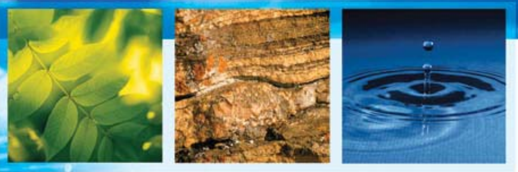
JOB NO.:	1907-S107
REPORT DATE:	October 2019
PROJECT DESCRIPTION:	Proposed Wetland Design Area SC-8
PROJECT LOCATION:	Fifth Road East and Green Mountain Road East City of Hamilton

LEGEND

▭	TOPSOIL	▨	SILTY CLAY	▦	LIMESTONE /DOLOSTONE

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





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APPENDIX B:

Soil Chemistry Report

Soil Engineers Ltd.
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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

September 3, 2019

Reference No. 1907-E107
Page 1 of 3

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
South of Green Mountain Road East, Between Tapleytown Road and Fifth Road East
City of Hamilton

Dear Sir:

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

The subject site is located on the southwest quadrant of Green Mountain Road East and Fifth Road East, in the City of Hamilton. It is understood that this 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 seven (7) boreholes at the subject site was conducted on August 14, 2019. The boreholes were drilled to depths ranging from 4.3 to 6.1 m below ground surface. The borehole and sampling locations are shown on the Sampling Location Plan, Drawing No. 1.

The boreholes were drilled to the sampling depths by a drilling rig. Soil samples were retrieved from the boreholes using a split spoon sampler, for soil classification and visual and olfactory observations. The sampling tool (i.e., split spoon) 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 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 in places, the site is underlain by strata of silty clay and dolomite/limestone bedrock. Detailed descriptions of the encountered subsurface conditions are presented on the Borehole Logs, comprising Figures 1 to 7. inclusive.

Site Condition Standard

The analytical results of the soil samples were compared 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").

Soil Sampling and Soil Quality

A total of thirteen (13) representative soil samples were retrieved from boreholes drilled 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	450676	Topsoil	0.0 – 1.0	0	OCPs
	BH1/3	450679	Silty Clay	1.6 – 2.0	0	M&I, PHCs
2	BH2/2	450681	Silty Clay	0.8 – 1.2	0	M&I
	BH2/5	450682	Silty Clay	3.1 – 3.5	0	PHCs
3	BH3/1	450683	Topsoil	0.0 – 0.15	0	OCPs
	BH3/4	450686	Silty Clay	2.4 – 2.7	0	M&I
4	BH4/1	450687	Topsoil	0.0 – 0.15	0	OCPs
	BH4/3	450689	Silty Clay	1.5 – 2.0	0	M&I
5	BH5/1	450690	Topsoil	0.0 – 0.1	0	M&I
	BH5/3	450691	Silty Clay	1.5 – 2.0	0	PHCs
6	BH6/2	450692	Silty Clay	0.8 – 1.2	0	M&I, PHCs
7	BH7/1	450694	Topsoil	0.0 – 0.1	0	OCPs
	BH7/2	450695	Silty Clay	0.8 – 1.2	0	M&I

*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 Standards with the exception of the following parameters:

Sample Name	Parameter	Unit	Table 1 Standards	Table 2 RPI Standards	Measured Value
BH1/3	Electrical Conductivity	mS/cm	0.57	0.7	0.624

In reviewing the results of the soil samples indicates that the tested parameters at the sampling locations meet Table 2 RPI 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.
EK/AH:ek

LICENSED PROFESSIONAL ENGINEER
A. M. HASSAN
100124527
Sept. 3, 2019
PROVINCE OF ONTARIO

Ahmed Hassan, P.Eng.

Enclosed

- Borehole Location Plan (1 Page)
- Borehole Logs (7)
- Certificate of Analysis (12 Pages)

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Borehole Location Plan


1014
89.4ha
EXISTING 6.0mx1.1m
OPEN BOTTOM
CONCRETE CULVERT
(INV. EL. = 192.00m)
RAISE ROAD GRADES TO
A MINIMUM CENTRELINE
ELEVATION OF 194.00m
(EX. EL. = 193.50m)
GREEN MOUNTAIN RD E
Green Mountain Rd E
BH/MW 1
BH 2
BH 2
BH/MW 1
T/B = 193.00m
INV. = 192.50m
EXISTING 600mm
CSP CULVERT
BH/MW 4
BH/MW 4
125.7ha
1027
27.4ha
BH/MW 6
BH/MW 6
5 Rd E
BH/MW 5
BH/MW 5
0.25% SLOPE
(MINIMUM)
BH/MW 7
BH/MW 7
BH/MW 3
BH/MW 3
T/B = 193.50m
INV. = 193.00m
MAXIMUM PONDING
ELEVATION = 193.70m
T/O FACILITY = 194.00m
Google Earth
© 2018 Google
300 m
N

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Borehole Logs

JOB NO.: 1907-S107

LOG OF BOREHOLE NO.: 1

FIGURE NO.: 1

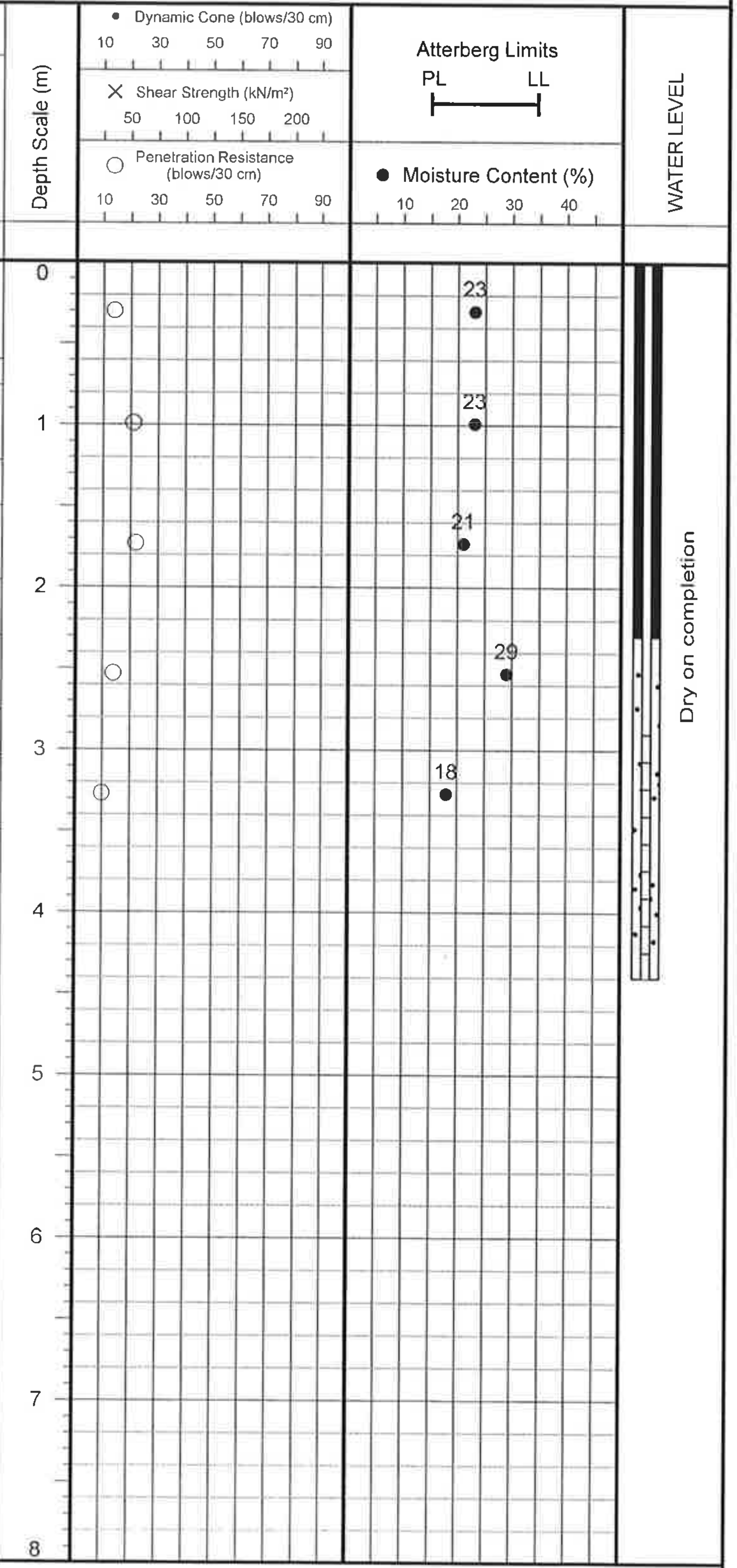
PROJECT DESCRIPTION: Proposed Wetland Design
Area SC-8

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

METHOD OF BORING: Flight-Auger

DRILLING DATE: August 14, 2019

El. (m) Depth (m)	SOIL DESCRIPTION	SAMPLES Number	SAMPLES Type	SAMPLES N-Value
192.5	Ground Surface			
0.0	**10 cm TOPSOIL**			
0.1	Stiff to very stiff	1	DO	14
		2	DO	21
	SILTY CLAY a tr. of sand occ. sand seams and layers	3	DO	22
		4	DO	14
	brown grey	5	DO	10
4.4	**Refusal to Augering** **Inferred Bedrock** **END OF BOREHOLE** Installed 50 mm Ø monitoring well to 4.4 m completed with 1.5 m screen Sand backfill from 2.3 m to 4.4 m Bentonite seal from 0.0 m to 2.3 m. Provided with steel casing and lock.			



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JOB NO.: 1907-S107

LOG OF BOREHOLE NO.: 2

FIGURE NO.: 2

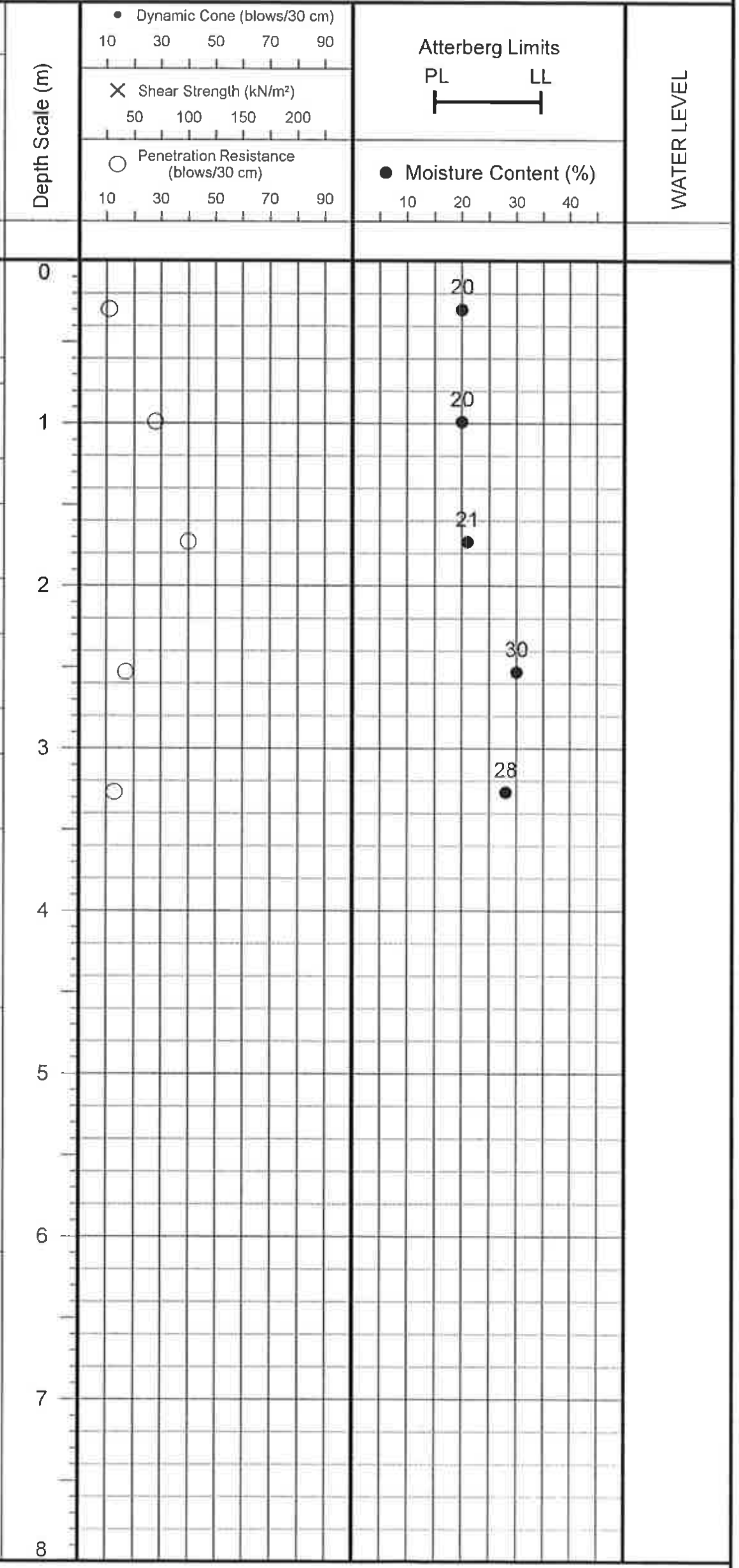
PROJECT DESCRIPTION: Proposed Wetland Design
Area SC-8

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

METHOD OF BORING: Flight-Auger

DRILLING DATE: August 13, 2019

El. (m) Depth (m)	SOIL DESCRIPTION	SAMPLES Number	SAMPLES Type	SAMPLES N-Value
193.5	Ground Surface			
0.0	**15 cm TOPSOIL**			
0.1	Stiff to hard	1	DO	11
	SILTY CLAY a tr. of sand occ. sand seams and layers	2	DO	28
		3	DO	40
		4	DO	17
	brown grey	5	DO	13
4.6	Grey **DOLOMITE/LIMESTONE BEDROCK**	6	RC RQD	90% 83%
6.1	**END OF BOREHOLE**			



JOB NO.: 1907-S107

LOG OF BOREHOLE NO.: 3

FIGURE NO.: 3

PROJECT DESCRIPTION: Proposed Wetland Design
Area SC-8

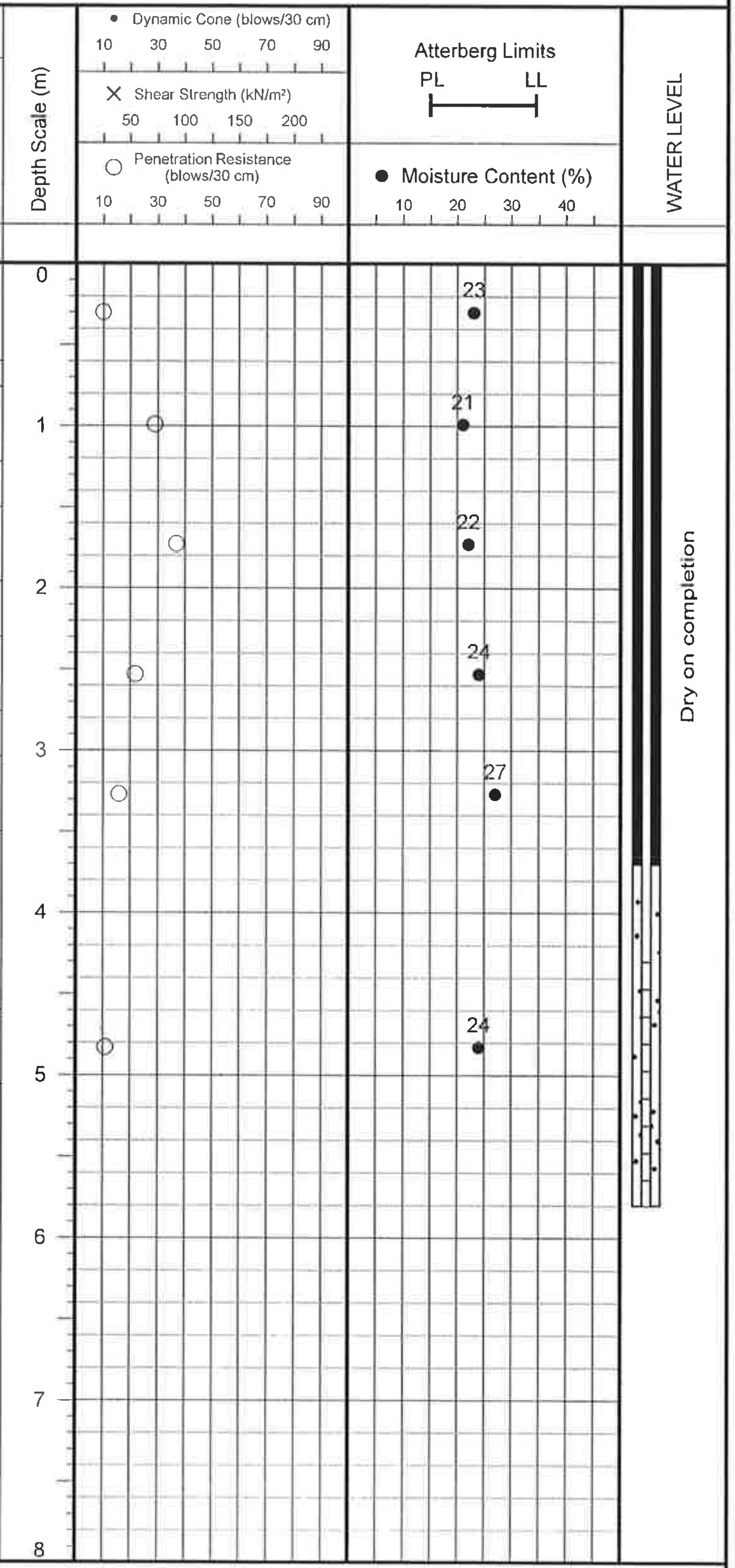
METHOD OF BORING: Flight-Auger

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

DRILLING DATE: August 13, 2019

El. (m) Depth (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value
194.5	Ground Surface			
0.0 0.1	**15 cm TOPSOIL**			
	Stiff to hard	1	DO	10
		2	DO	29
	SILTY CLAY a tr. of sand occ. sand seams and layers	3	DO	37
		4	DO	22
	brown grey	5	DO	16
		6	DO	11
5.8	**Refusal to Augering** **Inferred Bedrock** **END OF BOREHOLE**			

Installed 50 mm Ø monitoring well to 5.8 m
completed with 1.5 m screen
Sand backfill from 3.7 m to 5.8 m
Bentonite seal from 0.0 m to 3.7 m.
Provided with steel casing and lock.



Soil Engineers Ltd.

JOB NO.: 1907-S107

LOG OF BOREHOLE NO.: 4

FIGURE NO.: 4

PROJECT DESCRIPTION: Proposed Wetland Design
Area SC-8

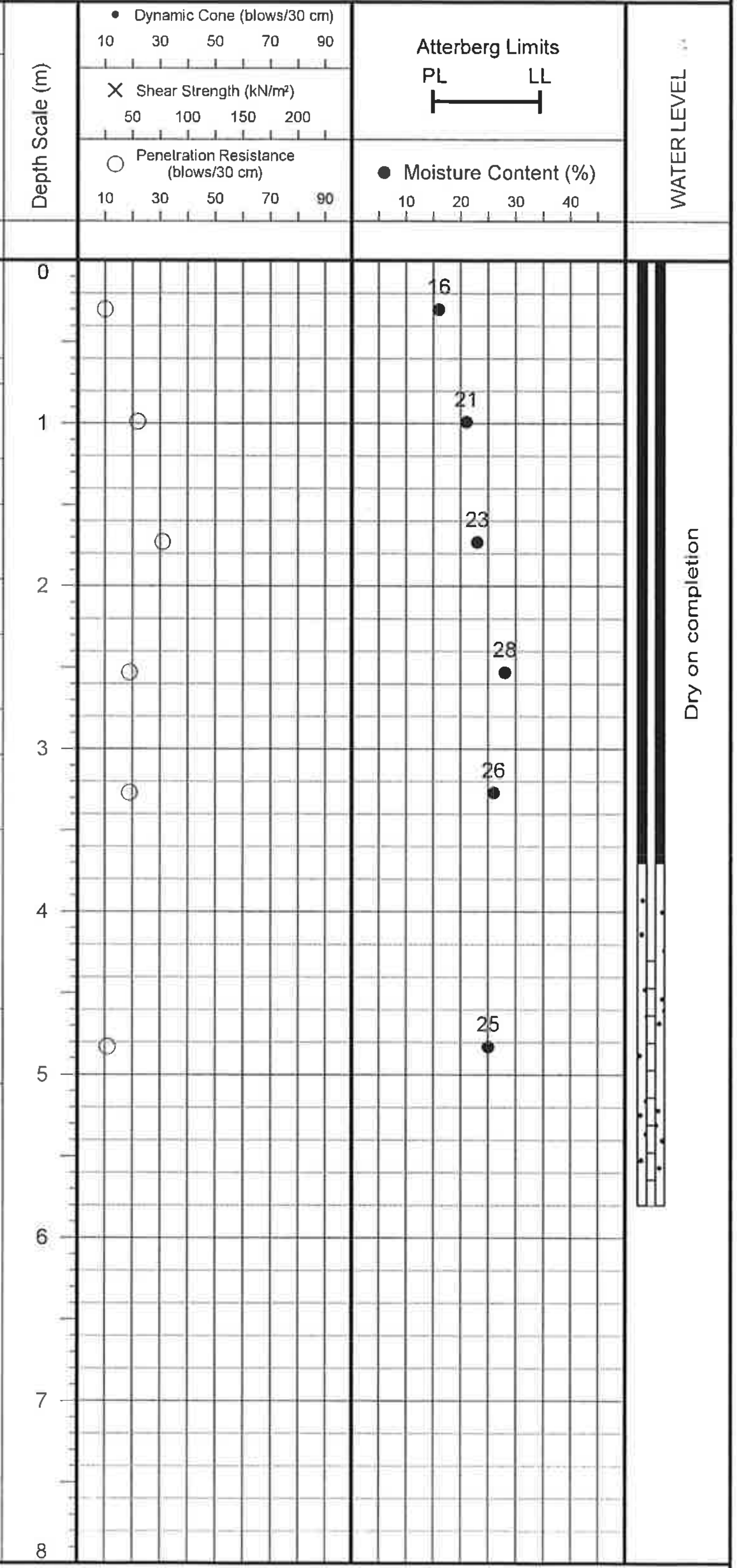
PROJECT LOCATION: Fifth Road East and Green Mountain Road East
City of Hamilton

METHOD OF BORING: Flight-Auger

DRILLING DATE: August 13, 2019

El. (m) Depth (m)	SOIL DESCRIPTION
195.5	Ground Surface
0.0 0.1	**15 cm TOPSOIL**
	Stiff to very stiff **SILTY CLAY** a tr. of sand occ. sand seams and layers brown grey
5.8	**Refusal to Augering** **Inferred Bedrock** **END OF BOREHOLE** Installed 50 mm Ø monitoring well to 5.8 m completed with 1.5 m screen Sand backfill from 3.7 m to 5.8 m Bentonite seal from 0.0 m to 3.7 m. Provided with steel casing and lock.

SAMPLES		
Number	Type	N-Value
1	DO	10
2	DO	22
3	DO	31
4	DO	19
5	DO	19
6	DO	11



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JOB NO.: 1907-S107

LOG OF BOREHOLE NO.: 5

FIGURE NO.: 5

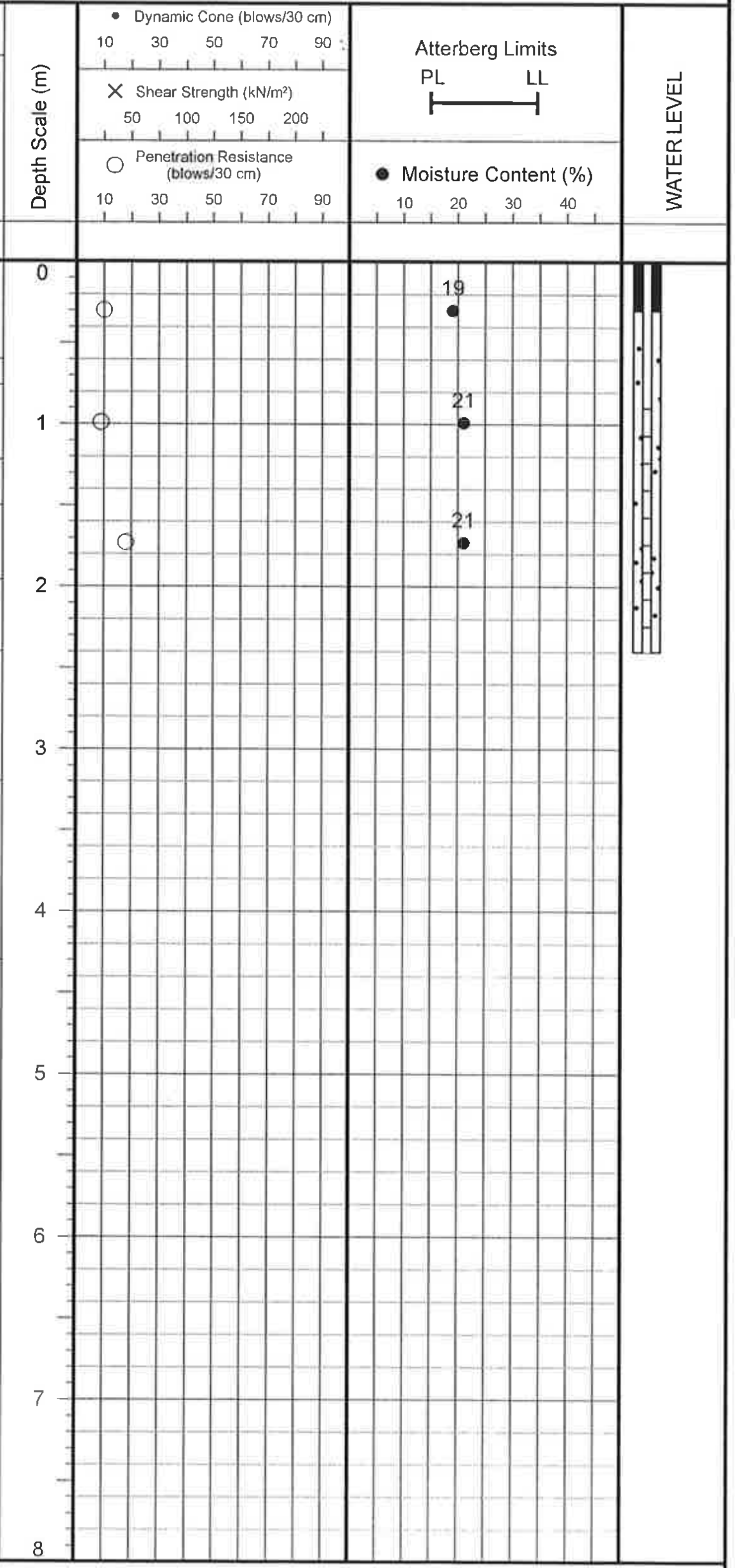
PROJECT DESCRIPTION: Proposed Wetland Design
Area SC-8

METHOD OF BORING: Flight-Auger

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

DRILLING DATE: August 13, 2019

El. (m) Depth (m)	SOIL DESCRIPTION	SAMPLES		
		Number	Type	N-Value
193.5	Ground Surface			
0.0	**10 cm TOPSOIL**			
0.1	Stiff to hard **SILTY CLAY** a tr. of sand occ. sand seams and layers	1	DO	10
		2	DO	9
		3	DO	18
2.4	Grey **DOLOMITE/LIMESTONE BEDROCK**	4	RC RQD	100% 31%
		5	RC RQD	100% 39%
4.3	**END OF BOREHOLE** Installed 50 mm Ø monitoring well to 2.4 m completed with 1.5 m screen Sand backfill from 0.3 m to 2.4 m Bentonite seal from 0.0 m to 0.3 m. Provided with steel casing and lock.			



Soil Engineers Ltd.

Page: 1 of 1

JOB NO.: 1907-S107

LOG OF BOREHOLE NO.: 6

FIGURE NO.: 6

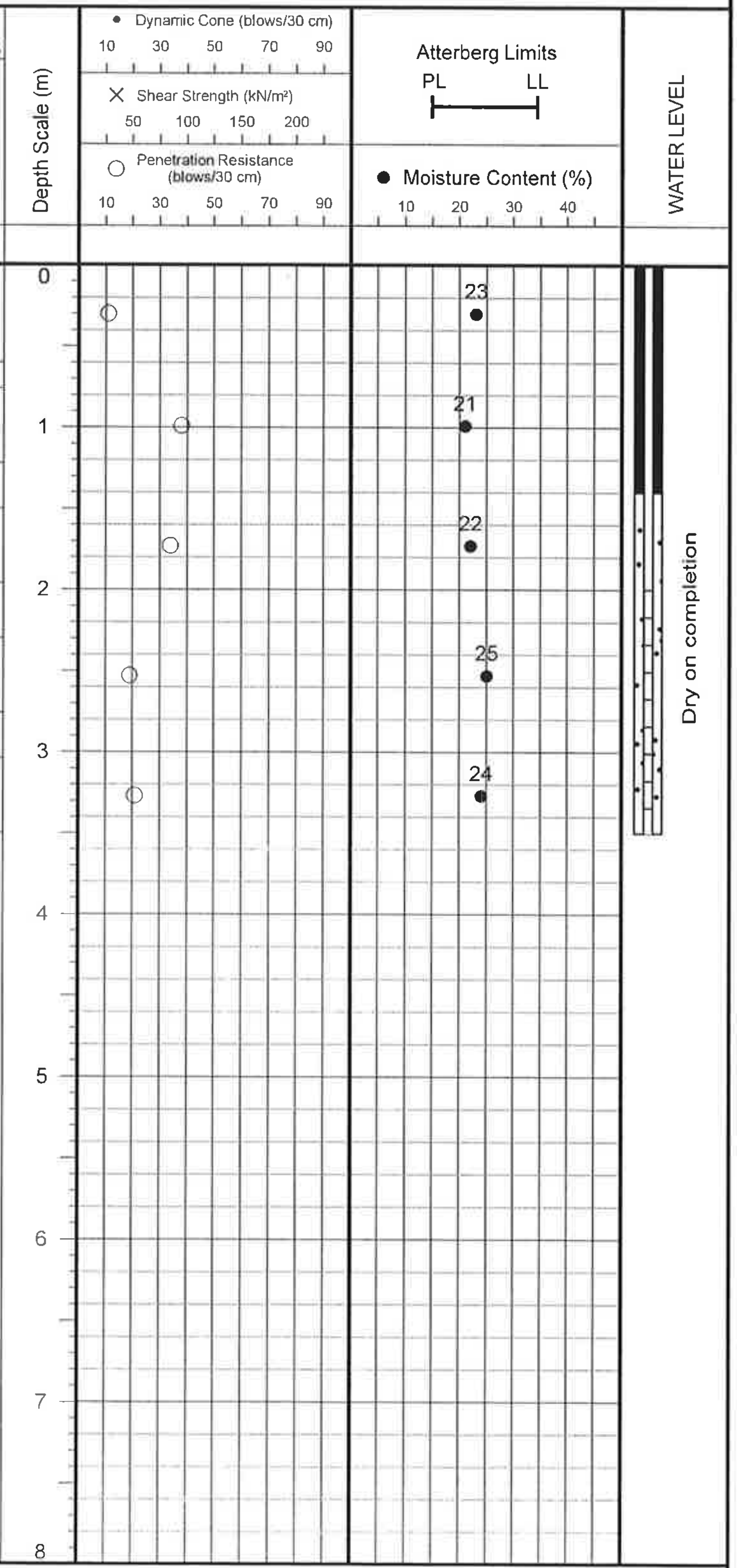
PROJECT DESCRIPTION: Proposed Wetland Design
Area SC-8

METHOD OF BORING: Flight-Auger

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

DRILLING DATE: August 14, 2019

El. (m) Depth (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value
194.0	Ground Surface			
0.0 0.1	**10 cm TOPSOIL**			
	Brown, stiff to hard **SILTY CLAY** a tr. of sand occ. sand seams and layers	1	DO	11
		2	DO	38
		3	DO	34
		4	DO	19
		5	DO	21
3.5	**Refusal to Augering** **Inferred Bedrock** **END OF BOREHOLE** Installed 50 mm Ø monitoring well to 3.5 m completed with 1.5 m screen Sand backfill from 1.4 m to 3.5 m Bentonite seal from 0.0 m to 1.4 m. Provided with steel casing and lock.			



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Page: 1 of 1

JOB NO.: 1907-S107

LOG OF BOREHOLE NO.: 7

FIGURE NO.: 7

PROJECT DESCRIPTION: Proposed Wetland Design
Area SC-8

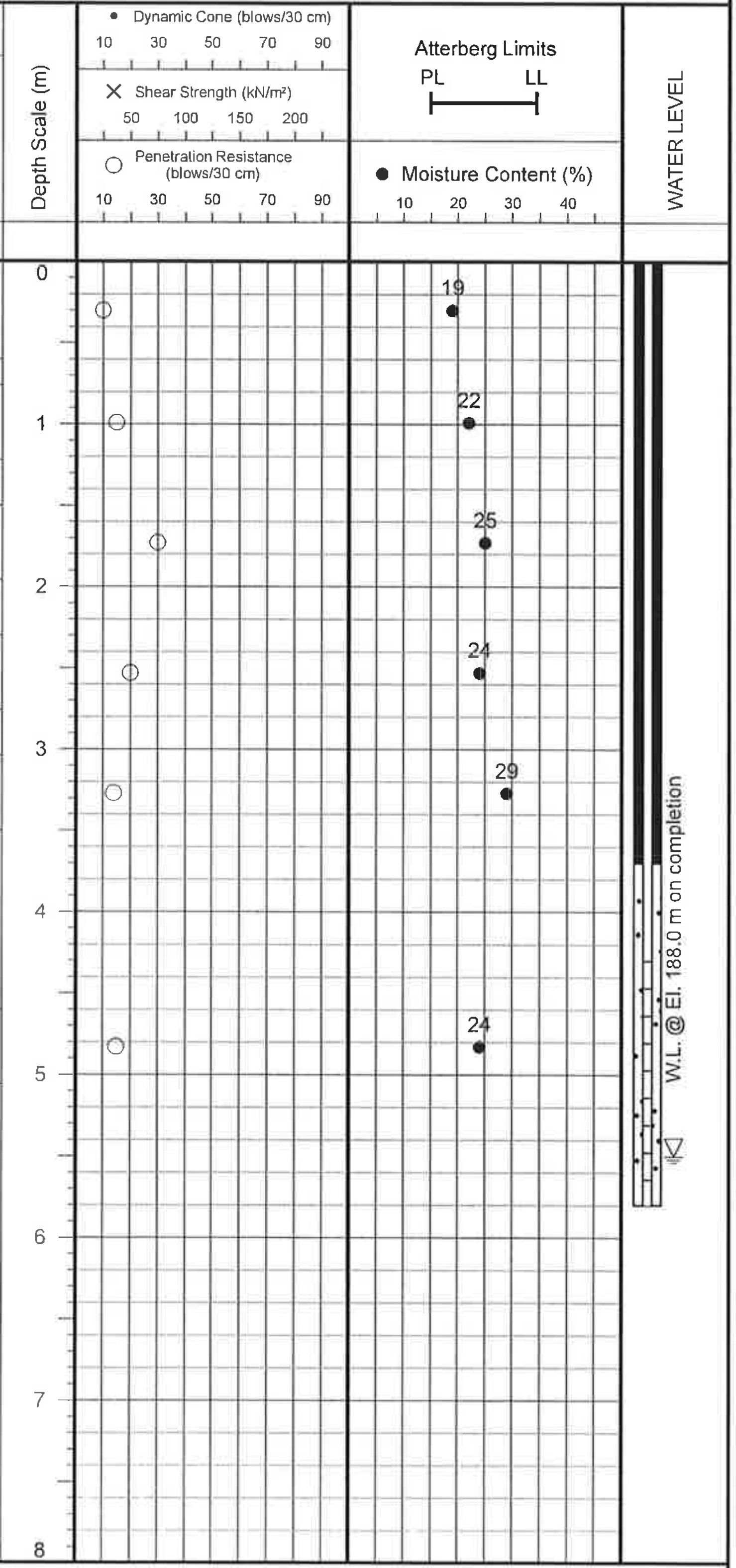
METHOD OF BORING: Flight-Auger

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

DRILLING DATE: August 14, 2019

El. (m) Depth (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value
193.5	Ground Surface			
0.0 0.1	**10 cm TOPSOIL**			
	Stiff to very stiff	1	DO	10
		2	DO	15
	SILTY CLAY a tr. of sand occ. sand seams and layers	3	DO	30
		4	DO	20
		5	DO	14
	brown grey			
		6	DO	15
5.8	**Refusal to Augering** **Inferred Bedrock** **END OF BOREHOLE**			

Installed 50 mm Ø monitoring well to 5.8 m completed with 1.5 m screen
Sand backfill from 3.7 m to 5.8 m
Bentonite seal from 0.0 m to 3.7 m.
Provided with steel casing and lock.



Soil Engineers Ltd.

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

Certificate of Analysis

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

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: 1907-E107

AGAT WORK ORDER: 19T506733

SOIL ANALYSIS REVIEWED BY: Nivine Basily, Inorganics Report Writer

TRACE ORGANICS REVIEWED BY: Pinkal Patel, Report Reviewer

DATE REPORTED: Aug 26, 2019

PAGES (INCLUDING COVER): 12

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: 19T506733
PROJECT: 1907-E107

CLIENT NAME: SOIL ENGINEERS LIMITED
SAMPLING SITE:

ATTENTION TO: Ahmed Hassan
SAMPLED BY:Angie

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

DATE RECEIVED: 2019-08-19

DATE REPORTED: 2019-08-26

			SAMPLE DESCRIPTION:	BH 1/3	BH 2/2	BH 3/4	BH 4/3	BH 5/1	BH 6/2	BH7/2
			SAMPLE TYPE:	Soil	Soil	Soil	Soil	Soil	Soil	Soil
			DATE SAMPLED:	2019-08-14	2019-08-13	2019-08-13	2019-08-13	2019-08-13	2019-08-14	2019-08-14
Parameter	**Unit**	**G / S**	**RDL**	**450679**	**450681**	**450686**	**450689**	**450690**	**450692**	**450695**
Antimony	µg/g	1.3	0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8
Arsenic	µg/g	18	1	6	4	4	5	3	5	4
Barium	µg/g	220	2	114	176	138	140	93	147	150
Beryllium	µg/g	2.5	0.5	0.8	0.8	0.9	0.8	0.9	0.9	0.8
Boron	µg/g	36	5	12	11	13	12	<5	11	11
Boron (Hot Water Soluble)	µg/g	NA	0.10	0.27	<0.10	0.15	<0.10	0.15	<0.10	<0.10
Cadmium	µg/g	1.2	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Chromium	µg/g	70	2	26	26	30	28	26	30	27
Cobalt	µg/g	21	0.5	16.2	12.7	15.4	13.0	13.3	13.4	12.7
Copper	µg/g	92	1	27	22	25	22	11	23	21
Lead	µg/g	120	1	17	14	15	14	49	15	13
Molybdenum	µg/g	2	0.5	0.6	<0.5	<0.5	<0.5	0.5	<0.5	<0.5
Nickel	µg/g	82	1	34	30	35	30	22	31	30
Selenium	µg/g	1.5	0.4	<0.4	<0.4	<0.4	<0.4	0.5	<0.4	<0.4
Silver	µg/g	0.5	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Thallium	µg/g	1	0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4
Uranium	µg/g	2.5	0.5	0.8	1.0	0.9	1.0	1.1	0.6	0.7
Vanadium	µg/g	86	1	36	34	39	37	35	39	37
Zinc	µg/g	290	5	66	56	67	60	169	65	56
Chromium VI	µg/g	0.66	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Cyanide	µg/g	0.051	0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040
Mercury	µg/g	0.27	0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Electrical Conductivity	mS/cm	0.57	0.005	**0.624**	0.354	0.314	0.225	0.170	0.186	0.206
Sodium Adsorption Ratio	NA	2.4	NA	1.09	0.705	0.684	0.544	0.828	0.212	0.295
pH, 2:1 CaCl2 Extraction	pH Units		NA	7.76	7.68	7.71	7.70	4.99	7.31	7.42

Certified By: Nivine Basily

AGAT Laboratories

Certificate of Analysis

AGAT WORK ORDER: 19T506733
PROJECT: 1907-E107

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

CLIENT NAME: SOIL ENGINEERS LIMITED
ATTENTION TO: Ahmed Hassan
SAMPLING SITE:
SAMPLED BY:Angie

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

DATE RECEIVED: 2019-08-19
DATE REPORTED: 2019-08-26

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.

450679-450695 EC was 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. SAR is a calculated parameter.

Analysis performed at AGAT Toronto (unless marked by *)

Certified By: Nivine Basily

Certificate of Analysis

AGAT WORK ORDER: 19T506733
PROJECT: 1907-E107

CLIENT NAME: SOIL ENGINEERS LIMITED
ATTENTION TO: Ahmed Hassan
SAMPLING SITE:
SAMPLED BY:Angie

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

DATE RECEIVED: 2019-08-19
DATE REPORTED: 2019-08-26

			SAMPLE DESCRIPTION:	BH 1/1	BH 3/1	BH 4/1	BH 7/1
			SAMPLE TYPE:	Soil	Soil	Soil	Soil
			DATE SAMPLED:	2019-08-14	2019-08-13	2019-08-13	2019-08-14
Parameter	**Unit**	**G / S**	**RDL**	**450676**	**450683**	**450687**	**450694**
Hexachloroethane	µg/g	0.01	0.01	<0.01	<0.01	<0.01	<0.01
Gamma-Hexachlorocyclohexane	µg/g	0.01	0.005	<0.005	<0.005	<0.005	<0.005
Heptachlor	µg/g	0.05	0.005	<0.005	<0.005	<0.005	<0.005
Aldrin	µg/g	0.05	0.005	<0.005	<0.005	<0.005	<0.005
Heptachlor Epoxide	µg/g	0.05	0.005	<0.005	<0.005	<0.005	<0.005
Endosulfan	µg/g	0.04	0.005	<0.005	<0.005	<0.005	<0.005
Chlordane	µg/g	0.05	0.007	<0.007	<0.007	<0.007	<0.007
DDE	µg/g	0.05	0.007	<0.007	<0.007	<0.007	<0.007
DDD	µg/g	0.05	0.007	<0.007	<0.007	<0.007	<0.007
DDT	µg/g	1.4	0.007	<0.007	<0.007	<0.007	<0.007
Dieldrin	µg/g	0.05	0.005	<0.005	<0.005	<0.005	<0.005
Endrin	µg/g	0.04	0.005	<0.005	<0.005	<0.005	<0.005
Methoxychlor	µg/g	0.05	0.005	<0.005	<0.005	<0.005	<0.005
Hexachlorobenzene	µg/g	0.01	0.005	<0.005	<0.005	<0.005	<0.005
Hexachlorobutadiene	µg/g	0.01	0.01	<0.01	<0.01	<0.01	<0.01
Moisture Content	%		0.1	18.1	19.8	16.3	14.1
Surrogate	**Unit**	**Acceptable Limits**					
TCMX	%	50-140		82	91	95	90
Decachlorobiphenyl	%	60-130		115	115	119	109

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.

450676-450694 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 *)

Jinkal Patel

Certified By:

Certificate of Analysis

AGAT WORK ORDER: 19T506733
PROJECT: 1907-E107

CLIENT NAME: SOIL ENGINEERS LIMITED
SAMPLING SITE:

ATTENTION TO: Ahmed Hassan
SAMPLED BY:Angie

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

DATE RECEIVED: 2019-08-19

DATE REPORTED: 2019-08-26

			SAMPLE DESCRIPTION:	BH 1/3	BH 2/5	BH 5/3	BH 6/2
			SAMPLE TYPE:	Soil	Soil	Soil	Soil
			DATE SAMPLED:	2019-08-14	2019-08-13	2019-08-13	2019-08-14
Parameter	**Unit**	**G / S**	**RDL**	**450679**	**450682**	**450691**	**450692**
Benzene	µg/g	0.02	0.02	<0.02	<0.02	<0.02	<0.02
Toluene	µg/g	0.2	0.05	<0.05	<0.05	<0.05	<0.05
Ethylbenzene	µg/g	0.05	0.05	<0.05	<0.05	<0.05	<0.05
Xylene Mixture	µg/g	0.05	0.05	<0.05	<0.05	<0.05	<0.05
F1 (C6 to C10)	µg/g	25	5	<5	<5	<5	<5
F1 (C6 to C10) minus BTEX	µg/g	25	5	<5	<5	<5	<5
F2 (C10 to C16)	µg/g	10	10	<10	<10	<10	<10
F3 (C16 to C34)	µg/g	240	50	<50	<50	<50	<50
F4 (C34 to C50)	µg/g	120	50	<50	<50	<50	<50
Gravimetric Heavy Hydrocarbons	µg/g	120	50	NA	NA	NA	NA
Moisture Content	%		0.1	17.5	17.1	14.6	15.2
Surrogate	**Unit**	**Acceptable Limits**					
Terphenyl	%	60-140		84	108	104	86

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.

450679-450692 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:

AGAT Laboratories

Guideline Violation

AGAT WORK ORDER: 19T506733

PROJECT: 1907-E107

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CLIENT NAME: SOIL ENGINEERS LIMITED

ATTENTION TO: Ahmed Hassan

SAMPLEID	SAMPLE TITLE	GUIDELINE	ANALYSIS PACKAGE	PARAMETER	UNIT	GUIDEVALUE	RESULT
450679	BH 1/3	ON T1 S RPI/ICC	O. Reg. 153(511) - Metals & Inorganics (Soil)	Electrical Conductivity	mS/cm	0.57	0.624

Quality Assurance

CLIENT NAME: SOIL ENGINEERS LIMITED
PROJECT: 1907-E107
SAMPLING SITE:

AGAT WORK ORDER: 19T506733
ATTENTION TO: Ahmed Hassan
SAMPLED BY:Angie

Soil Analysis

RPT Date: Aug 26, 2019			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	455928		<0.8	<0.8	NA	< 0.8	129%	70%	130%	94%	80%	120%	73%	70%	130%
Arsenic	455928		4	4	NA	< 1	106%	70%	130%	100%	80%	120%	101%	70%	130%
Barium	455928		117	116	1.3%	< 2	100%	70%	130%	93%	80%	120%	94%	70%	130%
Beryllium	455928		0.6	0.6	NA	< 0.5	92%	70%	130%	96%	80%	120%	105%	70%	130%
Boron	455928		8	8	NA	< 5	72%	70%	130%	97%	80%	120%	98%	70%	130%
Boron (Hot Water Soluble)	448597		0.17	0.15	NA	< 0.10	99%	60%	140%	100%	70%	130%	96%	60%	140%
Cadmium	455928		<0.5	<0.5	NA	< 0.5	111%	70%	130%	101%	80%	120%	103%	70%	130%
Chromium	455928		22	22	0.6%	< 2	90%	70%	130%	102%	80%	120%	106%	70%	130%
Cobalt	455928		7.2	7.0	2.8%	< 0.5	94%	70%	130%	102%	80%	120%	100%	70%	130%
Copper	455928		15	14	3.3%	< 1	91%	70%	130%	108%	80%	120%	101%	70%	130%
Lead	455928		11	11	0.1%	< 1	104%	70%	130%	97%	80%	120%	100%	70%	130%
Molybdenum	455928		0.8	0.7	NA	< 0.5	96%	70%	130%	99%	80%	120%	99%	70%	130%
Nickel	455928		14	14	2.1%	< 1	95%	70%	130%	103%	80%	120%	100%	70%	130%
Selenium	455928		0.7	0.7	NA	< 0.4	105%	70%	130%	95%	80%	120%	97%	70%	130%
Silver	455928		<0.2	<0.2	NA	< 0.2	85%	70%	130%	97%	80%	120%	93%	70%	130%
Thallium	455928		<0.4	<0.4	NA	< 0.4	96%	70%	130%	98%	80%	120%	99%	70%	130%
Uranium	455928		0.6	0.6	NA	< 0.5	106%	70%	130%	98%	80%	120%	101%	70%	130%
Vanadium	455928		34	34	0.5%	< 1	92%	70%	130%	101%	80%	120%	105%	70%	130%
Zinc	455928		71	71	1.1%	< 5	99%	70%	130%	107%	80%	120%	113%	70%	130%
Chromium VI	453974		<0.2	<0.2	NA	< 0.2	85%	70%	130%	104%	80%	120%	103%	70%	130%
Cyanide	459094		<0.040	<0.040	NA	< 0.040	105%	70%	130%	101%	80%	120%	103%	70%	130%
Mercury	455928		<0.10	<0.10	NA	< 0.10	94%	70%	130%	92%	80%	120%	98%	70%	130%
Electrical Conductivity	450679	450679	0.624	0.658	5.4%	< 0.005	99%	90%	110%						
Sodium Adsorption Ratio	450679	450679	1.09	1.10	1.1%	NA									
pH, 2:1 CaCl2 Extraction	459094		9.60	9.61	0.1%	NA	100%	80%	120%						

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
pH duplicates QA acceptance criteria was met relative as stated in Table 5-15 of Analytical Protocol document.

Nivine Basily

Certified By:

Quality Assurance

CLIENT NAME: SOIL ENGINEERS LIMITED
PROJECT: 1907-E107
SAMPLING SITE:

AGAT WORK ORDER: 19T506733
ATTENTION TO: Ahmed Hassan
SAMPLED BY:Angie

Trace Organics Analysis

RPT Date: Aug 26, 2019			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) - OC Pesticides (Soil)															
Hexachloroethane	450694	450694	< 0.01	< 0.01	NA	< 0.01	104%	50%	140%	103%	50%	140%	87%	50%	140%
Gamma-Hexachlorocyclohexane	450694	450694	< 0.005	< 0.005	NA	< 0.005	105%	50%	140%	109%	50%	140%	97%	50%	140%
Heptachlor	450694	450694	< 0.005	< 0.005	NA	< 0.005	102%	50%	140%	103%	50%	140%	100%	50%	140%
Aldrin	450694	450694	< 0.005	< 0.005	NA	< 0.005	109%	50%	140%	108%	50%	140%	104%	50%	140%
Heptachlor Epoxide	450694	450694	< 0.005	< 0.005	NA	< 0.005	105%	50%	140%	103%	50%	140%	108%	50%	140%
Endosulfan	450694	450694	< 0.005	< 0.005	NA	< 0.005	102%	50%	140%	104%	50%	140%	105%	50%	140%
Chlordane	450694	450694	< 0.007	< 0.007	NA	< 0.007	104%	50%	140%	103%	50%	140%	105%	50%	140%
DDE	450694	450694	< 0.007	< 0.007	NA	< 0.007	108%	50%	140%	107%	50%	140%	102%	50%	140%
DDD	450694	450694	< 0.007	< 0.007	NA	< 0.007	105%	50%	140%	107%	50%	140%	104%	50%	140%
DDT	450694	450694	< 0.007	< 0.007	NA	< 0.007	103%	50%	140%	106%	50%	140%	104%	50%	140%
Dieldrin	450694	450694	< 0.005	< 0.005	NA	< 0.005	109%	50%	140%	103%	50%	140%	103%	50%	140%
Endrin	450694	450694	< 0.005	< 0.005	NA	< 0.005	105%	50%	140%	106%	50%	140%	109%	50%	140%
Methoxychlor	450694	450694	< 0.005	< 0.005	NA	< 0.005	108%	50%	140%	102%	50%	140%	100%	50%	140%
Hexachlorobenzene	450694	450694	< 0.005	< 0.005	NA	< 0.005	102%	50%	140%	108%	50%	140%	95%	50%	140%
Hexachlorobutadiene	450694	450694	< 0.01	< 0.01	NA	< 0.01	104%	50%	140%	104%	50%	140%	91%	50%	140%
O. Reg. 153(511) - PHCs F1 - F4 (Soil)															
Benzene	445130		< 0.02	< 0.02	NA	< 0.02	83%	60%	130%	92%	60%	130%	89%	60%	130%
Toluene	445130		< 0.05	< 0.05	NA	< 0.05	83%	60%	130%	92%	60%	130%	95%	60%	130%
Ethylbenzene	445130		< 0.05	< 0.05	NA	< 0.05	84%	60%	130%	92%	60%	130%	87%	60%	130%
Xylene Mixture	445130		< 0.05	< 0.05	NA	< 0.05	85%	60%	130%	95%	60%	130%	87%	60%	130%
F1 (C6 to C10)	445130		< 5	< 5	NA	< 5	80%	60%	130%	92%	85%	115%	85%	70%	130%
F2 (C10 to C16)	445412		< 10	< 10	NA	< 10	96%	60%	130%	97%	80%	120%	82%	70%	130%
F3 (C16 to C34)	445412		< 50	< 50	NA	< 50	85%	60%	130%	84%	80%	120%	76%	70%	130%
F4 (C34 to C50)	445412		< 50	< 50	NA	< 50	89%	60%	130%	95%	80%	120%	110%	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).

Pinkal Patel

Certified By:

Method Summary

CLIENT NAME: SOIL ENGINEERS LIMITED
PROJECT: 1907-E107
SAMPLING SITE:

AGAT WORK ORDER: 19T506733
ATTENTION TO: Ahmed Hassan
SAMPLED BY:Angie

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

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: 1907-E107

SAMPLING SITE:

AGAT WORK ORDER: 19T506733

ATTENTION TO: Ahmed Hassan

SAMPLED BY:Angie

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
webearth.agatlabs.com

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 #: 19T506733
Cooler Quantity: Med
Arrival Temperatures: 8.5 | 3.3 | 3.3
8.7 | 2.5 | 3.4
Custody Seal Intact: ☐Yes ☐No ☐N/A
Notes:

Report Information:

Company: SEL
Contact: Ahmed, Steve, Efua
Address:
Phone: Fax:
Reports to be sent to:
1. Email: a.hassan@soilengineersltd.com
2. Email: steve.cha... — , ethumbah@—

Project Information:

Project: 1907-E107
Site Location:
Sampled By: Angie
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:

(Please check all applicable boxes)
☐ No Regulatory Requirement

☒ 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*

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	Metals and Inorganics	O. Reg 153: ☐ 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 ☐ NH₃ ☐ TKN ☐ NO₃ ☐ NO₂ ☐ 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	Potentially Hazardous or High Concentration (Y/N)
BH 1/1	8/14/2019	8:00	1	S														X			
BH 1/3	"	8:10	3				X						X	X							
BH 2/2	8/13/2019	9:00	1				X														
BH 2/5	"	9:10	2										X	X							
BH 3/1	8/13/19	10:00	1															X			
BH 3/4	"	10:10	1				X														
BH 4/1	"	11:00	1															X			
BH 4/2	"	11:10	1				X														
BH 5/1	"	12:00	1				X														
BH 5/3	"	12:10	2										X	X							
BH 6/2	8/14/19	9:00	3	↓			X						X	X							

Samples Relinquished By (Print Name and Sign):	Date	Time	Samples Received By (Print Name and Sign):	Date	Time
Steve	8/15/19	17:00		Aug 19/19	9:02
	Aug 19/19	11:37			

Page 1 of 2

Nº: T 092549

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AGAT Laboratories

5835 Coopers Avenue
Mississauga, Ontario L4Z 1Y2
Ph: 905.712.5100 Fax: 905.712.5122
webearth.agatlabs.com

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 #: 19T506733

Cooler Quantity: Med

Arrival Temperatures: 3.5 | 3.3 | 3.3
2.7 | 2.5 | 2.4

Custody Seal Intact: ☐ Yes ☐ No ☐ N/A

Notes:

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

Report Information:

Company: SEL
Contact: Ahmed, Steve, Elin
Address:
Phone: Fax:
Reports to be sent to:
1. Email: a.husian@soilengineersltd.com
2. Email: Steve cha@ — , ekhumbah@

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

Project Information:

Project: 1907-E057
Site Location:
Sampled By: Angie
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:

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	Metals and Inorganics	O. Reg 153 ☐ 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 ☐ NH₃ ☐ TKN ☐ NO₃ ☐ NO₂ ☐ 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						
BH7/1	8/14/19	12:00	1	S														X								
BH 7/2	"	12:00	1	S			X																			

Samples Relinquished By (Print Name and Sign):	Date	Time	Samples Received By (Print Name and Sign):	Date	Time	
Steve	8/15/19	17:00		Aug 9/19	9:02	
	Aug 19/19	11:37				Page 2 of 2
						Nº: T 089187

Document ID: DIV-78-1511.015

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APPENDIX C:

Hydrogeological Report

Hydrogeological Assessment

Proposed Wetland (Area SC-8)
South of Green Mountain Road East
Between Tapleytown Road and Fifth Road East

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: 1938339

February 2020

Table of Contents

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 a section of the Stoney Creek headwaters above the Niagara Escarpment.

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

- To utilize the floodplain areas of Upper Stoney 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.
- 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 June 17, 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, seasonal 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

Visual field reconnaissance of the study area was conducted on May 10 and July 19, 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 May site visit was carried out 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 Section 3 of this report.

2.3 Mini-piezometer Installation and Monitoring

The field work for this investigation was carried out on August 13 and 14, 2019 at which time seven boreholes were drilled to depths ranging from 2.4 to 5.8 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 standpipe piezometers were installed in Borehole 1 and in Boreholes 3 to 7, inclusive. 'NQ' size rock coring was carried out below the auger refusal depths in Boreholes 2 and 3 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 August 28, 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 seasonal 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 Stoney Creek watershed to retain water to reduce flood and erosion risks in the Stoney Creek urban area below the Niagara Escarpment and to provide enhanced wildlife habitat. The area 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 west in the upper reaches of Battlefield Creek (BC-1) to allow for flood risk mitigation and more natural stream flow through the subwatershed.

The current design concept calls for the construction of a single through the construction of a low berm oriented northeast-southwest across the main branch of Stoney Creek to the south of Green Mountain Road along with a combination of sinuous cut and fill embankments enclosing the ponding area on the east and west. Preliminary drawings do not show permanent water features however it is expected that some may be created opportunistically during the detailed design or construction phase.

3.2 Site Description

The SC-8 property is located at Part Lot 15, Concession 6 in the former Saltfleet Township (amalgamated by the City of Hamilton in 2001) (Map 1). The property is 9.05 hectares in area and fronts onto Green Mountain Road East with Tapleytown Road to the west, Mud Street East to the south and Fifth Road East to the east. The area contains roughly 400 m of the main channel of the Upper Stoney Creek which flows from south to north across the western portion of the property with additional intermittent tributary watercourses draining to the main channel from agricultural fields in the eastern half of the property. Lands within the general area are a mixture of agricultural lands, rural residential lots and the natural corridor associated with Stoney Creek.

The property forms a gently undulating plateau with elevations ranging from a high of approximately 196 metres above mean sea level (mASL) along Fifth Line East to a low of about 193 mASL along the creek channel immediately south of Green Mountain Road. Within the broader area, the dominant topographic feature is the Niagara Escarpment which is located approximately 2.1 km 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 consists of marsh and swamp thicket along the watercourse and agricultural fields and hedgerows over the balance of the property. 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 and Upper **Right**: a view of runoff draining from the agricultural fields via a small intermittent tributary channel; **Lower Left**: Looking southeast along ephemeral tributaries conveying runoff from the agricultural fields to the main channel of the upper Stoney Creek; **Lower Right**: Runoff pooled along the edge of the main Stoney Creek channel. A residence along the south side of Green Mountain Road is visible in the background. Photos taken May 10, 2019.

Figure 2 – Site Photos (5 and 6) **Left:** Looking to the southwest (upstream) along the main channel of the Stoney Creek tributary; **Right**: Looking to the north-northeast (downstream) along the flooded main channel of the upper Stoney Creek tributary. The confluence with intermittent tributaries draining the fields in the east half of the property is visible in the background. Photos taken May 10, 2019.

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 Stoney 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). Stoney Creek has a total area of approximately 1,590 hectares above (i.e. south of) the Niagara Escarpment.

The main tributary channel originates to the southwest of the site and is generally low-gradient, mainly ditched and channelized. At the culvert beneath Green Mountain Road, the channel is poorly defined with little flow during the dry summer months. Further upstream, the channel is more defined and lined by swamp thicket and marsh-type vegetation. Some pools were observed along this section by NSRI during their June site visit. Two intermittent tributaries connect with the main tributary along the northwest side of the subject property and convey surface flow from the agricultural fields and neighbouring properties. As noted, these are ephemeral features with neither flow nor standing water during the drier times of the year.

No discharge points (i.e. springs) were observed on the subject property.

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 and formed a series of glacial lakes within the Lake Erie basin and formed the physiographic region known as the Haldimand Clay Plain (Chapman and Putnam 1984). Sandy lacustrine deposits also occur but these are typically less widespread and were not observed on the subject property.

The surficial geology at the site is characterized by 100 to 150 mm of topsoil overlying a stratum of silty clay with occasional silt or sand laminations and considered to be of glaciolacustrine origin (Soil Engineers, 2019). The deposit is stiff to hard and the upper horizons were observed to be weathered, with fractures and roots. The deposit extended to bedrock which was encountered at depths ranging from 2.4 to 5.8 m. Geotechnical testing (see Appendix D) indicated that the natural Water Content of the material ranged from 16% to 30% (median 23%) with medium plasticity. Moisture contents are typically slightly above the plastic limit which will tend to reduce secondary fracture-related permeability at depth.

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.

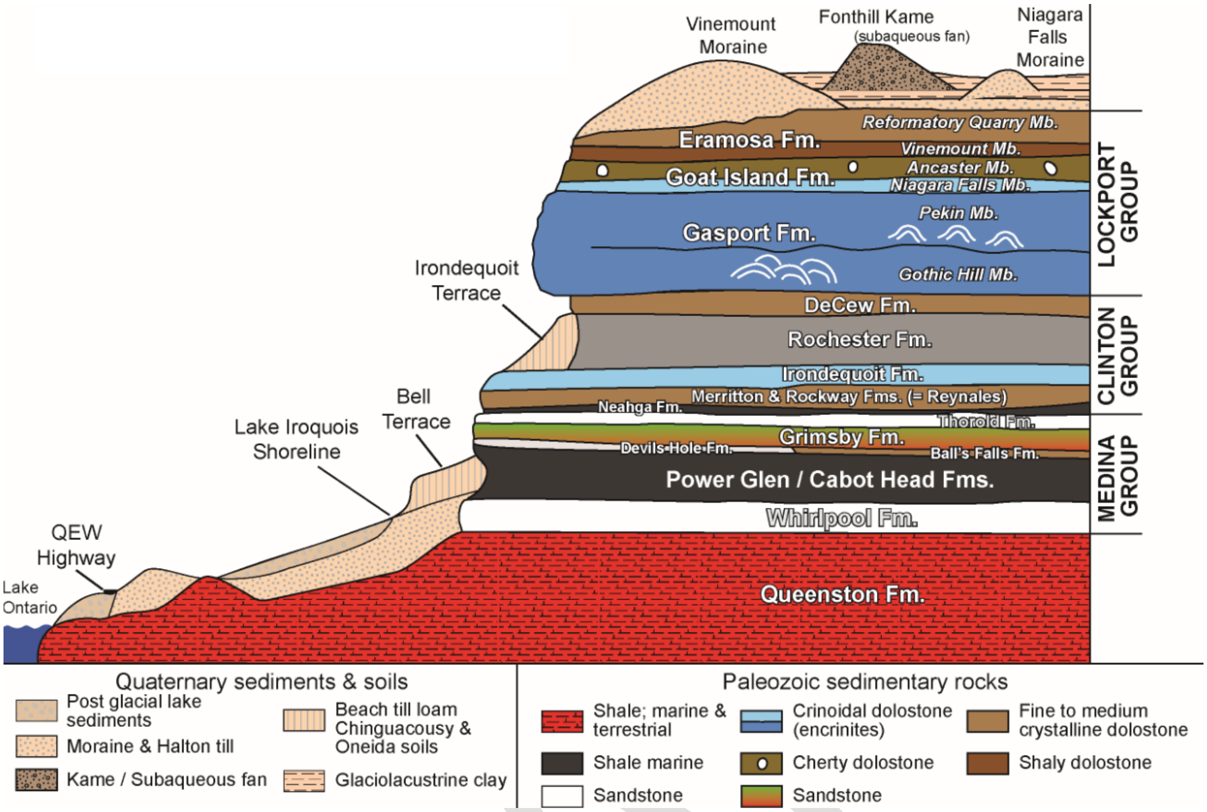

Figure 3 – Conceptual Geological Section (from Brett and Brunton, 2018)

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 Reformatory Quarry member forms the upper bedrock unit beneath the SC-8 site. Rock coring revealed a grey dolostone bedrock with Rock Quality Designation (RQD) values ranging from 30 to 83% (see Appendix D). 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 continuous across the site. 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	…	2.7 – 4.2	2.0 x 10^{-6}	Silty Clay	Hvorslev
3	…	4.2 – 5.7	1.8 x 10^{-6}	Silty Clay	Hvorslev
4	…	4.2 – 5.7	6.2 x 10^{-7}	Silty Clay	Hvorslev
5	…	0.8 – 2.3	7.0 x 10^{-6}	Silty Clay	Hvorslev
6	…	2.0 – 3.5	5.6 x 10^{-8}	Silty Clay	Hvorslev
7	…	4.2 – 5.7	1.4 x 10^{-5}	Silty Clay	Hvorslev
1	4	2.5	<1 x 10^{-8}	Silty Clay	Hazen
3	2	1.0	<1 x 10^{-8}	Silty Clay	Hazen
4	6	4.8	<1 x 10^{-8}	Silty Clay	Hazen
7	2	1.0	<1 x 10^{-8}	Silty Clay	Hazen

The fine-textured glaciolacustrine silty clay deposits are relatively impermeable (reported hydraulic conductivity values (k) ranging from 7 x 10^{-6} to less than 10^{-8} m s^{-1}). No measurements of bedrock permeability are available for the site, but solution-enlarged fractures will behave as open channels in the subsurface where present. We note that the development of karst is largely limited to the Reformatory Quarry member of the Eramosa Formation which is the host rock for karst development in the south part of the nearby BC-1 site, and for numerous karst features such as sinking streams, dolines, springs and caves at the Eramosa Karst Conservation Area approximately 7 km to the southwest of the SC-8 property (Buck et al., 2002).

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. 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 Monitoring Wells 1, 4, 5 and 7. Initial measurements taken in late August 2019 indicate that the groundwater table is located between 1.2 and 3 m below ground surface. During the autumn, the groundwater levels are observed to rise at all locations in response to the seasonal increase in precipitation and reduced evapotranspiration. The groundwater level in MW-1 fluctuated between about 1 and 1.5 m until late October when the level rose to about 0.3 m below ground surface. Response to precipitation events was rapid with a slow gradual decline in water levels over the week or so following the event. Groundwater temperature reached a peak of approximately 13 ^{o}C in mid-October before declining thereafter. Water levels in MW-4 declined steadily from about 2.5 m depth at the end of August to about 3.2 m depth at the beginning of November. During December, the groundwater levels recovered to about 2 m below ground surface. No response to precipitation events was apparent at this location. Groundwater temperature in MW-4 increased slowly from about 10 ^{o}C at the end of August to 11 ^{o}C at the end of December with the slow thermal response being consistent with very low permeability soils and generally low groundwater recharge. In MW-5, groundwater levels fluctuated around 1.4 m below ground surface between the end of August to the beginning of November when the level abruptly rose to ground surface during a period of heavy rainfall. The abrupt water level change is interpreted to represent the flooding of the wellhead as this well is located in a low area near the confluence of the Stoney Creek tributary and the channel draining the agricultural fields in the east part of the site. A response to rainfall events similar to that in MW-1 was observed at this location. Groundwater temperatures declined slowly from a peak of approximately 15 ^{o}C at the end of August to about 8 ^{o}C at the end of December. The water levels in MW-7 varied similarly to MW-4 with a marked thermal lag and no obvious response to precipitation events.

No signs of rapid recharge that might be consistent with underdraining by karst features was noted in any of the wells. Overall, the seasonal changes in groundwater level and temperatures are consistent with low permeability soils and low rates of groundwater recharge. The construction of a new wetland impoundment in this area will increase both evapotranspiration and recharge to the overburden and underlying bedrock aquifer but the low permeability of the soils will limit the amount of water exfiltrating through the base of the wetland and the majority of water losses from an permanent water features are predicted to be from evapotranspiration.

5. Discussion

5.1 Construction Aspects

The silty clay glaciolacustrine sediments encountered beneath surficial topsoil at the site are characterized by a low hydraulic conductivity, and a natural water content at or slightly above 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) of about 1 m. If we treat the shallow silty clay as a porous medium (a somewhat unreasonable assumption) then the amount of water loss through the base of the wetland may be crudely estimated by multiplying the observed groundwater ∆h by the effective porosity of the soils. Assuming an effective porosity of 20% and a ∆h of 1 m, we estimate that water levels in the wetland will fall by about 0.2 to 0.3 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.

Any permanent water features should be sited in areas of relatively thick overburden where at least 1.5 m of clayey soil can be maintained between the bottom of the water features and the underlying bedrock. This thickness is significantly greater than that recommended for the nearby BC-1 site because of the presence of the karst-susceptible Reformatory Quarry Member of the Eramosa Formation as the upper bedrock unit at the SC-8 site. Soil surfaces beneath permanent wetland areas and borrow excavations should be thoroughly proofrolled using a heavy sheepsfoot roller in order to eliminate any preferential conduits for groundwater flow into the deeper strata. This is especially important along the north part of the planned impoundment where standing water will be commonly impounded. It is less important toward the south of the property where surface waters will be impounded only infrequently and only to a shallow depth.

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 SC-8 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 Reformatory Quarry member of the Eramosa Formation forms the bedrock beneath the SC-8 site and this member is susceptible to karst formation. However, 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 the layer of low permeability silty clay between the base of the wetland pond and the underlying bedrock.

5.3 Potential for Adverse Effects

The planned construction of a wetland 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. No karst features were observed on the site 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 SC-8 property is underlain by a continuous deposit of silty clay glaciolacustrine sediments having a low hydraulic conductivity. 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.

No karst features were observed at the site and the relatively thick overburden (2.4 to 5.8 m) will protect the planned wetland impoundment from catastrophic water losses through drainage into karst features. 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 features 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

Charles Mitz, M.Eng. Ph.D., P.Geo.	Steve Blakey, M.Sc., P.Eng.
Senior Project Manager	Belleville Branch Manager

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.: 1907-S107

LOG OF BOREHOLE NO.: 1

FIGURE NO.: 1

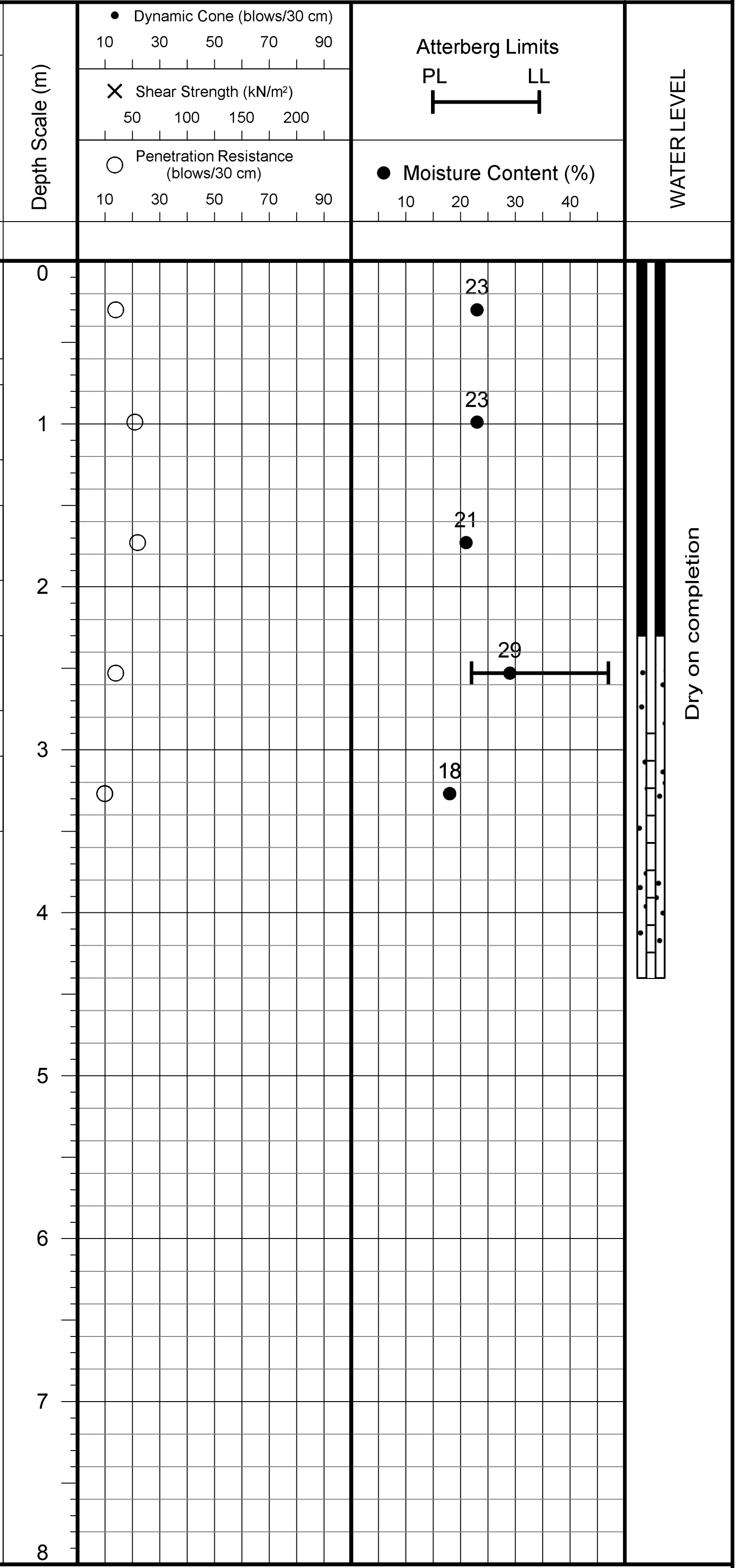
PROJECT DESCRIPTION: Proposed Wetland Design
Area SC-8

METHOD OF BORING: Flight-Auger

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

DRILLING DATE: August 14, 2019

El. (m) Depth (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value
193.2	Ground Surface			
0.0 0.1	**10 cm TOPSOIL**			
	Stiff to very stiff	1	DO	14
	weathered			
		2	DO	21
	SILTY CLAY medium plasticity occ. sand seams and layers	3	DO	22
		4	DO	14
	brown grey			
		5	DO	10
188.8 4.4	**Refusal to Augering** **Inferred Bedrock** **END OF BOREHOLE** Installed 50 mm Ø monitoring well to 4.4 m completed with 1.5 m screen Sand backfill from 2.3 m to 4.4 m Bentonite seal from 0.0 m to 2.3 m. Provided with steel casing and lock.			



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JOB NO.: 1907-S107

LOG OF BOREHOLE NO.: 2

FIGURE NO.: 2

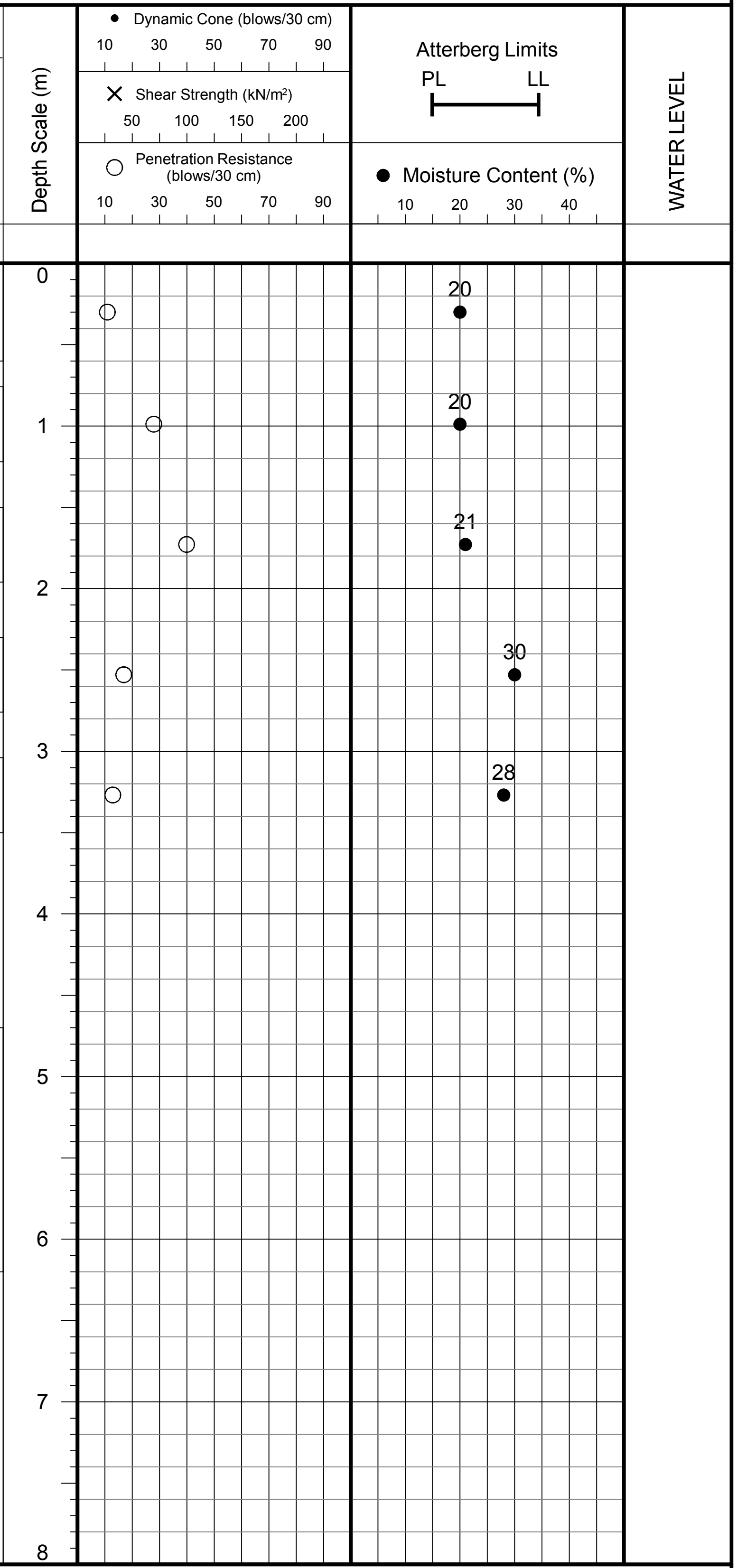
PROJECT DESCRIPTION: Proposed Wetland Design
Area SC-8

METHOD OF BORING: Flight-Auger

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

DRILLING DATE: August 13, 2019

El. (m) Depth (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value
193.7	Ground Surface			
0.0	**15 cm TOPSOIL**			
0.1	Stiff to hard	1	DO	11
	weathered	2	DO	28
	SILTY CLAY medium plasticity occ. sand seams and layers	3	DO	40
		4	DO	17
	brown grey	5	DO	13
189.0 4.7	Grey **DOLOMITE/LIMESTONE BEDROCK**	6	RC RQD	89% 83%
187.5 6.2	**END OF BOREHOLE**			



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JOB NO.: 1907-S107

LOG OF BOREHOLE NO.: 3

FIGURE NO.: 3

PROJECT DESCRIPTION: Proposed Wetland Design
Area SC-8

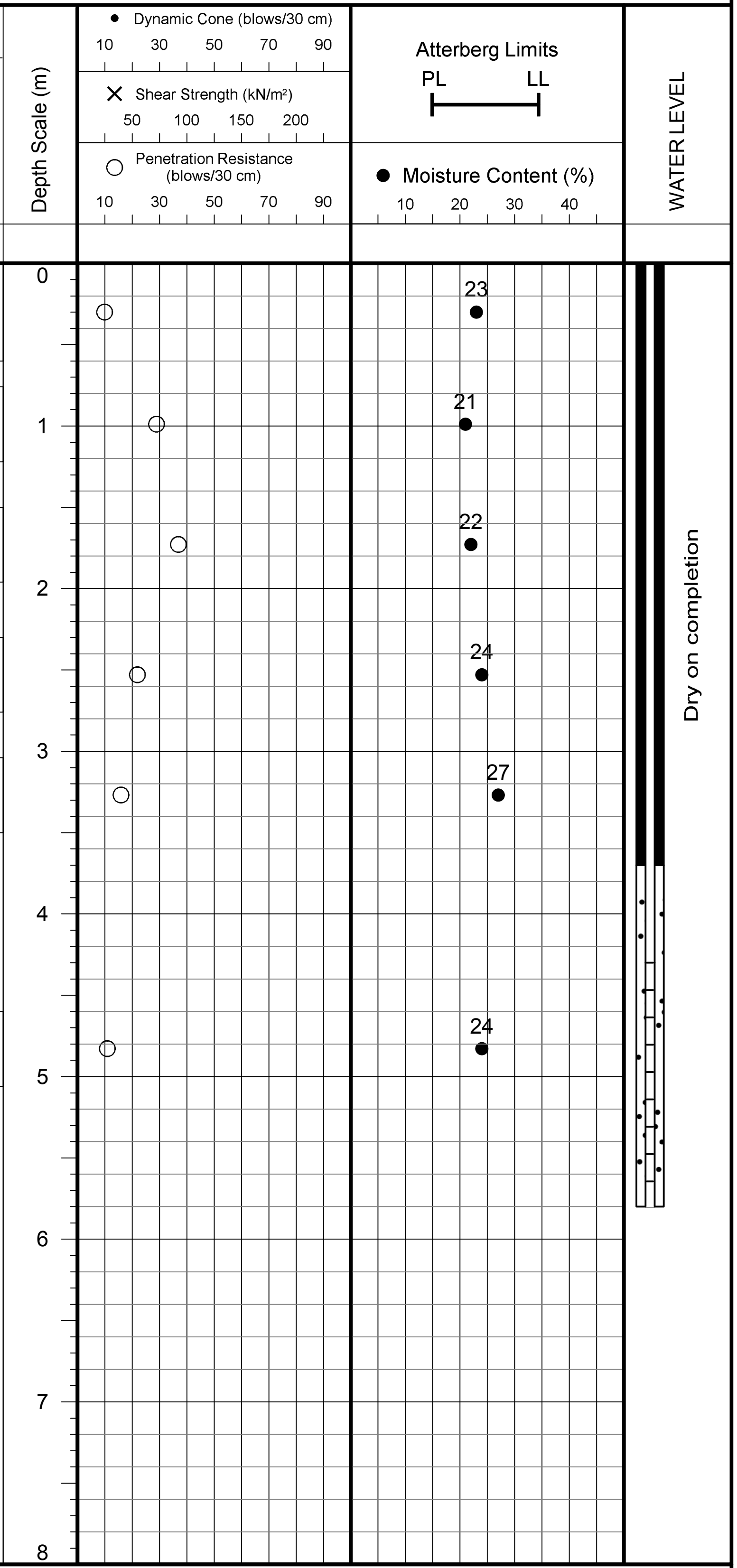
METHOD OF BORING: Flight-Auger

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

DRILLING DATE: August 13, 2019

El. (m) Depth (m)	SOIL DESCRIPTION	SAMPLES Number	SAMPLES Type	SAMPLES N-Value
194.9	Ground Surface			
0.0 0.1	**15 cm TOPSOIL**			
	Stiff to hard	1	DO	10
	weathered	2	DO	29
	SILTY CLAY medium plasticity occ. sand seams and layers	3	DO	37
		4	DO	22
	brown grey	5	DO	16
		6	DO	11
189.1 5.8	**Refusal to Augering** **Inferred Bedrock** **END OF BOREHOLE**			

Installed 50 mm Ø monitoring well to 5.8 m
completed with 1.5 m screen
Sand backfill from 3.7 m to 5.8 m
Bentonite seal from 0.0 m to 3.7 m.
Provided with steel casing and lock.



Soil Engineers Ltd.

JOB NO.: 1907-S107

LOG OF BOREHOLE NO.: 4

FIGURE NO.: 4

PROJECT DESCRIPTION: Proposed Wetland Design
Area SC-8

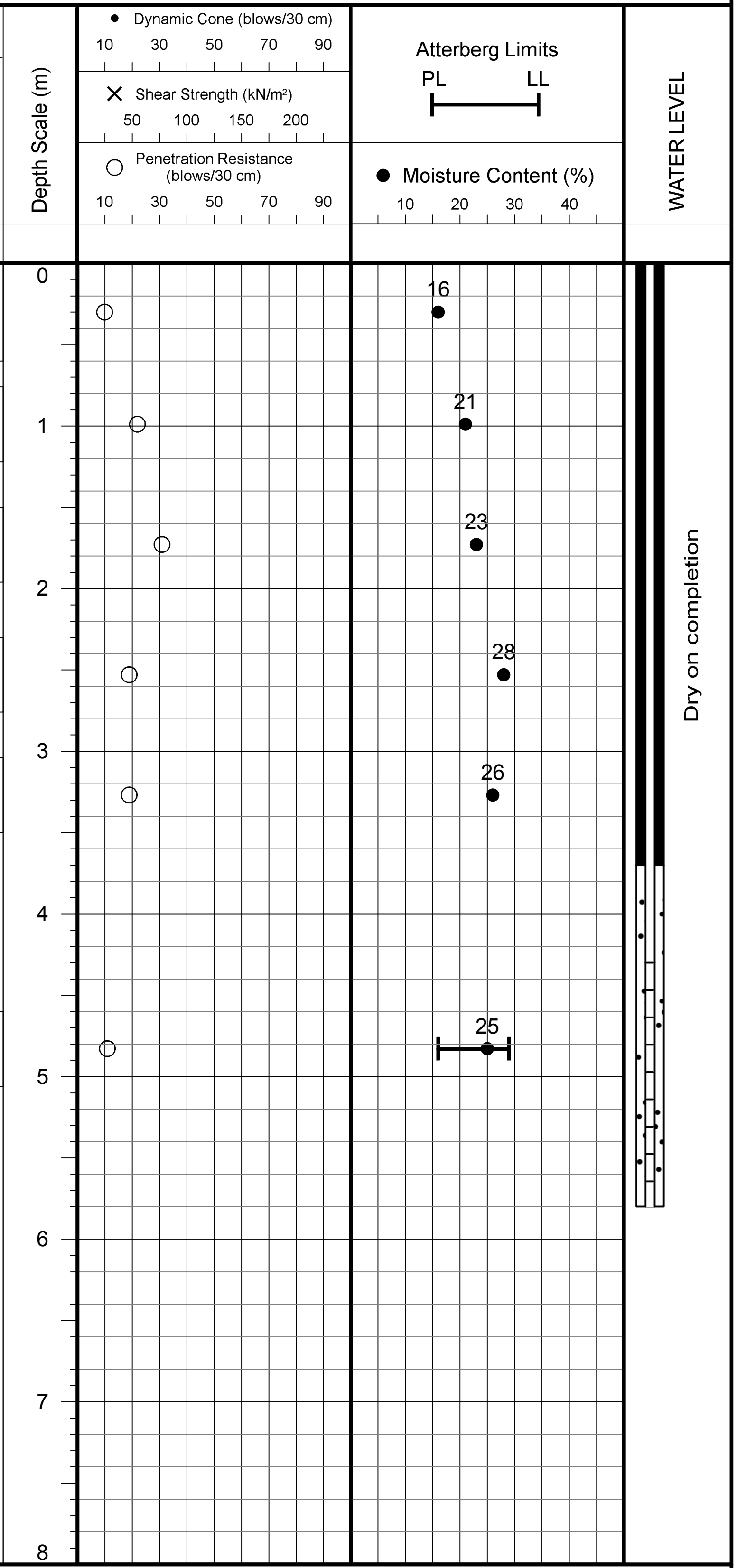
METHOD OF BORING: Flight-Auger

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

DRILLING DATE: August 13, 2019

El. (m) Depth (m)	SOIL DESCRIPTION	Number	Type	N-Value
195.2	Ground Surface			
195.2 0.0	**15 cm TOPSOIL**			
0.1	Stiff to very stiff	1	DO	10
	weathered	2	DO	22
	SILTY CLAY medium plasticity occ. sand seams and layers	3	DO	31
		4	DO	19
		5	DO	19
	brown grey	6	DO	11
189.4 5.8	**Refusal to Augering** **Inferred Bedrock** **END OF BOREHOLE**			

Installed 50 mm Ø monitoring well to 5.8 m completed with 1.5 m screen
Sand backfill from 3.7 m to 5.8 m
Bentonite seal from 0.0 m to 3.7 m.
Provided with steel casing and lock.



Soil Engineers Ltd.

Page: 1 of 1

JOB NO.: 1907-S107

LOG OF BOREHOLE NO.: 5

FIGURE NO.: 5

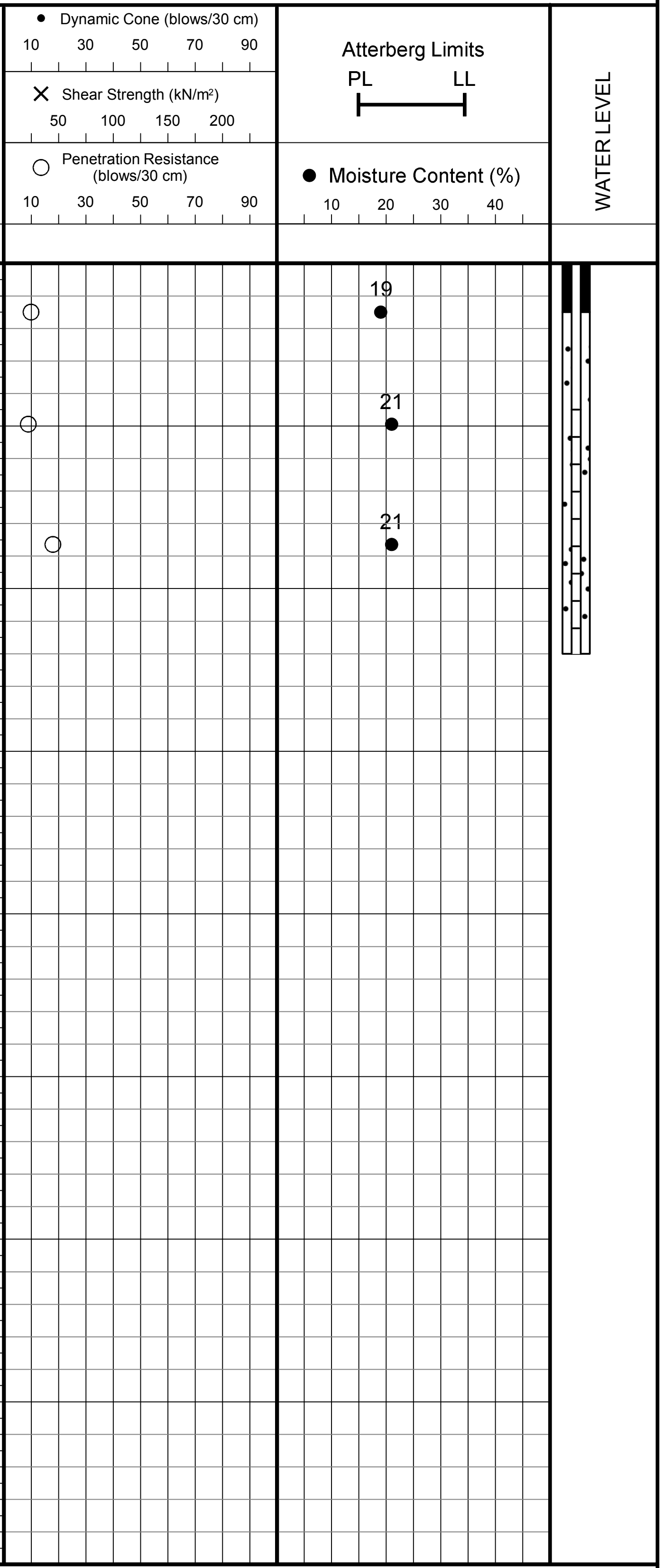
PROJECT DESCRIPTION: Proposed Wetland Design
Area SC-8

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

METHOD OF BORING: Flight-Auger

DRILLING DATE: August 13, 2019

El. (m) Depth (m)	SOIL DESCRIPTION	SAMPLES Number	SAMPLES Type	SAMPLES N-Value	Depth Scale (m)
193.3	Ground Surface				
0.0 0.1	**10 cm TOPSOIL**				0
	Brown, stiff to very stiff	1	DO	10	
	weathered	2	DO	9	1
	SILTY CLAY medium plasticity occ. sand seams and layers	3	DO	18	
					2
190.9 2.4	Grey	4	RC RQD	100% 31%	
	DOLOMITE/LIMESTONE BEDROCK				3
		5	RC RQD	100% 39%	4
189.0 4.3	**END OF BOREHOLE** Installed 50 mm Ø monitoring well to 2.4 m completed with 1.5 m screen Sand backfill from 0.3 m to 2.4 m Bentonite seal from 0.0 m to 0.3 m. Provided with steel casing and lock.				5
					6
					7
					8



Soil Engineers Ltd.

JOB NO.: 1907-S107

LOG OF BOREHOLE NO.: 6

FIGURE NO.: 6

PROJECT DESCRIPTION: Proposed Wetland Design
Area SC-8

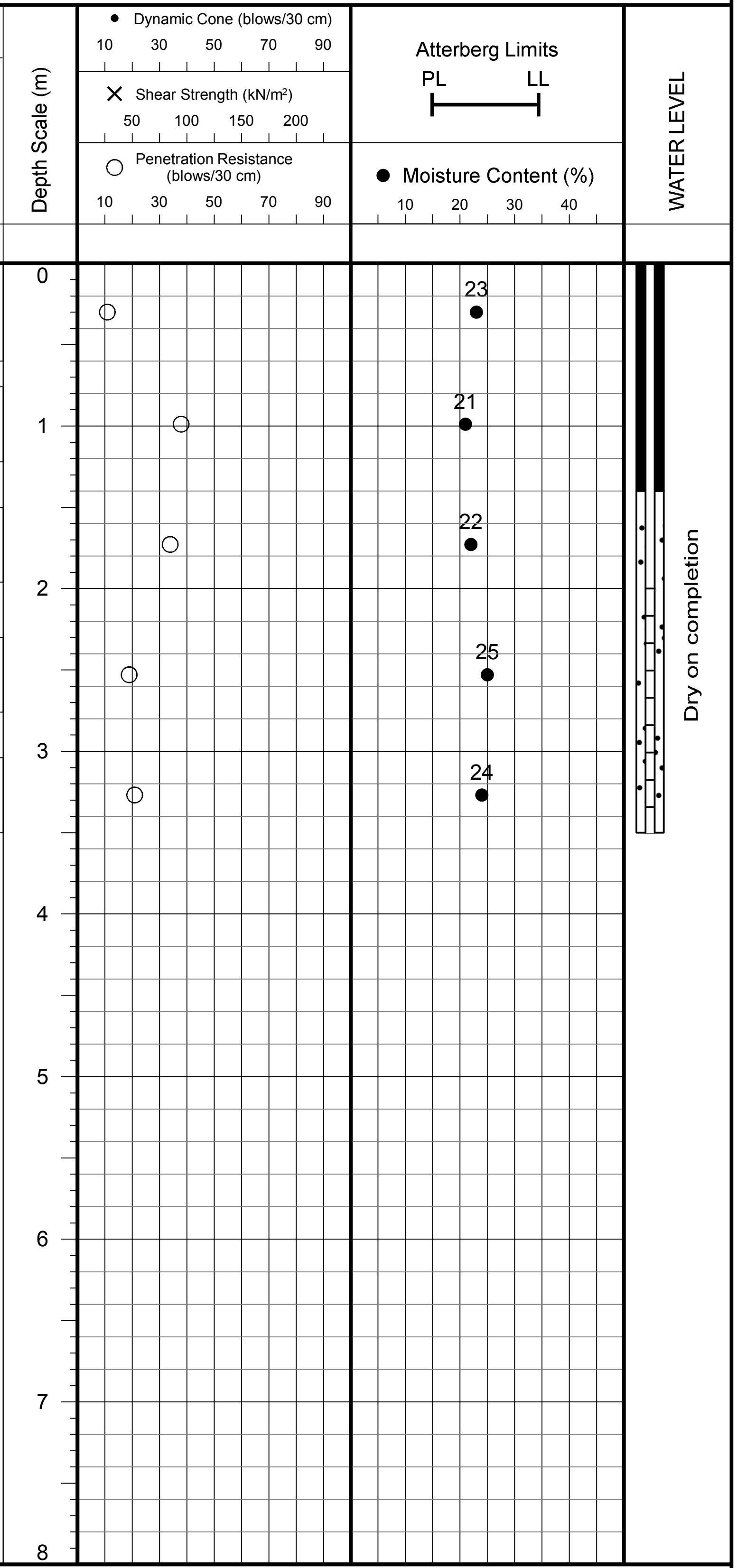
METHOD OF BORING: Flight-Auger

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

DRILLING DATE: August 14, 2019

El. (m) Depth (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value
195.0	Ground Surface			
0.0	**10 cm TOPSOIL**			
0.1	Brown, stiff to hard	1	DO	11
	weathered	2	DO	38
	SILTY CLAY medium plasticity occ. sand seams and layers	3	DO	34
		4	DO	19
		5	DO	21
191.5 3.5	**Refusal to Augering** **Inferred Bedrock** **END OF BOREHOLE**			

Installed 50 mm Ø monitoring well to 3.5 m
completed with 1.5 m screen
Sand backfill from 1.4 m to 3.5 m
Bentonite seal from 0.0 m to 1.4 m.
Provided with steel casing and lock.



Soil Engineers Ltd.

JOB NO.: 1907-S107

LOG OF BOREHOLE NO.: 7

FIGURE NO.: 7

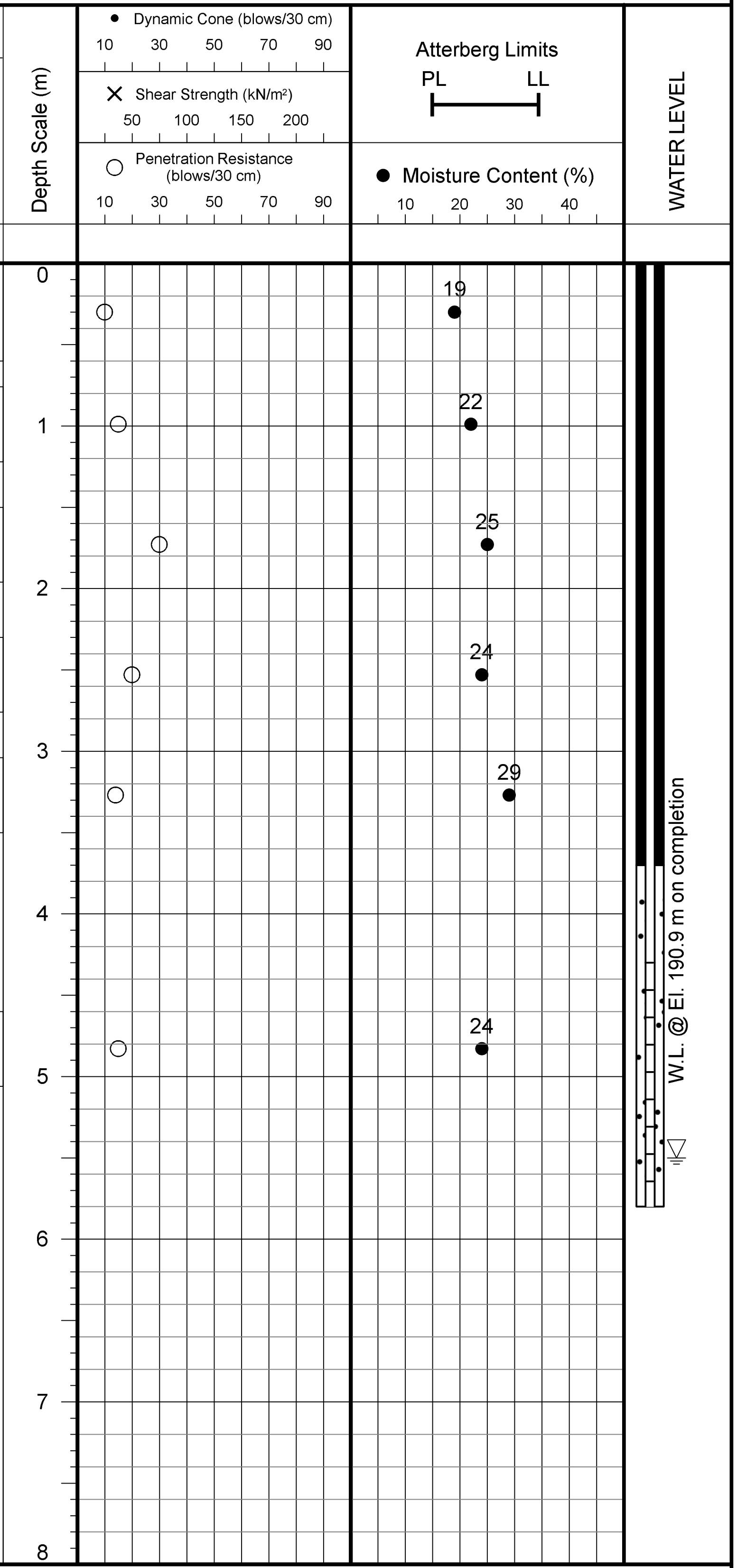
PROJECT DESCRIPTION: Proposed Wetland Design
Area SC-8

METHOD OF BORING: Flight-Auger

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

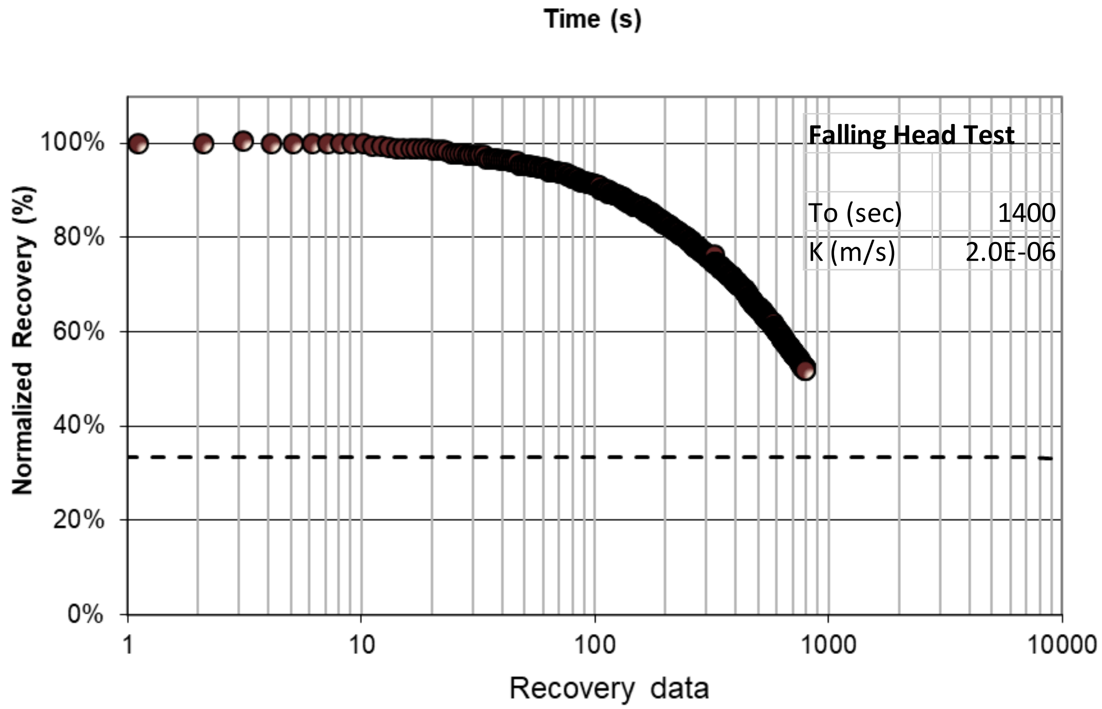
DRILLING DATE: August 14, 2019

El. (m) Depth (m)	SOIL DESCRIPTION	SAMPLES		
		Number	Type	N-Value
196.4	Ground Surface			
0.0 0.1	**10 cm TOPSOIL**			
	Stiff to very stiff	1	DO	10
	weathered			
		2	DO	15
	SILTY CLAY medium plasticity occ. sand seams and layers	3	DO	30
		4	DO	20
		5	DO	14
	brown grey			
		6	DO	15
190.6 5.8	**Refusal to Augering** **Inferred Bedrock** **END OF BOREHOLE** Installed 50 mm Ø monitoring well to 5.8 m completed with 1.5 m screen Sand backfill from 3.7 m to 5.8 m Bentonite seal from 0.0 m to 3.7 m. Provided with steel casing and lock.			



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 (NTS):

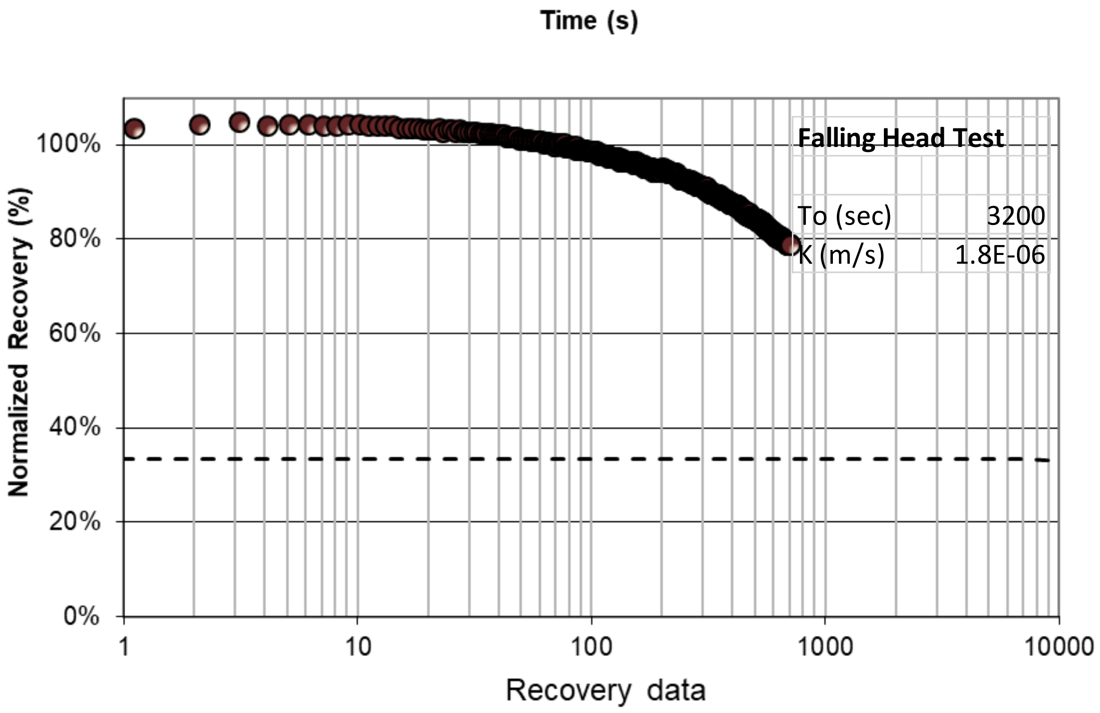
PROJECT:

**HYDROGEOLOGICAL ASSESSMENT
PROPOSED WETLAND (AREA SC-8)**

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:

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

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KEY PLAN (NTS):

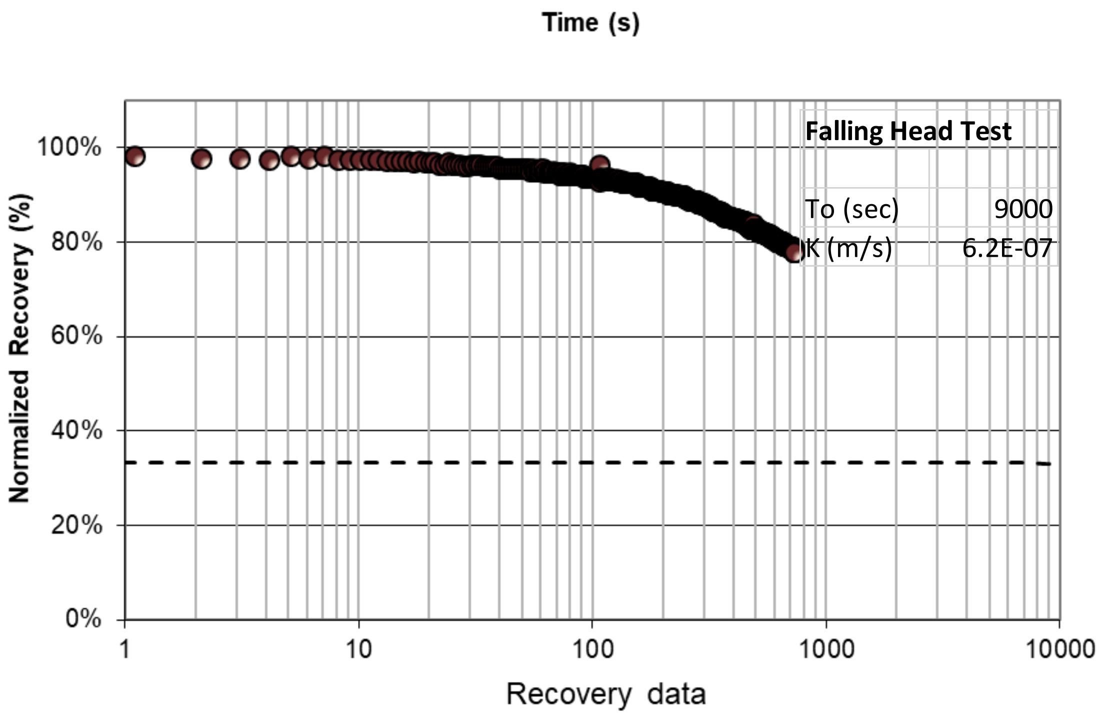
PROJECT:

**HYDROGEOLOGICAL ASSESSMENT
PROPOSED WETLAND (AREA SC-8)**

FIGURE B-2:

**SINGLE WELL HYD3AULIC 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:

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

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KEY PLAN (NTS):

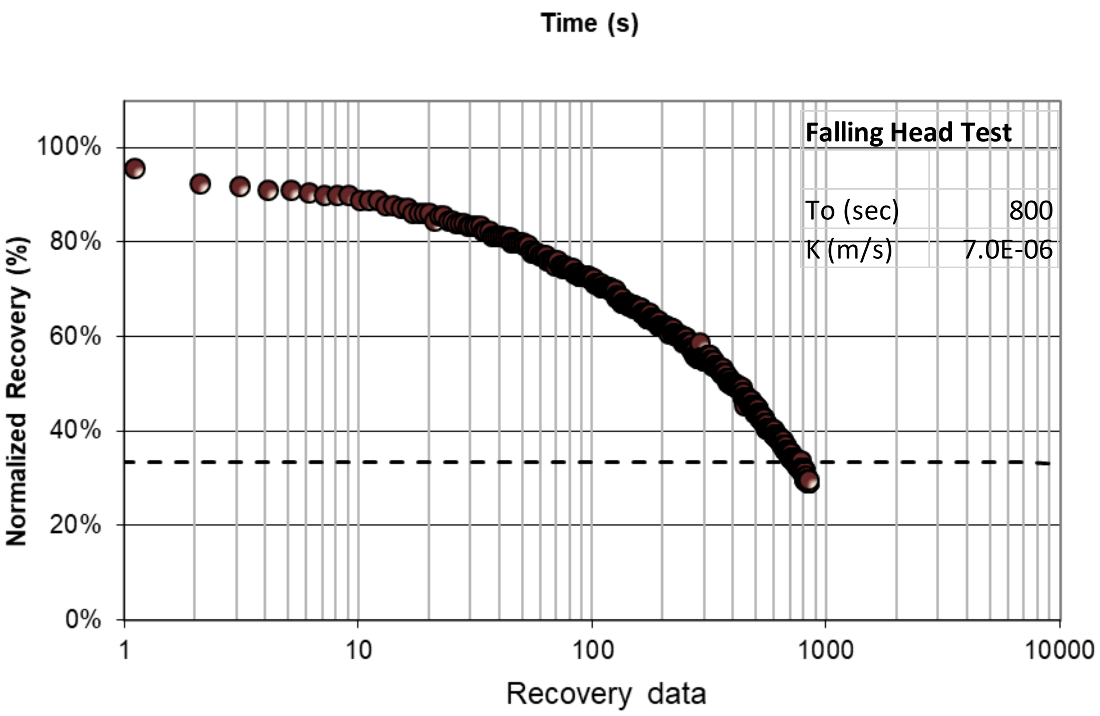
PROJECT:

HYDROGEOLOGICAL ASSESSMENT
PROPOSED WETLAND (AREA SC-8)

FIGURE B-3:

SINGLE WELL HYDRAULIC RESPONSE (SLUG) TEST – MW4

Scale: as shown



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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 (NTS):

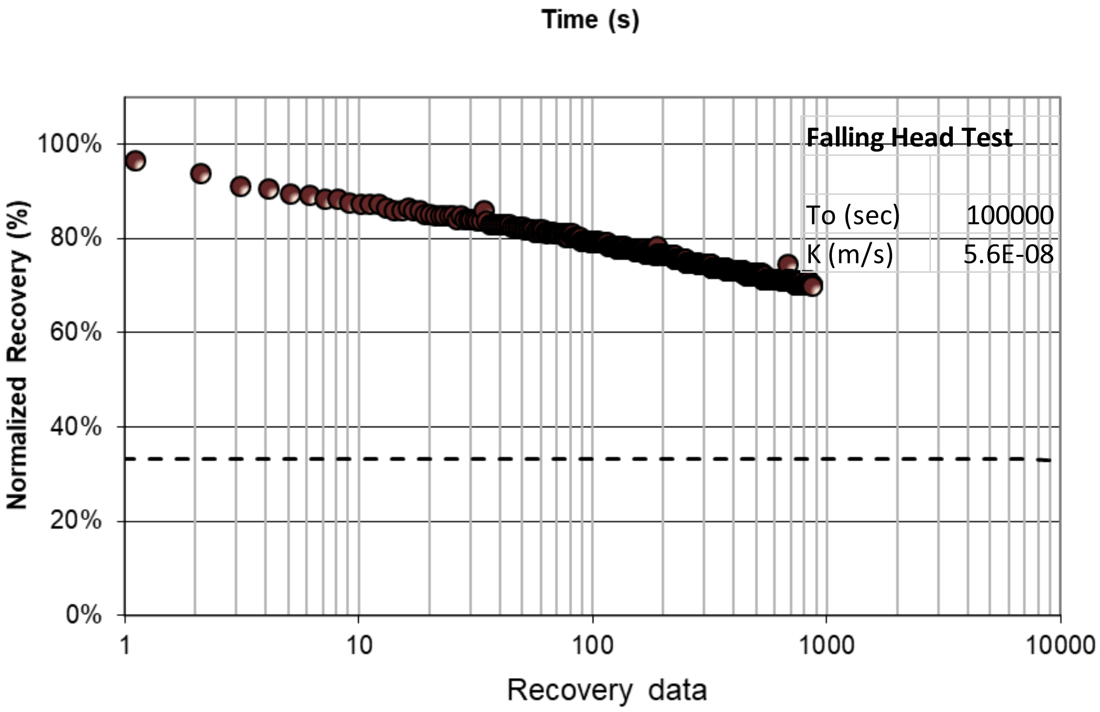
PROJECT:

**HYDROGEOLOGICAL ASSESSMENT
PROPOSED WETLAND (AREA SC-8)**

FIGURE B-4:

SINGLE WELL HYDRAULIC RESPONSE (SLUG) TEST – MW5

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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KEY PLAN (NTS):

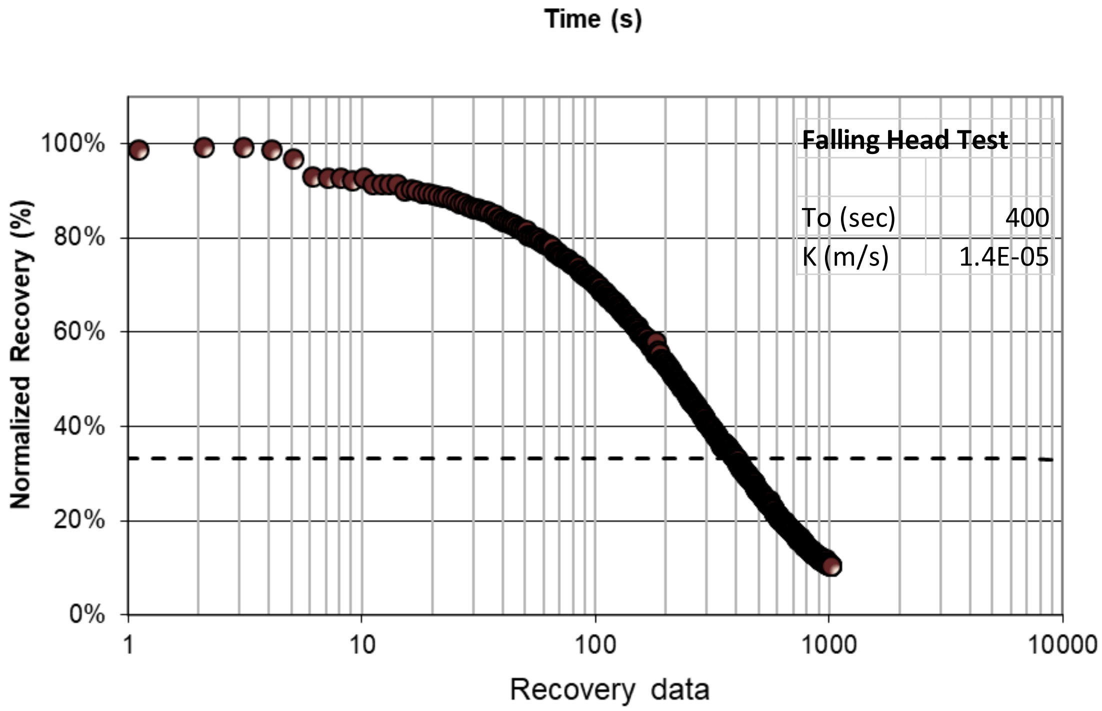
PROJECT:

**HYDROGEOLOGICAL ASSESSMENT
PROPOSED WETLAND (AREA SC-8)**

FIGURE B-5:

**SINGLE WELL HYDRAULIC RESPONSE
(SLUG) TEST – MW6**

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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KEY PLAN (NTS):

PROJECT:

**HYDROGEOLOGICAL ASSESSMENT
PROPOSED WETLAND (AREA SC-8)**

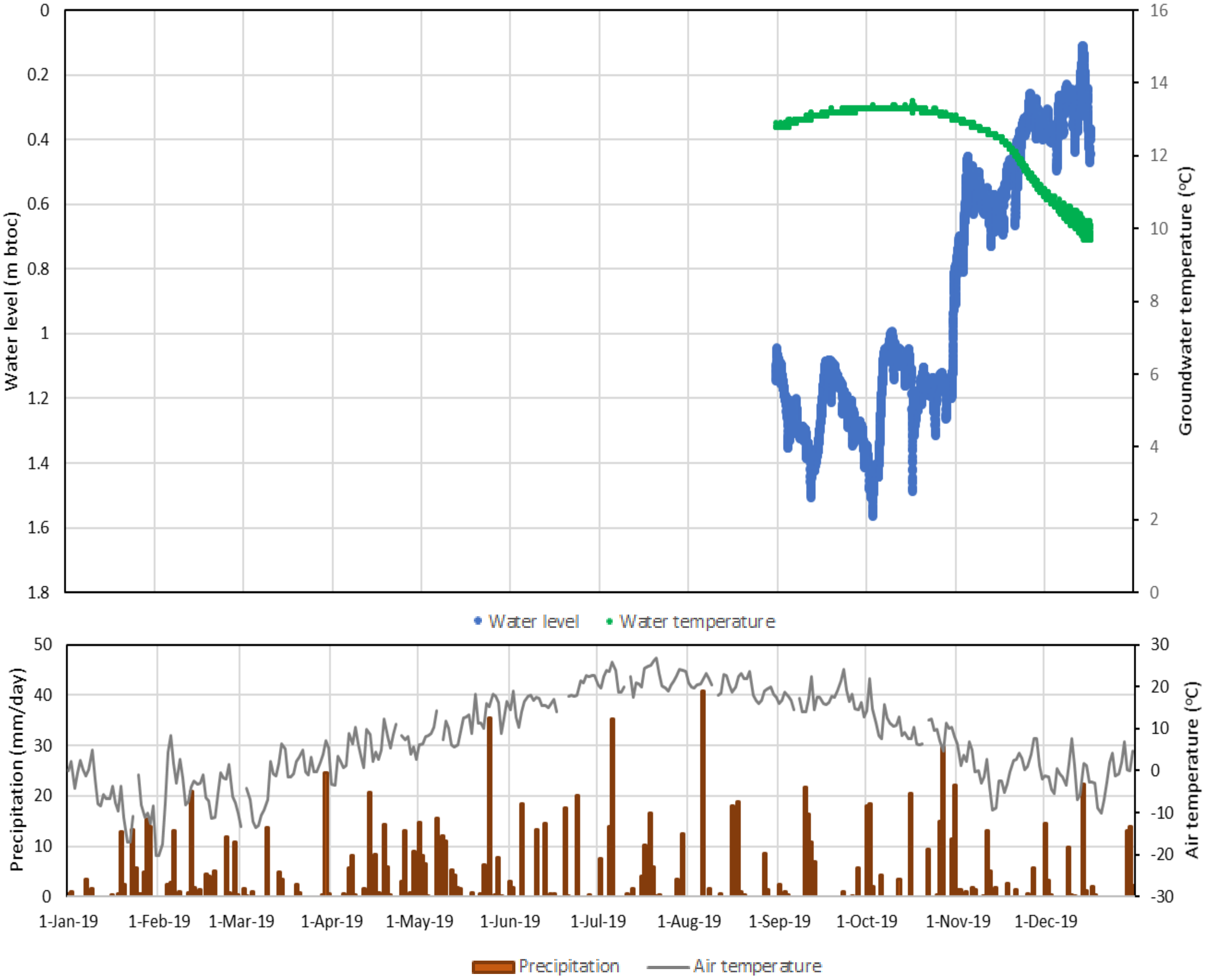
FIGURE B-6:

SINGLE WELL HYDRAULIC RESPONSE (SLUG) TEST – MW7

Scale: as shown

Appendix C

Hydrographs



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KEY PLAN (NTS):

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

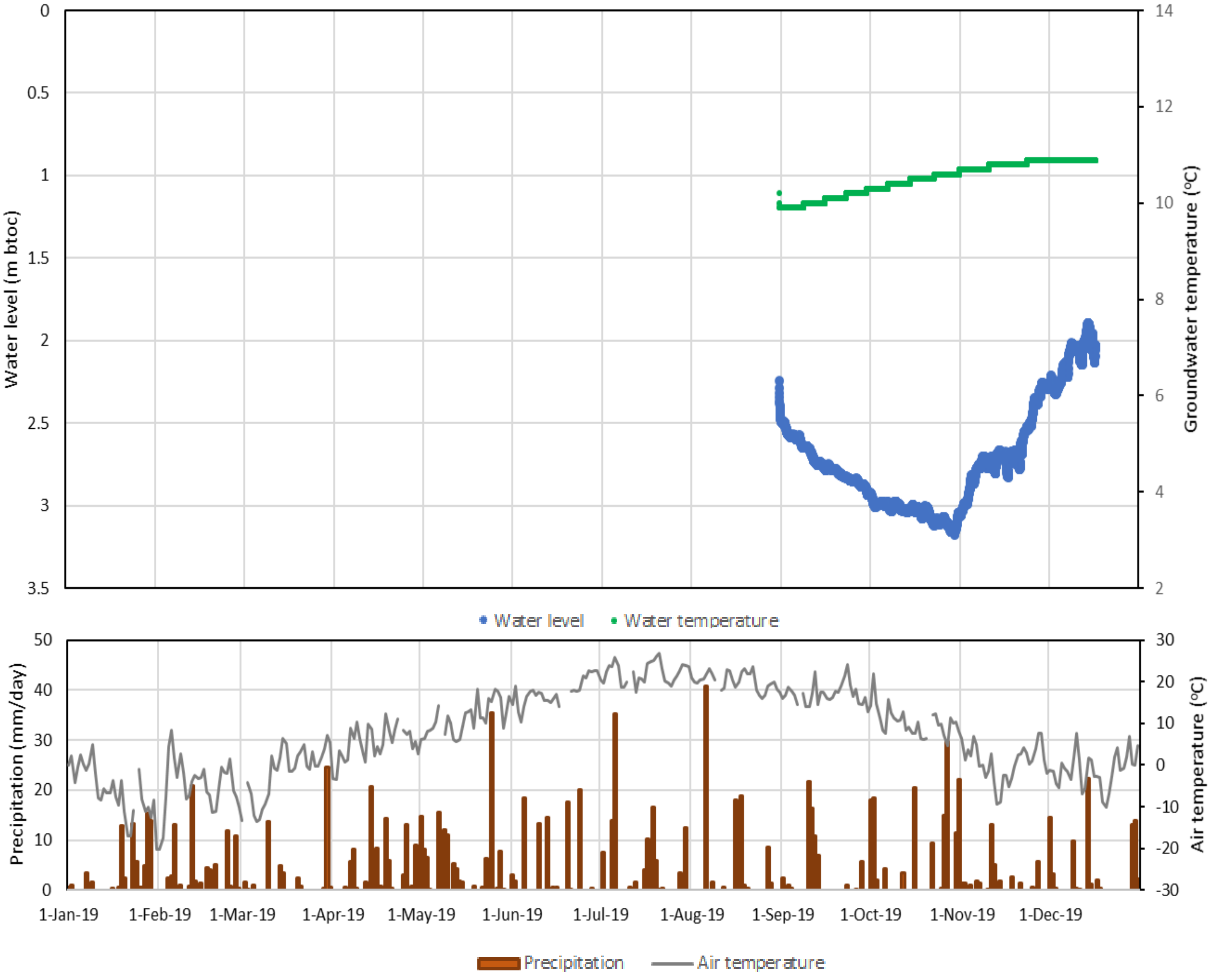
PROJECT:

HYDROGEOLOGICAL ASSESSMENT
PROPOSED WETLAND (AREA SC-8)

FIGURE C-1:

WELL HYDROGRAPH – MW-1

Scale: as shown



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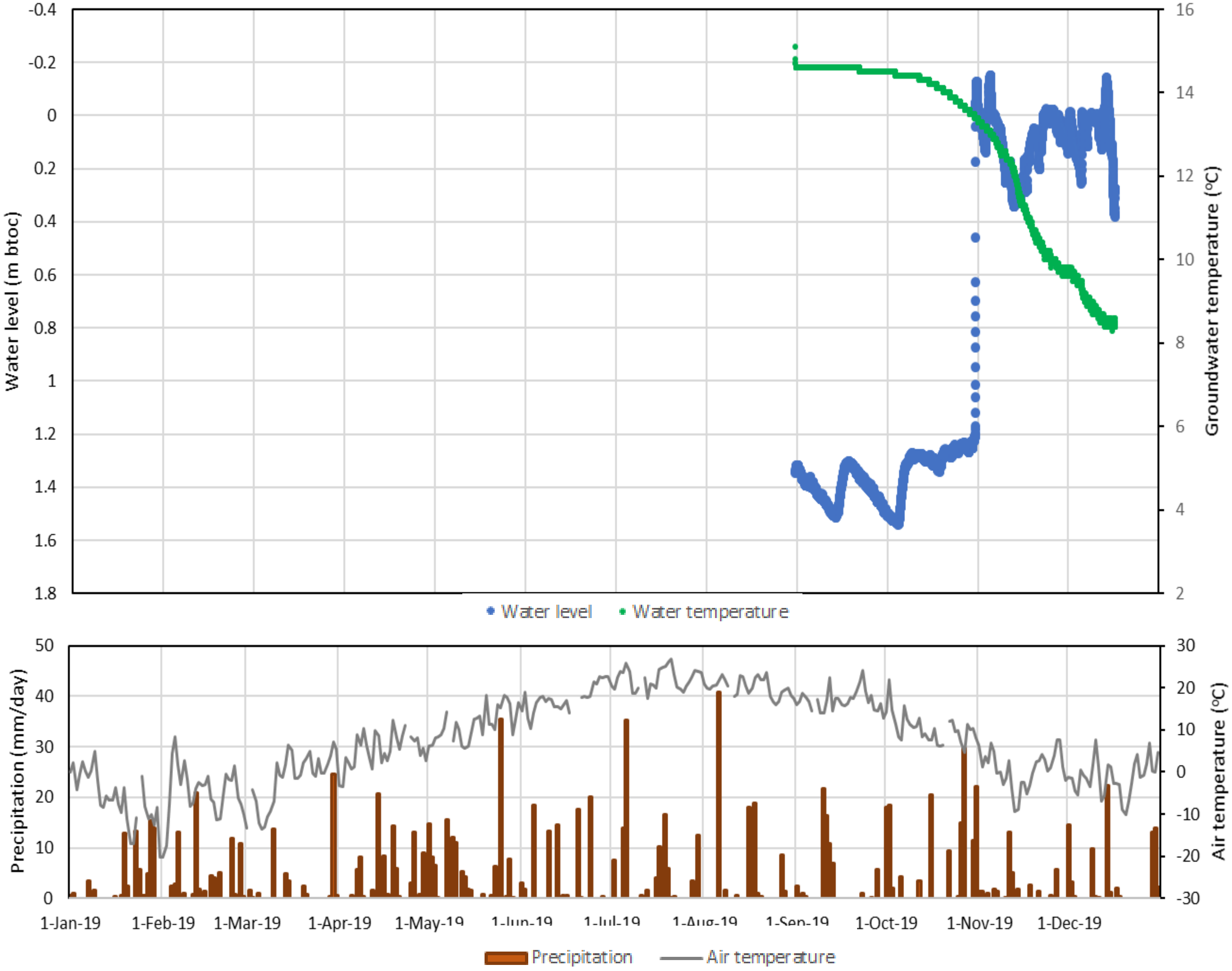
PROJECT:

HYDROGEOLOGICAL ASSESSMENT PROPOSED WETLAND (AREA SC-8)

FIGURE C-2:

WELL HYDROGRAPH – MW-4

Scale: as shown



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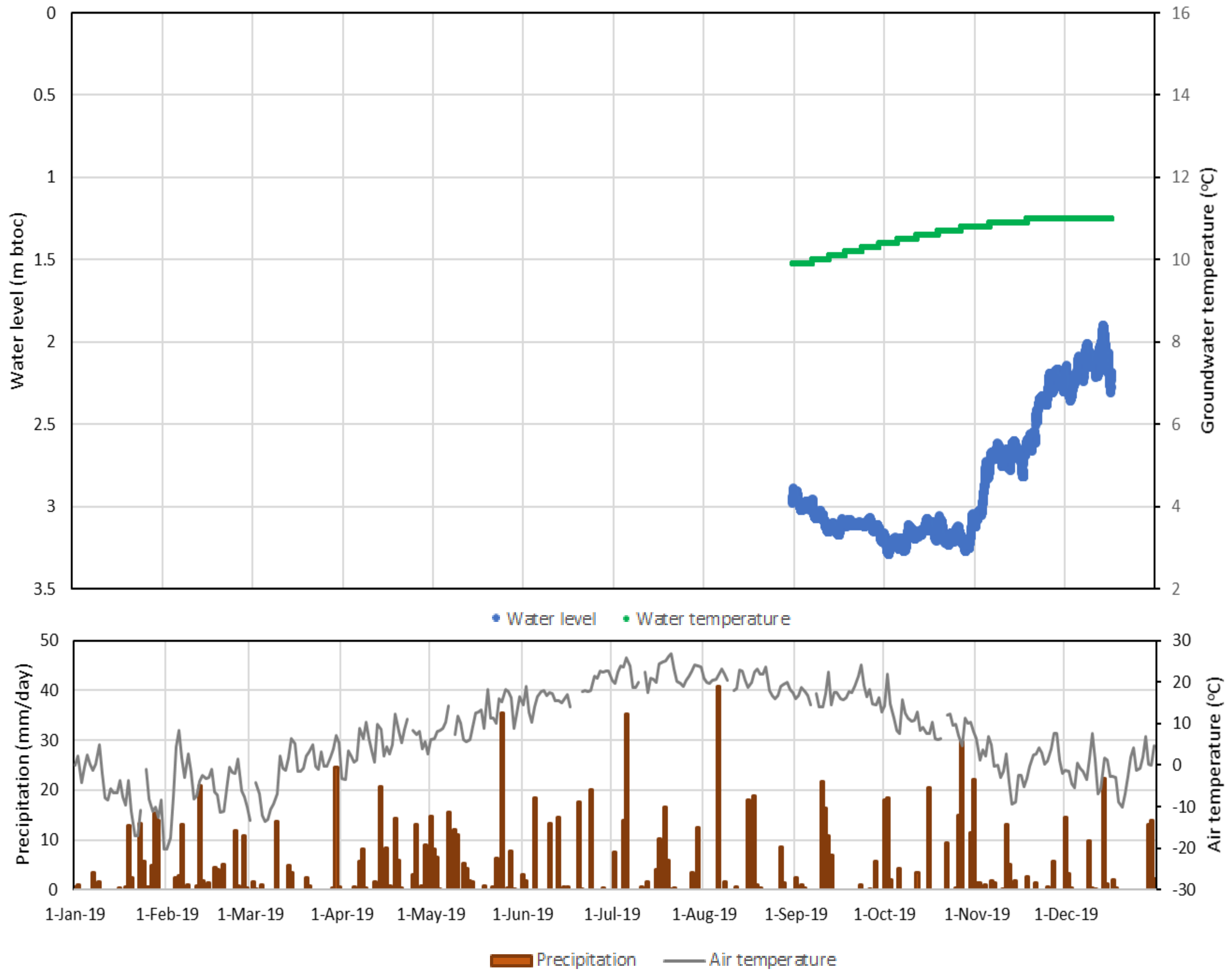
PROJECT:

HYDROGEOLOGICAL ASSESSMENT
PROPOSED WETLAND (AREA SC-8)

FIGURE C-3:

WELL HYDROGRAPH – MW-5

Scale: as shown



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PROJECT:

HYDROGEOLOGICAL ASSESSMENT
PROPOSED WETLAND (AREA SC-8)

FIGURE C-4:

WELL HYDROGRAPH – MW-7

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 (AREA SC-8)

SOUTH OF GREEN MOUNTAIN ROAD EAST
BETWEEN TAPLEYTOWN ROAD AND FIFTH ROAD EAST

CITY OF HAMILTON

REFERENCE NO. 1907-S107

OCTOBER 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 south side of Green Mountain Road East, between Tapleytown Road and Fifth 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 south side of Green Mountain Road East, between Tapleytown Road and Fifth 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. A tributary of Stoney Creek is traversing the site in south-north direction.

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 seven (7) sampled boreholes, was performed on August 13 and 14, 2019, at the locations shown on the Borehole Location Plan, Drawing No. 1. 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 2.4 to 5.8 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 the area of investigation is underlain by silty clay, overlying dolomite and limestone bedrock at a depth ranging from 2.4 to 5.8 m from the prevailing ground surface.

Detailed descriptions of the encountered subsurface conditions are presented on the Borehole Logs, comprising Figures 1 to 7, 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)

The revealed topsoil is 10 cm and 15 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 **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 4 representative samples and the results are plotted on Figure 8.

The obtained 'N' values range from 9 to 40, with a median of 17 blows per 30 cm of penetration, indicating the consistency of the deposit is stiff to hard, being generally very stiff. The silty clay near the ground surface is generally weathered, with fractures and roots inclusions, extending to a depth of 0.8± m from grade.

The Atterberg Limits of two representative samples 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	29% and 47%
Plastic Limit	16% and 22%
Natural Water Content	16% to 30% (median 23%)

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

Accordingly, the 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 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.

4.3 **Bedrock** (All Boreholes)

Refusal to auger drilling was contacted in the boreholes, at 2.4 to 5.8 m from the prevailing ground surface, or between El. 188.8 m and El. 191.5 m. It represents bedrock in this vicinity.

Rock coring was conducted below the refusal depths of 4.7 m and 2.4 m, at Boreholes 2 and 5, 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 to the depth of investigation, probably 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.

4.4 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 +
Silty Clay	16 to 30 (median 23)	20	16 to 24

The silty clay is generally suitable for a 95% or + Standard Proctor compaction. Wet or weathered soils will require aeration prior to structural compaction.

The silty clay should be compacted using a heavy-weight, kneading-type roller. When compacting the hard silty clay on the dry side of the optimum, the compactive energy will frequently bridge over the chunks in the soils and be transmitted laterally into the soil mantle. Therefore, the lifts must be limited to 20 cm or less (before compaction).

The presence of rock fragments 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

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

The majority of the boreholes remained dry upon completion of the field work and prior to rock coring. Groundwater was recorded at a depth of 5.5 m from grade or El. 190.9 m in Borehole 7. It should be noted that water was used for rock coring in Boreholes 2 and 5; therefore, record of groundwater in these boreholes after rock coring was not possible upon completion.

In excavation, any groundwater yield from the silty clay due to percolation of surface water is expected to be slow in rate and limited in quantity. Depending on the continuity of rock fractures, groundwater yield from bedrock is generally limited.

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, the area of investigation is underlain by a stratum of stiff to hard, generally very stiff silty clay, overlying dolomite and limestone bedrock at a depth ranging from 2.4 to 5.8 m from the prevailing ground surface, or between El. 188.8 m and El. 191.5 m. The bedrock is poor quality up to the depth of investigation, probably becoming good to excellent quality at the deeper level.

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 Stoney Creek for flood and erosion control. The existing road grade will be raised by 0.5 m (from the current elevation of 193.5 m) and new earth berms will be created to approximately194.0 m. The basin of the proposed wetland will be at El. 192.0± m.

6.1 **Wetland Construction**

The excavation will extend to El. 192.0± m. The invert and the walls of excavation are anticipated to consist of silty clay deposit.

All excavation should be carried out in accordance with Ontario Regulation 213/91. The types of soils are classified in Table 2.

Table 2 - Classification of Soils for Excavation

Material	Type
Bedrock	1
Silty Clay	2

Any excavation extending 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 underlying sound rock 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.

No continuous groundwater is anticipated within the depth of investigation. The yield of groundwater in any excavation is probably from the percolation of surface water. It can be drained towards sumps and removed by conventional pumping.

Earth fill will be used for the creation of earth berms around the wetland. Selected on site silty clay, free of organics, is suitable for the construction of the berms and embankment. It 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 subexcavated and the ground should 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 create a cavity in the embankment.

6.2 Soil Parameters

The recommended soil parameters for the project design are given in Table 3.

Table 3 - Soil Parameters

Unit Weight and Bulk Factor	**Unit Weight (kN/m^3)**	**Estimated Bulk Factor**	
	Bulk	**Loose**	**Compacted**
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

Table 3 - Soil Parameters (cont'd)

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. I. J. AL-ALI
100083356
oct 17, 2019

Basim Al-Ali, P.Eng.

CHUN C. B. SUN
Oct 17, 2019

Bennett Sun, P.Eng.
BAA/BS:dd

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.: 1907-S107

LOG OF BOREHOLE NO.: 1

FIGURE NO.: 1

PROJECT DESCRIPTION: Proposed Wetland Design
Area SC-8

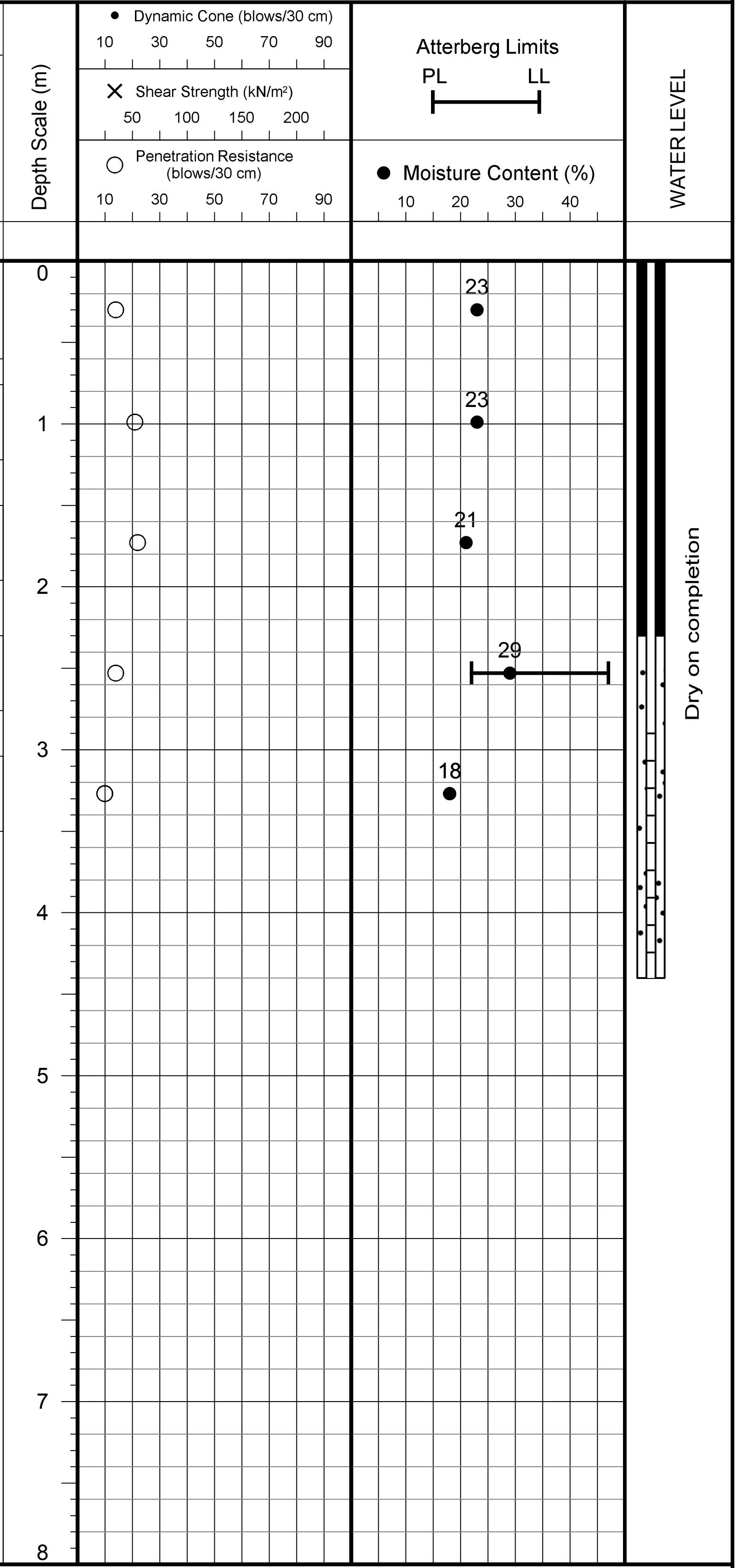
METHOD OF BORING: Flight-Auger

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

DRILLING DATE: August 14, 2019

El. (m) Depth (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value
193.2	Ground Surface			
0.0 0.1	**10 cm TOPSOIL**			
	Stiff to very stiff	1	DO	14
	weathered	2	DO	21
	SILTY CLAY medium plasticity occ. sand seams and layers	3	DO	22
		4	DO	14
	brown grey	5	DO	10
188.8 4.4	**Refusal to Augering** **Inferred Bedrock** **END OF BOREHOLE**			

Installed 50 mm Ø monitoring well to 4.4 m
completed with 1.5 m screen
Sand backfill from 2.3 m to 4.4 m
Bentonite seal from 0.0 m to 2.3 m.
Provided with steel casing and lock.



Soil Engineers Ltd.

JOB NO.: 1907-S107

LOG OF BOREHOLE NO.: 2

FIGURE NO.: 2

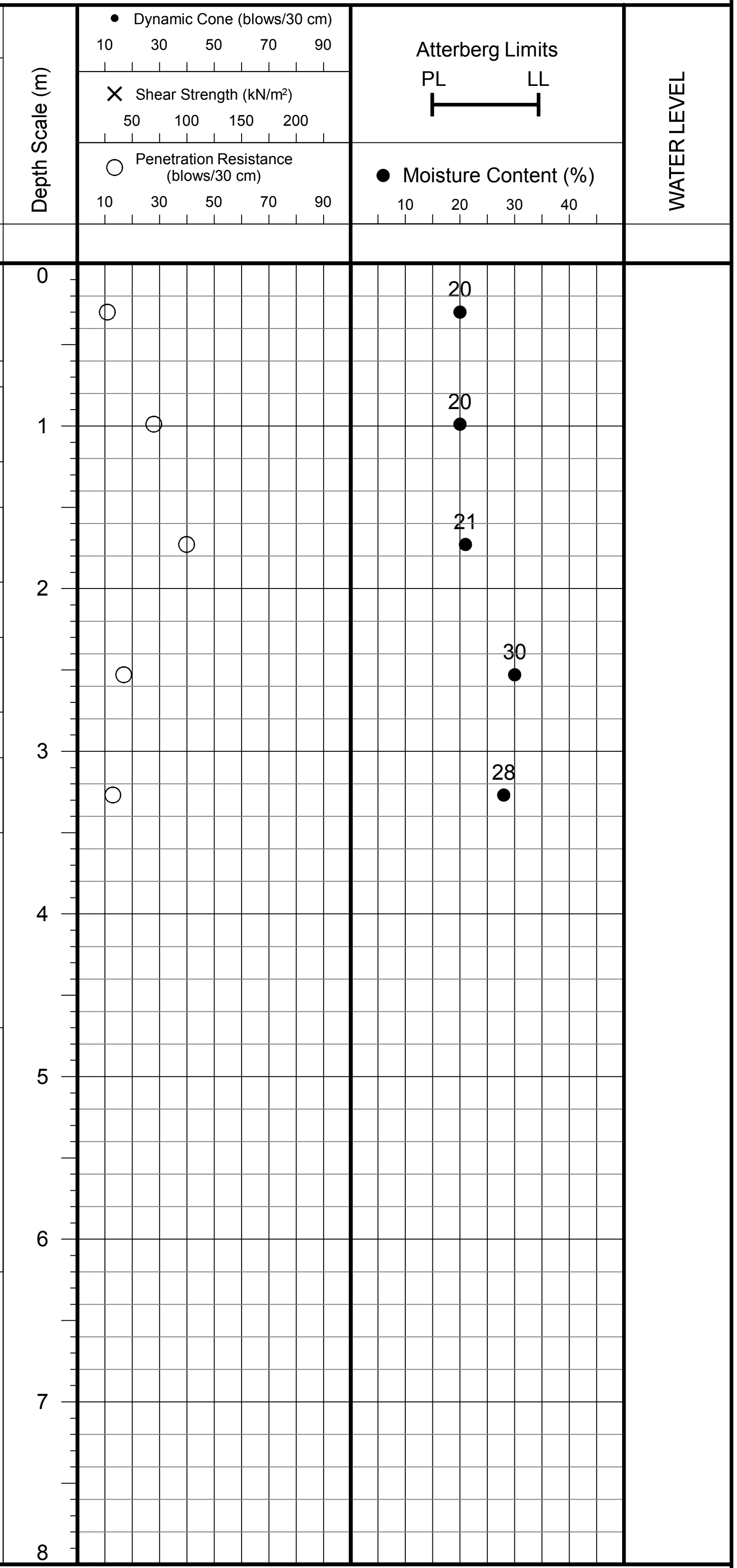
PROJECT DESCRIPTION: Proposed Wetland Design
Area SC-8

METHOD OF BORING: Flight-Auger

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

DRILLING DATE: August 13, 2019

El. (m) Depth (m)	SOIL DESCRIPTION	SAMPLES Number	SAMPLES Type	SAMPLES N-Value
193.7	Ground Surface			
0.0	**15 cm TOPSOIL**			
0.1	Stiff to hard	1	DO	11
	weathered			
		2	DO	28
	SILTY CLAY medium plasticity occ. sand seams and layers	3	DO	40
		4	DO	17
	brown grey			
		5	DO	13
189.0 4.7	Grey **DOLOMITE/LIMESTONE BEDROCK**	6	RC RQD	89% 83%
187.5 6.2	**END OF BOREHOLE**			



Soil Engineers Ltd.

Page: 1 of 1

JOB NO.: 1907-S107

LOG OF BOREHOLE NO.: 3

FIGURE NO.: 3

PROJECT DESCRIPTION: Proposed Wetland Design
Area SC-8

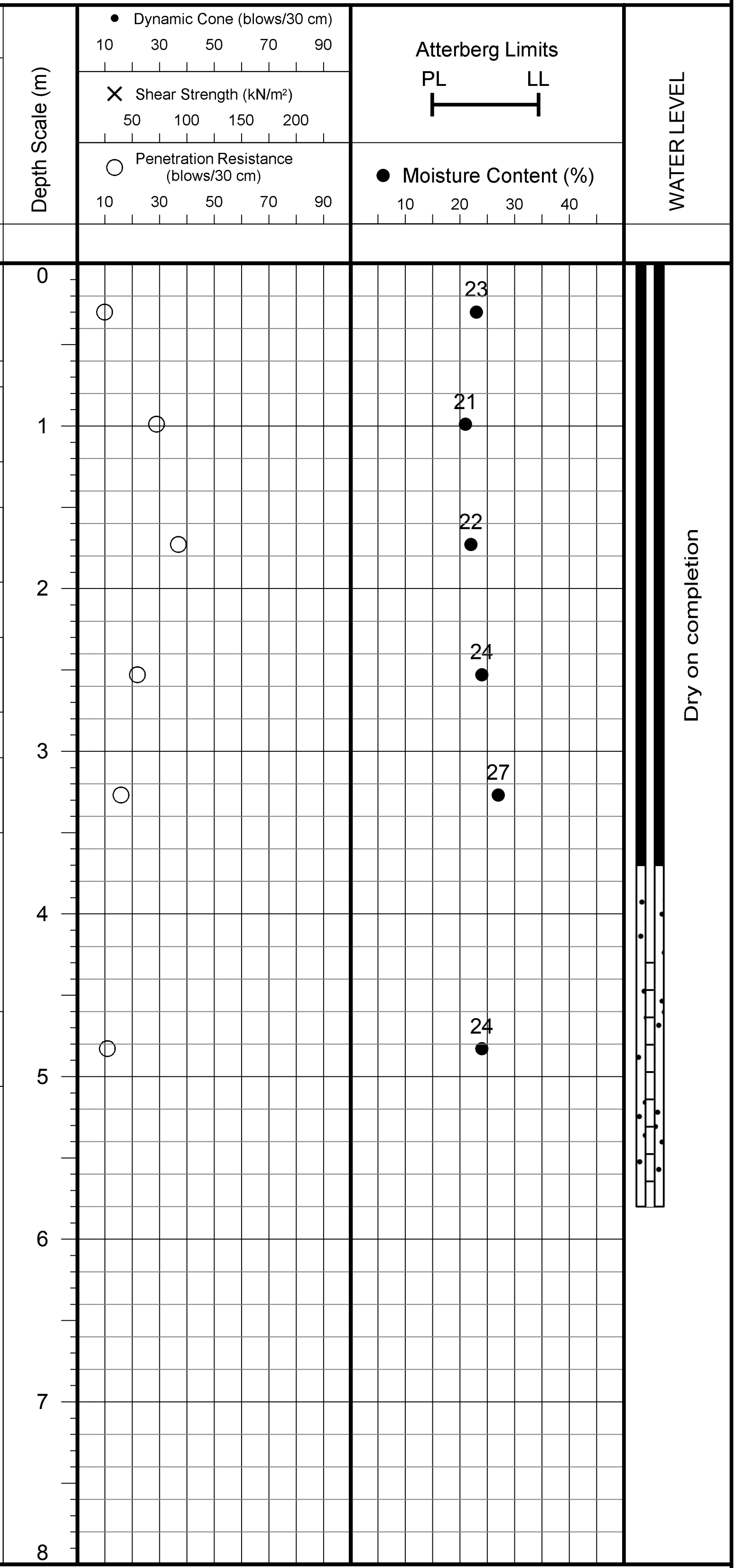
METHOD OF BORING: Flight-Auger

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

DRILLING DATE: August 13, 2019

El. (m) Depth (m)	SOIL DESCRIPTION	SAMPLES Number	SAMPLES Type	SAMPLES N-Value
194.9	Ground Surface			
0.0	**15 cm TOPSOIL**			
0.1	Stiff to hard	1	DO	10
	weathered	2	DO	29
	SILTY CLAY medium plasticity occ. sand seams and layers	3	DO	37
		4	DO	22
	brown grey	5	DO	16
		6	DO	11
189.1 5.8	**Refusal to Augering** **Inferred Bedrock** **END OF BOREHOLE**			

Installed 50 mm Ø monitoring well to 5.8 m
completed with 1.5 m screen
Sand backfill from 3.7 m to 5.8 m
Bentonite seal from 0.0 m to 3.7 m.
Provided with steel casing and lock.



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JOB NO.: 1907-S107

LOG OF BOREHOLE NO.: 4

FIGURE NO.: 4

PROJECT DESCRIPTION: Proposed Wetland Design
Area SC-8

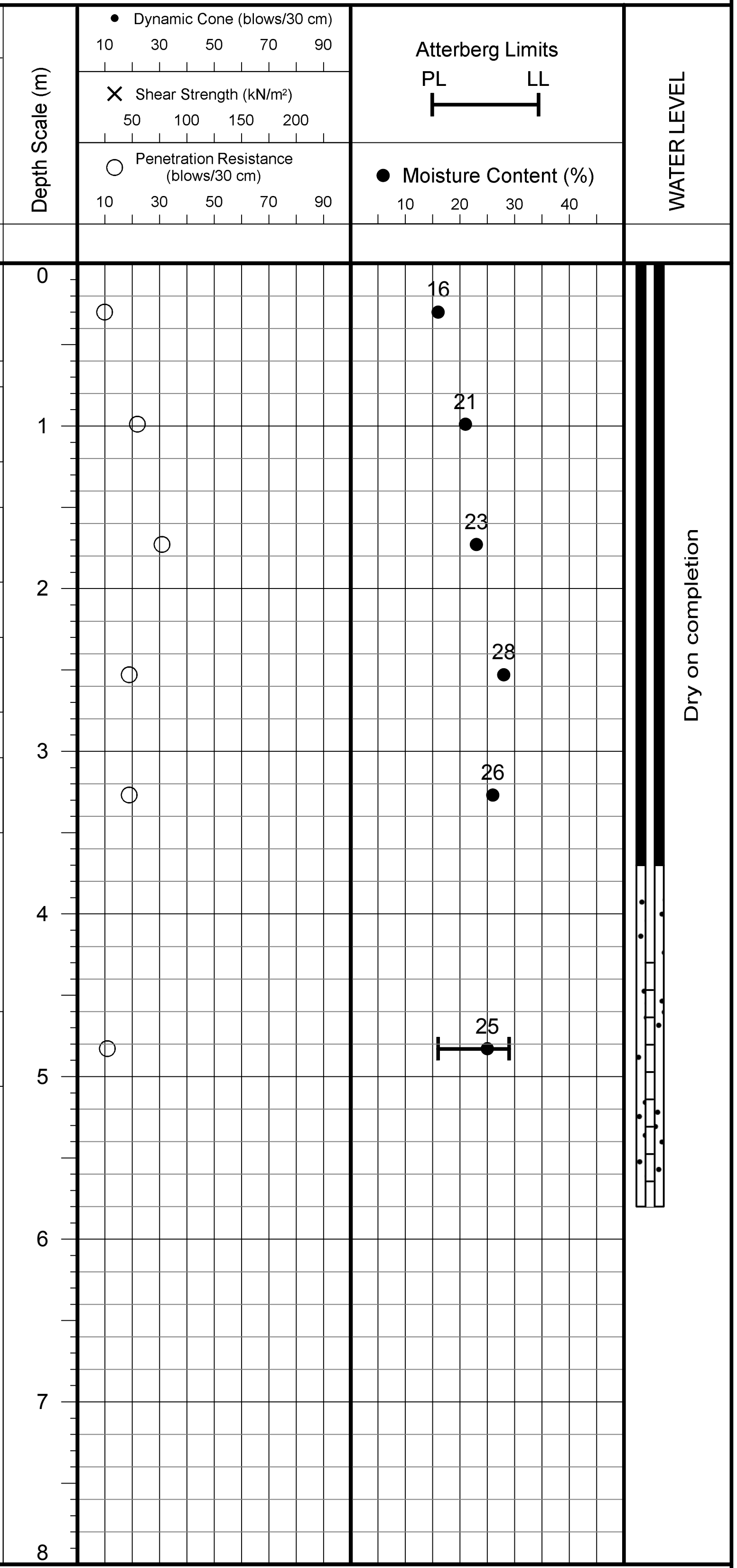
METHOD OF BORING: Flight-Auger

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

DRILLING DATE: August 13, 2019

El. (m) Depth (m)	SOIL DESCRIPTION
195.2	Ground Surface
0.0	**15 cm TOPSOIL**
0.1	Stiff to very stiff weathered **SILTY CLAY** medium plasticity occ. sand seams and layers brown grey
189.4 5.8	**Refusal to Augering** **Inferred Bedrock** **END OF BOREHOLE** Installed 50 mm Ø monitoring well to 5.8 m completed with 1.5 m screen Sand backfill from 3.7 m to 5.8 m Bentonite seal from 0.0 m to 3.7 m. Provided with steel casing and lock.

SAMPLES Number	Type	N-Value
1	DO	10
2	DO	22
3	DO	31
4	DO	19
5	DO	19
6	DO	11



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JOB NO.: 1907-S107

LOG OF BOREHOLE NO.: 5

FIGURE NO.: 5

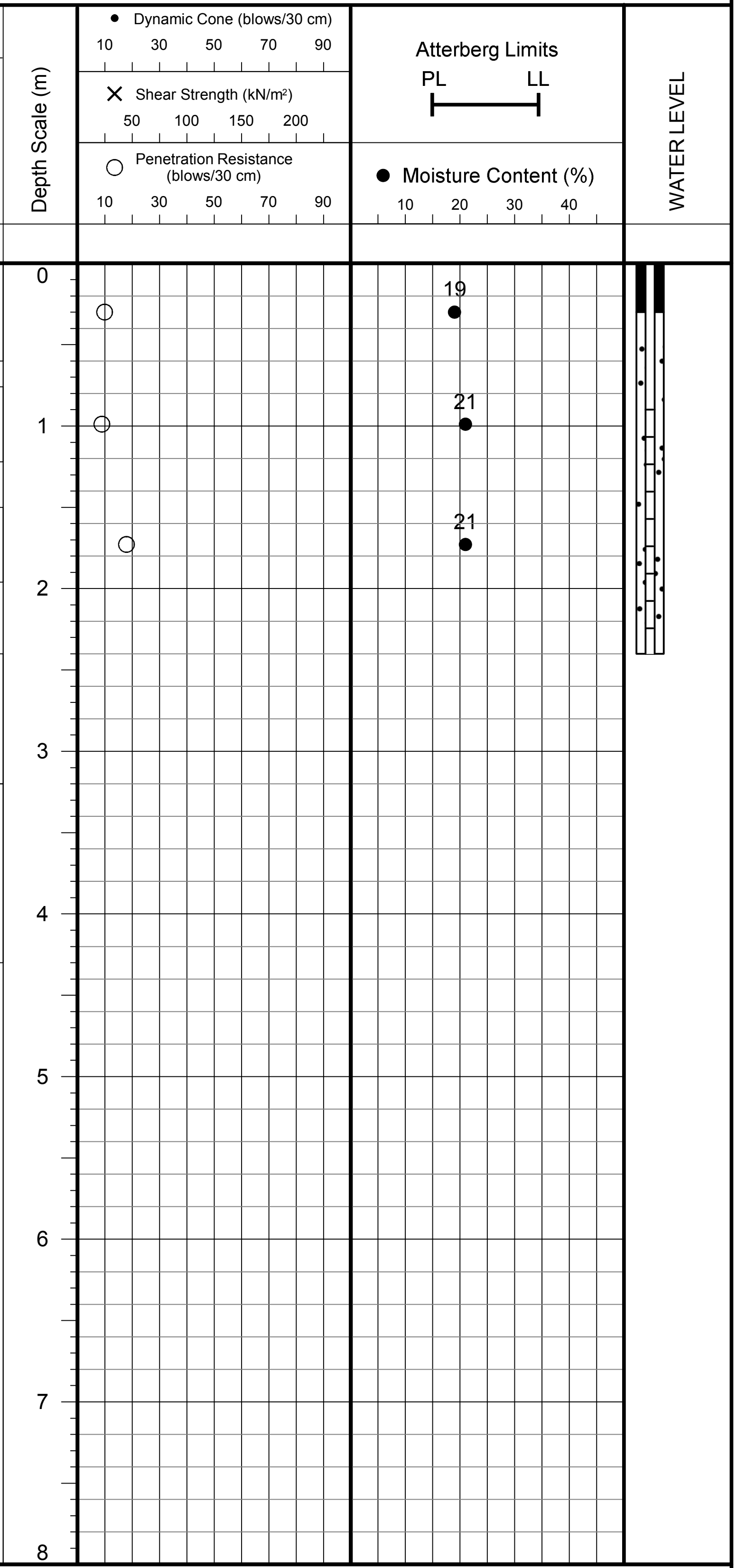
PROJECT DESCRIPTION: Proposed Wetland Design
Area SC-8

METHOD OF BORING: Flight-Auger

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

DRILLING DATE: August 13, 2019

El. (m) Depth (m)	SOIL DESCRIPTION	SAMPLES Number	SAMPLES Type	SAMPLES N-Value
193.3	Ground Surface			
0.0 0.1	**10 cm TOPSOIL**			
	Brown, stiff to very stiff	1	DO	10
	weathered	2	DO	9
	SILTY CLAY medium plasticity occ. sand seams and layers	3	DO	18
190.9 2.4	Grey	4	RC RQD	100% 31%
	DOLOMITE/LIMESTONE BEDROCK	5	RC RQD	100% 39%
189.0 4.3	**END OF BOREHOLE** Installed 50 mm Ø monitoring well to 2.4 m completed with 1.5 m screen Sand backfill from 0.3 m to 2.4 m Bentonite seal from 0.0 m to 0.3 m. Provided with steel casing and lock.			



Soil Engineers Ltd.

JOB NO.: 1907-S107

LOG OF BOREHOLE NO.: 6

FIGURE NO.: 6

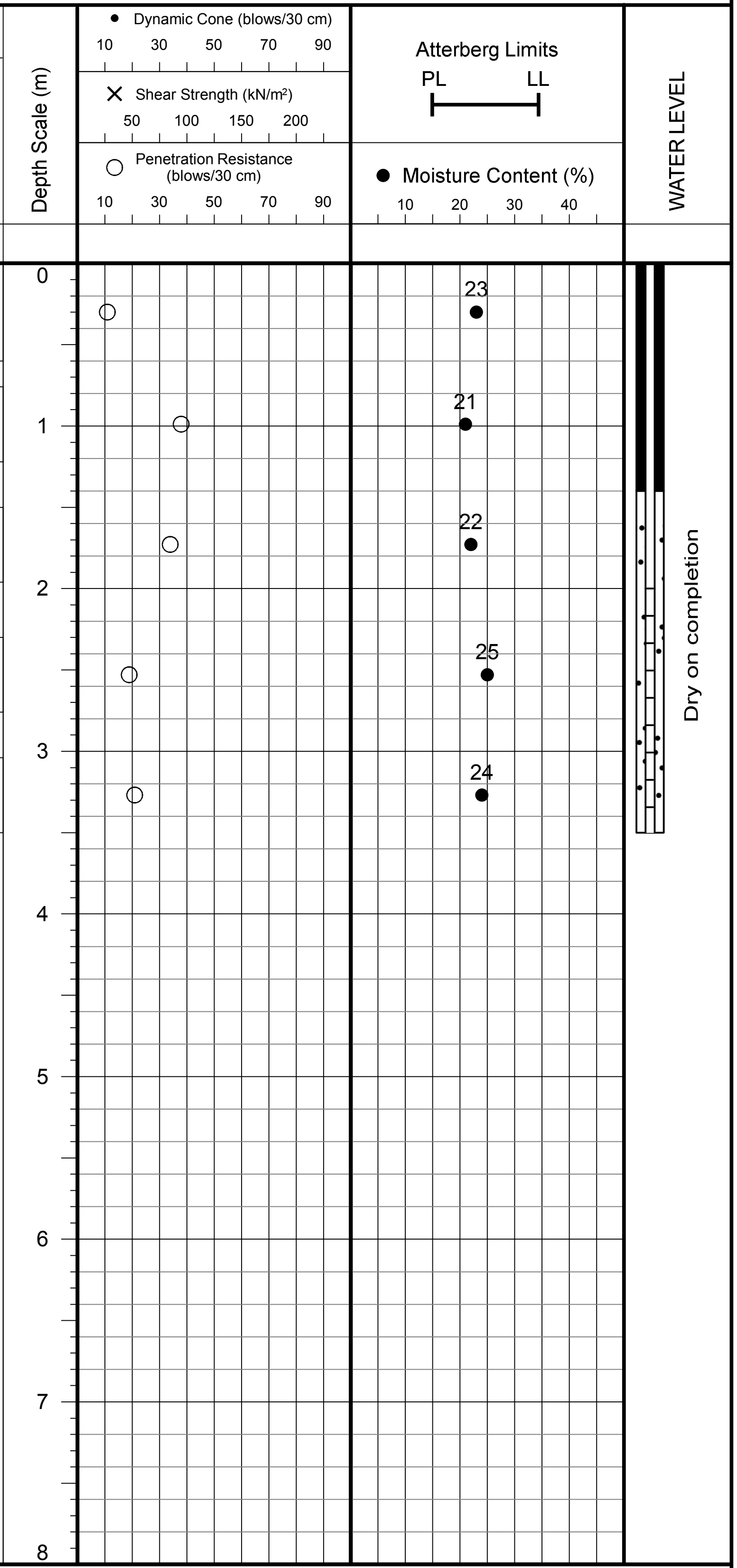
PROJECT DESCRIPTION: Proposed Wetland Design
Area SC-8

METHOD OF BORING: Flight-Auger

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

DRILLING DATE: August 14, 2019

El. (m) Depth (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value
195.0	Ground Surface			
0.0 0.1	**10 cm TOPSOIL**			
	Brown, stiff to hard	1	DO	11
	weathered	2	DO	38
	SILTY CLAY medium plasticity occ. sand seams and layers	3	DO	34
		4	DO	19
		5	DO	21
191.5 3.5	**Refusal to Augering** **Inferred Bedrock** **END OF BOREHOLE** Installed 50 mm Ø monitoring well to 3.5 m completed with 1.5 m screen Sand backfill from 1.4 m to 3.5 m Bentonite seal from 0.0 m to 1.4 m. Provided with steel casing and lock.			



Soil Engineers Ltd.

JOB NO.: 1907-S107

LOG OF BOREHOLE NO.: 7

FIGURE NO.: 7

PROJECT DESCRIPTION: Proposed Wetland Design
Area SC-8

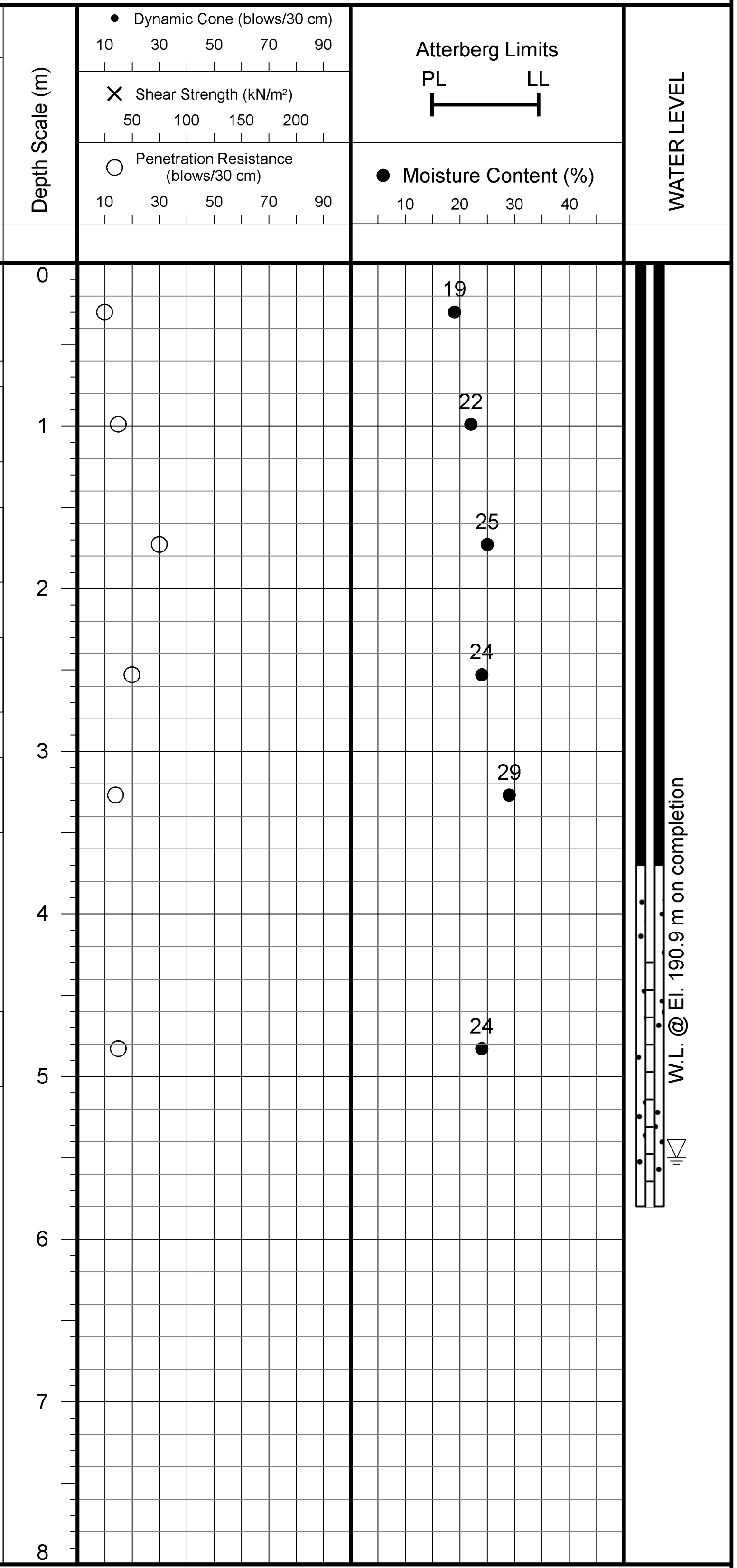
METHOD OF BORING: Flight-Auger

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

DRILLING DATE: August 14, 2019

El. (m) Depth (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value
196.4	Ground Surface			
0.0 0.1	**10 cm TOPSOIL**			
	Stiff to very stiff	1	DO	10
	weathered			
		2	DO	15
	SILTY CLAY medium plasticity occ. sand seams and layers	3	DO	30
		4	DO	20
		5	DO	14
	brown grey			
		6	DO	15
190.6 5.8	**Refusal to Augering** **Inferred Bedrock** **END OF BOREHOLE**			

Installed 50 mm Ø monitoring well to 5.8 m
completed with 1.5 m screen
Sand backfill from 3.7 m to 5.8 m
Bentonite seal from 0.0 m to 3.7 m.
Provided with steel casing and lock.



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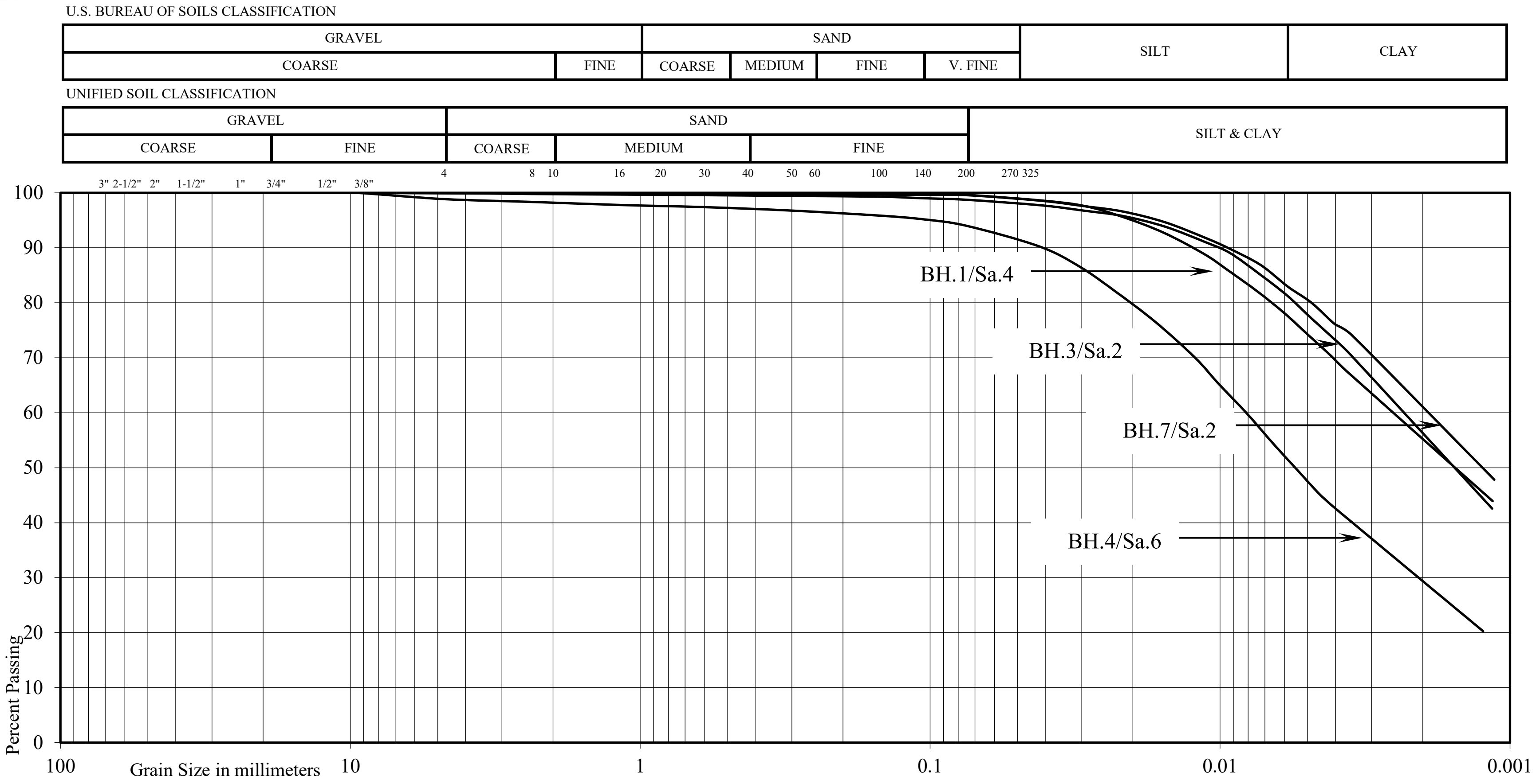
GRAIN SIZE DISTRIBUTION

Reference No: 1907-S107



Project: Proposed Wetland Design Area SC-8

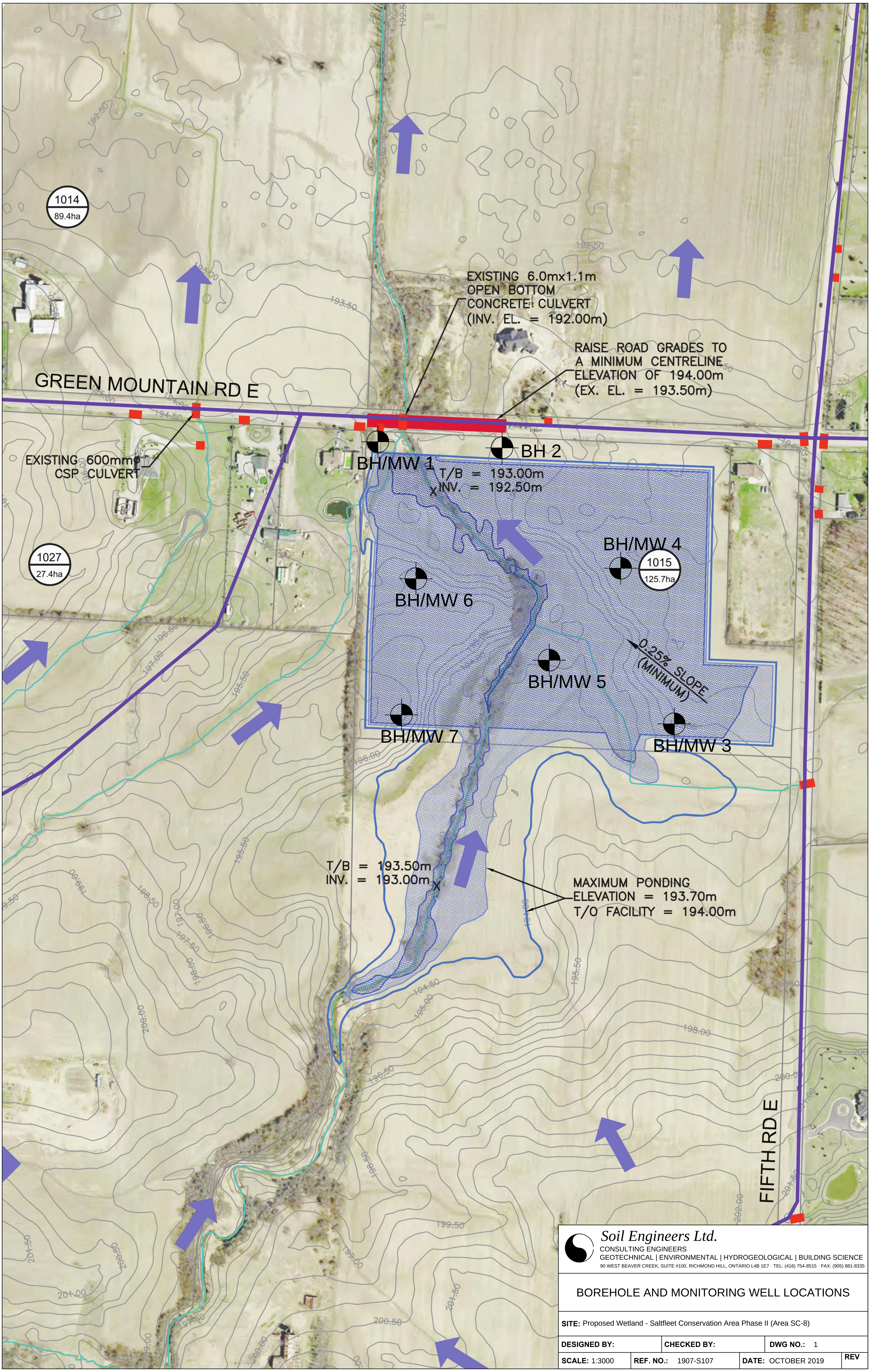
Location: Fifth Road East and Green Mountain Road East, City of Hamilton

Borehole No:	1	3	4	7
Sample No:	4	2	6	2
Depth (m):	2.5	1.0	4.8	1.0
Elevation (m):	190.7	193.9	190.4	195.4

BH./Sa.	1/4	3/2	4/6	7/2
Liquid Limit (%) =	47	-	29	-
Plastic Limit (%) =	22	-	16	-
Plasticity Index (%) =	25	-	13	-
Moisture Content (%) =	29	21	25	22
Estimated Permeability (cm./sec.) =	10^{-7}	10^{-7}	10^{-7}	10^{-7}

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

Figure: 8



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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 Phase II (Area SC-8)

DESIGNED BY:

CHECKED BY:

DWG NO.: 1

SCALE: 1:3000

REF. NO.: 1907-S107

DATE: OCTOBER 2019

REV

Soil Engineers Ltd.
CONSULTING ENGINEERS
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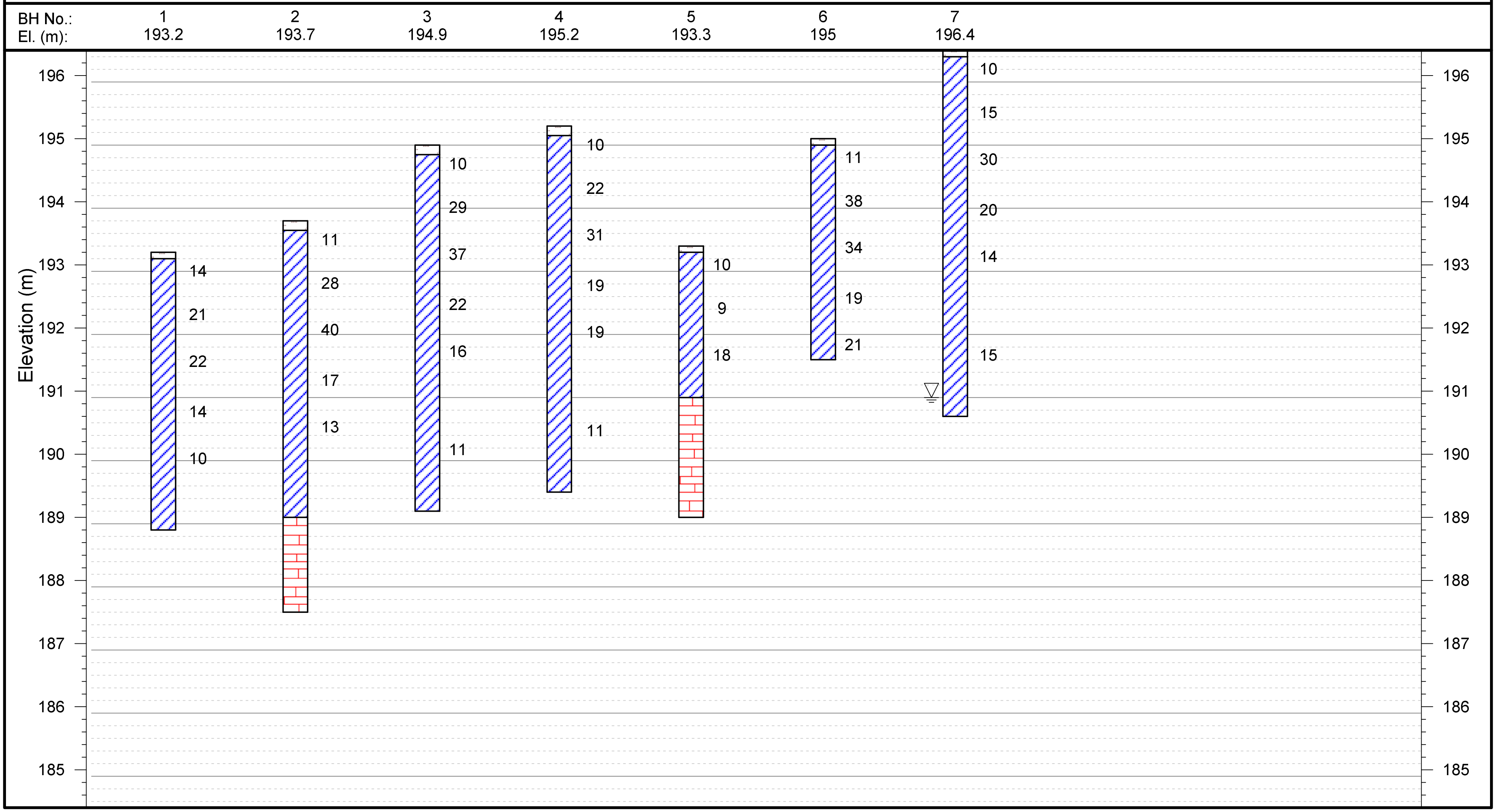
SUBSURFACE PROFILE
DRAWING NO. 2
SCALE: AS SHOWN

JOB NO.: 1907-S107
REPORT DATE: October 2019
PROJECT DESCRIPTION: Proposed Wetland Design
Area SC-8
PROJECT LOCATION: Fifth Road East and Green Mountain Road East
City of Hamilton

LEGEND

▭ TOPSOIL ▨ SILTY CLAY ▦ LIMESTONE /DOLOSTONE

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



APPENDIX D:

Natural Heritage Report

Saltfleet Conservation Area Wetland SC-8 Design

Natural Heritage Assessment Report

Prepared for:

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

Project No. 2286A | June 2020

NATURAL RESOURCE SOLUTIONS INC.
Aquatic, Terrestrial and Wetland Biologists

Saltfleet Conservation Area Wetland SC-8 Design

Natural Heritage Assessment Report

Project Team

Tara Brenton	Project Manager, Senior Terrestrial & Wetland Biologist / Certified Arborist
Patrick Deacon	Terrestrial and Wetland Biologist
Gina MacVeigh	Aquatic Biologist
Amy Reinert	Terrestrial and Wetland Biologist
Kaitlin Filippov	G.I.S. Analyst

Report submitted on June 3, 2020

Patrick Deacon
Terrestrial and Wetland Biologist

Table of Contents

List of Tables

List of Figures

List of Appendices

Maps

1.0 Introduction

Natural Resource Solutions Inc. (NRSI) was retained by Hamilton Region Conservation Authority (HCA) to prepare a Natural Heritage Assessment Report to inform the Preliminary Design Report for flood mitigation works being completed at the Saltfleet (SC-8) 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).

1.1 Background and HCA Objectives

The HCA's goal for the recently purchased Saltfleet SC-8 subject property is to create a new conservation area that will help to alleviate natural hazards (flooding) and enhance natural heritage components on site. At this time the development of public recreation opportunities is not a goal for this property. 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; and
- Restoring natural function of the watercourse within the study area.

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 Stoney Creek parcel), also referred to as SC-8, is 1 of 4 properties where wetland creation was recommended in the EA.

A startup meeting between HCA, Water's Edge and NRSI staff was held on July 24, 2019. The subject property, project objectives and foreseeable issues within the SC-8 subject property were discussed. The study team outlined the proposed workplan and HCA provided background data (mapping, reports and GIS data) to Water's Edge and NRSI.

1.2 Proposed Undertaking

The proposed works will include the creation of a soil berm and associated outlet control structure, as well as enhancements to aquatic, wetland and terrestrial habitats. These works are intended to meet the HCA objective of utilizing the floodplain area within the property to improve flood attenuation capacity and reduce erosion in the lower reach of Stoney Creek.

This report identifies the potential direct, indirect and induced impacts related to the development 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 berm 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 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 (Map 1). Lands within the study area are a mixture of agricultural lands, rural residential lots and the natural corridor associated with Stoney Creek.

The subject property is located at Part Lot 15, Concession 6 in the former Saltfleet Township (amalgamated by the City of Hamilton in 2001) (Map 1). The property is 9.05 hectares in area and fronts onto Green Mountain Road East with Tapleytown Road to the west, Mud Street East to the south and Fifth Road East to the east.

The Rural Hamilton Official Plan (OP, City of Hamilton 2018) identifies several natural heritage designations within the subject property. These designations are shown on Map 1 and include;

- The treed feature along the watercourse is considered a Natural Heritage Features Core Area and Key Natural Heritage Feature - Significant Woodlands and Wetlands;
- No mapped linkages are present on the property; however, a hedgerow 500m north of Green Mountain Road East is identified and links Stoney Creek to the Vinemount Swamp;
- The property contains a portion of the headwaters of Stoney Creek which are considered Key Hydrologic Feature - Streams;
- The entire property is part of the Greenbelt Protected Countryside; and
- The Greenbelt Natural Heritage System is approximately 500m north of the property.

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 development in relation to requirements for protection and mitigation during development in 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 (MNRF 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, including: ○ Fish habitat ○ Candidate SWH ○ Candidate foraging habitat for Species at Risk (SAR) bats.

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, 91 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, 1 SAR bird was observed (Barn Swallow). • Regulated habitat for the SAR bird is not present within the property • Based on field surveys, habitat is not present for SAR bat roosting.
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.	• As work is likely to be completed in the vicinity of the watercourse within the subject property, a proponent-led DFO assessment will be required (when detailed design is complete) 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. • DFO should be consulted as early within the process as feasible (usually around 60% detailed design). • Pending the works and result of review, an Authorization may be required. This will result in offsetting 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. • A wildlife sweep by a trained biologist may be warranted prior to any vegetation clearing.
Greenbelt Plan (MMAH 2017)	• The Greenbelt Plan was prepared under the authority of the Greenbelt Act (Government of Ontario 2005) 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: ○ Agricultural System, ○ Natural System, and, ○ 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. • None of the features within the subject property are considered part of the Natural Heritage System (NHS).
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 120 m 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 proposed development must demonstrate no negative impacts to the regulated natural features or their ecological functions.

Policy/Legislation	Description	Project Relevance
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 main watercourse corridor and associated vegetation) through the subject property is identified as a Natural Heritage Feature Core Area and two Key Natural Heritage Feature layers (Significant Woodland and Streams) under the RHOP. - A section of Stoney 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 tree inventory and Tree Protection Plan, following the City of Hamilton's Tree Protection Guidelines (2010) will be required if any trees need to be removed for the proposed development.
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.
Ministry of Environment, Conservation and Parks – (Environmental Protection Act, RSO 1990 Chapter E.19 and the 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 a 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. Authorization to proceed with the study was received in June 2019. The field program was initiated on June 19, 2019 and was completed by September 30, 2019. Details of each site visit are summarized in Table 2, below.

The terrestrial and aquatic monitoring station locations are shown on Map 2. Avian surveys were conducted as area searches of the Ecological Land Classification (ELC) communities and no point count stations were established for these surveys.

3.1 Terrestrial Field Surveys

3.1.1 Vegetation Surveys

All vegetation communities were mapped using the ELC system for southern Ontario (Lee et al. 1998). An inventory of vascular plants was completed for each ELC community including composition, dominance, uncommon species, soil characterization, topography and evidence of human impacts. Vegetation surveys were completed on 2 visits; in early 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.

A comprehensive inventory of trees proposed for removal (if any) 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 Breeding Bird Surveys

Breeding bird surveys were conducted on 2 dates in late June and 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 SCC were documented.

3.1.4 Herpetofaunal Surveys

Anuran Call Surveys

An evening anuran call survey was conducted in June following the Marsh Monitoring Program protocol (BSC 2009). A total of 3 stations were surveyed based on the presence of suitable habitats throughout the subject property (areas with seasonal standing water). Due to the timing of the contract award, surveys in April and May were not completed. 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 Nesting Surveys

A total of 3 surveys were conducted in June through early July to determine if turtle nesting habitat is present within the subject property. Additionally, NRSI staff documented any incidental wildlife observations during breeding bird and vegetation surveys. Search effort focused on the retired agricultural fields which contain bare soils adjacent to the watercourse and wetland features.

Table 2. Field Survey Summary

Survey Type	Protocol	Date (2019)	Start and End Time (24 hrs)	Temp. (°C)	Beaufort Wind Speed	Cloud Cover (%)	Precipitation	Observers
Vegetation								
ELC Mapping	Lee et al. 1998	July 9	0915-1300	26	0	10	None	T. Brenton
Vascular Flora Inventories[3]	Systematic search by ELC polygon	July 9	0915-1300	26	0	10	None	T. Brenton
		August 23	0840-1145	26	2	0	None	P. Deacon, M. Zago, M. Heyming
Bird Surveys								
Breeding Bird Survey	Area search OBBA 2001	June 21	0641-0810	17	2	20	None	T. Brenton
		July 9	0700-0816	17	1	5	None	T. Brenton
Reptile and Amphibian Surveys								
Anuran Call Survey	BSC 2009	June 19	2221-2237	17	0	40	None	G. MacVeigh, A. Reinert
Turtle Nest Search	Area search of fallow fields for nests.	June 19	1837-1942	28-25	1	30	None	G. MacVeigh, A. Reinert
		June 27	1800-1846	30	2	30	None	G. MacVeigh, A. Reinert
		July 2	1840-2015	25	1	100	Start at 1950	G. MacVeigh
Mammal Surveys								
Bat Cavity Habitat Assessment	OMNR 2011, MNRF 2014	July 9	0915-1300	26	0	10	None	T. Brenton
Bat Acoustic Monitoring	MNRF 2017	June 19-July 17	-	-	-	-	-	G. MacVeigh, A. Reinert
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	July 18	0715-1030	25	1	100	Rain yesterday	G. MacVeigh, N. Allen, S. Catry
		September 30	1145-1330	16	2	100	Rain yesterday	G. MacVeigh
Fish Community Survey	OSAP Screening Level Methodology (Stanfield 2017)	July 18	0715-1030	25	1	100	Rain yesterday	MacVeigh, N. Allen, S. Catry

3.1.5 Bat Surveys

Maternity Roost Assessment

An assessment for the presence of candidate bat roost trees was conducted on July 9. Trees which exhibit cracks or crevices were actively searched for with details pertaining to species, height, decay class and location recorded.

Acoustic Monitoring

Bat acoustic monitoring was completed at one location within the subject property (Map 2). 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, Northern Myotis and Tri-Colored Bats (MNRF 2017) and are described in detail below.

Acoustic Monitoring Station Locations

NRSI placed one acoustic monitoring station in an area with the most suitable bat habitat to assess the potential presence of SAR bats within the subject property. This station was located within suitable foraging habitat and along a potential movement/travel corridor in the MAM2 community (Map 2). The microphone was placed along the edge of the open habitat to conceal the microphone 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.

Acoustic Monitoring Frequency and Timing

Passive acoustic monitoring was conducted between June 19 and July 17, 2019 for a total of 29 nights. The acoustic detector was set to record bat passes for a total of five 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 >10°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.

Table 3. SM4 Acoustic Recorder Settings for Bat Monitoring

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

Acoustic Data Analysis

The acoustic recorder used for this study employs direct digital recording technology and is 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 one 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 one 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. 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 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; July 18 and September 30. The watercourses and reaches assessed, including sampling stations, are shown on Map 2. The on-site aquatic features were re-visited during the June 19 anuran survey visit to help refine the characterization.

The Tributary to Stoney Creek was divided into different sampling reaches and one 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 workplan provided to HCA as it provides repeatable quantitative measurements that facilitate accurate habitat comparisons for each sampling site from year to year.

The additional 2 reaches of the Tributary to Stoney 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 Assessment

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 July 7, 2019 by the MNRF Guelph District – Vineland Field Office (No. 1093659).

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 July 18, 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 (culvert crossing at Greenfield Road) to the upstream end of the subject property. No electrofishing occurred within the additional drainage/ephemeral features on site as they were 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

	Tributary to Stoney Creek EMS-001
Date	July 18, 2019
Sampling start time	0715hrs
Sampling end time	1030hrs
Air temperature (°C)	25
Water temperature (°C)	21.7
Time water temp. taken	1145hrs
Number of Netters	1
Voltage (V)	150-200
Pulsating Frequency (Hz)	60
Ampere (Amps)	40
Shocking time (sec.)	978

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 subject property soils are comprised of approximately 100-150mm of topsoil underlain by silty-clay varying from approximately 240cm to 580cm atop bedrock (Soil Engineers Limited 2019). No karst features are present on the subject property. Soil types vary widely within the subject property with a mixture of Lincoln silty-clay-loam, Haldimand silty-clay-loam and Smithville silt-loam present (Presant et al 1965). In general, these soils exhibit low hydraulic conductivity and are therefore conducive to holding water on the surface through the design of the constructed wetland features (Greer Galloway 2020).

The subject property is located within the Stoney Creek sub-watershed. Surface drainage moves from south to northeast to west, with headwaters originating to the south of Tapleytown. The site is gently rolling with higher elevations in the northeast (196 masl) directing overland flow toward the Green Mountain Road culvert (193 masl).

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.

Table 6. Vegetation Communities Identified within the Study Area

Ecosite Type	Community Description	Vegetation Composition
Wetland		
MAM2	Graminoid Mineral Meadow Marsh	Areas of marsh along the watercourse are dominated by Reed Canary Grass (*Phalaris arundinacea*), a non-native and invasive species, with Broad-leaved Cattail (*Typha latifolia*) present near the Green Mountain Road culvert. Marsh vegetation also extends along the western property boundary where it appears that surface drainage from the property to the west has been altered. Canada Goldenrod (*Solidago canadensis*) is present along the fringes of the marsh as well as New England Aster (*Symphyotrichum novae-angliae*), Common Milkweed (*Asclepias syriaca*) and Blue Vervain (*Verbena hastata*). Areas of mud flats, which are likely inundated each spring, contain species such as Common Water-plantain (*Alisma plantago-aquatica*), Blunt Spike-rush (*Eleocharis obtusa*) and Lesser Duckweed (*Lemna minor*). The non-native forbs, Purple Loosestrife (*Lythrum salicaria*) and European Water-horehound (*Lycopus europaeus*) are present in small numbers. Eastern Cottonwood (*Populus deltoides* ssp. *deltoides*) is beginning to establish within the marsh.
SWT2-13	Non-native Mineral Deciduous Thicket Swamp	Several areas of thicket swamp dominated by European Buckthorn (*Rhamnus cathartica*) are present along the watercourse. Hawthorn (*Crataegus* sp.) and Grey Dogwood (*Cornus foemina* ssp. *racemosa*) are present among the European Buckthorn as well as mid-age Bur Oak (*Quercus macrocarpa*), White Elm (*Ulmus americana*) and Crack Willow (*Salix fragilis*) which occur sporadically throughout. The dense shrub layer limits the groundcover to agricultural weeds such as Wild Carrot (*Daucus carota*) and Curly Dock (*Rumex crispus*). In the absence of annual cultivation, it is anticipated that European Buckthorn will quickly spread into the adjacent fields.
Cultural		
H	Hedgerow	The hedgerow along a portion of the western property boundary is comprised of European Buckthorn, Grey Dogwood, Staghorn Sumac (*Rhus typhina*) and Black Raspberry (*Rubus occidentalis*). Several desirable, native tree species are present in small numbers including Shagbark Hickory (*Carya ovata*), Black Cherry (*Prunus serotina*), White Elm and Bur Oak. Trembling Aspen (*Populus tremuloides*) is present and will likely seed into the fallow fields and wetland creation site in the near future.
-	Fallow Field	Two areas of field are present within the subject property which were in annual row crops as recently as 2018. These fields slope toward the watercourse in the centre of the parcel and do not hold large areas of standing water in the spring. During the 2019 surveys the fields contained bare soil with early establishment of Canada Goldenrod, New England Aster, and a variety of agricultural forbs and grasses.

4.2.2 Vascular Flora

A total of 104 species of vascular plants were recorded during detailed vegetation inventories within the subject property. Of the species inventoried, 47 are considered non-native. The high proportion of non-native species is typical of a site with a cultural history including recently retired agricultural lands. Species such as European Buckthorn and Purple Loosestrife are aggressive non-native species which can become widespread and compromise the diversity of intact vegetation communities.

Problematic non-native species that could compromise wetland creation works include Common Reed (*Phragmites australis* ssp. *australis*), European 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, SCC, or regionally significant plant species were observed. A complete list of the vascular flora species reported for the study area and observed by NRSI in 2019 is provided in Appendix II.

Tree Inventory

A detailed tree inventory within the footprint of the berm, where a small number of trees will be removed, will be completed by NRSI Certified Arborists in early summer 2020. This information 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, 32 bird species were observed by NRSI biologists within the subject property.

One SAR bird species, Barn Swallow (*Hirundo rustica*) was observed foraging above the watercourse (marsh and swamp thicket areas) and over the fields on several surveys in June and July. As many as 6 birds were present and likely nesting on a nearby building. This species is listed as Threatened provincially and federally (MNRF 2019b, Government of Canada

2019a). As typical nesting habitat is not present within the study area (buildings, bridges or other structures), and tree cavity nesting was not observed, regulated habitat is not present.

A number of locally significant bird species (HCA 2014) were observed during the breeding season, refer to Appendix III for a list of bird species which were documented. Species which are uncommon in Hamilton were observed including Brown Thrasher (*Toxostoma rufum*) – a pair (probable breeding evidence), and Northern Mockingbird (*Mimus polyglottos*) – perched on hydro wires along Green Mountain Road in suitable habitat (possible breeding evidence).

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 2018), 18 species of herpetofauna are known from the 10 x 10km square overlapping the study area. NRSI field investigations confirmed the presence of 2 species of anuran; Gray treefrog (*Hyla versicolor*) and Green Frog (*Lithobates clamitans melanota*) within the subject property. Neither species is considered a SAR, SCC or locally significant (HCA 2014). A full list of the reptile and amphibian species reported from the Study Area is provided in Appendix IV. Calling anuran surveys commenced in June and therefore survey data for the months of April and May was not collected. June surveys documented 2 species of anurans within the subject property. Table 7 provides a summary of the frog call survey results for 2019.

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]	2[2]	3			
ANR-001	Gray Treefrog	-	-	*	1	1+	Candidate
	Green Frog	-	-	1 (1)			
ANR-002	Gray Treefrog	-	-	*	1	1+	Candidate
	Green Frog	-	-	1 (1)			
ANR-003	Gray Treefrog	-	-	*	1	4+	Candidate
	Green Frog	-	-	1 (4)			

[1] Marsh monitoring anuran call code with estimated number of individuals in brackets.
[2] April and May surveys could not be conducted.
*Species calling from outside of plot.

Turtle nesting surveys did not observe any turtles or evidence of nests. No snake species were observed during the 2019 surveys.

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 12 species from the subject property. Appendix V provides a list of the mammal species reported from the study area.

Bat Survey Results

Four bat species were documented as present during passive acoustic monitoring conducted within the subject property. All of these species are considered common throughout Ontario. A summary of the acoustic monitoring results is provided in Figure 1.

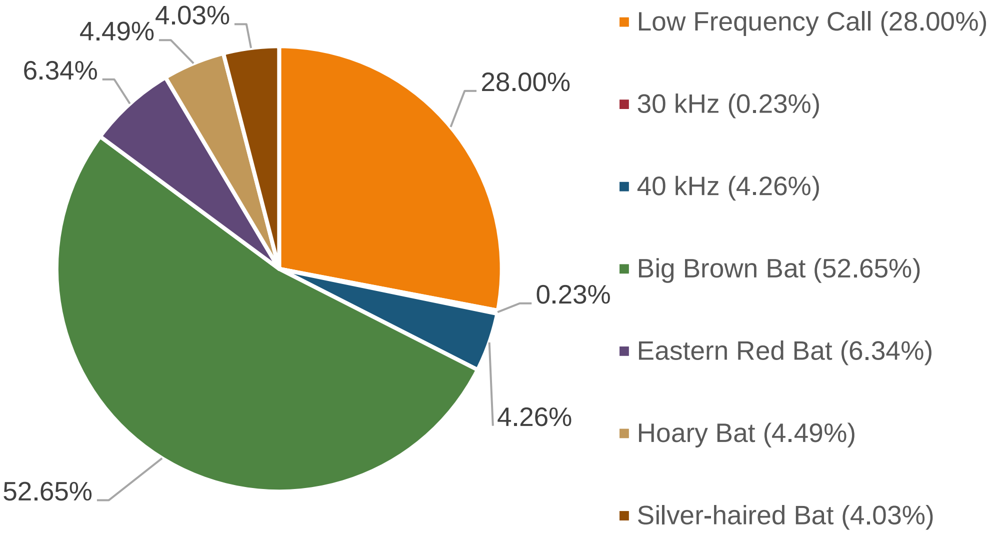


Figure 1. Bat species and species grouping classification results

A total of 868 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*) (52.65%). Several sequences were classified to Eastern Red Bat (*Lasiurus borealis*) (6.34%), Hoary Bat (*L. cinereus*) (4.49%) and Silver-haired Bat (*Lasionycteris noctivagans*) (4.03%).

Consistent with these findings, the site-level MLE values (throughout the entire monitoring period) for each species suggest that there is strong evidence for the presence of Big Brown Bat

(MLE=0), Eastern Red Bat (MLE=0) and Hoary Bat (MLE=0) and slightly weaker evidence for the presence of Silver-haired Bat (MLE=0.6) within the subject property.

Of those bat pass sequences that were classified to species groupings, 243 (28.00%) were identified to the Low Frequency species grouping, 2 (0.23%) to the 30 kHz species grouping and 37 (4.26%) to the 40 kHz 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 be considered probable evidence of the presence of SAR.

Species at Risk

Bat pass sequences classified to the 40 kHz species grouping were recorded during the monitoring period. 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 be considered probable evidence of the presence of SAR. Because no other Myotis species were detected during the monitoring period and there is a lack of suitable habitat for Myotis species within the subject property it is likely that the bat pass sequences identified to the 40 kHz species grouping are Eastern Red Bats and not bat SAR. However, the absence of bat SAR within the subject property is not confirmed.

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 40 kHz sequences, it is not likely that these bats are roosting within the vicinity of the monitoring station (Figure 2). Results indicate that they are however, using habitats within the vicinity of the monitoring station for foraging and/or as a movement or travel corridor between key habitats. Therefore, the SWT2-13 and MAM2 communities along the watercourse corridor are considered candidate foraging and movement/travel corridor habitat for potential bat SAR.

Significant Wildlife Habitat

Big Brown Bat and Silver-haired Bat were detected in relatively high numbers 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 habitat within the vicinity of the monitoring station for roosting habitat, including for maternity roost colonies, or at the very least foraging within the subject property shortly after leaving nearby roosts (Figure 3). The number and timing of Big Brown Bat and Silver-haired Bat recordings indicate that these species are also likely using habitat within the vicinity of the monitoring station for foraging and/or as a movement or travel corridor between key habitats.

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). Silver-haired Bats are solitary or may form small maternity colonies (van Zyll de Jong 1985).

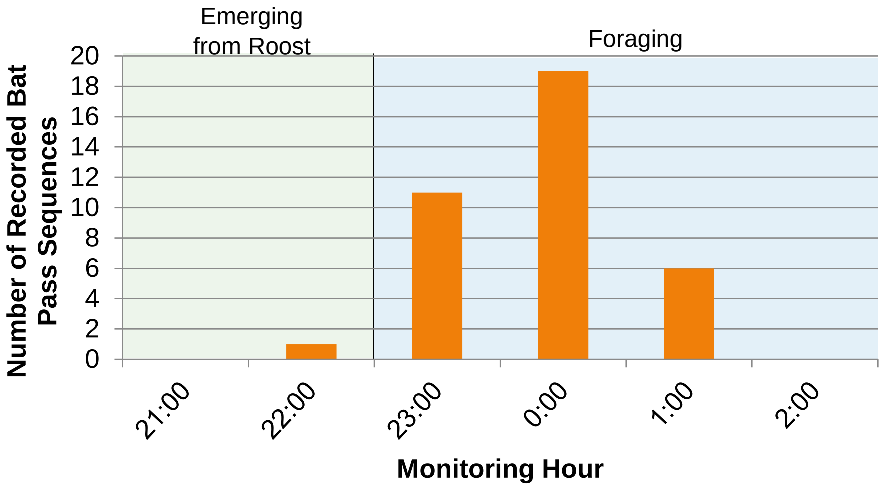


Figure 2. Potential bat SAR Abundance per hour

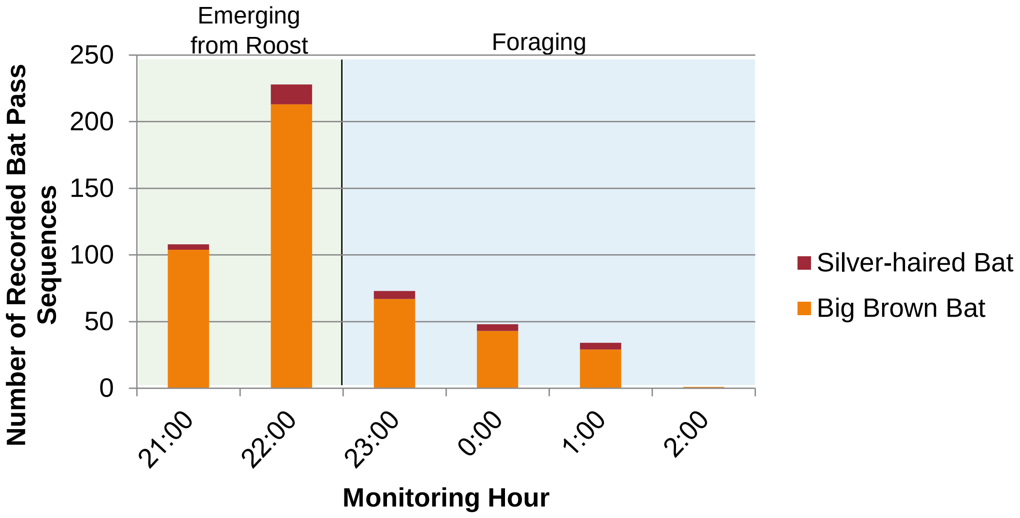


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Figure 3. Bat species detected and relative abundance per hour

There are no man-made structures or forest features (SWD, FOM, FOD communities) within the subject property suggesting that these species are likely roosting in one or several of the barn structures and/or forest features in the vicinity of the subject property. Therefore, Bat Maternity Colony SWH is not present within the subject property.

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, Twelve-spotted Skimmer (*Libellula pulchella*) was observed in the vicinity of marsh areas within the subject property. This species is considered common in Hamilton (HCA 2014) and can be found near marshes and wet meadows. Much of the watercourse corridor contains seasonal flowing with standing water present in the marsh features, both 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.

Butterflies

According to the Ontario Butterfly Atlas (Macnaughton et al. 2019), 39 butterfly species have been reported from the study area. NRSI staff observed 6 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 2019a). Several adults were observed throughout the summer and early fall as well as an observation of a caterpillar on the larval foodplant, Common Milkweed (*Asclepias syriaca*) which is present in small numbers along the hedgerow and the edges of the marsh communities. 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

The tributary to Stoney Creek originates to the southwest of the site, and has been heavily influenced by agricultural practices. This tributary is located entirely above the escarpment and has been previously identified through the EA (AMEC 2018) as being low-gradient, mainly ditched and channelized, which has resulted in generally broad and shallow watercourses, with few defining features. 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 and ditched deep sections. It also identifies that the Upper portion of Stoney Creek is heavily vegetated with emergent aquatic plants that can tolerate the lack of water in the summer. NRSI field assessments confirmed the findings from the EA and are discussed in more detail below.

4.4.1 Aquatic Habitat

Tributary to Stoney Creek

Reach 1 is located from the culvert crossing under Green Mountain Road (downstream extent), to where the representative OSAP was completed (Map 2). This reach is approximately 250m in length and has been influenced in the past by agricultural practices. At the culvert the channel is wide and pooled, with no flow. The substrates are comprised of silt and muck, with an abundance of Lesser Duckweed (*Lemna minor*), Pondweed species (*Potamogeton* sp.) and Cattails (*Typha* sp.), and a limited amount of Common Plantain (*Plantago major*). There was limited water at this location at the time of the assessment, with depths of 5 to 7cm. Upstream of the culvert the channel becomes defined as it traverses through a fairly straight and low-gradient reach. Some sections of the channel were dry and completely lined with Cattails. Muskrat trails were present and provided the main route for water to travel. Upstream of the Cattail lined area, the channel is channelized, with a uniform depth and width. Other than the pool at the culvert, no pools or riffles were identified within this reach. The average wetted width was 1.4m (larger at the culvert) and the average bankfull was 2.1m during the July assessment. During the June visit, the tributary had more water present, but limited flow. During the September field visit, a pool of water was present at the culvert with additional pockets of water (≤4cm depth) with no flow or connectivity within the remaining reach. There was also no water present downstream of the culvert.

The vegetation adjacent to the watercourse was limited in sections where the swamp thicket narrows and where row crop agriculture had previously tilled in close proximity to the watercourse. The banks are fairly stable with only localized erosion. Fish were observed throughout the reach during the July visit, and within the pockets of water during the September visit. An abundance of aquatic snails was also noted during the assessments.

Reach 2 is the representative OSAP site chosen and is shown on Map 2. 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 but a crossover was located at the top end of the reach, so a representative 40m reach was chosen. The average active channel width during the June assessment was 2.14m with depths ranging from 2.5 to 23cm. There was very limited flow with 0mm hydraulic head present. During the September site visit, only pockets of water or no water was present within the reach. Substrates were primarily silt with fine clay and minimal sand. In-stream cover was provided through woody debris and detritus. In-stream vegetation was consistent with Reach 1, although was not as prominent. The dominant vegetation community was swamp thicket on both banks, which provides good shading to the reach. Fish were observed within the channel during the July visit, and within the pockets of water during the September visit.

Reach 3 represents the feature upstream of the OSAP reach, to the edge of the subject property. Upstream of the OSAP reach, the channel is primarily the same with similar substrates, and uniform width and depth. During the July assessment there was minimal diffuse flow throughout this reach, and the reach was dry in September. Fish were not observed throughout this section during either site assessment.

Tributary 1

Tributary 1 is an ephemeral feature that was assessed on multiple occasions from its confluence with the main tributary to the subject property boundary, and at the Fifth Road crossing. This feature has been influenced by agricultural practices and conveys surface runoff from the fields during heavy rain/melt events. The channel is defined although there is limited substrate sorting, and it loses definition towards the Green Mountain Road East crossing. During the June site assessment there were a few pockets of water and the substrate was saturated. No flow or connection with the main tributary was observed. During the remaining two site assessments in July and September, there was no evidence of water, with the soils being cracked within the channel. Terrestrial grasses were also growing within the channel. No fish were observed within this channel.

Tributary 2

Tributary 2, as shown on Map 2, is an ephemeral feature that has been channelized from agricultural practices. Within the background mapping it indicates that there are two features that connect with the main tributary along the northwest side of the subject property. The one feature did not exist, and instead had been rerouted to a dug ditch along the property line and into a meadow feature. It connects to the main tributary approximately 10m up from the Green Mountain Road East culvert. This feature conveys surface flow from the agricultural fields and neighbouring property, including the outlet of a man-made pond feature. The channel was defined with evidence of high flow causing erosion within the channel. A patch of Common Reed is present along the property edge near where the pond will outlet. Limited water was present during all the assessments, with no fish observed.

4.5 Fish Community

The fish community was assessed in the Tributary of Stoney Creek on the subject property at station EMS-001 (Map 2). The reach was electrofished from the culvert crossing at Green Mountain Road, up to the property boundary. All available habitats were electrofished.

A complete list of species reported in background information sources and species observed in 2019 by NRSI is provided in Appendix VIII.

Six species of fish were captured within EMS-001. A total of 44 Brook Stickleback (*Culaea inconstans*), 2 Fathead Minnow (*Pimephales promelas*), 7 Central Mudminnow (*Umbra lima*), 6 Northern Pearl Dace, (*Margariscus nachtriebi*), 1 Northern Redbelly Dace (*Chrosomus eos*), and 1 Pumpkinseed (*Lepomis gibbosus*) were captured through the single pass backpack electrofishing. During the electrofishing, there were portions of the reach that could not be shocked due to a lack of water. At the time of the second aquatic habitat assessment in September, only pockets of water were present, with no flow or connection. Fish were observed within these pockets during the second assessment.

The species known from within this tributary are all considered native and common. They also make up a combination of highly tolerant and moderately tolerant species. None of the fish species known from within the Tributary to Stoney Creek and the subject property are considered to be SAR. The background review did not reveal the presence of any SAR fish or mussel species (DFO 2019).

5.0 Significance and Sensitivity of Natural Features

5.1 Watercourse and Fish Habitat

The portion of Stoney Creek which crosses the subject property is considered fish habitat and is identified as a Key Hydrologic Feature Stream (City of Hamilton 2018). Fish were found within this feature during the electrofishing, indicating that it provides direct habitat for at least a portion of the year. The additional aquatic features on site (Tributary 1 and 2) may still be considered fish habitat under the *Fisheries Act* (Government of Canada 2019b) as they would provide indirect habitat through directing 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. As per these guidelines, the fish habitat would be considered marginal for the intermittent features.

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 then 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. Through this process it was identified that the project should be sent for further review to the fisheries protection program at DFO.

5.2 Wetlands

The subject property contains a complex of marsh and swamp thicket along the watercourse and extending beyond the property to the north and south (Map 2). These unevaluated features are part of the Natural Heritage System (Core Area) (City of Hamilton 2018). The hydrology of these features is dependent upon the hydrologic regime of the watercourse which receives headwater flow from the south in the vicinity of Tapleytown. Any sizable reduction in the surface water input to wetlands below the berm may induce drier conditions at the perimeter of these features. These wetlands will still receive large seasonal flows from the upstream catchment that will maintain their wetland form.

In general, the wetlands are typical of low-lying riparian features on silty-clay soils in the Hamilton and Niagara area. Plant species diversity is low to moderate with no species having a high Coefficient of Conservatism (CC) value (i.e. species with a high fidelity to intact, high quality habitats). The predominance of European Buckthorn along the watercourse limits the vegetation diversity but does provide a corridor of natural cover to aid in wildlife refuge and movement. The sparse tree cover, dominated by fast-growing Crack Willow with some mid-age American Elm and Bur Oak indicates that the woody riparian vegetation has established relatively recently and the watercourse vegetation was very likely cleared historically.

The construction of the berm is likely to result in a larger area of wetland as a greater depth of surface water will be held on site for a longer period than the current conditions. Additionally, the design incorporates the creation of several wetland features within the retention area where upland row crop agriculture currently exists.

The wetland within the study area is unevaluated. The nearest evaluated wetland complex is the Vinemount Swamp PSW which is approximately 750m northeast of the subject property (and occurs within the Stoney Creek watershed). As surveys did not document SAR presence within the subject property, and given the distance from other PSWs to consider wetland complexing, it is unlikely that the wetland on site warrants PSW designation.

The marsh and swamp thicket features within the subject property have been identified as candidate SWH for Amphibian Breeding (Wetland), candidate Amphibian Movement Corridor and candidate habitat for terrestrial crayfish habitat. The observation of a Monarch caterpillar feeding on Swamp Milkweed was made within the marsh to the south of Green Mountain Road East; however, this report has not identified the habitat as significant for this species. These SWH types are discussed further in Section 5.4.

5.3 Woodlands

A large portion of the vegetated corridor is identified on Map 1 as a Key Natural Heritage Feature Significant Woodland and is part of the Natural Heritage System (Core Area) (City of Hamilton 2018). ELC surveys in 2019 found this feature to be comprised predominantly of non-native European Buckthorn with patchy and limited tree canopy. The tree and shrub cover along the watercourse serve to cool water temperatures and reduce erosion and sediment deposition. The cover of European Buckthorn, as well as Reed Canary Grass and Broad-leaved Cattail within the channel, is very tolerant of grading disturbance and fluctuations in hydrology and this feature would quickly adapt to alterations in site hydrology.

Although it would appear that the feature does not constitute a woodland, based on the limited tree cover and discontinuous canopy, this designation is supported as there is high potential for the enhancement of this feature. Following site restoration, it is anticipated that this feature will continue to provide valuable services including water quality improvement and wildlife habitat.

5.4 Significant Wildlife Habitat

Based on background information review, desktop analysis and field studies completed in 2019, 3 SWH types were determined to be candidate for the study area with no habitat types confirmed.

5.4.1 Specialized Wildlife Habitat

Amphibian Breeding Habitat (Wetland)

Due to the timing of surveys, April and May calling anuran data was unavailable for the assessment of this SWH type. In order to be considered significant, the Significant Wildlife Habitat Criterion Schedule for Ecoregion 7E (MNRF 2015) requires the presence of:

> "*…2 or more of the listed frog or toad species and with at least 20 breeding individuals… or 2 or more of the listed frog/toad species with Call Level of 3, or wetland with confirmed breeding Bullfrogs*".

It is possible that the threshold of diversity and abundance is present, in particular within the southern area of marsh extending toward Tapleytown which is approximately 2.5ha in size. The complex of smaller marsh and swamp thicket communities near Green Mountain Road East contain large amounts of European Buckthorn or are limited in size to fulfill the criteria but would act as supporting habitat were the SWH type confirmed to be present in the southern portion of the study area.

The retention of a large area of marsh to the south of the property will act as a refuge for amphibian populations and breeding during and immediately following the construction within the subject property. It is anticipated that suitable habitat can be restored and enhanced over the course of several years following the berm installation and wetland habitat creation.

Amphibian Movement Corridors

The Significant Wildlife Habitat Criterion Schedule for Ecoregion 7E (MNRF 2015) notes that movement corridors for amphibians moving from their terrestrial habitat to breeding habitat can be extremely important for local populations. This SWH type depends on the confirmation of SWH for Amphibian Breeding habitat (Wetland), as described above. Although the SWH type remains candidate, the site will undoubtedly benefit wildlife movement on the landscape.

An assessment of air photography in the vicinity of the subject property indicates that the corridor of natural vegetation may play an important role in wildlife movement through the headwaters of Stoney Creek and toward the Vinemount Swamp PSW to the northeast. Lands to the south of Tapleytown are largely agricultural and are limited in hedgerows, watercourses and forest parcels that would allow for a natural corridor connecting with Twenty Mile Creek which is approximately 5km south of the property. Although the corridor plays an important role in connecting wetland habitat within the study area, the impacts associated with the temporary disturbance can be mitigated through restoration and enhancement of the property.

5.4.2 Habitat for Species of Conservation Concern

Terrestrial Crayfish Habitat

The marsh and swamp thicket habitats along the watercourse and tributaries were identified as candidate habitat for terrestrial crayfish. A formal assessment of crayfish presence or absence was not conducted; however, no crayfish were observed incidentally during the 2019 surveys. This habitat type will be enhanced through the naturalization of wetland and riparian habitat above the berm which will in turn create additional suitable habitat for crayfish.

5.5 Habitat of Species at Risk

Suitable habitat for SAR bat roosting and foraging is limited within the subject property. Bat acoustic survey data suggests that bat calls recorded within the subject property are likely (although not certainly) attributed to Eastern Red Bat and not SAR *Myotis* species.

Based on the number and timing of recorded sequences, these bats are likely using habitats within the vicinity of the monitoring station for foraging or as a movement or travel corridor between key habitats. The swamp (SWT2-13) and marsh (MAM2) communities along the watercourse corridor are considered candidate foraging and movement/travel corridor habitat for bat species. Foraging, movement or travel corridor habitats are considered the least sensitive to alteration as opposed to maternal roost features (MNRF 2012). This report assumes that

SAR bats and their regulated habitat (roosting features) are not present and naturalization of the property will result in enhanced habitat which may support SAR bats once vegetation cover has established.

6.0 Impact Analysis

Potential impacts arising from the proposed development are determined by comparing the details of the proposed development with the characteristics of the existing natural features and their functions, as shown on Map 3. Where the berm creation works overlap with natural features or their vegetation protection zones, impacts may arise. The following is a description of the types of impacts that are discussed (based on the preliminary design):

- 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.
- Induced and cumulative impacts associated with impacts after the berm creation is complete 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 development area is provided in Table 8.

Table 8. Summary of Significant 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 2019b) • *Fish and Wildlife Conservation Act* (Government of Ontario 1997)	**Direct Impacts** • The berm construction and wetland creation will directly impact Stoney Creek as well as Tributary 1 and 2 through altered flow regimes, removal of fish habitat and the creation of a barrier to fish passage. • 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 berm), as well as erosion and sedimentation, contamination, nutrient concentrations during construction. **Induced Impacts** • Potential for induced impacts to fish through the creation of the barrier.	• Creek naturalization should be a focus for restoration and should include the creation of meander and pools of varying depths. This mitigation aligns with the HCA objective to restore natural function to the watercourse. • The establishment of vegetation on the berm and within the created wetlands will enhance water quality and reduce water temperature, in time, through shading. • Tributary 1 has limited vegetation cover and the re-instated alignment should be a focus for restoration to reduce sediment transport. • The Pathways of Effects (PoE) outlined by DFO were reviewed, and the potential stressor and potential effect of 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 preliminary designs indicate that a Request for Review is required. • Monitoring of fish habitat and fish populations should occur post construction. • The wetland is expected to decrease less frequent storm event peaks and reduce erosion, and is expected to provide more consistent groundwater and baseflow throughout the year. • All berm construction and creek enhancement should be completed during dry conditions and within the in-water timing window (and outside of breeding bird window) – September through March, ideally.

Significant Natural Feature	Relevant Policies	Potential Impacts	Recommended Mitigation
			• Implement an Erosion and Sediment Control Plan as per the drawing provided by Water's Edge. • Develop a Spill Response Plan. • Equipment operation, refueling and maintenance in designated areas away from existing natural features. • Stabilization of soil stockpiles and berms using a nurse crop. Stockpile locations are indicated on the design drawings. • 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, hydrometeorological 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 berm will directly impact the unevaluated wetland feature in the vicinity of the Green Mountain Road East culvert and extending south (berm footprint and excavated retention area). • It is unclear at this time if culvert upgrades or road widening will be undertaken; each would likely result in a larger footprint that would result in the removal of a portion of natural wetland.	• In order to preserve the hydrology of riparian wetland below the berms, the control structure should maintain some amount of surface water flow to the extent possible. • The berm will result in a net increase in wetland area and native plantings or seeding will be completed to enhance the diversity of the created habitat. This aligns with the HCA objective of enhancing and enlarging the existing wetland areas and creating additional wetlands as well as improving flood attenuation capacity and reducing erosion downstream.

Significant Natural Feature	**Relevant Policies**	**Potential Impacts**	**Recommended Mitigation**
	- Provincial Policy Statement (MMAH 2014)	**Indirect Impacts** - Wetland outside of the subject property may be altered by the berm construction. Wetland upstream may become inundated or drawn down depending on the berm outlet elevation and total area excavated for retention. Wetland to the north of Green Mountain Road East may receive lower volume and less frequent surface water flow given that the berm is intended to hold water on the HCA property. - The Hydrogeological Assessment (Greer Galloway 2020) states that 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. - Potential for erosion and sedimentation to impact the wetland during construction. **Induced Impacts** - The potential for spread of the existing patches of Common Reed and European Buckthorn, or introduction of new non-native species.	- 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 a small number of trees and shrubs in the footprint of the berm. - Created wetland, as shown on the Water's Edge drawings, includes open water marsh or deeper vernal pool areas, meadow marsh. The planting of trees and shrubs will create areas of swamp or lowland forest once the plantings mature and canopy begins to form. The combination of habitats will enhance the value of the site to a wide range of wildlife. - The limit of grading will be protected with heavy duty ESC which will double as vegetation protection fence. The fence will be removed once soils are stable on site. - Implement an Erosion and Sediment Control Plan. - Develop a Spill Response Plan. - Equipment operation and maintenance should occur in designated areas away from existing natural features. - Stabilization of soil stockpiles 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.
Significant Woodland	- Rural Hamilton Official Plan (City of Hamilton 2018)	**Direct Impacts** - Berm construction may require the removal of trees along the watercourse to achieve the desired grading in the retention area above the berm. The RHOP indicates that	- To the extent possible, native trees and shrubs should be retained and incorporated into the design. - The removal of European Buckthorn (through grading or herbicide application, or a combination) is recommended.

Significant Natural Feature	Relevant Policies	Potential Impacts	Recommended Mitigation
	- Provincial Policy Statement (MMAH 2014)	the Significant Woodland does not extend to Green Mountain Road East, but ends roughly central in the subject property. 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 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 will be delineated with heavy duty ESC fence which will be maintained until the nurse crop has established. - Disturbance to wildlife during construction will be temporary and is not anticipated to be significant.
Significant Wildlife Habitat	- Provincial Policy Statement (MMAH 2014) - Rural Hamilton Official Plan (City of Hamilton 2018)	**Direct Impacts** - Direct impacts to candidate SWH may include removal of Amphibian Breeding Habitat (Wetland) and the associated amphibian movement corridor. Both features may be restored, but the quality of habitat may be compromised for a number of years until naturalization efforts become effective. **Indirect Impacts** - The creation of the berm may result in deeper or more prolonged inundation which is likely to benefit amphibians.	- In order to mitigate impacts to amphibian habitat, the retention area above the berm and the deeper wetland features will be naturalized to provide a variety of wetland habitat types (marsh, thicket, swamp). - While much of the property will comprise natural habitat in time, native species plantings, as indicated on the Water's Edge design drawings, focus on enhancing the corridor along the watercourse to facilitate wildlife movement in a north-south direction. - Should the culvert be replaced beneath Green Mountain Road East, consideration should be given to designs which facilitate terrestrial wildlife passage beneath the road to reduce road mortality potential.

Significant Natural Feature	**Relevant Policies**	**Potential Impacts**	**Recommended Mitigation**
		Induced impacts - Introduction or proliferation of non-native or invasive species may reduce the quality of habitat and in turn reduce the suitability for anuran breeding and movement.	- In order to prevent the spread of Common Reed or other non-native species, equipment is to 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.
Breeding Bird Window	- *Migratory Birds Convention Act* (Government of Canada 1994)	- Vegetation removal within the breeding bird season may result in incidental take of bird species protected under the MBCA.	- 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 the wetland habitats on site, where vegetation clearing is proposed within the breeding bird window, nest sweeps are not likely to be effective. If necessary, sweeps may be conducted within areas of fallow field; however, the presence of an active nest will delay works.

7.0 Restoration and Enhancement

The proposed works and the large proportion of fallow field within the subject property present numerous opportunities for the creation and enhancement of wetland and fish habitat on site. Habitat for wildlife within upland areas may also be improved, either as part of this undertaking or through future site stewardship initiatives. A planting plan has been included as part of the Water's Edge drawing package.

Re-planting of Berm

In order to soften the visual impact of the berm, nearly 2500 trees and shrubs will be planted within the created wetland in areas adjacent to the berm (within the berm area). Planting on the berm will be limited to the application of seed. In order to ensure the long-term stability of the berm, and given the potentially challenging growing conditions, tree and shrub plantings have been excluded from the berm itself. however, it is anticipated that Poplar trees (*Populus* spp.) and other species with wind-borne seeds will colonize the berm in time. A mixture of caliper trees and smaller potted stock will be used. Planting locations have considered factors such as;

- Soil moisture relative to the tolerance of a given species;
- The potential for snow throw damage from plows;
- The hydro wires along the road; 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. During site grading, topsoil and organics will be sorted and retained for top-dressing to facilitate the establishment of trees and shrubs following construction.

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. In addition, an appropriate native meadow seed mixture should be applied.

Stabilization of the soils can be achieved through the application of Alsike Clover and Bird's-foot Trefoil seeded at 10kg/ha. Both species being relatively benign to escaping and affecting natural habitat and are effective at providing the required soil stabilization. An annual nurse crop of Oats, Annual Ryegrass, White Millet (*Panicum miliaceum*) or Buckwheat (*Fagopyrum esculentum*) should also be seeded to provide early cover and stabilization that will dissipate in several years.

The low application rate of Alsike Clover and Bird's-foot Trefoil is intended to allow for the application and establishment of 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 area several types of wetland may be restored. This undertaking aligns with the HCA goal of enhancing the natural heritage components on site and the objective of enhancing and enlarging the wetland within the property. Deeper excavations with a clay lining are likely to retain standing water for much or all of the year and provide ideal habitat for anuran breeding. Areas of shallow excavation will establish as marsh or mud flat which dry out by late spring and may provide nesting habitat for waterfowl or foraging habitat for shorebirds. Some areas will be planted in trees extensively to establish a seed source on the property and to create a swamp component. A planting plan that incorporates these considerations has been prepared as part of the Water's Edge drawing package.

In order to prevent erosion and retain soil moisture, the entire graded area will be seeded with a 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), 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.

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.

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. *racemosa*)
- Red Osier Dogwood (*Cornus sericea*)
- Staghorn Sumac (*Rhus typhina*)
- Nannyberry (*Viburnum lentago*)
- Hawthorn (*Crataegus* spp.)

Tree protection measures may include the application of Skoot™ browse protectant to stems, the installation of tree coils or tree tubes, and the staking and tethering of caliper trees using biodegradable straps and wooden stakes to ensure long-term survival of the trees and limit waste material left on site.

In order to increase tree establishment, the planting of acorns and nuts 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 inclusion of upland ridges in the site grading and 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.

Channel Creation and Naturalization

As a section of Stoney Creek and its floodplain will be graded, the design recommends that a meandering channel of varying depths be recreated. The HCA has identified restoring the natural function of the watercourse as an objective of this undertaking. The application of erosion control measures within this area is strongly recommended and may include hydro-seeding or terra-seeding of a nurse crop and native seed mixture. The Erosion and Sediment Control drawing provided by Water's Edge indicates that silt fence will be installed around much of the perimeter of the property with coir log placement used in the southern extent where the watercourses direct flow north toward Green Mountain Road. To the extent possible, existing native trees, shrubs and herbaceous vegetation will be retained. Recommendations relating to channel naturalization are outlined in the previous section. Photographs of the existing site conditions are provided in Appendix X.

Invasive Species Management

Management of European Buckthorn within the property should be considered. Those sections of the watercourse which are retained will harbor the species and will act as a seed source for the shrub to proliferate into areas of bare soil and meadow. Graded topsoil from along the corridor which is stockpiled and re-distributed will likely contain a seed bank which will germinate once the soils are redistributed. It is recommended that HCA undertake or contract the application of herbicide to the thickets and regrowth of European Buckthorn. Untreated, a large portion of the site is likely to transition to low-diversity thicket dominated by this species which will limit the potential for the establishment of diverse natural habitats. In comparison to the BC-1 property, the stands on the SC-8 property are practical to manage with reduced potential for re-introduction as the site is limited in natural features and hedgerows where the species could recolonize from.

Similarly, stands of Common Reed along the western property boundary have the potential to spread and should be managed. At a minimum, areas of grading which occur where this species is present should dispose of the topsoil and root materials at a location where the species will not establish and spread further. Burying this material at a depth of several metres is ideal if on-site management with herbicides cannot be undertaken.

Reed Canary Grass is the dominant species in the meadow marsh communities along the existing watercourse. This species is likely the non-native European type and is likely to outcompete any herbaceous vegetation within the created wetland 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.

Following the installation of plantings and seeding at the site, HCA staff should monitor for the establishment of invasive species annually for several years and periodically thereafter.

Barn Swallow Habitat Enhancement

Observation of Barn Swallow foraging in 2019 suggests that the species utilizes the creek corridor and marsh 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 Green Mountain Road East 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 in the coming years. 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. The drawings produced by Water’s Edge indicate that the pond design will include both nesting features as well as logs and rocks that will provide basking habitat.

8.0 Summary

NRSI was retained by HCA in June 2019 to complete a Natural Heritage Characterization Report in support of the construction of a berm at the Saltfleet SC-8 property. The berm is intended to retain surface water on the property in order to alleviate flooding in the lower reach of Stoney Creek. The intent of this report is to identify and characterize the natural features within the subject property, identify potential impacts associated with the development, and recommend appropriate mitigation measures.

The subject property contains a section of Stoney Creek and an associated corridor of swamp thicket and marsh vegetation. In general, the feature provides a natural corridor for wildlife movement within the sub-watershed.

Regulated habitat for SAR is not present within the subject property; however, Barn Swallow were documented foraging within the site and are likely nesting nearby. Bat acoustic surveys identified a small number of calls in the 40 kHz species grouping which are likely attributed to Eastern Red Bat and not SAR. Surveys identified 2 candidate SWH types; Amphibian Breeding (wetland) and Amphibian Movement Corridor. Based on the proposed development footprint, both of these candidate habitat types would be impacted but these effects can be mitigated through restoration and enhancement.

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 should contact DFO for review.

Other direct impacts associated with this undertaking include grading and vegetation removal. The design of the berm will not require the removal of trees; however, grading within the retention area may require the removal of trees and shrubs along the watercourse (within the non-native thicket swamp SWT2-13 communities and area identified as Significant Woodland).

Recommended mitigation includes the naturalization of the berm, wetland features and within the retention area through plantings of native trees and shrubs and the application of meadow and wetland seed mixtures. Disturbed sections of the watercourse will also be naturalized with a focus on creating meanders and variable depths of the channel bed. Timing windows including the breeding bird window and completing grading works during the dry period are also recommended.

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 berm as well as disturbance to wildlife during construction. The area above the berm includes both fallow agricultural field and graminoid marsh. Both communities are seen as resilient and unlikely to be negatively affected by temporary inundation in the spring. The wetland and riparian habitat below the berm will likely encounter a decrease in surface water input; however, the design of the control structure and the retained catchment and tributary inputs will continue to direct flow to these habitats to maintain their form.

Induced impacts as a result of the proposed development may include the establishment or proliferation of non-native invasive species to the site during the completion of grading. In the absence of parking or trails, the site is not likely to see increases in human use. Any laneways which are installed may create issues with waste 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 berm and flow control structure 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.

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Appendix I

Species at Risk, Species of Conservation Concern and Significant Wildlife Habitat Screening

Species at Risk and Species of Conservation Concern Screening Table

Scientific Name	Common Name	S-RANK[1]	ESA/ COSSARO[2]	COSEWIC[3]	SARA[3]	Background Source	Habitat Preference[4,5,6,7, 8]	Suitable Habitats within Subject Property	Rationale	NRSI Observed
Birds										
Empidonax virescens	Acadian Flycatcher	S2S3B	END	E	Schedule 1	MNRF 2019b	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	Less than 30 ha of forest present on study site. Wooded region along water course, but not extensive enough.	No
Pelecanus erythrorhynchos	American White Pelican	S2B	THR	NAR		MNRF 2019b	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 >5.5 km from Lake Ontario, the nearest large open body of water.	No
Haliaeetus leucocephalus	Bald Eagle	S2N, S4B	SC	NAR		MNRF 2019b	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 >5.5 km from Lake Ontario, the nearest large open body of water.	No
Riparia riparia	Bank Swallow	S4B	THR	T		BSC et al. 2009, MNRF 2019b	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
Tyto alba	Barn Owl	S1	END	E	Schedule 1	MNRF 2019b	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 that may provide suitable nesting habitat. Meadow habiats within the study area may provide suitable foraging habitat.	No
Hirundo rustica	Barn Swallow	S4B	THR	T		BSC et al. 2009, MNRF 2019b	Farmlands or rural areas; cliffs, caves, rock niches; buildings or other man-made structures for nesting; open country near body of water	Yes	individuals were observed foraging above the site but no nests or suitable nesting habitat is present.	**Yes**
Chlidonias niger	Black Tern	S3B	SC	NAR		MNRF 2019b	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. Watercourse on study site does not provide adequate open water.	No
Dolichonyx oryzivorus	Bobolink	S4B	THR	T	No Schedule	BSC et al. 2009, MNRF 2019b	Large, open expansive grasslands with dense ground cover; hayfields, meadows or fallow fields; marshes; requires tracts of grassland >50 ha	No	Large tracts of grassland greater than 50 ha in size are not present within the study area (only small patches). The majority of open lands within the study area are actively farmed. However, suitable habitat may be in vicinity of study site.	No

Scientific Name	Common Name	S-RANK[1]	ESA/ COSSARO[2]	COSEWIC[3]	SARA[3]	Background Source	Habitat Preference[4,5,6,7, 8]	Suitable Habitats within Subject Property	Rationale	NRSI Observed
Cardellina canadensis	Canada Warbler	S4B	SC	T	Schedule 1	BSC et al. 2009, MNRF 2019b	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 shape of the forest patches within the study area there is not interior forest habitat.	No
Setophaga cerulea	Cerulean Warbler	S3B	THR	E	Schedule 1	MNRF 2019b	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 not large enough in size to meet requirements. Nearby Vinemount swamp may provide more suitable habitat.	No
Chaetura pelagica	Chimney Swift	S4B, S4N	THR	T	Schedule 1	BSC et al. 2009, MNRF 2019b	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 watercourses are present within the study area but are not likely to provide suitable foraging habitat due to their size and lack of open water.	No
Chordeiles minor	Common Nighthawk	S4B	SC	T	Schedule 1	MNRF 2019b	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.	No
Sturnella magna	Eastern Meadowlark	S4B	THR	T	No Schedule	BSC et al. 2009, MNRF 2018b	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	Open meadows and cultivated land >10 ha in size is present within the study area.	No
Caprimulgus vociferus	Eastern Whip-poor-will	S4B	THR	T	Schedule 1	MNRF 2019b	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 not adequate in size.	No
Contopus virens	Eastern Wood-Pewee	S4B	SC	SC		BSC et al. 2009, MNRF 2019b	Open, deciduous, mixed or coniferous forest; predominated by oak with little understory; forest clearings, edges; farm woodlots, parks	Yes	Deciduous or mixed forests are present within the study area, however their species composition is unknown. Forest clearings and edges are also present.	No
Vermivora chrysoptera	Golden-winged Warbler	S3B	SC	T	Schedule 1	MNRF 2019b	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	A shrubby, grassy area with small trees adjacent to a forest appears to be present from aerial interpretation within the study area.	No
Ammodramus savannarum	Grasshopper Sparrow	S4B	SC	SC		BSC et al. 2009, MNRF 2019b	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	A shrubby, grassy area with small trees is present within the study area.	No

Scientific Name	Common Name	S-RANK^{1}	ESA/ COSSARO^{2}	COSEWIC^{3}	SARA^{3}	Background Source	Habitat Preference$^{4,5,6,7, 8}$	Suitable Habitats within Subject Property	Rationale	NRSI Observed
Ammodramus henslowii	Henslow's Sparrow	SHB	END	E	Schedule 1	MNRF 2019b	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
Podiceps auritus	Horned Grebe	S1B, S4N	SC	SC	No Schedule	MNRF 2019b	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 marshes are present within the study area. Small watercourses present on study site, and unlikely to contain emergent vegetation.	No
Rallus elegans	King Rail	S2B	END	E	Schedule 1	MNRF 2019b	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
Ixobrychus exilis	Least Bittern	S4B	THR	T	Schedule 1	MNRF 2019b	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 2019b	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 and in conjunction with surrounding land equates to a large enough habitat. The most recent observation within the vicinity of the study area was in 1963 (eBird 2019).	No
Falco peregrinus anatum/tundrius	Peregrine Falcon	S3B	SC	SC	Schedule 1	MNRF 2019b	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
Charadrius melodus (ssp. circumcinctus)	Piping Plover	S1B	END	E	Schedule 1	MNRF 2019b	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
Protonotaria citrea	Prothonotary Warbler	S1B	END	E	Schedule 1	BSC et al. 2009, MNRF 2019b	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	Contiguous forest within study site not adequately large enough for requirements. No known swamps are present within the study area.	No
Calidris canutus rufa	Red Knot (*rufa* subspecies)		END	E	No Schedule	MNRF 2019b	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 >5.5 km from Lake Ontario and does not contain any beaches or sandy areas.	No
Melanerpes erythrocephalus	Red-headed Woodpecker	S4B	SC	T	Schedule 1	BSC et al. 2009, MNRF 2019b	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	Small deciduous woodlot along fields present on study site and may provide suitable nesting and foraging habitat.	No

Scientific Name	Common Name	S-RANK[1]	ESA/ COSSARO[2]	COSEWIC[3]	SARA[3]	Background Source	Habitat Preference[4,5,6,7, 8]	Suitable Habitats within Subject Property	Rationale	NRSI Observed
Phalaropus lobatus	Red-necked Phalarope	S3S4B	SC			MNRF 2019b	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 marshes are present within the study area.	No
Asio flammeus	Short-eared Owl	S2N, S4B	SC	SC	Schedule 3	BSC et al. 2009, MNRF 2019b	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
Hylocichla mustelina	Wood Thrush	S4B	SC	T		BSC et al. 2009, MNRF 2019b	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 forest along watercourse may provide moist enough conditions and contain mature trees within the study area.	No
Icteria virens	Yellow-breasted Chat	S2B	END	E	Schedule 1	MNRF 2019b	Thickets, tall tangles of shrubbery beside streams, ponds; overgrown bushy clearings with deciduous thickets; nests above ground in bush, vines etc.	Yes	A shrubby area with thickets alongside a stream is present within the study area.	No
Herpetofauna										
Emydoidea blandingii	Blanding's Turtle (Great Lakes/St Lawrence population)	S3	THR	T	Schedule 1	Ontario Nature 2018, MNRF 2019b	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.	No	Only waterbodies contained in study site are small streams likely lacking adequate aquatic vegetation.	No
Chelydra serpentina serpentina	Common Snapping Turtle	S2B	SC	SC	Schedule 1	Ontario Nature 2018, MNRF 2019b	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	Streams are present within the study area that may provide suitable habitat. Suitable nesting habitat may also be present.	No
Heterodon platirhinos	Eastern Hog-nosed Snake	S3	THR	T	Schedule 1	MNRF 2019b	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
Sternotherus odoratus	Eastern Musk Turtle	S3	SC	SC	Schedule 1	Ontario Nature 2018, MNRF 2019b	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	Shallow slow moving water of streams present within study site. Nesting habitat may be availble dependent on abundance of debris	No
Thamnophis sauritus septentrionalis	Eastern Ribbonsnake (Great Lakes population)	S3	SC	SC	Schedule 1	MNRF 2019b	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 shallow streams are present within the study area.	No

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Pantherophis spiloides pop. 2	Gray Ratsnake (*Carolinian population*)	S1	END	E	Schedule 1	MNRF 2019b	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	Shrubby open areas, deciduous forest, thickets and field edges are present within the study area.	No
Ambystoma jeffersonianum	Jefferson Salamander	S2	END	E	Schedule 1	Ontario Nature 2018, MNRF 2018b MNRF 2019b	Damp shady deciduous forest, swamps, moist pasture, lakeshores; temporary woodland pools for breeding; hides under leaf litter, stones or in decomposing logs	Yes	Moist deciduous forest that may provide suitable breeding habitat is present within the study area.	No
Ambystoma laterale - (2) jeffersonianum	Unisexual *Ambystoma* Jefferson dependent population	S2	END	E	No Schedule	MNRF 2019b	Damp shady deciduous forest, swamps, moist pasture, lakeshores; temporary woodland pools for breeding; hides under leaf litter, stones or in decomposing logs	Yes	Moist deciduous forest that may provide suitable breeding habitat is present within the study area.	No
Graptemys geographica	Northern Map Turtle	S3B	SC	SC	Schedule 1	MNRF 2019b	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
Apalone spinifera spinifera	Spiny Softshell	S3	THR	E	Schedule 1	MNRF 2019b	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
Crotalus horridus	Timber Rattlesnake	SX	EXP	XT		MNRF 2018b	The Timber rattlesnake was consciously eradicated from Ontario by people. This rattlesnake was found along the Niagara Escarpment, primarily in the Niagara area.	No	This species is extripated from the area.	No
Mammals										
Taxidea taxus jacksoni	American Badger (*jacksoni subspecies)*	S2	END	E	Schedule 1	MNRF 2019b	Open grasslands and oak savannahs; dens in new hole or enlarged existing hole; sometimes makes food caches	Yes	Open meadows are present within the study area.	No
Myotis leibii	Eastern Small-footed Myotis	S2S3	END			MNRF 2019b	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 United States of America, it feeds primarily in forests, but also over waterbodies, within riparian forests, and occasionally open fields.	Yes	Riparian forests and open fields suitable for foraging present within study area.	No
Urocyon cinereoargenteus	Gray Fox	S1	THR	T	Schedule 1	Dobbyn 1994, MNRF 2019b	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, wooded, brushy, woodland-farmland edges and old fields with thicket communities are present within the study area.	No
Myotis lucifungus	Little Brown Myotis	S5	END	E	Schedule 1	Dobbyn 1994, MNRF 2019b	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 may provide suitable roosting habitat. Forest edges within the study area may provide suitable foraging habitat.	No

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Myotis septentrionalis	Northern Myotis	S3	END	E	Schedule 1	MNRF 2019b	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 may provide suitable roosting habitat. Forests within the study area may provide suitable foraging habitat.	No
Perimyotis subflavus	Tri-colored Bat	S3?	END	E	Schedule 1	Dobbyn 1994, MNRF 2019b	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 within the study area may provide suitable roosting habitat. A possible forested stream within the study area may also provide suitable foraging habitat.	No
Microtus pinetorum	Woodland Vole		SC	SC	Schedule 1	Dobbyn 1994, MNRF 2019b	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
Insects										
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
Danaus plexippus	Monarch	S2N, S4B	SC	SC	Schedule 1	McNaughton et al. 2018, MNRF 2019b	Exist primarily wherever milkweed and wildflowers exist; abandoned farmland, along roadsides, and other open spaces	Yes	A small amount of Milkweed is present and adults and a larva were observed.	**Yes**
Erynnis martialis	Mottled Duskywing	S2	END	E		MNRF 2019b	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
Pieris virginiensis	West Virginia White	S3	SC	SC		MNRF 2019b	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	The presence of toothworts has not been confirmed within the study area but suitable habitat is present (harwood forest).	No
Fishes										
Anguilla rostrata	American Eel	S1?	END	T		MNRF 2019b	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
Moxostoma duquesnei	Black Redhorse	S2	THR	T	No Schedule	MNRF 2019b	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	A possible watercourse is present within the study area but is likely small in size.	No
Esox americanus vermiculatus	Grass Pickerel	S3	SC	SC	Schedule 1	MNRF 2019b	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 within Lake Ontario.	No
Acipenser fulvescens	Lake Sturgeon (GL-USL Pop.)	S2	THR			MNRF 2019b	Generally inhabits the bottoms of shallow areas of large freshwater lakes and rivers.	No	A possible watercourse is present within the study area but is likely very small in size.	No
Ichthyomyzon fossor	Northern Brook Lamprey (GL-USL Pop.)	S3	SC	SC	Schedule 1	MNRF 2019b	Generally inhabits small rivers and clear streams of varying sizes. Adults spawn in gravelly riffles.	Yes	A possible watercourse which is likely small in size is present within the study area.	No

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Clinostomus elongatus	Redside Dace	S2	END	E	Schedule 1	MNRF 2019b	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	Yes	A possible watercourse which is likely small in size is present within the study area.	No
Ichthyomyzon unicuspis	Silver Lamprey (GL-USL Pop.)	S3	SC	SC		MNRF 2019b	Clean stream beds of sand and organic debris for larvae to live in, and unrestricted migration routes for spawning.	No	The possible watercourse within the study area likely has some intermittent sections and does not provide direct access to Lake Ontario.	No
Notropis photogenis	Silver Shiner	S2S3	SC	SC	Schedule 3	MNRF 2019b	Silver shiners prefer moderate to large size streams with swift currents that are free of weeds and have clean gravel or boulder bottoms.	No	A possible watercourse is present within the study area but is likely very small in size.	No
Molluscs										
Ligumia nasuta	Eastern Pondmussel	S1	END	SC	Schedule 1	MNRF 2019b	Generally inhabit sheltered areas of lakes or slow streams in substrates of fine sand and mud.	Yes	A possible watercourse, which may provide suitable habitat, is present within the study area.	No
Toxolasma parvus	Lilliput	S1	THR	E		MNRF 2019b	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.	Yes	A possible watercourse, which may provide suitable habitat, is present within the study area.	No
Quadrula quadrula	Mapleleaf	S2	THR	SC	Schedule 1	MNRF 2019b	Generally found in medium to large rivers in firmly packed substrate.	No	A possible watercourse is present within the study area but is likely very small in size.	No
Villosa iris	Rainbow	S2S3	SC	E	Schedule 1	MNRF 2019b	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.	Yes	A possible watercourse, which may provide suitable habitat, is present within the study area.	No
Plants										
Castanea dentata	American Chestnut	S2	END	E	Schedule 1	Oldham and Brinker 2009, MNRF 2019b	Moist to well drained forests on sand, occasionally heavy soils	Yes	Moist forests are present within the study area.	No
Frasera caroliniensis	American Columbo	S2	END	E	Schedule 1	Oldham and Brinker 2009, MNRF 2019b	Woodlands on sandy and clay soils	Yes	Woodlands on silty, clay loam soils are present within the study area.	No
Trichophorum planifolium	Bashful Bulrush	S1	END	E	Schedule 1	Oldham and Brinker 2009, MNRF 2019b	Dry to moist woodlands, usually under oak	Yes	Moist woodlands 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
Carex bicknellii var. bicknellii	Bicknell's Sedge	S2				Oldham and Brinker 2009	Open prairie and open oak woods, usually dry	No	No prairie is present within the study area.	No
Cimicifuga racemosa	Black Cohosh	S2				Oldham and Brinker 2009	Open, rich, moist woods	Yes	Moist forests are present within the study area.	No
Nyssa sylvatica	Black Gum	S3				Oldham and Brinker 2009	Dry to wet woods and savannahs	Yes	Moist forests are present within the study area.	No
Salix myricoides	Blue-leaf Willow	S3				Oldham and Brinker 2009	Dunes	No	No dunes are present within the study area.	No
Botrychium oneidense	Blunt-lobed Grape Fern	S3?				Oldham and Brinker 2009	Open woods, sandy old fields	Yes	Open woods and old fields are present within the study area.	No

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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
Phegopteris hexagonoptera	Broadbeech Fern	S3	SC	SC	Schedule 3	Oldham and Brinker 2009, MNRF 2019b	Rich, moist soil in mature deciduous forests	Yes	Moist deciduous forests are present within the study area.	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
Juglans cinerea	Butternut	S2?	END	E	Schedule 1	Oldham and Brinker 2009, MNRF 2019b	Stream banks and swamps, as well as upland beech-maple, oak-hickory, and mixed hardwood stands	Yes	Stream present within study area which may provide suitable growing conditions within mixed hardwood stand.	No
Potentilla canadensis	Canada (Dwarf) Cinquefoil	S2?				Oldham and Brinker 2009	Dry to moist open savannas, apparently in sandy soils	No	Savannas or sandy soils are not 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
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
Betula lenta	Cherry Birch	S1	END	E	Schedule 1	MNRF 2019b	Woods	Yes	Woodlands are present within the study area	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
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
Ptelea trifoliata	Common Hop-tree	S3	SC	T	Schedule 1	Oldham and Brinker 2009, MNRF 2019b	Shorelines and other dry sites	No	No shorelines present within the study area.	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
Magnolia acuminata	Cucumber Tree	S2	END	E	Schedule 1	MNRF 2019b	Rich, partly open, moist to wet woods	Yes	Moist woods are present within the study area.	No
Silphium perfoliatum var. perfoliatum	Cup-plant	S2				Oldham and Brinker 2009	Riverbanks, flloodplains and moist fields; planted, escaped elsewhere	Yes	Moist fields 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
Aureolaria virginica	Downy Yellow False Foxglove	S1		END		Oldham and Brinker 2009	Dry, open, deciduous woods	Yes	Open, deciduous woods are present within the study area.	No
Cornus florida	Eastern Flowering Dogwood	S2?	END	E	Schedule 1	Oldham and Brinker 2009, MNRF 2018b, MNRF 2019b	Dry (usually oak) to rich deciduous forests, especially on hillsides and river banks	Yes	Deciduous forests 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	No coniferous woods or sandy soil present within the study area.	No
Carex oligocarpa	Few-fruited Sedge	S3				Oldham and Brinker 2009	Dry woods and banks, alvar woodland	No	No alvars present within the study area.	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
Vitis labrusca	Fox Grape	S1				Oldham and Brinker 2009	Woods	Yes	Woods 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

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Pterospora andromedea	Giant Bird's Nest	S2				Oldham and Brinker 2009	Conifer woods, under pine	No	No coniferous woods present within the study area.	No
Panax quinquefolius	Ginseng	S3	END	E	Schedule 1	Oldham and Brinker 2009, MNRF 2019b	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
Arisaema dracontium	Green Dragon	S3	SC	SC	Schedule 3	Oldham and Brinker 2009, MNRF 2019b	Wet bottomlands along rivers and creeks	Yes	A forested watercourse is present within the study area.	No
Hybanthus concolor	Green Violet	S2				Oldham and Brinker 2009	Rich, wet-mesic floodplain forests and mesic forests over limestone	No	No limestone is present within the study area.	No
Linum sulcatum	Grooved Yellow Flax	S3				Oldham and Brinker 2009	Prairies and dry, sandy open sites	No	Dry, open sandy sites are not present within the study area.	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	Dry, open, sandy prairies are not 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	A forested watercourse is 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
Pycnanthemum incanum var. incanum	Hoary Mountain-mint	S1	END	E	Schedule 1	Oldham and Brinker 2009, MNRF 2019b	Dry woodlands in partial shade of oaks and in openings	Yes	Woodlands are present within the study area	No
Lithospermum incisum	Incised Puccoon	S1				Oldham and Brinker 2009	Dune,savannah, sandy woods and dry ground	No	No dunes or sandy areas are present within the study area.	No
Gymnocladus dioicus	Kentucky Coffee-tree	S2	THR	T	Schedule 1	Oldham and Brinker 2009, MNRF 2019b	Floodplains, edges of marshes and shallow soil over limestone	No	No limestone is present within the study area.	No
Hymenoxys herbacea	Lakeside Daisy	S3	THR	T	Schedule 1	MNRF 2019b	Open limestone pavement	No	No limestone is 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	No	No ponds present, watercourse likely too shallow.	No
Amelanchier amabalis	Large-flowered Juneberry	S2S3				Oldham and Brinker 2009	Open rocky or sandy woods and edges	No	No rocky or sandy woods are present within the study area.	No
Saururus cernuus	Lizard's-tail	S3				Oldham and Brinker 2009	Shores and shallow water	No	No shorelines present within the study area.	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	No open sandy areas present within the study area.	No
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
Carex mesochorea	Midland Sedge	S1				Oldham and Brinker 2009	Dry, open woodland	Yes	Open woods 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	Sandy areas are not present within the study area.	No
Quercus ellipsoidalis	Northern Pin Oak	S3				Oldham and Brinker 2009	Open habitats or on edges of closed forests	Yes	Open habitats and forest edges are present within the study area.	No
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
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
Hieracium paniculatum	Panicled Hawkweed	S2?				Oldham and Brinker 2009	Dry open woods and sandy slopes	No	Sandy areas are not present within the study area.	No

Scientific Name	Common Name	S-RANK[1]	ESA/ COSSARO[2]	COSEWIC[3]	SARA[3]	Background Source	Habitat Preference[4,5,6,7, 8]	Suitable Habitats within Subject Property	Rationale	NRSI Observed
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
Uvularia perfoliata	Perfoliate Bellwort	S1				Oldham and Brinker 2009	Rich, mesic woodlands; dry oak-pine woods and thickets	Yes	Moist woodlands and thickets 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
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
Fraxinus profunda	Pumpkin Ash	S2?				Oldham and Brinker 2009	Moist woods	Yes	Moist woods 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
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	No rocky or sandy areas are present within the study area.	No
Aplectrum hyemale	Putty-root	S2				Oldham and Brinker 2009	Moist deciduous woods	Yes	Moist deciduous woods are present within the study area.	No
Morus rubra	Red Mulberry	S2	END	E	Schedule 1	Oldham and Brinker 2009, MNRF 2019b	Moist woods and wooded river valleys	Yes	Moist woods are present within the study area.	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
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
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
Eurybia schreberi	Schreber's Aster	S2S3				Oldham and Brinker 2009	Woods	Yes	Woods are present within the study area.	No
Cyperus schweinitzii	Schweinitz's Umbrella Sedge	S3				Oldham and Brinker 2009	Dry open sandy areas	No	No open sandy areas 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
Sphenopholis nitida	Slender Eaton's Grass	S1				Oldham and Brinker 2009	Rich deciduous forests	Yes	Deciduous forests 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
Aureolaria flava	Smooth Yellow False Foxglove	S2?				Oldham and Brinker 2009	Open oak woods	Yes	Open woods 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	No rocky areas or dunes are present within the study area.	No
Zizania aquatica var. aquatica	Southern Wild-rice	S3				Oldham and Brinker 2009	Wetlands, marshes	No	No marshes with open water are present within the study area.	No
Chimaphila maculata var. maculata	Spotted Wintergreen	S1	END	E	Schedule 1	Oldham and Brinker 2009, MNRF 2018b	Dry, sandy woods	No	No dry, sandy woods are present within the study area.	No
Dichanthelium dichotomum var. dichotomum	Spreading Panic Grass	S2				Oldham and Brinker 2009	Dry to mesic sandy or rocky deciduous forest	No	No rocky or sandy forests 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
Solidago rigida ssp. rigida	Stiff-leaved Goldenrod	S3				Oldham and Brinker 2009	Dry, sandy soil, prairies and waste places	No	No sandy areas are present within the study area.	No

Scientific Name	Common Name	S-RANK[1]	ESA/ COSSARO[2]	COSEWIC[3]	SARA[3]	Background Source	Habitat Preference[4,5,6,7, 8]	Suitable Habitats within Subject Property	Rationale	NRSI Observed
Eupatorium altissimum	Tall Joe-pyeweed	S1				Oldham and Brinker 2009	Alvars, open woodlands and savannah, adventive along railways and roadsides	No	No alvars 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
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	Yes	Wet shores at edge of streams 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
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
Lycopus virginicus	Virginia Water-horehound	S3				Oldham and Brinker 2009	Wet ground	Yes	Wet ground is present within the study area.	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	Streams present within study area may be slow flowing enough to support growth.	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
Eurybia divaricata	White Wood Aster	S2	THR	T	Schedule 1	Oldham and Brinker 2009, MNRF 2019b	Mesic to dry deciduous woods	Yes	Deciduous woods are present within the study area.	No
Baptisia tinctoria	Wild Indigo	S2				Oldham and Brinker 2009	Prairies, roadsides and sandy open woods	Yes	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
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
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

[1]MNRF2019a, [2]MNRF 2018a, [3]Government of Canada 2019a, [4]MNRF 2000, [5]MNRF 2019b, [6]Oldham and Brinker 2009, [7]Reznicek et al. 2011, [8]Riley 1989

Saltfleet CA Wetland Design (SC-8) Significant Wildlife Habitat Assessment Tables

Table 1. Characteristics of Seasonal Concentration Areas for Ecoregion 7E.

		Candidate SWH		Confirmed SWH	Study Area
	Wildlife Species[1]	**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[í] 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.	CUM1 and CUT1 habitats were confirmed to be absent from the subject property during the vegetation community mapping. Sheet water was not observed within the agricultural fields. None of the target species have been observed within the study area or vicinity (BSC et al. 2009, NHIC 2018b, MNRF 2019b). **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[í] or more of listed species for 7 days[í], 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 mapping confirmed the absence of the vegetation types required to provide suitable waterfowl stopover and staging areas. Canada Goose is known from the study area and vicinity (BSC et al. 2009); however, none were observed during the breeding bird surveys or incidentally during surveys conducted in 2019 (BSC et al. 2009). **Not SWH**

Table 1. Characteristics of Seasonal Concentration Areas for Ecoregion 7E.

		Candidate SWH		Confirmed SWH	Study Area
	Wildlife Species[1]	**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[í] 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[í] 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 mapping confirmed the presence of MAM2 along the west side of the subject property; however, these communities are very small in size and provide marginal habitat. No large shorelines are present within the study area. Spotted Sandpiper is known from the study area and vicinity (BSC et al. 2009) and was also observed within the SWT2-13 community during the breeding bird surveys. Individuals observed were showing agitated behaviour so may have been utilizing the area for nesting and foraging; however, not suitable migratory stopover habitat. **Not SWH**

Table 1. Characteristics of Seasonal Concentration Areas for Ecoregion 7E.

		Candidate SWH		**Confirmed SWH**	**Study Area**
	Wildlife Species[1]	**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 mapping did not identify a combination of forest, fields and upland habitats that are required. Suitable Bald Eagle habitat is not present as the study area is located >5.5 km from Lake Ontario, the nearest shoreline. Red-tailed Hawk, Northern Harrier, Short-eared Owl and American Kestrel are known from the study area or vicinity (BSC et al. 2009). Bald Eagle has the potential of occuring within Hamilton Region (MNRF 2019b). No raptor species were observed during the 2019 field surveys. **Not SWH**

Table 1. Characteristics of Seasonal Concentration Areas for Ecoregion 7E.

		Candidate SWH		**Confirmed SWH**	**Study Area**
	Wildlife Species[1]	**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[í]. • The area includes 200m radius around the entrance of the hibernaculum[cxlviii, ccvii, í]. 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). **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[í] • >5 Adult Female Silver-haired Bats[í] • The area of the habitat includes the entire woodland or the forest stand ELC Ecosite containing the maternity colonies[í]. • 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 mapping confirmed the absence of FOD, FOM, SWD and SWM communities. There are no man-made structires within the subject property. Big Brown Bat and Silver-haired Bat have been observed within the study area or vicinity (Dobbyn 1994). Targeted bat surveys identified Big Brown Bats, suggesting that they are roosting nearby. There are several suitable man-made structures and forest features within close vicinity of the subject property that are likely providing roosting habitat. **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: 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[i]. • One or more Northern Map Turtle or Snapping Turtle over-wintering within a wetland is significant[i]. • 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 mapping identified SWT habitat through the central portion of the subject property; however, water levels within the creek are not likely deep enough not to freeze during the winter months. 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 are known from the study area and vicinity (Ontario Nature 2018). Northern Map Turtle has the potential to occur within Hamilton Region (MNRF 2019b). **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)[í]. • 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[í]. • 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 are known from the study area and vicinity (Ontario Nature 2018). Eastern Ribbonsnake has the potential to occur within Hamilton Region (MNRF 2019b). 1 Eastern Gartersnake was observed during the 2019 field surveys. Foraging habitat is likely present in the SWT2-13 communities and fallow fields; however, no suitable hibernaculum features or congregations of snakes were not observed. **Not SWH**

Table 1. Characteristics of Seasonal Concentration Areas for Ecoregion 7E.

		Candidate SWH		Confirmed SWH	Study Area
	Wildlife Species[1]	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 communitymapping confirmed the absence of the required ecosites. No eroding banks, sandy hills, borrow pits, steep slopes, sand piles, cliff faces or suitable man-made structures are present within the subject property. Northern Rough-winged Swallow is known from the study area and vicinity (BSC et al. 2009); however, no Cliff Swallows or Northern-Rough-winged Swallows were observed during the targeted breeding bird 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: 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 mapping confirmed the absence of swamp and fen habitat types. Wetlands, lakes, and other significant water features are not found in study area. No heron or egret species were observed during the breeding bird surveys, or incidentally during other on-site 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: Colonially - Nesting Bird Breeding Habitat (Ground)					
<u>Rationale:</u> 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. <u>Information Sources</u> • 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 is known from the study area and vicinity (BSC et al. 2009). Large numbers of Ring-billed Gull were observed foraging in the agricultural fields outside of the subject property and flying overhead during the breeding bird surveys; however, suitable colonial nesting habitat is not present. **Not SWH**

Table 1. Characteristics of Seasonal Concentration Areas for Ecoregion 7E.

		Candidate SWH		**Confirmed SWH**	**Study Area**
	Wildlife Species[1]	**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[í]. • SWHMIST[cxlix] Index #16 provides development effects and mitigation measures.	Vegetation community mapping confirmed the absence of the required ELC community series. The study area is approximately 5.5 km from Lake Ontario. Painted Lady, Red Admiral and Monarch are known from the study area and vicinity (MacNaughton et al. 2018). Painted Lady was observed nectaring within the SWT community and Monarch caterpillars were observed on Common Milkweed plants along the perimeter of the SWT community. **Not SWH**

Table 1. Characteristics of Seasonal Concentration Areas for Ecoregion 7E.

		Candidate SWH		Confirmed SWH	Study Area
	Wildlife Species[1]	**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 confirmed the absence of the required ELC ecosites. Several migratory songbirds are known from the study area and vicinity (BSC et al. 2009). Targeted migratory bird surveys were not conducted as site is >5km from Lake Ontario. **Not SWH**

Table 1. Characteristics of Seasonal Concentration Areas for Ecoregion 7E.

		Candidate SWH		Confirmed SWH	Study Area
	Wildlife Species[1]	**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[i]. • 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[i]. 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[i]. • 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 confirmed the absence of the required ELC ecosites. No Deer Wintering Areas have been mapped by the MNRF in the study area. **Not SWH**

Saltfleet CA Wetland Design (SC-8) Significant Wildlife Habitat Assessment Tables

Table 2. Characteristics of Rare Vegetation Communities for Ecoregion 7E.

	Candidate SWH			**Confirmed SWH**	**Study Area**
Rare Vegetation Community[1]	**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.	None of the listed ELC communities were identified to be present during the 2019 surveys. **Not SWH**
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)[ĺ]. • SWHMIST[cxlix] Index #20 provides development effects and mitigation measures.	None of the listed ELC communities were identified to be present during the 2019 surveys. **Not SWH**

Table 2. Characteristics of Rare Vegetation Communities for Ecoregion 7E.

	Candidate SWH			Confirmed SWH	Study Area
Rare Vegetation Community[1]	**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.	None of the listed ELC communities were identified to be present during the 2019 surveys. **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 aerial imagery interpretation and knowledge of the study area, Old Growth Forest is not present. **Not SWH**
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.	None of the listed ELC communities were identified to be present during the 2019 surveys. **Not SWH**

Table 2. Characteristics of Rare Vegetation Communities for Ecoregion 7E.

	Candidate SWH			Confirmed SWH	Study Area
Rare Vegetation Community[1]	**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[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 • 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[i]. 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.	None of the listed ELC communities were identified to be present during the 2019 surveys. **Not SWH**
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 were identified during the 2019 field surveys. **Not SWH**

Saltfleet CA Wetland Design (SC-8) Significant Wildlife Habitat Assessment Tables

Table 3. Characteristics of Specialized Wildlife Habitat for Ecoregion 7E.

		Candidate SWH		**Confirmed SWH**	**Study Area**
	Wildlife Species[1]	**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[i], or, • Presence of 10 or more nesting pairs for listed species including Mallards[i]. • 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 mapping did not identify suitable upland habitats adjacent to the SWT2 community that runs through the central portion of the subject property. Wood Duck and Mallard are known from the study area and vicinity (BSC et al. 2009). None of the listed waterfowl were observed during the focus breeding bird surveys, or incidentally during the other 2019 surveys. **Not SWH**

Table 3. Characteristics of Specialized Wildlife Habitat for Ecoregion 7E.

		Candidate SWH		Confirmed SWH	Study Area
	Wildlife Species[1]	**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 mapping confirmed the absence of the ELC community series required. None of the targeted species are known from the study area or vicinity (BSC et al. 2009) and none were observed during the 2019 field surveys. Bald Eagle has the potential to occur within Hamilton Region (MNRF 2019b). **Not SWH**

Table 3. Characteristics of Specialized Wildlife Habitat for Ecoregion 7E.

		Candidate SWH		Confirmed SWH	Study Area
	Wildlife Species[1]	**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 confirmed the absence of any firested habitats within the subject property. Cooper's Hawk and Sharp-shinned Hawk are known from the study area and vicinity (BSC et al. 2009); however, none of the targe species were observed during the 2019 field surveys. **Not SWH**
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.	Some exposed soils were identified to be present adjacent to the SWT community that makes up the central portion of the subject property. Midland Painted Turtle and Snapping Turtle are known from the study area and vicinity (Ontario Nature 2018). Northern Map Turtle has the potential to occur within Hamilton Region (MNRF 2019b). No turtles were observed during the focused turtle nesting habitat surveys, or incidentally during other field surveys. While no nesting activity was observed, the SWT2-13 vegetated corridor may provide suitable refuge or foraging habitat for turtles. **Not SWH**

Table 3. Characteristics of Specialized Wildlife Habitat for Ecoregion 7E.

		Candidate SWH		**Confirmed SWH**	**Study Area**
	Wildlife Species[1]	**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[i] 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.	No seeps or springs were observed within the subject property during the 2019 field surveys and vegetation community mapping confirmed the absence of forested habitats. Wild Turkey, White-tailed Deer and Salamander spp. are known from the study area and vicinity (BSC et al. 2009, Dobbyn 1994, Ontario Nature 2018). Signs of White-tailed Deer were observed; however, it is likely that they are utilizing the central corridor and fallow agricultural fields for foraging. **Not SWH**
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 mapping confirmed the absence of forest or swamp communities within the subject property. Eastern Newt, Blue-spotted Salamander, Gray Treefrog, Spring Peeper and Wood Frog are known from the study area and vicinity (Ontario Nature 2018). Gray Treefrogs were heard calling from in the MAM and SWT communities during the anuran call surveys. **Not SWH**

Table 3. Characteristics of Specialized Wildlife Habitat for Ecoregion 7E.

		Candidate SWH		**Confirmed SWH**	**Study Area**
	Wildlife Species[1]	**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 >500m² (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 1 or 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[í]. • 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 mapping identified SWT2-13 along the central portion of the subject property and very small MAM communities along the western boundary. Eastern Newt, American Toad, Blue-spotted Salamander, Gray Treefrog, Northern Leopard Frog, Green Frog and Bullfrog are known from the study aea and vicinity (Ontario Nature 2018). The project did not commence until June 2019, therefore only 1 anuran call survey was conducted. Gray Treefrogs and Green Frogs were heard calling at a Call Level of 1 at all 3 stations. The SWT and MAM vegetation communities may be considered Candidate SWH despite the lower number of calling anurans heard in June. 2019 surveys documented Gray Treefrog and Northern Green Frog within the study area. Surveys were limited to June and therefore the habitat type cannot be confirmed. **Candidate SWH**
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[í]. • Note: any site with breeding Cerulean Warblers or Canada Warbler is to be considered SWH[í]. • 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 mapping confirmed the absence of the required ELC ecosites within the subject property. Red-breasted Nuthatch, Veery, Ovenbird, Scarlet Tanager, Winter Wren and Canada Warbler are known from the study area and vicinity (BSC et al. 2009). Cerulean Warbler has the potential to occur within Hamilton Region (MNRF 2019b). None of the target bird species were observed during the focused breeding bird surveys, or incidentally during other surveys and no interior woodland habitat is present. **Not SWH**

Saltfleet CA Wetland Design (SC-8) Significant Wildlife Habitat Assessment Tables

Table 4. Characteristics of Habitat for Species of Conservation Concern for Ecoregion 7E.

		Candidate SWH		**Confirmed SWH**	**Study Area**
	Wildlife Species[1]	**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[í]. • Note: any wetland with breeding of 1 or more Trumpeter Swans, Black Terns, Green Heron or Yellow Rail is SWH[í]. • 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 mapping identified both MAM2 and SWT2 habitats within the subject property. Very little open water or emergent vegetation are present within these communities. Virginia Rail, Sora, Marsh Wren, Sedge Wren and Green Heron are known from the study area and vicinity (BSC et al. 2009). Black Tern has the potential to occur within Hamilton Region (MNRF 2019b). None of the target species were observed during the focused breeding bird surveys, or incidentially during the 2019 field surveys. **Not SWH**
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)[í]. 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[í]. • 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 mapping confirmed the absence of CUM habitat within the subject property. It appears that the fallow fields have only been left inactive for a short amount of time. All of the target species are known from the study area and vicinity (BSC et al. 2009). Savannah Sparrow was heard singing from the active agricultural fields beyond the subject property boundary. **Not SWH**

Table 4. Characteristics of Habitat for Species of Conservation Concern for Ecoregion 7E.

		Candidate SWH		**Confirmed SWH**	**Study Area**
	Wildlife Species[1]	**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)[í]. Shrub thicket habitats (>10 ha) are most likely to support and sustain a diversity of these species[clxxiii]. 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[í]. • A field with breeding Yellow-breasted Chat or Golden-winged Warbler is to be considered as Significant Wildlife Habitat[í]. • 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 mapping confirmed the absence of the required ELC communities; however, the central vegetated corridor is comprised of shrub thicket swamp. Brown Thrasher, Field Sparrow, Black-billed Cuckoo, Eastern Towhee and Willow Flycatcher are known from the study area and vicinity (BSC et al. 2009). Yellow-breasted Chat and Golden-winged Warbler have the potential to occur within Hamilton Region (MNRF 2019b). Only 1 indictor species; Brown Thrasher and 1 common species; Willow Flycatcher were observed during the breeding bird surveys within the central SWT2 corridor. While some breeding evidence was observed, the area does not meet the criteria for significance. **Not 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 mapping identified MAM2 and SWT2 communities within the subject property. While no terrestrial crayfish or their chimneys were observed, these community may provide suitable habitat. **Candidate 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 needs 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. Monarch butterfly was observed in the marsh (2 adults and a caterpillar). Given the low numbers and limited habitat, this report does not identify SWh for this species. **Not SWH**

Table 5. Characteristics of Animal Movement Corridors for Ecoregion 7E.

		Candidate SWH		Confirmed SWH	Study Area
	Wildlife Species[1]	**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[í]. 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.	While amphibian movement was not specifically observed and vegetation is predominantly non-native, the SWT2 community associated with the central portion of the subject property and watercourse provides a candidate movement corridor. The small culvert in the northeast extent of the subject property may allow for amphibian movement to the vegetated habitats north of Green Mountain Road E. 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). 2019 surveys documented Gray Treefrog and Northern Green Frog within the study area. **Candidate SWH**

Appendix II
Vascular Plant Species Reported from the Study Area

Vascular Plant Species Reported From the Study Area

										NRSI Observations			
Scientific Name	**Common Name**	**CC**	**CW**	**Weed**	**SRANK[1]**	**SARO[2]**	**COSEWIC[3]**	**HRCA NAI[4]**	**NHIC[1]**	**Fallow Field**	**MAM2-2**	**SWT2-13**	**Hedgerow**
Gymnosperms	**Conifers**												
Cupressaceae	**Cypress Family**												
Juniperus virginiana	Red Cedar	4	3		S5								X
Dicotyledons	**Dicots**												
Aceraceae	**Maple Family**												
Acer negundo	Manitoba Maple	0	-2		S5			X				X	
Anacardiaceae	**Sumac or Cashew Family**												
Rhus typhina	Staghorn Sumac	1	5		S5			X					X
Apiaceae	**Carrot or Parsley Family**												
Cicuta maculata	Spotted Water-hemlock	6	-5		S5			X		X			
Daucus carota	Wild Carrot		5	-2	SE5			I			X	X	X
Asclepiadaceae	**Milkweed Family**												
Asclepias syriaca	Common Milkweed	0	5		S5			X			X	X	
Asteraceae	**Composite or Aster Family**												
Ambrosia artemisiifolia	Common Ragweed	0	3		S5			X		X	X		
Arctium minus	Common Burdock		5	-2	SE5			I		X	X		
Bidens frondosa	Devil's Beggar-ticks	3	-3		S5			X			X		
Cichorium intybus	Chicory		5	-1	SE5			I		X	X		
Cirsium arvense	Canada Thistle		3	-1	SE5			I		X	X	X	
Cirsium vulgare	Bull Thistle		4	-1	SE5			I		X	X		
Conyza canadensis	Horseweed	0	1		S5			X		X			
Erigeron annuus	Daisy Fleabane	0	1		S5			X		X	X	X	
Erigeron philadelphicus	Philadelphia Fleabane	1	-3		S5			X		X			
Eurybia macrophylla	Large-leaved Aster	5	5		S5			X			X		
Euthamia graminifolia	Flat-topped Bushy Goldenrod	2	-2		S5			X			X	X	
Gnaphalium uliginosum	Low Cudweed		0	-1	SE5			I		X			
Lactuca serriola	Prickly Lettuce		0	-1	SE5			I		X			
Leucanthemum vulgare	Ox-eye Daisy		5	-1	SE5			I		X	X		X
Matricaria discoidea	Pineapple-weed				SE5			I		X			
Solidago canadensis	Canada Goldenrod	1	3		S5			X		X	X	X	X
Sonchus arvensis ssp. arvensis	Field Sow-thistle				SE5			I		X	X		
Sonchus asper ssp. asper	Spiny-leaved Sow-thistle		0	-1	SE5			I			X		
Sonchus oleraceus	Common Sow-thistle		3	-1	SE5			I		X			X
Symphyotrichum lanceolatum var. *lanceolatum*	Tall White Aster	3	-3		S5			X			X		
Symphyotrichum novae-angliae	New England Aster	2	-3		S5			X		X	X	X	
Symphyotrichum pilosum var. *pilosum*	Hairy Aster	4	2		S5			X			X		
Symphyotrichum puniceum	Purple-stemmed Aster				S5						X		
Xanthium spinosum	Spiny Cocklebur		3	-1	SE2?					X	X	X	
Balsaminaceae	**Touch-me-not Family**												
Impatiens capensis	Spotted Touch-me-not	4	-3		S5			X		X	X		
Brassicaceae	**Mustard Family**												
Alliaria petiolata	Garlic Mustard		0	-3	SE5			I				X	
Hesperis matronalis	Dame's Rocket		5	-3	SE5			I				X	
Raphanus raphanistrum	Wild Radish		5	-1	SE3					X		X	
Caprifoliaceae	**Honeysuckle Family**												
Lonicera tatarica	Tartarian Honeysuckle		3	-3	SE5			I				X	
Caryophyllaceae	**Pink Family**												
Dianthus armeria	Deptford Pink		5	-1	SE5			I					X

Scientific Name	Common Name	CC	CW	Weed	SRANK[1]	SARO[2]	COSEWIC[3]	HRCA NAI[4]	NHIC[1]	NRSI Observations			
										Fallow Field	MAM2-2	SWT2-13	Hedgerow
Chenopodiaceae	**Goosefoot Family**												
Chenopodium simplex	Maple-leaved Goosefoot	0	-5		S5			U			X		
Cornaceae	**Dogwood Family**												
Cornus foemina ssp. *racemosa*	Red Panicled Dogwood	2	-2		S5			X		X		X	X
Cornus stolonifera	Red-osier Dogwood	2	-3		S5			X				X	
Dipsacaceae	**Teasel Family**												
Dipsacus fullonum ssp. *sylvestris*	Wild Teasel		5	-1	SE5			I		X	X		
Euphorbiaceae	**Spurge Family**												
Acalypha virginica var. *rhomboidea*	Three-seeded Mercury	0	3		S5			X		X			
Fabaceae	**Pea Family**												
Glycine max	Soya Bean		5	-1	SE2					X			
Lotus corniculatus	Bird's-foot Trefoil		1	-2	SE5			I		X	X		
Medicago lupulina	Black Medick		1	-1	SE5			I		X			
Trifolium pratense	Red Clover		2	-2	SE5			I		X	X		
Vicia cracca	Tufted Vetch		5	-1	SE5			I		X	X	X	
Fagaceae	**Beech Family**												
Quercus macrocarpa	Bur Oak	5	1		S5			X				X	X
Guttiferae	**St. John's-wort Family**												
Hypericum perforatum	Common St. John's-wort		5	-3	SE5			I			X		
Juglandaceae	**Walnut Family**												
Carya ovata	Shagbark Hickory	6	3		S5			X					X
Lamiaceae	**Mint Family**												
Lycopus americanus	Cut-leaved Water-horehound	4	-5		S5			X			X		
Lycopus europaeus	European Water-horehound		-5	-2	SE5			I			X	X	
Lythraceae	**Loosestrife Family**												
Lythrum salicaria	Purple Loosestrife		-5	-3	SE5			I			X	X	
Oleaceae	**Olive Family**												
Fraxinus americana	White Ash	4	3		S5			X			X		X
Fraxinus pennsylvanica	Green Ash	3	-3		S5			X				X	
Ligustrum vulgare	Common Privet		1	-2	SE5			I				X	
Onagraceae	**Evening-primrose Family**												
Ludwigia palustris	Marsh Purslane	5	-5		S5			X		X			
Oxalidaceae	**Wood Sorrel Family**												
Oxalis stricta	Upright Yellow Wood-sorrel	0	3		S5			X		X		X	
Plantaginaceae	**Plantain Family**												
Plantago major	Common Plantain		-1	-1	SE5			I		X			
Polygonaceae	**Smartweed Family**												
Polygonum aviculare	Prostrate Knotweed		1	-1	SNA			X		X			
Polygonum persicaria	Lady's-thumb		-3	-1	SE5			I		X			
Rumex acetosella	Sheep Sorrel		0		SNA			I			X		
Rumex crispus	Curly-leaf Dock		-1	-2	SE5			I		X	X	X	
Ranunculaceae	**Buttercup Family**												
Ranunculus acris	Tall Buttercup		-2	-2	SE5			I				X	

Scientific Name	Common Name	CC	CW	Weed	SRANK[1]	SARO[2]	COSEWIC[3]	HRCA NAI[4]	NHIC[1]	NRSI Observations			
										Fallow Field	MAM2-2	SWT2-13	Hedgerow
Ranunculus pensylvanicus	Bristly Buttercup	3	-5		S5			X			X		
Ranunculus sceleratus	Cursed Buttercup	2	-5		S5			X		X			
Rhamnaceae	**Buckthorn Family**												
Rhamnus cathartica	European Buckthorn		3	-3	SE5			I				X	X
Rosaceae	**Rose Family**												
Crataegus species	Hawthorn species											X	X
Fragaria virginiana	Wild Strawberry				S5			X		X		X	
Geum aleppicum	Yellow Avens	2	-1		S5			X		X	X	X	
Malus domestica	Apple												X
Potentilla norvegica	Rough Cinquefoil				S5			I		X			
Potentilla recta	Rough-fruited Cinquefoil		5	-2	SE5			I				X	
Prunus avium	Cherry Plum		5	-2	SE4			I					X
Prunus serotina	Black Cherry	3	3		S5			X					X
Pyrus communis	Common Pear		5	-1	SE4			I				X	X
Rosa rubiginosa	Sweetbrier Rose		5	-1	SE4			I					X
Rubus occidentalis	Black Raspberry	2	5		S5			X					X
Salicaceae	**Willow Family**												
Populus deltoides ssp. *deltoides*	Eastern Cottonwood	4	-1		S5			X			X		
Populus tremuloides	Trembling Aspen	2	0		S5			X					X
Salix species	Willow species												X
Salix fragilis	Crack Willow		-1	-3	SE5			I				X	
Simaroubaceae	**Ailanthus Family**												
Ailanthus altissima	Tree-of-heaven		5	-1	SE5			I					X
Ulmaceae	**Elm Family**												
Ulmus americana	White Elm	3	-2		S5			X				X	X
Urticaceae	**Nettle Family**												
Urtica dioica ssp. *dioica*	European Stinging Nettle		-1	-1	SE2			I				X	
Verbenaceae	**Vervain Family**												
Verbena hastata	Blue Vervain	4	-4		S5			X			X		
Verbena urticifolia	White Vervain	4	-1		S5			X			X		
Vitaceae	**Grape Family**												
Vitis riparia	Riverbank Grape	0	-2		S5			X				X	X
Monocotyledons	**Monocots**												
Alismataceae	**Water-plantain Family**												
Alisma plantago-aquatica	Common Water-plantain	3	-5		S5			X		X	X	X	
Cyperaceae	**Sedge Family**												
Carex vulpinoidea	Fox Sedge	3	-5		S5			X			X		
Eleocharis obtusa	Blunt Spike-rush	5	-5		S5			X		X	X		
Schoenoplectus tabernaemontani	American Great Bulrush	5	-5		S5						X		
Juncaceae	**Rush Family**												
Juncus tenuis	Path Rush	0	0		S5			X			X		
Lemnaceae	**Duckweed Family**												
Lemna minor	Lesser Duckweed	2	-5		S5			X			X		
Liliaceae	**Lily Family**												
Allium canadense var. canadense	Wild Garlic	8	3		S5			X			X		

Scientific Name	Common Name	CC	CW	Weed	SRANK[1]	SARO[2]	COSEWIC[3]	HRCA NAI[4]	NHIC[1]	NRSI Observations			
										Fallow Field	MAM2-2	SWT2-13	Hedgerow
Poaceae	**Grass Family**												
Echinochloa crusgalli	Common Barnyard Grass		-3	-1	SE5			I			X		
Hordeum jubatum	Squirrel-tail Grass		-1	-1	SE5			I		X	X		
Leersia oryzoides	Rice Cut Grass	3	-5		S5			X			X		
Panicum capillare	Witch Grass	0	0		S5			X		X			
Phalaris arundinacea	Reed Canary Grass	0	-4		S5			X			X	X	
Phleum pratense	Timothy		3	-1	SE5			I		X	X		
Phragmites australis ssp. *australis*	European Common Reed				SNA			I					X
Poa pratensis	Kentucky Bluegrass	0	1		S5			I		X	X		
Typhaceae	**Cattail Family**												
Typha angustifolia	Narrow-leaved Cattail	3	-5		S5			X		X		X	
Typha latifolia	Broad-leaved Cattail	3	-5		S5			X			X	X	
								Total	**0**	**48**	**54**	**38**	**24**
										104			

[1] MNRF 2019a; [2] MNRF 2019b; [3] COSEWIC 2019; [4] HRCA 2014

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 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[4]	HRCA NAI[4]	OBBA[5]	NRSI Observations
Anatidae	**Ducks, Geese & Swans**							
Branta canadensis	Canada Goose	S5				C	CO	
Cygnus olor	Mute Swan	SNA				R (I)	CO	
Cygnus buccinator	Trumpeter Swan	S4	NAR	NAR		R		X
Aix sponsa	Wood Duck	S5				U	CO	
Anas platyrhynchos	Mallard	S5				C	CO	
Phasianidae	**Partridges, Grouse & Turkeys**							
Phasianus colchicus	Ring-necked Pheasant	SNA				R (I)	PR	
Meleagris gallopavo	Wild Turkey	S5				C	CO	
Columbidae	**Pigeons & Doves**							
Columba livia	Rock Pigeon	SNA				A	CO	
Zenaida macroura	Mourning Dove	S5				A	CO	PO
Cuculiformes	**Cuckoos & Anis**							
Coccyzus americanus	Yellow-billed Cuckoo	S4B				R	PR	
Coccyzus erythropthalmus	Black-billed Cuckoo	S5B				U	PO	
Apodidae	**Swifts**							
Chaetura pelagica	Chimney Swift	S4B, S4N	THR	T	Schedule 1	U	PR	
Trochilidae	**Hummingbirds**							
Archilochus colubris	Ruby-throated Hummingbird	S5B				U	PR	
Rallidae	**Railes, Gallinules & Coots**							
Rallus limicola	Virginia Rail	S5B				U	PR	
Porzana carolina	Sora	S4B				U	PR	
Charadriidae	**Plovers**							
Charadrius vociferus	Killdeer	S5B, S5N				A	CO	PO
Scolopacidae	**Waders**							
Bartramia longicauda	Upland Sandpiper	S4B				R	CO	
Scolopax minor	American Woodcock	S4B				C	CO	
Actitis macularia	Spotted Sandpiper	S5				C	CO	PR
Laridae	**Gulls, Terns & Skimmers**							
Larus delawarensis	Ring-billed Gull	S5B, S4N				A	CO	X
Larus argentatus	Herring Gull	S5B, S5N				C		X
Ardeidae	**Herons & Bitterns**							
Ardea herodias	Great Blue Heron	S4B				U	PR	
Butorides virescens	Green Heron	S4B				U	CO	
Cathartidae	**Vultures**							
Cathartes aura	Turkey Vulture	S5B				U	PR	

Scientific Name	Common Name	SRANK[1]	SARO[2]	COSEWIC[3]	SARA Schedule[4]	HRCA NAI[4]	OBBA[5]	NRSI Observations
Accipitridae	**Hawks, Kites, Eagles & Allies**							
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	
Buteo jamaicensis	Red-tailed Hawk	S5	NAR	NAR		C	CO	
Strigidae	**Typical Owls**							
Megascops asio	Eastern Screech-Owl	S4	NAR	NAR		U	PO	
Bubo virgianus	Great Horned Owl	S4				C	CO	
Asio flammeus	Short-eared Owl	S2N, S4B	SC	SC	Schedule 3	R	PR	
Alcedinidae	**Kingfishers**							
Megaceryle alcyon	Belted Kingfisher	S4B				U	PO	
Picidae	**Woodpeckers**							
Melanerpes erythrocephalus	Red-headed Woodpecker	S4B	SC	END	Schedule 1	R	CO	
Melanerpes carolinus	Red-bellied Woodpecker	S4				U	CO	
Dryobates pubescens	Downy Woodpecker	S5				C	CO	
Dryobates villosus	Hairy Woodpecker	S5				U	PR	
Colaptes auratus	Northern Flicker	S4B				C	CO	PR
Falconidae	**Caracaras & Falcons**							
Falco sparverius	American Kestrel	S4				U	CO	
Tyrannidae	**Tyrant Flycatchers**							
Contopus virens	Eastern Wood-Pewee	S4B	SC	SC		C	PR	
Empidonax alnorum	Alder Flycatcher	S5B				U	PR	
Empidonax traillii	Willow Flycatcher	S5B				C	CO	PO
Empidonax minimus	Least Flycatcher	S4B				U	PO	
Sayornis phoebe	Eastern Phoebe	S5B				U	CO	
Myiarchus crinitus	Great Crested Flycatcher	S4B				C	CO	
Tyrannus tyrannus	Eastern Kingbird	S4B				A	CO	PO
Vireonidae	**Vireos**							
Vireo gilvis	Warbling Vireo	S5B				C	PR	
Vireo olivaceus	Red-eyed Vireo	S5B				C	CO	
Corvidae	**Crows & Jays**							
Cyanocitta cristata	Blue Jay	S5				A	CO	
Corvus brachyrhynchos	American Crow	S5B				C	CO	PO
Alaudidae	**Larks**							
Eremophila alpestris	Horned Lark	S5B				C	CO	PO
Hirundinidae	**Swallows**							
Progne subis	Purple Martin	S4B				U	CO	
Tachycineta bicolor	Tree Swallow	S4B				A	CO	PR
Stelgidopteryx serripennis	Northern Rough-winged Swallow	S4B				C	CO	
Riparia riparia	Bank Swallow	S4B	THR	T		U	PO	
Hirundo rustica	Barn Swallow	S4B	THR	T		C	CO	PO

Scientific Name	Common Name	SRANK[1]	SARO[2]	COSEWIC[3]	SARA Schedule[4]	HRCA NAI[4]	OBBA[5]	NRSI Observations
Paridae	**Chickadees & Titmice**							
Poecile atricapillus	Black-capped Chickadee	S5				A	CO	
Baeolophus bicolor	Tufted Titmouse	S4				R	PO	
Sittidae	**Nuthatches**							
Sitta canadensis	Red-breasted Nuthatch	S5				U	CO	
Sitta carolinensis	White-breasted Nuthatch	S5				C	PR	
Troglodytidae	**Wrens**							
Troglodytes aedon	House Wren	S5B				C	CO	
Troglodytes hiemalis	Winter Wren	S5B				U	PO	
Cistothorus platensis	Sedge Wren	S4B	NAR	NAR		R	PO	
Cistothorus palustris	Marsh Wren	S4B				U	PO	
Thryothorus ludovicianus	Carolina Wren	S4				R	PR	
Polioptilidae	**Gnatcatchers**							
Polioptila caerulea	Blue-gray Gnatcatcher	S4B				U	PR	
Turdidae	**Thrushes**							
Sialia sialis	Eastern Bluebird	S5B	NAR	NAR		U	CO	
Catharus fuscescens	Veery	S4B				C	PR	
Hylocichla mustelina	Wood Thrush	S4B	SC	T		C	PR	
Turdus migratorius	American Robin	S5B				A	CO	CO
Mimidae	**Mockingbirds, Thrashers & Allies**							
Dumetella carolinensis	Gray Catbird	S4B				A	CO	PR
Toxostoma rufum	Brown Thrasher	S4B				U	CO	PR
Mimus polyglottos	Northern Mockingbird	S4				U	CO	PO
Sturnidae	**Starlings**							
Sturnus vulgaris	European Starling	SNA				A (I)	CO	CO
Bombycillidae	**Waxwings**							
Bombycilla cedrorum	Cedar Waxwing	S5B				C	CO	PO
Passeridae	**Old World Sparrows**							
Passer domesticus	House Sparrow	SNA				A (I)	CO	PO
Fringillidae	**Finches & Allies**							
Carpodacus mexicanus	House Finch	SNA				A (I)	CO	
Spinus tristis	American Goldfinch	S5B				A	CO	PR
Parulidae	**Wood Warblers**							
Seiurus aurocapillus	Ovenbird	S4B				C	PO	
Protonotaria citrea	Prothonotary Warbler	S1B	END	E	Schedule 1	R	PO	
Geothylpis trichas	Common Yellowthroat	S5B				C	PR	PO
Setophaga ruticilla	American Redstart	S5B				U	PO	
Setophaga petechia	Yellow Warbler	S5B				A	CO	PO
Setophaga pensylvanica	Chestnut-sided Warbler	S5B				U	PO	
Cardellina canadensis	Canada Warbler	S4B	SC	T	Schedule 1	R	PO	

Scientific Name	Common Name	SRANK[1]	SARO[2]	COSEWIC[3]	SARA Schedule[4]	HRCA NAI[4]	OBBA[5]	NRSI Observations
Emberizidae	**New World Sparrows & Allies**							
Pipilo erythrophthalmus	Eastern Towhee	S4B				U	PO	
Spizella passerina	Chipping Sparrow	S5B				A	CO	PO
Spizella pusilla	Field Sparrow	S4B				C	CO	
Pooecetes gramineus	Vesper Sparrow	S4B				U	PR	
Passerculus sandwichensis	Savannah Sparrow	S4B				A	CO	PO
Ammodramus savannarum	Grasshopper Sparrow	S4B	SC	SC		U	PO	
Melospiza melodia	Song Sparrow	S5B				A	CO	CO
Melospiza georgiana	Swamp Sparrow	S5B				C	PR	
Cardinalidae	**Cardinals, Grosbeaks & Allies**							
Piranga olivacea	Scarlet Tanager	S4B				U	PO	
Cardinalis cardinalis	Northern Cardinal	S5				A	CO	PO
Pheucticus ludovicianus	Rose-breasted Grosbeak	S4B				C	CO	
Passerina cyanea	Indigo Bunting	S4B				C	CO	PO
Icteridae	**Blackbirds**							
Dolichonyx oryzivorus	Bobolink	S4B	THR	T	No Schedule	U	CO	
Agelaius phoeniceus	Red-winged Blackbird	S4				A	CO	PR
Sturnella magna	Eastern Meadowlark	S4B	THR	T	No Schedule	U	CO	
Quiscalus quiscula	Common Grackle	S5B				A	CO	PO
Molothrus ater	Brown-headed Cowbird	S4B				A	CO	PR
Icterus spurius	Orchard Oriole	S4B				U	PR	
Icterus galbula	Baltimore Oriole	S4B				C	CO	
						Total	**101**	**31**

[1]MNRF 2019a; [2]MNRF 2019b; [3]COSEWIC 2019; [4]HRCA 2014; [5]BSC et al. 2006

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]	HRCA NAI[4]	ORAA[5]	NHIC[1]	NRSI Observations
Turtles								
Chelydra serpentina serpentina	Snapping Turtle	S3	SC	SC	C	X		
Chrysemys picta marginata	Midland Painted Turtle	S5		SC	C	X		
Sternotherus odoratus	Eastern Musk Turtle	S3	SC	SC	R	X		
Snakes								
Opheodrys vernalis	Smooth Greensnake	S4			R	X		
Nerodia sipedon sipedon	Northern Watersnake	S5	NAR	NAR	R	X		
Thamnophis sirtalis sirtalis	Eastern Gartersnake	S5			C	X		
Salamanders								
Ambystoma jeffersonianum	Jefferson Salamander	S2	END	E	R	X		
Ambystoma sp.	Jefferson/Blue-spotted Salamander (	S2				X		
Ambystoma laterale	Blue-spotted Salamander	S4			R	X		
Notophthalmus viridescens viridesc	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		
Hyla versicolor	Tetraploid Gray Treefrog	S5			C	X		X
Pseudacris crucifer	Spring Peeper	S5			C	X		
Lithobates catesbeiana	American Bullfrog	S4			U	X		
Lithobates clamitans melanota	Northern Green Frog	S5			C	X		X
Lithobates pipiens	Northern Leopard Frog	S5	NAR	NAR	C	X		
Lithobates sylvaticus	Wood Frog	S5			C	X		
					Total	**18**	**0**	**2**

[1]MNRF 2019a; [2]MNRF 2019b; [3]COSEWIC 2019; [4]HRCA 2014; [5]Ontario Nature 2018

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]	HRCA NAI[4]	Ontario Mammal Atlas[5]	NHIC[1]	NRSI Observations
Didelphimorphia	**Opossums**							
Didelphis virginiana	Virginia Opossum	S4			C	X		
Insectivora	**Shrews and Moles**							
Blarina brevicauda	Northern Short-tailed Shrew	S5			C	X		
Condylura cristata	Star-nosed Mole	S5			C	X		
Parascalops breweri	Hairy-tailed Mole	S4			U	X		
Sorex cinereus	Masked Shrew	S5			C	X		
Chiroptera	**Bats**							
Eptesicus fuscus	Big Brown Bat	S4			UNK	X		X
Lasionycteris noctivagans	Silver-haired Bat	S4			UNK	X		X
Lasiurus borealis	Eastern Red Bat	S4			UNK	X		X
Lasiurus cinereus	Hoary Bat	S4			UNK	X		X
Myotis lucifugus	Little Brown Myotis	S4	END	E	UNK	X		
Lagomorpha	**Rabbits and Hares**							
Lepus europaeus	European Hare	SNA			CI	X		
Sylvilagus floridanus	Eastern Cottontail	S5			C	X		X
Rodentia	**Rodents**							
Castor canadensis	Beaver	S5			C	X		
Glaucomys volans	Southern Flying Squirrel	S4	NAR	NAR	C	X		
Marmota monax	Woodchuck	S5			C	X		
Microtus pennsylvanicus	Meadow Vole	S5			C	X		
Microtus pinetorum	Woodland Vole	S3?	SC	SC	R	X		
Napaeozapus insignis	Woodland Jumping Mouse	S5			U	X		
Ondatra zibethicus	Muskrat	S5			C	X		X
Peromyscus leucopus	White-footed Mouse	S5			C	X		
Rattus norvegicus	Norway Rat	SNA			CI	X		
Sciurus carolinensis	Eastern Gray Squirrel	S5			C	X		
Tamiasciurus hudsonicus	Red Squirrel	S5			C	X		X
Tamias striatus	Eastern Chipmunk	S5			C	X		X
Zapus hudsonius	Meadow Jumping Mouse	S5			C	X		
N/A	Mouse Species	-			-			X

Scientific Name	Common Name	SRANK[1]	SARO[2]	COSEWIC[3]	HRCA NAI[4]	Ontario Mammal Atlas[5]	NHIC[1]	NRSI Observations
Carnivora	**Carnivores**							
Canis latrans	Coyote	S5			C	X		X
Mephitis mephitis	Striped Skunk	S5			C	X		
Mustela erminea	Ermine	S5			U	X		
Mustela frenata	Long-tailed Weasel	S4			C	X		
Mustela vison	American Mink	S4			C	X		
Procyon lotor	Northern Raccoon	S5			C	X		X
Vulpes vulpes	Red Fox	S5			C	X		
Artiodactyla	**Deer and Bison**							
Odocoileus virginianus	White-tailed Deer	S5			C	X		X
					Total	**33**	**0**	**12**

[1]MNRF 2019a; [2]MNRF 2019b; [3]COSEWIC 2019; [4]HRCA 2014; [5]Dobbyn 1994

Appendix VI

Dragonfly and Damselfly 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]	HRCA NAI[4]	Odonate Atlas[5]	NHIC[1]	NRSI Observations
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		
Libellulidae	**Skimmers**							
Erythemis simplicicollis	Eastern Pondhawk	S5			C	X		
Libellula luctuosa	Widow Skimmer	S5			C	X		
Libellula pulchella	Twelve-spotted Skimmer	S5			C	X		X
Plathemis lydia	Common Whitetail	S5			C	X		
					Total	**7**	**0**	**1**

[1]MNRF 2019a, [2]MNRF 2019b, [3]COSEWIC 2019, [4]HRCA 2014, [5]MNRF 2019c

Appendix VII

Butterfly Species Reported from the Study Area

Butterfly Species Reported From the Study Area

Scientific Name	Common Name	SRANK[1]	SARO[2]	COSEWIC[3]	HRCA NAI[4]	TEA Atlas[5]	NHIC[1]	NRSI Observations
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		
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		
	Skipper sp.	-			-			X
Papilionidae	**Swallowtails**							
Papilio glaucus	Eastern Tiger Swallowtail	S5			C	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		X
Colias philodice	Clouded Sulphur	S5				X		
Pieris rapae	Cabbage White	SNA			C	X		X
Zerene cesonia	Southern Dogface	SNA				X		
Lycaenidae	**Harvesters, Coppers,**							
Celastrina ssp.	Azure Species	-			-			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]	HRCA NAI[4]	TEA Atlas[5]	NHIC[1]	NRSI Observations
Nymphalidae	**Brush-footed Butterflies**							
Cercyonis pegala	Common Wood-Nymph	S5			C	X		
Coenonympha tullia	Common Ringlet	S5			C	X		
Danaus plexippus	Monarch	S2N, S4B	SC	E	C	X		X
Junonia coenia	Common Buckeye	SNA			U	X		
Lethe anthedon	Northern Pearly-Eye	S5			C	X		
Lethe appalachia	Appalachian Brown	S4			C	X		
Lethe eurydice	Northern Eyed Brown	S5			C	X		
Limenitis archippus	Viceroy	S5			C	X		
Limenitis arthemis astyanax	Red-spotted Purple	S5			C	X		
Nymphalis antiopa	Mourning Cloak	S5			C	X		
Phyciodes cocyta	Northern Crescent	S5				X		
Polygonia comma	Eastern Comma	S5			C	X		
Polygonia comma	Hop Merchant	S5				X		
Polygonia interrogationis	Question Mark	S5			C	X		
Speyeria cybele	Great Spangled Fritillary	S5			C	X		
Vanessa atalanta	Red Admiral	S5			C	X		
Vanessa cardui	Painted Lady	S5			C	X		X
Vanessa virginiensis	American Lady	S5			C	X		
					Total	**41**	**0**	**6**

[1]MNRF 2019a; [2]MNRF 2019b; [3]COSEWIC 2019; [4]HRCA 2014; [5]Macnaughton et al. 2019

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[4]	HRCA NAI[5]	Amec[6]	NRSI Observations
Cyprinidae	**Carps and Minnows**							
Chrosomus eos	Northern Redbelly Dace	S5				C	X	
Margariscus nachtriebi	Northern Pearl Dace	S5				C	X	
Pimephales promelas	Fathead Minnow	S5				C	X	
Umbridae	**Mudminnows**							
Umbra limi	Central Mudminnow	S5				C	X	
Gasterosteidae	**Sticklebacks**							
Culaea inconstans	Brook Stickleback	S5				C	X	
Centrarchidae	**Sunfishes and Basses**							
Lepomis gibbosus	Pumpkinseed	S5				C	X	
						Total	**6**	**0**

[1]MNRF 2019a; [2]MNRF 2019b; [3]COSEWIC 2019; [4]Government of Canada 2019; [5]HRCA 2014; [6]Amec 2018

Appendix IX
Aquatic Effects Summary Table

Aquatics Effects Assessment Summary Table – Tributary to Stoney Creek

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					
Tributary to Stoney 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	Ensure detailed design allows for baseflow to continue into the downstream system during periods where water is present. System is intermittent. Ensure riparian plantings are included in the detail design. Vegetation along and adjacent to berms will enhance water quality and water temperature, in time, through shading. Carry out the works in the dry, within confines of coffer dams (if necessary). If dewatering is required, a fish salvage should be completed, as well fish screens should be utilized and the water 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. Carry out the works within the in-water timing window between July 1 to March 31 outside of spawning and rearing times for fish. This will also ensure that the riparian habitat is established before the winter months. Prepare and 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. Re-instate and re-stabilize banks of watercourse (where restoration occurring) and edges of the berms disturbed during construction to pre-construction or better condition. Soil stockpiles and berms to be stabilized using a nurse crop.	No residual effects anticipated. Water quality should increase and sediment concentration should decrease with the creation of the wetland and 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 should 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 should be designed and implemented prior to any grading or earth moving. Standard ESC measures to be followed (as per DFO measures identified on the DFO website). Work in the dry and heed weather advisories and schedule works to avoid wet, windy and raining periods. Regularly monitor the watercourse for signs of sedimentation during all phases of the work and take corrective action 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 berm and wetlands. Change in ephemeral channel for the Tributary to input into the wetland area (more so to where it was prior to being altered). Erosion potential will decrease with the wetland design.	**Potential**
	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	Ensure detailed design allows for baseflow to continue into the downstream system. System is intermittent. Control structure on the berm should maintain some amount of surface water flow to the extent possible to preserve the hydrology of the downstream wetlands. Ensure native riparian plantings are included in the detail design. Vegetation within the berms will enhance water quality and water temperature, in time, through shading. Maintain an undisturbed vegetated buffer zone between areas of on-land activity and the high-water mark of the Creek. Avoid tree removals where possible. Use methods to prevent soil compaction, such as swamp mats or pads. Prepare and 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. Re-instate and re-stabilize banks of watercourse and edges of the berms disturbed during construction to pre-construction or better condition. Soil stockpiles and berms to 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 should increase and sediment concentration should decrease with the creation of the wetland and stream restoration. 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	Minimize vegetation removal where possible. Prepare and ESC plan. Stabilize disturbed banks with native seed mixture and/or cover exposed areas 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 restoration. 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	Minimize the removal of aquatic vegetation where possible to retain adequate cover and habitat for aquatic species. Follow in-water timing windows and work in the dry where possible. If possible, replant native species or aquatic species within the wetland cells.	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 by trained biologists and released downstream in similar habitat prior to dewatering. Creating the berm with outlet structures is to help with flow downstream of the escarpment.	Residual effects are expected due to the addition of the berm. This will change the access of habitats for fish. The frequency of flow will also change as this berm will reduce flooding and erosion downstream of the site.	**Potential**
	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 downstream passage of fish Flow alteration (timing, duration, intensity)	Change in access to habitats	Fish passage will be removed from the tributary to Stoney Creek where the berm/barrier will be placed. There is limited fish habitat present within the upstream sections of this feature as the system is 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.	As the creation of the wetland habitats include a berm which goes across the existing Stoney Creek tributary (which is an intermittent feature) there will be a residual effect as fish will no longer be able to utilize those areas at any points of the year. The wetlands should provide fish habitat once established but there will be limited connectivity to the downstream system (which already dries up).	**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

Tributary to Stoney Creek

Reach 1 – July 2019


Photo 1: Facing upstream from Green Mountain Road


Photo 2: Facing downstream from Green Mountain Road


Photo 3: Facing upstream within Reach 1

Reach 1 – September 2019


Photo 4: Facing upstream from Green Mountain Road


Photo 5: Facing downstream from Green Mountain Road


Photo 6: Facing upstream within Reach 1

Reach 2 – OSAP

July 2019


Photo 7: Facing upstream into OSAP reach


Photo 8: OSAP reach


Photo 9: Upstream end of OSAP reach

September 2019


Photo 10: Facing upstream in OSAP Reach


Photo 11: Facing upstream in OSAP reach


Photo 12: Upstream end of OSAP reach

Reach 3

July 2019

September 2019


Photo 13: Upstream view in Reach 3


Photo 15: Reach 3, dry


Photo 14: Clear, flowing in Reach 3

Tributary 1
July 2019

Photo 16: Ephemeral channel, grass lined

Photo 17: Dry soils, grass lined

Photo 18: Facing downstream into Stoney Creek Trib.

Photo 19: No flow into main Tributary, water pooled

Photo 20: Main channel, soft substrates and aquatic vegetation present

Photo 21: Snails throughout main channel, but an abundance at this outlet from Trib 1

September 2019


Photo 22: Facing upstream into fallow field


Photo 23: Limited to no channel definition


Photo 24: Outlet into main channel. Pool much smaller.

Tributary 2
July 2019


Photo 25: Facing towards Green Mountain Road


Photo 28: Facing south along west property boundary


Photo 26: Limited water, very minimal flow in some locations


Photo 29: Facing north along west property boundary


Photo 27: Soft substrates


Photo 30: Wet soils, no water

September 2019

Photo 31: Looking into the meadow

Photo 32: Pooled water in tire tracks

Photo 33: Large patch of Phragmites on edge of property

Photo 34: No water, damp soils

Photo 35: Erosion along property boundary from feature being moved

Photo 36: South facing, grass lined

Terrestrial Habitat Photographs

Photograph 1: The eastern fallow field and dense stands of European Buckthorn (*Rhamnus cathartica*) along the watercourse (photograph taken from centre of property looking NW toward culvert on Green Mountain Road East).

Photograph 2: Early successional vegetation establishment along Tributary 1 in southeast corner of property.

Photograph 3: Wetland vegetation throughout the lower section of the watercourse. Both marsh and swamp thicket communities are present along the length of the feature.

Photograph 4: Dense stand of Broad-leaved Cattail (*Typha latifolia*) where watercourse approaches Green Mountain Road East culvert.

Photograph 5: View of western property boundary (to right) where adjacent landowner has altered surface water flow pattern. Graminoid marsh is present in foreground and the western fallow field in the background.

Photograph 6: Monarch (*Danaus plexippus*) caterpillar foraging on Common Milkweed (*Asclepias syriaca*) near Green Mountain Road East culvert.

APPENDIX E:

Archaeology Report

Stage 1 Archaeological Assessment, Saltfleet Conservation Area SC-8

Part of Lot 15 Concession 6,
Geographic Township of Saltfleet,
Historical County of Wentworth,
now in the City of Hamilton

Submitted to:
Water's Edge Environmental Solutions Team Ltd.
25 Water Street South,
Cambridge, ON N1R 3C7

and the

Ontario's Ministry of Tourism, Culture and Sport

Submitted by:

Detritus
CONSULTING LTD.
archaeology · heritage

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Licensee: Mr. Garth Grimes
License Number: P017
PIF Number: P017-0735-2019
CP Number: 2019-092

ORIGINAL REPORT

August 23, 2019

Executive Summary

Detritus Consulting Ltd. ('Detritus') was retained by Mr. Ed Gazendam of Water's Edge Environmental Solutions Team Ltd. ('the Proponent') to conduct a Stage 1 archaeological assessment on a derelict property located Lot 15 Concession 6, Geographic Township of Saltfleet, Historical County of Wentworth, now in the City of Hamilton, Ontario (Figure 1). This investigation was conducted in advance of the Saltfleet Conservation Area Wetland Restoration Program (Figure 4). The development is located on a derelict property, which measures 9.05 hectares ('Study Area') and is located south of Green Mountain Road East and Fifth Road East. At the time of assessment, the Study Area comprises overgrown weed and grass. Furthermore, a portion of Stoney Creek transects the Study Area from northwest to southwest; the creek itself is flanked on either side by overgrown weeds, scrubs and small trees. Additionally, a tributary of Stoney Creek extends from the southern portion of Stoney Creek to the southeast. The limits of the Study Area were surveyed and marked by the Proponent prior to the assessment.

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 prior to the wetland restoration 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 a property inspection, resulted in the determination that portions of the Study Area exhibit a moderate to high potential for the identification and recovery of archaeological resources (Figure 3). These areas were limited to the overgrown weed and grass component of the Study Area and the overgrown area with small trees and shrubs on either side of Stoney Creek. As such, **a Stage 2 archaeological assessment is recommended for the portions of the Study Area retaining archaeological potential**.

In accordance with Section 2.1.2 of the *Standards and Guidelines* (Government of Ontario 2011), if portions of the Study Area retaining archaeological potential are inaccessible for ploughing, they will be subject to a typical test pit assessment at a 5m interval. Each test pit must be approximately 30 centimetres (cm) in diameter and excavated 5cm into sterile subsoil. The soils 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.

If portion of the overgrown weeds and grass that retains archaeological potential and is accessible for ploughing it 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.

Furthermore, the remainder of the Study Area which comprises a portion of Stoney Creek and a tributary of Stoney Creek were evaluated as being permanently wet and therefore were determined to retain no potential, as per Section 2.1, Standard 2a of the *Standards and Guidelines* (Government of Ontario 2011). This permanently wet area was photo documented during the Stage 1 assessment as per Section 2.1, Standard 6 and Section 7.8.6, Standard 1b of the *Standards and Guidelines* (Government of Ontario 2011).

Lastly, if any of the areas recommended for Stage 2 assessment are determined to be previously disturbed or permanently wet during the course of the Stage 2 assessment, they will be photo documented as per Section 2.1, Sections 2b and 6 of the *Standards and Guidelines* (Government of Ontario 2011).

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 Director:	Mathew Gibson, R1160
Report Preparation:	Amanda Laprise, R470
Mapping and GIS:	Amanda Laprise, R470
Licensee Review:	Garth Grimes, P017

Acknowledgments

Generous contributions by the following individual made this report possible.

- Mr. Ed Gazendam, Ph. D., P. Eng., President, Sr. Geomorphologist; Water's Edge Environmental Solutions Team Ltd.

1.0 Project Context

1.1 Development Context

Detritus Consulting Ltd. ('Detritus') was retained by Mr. Ed Gazendam of Water's Edge Environmental Solutions Team Ltd. ('the Proponent') to conduct a Stage 1 archaeological assessment on a derelict property located Lot 15 Concession 6, Geographic Township of Saltfleet, Historical County of Wentworth, now in the City of Hamilton, Ontario (Figure 1). This investigation was conducted in advance of the Saltfleet Conservation Area Wetland Restoration Program (Figure 4). The development is located on a derelict property, which measures 9.05 hectares ('Study Area') and is located south of Green Mountain Road East and Fifth Road East.

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 prior to the wetland restoration 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 region was occupied by the Neutral or Attawandaron tribe. The earliest recorded visit to the region was undertaken by Étienne Brûlé, who requested permission of Samuel de Champlain to live among the Algonquin people and to learn their language and customs. The purpose of this endeavour was to establish good relations with the Aboriginal communities in advance of future military and colonial enterprises. In 1615, Brûlé joined twelve Huron warriors during their visit to the Andaste people, allies of the Huron, to ask their assistance in an expedition being planned by Champlain. Brûlé arrived two days late, however, and the Hurons were already 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 fur trade as well as the 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 watershed moment in the evolution of the post-contact Aboriginal occupation of Southern Ontario. It was at this time that various Iroquoian-speaking communities began migrating into southern Ontario from New York State, followed by the arrival of 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 (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).

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 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; Tanner 1987; Weaver 1978). Despite the inevitable 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.

The history of the area began on July 24, 1788, when Sir Guy Carleton, the Governor-General of British North America, divided the Province of Québec into the administrative districts of Hesse, Nassau, Mecklenburg and Lunenburg (Archives of Ontario 2009). Further change came in December 1791 when the former Province of Québec was rearranged into Upper Canada and Lower Canada under the *Constitutional Act*. Colonel John Graves Simcoe was appointed as Lieutenant-Governor of Upper Canada (Coyne 1895); he initiated several initiatives to populate the province including the establishment of shoreline communities with effective transportation links between them.

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. 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 (Archives of Ontario 2009).

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). The township was originally laid out in eight concessions between Lake Ontario and the Township of Binbrook to the south. Settlement began in 1786 during the aftermath of the Revolutionary War with an influx of loyalist immigrants from New York State. 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 or Stoney Creek that span the township. Also visible are the early communities of Tapleytown and Stoney Creek, which are located southwest and northwest of the Study Area respectively.

According to the *Historical Atlas* map of Saltfleet Township, John Penfold owned Lot 15, Concession 6. A single structure and accompanying orchard are depicted on the western boundary of the lot, between Lots 15 and 16 southwest of the Study Area. Additionally, a portion of Stoney Creek is illustrated crossing through the western half of the lot, in the vicinity of the Study Area.

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 comprises overgrown weed and grass. Furthermore, a portion of Stoney Creek transects the Study Area from northwest to southwest; the creek itself is flanked on either side by overgrown weeds, scrubs and small trees. Additionally, a tributary of Stoney Creek extends from the southern portion of Stoney Creek to the southeast. 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.

The Study Area is situated within the Haldimand Clay Plain physiographic region (Chapman and Putnam 1984). This region occupies some 1350 square miles that were once submerged below glacial Lake Warren. The clay plain can be subdivided into a series of belt-like regions. 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). The soil is suitable for corn and soy beans in rotation with cereal grains as well as alfalfa and clover (Huffman and Dumanski 1986).

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 source of potable water is Stoney Creek, which transects the Study Area from northwest to southeast.

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 block 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 no registered archaeological sites within 1km of the Study Area. 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 archaeological assessment compiled the available information concerning any known and/or potential archaeological heritage resources within the Study Area. A property inspection was conducted under PIF P017-0735-2019 issued to Mr. Garth Grimes by the MTCS. The property inspection was completed on July 21, 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 hot and partly cloudy, and visibility of land features was excellent. At no time were field or weather conditions detrimental to the identification of features of archaeological potential. The limits of the Study Area were surveyed and marked by the Proponent prior to the assessment.

The results of the Stage 1 background research and optional property inspection indicate that the majority of the Study Area retains archaeological potential. 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 10 illustrate observed areas of archaeological potential. These areas include overgrown weeds and grass component of the Study Area and the overgrown weeds and grass with small trees and shrubs on either side of Stoney Creek. Photos 4, 6 and 8 illustrate Stoney Creek and a tributary of Stoney Creek, which were determined to be permanently wet and therefore retain no archaeological potential.

3.0 Analysis and Conclusions

Detritus was retained by the Proponent to conduct a Stage 1 archaeological assessment on a derelict property located Lot 15 Concession 6, Geographic Township of Saltfleet, Historical County of Wentworth, now in the City of Hamilton, Ontario (Figure 1). This investigation was conducted in advance of the Saltfleet Conservation Area Wetland Restoration Program (Figure 4). The development is located on a derelict property, which measures 9.05 hectares ('Study Area') and is located south of Green Mountain Road East and Fifth Road East. At the time of assessment, the Study Area comprises overgrown weed and grass. Furthermore, a portion of Stoney Creek transects the Study Area from northwest to southwest; the creek itself is flanked on either side by overgrown weeds, scrubs and small trees. Additionally, a tributary of Stoney Creek extends from the southern portion of Stoney Creek to the southeast. The limits of the Study Area were surveyed and marked by the Proponent prior to the assessment.

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 source of potable water is Stoney Creek, which transects the Study Area from northwest to southeast.

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 physiographic region. As was discussed earlier, the soils within this region are imperfectly drained and suitable for pre-contact and post contact Aboriginal agricultural. Given this, the distance to potable water, 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 is 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 & Smith 1875; Figure 2) 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 Tapleytown and Stoney Creek. Considering this, the potential for post-contact Euro-Canadian archaeological resources within the Study Area is judged to be moderate to high.

Finally, despite the factors mentioned above, extensive land disturbance can eradicate archaeological potential within a Study Area (Wilson and Horne 1995). The portion of Stoney Creek and the tributary of Stoney Creek that run through the Study Area were evaluated as being permanently wet and therefore were determined to retain no potential, as per Section 2.1, Standard 2a of the *Standards and Guidelines* (Government of Ontario 2011). These permanently wet areas were photo documented during the Stage 1 assessment as per Section 2.1, Standard 6 and Section 7.8.6, Standard 1b of the *Standards and Guidelines* (Government of Ontario 2011).

Given that no visible areas of disturbance could be identified, Detritus determined that the overgrown weeds and grass component of the Study Area and the overgrown area with small trees and shrubs on either side of Stoney Creek demonstrated the potential for the recovery of pre-contact Aboriginal, post-contact Aboriginal, and Euro-Canadian archaeological resources, and were recommended for additional assessment.

4.0 Recommendations

The Stage 1 archaeological assessment, involving background research and a property inspection, resulted in the determination that portions of the Study Area exhibit a moderate to high potential for the identification and recovery of archaeological resources (Figure 3). These areas were limited to the overgrown weed and grass area and the overgrown areas with small trees and shrubs on either side of Stoney Creek. As such, **a Stage 2 archaeological assessment is recommended for the portions of the Study Area retaining archaeological potential**.

In accordance with Section 2.1.2 of the *Standards and Guidelines* (Government of Ontario 2011), if portions of the Study Area retaining archaeological potential are inaccessible for ploughing, they will be subject to a typical test pit assessment at a 5m interval. Each test pit must be approximately 30 centimetres (cm) in diameter and excavated 5cm into sterile subsoil. The soils 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.

If portion of the overgrown weeds and grass that retains archaeological potential and is accessible for ploughing it 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.

Furthermore, the remainder of the Study Area which comprises a portion of Stoney Creek and a tributary of Stoney Creek were evaluated as being permanently wet and therefore were determined to retain no potential, as per Section 2.1, Standard 2a of the *Standards and Guidelines* (Government of Ontario 2011). This permanently wet area was photo documented during the Stage 1 assessment as per Section 2.1, Standard 6 and Section 7.8.6, Standard 1b of the *Standards and Guidelines* (Government of Ontario 2011).

Lastly, if any of the areas recommended for Stage 2 assessment are determined to be previously disturbed or permanently wet during the course of the Stage 2 assessment, they will be photo documented as per Section 2.1, Sections 2b and 6 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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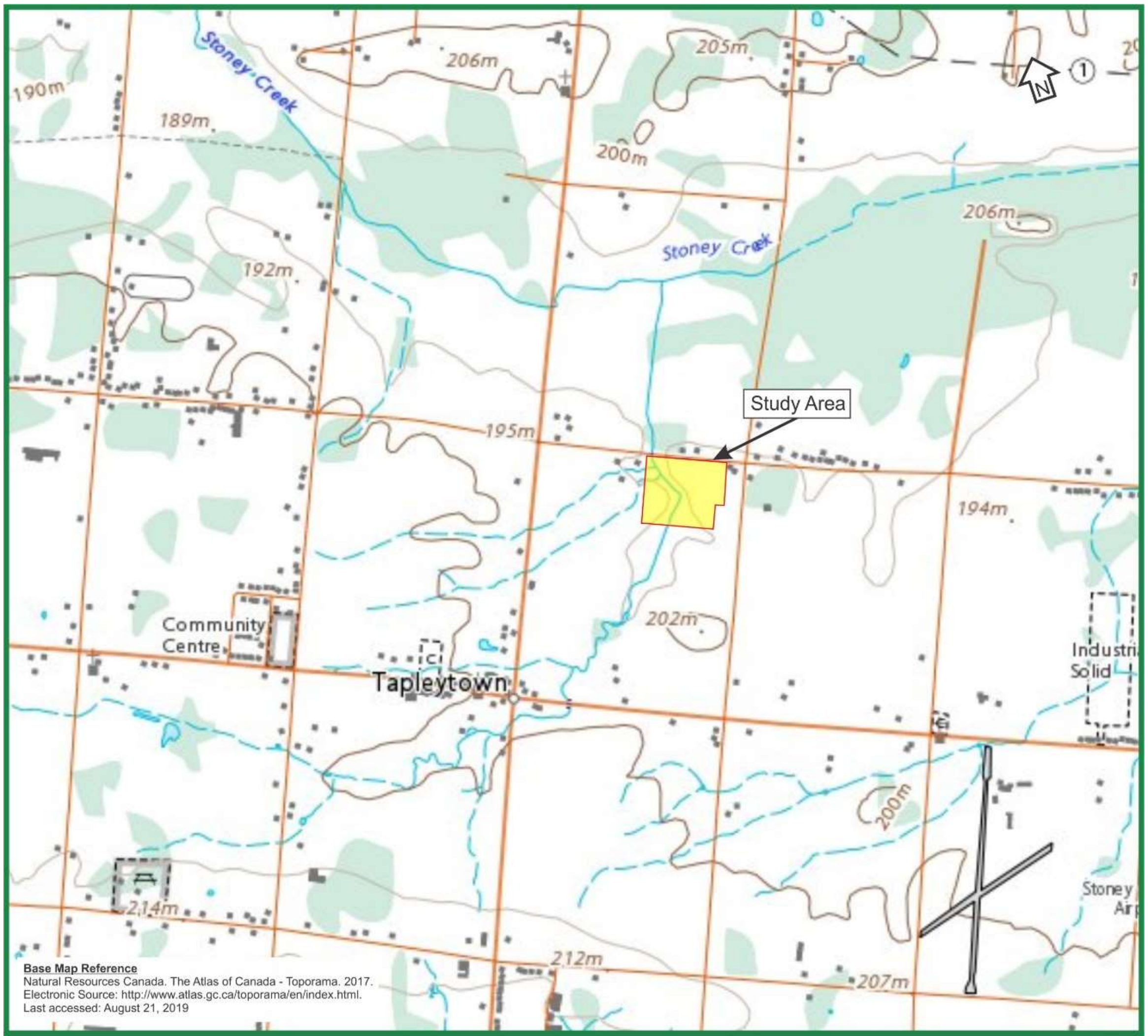
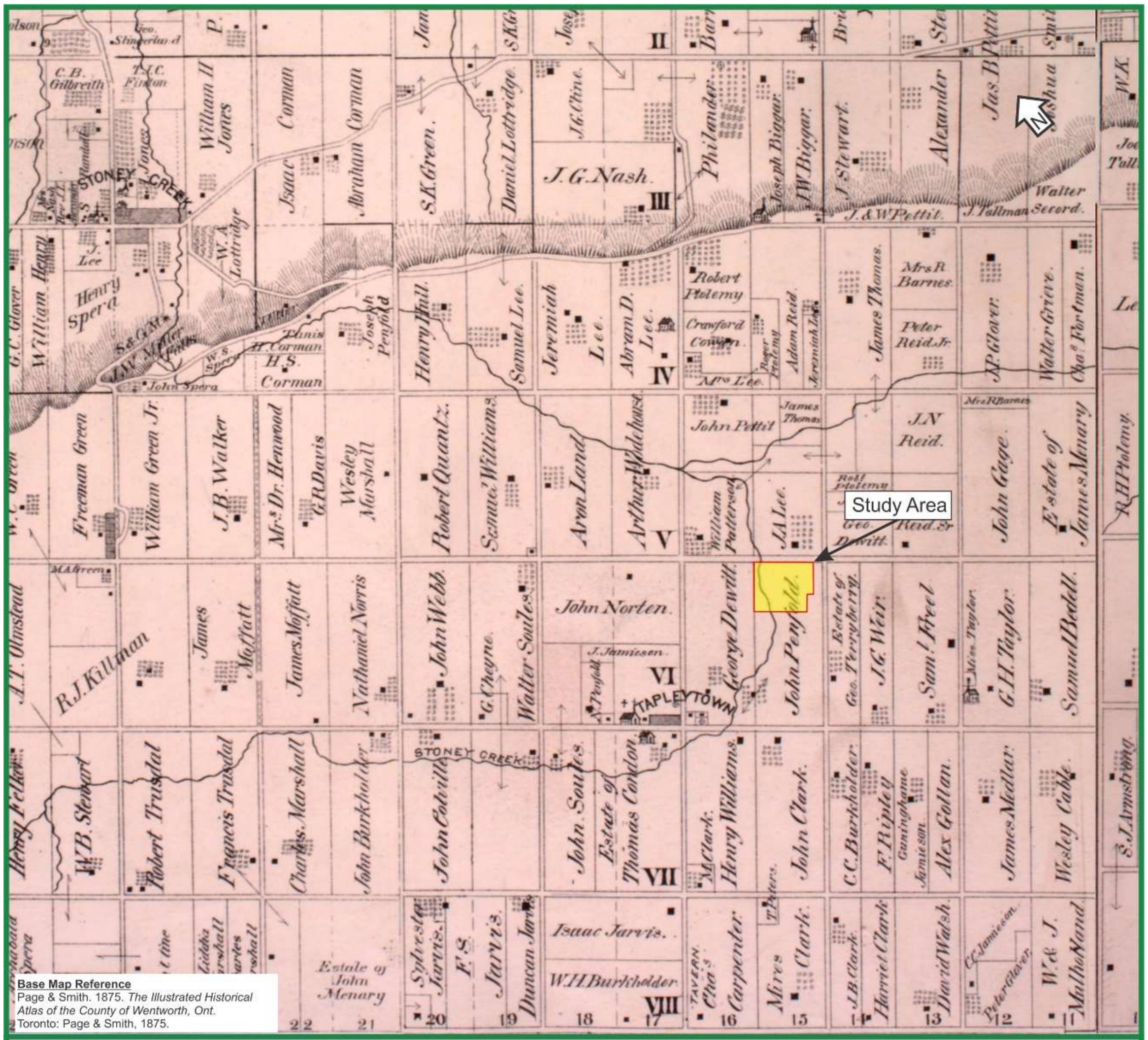
7.0 Maps



Base Map Reference
Natural Resources Canada. The Atlas of Canada - Toporama. 2017.
Electronic Source: http://www.atlas.gc.ca/toporama/en/index.html.
Last accessed: August 21, 2019

Scale 1:30 000

Figure 1: Study Area



Study Area

Base Map Reference
Page & Smith. 1875. *The Illustrated Historical Atlas of the County of Wentworth, Ont.* Toronto: Page & Smith, 1875.

Not to Scale

Figure 2: Portion of the 1875 *Historical Atlas* Map of Saltfleet Township

Figure 3: Archaeological Potential and Further Work Recommendations

Figure 4: Development Plan

8.0 Images

Photo 1: Derelict Overgrown Weeds and Grass Component of the Study Area, Retains Archaeological Potential, facing northwest

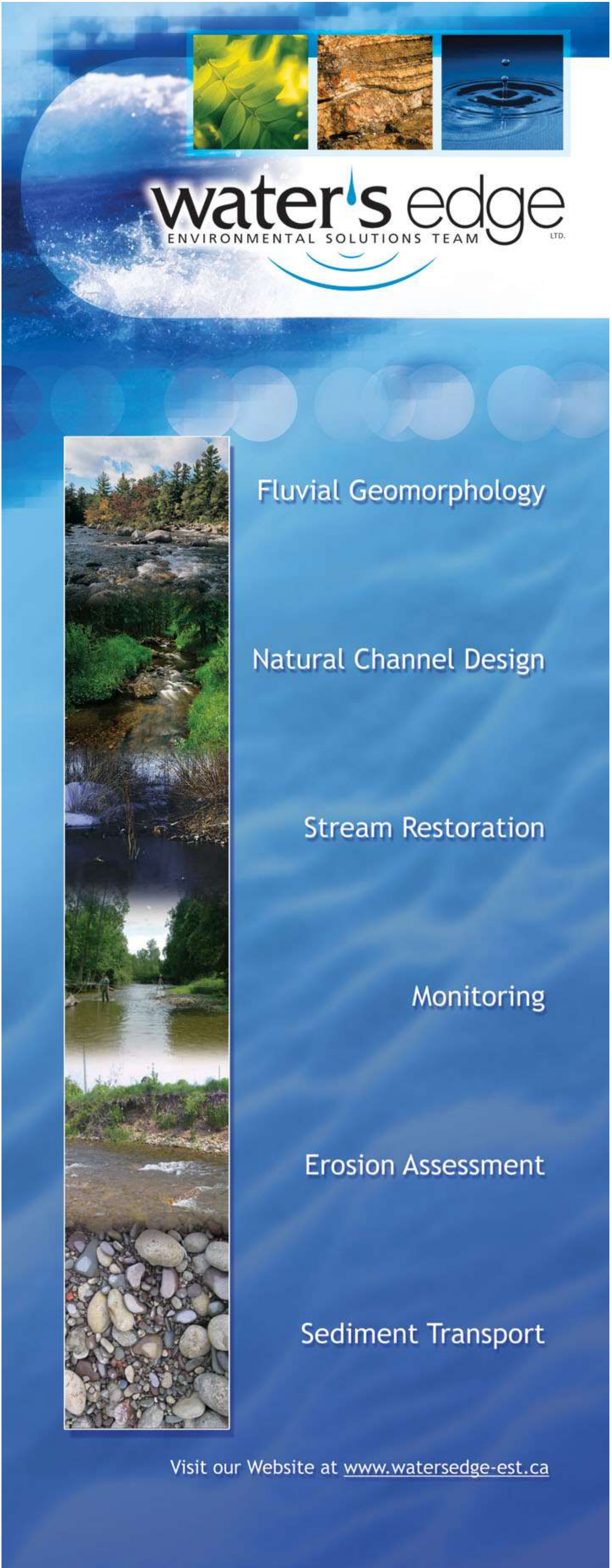
Photo 2: Derelict Overgrown Weeds and Grass Component of the Study Area, Retains Archaeological Potential, facing northeast

Photo 3: Derelict Overgrown Weeds and Grass Component of the Study Area, Retains Archaeological Potential, facing northwest

Photo 4: Derelict Overgrown Weeds and Grass Component of the Study Area, Retains Archaeological Potential; Tributary of Stoney Creek Permanently Wet, facing north

Photo 9: Derelict Overgrown Weeds and Grass Component of the Study Area, Retains Archaeological Potential, facing northeast

Photo 10: Derelict Overgrown Weeds and Grass Component of the Study Area, Retains Archaeological Potential, facing northwest



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APPENDIX F:

Hydrological & Hydraulic Modelling

SC-8 HEC-HMS Modelling Parameters

The SC-8 subcatchments based on existing conditions are shown in **Table 1**. The proposed wetland design will result in subcatchment W140 entering the channel downstream of the wetland facility outlet The model parameters outlined in this section apply to the proposed conditions model with modified subcatchments. **Figure A-1** shows the subcatchment areas used in the model.

Table 2 shows the curve number and percent impervious for the subcatchments; the percent impervious for the subcatchments was based on the average percent impervious for the entire contributing area of SC-8. **Table 3** includes Transform parameters for each subcatchment. **Table 4** includes the reach parameters for channel routing.

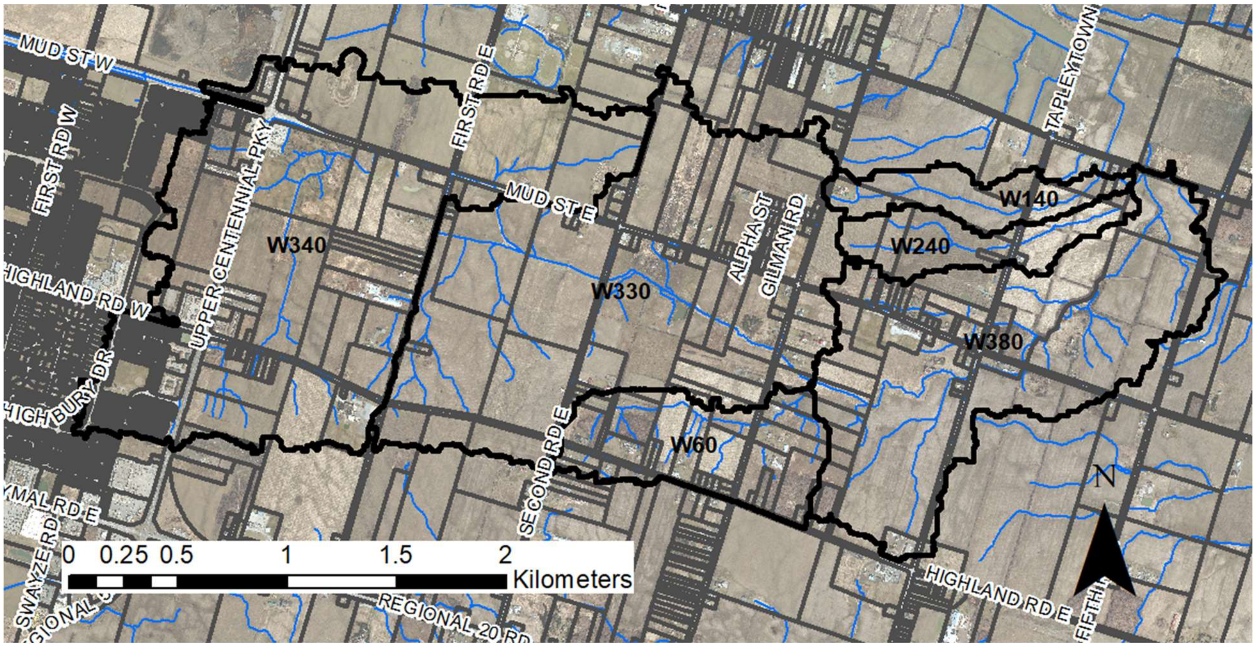


Figure A1 Subcatments for SC8

Table 1: Subcatchment Areas

Subcatchment	Area (km^2)
W340	2.506132
W60	0.52311
W330	2.2473
W380	1.570311
W240	0.280163
W140	0.25313

Table 2: Loss Parameters

	AMC II		AMC III	
Subcatchment	Curve Number	% Impervious	Curve Number	% Impervious
W340	83.724	10	92.207	10
W60	87.035	10	93.917	10
W330	86.87	10	93.834	10
W380	85.517	10	93.142	10
W240	85.538	10	93.152	10
W140	85.21	10	92.9829722	10

Table 3: Transform Parameters

Subcatchment	Time of Concentration (hours)	Storage Coefficient (hours)
W340	1.970604	1.86276
W60	1.107852	1.107852
W330	2.2059	2.147076
W380	2.294136	2.617668
W240	1.07844	1.705896
W140	1.07844	2.166684

Table 4: Reach Parameters

Reach	Length (m)	Slope (m/m)	Manning's n	Channel Shape	Channel Width	Channel Side Slope
R10	1953.6	0.000931	0.035	Trapezoid	2	3
R210	2703.9	0.0033285	0.035	Trapezoid	2	3

HEC-HMS Summary Output Table

Project No. 190 Project Name: SC-8 Wetland
Date 18-Oct-24

25mm Existing Uncontrolled Storm

Hydrologic Element	Drainage Area (km2)	Peack Discharge (m3/s)	Volume (mm)	Volume (1000M3)
W580	2	0.329	8.33	16.7
W430	0.6	0.444	8.94	4.9
J452	2.6	0.499	8.46	21.6
R160	2.6	0.495	8.46	21.6
W420	1.6	0.321	8.78	14.5
W410	0.5	0.297	8.48	4
J457	4.7	1.019	8.57	40.1
R150	4.7	1.018	8.58	40.1
W380	0.8	0.345	8.3	6.9
W370	0.8	0.399	7.41	5.8
J468	6.3	1.612	8.4	52.9
J100	2.5	2.105	11.65	29.2
W340_SC8	2.5	2.105	11.65	29.2
R10_SC8	2.5	2.019	11.57	29
W330_SC8	2.2	2.012	13.51	30.4
W60_SC8	0.5	0.759	13.62	7.1
J75	5.3	4.359	12.6	66.5
R210_SC8	5.3	4.345	12.6	66.5
W380_SC8	1.6	1.158	12.68	19.9
W240_SC8	0.3	0.287	12.69	3.6
SC-8 Inflows	7.1	5.634	12.62	89.9
W140_SC8	0.3	0.217	12.5	3.2
SC8 Outlet	7.4	5.804	12.62	93.1
R230	7.4	5.796	12.62	93.1
R140	6.3	0.265	5.67	35.7
W360	1.4	0.778	8.76	12.1
W530	0.1	0.152	10.03	1.2
J462	15.2	6.616	9.37	142.1
R130	15.2	6.486	9.4	142.6
W390	1.3	0.792	8.48	11.4
W350	0.9	0.351	9.25	8
J465	17.4	7.237	9.32	162
R1160	17.4	6.98	9.28	161.3
W1140	2	1.227	9.16	18.4
SC-5 Scenari	19.4	7.399	9.27	179.7
R3570	19.4	7.397	9.27	179.7
W3550	0.2	0.23	7.95	1.5
SC-5 Scenari	19.6	7.397	9.26	181.2
R3070	19.6	7.397	9.26	181.2
W3540	0	0.084	10.13	0.5
J479	19.6	7.397	9.26	181.7
R90	19.6	7.395	9.26	181.7
W3050	0.9	1.729	18.41	16.1
W320	0.6	0.391	19.08	11.3
J482	21.1	7.726	9.91	209.1
R3020	21.1	7.726	9.91	209.1
W3010	0	0.034	23.76	0.1
J486 - Flow G	21.1	7.726	9.91	209.1
R50	21.1	7.724	9.92	209.2
W450_BC1	1.4	0.541	6.24	8.6
W410_BC1	0.1	0.053	3.52	0.3
East Facility I	1.5	0.56	6.06	8.9

R220_BC1	1.5	0.559	6.06	8.9
W150_BC1	0.4	0.153	4.92	2.1
W390_BC1	0.1	0.042	4.38	0.3
W350_BC1	0	0.007	3.47	0.1
West Facility	0.5	0.185	4.78	2.5
R340_BC1	0.5	0.185	4.78	2.5
W440_BC1	0	0.033	8.44	0.1
W330_BC1	0	0.007	5.81	0
W230_BC1	0	0.008	8.11	0
J200_BC1	2	0.741	5.76	11.5
R300_BC1	2	0.74	5.76	11.5
W290_BC1	0.2	0.138	6.32	1.1
W90_BC1	0	0.012	11.16	0
W130_BC1	0	0.002	8.33	0
J100_BC1	2.2	0.819	5.81	12.7
R100	2.2	0.815	5.82	12.7
W330	1	0.68	12.69	12.7
W480	0.7	0.803	9.57	6.9
J477	3.9	1.903	8.27	32.3
R3120	3.9	1.903	8.27	32.3
W3110	1	1.15	10.57	10.9
J497	4.9	2.747	8.75	43.1
R750	4.9	2.747	8.75	43.1
W3100	1	2.129	13.38	13.2
J495	5.9	3.787	9.53	56.4
R80	5.9	3.78	9.54	56.5
W730	1.5	2.312	19.72	28.7
W3000	0.1	0.1	13.99	2
J493	28.6	9.647	10.36	296.4
R20	28.6	9.575	10.36	296.5
W840	1.7	1.584	17.77	31
W830	0.4	0.819	19.39	8
J485	2.2	2.316	18.08	39
R70	2.2	2.282	18.06	39
W250	0.7	1.52	22.8	16.3
W780	0.4	0.79	19.68	8.4
J487	3.3	4.408	19.3	63.7
R40	3.3	4.407	19.3	63.7
W290	0.4	0.803	20.71	8.7
W260	0	0.041	20.45	0.2
J490	32.3	13.926	11.41	369.1
R10	32.3	13.736	11.4	368.8
W240	1.2	3.118	22.97	28.7
Outlet	33.6	15.323	11.83	397.5

HEC-HMS Summary Output Table

Project No. 190 Project Name: SC-8 Wetland

Date 18-Oct-24

25mm Proposed Controlled Storm

Hydrologic Element	**Drainage Area (km2)**	**Peack Discharge (m3/s)**	**Volume (mm)**	**Volume (1000M3)**
W580	2	0.329	8.33	16.7
W430	0.6	0.444	8.94	4.9
J452	2.6	0.499	8.46	21.6
R160	2.6	0.495	8.46	21.6
W420	1.6	0.321	8.78	14.5
W410	0.5	0.297	8.48	4
J457	4.7	1.019	8.57	40.1
R150	4.7	1.018	8.58	40.1
W380	0.8	0.345	8.3	6.9
W370	0.8	0.399	7.41	5.8
J468	6.3	1.612	8.4	52.9
J100	2.5	2.105	11.65	29.2
W340_SC8	2.5	2.105	11.65	29.2
R10_SC8	2.5	2.019	11.57	29
W330_SC8	2.2	2.012	13.51	30.4
W60_SC8	0.5	0.759	13.62	7.1
J75	5.3	4.359	12.6	66.5
R210_SC8	5.3	4.345	12.6	66.5
W380_SC8	1.6	1.158	12.68	19.9
W240_SC8	0.3	0.287	12.69	3.6
SC-8 Inflows	7.1	5.634	12.62	89.9
SC-8 Wetlan	7.1	4.746	13.62	97.1
W140_SC8	0.3	0.217	12.5	3.2
SC8 Outlet	7.4	4.855	13.58	100.2
R230	7.4	4.852	13.62	100.5
R140	6.3	0.265	5.67	35.7
W360	1.4	0.778	8.76	12.1
W530	0.1	0.152	10.03	1.2
J462	15.2	5.507	9.85	149.5
R130	15.2	5.401	9.95	151
W390	1.3	0.792	8.48	11.4
W350	0.9	0.351	9.25	8
J465	17.4	5.898	9.8	170.3
R1160	17.4	5.764	9.87	171.5
W1140	2	1.227	9.16	18.4
SC-5 Scenari	19.4	6.055	9.79	189.8
R3570	19.4	6.053	9.8	189.9
W3550	0.2	0.23	7.95	1.5
SC-5 Scenari	19.6	6.053	9.78	191.4
R3070	19.6	6.052	9.78	191.4
W3540	0	0.084	10.13	0.5
J479	19.6	6.052	9.78	191.9
R90	19.6	6.051	9.79	192.1
W3050	0.9	1.729	18.41	16.1
W320	0.6	0.391	19.08	11.3
J482	21.1	6.308	10.4	219.4
R3020	21.1	6.308	10.41	219.5
W3010	0	0.034	23.76	0.1
J486 - Flow G	21.1	6.308	10.41	219.5
R50	21.1	6.306	10.42	219.8
W450_BC1	1.4	0.541	6.24	8.6
W410_BC1	0.1	0.053	3.52	0.3

East Facility I	1.5	0.56	6.06	8.9
East Facility_	1.5	0.025	2.02	3
R220_BC1	1.5	0.025	2.02	3
W150_BC1	0.4	0.153	4.92	2.1
W390_BC1	0.1	0.042	4.38	0.3
W350_BC1	0	0.007	3.47	0.1
West Facility	0.5	0.185	4.78	2.5
West Facility_	0.5	0	0	0
R340_BC1	0.5	0	0	0
W440_BC1	0	0.033	8.44	0.1
W330_BC1	0	0.007	5.81	0
W230_BC1	0	0.008	8.11	0
J200_BC1	2	0.046	1.57	3.2
R300_BC1	2	0.045	1.57	3.2
W290_BC1	0.2	0.138	6.32	1.1
W90_BC1	0	0.012	11.16	0
W130_BC1	0	0.002	8.33	0
J100_BC1	2.2	0.177	1.96	4.3
R100	2.2	0.168	1.96	4.3
W330	1	0.68	12.69	12.7
W480	0.7	0.803	9.57	6.9
J477	3.9	1.44	6.11	23.8
R3120	3.9	1.44	6.11	23.8
W3110	1	1.15	10.57	10.9
J497	4.9	2.478	7.04	34.7
R750	4.9	2.48	7.05	34.7
W3100	1	2.129	13.38	13.2
J495	5.9	3.722	8.1	48
R80	5.9	3.715	8.12	48
W730	1.5	2.312	19.72	28.7
W3000	0.1	0.1	13.99	2
J493	28.6	9.097	10.44	298.6
R20	28.6	9.013	10.44	298.8
W840	1.7	1.584	17.77	31
W830	0.4	0.819	19.39	8
J485	2.2	2.316	18.08	39
R70	2.2	2.282	18.06	39
W250	0.7	1.52	22.8	16.3
W780	0.4	0.79	19.68	8.4
J487	3.3	4.408	19.3	63.7
R40	3.3	4.407	19.3	63.7
W290	0.4	0.803	20.71	8.7
W260	0	0.041	20.45	0.2
J490	32.3	14.072	11.48	371.4
R10	32.3	13.872	11.5	371.8
W240	1.2	3.118	22.97	28.7
Outlet	33.6	15.473	11.92	400.5

HEC-HMS Summary Output Table

Project No. 190 Project Name: SC-8 Wetland

Date 18-Oct-24

2 Year Existing Uncontrolled Storm

Hydrologic Element	Drainage Area (km2)	Peack Discharge (m3/s)	Volume (mm)	Volume (1000M3)
W580	2	0.853	30.47	61
W430	0.6	1.128	30.9	17.1
J452	2.6	1.265	30.57	78.1
R160	2.6	1.228	30.55	78
W420	1.6	0.778	30.87	50.9
W410	0.5	0.758	30.38	14.5
J457	4.7	2.396	30.64	143.4
R150	4.7	2.394	30.66	143.5
W380	0.8	0.848	30.04	25.1
W370	0.8	1.088	28.65	22.3
J468	6.3	4.065	30.33	190.9
J100	2.5	4.369	34.48	86.4
W340_SC8	2.5	4.369	34.48	86.4
R10_SC8	2.5	4.159	34.38	86.2
W330_SC8	2.2	3.92	37.47	84.2
W60_SC8	0.5	1.496	37.63	19.7
J75	5.3	8.766	36.02	190.1
R210_SC8	5.3	8.733	36.02	190
W380_SC8	1.6	2.32	36.17	56.8
W240_SC8	0.3	0.591	36.19	10.1
SC-8 Inflows	7.1	11.334	36.06	257
W140_SC8	0.3	0.449	35.88	9.1
SC8 Outlet	7.4	11.668	36.05	266.1
R230	7.4	11.658	36.06	266.1
R140	6.3	1.758	29.56	186.1
W360	1.4	1.894	30.66	42.2
W530	0.1	0.38	32.83	4.1
J462	15.2	14.643	32.85	498.5
R130	15.2	14.166	32.78	497.5
W390	1.3	1.988	30.16	40.4
W350	0.9	0.806	31.22	27
J465	17.4	16.085	32.5	564.9
R1160	17.4	15.14	32.3	561.4
W1140	2	2.903	30.98	62.1
SC-5 Scenari	19.4	16.358	32.16	623.5
R3570	19.4	16.351	32.16	623.4
W3550	0.2	0.652	28.78	5.5
SC-5 Scenari	19.6	16.408	32.13	629
R3070	19.6	16.407	32.13	629
W3540	0	0.197	31.43	1.5
J479	19.6	16.421	32.13	630.5
R90	19.6	16.423	32.12	630.4
W3050	0.9	2.795	43.49	38
W320	0.6	0.649	44.37	26.2
J482	21.1	17.281	32.93	694.6
R3020	21.1	17.28	32.93	694.6
W3010	0	0.049	50.3	0.1
J486 - Flow G	21.1	17.281	32.94	694.7
R50	21.1	17.277	32.93	694.5
W450_BC1	1.4	1.306	23.02	31.6
W410_BC1	0.1	0.202	16.9	1.6
East Facility I	1.5	1.351	22.64	33.2

R220_BC1	1.5	1.348	22.63	33.2
W150_BC1	0.4	0.437	20.94	8.9
W390_BC1	0.1	0.143	19.48	1.3
W350_BC1	0	0.021	16.71	0.4
West Facility	0.5	0.534	20.55	10.6
R340_BC1	0.5	0.534	20.55	10.6
W440_BC1	0	0.089	28.86	0.5
W330_BC1	0	0.023	23.17	0.1
W230_BC1	0	0.023	28.19	0.1
J200_BC1	2	1.828	22.16	44.5
R300_BC1	2	1.824	22.16	44.5
W290_BC1	0.2	0.398	24.37	4.2
W90_BC1	0	0.028	33.79	0.1
W130_BC1	0	0.005	28.64	0
J100_BC1	2.2	2.009	22.36	48.8
R100	2.2	1.997	22.36	48.8
W330	1	1.354	36.05	36
W480	0.7	1.954	31.46	22.7
J477	3.9	4.281	27.54	107.4
R3120	3.9	4.281	27.55	107.4
W3110	1	2.574	32.71	33.6
J497	4.9	6.179	28.62	141.1
R750	4.9	6.178	28.62	141.1
W3100	1	4.089	36.37	36
J495	5.9	8.205	29.92	177
R80	5.9	8.197	29.94	177.2
W730	1.5	3.618	45.24	65.8
W3000	0.1	0.186	37.24	5.4
J493	28.6	21.559	32.96	943
R20	28.6	21.541	32.96	943.2
W840	1.7	2.662	42.56	74.3
W830	0.4	1.28	44.76	18.6
J485	2.2	3.813	42.98	92.8
R70	2.2	3.753	42.95	92.8
W250	0.7	2.177	49.15	35.2
W780	0.4	1.226	45.15	19.2
J487	3.3	6.958	44.58	147.1
R40	3.3	6.952	44.58	147.2
W290	0.4	1.224	46.51	19.5
W260	0	0.064	46.3	0.4
J490	32.3	25.684	34.33	1110.2
R10	32.3	25.546	34.29	1108.9
W240	1.2	4.449	49.35	61.6
Outlet	33.6	27.907	34.85	1170.5

HEC-HMS Summary Output Table

Project No. 190 Project Name: SC-8 Wetland

Date 18-Oct-24

2 Year Proposed Controlled Storm

Hydrologic Element	**Drainage Area (km2)**	**Peack Discharge (m3/s)**	**Volume (mm)**	**Volume (1000M3)**
W580	2	0.853	30.47	61
W430	0.6	1.128	30.9	17.1
J452	2.6	1.265	30.57	78.1
R160	2.6	1.228	30.55	78
W420	1.6	0.778	30.87	50.9
W410	0.5	0.758	30.38	14.5
J457	4.7	2.396	30.64	143.4
R150	4.7	2.394	30.66	143.5
W380	0.8	0.848	30.04	25.1
W370	0.8	1.088	28.65	22.3
J468	6.3	4.065	30.33	190.9
J100	2.5	4.369	34.48	86.4
W340_SC8	2.5	4.369	34.48	86.4
R10_SC8	2.5	4.159	34.38	86.2
W330_SC8	2.2	3.92	37.47	84.2
W60_SC8	0.5	1.496	37.63	19.7
J75	5.3	8.766	36.02	190.1
R210_SC8	5.3	8.733	36.02	190
W380_SC8	1.6	2.32	36.17	56.8
W240_SC8	0.3	0.591	36.19	10.1
SC-8 Inflows	7.1	11.334	36.06	257
SC-8 Wetlan	7.1	10.075	37.02	263.8
W140_SC8	0.3	0.449	35.88	9.1
SC8 Outlet	7.4	10.351	36.98	272.9
R230	7.4	10.344	37.02	273.2
R140	6.3	1.758	29.56	186.1
W360	1.4	1.894	30.66	42.2
W530	0.1	0.38	32.83	4.1
J462	15.2	13.177	33.32	505.6
R130	15.2	12.931	33.31	505.5
W390	1.3	1.988	30.16	40.4
W350	0.9	0.806	31.22	27
J465	17.4	14.576	32.96	572.9
R1160	17.4	13.934	32.87	571.4
W1140	2	2.903	30.98	62.1
SC-5 Scenari	19.4	14.97	32.68	633.4
R3570	19.4	14.967	32.68	633.4
W3550	0.2	0.652	28.78	5.5
SC-5 Scenari	19.6	15.018	32.64	639
R3070	19.6	15.017	32.64	639
W3540	0	0.197	31.43	1.5
J479	19.6	15.03	32.64	640.5
R90	19.6	15.03	32.64	640.5
W3050	0.9	2.795	43.49	38
W320	0.6	0.649	44.37	26.2
J482	21.1	15.794	33.42	704.8
R3020	21.1	15.793	33.42	704.8
W3010	0	0.049	50.3	0.1
J486 - Flow G	21.1	15.794	33.42	704.9
R50	21.1	15.793	33.42	705
W450_BC1	1.4	1.306	23.02	31.6
W410_BC1	0.1	0.202	16.9	1.6

East Facility I	1.5	1.351	22.64	33.2
East Facility_	1.5	0.183	15.55	22.8
R220_BC1	1.5	0.182	15.53	22.8
W150_BC1	0.4	0.437	20.94	8.9
W390_BC1	0.1	0.143	19.48	1.3
W350_BC1	0	0.021	16.71	0.4
West Facility	0.5	0.534	20.55	10.6
West Facility_	0.5	0.025	5.37	2.8
R340_BC1	0.5	0.025	5.37	2.8
W440_BC1	0	0.089	28.86	0.5
W330_BC1	0	0.023	23.17	0.1
W230_BC1	0	0.023	28.19	0.1
J200_BC1	2	0.209	13.07	26.2
R300_BC1	2	0.209	13.06	26.2
W290_BC1	0.2	0.398	24.37	4.2
W90_BC1	0	0.028	33.79	0.1
W130_BC1	0	0.005	28.64	0
J100_BC1	2.2	0.497	13.99	30.5
R100	2.2	0.469	13.93	30.4
W330	1	1.354	36.05	36
W480	0.7	1.954	31.46	22.7
J477	3.9	3.195	22.83	89
R3120	3.9	3.194	22.82	89
W3110	1	2.574	32.71	33.6
J497	4.9	5.555	24.89	122.6
R750	4.9	5.553	24.88	122.6
W3100	1	4.089	36.37	36
J495	5.9	8.023	26.8	158.6
R80	5.9	8.02	26.8	158.6
W730	1.5	3.618	45.24	65.8
W3000	0.1	0.186	37.24	5.4
J493	28.6	18.519	32.67	934.8
R20	28.6	18.503	32.68	935
W840	1.7	2.662	42.56	74.3
W830	0.4	1.28	44.76	18.6
J485	2.2	3.813	42.98	92.8
R70	2.2	3.753	42.95	92.8
W250	0.7	2.177	49.15	35.2
W780	0.4	1.226	45.15	19.2
J487	3.3	6.958	44.58	147.1
R40	3.3	6.952	44.58	147.2
W290	0.4	1.224	46.51	19.5
W260	0	0.064	46.3	0.4
J490	32.3	25.426	34.08	1102.1
R10	32.3	25.094	34.05	1101.2
W240	1.2	4.449	49.35	61.6
Outlet	33.6	27.569	34.62	1162.8

HEC-HMS Summary Output Table

Project No. 190 Project Name: SC-8 Wetland

Date 18-Oct-24

5 Year Existing Uncontrolled Storm

Hydrologic Element	**Drainage Area (km2)**	**Peack Discharge (m3/s)**	**Volume (mm)**	**Volume (1000M3)**
W580	2	1.202	41.57	83.2
W430	0.6	1.621	41.92	23.2
J452	2.6	1.823	41.65	106.4
R160	2.6	1.765	41.62	106.3
W420	1.6	1.094	41.93	69.1
W410	0.5	1.095	41.4	19.7
J457	4.7	3.429	41.71	195.2
R150	4.7	3.426	41.73	195.3
W380	0.8	1.224	41.02	34.3
W370	0.8	1.595	39.5	30.8
J468	6.3	5.888	41.36	260.4
J100	2.5	6.013	45.69	114.5
W340_SC8	2.5	6.013	45.69	114.5
R10_SC8	2.5	5.723	45.57	114.2
W330_SC8	2.2	5.286	48.98	110.1
W60_SC8	0.5	2.027	49.15	25.7
J75	5.3	11.982	**47.37**	250
R210_SC8	5.3	11.936	47.36	249.9
W380_SC8	1.6	3.152	47.55	74.7
W240_SC8	0.3	0.808	47.57	13.3
SC-8 Inflows	7.1	15.496	47.41	337.9
W140_SC8	0.3	0.615	47.23	12
SC8 Outlet	7.4	15.953	47.41	349.9
R230	7.4	15.94	47.41	349.9
R140	6.3	2.858	43.7	275.1
W360	1.4	2.714	41.67	57.4
W530	0.1	0.54	44.07	5.4
J462	15.2	20.695	45.32	687.9
R130	15.2	19.815	45.17	685.5
W390	1.3	2.866	41.11	55.1
W350	0.9	1.144	42.24	36.5
J465	17.4	22.475	44.71	777.1
R1160	17.4	20.767	44.34	770.7
W1140	2	4.135	41.95	84.1
SC-5 Scenari	19.4	22.322	44.1	854.8
R3570	19.4	22.314	44.09	854.7
W3550	0.2	0.954	39.46	7.6
SC-5 Scenari	19.6	22.384	44.05	862.3
R3070	19.6	22.382	44.05	862.3
W3540	0	0.281	42.21	2.1
J479	19.6	22.399	44.04	864.4
R90	19.6	22.401	44.03	864.2
W3050	0.9	3.675	55.24	48.3
W320	0.6	0.842	56.18	33.2
J482	21.1	23.451	44.84	945.7
R3020	21.1	23.45	44.84	945.7
W3010	0	0.063	62.39	0.2
J486 - Flow G	21.1	23.451	44.84	945.9
R50	21.1	23.448	44.83	945.6
W450_BC1	1.4	1.955	32.31	44.4
W410_BC1	0.1	0.343	24.98	2.3
East Facility I	1.5	2.023	31.85	46.7

R220_BC1	1.5	2.017	31.85	46.7
W150_BC1	0.4	0.679	30	12.7
W390_BC1	0.1	0.231	28.21	2
W350_BC1	0	0.035	24.74	0.6
West Facility	0.5	0.833	29.53	15.2
R340_BC1	0.5	0.832	29.53	15.2
W440_BC1	0	0.13	39.37	0.7
W330_BC1	0	0.035	32.71	0.1
W230_BC1	0	0.034	38.61	0.1
J200_BC1	2	2.749	31.33	62.9
R300_BC1	2	2.745	31.32	62.8
W290_BC1	0.2	0.602	34.13	5.8
W90_BC1	0	0.039	44.95	0.2
W130_BC1	0	0.007	39.12	0
J100_BC1	2.2	3.017	31.57	68.9
R100	2.2	2.998	31.57	68.9
W330	1	1.852	47.4	47.3
W480	0.7	2.787	42.44	30.6
J477	3.9	6.244	37.63	146.7
R3120	3.9	6.244	37.63	146.7
W3110	1	3.624	43.74	45
J497	4.9	9.027	38.91	191.7
R750	4.9	9.025	38.91	191.7
W3100	1	5.616	47.6	47.1
J495	5.9	11.65	40.36	238.8
R80	5.9	11.622	40.38	238.9
W730	1.5	4.698	57.1	83.1
W3000	0.1	0.252	48.55	7.1
J493	28.6	28.869	44.55	1274.7
R20	28.6	28.848	44.56	1274.9
W840	1.7	3.493	54.24	94.6
W830	0.4	1.667	56.59	23.5
J485	2.2	4.993	54.69	118.1
R70	2.2	4.915	54.65	118
W250	0.7	2.78	61.2	43.8
W780	0.4	1.594	57	24.2
J487	3.3	9.058	56.37	186.1
R40	3.3	9.055	56.38	186.1
W290	0.4	1.582	58.44	24.5
W260	0	0.083	58.25	0.5
J490	32.3	35.586	45.95	1486
R10	32.3	35.351	45.9	1484.3
W240	1.2	5.687	61.41	76.6
Outlet	33.6	38.355	46.47	1560.9

HEC-HMS Summary Output Table

Project No. 190 Project Name: SC-8 Wetland

Date 18-Oct-24

5 Year Proposed Controlled Storm

Hydrologic Element	Drainage Area (km2)	Peack Discharge (m3/s)	Volume (mm)	Volume (1000M3)
W580	2	1.202	41.57	83.2
W430	0.6	1.621	41.92	23.2
J452	2.6	1.823	41.65	106.4
R160	2.6	1.765	41.62	106.3
W420	1.6	1.094	41.93	69.1
W410	0.5	1.095	41.4	19.7
J457	4.7	3.429	41.71	195.2
R150	4.7	3.426	41.73	195.3
W380	0.8	1.224	41.02	34.3
W370	0.8	1.595	39.5	30.8
J468	6.3	5.888	41.36	260.4
J100	2.5	6.013	45.69	114.5
W340_SC8	2.5	6.013	45.69	114.5
R10_SC8	2.5	5.723	45.57	114.2
W330_SC8	2.2	5.286	48.98	110.1
W60_SC8	0.5	2.027	49.15	25.7
J75	5.3	11.982	47.37	250
R210_SC8	5.3	11.936	47.36	249.9
W380_SC8	1.6	3.152	47.55	74.7
W240_SC8	0.3	0.808	47.57	13.3
SC-8 Inflows	7.1	15.496	47.41	337.9
SC-8 Wetlan	7.1	14.588	48.38	344.8
W140_SC8	0.3	0.615	47.23	12
SC8 Outlet	7.4	14.988	48.34	356.7
R230	7.4	14.97	48.38	357
R140	6.3	2.858	43.7	275.1
W360	1.4	2.714	41.67	57.4
W530	0.1	0.54	44.07	5.4
J462	15.2	19.582	45.79	695
R130	15.2	18.738	45.71	693.7
W390	1.3	2.866	41.11	55.1
W350	0.9	1.144	42.24	36.5
J465	17.4	21.094	45.18	785.3
R1160	17.4	19.526	44.94	781.1
W1140	2	4.135	41.95	84.1
SC-5 Scenari	19.4	20.89	44.63	865.2
R3570	19.4	20.884	44.63	865.1
W3550	0.2	0.954	39.46	7.6
SC-5 Scenari	19.6	20.949	44.58	872.7
R3070	19.6	20.948	44.58	872.7
W3540	0	0.281	42.21	2.1
J479	19.6	20.964	44.57	874.8
R90	19.6	20.964	44.57	874.8
W3050	0.9	3.675	55.24	48.3
W320	0.6	0.842	56.18	33.2
J482	21.1	21.919	45.34	956.3
R3020	21.1	21.919	45.34	956.3
W3010	0	0.063	62.39	0.2
J486 - Flow G	21.1	21.92	45.34	956.5
R50	21.1	21.917	45.34	956.5
W450_BC1	1.4	1.955	32.31	44.4
W410_BC1	0.1	0.343	24.98	2.3

East Facility I	1.5	2.023	31.85	46.7
East Facility_	1.5	0.281	23.76	34.9
R220_BC1	1.5	0.281	23.75	34.8
W150_BC1	0.4	0.679	30	12.7
W390_BC1	0.1	0.231	28.21	2
W350_BC1	0	0.035	24.74	0.6
West Facility	0.5	0.833	29.53	15.2
West Facility_	0.5	0.058	13.13	6.8
R340_BC1	0.5	0.058	13.13	6.8
W440_BC1	0	0.13	39.37	0.7
W330_BC1	0	0.035	32.71	0.1
W230_BC1	0	0.034	38.61	0.1
J200_BC1	2	0.341	21.2	42.5
R300_BC1	2	0.341	21.18	42.5
W290_BC1	0.2	0.602	34.13	5.8
W90_BC1	0	0.039	44.95	0.2
W130_BC1	0	0.007	39.12	0
J100_BC1	2.2	0.747	22.24	48.5
R100	2.2	0.708	22.16	48.3
W330	1	1.852	47.4	47.3
W480	0.7	2.787	42.44	30.6
J477	3.9	4.511	32.37	126.2
R3120	3.9	4.511	32.36	126.2
W3110	1	3.624	43.74	45
J497	4.9	7.856	34.74	171.2
R750	4.9	7.857	34.73	171.1
W3100	1	5.616	47.6	47.1
J495	5.9	11.269	36.88	218.2
R80	5.9	11.255	36.87	218.2
W730	1.5	4.698	57.1	83.1
W3000	0.1	0.252	48.55	7.1
J493	28.6	25.436	44.21	1264.8
R20	28.6	25.415	44.21	1265
W840	1.7	3.493	54.24	94.6
W830	0.4	1.667	56.59	23.5
J485	2.2	4.993	54.69	118.1
R70	2.2	4.915	54.65	118
W250	0.7	2.78	61.2	43.8
W780	0.4	1.594	57	24.2
J487	3.3	9.058	56.37	186.1
R40	3.3	9.055	56.38	186.1
W290	0.4	1.582	58.44	24.5
W260	0	0.083	58.25	0.5
J490	32.3	34.475	45.64	1476.1
R10	32.3	34.139	45.6	1474.8
W240	1.2	5.687	61.41	76.6
Outlet	33.6	37.382	46.19	1551.4

HEC-HMS Summary Output Table

Project No. 190 Project Name: SC-8 Wetland

Date 18-Oct-24

10 Year Existing Uncontrolled Storm

Hydrologic Element	Drainage Area (km2)	Peack Discharge (m3/s)	Volume (mm)	Volume (1000M3)
W580	2	1.409	48	96
W430	0.6	1.919	48.31	26.7
J452	2.6	2.162	48.06	122.8
R160	2.6	2.092	48.04	122.7
W420	1.6	1.282	48.34	79.7
W410	0.5	1.297	47.78	22.8
J457	4.7	4.052	48.12	225.2
R150	4.7	4.049	48.15	225.3
W380	0.8	1.45	47.39	39.6
W370	0.8	1.902	45.81	35.7
J468	6.3	6.993	47.76	300.6
J100	2.5	7	52.16	130.7
W340_SC8	2.5	7	52.16	130.7
R10_SC8	2.5	6.661	52.02	130.4
W330_SC8	2.2	6.098	55.58	124.9
W60_SC8	0.5	2.347	55.76	29.2
J75	5.3	13.908	53.91	284.4
R210_SC8	5.3	13.856	53.89	284.4
W380_SC8	1.6	3.647	54.1	85
W240_SC8	0.3	0.939	54.12	15.2
SC-8 Inflows	7.1	17.982	53.95	384.5
W140_SC8	0.3	0.714	53.76	13.6
SC8 Outlet	7.4	18.52	53.94	398.1
R230	7.4	18.487	53.94	398.1
R140	6.3	3.479	50.93	320.6
W360	1.4	3.206	48.05	66.2
W530	0.1	0.636	50.57	6.2
J462	15.2	24.349	52.13	791.2
R130	15.2	23.166	51.91	787.8
W390	1.3	3.396	47.47	63.6
W350	0.9	1.348	48.62	42
J465	17.4	26.264	51.4	893.4
R1160	17.4	24.229	50.99	886.1
W1140	2	4.876	48.31	96.8
SC-5 Scenari	19.4	26.028	50.71	983
R3570	19.4	26.013	50.71	982.9
W3550	0.2	1.14	45.69	8.8
SC-5 Scenari	19.6	26.091	50.66	991.7
R3070	19.6	26.09	50.66	991.7
W3540	0	0.334	48.47	2.4
J479	19.6	26.109	50.65	994.1
R90	19.6	26.109	50.64	993.9
W3050	0.9	4.204	61.95	54.2
W320	0.6	0.956	62.91	37.2
J482	21.1	27.282	51.45	1085.2
R3020	21.1	27.281	51.45	1085.2
W3010	0	0.071	69.25	0.2
J486 - Flow G	21.1	27.283	51.46	1085.4
R50	21.1	27.277	51.44	1085.2
W450_BC1	1.4	2.364	37.86	52
W410_BC1	0.1	0.438	29.91	2.8
East Facility I	1.5	2.447	37.35	54.8

R220_BC1	1.5	2.438	37.35	54.8
W150_BC1	0.4	0.835	35.43	15
W390_BC1	0.1	0.288	33.48	2.3
W350_BC1	0	0.044	29.64	0.7
West Facility	0.5	1.024	34.91	18
R340_BC1	0.5	1.023	34.92	18
W440_BC1	0	0.156	45.52	0.8
W330_BC1	0	0.043	38.38	0.2
W230_BC1	0	0.041	44.7	0.2
J200_BC1	2	3.329	36.81	73.8
R300_BC1	2	3.323	36.8	73.8
W290_BC1	0.2	0.733	39.91	6.8
W90_BC1	0	0.046	51.39	0.2
W130_BC1	0	0.009	45.25	0
J100_BC1	2.2	3.649	37.07	80.9
R100	2.2	3.628	37.06	80.8
W330	1	2.15	53.94	53.8
W480	0.7	3.294	48.81	35.2
J477	3.9	7.452	43.55	169.8
R3120	3.9	7.452	43.55	169.8
W3110	1	4.262	50.13	51.6
J497	4.9	10.796	44.92	221.4
R750	4.9	10.805	44.93	221.4
W3100	1	6.554	54.07	53.5
J495	5.9	13.935	46.45	274.9
R80	5.9	13.934	46.48	275
W730	1.5	5.341	63.86	92.9
W3000	0.1	0.291	55.06	8
J493	28.6	33.451	51.07	1461.1
R20	28.6	33.424	51.07	1461.2
W840	1.7	3.987	60.92	106.3
W830	0.4	1.899	63.33	26.3
J485	2.2	5.696	61.39	132.6
R70	2.2	5.606	61.34	132.5
W250	0.7	3.139	68.04	48.7
W780	0.4	1.814	63.76	27.1
J487	3.3	10.306	63.1	208.3
R40	3.3	10.309	63.11	208.3
W290	0.4	1.796	65.23	27.4
W260	0	0.096	65.04	0.5
J490	32.3	41.649	52.49	1697.4
R10	32.3	41.326	52.43	1695.5
W240	1.2	6.427	68.25	85.1
Outlet	33.6	44.779	53.01	1780.6

HEC-HMS Summary Output Table

Project No. 190 Project Name: SC-8 Wetland
Date 18-Oct-24

10 Year Proposed Controlled Storm

Hydrologic Element	Drainage Area (km2)	Peack Discharge (m3/s)	Volume (mm)	Volume (1000M3)
W580	2	1.409	48	96
W430	0.6	1.919	48.31	26.7
J452	2.6	2.162	48.06	122.8
R160	2.6	2.092	48.04	122.7
W420	1.6	1.282	48.34	79.7
W410	0.5	1.297	47.78	22.8
J457	4.7	4.052	48.12	225.2
R150	4.7	4.049	48.15	225.3
W380	0.8	1.45	47.39	39.6
W370	0.8	1.902	45.81	35.7
J468	6.3	6.993	47.76	300.6
J100	2.5	7	52.16	130.7
W340_SC8	2.5	7	52.16	130.7
R10_SC8	2.5	6.661	52.02	130.4
W330_SC8	2.2	6.098	55.58	124.9
W60_SC8	0.5	2.347	55.76	29.2
J75	5.3	13.908	53.91	284.4
R210_SC8	5.3	13.856	53.89	284.4
W380_SC8	1.6	3.647	54.1	85
W240_SC8	0.3	0.939	54.12	15.2
SC-8 Inflows	7.1	17.982	53.95	384.5
SC-8 Wetlan	7.1	17.41	54.91	391.3
W140_SC8	0.3	0.714	53.76	13.6
SC8 Outlet	7.4	17.901	54.87	405
R230	7.4	17.873	54.91	405.2
R140	6.3	3.479	50.93	320.6
W360	1.4	3.206	48.05	66.2
W530	0.1	0.636	50.57	6.2
J462	15.2	23.594	52.6	798.3
R130	15.2	22.203	52.46	796.1
W390	1.3	3.396	47.47	63.6
W350	0.9	1.348	48.62	42
J465	17.4	25.008	51.88	901.7
R1160	17.4	22.959	51.58	896.4
W1140	2	4.876	48.31	96.8
SC-5 Scenari	19.4	24.542	51.24	993.3
R3570	19.4	24.534	51.24	993.2
W3550	0.2	1.14	45.69	8.8
SC-5 Scenari	19.6	24.606	51.19	1002
R3070	19.6	24.605	51.19	1002
W3540	0	0.334	48.47	2.4
J479	19.6	24.623	51.18	1004.4
R90	19.6	24.623	51.18	1004.4
W3050	0.9	4.204	61.95	54.2
W320	0.6	0.956	62.91	37.2
J482	21.1	25.7	51.95	1095.7
R3020	21.1	25.699	51.95	1095.7
W3010	0	0.071	69.25	0.2
J486 - Flow G	21.1	25.7	51.95	1095.9
R50	21.1	25.696	51.95	1095.9
W450_BC1	1.4	2.364	37.86	52
W410_BC1	0.1	0.438	29.91	2.8

East Facility I	1.5	2.447	37.35	54.8
East Facility_	1.5	0.367	28.76	42.2
R220_BC1	1.5	0.367	28.74	42.2
W150_BC1	0.4	0.835	35.43	15
W390_BC1	0.1	0.288	33.48	2.3
W350_BC1	0	0.044	29.64	0.7
West Facility	0.5	1.024	34.91	18
West Facility_	0.5	0.077	17.9	9.2
R340_BC1	0.5	0.077	17.9	9.2
W440_BC1	0	0.156	45.52	0.8
W330_BC1	0	0.043	38.38	0.2
W230_BC1	0	0.041	44.7	0.2
J200_BC1	2	0.447	26.15	52.5
R300_BC1	2	0.447	26.13	52.4
W290_BC1	0.2	0.733	39.91	6.8
W90_BC1	0	0.046	51.39	0.2
W130_BC1	0	0.009	45.25	0
J100_BC1	2.2	0.903	27.26	59.5
R100	2.2	0.858	27.17	59.3
W330	1	2.15	53.94	53.8
W480	0.7	3.294	48.81	35.2
J477	3.9	5.307	38.02	148.2
R3120	3.9	5.307	38.01	148.2
W3110	1	4.262	50.13	51.6
J497	4.9	9.251	40.54	199.8
R750	4.9	9.268	40.52	199.7
W3100	1	6.554	54.07	53.5
J495	5.9	13.426	42.79	253.2
R80	5.9	13.333	42.78	253.1
W730	1.5	5.341	63.86	92.9
W3000	0.1	0.291	55.06	8
J493	28.6	29.76	50.68	1449.9
R20	28.6	29.73	50.68	1450.2
W840	1.7	3.987	60.92	106.3
W830	0.4	1.899	63.33	26.3
J485	2.2	5.696	61.39	132.6
R70	2.2	5.606	61.34	132.5
W250	0.7	3.139	68.04	48.7
W780	0.4	1.814	63.76	27.1
J487	3.3	10.306	63.1	208.3
R40	3.3	10.309	63.11	208.3
W290	0.4	1.796	65.23	27.4
W260	0	0.096	65.04	0.5
J490	32.3	40.044	52.14	1686.4
R10	32.3	39.672	52.1	1684.8
W240	1.2	6.427	68.25	85.1
Outlet	33.6	43.397	52.7	1769.9

water's edge
ENVIRONMENTAL SOLUTIONS TEAM LTD.

HEC-HMS Summary Output Table

Project No. 190 Project Name: SC-8 Wetland

Date 18-Oct-24

25 Year Existing Uncontrolled Storm

Hydrologic Element	Drainage Area (km2)	Peack Discharge (m3/s)	Volume (mm)	Volume (1000M3)
W580	2	1.689	56.19	112.4
W430	0.6	2.332	56.47	31.3
J452	2.6	2.631	56.25	143.7
R160	2.6	2.499	56.18	143.5
W420	1.6	1.538	56.52	93.2
W410	0.5	1.577	55.94	26.7
J457	4.7	4.906	56.28	263.4
R150	4.7	4.899	56.3	263.5
W380	0.8	1.763	55.53	46.4
W370	0.8	2.325	53.88	42
J468	6.3	8.458	55.9	351.9
J100	2.5	8.366	60.4	151.4
W340_SC8	2.5	8.366	60.4	151.4
R10_SC8	2.5	7.959	60.24	151
W330_SC8	2.2	7.216	63.96	143.7
W60_SC8	0.5	2.792	64.15	33.6
J75	5.3	16.57	62.21	328.3
R210_SC8	5.3	16.494	62.2	328.2
W380_SC8	1.6	4.33	62.42	98
W240_SC8	0.3	1.12	62.45	17.5
SC-8 Inflows	7.1	21.416	62.26	443.7
W140_SC8	0.3	0.853	62.07	15.7
SC8 Outlet	7.4	22.048	62.25	459.4
R230	7.4	22.024	62.25	459.4
R140	6.3	4.323	59.86	376.8
W360	1.4	3.884	56.2	77.4
W530	0.1	0.77	58.83	7.3
J462	15.2	29.402	60.68	920.9
R130	15.2	27.746	60.36	916
W390	1.3	4.128	55.59	74.5
W350	0.9	1.628	56.77	49.1
J465	17.4	31.426	59.81	1039.5
R1160	17.4	28.947	59.32	1031
W1140	2	5.901	56.44	113.1
SC-5 Scenari	19.4	31.078	59.02	1144.1
R3570	19.4	31.059	59.02	1144
W3550	0.2	1.4	53.67	10.3
SC-5 Scenari	19.6	31.146	58.96	1154.3
R3070	19.6	31.145	58.96	1154.3
W3540	0	0.408	56.49	2.8
J479	19.6	31.166	58.96	1157.1
R90	19.6	31.136	58.94	1156.7
W3050	0.9	4.944	70.45	61.6
W320	0.6	1.112	71.44	42.2
J482	21.1	32.44	59.77	1260.6
R3020	21.1	32.438	59.77	1260.6
W3010	0	0.083	77.91	0.2
J486 - Flow G	21.1	32.44	59.77	1260.8
R50	21.1	32.44	59.76	1260.5
W450_BC1	1.4	2.945	45.06	61.9
W410_BC1	0.1	0.574	36.42	3.4
East Facility I	1.5	3.045	44.52	65.3

R220_BC1	1.5	3.035	44.51	65.3
W150_BC1	0.4	1.057	42.52	18
W390_BC1	0.1	0.371	40.37	2.8
W350_BC1	0	0.058	36.12	0.8
West Facility	0.5	1.297	41.95	21.6
R340_BC1	0.5	1.296	41.95	21.6
W440_BC1	0	0.191	53.4	0.9
W330_BC1	0	0.055	45.73	0.2
W230_BC1	0	0.051	52.54	0.2
J200_BC1	2	4.149	43.94	88.2
R300_BC1	2	4.139	43.94	88.2
W290_BC1	0.2	0.918	47.39	8.1
W90_BC1	0	0.056	59.61	0.2
W130_BC1	0	0.011	53.12	0
J100_BC1	2.2	4.54	44.24	96.5
R100	2.2	4.515	44.21	96.4
W330	1	2.56	62.25	62.1
W480	0.7	4.001	56.94	41
J477	3.9	9.143	51.18	199.6
R3120	3.9	9.142	51.18	199.6
W3110	1	5.153	58.28	59.9
J497	4.9	13.317	52.66	259.5
R750	4.9	13.31	52.66	259.5
W3100	1	7.865	62.31	61.6
J495	5.9	17.293	54.28	321.2
R80	5.9	17.22	54.3	321.3
W730	1.5	6.236	72.41	105.3
W3000	0.1	0.346	63.34	9.2
J493	28.6	39.409	59.29	1696.4
R20	28.6	39.369	59.29	1696.5
W840	1.7	4.669	69.39	121.1
W830	0.4	2.224	71.86	29.8
J485	2.2	6.669	69.86	150.9
R70	2.2	6.56	69.81	150.8
W250	0.7	3.641	76.67	54.9
W780	0.4	2.121	72.3	30.7
J487	3.3	12.043	71.62	236.4
R40	3.3	12.05	71.62	236.4
W290	0.4	2.095	73.81	31
W260	0	0.112	73.63	0.6
J490	32.3	50.026	60.74	1964.4
R10	32.3	49.565	60.67	1962.2
W240	1.2	7.467	76.89	95.9
Outlet	33.6	53.693	61.28	2058.1

HEC-HMS Summary Output Table

Project No. 190 Project Name: SC-8 Wetland

Date 18-Oct-24

25 Year Proposed Controlled Storm

Hydrologic Element	**Drainage Area (km2)**	**Peack Discharge (m3/s)**	**Volume (mm)**	**Volume (1000M3)**
W580	2	1.689	56.19	112.4
W430	0.6	2.332	56.47	31.3
J452	2.6	2.631	56.25	143.7
R160	2.6	2.499	56.18	143.5
W420	1.6	1.538	56.52	93.2
W410	0.5	1.577	55.94	26.7
J457	4.7	4.906	56.28	263.4
R150	4.7	4.899	56.3	263.5
W380	0.8	1.763	55.53	46.4
W370	0.8	2.325	53.88	42
J468	6.3	8.458	55.9	351.9
J100	2.5	8.366	60.4	151.4
W340_SC8	2.5	8.366	60.4	151.4
R10_SC8	2.5	7.959	60.24	151
W330_SC8	2.2	7.216	63.96	143.7
W60_SC8	0.5	2.792	64.15	33.6
J75	5.3	16.57	62.21	328.3
R210_SC8	5.3	16.494	62.2	328.2
W380_SC8	1.6	4.33	62.42	98
W240_SC8	0.3	1.12	62.45	17.5
SC-8 Inflows	7.1	21.416	62.26	443.7
SC-8 Wetlan	7.1	21.133	63.22	450.6
W140_SC8	0.3	0.853	62.07	15.7
SC8 Outlet	7.4	21.736	63.18	466.3
R230	7.4	21.69	63.22	466.5
R140	6.3	4.323	59.86	376.8
W360	1.4	3.884	56.2	77.4
W530	0.1	0.77	58.83	7.3
J462	15.2	29	61.15	928
R130	15.2	26.895	60.9	924.3
W390	1.3	4.128	55.59	74.5
W350	0.9	1.628	56.77	49.1
J465	17.4	30.297	60.29	1047.8
R1160	17.4	27.645	59.92	1041.4
W1140	2	5.901	56.44	113.1
SC-5 Scenari	19.4	29.555	59.56	1154.5
R3570	19.4	29.537	59.56	1154.4
W3550	0.2	1.4	53.67	10.3
SC-5 Scenari	19.6	29.618	59.5	1164.8
R3070	19.6	29.617	59.5	1164.8
W3540	0	0.408	56.49	2.8
J479	19.6	29.637	59.49	1167.5
R90	19.6	29.606	59.48	1167.4
W3050	0.9	4.944	70.45	61.6
W320	0.6	1.112	71.44	42.2
J482	21.1	30.815	60.27	1271.2
R3020	21.1	30.815	60.27	1271.2
W3010	0	0.083	77.91	0.2
J486 - Flow G	21.1	30.816	60.28	1271.5
R50	21.1	30.815	60.27	1271.4
W450_BC1	1.4	2.945	45.06	61.9
W410_BC1	0.1	0.574	36.42	3.4

East Facility I	1.5	3.045	44.52	65.3
East Facility_	1.5	0.48	35.49	52.1
R220_BC1	1.5	0.48	35.48	52
W150_BC1	0.4	1.057	42.52	18
W390_BC1	0.1	0.371	40.37	2.8
W350_BC1	0	0.058	36.12	0.8
West Facility	0.5	1.297	41.95	21.6
West Facility_	0.5	0.103	24.2	12.5
R340_BC1	0.5	0.103	24.19	12.5
W440_BC1	0	0.191	53.4	0.9
W330_BC1	0	0.055	45.73	0.2
W230_BC1	0	0.051	52.54	0.2
J200_BC1	2	0.588	32.78	65.8
R300_BC1	2	0.588	32.76	65.7
W290_BC1	0.2	0.918	47.39	8.1
W90_BC1	0	0.056	59.61	0.2
W130_BC1	0	0.011	53.12	0
J100_BC1	2.2	1.123	33.96	74.1
R100	2.2	1.069	33.86	73.8
W330	1	2.56	62.25	62.1
W480	0.7	4.001	56.94	41
J477	3.9	6.418	45.39	177
R3120	3.9	6.419	45.38	177
W3110	1	5.153	58.28	59.9
J497	4.9	11.196	48.07	236.9
R750	4.9	11.212	48.06	236.8
W3100	1	7.865	62.31	61.6
J495	5.9	16.144	50.44	298.5
R80	5.9	16.127	50.42	298.3
W730	1.5	6.236	72.41	105.3
W3000	0.1	0.346	63.34	9.2
J493	28.6	35.442	58.87	1684.3
R20	28.6	35.404	58.87	1684.5
W840	1.7	4.669	69.39	121.1
W830	0.4	2.224	71.86	29.8
J485	2.2	6.669	69.86	150.9
R70	2.2	6.56	69.81	150.8
W250	0.7	3.641	76.67	54.9
W780	0.4	2.121	72.3	30.7
J487	3.3	12.043	71.62	236.4
R40	3.3	12.05	71.62	236.4
W290	0.4	2.095	73.81	31
W260	0	0.112	73.63	0.6
J490	32.3	47.789	60.37	1952.4
R10	32.3	47.335	60.31	1950.5
W240	1.2	7.467	76.89	95.9
Outlet	33.6	51.736	60.93	2046.4

HEC-HMS Summary Output Table

Project No. 190: Project Name: SC-8 Wetland

Date 18-Oct-24

50 Year Existing Uncontrolled Storm

Hydrologic Element	Drainage Area (km2)	Peack Discharge (m3/s)	Volume (mm)	Volume (1000M3)
W580	2	1.92	63.57	127.2
W430	0.6	2.649	63.81	35.3
J452	2.6	2.998	63.63	162.5
R160	2.6	2.761	63.47	162.1
W420	1.6	1.748	63.89	105.4
W410	0.5	1.794	63.29	30.2
J457	4.7	5.556	63.6	297.7
R150	4.7	5.552	63.62	297.7
W380	0.8	2.01	62.87	52.6
W370	0.8	2.657	61.17	47.7
J468	6.3	9.506	63.22	398
J100	2.5	9.414	67.81	169.9
W340_SC8	2.5	9.414	67.81	169.9
R10_SC8	2.5	8.955	67.64	169.5
W330_SC8	2.2	8.07	71.48	160.6
W60_SC8	0.5	3.121	71.68	37.5
J75	5.3	18.617	69.68	367.6
R210_SC8	5.3	18.535	69.66	367.6
W380_SC8	1.6	4.858	69.9	109.8
W240_SC8	0.3	1.257	69.92	19.6
SC-8 Inflows	7.1	24.058	69.72	496.9
W140_SC8	0.3	0.958	69.54	17.6
SC8 Outlet	7.4	24.781	69.72	514.5
R230	7.4	24.742	69.72	514.5
R140	6.3	5.054	67.63	425.8
W360	1.4	4.414	63.55	87.5
W530	0.1	0.869	66.27	8.2
J462	15.2	33.327	68.26	1036
R130	15.2	31.472	67.89	1030.3
W390	1.3	4.698	62.91	84.3
W350	0.9	1.85	64.12	55.4
J465	17.4	35.687	67.32	1170
R1160	17.4	32.771	66.77	1160.5
W1140	2	6.699	63.77	127.8
SC-5 Scenari	19.4	35.212	66.46	1288.2
R3570	19.4	35.188	66.45	1288.1
W3550	0.2	1.597	60.89	11.7
SC-5 Scenari	19.6	35.286	66.4	1299.8
R3070	19.6	35.284	66.4	1299.8
W3540	0	0.464	63.73	3.1
J479	19.6	35.309	66.39	1303
R90	19.6	35.276	66.38	1302.8
W3050	0.9	5.481	78.06	68.2
W320	0.6	1.232	79.07	46.7
J482	21.1	36.735	67.22	1417.8
R3020	21.1	36.734	67.22	1417.8
W3010	0	0.092	85.63	0.2
J486 - Flow G	21.1	36.735	67.22	1418
R50	21.1	36.737	67.21	1417.7
W450_BC1	1.4	3.414	51.66	71
W410_BC1	0.1	0.685	42.45	3.9
East Facility I	1.5	3.529	51.08	74.9

R220_BC1	1.5	3.517	51.07	74.9
W150_BC1	0.4	1.237	49.02	20.7
W390_BC1	0.1	0.439	46.72	3.2
W350_BC1	0	0.069	42.13	1
West Facility	0.5	1.518	48.41	24.9
R340_BC1	0.5	1.516	48.41	24.9
W440_BC1	0	0.218	60.54	1
W330_BC1	0	0.064	52.45	0.2
W230_BC1	0	0.058	59.63	0.2
J200_BC1	2	4.814	50.49	101.3
R300_BC1	2	4.804	50.48	101.3
W290_BC1	0.2	1.062	54.21	9.2
W90_BC1	0	0.063	67	0.3
W130_BC1	0	0.012	60.25	0
J100_BC1	2.2	5.268	50.8	110.8
R100	2.2	5.233	50.76	110.7
W330	1	2.877	69.72	69.5
W480	0.7	4.534	64.27	46.3
J477	3.9	10.434	58.11	226.6
R3120	3.9	10.434	58.11	226.6
W3110	1	5.825	65.63	67.5
J497	4.9	15.295	59.68	294.1
R750	4.9	15.305	59.68	294.1
W3100	1	8.829	69.73	69
J495	5.9	19.957	61.36	363.1
R80	5.9	19.877	61.37	363.2
W730	1.5	6.893	80.05	116.5
W3000	0.1	0.388	70.78	10.3
J493	28.6	44.664	66.67	1907.7
R20	28.6	44.621	66.68	1907.7
W840	1.7	5.186	76.97	134.3
W830	0.4	2.459	79.49	33
J485	2.2	7.398	77.46	167.3
R70	2.2	7.275	77.39	167.1
W250	0.7	4.002	84.38	60.4
W780	0.4	2.344	79.94	34
J487	3.3	13.334	79.24	261.5
R40	3.3	13.335	79.24	261.6
W290	0.4	2.312	81.48	34.2
W260	0	0.124	81.31	0.6
J490	32.3	56.624	68.16	2204.1
R10	32.3	56.011	68.08	2201.6
W240	1.2	8.205	84.6	105.5
Outlet	33.6	60.668	68.69	2307.2

HEC-HMS Summary Output Table

Project No. 190 Project Name: SC-8 Wetland

Date 18-Oct-24

50 Year Proposed Controlled Storm

Hydrologic Element	**Drainage Area (km2)**	**Peack Discharge (m3/s)**	**Volume (mm)**	**Volume (1000M3)**
W580	2	1.92	63.57	127.2
W430	0.6	2.649	63.81	35.3
J452	2.6	2.998	63.63	162.5
R160	2.6	2.761	63.47	162.1
W420	1.6	1.748	63.89	105.4
W410	0.5	1.794	63.29	30.2
J457	4.7	5.556	63.6	297.7
R150	4.7	5.552	63.62	297.7
W380	0.8	2.01	62.87	52.6
W370	0.8	2.657	61.17	47.7
J468	6.3	9.506	63.22	398
J100	2.5	9.414	67.81	169.9
W340_SC8	2.5	9.414	67.81	169.9
R10_SC8	2.5	8.955	67.64	169.5
W330_SC8	2.2	8.07	71.48	160.6
W60_SC8	0.5	3.121	71.68	37.5
J75	5.3	18.617	69.68	367.6
R210_SC8	5.3	18.535	69.66	367.6
W380_SC8	1.6	4.858	69.9	109.8
W240_SC8	0.3	1.257	69.92	19.6
SC-8 Inflows	7.1	24.058	69.72	496.9
SC-8 Wetlan	7.1	23.894	70.68	503.8
W140_SC8	0.3	0.958	69.54	17.6
SC8 Outlet	7.4	24.585	70.65	521.4
R230	7.4	24.541	70.68	521.6
R140	6.3	5.054	67.63	425.8
W360	1.4	4.414	63.55	87.5
W530	0.1	0.869	66.27	8.2
J462	15.2	33.08	68.73	1043.1
R130	15.2	30.73	68.44	1038.7
W390	1.3	4.698	62.91	84.3
W350	0.9	1.85	64.12	55.4
J465	17.4	34.658	67.8	1178.4
R1160	17.4	31.526	67.37	1171
W1140	2	6.699	63.77	127.8
SC-5 Scenari	19.4	33.741	67	1298.8
R3570	19.4	33.715	67	1298.7
W3550	0.2	1.597	60.89	11.7
SC-5 Scenari	19.6	33.808	66.94	1310.4
R3070	19.6	33.805	66.94	1310.4
W3540	0	0.464	63.73	3.1
J479	19.6	33.828	66.93	1313.5
R90	19.6	33.798	66.92	1313.4
W3050	0.9	5.481	78.06	68.2
W320	0.6	1.232	79.07	46.7
J482	21.1	35.172	67.73	1428.4
R3020	21.1	35.171	67.73	1428.4
W3010	0	0.092	85.63	0.2
J486 - Flow G	21.1	35.172	67.73	1428.6
R50	21.1	35.163	67.72	1428.6
W450_BC1	1.4	3.414	51.66	71
W410_BC1	0.1	0.685	42.45	3.9

East Facility I	1.5	3.529	51.08	74.9
East Facility_	1.5	0.582	41.63	61.1
R220_BC1	1.5	0.582	41.61	61
W150_BC1	0.4	1.237	49.02	20.7
W390_BC1	0.1	0.439	46.72	3.2
W350_BC1	0	0.069	42.13	1
West Facility	0.5	1.518	48.41	24.9
West Facility_	0.5	0.129	30	15.4
R340_BC1	0.5	0.129	30	15.4
W440_BC1	0	0.218	60.54	1
W330_BC1	0	0.064	52.45	0.2
W230_BC1	0	0.058	59.63	0.2
J200_BC1	2	0.716	38.84	77.9
R300_BC1	2	0.716	38.82	77.9
W290_BC1	0.2	1.062	54.21	9.2
W90_BC1	0	0.063	67	0.3
W130_BC1	0	0.012	60.25	0
J100_BC1	2.2	1.294	40.08	87.4
R100	2.2	1.228	39.95	87.1
W330	1	2.877	69.72	69.5
W480	0.7	4.534	64.27	46.3
J477	3.9	7.281	52.06	203
R3120	3.9	7.281	52.06	203
W3110	1	5.825	65.63	67.5
J497	4.9	12.687	54.89	270.5
R750	4.9	12.704	54.87	270.4
W3100	1	8.829	69.73	69
J495	5.9	18.254	57.36	339.4
R80	5.9	18.184	57.32	339.2
W730	1.5	6.893	80.05	116.5
W3000	0.1	0.388	70.78	10.3
J493	28.6	40.525	66.22	1894.6
R20	28.6	40.481	66.22	1894.7
W840	1.7	5.186	76.97	134.3
W830	0.4	2.459	79.49	33
J485	2.2	7.398	77.46	167.3
R70	2.2	7.275	77.39	167.1
W250	0.7	4.002	84.38	60.4
W780	0.4	2.344	79.94	34
J487	3.3	13.334	79.24	261.5
R40	3.3	13.335	79.24	261.6
W290	0.4	2.312	81.48	34.2
W260	0	0.124	81.31	0.6
J490	32.3	53.834	67.75	2191.1
R10	32.3	53.305	67.68	2188.9
W240	1.2	8.205	84.6	105.5
Outlet	33.6	58.222	68.31	2294.4

HEC-HMS Summary Output Table

Project No. 190 Project Name: SC-8 Wetland

Date 18-Oct-24

100 Year Existing Uncontrolled Storm

Hydrologic Element	**Drainage Area (km2)**	**Peack Discharge (m3/s)**	**Volume (mm)**	**Volume (1000M3)**
W580	2	2.154	70.88	141.8
W430	0.6	2.97	71.1	39.4
J452	2.6	3.371	70.93	181.2
R160	2.6	3.022	70.68	180.5
W420	1.6	1.96	71.19	117.4
W410	0.5	2.015	70.58	33.6
J457	4.7	6.185	70.85	331.6
R150	4.7	6.182	70.87	331.7
W380	0.8	2.26	70.14	58.7
W370	0.8	2.995	68.4	53.3
J468	6.3	10.536	70.47	443.6
J100	2.5	10.478	75.14	188.3
W340_SC8	2.5	10.478	75.14	188.3
R10_SC8	2.5	9.975	74.96	187.9
W330_SC8	2.2	8.935	78.91	177.3
W60_SC8	0.5	3.455	79.11	41.4
J75	5.3	20.691	77.05	406.6
R210_SC8	5.3	20.608	77.04	406.5
W380_SC8	1.6	5.393	77.29	121.4
W240_SC8	0.3	1.395	77.31	21.7
SC-8 Inflows	7.1	26.762	77.1	549.5
W140_SC8	0.3	1.065	76.92	19.5
SC8 Outlet	7.4	27.563	77.1	569
R230	7.4	27.522	77.1	569
R140	6.3	5.791	75.24	473.7
W360	1.4	4.952	70.83	97.5
W530	0.1	0.97	73.62	9.1
J462	15.2	37.316	75.73	1149.3
R130	15.2	35.245	75.31	1142.9
W390	1.3	5.277	70.17	94
W350	0.9	2.074	71.4	61.7
J465	17.4	40.024	74.72	1298.6
R1160	17.4	36.602	74.1	1287.9
W1140	2	7.51	71.03	142.4
SC-5 Scenari	19.4	39.371	73.78	1430.2
R3570	19.4	39.344	73.78	1430.1
W3550	0.2	1.796	68.05	13.1
SC-5 Scenari	19.6	39.453	73.72	1443.2
R3070	19.6	39.451	73.72	1443.2
W3540	0	0.52	70.92	3.5
J479	19.6	39.478	73.71	1446.7
R90	19.6	39.442	73.69	1446.3
W3050	0.9	6.027	85.57	74.8
W320	0.6	1.354	86.58	51.2
J482	21.1	41.065	74.55	1572.3
R3020	21.1	41.063	74.55	1572.2
W3010	0	0.1	93.23	0.3
J486 - Flow G	21.1	41.064	74.55	1572.5
R50	21.1	41.066	74.53	1572.2
W450_BC1	1.4	3.898	58.28	80.1
W410_BC1	0.1	0.799	48.55	4.5
East Facility I	1.5	4.028	57.66	84.6

R220_BC1	1.5	4.014	57.66	84.6
W150_BC1	0.4	1.422	55.56	23.5
W390_BC1	0.1	0.509	53.12	3.7
W350_BC1	0	0.081	48.21	1.1
West Facility	0.5	1.746	54.91	28.3
R340_BC1	0.5	1.745	54.91	28.3
W440_BC1	0	0.245	67.64	1.1
W330_BC1	0	0.073	59.17	0.3
W230_BC1	0	0.065	66.7	0.2
J200_BC1	2	5.5	57.05	114.5
R300_BC1	2	5.491	57.05	114.5
W290_BC1	0.2	1.21	61.03	10.4
W90_BC1	0	0.07	74.32	0.3
W130_BC1	0	0.014	67.33	0
J100_BC1	2.2	6.018	57.39	125.2
R100	2.2	5.976	57.34	125.1
W330	1	3.198	77.1	76.9
W480	0.7	5.076	71.54	51.6
J477	3.9	11.802	65.02	253.5
R3120	3.9	11.801	65.02	253.5
W3110	1	6.509	72.9	75
J497	4.9	17.281	66.67	328.5
R750	4.9	17.271	66.67	328.6
W3100	1	9.809	77.06	76.2
J495	5.9	22.662	68.41	404.8
R80	5.9	22.641	68.42	404.9
W730	1.5	7.562	87.59	127.4
W3000	0.1	0.431	78.14	11.4
J493	28.6	50	73.95	2115.8
R20	28.6	49.951	73.95	2115.9
W840	1.7	5.71	84.45	147.4
W830	0.4	2.699	87.02	36.1
J485	2.2	8.138	84.94	183.4
R70	2.2	8.006	84.87	183.3
W250	0.7	4.371	91.97	65.9
W780	0.4	2.572	87.47	37.2
J487	3.3	14.647	86.75	286.3
R40	3.3	14.641	86.75	286.3
W290	0.4	2.532	89.03	37.4
W260	0	0.136	88.87	0.7
J490	32.3	63.284	75.46	2440.3
R10	32.3	62.497	75.37	2437.5
W240	1.2	8.96	92.2	115
Outlet	33.6	67.731	76	2552.5

HEC-HMS Summary Output Table

Project No. 190 Project Name: SC-8 Wetland

Date 18-Oct-24

100 Year Proposed Controlled Storm

Hydrologic Element	**Drainage Area (km2)**	**Peack Discharge (m3/s)**	**Volume (mm)**	**Volume (1000M3)**
W580	2	2.154	70.88	141.8
W430	0.6	2.97	71.1	39.4
J452	2.6	3.371	70.93	181.2
R160	2.6	3.022	70.68	180.5
W420	1.6	1.96	71.19	117.4
W410	0.5	2.015	70.58	33.6
J457	4.7	6.185	70.85	331.6
R150	4.7	6.182	70.87	331.7
W380	0.8	2.26	70.14	58.7
W370	0.8	2.995	68.4	53.3
J468	6.3	10.536	70.47	443.6
J100	2.5	10.478	75.14	188.3
W340_SC8	2.5	10.478	75.14	188.3
R10_SC8	2.5	9.975	74.96	187.9
W330_SC8	2.2	8.935	78.91	177.3
W60_SC8	0.5	3.455	79.11	41.4
J75	5.3	20.691	77.05	406.6
R210_SC8	5.3	20.608	77.04	406.5
W380_SC8	1.6	5.393	77.29	121.4
W240_SC8	0.3	1.395	77.31	21.7
SC-8 Inflows	7.1	26.762	77.1	549.5
SC-8 Wetlan	7.1	26.602	78.06	556.4
W140_SC8	0.3	1.065	76.92	19.5
SC8 Outlet	7.4	27.367	78.02	575.8
R230	7.4	27.332	78.06	576.1
R140	6.3	5.791	75.24	473.7
W360	1.4	4.952	70.83	97.5
W530	0.1	0.97	73.62	9.1
J462	15.2	37.068	76.2	1156.4
R130	15.2	34.601	75.85	1151.2
W390	1.3	5.277	70.17	94
W350	0.9	2.074	71.4	61.7
J465	17.4	39.1	75.2	1306.9
R1160	17.4	35.398	74.71	1298.4
W1140	2	7.51	71.03	142.4
SC-5 Scenari	19.4	37.939	74.33	1440.8
R3570	19.4	37.913	74.32	1440.7
W3550	0.2	1.796	68.05	13.1
SC-5 Scenari	19.6	38.016	74.26	1453.8
R3070	19.6	38.015	74.26	1453.8
W3540	0	0.52	70.92	3.5
J479	19.6	38.04	74.25	1457.3
R90	19.6	38.002	74.25	1457.1
W3050	0.9	6.027	85.57	74.8
W320	0.6	1.354	86.58	51.2
J482	21.1	39.535	75.06	1583.1
R3020	21.1	39.533	75.06	1583.1
W3010	0	0.1	93.23	0.3
J486 - Flow G	21.1	39.535	75.06	1583.4
R50	21.1	39.534	75.06	1583.3
W450_BC1	1.4	3.898	58.28	80.1
W410_BC1	0.1	0.799	48.55	4.5

East Facility I	1.5	4.028	57.66	84.6
East Facility_	1.5	0.724	47.91	70.3
R220_BC1	1.5	0.724	47.88	70.2
W150_BC1	0.4	1.422	55.56	23.5
W390_BC1	0.1	0.509	53.12	3.7
W350_BC1	0	0.081	48.21	1.1
West Facility	0.5	1.746	54.91	28.3
West Facility_	0.5	0.155	35.86	18.5
R340_BC1	0.5	0.155	35.86	18.5
W440_BC1	0	0.245	67.64	1.1
W330_BC1	0	0.073	59.17	0.3
W230_BC1	0	0.065	66.7	0.2
J200_BC1	2	0.886	45.02	90.3
R300_BC1	2	0.885	45	90.3
W290_BC1	0.2	1.21	61.03	10.4
W90_BC1	0	0.07	74.32	0.3
W130_BC1	0	0.014	67.33	0
J100_BC1	2.2	1.468	46.31	101
R100	2.2	1.392	46.16	100.7
W330	1	3.198	77.1	76.9
W480	0.7	5.076	71.54	51.6
J477	3.9	8.174	58.77	229.2
R3120	3.9	8.173	58.76	229.1
W3110	1	6.509	72.9	75
J497	4.9	14.211	61.71	304.1
R750	4.9	14.237	61.69	304
W3100	1	9.809	77.06	76.2
J495	5.9	20.387	64.26	380.2
R80	5.9	20.412	64.22	380
W730	1.5	7.562	87.59	127.4
W3000	0.1	0.431	78.14	11.4
J493	28.6	45.642	73.47	2102.1
R20	28.6	45.594	73.47	2102.2
W840	1.7	5.71	84.45	147.4
W830	0.4	2.699	87.02	36.1
J485	2.2	8.138	84.94	183.4
R70	2.2	8.006	84.87	183.3
W250	0.7	4.371	91.97	65.9
W780	0.4	2.572	87.47	37.2
J487	3.3	14.647	86.75	286.3
R40	3.3	14.641	86.75	286.3
W290	0.4	2.532	89.03	37.4
W260	0	0.136	88.87	0.7
J490	32.3	59.974	75.03	2426.6
R10	32.3	59.321	74.96	2424.1
W240	1.2	8.96	92.2	115
Outlet	33.6	64.796	75.6	2539.1

HEC-HMS Summary Output Table

Project No. 190 Project Name: SC-8 Wetland

Date 18-Oct-24

Hazel AMC III Existing Uncontrolled Storm

Hydrologic Element	Drainage Area (km2)	Peack Discharge (m3/s)	Volume (mm)	Volume (1000M3)
W580	2	6.471	184.64	369.4
W430	0.6	5.386	184.55	102.2
J452	2.6	9.483	184.62	471.6
R160	2.6	8.205	183.45	468.6
W420	1.6	5.932	184.8	304.7
W410	0.5	4.189	184.07	87.7
J457	4.7	16.436	183.99	861.1
R150	4.7	16.428	184	861.1
W380	0.8	5.707	183.53	153.5
W370	0.8	6.596	181.49	141.4
J468	6.3	26.672	183.62	1156
J100	2.5	21.367	188.94	473.5
W340_SC8	2.5	21.367	188.94	473.5
R10_SC8	2.5	21.012	188.73	473
W330_SC8	2.2	18.267	193.4	434.6
W60_SC8	0.5	5.357	193.63	101.3
J75	5.3	43.535	191.2	1008.9
R210_SC8	5.3	43.46	191.19	1008.8
W380_SC8	1.6	11.826	191.5	300.7
W240_SC8	0.3	2.547	191.53	53.7
SC-8 Inflows	7.1	57.401	191.27	1363.2
W140_SC8	0.3	2.127	191.07	48.4
SC8 Outlet	7.4	59.306	191.26	1411.6
R230	7.4	59.265	191.25	1411.5
R140	6.3	20.993	190.49	1199.2
W360	1.4	11.099	184.28	253.8
W530	0.1	1.365	187.62	23.2
J462	15.2	90.948	190.28	2887.7
R130	15.2	88.618	189.84	2881.1
W390	1.3	11.369	183.47	245.8
W350	0.9	5.413	184.83	159.8
J465	17.4	102.344	189.1	3286.6
R1160	17.4	95.498	188.04	3268.2
W1140	2	16.481	184.34	369.4
SC-5 Scenari	19.4	103.357	187.66	3637.7
R3570	19.4	103.264	187.65	3637.4
W3550	0.2	2.341	180.63	34.8
SC-5 Scenari	19.6	103.282	187.58	3672.2
R3070	19.6	103.277	187.58	3672.2
W3540	0	0.612	183.61	9
J479	19.6	103.28	187.57	3681.2
R90	19.6	103.224	187.56	3680.9
W3050	0.9	8.888	200.56	175.3
W320	0.6	3.275	201.68	119.2
J482	21.1	106.647	188.49	3975.4
R3020	21.1	106.645	188.49	3975.4
W3010	0	0.04	208.89	0.6
J486 - Flow G	21.1	106.645	188.49	3976
R50	21.1	106.636	188.47	3975.5
W450_BC1	1.4	11.205	189.15	259.9
W410_BC1	0.1	1.259	181.58	16.8
East Facility I	1.5	11.675	188.67	276.8

R220_BC1	1.5	11.673	188.67	276.8
W150_BC1	0.4	3.841	187.51	79.3
W390_BC1	0.1	0.866	185.53	12.8
W350_BC1	0	0.224	181.27	4.1
West Facility	0.5	4.768	186.97	96.3
R340_BC1	0.5	4.766	186.97	96.3
W440_BC1	0	0.235	196.09	3.2
W330_BC1	0	0.063	190.27	0.8
W230_BC1	0	0.051	195.48	0.7
J200_BC1	2	16.438	188.31	377.8
R300_BC1	2	16.419	188.3	377.8
W290_BC1	0.2	1.99	191.62	32.7
W90_BC1	0	0.057	200.15	0.8
W130_BC1	0	0.007	195.9	0.1
J100_BC1	2.2	18.221	188.58	411.3
R100	2.2	18.133	188.57	411.3
W330	1	7.226	191.27	190.8
W480	0.7	7.783	184.86	133.2
J477	3.9	32.167	188.57	735.3
R3120	3.9	32.159	188.58	735.4
W3110	1	10.604	186.31	191.6
J497	4.9	42.246	188.1	927
R750	4.9	42.239	188.1	927
W3100	1	11.953	190.86	188.8
J495	5.9	51.816	188.56	1115.8
R80	5.9	51.788	188.57	1115.8
W730	1.5	13.126	202.79	295.1
W3000	0.1	1.004	192.14	28
J493	28.6	143.261	189.24	5414.4
R20	28.6	143.066	189.23	5414.1
W840	1.7	12.313	199.28	347.7
W830	0.4	4.173	202.15	83.8
J485	2.2	16.27	199.83	431.6
R70	2.2	16.192	199.76	431.4
W250	0.7	6.96	207.55	148.7
W780	0.4	4.138	202.65	86.1
J487	3.3	27.054	201.82	666.2
R40	3.3	27.05	201.83	666.2
W290	0.4	4.019	204.37	85.8
W260	0	0.11	204.26	1.6
J490	32.3	173.767	190.72	6167.7
R10	32.3	173.157	190.63	6165
W240	1.2	12.788	207.79	259.2
Outlet	33.6	183.452	191.27	6424.2

HEC-HMS Summary Output Table

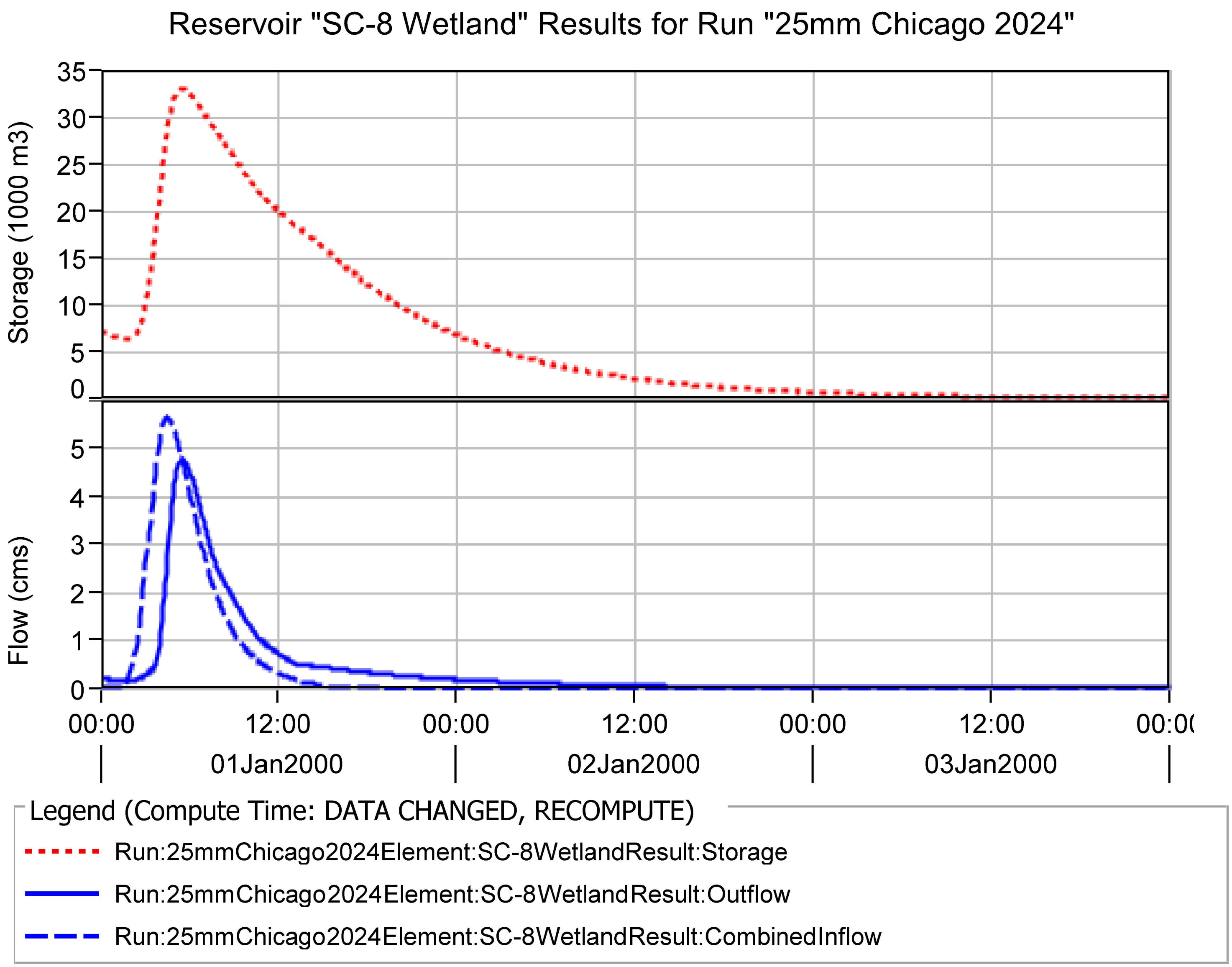
Project No. 190 Project Name: SC-8 Wetland

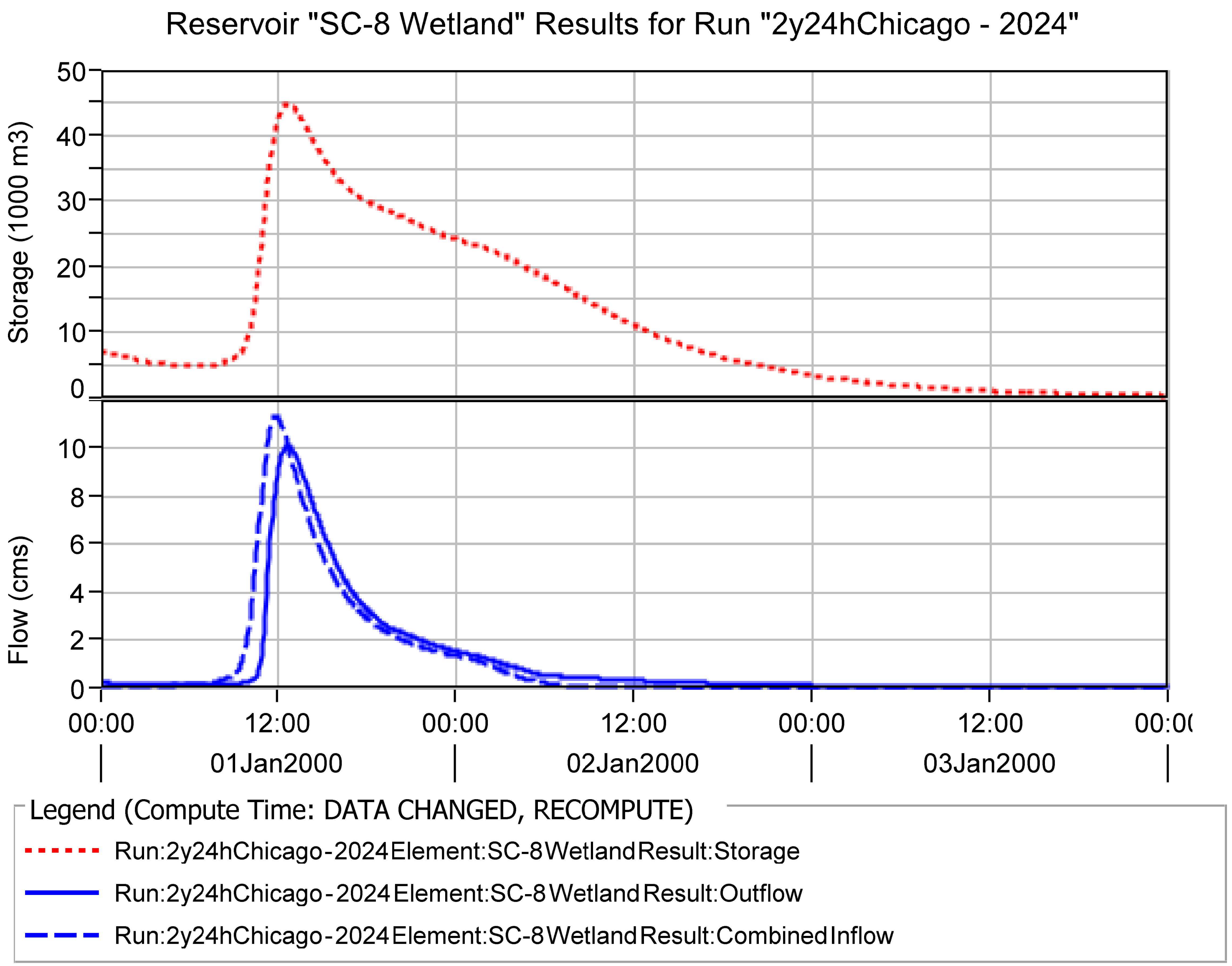
Date 18-Oct-24

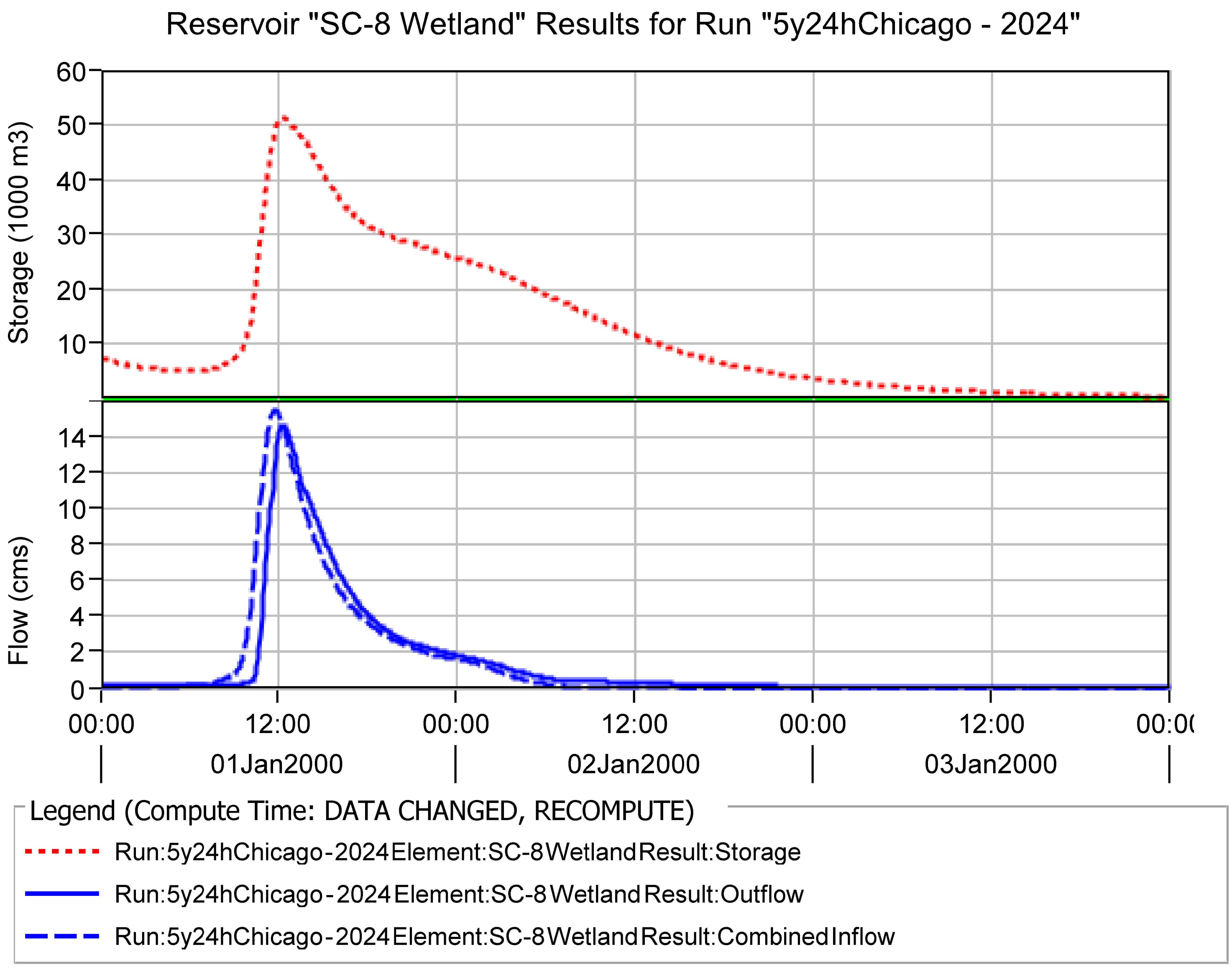
Hazel AMC III Proposed Controlled Storm

Hydrologic Element	Drainage Area (km2)	Peack Discharge (m3/s)	Volume (mm)	Volume (1000M3)
W580	2	6.471	184.64	369.4
W430	0.6	5.386	184.55	102.2
J452	2.6	9.483	184.62	471.6
R160	2.6	8.205	183.45	468.6
W420	1.6	5.932	184.8	304.7
W410	0.5	4.189	184.07	87.7
J457	4.7	16.436	183.99	861.1
R150	4.7	16.428	184	861.1
W380	0.8	5.707	183.53	153.5
W370	0.8	6.596	181.49	141.4
J468	6.3	26.672	183.62	1156
J100	2.5	21.367	188.94	473.5
W340_SC8	2.5	21.367	188.94	473.5
R10_SC8	2.5	21.012	188.73	473
W330_SC8	2.2	18.267	193.4	434.6
W60_SC8	0.5	5.357	193.63	101.3
J75	5.3	43.535	191.2	1008.9
R210_SC8	5.3	43.46	191.19	1008.8
W380_SC8	1.6	11.826	191.5	300.7
W240_SC8	0.3	2.547	191.53	53.7
SC-8 Inflows	7.1	57.401	191.27	1363.2
SC-8 Wetland	7.1	57.358	192.25	1370.2
W140_SC8	0.3	2.127	191.07	48.4
SC8 Outlet	7.4	59.237	192.21	1418.6
R230	7.4	59.19	192.24	1418.8
R140	6.3	20.993	190.49	1199.2
W360	1.4	11.099	184.28	253.8
W530	0.1	1.365	187.62	23.2
J462	15.2	90.906	190.76	2895
R130	15.2	88.578	190.35	2888.8
W390	1.3	11.369	183.47	245.8
W350	0.9	5.413	184.83	159.8
J465	17.4	102.102	189.55	3294.3
R1160	17.4	95.314	188.54	3276.9
W1140	2	16.481	184.34	369.4
SC-5 Scenari	19.4	102.993	188.11	3646.3
R3570	19.4	102.901	188.1	3646.1
W3550	0.2	2.341	180.63	34.8
SC-5 Scenari	19.6	102.915	188.02	3680.9
R3070	19.6	102.914	188.02	3680.9
W3540	0	0.612	183.61	9
J479	19.6	102.916	188.01	3689.9
R90	19.6	102.852	188	3689.6
W3050	0.9	8.888	200.56	175.3
W320	0.6	3.275	201.68	119.2
J482	21.1	106.205	188.9	3984.1
R3020	21.1	106.204	188.9	3984.1
W3010	0	0.04	208.89	0.6
J486 - Flow G	21.1	106.204	188.9	3984.7
R50	21.1	106.201	188.89	3984.4
W450_BC1	1.4	11.205	189.15	259.9
W410_BC1	0.1	1.259	181.58	16.8

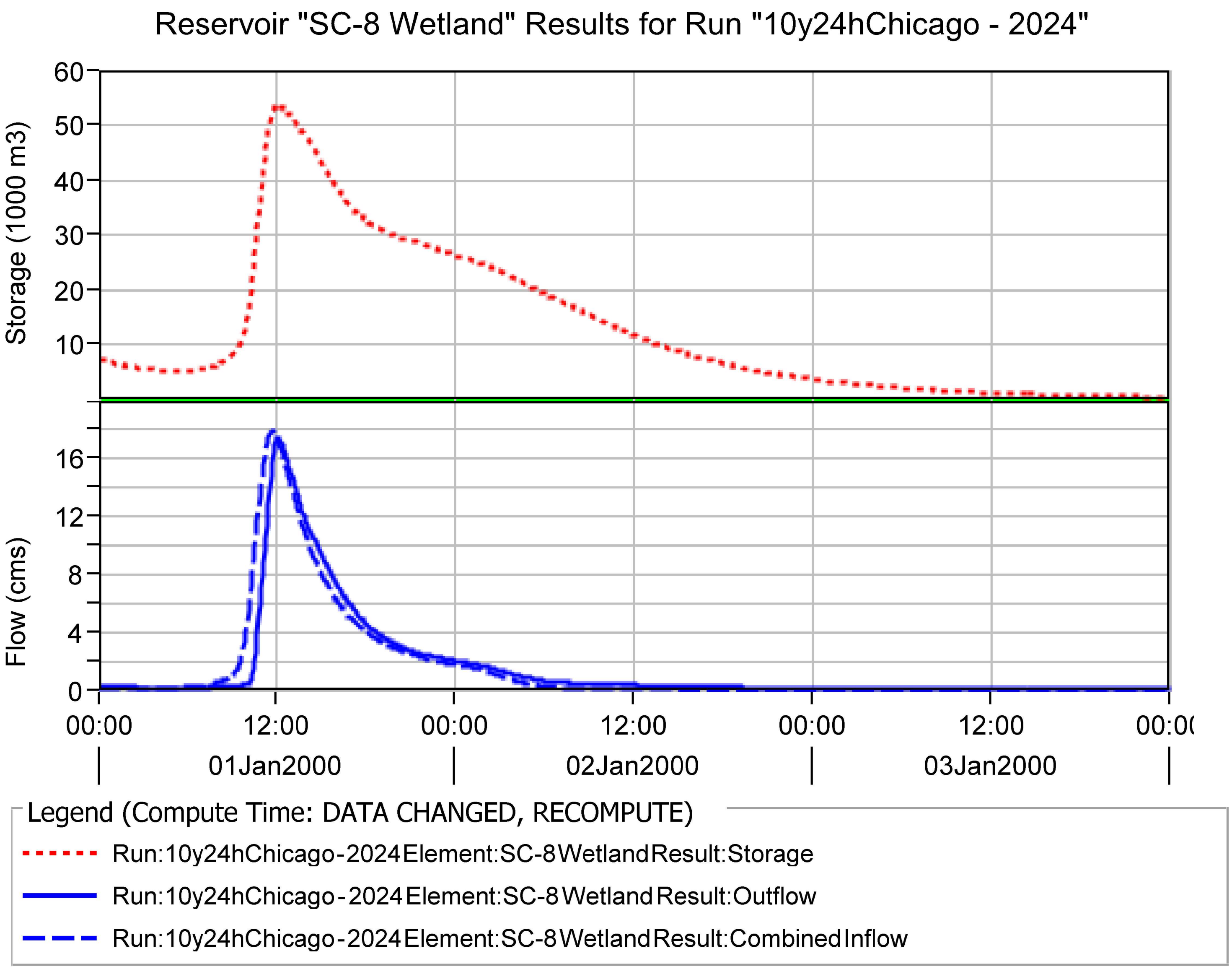
East Facility I	1.5	11.675	188.67	276.8
East Facility_	1.5	10.572	179.27	263
R220_BC1	1.5	10.564	179.24	262.9
W150_BC1	0.4	3.841	187.51	79.3
W390_BC1	0.1	0.866	185.53	12.8
W350_BC1	0	0.224	181.27	4.1
West Facility	0.5	4.768	186.97	96.3
West Facility_	0.5	2.239	163.37	84.1
R340_BC1	0.5	2.239	163.37	84.1
W440_BC1	0	0.235	196.09	3.2
W330_BC1	0	0.063	190.27	0.8
W230_BC1	0	0.051	195.48	0.7
J200_BC1	2	12.716	175.36	351.8
R300_BC1	2	12.712	175.33	351.8
W290_BC1	0.2	1.99	191.62	32.7
W90_BC1	0	0.057	200.15	0.8
W130_BC1	0	0.007	195.9	0.1
J100_BC1	2.2	13.436	176.65	385.3
R100	2.2	13.389	176.41	384.8
W330	1	7.226	191.27	190.8
W480	0.7	7.783	184.86	133.2
J477	3.9	24.885	181.77	708.8
R3120	3.9	24.89	181.76	708.8
W3110	1	10.604	186.31	191.6
J497	4.9	34.463	182.71	900.4
R750	4.9	34.473	182.69	900.3
W3100	1	11.953	190.86	188.8
J495	5.9	43.696	184.05	1089.1
R80	5.9	43.672	184	1088.7
W730	1.5	13.126	202.79	295.1
W3000	0.1	1.004	192.14	28
J493	28.6	134.92	188.6	5396.2
R20	28.6	134.773	188.59	5395.9
W840	1.7	12.313	199.28	347.7
W830	0.4	4.173	202.15	83.8
J485	2.2	16.27	199.83	431.6
R70	2.2	16.192	199.76	431.4
W250	0.7	6.96	207.55	148.7
W780	0.4	4.138	202.65	86.1
J487	3.3	27.054	201.82	666.2
R40	3.3	27.05	201.83	666.2
W290	0.4	4.019	204.37	85.8
W260	0	0.11	204.26	1.6
J490	32.3	165.31	190.15	6149.4
R10	32.3	164.774	190.08	6147.1
W240	1.2	12.788	207.79	259.2
Outlet	33.6	174.895	190.74	6406.3

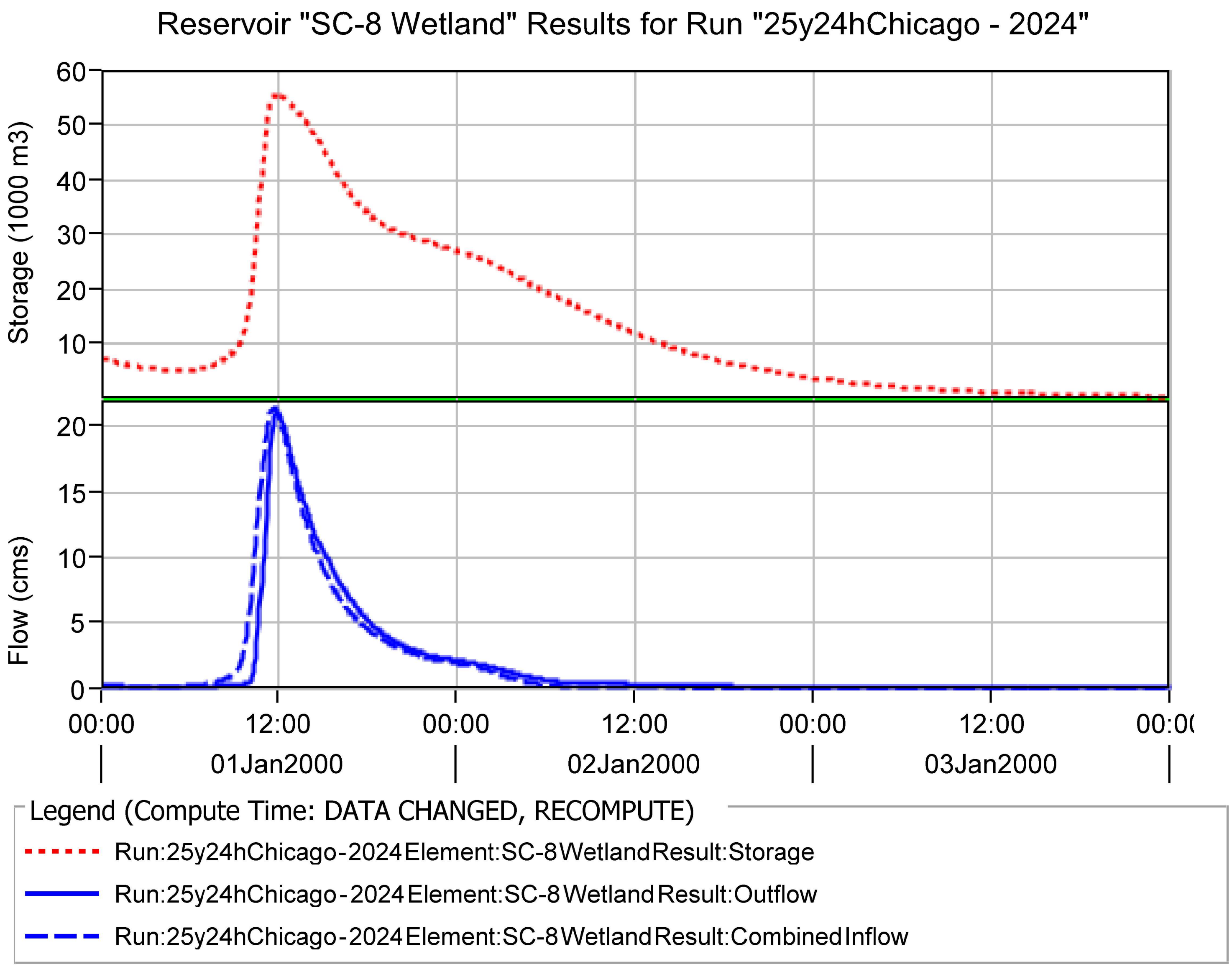

Reservoir "SC-8 Wetland" Results for Run "25mm Chicago 2024"
Storage (1000 m3)
35
30
25
20
15
10
5
0
Flow (cms)
5
4
3
2
1
0
00:00
12:00
00:00
12:00
00:00
12:00
00:0
01Jan2000
02Jan2000
03Jan2000
Legend (Compute Time: DATA CHANGED, RECOMPUTE)
Run:25mmChicago2024Element:SC-8WetlandResult:Storage
Run:25mmChicago2024Element:SC-8WetlandResult:Outflow
Run:25mmChicago2024Element:SC-8WetlandResult:CombinedInflow

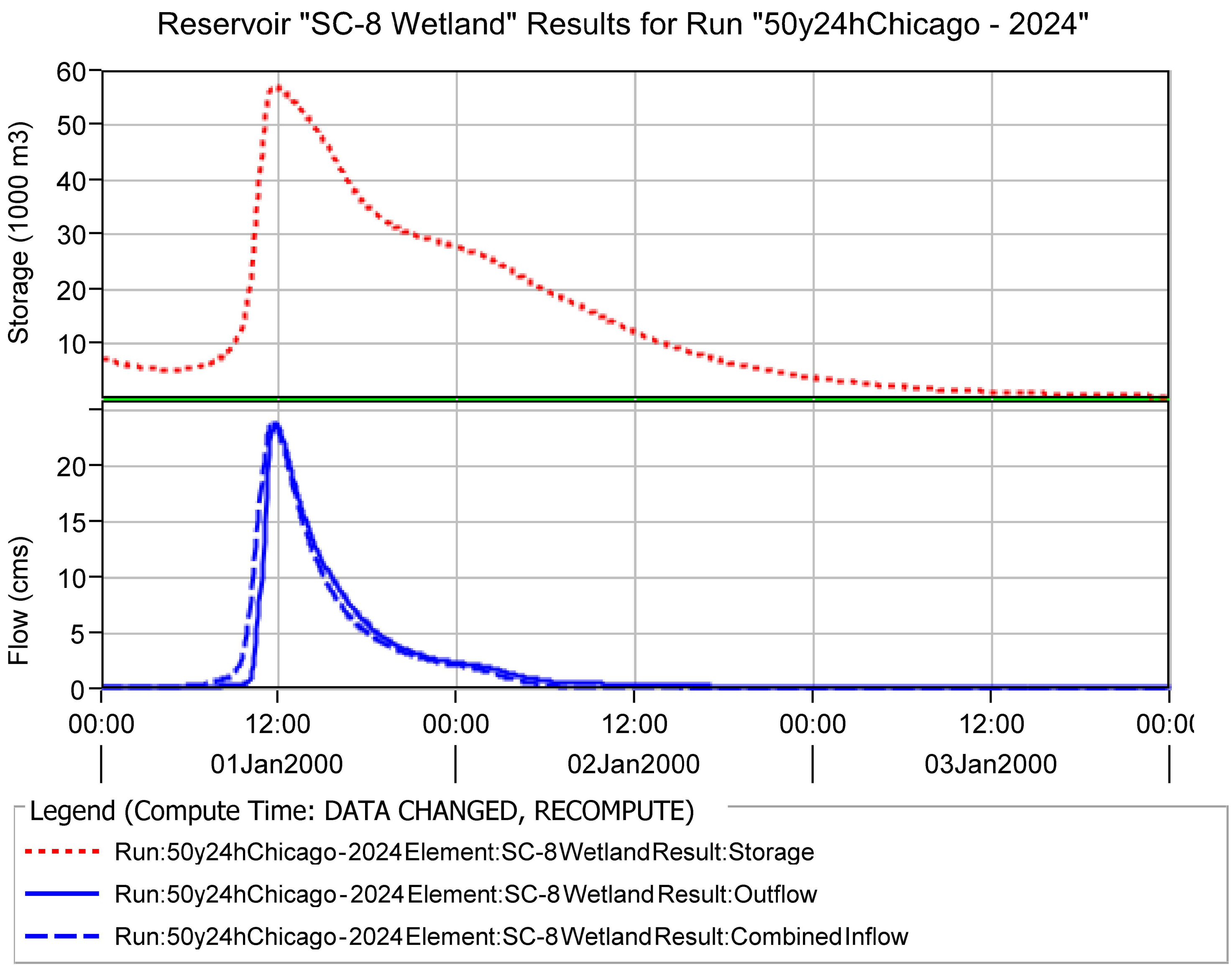

Reservoir "SC-8 Wetland" Results for Run "2y24hChicago - 2024"
Storage (1000 m3)
50
40
30
20
10
0
Flow (cms)
10
8
6
4
2
0
00:00
12:00
00:00
12:00
00:00
12:00
00:0
01Jan2000
02Jan2000
03Jan2000
Legend (Compute Time: DATA CHANGED, RECOMPUTE)
Run:2y24hChicago-2024 Element:SC-8 Wetland Result:Storage
Run:2y24hChicago-2024 Element:SC-8 Wetland Result:Outflow
Run:2y24hChicago-2024 Element:SC-8 Wetland Result:Combined Inflow

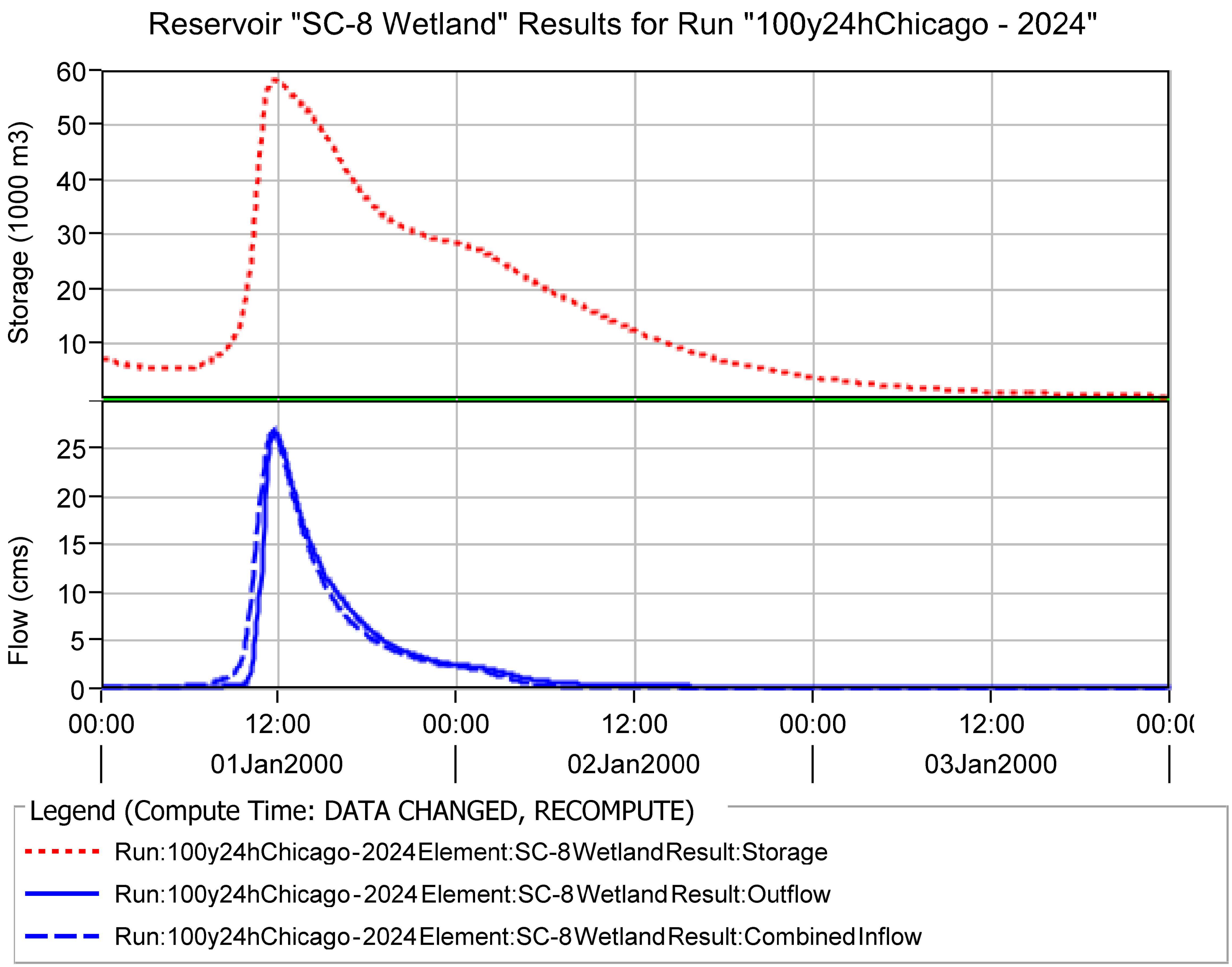


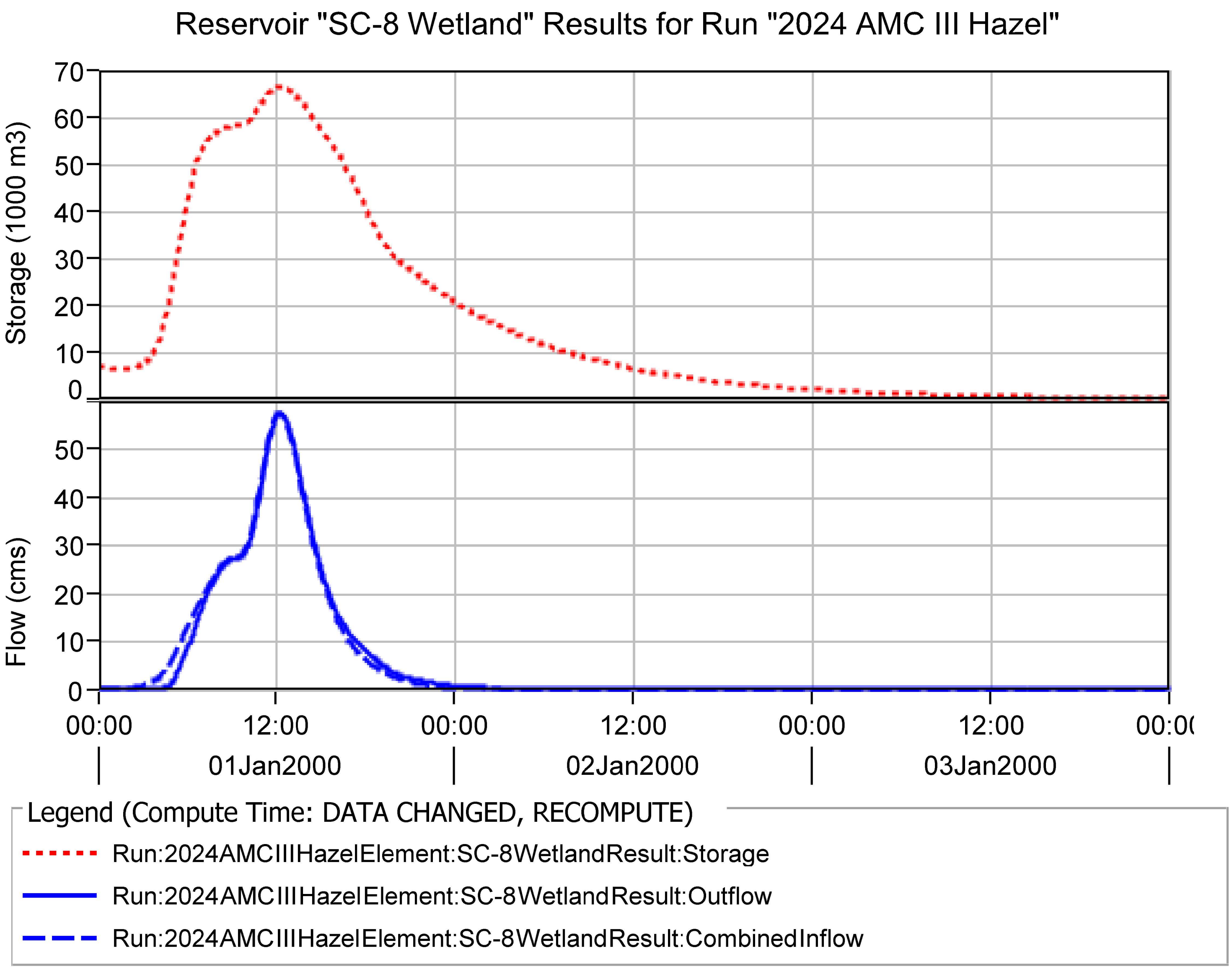
Reservoir "SC-8 Wetland" Results for Run "5y24hChicago - 2024"


Reservoir "SC-8 Wetland" Results for Run "10y24hChicago - 2024"
Storage (1000 m3)
60
50
40
30
20
10
Flow (cms)
16
12
8
4
0
00:00
12:00
00:00
12:00
00:00
12:00
00:0
01Jan2000
02Jan2000
03Jan2000
Legend (Compute Time: DATA CHANGED, RECOMPUTE)
Run:10y24hChicago-2024 Element:SC-8 Wetland Result:Storage
Run:10y24hChicago-2024 Element:SC-8 Wetland Result:Outflow
Run:10y24hChicago-2024 Element:SC-8 Wetland Result:Combined Inflow


Reservoir "SC-8 Wetland" Results for Run "25y24hChicago - 2024"
Storage (1000 m3)
60
50
40
30
20
10
Flow (cms)
20
15
10
5
0
00:00
12:00
00:00
12:00
00:00
12:00
00:0(
01Jan2000
02Jan2000
03Jan2000
Legend (Compute Time: DATA CHANGED, RECOMPUTE)
Run:25y24hChicago-2024 Element:SC-8 Wetland Result:Storage
Run:25y24hChicago-2024 Element:SC-8 Wetland Result:Outflow
Run:25y24hChicago-2024 Element:SC-8 Wetland Result:Combined Inflow


Reservoir "SC-8 Wetland" Results for Run "50y24hChicago - 2024"
Storage (1000 m3)
60
50
40
30
20
10
Flow (cms)
20
15
10
5
0
00:00
12:00
00:00
12:00
00:00
12:00
00:0
01Jan2000
02Jan2000
03Jan2000
Legend (Compute Time: DATA CHANGED, RECOMPUTE)
Run:50y24hChicago-2024 Element:SC-8 Wetland Result:Storage
Run:50y24hChicago-2024 Element:SC-8 Wetland Result:Outflow
Run:50y24hChicago-2024 Element:SC-8 Wetland Result:Combined Inflow


Reservoir "SC-8 Wetland" Results for Run "100y24hChicago - 2024"
Storage (1000 m3)
60
50
40
30
20
10
Flow (cms)
25
20
15
10
5
0
00:00
12:00
00:00
12:00
00:00
12:00
00:0(
01Jan2000
02Jan2000
03Jan2000
Legend (Compute Time: DATA CHANGED, RECOMPUTE)
Run:100y24hChicago-2024 Element:SC-8 Wetland Result:Storage
Run:100y24hChicago-2024 Element:SC-8 Wetland Result:Outflow
Run:100y24hChicago-2024 Element:SC-8 Wetland Result:Combined Inflow


Reservoir "SC-8 Wetland" Results for Run "2024 AMC III Hazel"
Storage (1000 m3)
70
60
50
40
30
20
10
0
Flow (cms)
50
40
30
20
10
0
00:00
12:00
00:00
12:00
00:00
12:00
00:0
01Jan2000
02Jan2000
03Jan2000
Legend (Compute Time: DATA CHANGED, RECOMPUTE)
Run:2024AMCIIIHazelElement:SC-8WetlandResult:Storage
Run:2024AMCIIIHazelElement:SC-8WetlandResult:Outflow
Run:2024AMCIIIHazelElement:SC-8WetlandResult:CombinedInflow

water's edge
ENVIRONMENTAL SOLUTIONS TEAM LTD.

HEC-RAS Summary Output Table

Project No. 19028

Project Name: SC-8 Wetland

Date 18-Oct-24

River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
1315	Hazel	SC-8 Existing	57.4	194.05	195.69	195.69	196.17	0.013293	3.76	22.35	23.38	1.07
1315	Hazel	SC-8 Proposed	57.4	194.05	195.69	195.69	196.17	0.013292	3.76	22.35	23.38	1.07
1315	100	SC-8 Existing	26.8	194.05	195.29	195.29	195.59	0.013016	2.88	13.42	21.65	1
1315	100	SC-8 Proposed	26.8	194.05	195.29	195.29	195.59	0.013015	2.88	13.42	21.65	1
1315	50	SC-8 Existing	24.1	194.05	195.25	195.25	195.53	0.012978	2.78	12.49	21.44	0.99
1315	50	SC-8 Proposed	24.1	194.05	195.25	195.25	195.53	0.012977	2.78	12.49	21.44	0.99
1315	25	SC-8 Existing	21.4	194.05	195.2	195.2	195.46	0.012989	2.67	11.5	21.21	0.98
1315	25	SC-8 Proposed	21.4	194.05	195.2	195.2	195.46	0.012989	2.67	11.5	21.21	0.98
1315	10	SC-8 Existing	18	194.05	195.14	195.14	195.38	0.013088	2.53	10.16	20.88	0.97
1315	10	SC-8 Proposed	18	194.05	195.14	195.14	195.38	0.01309	2.53	10.16	20.88	0.97
1315	5	SC-8 Existing	15.5	194.05	195.09	195.09	195.31	0.01283	2.39	9.21	20.59	0.95
1315	5	SC-8 Proposed	15.5	194.05	195.09	195.09	195.31	0.012823	2.39	9.21	20.59	0.95
1315	2	SC-8 Existing	11.3	194.05	194.99	194.99	195.18	0.013896	2.22	7.1	19.88	0.96
1315	2	SC-8 Proposed	11.3	194.05	194.99	194.99	195.18	0.0139	2.22	7.1	19.88	0.96
1253	Hazel	SC-8 Existing	57.4	193.22	194.87	194.76	195.06	0.005607	2.52	41.76	61.75	0.7
1253	Hazel	SC-8 Proposed	57.4	193.22	195.11	194.76	195.2	0.002456	1.86	57.1	67.99	0.48
1253	100	SC-8 Existing	26.8	193.22	194.58	194.43	194.71	0.004441	1.9	24.98	53.49	0.6
1253	100	SC-8 Proposed	26.8	193.22	194.8	194.43	194.85	0.001642	1.31	37.1	58.84	0.38
1253	50	SC-8 Existing	24.1	193.22	194.55	194.4	194.66	0.004	1.77	23.37	51.29	0.57
1253	50	SC-8 Proposed	24.1	193.22	194.76	194.4	194.8	0.001584	1.26	34.72	58.2	0.37
1253	25	SC-8 Existing	21.4	193.22	194.51	194.38	194.61	0.003845	1.69	21.48	49.82	0.55
1253	25	SC-8 Proposed	21.4	193.22	194.71	194.38	194.76	0.001526	1.2	32.1	57.17	0.36
1253	10	SC-8 Existing	18	193.22	194.46	194.32	194.55	0.003617	1.58	19.03	46.59	0.53
1253	10	SC-8 Proposed	18	193.22	194.65	194.32	194.69	0.001442	1.13	28.58	55.37	0.35
1253	5	SC-8 Existing	15.5	193.22	194.42	194.29	194.5	0.00328	1.46	17.19	42.87	0.5
1253	5	SC-8 Proposed	15.5	193.22	194.59	194.29	194.63	0.0014	1.07	25.6	53.75	0.34
1253	2	SC-8 Existing	11.3	193.22	194.34	194.17	194.41	0.002855	1.27	13.85	39.19	0.46
1253	2	SC-8 Proposed	11.3	193.22	194.45	194.17	194.48	0.001504	1.01	18.33	44.76	0.34
1226	Hazel	SC-8 Existing	57.4	193.18	194.81		194.92	0.003726	2.11	52.78	73.75	0.57
1226	Hazel	SC-8 Proposed	57.4	193.46	194.91		195.1	0.005416	2.63	45.31	77.97	0.71
1226	100	SC-8 Existing	26.8	193.18	194.52		194.6	0.002926	1.6	32.58	66.69	0.49
1226	100	SC-8 Proposed	26.8	193.46	194.69		194.79	0.003041	1.76	29.38	65.36	0.52
1226	50	SC-8 Existing	24.1	193.18	194.49		194.56	0.002821	1.54	30.38	65.7	0.47
1226	50	SC-8 Proposed	24.1	193.46	194.65		194.74	0.002972	1.7	26.89	63.63	0.51
1226	25	SC-8 Existing	21.4	193.18	194.45		194.52	0.002725	1.48	27.99	64.59	0.46
1226	25	SC-8 Proposed	21.4	193.46	194.6		194.7	0.002949	1.65	24.06	61.6	0.5
1226	10	SC-8 Existing	18	193.18	194.41		194.47	0.002556	1.39	24.89	62.9	0.45
1226	10	SC-8 Proposed	18	193.46	194.54	194.23	194.63	0.002848	1.56	20.5	58.42	0.49
1226	5	SC-8 Existing	15.5	193.18	194.36		194.42	0.002462	1.32	22.24	61.34	0.43
1226	5	SC-8 Proposed	15.5	193.46	194.49	194.18	194.58	0.002821	1.5	17.45	54.97	0.48
1226	2	SC-8 Existing	11.3	193.18	194.28		194.34	0.002231	1.19	17.46	58.98	0.41
1226	2	SC-8 Proposed	11.3	193.46	194.34		194.43	0.003058	1.4	11.07	30.83	0.49
1205	Hazel	SC-8 Existing	57.4	193.2	194.62		194.82	0.007986	2.73	39.31	67.26	0.81
1205	Hazel	SC-8 Proposed	57.4	193.4	194.78	194.78	194.99	0.006765	2.73	44.08	89.32	0.78
1205	100	SC-8 Existing	26.8	193.2	194.41		194.53	0.005039	1.91	26.14	62.09	0.63
1205	100	SC-8 Proposed	26.8	193.4	194.48	194.48	194.69	0.007099	2.34	20.39	63.42	0.76
1205	50	SC-8 Existing	24.1	193.2	194.39		194.49	0.004816	1.83	24.42	61.21	0.61
1205	50	SC-8 Proposed	24.1	193.4	194.44	194.44	194.65	0.007153	2.29	17.97	58.53	0.76
1205	25	SC-8 Existing	21.4	193.2	194.36		194.46	0.004452	1.72	22.78	59.39	0.58
1205	25	SC-8 Proposed	21.4	193.4	194.4	194.4	194.6	0.007071	2.21	15.73	53.54	0.75
1205	10	SC-8 Existing	18	193.2	194.32		194.41	0.004129	1.61	20.33	58.24	0.56
1205	10	SC-8 Proposed	18	193.4	194.33	194.33	194.53	0.007845	2.19	11.86	44.79	0.78
1205	5	SC-8 Existing	15.5	193.2	194.28		194.36	0.003732	1.49	18.53	56.67	0.53
1205	5	SC-8 Proposed	15.5	193.4	194.18	194.18	194.45	0.012642	2.43	7.68	16.31	0.95
1205	2	SC-8 Existing	11.3	193.2	194.22		194.28	0.003224	1.31	14.85	53.11	0.48
1205	2	SC-8 Proposed	11.3	193.4	194.07	194.07	194.3	0.013287	2.2	5.95	14.52	0.95
1189	Hazel	SC-8 Existing	57.4	192.9	194.57	194.49	194.72	0.007127	2.48	46.55	87.4	0.76
1189	Hazel	SC-8 Proposed	57.4	193	194.56	194.46	194.72	0.00652	2.5	46.94	91.03	0.74
1189	100	SC-8 Existing	26.8	192.9	194.36	194.29	194.46	0.005071	1.82	29.63	78.69	0.62
1189	100	SC-8 Proposed	26.8	193	194.3	194.1	194.41	0.005326	1.91	26.15	67.33	0.64
1189	50	SC-8 Existing	24.1	192.9	194.33	194.27	194.43	0.005004	1.77	27.33	76.91	0.61
1189	50	SC-8 Proposed	24.1	193	194.27	194.11	194.37	0.005093	1.83	24.24	64.33	0.62
1189	25	SC-8 Existing	21.4	192.9	194.3	194.23	194.39	0.004972	1.72	24.94	76.21	0.61
1189	25	SC-8 Proposed	21.4	193	194.23	194.08	194.33	0.004872	1.74	22.22	61.87	0.61
1189	10	SC-8 Existing	18	192.9	194.25	194.19	194.34	0.005085	1.67	21.32	73.03	0.61
1189	10	SC-8 Proposed	18	193	194.19	194.03	194.28	0.004552	1.63	19.56	58.36	0.58
1189	5	SC-8 Existing	15.5	192.9	194.23	194.17	194.31	0.004528	1.54	19.55	69.81	0.57
1189	5	SC-8 Proposed	15.5	193	194.15	193.99	194.23	0.004288	1.53	17.44	55.15	0.56
1189	2	SC-8 Existing	11.3	192.9	194.16	194.11	194.23	0.004437	1.42	14.55	63.61	0.55
1189	2	SC-8 Proposed	11.3	193	194.08	193.9	194.13	0.003458	1.28	14.06	36.74	0.49

1148	Hazel	SC-8 Existing	57.4	192.81	194.34		194.43	0.005284	2.08	57.58	110.17	0.64
1148	Hazel	SC-8 Proposed	57.4	192.85	194.37		194.44	0.004808	1.91	61.15	112.77	0.6
1148	100	SC-8 Existing	26.8	192.81	194.04	194.04	194.16	0.009355	2.22	26.54	92.38	0.8
1148	100	SC-8 Proposed	26.8	192.85	194.09		194.15	0.005785	1.69	32.47	89.33	0.62
1148	50	SC-8 Existing	24.1	192.81	194.02	194.02	194.14	0.008963	2.14	24.85	91.76	0.78
1148	50	SC-8 Proposed	24.1	192.85	194.06		194.12	0.005855	1.66	29.88	87.07	0.62
1148	25	SC-8 Existing	21.4	192.81	194	194	194.11	0.008587	2.05	22.98	91	0.76
1148	25	SC-8 Proposed	21.4	192.85	194.03		194.09	0.005911	1.62	27.26	84.74	0.62
1148	10	SC-8 Existing	18	192.81	193.98	193.98	194.08	0.007721	1.9	20.67	89.55	0.72
1148	10	SC-8 Proposed	18	192.85	193.99		194.05	0.005859	1.55	24.01	81.74	0.61
1148	5	SC-8 Existing	15.5	192.81	193.94	193.94	194.05	0.008395	1.91	17.41	83.13	0.74
1148	5	SC-8 Proposed	15.5	192.85	193.96		194.01	0.005647	1.48	21.69	78.96	0.59
1148	2	SC-8 Existing	11.3	192.81	193.89	193.89	193.99	0.007262	1.71	13.91	75.39	0.68
1148	2	SC-8 Proposed	11.3	192.85	193.91		193.95	0.004996	1.32	17.74	74	0.55
1124	Hazel	SC-8 Existing	57.4	192.71	194.33	194.02	194.36	0.001752	1.19	96.52	186.7	0.37
1124	Hazel	SC-8 Proposed	57.4	193	194.34	194.01	194.37	0.002062	1.24	92.02	158.63	0.4
1124	100	SC-8 Existing	26.8	192.71	194.01	193.86	194.04	0.002867	1.26	47.38	140.64	0.45
1124	100	SC-8 Proposed	26.8	193	194.02	193.86	194.05	0.003404	1.21	45.3	132.54	0.48
1124	50	SC-8 Existing	24.1	192.71	193.97	193.84	194	0.003019	1.26	42.12	134.88	0.46
1124	50	SC-8 Proposed	24.1	193	193.99	193.84	194.02	0.003737	1.22	40.45	127.67	0.5
1124	25	SC-8 Existing	21.4	192.71	193.93	193.83	193.97	0.003231	1.27	36.92	128.66	0.47
1124	25	SC-8 Proposed	21.4	193	193.95	193.83	193.98	0.004025	1.21	35.84	120.84	0.51
1124	10	SC-8 Existing	18	192.71	193.88	193.81	193.92	0.003655	1.3	30.44	123.3	0.5
1124	10	SC-8 Proposed	18	193	193.9	193.8	193.93	0.004504	1.21	30.15	113.24	0.54
1124	5	SC-8 Existing	15.5	192.71	193.84	193.78	193.88	0.003973	1.31	25.58	119.76	0.52
1124	5	SC-8 Proposed	15.5	193	193.86	193.79	193.9	0.005049	1.22	25.86	108.54	0.56
1124	2	SC-8 Existing	11.3	192.71	193.76	193.69	193.82	0.004248	1.37	17.13	93.69	0.53
1124	2	SC-8 Proposed	11.3	193	193.8	193.74	193.83	0.005696	1.18	19.47	101.11	0.58
1087	Hazel	SC-8 Existing	57.4	192.61	194.32	193.81	194.32	0.000569	0.73	158.05	287.3	0.21
1087	Hazel	SC-8 Proposed	57.4	192.8	194.32	193.78	194.33	0.000623	0.68	154.49	283.87	0.21
1087	100	SC-8 Existing	26.8	192.61	193.98	193.71	193.99	0.000836	0.71	84.53	217.47	0.25
1087	100	SC-8 Proposed	26.8	192.8	193.99	193.66	194	0.000899	0.62	82.17	201.97	0.24
1087	50	SC-8 Existing	24.1	192.61	193.94	193.68	193.95	0.000903	0.71	76.08	206.23	0.25
1087	50	SC-8 Proposed	24.1	192.8	193.95	193.64	193.95	0.000975	0.62	74.04	195.34	0.25
1087	25	SC-8 Existing	21.4	192.61	193.9	193.66	193.9	0.001016	0.73	67.13	200.38	0.27
1087	25	SC-8 Proposed	21.4	192.8	193.91	193.63	193.91	0.001058	0.62	66.08	188.62	0.26
1087	10	SC-8 Existing	18	192.61	193.84	193.64	193.85	0.001162	0.74	55.92	193.57	0.28
1087	10	SC-8 Proposed	18	192.8	193.85	193.61	193.86	0.001211	0.62	55.7	179.47	0.27
1087	5	SC-8 Existing	15.5	192.61	193.79	193.62	193.8	0.001304	0.75	47.54	182.21	0.29
1087	5	SC-8 Proposed	15.5	192.8	193.8	193.6	193.81	0.001416	0.63	47.23	170.92	0.29
1087	2	SC-8 Existing	11.3	192.61	193.71	193.58	193.72	0.001547	0.75	33.93	151.45	0.31
1087	2	SC-8 Proposed	11.3	192.8	193.72	193.57	193.73	0.001922	0.65	33.76	148.07	0.32
1042	Hazel	SC-8 Existing	57.4	192.64	194.29		194.3	0.000447	0.68	171.75	234.37	0.19
1042	Hazel	SC-8 Proposed	57.4	192.89	194.29		194.3	0.000756	0.75	139.41	226.64	0.24
1042	100	SC-8 Existing	26.8	192.64	193.95		193.96	0.000599	0.64	93.05	219.84	0.21
1042	100	SC-8 Proposed	26.8	192.89	193.94		193.95	0.001053	0.67	67.48	173.45	0.26
1042	50	SC-8 Existing	24.1	192.64	193.91		193.91	0.000659	0.65	83.55	217.57	0.22
1042	50	SC-8 Proposed	24.1	192.89	193.9		193.91	0.001122	0.66	60.15	159.25	0.27
1042	25	SC-8 Existing	21.4	192.64	193.86		193.87	0.000714	0.65	73.31	214.58	0.23
1042	25	SC-8 Proposed	21.4	192.89	193.85		193.86	0.001198	0.65	53.17	151.6	0.27
1042	10	SC-8 Existing	18	192.64	193.8		193.8	0.000835	0.67	60.05	203.85	0.24
1042	10	SC-8 Proposed	18	192.89	193.79		193.8	0.001329	0.63	43.99	140.66	0.28
1042	5	SC-8 Existing	15.5	192.64	193.74		193.75	0.000962	0.69	50.47	174.83	0.26
1042	5	SC-8 Proposed	15.5	192.89	193.73		193.74	0.001491	0.62	37.35	89.15	0.29
1042	2	SC-8 Existing	11.3	192.64	193.65		193.66	0.001286	0.72	34.97	150.46	0.29
1042	2	SC-8 Proposed	11.3	192.89	193.63		193.64	0.001831	0.58	28.62	86.13	0.31
1013	Hazel	SC-8 Existing	57.4	192.65	194.28		194.29	0.000448	0.68	164.88	211.8	0.2
1013	Hazel	SC-8 Proposed	57.4	192.92	194.27		194.28	0.000602	0.71	147.03	201.78	0.21
1013	100	SC-8 Existing	26.8	192.65	193.93		193.94	0.000537	0.6	93.62	198.58	0.2
1013	100	SC-8 Proposed	26.8	192.92	193.92		193.92	0.000805	0.63	78.28	180.45	0.23
1013	50	SC-8 Existing	24.1	192.65	193.89		193.89	0.000579	0.6	84.77	196.19	0.21
1013	50	SC-8 Proposed	24.1	192.92	193.87		193.88	0.000885	0.64	69.98	176.4	0.24
1013	25	SC-8 Existing	21.4	192.65	193.84		193.85	0.000623	0.6	75.29	193.8	0.22
1013	25	SC-8 Proposed	21.4	192.92	193.82		193.83	0.000986	0.64	61.61	173.36	0.25
1013	10	SC-8 Existing	18	192.65	193.77		193.78	0.000727	0.61	62.67	188.87	0.23
1013	10	SC-8 Proposed	18	192.92	193.75		193.76	0.00121	0.66	49.81	169.37	0.27
1013	5	SC-8 Existing	15.5	192.65	193.72		193.73	0.00086	0.63	52.64	173.5	0.25
1013	5	SC-8 Proposed	15.5	192.92	193.69		193.7	0.001392	0.66	41.25	130.26	0.29
1013	2	SC-8 Existing	11.3	192.65	193.61		193.62	0.001255	0.68	35.13	151.39	0.29
1013	2	SC-8 Proposed	11.3	192.92	193.57		193.58	0.002231	0.7	27.07	102.75	0.35

952	Hazel	SC-8 Existing	57.4	192.38	194.24	193.58	194.26	0.000614	0.81	126.1	305.32	0.23
952	Hazel	SC-8 Proposed	57.4	192.25	194.23	193.61	194.24	0.000632	0.9	123.43	311.14	0.23
952	100	SC-8 Existing	26.8	192.38	193.9	193.46	193.91	0.000521	0.61	80.92	259.47	0.2
952	100	SC-8 Proposed	26.8	192.25	193.87	193.44	193.88	0.000542	0.7	77.02	257.27	0.21
952	50	SC-8 Existing	24.1	192.38	193.85	193.45	193.86	0.000527	0.59	75.14	237.46	0.2
952	50	SC-8 Proposed	24.1	192.25	193.83	193.42	193.84	0.000551	0.69	71.09	243.97	0.21
952	25	SC-8 Existing	21.4	192.38	193.8	193.43	193.81	0.000543	0.58	68.88	216.52	0.2
952	25	SC-8 Proposed	21.4	192.25	193.78	193.4	193.79	0.00056	0.67	65.06	226.28	0.21
952	10	SC-8 Existing	18	192.38	193.73	193.4	193.74	0.000575	0.56	60.32	194.97	0.2
952	10	SC-8 Proposed	18	192.25	193.7	193.37	193.71	0.000601	0.66	56.24	201.71	0.21
952	5	SC-8 Existing	15.5	192.38	193.67	193.38	193.68	0.00063	0.56	53.02	187.97	0.21
952	5	SC-8 Proposed	15.5	192.25	193.63	193.34	193.64	0.000693	0.68	48.09	175.79	0.22
952	2	SC-8 Existing	11.3	192.38	193.55	193.35	193.56	0.000886	0.59	38.3	164.04	0.24
952	2	SC-8 Proposed	11.3	192.25	193.45	193.28	193.47	0.001505	0.87	27.72	121.41	0.32
924	Hazel	SC-8 Existing	57.4	192.35	194.24	193.58	194.25	0.000161	0.42	257.78	294.07	0.12
924	Hazel	SC-8 Proposed	57.4	192.27	194.23	193.51	194.23	0.000142	0.48	261.39	293.4	0.12
924	100	SC-8 Existing	26.8	192.35	193.89	193.43	193.89	0.000473	0.59	79.8	273.86	0.19
924	100	SC-8 Proposed	26.8	192.27	193.87	193.21	193.87	0.000264	0.56	91.45	270.5	0.15
924	50	SC-8 Existing	24.1	192.35	193.84	193.42	193.85	0.000478	0.57	74.21	268.87	0.19
924	50	SC-8 Proposed	24.1	192.27	193.82	193.17	193.82	0.00026	0.54	85.47	266.65	0.15
924	25	SC-8 Existing	21.4	192.35	193.79	193.39	193.8	0.000491	0.56	68.09	263.08	0.19
924	25	SC-8 Proposed	21.4	192.27	193.77	193.11	193.77	0.000253	0.52	79.34	262.69	0.15
924	10	SC-8 Existing	18	192.35	193.72	193.37	193.73	0.00052	0.54	59.64	259.25	0.2
924	10	SC-8 Proposed	18	192.27	193.69	193.02	193.7	0.000253	0.5	70.21	256.75	0.15
924	5	SC-8 Existing	15.5	192.35	193.66	193.36	193.66	0.000577	0.54	52.28	249.43	0.2
924	5	SC-8 Proposed	15.5	192.27	193.62	193	193.63	0.000268	0.5	61.62	251	0.15
924	2	SC-8 Existing	11.3	192.35	193.52	193.29	193.53	0.000872	0.58	36.7	207.12	0.24
924	2	SC-8 Proposed	11.3	192.27	193.44	192.93	193.45	0.000409	0.54	39.63	187.5	0.18
895	Hazel	SC-8 Existing	57.4	192.42	194.24	193.55	194.24	0.000186	0.48	220.37	225.47	0.13
895	Hazel	SC-8 Proposed	57.4	192.25	194.23	193.13	194.23	0.000083	0.38	273.42	213.4	0.09
895	100	SC-8 Existing	26.8	192.42	193.87	193.42	193.88	0.000413	0.59	85.58	206.77	0.18
895	100	SC-8 Proposed	26.8	192.25	193.87	193.02	193.87	0.00008	0.32	149.4	201.41	0.09
895	50	SC-8 Existing	24.1	192.42	193.83	193.41	193.83	0.000416	0.57	79.76	205.14	0.18
895	50	SC-8 Proposed	24.1	192.25	193.82	193	193.82	0.000076	0.3	142.55	200.99	0.08
895	25	SC-8 Existing	21.4	192.42	193.78	193.37	193.78	0.000425	0.56	73.37	203.28	0.18
895	25	SC-8 Proposed	21.4	192.25	193.77	192.98	193.77	0.00007	0.28	135.52	200.56	0.08
895	10	SC-8 Existing	18	192.42	193.7	193.35	193.71	0.00045	0.55	64.45	201.11	0.19
895	10	SC-8 Proposed	18	192.25	193.69	192.96	193.7	0.000064	0.26	125.02	199.93	0.07
895	5	SC-8 Existing	15.5	192.42	193.64	193.32	193.65	0.000498	0.55	56.56	199.76	0.19
895	5	SC-8 Proposed	15.5	192.25	193.62	192.94	193.63	0.000062	0.25	115.11	199.25	0.07
895	2	SC-8 Existing	11.3	192.42	193.5	193.27	193.51	0.000786	0.61	39.14	194.36	0.23
895	2	SC-8 Proposed	11.3	192.25	193.44	192.86	193.44	0.000074	0.24	89.2	197.39	0.08
868	Hazel	SC-8 Existing	57.4	192.37	194.23	193.59	194.24	0.000212	0.5	201.08	193.05	0.14
868	Hazel	SC-8 Proposed	57.4	192.28	194.23	192.23	194.23	0.000038	0.25	370.06	234.27	0.06
868	100	SC-8 Existing	26.8	192.37	193.85	193.43	193.86	0.000739	0.75	62.68	181.38	0.24
868	100	SC-8 Proposed	26.8	192.28	193.86	191.82	193.87	0.000033	0.2	196.99	229.83	0.06
868	50	SC-8 Existing	24.1	192.37	193.81	193.42	193.82	0.000743	0.73	58.46	180.72	0.24
868	50	SC-8 Proposed	24.1	192.28	193.82	191.78	193.82	0.00003	0.19	190.16	229.53	0.05
868	25	SC-8 Existing	21.4	192.37	193.76	193.4	193.77	0.000756	0.71	53.8	178.86	0.24
868	25	SC-8 Proposed	21.4	192.28	193.77	191.74	193.77	0.000027	0.17	183.13	229.23	0.05
868	10	SC-8 Existing	18	192.37	193.68	193.38	193.69	0.0008	0.69	47.26	177.22	0.24
868	10	SC-8 Proposed	18	192.28	193.69	191.68	193.69	0.000023	0.15	172.62	228.77	0.05
868	5	SC-8 Existing	15.5	192.37	193.62	193.35	193.63	0.000889	0.69	41.36	174.28	0.25
868	5	SC-8 Proposed	15.5	192.28	193.62	191.63	193.62	0.000021	0.14	162.69	228.34	0.04
868	2	SC-8 Existing	11.3	192.37	193.46	193.31	193.48	0.001573	0.79	27.51	168.47	0.32
868	2	SC-8 Proposed	11.3	192.28	193.44	191.55	193.44	0.00002	0.12	136.62	227.19	0.04
842	Hazel	SC-8 Existing	57.4	192.33	194.22		194.23	0.000321	0.65	161.12	152.09	0.17
842	Hazel	SC-8 Proposed	57.4	192.25	194.23		194.23	0.000037	0.25	371.03	228.9	0.06
842	100	SC-8 Existing	26.8	192.33	193.85		193.85	0.00025	0.48	106.4	141.99	0.14
842	100	SC-8 Proposed	26.8	192.25	193.86		193.87	0.000018	0.15	288.82	226.64	0.04
842	50	SC-8 Existing	24.1	192.33	193.8		193.81	0.000245	0.46	99.91	140.83	0.14
842	50	SC-8 Proposed	24.1	192.25	193.82		193.82	0.000017	0.14	277.96	226.34	0.04
842	25	SC-8 Existing	21.4	192.33	193.75		193.76	0.000244	0.44	92.76	139.82	0.14
842	25	SC-8 Proposed	21.4	192.25	193.77		193.77	0.000015	0.13	266.79	226.03	0.04
842	10	SC-8 Existing	18	192.33	193.68		193.68	0.000243	0.42	82.8	137.24	0.14
842	10	SC-8 Proposed	18	192.25	193.69		193.69	0.000013	0.12	250.1	225.57	0.03
842	5	SC-8 Existing	15.5	192.33	193.61		193.62	0.000257	0.41	73.87	135.58	0.14
842	5	SC-8 Proposed	15.5	192.25	193.62		193.62	0.000012	0.11	234.32	225.13	0.03
842	2	SC-8 Existing	11.3	192.33	193.46		193.46	0.000373	0.44	52.93	129.57	0.16
842	2	SC-8 Proposed	11.3	192.25	193.44		193.44	0.000012	0.1	192.96	223.98	0.03

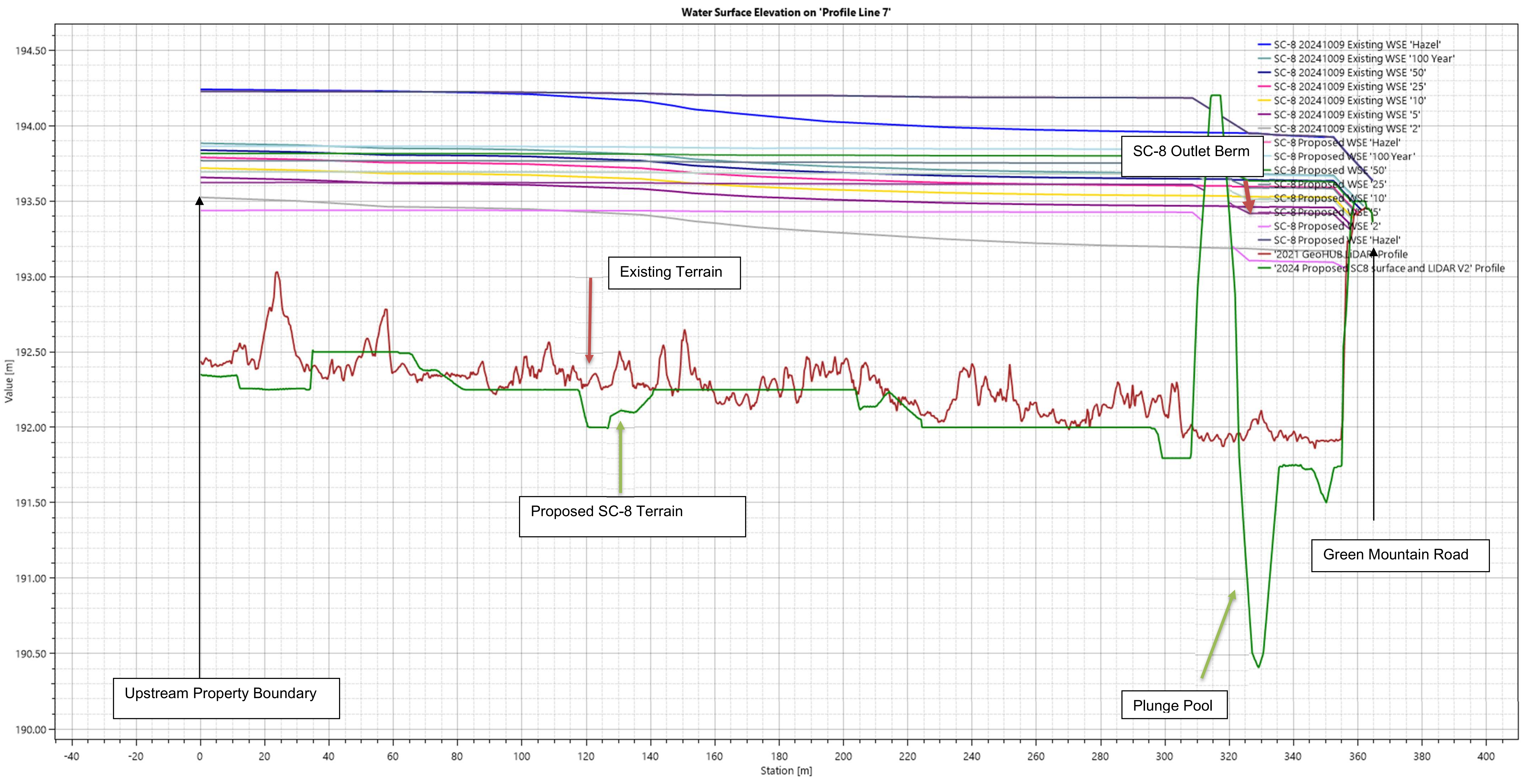
824	Hazel	SC-8 Existing	57.4	192.32	194.21		194.22	0.000453	0.76	135.57	129.43	0.2
824	Hazel	SC-8 Proposed	57.4	192.25	194.22		194.23	0.00009	0.38	229.52	141.83	0.09
824	100	SC-8 Existing	26.8	192.32	193.84		193.85	0.00035	0.55	89.67	120.07	0.17
824	100	SC-8 Proposed	26.8	192.25	193.86		193.86	0.000042	0.22	179.48	137.07	0.06
824	50	SC-8 Existing	24.1	192.32	193.8		193.8	0.00034	0.52	84.25	118.12	0.17
824	50	SC-8 Proposed	24.1	192.25	193.82		193.82	0.000039	0.21	172.94	136.44	0.06
824	25	SC-8 Existing	21.4	192.32	193.75		193.75	0.000335	0.5	78.29	116.61	0.16
824	25	SC-8 Proposed	21.4	192.25	193.77		193.77	0.000034	0.19	166.24	135.79	0.05
824	10	SC-8 Existing	18	192.32	193.67		193.68	0.000334	0.48	70	114.51	0.16
824	10	SC-8 Proposed	18	192.25	193.69		193.69	0.00003	0.17	156.27	134.44	0.05
824	5	SC-8 Existing	15.5	192.32	193.61		193.61	0.000349	0.46	62.55	112.24	0.16
824	5	SC-8 Proposed	15.5	192.25	193.62		193.62	0.000027	0.16	146.92	133.15	0.05
824	2	SC-8 Existing	11.3	192.32	193.45		193.45	0.000504	0.48	44.96	106.58	0.19
824	2	SC-8 Proposed	11.3	192.25	193.44		193.44	0.000025	0.14	122.73	129.69	0.04
789	Hazel	SC-8 Existing	57.4	192.22	194.17		194.2	0.001032	1.2	87.27	85.2	0.31
789	Hazel	SC-8 Proposed	57.4	192.13	194.22		194.22	0.000163	0.54	179.75	122.23	0.13
789	100	SC-8 Existing	26.8	192.22	193.81		193.83	0.000744	0.86	58.29	79.05	0.25
789	100	SC-8 Proposed	26.8	192.13	193.86		193.86	0.000082	0.33	137.35	116.73	0.09
789	50	SC-8 Existing	24.1	192.22	193.77		193.78	0.00072	0.83	54.81	78.22	0.24
789	50	SC-8 Proposed	24.1	192.13	193.81		193.81	0.000076	0.31	131.83	116.02	0.08
789	25	SC-8 Existing	21.4	192.22	193.72		193.73	0.000704	0.8	50.94	77.31	0.24
789	25	SC-8 Proposed	21.4	192.13	193.76		193.77	0.000068	0.29	126.17	115.29	0.08
789	10	SC-8 Existing	18	192.22	193.65		193.66	0.000691	0.76	45.5	75.9	0.23
789	10	SC-8 Proposed	18	192.13	193.69		193.69	0.00006	0.26	117.76	114.2	0.07
789	5	SC-8 Existing	15.5	192.22	193.58		193.59	0.00071	0.74	40.54	74.31	0.23
789	5	SC-8 Proposed	15.5	192.13	193.62		193.62	0.000056	0.24	109.84	113.16	0.07
789	2	SC-8 Existing	11.3	192.22	193.41		193.43	0.001047	0.79	28.23	69.81	0.28
789	2	SC-8 Proposed	11.3	192.13	193.44		193.44	0.000057	0.22	89.25	110.76	0.07
771	Hazel	SC-8 Existing	57.4	192.28	194.11		194.16	0.00168	1.48	68.78	72.81	0.39
771	Hazel	SC-8 Proposed	57.4	192.25	194.21		194.22	0.000259	0.65	149.08	113.76	0.16
771	100	SC-8 Existing	26.8	192.28	193.78		193.81	0.001156	1.03	45.96	66.08	0.31
771	100	SC-8 Proposed	26.8	192.25	193.86		193.86	0.000142	0.41	110.32	107.46	0.11
771	50	SC-8 Existing	24.1	192.28	193.73		193.76	0.001117	0.99	43.16	65.21	0.3
771	50	SC-8 Proposed	24.1	192.25	193.81		193.81	0.000132	0.39	105.27	106.62	0.11
771	25	SC-8 Existing	21.4	192.28	193.69		193.71	0.001092	0.95	40.02	64.38	0.3
771	25	SC-8 Proposed	21.4	192.25	193.76		193.76	0.000122	0.37	100.12	105.75	0.1
771	10	SC-8 Existing	18	192.28	193.62		193.64	0.001074	0.9	35.59	62.85	0.29
771	10	SC-8 Proposed	18	192.25	193.69		193.69	0.00011	0.34	92.46	104.41	0.1
771	5	SC-8 Existing	15.5	192.28	193.55		193.57	0.001081	0.86	31.63	59.59	0.29
771	5	SC-8 Proposed	15.5	192.25	193.62		193.62	0.000105	0.31	85.26	103.01	0.09
771	2	SC-8 Existing	11.3	192.28	193.37		193.39	0.00173	0.93	21.08	54.6	0.35
771	2	SC-8 Proposed	11.3	192.25	193.43		193.44	0.00012	0.3	66.64	99.34	0.1
751	Hazel	SC-8 Existing	57.4	192.1	194.07		194.12	0.001636	1.46	70.44	73.58	0.38
751	Hazel	SC-8 Proposed	57.4	192.25	194.2		194.21	0.000214	0.6	166.78	126.8	0.15
751	100	SC-8 Existing	26.8	192.1	193.75		193.78	0.001066	1	48.15	67.24	0.3
751	100	SC-8 Proposed	26.8	192.25	193.85		193.86	0.000118	0.39	123.57	121.35	0.1
751	50	SC-8 Existing	24.1	192.1	193.71		193.73	0.001016	0.96	45.38	65.98	0.29
751	50	SC-8 Proposed	24.1	192.25	193.81		193.81	0.000111	0.37	117.89	120.61	0.1
751	25	SC-8 Existing	21.4	192.1	193.66		193.68	0.000977	0.91	42.27	64.67	0.28
751	25	SC-8 Proposed	21.4	192.25	193.76		193.76	0.000102	0.34	112.08	119.86	0.1
751	10	SC-8 Existing	18	192.1	193.59		193.61	0.000942	0.86	37.89	63.04	0.27
751	10	SC-8 Proposed	18	192.25	193.68		193.69	0.000093	0.31	103.41	118.72	0.09
751	5	SC-8 Existing	15.5	192.1	193.53		193.55	0.00097	0.83	33.78	61.76	0.27
751	5	SC-8 Proposed	15.5	192.25	193.62		193.62	0.000089	0.3	95.21	117.63	0.09
751	2	SC-8 Existing	11.3	192.1	193.33		193.35	0.001719	0.94	21.79	55.58	0.35
751	2	SC-8 Proposed	11.3	192.25	193.43		193.43	0.000104	0.29	73.78	114.12	0.09
730	Hazel	SC-8 Existing	57.4	192.16	194.03		194.09	0.001845	1.51	64.33	63.19	0.41
730	Hazel	SC-8 Proposed	57.4	192.08	194.2		194.2	0.000064	0.33	248.67	132.27	0.08
730	100	SC-8 Existing	26.8	192.16	193.73		193.76	0.00107	0.98	46.03	58.63	0.3
730	100	SC-8 Proposed	26.8	192.08	193.85		193.85	0.000026	0.19	202.76	131.05	0.05
730	50	SC-8 Existing	24.1	192.16	193.69		193.71	0.001005	0.93	43.7	57.81	0.29
730	50	SC-8 Proposed	24.1	192.08	193.81		193.81	0.000023	0.17	196.62	130.47	0.05
730	25	SC-8 Existing	21.4	192.16	193.64		193.66	0.000955	0.88	41.03	57.14	0.28
730	25	SC-8 Proposed	21.4	192.08	193.76		193.76	0.00002	0.16	190.33	129.83	0.04
730	10	SC-8 Existing	18	192.16	193.58		193.59	0.000902	0.81	37.2	56.16	0.27
730	10	SC-8 Proposed	18	192.08	193.68		193.69	0.000017	0.14	180.92	128.87	0.04
730	5	SC-8 Existing	15.5	192.16	193.51		193.53	0.000896	0.77	33.56	54.48	0.26
730	5	SC-8 Proposed	15.5	192.08	193.62		193.62	0.000015	0.12	172.01	127.95	0.04
730	2	SC-8 Existing	11.3	192.16	193.3		193.32	0.001578	0.86	22.24	50.5	0.33
730	2	SC-8 Proposed	11.3	192.08	193.43		193.43	0.000012	0.1	148.65	124.86	0.03

694	Hazel	SC-8 Existing	57.4	192.02	193.99		194.02	0.001196	1.28	86.76	94.02	0.33
694	Hazel	SC-8 Proposed	57.4	192	194.19		194.2	0.000254	0.66	143.12	94.9	0.16
694	100	SC-8 Existing	26.8	192.02	193.71		193.72	0.000676	0.84	61.53	83.24	0.24
694	100	SC-8 Proposed	26.8	192	193.85		193.85	0.000123	0.4	110.76	93.39	0.11
694	50	SC-8 Existing	24.1	192.02	193.67		193.68	0.000632	0.8	58.32	82.08	0.23
694	50	SC-8 Proposed	24.1	192	193.8		193.8	0.000112	0.38	106.44	92.81	0.1
694	25	SC-8 Existing	21.4	192.02	193.62		193.63	0.000599	0.76	54.64	79.84	0.22
694	25	SC-8 Proposed	21.4	192	193.75		193.76	0.000101	0.35	102.01	92.22	0.09
694	10	SC-8 Existing	18	192.02	193.56		193.57	0.000567	0.71	49.36	78.03	0.21
694	10	SC-8 Proposed	18	192	193.68		193.68	0.000087	0.31	95.39	91.24	0.09
694	5	SC-8 Existing	15.5	192.02	193.49		193.5	0.00058	0.69	44.19	76.6	0.21
694	5	SC-8 Proposed	15.5	192	193.61		193.61	0.00008	0.29	89.14	90.24	0.08
694	2	SC-8 Existing	11.3	192.02	193.25		193.27	0.001174	0.82	27.09	66.54	0.29
694	2	SC-8 Proposed	11.3	192	193.43		193.43	0.000078	0.26	72.77	87.25	0.08
665	Hazel	SC-8 Existing	57.4	191.99	193.97		193.99	0.000758	1.03	112.03	125.9	0.26
665	Hazel	SC-8 Proposed	57.4	192	194.19		194.19	0.000119	0.48	202.73	125.9	0.11
665	100	SC-8 Existing	26.8	191.99	193.7		193.71	0.000456	0.7	78.28	114.07	0.2
665	100	SC-8 Proposed	26.8	192	193.85		193.85	0.000055	0.29	159.75	124.8	0.07
665	50	SC-8 Existing	24.1	191.99	193.66		193.67	0.00041	0.65	74.08	106.09	0.19
665	50	SC-8 Proposed	24.1	192	193.8		193.8	0.00005	0.27	153.98	124.09	0.07
665	25	SC-8 Existing	21.4	191.99	193.61		193.62	0.00039	0.62	69.3	104.25	0.18
665	25	SC-8 Proposed	21.4	192	193.75		193.75	0.000044	0.25	148.07	123.36	0.06
665	10	SC-8 Existing	18	191.99	193.55		193.55	0.000371	0.59	62.43	101.39	0.17
665	10	SC-8 Proposed	18	192	193.68		193.68	0.000038	0.22	139.23	122.27	0.06
665	5	SC-8 Existing	15.5	191.99	193.48		193.49	0.000382	0.57	55.67	99.04	0.17
665	5	SC-8 Proposed	15.5	192	193.61		193.61	0.000034	0.2	130.83	121.22	0.05
665	2	SC-8 Existing	11.3	191.99	193.22		193.24	0.000959	0.75	31.67	87.07	0.26
665	2	SC-8 Proposed	11.3	192	193.43		193.43	0.000032	0.18	108.76	118.41	0.05
642	Hazel	SC-8 Existing	57.4	192.02	193.97		193.98	0.00049	0.84	135.08	139.69	0.21
642	Hazel	SC-8 Proposed	57.4	192	194.19		194.19	0.000075	0.38	242.45	140.1	0.09
642	100	SC-8 Existing	26.8	192.02	193.69		193.7	0.000289	0.57	97.03	133.87	0.16
642	100	SC-8 Proposed	26.8	192	193.85		193.85	0.000032	0.22	194.72	138.53	0.05
642	50	SC-8 Existing	24.1	192.02	193.65		193.66	0.000274	0.55	92.02	133.1	0.15
642	50	SC-8 Proposed	24.1	192	193.8		193.8	0.000029	0.21	188.33	137.16	0.05
642	25	SC-8 Existing	21.4	192.02	193.61		193.61	0.000263	0.52	86.03	131.63	0.15
642	25	SC-8 Proposed	21.4	192	193.75		193.75	0.000026	0.19	181.83	136.03	0.05
642	10	SC-8 Existing	18	192.02	193.54		193.54	0.000254	0.49	77.34	129.18	0.15
642	10	SC-8 Proposed	18	192	193.68		193.68	0.000022	0.17	172.04	135.89	0.04
642	5	SC-8 Existing	15.5	192.02	193.47		193.48	0.000256	0.48	68.87	122.75	0.15
642	5	SC-8 Proposed	15.5	192	193.61		193.61	0.000019	0.15	162.68	135.76	0.04
642	2	SC-8 Existing	11.3	192.02	193.21		193.22	0.000681	0.65	38.18	105.42	0.23
642	2	SC-8 Proposed	11.3	192	193.43		193.43	0.000017	0.13	137.7	135.41	0.04
621	Hazel	SC-8 Existing	57.4	191.93	193.96		193.97	0.00037	0.75	157.18	167.36	0.19
621	Hazel	SC-8 Proposed	57.4	191.8	194.19		194.19	0.00008	0.45	261.12	181.96	0.09
621	100	SC-8 Existing	26.8	191.93	193.69		193.69	0.000202	0.49	113.48	150.88	0.13
621	100	SC-8 Proposed	26.8	191.8	193.85		193.85	0.00004	0.28	199.94	177.28	0.06
621	50	SC-8 Existing	24.1	191.93	193.65		193.65	0.000187	0.46	107.91	147.72	0.13
621	50	SC-8 Proposed	24.1	191.8	193.8		193.8	0.000037	0.27	191.75	177.07	0.06
621	25	SC-8 Existing	21.4	191.93	193.6		193.61	0.000176	0.44	101.34	144.76	0.12
621	25	SC-8 Proposed	21.4	191.8	193.75		193.75	0.000033	0.25	183.31	176.85	0.06
621	10	SC-8 Existing	18	191.93	193.54		193.54	0.000167	0.41	91.77	142.9	0.12
621	10	SC-8 Proposed	18	191.8	193.68		193.68	0.000029	0.23	170.63	175.87	0.05
621	5	SC-8 Existing	15.5	191.93	193.47		193.47	0.00017	0.4	82.23	139.34	0.12
621	5	SC-8 Proposed	15.5	191.8	193.61		193.61	0.000027	0.22	158.55	174.81	0.05
621	2	SC-8 Existing	11.3	191.93	193.2		193.2	0.000435	0.54	46.73	121.06	0.18
621	2	SC-8 Proposed	11.3	191.8	193.43		193.43	0.000029	0.21	126.6	171.97	0.05
617	Hazel	SC-8 Existing	57.4	191.95	193.96		193.97	0.000375	0.75	157.64	169.7	0.19
617	Hazel	SC-8 Proposed	57.4	191.82	194.19	193.05	194.19	0.000099	0.42	247.61	187.62	0.09
617	100	SC-8 Existing	26.8	191.95	193.68		193.69	0.000203	0.49	114	152.03	0.13
617	100	SC-8 Proposed	26.8	191.82	193.85	192.83	193.85	0.000053	0.28	184.53	182.8	0.07
617	50	SC-8 Existing	24.1	191.95	193.65		193.65	0.000191	0.47	108.36	150.93	0.13
617	50	SC-8 Proposed	24.1	191.82	193.8	192.77	193.8	0.000049	0.27	176.1	182.07	0.06
617	25	SC-8 Existing	21.4	191.95	193.6		193.61	0.000182	0.44	101.61	148.68	0.13
617	25	SC-8 Proposed	21.4	191.82	193.75	192.71	193.75	0.000045	0.25	167.44	181.32	0.06
617	10	SC-8 Existing	18	191.95	193.54		193.54	0.000172	0.42	91.83	145.36	0.12
617	10	SC-8 Proposed	18	191.82	193.68	192.63	193.68	0.000041	0.23	154.45	180.19	0.06
617	5	SC-8 Existing	15.5	191.95	193.47		193.47	0.000176	0.41	82.13	141.71	0.12
617	5	SC-8 Proposed	15.5	191.82	193.61	192.58	193.61	0.000039	0.22	142.08	179.1	0.06
617	2	SC-8 Existing	11.3	191.95	193.19		193.2	0.0005	0.57	45.21	126.24	0.2
617	2	SC-8 Proposed	11.3	191.82	193.43	192.46	193.43	0.000044	0.22	109.42	174.68	0.06

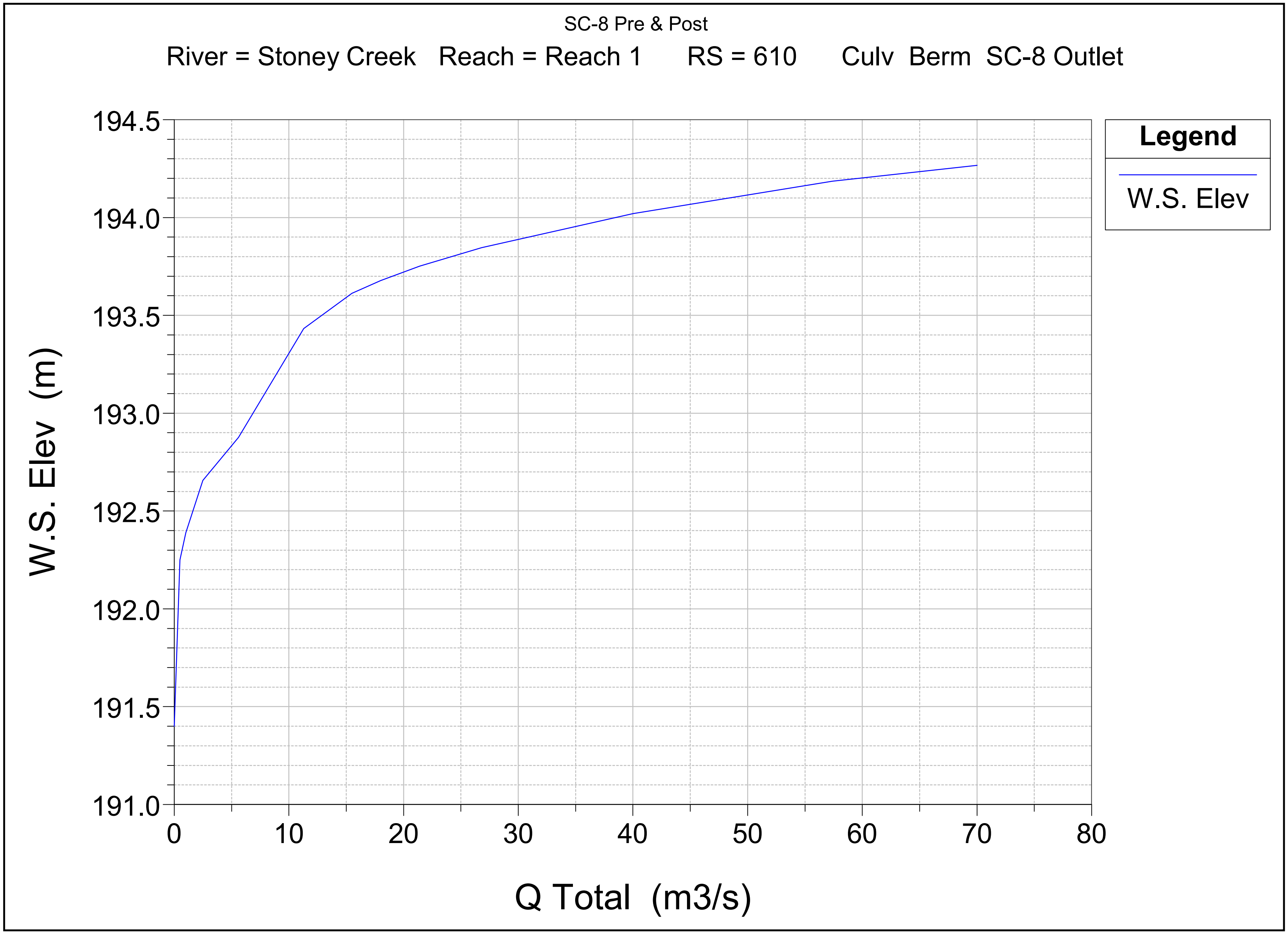
599	Hazel	SC-8 Existing	57.4	191.92	193.95		193.96	0.000314	0.68	172.11	184.09	0.17
599	Hazel	SC-8 Proposed	59.2	190.76	193.95	192.72	193.96	0.000158	0.7	207.49	195.49	0.13
599	100	SC-8 Existing	26.8	191.92	193.68		193.69	0.000173	0.45	124.52	168.76	0.12
599	100	SC-8 Proposed	27.4	190.76	193.68	192.01	193.68	0.00007	0.44	155.47	178.16	0.09
599	50	SC-8 Existing	24.1	191.92	193.65		193.65	0.000163	0.42	118.32	166.91	0.12
599	50	SC-8 Proposed	24.6	190.76	193.64	191.99	193.64	0.000063	0.41	148.97	175.21	0.08
599	25	SC-8 Existing	21.4	191.92	193.6		193.6	0.000154	0.4	110.87	164.21	0.12
599	25	SC-8 Proposed	21.7	190.76	193.59	191.91	193.6	0.000056	0.38	140.98	171.5	0.08
599	10	SC-8 Existing	18	191.92	193.53		193.54	0.000146	0.38	100.12	160.49	0.11
599	10	SC-8 Proposed	17.9	190.76	193.52	191.8	193.52	0.000048	0.34	128.09	165.26	0.07
599	5	SC-8 Existing	15.5	191.92	193.47		193.47	0.000151	0.37	89.36	157.38	0.11
599	5	SC-8 Proposed	15	190.76	193.42	191.71	193.43	0.000043	0.32	113.35	154.81	0.07
599	2	SC-8 Existing	11.3	191.92	193.19		193.19	0.000469	0.54	47.4	142.43	0.19
599	2	SC-8 Proposed	10.4	190.76	193.11	191.55	193.11	0.000058	0.33	69.71	122.02	0.08
596	Hazel	SC-8 Existing	57.4	191.92	193.95		193.96	0.000309	0.68	173.27	185.41	0.17
596	Hazel	SC-8 Proposed	59.2	190.42	193.95		193.96	0.000125	0.68	221.17	201.13	0.12
596	100	SC-8 Existing	26.8	191.92	193.68		193.69	0.000172	0.45	125.14	170.77	0.12
596	100	SC-8 Proposed	27.4	190.42	193.68		193.68	0.000052	0.41	167.68	181.47	0.08
596	50	SC-8 Existing	24.1	191.92	193.64		193.65	0.000163	0.43	118.83	169.74	0.12
596	50	SC-8 Proposed	24.6	190.42	193.64		193.64	0.000046	0.38	161.08	177.74	0.07
596	25	SC-8 Existing	21.4	191.92	193.6		193.6	0.000153	0.41	111.27	167.16	0.12
596	25	SC-8 Proposed	21.7	190.42	193.59		193.6	0.00004	0.35	152.99	173.53	0.07
596	10	SC-8 Existing	18	191.92	193.53		193.54	0.000147	0.39	100.36	162.9	0.11
596	10	SC-8 Proposed	17.9	190.42	193.52		193.52	0.000034	0.32	139.9	168.77	0.06
596	5	SC-8 Existing	15.5	191.92	193.47		193.47	0.000153	0.38	89.4	160.89	0.11
596	5	SC-8 Proposed	15	190.42	193.42		193.43	0.00003	0.29	124.77	160.59	0.06
596	2	SC-8 Existing	11.3	191.92	193.18		193.19	0.000516	0.57	45.89	146.41	0.2
596	2	SC-8 Proposed	10.4	190.42	193.11		193.11	0.000033	0.29	79.42	115.33	0.06
590	Hazel	SC-8 Existing	57.4	191.91	193.94		193.96	0.000502	0.9	127.28	130.4	0.22
590	Hazel	SC-8 Proposed	59.2	191.58	193.94		193.96	0.000366	0.89	142.56	138.87	0.2
590	100	SC-8 Existing	26.8	191.91	193.68		193.68	0.000256	0.58	94.25	121.06	0.15
590	100	SC-8 Proposed	27.4	191.58	193.67		193.68	0.000175	0.56	105.86	128.97	0.13
590	50	SC-8 Existing	24.1	191.91	193.64		193.65	0.000237	0.55	89.86	119.7	0.15
590	50	SC-8 Proposed	24.6	191.58	193.63		193.64	0.000158	0.53	101.21	126.67	0.13
590	25	SC-8 Existing	21.4	191.91	193.6		193.6	0.000221	0.52	84.59	117.88	0.14
590	25	SC-8 Proposed	21.7	191.58	193.59		193.59	0.000143	0.5	95.47	124.33	0.12
590	10	SC-8 Existing	18	191.91	193.53		193.53	0.000205	0.48	76.91	115.7	0.13
590	10	SC-8 Proposed	17.9	191.58	193.51		193.52	0.000127	0.45	86.15	120.43	0.11
590	5	SC-8 Existing	15.5	191.91	193.46		193.47	0.000203	0.46	69.17	112.92	0.13
590	5	SC-8 Proposed	15	191.58	193.42		193.43	0.000124	0.43	75.33	115.34	0.11
590	2	SC-8 Existing	11.3	191.91	193.18		193.19	0.000523	0.62	38.32	101.72	0.2
590	2	SC-8 Proposed	10.4	191.58	193.1		193.11	0.000181	0.45	43.52	70.71	0.13
576	Hazel	SC-8 Existing	59.3	191.87	193.93		193.95	0.000515	0.98	121.46	126.58	0.23
576	Hazel	SC-8 Proposed	59.2	191.54	193.93		193.95	0.000493	0.92	128.15	137.56	0.22
576	100	SC-8 Existing	27.6	191.87	193.67		193.68	0.000235	0.6	91.09	113.05	0.15
576	100	SC-8 Proposed	27.4	191.54	193.67		193.68	0.000244	0.58	93.17	122.4	0.15
576	50	SC-8 Existing	24.8	191.87	193.63		193.64	0.000214	0.56	87.05	111.31	0.14
576	50	SC-8 Proposed	24.6	191.54	193.63		193.64	0.000223	0.55	88.79	120.58	0.14
576	25	SC-8 Existing	22.05	191.87	193.59		193.6	0.000196	0.53	82.2	109.44	0.14
576	25	SC-8 Proposed	21.7	191.54	193.59		193.59	0.000204	0.51	83.37	118.29	0.14
576	10	SC-8 Existing	18.5	191.87	193.53		193.53	0.000175	0.48	75.14	107.28	0.13
576	10	SC-8 Proposed	17.9	191.54	193.51		193.52	0.000186	0.47	74.55	114.46	0.13
576	5	SC-8 Existing	16	191.87	193.46		193.46	0.000169	0.46	68.03	104.27	0.12
576	5	SC-8 Proposed	15	191.54	193.42		193.42	0.000189	0.46	64.25	109.45	0.13
576	2	SC-8 Existing	11.7	191.87	193.17		193.18	0.000333	0.55	39.78	91.58	0.17
576	2	SC-8 Proposed	10.4	191.54	193.1		193.1	0.000308	0.48	36.24	65.73	0.16
572	Hazel	SC-8 Existing	59.3	191.91	193.93	193.04	193.94	0.000404	0.87	135.2	121.47	0.2
572	Hazel	SC-8 Proposed	59.2	191.72	193.92	193.11	193.95	0.000588	1.08	124.67	143.06	0.25
572	100	SC-8 Existing	27.6	191.91	193.67	192.97	193.68	0.000177	0.53	105.27	112.67	0.13
572	100	SC-8 Proposed	27.4	191.72	193.66	192.95	193.67	0.000282	0.68	89.45	121.55	0.17
572	50	SC-8 Existing	24.8	191.91	193.64	192.91	193.64	0.00016	0.49	101.23	111.73	0.12
572	50	SC-8 Proposed	24.6	191.72	193.63	192.89	193.64	0.000258	0.64	85.14	119.68	0.16
572	25	SC-8 Existing	22.05	191.91	193.59	192.84	193.6	0.000146	0.46	96.33	110.63	0.12
572	25	SC-8 Proposed	21.7	191.72	193.58	192.83	193.59	0.000237	0.6	79.78	117.46	0.15
572	10	SC-8 Existing	18.5	191.91	193.53	192.76	193.53	0.000128	0.42	89.2	108.4	0.11
572	10	SC-8 Proposed	17.9	191.72	193.51	192.73	193.51	0.000216	0.56	71.02	113.56	0.14
572	5	SC-8 Existing	16	191.91	193.46	192.69	193.46	0.000122	0.4	81.97	106.71	0.11
572	5	SC-8 Proposed	15	191.72	193.41	192.65	193.42	0.000219	0.54	60.88	107.04	0.14
572	2	SC-8 Existing	11.7	191.91	193.17	192.58	193.18	0.000211	0.45	53.09	94.87	0.13
572	2	SC-8 Proposed	10.4	191.72	193.09	192.45	193.1	0.000305	0.54	36.21	64.22	0.16

561	Green Mountain R		Culvert									
554	Hazel	SC-8 Existing	59.3	191.78	193.48	193.28	193.57	0.002867	1.87	64.09	97.72	0.49
554	Hazel	SC-8 Proposed	59.2	191.78	193.47	193.29	193.57	0.002745	1.88	64.3	97.69	0.49
554	100	SC-8 Existing	27.6	191.78	193.26	193.07	193.31	0.00166	1.28	43.88	92.76	0.37
554	100	SC-8 Proposed	27.4	191.78	193.26	193.06	193.31	0.001556	1.28	43.92	92.6	0.36
554	50	SC-8 Existing	24.8	191.78	193.22	193.04	193.27	0.001708	1.27	39.59	90.73	0.37
554	50	SC-8 Proposed	24.6	191.78	193.21	193.03	193.26	0.001582	1.26	39.71	90.53	0.36
554	25	SC-8 Existing	22.05	191.78	193.18	193.01	193.23	0.001709	1.24	35.8	88.59	0.37
554	25	SC-8 Proposed	21.7	191.78	193.17	192.81	193.22	0.001573	1.22	35.69	88.5	0.36
554	10	SC-8 Existing	18.5	191.78	193.12	192.73	193.17	0.001715	1.2	30.52	86.58	0.36
554	10	SC-8 Proposed	17.9	191.78	193.11	192.69	193.15	0.001546	1.17	30.04	86.14	0.35
554	5	SC-8 Existing	16	191.78	193.07	192.65	193.12	0.001673	1.15	26.86	84.7	0.36
554	5	SC-8 Proposed	15	191.78	193.06	192.59	193.1	0.001458	1.1	25.94	84.44	0.34
554	2	SC-8 Existing	11.7	191.78	192.94	192.5	193.05	0.002816	1.51	7.73	75.35	0.46
554	2	SC-8 Proposed	10.4	191.78	192.91	192.42	193	0.002181	1.35	7.71	70.81	0.41
549	Hazel	SC-8 Existing	59.3	191.91	193.48		193.53	0.002399	1.51	72.74	96.42	0.45
549	Hazel	SC-8 Proposed	59.2	191.91	193.48		193.53	0.002398	1.51	72.66	96.41	0.45
549	100	SC-8 Existing	27.6	191.91	193.27		193.29	0.00137	1	52.6	91.38	0.33
549	100	SC-8 Proposed	27.4	191.91	193.27		193.29	0.001375	1	52.28	91.25	0.33
549	50	SC-8 Existing	24.8	191.91	193.22		193.25	0.00142	0.98	48.39	90.48	0.33
549	50	SC-8 Proposed	24.6	191.91	193.22		193.24	0.00142	0.98	48.14	90.42	0.33
549	25	SC-8 Existing	22.05	191.91	193.18		193.2	0.001433	0.96	44.61	89.71	0.33
549	25	SC-8 Proposed	21.7	191.91	193.18		193.2	0.001434	0.95	44.11	89.56	0.33
549	10	SC-8 Existing	18.5	191.91	193.12		193.14	0.00145	0.92	39.35	87.65	0.33
549	10	SC-8 Proposed	17.9	191.91	193.11		193.13	0.001454	0.91	38.45	87.49	0.33
549	5	SC-8 Existing	16	191.91	193.08		193.1	0.001457	0.89	35.62	86.92	0.33
549	5	SC-8 Proposed	15	191.91	193.06		193.08	0.001443	0.87	34.21	86.7	0.32
549	2	SC-8 Existing	11.7	191.91	192.97		192.99	0.001839	0.9	26.46	85	0.36
549	2	SC-8 Proposed	10.4	191.91	192.94		192.96	0.002099	0.92	23.17	84.17	0.38
496	Hazel	SC-8 Existing	59.3	191.44	193.32		193.39	0.003145	1.74	64.04	97.59	0.5
496	Hazel	SC-8 Proposed	59.2	191.44	193.32		193.39	0.003144	1.74	63.98	97.55	0.5
496	100	SC-8 Existing	27.6	191.44	193.21		193.23	0.001087	0.96	53.6	91.33	0.29
496	100	SC-8 Proposed	27.4	191.44	193.2		193.23	0.001092	0.96	53.25	91.2	0.29
496	50	SC-8 Existing	24.8	191.44	193.16		193.18	0.001101	0.94	49.34	87	0.29
496	50	SC-8 Proposed	24.6	191.44	193.16		193.18	0.001098	0.94	49.11	86.91	0.29
496	25	SC-8 Existing	22.05	191.44	193.12		193.14	0.001073	0.9	45.83	84.65	0.29
496	25	SC-8 Proposed	21.7	191.44	193.11		193.13	0.001069	0.9	45.38	84.41	0.29
496	10	SC-8 Existing	18.5	191.44	193.06		193.08	0.001037	0.85	40.97	83.31	0.28
496	10	SC-8 Proposed	17.9	191.44	193.05		193.07	0.001023	0.84	40.15	82.83	0.28
496	5	SC-8 Existing	16	191.44	193.02		193.04	0.000975	0.81	37.65	81.9	0.27
496	5	SC-8 Proposed	15	191.44	193.01		193.02	0.000933	0.78	36.49	81.4	0.26
496	2	SC-8 Existing	11.7	191.44	192.9		192.92	0.001106	0.78	28.42	75.61	0.28
496	2	SC-8 Proposed	10.4	191.44	192.86		192.87	0.001234	0.79	24.87	73.3	0.29
434	Hazel	SC-8 Existing	59.3	191.35	193.07	193.07	193.16	0.004412	1.99	75.62	527.29	0.6
434	Hazel	SC-8 Proposed	59.2	191.35	193.07	193.07	193.16	0.004397	1.99	75.62	527.29	0.6
434	100	SC-8 Existing	27.6	191.35	192.87	192.87	193.07	0.007377	2.25	21.63	440.66	0.75
434	100	SC-8 Proposed	27.4	191.35	192.87	192.87	193.06	0.007212	2.23	21.73	441.06	0.74
434	50	SC-8 Existing	24.8	191.35	192.86	192.86	193.03	0.006135	2.05	21.3	439.7	0.68
434	50	SC-8 Proposed	24.6	191.35	192.86	192.86	193.03	0.006145	2.05	21.11	439.12	0.68
434	25	SC-8 Existing	22.05	191.35	192.83	192.83	192.99	0.005961	1.97	19.12	431.76	0.67
434	25	SC-8 Proposed	21.7	191.35	192.83	192.83	192.99	0.00595	1.96	18.81	430.79	0.67
434	10	SC-8 Existing	18.5	191.35	192.78	192.78	192.94	0.005802	1.87	15.96	418.33	0.66
434	10	SC-8 Proposed	17.9	191.35	192.77	192.77	192.93	0.005907	1.87	15.17	412.68	0.66
434	5	SC-8 Existing	16	191.35	192.71	192.71	192.89	0.007085	1.95	11.53	378.71	0.71
434	5	SC-8 Proposed	15	191.35	192.64	192.64	192.86	0.009683	2.13	8.2	318.09	0.82
434	2	SC-8 Existing	11.7	191.35	192.6	192.46	192.76	0.007206	1.77	7.14	272.14	0.7
434	2	SC-8 Proposed	10.4	191.35	192.55	192.35	192.7	0.007767	1.74	6.15	216.29	0.72
284	Hazel	SC-8 Existing	59.3	191.12	192.89	192.34	192.89	0.000059	0.25	462.23	530.3	0.07
284	Hazel	SC-8 Proposed	59.2	191.12	192.89	192.34	192.89	0.000058	0.25	462.22	530.3	0.07
284	100	SC-8 Existing	27.6	191.12	192.56	192.28	192.57	0.000058	0.2	292.03	530.3	0.07
284	100	SC-8 Proposed	27.4	191.12	192.56	192.28	192.57	0.000057	0.2	291.98	530.3	0.06
284	50	SC-8 Existing	24.8	191.12	192.51	192.26	192.51	0.000068	0.21	260.43	530.3	0.07
284	50	SC-8 Proposed	24.6	191.12	192.51	192.26	192.51	0.000067	0.21	260.38	530.3	0.07
284	25	SC-8 Existing	22.05	191.12	192.47	192.24	192.48	0.000066	0.2	244.24	530.3	0.07
284	25	SC-8 Proposed	21.7	191.12	192.47	192.24	192.48	0.000064	0.2	244.17	530.3	0.07
284	10	SC-8 Existing	18.5	191.12	192.4	192.22	192.4	0.000086	0.22	202.24	530.3	0.08
284	10	SC-8 Proposed	17.9	191.12	192.4	192.22	192.4	0.000081	0.21	202.06	530.3	0.07
284	5	SC-8 Existing	16	191.12	192.35	192.21	192.35	0.000096	0.22	175.83	528.66	0.08
284	5	SC-8 Proposed	15	191.12	192.35	192.2	192.35	0.000085	0.21	175.48	528.63	0.08
284	2	SC-8 Existing	11.7	191.12	192.3	192.17	192.31	0.001378	0.88	31.14	514.51	0.31
284	2	SC-8 Proposed	10.4	191.12	192.3	192.15	192.31	0.00108	0.78	31.22	514.7	0.27

133	Hazel	SC-8 Existing	59.3	191.15	192.88	192.12	192.88	0.000029	0.18	571.28	528	0.05
133	Hazel	SC-8 Proposed	59.2	191.15	192.88	192.12	192.88	0.000029	0.18	571.28	528	0.05
133	100	SC-8 Existing	27.6	191.15	192.56	192.12	192.56	0.00002	0.12	402.46	528	0.04
133	100	SC-8 Proposed	27.4	191.15	192.56	192.12	192.56	0.00002	0.12	402.46	528	0.04
133	50	SC-8 Existing	24.8	191.15	192.5	192.12	192.5	0.000021	0.12	370.76	528	0.04
133	50	SC-8 Proposed	24.6	191.15	192.5	192.12	192.5	0.000021	0.12	370.76	528	0.04
133	25	SC-8 Existing	22.05	191.15	192.47	192.12	192.47	0.000019	0.11	354.83	528	0.04
133	25	SC-8 Proposed	21.7	191.15	192.47	192.12	192.47	0.000019	0.11	354.83	528	0.04
133	10	SC-8 Existing	18.5	191.15	192.39	192.12	192.39	0.00002	0.11	312.66	528	0.04
133	10	SC-8 Proposed	17.9	191.15	192.39	192.12	192.39	0.000019	0.11	312.66	528	0.04
133	5	SC-8 Existing	16	191.15	192.34	192.12	192.34	0.00002	0.1	286.27	528	0.04
133	5	SC-8 Proposed	15	191.15	192.34	192.12	192.34	0.000018	0.1	286.27	528	0.04
133	2	SC-8 Existing	11.7	191.15	192.3	192.12	192.3	0.000014	0.08	265.19	528	0.03
133	2	SC-8 Proposed	10.4	191.15	192.3	192.12	192.3	0.000011	0.07	265.19	528	0.03



water's edge
ENVIRONMENTAL SOLUTIONS TEAM LTD.


SC-8 Pre & Post
River = Stoney Creek Reach = Reach 1 RS = 610 Culv Berm SC-8 Outlet
Legend
W.S. Elev
W.S. Elev (m)
194.5
194.0
193.5
193.0
192.5
192.0
191.5
191.0
0
10
20
30
40
50
60
70
80
Q Total (m3/s)

water's edge
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Fluvial Geomorphology

Natural Channel Design

Stream Restoration

Monitoring

Erosion Assessment

Sediment Transport

Visit our Website at www.watersedge-est.ca

APPENDIX G:

Design Plan Package